REVISED DRAFT
Subject to revision

Remedial Investigation Addendum

West Lake Landfill
Operable Unit 1

Prepared For:

West Lake OU-1 Respondents Group

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EXECUTIVE SUMMARY

This revised draft RI Addendum is being submitted in accordance with the EPA's December 9, 2015 Statement of Work for Remedial Investigation/Final Feasibility Study, as further set forth in the approved Abbreviated Work Plan for Remedial Investigation Addendum and Final Feasibility Study for West Lake Landfill Operable Unit-1, dated May 6, 2016 (final revision). This revised draft RI Addendum also addresses comments received from EPA on March 14, 2017, and April 25, 2017, to the draft RI Addendum submitted to EPA on July 29, 2017.

The RI Addendum provides updates to the nature and extent of radiologically-impacted material (RIM) at the Site and the contaminant extent, fate and transport since the first RI was finalized in 2000, including updated discussions of the nature and extent of occurrences of RIM within OU-1 and radionuclide and chemical extent, fate and transport, and the current Conceptual Site Model (CSM). An updated Baseline Risk Assessment is also being completed and will be submitted contemporaneously with this revised draft RI Addendum.

The West Lake Landfill (the Site) is an inactive waste disposal facility near St. Louis, Missouri, that accepted wastes for on-site disposal from approximately the 1950s through 2005. Operable Unit-1 (OU-1) at the Site addresses two main areas (Areas 1 and 2), as well as property adjacent to Area 2 - the Buffer Zone and Lot 2A2 - where radionuclides have been identified within soil and solid waste materials previously disposed at the Site. Other portions of the Site that contain solid wastes are included within OU-2. Pursuant to EPA's direction, the RIA presents results of groundwater sampling, but analysis of groundwater will not be addressed in this report but instead through future investigation reports for the proposed Operable Unit 3.

The Site has been the subject of extensive investigation, monitoring and sampling activities over the course of forty (40) years, and has been studied by local, state and federal agencies including the EPA, the United States Army Corps of Engineers (USACE), United States Geologic Survey (USGS), Nuclear Regulatory Commission (NRC), Agency for Toxic Substance and Disease Registry (ATSDR), Missouri Department of Natural Resources (MDNR), Missouri Department of Health and Senior Services (MDHSS), and the St. Louis County Department of Health, among others. This extensive sampling and analysis of the Site has included four overland radiation surveys; 314 soil borings, hand augers and GCPT soundings; analysis of approximately 500 soil/waste samples; and sampling and analysis of other media, including radon, air/dust, surface water/ stormwater, sediment, and groundwater.

The RI Addendum presents a Conceptual Site Model addressing:

- Site Description and Setting;
- History of the Landfills;
- Site Geology and Hydrogeology;
- Nature and Extent of Radiologically Impacted Materials; and
- Potential Migration Pathways

- Potential Receptors and Exposure Routes; and
- Summary of Potential Risks.

As a result of this extensive study, sampling, and characterization, knowledge of the nature and extent of RIM at the Site has been greatly enhanced over the 30-plus years since the first investigations were performed by the NRC. The RIM at the Site (defined by EPA as any material [soil/MSW] that contains combined Ra-226 plus Ra-228 or combined Th-230 plus Th-232 at levels greater than 5 pCi/g above background (EPA, 2010b)) is irregularly interspersed within the overall larger matrix of MSW. The distribution of the RIM within the landfilled areas has been impacted by both natural and anthropogenic processes, such as the initial placement and the subsequent 40-plus years of decomposition, consolidation and differential settlement of the MSW over time. Consequently, the RIM is now interspersed within separate areas and intervals of MSW such that RIM cannot be easily distinguished from the surrounding MSW, landfill cover, and native soil matrix within which it is found. RIM is not present as a laterally continuous layer. RIM has been identified in MSW at the surface or in the subsurface beneath approximately 8.2 acres of Area 1 and an estimated 24.9 acres of Area 2. See Figures 6-12 and 6-13.

In addition, the potential migration pathways (air, stormwater, and sediment) have been extensively studied, and the data collected to date shows that results are generally below regulatory standards. For example, perimeter monitoring of radon levels in the ambient air around the perimeters of Areas 1 and 2 indicate that radon levels at the Site perimeter were less than the standard of 0.5 pCi/L above background concentrations, and stormwater monitoring performed in 2015-2017 from Areas 1 and 2 indicated that levels of radium and uranium were below drinking water standards.

The results of the extensive investigations described in this RI Addendum demonstrate that there are no current exposures to radionuclides at or from the Site by on-site or off-site workers or the general public above the EPA's acceptable risk range. The Final Feasibility Study for the Site will identify and evaluate remedial alternatives to address potential exposures that may occur in the future.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

List of Tables

List of Tables (cont.)

List of Figures

List of Figures (cont.)

List of Figures (cont.)

APPENDICES

APPENDICES (cont.)

APPENDICES (cont.)

List of Acronyms

AEC	Atomic Energy Commission
AMSL	above mean sea level
AOA	Air Operations Area
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirements
ASAOC	Administrative Settlement Agreement and Order on Consent
ASAP	Amended Sampling and Analysis Plan
ASPECT	Airborne Spectral Photometric Environmental Collection Technology
ATSDR	Agency for Toxic Substances and Disease Registry
Auxier	Auxier & Associates, Inc.
bcy	bank cubic yard
bgs	below ground surface
Bi	Bismuth
BMAC	Bridgeton Municipal Athletic Complex
BOD	Biological Oxygen Demand
BRA	Baseline Risk Assessment
BTEX	Benzene, toluene, ethylbenzene and xylenes
BTV	Background Threshold Values
C&D	Construction and Demolition
CBRN	Chemical Biological Radiological and Nuclear
CEC	Cation Exchange Capacity
CERCLA	Comprehensive Environmental Recovery, Compensation, & Liability Act
cf	cubic feet
cfm	cubic feet per minute
CFR	Code of Federal Regulations
cm	centimeter
cm/sec	centimeter per second
CMAT	Consequence Management Advisory Team
COCs	Chemicals of concern
COD	Chemical Oxygen Demand
CoPC	Constituent of Potential Concern
cpm	counts per minute
cps	counts per second
CPT	Cone Penetration Test
CSR	Code of State Regulations
CSU	Combined Standard Uncertainty
CSM	Conceptual Site Model
cy, or cu yd	cubic yard
DAF	Dilution-Attenuation Factor
DCGL	Derived concentration guideline
DOD	Department of Defense
DOE	United States Department of Energy
DOT	United States Department of Transportation
DQO	data quality objective

List of Acronyms (cont.)

ea	each
EDE	Effective Dose Equivalent
EMPA	Electron Microprobe Analysis
EMSI	Engineering Management Support, Inc.
EPA	United States Environmental Protection Agency
EPC	Exposure point concentration
ERA	Ecological Risk Assessment
EVOH	ethylene vinyl alcohol
F&T	Fate & Transport
FAA	Federal Aviation Administration
FEI	Feezor Engineering, Inc.
FS	Feasibility Study
FFS	Final Feasibility Study
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
Fm.	Formation
ft	feet
FUSRAP	Formerly Utilized Sites Remedial Action Program
GCPT	Gamma Cone Penetrometer
G-M	Geiger-Mueller
GPS	Global Positioning System
gm, or g	gram
gpd	gallons per day
gpm	gallons per minute
HHRA	Human Health Risk Assessment
HISS	Hazelwood Interim Storage Site
hr	hour
IB	Isolation Barrier
ICs	Institutional Controls
IG	Intrinsic Germanium
IRIS	Integrated Risk Information System
K	Potassium
kg	kilogram
L	liter
LAACCs	Large Area Activated Charcoal Canisters
lbs	pounds
LBSR	Leached Barium Sulfate Residues
lcy	loose cubic yard
LCS	Leachate Collection System
LEL	lower explosive limit
LoMR	Letter of Map Revision
LUST	Leaking underground storage tank
MARLAP	Multi-Agency Radiological Laboratory Analytical Procedures Manual
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual

List of Acronyms (cont.)

MBT	MBT Laboratory (Rancho Cordova, CA)
MCA	Multichannel analyzer
MCL	Maximum contaminant level
MCL	Materials and Chemistry Laboratory, Inc.
MCLG	Maximum contaminant level goal
MDA	Minimum detectable activity
MDH	Missouri Department of Health
MDHSS	Missouri Department of Health and Senior Services
MDNR	Missouri Department of Natural Resources
MDOC	Missouri Department of Conservation
MECA	Missouri Environmental Covenants Act
m	meter
m^3	cubic meter
mCi/cc	microCuries per cubic centimeter
mg	milligram
min	minute
ml	milliliter
mm	millimeter
MMP	Material Management Plan
mo	month
MOU	Memorandum of Understanding
mrem	millirem
mrem/yr	millirem per year
MSD	Metropolitan Sewer District
msf	thousand square feet
MSW	Municipal solid waste
MSWLF	Municipal Solid Waste Landfill
Na	Sodium
NaI	Sodium-iodide
NAS	National Academy of Sciences
NCC	Non-combustible cover
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NESHAPs	National Emissions Standards for Hazardous Air Pollutants
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NORM	Naturally occurring radioactive material
NPL	National Priorities List
NTU	Nephelometric Turbidity Unit
OEM	Office of Emergency Management
OLEM	Office of Land and Emergency Management
ORP	oxidation-reduction potential

List of Acronyms (cont.)

OSL	Optically Stimulated Luminescent
OSTRI	Office of Superfund Technology Research and Innovation
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
Pa	Protactinium
PAH	Poly-nuclear aromatic hydrocarbon
Pb	Lead
PCBs	Poly-chlorinated biphenyls
pCi	picoCurie
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter
PID	Photo Ionization Detector
Po	Polonium
Ppb	Parts per billion
ppm	Parts per million
PRG	Preliminary Remediation Goals
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
R	Roentgen
RA	Remedial Action
RD	Remedial design
Ra	Radium
RACM	Regulated Asbestos Containing Materials
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RDWP	Remedial Design Work Plan
rem	Roentgen equivalent in man
RESRAD	Residual Radioactive materials
RGGS	FUSRAP Remediation Goals
RI	Remedial Investigation
RIM	Radiologically Impacted Material
RMC	Radiation Management Corporation
RML	radioactive material license
ROD	Record of Decision
RSMo	Revised Statutes of Missouri
SAP	Sampling and Analysis Plan
SBT	Soil Behavior Types
SBLT	Sequential batch leaching tests
SCM	Site Conceptual Model
SCS	Soil Conservation Service
SCSR	Site Characterization Summary Report
sec, or s	second

List of Acronyms (cont.)

sf or sq ft	square feet
SFS	Supplemental Feasibility Study
SLAPS	St. Louis Airport Site
SLDS	St. Louis Downtown Site
SPCS	State Plan Coordinate System
SPLP	Synthetic Precipitation Leaching Procedure
SSE	Subsurface Event
SSPA	S.S. Papadopulos & Associates, Inc.
SSR	Subsurface Chemical Reaction
ST	Short Term
START	Superfund Technical Assessment and Response Team
STLAA	St. Louis Airport Authority
SOW	Statement of Work
SVOCs	Semi-Volatile Organic Compounds
SWMP	Solid Waste Management Program
TAL	Target Analyte List
TBC	To Be Considered
TCLP	Toxicity Characteristics Leaching Procedure
TDS	Total Dissolved Solids
Th	Thorium
Tl	Thallium
TLD	Thermoluminescent Dosimeter
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TS	Transfer Station
TSS	Total Suspended Solids
U	Uranium
UAO	Unilateral Administrative Order
UCL	Upper Confidence Limit
µg	microgram
UMTRCA	Uranium Mill Tailings Radiation Control Act
µR	microRoentgen
USACOE	United States Army Corps of Engineers
U.S.C.	United States Code
USCS	Unified Soil Classification System
USFS	U.S. Fish & Wildlife Service
USGS	United States Geological Survey
UST	Underground storage tank
UTM	Universal Transverse Mercator
VFA	Volatile Fatty Acid
VOCs	Volatile Organic Compounds
XRD	X-Ray Diffraction
yr	Year
WIMS	Well Information Management System

List of Acronyms (cont.)

WL	Work Level

1. INTRODUCTION

This Remedial Investigation Addendum (RI Addendum) report has been prepared by Engineering Management Support Inc. (EMSI) on behalf of Cotter Corporation (N.S.L.), Bridgeton Landfill, LLC (formerly known as Laidlaw Waste Systems [Bridgeton], Inc.), Rock Road Industries, Inc., and the United States Department of Energy (the "OU-1 Respondents" or more simply the "Respondents"). This RI Addendum updates the discussions of the Site conditions, nature and extent of radionuclide and chemical occurrences, and other evaluations presented in the original Remedial Investigation report prepared in 2000 (the 2000 RI report) (EMSI, 2000). This RI Addendum has been prepared at the request of the U.S. Environmental Protection Agency (EPA) as part of the Remedial Investigation/Feasibility Study (RI/FS) for Operable Unit 1 (OU-1) at the West Lake Landfill Superfund Site (the Site) located in Bridgeton, Missouri, in accordance with EPA's December 9, 2015 letter and Statement of Work (EPA, 2015a).

The areas of the West Lake Landfill where radiologically impacted materials (RIM) are present have been designated by EPA as OU-1. OU-1 comprises Radiological Area 1 and Radiological Area 2 (or more simply as Area 1 and Area 2). In addition to RIM, these two areas also contain municipal solid waste (MSW), industrial waste and construction and demolition (C&D) debris which may contain other non-radionuclide constituents such as trace metals and volatile organic compounds (VOCs) typically found in MSW landfills. OU-1 also includes a 1.78-acre parcel of land adjacent to Area 2 known as the Buffer Zone and an adjacent parcel (Lot 2A2) that is part of the adjacent Crossroads Industrial Park. Although the Buffer Zone and Lot 2A2 were never used for landfilling or waste disposal, radionuclides have been documented to be present in soil on these parcels of land as well. Investigations and evaluations of non-radioactive constituents in other parts of the Site outside of Areas 1 and 2 are being performed by Bridgeton Landfill, LLC under a separate operable unit (OU-2) RI/FS.

The RI Addendum for OU-1 has been prepared in accordance with the requirements of the 1993 Administrative Order on Consent (AOC) (as amended) between the EPA and the OU-1 Respondents, EPA's Statement of Work for the Remedial Investigation Addendum and Final Feasibility Study for West Lake Landfill Operable Unit-1 dated December 9, 2015 (2015 SOW) (EPA, 2015a), the EPA-approved Abbreviated Work Plan for Remedial Investigation Addendum and Final Feasibility Study (RI/FFS Work Plan) for West Lake Landfill Operable Unit-1 (EMSI, 2016a), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP or National Contingency Plan), 400 C.F.R. Part 300.

1.1 Purpose and Scope of the RI Addendum

The purpose of the RI Addendum is to update the data and results of the various Site characterization activities provided in the 2000 RI report and to incorporate the results of the various investigations conducted since the 2000 RI report was completed. The RI Addendum

has been prepared using the same outline and framework used to complete the 2000 RI report as required by Section 4.4.3 of the SOW of the 1993 AOC, which states that the RI report should summarize the results of the field activities conducted to characterize the following:

- Conditions at the Site;
- The sources of contaminants;
- The nature and extent of contaminants and associated impacts; and
- The fate and transport of the contaminants.

Each of these requirements is addressed in later sections of this report.

The 2015 SOW, as further detailed in the RI/FFS Work Plan, states that the RI Addendum shall reflect all new information and data collected at OU-1 since 2008, including an updated conceptual site model. Therefore, this RI Addendum addresses all media at the Site including soil/waste, rainwater/stormwater runoff, surface water, sediment, air and groundwater. EPA has indicated that additional evaluations of groundwater will be performed in the future as part of a separate operable unit, OU-3. Therefore, while the groundwater component of this RI Addendum updates the data and discussions performed in the 2000 RI, Respondents anticipate that additional evaluations of groundwater conditions will be performed as part of the OU-3 investigations.

1.2 Report Organization

The remainder of this report is organized as follows:

- Section 2 presents a summary of various investigations and evaluations that have been performed as part of the assessment of OU-1 Areas 1 and 2 or performed for other purposes that may otherwise contain information potentially relevant to OU-1;
- Section 3 presents a general description of the Site, as well as its location and the characteristics of surface features;
- Section 4 describes the various investigations performed as part of the OU-1 Remedial Investigation;
- Section 5 describes the physical characteristics of the Site;
- Section 6 describes the nature, occurrence and distribution of the sources of contamination associated with OU-1, including affected media, location, types of

contamination, physical state of contaminants, contaminant concentrations and quantity of contaminants and affected media;

- Section 7 presents an evaluation of radionuclide occurrences in environmental media and discusses the fate and persistence of radionuclides;

- Section 8 presents a summary of the non-radiological contaminants detected in Areas 1 and 2 and the various environmental media in the vicinity of these areas;

- Section 9 presents a revised conceptual site model of the site conditions, RIM occurrences, radionuclides in environmental media, potential pathways through which radionuclides could migrate from Areas 1 and 2, and the potential receptors that potentially could be exposed to radionuclides; and

- Section 10 lists the various references used in completing this RI Addendum.

The appendices that have been prepared as part of the RI Addendum include the following:

Appendix A: Surface Gamma Scans of Areas 1 and 2

Appendix B: Soil Boring Logs

Appendix C: Downhole Gamma Logs and Core Scans

Appendix D: Soil Sample Analytical Results Summary Tables

Appendix E: Groundwater Monitoring Well Data

Appendix F: Groundwater Sampling Results Summary Tables

Appendix G: Stormwater and Sediment Sampling Results Summary Tables

Appendix H: Air Monitoring and Radon Flux Sampling Results Summary Tables

Appendix I: Vegetation Sampling Results Summary Tables

Appendix J: Well Hydrographs

Appendix K: Water Level and Potentiometric Surface Maps

Appendix L: Borehole Summary Sheets

Appendix M: Cross-Sections

Appendix N: Groundwater Quality Summary Figures and Tables

Appendix O: Historical Aerial Photographs

Appendix P: Three-Dimensional Extent of RIM

An updated Baseline Risk Assessment is being prepared separately by Auxier & Associates, Inc., for submittal concurrently with this RIA. A report discussing the results of laboratory testing and modeling of potential leaching of radionuclides is also being prepared by S.S. Papadopulos & Associates and is expected to be submitted separately shortly after submittal of this RIA.

2. SUMMARY OF INVESTIGATIONS

Numerous reports on the conditions at the Site have previously been prepared. These include reports prepared prior to EPA's issuance of the Record of Decision (ROD) for OU-1 in 2008 (EPA, 2008a) and reports that have been prepared subsequent to the 2008 ROD. A description of the various reports prepared for OU-1 or potentially related to OU-1 is presented in this section and includes the following:

Pre-ROD:

- Pre-RI reports;
- OU-1 RI/FS Work Plan and related documents;
- OU-1 RI/FS Reports;
- Work plans and RI/FS reports prepared for OU-2;
- Reports prepared as part of the landfill development and operations; and
- Investigative reports associated with the Buffer Zone and Crossroads properties (formerly referred to as the Ford property) located immediately to the west of Area 2.

Post-ROD:

- Supplemental Feasibility Study (SFS) and additional SFS evaluation reports;
- Comprehensive Groundwater Sampling Event reports;
- Phase 1 investigation reports;
- Perimeter air monitoring reports;
- Reports prepared pursuant to a Unilateral Administrative Order (UAO) for Removal Action (Surface Fire Prevention UAO);
- Work Plan for construction of a non-combustible cover pursuant to the UAO for removal action;
- Stormwater monitoring plans;
- Work plan for additional investigations and testing by Cotter Corporation;

- Bridgeton Landfill reports; and
- Reports prepared by or on behalf of EPA related to the Site.

Other Reports

- Reports prepared by EPA for off-site areas;
- Reports prepared by MDNR; and
- Haul route investigation reports.

The specific reports that have previously been prepared and that were considered during the preparation of this RI Addendum are listed below.

2.1 Pre-ROD Investigations and Reports

2.1.1 Pre-RI Reports

The following reports were prepared prior to the initiation of the RI/FS activities for OU-1:

- IE Investigation Report No. 76-01 (U.S. Nuclear Regulatory Commission Office of Inspection and Enforcement Region III, 1976);
- Report of Site Visit - West Lake Landfill, St. Louis County, Missouri (Radiation Management Corporation, 1981);
- Radiological Survey of the West Lake Landfill, St. Louis County, Missouri (Radiation Management Corporation, 1982);
- Engineering Evaluation of Options for Disposition of Radioactively Contaminated Residues Presently in the West Lake Landfill, St. Louis County, Missouri (Banerji et al., University of Missouri – Columbia, 1984);
- Radioactive Material in the West Lake Landfill, Summary Report (U.S. Nuclear Regulatory Commission, 1988);
- Letter from Rodney Bloese to Joseph Homsy re: West Lake Landfill CERCLA Site dated December 12, 1989, (Foth & Van Dyke, 1989) (contains information on local water wells);

- Aerial Photographic Analysis of the Westlake Landfill Site, Bridgeton, Missouri (EPA, 1989);

- Aerial Photographic Analysis of the Westlake Landfill Site, Bridgeton, Missouri (EPA, 1991); and

- Preliminary Health Assessment, West Lake Landfill, Bridgeton, St. Louis County, Missouri (Missouri Department of Health, 1991).

2.1.2 Operable Unit-1 RI/FS Work Plans

The following planning documents were previously prepared as part of the RI/FS for OU-1:

- RI/FS Work Plan for the West Lake Site, Bridgeton, Missouri, August 15, 1994 (McLaren/Hart, 1994);

- Amended Sampling and Analysis Plan (ASAP), West Lake Landfill Operable Unit 1, February 29, 1997 (EMSI, 1997a);

- Responses to EPA's Comments on the Amended Sampling and Analysis Plan (ASAP) for Operable Unit 1, West Lake Landfill (EMSI, 1997b); and

- Draft Investigation Derived Waste Management and Interim Remedial Measures Plan, West Lake Landfill Operable Unit 1, September 1997 (EMSI, 1997c).

The RI/FS Work Plan was approved by EPA in September 1994 (EPA, 1994). The ASAP, although not formally approved, was submitted to EPA for review and comment (EPA, 1997a and 1997b) and appropriate responses or modifications to the draft ASAP were provided to EPA (EMSI, 1997b). EPA subsequently provided verbal authorization to proceed with the ASAP activities. EPA provided comments on the Draft Investigation Derived Waste Management and Interim Remedial Measures Plan; responses to those comments and necessary modifications to the draft plan were prepared and approved by EPA.

In addition, minor modifications to some of these plans were made and approved by EPA and/or its oversight contractor during the course of the field investigations. Many of these changes were documented in letters prepared by McLaren/Hart. Some of these changes were formally approved in letters from EPA. Where appropriate, these specific letters are referenced as part of the discussions of the various investigative activities contained in Section 4 of this RI Addendum.

On December 9, 2015, EPA issued an addendum to the OU-1 AOC and an associated Scope of Work (SOW) requiring, among other things, preparation of an RI Addendum, updated Baseline Risk Assessment (BRA) and Final Feasibility Study (FFS). In accordance with this addendum

and SOW, an Abbreviated Work Plan for Remedial Investigation Addendum and Final Feasibility Study (Abbreviated Work Plan) was prepared (EMSI, 2016a) and subsequently approved by EPA on May 18, 2016 (EPA, 2016b). EPA subsequently provided further direction and clarification relative to some of the tasks described in the SOW and the Abbreviated Work Plan (EPA, 2016a).

2.1.3 Operable Unit-1 RI/FS Reports

The following investigative documents were previously prepared as part of the RI/FS for OU-1:

- Overland Gamma Survey Report, West Lake Landfill Radiological Areas 1 & 2, April 30, 1996 (McLaren/Hart, 1996a);
- Site Reconnaissance Report, West Lake Landfill Radiological Areas 1 & 2, May 16, 1996 (McLaren/Hart, 1996b);
- Threatened or Endangered Species Assessment Report, West Lake Landfill Radiological Areas 1 & 2, May 17, 1996 (McLaren/Hart, 1996c);
- Radon Gas, Landfill Gas and Fugitive Dust Report, West Lake Landfill Areas 1 & 2, November 22, 1996 (McLaren/Hart, 1996d);
- Rainwater Runoff, Erosional Sediment, Surface Water, and Leachate Sampling Data Report, West Lake Landfill Areas 1 & 2, November 22, 1996 (McLaren/Hart, 1996e);
- Split Soil and Groundwater Sampling Data Summary Report, West Lake Landfill Areas 1 & 2, November 22, 1996 (McLaren/Hart, 1996f);
- Groundwater Conditions Report, West Lake Landfill Areas 1 & 2, November 26, 1996 (McLaren/Hart, 1996g);
- Soil Boring/Surface Soil Investigation Report, West Lake Landfill Areas 1 & 2, November 26, 1996 (McLaren/Hart, 1996h);
- Interim Investigation Results Technical Memorandum, West Lake Landfill Operable Unit 1, January 28, 1997 (EMSI, 1997d);
- Site Characterization Summary Report, West Lake Landfill Operable Unit 1, August 1997 (EMSI, 1997e);
- Remedial Investigation Report (EMSI, 2000);

- Baseline Risk Assessment (Auxier & Associates, Inc. [Auxier], 2000); and
- Feasibility Study Report, West Lake Landfill Operable Unit 1 (EMSI, 2006a).

2.1.4 Operable Unit-2 Plans and Reports

The following investigative documents were previously prepared on behalf of Laidlaw Waste Systems, Inc. or Allied Waste Industries (Bridgeton), Inc. as part of the RI/FS for OU-2:

- Remedial Investigation/Feasibility Study Work Plan (Golder Associates, 1995a);
- Draft Hydrogeological Characterization Report for the Bridgeton Active Sanitary Landfill, Bridgeton, Missouri, September 1995 (Golder Associates, 1995b);
- Physical Characterization Technical Memorandum for the West Lake Landfill Operable Unit 2, Bridgeton, Missouri, November 1996 (Golder Associates, 1996a);
- West Lake Landfill, Operable Unit 2 RI/FS, Site Characterization Summary Report, December 1997 (Water Management Consultants, 1997);
- Remedial Investigation Report for OU-2 (Herst & Associates, 2005);
- West Lake Landfill Operable Unit 2 Baseline Risk Assessment (Veritox, Inc., 2005); and
- Feasibility Study Report West Lake Landfill Operable Unit 2, Bridgeton, Missouri (Herst & Associates, 2006).

2.1.5 Bridgeton Landfill Reports

The following reports were prepared on behalf of Laidlaw Waste Systems, Inc. in support of the landfill development and operations at the Bridgeton Landfill:

- Environmental Investigation and Health Impact Assessment, Bridgeton Sanitary Landfill, October 1993 (Golder Associates, 1993); and
- Radiological Survey of West Lake Landfill Bridgeton, Missouri, June 4, 1996 (Golder Associates, 1996b).

2.1.6 Former Ford Motor Credit Property Reports

In addition to the studies discussed in the OU-1 investigative reports regarding the property formerly owned by Ford Financial Services Group (Ford), which is now the Buffer Zone and Crossroads property, the following reports were prepared specifically for the Ford property located to the west of and adjacent to Area 2:

- Phase II Investigation Report (Dames & Moore, 1990); and
- Phase III Radiological Site Assessment, Earth City Industrial Park (Dames & Moore, 1991).

2.2 Post ROD Investigations and Evaluations

Upon completion of the OU-1 and OU-2 RI and FS reports, EPA issued Proposed Plans for the West Lake Landfill OU-1 and OU-2 (EPA, 2006a and 2006b). EPA held three public meetings and solicited and accepted public comments on the proposed plans over a period of approximately two years and subsequently prepared and issued RODs for OU-1 (EPA, 2008a) and OU-2 (EPA, 2008b) in 2008.

After issuance of the 2008 RODs, additional investigations and evaluations of conditions associated with OU-1 were performed by the OU-1 Respondents in response to specific requests by EPA (EPA, 2015a, 2015b, 2015c, 2013a, 2013b, 2012, and 2010) and administrative orders from EPA (2015d). Pursuant to a Unilateral Administrative Order for Removal Action (UAO) for a Surface Fire Prevention from EPA (EPA, 2015d), during the first half of 2016 the OU-1 Respondents also removed vegetation and placed a non-combustible cover (NCC) over those portions of Areas 1 and 2 where RIM is present at the ground surface. Bridgeton Landfill, LLC individually has also performed additional investigations and evaluations in response to administrative orders from EPA (EPA, 2016 and 2014), pursuant to orders from the Missouri Department of Natural Resources (MDNR), and as part of normal, routine closure and care of the inactive Bridgeton Landfill.

2.2.1 Post ROD OU-1 Reports and Evaluations

The following OU-1 RI/FS investigations and evaluations were completed after the 2008 ROD for OU-1:

- Remedial Design Work Plan (EMSI, 2008);
- Vegetative Sampling Results Summary in Support of Health and Safety Plan for Vegetation Clearing and Grubbing, West Lake Landfill Operable Unit 1, Bridgeton Missouri (TA Woodford and Associates, LLC, 2009);

- Supplemental Feasibility Study Work Plan (EMSI, 2010);
- Supplemental Feasibility Study (EMSI, 2011);
- Sampling and Analysis Plan – Additional Groundwater Monitoring, West Lake Landfill Operable Unit 1, Bridgeton, Missouri (EMSI, 2012a);
- Work Plan Partial Excavation Alternative (EMSI, 2012b);
- Groundwater Monitoring Report – 2012 Additional Groundwater Sampling Event, West Lake Landfill Operable Unit-1 (EMSI, 2012c);
- Work Plan – Evaluation of the Potential Impacts to the ROD-Selected Remedy from a Possible Subsurface Smoldering Event (EMSI, 2013a);
- Work Plan, Evaluation of Potential Impacts of a Tornado on the ROD-Selected Remedy for the West Lake Landfill OU-1 (EMSI, 2013b);
- Groundwater Monitoring Report – April 2013 Additional Groundwater Sampling Event, West Lake Landfill Operable Unit-1 (EMSI, 2013c);
- Evaluation of Possible Effects of a Tornado on the Integrity of the Record of Decision – Selected Remedy for Operable Unit-1 at the West Lake Landfill (EMSI, 2013d)[1];
- Work Plan Additional Present Value Cost Estimates (ESMI, 2013e);
- Work Plan Evaluation of the Use of Apatite/Phosphate Treatment Technologies (EMSI, 2013f);
- Groundwater Monitoring Report – July 2013 Additional Groundwater Sampling Event, West Lake Landfill Operable Unit-1 (EMSI, 2013g);
- Revised Work Plan – Evaluation of Alternative Landfill Cover Design, West Lake Landfill Operable Unit 1, Bridgeton, Missouri (EMSI, 2014a)[2];
- Groundwater Monitoring Report – October 2013 Additional Groundwater Sampling Event, West Lake Landfill Operable Unit-1 (EMSI, 2014b);

[1] Submitted to EPA on October 11, 2013 but not yet approved or commented on as of the date of this RI Addendum.
[2] Submitted to EPA on January 27, 2015 but not yet approved or commented on as of the date of this RI Addendum.

- Evaluation of Possible Impacts of a Potential Subsurface Smoldering Event on the Record of Decision – Selected Remedy for Operable Unit-1 at the West Lake Landfill (EMSI, 2014c)[3];

- Air Monitoring, Sampling and QA/QC Plan, West Lake Landfill Superfund Site Operable Unit 1 (Auxier, 2014);

- Memorandum: Additional Present Value Cost Estimates (EMSI, 2014d)[4];

- Estimated Volumes for Partial Excavation Options Identified by EPA (EMSI and FEI, 2014);

- Evaluation of Alternative Landfill Cover Designs, West Lake Landfill Operable Unit-1 (EMSI, 2015a);

- Phase 1D Investigation – Additional Characterization of Extent of Radiologically-Impacted Material in Area 1: Revised Addendum to Phase 1 Work Plans for Isolation Barrier Investigation, West Lake Landfill Operable Unit-1, Bridgeton, Missouri (EMSI, 2015b);

- Revised Work Plan Partial Excavation Alternative, West Lake Landfill Operable Unit-1 (EMSI, 2015c);

- Revised Work Plan Alternative Area 2 Excavation Depths and Volumes, West Lake Landfill Operable Unit-1 (EMSI, 2015d)[5];

- Scope of Work and Schedule Fate and Transport (F&T) Modeling, West Lake Landfill Operable Unit (OU) 1 (S.S. Papadopulos & Associates, Inc. [SSPA], 2015a)[6];

- Work Plan for Additional Characterization of Extent of Radiologically-Impacted Material in Areas 1 and 2, West Lake Landfill Operable Unit-1, Bridgeton, Missouri (EMSI, 2015e);

- Quality Assurance Project Plan Addendum, Radiologically Impacted Material in Areas 1 and 2, West Lake Landfill Operable Unit-1, Bridgeton, Missouri (SSPA, 2015b);

[3] Submitted to EPA on January 14, 2014 and comments provided by EPA ORD NRRL ETSC dated March 28, 2014 and no further revision of the document was requested by EPA.
[4] Submitted to EPA on October 31, 2014 but not yet approved or commented on as of the date of this RI Addendum.
[5] Submitted to EPA on July 23, 2015 but not yet approved or commented on as of the date of this RI Addendum.
[6] Submitted to EPA on July 31, 2015 but not yet approved or commented on as of the date of this RI Addendum.

- Work Plan for Installation of a Non-Combustible Cover over Radiologically-Impacted Material At or Near the Ground Surface in Radiological Areas 1 and 2, West Lake Landfill Operable Unit-1 (EMSI, FEI, and Auxier, 2016);

- Comprehensive Phase 1 Report, Investigation of Radiological Area 1, West Lake Landfill Operable Unit-1 (EMSI, FEI, P.J. Carey, and Auxier, 2016);

- West Lake Landfill Perimeter Air Monitoring Quarterly Report, May, June and July 2016, (Auxier and EMSI, 2017a);

- West Lake Landfill Perimeter Air Monitoring Quarterly Report, February, March and April 2016, (Auxier and EMSI, 2017b);

- West Lake Landfill Perimeter Air Monitoring Quarterly Report, November and December 2015 and January 2016, (Auxier and EMSI, 2016e);

- West Lake Landfill Perimeter Air Monitoring Quarterly Report, August, September and October 2015, (Auxier and EMSI, 2016d);

- West Lake Landfill Perimeter Air Monitoring Quarterly Report, May, June and July, 2015, (Auxier and EMSI, 2016c);

- Stormwater Monitoring During Non-Combustible Cover Construction, West Lake Landfill Operable Unit-1, Bridgeton, Missouri (EMSI, 2016c);

- Evaluation of Apatite/Phosphate Treatment Technologies, West Lake Landfill Operable Unit-1, Bridgeton Missouri (EMSI, 2016a)[7];

- Draft Stormwater Monitoring Plan, West Lake Landfill Operable Unit-1, Bridgeton Missouri (EMSI, 2017)[8];

- Work Plan for Installation of a Non-Combustible Cover over Radiologically-Impacted Material At or Near the Ground Surface in Radiological Areas 1 and 2, West Lake Landfill Operable Unit-1 Addendum 1 (EMSI, FEI, and Auxier, 2017); and

- Additional investigations, sample collection and laboratory analyses were also performed by Cotter Corporation (N.S.L.) pursuant to the "Work Plan for Further Characterization of Extent of Radiologically Impacted Material in Areas 1 and 2, West Lake Landfill Operable Unit-1, Bridgeton, Missouri" (Arcadis, 2015).

[7] Submitted to EPA on October 1, 2016 but not yet approved or commented on as of the date of this RI Addendum.
[8] Submitted to EPA on March 22, 2017 but not yet approved or commented on as of the date of this RI Addendum.

2.2.2 Post-ROD Bridgeton Landfill Reports

Bridgeton Landfill, LLC conducts regular monitoring of groundwater and air emissions at the Bridgeton Landfill. Reports associated with this monitoring are available on the MDNR Bridgeton Landfill website.[9] In addition, in response to the occurrence of a subsurface exothermic (heat-generating) reaction (SSR) within a portion of the South Quarry of the Bridgeton Landfill,[10] Bridgeton Landfill, LLC has performed numerous investigations and evaluations, including:

- Waste Limits Investigation Summary Report, Bridgeton Landfill MSW Permit No. 118912 (Aquaterra, 2011);
- Bridgeton Landfill Air and Landfill Gas Sampling August 2012: Summary of Findings (Stantec, 2012);
- Bridgeton Landfill North Quarry Contingency Plan – Part 1 (Bridgeton Landfill, LLC, 2013a);
- Bridgeton Landfill – Landfill Gas Corrective Action Plan Update (Bridgeton Landfill, LLC, et al., 2013a);
- Bridgeton Landfill North Quarry Contingency Plan – Part 2 (Bridgeton Landfill, LLC, 2013b);
- Gas Wellfield Management, Bridgeton Landfill, Bridgeton Missouri (Bridgeton Landfill, LLC, 2013c);
- Bridgeton Landfill North Quarry Action Plan (Bridgeton Landfill, LLC, et al., 2013b);
- Gas Wellfield Management, Oxygen Control Measures, Bridgeton Landfill, Bridgeton Missouri (Bridgeton Landfill, LLC, 2013d);
- Landfill Gas Correction Action Plan Update (Feezor Engineering, Inc., 2014a);
- Bridgeton Landfill – West Lake Landfill Gamma Cone Penetration Test (GCPT) Work Plan Revision 2 (Feezor Engineering, Inc., et al., 2013);
- Core Sampling (Phase 1B, 1C, and 2) Work Plan Revision 1 (Feezor Engineering, Inc., et al., 2014);

[9] http://dnr.mo.gov/bridgeton
[10] This heat-generating event has been referred to in previous reports as a "subsurface smoldering event" or "SSE". The terminology has since been updated based on further study of the nature of the reaction.

- Groundwater Monitoring Well Installation Report, Bridgeton Landfill, LLC – Bridgeton Landfill, Bridgeton, Missouri (Herst & Associates, Inc., 2014);

- Work Plan for Removal Action Preconstruction Work, West Lake Landfill Superfund Site (EMSI, et al., 2014a);

- Expanded Heat Removal Pilot Study, Bridgeton Landfill, Bridgeton, Missouri (Bridgeton Landfill, LLC, 2014);

- Thermal Isolation Barrier Waste Relocation Areas, West Lake Landfill Superfund Site (Feezor Engineering, Inc. and EMSI, 2014);

- Isolation Barrier Alternatives Analysis, West Lake Landfill Superfund Site (EMSI et al., 2014b);

- Corrective Action Plan Potential Northward Progression of Subsurface Smoldering Event, Bridgeton Landfill (CEC, 2014);

- Bridgeton Landfill Thermal Isolation Barrier Investigation Phase 1 Report prepared on behalf of Bridgeton Landfill, LLC (Feezor Engineering, Inc., 2014b);

- Bird Management and Control Plans for Various Barrier Options at West Lake Site, Bridgeton Landfill, St. Louis, MO (LGL, Ltd., 2015);

- Evaluation of Remedial Action Approaches for Hot Spot Remediation (SCS Engineers, 2015);

- Corrective Action Measures for Isolated “Hot Spot” in the North Quarry, Bridgeton Landfill, LLC, Bridgeton Missouri (Bridgeton Landfill, LLC, 2015);

- Expanded Heat Removal Pilot Study Initial Report, Bridgeton Landfill, Bridgeton, St. Louis County, Missouri (Feezor Engineering, Inc., 2015a);

- Bridgeton Landfill Ambient Air and Landfill Source Gas Sampling – January 2015 (Stantec, 2015);

- Technical Evaluation of a Heat Extraction Barrier, Bridgeton Landfill, Bridgeton, St. Louis County, Missouri (Feezor Engineering, Inc., 2015b);

- Final Supplemental Radon Flux Analysis from the Area South of the Proposed Isolation Barrier (Auxier and EMSI, 2016a)[11];

- Final Particulate Emission Analysis from Area South of Proposed Isolation Barrier, West Lake Landfill Superfund Site (Auxier and EMSI, 2016b) [12];

- Comprehensive Sampling Plan for Monitoring Sulfur Dioxide in Ambient Air (Stantec Consulting Services, Inc., 2016a);

- Summary of Air Quality Monitoring Data, Third Quarter 2016 (Stantec Consulting Services, Inc., 2016b);

- Summary of Air Quality Monitoring Data, Fourth Quarter 2016 (Stantec Consulting Services, Inc., 2017);

- Corrective Action Measures Inert Gas Injection Work Plan for Hot Spot Remediation (SCS Engineers, 2016) [13];

- North Quarry Subsurface Temperature Monitoring Probes (TMPs) Work Plan (Feezor Engineering, Inc., 2016e)[14];

- EVOH Cover Design at Bridgeton Landfill (Cornerstone Environmental, 2016);

- Groundwater Technical Report, Bridgeton Landfill (Feezor Engineering, Inc., 2016c);

- As-Built Drawings for Neck Heat Extraction System, Bridgeton Landfill (Feezor Engineering, Inc., 2016d)[15];

- Record Drawings for Seventeen Additional and Two Replacement Temperature Monitoring Probe Installation in the North Quarry, Bridgeton Landfill (Feezor Engineering, Inc., 2016a)[16]; and

[11] Submitted to EPA on March 28, 2016 but not yet approved or commented on as of the date of this RI Addendum.
[12] Submitted to EPA on March 28, 2016 but not yet approved or commented on as of the date of this RI Addendum.
[13] Submitted to EPA on December 19, 2016 but not yet approved or commented on as of the date of this RI Addendum.
[14] Submitted to EPA on December 19, 2016 but not yet approved or commented on as of the date of this RI Addendum.
[15] Submitted to EPA on November 23, 2016, comments received February 17, 2017 and responses to comments provided on March 7, 2017, but not yet approved as of the date of this RI Addendum.
[16] Submitted to EPA on December 19, 2016 but not yet approved or commented on as of the date of this RI Addendum.

- 2017 Comments to the As-Built Drawings for Neck Heat Extraction System, Bridgeton Landfill (Feezor Engineering, Inc., 2017)[17].

2.2.3 Post-ROD Reports Prepared by or on behalf of EPA

In addition to the various investigations and evaluations performed by the OU-1 Respondents and Bridgeton Landfill, LLC, EPA (in conjunction with other agencies) has also conducted additional investigations of the Site, including:

- Radiological and Infrared Survey of West Lake Landfill, Bridgeton, Missouri, Airborne Spectral Photometric Environmental Collection Technology (ASPECT), (EPA-OEM-CMAT, 2013);
- Downhole Gamma Logging November 2012 (EPA, 2013);[18]
- Isolation Barrier Alignment Alternatives Assessment, West Lake Landfill, Bridgeton, Missouri (USACE, 2014);
- Background Groundwater Quality, Review of 2012-14 Groundwater Data, and Potential Origin of Radium at the West Lake Landfill Site, St. Louis County, Missouri (USGS, 2014);
- Quality Assurance Project Plan for Baseline Off-Site Air Monitoring and Sampling, West Lake Landfill Site, Bridgeton, Missouri (TetraTech, 2014a);
- Interim Data Summary of Ongoing Baseline Off-Site Air Monitoring via Sampling for Volatile Organic Compounds and Hydrogen Sulfide by Application of Passive/Diffusive Sampling Methods, West Lake Landfill Site, Bridgeton, Missouri (TetraTech, 2015a);
- Interim Data Summary of Ongoing Baseline Off-Site Air Monitoring Radiological Parameters, West Lake Landfill Site, Bridgeton, Missouri (TetraTech, 2015b);
- Interim Data Summary of Ongoing Baseline Off-Site Air Monitoring for Carbon Monoxide, Hydrogen Sulfide, and Sulfur Dioxide Measurements, West Lake Landfill Site, Bridgeton, Missouri (TetraTech, 2015c);
- Interim Data Summary of Ongoing Baseline Off-Site Air Monitoring Volatile Organic Compounds and Hydrogen Sulfide by Application of Passive/Diffusive Sampling Methods, West Lake Landfill Site, Bridgeton, Missouri (TetraTech, 2015d);

[17] Submitted to EPA on March 17, 2017 but not yet approved or commented on as of the date of this RI Addendum.
[18] A formal report was not prepared, but a summary table of the results of the downhole logging was made available and is included in Appendix C-3.

- Interim Data Summary of Ongoing Baseline Off-Site Air Monitoring Radiological Parameters, West Lake Landfill Site, Bridgeton, Missouri (Tetra Tech, 2015e);

- Health Consultation – An Evaluation of Radiation in Groundwater and Air, West Lake Landfill Operable Unit 1, Bridgeton, St. Louis County, Missouri (ATSDR, 2015);

- Quality Assurance Project Plan for Radon Emanation Coefficient Study, West Lake Landfill Site, Bridgeton, Missouri (TetraTech, 2015f);

- Isolation Barrier Alignment Alternatives Assessment Amendment 1, West Lake Landfill, Bridgeton, Missouri (USACE, 2015); and

- Quality Assurance Project Plan for Soil/Sediment Sampling of Drainage Features at the West Lake Landfill Site (TetraTech, 2016a).

2.3 Other reports

EPA and other federal agencies also conducted additional investigations in the vicinity of the West Lake Landfill both before and after issuance of the RODs for OU-1 and OU-2 in 2008. MDNR and the Missouri Department of Health and Senior Services (MDHSS) have also performed sampling and monitoring in the vicinity of the West Lake and Bridgeton Landfills. DOE, USACE and MDNR also conducted investigations of potential routes that may have been used to transport radionuclide-bearing materials to the West Lake Landfill.

2.3.1 Bridgeton Municipal Athletic Complex

In response to concerns raised by members of the community, EPA conducted an investigation of potential occurrences of radionuclides at the Bridgeton Municipal Athletic Complex (BMAC). The results of this investigation were presented in the following report:

- Final Pre-CERCLIS Screening Report Bridgeton Municipal Athletic Complex, Bridgeton, Missouri (TetraTech, 2014b);

2.3.2 MDNR and MDHSS Reports and Permits

MDNR issued seven different permits for solid waste disposal at the West Lake Landfill including:

- Permit Nos. 118903 and 218903 dated January 1, 1976;

- Permit No. 118906 dated January 1, 1976;
- Permit No. 118908 dated August 27, 1980;
- Permit No. 118909 dated August 20, 1981;
- Permit No. 218912 dated September 17, 1984;
- Permit No. 118912 dated November 18, 1985; and
- Permit No. 118912 Modification dated October 23, 1993.

MDNR, MDHSS and the Missouri Attorney General's Office also have conducted sampling in the vicinity of the Site and prepared reports of the results of the sampling, including:

- West Lake Landfill Radiological Survey, May 16, 2013 (MDNR, 2013);
- West Lake Landfill Vicinity Radiological Survey and Sampling, November 4-6, 2015, Final Report (MDNR, 2016);
- Daily Air Monitoring Reports from 2013 through 2016, which are available on the MDNR website at http://dnr.mo.gov/env/swmp/facilities/BridgetonSanitaryLandfill-RCP.htm and http://dnr.mo.gov/bridgeton/BridgetonSanitaryLandfillReports.htm, and which include the following:
    - MDHSS Reviews of Air Monitoring Data
    - Hourly Average Meteorological Data
    - Air Sampling Summary Data Using Area RAE
    - Daily Air Monitoring Reports
- MDHSS's Bridgeton Sanitary Landfill Radiological Air Sampling Report (MDHSS, 2013);
- MDHSS's Bridgeton/West Lake Landfill Radiological Sampling Final Report (MDHSS, 2015)[19];
- Bridgeton Sanitary Landfill Groundwater Investigation Report, St. Louis County, Missouri, August 2015; and

[19] Available at http://health.mo.gov/living/environment/bridgeton/pdf/BridgetonAirSamplingAnalysisReport_November2015_final_May2016.pdf

- Bridgeton Landfill NPDES permit (new permit pending).

2.3.3 Transport Route Investigation Reports

Although not part of the West Lake Landfill Site or OU-1, the U.S. Department of Energy, the U.S. Army Corps of Engineers (USACE) and MDNR also conducted investigations of potential haul routes between the Latty Avenue site in North County and the West Lake Landfill. The results of these investigations are documented in the following reports:

- Results of Mobile Gamma Scanning Activities in Berkeley, Bridgeton and Hazelwood, Missouri (Oak Ridge National Laboratory, Health and Safety Research Division, 1985);

- North St. Louis County Haul Road Analysis and Justification for Additional Investigation – Evaluation of Inaccessible Materials Beneath Pavements (USACE, 2005); and

- MDNR performed sampling along St. Charles Rock Road, Boenker Road, and Taussig Road in August and September 2005 – no formal report was prepared for this sampling but the coordinates of the sample locations and the analytical laboratory reports are posted on MDNR's website at http://dnr.mo.gov/env/hwp/fedfac/fusrap/reports.htm.

The 2014 Health Consultation prepared by the Center for Disease Control – Agency for Toxic Substances and Disease Registry (ATSDR) provides a summary of the results of the haul road sampling.

3. SITE BACKGROUND

This section presents a brief description of the West Lake Landfill Superfund Site, including its location, an overview of past and current landfill operations, and a discussion of activities occurring adjacent to the Site.

3.1 Site Description and Location

The West Lake Landfill Superfund Site is located within the western portion of the St. Louis metropolitan area on the east side of the Missouri River (Figure 3-1). The Site is situated approximately one mile north of the intersection of Interstate 70 and Interstate 270 within the city limits of the City of Bridgeton in northwestern St. Louis County. The landfill property has an address of 13570 St. Charles Rock Road, Bridgeton, Missouri (Figure 3-2).

The landfill property consists of an approximately 200-acre parcel of land that includes six identified waste disposal areas or units, including Radiological Area 1 (Area 1), Radiological Area 2 (Area 2), a closed demolition landfill, an inactive sanitary landfill, and the North Quarry and South Quarry portions of the permitted Bridgeton Landfill. In addition to the former landfill disposal areas, included within the boundaries of the landfill property are a solid waste transfer station and an asphalt batch plant, although these operations are not the subject of the RI Addendum.

Adjacent properties that, although not used for waste disposal, are known to contain radionuclides in soil as a result of transport of radionuclides by surficial processes from OU-1 include the Buffer Zone and Lot 2A2 of the Crossroads Industrial Park. Per CERCLA Section 101(9)(B), a facility includes any site or area where a hazardous substance has been deposited, stored, disposed of, or placed, or otherwise come to be located. Accordingly, these adjacent properties are included in this investigation as part of the Site. Current ownership of properties included in the definition of the Site and OU-1 is depicted on Figure 3-3.

A six-foot-high chain-link fence with a three-strand barbed wire canopy encloses the entire landfill property. The main access gate is located on the northeastern perimeter off of St. Charles Rock Road. An additional gate is located on the southwestern perimeter of the landfill property.

The landfill property is bordered by Crossroads Industrial Park to the northwest and St. Charles Rock Road (State Highway 180) to the north and east. Taussig Road, commercial facilities (including the Republic Services, Inc. hauling company facility), and agricultural land are located to the southeast. The landfill property is bounded to the south and west by Old St. Charles Rock Road (now vacated) and the Earth City Industrial Park (Earth City) stormwater/ flood control pond. The Earth City commercial/industrial complex continues to the west and north of the flood control pond and extends to the Missouri River. Earth City is separated from the river by an engineered levee system owned and maintained by the Earth City Flood Control District.

On the west side of Area 2 is the property referred to in the OU-1 RI (EMSI, 2000) as the Ford property because it was previously owned by Ford Motor Credit, Inc. In 1998, the majority of the Ford property was sold to Crossroad Properties, LLC and has since been developed into the Crossroads Industrial Park. Ford initially retained ownership of a 1.78-acre parcel located immediately adjacent to the west of Area 2 (Figure 3-2). Ownership of this 1.78-acre parcel was subsequently transferred to Rock Road Industries, Inc. to provide a buffer between the landfill and adjacent property, and therefore this parcel has been identified as the "Buffer Zone." Crossroad Properties, LLC initially developed all the former Ford property with the exception of Lot 2A2, a 3.58-acre parcel located immediately north of the Buffer Zone. Lot 2A2 was subsequently developed by AAA Trailer, the owner of much of the property immediately to the north of the Buffer Zone and Area 2 (Figures 3-2 and 3-3) although Lot 2A2 is still owned by Crossroad Properties, LLC. Property to the north and northeast of the landfill, across St. Charles Rock Road, is moderately developed with commercial, retail and manufacturing operations. Zoning for the parcels that make up the landfill property and surrounding parcels is depicted on Figure 3-4.

The West Lake Landfill Superfund Site consists of the various parcels that comprise the landfill property (on-property) and adjacent properties (off-property) where radionuclides have been or could be identified in the soil. The OU-1 portion of the Site includes Areas 1 and 2, the Buffer Zone and the adjacent off-property parcels B and C of Lot 2A2 owned by Crossroad Properties, LLC that are currently used by AAA Trailer for outdoor storage of tractor-truck trailers. OU-2 consists of all other portions of the landfill property. These areas are shown on Figure 3-5.

3.2 Land Use Restrictions

An institutional control in the form of a "Declaration of Covenants and Restrictions" was recorded on June 30, 1997, and a supplemental "Declaration of Covenants and Restrictions" was recorded on January 20, 1998, prohibiting residential use and groundwater use on any of the landfill property and restricting construction of buildings and underground utilities and pipes within Areas 1 and 2. On October 31, 2016, the prior institutional controls were modified by a further supplemental "Declaration of Covenants and Restrictions" recorded against all of the OU-1 Areas (Areas 1 and 2 and the Buffer Zone) and the OU-2 landfill areas to include the OU-1 areas not included under the prior institutional controls, and to prohibit use of the premises for commercial and industrial purposes including but not limited to use as a storage yard, and to prohibit placement of water wells for agricultural purposes. These institutional controls cannot be terminated without the written approval of the current property owners, MDNR, and EPA.

In addition, in 2005, the City of St. Louis entered into a Negative Easement and Declaration of Restrictive Covenants Agreement with Bridgeton Landfill, LLC (among other entities) to prohibit depositing or dumping of new or additional putrescible waste on the entirety of the Bridgeton Landfill after August 1, 2005 (City of St. Louis, 2005). This negative easement stemmed in part from an earlier determination by the Federal Aviation Administration (FAA)

and the United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA) that the landfill was a hazardous wildlife attractant for the Lambert-St. Louis International Airport (City of St. Louis, 2010). In particular, the proximity of the airport to the landfill presents a risk of bird strikes. Certain types of scavenging birds (e.g., gulls, crows) are attracted to exposed putrescible wastes at landfills, and accordingly can present a bird strike risk to passing aircraft. Similarly, bird flocks also pose a serious risk to aircraft from the potential of being sucked into the jet engines of commercial aircraft, thereby causing complete engine failure.

The northwest end of the Lambert-St. Louis International Airport ("Lambert Airport") runway 11 is located approximately 8,450 feet from the nearest point of the landfill mass (east corner of the South Quarry portion of the Bridgeton Landfill). The northwest end of runway 11 is located approximately 9,350 feet from the nearest point of Area 1 and approximately 11,000 feet from the nearest point of Area 2. Therefore, portions of both the Bridgeton Landfill and Area 1 are located at distances that are less than the FAA siting guidance of a 10,000-foot separation radius between an airport's Air Operations Area (AOA) and a municipal solid waste landfill (MSWLF)[20]. In addition, the FAA recommends a distance of 5 miles between the farthest edge of an airport's AOA and any hazardous waste wildlife attractant (*e.g.*, an active MSWLF), if the attractant could cause hazardous wildlife movement into or across the approach or departure airspace[21]. All portions of the West Lake Landfill and Bridgeton Landfill are located within this 5-mile distance. Construction or establishment of new MSWLFs is prohibited within 6 statute miles of the property boundary of certain public-use airports.[22]

3.3 Summary of Landfill Units and Operations

The West Lake Landfill property can be divided into five units:

- Radiological Area 1, which is adjacent to and in part overlain by waste material within the North Quarry portion of the Bridgeton Landfill;
- Radiological Area 2;
- Closed Demolition Landfill;
- Inactive Sanitary Landfill; and
- The Bridgeton Landfill (including the North Quarry portion and the South Quarry portion).

[20] FAA Advisory Circular No. 150/5200-33B dated August 28, 2007.
[21] Ibid.
[22] Ibid and FAA Advisory Circular No. 150/5200-34A dated January 26, 2006.

These five areas are briefly discussed below. There is also a surface water retention pond, abandoned leachate lagoon, a closed leachate retention pond, a former soil borrow area, a current soil stock pile area, and an active leachate treatment facility associated with the Bridgeton Landfill. Operable Unit 1 comprises Radiological Areas 1 and 2, the Buffer Zone and Lot 2A2 of the adjacent property owned by Crossroads Properties LLC (Figure 3-5). The Bridgeton Landfill, the Closed Demolition Landfill, and the Inactive Sanitary Landfill are all part of OU-2.

The West Lake Landfill contains multiple areas of differing past operations. The landfill property was used agriculturally until a limestone quarrying and crushing operation began in 1939. The quarrying operation continued until 1988 and resulted in shallow excavation areas and two quarry pits, the North Quarry Pit and the South Quarry Pit (Figure 3-5), which were excavated to a maximum depth of 240 feet below ground surface (bgs) (Herst & Associates, 2005a).

The landfill property contains several areas where solid wastes have been disposed. The date on which landfilling activities started at the West Lake Landfill is not known with certainty and has been variously cited as beginning in or around the early 1950s (EMSI, 2000), or as starting in 1952 or possibly 1962 (Herst & Associates, 2005). The landfill was not officially permitted for use as a sanitary landfill until 1952. EPA has reported that "from 1941 through 1953 it appeared that limestone extraction was the prime activity at the facility; however, as time passed the focus of the activity appeared to shift to waste disposal" (EPA, 1989). EPA has reported that historical aerial photography from 1953 indicates use of a landfill had commenced (EPA, 1989). Mine spoils from quarrying operations were deposited on adjacent land immediately to the west of the quarry (Herst & Associates, 2005). Portions of the quarried areas and adjacent areas were subsequently used for landfilling municipal refuse, industrial solid wastes and construction and demolition debris. EPA has reported that liquid wastes and sludges were also disposed of at the landfill (EPA, 1989). These operations, which predated state and federal laws and regulations governing such operations, occurred in areas that subsequently have been identified as Area 1, Area 2, the Closed Demolition Landfill, and the Inactive Sanitary Landfill (Figure 3-6).

3.3.1 Landfill Permit History

The early landfilling activities (prior to 1974) were not subject to state permitting (although they were still subject to an authorization issued by the county), and the portion of the landfill property where these activities occurred has been referred to as the "unregulated landfill." Waste disposal in St. Louis County was regulated solely by St. Louis County authorities until 1974, when the MDNR was formed (Herst & Associates, 2005). Landfill activities conducted in 1974 and afterwards were subject to a permit from MDNR.

In 1974, MDNR identified six areas as waste disposal areas, four of which were subsequently permitted for waste disposal and two of which (the majority of Area 1 and the majority of Area 2) were not so permitted and were therefore closed in 1974 (Herst & Associates, 2005). The

areas subsequently permitted by MDNR for waste disposal are referred to as the "regulated landfill." These areas are shown on Figure 3-7 and are discussed further below.

On August 27, 1974, MDNR granted authorization for a sanitary landfill on 25 acres in the area now identified as the Inactive Sanitary Landfill. MDNR subsequently issued a permit (No. 118903) for this area on January 27, 1976 (Herst & Associates, 2005). MDNR also issued a permit (No. 218903) for operation of a solid waste disposal area for a demolition landfill on 27 acres of land that included a large portion of the area that has subsequently been identified as the Closed Demolition Landfill. The Closed Demolition Landfill was constructed over an area that had previously been used for disposal of sanitary waste. This permit also included the eastern portion of Area 2, the eastern portion of the inactive sanitary landfill, and the western portion of Area 1 (Figure 3-7). On May 23, 1978, permit No. 118903 was modified to include an additional 3.5 acres within the area of the Inactive Sanitary Landfill.

On August 27, 1980, MDNR issued a permit (No. 118908) for operation of a sanitary landfill on 6 acres located in the area now identified as the Inactive Sanitary Landfill. On September 18, 1984, MDNR issued a permit (No. 218912) for operation of a demolition landfill on 22 acres in the area now identified as the Closed Demolition Landfill.

On January 22, 1979, MDNR issued a permit (No. 118906) for operation of a sanitary landfill on 13 acres in the portion of the property described as the North Quarry Pit (Herst & Associates, 2005). A subsequent permit (No. 118909) was issued August 20, 1981 to allow for expansion of the North Quarry landfill. On November 11, 1985, MDNR issued permit No. 118912, which allowed for a 33-acre expansion of sanitary landfill operations into the South Quarry area and continued waste placement in the North Quarry, thereby superseding prior permits No. 118909 and 118906. Permit No. 118912 covers a 52-acre area[23] that encompasses the North Quarry and South Quarry, which together comprise what is currently identified as the Bridgeton Landfill. Placement of waste material in the North and South Quarry areas ceased in 2004. No active landfilling has occurred since 2004, although ongoing activities related to closure and maintenance and monitoring of the Bridgeton Landfill continue to be conducted.

3.3.2 West Lake Landfill Areas 1 and 2

Based on visual inspection and geologic logging of drill cuttings and core samples, the primary waste materials disposed in Areas 1 and 2 were municipal solid wastes (MSW) and construction and demolition debris (C&D debris/wastes) (EMSI, 2000). Some industrial wastes may also have been disposed in these areas.

[23] Per Herst & Associates, Inc. 1995, although the permitted area was 52 acres, the permit drawings (Drawing 2 Revision 3) prepared by Burns & McDonnell include 54.1 acres. A 2010 investigation of the limits of waste associated with permit 118912 performed by AquaTerra determined that the area of waste disposal subject to this permit is 50.23 acres.

Radionuclides have been found in two areas at the landfill: Radiological Area 1 and Radiological Area 2 of OU-1, as described further below.

3.3.2.1 West Lake Landfill Radiological Area 1

Area 1, which encompasses approximately 17.6 acres, is located immediately to the southeast of the landfill entrance (Figure 3-6). This area was part of the unregulated landfill operations conducted up through 1974, although the southwestern portion of what is currently identified as Area 1 was historically included under permit No. 218903 (Figure 3-7)[24]. Based on the drilling cores and samples obtained as part of the RI/FS and subsequent investigations for OU-1, the waste materials within Area 1 consist primarily of municipal refuse (sanitary wastes). Pursuant to a Materials Management Plan (EMSI, 2006b) approved by MDNR, inert fill material (concrete rubble and brick) was placed over portions of Area 1 between 2006 and 2008.

Remnants of an asphalt entrance road and parking area are located on the northwestern border of Area 1 to the south of the landfill office building. An abandoned underground diesel tank is also located beneath the asphalt-paved area. The tank is no longer in use but has not been removed because it is within the boundaries of Area 1. Prior to 2013, the remaining portions of Area 1 were mainly covered with grass, shrubs and trees. In 2013, 2014 and 2015, vegetation was cleared along the alignments of numerous access roads and road base material was placed along these roads to support additional drilling activities. In 2016, approximately 2.6 acres in the northern portion of Area 1 were cleared of vegetation and covered with road base material as part of construction of an NCC over areas where RIM was present at the ground surface (EMSI, 2016c) pursuant to a UAO for removal action issued by EPA (2015d). Small and medium-sized trees and shrubs still cover the northern, eastern and southwestern portions of Area 1. The southeastern portion of Area 1 was covered beneath the above-grade portion of the North Quarry portion of the Bridgeton Landfill in approximately 2002-2003 (Figure 3-8).

3.3.2.2 West Lake Landfill Radiological Area 2

Radiological Area 2, which encompasses approximately 47.3 acres, is located in the northwestern part of the landfill property. This area was also part of the unregulated landfill operations conducted up through 1974, although a small part of the eastern portion of Area 2 was also included within permit No. 218903 (Figure 3-6). Based on inspection of the drilling cores and samples obtained as part of the RI/FS investigations for OU-1, the waste materials within Area 2 consist of C&D waste/debris and MSW. Pursuant to a Materials Management Plan (EMSI, 2006b) approved by MDNR, inert fill material (concrete rubble and brick) was placed over portions of Area 2 between 2006 and 2008.

[24] The permitted areas identified in Permit Nos. 118906 and 118912 overlap the southeast margin of Area 1. These permits were issued for the North Quarry portion of the Bridgeton Landfill and material placed pursuant to these permits was placed in the North Quarry portion of the Bridgeton Landfill. However, the area included under these permits extends over the southern part of Area 1.

Prior to 2015, large portions of this area were covered with grasses, native bushes and trees, while other portions were unvegetated and covered with inert fill material consisting of soil, gravel, concrete rubble and brick material. Miscellaneous debris consisting of concrete pipe, metal and automobile parts, discarded building materials, and other non-perishable materials were also present on the surface. During the 1994-1996 OU-1 RI field investigations, a number of small depressions, some of which seasonally contain ponded water and phreatophytes such as cattails, were scattered throughout Area 2, in large part due to the presence of small berms located along the top of the major landfill berm/slope along the northern, northeastern and western portions of Area 2, which are intended to contain runoff from Area 2. With the exception of the landfill slope adjacent to the Buffer Zone, the slopes of landfill berm were covered with a dense growth of trees, vines and bushes.

In 2015, vegetation was cleared along the alignments of numerous access roads and roadbase material was placed along these roads to support additional drilling activities. In 2016, approximately 17.2 acres in the central portion of Area 2 were cleared of vegetation and covered with road base material as part of construction of an NCC over areas where RIM was present at the ground surface, pursuant to a UAO for removal action issued by EPA (2015d). Vegetation, including large trees, was cleared from the southwestern portion of the landfill berm/slope adjacent to the Buffer Zone, and approximately 1.78 acres of the Buffer Zone was covered with rock, including construction of a large rock buttress in this area as part of the NCC construction for Area 2 (EMSI, 2016c). Large and medium-sized trees and shrubs still cover the northern, western and southern portions of Area 2.

3.3.3 Inactive Landfill Operations in OU-2

The Inactive Sanitary Landfill is located to the southwest of the Closed Demolition Landfill. The operations performed in this area were also part of the unregulated landfill operations conducted up through 1974 that were subsequently regulated by MDNR and included within the scope of permits No. 118903, 218903, 118908, and 218912 (Figure 3-6). Based on the results of visual inspection and geologic logging of drill cuttings and core samples, MSW is the primary waste disposed in the Inactive Sanitary Landfill (Herst & Associates, 2005a). Some industrial wastes may also have been disposed in this area, but based on the visual inspection and geologic logging of drill cuttings and core samples, industrial wastes do not appear to have been a major portion of the wastes disposed in the Inactive Sanitary Landfill.

A Closed Demolition Landfill and another former sanitary landfill area are located in the north central part of the landfill property. The Closed Demolition Landfill is located on the southeast side of Area 2, between Area 2 and the landfill entrance road. Based on prior reports and the results of drilling and sampling, only C&D debris/wastes are expected to have been disposed of in the Closed Demolition Landfill. However, review of the permit history (see discussion above) indicates that sanitary wastes may have been placed in this area pursuant to Permit No. 218903

prior to placement of overlying C&D debris/wastes.

3.3.4 Bridgeton Landfill

The Bridgeton Landfill is located in the former North Quarry and South Quarry portions of the landfill property (Figures 3-6 and 3-10). Collectively, the North and South Quarry landfill areas make up the former Permitted Sanitary Landfill, also known as the Bridgeton Landfill. Waste disposal in the Bridgeton Landfill consisted primarily of MSW and commercial waste. Disposal of waste materials in the Bridgeton Landfill ceased in 2004 pursuant to an agreement with the City of St. Louis to reduce the potential for birds to interfere with operations at a new runway at the nearby Lambert-St. Louis International Airport (Lambert Field), the western end of which is located approximately 9,166 feet from the landfill. Although included within the overall scope of Operable Unit-2, the Bridgeton Sanitary Landfill is inactive and undergoing closure pursuant to MDNR supervision.

Review of historical aerial photographs indicates that quarrying activities (removal of limestone) continued to be conducted in the North Quarry up through 1979. Figures 3-9a through 3-9e display the changes (lowering) in elevation of the base of the North Quarry over various periods between 1969 through 1977 (aerial photographs of sufficient resolution to estimate ground surface elevations were not available for the 1978 – 1979 time frame). Based on the decrease in elevation of the quarry floor between 1969 and 1971 (the areas depicted with orange and yellow colors on Figure 3-9a), rock quarrying was being conducted in the southern portion of the North Quarry during this time frame. Some rock continued to be removed from this area during the period between 1971 and 1973; however, based on the change in the elevation of the quarry floor, the majority of the rock quarrying activity in the North Quarry shifted to the north during this period (Figure 3-9b). Between 1973 and 1974 rock quarrying was occurring in the neck area located between the North and South Quarries (Figure 3-9c). Between 1974 and 1975, quarrying occurred in the northern portion of the North Quarry (Figure 3-9d). Between 1975 and 1977, the majority of rock quarrying occurred in the central and southern portions of the North Quarry (Figure 3-9e). Figure 3-9f presents the composite change (decrease) in the elevation of the base of the North Quarry over the period between 1969 and 1977 and indicates that the elevation of the floor of the North Quarry was lowered approximately 25 to 75 feet over this period. Because rock quarrying was occurring in the North Quarry area during this period, placement of waste would likely not have occurred in North Quarry prior to at least 1977, and any materials that may have been present in the bottom of North Quarry in the 1973-time frame would likely have been removed as part of the ongoing rock quarrying activity in this area during this time period.

The first permit for placement of waste materials in the North Quarry portion of the Bridgeton Landfill (Permit No. 118906) was issued on January 22, 1979. Review of a May 1977 aerial photograph does not indicate that any waste is present in the North Quarry area at that time, while review of a July 26, 1979 aerial photograph indicates that waste placement is occurring in the North Quarry by this time. Based on the permit date and review of the historical aerial photographs, it seems likely that placement of waste in the North Quarry began in or around

1979. Landfilling continued in the North Quarry area until 1985 when the landfill underwent expansion to the southwest into the area described as the South Quarry Pit pursuant to an additional permit (No. 118912) issued by MDNR on November 18, 1985 (Herst & Associates, 2005).

The North Quarry portion of the Bridgeton Landfill is located to the south of and adjacent to Area 1. Former landfilling activities associated with the North Quarry portion of the Bridgeton Landfill included filling of the former North Quarry pit and above-grade landfilling over the top of the North Quarry pit that also extended outward beyond the edges of the former quarry pit. The above-grade portion of the North Quarry portion of the Bridgeton Landfill extends out over and overlaps the southern portion of Area 1. Based on the date of Permit No. 118906 and review of historical aerial photographs, placement of waste in the North Quarry began in 1979 with initial waste placement occurring in the northeastern portion of the North Quarry area (nearest to St. Charles Rock Road) and subsequently progressing to the southwest (toward the South Quarry). By 1985, most of the northeastern part (*i.e.*, the part adjacent to Area 1) of the below-grade (quarry) portion of the North Quarry had been filled with waste; however, waste disposal in the southwestern portion of the North Quarry (*i.e.*, the "neck" area) continued to occur up through approximately 2002. Placement of waste in the above-ground portion of the North Quarry portion of the Bridgeton Landfill that extended over the southern portion of Area 1 occurred in approximately 2002 – 2004 (Figure 3-8). Landfilling in the North Quarry of the Bridgeton Landfill ceased in 2004.

The South Quarry portion of the Bridgeton Landfill is located adjacent to and southwest of the North Quarry portion of the Bridgeton Landfill. The quarrying operations historically extended from the North Quarry to the South Quarry, resulting in two quarry pits being connected via a narrow area referred to as the "neck" (see Figure 3-10). The South Quarry area is located adjacent to the southernmost portion of the Inactive Sanitary Landfill (Figure 3-6). Landfilling in the South Quarry portion of the Bridgeton Landfill began in 1985 and ceased in 2004.

3.4 Buffer Zone and Lot 2A2

The property located to the west of Area 2 was formerly owned by Ford Motor Credit (Ford) and was referred to as the Ford property during performance of the 2000 OU-1 RI. Ford sold most of this property in 1997, and it was subsequently developed as the Crossroads Industrial Park between approximately 1998 through 2000. Most of the parcels associated with the Crossroads Industrial Park were subsequently sold at various times to individual owners; however, Crossroad Properties LLC retained ownership of Lot 2A2 Parcels B and C. Lot 2A2 is currently used for outdoor storage of trailer trucks by AAA Trailer, which operates on a facility located on Lot 2A1 immediately to the west of Lot 2A2.

The Buffer Zone – a portion of the former Ford property that was sold to Rock Road Industries on February 2, 2001 – is located between the Area 2 slope to the east and the Crossroads Industrial Park to the west (Figures 3-5 and 3-6). The Buffer Zone includes the area of

radiologically impacted surface soils identified in the "Phase III Radiological Assessment" performed by Dames & Moore for Ford Financial Services Group (Ford) in 1991. Investigations conducted as part of the OU-1 RI identified the presence of radionuclides in surface soil on both the Buffer Zone and Lot 2A2. The presence of radionuclides on these properties has been interpreted to be the result of historical erosion of impacted soil from Area 2 (see Section 6.7 for detailed discussion of radionuclide occurrences on the Buffer Zone and Lot 2A2).

Per the CERCLA definition of a facility (see prior discussion in Section 3.1), the Superfund Site includes all of the landfill property plus the Buffer Zone and Lot 2A2. OU-1 includes Area 1, Area 2, the Buffer Zone and Lot 2A2. OU-2 includes the Closed Demolition Landfill, the Inactive Sanitary Landfill, the Bridgeton Landfill (North Quarry and South Quarry areas), and associated facilities including the landfill access road, landfill office, transfer station, asphalt plant, stormwater retention basin, and the OU-2 soil borrow and stockpile area.

3.5 Other Significant Features in the Vicinity of the Site

The West Lake Landfill is located approximately 1.75 miles to the east-southeast of the Missouri River with portions of the Site ranging from 1.4 to 2.0 miles from the river. The Earth City Industrial Park is located on the Missouri River floodplain to the west of the Site. The Earth City Industrial Park is protected from flooding by a levee (Figure 3-2) and stormwater management system operated and maintained by the Earth City Flood Control and Levee District. The stormwater management system includes a series of stormwater detention ponds, one of which is located along the west side of the landfill property (Figure 3-6). Another constructed stormwater detention pond is located across St. Charles Rock Road to the north of Area 2. A low area that accumulates stormwater is located near the northern portion of Area 2, on the south side of St. Charles Rock Road. Although it consisted of a pond during the time frame when the original OU-1 field investigations were conducted (1995-1997) and therefore was identified as the North Surface Water Body, over the years this area has become overgrown and silted in, and only contains water after storm events. In addition to overland flow from the north slope of Area 2, stormwater runoff from much of the West Lake Landfill area is conveyed to this area via the internal stormwater conveyance ditches and the perimeter stormwater conveyance structures and ditch located along the southwest side of St. Charles Rock Road. Inspection of the North Surface Water Body has not identified any outlet or pathway for discharge of water, and therefore, water that accumulates in this area appears to dissipate over time by evaporation and infiltration. Additional discussion of surface water features is presented in Section 5.3.3.

The Site, at its closest point is located within approximately 8,500 feet of the end of runway 11 of Lambert St. Louis International Airport. The Site is situated within the takeoff and approach routes for the airport. As discussed in Section 3.2, the landfill is subject to a Negative Easement and Declaration of Restrictive Covenants Agreement between the City of St. Louis and Bridgeton Landfill, LLC (among other entities) that prohibits depositing or dumping of new or additional putrescible waste on the entirety of the Bridgeton Landfill after August 1, 2005 (City of St. Louis, 2005).

4. SITE INVESTIGATION ACTIVITIES

This section of the RI Addendum report describes the various Site investigation activities performed in conjunction with the development of the RI and RI Addendum for OU-1. More detailed descriptions of the RI field investigations can be found in the various reports listed in Section 2 of this document and referenced in the following discussions.

4.1 Site Reconnaissance

McLaren/Hart completed a Site reconnaissance in 1994 to identify Site features that may have changed since preparation of the 1994 RI/FS Work Plan and to identify Site conditions that may affect the remedial investigations and ultimately the development of remedial alternatives. McLaren/Hart summarized its reconnaissance in a report titled Site Reconnaissance Report - West Lake Landfill Radiological Areas 1 & 2, dated May 16, 1996 (McLaren/Hart, 1996b) (the Site Reconnaissance Report), which was previously submitted to EPA.

The Site reconnaissance was completed on October 18, 1994, prior to the start of any of the sampling activities.

A general summary of results of the Site reconnaissance effort and the conclusions reached by McLaren/Hart are as follows:

- No changed conditions since the submittal of the 1994 RI/FS Work Plan were identified by McLaren/Hart;
- No planned or new residential or commercial construction was identified by McLaren/Hart at the time the site reconnaissance was conducted in 1994[25];
- No evidence of potential hazardous chemicals in Areas 1 and 2 was identified by McLaren/Hart;
- McLaren/Hart identified four locations from which runoff from Area 1 occurred. This runoff flowed into the perimeter drainage ditch and ultimately into a closed topographic depression (the North Surface Water Body) near the northern portion of Area 2 (Figure 4-1);
- During the October 1994 site reconnaissance, McLaren/Hart identified five locations where runoff from Area 2 could occur. Any such runoff would flow either to the North

[25] It should be noted that although no new construction was identified at the time of McLaren/Hart's site reconnaissance in 1994, substantial new commercial building construction has occurred in the vicinity of the Site since that time.

Surface Water Body, onto a portion of the Ford Property or out along the access road to Area 2 in the vicinity of the demolition landfill and the roll-off bin storage area;

- McLaren/Hart identified potential locations for the staff gauges and surface water sampling points within the North Surface Water Body and the flood control channel located along the western portion of the Site. These locations were presented to EPA in McLaren/Hart's March 30, 1995 letter (McLaren/Hart, 1995a) and were approved by EPA on May 5, 1995 (EPA, 1995a);

- McLaren/Hart inventoried all existing monitoring wells which could be located at the landfill, noted those wells with problems (such as crushed or broken casings), re-surveyed the well locations and collar elevations, re-developed the existing wells, and evaluated the suitability of the existing wells for use in water level measurements and groundwater sampling;

- McLaren/Hart located a number of cased soil borings used by Radiation Management Corporation (RMC) during its investigations conducted in 1981; and

- McLaren/Hart performed an inspection of the Site for evidence of threatened or endangered species habitat (discussed below in Section 4.2).

A detailed description of the specific activities completed as part of the Site reconnaissance effort (including the methods used), as well as the conclusions reached by McLaren/Hart, can be found in the Site Reconnaissance Report (McLaren/Hart, 1996b).

4.2 Threatened or Endangered Species Assessment

McLaren/Hart completed an assessment of the potential for the presence of threatened or endangered species occurrences at the Site. The purpose of this assessment was to identify and characterize the dominant plant communities and to assess the Site for the presence of threatened or endangered species.

Following the completion of the threatened or endangered species assessment, McLaren/Hart concluded that:

- Four dominant plant communities exist at the Site, including a forested community, an old field community, a maintained field community, and a wetland type vegetated community (plant species that may be found in wetlands);

- Six small isolated areas in Area 1 (Figure 4-2) and ten small isolated areas in Area 2 (Figure 4-3) contain plant species that may be found in wetlands (wetland type vegetated community). These areas were located in small surface depressions in the surface of the

Site and are an artifact of landfill construction and settlement and the placement of perimeter berms which obstruct surface water flow, restrict off-site flow of rainwater runoff, and lead to water ponding on Site surfaces;

- Given that the small isolated depressions within Areas 1 and 2 are generally less than one-tenth of an acre in size (actual size varies from 0.01 to 0.36 acres), they do not contain water except after a rainwater event, they do not appear capable of functioning together as a wetland complex, and they are artifacts of landfill construction and subsequent subsidence, McLaren/Hart concluded that no further assessment of these areas was necessary or appropriate to determine whether any of these areas exhibit other necessary characteristics of a wetland; and

- Review of the U.S. Fish & Wildlife Service and Missouri Department of Conservation databases, along with the results of the field inspection, did not indicate that any threatened or endangered species (including the Western Fox Snake) were present in the vicinity of the Site; therefore, no further assessment activities were necessary.

A detailed description of the specific activities completed as part of the threatened or endangered species assessment (including the methods used), as well as the results obtained by McLaren/Hart, can be found in the Threatened or Endangered Species Assessment Report - West Lake Landfill Radiological Areas 1 & 2 (McLaren/Hart, 1996c).

Potential risks to ecological receptors were evaluated as part of the original Baseline Risk Assessment (Auxier, 2000) and the updated Baseline Risk Assessment (Auxier, 2017).

4.3 Surface Gamma Surveys

Six surveys of gamma radiation levels at the Site have been performed prior to and as part of the OU-1 RI/FS, including:

- Aerial flyover performed by RMC for the Nuclear Regulatory Commission (NRC) in 1978 (RMC, 1982);

- Overland gamma surveys performed by RMC for the NRC in 1981 (RMC, 1982);

- Overland gamma survey performed by McLaren/Hart as part of the OU-1 RI field investigations (McLaren/Hart, 1996a);

- Aerial survey performed by EPA in 2013 (EPA, 2013a);

- Various localized overland gamma surveys along the perimeters of Areas 1 and 2 in conjunction with installation of new fencing in 2013 and along access roads and drill

pads in conjunction with the Phase 1A/B/C investigation (FEI, et al., 2014a) performed in 2013 and 2014, the Phase 1D investigation (EMSI et al., 2016b) performed in 2015, and the Additional Characterization of Areas 1 and 2 conducted in 2015; and

- Overland gamma surveys conducted in conjunction with the installation of a non-combustible cover over areas where RIM is present at the ground surface in Areas 1 and 2.

In addition, three radiation surveys have been conducted in off-site areas near the West Lake Landfill, including the EPA survey of the Bridgeton Municipal Athletic Complex (BMAC) conducted in 2014 and MDNR surveys conducted in 2013 and 2015 in areas around the Site.

4.3.1 NRC Gamma Surveys

The 1982 RMC report includes only a brief discussion and a figure of the results of the 1978 NRC flyover overland gamma survey. The actual measurement values are not included, and there is no reference to a specific report associated with the 1978 flyover. A figure prepared by NRC (RMC, 1982) displaying the results of the 1978 aerial survey is included in Appendix A-1. The 1978 aerial survey identified two areas with external radiation levels as high as 100 microRems/hour (µR/hr). These two areas generally appear to correlate with Areas 1 and 2; however, the figure in the NRC report only provides approximate location information for the results of the survey.

RMC (1982) subsequently performed two surveys of external gamma radiation levels: a preliminary survey performed in November 1980 and an additional survey conducted in May and July 1981 (Appendix A-1). These surveys were performed using a 10-meter by 10-meter grid system over Areas 1 and 2 (Appendix A-1). External gamma levels were obtained using a sodium-iodide (NaI) scintillation detector at one meter above ground surface at each grid point (*i.e.*, at each intersection of two grid lines). The NaI count rate was converted to values of µR/hr. A Geiger-Mueller (G-M) portable survey instrument was also used for areas where higher external radiation rates were encountered (RMC, 1982). Beta-gamma measurements were also obtained using an end window G-M tube held one centimeter (1 cm) above the ground surface to identify the presence or absence of surface contamination (RMC, 1982).

The results obtained by the November 1980 survey conducted by RMC are shown on figures included in Appendix A-1 and indicate two areas of elevated external radiation levels where levels exceeded 100 µR/hr at one meter. The results of the May/July 1981 survey are provided on figures included in Appendix A-1 and, according to RMC (1982), indicated that the external gamma levels had decreased significantly between 1980 and 1981, especially in Area 1, due to ongoing activities at the Site which resulted in placement of additional fill material. RMC estimated that approximately 4 feet of sanitary fill had been added to Area 1 and a similar thickness of construction fill had been added to Area 2 between the 1980 and 1981 surveys (RMC, 1982).

4.3.2 McLaren/Hart Overland Gamma Survey

The purpose of the overland gamma survey was to delineate the approximate areal extent of Radiological Areas 1 and 2 and to identify areas of elevated gamma readings ("radiologically affected areas") for investigation during subsequent field activities. Information from the overland gamma survey was subsequently used in finalizing the locations of those soil borings and monitoring well installations that would be located in radiologically affected areas. McLaren/Hart prepared a report for this activity titled Overland Gamma Survey Report - West Lake Landfill Radiological Areas 1 & 2 dated April 30, 1996 (McLaren/Hart, 1996a).

The overland gamma survey was performed by McLaren/Hart in conjunction with Scientific Ecology Group in October/November 1994. The survey area included not only Areas 1 and 2 but also portions of the former Ford property (now the Buffer Zone and Lot 2A2 of the Crossroads Industrial Park) and portions of the Site access roads around the engineering office and the associated parking area (Figure 4-4).

The survey was completed by collecting near-continuous readings on an approximately 30-foot transect spacing. Readings were collected using a 2-inch by 2-inch sodium iodide detector. Measurements were also taken at eight potential background locations. Measurements were obtained at approximately every 1 to 2 seconds at a walking speed of approximately 2 feet per second, resulting in a 1 to 4-foot by 30-foot grid. The resulting data (56,736 readings) were evaluated and computer-processed by McLaren/Hart to depict the areal distributions of the resultant overland gamma readings based upon different assumed background levels.

The results of the overland gamma survey are described in detail in the Overland Gamma Survey Report - West Lake Landfill Radiological Areas 1 & 2 (McLaren Hart, 1996a). Significant findings reached by McLaren/Hart include the following:

- Evaluation and comparison of the results from the eight background locations indicated a wide range of background values;

- A single "site specific" background value could not be derived because of the wide variation in background values. McLaren/Hart suggested a range between 10 and 20 μR/hr;

- The size of the areas defined as two times background was dependent upon the assumed background value. McLaren/Hart prepared five different figures depicting the areas with gamma readings twice the background level based upon background values of 10, 12.5, 15, 17.5 and 20 μR/hr (Appendix A-2);

- McLaren/Hart concluded that the 17.5 and 20 μR/hr values were the most representative of background conditions based upon the generally known locations of the radiological materials at the landfill; and

- Based upon the overland gamma survey, McLaren/Hart identified locations to advance soil borings to collect vertical profiles of the radiologically impacted materials.

Based upon discussions with EPA during preparation of the RI report (EMSI, 2000), the overland gamma survey based on a background value of 15 µR/hr (Figure 4-4) was considered representative of Site conditions.

4.3.3 EPA ASPECT Flyover Survey

The EPA Office of Emergency Management (OEM), Chemical Biological Radiological and Nuclear (CBRN) Consequence Management Advisory Division (CMAD)[26] manages the Airborne Spectral Photometric Environmental Collection Technology (ASPECT) Program. In January 2013, EPA Region 7 requested that the ASPECT Program conduct radiological and infrared surveys over the West Lake Landfill (EPA-OEM-CMAT, 2013). The surveys were conducted on March 8, 2013, between 10:00 a.m. and 12:00 noon. The purpose of the radiological survey was to identify areas of elevated gamma radiation in OU-1 as compared to normal background levels (EPA-OEM-CMAT, 2013). The purpose of the infrared survey was to identity any heat signatures associated with the ongoing subsurface reaction (SSR) in a portion of the South Quarry of the Bridgeton Landfill, which constitutes part of Operable Unit 2 (EPA-OEM-CMAT, 2013).

The infrared survey did not detect any heat signatures that the ASPECT team associated with an SSR. The methods used and results obtained from the infrared survey are further discussed in the ASPECT report (EPA-OEM-CMAT, 2013).

The radiological survey collected about 800 gamma radiation measurements, of which only 10 (or approximately 1.25%) indicated the presence of elevated Bi-214 (which likely indicates the presence of Ra-226) (EPA-OEM-CMAT, 2013).[27] According to the report of the survey results, all of the elevated radiation measurements were detected during the West Lake Landfill survey over 20 contiguous acres associated with Operable Unit 1, Area 2 (EPA-OEM-CMAT, 2013). The EPA's radiological survey results from the 2013 report are included in Appendix A-3.

[26] Previously named the Consequence Management Advisory Team (CMAT) at the time the EPA flyover was conducted at the West Lake Landfill.
[27] Bismuth-214 is the ninth decay product in the Uranium-238 decay chain, and a much stronger gamma emitter than Uranium-238 itself. In this survey, "the Bismuth-214 most likely indicates the presence of Radium-226 (the fifth decay product of Uranium-238) rather than Uranium-238 since the original uranium ore was chemically separated from the rest of its decay products." (EPA-OEM-CMAT, 2013).

4.3.4 Additional Gamma Surveys for OU-1 Post-ROD Investigations

Overland gamma surveys were conducted as part of vegetation clearing and road and drill pad construction conducted in conjunction with the Bridgeton Landfill Thermal Isolation Barrier Phase 1A/B/C investigations performed in 2013 and 2014 (FEI et al., 2014a and EMSI et al., 2016b), the OU-1 Phase1D investigation performed in 2015 (EMSI et al., 2016b) and the Additional Characterization of Areas 1 and 2 (EMSI, 2015e) performed in 2015. Additional overland gamma surveys have been performed in conjunction with installation of a non-combustible cover over areas where RIM is present at or near the ground surface in Areas 1 and 2 (EMSI et al., 2016a).

In order to provide physical access to investigation locations, vegetation clearing and road and drill pad construction was required as part of the Phase 1 and Additional Characterization investigations. Before clearing the vegetation, preliminary alignments for each of the paths were staked by an on-site surveyor in conjunction with performance of an overland gamma scan by an Auxier on-site health physicist. The overland gamma scan was conducted using a Ludlum 2221 ratemeter/scaler mated to a Ludlum 44-10 2x2" NaI detector to survey selected portions of ground surface within and around Area 1. This instrument was operated in the ratemeter mode and was coupled to a Trimble GPS. Using the ratemeter mode allowed the gamma count rate from the instrument to be collected at one-second intervals. The gamma measurement was assigned to its specific measurement location (latitude and longitude) via the Trimble GPS.

The overland gamma survey results obtained as part of the Phase 1A/B/C and the Phase 1D investigations are presented in Appendix M of the Comprehensive Phase 1 Report of Investigation of Radiological Area 1 (EMSI et al., 2016b). Graphical portrayals of the results obtained from these surveys and the subsequent surveys performed as part of the Additional Characterization of Areas 1 and 2 are presented in Appendix A-4.

Overland gamma surveys were conducted in Areas 1 and 2 during the first half of 2016 in conjunction with construction of a non-combustible (road base) cover over areas where RIM is present at or near the ground surface. These surveys were performed along the margins of the areas covered, or to be covered, by the road base material. These surveys were conducted using the same equipment and procedures that were used to perform the overland gamma surveys during the Phase 1 investigations of Area 1. The results of these surveys are included in Appendix A-7.

4.3.5 EPA Gamma Surveys of Bridgeton Municipal Athletic Complex

In May 2014, EPA, through the Tetra Tech, Inc. (Tetra Tech) Superfund Technical Assessment and Response Team (START), collected gross gamma measurements of exterior surfaces at the Bridgeton Municipal Athletic Complex (BMAC) and two reference areas (Koch and Blanchette parks). BMAC is located approximately one mile to the northeast of the West Lake Landfill.

Koch park is located approximately 5 miles to the northeast of West Lake Landfill and Blanchette park is located approximately 2.75 miles to the northwest of West Lake Landfill.

Due to natural variations in radiation levels, the gross gamma survey was split into three surface types: grass-covered areas, exposed soil areas, and improved surfaces. A total of 58,716 data points were acquired across the BMAC site. The survey data were generated using a Ludlum Model 2221 ratemeter with a Ludlum Model 44-20 sodium iodide scintillation detector, coupled with a global positioning system (GPS) unit. The survey was performed by having the surveyor walk at a rate of 1 to 2 feet per second along transects spaced approximately 3 meters apart. The detector was held at a consistent 6 inches above ground surface. Figures and summary tables included in the EPA report (Tetra Tech, 2014b) to present the results of the gamma survey are included in Appendix A-5. According to EPA, geographic plots of the data revealed natural differences in gamma activity exhibited by the different surface materials and no unusual patterns or concentrated discrete areas of elevated gross gamma activity were observed (Tetra Tech, 2014b).

The EPA report evaluated three pathways at the park by which human receptors (that is, park visitors and on-site workers) could possibly come into contact with radiological materials: surface water, soil exposure, and air migration. EPA concluded that a release to each of these pathways was unlikely because no significant findings resulted from the sampling efforts. EPA also concluded that none of the survey data acquired within BMAC displayed values greater than two times the mean, a level at which EPA Region 7 typically conducts further investigation (Tetra Tech, 2014b).

4.3.6 MDNR Gamma Measurements

MDNR measured gamma levels at various off-site locations around the Site in 2013 and 2015. On May 16, 2013, MDNR personnel measured gamma radiation levels upwind and downwind of the Site using a Ludlum model 2221 with 44-10 sodium iodide probe (MDNR, 2013). The summary table of the results of the MDNR 2013 gamma measurements and the figure showing the measurement locations that are contained in the MDNR report (MDNR, 2013) are included in Appendix A-6. According to MDNR, measurements collected from the downwind locations were consistent with measurements collected at the upwind, or background, locations (MDNR, 2013).

MDNR collected additional gamma measurements in November 2015 (MDNR, 2016). These data were used to support selection of locations for collection of soil and dust swipe samples by MDNR. The same type of instrument used for the 2013 gamma measurements was used for the 2015 gamma measurements. According to MDNR, survey values revealed the vast majority of instantaneous readings in each area fell in the lower range of the detected values for gamma radiation, with brief fluctuations to comparatively higher values. Soil sample location S02, located in the vicinity of some brick and other construction debris on private property immediately adjacent to the north side of Area 2, and soil sample location S10 located at the toe

of the slope on Area 2, reportedly had some persistent readings approximately 20% to 30% higher than other readings in the same areas (MDNR, 2016). The summary table of the results of the MDNR 2015 gamma measurements and the figure showing the measurement locations, from the MDNR report (MDNR, 2016), are included in Appendix A-6.

4.4 Soil Borings and Logging

Soil borings were drilled in Areas 1 and 2 in conjunction with the following investigations:

- NRC (RMC, 1982) investigation;
- 1995 OU-1 (McLaren/Hart, 1996h) field investigations;
- 1997 Additional investigations (EMSI, 1997e and 2000);
- 2014 Phase 1C investigation (FEI et al., 2014a);
- 2015 Phase 1D investigation (EMSI et al., 2016b);
- 2015 Additional Characterization of Areas 1 and 2 (EMSI, 2015e);
- Additional borings drilled to collect samples for testing to support fate and transport evaluations (SSPA, 2015a); and
- Additional borings drilled in conjunction with the 2015 Additional Characterization of Areas 1 and 2, and in accordance with a work plan developed by Cotter Corporation (Arcadis, 2015).

To date, a total of 314 soil borings have been drilled in Areas 1 and 2, including in 84 soil borings and 112 gamma cone penetrometer (GCPT) soundings in Area 1, 88 soil borings and 5 hand auger borings in Area 2, and 10 soil borings and 15 hand auger borings on portions of the former Ford property (now the Buffer Zone and Lot 2A2 and Lot 2A1 – AAA Trailer) (Table 4-1). Figure 4-5 presents the locations of the various soil borings and GCPT soundings drilled in or near Area 1. Figure 4-6 presents the locations of the various soil borings drilled in or near Area 2. Table 4-2 provides the surveyed location and elevation data for the various borings.

Surveying at the Site has been performed using a local survey coordinate system that is a slight modification of the 1927 Missouri East State Plane Coordinate System (SPCS). In November 2016, Weaver Consultants surveyed the local (Site) control points and rotated them in AutoCAD to the state plane coordinates that were surveyed at the same time. Based on this rotation, survey information developed in and tied to the Site control system can be converted to 1983 Missouri East state plane coordinates by adding 40.97 feet to the northing, adding 320174.7 feet to the

easting, and subtracting 0.402 feet from the elevation. Missouri East state plane coordinates calculated using this method are included on Table 4-12 which summarizes the survey data for all of the soil borings and GCPT soundings.

4.4.1 RMC Investigation Soil Borings (1981)

In 1981, RMC, on behalf of NRC, reportedly drilled 43 auger borings at West Lake Landfill including 11 in Area 1 and 32 in Area 2; however, the RMC 1982 report only contains measurements and data for 41 borings. Figure 9 of the 1982 RMC report displays locations for 10 borings in Area 1 (24-29, 36-38 and 41) and Figure 10 of the report displays locations for 30 borings in or near Area 2 (2-23, 30-35, and 39-40). The figures from the 1982 RMC report showing the locations of the NRC borings are included in Appendix C-1. The RMC report did not include survey data or detailed figures of the boring locations, and the figures in the report only approximately match the actual areas. RMC installed 4-inch diameter poly-vinyl chloride (PVC) casing in each boring to facilitate downhole logging. The RMC report (RMC, 1982) does not contain any information regarding the specific drilling equipment that was used, sample collection methodology, or decontamination procedures employed during the drilling and sampling activities. The report also does not contain any boring (geologic) logs or other descriptions of the materials encountered or any information on the total depth drilled or the depth of the PVC casings that were installed. The locations of the RMC soil borings are provided on generalized figures of Areas 1 and 2 (Appendix C-1); however, no survey data are included in the RMC report. (RMC, 1982).

RMC reports that each hole was scanned with a 2-inch by 2-inch NaI activated with thallium (Tl) scintillation detector and rate meter system (RMC, 1982). The logging results from the RMC report (RMC, 1982) are provided in Appendix C-1. Representative holes were then logged using an *in-situ* gamma measurement system consisting of an intrinsic germanium (IG) detector coupled to a multichannel analyzer (MCA) to provide qualitative and quantitative radioisotope data in lieu of collecting core samples and submitting them for laboratory analyses. Measurement intervals ranged from 6 to 24 inches, depending on factors such as hole depth and activity (RMC, 1982). The RMC IG logging results (RMC, 1982) are provided in Appendix C-1.

During the OU-1 RI field investigations in 1995, McLaren/Hart located the PVC casings in Area 1 and many of the PVC casings in Area 2 associated with the NRC borings and obtained survey data for those locations (McLaren/Hart, 1996h). Specifically, McLaren/Hart located the PVC pipes that RMC installed in its borings including all 10 RMC borings in Area 1 and 18 of the 31 borings (borings 4-13, 18-20, 33-35, and 39-40) in Area 2. The locations of these borings are shown on Figures 4-5 and 4-6. The approximate locations of all but one of the remaining NRC borings are also shown on these figures based on a best-fit translation from the figures in the RMC report[28].

[28] The figures in the RMC report do not include the location of RMC boring 1.

4.4.2 OU-1 RI Soil Boring and Logging (1995)

As part of the OU-1 RI field investigations conducted in 1995, McLaren/Hart drilled and logged over 60 soil borings in Areas 1 and 2. McLaren/Hart's soil boring and logging investigation included the following:

- Pre-screening of each soil boring location within the landfill for potential large metal obstacles and methane concentrations;

- Drilling of 20 borings in Area 1 and 40 borings in Area 2, including pre-drilling of all planned monitoring wells to be completed through areas underlain by landfill refuse. In addition, five hand borings were drilled and sampled in a closed topographic depression within Area 2; and

- Down-hole radiological logging of all of the newly drilled soil borings and of all existing monitoring wells and cased soil borings remaining from the prior Site investigation (RMC, 1982) that could be located.

The methods and procedures used to complete the soil borings included auger and mud rotary drilling and soil boring advancement, down-hole radiological logging, and soil-boring abandonment. Summary information on each activity is provided below. Detailed descriptions of each field activity and laboratory analysis conducted by McLaren/Hart are contained in the Soil Boring/Surface Soil Investigation Report (McLaren/Hart, 1996h).

Surface geophysical surveying, consisting of a non-intrusive total magnetic surface survey, was performed at each of the McLaren/Hart planned boring locations in Areas 1 and 2. Geotechnology of St. Louis, Missouri using a GEM GSM-19 magnetometer/gradiometer, completed the surface geophysical survey. The objective of the surface geophysical surveys was to identify the spot within 30 feet of each proposed location within Areas 1 and 2 with the lowest potential for buried ferromagnetic debris. Final borings were then advanced at the selected locations. Further details related to the surface geophysical surveys are presented in the Soil Boring/Surface Soil Investigation Report (McLaren/Hart, 1996h).

A total of 20 soil boring locations were ultimately drilled by McLaren/Hart in Area 1 (WL-101 through WL-120), and 41 soil borings (WL-201 through WL-241) plus five hand-auger borings (WL-242 through WL-246) were drilled in or near Area 2 (includes 8 borings drilled on the former Ford property adjacent to Area 2). (McLaren/Hart, 1996h). To avoid creating a conduit for leachate migration, any boring that encountered perched water (see discussion in Section 4.6 below) was abandoned prior to reaching total depth and a new boring was drilled outside of the area of perched water. In addition, at several locations, multiple borings were drilled due to encountering auger refusal at shallow depths or to loss of the boring due to caving of the borehole walls or flowing sands encountered in the alluvial materials beneath the landfill deposits.

In addition, five hand-auger borings (WL-242 through WL-246) were advanced to depths of one to two feet in and around a closed topographic depression near the northern landfill berm in the northeastern portion of Area 2. These five hand-auger borings were recommended in the Overland Gamma Survey Report (McLaren/Hart, 1996a).

Three different drilling methods were utilized during the soil boring activities. Borings in areas underlain by landfill debris were advanced to the bedrock contact using a 24-inch diameter truck mounted auger. Borings in areas not expected to be underlain by landfill debris (*i.e.* the Ford property) were advanced with a hollow-stem auger drill rig. Shallow borings located in the closed topographic depression in the northern portion of Area 2 were manually advanced with a hand-auger. All of the drill rig-advanced soil borings were drilled using the procedures proposed in the RI/FS Work Plan. (McLaren/Hart, 1996h).

Organic vapor, explosive gas and gamma radiation measurements were obtained in the field during the advancement of each soil boring using a photo-ionization detector (PID), an oxygen/combustible gas indicator, and a Geiger/Mueller instrument, respectively. Field measurements were generally made at 5-foot intervals during drilling and when visual changes in the drill cuttings were observed. (McLaren/Hart, 1996h).

Samples of the materials encountered during the McLaren/Hart OU-1 drilling were routinely collected at 5-foot intervals from each large diameter and hollow-stem auger borings. Two samples per boring were subsequently selected for laboratory analyses based on the results of the downhole gamma logging of each boring. Samples from the hand-auger borings were obtained from depths of one to three feet (McLaren/Hart, 1996h). Samples selected for priority pollutant analyses were collected by McLaren/Hart from the bottom of the borings in the lower portion of the landfill debris, generally at the same depth as the lower radiological sample collected in each boring. Contingency samples were collected based on visual observations, odor and field monitoring (McLaren/Hart, 1996h). Surface soil samples were collected from the upper two inches of soil cover, except for those samples selected for VOC analyses, which were collected from a depth of 18 to 24 inches below ground surface (McLaren/Hart, 1996h).

Down-hole radiological logging was performed at the completion of each soil boring and pre-drilled monitoring well location. All accessible cased soil borings and monitoring wells from the earlier RMC investigation (RMC, 1982) identified in Areas 1 and 2 were also logged. McLaren/Hart used a Mount Sopris MGX digital logger and a combination Stratigraphic Gamma/Electric Probe instrument to perform the logging. All logging activities were completed according to the protocols presented in the RI/FS Work Plan (McLaren/Hart, 1994) with the minor exceptions noted below. Detailed information regarding the downhole radiological logging of the soil borings is presented in McLaren/Hart's Soil Boring/Surface Soil Investigation Report (McLaren/Hart, 1996h).

Upon completion of the drilling and sampling activities conducted by McLaren/Hart, all of the soil borings, except for those used for construction of monitoring wells, were abandoned.

(McLaren/Hart, 1996h). After backfilling, all of the soil boring locations were surveyed for location. Exceptions included WL-110, which was obstructed by equipment at the time the survey was performed, and the hand auger borings, which were drilled after the surveying activities had been completed. (McLaren/Hart, 1996h).

Detailed lithologic logs were prepared for each machine-advanced boring. The lithologic logs include descriptions of the soil and bedrock materials encountered and classification based on the Unified Soil Classification System. The McLaren/Hart soil boring logs are presented in Appendix B-1. The McLaren/Hart downhole gamma logs from these borings are contained in Appendix C-2. Tables 4-3a and 4-3b summarize the results of the downhole logging. Additional details regarding the drilling procedures and results of the RI boring program are presented in McLaren/Hart's Soil Boring/Surface Soil Investigation Report (McLaren/Hart, 1996h).

4.4.3 Supplemental OU-1 RI Soil Boring, Logging and Sampling (1997 and 2000)

At the request of EPA, EMSI conducted supplemental surface and subsurface soil investigation activities to assess the lateral extent of constituents in the southwestern portion of Area 1. The supplemental activities were described in a letter to EPA (EMSI, 1997b), which responded to EPA's comments on the ASAP (EPA, 1997b). Detailed descriptions of the supplemental field activities conducted by EMSI can be found in the letter from EMSI to EPA dated April 29, 1997 (EMSI, 1997b) and the Site Characterization Summary Report (SCSR) for OU-1 (EMSI, 1997e).

The supplemental investigations entailed, in part, drilling of four borings (WL-121, -122, -123 and -124) in the southwestern portion of Area 1. EMSI advanced an additional four soil borings on May 13 and May 14, 1997, in accordance with the procedures contained in the approved ASAP. All four borings were advanced using a hollow-stem auger until alluvial materials were encountered. Because these borings only extended to the base of refuse, detailed boring logs were not prepared (EMSI, 1997e).

Each boring was logged by CoLog using gamma-gamma and natural gamma tools. CoLog also used a Mount Sopris MGX digital logger and a combination Stratigraphic Gamma/Electric Probe instrument to perform the logging of the four borings drilled as part of the ASAP implementation. All logging activities were completed in general accordance with the protocols presented in the RI/FS Work Plan. Results of the downhole logging were evaluated in the field as they were obtained and final downhole logs were not prepared by CoLog. All four of the borings advanced by EMSI were abandoned using the procedures presented in the EPA-approved RI/FS Work Plan (McLaren/Hart, 1994).

Soil samples were collected at the surface and submitted for radiological analysis (EMSI, 1997e). Although collection of subsurface soil samples for radiological analyses was specified in the ASAP, discrete layers of soil were not encountered in these borings. As a result, subsurface soil samples were not obtained and submitted for radiological analyses from these borings. Furthermore, the field team performing this evaluation concluded that downhole

gamma readings were not elevated sufficiently above baseline to require collection of samples. Because printed downhole logs were not prepared by CoLog, the available information does not allow for an independent evaluation of this conclusion.

In addition to the four soil borings drilled in Area 1, eight hand-auger borings (FP-1 through FP-8) were drilled by EMSI to depths of 5 feet on the Ford property. A hand auger was advanced at each location and samples were collected from the hand auger boring at depth intervals of 0-3 inches, 3 to 6 inches, 6 to 12 inches, 1 to 2 feet, 2 to 3 feet, 3 to 4 feet, and 4 to 5 feet bgs. (EMSI, 1997e). The locations of these eight hand-auger borings are shown on Figure 4-6 ("shallow samples"). Surface and near-surface soil samples were collected from each of these eight locations as part of the 1997 supplemental investigations. Surface samples were collected at a depth interval between 0 to 3 inches below ground surface (bgs) at each location.

In November 1999, third parties scraped the vegetation and surface soil on Lot 2A2 and the Buffer Zone to a depth of approximately 2 to 6 inches. The removed materials were piled in a berm along the southern boundary of the Buffer Zone, adjacent to the northwestern boundary of the West Lake Landfill. A small amount of removed materials was also placed in a small pile on Lot 2A2 near the base of the landfill berm along the east side of Lot 2A1. Upon discovery of these surface soil relocation activities, additional surface soil samples (RC-01 through RC-07) were collected from the Buffer Zone and Lot 2A2 in February 2000.

Inspection of the Buffer Zone in May 2000 indicated that native vegetation had been re-established over both the disturbed area and the stockpiled materials. The presence of native vegetation over these materials was determined to be sufficient to prevent windblown or rainwater runoff dispersal of these materials. A 2004 inspection of this area indicated that additional soil removal/regrading had been performed on the remaining portion of Lot 2A2 and the adjacent Buffer Zone property. These activities appear to have resulted in removal of the soil stockpiles created during the previous regrading activity, removal of any remaining soil on Lot 2A2 and the Buffer Zone not scraped up during the 1999 event, and placement of gravel over the entirety of Lot 2A2 and the Buffer Zone. According to AAA Trailer, all of the soil removed during the July 1999 grading work and the May 2003 installation of the gravel layer was placed in the northeastern corner of the Buffer Zone (terra technologies, 2004). The OU-1 Respondents subsequently installed a fence between the Buffer Zone and Lot 2A2 to prevent any future disruption of the Buffer Zone.

In 2015, MDNR collected a soil sample (S-09) from the southwestern portion of Lot 2A2 Parcel C (MDNR, 2016). In 2016, Feezor Engineering, Inc. and EPA collected a soil/sediment sample (SEDIMENT 2016-03-16B) from southernmost portion of Lot 2A1 (*i.e.*, the AAA Trailer facility property). Other than these two samples, sampling of soil on the Buffer Zone and Lot 2A2 has not been performed since the most recent (May 2003) grading work. Therefore, the levels and extent of radionuclides, if any, that may remain in the soil on the majority of the Buffer Zone and Lot 2A2 properties are not known with certainty. Additional soil sampling to determine current conditions with respect to radionuclide occurrences in soil on the Buffer Zone and Lot 2A2 soil is expected to be conducted as part of implementation of the selected remedy for this area.

4.4.4 EPA Downhole Gamma Logging (2012)

In November 2012, EPA conducted downhole gamma logging in 68 OU-1 and OU-2 groundwater monitoring wells. This work was performed pursuant to the August 2012 Quality Assurance Project Plan (QAPP) for Surface Gamma Scans and Down-hole Gamma Scans, West Lake Landfill OU-1 (EPA, 2012a). Due to the presence of extensive vegetative cover, the surface gamma scan portion of the work described in the QAPP was not performed. Instead, a flyover survey was conducted (as previously discussed in Section 4.3.3).

According to the QAPP, the down-hole gamma scans were to be conducted using a Ludlum Model 2241-3 with a 44-62 detector. The detector was to be lowered to the bottom of each accessible well or to a maximum depth of 150 feet, whichever was less. The detector was then to be raised in one-foot increments and measurements were to be recorded at each interval using the scaler set for a 6-second count. A report of the results of the downhole logging was not prepared; however, EPA did provide a spreadsheet of the results of the downhole logging. This spreadsheet is included in Appendix C-3.

4.4.5 Phase 1 Investigations (2013-2015)

The Phase I investigation was initially undertaken at the direction of EPA, and on behalf of Bridgeton Landfill, LLC, to support selection of possible locations and development of certain selected primary criteria for a potential thermal isolation barrier (IB) between the West Lake Landfill Area 1 and the adjacent (and in part overlying) waste materials in the North Quarry area of the Bridgeton Landfill. During the course of the investigation, the project scope was expanded, at the direction of EPA and on behalf of the OU-1 Respondents, to incorporate the task of more broadly defining the extent of RIM in the southern and southwestern portions of Area 1 (EMSI, et al., 2016b).

Phase 1 field investigations were conducted in four phases, including:

- Phase 1A – Gamma Cone Penetrometer (GCPT) investigation performed by Feezor Engineering, Inc. in November 2013 (FEI, et al., 2013);
- Phase 1B – GCPT investigation performed by Feezor Engineering, Inc. in January and February 2014 (FEI, et al., 2013);
- Phase 1C – Sonic drilling and direct-push boring and soil/waste sampling program performed by Feezor Engineering, Inc. in January and February 2014 (FEI, et al, 2014); and
- Phase 1D – GCPT investigation and Sonic boring and soil/waste sampling program performed by EMSI and others in May through July 2015 (EMSI, et al., 2016b).

Phases 1A, 1B and 1C included a total of 90 testing site locations, including 84 new boring and GCPT sounding locations and 6 locations adjacent to prior borings that were re-tested to verify the effectiveness of the GCPT technique and to provide correlation between the GCPT results and the previous investigation (*i.e.,* RI and NRC) results. An additional 20 boring locations were added as part of the Phase 1D investigation.

All of the Phase 1 investigations were performed pursuant to the following work plans which were submitted to and approved by EPA:

- Bridgeton Landfill – West Lake Landfill Gamma Cone Penetration Test (GCPT) Work Plan, Revision 2, September 27, 2013 (FEI et al., 2013);

- Core Sampling (Phase 2) Work Plan Bridgeton Landfill – West Lake Landfill, November 19, 2013 (FEI, 2013);

- Core Sampling (Phase 1B, 1C, and 2) Work Plan, Revision 1, January 8, 2014 (FEI et al., 2014); and

- Phase 1D Investigation – Additional Characterization of Extent of Radiologically-Impacted Material in Area 1: Revised Addendum to Phase 1 Work Plans for Isolation Barrier Investigation, West Lake Landfill Operable Unit-1, Bridgeton, Missouri (EMSI, 2015b).

A Phase 2 Core Sampling Work Plan was also prepared by Feezor Engineering, Inc. in 2013, the stated purpose of which was to collect and analyze soil core samples for the presence or absence of RIM as well as to confirm the characteristics of the subsurface material along the proposed thermal isolation barrier alignment (FEI, 2013). Based on the results of the Phase 1 investigation, however, the Phase 2 investigation was determined by EPA to not be necessary, as any further required geotechnical data would be obtained as part of Isolation Barrier (IB) design activities to be performed in support of the selected IB alignment (EPA, 2016c).

Field activities conducted as part of the Phase 1 soil investigation included the following:

- Vegetation clearing;
- Surface gamma scanning;
- Access road and drill pad construction;
- Surveying;
- Gamma Cone Penetrometer (GCPT) soundings;
- Soil borings and downhole logging;
- Collection of core or other soil samples; and
- Gamma and alpha (Phase 1D only) scans of the core material.

4.4.5.1 Gamma Cone Penetrometer (GCPT) Soundings

A total of 112 Gamma Cone Penetrometer soundings were conducted in Area 1 as part of the Phase 1A, Phase 1B and Phase 1D investigations for assessing an alignment for a potential thermal isolation barrier at the Site and, in the case of Phase 1D, evaluating the extent of RIM. ConeTec, Inc. performed all of the GCPT soundings. The locations of the GCPT soundings are shown on Figure 4-5. Additional detailed information regarding the GCPT investigations can be found in the Comprehensive Phase 1 Report (EMSI et al., 2016).

As part of the GCPT investigations, data were collected regarding the presence of elevated gamma levels and the stratigraphy, nature, and geotechnical properties of the subsurface materials, as well as liquid levels, in support of the preliminary design of the thermal IB system. Tip force, sleeve force and pressure were all recorded as the Cone Penetration Test (CPT) drill rods were advanced by pushing the instrument package downward through the waste materials and underlying alluvial deposits to the target depths at each location. Readings were taken at intervals not exceeding 5 cm. Application of the CPT technology and the CPT's soil behavior types (SBT) was not designed for or intended for characterizing non-native geologic materials such as MSW. This technology was utilized as a way of identifying the base of trash/top of alluvium or bedrock. Interpretation of specific lithologies or waste materials based on the CPT responses obtained during the Phase 1 investigation is only considered to be an approximate, qualitative indication of the potential materials encountered and the depth intervals to the interfaces between the various materials within the overall waste mass.

During each sounding, gamma radiation logging was performed using a proprietary device that is included in the equipment tool string behind the CPT probe. The device used a Cesium Iodide crystal, which differs from a typical downhole logging gamma detector in that it is part of the push rod system and therefore has greater shielding owing to the greater thickness of the surrounding drill rod walls, and is also smaller in diameter than a typical downhole logging tool in order to allow the gamma detector to fit inside the drill rod. The validity of the GCPT method for identification of RIM was verified by drilling and logging within, or adjacent to, prior boreholes where RIM was encountered during previous investigations.

Before conducting each GCPT sounding, a response check of the GCPT was performed with a check source (potassium carbonate [K_2CO_3] which contains the naturally occurring radioisotope potassium-40). In addition, an instrument baseline/ background reading was also obtained before each sounding by inserting the tool string into a thick lead shield cylinder. These instrument response checks were performed by ConeTec personnel as part of the routine GCPT sounding activities. The software used to record the GCPT sounding data would not allow the ConeTec crew to proceed with any sounding activities until acceptable instrument response checks had been completed.

In addition to the instrument response checks, the ability of the GCPT equipment to identify elevated gamma levels was also checked prior to each phase of the GCPT investigation. Specifically, the GCPT rig was taken to one or more prior NRC investigation locations that also

had been subjected to downhole gamma logging by McLaren/Hart during the 1995 RI investigation. Three known elevated NRC (RMC, 1982) soil boring locations (PVC-28, PVC-25 and PVC-36) were used to test the correlation between the GCPT gamma responses to gamma activity levels identified by prior 1995 RI downhole gamma logs. Although the magnitude of the responses may have varied slightly, the GCPT sounding identified an elevated subsurface gamma response at approximately the same intervals as those identified by the RI logging, indicating that the GCPT device was capable of detecting elevated gamma radiation in the subsurface. These results validated the use of the GCPT device as a screening tool for identifying RIM in the subsurface.

During the course of the Phase 1A investigation, CPT soundings were also performed adjacent to three prior 1995 RI borings (WL-108, WL-111, and WL-119) in order to correlate the CPT data to known subsurface conditions. Correlation of the CPT data to subsurface conditions primarily focused on identification of the boundary between waste materials and underlying alluvial deposits.

Upon completion of the calibration checks, the GCPT was set up at each investigation location and the GCPT tool was pushed through the waste materials and the underlying alluvium to the total depth of each sounding while simultaneously recording the readings from the CPT and gamma tools. Instrument readings were obtained at approximately 5 centimeter intervals as the tool string was pushed downward through the waste materials and underlying alluvial deposits. Instrument readings were viewed on screens within the GCPT rig and were collected by an automated digital recorder in the rig that was electronically connected to the downhole tools.

Upon completion of the GCPT soundings, each sounding hole was backfilled with bentonite pellets. The actual GCPT sounding locations were subsequently surveyed.

The GCPT data were used as a screening tool. A field screening value of 200-250 cps was developed in the field based on review of the results from the initial GCPT soundings. This field screening value was based in part on the 12,000 counts per minute (cpm) [200 counts per second (cps)] screening level used in the field for clearing the ground surface in the various work areas. This value is also approximately two times the value of 6,000 cpm (100 cps) baseline gamma readings observed during the downhole gamma scans performed during the RI (*i.e.*, the baseline or "background" gamma level observed on the downhole logging results for borings or boring intervals that did not encounter RIM during the RI). Use of the 200-250 cps value as an appropriate field screening level was subsequently verified by the results of the Phase 1 field soil/waste sampling and laboratory analyses and downhole gamma logging of the Phase 1 borings.[29]

[29] The primary purpose of this field screening value was to provide the field crew with an initial indication of sounding locations/depth intervals where RIM may be present, and it should not be used or otherwise interpreted as a basis for making a final determination as to actual occurrences of RIM. Note that use of this field screening value results in instances of false positives - that is, a determination that RIM may be present which is not subsequently confirmed by other investigative results such as the downhole gamma logging, core scans or laboratory analyses.

A total of 68 GCPT soundings were completed between November 13, 2013 and November 25, 2013 during the Phase 1A investigation. Because the results of the Phase 1A GCPT investigation indicated that RIM may be present outside of the previously defined extent of RIM, an additional phase of GCPT investigation was performed. The objective of this subsequent investigation (Phase 1B) was to further define the boundary of the elevated gamma readings along the southwestern portion of OU-1 Area 1. In addition, some of the Phase 1A GCPT soundings encountered refusal at shallow depths due to the presence of inert fill. During Phase 1B, a Sonic drill rig was used to drill through the 4- to 10-foot layer of inert fill at these locations to allow the GCPT tool string to be hydraulically pushed through the underlying waste materials.

ConeTec, Inc. also performed the GCPT soundings for the Phase 1B investigation. The same staff from ConeTec from the Phase 1A investigation returned to conduct the Phase 1B investigation. GCPT soundings were performed at a total of 26 locations between January 29, 2014 and February 20, 2014. The same procedures were used to perform the Phase 1B investigation as had been previously used to perform the Phase 1A investigation. A calibration check was performed by re-logging PVC-25 (GCPT PVC-25R). In addition to re-verifying the performance of the GCPT tool at the PVC-25 location, an additional GCPT sounding (GCPT 2-2C) was also performed at location 2-2 for comparison to the Phase 1A results. Although the observed gamma levels differed slightly, most likely due to spatial variability in the RIM activity levels, both soundings (GCPT PVC-25R and GCPT 2-2C) detected elevated gamma readings at approximately the same depth interval as those previously identified, verifying the performance of the GCPT for RIM identification.

Based on review of all of the results obtained from the Phase 1A, 1B and 1C investigations, EPA determined (EPA, 2015b) that additional investigation was needed to further characterize the lateral extent of RIM in the western and southwestern portions of Area 1. Therefore, the Phase 1D GCPT investigation and associated Phase 1D soil boring program were performed by the OU-1 Respondents to complete the assessment of the extent of RIM in this portion of Area 1. The procedures used for the Phase 1D investigation were the same as those used for the prior Phase 1 investigation. The Phase 1D investigation included performance of GCPT soundings at 18 locations between May 12, 2015 and May 20, 2015.

Results of the Phase 1 GCPT soundings are presented in Appendix B. A total of 68 soundings were completed during the Phase 1A investigation and 26 soundings were completed during the Phase 1B investigation. The Phase 1A/1B GCPT sounding data are presented in Appendix B-1. The relevant pore water pressure dissipation tests obtained during Phase 1A and 1B are included in Appendix B-2. Results of the Phase 1D GCPT investigation are presented in Appendix B-3 (GCPT soundings) and Appendix B-4 (pore water dissipation tests). The GCPT depths, maximum gamma readings and the depths associated with the maximum gamma readings are summarized in Table 4-3a and presented graphically on Figure 4-7. Additional information and details regarding the procedures used to perform the GCPT soundings and the results obtained are presented in the Comprehensive Phase 1 Report (EMSI et al., 2016b).

4.4.5.2 Phase 1C and 1D Soil Borings and Downhole Logging

A Sonic rig was used to drill borings and collect core samples from select locations in Area 1 as part of the Phase 1C and Phase 1D investigations.

During Phase 1C, 16 Sonic borings were drilled, and an additional 20 borings were drilled during Phase 1D. Sonic borings drilled during Phase 1C included 1-2, 2-2, 5-3, 8-1, 12-5, 13-3, 13-6, 14-2, 14-4, 14-5 14-7, 15-2, 16-3, 16-6, 1C-6, and WL-119. These borings were drilled over the period from January 14, 2014 through February 25, 2014.

The intended purpose of the borings was to:

- Identify the bottom of waste;
- Collect soil/waste samples from intervals where elevated gamma responses were observed to verify that such responses were due to the presence of radium, thorium and/or uranium as opposed to other possible sources of gamma radiation such as potassium-40; and
- Verify the absence of RIM in areas where the GCPT did not detect elevated gamma levels (FEI, et al., 2014, FEI, 2014b, and EMSI et al., 2016b).

Once each borehole reached its total depth, a temporary 2-inch diameter PVC pipe fitted with an end cap was inserted into the hole to prevent its collapse. A 1-inch sodium-iodide (NaI) probe with a long cable was lowered into the casing and used to record 1-minute gamma radiation measurements at half-foot (6-inch) intervals along the length of each borehole. These measurements were recorded in cpm and the depth of each measurement was recorded as depth below ground surface (bgs). This “gamma log” was used to identify the depth bgs of the subsurface soil layers producing elevated radiation levels. Downhole gamma logs obtained during the Phase 1C investigation are presented in Appendix C-5. Tables 4-3a and 4-3b summarize the results of the downhole logging.

A geologist/field engineer inspected and geologically logged the core samples obtained from each boring. Sonic drilling boring logs for the Phase 1C borings are included as Appendix B-2. Photographic logs of the Phase 1C core samples were also assembled for each boring and are included in Appendix B-3.

Concurrent with borehole logging, radiation levels from the soil core were determined by taking 1-minute integrated gamma measurements at 1-foot intervals along the length of each core sample using a Ludlum Model 2221 meter coupled to a Ludlum 44-20 3x3 inch NaI detector (FEI, 2014b and EMSI et al., 2016b). Results of the gamma scans of the Phase 1C core samples are also included on the borehole logging reports in Appendix C-5.

Due to the poor core recovery (low percentage of core obtained per foot of drilling) from some of the borings (in some instances less than 50% of the core was recovered from a particular interval), the listed sample interval may vary from the actual depth from which the sample was collected. The recovered sample material could actually have been obtained from the top of the core run, the bottom portion of the core run, anywhere in between, or could represent a fraction of the material obtained throughout the entire core sample interval. For example, for the five-foot core sample interval extending from 33 to 38 feet bgs in Sonic borehole 5-3, 43 inches of core was obtained from the total 60-inch (5-foot) core sample interval (72% recovery). A sample was collected from the uppermost portion of the recovered core and was identified by a sample interval of 33-34 feet bgs; however, due to the fact that complete core sample (*e.g.*, 100% recovery) was not obtained, the top of the actual sample location could have been as low as 34.5 feet bgs (*i.e.*, if the entire missing core interval of 17 inches or approximately 1.5 feet had been located at the top of the core sample interval, the depth to the top of the sample interval could have been 1.5 feet below the top of the core sample interval) (FEI, 2014b and EMSI et al., 2016b). Thus, there are instances when the core gamma scan, downhole scan, and sampled interval depths may not coincide exactly. However, it is important to note that each core scan corresponds to the sample run number indicated on the borehole log.

Recovery of soil/waste samples was frequently lower than originally expected with the Sonic drilling method, and in some locations samples from target intervals identified by the GCPT investigation were unobtainable. A third drilling technology, percussion direct-push drilling, was therefore deployed to attempt to obtain samples from specific depth intervals that displayed elevated gamma readings in the adjacent GCPT sounding, but from which only poor core recovery was obtained with the Sonic drilling method. Roberts Environmental Drilling conducted percussion direct-push drilling using a Geoprobe 8040-DT. The percussion direct-push drilling was conducted in general adherence to the procedures outlined in ASTM D6282-98, and occurred from March 6, 2014 to March 13, 2014. The Geoprobe 8040-DT used either a 4.5-inch diameter rod (which collected a 3-inch diameter sample) or a 3.5-inch diameter rod (which collected a 1.85-inch diameter sample) to collect 5-foot interval samples (FEI, 2014b and EMSI et al., 2016b).

Several attempts had to be made with the direct-push drill at various locations as a result of the rig encountering refusal due to the presence of an obstruction or other condition that prevented pushing of the direct-push drill down to the targeted depth for a boring. After making several attempts with the direct-push drill, the drilling method was modified to incorporate blind drilling (*i.e.*, no sample collection) down to the targeted depth interval followed by use of the sample collection tool to attempt to obtain a core sample that extended from a few feet above to just below the targeted sample interval. Specifically, the term “blind drilling” means that rather than collecting and logging samples over the full length of the boring, the boring was rapidly advanced to the targeted depth interval without any logging or sampling being performed, at which point collection of samples and detailed geologic logging we conducted. Use of this procedure was considered appropriate because the borings that were “blind drilled” were offset from prior borings that had been drilled, sampled and logged, but from which no recovery was obtained from the interval suspected to contain RIM. Blind drilling was performed because the

direct-push sampler would often be clogged by various items within the trash or by small rocks, resulting in refusal. Fifteen direct-push borings were drilled at the following nine locations: 1-2, 1C-2RA, 1C-6T1, 2-2, 2-3, 1C-4R (2 Locations), 1C-12 (3 Locations), 8-1 (2 Locations), and WL-119 (3 Locations) (FEI, 2014b and EMSI et al., 2016b).

Additional information and details regarding the Phase 1C investigation can be found in the December 2014 Bridgeton Landfill Thermal Isolation Barrier Investigation Phase 1 Report (FEI, 2014a) as well as the Comprehensive Phase 1 Report (EMSI, et al., 2016b).

The same Sonic drilling procedures were used to drill and log the 20 Phase 1D borings (1D-1 through 1D-20). Drilling of the Phase 1D borings began on June 3, 2015, and was completed on July 15, 2015. Sonic drilling boring logs for the Phase 1D borings are included as Appendix B-4. Photographic logs of the Phase 1D core samples were also assembled for each boring and are included in Appendix B-5. Downhole gamma logs from the Phase 1D investigation are presented in Appendix C-6. One modification was made to the procedures used to perform the Phase 1D core scans: the Phase 1D cores also underwent alpha scanning, in addition to the gamma scanning procedures used for the Phase 1C cores. The purpose of the alpha scans was to provide an indication of the presence of non-gamma emitting radionuclides such as thorium. The results of the Phase 1D alpha and gamma scans of the core samples are presented in Appendix C-6.

Additional information related to the Phase 1D investigation can be found in the Comprehensive Phase 1 Report (EMSI, et al., 2016b).

4.4.6 Additional Characterization of Areas 1 and 2 (2015)

In an April 20, 2015, letter to the OU-1 Respondents (EPA, 2015c), EPA indicated that additional data would be needed from Areas 1 and 2 to better define the extent of RIM in order to evaluate a partial excavation alternative. A work plan for this additional characterization work was prepared for EPA review and comment, and finalized in September 2015 (EMSI, 2015e). The work plan proposed drilling 25 additional borings, including seven in Area 1 and 18 in Area 2.

Drilling these borings was initially attempted in late October and early November 2015 using direct push drilling rigs. These attempts were unsuccessful and ultimately a Sonic drill rig was brought on-site to drill the borings. Drilling activities commenced on November 9, 2015 and were completed by December 18, 2015.

A total of 26 borings[30] were drilled as part of the Additional Characterization work, including seven borings in Area 1 (AC-1 through AC-7) and 19 borings in Area 2 (AC-8 through AC-26). The borings were drilled and core samples obtained using the same equipment as was used to

[30] A twenty-sixth boring was drilled as a step-out boring to AC-20.

complete the Phase 1C and 1D soil borings. The downhole gamma logging was performed using the same procedures, equipment, and personnel that had been used to conduct the downhole logging for the Phase 1D investigation. The same procedures and personnel were used to log the core samples and conduct the core scans, which again included both gamma and alpha scans (EMSI, 2015e).

Boring logs developed from the additional characterization of Areas 1 and 2 are included as Appendix B-6. Photographic logs of the samples obtained from the additional characterization of Areas 1 and 2 are included in Appendix B-7. Downhole gamma logs and core scan results for the 26 Additional Characterization borings are included in Appendix C-7. Tables 4-3a and 4-3b summarize the results of the downhole logging.

4.4.7 Borings for Collection of Samples for Fate and Transport Testing (2015)

Ten direct push soil borings were also drilled during the Additional Characterization investigation to collect samples for testing to support the fate and transport evaluations. These ten borings were drilled adjacent to borings that had been previously drilled as part of the Additional Characterization investigation, the prior Phase 1D investigation, or in some cases adjacent to some of the 1995 OU-1 RI borings. Four of these borings were drilled in Area 1 adjacent to borings AC-1, AC-3, 1D-3, and WL-114 and six of the borings were drilled in Area 2 adjacent to borings AC-16, AC-18, AC-19, AC-21, AC-24 and WL-209.

SSPA determined that to meet sample preservation requirements, these boings needed to be "blind drilled" in order to best obtain and preserve the samples in conditions as close to the ambient geochemical conditions as possible. Because these borings were drilled using the direct push methodology and samples were only collected from specific depth intervals, boring logs were not prepared for these borings; however, all of these borings were drilled adjacent to other additional characterization borings or prior 1995 RI borings for which boring logs are available. In addition, because these borings were drilled adjacent to previously drilled borings, downhole gamma logging was not performed in these borings. Boring logs and downhole gamma results are available for the borings located immediately adjacent to the fate and transport borings are include in Appendices B and C. Results of the testing of the fate and transport samples and the associated evaluation of potential transport of radionuclides at the Site are presented in a separate report (SSPA, 2017b).

4.4.8 Additional Borings Performed by Cotter Corporation (2015)

In 2015, Cotter Corporation (N.S.L.) (Cotter) conducted additional investigations in Areas 1 and 2 beyond those performed for the Additional Characterization of Areas 1 and 2. Specifically, Arcadis U.S., Inc. (Arcadis), on behalf of Cotter Corporation, prepared a Work Plan for Further

Characterization of Extent of Radiological Material in Areas 1 and 2 (Arcadis, 2015) (the Cotter Work Plan). EPA approved the Cotter Work Plan on September 8, 2015.

As set forth in the Cotter Work Plan (Arcadis, 2015), Cotter proposed to drill seven additional borings that were precisely placed in locations adjacent to previously drilled RI borings with detected levels of RIM (Arcadis, 2015). Because two of the locations identified by Arcadis were already being re-drilled as part of the Additional Characterization effort, only five additional borings were ultimately drilled and sampled as part of the Cotter work, including three borings in Area 1 (WL-102-CT, WL-106A-CT and WL-114-CT) and two in Area 2 (WL-209-CT and WL-234-CT). In addition to what was described in the work plan, Cotter personnel inspected the archived core material from the Phase 1C, Phase 1D and the Additional Characterization investigations and selected additional core samples for laboratory testing.

The same procedures, equipment and personnel that were used to drill the borings for the Additional Characterization of Areas 1 and 2 were used to drill the additional borings identified by Cotter. These borings were drilled as part of the field investigations conducted for the Additional Characterization effort.

Boring logs developed from the five borings drilled as part of the Cotter investigation are included as Appendix B-8. Photographic logs of the core samples obtained from the Cotter investigation are included in Appendix B-9. Downhole gamma logs and core scan results for the five Cotter borings are included in Appendix C-8. Tables 4-3a and 4-3b summarize the results of the downhole logging.

Figures 4-7 and 4-8 present summaries of the downhole gamma data obtained from all of the various RI investigations including the McLaren/Hart RI borings, the Phase 1A/1B/1C investigation performed by Feezor Engineering, Inc., the Phase 1D investigation, the Additional Characterization of Areas 1 and 2, and the additional borings drilled for Cotter.

4.5 Soil Sample Collection and Analyses

Soil samples were collected and analyzed as part of the following investigations:

- NRC (RMC, 1982) investigation;
- 1995 OU-1 (McLaren/Hart, 1996f) field investigations;
- 1997 Additional investigations (EMSI, 1997e and 2000);
- 2014 Phase 1C investigation (FEI, 2014b);

- 2014 EPA soil sampling at BMAC; and
- 2015 Phase 1D investigation (EMSI et al., 2016b);
- 2015 Additional Characterization of Areas 1 and 2 (EMSI, 2015e);
- 2015 collection of samples for testing to support fate and transport evaluations (SSPA, 2015a);
- 2015 collection of additional samples by Cotter Corporation (Arcadis, 2015);
- 2015 MDNR soil sampling.

Discussion of each of these investigations follows below.

4.5.1 NRC Soil Samples (1981)

RMC, on behalf of NRC, collected soil samples from Areas 1 and 2. The 1982 RMC report states that total of 61 surface soil samples were collected and analyzed on-site for gamma activity (RMC, 1982). Figures from the 1982 RMC report showing the locations of the surface soil samples are included in Appendix D-1. However, the sample identities included in the summary tables do not match the sample identifications included on the RMC figures. In some cases, the sample identifiers listed on the summary table reflect the coordinates of the grid system used by RMC (Appendix D-1); however, many of the samples are only identified as "SPEC" with only very general descriptions of the locations where the samples were obtained. Accordingly, the exact sampling locations for those samples is uncertain.

According to the RMC report, samples were reportedly normally stored for 10 to 14 days to allow for ingrowth of radium daughters (RMC, 1982). Concentrations of uranium-238 (U-238), radium-226 (Ra-226) [from lead-214 (Pb-214) and bismuth-214 (Bi-214)], radium-223 (Ra-223), lead-211 (Pb-211) and lead-212 (Pb-212) were determined for each sample (RMC, 1982). A summary table prepared by RMC (1982) of the results of the on-site analyses of surface soil samples collected by RMC is included in Appendix D-1. In addition to the on-site gamma analyses, the report (RMC, 1982) states that a set of 12 samples was submitted to the RMC radiochemical laboratories for thorium and uranium radiochemical determinations; however, the report only presents results for 10 samples. Only very general information is provided regarding the samples, and as a result the specific locations where most of the samples for off-site analyses were obtained cannot be determined from the information provided in the report.

A total of 41 borings were reportedly drilled by RMC.[32] The locations of the holes drilled by RMC are shown on figures prepared by RMC that are included in Appendix C-1. The locations of these borings are also included on Figures 4-5 and 4-6. Depths of these boreholes were not provided by NRC. All of the borings were drilled with a 6-inch auger and lined with 4-inch PVC casing. Each hole was scanned with a 2-inch by 2-inch NaI (T1) detector and rate meter system for an initial indication of the location of subsurface contamination (Appendix C-1). A total of 19 of the borings drilled by RMC were subjected to detailed gamma logging using the IG detector and MCA, which allowed for a quantitative determination of specific radionuclide activity levels.[33]

The results of the on-site measurements of radionuclide activities made by RMC are included in Appendix D-1. The data include results for U-238, Pb-214, Bi-214, Ra-226, Ra-223, Pb-212, Pb-211 and potassium-40 (K-40); however, results for all of these radionuclides are not provided for all of the borings. The report states that "[a]n occasional core sample was taken to verify the in-situ measurements and to confirm the presence or absence of non-gamma emitting nuclides such as Th-230"; however, results are only reported for one borehole sample from an unspecified depth interval from borehole 11. Consequently, no thorium data were obtained from the subsurface during this investigation (RMC, 1982). Ra-228 data were also not obtained. It should be noted that, based on review of the data, at least one of the reported results (4.4E9 for Ra-226 in borehole #21) is clearly incorrect and likely reflects a typographical error (*i.e.*, a value of 4.4E9 was mistakenly entered in place of a value of 4.4E0) (RMC, 1982).

4.5.2 OU-1 RI Soil Sample Collection and Analyses (1995-1997)

A total of 176 soil samples were collected and submitted for laboratory analyses during the OU-1 RI, 163 of which were investigative samples and 13 of which were field duplicate samples.[34] A total of 54 samples (48 investigative and 6 field duplicates) were obtained from Area 1 and 80 samples (74 investigative and 6 field duplicates) were obtained from Area 2. A total of 38 samples, including one field duplicate sample, were obtained from the former Ford property. Four background soil samples were also collected (McLaren/Hart, 1996f).

A total of 44 surface soil samples (43 investigative samples plus 1 duplicate) were collected and submitted for laboratory analyses during the OU-1 RI. Surface samples were collected from 21

[32] Page 14 of the RMC report states that a total of 43 holes were drilled (11 in Area 1 and 32 in Area 2); however, the data tables in the RMC report only list 41 borings: 10 in area 1 and 31 in Area 2, and the figures in the RMC report only display 40 borings: 10 in Area 1 and 30 in Area 2 (the location of boring no. 1 is not shown on the figures).

[33] According to RMC's report, these holes were selected based on the initial scans; more specific detail is not provided (RMC, 1982).

[34] According to the McLaren/Hart report, "d]uplicate and matrix spike duplicate samples were randomly selected prior to the start of the drilling program and were collected in the same manner as the sample for which they are a duplicate." (McLaren/Hart, 1996f).

of the McLaren/Hart soil borings: five borings in Area 1, nine borings in Area 2, two borings on the former Ford property and from the five hand-auger borings (WL-242 through WL-246) in Area 2 (McLaren/Hart, 1996h and EMSI, 2000). McLaren Hart also collected surface soil samples from four background locations (McLaren/Hart, 1996h). Surface soil samples were also collected from the four borings drilled in Area 1 by EMSI in 1997 (WL-121 through WL-124) (EMSI, 2000). Sixteen surface soil samples (15 investigative samples plus one duplicate) were collected from the former Ford property as part of the 1997 hand auger boring investigation conducted by EMSI (EMSI, 2000). Seven surface soil samples were collected from Lot 2A2 by Herst & Associates on behalf of EMSI in 2000 (RC-samples). Results of these seven samples were reported to EPA as part of the OU-1 monthly progress report for March 2000 submitted to EPA on April 10, 2000.

A total of 132 subsurface samples (120 investigative samples plus 12 field duplicate samples) were collected as part of the OU-1 RI investigations in 1995. A total of 45 subsurface samples (39 investigative samples plus 6 field duplicate samples) were collected from Area 1 and 67 subsurface samples (61 investigative samples plus 6 field duplicate samples) were obtained from Area 2. A total of 20 subsurface samples were obtained from the former Ford property, including 12 obtained by McLaren/Hart, and an additional 8 samples collected by EMSI in 1997.

Surface soil samples obtained from the machine-drilled borings were collected from the upper two inches of soil material, except for those samples collected for VOC analyses which, due to volatilization potential, were obtained from a depth of 18 to 24 inches below ground surface. Subsurface samples were collected at 5-foot intervals from the large-diameter (24-inch) and hollow-stem auger borings. Samples were collected directly from the tip of the large-diameter auger or with split-spoon samplers in the case of the hollow-stem augers. Samples from the hand-auger borings in the closed topographic depression in the northern portion of Area 2 were obtained using a split-spoon sampler from the surface to a depth of two feet. All samples were placed in sealed plastic bags and labeled with the sample number and other identifying information immediately upon sample collection (McLaren/Hart, 1996h).

Soil samples were also collected from four background locations in accordance with McLaren/Hart's letter of September 12, 1995 (McLaren/Hart, 1995c), as approved by EPA in its letter of September 21, 1995 (EPA, 1995a). The four locations from which background samples were obtained included:

- Loess material present in the borrow pit area;
- Shale material present in the landfill soil borrow pit area;[35]

[35]This shale was incorrectly labeled by McLaren/Hart and referred to in the McLaren/Hart reports as the Ladonda Shale. There is no Ladonda Shale present in Missouri. There is a Lagonda formation which contains shale; however, this formation is much higher stratigraphically and therefore not present at the Site. The shale material present in the landfill soil borrow pit from which McLaren/Hart obtained its sample is actually part of the Cheltenham Formation.

- The western, non-impacted portion of the former Ford property; and

- From an area adjacent to the McLaren/Hart office located across St. Charles Rock Road from the Site.

Background samples were collected using a trowel from depths of six to twelve inches.

All of the surface soil samples were analyzed for radionuclides. In addition, two samples per boring were also selected for radionuclide analysis. Subsurface samples were selected based on the results of the down-hole radiological logging described below. Specifically, the subsurface sample obtained from the depth interval nearest to the depth of the gamma log peak was generally submitted for radiological analyses. Samples selected for radiological analyses were transferred from the labeled plastic bags to appropriate glass containers and recorded on the chain-of-custody form.

Surface samples were also collected from each of the four borings drilled by EMSI in Area 1 in May 1997. These samples (along with one duplicate) were submitted to the Quanterra Environmental Services (Quanterra) Laboratories' St. Louis, Missouri laboratory for analyses for the radionuclides analyzed by McLaren/Hart during the RI field program. Surface samples (0 to 3 inch depths) and samples from the 1- to 2-foot depth intervals obtained from the hand-auger borings drilled by EMSI on the Ford property were also submitted to Quanterra for radiological analyses (McLaren/Hart, 1996h).

Quanterra performed all radiological analyses of the McLaren/Hart, EMSI and Herst/EMSI soil samples. Quanterra also performed laboratory duplicate radiological analyses on 10% of the soil samples. Radiological analyses of the soil samples were performed using National Academy of Sciences (NAS) or EPA methodologies as prescribed by the RI/FS Work Plan and associated Sampling and Analysis and Quality Assurance Project Plans.

Appendix D-2 contains a summary of the results of the radiological analyses of soil samples. The analytical laboratory reports for the McLaren/Hart samples were included in McLaren/Hart's Soil Boring/Surface Soil Investigation Report (McLaren/Hart, 1996h). The analytical laboratory reports for the 1997 sampling conducted by EMSI and the analytical summary reports for the surface soil samples collected by Herst & Associates on behalf of EMSI in 2000 were provided to EPA with the monthly OU-1 progress reports for August and October 1997 and March 2000.

In addition to the investigative samples, at EPA's request, ten split samples from the McLaren/Hart investigation were independently analyzed by Accu-Labs Research (Accu-Labs) in their Golden, Colorado laboratory. The specific split samples were selected after review of the initial soil analyses performed by Quanterra. Copies of the laboratory analytical reports and a detailed discussion of the split sampling activities and results are presented in the Split Soil and Groundwater Sampling Data Report - West Lake Landfill Areas 1 & 2 (McLaren/Hart, 1996f).

Summary tables of the split soil sample laboratory analytical results are included in Appendix D-2.

In addition to the radiological analyses, selected soil samples obtained by McLaren/Hart were also analyzed for organic and trace metal priority pollutants and other chemical parameters. Per the 1996 McLaren/Hart Soil Boring and Surface Soil Investigation report (McLaren/Hart, 1996h, p. 2-5), "Soil samples selected for priority pollutant analyses were collected from the bottom of the boring in the lower portion of the landfill debris, and generally at the same depth as the lower radiological sample collected in that boring. Contingency soil samples were collected based on visual observations, odor and monitoring. In the contingency sampled borings, a second sample was collected below the depth that triggered collection of the contingency sample." McLaren/Hart (1996h) reported that all priority pollutant samples were immediately placed in appropriate, labeled glass containers. Priority pollutant analyses were performed by MBT Laboratory, Rancho Cordova, California (MBT), in accordance with standard EPA methods for soil samples as described in the RI/FS Work Plan and the associated Sampling and Analysis and Quality Assurance Project Plans. Duplicate analyses were performed on 10% of the soil samples, and matrix spike and matrix spike duplicate analyses were obtained from 5% of the samples. Duplicate and spike samples were randomly selected prior to the start of the drilling program. As agreed to by EPA, split sample analyses for priority pollutants were not conducted using the soil samples as the decision to obtain split samples was made after the holding times for most of the analyses had been exceeded.

A total of 15 surface soil samples were submitted for trace metals and organic priority pollutant analyses (*i.e.*, VOCs, semi-volatile organic compounds [SVOCs], pesticides and polychlorinated biphenyls plus total petroleum hydrocarbons). In total, 25 subsurface soil samples plus three duplicate samples were submitted for organic priority pollutant analyses. Nineteen subsurface samples plus three duplicates were submitted for inorganic (trace metal) priority pollutant analyses.

As previously discussed, surface soil samples were generally collected from a depth of two inches except for samples for VOC and SVOC analyses, which were collected from a depth of 18 to 24 inches due to the potential for volatilization. In general, subsurface samples for priority pollutant analyses were obtained at the bottom of selected borings in the lower portion of the landfill debris, generally at the same depth as the lowermost radiological sample collected in each boring. Based on visual observations, soil samples were also collected from other depths in some of the borings for priority pollutant analyses. In the event of collection of a contingent soil sample based on visual or other observations, a second sample was collected for priority pollutant analysis from a depth interval below the depth that triggered collection of the contingency sample.

Summary tables of the results of the non-radiological analyses of the soil samples are included in Appendix D-2. The complete laboratory analytical reports for the chemical analyses are included in McLaren/Hart's Soil Boring/Surface Soil Investigation Report (McLaren/Hart, 1996h).

During its initial review of the radiological data, McLaren/Hart noted apparent inconsistencies in the Th-230 results. It appeared that some of the reported occurrences of the higher levels of Th-230 were not consistent with other laboratory results and Site data. In addition, the results of some of the samples collected from background locations were also anomalously high.

Based on these apparent discrepancies in the Th-230 results, McLaren/Hart initially had the laboratory (Quanterra) re-analyze some of the samples. As a result, about 20 percent of the samples were re-analyzed, and the results of these analyses indicated substantially lower Th-230 levels. The analytical laboratory identified two possible factors contributing to the erroneously high results. One source of this problem was poor laboratory spiked tracer recovery due to tailing of the tracer (thorium-229 [Th-229]) into the Th-230 region of the analytical curve. This "tailing effect" resulted in higher reported values for Th-230. A second source of the higher reported Th-230 levels was analytical interference with the uranium-234 (U-234) in the samples. Both of these effects were identified by the laboratory and are discussed further in McLaren/Hart's Soil Boring/Surface Soil Investigation Report (McLaren/Hart, 1996h) and the laboratory correspondence contained in the appendices to McLaren/Hart's report.

Quanterra revised their protocols to eliminate interference from these two sources. The surface samples with initial analytical results greater than 5 pCi/g and the subsurface samples with initial analytical results greater than 15 pCi/g were then re-analyzed for Th-230 using the revised protocols. The resulting re-analyzed values were determined by the laboratory and McLaren/Hart to be the valid and representative analyses. A summary of the various re-analysis events and the specific samples that were subjected to re-analysis is contained in the appendix to McLaren/Hart's Soil Boring/Surface Soil Investigation Report (McLaren/Hart, 1996h). The re-analyzed values were used in the subsequent data presentations and interpretations.

Although McLaren/Hart and the laboratory did identify and ultimately resolve the Th-230 data quality issue, an outstanding data quality issue still remains. Specifically, although the majority of the samples with reportedly high levels of Th-230 were ultimately re-analyzed, samples with lesser, but still reported, levels of Th-230 were not re-analyzed. Selection of samples for re-analysis was based on the initial reported results. Therefore, surface samples with Th-230 activity levels below 5 picocuries per gram (pCi/g) and subsurface samples with levels below 15 pCi/g were not re-analyzed. Therefore, the Th-230 results for these samples may be biased high.

As previously indicated, McLaren/Hart provided split soil samples to Accu-Labs Research at the request of EPA. The results of the split-sample analyses are included in McLaren/Hart's Split Soil and Groundwater Sampling Data Summary Report - West Lake Landfill Areas 1 & 2 (McLaren/Hart, 1996f). McLaren/Hart concluded that the results of the split sample analyses confirmed the validity of the radiological results in general. McLaren/Hart further concluded that the results of the split sample analyses also supported their conclusion that the initial Quanterra results were affected by the analytical problems described above, initially resulting in artificially high Th-230 results.

Based upon the results of the various laboratory evaluations, the results of the data validation and data evaluation performed by McLaren/Hart, and the results of the re-analyses of the soil samples, McLaren/Hart and the laboratory (Quanterra) concluded that the initial Th-230 results were erroneous and biased high. As a result, only the re-analyzed sample results were presented and evaluated in the McLaren/Hart in the Soil Boring/Surface Soil Investigation Report (McLaren/Hart, 1996h) and the RI. This approach has also been used during preparation of this RI Addendum report.

Although all of the reportedly valid Th-230 results provided by Quanterra were considered in the 2000 RI and in the RI Addendum, it should be noted that there are some reported occurrences of elevated Th-230 which are inconsistent with other measures of radionuclide activity obtained as part of the RI effort. For example, several instances of reportedly elevated Th-230 occurrences were detected by the laboratory analyses in locations where elevated overland gamma results, elevated downhole gamma results, or elevated levels of other radionuclides were not detected. Generally, the Th-230 levels associated with these inconsistencies are only slightly above the reference levels. As a result, the representativeness of these few Th-230 results may be suspect; however, as Th-230 is not a strong gamma emitter, none of the results of the laboratory analyses have been ignored or otherwise discounted based on this inconsistency.

4.5.3 Phase 1 Investigation Soil Sample Collection and Analyses (2014-2015)

A total of 128 subsurface samples were collected as part of the Phase 1C (82 samples, including 74 investigative samples and 8 field duplicate samples) and Phase 1D (42 investigative samples and 4 field duplicate samples) investigations of Area 1. As discussed in Section 4.4.5.2, above, these samples were primarily collected from core sample material obtained using the Sonic drilling rig. In addition, grab samples were also collected using a direct push rig to obtain samples from intervals where the Sonic method core recovery was poor.

All of these samples were submitted to Eberline Analytical in Oak Ridge, TN for radionuclide analyses. Eberline used two types of analyses to quantify radionuclides in the samples. Isotopic thorium and isotopic uranium were determined using alpha spectroscopy (Method EML U-02 for isotopic uranium and EML Th-01 for isotopic thorium). Ra-226 and Ra-228 (Ra-228) activities were inferred from their gamma emitting decay products after a 30-day hold time. The samples were also analyzed for potassium-40. A full laboratory report of all detected gamma emitters was also requested (Method LANL ER-130). The Phase 1D samples submitted to Eberline Analytical were also analyzed for actinium-227, protactinium-231, and Pb-210. In addition to the radionuclide analyses, Phase 1D samples were also submitted to Test America's St. Louis laboratory for Target Analyte List (TAL) trace metals plus scandium, niobium, and tantalum, and sulfate, carbonate and fluoride analyses.

The complete set of Eberline laboratory reports and the complete set of Test America laboratory reports were included in the Comprehensive Phase 1 Report (EMSI, et al., 2016b). All of the laboratory analytical results (both radionuclide and non-radionuclide data) were subjected to

independent data validation by Auxier) (Appendix D-3) or EMSI (Appendix D-4). The radionuclide data were validated using the procedures set forth in MARLAP (EPA, 2004). The non-radionuclide data were validated in accordance with the EPA's National Functional Guidelines for Inorganic Superfund Data Review (EPA, 2014).

Summary tables of the results of the radionuclide laboratory analyses for the Phase 1C samples are included in Appendix D-3. Summary tables of the results of the radionuclide and non-radionuclide laboratory analyses for the Phase 1D samples are included in Appendix D-4.

4.5.4 Additional Characterization of Areas 1 and 2 (2015-2016)

A total of 64 subsurface samples (58 investigative samples and 6 field duplicate samples) were collected as part of the Additional Characterization of Areas 1 and 2, including 15 samples from Area 1 (14 investigative samples plus 1 field duplicate sample) and 49 samples (44 investigative samples and 5 field duplicate samples) from Area 2. These samples were collected from core sample material obtained using the Sonic drilling rig.

All of these samples were submitted to Eberline Analytical in Oak Ridge, TN for radionuclide analyses. Eberline used two types of analyses to quantify radionuclides in the samples, as described in Section 4.5.3. Like the Phase I samples, these samples were also analyzed for actinium-227, protactinium-231, and Pb-210. In addition to the radionuclide analyses, the additional characterization samples were also submitted to Test America's St. Louis laboratory for TAL trace metals plus scandium, niobium, and tantalum, and sulfate, carbonate and fluoride analyses.

The complete set of Eberline laboratory reports and the complete set of Test America laboratory reports were submitted to EPA as part of the OU-1 monthly status reports for December 2015 and January and February 2016. All of the laboratory analytical results (both radionuclide and non-radionuclide data) were subjected to independent data validation by EMSI (Appendix D-5). The radionuclide data were validated using the procedures set forth in MARLAP (EPA, 2004). The non-radionuclide data were validated in accordance with the EPA's National Functional Guidelines for Inorganic Superfund Data Review (EPA, 2014).

Summary tables of the results of the radionuclide laboratory analyses for the Additional Characterization samples are included in Appendix D-5. Summary tables of the results of the non-radionuclide laboratory analyses are also included in Appendix D-5.

4.5.5 Sample Testing and Analyses for Fate and Transport Evaluations (2015-2016)

Samples were also collected in December 2015 from select locations and depth intervals during the Additional Characterization work for additional testing to obtain site-specific data for use in the fate and transport evaluations. Testing is designed to identify and distinguish the chemical

composition of the materials containing radionuclides and the speciation of the radionuclides in these materials, and to provide data to parameterize the geochemical fate and transport model (EPA 2007; EPA 2010). Two samples were collected from each of four borings in Area 1 (AC-1-FT 12-13 and 28-29 ft, AC-3-FT 4-5 ft plus duplicate and 27-28 ft, 1D-3-FT 27-28 and 41-42 ft, and WL-114-FT 1-2 and 10-11 ft) and two samples from each of six borings in Area 2 (AC-16-FT 16-17 and 28-29 ft, AC-18-FT 1-2 and 10-11 ft, AC-19-FT 3-4 and 23-24 ft, AC-21-FT 8-9 and 27-28 ft, AC-24-FT 1-2 and 24-25 ft, and WL-209-FT 1-2 and 17-18 ft) resulting in a total of 20 soil/waste samples plus two duplicate samples for testing for fate and transport properties. The first sample obtained from each boring was selected from a depth interval that displayed high gamma readings (based on downhole gamma scans and cores scans from adjacent Additional Characterization borings). Analytical data from these samples were used to evaluate the geochemistry and overall stability/leachability of the radionuclide occurrences in Areas 1 and 2. The second sample obtained from each boring was collected from a deeper interval that did not display elevated gamma readings. A field duplicate sample was obtained from both groups of samples. Analytical data from these samples were used to evaluate potential attenuation of radionuclides that may be mobilized from the overlying RIM (SSPA, 2017b).

Samples were placed in plastic bags, vacuum-sealed, and subsequently shipped to the laboratory on ice in order to preserve the *in-situ* chemical oxidation state of the samples (EPA 2006b). Prior to analysis at the laboratory, the samples were air-dried and homogenized by the laboratory in a glove box.

The fate and transport samples were subjected to the following analyses:

- Uranium, thorium, and radium isotopes;
- Major cations and anions (including calcium, magnesium, sodium, potassium, barium, carbonate, sulfate, fluoride and phosphate);
- Redox indicators (Fe(II), Fe(III), sulfide, and U(VI))[36];
- Total organic carbon (TOC);
- X-Ray Diffraction (XRD) to quantify the major minerals present in each sample (*e.g.*, barite and/or calcite in the soil/waste);
- Sequential extraction analysis consisting of sample digestion in a series of sequential extraction steps designed to dissolve specific minerals (and associated radionuclides) to assess the speciation of U, Ra, and Th in the specific minerals within the samples (such as barite), and the concentrations of iron oxyhydroxides for adsorption.

[36] Evaluation of redox conditions including Eh-pH diagrams is included in the Fate and Transport Evaluation for Radiologically-Impacted Material, West Lake Landfill Operable Unit-1, Bridgeton, Missouri prepared by S.S. Papadopulos & Associates, Inc. (SSPA, 2017b)

- Electron Microprobe Analysis (EMPA), to evaluate the composition and grain sizes of important minerals present in the samples (*e.g.*, barite, gypsum, calcite, and oxides);

- Cation-Exchange-Capacity (CEC) to estimate the potential capacity of the waste/soil to adsorb radionuclides; and

- Sequential batch leaching tests (SBLT) consisting of three tests using a synthetic landfill leachate solution and three tests using a synthetic precipitation leaching procedure (SPLP) leachate.

Analysis for the radiochemical, major cations/anions, redox indicators, and TOC were performed by the Eberline laboratory in Oak Ridge, TN. The XRD, sequential extraction, EMPA, CEC, and SBLT testing was conducted by Materials and Chemistry Laboratory, Inc. (MCL) in Oak Ridge, TN. Laboratory analytical results for the radiochemical, major cations/anions, redox indicators, and TOC parameters and summary tables of these data are included in the separate Fate and Transport Evaluation report (SSPA, 2017b). The analytical laboratory reports for these tests were provided to EPA in the monthly status reports for March, April and May 2016.

4.5.6 Additional Testing Performed by Cotter (2016)

As previously discussed in Section 4.4.8, five additional soil borings (three in Area 1 and two in Area 2) located adjacent to prior OU-1 RI (McLaren/Hart) borings were drilled and sampled in accordance with the Cotter Work Plan (Arcadis, 2015). Cotter also collected samples from core materials from some of the Additional Characterization borings and from core material collected during the prior Phase 1C and Phase 1D investigations. The Cotter data were collected in part to "help determine the presence of radiological materials with chemical compositions diagnostically different from LBSR." (Arcadis, 2015b). Consequently, collection of samples by Cotter was heavily biased toward collection of samples with the highest levels of radium and thorium at the Site with the goal of "identification and evaluation of any non-LBSR material[.]" (Arcadis, 2015b).

Specifically, in early January 2016, Arcadis, on behalf of Cotter, collected 15 samples including five samples plus three field duplicate samples from the five borings drilled for Cotter (WL-102-CT-A and WL-102 CT-A Dup from 4-5 ft, WL-106A-CT from 10-12 ft, WL-114-CT from 7-8 ft, WL-209-CT and WL-209-CT DUP from 1-3 ft, and WL-234-CT and WL-234-CT DUP from 8-10 ft), one sample from Additional Characterization boring AC-24 (Cotter sample identified as WL-210-CT 4-5 ft), and four samples from the archived core material from three Phase 1C borings (1-2 from 39-40 ft, 5-3-A from 28-30 ft and 5-3 from 33-34 ft, and 1C-6 from 25-27 ft), and two samples from Phase 1D borings (1D-7 83-84 ft and 1D-16 46-47 ft). In February 2016, Cotter requested that an additional 11 samples plus one field duplicate be collected from the archived core materials from the five Cotter borings (WL-102-CTA 2-3 ft and 22-23 ft, WL-106A-CT 4-6 ft, WL-114-CT 32-33 ft, WL-209-CT 9-10, 21-23 ft [plus DUP #1 from this

interval] and 26-27 ft, WL-234-CT 18-19 and 44-45 ft) and two Additional Characterization borings (AC-24 [WL-210-CT] 45-46 ft and AC-25 [WL-235-CT] 21-22 ft. These samples were collected by Feezor Engineering, Inc. and Auxier on behalf of Cotter. In mid-April 2016, Arcadis, on behalf of Cotter, collected an additional 11 samples plus one duplicate sample from the archived core material from the Additional Characterization investigation (AC-1 19-20 ft, AC-3 9-10, 14-19, and 36-39 ft, AC-8 4-10 ft, AC-10 12-13 ft, AC-13 4-6 ft, AC-15 29-30 ft, AC-16 11-14 (plus a duplicate from this interval) and 19-20 ft and AC-21 20-24 ft. Altogether, Cotter collected a total of 39 samples, including 5 field duplicate samples.[37]

The samples collected by Cotter were submitted to Test America's St. Louis laboratory for radionuclide analyses (Ra-226, Ra-228, thorium isotopes, uranium isotopes, Pb-210 and gamma emitters), TAL metals plus tantalum, niobium and scandium analyses, carbonate, sulfate, fluoride and pH. The Cotter samples were also subjected to Toxicity Characteristics Leaching Procedure (TCLP) with the TCLP extracts being analyzed for the same radionuclides as listed above, plus barium. Some of the Cotter samples were also analyzed by MCL using x-ray diffraction (XRD) for further characterization of the major minerals in those samples (*e.g.*, barite or calcite in the soil/waste).

The Test America laboratory reports for the first two sets of samples collected by Cotter were submitted to EPA as part of the monthly status reports for March and April 2016. Laboratory reports for the samples collected in April 2016 and the XRD analysis were provided to EPA as part of the June 2016 monthly status report. All of the laboratory analytical results (both radionuclide and non-radionuclide data) were subjected to independent data validation by EMSI (Appendix D-6). The radionuclide data were validated using the procedures set forth in MARLAP (EPA, 2004). The non-radionuclide data were validated in accordance with the EPA's National Functional Guidelines for Inorganic Superfund Data Review (EPA, 2014). Summary tables of the results of the radionuclide and chemical laboratory analyses for the samples collected by Cotter are included in Appendix D-6.

The data validation resulted in some of the Ra-226 and Th-230 results for laboratory reports J15607 and J15609 being qualified as estimated due to chemical recoveries being outside of control limits, laboratory duplicate sample results being outside of control limits, and in the case of Ra-226, barium carrier recovery outside of control limits. All of the Ra-226 and Th-230 results for J15607 and J15609 were also qualified as estimated due to detections of Ra-226 and Th-230 in the laboratory method blank samples.

Because of questions associated with a subset of the Cotter samples (results reported for Test America job numbers J15607 and J15609), EPA elected to have a third party conduct an independent analysis of these samples. EPA directed Cotter to ship the laboratory sample containers from Test America to Southwest Research Institute (SwRI), where they were subjected to re-analysis on behalf of EPA. Summary tables of the SWRI analytical results are included in Appendix D-11.

These data, along with other data such as the original McLaren/Hart Th-230 results, were further evaluated regarding their potential use for the update to the Baseline Risk Assessment. The results of this data usability evaluation are presented in Appendix D-12.

4.5.7 EPA Soil Sampling at the Bridgeton Municipal Athletic Complex (2014)

In May 2014, EPA, through the TetraTech START program, collected 112 soil samples from the BMAC and two reference areas (Koch and Blanchette parks). BMAC is located approximately one mile northeast of the West Lake Landfill. Koch park is located approximately 5 miles to the northeast of West Lake Landfill and Blanchette park is located approximately 2.75 miles to the northwest of West Lake Landfill.

TetraTech submitted the soil samples to Test America for radionuclide analyses, in particular U-238, Th-230, Ra-226, and Pb-210. The results were compared to background threshold values (BTV) calculated from the results obtained from the two reference areas. Any BMAC results that exceeded the BTV were compared to two risk-based standards: EPA's preliminary remediation goals (PRGs) for residential soil and the Formerly Utilized Sites Remedial Action Program (FUSRAP) remediation goals (FUSRAP RGs) to determine if further data review or investigation were warranted.

The results of the investigation are detailed in the 2014 TetraTech report, and copies of the summary tables of the analytical results of the soil samples are included in Appendix D-7. Overall, the majority of the sample results were less than the BTVs, and those few samples with results greater than the BTVs were less than the EPA PRGs and FUSRAP RGs.

TetraTech reported that none of the samples collected by EPA contained any radionuclides at levels above the remediation goals established for the St. Louis FUSRAP sites (TetraTech, 2014b). TetraTech concluded that no further assessment was required for the BMAC site (TetraTech, 2014b). In its July 31, 2014 press release, EPA stated that "the facility [BMAC] is suitable for public use and requires no further environmental response."[38] Based on the TetraTech results, EPA concluded in the press release that the park was safe for public use, and that no additional environmental action was warranted for the BMAC facility.

4.5.8 MDNR Soil Sampling (2015)

In November of 2015, MDNR collected soil samples from ten locations in the vicinity of West Lake Landfill The samples were submitted to Eberline Laboratory in Oak Ridge, TN for analyses for isotopic uranium, isotopic thorium, Ra-226 and Ra-228, Pb-210 and gross alpha/gross beta. A figure from the MDNR report (MDNR, 2016) showing the locations of the

[38]Available at https://yosemite.epa.gov/opa/admpress.nsf/0/6ACA0E08A1803E1785257D26006D38BE.

samples and a table of the results of the sample analyses from this report are included in Appendix D-8.

With the exception of two samples, the analytical results for these samples were below the unrestricted use criteria (see discussion in Section 6.2.6) used to identify potential RIM. Sample S-9, which was obtained from the southernmost portion of the AAA Trailer lot (former Ford property), contained a combined thorium (Th-230 plus Th-232) level of 9.2 pCi/g, as compared to the unrestricted use criteria of 7.9 pCi/g. Sample S-10, which was collected from property owned by Rock Road Industries and is within the limits of West Lake Landfill Radiological Area 2, contained a combined thorium level of 24.6 pCi/g. The area from which this sample was obtained was subsequently covered with rock as part of the NCC construction.

4.6 OU-1 Perched Water Sample Collection and Analyses (1995)

Perched water was encountered at shallow depths within the landfill debris in eight of the 61 soil borings drilled by McLaren/Hart in 1995. The presence of perched water encountered during drilling of the original OU-1 RI borings in 1995 was discussed in the 1996 McLaren/Hart Soil Boring/Surface Soil Investigation report submitted to EPA in November 1996 and reiterated in the previously approved 2000 RI report. Other than identification of the soil borings where perched water was encountered, no other description of the occurrence of perched water was provided by McLaren/Hart.

Per the McLaren/Hart 1996 Soil Boring and Surface Soil Sampling report (McLaren/Hart, 1996h), perched water was encountered at the following locations and depths in Areas 1 and 2:

Soil Boring	Depth Encountered	Sample Collected
WL-108	22 feet below grade	Yes (plus field duplicate)
WL-116	8 feet below grade	No
WL-215	6 feet below grade	No
WL-217	12 feet below grade	No
WL-219	25 feet below grade	Yes
WL-220	30 feet below grade	Yes
WL-231	31 feet below grade	Yes
WL-240	5 feet below grade	No

The McLaren/Hart 1996 report states that “Figure 2-6 [reproduced as RI Figure 4-9] identifies the borings in which perched water was encountered, the borings sampled, and the areal extent of the perched water. As shown on this figure, the presence of perched water is very limited in extent and isolated in nature.” No other information regarding the definition or nature of the perched water occurrences was included in the original 1996 McLaren/Hart report.

Based on EMSI's experience investigating other municipal solid waste (MSW) landfill sites, including Superfund MSW landfill sites, it is presumed that the presence of perched water results from accumulation of infiltration on layers of relatively lower permeability waste materials or soil layers. Owing to the overall heterogeneous nature of MSW landfills and the limited extent and continuity of any lower permeability layers within a waste mass, occurrences of perched water within MSW landfills typically include only very thin intervals of limited areal extent.

McLaren/Hart identified occurrences of perched water in two of the 20 borings in Area 1 (WL-108 and WL-116) and in six of the 41 borings in Area 2 (WL-215, WL-217, WL-219, WL-222, WL-231, and WL-240). Perched water was encountered at depths of 12 feet in WL-108 and at 8 feet in WL-116. Perched water was encountered at depths of 6 feet in WL-215 and at 4.5 feet in WL-240 in the northeastern portion of Area 2 and at 12 feet in WL-217 in the south-central portion of Area 2. Perched water was also encountered at depths of 21 and 23 feet respectively in borings WL-219 and WL-220, which are located in the Inactive Sanitary Landfill area, just outside the southwestern portion of Area 2 and at a depth of 31.5 feet in boring WL-231 in the northern portion of Area 2.

Based on the depths that the perched water was encountered and the proximity of the various boreholes in which the perched water was encountered, McLaren/Hart (1996h) identified five distinct bodies of perched water at the Site: one in Area 1 and four in Area 2 (Figure 4-9). Overall, the presence of perched water appeared to be very limited and isolated in nature.

By far the largest body of perched water identified by McLaren/Hart was located in the westernmost portion of Area 2. Two samples of this perched water (from WL-219 and WL-220) were submitted for radiological analyses and one sample (WL-219) was submitted for chemical analyses. In addition, this body of perched water was also interpreted by McLaren/Hart to be the source of an observed seep located near the northern end of the western boundary of Area 2. A sample of this seep was also collected and submitted for radiological and chemical analyses. The results of the analyses of this seep sample are presented in the Rainwater Runoff Report (McLaren/Hart, 1996e). The area of the seep was inspected on May 12, 2017, and it was found that seepage was occurring in this area; however, this seepage remains localized, and no seepage or flow has ever been observed on the face of the Area 2 slope.

Two other small bodies of perched groundwater were encountered in Area 2 (WL-215 and WL-240). Samples were not obtained from these areas. These perched water bodies were interpreted by McLaren/Hart to occur as small, isolated bodies located near the center of Area 2 and therefore not directly subject to potential off-site discharge. In addition, no underlying groundwater impacts were detected in nearby monitoring wells D-13 or S-10, I-11 and D-12.

When perched water was encountered, McLaren/Hart terminated the soil boring at a depth of approximately five feet below the depth at which the perched water was encountered. Perched water samples were then collected from four of the open borings (WL-108, WL-219, WL-220, and WL-231) using a disposable bailer or a decontaminated 5-gallon bucket attached to the bottom of the Kelly bar of the drill rig. After collection of the perched water sample, the boring

was then abandoned and a new boring was drilled outside of the presumed extent of the perched water.

The 1994 EPA-approved RI/FS Work Plan called for collection of perched water samples but no specific requirements were established for analytical testing. The four perched water samples were analyzed for radionuclides and three of these samples (from WL-108, WL-219 and WL-231) were analyzed for priority pollutant organic and trace metal parameters and leachate indicator parameters (biological oxygen demand, chemical oxygen demand, pH, total dissolved solids, total organic carbon, chlorides, nitrite, nitrate, ammonia, total phosphorous, and sulfide). Radiological analyses were performed by Quanterra and priority pollutant analyses were performed by MBT in accordance with the standard methods and procedures for water samples described in the 1994 RI/FS Work Plan and the associated Sampling and Analysis and Quality Assurance Project Plans.

One of the perched water samples (from WL-108) obtained from the perched water body in Area 1 was submitted for radiological and chemical analyses. Another sample was collected (WL-231) from a small body of perched water located in the northernmost portion of Area 2 just south of the North Surface Water Body. This sample was also submitted for chemical and radiological analyses. Tables summarizing the results of these analyses are included in Appendix D-9.

Perched water was not encountered in any of the borings drilled during the subsequent investigations, including the additional borings drilled by EMSI in 1997, the Phase 1 investigation borings, the borings drilled for the Additional Characterization of Areas 1 and 2, or the additional borings drilled by Cotter. More specifically, borings drilled adjacent to WL-108 and WL-116 in Area 1 and WL-209 and WL-210 in Area 2, locations that McLaren/Hart identified the perched water, 1995 did not did not encounter perched water.

A specific reason as to why perched water was not encountered during subsequent investigations performed 20 years later cannot be identified but may reflect, without limitation, one of more of the following factors:

- Differences in antecedent precipitation conditions between the various soil boring investigations;
- Differences between the drilling and sampling methods used and the resultant samples and information obtained to assess the possible presence of perched water;
- The presence of extensive vegetation cover during the later investigations that would intercept precipitation preventing it from infiltrating and also through transpiration would remove significant amounts of infiltrated precipitation;
- Drainage of whatever perched water was present in 1995 down through the boreholes during and/or subsequent to the 1995 soil boring program;

- Water consumed during waste degradation; and/or

- Effects associated with placement of additional (inert) fill material in low areas in 2006 and 2007 pursuant to the approved 2006 Materials Management Plan.

In contrast to the 1995 soil borings, which were drilled with augers, and in many cases large diameter bucket auger drilling equipment, the soil borings drilled in 2015 and 2016 were drilled with Sonic (vibratory) drilling equipment. The 1995 investigations included collection of grab samples from drill cuttings whereas the 2015 and 2016 investigations included collection of soil cores. Detailed examination and geologic logging of the soil cores obtained in 2015 and 2016 did not identify and any saturated intervals within the waste mass but only identified actual or potential saturated conditions at or below the base of the waste mass.

4.7 OU-1 Geotechnical Sampling and Testing

The RI/FS Work Plan, specifically the Sampling and Analysis Plan (SAP), required that a geotechnical investigation be conducted to evaluate the stability of the slope (berm) on the north side of Area 2. This area was subjected to significant erosion loss (referred to in the AOC SOW and RI/FS Work Plan as a "slope failure"). This erosional loss occurred prior to 1987 and resulted in transport of soil, some of which contained radionuclides, from Area 2 down onto a portion of the adjacent Ford property.

McLaren/Hart drilled soil boring WL-208 at the top of the landfill slope and boring WL-206 at the base of the landfill slope in this area. Soil samples were obtained from these borings and submitted for chemical and radiological analyses, but samples from these borings were not submitted for geotechnical testing (McLaren/Hart, 1996h). Four surficial soil samples were obtained from the slope area in the vicinity of surface water sampling Weir 5 and tested for moisture content and three of the samples were tested for bulk density and dry density (the fourth sample was considered to be disturbed). Only one of these samples was tested for direct shear strength. Shannon & Wilson Inc. performed all of the geotechnical tests at their St. Louis, Missouri laboratory. McLaren/Hart also attempted to perform a visual inspection of the landfill slope but dense vegetation along the slope prevented meaningful inspection. Although McLaren/Hart performed the geotechnical testing, the results of this investigation were not included in any of the McLaren/Hart data reports. Therefore, a copy of Shannon & Wilson's report was included as Attachment A to the IIR Technical Memorandum (EMSI, 1997d). The results of this testing were also discussed in the Site Characterization Summary Report (EMSI, 1997e).

The geotechnical data developed by McLaren/Hart were not sufficient to perform a slope stability analysis of this area. Based on discussions with EPA, it was decided that rather than perform additional field work to address the stability of this slope, the Respondents would agree to regrade this slope, through either excavation or placement of additional fill materials, as part of any remedy that may be selected for OU-1. Regrading of this slope to a lower angle would

obviate the need for additional investigative and testing activities. This approach was accepted and agreed to by EPA.

Although geotechnical testing was not performed as part of the OU-1 investigations, geotechnical testing of unconsolidated materials was also conducted by Bridgeton Landfill, LLC as part of the OU-2 RI. Tests performed included moisture content, specific gravity, particle size distribution, and Atterburg Limits. Summary tables of the results of these tests are included in Appendix D-10. Additional details regarding these tests and the results can be found in the OU-2 RI report (Herst & Associates, 2005). This information is identified in the event that such data are needed for other evaluations such as fate and transport evaluations.

4.8 Monitoring Well Installation and Development

McLaren/Hart installed 14 new groundwater monitoring wells as part of the OU-1 RI investigations. The 14 new monitoring wells included four wells in Area 1, four wells in Area 2 and six wells on the former Ford property. Details on well locations, depths and well construction are presented in the Groundwater Conditions Report (McLaren/Hart, 1996g). Additional information regarding the construction of these and other existing wells at the Site can be found in the Groundwater Conditions Report, West Lake Landfill Areas 1 & 2 (McLaren/Hart, 1996g) and in the RI/FS Work Plan (McLaren/Hart, 1994a).

The 14 new wells installed by McLaren/Hart and 30 existing monitoring wells were developed during the OU-1 RI field investigations by removing a minimum of 10 well volumes of groundwater. During well development, McLaren/Hart also monitored pH, electrical conductivity, and temperature. Well development continued until consecutive readings were within 10 percent of each other and the produced water was non-turbid. All development water was containerized and analyzed per St. Louis Metropolitan Sewer District (MSD) disposal criteria. The water was then discharged into the MSD system upon receipt of results and with MSD approval.

The OU-2 RI field investigations performed by Bridgeton Landfill, LLC included installation of 49 piezometers in the alluvium and underlying bedrock located in single, paired and clustered configurations at 33 locations. Details regarding the installation and development of these piezometers is presented in the OU-2 RI report (Herst & Associates, 2005) and the Physical OU-2 Characterization Technical Memorandum (Golder Associates, 1996a) prepared on behalf of Bridgeton Landfill, LLC.

Bridgeton Landfill, LLC is conducting assessment groundwater monitoring. Eight new groundwater wells (PZ-209-SS, 209-SD, 210-SS, -210-SD, -211-SS, -211-SD, -212-SS, and -212-SD) were installed near the eastern corner of the South Quarry portion of the Bridgeton Landfill in October 2013. The wells were constructed as four clusters of two wells each. Information regarding installation of these wells is presented in the Groundwater Monitoring Well Installation Report, Bridgeton Landfill, LLC (Herst & Associates, 2014).

Copies of the well construction records for the OU-1 RI monitoring wells and all other monitoring wells, including pre-existing monitoring wells, OU-2 monitoring wells and monitoring wells associated with the Bridgeton Landfill, are contained in Appendix E-1.

4.9 Hydraulic Conductivity Testing

McLaren/Hart completed hydraulic conductivity testing on twelve of the new wells and six of the existing wells using the protocols presented in the approved RI/FS Work Plan. Testing was conducted on six shallow alluvial wells (S-1, S-5, S-8, S-84, MW-F3, and MW-101), six intermediate depth alluvial wells (I-2, I-4, I-7, I-9, I-11, and I-68), and six deep alluvial wells (D-3, D-6, D-12, D-13, D-85, and D-93) (McLaren/Hart, 1996g).

Specifically, single well hydraulic tests consisting of rising head (slug out) and falling head (slug in) tests were performed on wells completed with well screens that were completely submerged below the water table. The slug tests were performed using either a 5-foot long by 1¾-inch diameter PVC slug filled with sand or a 3-foot long x 1¼ inch diameter aluminum slug. An In-Situ Hermit Environmental Data Logger (Model SE1000C) connected to a pressure transducer was used to measure changes in the water level to a precision of 0.01 feet.

Additional information and the results of the hydraulic conductivity testing are presented in the McLaren/Hart Groundwater Conditions Report, West Lake Landfill Areas 1 & 2 (McLaren/Hart, 1996g) and the 2000 RI report (EMSI, 2000). The results of the hydraulic conductivity testing are also summarized in Appendix E-2. It should be noted that although slug tests provide a method to quickly obtain hydraulic conductivity estimates from a large number of locations at a relatively low cost, such tests only apply stress to the subsurface materials in the immediate vicinity of the well being tested. Testing using a pumping well and multiple observation wells allows for an estimate based on hydraulic stress applied to a larger volume of subsurface material and would also allow for evaluation of transient properties (*e.g.*, storage coefficients). A combination of slug or other single point tests distributed over a broad area coupled with a longer-term pumping test to confirm the results of the single well tests is a more reliable method for characterization of hydraulic properties.

Hydraulic conductivity testing was also performed in conjunction with the OU-2 RI. Hydraulic conductivity testing performed during the OU-2 RI included packer testing in open boreholes, single well (slug) tests, and laboratory permeability testing of soil samples. Details regarding the specific tests that were performed, the methods used, and the results can be found in the Physical Characterization Technical Memorandum for West Lake Landfill OU-2 (Golder Associates, 1996a) and in the Remedial Investigation Report for West Lake Landfill OU-2 (Herst & Associates, 2005) prepared on behalf of Bridgeton Landfill, LLC. Summary tables of the results of the OU-2 hydraulic conductivity tests are included in Appendix E-2.

4.10 Groundwater Level Measurements

Comprehensive sets of groundwater level measurement data were obtained during the OU-1 RI (McLaren/Hart, 1996g and EMSI, 2000) and also during the post-ROD groundwater investigations (EMSI, 2012c, 2013c, 2013g and 2014b). Figure 4-10 displays the current monitoring well network. Table 4-4 presents the horizontal coordinates and vertical elevations of all of the current groundwater monitoring wells. These survey data were obtained when all of the wells were re-surveyed for location and elevations in conjunction with the July/August 2012 groundwater monitoring event.

As previously noted, surveying at the Site has been performed using a local survey coordinate system that is a slight modification of the 1927 Missouri East. In November 2016, Weaver Consultants surveyed the local (Site) control points and rotated them in AutoCAD to the state plane coordinates that were surveyed at the same time. Based on this rotation, survey information developed in and tied to the Site control system can be converted to 1983 Missouri East state plane coordinates by adding 40.97 feet to the northing, adding 320174.7 feet to the easting, and subtracting 0.402 feet from the elevation. Missouri East state plane coordinates calculated using this method are included on Table 4-3, which summarizes the survey data for all of the groundwater monitoring wells.

4.10.1 OU-1 RI Water Level Measurements

McLaren/Hart measured groundwater levels from all existing monitoring wells on a monthly basis from November 1994 to November 1995 and from the (then)-newly-constructed wells from their development date to November 1995. Groundwater level measurements were subsequently collected on a quarterly basis from all wells through October 1996. McLaren/Hart followed the protocols presented in the approved 1994 RI/FS Work Plan during each measurement episode. Wells from which groundwater level data were obtained are shown on Figure 4-11. Additional information and the results of the water level measurement activities are presented in the McLaren Hart Groundwater Conditions Report, West Lake Landfill Areas 1 & 2 (McLaren/Hart, 1996g) and the 2000 RI report (EMSI, 2000). The water level measurement data are also presented on tables contained in Appendix E-3.

4.10.2 Post-ROD OU-1 Water Level Measurements

In May 2012 EPA directed the OU-1 Respondents to perform an additional round of groundwater sampling at the West Lake Landfill Superfund Site. This additional round of groundwater sampling was performed in July and August 2012. In January 2013, EPA directed the OU-1 Respondents to perform additional groundwater sampling at the West Lake Landfill Superfund Site. Three additional rounds of groundwater sampling were performed in April, July and October 2013.

During each of these events, water levels were obtained from all of the monitoring wells located at the West Lake Landfill and the adjacent Bridgeton Landfill. The locations of the wells from which water levels were obtained is provided on Figure 4-10. Tabular summaries of the water level data obtained during these four events are included in Appendix E-3.

4.10.3 OU-2 and Bridgeton Landfill Water Level Measurements

During performance of the OU-2 RI field investigations, groundwater levels were measured monthly for a period of 16 months from June 1995 through September 1996. A tabular summary of the water level data obtained during this period is included in Appendix E-3. Additional information relative to the OU-2 water level measurements can be found in the OU-2 RI report (Herst & Associates, 2005) and the Physical Characterization Technical Memorandum (Golder Associates, 1996a) prepared on behalf of Bridgeton Landfill, LLC.

Bridgeton Landfill, LLC performs quarterly groundwater monitoring, including collection of water level data, as part of the detection monitoring program for the Bridgeton Landfill. This monitoring program includes collection of water levels from one alluvial well (PZ-114-AS) and thirteen bedrock wells (PZ-100-SS, -104-SS, -106-SS, -109-SS, -110-SS, -115-SS, -201A-SS, -205-SS, -100-SD, -104-SD, -106-SD, and 111-SD). Data obtained from this monitoring program are provided by Bridgeton Landfill, LLC to MDNR as part of reports of the Quarterly Sampling Events – Detection Monitoring Program for the Bridgeton Landfill (*e.g.,* Detection Monitoring Program Groundwater Statistical Analysis Report November/December 2015 Quarterly Sampling Event, Bridgeton Landfill, LLC, prepared by Jett Environmental Consulting, February 2016).

Bridgeton Landfill, LLC also collected long-term water level measurements from 14 bedrock monitoring wells at the Bridgeton Landfill. The wells included in this program were PZ-100-SS, -100-SD, 103-SS, -104-SS, -106-SS, -106-SD, 107-SS, 109-SS, 110-SS, 111-SD, -204-SD, -205-SS, -212-SS, and 212-SD. Water level data were collected from these wells over the period from November 2013 through May 2014 using pressure transducers installed in each well to record water level and water temperature at a rate of once per hour during the six-month period (Herst & Associates, 2014). Additional details regarding the scope, methodology and result of this study are presented in the Long-Term Water Level Monitoring Summary, Bridgeton Landfill, Bridgeton, Missouri (Herst & Associates, 2014).

4.11 Groundwater Sample Collection

Groundwater sampling associated with various programs has been conducted on- and off-site since 1980. These programs include the NRC investigation in 1980/1981, five events from 1995-1997 during the RI investigation, two OU-1 events in 2004, four OU-1 events 2012-2013, sampling of off-site private wells in 2013, monitoring associated with the OU-2 RI/FS, and on-going compliance monitoring conducted by Bridgeton Landfill, LLC. To date, only limited

sampling of off-site groundwater has been conducted. Additional testing of off-site ground water is anticipated to occur as part of the OU-3 investigations.

4.11.1 NRC (RMC) Groundwater Sampling (1981)

RMC reportedly collected 10 groundwater samples, including two samples collected from two off-site monitoring wells in the fall of 1980 and eight samples collected in the spring and summer of 1981 (RMC, 1982). The RMC report identifies the two off-site monitoring wells as "Off-site Sample Well 3, West Boundary of the Landfill" and "Off-site Sample Well 4, North Boundary of the Landfill." (RMC, 1982). The RMC 1982 report does not contain a figure showing the locations of these wells or any other documentation to identify the location of these two wells, however. Furthermore, the first known wells installed at the landfill were not installed until just after the dates that RMC collected samples from these two wells. Samples obtained from these two wells were analyzed for gross alpha and gross beta activities and the results were less than EPA drinking water standards (RMC, 1982).

RMC also reportedly collected four samples from each of the RMC boreholes 14 and 15, both of which were located in the portion of the former Ford property that subsequently became known as the Buffer Zone (RMC, 1982). These samples were analyzed for gross alpha and gross beta with all of the results less than EPA drinking water standards. These samples were not analyzed for specific radionuclides (RMC, 1982).

4.11.2 OU-1 RI Groundwater Sampling (1994-1997)

McLaren/Hart conducted four different groundwater sampling events. In addition, a fifth supplemental groundwater sampling was performed by Golder Associates on behalf of EMSI. Locations of groundwater monitoring wells sampled are shown on Figure 4-12. Details regarding the scope, procedures and results of the groundwater investigation are presented in McLaren/Hart's Groundwater Conditions Report - West Lake Landfill Areas 1 & 2 (McLaren/Hart, 1996g) and SCSR (EMSI, 1997e) and in the OU-1 RI report (EMSI, 2000).

The first groundwater sampling event conducted by McLaren/Hart (in November 1994) consisted of collecting grab samples from the 30 wells prior to their development to obtain approval for disposal of the development and purge water. Each sample was analyzed for gross alpha. The samples were collected with dedicated disposable bailers from each well prior to their redevelopment. The unfiltered samples were then analyzed for gross alpha. The gross alpha data provided a preliminary indication of whether groundwater in the vicinity of each well was radiologically impacted and if special handling and segregation of the development water was necessary. Three wells were re-sampled, filtered, and re-analyzed following initial gross alpha results above the MSD standard. All three re-analyzed results were below the MSD standards. Further information on this task is presented in the Groundwater Conditions Report (McLaren/Hart, 1996g).

The second (November 1995) and third (February 1996) groundwater sampling events conducted by McLaren/Hart included sampling of the 14 new wells and 16 existing wells. These samples were analyzed for radionuclides, priority pollutant metals, VOCs, SVOCs, pesticides and PCBs, and petroleum hydrocarbons. McLaren/Hart completed a fourth round of groundwater sampling in May 1996 to resolve issues (see additional discussion below) related to Th-230 (potential false positives) and Ra-226 (analytical results above Maximum Contaminant Levels [MCLs]). All three sampling episodes were completed using the protocols specified in the approved 1994 RI/FS Work Plan (McLaren/Hart, 1994).

The 1994 RI/FS Work Plan called for sampling all of the newly constructed RI monitoring wells as well as 14 of the existing monitoring wells. The 14 existing monitoring wells to be sampled included five shallow wells (S-60, S-61, S-84, MW-101, and MW-106), five intermediate wells (I-62, I-65, I-66, I-67, and I-68), and four deep wells (D-83, D-85, D-93, and D-94).

A total of 30 monitoring wells were sampled in each of the second, third and fourth episodes discussed above to comply with the RI/FS Work Plan requirements. The set of wells sampled included 14 newly constructed RI monitoring wells, two shallow wells (MW-F3 and PZ-114-AS) that were part of the landfill monitoring program and that were substituted for two of the planned new wells, and 14 other existing monitoring wells, two of which serve as background monitoring wells. The wells sampled are summarized on Table 4-5 and construction information for these wells is summarized on Table 4-4.

Two background wells, S-80 and MW-107, were included in the groundwater sampling episodes. These wells are considered background because they are horizontally located 3,800 and 4,400 feet respectively from the closest boundary of either Area 1 or Area 2 (Figure 4-12). In addition, these wells are considered to be upgradient of the landfill because their water level elevations are generally 3 and 13 feet higher respectively than the groundwater elevations beneath Areas 1 and 2.

In January 1996, Quanterra identified a data quality issue relative to the Th-230 analytical results obtained from the November 1995 groundwater sampling activity. Specifically, the Th-230 results from the November 1995 samples appeared to contain false positives or to have been reported at levels higher than actually present. This problem was a result of the volume reduction portion of the sample preparation and analysis procedure and was identified by Quanterra based on poor analytical recoveries of the laboratory-spiked tracer (Th-229). Many of the analytical results for the November 1995 samples displayed either no tracer recovery or had tracer recoveries below Quanterra's internal acceptance criteria of 20%. As a result of the poor tracer recovery, a greater instrument response factor was used in the calculation of the sample activity levels resulting in artificially high reported sample results. As a result of Quanterra's identification of the problem, Quanterra implemented a corrective action procedure with respect to samples collected during the February 1996 sampling method consisting of a change from the precipitation method to an evaporative technique during sample preparation. In addition, a

fourth round of groundwater sampling and Th-230 analyses was implemented by McLaren/Hart in May of 1996 using the revised sample preparation protocol.

Review of the Th-230 data shows that the November 1995 unfiltered samples exceeded the February and May 1996 values for 15 of 18 wells where Th-230 was detected. The November 1995 filtered samples also exceeded the February and May 1996 values in 12 of the 14 wells where Th-230 was detected. Therefore, the November 1995 groundwater analytical results for Th-230 appear to be biased high (EMSI, 2000). This bias needs to be considered in any potential use of these data.

A data quality issue was also identified with respect to the radium analyses. Specifically, the protocol in the 1994 RI/FS Work Plan required an analytical method (EPA Method 903.0) with a minimum detectable activity (MDA) level below the MCL values; however, this analytical method was not specified on the chain-of-custody forms for both the November 1995 and February 1996 sampling events. As a result, only gamma spectroscopy results were obtained for these groundwater samples. The minimum activity levels detectable by gamma spectroscopy analyses exceed the MCL for Ra-226 and Ra-228. As a result, the unfiltered samples obtained in February 1996 were analyzed for Ra-226 using the EPA method with the lower MDA level. In addition, as directed by EPA, all of the wells were re-sampled for radium isotopes in conjunction with the re-sampling for Th-230 performed in May of 1996. These samples were analyzed for Ra-226 using the EPA method with the lower MDA level.

Additional groundwater samples were collected during May 1997 according to the procedures presented in the EPA-approved ASAP. The additional data were collected to compare the Site radiological levels in groundwater to the State of Missouri MCLs and to resolve issues associated with potential data quality problems related to the thorium isotope results. Additional filtered and unfiltered samples were collected from seven groundwater monitoring wells (S-82, I-2, I-4, D-3, D-6, D-12, D-93) and analyzed for gross alpha and the approved radionuclide suite. A sample could not be collected from well D-14 because of an obstruction in the casing. A duplicate sample from well S-82 was also submitted for quality assurance evaluation.

The results obtained from groundwater sampling performed during the OU-1 RI are tabulated in Appendix F-1. Additional information regarding the OU-1 groundwater sampling activities and results can be found in the Groundwater Conditions Report, West Lake Landfill Areas 1 & 2 (McLaren/Hart, 1996g) and the 2000 RI report (EMSI, 2000).

4.11.3 OU-1 FS Groundwater Sampling (2004)

At EPA's request, two additional rounds of groundwater monitoring were performed in 2004 (EMSI, 2004) to verify that the then-current groundwater quality was consistent with that characterized during the 1995, 1996 and 1997 sampling performed for the OU-1 RI. The additional groundwater monitoring was performed by Herst & Associates, on behalf of EMSI, in March and May 2004. A total of 18 wells were sampled including wells S-5, S-84, I-4, I-68, D-

3, and D-85 in Area 1 and wells S-1, S-10, S-61, S-82, I-2, I-9, I-11, D-6, D-12, D-13, D-93, and MW-102 in Area 2.

Samples collected from these wells were analyzed by Severn Trent Laboratories' St. Louis, MO laboratory for isotopic thorium, isotopic uranium, Ra-226, Ra-228 and VOCs. The analytical laboratory reports for these two groundwater monitoring events were provided to EPA as part of the April and June 2004 monthly progress reports for OU-1. Tabulated summaries of the results of the 2004 groundwater monitoring are included in Appendix F-2.

4.11.4 Post-ROD OU-1 Groundwater Sampling (2012-2014)

During a May 2012 conference call, EPA asked the OU-1 Respondents to perform an additional round of groundwater sampling at the Site. EPA indicated that, following consultation with the National Remedy Review Board, it believed additional groundwater monitoring was necessary to verify that then-current groundwater conditions were consistent with prior groundwater sampling performed in 1995, 1996, and 1997 as part of the RI, and in 2004 as part of the FS. This additional groundwater sampling event was conducted in July and August 2012 and a report presenting the results was submitted to EPA and MDNR in December 2012 (EMSI, 2012c).

In a January 2013 letter to the OU-1 Respondents, EPA indicated that more groundwater data were needed and requested the Respondents perform additional rounds of groundwater sampling in 2013. Subsequent discussions between EPA and the Respondents resulted in a decision to perform three additional rounds of groundwater sampling which were conducted in April, July and October 2013. Data summary reports for these additional rounds of sampling were prepared and submitted in July and December 2013 and in February 2014 (EMSI, 2013c, 2013g, and 2014).

For all of the 2012 and the 2013 groundwater monitoring events, EPA requested that all available groundwater monitoring wells at the West Lake Landfill Superfund Site property be included in the sampling activities. The monitoring wells/piezometers at the property include:

- Those wells still in existence from the group of 30 wells that had previously been sampled as part of the OU-1 RI/FS;

- The group of 24 wells that had previously been sampled as part of the OU-2 RI investigation but which, prior to the July/August 2012 event, had not been sampled since 1997 and for the most part were not previously sampled for Ra-228; and

- Additional wells associated with the Former Active Sanitary Landfill (a/k/a the Bridgeton Landfill or the Permitted Landfill) which, prior to the July/August 2012 sampling event, had never been sampled for any radioisotopes.

Figure 4-10 shows the locations of the 78 groundwater monitoring wells sampled during one or more of the four 2012/2013 monitoring events. Table 4-4 summarizes information regarding the construction and completion details for these wells. Table 4-6 provides a comprehensive listing of the wells sampled during each of the four groundwater monitoring events. Table 4-7 provides a listing of the general area in which each well is located and the hydrogeologic unit each well is screened across.

In addition to the above-referenced wells and as part of Bridgeton Landfill's closure activities, Bridgeton Landfill, LLC installed eight additional groundwater monitoring wells at or adjacent to the Bridgeton Landfill during October 2-8 and 15-20, 2013. The new wells were developed and groundwater from the wells was sampled on November 6 and 7, 2013. A copy of the Groundwater Monitoring Well Installation Report (Herst & Associates, 2014) was provided as Appendix A to the report on the October 2013 groundwater sampling activities (EMSI, 2014b). These eight wells were sampled a second time in February 2014.

EPA directed that for the additional groundwater sampling events, samples obtained from the various Site wells be analyzed for the following parameters:

1. Uranium (U-234, -235 and -238), thorium (Th-230 and Th-232), and radium (Ra-226 and Ra-228) radioisotopes, with all radioisotopes analyzed for both total (unfiltered samples) and dissolved (filtered samples) phases;

2. Total and dissolved phase trace metals;

3. VOCs; and

4. SVOCs.

EPA determined that analyses for SVOCs performed as part of the August 2012 monitoring event did not need to be repeated as part of the three 2013 groundwater monitoring events. This change is reflected in the EPA-approved March 18, 2013 SAP Addendum for the 2013 groundwater monitoring events.

Results of the additional groundwater monitoring activities, including descriptions of the field and sample collection activities and summaries of the results of the laboratory analyses, were previously provided to EPA (EMSI, 2012c, 2013c, 2013g, and 2014b). These reports also contain copies of the various field data sheets, the analytical laboratory reports, and the data validation reports and resultant database. Tabulated summaries of the results of the additional OU-1 groundwater sampling conducted from 2012 through 2014 are included in Appendix F-3.

Both EPA and MDNR collected split (duplicate) samples from some of the OU-1 groundwater samples obtained during the additional groundwater monitoring activities. Tabulated summaries of the EPA and MDNR results and comparisons to the OU-1 results are presented in Appendix F-4.

4.11.5 Sampling of Private Wells (2013)

The USGS, working on behalf of EPA, identified various private water supply wells in the general vicinity of the West Lake Landfill Superfund Site. EPA collected samples in 2013 from six alluvial wells located to the north of the West Lake Landfill and analyzed the samples for VOCs and total (unfiltered) radionuclides.

The EPA provided contact information to Respondents for sampling of other nearby off-site wells. Herst & Associates, on behalf of EMSI, contacted the various owners of these six private wells and the owners of other water wells in the general area of the Site and inquired about their willingness to have their wells sampled on behalf of the OU-1 Respondents. Only one owner that owned two alluvial wells located to the south of the Site agreed to allow samples to be collected, and Herst & Associates collected samples from these two wells in August 2013.

After attempts to gain access to these wells were unsuccessful, the EPA requested that the USGS obtain access for sampling. The USGS subsequently contacted the various well owners about allowing the USGS to collect samples from the wells, and obtained permission to resample four wells. Well owners for three of these wells had been previously contacted by the Respondents: alluvial well B4-S (permission also given for deep alluvial well B4-D but it had been winterized and was thus unavailable) and another alluvial well B3. USGS also obtained permission to sample three bedrock wells (A5, D-1, and E-1). The USGS was able to obtain permission to sample four additional wells, three of which were located 3.5 to 4.75 miles to the south or southwest of the Site (*i.e.*, upgradient or cross-gradient from the Site) including two bedrock wells and one alluvial well, and one additional bedrock well located near Weldon Spring, 13.5 miles to the southwest of the Site (USGS, 2014). The USGS subsequently collected samples from these four wells in November 2013. Further discussion of the results of the USGS evaluations is presented in Section 7.5.1.1.5 of this RI Addendum.

Herst & Associates, on behalf of EMSI, collected split samples from the USGS sampling of these wells. The USGS subsequently determined that one of the alluvial wells was connected to a water softener above the point at which the sample was collected and therefore the results from this well were discarded by the USGS (USGS, 2014). A tabular summary of the results of the analyses of the samples obtained by Herst & Associates in conjunction with the USGS sampling of private wells is presented in Appendix F-5. Results of the EPA and USGS sampling of private wells is presented in the USGS report (USGS, 2014).

4.11.6 OU-2 Groundwater Monitoring (1995-1996 and 2004)

Two rounds of groundwater sampling were conducted in February/March 1997 and May/June 1997 on behalf of Bridgeton Landfill, LLC as part of the OU-2 RI (Herst & Associates, 2005). Groundwater sampling was also conducted at five wells (PZ-300-AS, -300-SS, and -700-AD and I-50 and S-80) in December 1995 prior to decommissioning of those wells in conjunction with property development activities. Details regarding the OU-2 groundwater sampling activities

and the results of the OU-2 groundwater sampling are presented in the Site Characterization Summary Report for West Lake Landfill Operable Unit 2 RI/FS (Water Management Consultants, 1997) and are discussed in both that report and in the OU-2 RI report (Herst & Associates, 2005).

Supplemental groundwater sampling for OU-2 was conducted by Bridgeton Landfill, LLC in December 2003 and May 2004 from a selected list of alluvial wells. The results of this sampling event were presented in the OU-2 Monthly Reports dated March 9, 2004 and August 9, 2004 (Herst & Associates, 2005). Results obtained during this sampling event are evaluated as part of the overall OU-2 groundwater sampling discussion in the OU-2 RI report. Although the primary purpose of the OU-2 groundwater sampling efforts was for characterization of water quality conditions associated with OU-2, analyses for radionuclides in groundwater were included during some of the OU-2 groundwater monitoring events. These data are tabulated and presented in Appendix F-6.

4.11.7 Bridgeton Landfill Groundwater Monitoring

Detection and assessment groundwater monitoring are conducted by Bridgeton Landfill, LLC for the Bridgeton Landfill. Although this sampling primarily consists of VOCs, trace metals and general water quality parameters, analyses for radionuclides have been conducted for some of the samples obtained during some of these events. The radionuclide data obtained from these samples are tabulated and presented in Appendix F-6. Bridgeton Landfill is also in the process of implementing corrective actions as described in the Feezor Engineering, Inc. November 2016 report (FEI, 2016c).

4.12 Surface Water and Sediment Investigation

Surface water and sediment samples were collected during the OU-1 RI field investigations. Sediment samples were also collected as part of the Additional Characterization of Areas 1 and 2. Stormwater runoff samples have been and continue to be collected from OU-1, initially in conjunction with construction of the NCC on portions of Areas 1 and 2 pursuant to the UAO for Removal Action [the Surface Fire Prevention Removal Action] (EPA, 2015d) and subsequently as part of the overall OU-1 RI/FS work. These samples are analyzed for a standard list of parameters associated with municipal solid waste landfills along with radionuclides.

In addition, Bridgeton Landfill, LLC performs stormwater monitoring relative to the Bridgeton Landfill in accordance with a permit issued by MDNR. This monitoring includes standard parameters for a landfill facility and does not include radionuclides. MDNR also collected a surface water sample as part of its 2015 survey and sampling activities (MDNR, 2016).

A description of the various rainfall/runoff, surface water, stormwater and sediment sampling activities that have been performed at the Site is provided in the following subsections. The

analytical results of these sampling activities are included in Appendix G and are discussed and evaluated in Section 7.2 and 7.3 of this report.

4.12.1 OU-1 RI Surface Water and Sediment Sampling (1995-1997)

McLaren/Hart performed surface water and sediment sampling to provide the data necessary to evaluate the surface water - groundwater interactions and to assess the potential for chemical transport via surface water and sediments. This investigation included obtaining water level measurements from the various surface water bodies in the area and measurement of rainwater runoff flows from Areas 1 and 2 (Figure 4-13). This investigation also included sampling and radionuclide and chemical analyses of rainwater runoff and erosional sediments from nine weir locations at the margins of Areas 1 and 2 along with sampling and chemical analyses at two surface water locations in the vicinity of the Site. Samples were collected by McLaren/Hart from the Area 1 weir locations on May 18-19, 1995, and samples from the Area 2 weirs were collected on April 29, 1996. McLaren/Hart collected surface water samples from the North Surface Water Body (SW-2) located adjacent to the northern portion of Area 2 and from the Earth City stormwater pond located adjacent to the southwestern portion of Area 2 in November 1995.

In addition, samples and chemical analyses were performed on the leachate from the seep (Figures 4-9 and 4-13) that was observed near the western boundary of Area 2 during the 1995 field investigations. The methodologies used, scope of activities and the results of these investigations are described in McLaren/Hart's Rainwater Runoff, Erosional Sediment, Surface Water, and Leachate Sampling Data Report - West Lake Landfill Areas 1 & 2 (McLaren/Hart, 1996e).

Supplemental rainwater runoff, surface water, and sediment investigation activities were conducted by EMSI. EMSI collected samples from weirs 3 and 4 in Area 1 and from weirs 5, 8 and 9 in Area 2 on August 19, 1997. EMSI also collected samples from the North Surface Water Body and the Earth City stormwater pond on this date. All of these samples were analyzed for radionuclides only.

Analytical results from the rainwater-runoff and surface water samples are presented in Appendix G-2. Additional information and details regarding the rainwater runoff, sediment and surface water sampling performed as part of the OU-1 RI field investigations are included in the Rainwater Runoff, Erosional Sediment, Surface Water, and Leachate Sampling Data Report (McLaren/Hart, 1996e), the ASAP (EMSI, 1997a), the SCSR (EMSI, 1997e), and the 2000 OU-1 RI Report (EMSI, 2000). Additional information regarding these activities is also included in McLaren/Hart's letters of March 30, 1995 (McLaren/Hart, 1995a) and June 22, 1995 (McLaren/Hart, 1995d), EMSI's letter of April 29, 1997 (EMSI, 1997b) and EPA's letter of May 5, 1995 (EPA, 1995b).

4.12.1.1 Rainwater Runoff Sampling

The locations of the various weirs used to obtain rainwater/runoff and erosional sediment samples at the Site during the OU-1 RI in 1995 - 1997 are shown on Figure 4-13. This figure also shows the locations from which off-site sediment samples were obtained. Also shown on this figure are the various locations from which surface water level measurements were obtained and the off-site surface water quality sample collection locations.

Field reconnaissance of then-current topographic conditions and the presence of erosional channels conducted by McLaren/Hart (1996e) during October 1994 to March 1995 was used to identify nine locations (four in Area 1 and five in Area 2) where rainwater could potentially run off of Areas 1 and 2. To estimate the amount of rainwater runoff flow from Areas 1 and 2, McLaren/Hart installed a series of calibrated "V-notch" weirs at each of the nine locations.[39] At each of the sampling locations, runoff was directed through the "V-notch" weir. The weirs were installed in April 1995 and surveyed for location and elevation control.

Per the 1994 EPA-approved RI/FS Work Plan, rainwater runoff samples were to be collected within 24 hours of a rainwater event that produced a sufficient quantity of runoff for collection of samples. Specifically, rainwater runoff samples were to be collected after a storm that was forecast to produce at least 1 inch of rain at nearby Lambert Field (the St. Louis International Airport).

Samples were collected from the four Area 1 weirs on May 18 and 19, 1995; however, sampling of the Area 2 weirs could not occur at this time as planned. The severity of the storm associated with this rainfall event (9.54 inches on May 16 and 17, 1995, equivalent to a 100-year storm event for a two-day duration) caused erosional scour and undermined the weirs placed near the western slope of Areas 2 (above a portion of the Ford property). In addition, on the east side of Area 2, water from adjacent landfill operations (roll-off box storage area and the construction debris landfill) flowed toward and commingled with the runoff from Area 2. At the time of the May 1995 storm, the weirs on the eastern portion of Area 2 were not located in a manner to isolate and sample Area 2 runoff only.

During the remainder of 1995 and the first quarter of 1996, McLaren/Hart (1996e) reported that no storms producing sufficient runoff for sampling the Area 2 weirs occurred. As required by the RI/FS Work Plan, McLaren/Hart performed site reconnaissance throughout this period during and after each storm which produced at least one inch of rainwater at Lambert Field or which had the potential to produce sufficient runoff for sampling. Based on daily precipitation records, there were only two events that produced over one inch of rain at Lambert Field during the period from May through December of 1995. Reconnaissance of the weirs during both of these events indicated that runoff was not occurring.

[39] These weirs no longer exist on the Site.

Area 2 rainwater-runoff samples were finally collected on April 29, 1996. At the time the sampling was performed, no runoff was occurring at Weir 6, one of the three weirs located along the western portion of Area 2. As a result, no runoff sample could be collected from this location. On the east side of Area 2, water had ponded around the two weir locations (Weirs 8 and 9); however, no runoff was occurring. As a result, samples of the ponded water were collected.

As previously described in Section 4.11.2 as part of the discussion of the groundwater investigation, the required analytical technique for radium isotope analyses in water samples was not specified by McLaren/Hart on the chain-of-custody forms. The error was identified by McLaren/Hart in May 1996 and brought to the attention of the EPA Project Manager. At the direction of EPA, all of the monitoring wells were re-sampled for Ra-226 and Ra-228 as part of the groundwater investigation; however, EPA did not require re-sampling of the surface water and rainwater investigation. Consequently, the MDA levels for the rainwater runoff and surface water samples collected by McLaren/Hart exceeded the MCL for Ra-226 and Ra-228. Therefore, additional surface water samples were collected by EMSI in May 1997 for radium analyses. These results were presented in the SCSR (EMSI, 1997e) and are described further in Section 7 of this report.

EMSI performed additional surface water and sediment sampling in May 1997. Rainfall runoff samples were also collected from Weirs 3, 4, 5, 8, 9, and 10 on August 19, 1997 as part of the ASAP field activities to verify the results reported in the Rainwater Runoff, Erosional Sediment, Surface Water, and Leachate Sampling Data Report (McLaren/Hart, 1996e). Rainwater runoff samples were not collected from Weirs 1, 2, 6, and 7 because rainfall during the field program interval was insufficient to produce runoff at these locations.

The May 1997 sampling activity also included collection of a sample from an additional location, Weir 10. Weir 10 was installed in May 1997 to provide supplementary data for the areas drained by Weir 8 and Weir 9. Specifically, Weir 10 was installed down-slope of Weirs 8 and 9 in an attempt to obtain flowing rather than ponded runoff from this portion of Area 2. It should be noted, however, that the location at which Weir 10 was installed potentially received some minor component of runoff from a limited portion of the Site south of Area 2.

In addition to verifying the results obtained by McLaren/Hart, the EMSI sampling was also intended to provide concentration data for gross alpha, Ra-226 and Ra-228 using an analytical method with detection limits below relevant MCLs and to further evaluate the Th-232/Ra-228 and Th-230/Ra-226 relationships.

Tabulated summaries of the results of the radiological and non-radiological analyses of the rainwater runoff samples are contained in Appendix G-1.

4.12.1.2 Erosional Sediment Sampling

Concurrent with the rainwater runoff sampling, McLaren/Hart collected erosional sediment samples from sediment that had accumulated behind the "V-notch" weirs. As required by the RI/FS Work Plan, erosional sediment samples were collected after rainwater runoff had abated. Sample collection and handling were performed consistent with the procedures outlined in the SAP. Additional information is presented in the Rainwater Runoff, Erosional Sediment, Surface Water and Leachate Sampling Data Report (McLaren/Hart, 1996e).

Sediment samples were also collected by EMSI in 1997 as part of the ASAP. EMSI collected sediment samples from the following locations:

- Sample location SED-1 located at the intersection of the Site property boundary and the east-west drainage ditch along the south side of the access road. This location is where sediment mobilized from Area 1 would have exited the Site;

- Sample location SED-2 located at the intersection of the Site property boundary and the northern access road perimeter ditch;

- Sample location SED-3 located in the perimeter ditch along the west side of St. Charles Rock Road halfway between the SED-2 sampling location and the North Surface Water Body; and

- Sample location SED-4 located along the perimeter ditch on the west side of St. Charles Rock Road immediately upstream from the North Surface Water Body.

- Sediment samples were also collected by EMSI from behind six of the ten weirs (Weirs 3, 4, 5, 8, 9, and 10) according to the amended ASAP to verify the results reported in the Rainwater Runoff, Erosional Sediment, Surface Water, and Leachate Sampling Data Report (McLaren/Hart, 1996e). The sampling included Weir 10, which was installed in May 1997 to provide supplementary data for the areas drained by Weir 8 and Weir 9. Additional information is presented in the SCSR (EMSI, 1997e).

The results of the radiological and non-radiological analyses of the erosional sediment samples are summarized in Appendix G-2.

4.12.1.3 Surface Water and Leachate Sampling

Surface water samples were collected from the North Surface Water Body and from the flood control channel along the west side of the property (the Earth City Flood Control Channel) in accordance with the procedures outlined in the 1994 RI/FS Work Plan. Complete details regarding the initial surface water sampling are presented in the Rainwater Runoff, Erosional Sediment, Surface Water and Leachate Sampling Data Report. In accordance with the ASAP,

supplemental surface water samples were collected by EMSI in May 1997, as discussed in the SCSR (EMSI, 1997e).

McLaren/Hart collected a leachate sample from a seep that was located on the western landfill slope near the southwest corner of Area 2 as required in the RI/FS Work Plan. No other leachate seeps were identified. Details of the leachate seep sampling are presented in the Rainwater Runoff, Erosional Sediment, Surface Water and Leachate Sampling Data Report.

Surface water samples were collected by EMSI on May 15, 1997, as part of the ASAP field activities were only analyzed for radionuclides. Surface water samples were collected from near the southern edge of the North Surface Water Impoundment and from the Earth City Flood Control Channel at McLaren/Hart staff gage location 6 / 7. These locations were selected because they were the approximate locations where all runoff contributions from the Site reached the perimeter surface water drainage system (McLaren/Hart, 1996e). The purpose of these additional samples was to provide confirmation of the radionuclide results previously obtained by McLaren/Hart. The samples were collected according to the protocols outlined in the EPA-approved ASAP.

The results of the radiological and non-radiological analyses of the surface water samples are presented in Appendix G-1.

4.12.2 Post-ROD Sediment and Stormwater Sampling (2016 and 2017)

In conjunction with the Additional Characterization work, additional sediment samples were collected in 2016 and 2017. Stormwater monitoring was performed in 2016 and 2017, initially in conjunction with NCC construction and subsequently as part of the OU-1 RI/FS work.

4.12.2.1 Post-ROD Sediment Sampling

EPA requested that as part of the Additional Characterization of Areas 1 and 2, additional sediment samples be collected from three of the four locations from which sediment samples were obtained in May 1997; specifically, SED-1, SED-2 and SED-4 (EMSI, 2015e). Sediment samples were collected from these locations on January 8, 2016. The locations from which these sediment samples were obtained are shown on Figure 4-14. Analytical results obtained for these samples are summarized in Appendix G-3.

On behalf of EPA, TetraTech START prepared a QAPP for Soil/Sediment Sampling of Drainage Features, West Lake Landfill Site, Bridgeton, Missouri (TetraTech, 2016). Pursuant to this QAPP, EPA planned on collecting eight additional sediment samples. Subsequently, it was determined that three of these locations (SED-1, SED-2 and SED-4) had just been sampled a month earlier (January 8, 2016) as part of the Additional Characterization of Areas 1 and 2, and

therefore EPA determined that additional samples were not required at that time from these locations.

On March 16, 2016, representatives of EPA, EMSI, and Feezor Engineering, Inc. (FEI), inspected the remaining five proposed sediment sample locations. Based on this inspection it was determined that one of the locations had just been sampled as part of collection of soil samples along the perimeter of Area 2 adjacent to the AAA Trailer property and that there was no potential for runoff from Area 2 at two of the proposed locations. A sediment sample (SEDIMENT-2016-03-16B) and a duplicate sample (SEDIMENT-2016-03-16B DUP) were collected from the stormwater channel located on the north side of the Site access road, southwest of the parking area associated with the landfill engineering office. A sediment sample (SEDIMENT-2016-03-16A) was also collected near but upstream of a culvert that conveys runoff from the AAA Trailer property beneath the embankment associated with Old St. Charles Rock Road to a point where it discharges into the Earth City Flood Control Channel. EPA also collected split samples from these locations. The locations of these two additional sediment samples are shown on Figure 4-14. Analytical results for these sediment samples are summarized in Appendix G-3.

The results of the sediment sampling indicated that radionuclides were present at SED-4 at levels that met the definition of RIM for OU-1. Specifically, the combined Thorium concentrations for SED4 and SED 4-EPA DUP were 16.16 pCi/g and 20.63 pCi/g, respectively, which exceeds the established limit of 7.9 pCi/g. EPA requested that five additional sediment samples be collected downstream from the SED-4 location. On June 10, 2016, an additional sediment sample plus a duplicate sample were collected from SED-4, and samples were also collected from three points (SED-6, SED-7 and SED-8) located approximately 110, 280, and 390 (respectively) to the northwest (downstream) from SED-4. Two additional locations (SED-9 and SED-10) were located in an area of standing water and could not safely be sampled on this date. Samples were collected from these two locations on January 19, 2017. None of these samples contained radium or thorium levels above the established limit of 7.9 pCi/g. Analytical results for all of the 2016 and 2017 sediment samples are included in Appendix G-3. Analytical results for the 2016-2017 sediment samples are summarized on Table 7-12 and discussed in Section 7.3.

4.12.2.2 Post-ROD Stormwater Sampling

By email dated February 12, 2016, EPA informed the OU-1 Respondents that the removal action being performed in response to the UAO for Removal Action (EPA, 2015d)[40] needed to comply with the applicable or relevant and appropriate requirements (ARARs) of other environmental laws identified by MDNR. In particular, EPA instructed the OU-1 Respondents that "the State-identified ARARs associated with Storm Water will apply to the Surface Fire Mitigation Removal Action and should be complied with until this action is complete." In response, an

[40] Also referred to as the Surface Fire Mitigation Removal Action, which included, in part, construction of a non-combustible cover (NCC) over areas where RIM was present at the gorund surface.

initial Stormwater Monitoring Plan was prepared and submitted to EPA (EMSI, 2016b). EPA provided conditional approval of this plan on March 1, 2016 and subsequently provided comments on April 4, 2016. A revised plan was prepared and submitted to EPA on April 12, 2016. On July 5, 2016, EPA Region 7 provided comments to the Revised Storm Water Monitoring Proposal, and also forwarded a letter from the MDNR with additional comments related to stormwater monitoring. Respondents submitted a further revised plan responding to EPA's July 5 comments on July 15, 2016. EPA provided comments on this plan on September 9, 2016. Subsequent discussions with EPA resulted in the stormwater program being incorporated into the overall OU-1 RI/FS work rather than remaining as part of the UAO for Removal Action. On December 12, 2016, EPA formally notified the Respondents of this change. A stormwater monitoring plan for OU-1 was developed and submitted to EPA on March 22, 2017. This revised plan was based in part on the prior draft NCC stormwater monitoring plan and incorporated additions and revisions necessary to address the comments provided in EPA's September 9, 2016 letter. As of the date of this draft of the RIA, this plan has not yet been approved or commented on by EPA.

During development of the Stormwater Monitoring Plan, EMSI and FEI utilized facility topography information to identify potential drainage basins and precipitation drainage pathways for OU-1 Areas 1 and 2 of the West Lake Landfill (Figure 4-15). Area 1 consists of two primary drainage basins with two potential drainage pathways that lead to two potential outfall points, OU-1-001 and OU-1-002 (initially identified as NCC-001 and NCC-002). Five distinct drainage basins were identified relative to Area 2, some of which include portions of adjacent OU-2 landfill areas (including a portion of the closed demolition landfill and the inactive sanitary landfill). Only two of these five drainage basins are expected to have the potential for off-site discharge of stormwater. Specifically, stormwater runoff from Area 2 (as well as adjacent areas outside of Area 2) could potentially flow off-site at points NCC-003 and NCC-004. Two other drainage basins appear to be completely contained, resulting in ponding of surface water without any discharge. The fifth drainage basin does not appear to have any organized drainage but instead contributes only overland flow off of Area 2 onto the adjacent Buffer Zone. The surface of the Buffer Zone is flat, and visual inspection of the perimeter of the Buffer Zone did not identify any engineered structures or erosional channels that convey stormwater off of the Buffer Zone. The elevation of the adjacent AAA Trailer property and the grade of the alignment of Old St. Charles Rock Road are higher than the surface of the Buffer Zone, effectively limiting discharge of stormwater from the Buffer Zone. Inspection and monitoring of these four outfalls began in February 2016. In accordance with EPA's April 4, 2016 comment letter, inspection of the north and northwest slopes of Area 2 for possible stormwater discharge was initiated in April 2016.

In addition to the above-described activities, on April 26, 2016, runoff from the newly constructed rock buttress along the margin of Area 2 and the adjacent Buffer Zone flowed toward and collected along the property boundary between the Buffer Zone and the adjacent AAA Trailer property, with the accumulated water extending onto portions of the AAA Trailer property. A sample of the ponded water was collected and submitted for laboratory analyses for the same parameters included in the Stormwater Monitoring Plan. Results of this sample are also

included on the tabulated summary in Appendix G-4. In response to this occurrence, as part of the NCC construction, a berm was built along the fence line to prevent stormwater that may accumulate on the Buffer Zone from flowing into the AAA Trailer trailer parking area.

Inspection and sampling of any observed discharge along the east boundary of Area 1 was voluntarily performed by the Respondents beginning in May 2016, and was subsequently continued pursuant to a requirement set forth in EPA's July 5, 2016 comment letter. In September 2016, monitoring point NCC-003 was relocated to NCC-003A (later OU-1-003A) near the entrance to Area 2 to isolate potential stormwater discharge from Area 2 from other sources of stormwater runoff in the vicinity of NCC-003.

EPA's September 9, 2016 comments required two additional potential outfall locations, OU-1-005 and OU-1-006 (originally identified as NCC-005 and NCC-006), located along the boundary between the Buffer Zone and adjacent AAA Trailer facility (Lot 2A2), to be inspected for potential stormwater discharge, and if discharge was observed, to be sampled as part of the stormwater monitoring program. EPA's September 9, 2016 letter also added existing Bridgeton Landfill outfall 007 to the NCC stormwater monitoring program (identified as OU-1-007) even though flow from Area 1 or 2 to this outfall was already being monitoring at upstream monitoring points OU-1-001 and OU-1-003/003A (originally identified as NCC-003/NCC-003A). Monitoring of these additional points was initiated in November 2016.

Pursuant to the initial and the revised Stormwater Monitoring Plans and EPA's comment letters, stormwater monitoring has been performed at up to 11 locations (Figure 4-16) including the following:

- OU-1-001 (formerly NCC-001)
- OU-1-002 (formerly NCC-002)
- OU-1-003A (formerly NCC-003A and also NCC-003)
- OU-1-004 (formerly NCC-004)
- OU-1-005
- OU-1-006
- OU-1-007
- OU-1-008
- OU-1-009
- OU-1-010
- OU-1-011

In addition, the northern and northwestern boundaries of Area 2 are observed for evidence of stormwater runoff (such as erosional channels or sediment deposition areas) after precipitation events greater than 0.1 inches; however, no indication of any stormwater discharge has ever been observed in these areas.

In accordance with the Stormwater Monitoring Plan (as revised), the potential outfall points are inspected for stormwater flow during or immediately after rainfall events that are anticipated to result in at least one-tenth inch of precipitation[41]. In the event of the presence of stormwater flow at any of the monitoring points, samples are collected for laboratory analysis. Once a sample has been collected from a monitoring point during any monthly period, no further inspections or sampling of that location is performed during that month. Stormwater samples are submitted to Eberline Laboratory for radium, thorium and uranium isotope analyses, as well as for gross alpha and gross beta, and to TekLab for the analytical parameters identified in the Stormwater Monitoring Plan, which include total recoverable trace metals, benzene and ethyl benzene, pH, biological oxygen demand, chemical oxygen demand, total suspended solids, settleable solids, oil and grease, ammonia, chloride plus sulfates and total hardness. Beginning in May 2016, total uranium as a metal was also added to the analyte list for both Eberline and TekLab (subcontracted to Pace Labs).

Analytical laboratory reports for these samples are submitted to EPA, initially as part of the monthly status reports for the UAO Removal Action for Surface Fire Prevention, and subsequently as part of the OU-1 monthly progress reports beginning in December 2016. Copies of the analytical results summary tables provided by the laboratories are included in Appendix G-4. Tabulated summaries of the results for the stormwater samples are presented on Tables 7-11 and 7-12. Radionuclide results from this sampling are discussed in Section 7.2.1.2. Results of the analyses of physical and chemical parameters are discussed in Section 8.6.

Stormwater monitoring activities continue to be performed as of the date of this draft RI Addendum. Any additional stormwater monitoring data generated and available after preparation of the draft RI Addendum but before the preparation of the final RI Addendum may be included in the final version of the RI Addendum, if so directed by EPA, otherwise they will continue to be submitted as part of the OU-1 monthly reports.

4.12.3 MDNR Surface Water Sample

In conjunction with its 2015 Radiological Survey and Sampling activities (MDNR, 2016), MDNR collected a sample from standing water that had accumulated from a rainstorm that occurred on November 5, 2015. The sample was collected from a wooded area on an off-site undeveloped property located to the southwest of the inactive sanitary landfill and the Earth City Flood Control Channel. The sample and a field duplicate sample were submitted to Eberline Laboratory for radium, uranium metal, gross alpha and gross beta analyses. The sample results were below laboratory detection limits or below regulatory action and screening levels. A table summarizing the MDNR sample results and figures showing the sample collection locations is contained in Appendix G-5.

[41] Memoranda documenting the results of the stormwater inspections were included with the NCC progress reports beginning in July 2016, and subsequently with the OU-1 monthly progress reports beginning in December 2016, both of which are submitted to EPA with copies to MDNR.

4.12.4 Bridgeton Landfill Stormwater Monitoring

Bridgeton Landfill, LLC conducts stormwater monitoring pursuant to Missouri State Operating Permit No. MO-0112771. Specifically, Bridgeton Landfill, LLC monitors five outfalls (003, 004, 005, 006, and 007) at the Site (Figure 4-17)[42]. Stormwater flow to four of these outfalls is derived only from areas associated with Bridgeton Landfill. Stormwater flow to the fifth outfall (007) includes flow from portions of the Inactive Sanitary Landfill, the Closed Demolition Landfill, Area 1 and Area 2 (Figure 4-17).

Stormwater samples collected by Bridgeton Landfill are analyzed for the parameters specified in the permit, including total recoverable trace metals, benzene and ethyl benzene, pH, biological oxygen demand, chemical oxygen demand, total suspended solids, settleable solids, oil and grease, ammonia, chloride plus sulfates and total hardness. Bridgeton Landfill, LLC submits the results of the stormwater monitoring to MDNR. Results of the Bridgeton Landfill stormwater monitoring are summarized in Appendix G-6.

4.13 Air Monitoring

Air monitoring activities conducted for or related to West Lake Landfill OU-1 have included collection of fugitive dust samples and analysis of such samples for radionuclides, collection of air samples for VOC analyses, collection and analysis of air samples for radon analyses, and monitoring of radon emissions from the landfill surface.

In 1981, RMC, on behalf of the NRC, performed radon flux measurements and collected fugitive dust samples for gamma analyses of Radon-219 daughter products such as Pb-211. Results are presented in the 1982 RMC report.

McLaren/Hart performed an investigation of radon gas levels at the surface of the Site and of the potential for VOC emissions from the landfill in 1995, and also conducted sampling in 1996 to evaluate the potential for transport of radionuclides and trace metals in fugitive dust derived from Areas 1 and 2. The scope of these activities, methodologies used, and the results of these investigations are described in detail in the Radon Gas, Landfill Gas and Fugitive Dust Report - West Lake Landfill Areas 1 & 2 (McLaren/Hart, 1996d). In addition, as part of the supplemental field investigation activities described in the ASAP, EMSI completed a radon flux measurement program in June 1997.

Auxier collected fugitive dust samples in 2013 and 2014 in conjunction with drilling performed during the Phase 1 investigations (EMSI et al., 2016b). On behalf of the OU-1 Respondents Auxier also perform Site-wide perimeter air monitoring for radionuclides, gamma, and radon at 13 locations and for VOCs at 5 of these locations, beginning in May 2015. This monitoring is performed in accordance with the Air Monitoring, Sampling and QA/QC Plan West Lake

[42] A sixth outfall shown on Figure 4-16 (Outfall No. 1) is no longer monitored by Bridgeton Landfill, LLC.

Landfill Superfund Site Operable Unit 1 (Auxier 2014) with quarterly reports submitted to EPA. This monitoring continues to be performed.

EPA performed air monitoring at five off-site locations that included collection of samples for fugitive dust and analysis of these samples for radionuclides and measurement of gamma and radon levels over the period from April 2014 through July 2015 (TetraTech, 2015b, 2015e, and 2015h). EPA also collected and analyzed samples for VOCs, as well as measurement of hydrogen sulfide, carbon monoxide, and sulfur dioxide, over the period from December 2014 through May 2015 (TetraTech 2015, 2015a, 2015c, 2015d and 2015g).

MDNR collected dust samples in 2013 and 2015. MDHSS has also been conducting air monitoring since April 2013, including continuous monitoring of reduced sulfur compounds (reported as hydrogen sulfide), sulfur dioxide, carbon monoxide, and total VOCs at three locations; twice daily surveillance of hydrogen sulfide, benzene, and odor levels around the periphery of the Bridgeton/West Lake Landfill; and weekly VOC compound-specific sampling in locations upwind and downwind of the Site. MDNR also monitors gamma radiation rates (SWAPE, 2013).

4.13.1 Fugitive Dust Monitoring

Fugitive dust samples were collected by RMC in 1981 (RMC, 1982), by McLaren/Hart in 1996 (McLaren/Hart, 1996d), and by Auxier in 2013, 2014 and 2015 (FEI, 2014b, EMSI et al., 2016b) as part of Site investigations. In addition, Auxier performed continuous perimeter air monitoring at 13 locations around Areas 1 and 2 beginning in May 2015 through April 2016 (Auxier, 2016c, 2016d and 2016e). This perimeter air monitoring program continues to be performed after April 2016.

EPA monitored fugitive dust at five off-site locations over the period from May 2014 through July 2015 (TetraTech, 2015h).

4.13.1.1 OU-1 RI Fugitive Dust Sampling (1996)

McLaren/Hart prepared a detailed plan for the fugitive dust sampling effort and submitted this plan to EPA in a December 4, 1995 letter (McLaren/Hart, 1995f). EPA approved this plan prior to the start of the field activities (EPA, 1995c).

McLaren/Hart completed the fugitive dust sampling on April 11, 1996. Samples were collected at locations in both Area 1 and Area 2 that were upwind and downwind of previously defined radiologically affected areas (Figures 4-18 and 4-19). All samples were collected within 40 feet of the radiologically affected areas to simulate worst-case scenarios (McLaren/Hart, 1996d). The fugitive dust samplers were operated for an 8-hour period and the samples were collected on

closed-face filter cassettes, sealed, and submitted to the laboratories for analyses (McLaren/Hart, 1996d).

Results of the McLaren/Hart fugitive dust sampling were reported in the Radon Gas, Landfill Gas and Fugitive Dust Report (McLaren/Hart, 1996d). McLaren/Hart tabulations of the sample results are included in Appendix H-2.

4.13.1.2 Particulate Monitoring During the Phase 1 Investigations (2013-2015)

Fugitive dust samples were collected for purposes of assessing possible impacts to workers during drilling of the Phase 1 borings in Area 1. Specifically, fugitive dust samples were collected from each work site area and from two stationary high-volume air samplers.

A high-volume air sampling device was employed next to each work area (*e.g.*, drill site) to monitor for the presence of any airborne radioactive material. This air sampling device was placed adjacent to the drilling location in the downwind sector. Analysis of the results indicates all samples were well below the regulatory limit for workers of 5,000 mrem/y (10 CFR Part 20 Subpart C §20.1201(a)(1)(i)).

In addition to the specific work site area air sampling, two stationary high-volume air sampling stations were established. One station was set up adjacent to the job-site trailer located in Area 1 and the second station was set up adjacent to the Bridgeton Landfill transfer station. Each air sampling device was located in a weather protective housing. A summary of the results of the general area air sampling is presented in the Comprehensive Phase 1 Report (EMSI, et al., 2016b). Analysis of the results indicates all samples were well below the regulatory limit for air effluents from NRC-licensed facilities of 50 mrem/y (10 CFR Part 20 Appendix B).

A summary of the specific sampling activities and the results of the specific work site and general area air sampling conducted during the Phase 1A/1B/1C and the Phase 1D investigations is presented in the Comprehensive Phase 1 Report (EMSI, et al., 2016b). The tabulated summaries of the Phase 1A/1B/1C and Phase 1D air monitoring presented in the Comprehensive Phase 1 report are included in Appendix H-3.

4.13.1.3 OU-1 Perimeter Air Monitoring (2015-2017)

The currently ongoing air monitoring activities at the Site include sampling for airborne radioactive particulates, radon gas, and VOCs, as well as measurements of gamma radiation. Sampling is performed continuously at the perimeters of OU-1 Areas 1 and 2. Data collected from the monitoring activities are used to assess and document the air quality along the boundaries of OU-1. The monitoring was performed and is currently being performed according to the requirements described in the Air Monitoring, Sampling, and QA/QC Plan (Auxier, 2014).

An integrated system of 13 environmental monitoring stations has been installed at the Site. Twelve of these stations are located around the perimeters of OU-1 Areas 1 and 2, with two located close to the nearest on-site buildings (the landfill office and the transfer station building). The thirteenth station is located in the southwest corner of the Site, the farthest distance on-site from Areas 1 and 2. These 13 locations were selected to ensure that the monitoring network encompassed Areas 1 and 2, including the entrance road and the road through the center of the Site (Figure 4-20).

An on-site meteorological station (the "met station") measures and logs temperature, barometric pressure, relative humidity, wind speed and wind direction. The station is located adjacent to the landfill office building (13570 St. Charles Rock Road).

The air monitoring network shown in Figure 4-20 provides coverage around Areas 1 and 2 under all wind direction conditions. The air monitoring and sampling locations near the center of the Site are arranged in a broad line oriented approximately southeast to northwest and parallel to the predominant wind directions. Additional stations are located transverse to this orientation, parallel to the less dominant southwest and northeast wind directions.

The sampling and sensor equipment in each monitoring station enclosure operate continuously. The equipment in these stations consists of a high-volume air sampler for airborne particulates, a continuous radon monitor (alpha track etch), and an environmental radiation detector called a thermoluminescent dosimeter (TLD).

Particulates gathered on air sample filters are collected every four weeks (28 days) and analyzed for alpha and beta emitters. During any 12-week period, samples collected from all of the stations during the middle 4-week period are analyzed for specific isotopes.

Alpha track etch monitors provide a cumulative measure of radon gas present and allow determination of average radon levels for the sampling period. TLDs measure ambient gamma radiation levels. Radiation dosimeters and alpha track etch detectors are exchanged and sent for analysis every calendar quarter.

Five of the monitoring stations house continuous passive samplers to monitor for VOCs. Monitoring of VOCs is performed using the Radiello Code 130 chemical adsorbing cartridge diffusion samplers that are left in place for periods of 14 days. The Radiello Code 130 cartridges consist of a stainless-steel net cylinder with 100 mesh grid opening and 5.8 mm diameter, packed with approximately 530 milligrams of activated charcoal. VOCs are trapped by adsorption and recovered by carbon disulfide displacement.

Gamma radiation is measured by installing thermoluminescent detectors (TLDs) at each of the 13 air monitoring stations. The TLDs are installed approximately three feet above the ground surface inside a housing shelter. A duplicate TLD is installed at one of the stations. Prior to January 2016, TLDs more suited to occupational monitoring were deployed. TLDs better suited to outdoor conditions were deployed for the fourth quarter of the 1st year of sampling and going

forward. These TLDs are packaged in a heat-sealed package to protect the TLDs from moisture and dirt, which can cause erroneous results. Sixteen environmental TLDs were requested and received from the laboratory. The 16 TLDs included 13 for station monitoring, a duplicate TLD, a control, and a trip blank to assist in evaluating the source of sample exposures. The trip blank is stored in a lead-lined container during the sampling period, but shipped normally with the other TLDs. This allows for differentiating exposures that occur during shipping from exposures that occur during deployment.

Results of the perimeter air monitoring program are reported to EPA on a quarterly basis (Auxier and EMSI, 2016c, d, and e and 2017a and b). Tabulated summaries of the air monitoring data obtained from the perimeter air monitoring report are contained in the various quarterly reports and have been included in Appendix H-3 and on Tables 7-5 through 7-9). Results of the air monitoring are discussed in Section 7.1.

4.13.1.4 EPA Off-site Particulate Air Monitoring (2014-2015)

EPA set up five off-site monitoring stations near the Site in April 2014; these activities included installations of electrical service, instrument weather housings, monitoring and sampling devices (including particulate air samplers, RAE Systems AreaRAEs, Saphymo GammaTRACERs, electret ion chamber radon detectors, and optically stimulated luminescent [OSL] dosimeters), and a wireless remote monitoring network (see Appendix H-4 for locations of the air monitoring stations). Between April/May 2014 and May 2015, EPA conducted ongoing baseline period off-site air monitoring and sampling at the five monitoring stations (TetraTech, 2014a, 2015b, 2015e, and 2015h).

The radiological parameters of potential concern were identified in the QAPP (TetraTech, 2014a) based on historical information regarding the site and program experience with similar types of sites. During the baseline sampling period, the presence of naturally occurring alpha-, beta-, and gamma-emitting radionuclides on airborne particulates was assessed. The radionuclides of potential concern based on characteristics of the OU-1 RIM were identified as Th-230, Ra-226, and radon. Assessments of gross alpha, beta, and gamma activities (including environmental dosimetry measurements) also occurred at each monitoring station.

To determine airborne concentrations of radionuclides transported via airborne particulates, airborne particulates are collected onto 2-inch-diameter borosilicate glass fiber filter media by use of high-volume air samplers (RADeCO Model HD28 or equivalent air sampler). One air sampler is operated at each off-site monitoring station to collect airborne particulates continuously onto the filter media for a duration of 7 days. The air samplers are operated at a flow rate of at least 2.0 cubic feet per minute (cfm) to yield a minimum air sample volume of 20,160 cubic feet (571 cubic meters [m^3]). At the end of the sampling period, the sample filter is submitted for laboratory analysis, a new filter is installed, and a new 7-day sampling period begins.

The filters are analyzed by TestAmerica of Earth City, Missouri, for gross alpha, gross beta, gamma-emitting radionuclides, isotopic uranium, isotopic thorium, and total alpha-emitting radium. The laboratory results are reported as total activity (in picoCuries [pCi]) per filter. Total air volume drawn through the filter is recorded by the field sampler at the time of filter collection. Air concentrations are calculated by dividing the per filter total activity (in pCi) by the volume of air drawn through the filter (in m^3) to yield an air concentration in units of pCi/m^3.

Hydrogen sulfide (H_2S), sulfur dioxide (SO_2), and carbon monoxide (CO) measurements were collected from June 1, 2014, to January 31, 2015 via RAE Systems, Inc. AreaRAE instruments. The AreaRAE is a portable multi-gas monitor generally used by workers in potentially hazardous environments to provide real-time measurements from various internal sensors that monitor for toxic gases (such as CO, SO_2, and H_2S), combustible gases, oxygen levels, and gamma radiation. At each of the five monitoring stations, EPA installed AreaRAE detectors equipped with CO, SO_2, and H_2S electrochemical sensors.

Baseline sampling for VOCs and H_2S via passive/diffusive methods began in December 2014. Sampling for VOCs during the baseline monitoring period occurred primarily by use of Summa canisters (collected over a 24-hour period) and laboratory analysis via EPA Method TO-15. Sampling by use of Summa canisters occurred weekly at the air monitoring stations from May 8 to December 17, 2014. Subsequently, sampling occurred via deployment of Radiello brand passive/diffusive samplers fitted with activated charcoal adsorbent cartridges. The cartridges were generally deployed at each of the five monitoring stations continuously for sampling durations of approximately 7 days. At the end of the sampling duration, the deployed cartridges were collected, and a new sampling deployment was initiated with new cartridges. The Radiello cartridges for VOC sampling were shipped to Pace Analytical Laboratory (Pace) in Lenexa, Kansas, for analysis via Method EPA TO17 modified for analysis of the Radiello cartridges.

Hydrogen sulfide (H_2S), another parameter of potential concern identified in the QAPP (TetraTech, 2014), was also sampled by use of Radiello cartridges concurrently with the VOC Radiello sampling at the five air monitoring stations. Radiello samplers deployed for H_2S sampling were fitted with adsorbent cartridges containing zinc acetate. These cartridges were shipped to ALS Laboratory in Simi Valley, California, for analysis via an extraction and colorimetric analysis specified by the Radiello cartridge manufacturer.

Results of the EPA off-site monitoring program have been reported in various reports prepared by TetraTech (2015a, b, c, d, and e). A figure showing the locations of the air monitoring stations and tabulated summaries prepared by TetraTech of the results of the EPA air monitoring program is included in Appendix H-4.

4.13.1.5 MDNR Air Quality Monitoring (2013-2016)

In February 2013, MDNR implemented a program of continuous monitoring of reduced sulfur compounds (reported as hydrogen sulfide), sulfur dioxide, carbon monoxide, and total VOCs at

three fixed air monitoring locations located near (but not on) the Site. MDNR also conducts routine, twice daily surveillance of hydrogen sulfide, benzene, and odor levels around the entire perimeter of the Site. In addition, MDNR performs weekly VOC compound-specific sampling in locations upwind and downwind of the Site and submits these samples to an off-site laboratory. MDNR also monitors for gamma radiation. The procedures used to perform this monitoring are documented in the SAP for Air Sampling Activities at the Bridgeton Sanitary Landfill in Bridgeton, Missouri (SWAPE, 2013).

MDNR has used AreaRAE and MultiRAE monitoring instruments (manufactured by RAE Systems, Inc.) during air quality monitoring at the Site in February and March 2013 and through the present. These units monitor for VOCs in ambient air at the ppm level and also monitor other parameters such as oxygen, carbon monoxide, sulfur dioxide, gamma radiation, and combustible gases (as lower explosive limit ["LEL"] of methane in percent). MDNR also performs twice-daily monitoring at various points around the perimeter of the Site for benzene using a UltraRae 3000 instrument and for H2S using a Jerome Analyzer. MDNR also operates a meteorological station in the parking lot for the Hussmann manufacturing facility, located to the east of the landfill across St. Charles Rock Road.

Results of the MDNR air monitoring activities are reported weekly in the form of data tabulations for each week, including Hourly Average Meteorological Data, Air Sampling Summary Data Using AreaRAE, and Daily Air Monitoring Reports, all of which are posted on the MDNR Bridgeton Sanitary Landfill Facility Information website.[43] The Missouri Department of Health & Senior Services (MDHSS) reviews these data to identify potential public health concerns for short-term health effects and presents its evaluations in separate reports.

Due to the fact that MDNR has issued four air monitoring reports for each week beginning May 20, 2013, a large number of reports have been prepared (currently approaching 500 reports), making it too cumbersome to include all of them in this RI Addendum. A tabular summary of the MDNR monitoring data is presented in Appendix H-3. From March 30, 2017 to April 3, 2017 (the date of the most current MDHSS report as of the writing of this RI Addendum draft), MDHSS consistently concluded that gamma radiation rates continued to be indistinguishable from natural background levels and were below levels of public health concern.[44]

4.13.1.6 MDHSS Air Quality Monitoring (2013 and 2015)

Staff from MDHSS collected radiological data from locations in the vicinity of the Site in 2013 and 2015. The objective of each of the two sampling operations was to determine whether levels of alpha/beta activity around the Site in upwind and downwind locations were distinguishable from the alpha/beta levels in background locations.

[43] http://dnr.mo.gov/bridgeton/index.html
[44] DHSS's reports are available at http://health.mo.gov/living/environment/bridgeton/

In June 2013, a total of 16 particulate air samples were collected in upwind and predominant downwind directions around the Site. These air samples were then compared to eight air samples that were collected in background areas located west of (but still in relative proximity to) the Site. The background areas were areas not known to be associated with any potential sources of radiation. Sampling procedures are detailed in the MDHSS's Bridgeton Sanitary Landfill Radiological Air Sampling Report (MDHSS, 2013).[45] Analysis of air samples was completed by Eberline Analytical/Oak Ridge Laboratory of Oak Ridge, TN.

As explained by MDHSS, the NRC's effluent air concentrations (10 C.F.R. 20 Appendix B, Table 2, Column 1) were used as guidance for identifying a screening level because they are applicable for assessment and control of dose to the public. In particular, the concentrations listed in this table are equivalent to radionuclide concentrations which, if inhaled or ingested continuously over the course of a year, would produce a dose of 50 milliRem. For comparison purposes, EPA and the National Council on Radiation Protection and Measurements (NCRP) report that the estimated average annual radiation dose per person is approximately 620 milliRem – most of which comes from natural background radiation sources.[46]

MDHSS concluded that the air sampling results obtained in June 2013 confirmed that alpha/beta activities around the Site were indistinguishable from background conditions (MDHSS, 2013).

In November 2015, staff from MDHSS collected 31 particulate air samples in predominant upwind and downwind directions from locations in the vicinity of the Site to be analyzed for alpha/beta activity (DHSS, 2015). Thirteen air samples were collected from background areas for comparison purposes. Analysis of these air samples was completed by Eberline Analytical/Oak Ridge Laboratory, Oak Ridge, TN. In addition, ambient gamma readings were taken by MDHSS staff at approximate 15-minute intervals over a two-day period at sample locations around the Site and in background locations. Sampling procedures are detailed in the MDHSS's Bridgeton/ West Lake Landfill Radiological Sampling Final Report (MDHSS, 2015).[47]

Based on the results of the two sampling events, MDHSS concluded that no significant difference was observed between the background, upwind, and downwind ambient air samples for alpha, beta, or gamma radiation (MDHSS, 2015).

[45] Available at http://health.mo.gov/living/environment/bridgeton/pdf/rasamplingreport.pdf
[46] *See* https://www.epa.gov/radiation/radiation-sources-and-doses
[47] Available at http://health.mo.gov/living/environment/bridgeton/pdf/BridgetonAirSamplingAnalysisReport_November2015_final_May2016.pdf

4.13.2 Radon Monitoring

Measurements of radon flux emanating from the surface of Areas 1 and 2 (radon emanation) and measurements of radon activity levels in air have been made at the West Lake Landfill. These various radon monitoring activities are discussed in the following sections.

4.13.2.1 NRC (RMC) Radon Flux Monitoring (1981)

NRC (RMC) obtained radon flux measurements in 1981 for radon-222 (Rn-222) and radon-220 (Rn-220). The principal measurement technique used by RMC was collection of a filtered gas sample from an accumulator and subsequent counting in a radon gas analyzer (RMC, 1982). A second method using charcoal canisters was also employed as a check on the accumulator technique (RMC, 1982). Due to its short half-life (4 days), the presence of radon-219 (Rn-219) was determined using gamma spectroscopy of high volume particulate sample filters to detect Rn-219 daughter decay products (see prior discussion above in Section 4.13.1.1).

A total of 111 grab samples using the radon accumulator method were collected from 32 locations between May and August 1981 and showed levels ranging from 0.2 pCi per meter squared per second ($pCi/m^2/s$) in background areas to 868 $pCi/m^2/s$ in areas of surface contamination (RMC, 1982). A total of 35 charcoal canister samples were gathered at 19 locations over a three-month period and showed levels ranging from 0.3 to 613 $pCi/m^2/s$.

Copies of the tabulated summaries of the results as presented in the RMC 1982 report are included in Appendix H-6.

RMC also collected high volume particulate samples in 1981 to assess the presence of radon-219 (Rn-219) daughter products such as Pb-211 (RMC, 1982). Total radon daughter levels were also estimated by gross alpha activity on particulate filters, the results of which were then used to determine work level (WL) values.

RMC collected particulate samples from 43 locations in November 1980 (RMC, 1982). The samples were collected on filters using high-volume particulate samplers that were operated for 10 minute durations at a flow rate of 570 liters/minute (L/min); however, the report also states that the total volume was 1.4 E6 milliliters (ml) which, for a 10-minute sample duration, corresponds to a flow rate of 140 L/min. The samples were analyzed (method and equipment used are not specified in the RMC report) for long-lived gross alpha activity and reported in units of microCuries per cubic centimeter (µCi/cc).

In addition to the 10-minute duration samples, five 20-minute high-volume air samples were taken and counted immediately on the IG gamma spectroscopy system to detect the presence of Rn-219 daughters. All samples were taken near areas with surface contamination. Sample activities were reported in units of µCi/cc.

Copies of the tabulated results of the NRC (RMC) particulate sampling that were part of the RMC 1982 report are included in Appendix H-6.

4.13.2.2 OU-1 RI Radon Flux Sampling (1997)

The 1994 RI/FS Work Plan required that radon activity data be collected to assess the radon flux from the surface of the Site. Specific locations for the radon sampling effort were proposed by McLaren/Hart in their letter of June 22, 1995 (McLaren/Hart, 1995d) and approved by EPA in their letter of September 11, 1995 (EPA, 1995d). Although the procedures set forth in the RI/FS Work Plan were followed, the results from the initial radon-flux measurement effort performed by McLaren/Hart were reported as a concentration rather than flux. Radon Detection Systems, Inc., the company completing the work, could not calculate flux values from the data collected; therefore, the flux measurements could not be obtained as required in the RI/FS Work Plan. A discussion of the radon sampling methodology used and results obtained by McLaren/Hart is presented in the Radon Gas, Landfill Gas and Fugitive Dust Report (McLaren/Hart, 1996d).

Because radon flux estimates could not be obtained from the McLaren/Hart effort, radon flux measurements were obtained by EMSI as part of the ASAP activities. The radon flux measurement program completed by EMSI employed the Large Area Activated Charcoal Canisters (LAACC) method presented in Method 115, Appendix B, 40 CFR, Part 61. This method was established to measure radon flux values on uranium mill tailing piles. Radon flux was measured rather than concentration because no structures are present in either Area 1 or Area 2 that would result in the buildup of radon concentrations. Instead, the potential transport pathway for radon is the migration of the gas through the atmosphere.

The protocols used for the LAACC radon flux measurement program and calculations are included in Appendix A of the ASAP. These protocols are contained in the USEPA report *Radon Flux Measurements on Gardinier and Royster Phosphogypsum Piles near Tampa and Mulberry, Florida* (USEPA, 1986). Specific protocols used by Tellco Environmental, the EMSI subcontractor that provided the LAACCs and performed the calculations to determine radon flux, are also included in Appendix A of the ASAP (EMSI, 1997a).

The radon flux measurements performed by EMSI were made at 54 locations in Areas 1 and 2 and the Ford property (Figure 4-21). Radon flux measurements were obtained adjacent to each of the statistically unbiased random boring locations within the grids established for the soil sampling programs within Area 1 (one sample in each of 22 grids) and Area 2 (one sample in each of 32 grids). Each sample in Area 1 was representative of the 38,250-square feet area within individual 170 foot by 225 foot grids. Each sample in Area 2 was representative of the 67,600-square feet area within individual 260 foot by 260 foot grids. A 10-inch diameter LAACC charged with 180 grams of baked activated charcoal was placed on the soil surface adjacent to each of the 54 random boring locations and allowed to collect radon for a 24-hour time period. After receipt in the laboratory, each sample of exposed charcoal was weighed and radon was measured by means of gamma spectroscopy. Radon flux was calculated using the

equations contained in Appendix A of the ASAP. The results of the 1997 EMSI radon flux measurements are discussed in Section 7.1.1.1 of this RI Addendum.

4.13.2.3 OU-1 NCC Radon Flux Measurements (2016)

Additional radon flux measurements were collected in 2016 in conjunction with the construction of the Non-Combustible Cover. A total of 35 measurements (not including duplicate samples) were obtained from Area 1 and a total of 76 measurements (not including duplicate samples) were obtained from Area 2 (Figure 4-22). The measurements were made using the LAACC method presented in Method 115, Appendix B, 40 C.F.R., Part 61. Radon flux measurements were obtained on an approximately 150 foot x 150 foot grid in Areas 1 and 2, making each sample representative of an area of approximately 22,500 ft^2 or approximately one-half acre. The locations of these samples are shown on Figure 4-23. Results of this sampling are discussed in Section 7.1.1.1.

4.13.2.4 OU-1 Perimeter Airborne Gamma Radiation and Radon Monitoring (2015-2016)

Gamma radiation and radon are measured at each of the 13 air monitoring stations (Figure 4-20) as part of the perimeter air monitoring program (Auxier, 2014). Gamma radiation is measured using TLDs at each of the 13 air monitoring stations. The TLDs are housed within each air monitoring location shelter, which are constructed approximately three feet above the ground surface. A duplicate TLD is placed at one of the stations. Radon alpha track detectors are also deployed at each of the 13 air monitoring stations to measure alpha particles emitted from radon and its associated decay products. Radon detectors are co-located with the TLDs in the monitoring station shelters. The TLDs and radon detectors are collected every three months and sent to off-site laboratories for analysis. Recorded radon concentrations are listed in picocuries per liter (pCi/L) in air.

Results of the perimeter air monitoring program are reported to EPA on a quarterly basis (Auxier and EMSI, 2016c, d, and e and 2017a and b). Tabulated summaries of the air monitoring data obtained from the perimeter air monitoring program are contained in the various quarterly reports and have been included in Appendix H-3.

4.13.2.5 EPA Off-site Airborne Radon Monitoring (2014-2015)

Between April/May 2014 and May 2015, EPA conducted off-site air monitoring at five locations (see discussion in Section 4.13.15, above). This monitoring included placement and reading of Electret ion chamber radon detectors (Rad Elec E-PERM®) equipped with high-volume chamber ("H-chamber") short-term ("ST") electrets to assess Rn-222 levels at each off-site monitoring station. Electret measurements involve use of an Electret Voltage Reader to measure a beginning and final electrical charge on the electret exposed for a specified time period. In addition, one

pocket ion chamber per station (co-located with the electret ion chamber radon detectors) provides a gross gamma activity measurement used in the final Rn-222 measurement calculation. Electrets and pocket ion chambers are read weekly to yield a Rn-222 measurement that has been continuously integrated (averaged) over the week-long exposure duration. Three electret ion chambers were deployed per off-site monitoring station to provide redundant measurements in case of a device failure as well as to provide an indication of total method precision.

EPA also obtained continuous external gamma exposure rate measurements by use of Saphymo GammaTRACERs. At each of the five monitoring stations, EPA installed a Saphymo GammaTRACER exposure rate monitor that incorporates two GM detector tubes (a high-range detector and a low-range detector). The GM tubes respond to ionization produced within the detector by gamma radiation. On an hourly basis, the GammaTRACER is programmed to report an average exposure rate reading from the previous hour-long interval. The exposure rate measurement is reported in units of μR/hr. Although a release of RIM via airborne particulates from the West Lake Landfill Site is not anticipated to result in an off-site external gamma exposure rate distinguishable from background variability, acquisition of these data was performed because the data possibly will be used as a reference for future monitoring campaigns that include exposure rate measurements. Moreover, sources of gamma activity not related to West Lake Landfill RIM may occasionally induce a detector response above background. Such sources may include nuclear medical materials passing by the detector (including patients receiving nuclear medicine), cosmic events (such as naturally occurring gamma-ray bursts), or precipitation to which naturally occurring airborne radionuclides adhere.

Results of the EPA off-site monitoring program have been reported in various reports prepared by TetraTech (2015a, b, c, d, and e). A figure showing the locations of the air monitoring stations and tabulated summaries prepared by TetraTech of the results of the EPA air monitoring program are included in Appendix H-4.

4.14 Vegetation Sampling

Collection and analysis of vegetation samples was performed by NRC (RMC) and also by the OU-1 Respondents. These sampling efforts are described below.

4.14.1 NRC (RMC) Vegetation Sampling (1981)

In 1981 NRC (RMC) collected samples of grasses and weeds from on-site and crop samples (winter wheat) from the former Ford property (RMC, 1982). These samples were dried, crushed and counted on the IG gamma ray spectroscopy system used by RMC. RMC reported that no elevated activities were found in these samples. However, no figures showing the specific sampling locations nor were tables or summaries of the specific results of these analyses were included in the RMC 1982 report.

4.14.2 OU-1 Post-ROD Vegetation Sampling (2009)

In anticipation of the start of remedial design activities, and specifically in order to assess the potential for release of radionuclides during clearing and grubbing of vegetation in advance of performing a topographic survey, the OU-1 Respondents collected samples of leafy vegetation and twigs in 2009 and analyzed these samples for radionuclides (TA Woodford and Associates, LLC, 2009). A total of seven samples were collected from Area 1 and 13 samples were collected from Area 2. A duplicate sample was obtained from each area for quality control purposes. Sample collection sites focused on areas displaying gamma levels twice that of the gross gamma background (>25 µR/hour) where physical access and the presence of vegetation allowed. Two background area vegetation samples were also collected from along the Missouri River at the end of St. Charles Rock Road.

A copy of the summary table of the results of the vegetation sampling is included in Appendix I-1.

4.14.3 OU-1 NCC Vegetation Sampling

EPA requested that vegetation sampling be conducted by the OU-1 Respondents as part of the NCC construction project. A draft vegetation sampling plan was prepared and submitted to EPA on April 3, 2017. As of the date this draft RI Addendum was prepared, no comments have been received and this plan has not yet been approved. If this sampling is completed prior to finalization of the RIA, the results of this sampling may be included in the final RI Addendum if so directed by EPA.

4.15 Review of Historical Aerial Photographs

Historical aerial photographs of the Site area were previously reviewed by EPA's Environmental Monitoring Systems Laboratory (1989 and 1991). EPA's reports, other aerial photographs, and aerial photographs available through GoogleEarth were reviewed to gain an understanding of the sequence of historical activities related to waste disposal at the landfill, the appearance and changes over time of the various surface water bodies and drainage patterns at the Site. Table 4-8 presents a listing of the various aerial photographs that were reviewed. Copies of these aerial photographs (other than those available through GoogleEarth) are contained in Appendix O-1. Discussions of the results of these reviews are presented in Sections 5.3.3.4, 5.5.2 and other sections of this RIA as appropriate.

5. PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section of the RI Addendum describes the physical setting and characteristics of the West Lake Landfill area. The discussions presented below address the climatic conditions of the area, current and potential land uses at and around the Site, topography and surface features, vegetation and wildlife present in the area, geologic conditions, and hydrogeologic conditions in the vicinity of the Site.

5.1 Climate

The climate of the St. Louis area is typical of the Midwestern United States with a modified continental climate that has four distinct seasons.

5.1.1 Temperature

Winter temperatures are generally not severe, with the first frost usually occurring in October and freezing temperatures generally not persisting past March. Records since 1870 show that temperatures drop to zero (0°F) or below an average of two or three days per year. Temperatures remain at or below freezing (32°F) less than 25 days in most years.

Summers in the St. Louis area are hot and humid. The long-term record since 1870 indicates that temperatures of 90 degrees Fahrenheit or higher occur on about 35 to 40 days per year. Extremely hot days of 100 degrees Fahrenheit or more generally occur no more than five days per year.

5.1.2 Precipitation

Normal annual precipitation based on records dating back to 1871 is a little less than 34 inches. Normal monthly precipitation as measured at nearby Lambert St. Louis International Airport (Lambert Field) is presented on Figure 5-1. Lambert Field is located approximately 3.7 miles east of the Site.

The three winter months are usually the driest, with an average total of approximately 6 inches of precipitation. Average snowfall per winter season is slightly greater than 18 inches. Snowfall of an inch or more is received on five to ten days in most years. Record snowfall accumulation over the past 30 years was 66.0 inches recorded during the 1977-78 winter season.

The spring months of March through May are the wettest, with normal total precipitation of just under 10.5 inches. Thunderstorms normally occur 40 to 50 days per year. During any given

year, a few of these storms can be classified as severe with hail and damaging wind. Tornadoes have occurred in the St. Louis area.

5.1.3 Wind Distribution

Between December and April, the predominant wind direction at Lambert Field is from the northwest and west-northwest. Throughout the remainder of the year, the predominant wind direction is from the south. Figure 5-2 presents a wind rose diagram of average annual wind directions at Lambert Field for the period from 1961 through 1990. Figure 5-3 presents a wind rose diagram for Lambert Field for the period from 1991 through 2006. Data regarding the frequency of the various wind directions at Lambert Field over the period from 1961 through 1981 is included in Appendix J-1.

Considering differences in topography between Lambert Field and the Site, the actual wind directions at the Site may be slightly different, and possibly skewed in a northeast-southwest direction parallel to the Missouri River valley. In May 2015, an on-site meteorological station was established to measure wind speed and direction and air temperature. Results of the first year of monitoring are included in Appendix J-2. Wind rose diagrams of this data are included in Appendix H-3. These data indicate that the predominant wind direction at the Site during this period was from the south-southeast; however, winds out of the north were observed to dominate during the end of September through mid-October 2015 and winds out of the west, northwest and north were more dominant during January and February 2016.

5.2 Land Use

The Site is located in a predominately industrial area. The land use zoning for the Site and surrounding area is shown on Figure 3-4.

The southern portion of the Site is zoned M-1 (manufacturing district, limited). The southernmost portion of the Site is permitted for sanitary landfill operations (Permit No.118912). Although the northern portion of the Site area is zoned R-1 (one family dwelling district), residential land use has been precluded at the West Lake Landfill (including Areas 1 and 2) by Declaration of Covenants and Restrictions recorded on June 30, 1997 by each of the fee owners against their respective parcels. These restrictive covenants also prohibit use of groundwater from beneath the Site. Construction work, commercial and industrial uses have also been precluded on Areas 1 and 2 by a Supplemental Declaration of Covenants and Restrictions recorded by Rock Road Industries, Inc. in 1998 prohibiting the placement of buildings and restricting the installation of underground utilities, pipes and/or excavation upon its property. A Declaration of Covenants and Restrictions was recorded by Rock Road industries, Inc. on October 31, 2016 to prohibit in perpetuity use for residential purposes, commercial and industrial purposes, including but not limited to use as a storage yard, and installation of water wells for drinking water use on all portions of Areas 1 and 2 and the Buffer Zone. These deed restrictions

cannot be terminated without the written approval of the respective parcel owners, as well as both MDNR and EPA.

In addition, in 2005, the City of St. Louis entered into a Negative Easement and Declaration of Restrictive Covenants Agreement with Bridgeton Landfill, LLC (among other entities) to prohibit depositing or dumping of new or additional putrescible waste on the entirety of the Bridgeton Landfill after August 1, 2005 (City of St. Louis, 2005). This negative easement stemmed in part from an earlier determination by the Federal Aviation Administration (FAA) and the United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA) that the Site was a hazardous wildlife attractant for the Lambert-St. Louis International Airport (City of St. Louis, 2010). In particular, the proximity of the airport to the Site presents a risk of bird strikes. At its closest point, the Site is located within approximately 9,166 feet of a Lambert Airport runway, which is less than the FAA siting guidance of a 10,000-foot separation radius. Certain types of scavenging birds (e.g., gulls, crows) are attracted to exposed putrescible wastes at landfills, and accordingly can present a bird strike risk to passing aircraft. Similarly, bird flocks also pose a serious risk to aircraft (by, e.g., being sucked into the jet engines of commercial aircraft, thereby causing complete engine failure).

The property to the west and northwest of the Site is part of the Crossroads Industrial Park. The property to the north and east of the Site, across St. Charles Rock Road, is moderately developed with commercial, retail and manufacturing operations. The Earth City industrial park is located adjacent to the Site on the west and southwest, across Old St. Charles Rock Road (now vacated) and the Earth City flood control channel. Undeveloped property used for agriculture and for the landfill soil stockpile is located to the southeast. Mixed commercial, retail, and manufacturing facilities are present to the southeast of the Site along St. Charles Rock Road.

The nearest residential area to the Site is the Terrisan Reste mobile home park, which is located to the southeast of the Site, approximately 0.7 miles from Area 1 and 1.1 miles from Area 2. The "Spanish Village," residential subdivision is located to the south of the Site near the intersection of St. Charles Rock Road and I-270, approximately 1 mile from Area 1 and 1.25 miles from Area 2.

5.3 Surface Features

This section includes a description of the Site topographic conditions, surface soil conditions, runoff drainage patterns, and surface water bodies in the area.

5.3.1 Topography

The Site is situated on the eastern edge of the Missouri River floodplain. The Missouri River is located approximately two miles to the west of the Site. The river flows in a predominantly north-northeasterly direction in the vicinity of the Site at an elevation of approximately 425 feet

above mean sea level (amsl) based on the National Geodetic Vertical Datum (NGVD). The river is separated from the surrounding areas by a levee system constructed to an average elevation of approximately 435 to 440 feet amsl in this area (McLaren/Hart, 1994).

The Site is located in an area that is transitional between the floodplain immediately to the west and the loessial bluffs approximately one-half mile to the east. The edge of the Missouri River valley is oriented north to south in the vicinity of the Site. Prior to development of the Site, the edge of the river valley was present near the center of the Site. As a result of placement of landfill materials, the higher topography associated with the loessial bluffs to the east has been extended further to the west.

The topography of the area around the Site is gently rolling, ranging in elevation from approximately 430 to 500 feet amsl (Figure 5-4). Ground elevations range from approximately 436 to 524 feet amsl on the landfill property. The topography of the area has been significantly altered by quarry activities in the eastern portion of the Site area, and by placement of mine spoils (unused quarry material) and landfill materials in the western portion of the Site.

Area 1 is situated on the north and western slopes of a topographically high area within the Site. Ground surface elevation varies from a high of approximately 478 feet amsl on the south (not counting the overlying above-grade portion of the North Quarry landfill, which rises to a height of 524 ft amsl above the southern boundary of Area 1) to a low of approximately 450 feet amsl at the roadway near the property entrance. The southernmost portion of Area 1 was covered by the above-ground (above the top of the quarry itself) portion of the North Quarry Landfill during final filling and grading of the North Quarry Landfill. Consequently, the northernmost portion of the North Quarry Landfill extends out over the southernmost portion of Area 1 such that the current elevations in the southwestern portion of Area 1 now extend up to 524 feet amsl.

Area 2 is situated between a topographic high of landfilled material on the south and the Buffer Zone and Crossroads property on the west. The highest elevations are in the southwest portion of Area 2, where the flank of the topographic high of landfilled materials extends into this area. The topographic high just outside of Area 2 has a maximum elevation of approximately 522 feet amsl sloping to approximately 470 feet amsl near the top of the landfill berm along the north side of Area 2. The western and northern portions of Area 2 are defined by a large slope such that the upper surface of Area 2 is located approximately 20 to 30 feet above the adjacent Buffer Zone and Crossroads property (elevations of approximately 445 ft amsl) located to the north and west of Area 2 and the North Surface Water Body (discussed in Section 5.3.3 below) that is located in the northernmost corner of the Site. The ground surface of Area 2 is approximately 30 to 40 feet higher than the water surface in the flood control channel (discussed in Section 5.3.3 below) that is located to the west of Area 2.

The majority of Area 2 slopes to the north-northeast; however, the surface is irregularly graded with elevations varying from approximately 460 to 490 feet amsl. A large topographic depression is located near and along the northern berm of the Site. The elevation of the bottom of this closed depression is 456 feet amsl. A small berm exists along much of the top of the

landfill slope along the northern, western and eastern sides of Area 2 such that stormwater does not run down the slope but is instead retained on the surface of Area 2 where it either evaporates or infiltrates into the underlying materials.

5.3.2 Surface Soils

According to the U.S. Soil Conservation Service (SCS), surficial soils along the floodplain of the Missouri River generally consist of Blake-Eudora-Waldron association while the surficial soils on the bluffs east of the river are the Urban Land-Harvester-Fishpot association (SCS, 1982). The floodplain materials are described as nearly level, somewhat poorly drained to well drained, deep soils formed in alluvial sediment. The upland materials are urban land and nearly level to moderately steep, moderately well drained to somewhat poorly drained, deep soils formed in silty fill material, loess and alluvium which are formed on uplands, terraces, and bottom lands.

Soils in the area of the Site consist of the Freeburg-Ashton-Weller association, which are nearly level to gently sloping, somewhat poorly drained, deep soils formed in loess and alluvial sediment. The Freeburg silt loam is found on the terrace adjacent to the eastern Site boundary, while the Ashton silt loam is found to the east and south of the South Quarry portion of the Bridgeton Landfill (including the landfill borrow area).

The Freeburg unit is identified as a somewhat poorly drained silt loam to silty clay loam, up to 60 inches thick. The permeability of this soil is characterized by the SCS as moderately slow (about 10^{-4} centimeters per second [cm/sec]), and the surface runoff is medium. According to the SCS, a perched water table is often present within this unit in the spring at a depth of 1.5 to 3 feet. The Freeburg unit's suitability for landfill cover material is described as fair due to its clay content (12 to 35%) and wetness.

The Ashton unit is a well-drained silty loam to silty clay loam, also up to 60 inches thick. The permeability of this unit is also moderately slow and the surface runoff is medium. The suitability of the Ashton unit for landfill cover material is described as fair due to the clay content (10 to 40%).

5.3.3 Surface Water Drainage

This section describes the current drainage patterns in Areas 1 and 2 as well as the drainage patterns that were observed to exist during performance of the RI field investigations in 1995-1997. This section also includes a description of permanent or perennial surface water bodies located in the immediate vicinity of the Site.

5.3.3.1 Current Drainage Patterns in Areas 1 and 2 (2016)

Current surface water runoff patterns for Areas 1 and 2 are presented on Figure 4-15. This discussion reflects current (*i.e.*, 2016) surface water drainage patterns and as such may differ from the description presented in the original 2000 RI (EMSI, 2000) or earlier reports (McLaren/Hart 1996e).

Runoff from the eastern portion of Area 1 flows into the perimeter ditch along the north side of Area 1 (south side of the Site access road) from which it flows northeastward to the perimeter drainage ditch located along the northeast side of the Site adjacent to the west of St. Charles Rock Road (the Northeast Perimeter Drainage Ditch). Runoff from the western portion of Area 1 flows to an inlet structure located on the south side of the Site access road, which conveys flow under the access road to the perimeter ditch on the north side of the access road from which it flows to the Northeast Perimeter Drainage Ditch. Therefore, all runoff from Area 1 ultimately flows into the Northeast Perimeter Drainage Ditch, which then flows into the surface water body located north of Area 2 on the northeastern-most corner of the Site (the North Surface Water Body).

Runoff from the northern (majority) portion of Area 2 flows into one of two closed topographic depressions created by the presence of the perimeter berm located at the top of the Area 2 landfill slope. Runoff from the southeastern portion of Area 2, adjacent to the Closed Demolition Landfill, flows to the northeast where it enters the Northeast Perimeter Drainage Ditch and subsequently flows into the North Surface Water Body. Runoff from the southernmost portion of Area 2 eventually flows to the southeast along the internal road that provides access to Area 2 and down to the drainage ditch located on the north side of the Site access road from where it also flows to the Northeast Perimeter Drainage Ditch. Therefore, runoff from these portions of Area 2, like the runoff from Area 1, ultimately flows into the Northeast Perimeter Drainage Ditch, which flows into the North Surface Water Body.

Runoff from the southwestern portion of Area 2 flows as overland flow onto the Buffer Zone where it ponds, unless sufficient water accumulates such that the water reaches the western portion of the Buffer Zone where it can flow overland onto the southwest portions of Lots 2A2 and 2A1 and from there into a culvert that conveys stormwater to the large Earth City stormwater basin located adjacent to Area 2 and the AAA Trailer property.

5.3.3.2 Area 1 Drainage During the OU-1 RI (1995-97)

McLaren/Hart reported (McLaren/Hart, 1996e) and the OU-1 RI (EMSI, 2000) reported that the majority of the runoff from Area 1 ultimately flowed into the North Surface Water Body. Four locations (Weirs 1, 2, 3, and 4) where rainwater runoff flowed from Area 1 were identified (Figure 4-13). All four locations were located in the northern portion of Area 1 and discharged into the drainage ditch located on the south side of the Site entrance road. Flow in this ditch occurred in a northeasterly direction and exits the Site through a culvert beneath the entrance

road near the property fence line. From there, runoff flowed into the Northeast Perimeter Drainage Ditch and ultimately into the North Surface Water Body.

As discussed in Section 5.3.1, the ground surface of Area 1 is irregular and some of the runoff historically flowed into and accumulated in several small topographic depressions in this area. Standing water of up to six inches in depth was reported to be present in these topographic lows following precipitation events during the OU-1 RI field work. Pursuant to a 2006 Materials Management Plan (MMP) [EMSI, 2006b], inert fill was placed in these low areas such that accumulating runoff no longer creates standing water in these areas but likely still infiltrates into the underlying materials in these areas.

5.3.3.3 Area 2 Drainage During the OU-1 RI (1995-97)

McLaren/Hart (1996e) reported that the majority of the runoff from Area 2 flowed into a closed topographic depression located in the southeastern portion of Area 2. McLaren/Hart (1996b and 1996e) identified five locations at which runoff flowed off-site from Area 2. Three of these locations (Weirs 5, 6 and 7) were at the top of the slope above the landfill berm in the western portion of Area 2 above the Buffer Zone. These locations were identified by the presence of erosional runnels. With the exception of one heavy storm in mid-May 1995, flow was only observed during the OU-1 RI field work at one of these locations (McLaren/Hart, 1996e and EMSI, 2000). This location, Weir 5, was located in the vicinity of the historic berm failure and resulting erosional runoff that led to the accumulation of radiologically-impacted soil in the southern portion of what at the time was the Ford property (Figure 4-13). At the other two locations (Weirs 6 and 7), water had to pond up to a height sufficient to over-top a berm at the top of the landfill slope before any flow would occur. Based on observations made throughout the course of the RI field investigations, McLaren/Hart concluded that this was not a frequent occurrence. Observations made by EMSI also supported this conclusion.

Two additional locations (Weirs 8 and 9) of off-site flow were located in the southern portion of Area 2 near the roadway in the area historically used for storage of roll-off bins (Figure 4-13). In these areas, runoff appeared to occur primarily as sheet flow, and extensive erosional runnelling was not observed. Runoff from the former roll-off storage bin area and the Closed Demolition Landfill area was observed to commingle with runoff from Area 2 near Weirs 8 and 9.

In the summer of 1997, Weir 10 was installed downslope from Weirs 8 and 9. Prior monitoring of storm events had indicated that only ponded water was present at Weirs 8 and 9. As a result, only ponded water had been obtained from these locations. Weir 10 was subsequently installed to attempt to sample flowing runoff from this area. However, in placing Weir 10 further downslope from Weirs 8 and 9, the runoff flowing through Weir 10 included a combination of runoff from both Area 2 and other areas outside of Area 2; therefore, the sample obtained in August 1997 from Weir 10 reflected a combination of water quality from runoff from a portion of Area 2 plus portions of the Closed Demolition Landfill, Inactive Sanitary Landfill and the roll-off bin storage area.

5.3.3.4 Surface Water Bodies at or near the Site

There are three surface water bodies present in the vicinity of the Site. Two of those bodies – the North Surface Water Body and the flood control channel associated with the Earth City Industrial Park (Figure 4-13) – have already been discussed. In addition, there is a stormwater detention pond associated with the Bridgeton Landfill which is hydraulically isolated from Area 1 and Area 2 and consequently does not receive any surface water runoff from Areas 1 and 2 (Figure 4-15).

The North Surface Water Body is located between the Crossroads Industrial Park and St. Charles Rock Road, immediately to the north of Area 2. Review of historical aerial photographs (Appendix O) indicates that the North Surface Water Body did not exist in 1941 but does appear on the 1953 aerial photograph. Review of these photographs indicates that the North Surface Water Body is primarily located to the north of Area 2, but in some photographs the pond size appears larger and extends to the south along the northeast side of Area 2, between Area 2 and St. Charles Rock Road. The North Surface Water Body receives water from the Northeast Perimeter Drainage Ditch, which separates St. Charles Rock Road from the Site. This water body also receives runoff from St. Charles Rock Road. During the RI field investigations, this water body was reported to contain water throughout the year. Measurements made by McLaren/Hart indicated a water level fluctuation between approximately 435.4 and 437.3 feet amsl. Over the years since the OU-1 RI field investigations were performed (*i.e.*,1994-1997), the portion of the North Surface Water Body located adjacent to Area 2 has become overgrown such that a much smaller pond currently exists. Review of the historical aerial photographs indicates that the portion of the pond adjacent to Area 2 had become overgrown by approximately 2003. Although a portion of the pond adjacent to Area 2 has become overgrown, swamp-like conditions are present in this area.

The Earth City flood control channel is part of an extensive series of interconnected channels that are used to manage stormwater runoff within the Earth City Industrial Park. The portion of the Earth City flood control channel that is located adjacent to Area 2 does not appear to be present in the 1991 aerial photograph and first appears in the 1993 aerial photograph. The water level in the flood control channel varies throughout the year in response to variations in precipitation and changes resulting from pumping by Earth City of water from the flood control channel to the Missouri River. Measurements made by McLaren/Hart indicated a water level fluctuation between approximately 432.5 and 434.5 feet amsl.

Bridgeton Landfill previously operated a lined aeration basin for treatment of leachate (leachate pond) that was located adjacent to the southwest side of the South Quarry portion of the Bridgeton Landfill (Figure 3-6). This pond is not present on the 1977 aerial photograph and does not appear to be present on the 1979 aerial photograph; however, the area where the leachate pond existed is obscured on the 1979 photograph due to cloud cover. The leachate pond is first seen on the 1982 aerial photograph and is gone by the time of the November 2003 photograph.

Bridgeton Landfill also operates a stormwater retention basin located to the northeast of the South Quarry portion of the Bridgeton Landfill, immediately to the northwest of the Bridgeton Landfill soil stockpile area (Figure 3-6). This stormwater basin is not present in the 1993 aerial photograph and first appears in the 1998 aerial photograph. This stormwater basin is still present at the Site today.

Review of the aerial photographs indicates that a number of small areas of what appear to be ponded water were present on the surface of Area 1. These small "ponds" were not present in the 1990 aerial photograph and first appear in the 1993 aerial photograph. They continue to appear in the 1995, 1997, 1998, 1999, 2000 and 2001 photographs, although the number of such areas and their sizes appear to decrease over time. In March 2002, a large pond appears in the northeastern part of the North Quarry portion of the Bridgeton Landfill, adjacent to Area 1 (Figure 3-8). This pond is visible in photographs obtained prior to May 2007, when it disappears due to the placement of inert fill material in this area pursuant to the MDNR approved Materials Management Plan (MMP, EMSI, 2006b). No ponds or areas of surface water accumulation were observed in Area 2 on any of the historical aerial photographs. During the NCC construction, ponding of water on the surface of southeastern portion of Area 2 was observed to occur during periods of prolonged heavy rains; however, this water dissipated over the course of a few days

5.3.4 Missouri River Floodplain

Identification of the geomorphic floodplain was performed by reviewing a 1954 aerial photograph and an unpublished Missouri Department of Natural Resources – Division of Geology and Land Survey geologic map of the St. Charles Missouri quadrangle, which includes the Site and surrounding area (http://www.dnr.mo.gov/geology/statemap/stlouis/sl8615.htm) (Figure 5-5). These documents were reviewed to identify the location of the bluffs and terrace alluvium deposits that defined the pre-development geomorphic floodplain prior to the time the topography of the Site and surrounding area were modified by quarrying, landfilling, and commercial/industrial development. From this information, the Missouri River alluvial valley deposits (Qal), terrace deposits (Qt), and consolidated bedrock formations were located and used to delineate the historical extent of the floodplain. The potential limits of the historical Missouri River floodplain in the area of the Site are shown on Figure 5-6. As shown on Figure 5-6, the historic geomorphic floodplain originally included portions of the northwestern portion of the West Lake Landfill Superfund Site property.

The Earth City Flood Control and Levee District has constructed and operates and maintains a levee and stormwater management system in order to protect the Earth City development from Missouri River floods with a recurrence interval greater than 500 years (commonly referred to as a 500-year flood). As the Earth City levee system is located between the Missouri River and the Site, this levee system also acts to protect the Site from a 500-year flood.

The Federal Emergency Management Agency (FEMA) prepares Flood Insurance Rate Maps (FIRM) for many portions of the country. These maps are available online through FEMA's

Map Service Center site.[48] The area of the West Lake Landfill is on FIRM Map Number 29189C0039K dated February 4, 2015 (FEMA, 2015). The FIRM map (Figure 5-7) indicates that the entire West Lake Landfill property, including Areas 1 and 2, is outside the 0.2-percent annual chance (500-year) floodplain. The Buffer Zone and Lot 2A2 are located within that portion of the 500-year floodplain that is protected from flooding by the Earth City levee and flood control system. No flooding of the landfill, Buffer Zone, or the adjacent Crossroads Property occurred in 1993 or 1995 during the 500- and 300-year flood events that occurred in those years, respectively.

5.4 Biota

An assessment of the plant communities present at the Site, the potential for the presence of threatened or endangered species, and a description of the types of wildlife observed to be present at the Site was performed by McLaren/Hart (1996c) as part of the RI/FS investigations. The results of this survey are presented in the McLaren/Hart report and are briefly summarized below.

In 2000, a screening-level ecological risk assessment (2000 SERA) was prepared to evaluate the potential for adverse ecological effects associated with exposure to both radiological and chemical constituents present in environmental media in OU-1 (Chapter 7 of Auxier 2000). The 2000 SERA found that while certain indicator species in and around OU-1 may be under stress from a variety of stressors, including trace metals, radium and the physical disruptions associated with landfill operations, "*…both Areas 1 and 2 currently support vegetative and animal communities and there is no observable impact to the health of the plant communities.*" A 2016 review of recent changes in EPA guidance and databases found the general approach followed in the 2000 SERA was still valid, as were its conclusions. An Updated Baseline Risk Assessment prepared by Auxier (2017a) contains a description of the review and its conclusions.

5.4.1 Plant Communities

Three types of plant communities were identified in Areas 1 and 2 during the OU-1 RI field investigations. Plant species identified in both areas are summarized in Table 5-1. These include old field and hydrophilic plant communities identified in both Areas 1 and 2 and a forest plant community identified in Area 2 only. The old field plant community consists of open areas dominated by weedy species such as herbs, grasses and occasional sun-loving, fast-growing trees. Old fields typically contain annual, biannual and perennial herbaceous plants, mixed among grasses and a few pioneer woody species (Kricher and Morrison, 1988). The hydrophilic communities are defined as areas, irrespective of size, that contain ponded water or vegetation typically adapted for saturated soil conditions. Forested plant communities are dominated by

[48] http://msc.fema.gov

woody plant species (trees) that have a well-developed canopy and under-story (Kricher and Morrison, 1988).

A fourth plant community, a maintained field community, was identified in areas adjacent to the Site. Maintained field communities consist of open areas dominated by grass species. These areas are maintained by mowing at a frequency of approximately once per year.

Much of the biota evaluated as part of that 1996 assessment was removed during the 2016 installation of a Non-combustible Cover over parts of OU-1. In 2016, approximately 21.5 acres of OU-1 (2.6 acres in Area 1, 17.2 acres in Area 2, and 1.78 acres in the Buffer Zone) of existing vegetation were removed prior to installation of a noncombustible cover made of geofabric overlaid with a layer of stone. Fragments of four dominant plant communities still exist in OU-1, including a forested community, an old field community, a maintained field community, and a small <0.1-acre area containing some plant species that may be found in wetlands. In addition, the property to the north was developed into the Crossroads Industrial Park resulting in removal of the maintained field community that previously existed in that area.

5.4.1.1 Area 1 Plant Communities (1994-95)

Area 1 consists predominantly of old field community dominated by grasses and various herbaceous plant species interspersed with six small depressions dominated by hydrophilic vegetation (Figure 4-2). The old field community in Area 1 was dominated by various grass species such as bluestem, foxtail, and other grasses. Other dominant herbaceous species noted include goldenrod, nodding thistle and curled dock. Other species noted included common plantain and field pennycress. No woody species were observed to be dominant in Area 1 during the RI field investigation.

Six small isolated areas of hydrophilic plant communities were identified in Area 1 (Figure 4-2) during the OU-1 RI field investigations. These species included herbaceous vegetation such as rushes, curled dock, and cattail. A green alga, Sprirogyra spp., was also present in two areas in which standing water was observed. All of the hydrophilic communities were present in small surface depressions in the landfill cap that likely are the result of differential landfill subsidence over time and resultant poor surface drainage.

After the OU-1 RI field investigations, extensive growth of woody vegetation, consisting of honeysuckle and other shrubs, cottonwood trees and occasional willow, hackberry and box elder trees covered much of Area 1. In addition, the small isolated areas that previously contained hydrophilic vegetation were filled with inert fill material between approximately 2006 – 2008 pursuant to the MMP.

More recently, the vegetation in portions of Area 1 has been cleared and rock/roadbase material has been laid down in conjunction with construction of access roads and drill pads for additional investigations and as part of construction of the NCC.

5.4.1.2 Area 2 Plant Communities (1994-95)

Area 2 plant communities observed during the RI field work included an old field community, a forested berm area dominated by woody vegetation and small isolated hydrophilic communities containing cattails and other hydrophilic species (Figure 4-3). The old field plant community dominated the majority of Area 2 at the time of the RI field work. This community was present over the majority of the landfill surface between the landfill berm on the north and west margins of this area and the other landfill areas located to the east and south of this area. The old field community in Area 2 was dominated by invasive herbaceous species such as nodding thistle, yellow sheet clover and goldenrod. Various grass species were also noted to be present. Woody species including numerous young stands of staghorn sumac, and eastern cottonwoods were also present in Area 2.

At the time of the field work for the 1996 RI, the landfill berm along the north and west boundaries of Area 2 contained a forest plant community. This community consisted of predominantly woody species including eastern cottonwood, willows, dogwoods and ash trees. A species of grape was the dominant vine present in the forested community of Area 2. Bedstraw and other old field species were previously present along the edge habitat between the forest community and the old field community.

Ten small isolated areas containing plant species typical of hydrophilic communities were identified in Area 2 (Figure 4-3). In most of these areas, cattails were the dominant (or the only) species present. Similar to Area 1, these areas were present in small depressions that were presumably the result of differential settlement in the landfill and resultant obstruction of the surface water drainage in these areas.

As with Area 1, extensive growth of woody vegetation – consisting of honeysuckle and other shrubs, cottonwood trees and occasional willow, hackberry and box elder trees – occurred over much of Area 2 after the OU-1 RI field investigations. In addition, many of the low-lying areas that previously contained hydrophilic vegetation were filled with inert fill material pursuant to the MMP. More recently, the vegetation over much of Area 2 has been cleared and rock/roadbase material has been laid down in conjunction with construction of access roads and drill pads for additional investigations and construction of the NCC.

5.4.1.3 Plant Communities in Other Areas at or Near the Site (1994-95)

Plant communities were characterized during the RI field investigations for three other areas adjacent to Areas 1 and 2. These include the North Surface Water Body, the Earth City flood control channel and the uncultivated portion of the former Ford property west of Area 2.

The North Surface Water Body is located to the north/northwest of Area 2 at the north-easternmost corner of the Site. A forest-type plant community that includes eastern cottonwoods, ashes, dogwoods, and willows dominated the edges of this surface water body at the time of the RI field investigations, and continues to exist as of the date of this RI Addendum. The canopy cover and under-story were (and still are) dense in the vicinity of Area 2. The vegetation associated with the North Surface Water Body is a continuation of the adjacent plant community located on the landfill berm on the north and west margins of Area 2. The banks of the North Surface Water Body are not well defined and at the time of the plant assessment, water flow appeared to be very slow to non-existent in the North Surface Water Body.

The Earth City flood control channel is located off-site on property associated with the Earth City development. A fence restricts access to the Site from or to the Earth City flood control channel. This flood control channel consists of well-defined, man-made bed and banks. The shores of the flood control channel consist of a maintained field community.

The former Ford property located to the north and west of Area 2 consisted of an old field community during the RI field work. This area was not being farmed at the time of the field work and had not been farmed since the 1980s. Dominant plant species in this area included nodding thistle, goldenrod, daisy fleabane, yellow sweet clover and various grasses. After the OU-1 RI, the vegetation in this area (as with the rest of the former Ford property except for the Buffer Zone) was removed as part of the development of the Crossroads Industrial Park. Vegetation on the Buffer Zone was recently removed as part of construction of the NCC.

5.4.2 Threatened and Endangered Species

Federal and State listings of threatened and endangered species were requested from the U.S. Fish & Wildlife Service (USFWS) and from the Missouri Department of Conservation (MDOC) by McLaren/Hart as part of their activities related to preparation of the RI/FS Work Plan (McLaren/Hart, 1994). The USFWS responded that "[n]o federally-listed endangered or threatened species occur in the project area" (USFWS, 1994). The MDOC responded that "[d]epartment staff examined map and computer files for federal and state threatened and endangered species and determined that no sensitive species or communities are known to occur on the landfill property or surrounding area" (MDOC, 1994).

After receipt of these letters, Ms. Cherri Baysinger-Daniels of the Missouri Department of Health (MDH) stated that on October 23, 1994 she observed a western fox snake (*Elaphe vulpina vulpina*), a Missouri state-listed endangered species, at the Site. The western fox snake is a marsh-dwelling member of the rat snake group (MDOC, 1992). This snake is believed to be an inhabitant of open grasslands and the borders of woods. In Missouri, the fox snake has been found near large natural marshes (MDOC, 1992). At the time of the RI field investigations, the western fox snake was reported to be present only in St. Charles and Lincoln counties (MDOC, 1994 and 1995).

In response to Ms. Baysinger-Daniels' observation, McLaren/Hart requested another database search of the western fox snake's distribution in Missouri (McLaren/Hart, 1996c). This second search indicated that there were no records of occurrences of the western fox snake reported for St. Louis County, Missouri. If Ms. Baysinger-Daniels' preliminary observation had been verified, the presence of the western fox snake at the Site would have represented a new location for this species and a new county record. A voucher specimen is required to adequately document a new county record (MDOC, 1995). A photograph of a specimen, showing both the dorsal and ventral views, would suffice as a voucher specimen (MDOC, 1995). As a voucher specimen was not obtained, Ms. Baysinger-Daniels' observation alone is insufficient to verify an occurrence of the western fox snake in St. Louis County.

During the field survey, McLaren/Hart examined areas most likely to be inhabited by the western fox snake in an effort to verify and document Ms. Baysinger-Daniels' observation. Each vegetative community, with emphasis on marshy areas, was qualitatively examined for the presence of the western fox snake or other reptiles. The reptile search was performed concurrently with the evaluation of the vegetative communities. Basking areas, large rocks, logs and pieces of plywood were examined for the presence of snakes. No specimens of the western fox snake were observed during the biological survey or during any of the other RI/FS field investigations.

5.4.3 Area Wildlife

Numerous species and signs of species of wildlife were observed to be present in the Site area during the activities associated with the biological survey. Deer (*Odocoileous spp.*) tracks were noted by McLaren/Hart (1996c) in Area 2 and on the adjacent former Ford property. Based on the home range of deer, it is likely that all areas of the Site are accessible to this species. Rabbits (*Sylvilgus floridanus*) or signs of rabbits were observed in Areas 1 and 2, areas surrounding the North Surface Water Body and the former Ford property. It is likely that rabbits are cosmopolitan throughout the Site and surrounding area. Other cosmopolitan species include red-winged black birds (*Aeqlaius phoeniceus*), robins (*Turdus migratorius*) and occasionally crows (*Corvus brachynchos*).

A great blue heron (*Ardea herodias*), a piscivorous bird, was observed flying above the Site and landing in the Earth City flood control channel (McLaren/Hart, 1996c). This species is likely to use aquatic habitats both on and off-site, but it will feed only in those waters containing prey species of fish and amphibians.

Several pellets containing fur were observed in Areas 1 and 2 and a relatively large den was observed in the landfill berm along the northwest side of Area 2 (McLaren/Hart, 1996c). These pellets and the den were possibly due to coyotes (*Canis latrans*), red fox (*Vulpes*) or possibly both. The home range of these species is large enough to include the Site, and the presence of rabbits suggests a food source for these species (McLaren/Hart, 1996c).

Although not documented by the McLaren/Hart survey, raccoons have been observed to be present at the Site, including at one time within the attic of the Site office building.

5.5 Subsurface Features

The subsurface conditions beneath the Site consist of municipal refuse, construction and demolition debris, other wastes and the associated soil cover materials, alluvial deposits and limestone, dolomite and shale bedrock as further discussed below.

5.5.1 Geology

The bedrock geology of the Site area consists of Paleozoic age sedimentary rocks that in turn overlay Pre-Cambrian-age igneous and metamorphic rocks. The Paleozoic bedrock is overlain by unconsolidated alluvial and loess deposits of recent (Holocene) age. A generalized stratigraphic column for the St. Louis area is presented on Figure 5-8.

Bedrock units are only present at or near the surface in the southern portion of the Site (*i.e.*, south of the edge of geomorphic floodplain [Figure 5-5]). Bedrock units were exposed in the quarry areas and were inspected and mapped as part of the OU-2 RI. To the north of the edge of the geomorphic floodplain, the Site is underlain by alluvial deposits. Consequently, the various monitoring wells installed at the Site consist primarily of bedrock wells in the southern third of the Site and alluvial wells in the northern two-thirds of the Site.

5.5.1.1 Bedrock Geology

The lowermost bedrock units beneath the Site consist of Pre-Cambrian igneous and metamorphic rocks that are overlain by cherty dolomite, siltstone, sandstone and shale of Cambrian age. These deposits are overlain by approximately 2,300 feet of limestone, dolomite, shale and sandstone of Ordovician age which in turn are overlain by approximately 200 feet of cherty limestones of Silurian age. Devonian age sandstone, limestone and shale deposits lie unconformably on the Silurian age deposits.

The uppermost bedrock units in the vicinity of the Site consist of Mississippian age limestone and dolomite with inter-bedded shale and siltstone layers of the Kinderhookian, Osagean, and Meramecian Series. The Kinderhookian Series is an undifferentiated limestone, dolomitic limestone, shale and siltstone unit ranging in thickness from 0 to 122 feet in the St. Louis area. The Osagean Series consists of the Fern Glen Formation, a red limestone and shale, and the Burlington-Keokuk Formation, a cherty limestone. The Fern Glen Formation ranges in thickness from 0 to 105 feet and the Burlington-Keokuk Formation ranges from 0 to 240 feet thick in the St. Louis Area.

The Meramecian Series overlies the Osagean Series rocks. The Meramecian Series consists of several formations including the Warsaw Formation, the Salem Formation, the St. Louis Formation, and the St. Genevieve Formation. The St. Genevieve Formation is reportedly not present in the vicinity of the Site (Golder, 1996a).

Pennsylvanian-age Missourian, Desmoisian, and Atokan formations are present in some areas above the Mississippian-age rocks. The Pennsylvanian-age rocks consist primarily of shale, siltstone, and sandstone with silt and clay. These formations range in combined thickness from 0 to 375 feet in this area. The Atokan-Series Cheltenham Formation was identified as being present in the Site soil borrow area located in the former southeastern corner of the Site.[49]

The following sub-sections provide additional detailed information regarding the uppermost bedrock units beneath the Site. Additional information on the bedrock conditions beneath the Site is contained in the *Physical Characterization Technical Memorandum for the West Lake Landfill, Operable Unit 2, Bridgeton, Missouri* prepared by Golder Associates, Inc. (1996a) and the OU-2 RI report (Herst & Associates, 2005).

5.5.1.1.1 Keokuk Formation

The Keokuk Formation beneath the Site was generally identified as a fresh to slightly or moderately weathered, thin- to medium-bedded, very light gray to light olive, medium- to coarse-grained, medium strong, fossiliferous limestone (Golder, 1996a). Dolomite and dolomitic limestone beds as well as chert layers and nodules were observed by Golder (1996a) to be present with the Keokuk Formation. The limestone units of the Keokuk Formation were variously described as siliceous and arenaceous (sandy) as well as porous and vuggy.

Fractures were infrequently (generally less than two fractures per foot) identified in the Keokuk Formation and were generally described as irregular and rough (Golder, 1996a). Some fractures were reported to be bedded and planar (Golder, 1996a). Golder (1996a) identified open vugs and/or porous zones in the lower portion of the formation below an elevation of 100 feet amsl.

The Keokuk Formation was encountered in the Site boreholes at depths of 365 to 375 feet bgs along the eastern edge of the South Quarry portion of the Bridgeton Landfill at elevations ranging from 115 to 126 feet amsl (Golder, 1996a). Along the western edge of the South Quarry Landfill, the Keokuk Formation was encountered at depths of approximately 345 feet bgs (elevation of 115 feet amsl).

[49] The southeastern boundary of the Site has since changed due to the sale of the former soil borrow area, which was part of the original landfill property.

5.5.1.1.2 Warsaw Formation

The Warsaw Formation is located above the Keokuk Formation. The Warsaw Formation. was generally described as being a fresh and thickly bedded limestone with numerous beds of calcareous claystone and fossiliferous limestone beneath the Site (Golder, 1996a). Various portions of the Warsaw Formation were described by Golder (1996a) as arenaceous (sandy) or argillaceous (clayey). Many interbeds of dolomite, claystone, siltstone, clayey siltstone, and silty claystone were also observed to be present (Golder, 1996a). The limestone beds were very fine- to very coarse-grained or micro- to coarsely crystalline ranging in color from dark greenish gray to olive black (Golder, 1996a). The beds of this formation were characterized by vuggy porosity (Golder, 1996a).

The lower portion of the Warsaw Formation is reported to consist primarily of thin- to medium-bedded limestone, which includes thin chert layers and small chert nodules. The lower portion of the Warsaw Formation grades into the upper portion of the Keokuk Formation. The upper portion of the Warsaw Formation was characterized by a 2.5- to 10-foot-thick claystone or siltstone layer commonly referred to as the Warsaw Shale (Golder, 1996a).

Fractures in the Warsaw Formation were rare and generally did not exceed a frequency of one fracture per foot (Golder, 1996a). Fractures observed by Golder (1996a) were reported to be generally jointed, irregular or planar, and rough or smooth. Clay infilling of joints was common (Golder, 1996a).

The Warsaw Formation was encountered in boreholes drilled by Golder (1996a) at about 256 bgs (approximately 226 feet amsl) near the eastern edge of the South Quarry portion of the Bridgeton Landfill (*i.e.*, in the boring for well PZ-104-KS). Along the western edge of the South Quarry portion of the Bridgeton Landfill, the Warsaw Formation was encountered at depths ranging from about 200 to 210 feet bgs (*i.e.*, in boring for well PZ-106-KS), equivalent to an elevation of about 280 feet amsl. The average elevation of the base of the South Quarry portion of the Bridgeton Landfill is approximately 250 feet amsl indicating that the quarrying activities terminated at or near the top of the Warsaw Formation (Golder, 1996a). The thickness of the Warsaw Formation encountered beneath the Site ranged from about 130 to 145 feet.

5.5.1.1.3 Salem Formation

The Salem Formation lies above the Warsaw Formation. The Salem Formation beneath the Site was described by Golder (1996a) as a fresh, thinly- to thickly-bedded, pale-yellowish brown to light olive gray limestone. The limestone was variously described as argillaceous or arenaceous, bioclastic, fossiliferous, or fossiliferous dolomitic limestone. Interbedded dolomitic layers were common and chert clasts, nodules and layers were scattered throughout the formation at varying frequencies (Golder, 1996a).

Fracturing is reported (Golder, 1996a) to be rare in the Salem Formation with fracture frequencies of zero to one fracture per foot in the lower portion of the formation increasing to up to two fractures per foot in the upper portion (Golder, 1996a). The fractures primarily consisted of joints with surfaces varying from irregular and rough to planar and smooth.

The Salem Formation was encountered during drilling performed by Golder (1996a) at depths of approximately 165 feet below ground surface (about 320 feet amsl) along the eastern edge of the Bridgeton Landfill. Depths to the top of this formation ranged from approximately 115 to 135 feet bgs (about 328 to 340 feet amsl) along the western edge of the Bridgeton Landfill (Golder, 1996a). The thickness of the Salem Formation ranges between 67 and 83 feet beneath Site area (Golder, 1996a).

5.5.1.1.4 St. Louis Formation

The primary bedrock unit beneath the Site is the St. Louis Formation which has generally been described as consisting of inter-bedded fresh to slightly weathered limestone and dolomite (Golder, 1996a). Based upon observations of core samples, Golder (1996a) described the St. Louis Formation beneath the Site as a very light gray to olive gray, fine to medium crystalline or fine- to medium-grained limestone inter-bedded or inter-layered with lesser amounts of claystone and siltstone. The limestone beds ranged from thin to very thick and were variously characterized as arenaceous, argillaceous, dolomitic, or clastic (Golder, 1996a). The St. Louis Formation grades downward into the underlying Salem Formation (Golder, 1996a).

Fractures were identified by Golder (1996a) in the core samples of the St. Louis Formation at frequencies of zero to ten fractures per foot with the fractures generally classified as jointed, irregular, or rough. The fractures were generally infilled with clay. Stylolitic (column-like) joints were also reportedly observed (Golder, 1996a).

The top of the St. Louis Formation was encountered during drilling by Golder (1996a) at depths ranging from 14 to 52 feet to between 20 and 110 feet bgs along the eastern and western edges of the Bridgeton Landfill, respectively. The elevation of the top of the St. Louis Formation ranges from between 425 and 460 feet amsl beneath the eastern portion of the Bridgeton Landfill to between 379 and 442 amsl beneath the western portion of the Bridgeton Landfill (Golder, 1996a). These variations in the depth to and elevation of the top of the St. Louis Formation reflect the presence of the edge of the buried Missouri River valley beneath the Site and the presence of the limestone bluffs upon which the limestone quarry was sited (Golder, 1996a). The thickness of the St. Louis Formation ranges from approximately 65 to 130 feet in the areas adjacent to the South Quarry portion of the Bridgeton Landfill.

5.5.1.1.5 Cheltenham Formation

The Cheltenham Formation was only encountered near the surface at one location (PZ-301-SS) in the southern portion of the former landfill borrow area which was located to the south of the South Quarry portion of the Bridgeton Landfill. The Cheltenham Formation reportedly consists of clays and associated clastic deposits (Golder, 1996a). The clays are reported to be mostly white to light- or medium-gray purplish to red; however, at the Site the claystone of this formation was found to be predominantly olive to greenish gray to light brownish gray (Golder, 1996a). Thin limestone, siltstone and coal beds were also present in the formation (Golder, 1996a).

At PZ-301-SS, the Cheltenham Formation was identified from 19.1 to 71.5 feet bgs (Golder, 1996a). With exception of the upper 10 feet, cores obtained from this formation were relatively unfractured (Golder, 1996a).

5.5.1.2 Unconsolidated Materials

A surficial geological map of the unconsolidated materials and bedrock units present at the ground surface in the general area of the Site is presented on Figure 5-5. Unconsolidated materials at the Site consist primarily of alluvium and loess.

During the late Pleistocene period loess consisting primarily of windblown silt with lesser amounts of clay was eroded from glacial outwash deposits by wind action and re-deposited as windblown deposits. Loess deposits range up to 80 feet thick along the bluffs and hills to the east of the Site; however, the loess deposits at the Site are relatively thin (Golder, 1996a). Silty clay and clayey silt deposits were identified with thickness from 13 to 22 feet along the eastern edge of the Bridgeton Landfill (Golder, 1996a). Loess was not commonly encountered along the western edge of the Bridgeton Landfill and where encountered in the western portion of the Bridgeton Landfill, these deposits were about 10 to 15 feet thick and were occasionally found to be interbedded with the underlying alluvial deposits.

Alluvial deposits in the Site area typically consist of fine-grained materials (clay and silt) overlying coarse-grained (sand and gravel) materials. The coarse-grained materials primarily consist of poorly sorted sands and have been interpreted to be the result of point bar deposits associated with the Missouri River (Golder, 1996a). The finer grained deposits have been interpreted to represent overbank deposits associated with the Missouri River floodplain. The thickness of the alluvial deposits and the depth to the top of bedrock increase from the eastern to the western portions of the Site. This increase in depth results from the presence of the buried alluvial valley beneath the western portion of the Site. Along the western portion of the Bridgeton Landfill, in the vicinity of Area 1, the alluvial deposits are up to 120 feet thick.

5.5.2 Landfill Deposits

The various areas of landfilling activities were previously described in Section 3.2. The deposits associated with past landfilling primarily include municipal refuse, construction and demolition fill, and associated soil cover. The depth and configuration of the landfill deposits varies between each of the various areas of prior landfilling activities. The amount of variation depends in part upon the pre-landfill topography and the effects of pre-landfill disturbances (*e.g.*, mining activities), the amount of above-grade disposal that took place, and the type of waste materials disposed. The description of the nature and configuration of the solid waste materials associated with the Bridgeton Landfill has been developed as part of OU-2 (Golder, 1996a and Water Management Consultants, 1997).

5.5.2.1 Waste Materials in Areas 1 and 2

The known disposal history of the Site is summarized in Section 3.2 of this RI Addendum and is further discussed in Section 6.1 relative to Areas 1 and 2. No contemporaneous reports, drawings or other records from the former Site operators are currently known to exist regarding the construction of the disposal units or the overall types and amounts of wastes that were disposed in the Area 1 and Area 2 landfills during their operation. An October 2, 1980 MDNR memorandum acknowledged that there was "little known about what went into Westlake Landfill prior to State regulation," but listed a number of industrial and chemical wastes known to have been disposed of in the landfill (MDNR, 1980). That memorandum listed wastes associated with insecticides, herbicides, oily sludges and waste water treatment sludges, along with various chemical and industrial waste materials. Underlying documentation associated with these materials was not included with the memo, nor does the memorandum identify the time periods, volumes, or waste disposal locations.

Historical aerial photographs (Appendix O) were reviewed to gain some insight into the history of activities in Areas 1 and 2 and the adjacent waste disposal areas. Based on this review, rock quarrying at the West Lake quarry began prior to 1941 in the southern portion of the North Quarry pit with rock quarrying in the South Quarry beginning sometime after 1941 but prior to 1958. The first activities in Area 1 and 2 appear to have occurred sometime prior to 1965, at which time the surface of Area 1 appears to be used for activities ancillary to the rock quarrying (*e.g.*, stockpiling of material). The first sign of disturbance in Area 2 was observed on the southwest corner (west half of area 2) by April 1964. Two bermed cells containing piles of material are visible. By July 1965, a berm had been constructed along the north side of the west half of Area 2. By 1965, there is a building located at the same location as the current landfill office so it is possible that Area 2 was being used for waste disposal by this time. In 1968, Area 1 appears to continue to be used for activities ancillary to the rock quarry and quarrying and earth removal activities are also visible immediately east of Area 1 and Area 2 appears to be being used for waste disposal. In 1969, most of the disturbed by excavation or landfill activities. In 1971, Area 1 appears to continue to be used for activities ancillary to the quarrying and the entire area of Area 2 is now disturbed. In May 1971, the area of landfilling in Area 1 had

expanded slightly and piles are visible on the surface. In 1971 and 1972, most of the active filling is concentrated on the east half of Area 2, although additional filling is also seen on the west half of the area in some of the aerial photos during this period. By October 1971, the piles are not visible on the southwest fill lobe of Area 1, an d the surface has been modified by grading since the last photo. In August 1972, filling activities in Area 1 appear to continue moving to the west and south across the area. A berm has been closed on the southeast corner of the area. On September 19, 1973, filling continues on the north side of Area 1 at higher elevations. Ungraded piles of material are visible on the area. By 1974, large portions of Area 2 are now used for stockpiling of materials associated with the rock quarrying operations

By early April 1975, and a new building and parking area has been constructed in the north-center of Area 2. Also in April 1975, a new access road is visible from the northwest corner of Area 1. Additional disturbed areas can be seen on the April 1976 photograph. The 1977 photograph displays areas of fill or possibly stockpile material on both Areas 1 and 2. The 1979 photograph displays the first signs of waste disposal in the North Quarry, with waste being placed in the northern portion (closest to St. Charles Rock Road) portion of the quarry. Also in 1979, a rectangular parking area has been constructed along the north side of Area 1. Filling is visible along a low area on the west side of Area 1. A haul road and several areas of what appear to be stockpiles are present in Area 1 and areas of fill or stockpiling can be observed in Area 2. In 1981, additional filling is visible on the southwest side of Area 1. Numerous stockpiles are present on Area 2 in 1982, but no activities appear to be occurring on Area 1 by 1982. Ancillary equipment to the rock quarrying (*e.g.*, rock crushers) and stockpiles are still present in 1985. Other than a parking lot, no activities are seen in Area 1 and some placement of fill or stockpile material is occurring in Area 2. By 1993, the asphalt and concrete batch plants appear to be present, no activities appear to be occurring in Areas 1 and 2, and the building that was present in Area 2 is now gone. Review of subsequent aerial photographs (*i.e.*, post-1993) did not identify any activities occurring on Areas 1 or 2 with the exception of the placement of inert fill materials in the 2006-2008 timeframe pursuant to the Materials Management Plan (EMSI, 2006b).

Based on the various RI investigations (McLaren/Hart, 1996h, EMSI, 2000, FEI, et al., 2014, EMSI, 2015e and EMSI et al., 2016b), it appears that Areas 1 and 2 were filled using an "area-fill" approach in which the solid waste and cover materials were deposited onto the existing land surface. The wastes encountered during the various RI drilling and sampling activities in Areas 1 and 2 (McLaren/Hart, 1996h, EMSI, 2000, FEI, et al., 2014, EMSI, 2015e, and EMSI et al., 2016b) appear to be composed of municipal solid waste consisting primarily of household trash, construction and demolition fill, and associated soil cover.

The thickness of the landfill deposits as encountered in soil borings varies from 2.5 to 95.2 feet with an average thickness of 43.4 feet in Area 1.[50] The thickness of landfill deposits encountered in the soil borings in Area 2 varied from 5 to 65.8 feet with an average thickness of 31.6 feet. Figure 5-9 displays the elevation of the base of refuse in Area 1. Subtracting the

[50] These values include the thickness of refuse in the above-ground portion of the North Quarry that overlies the southwestern portion of Area 1.

depth/elevation of the base of refuse from the depth/elevation of the top of refuse (which is not the same as the ground surface elevation due to the presence of cover soil and the placement of additional inert fill material in the 2006-2008 time frame) results in the thickness of refuse at any location. The values for the thickness of refuse in Area 1 were contoured as shown on Figure 5-10 to provide an estimate of the overall thicknesses of waste materials in Area 1. The elevations of the top and bottom of refuse were used in conjunction with the areal extent of Area 1 to estimate the total volume of waste in Area 1 which is estimated to be approximately 1,031,000 cubic yards. Note this volume includes the above-grade part of the North Quarry portion of the Bridgeton Landfill that extends out over the southern portion of Area 1. Similarly, Figure 5-11 displays the elevation of the base of waste in Area 2 and Figure 5-12 displays the thickness of waste in Area 2. The total volume of waste in Area 2 is estimated to be approximately 1,443,000 cubic yards. The configuration of the RIM in Areas 1 and 2 is addressed as part of the discussions of source areas in Section 6 of this report.

Based upon observations made by McLaren/Hart during the 1995-96 RI soil boring program, there appears to be minimal soil material or soil layers within the landfill debris. Where soil was encountered during the boring program, it was generally one to two feet thick or less. The soil material encountered during the boring program consisted of silt and sand with some gravel. The greatest soil thickness encountered during the boring program was found at the ground surface where the soil thickness was reported by McLaren/Hart to commonly be three to five feet thick.

Boring logs developed in 2014 and 2015 based on the soil borings drilled and examination of core samples obtained during the Phase 1, Additional Characterization and Cotter investigations provide significantly more detailed information as to the nature of the waste materials compared to the information obtained from the RI borings. Review of the boring logs from the more recent investigations indicated that significant decomposition (composting) of the waste materials had occurred. Consequently, much of the waste materials in Areas 1 and 2 were of a soil-like consistency; however, significant amounts of intact, undecomposed materials such as plastic, cloth, wood and wood scraps, rubber-like items, metal, glass, concrete, brick, shredded foam and plastic, wire strands, tire scraps, cinder block pieces, limestone rubble, and other materials were still present within the waste mass. Unique, identifiable materials such as metal bedsprings, paint residue, plastic bags, electrical cord, drywall, shoes, book pages, flatware, milk cartons, a baseball, Styrofoam cups, sawdust, intact newspaper, cardboard and other undecomposed items were also present.

5.5.2.2 Soil Cover Over Areas 1 and 2

With the exception of the limited information presented in the McLaren/Hart Soil Boring and Surface Sampling Report (McLaren/Hart, 1996h), little specific information was developed for the OU-1 RI on the nature and thickness of the soil cover that exists over Areas 1 and 2. None of the pre-1996 RI reports contain any drilling or borehole logs or other information on the nature of the materials encountered during drilling. Borehole logs developed by McLaren/Hart as part of their drilling and well installation efforts contain descriptions of the materials encountered;

however, the soil cover materials were generally not described separately from the landfill materials, as large diameter augers were used to drill these borings. Review of the field logs indicates that where the cover materials were described by McLaren/Hart's field personnel, they generally consisted of less than one and up to approximately five feet of sandy or clayey silt.

EMSI drilled four borings along the west side of Area 1 in 1997 pursuant to the Amended Sampling and Analysis Plan (ASAP) (EMSI, 1997a). Soil cover materials encountered by EMSI during OU-1 RI drilling efforts were described as a loose, slightly moist, mottled gray, brown clayey sand grading to gray clayey sand at a depth of 30 inches. The total thickness of soil cover materials encountered at the four locations drilled by EMSI in Area 1 in 1997 varied from approximately 24 to 60 inches.

A generalized description of the landfill cover conditions was developed for the OU-1 RI (EMSI, 2000) based on the information available from the boring logs and general observations made during the various field activities, particularly the 1997 radon flux measurements. Based on this information, the landfill cover materials over Area 1 can be described as approximately three to five feet of well-vegetated clayey sand or sandy, silty clay. The cover materials over Area 2 can be described as approximately one to two feet of well to poorly vegetated clayey, silty sand or sandy, silty clay. The soil cover over Area 2 contained some concrete chunks or other pieces of construction/demolition debris. Parts of the central portion of Area 2 contained little to no vegetative cover, indicative of a thin and/or rocky cover material with limited to no ability to support vegetation.
After completion of the 2000 OU-1 RI, additional inert fill material consisting of concrete rubble, off-specification concrete block material, off-specification brick, concrete pipe, used brick, and similar materials were placed over portions of Areas 1 and 2 pursuant to a Materials Management Plan (EMSI, 2006b) approved by MDNR in 2006. Placement of inert fill material occurred between 2006 and 2008.

Review of Phase 1, Additional Characterization, and Cotter investigation logs of borings that were drilled through waste indicates that the soil cover over Area 1 averages approximately 7.6 feet, ranging from a minimum of approximately 0.92 feet to a maximum of 25.5 feet. The thickness of soil cover in Area 2 was similar, averaging 6.7 feet, and ranging from approximately 0.83 feet up to 25.7 feet.

5.5.3 Geologic Cross Sections

Geologic cross sections are two-dimensional vertical profiles portraying an interpretation of subsurface conditions used to display the spatial positions and relationships between various geologic units.

Figures 5-13 and 5-14 present geologic cross sections located along southeast to northwest alignments across the Site. The alignments of these sections were chosen to maximize the use of available soil boring information and because they are oriented in a southeast to northwest

direction, parallel to the direction of groundwater flow beneath the Site. These figures display the relationships between the landfill waste deposits and the underlying alluvial deposits and bedrock units based on the Site boring logs.

Figure 5-13 presents a southeast-northwest oriented cross-section through the North Quarry portion of the Bridgeton Landfill, through Area 1 and the Closed Demolition Landfill and extending up through Area 2. Figure 5-14 presents a similar southeast-northwest oriented cross-section extending from the South Quarry portion of the Bridgeton Landfill through the Inactive Sanitary Landfill up through Area 2. These figures present the overall relationship between the various solid waste units and the relationship of these units to the alluvium and bedrock units, including displaying the approximate depth of the North and South Quarry portions of the Bridgeton Landfill relative to the alluvium and bedrock materials.

In addition, these figures illustrate the absence of alluvial materials beneath the southern portions of the Site, in the vicinity of the North and South Quarry portions of the Bridgeton Landfill, south of the identified extent of the geomorphic floodplain. These figures also show the thickening of the alluvial deposits immediately to the north of the North and South Quarry portions of the Bridgeton Landfill. These figures also display the relationship of the RIM encountered along that particular cross-section relative to the various solid waste units, the alluvium and the groundwater levels within the alluvium beneath Areas 1 and 2. As can be seen on these figures, the base (lowermost portion) of the RIM is located above the groundwater level (saturated portion) of the alluvium.

The September 2013 water level data for each monitoring well/piezometer and the inferred potentiometric surface (see discussion below) are also presented on these cross sections in order to portray the position of the RIM and solid wastes relative to the groundwater levels. Although this will be discussed more in the next sections, the water levels and inferred potentiometric levels within the alluvium and bedrock units indicate that the hydraulic gradient within these units is primarily horizontal from the southeast to the northwest, toward the Missouri River. There does appear to be an upward gradient from the Keokuk Formation through the Warsaw Formation to the Salem Formation as evidenced by the more nearly horizontal potentiometric lines within the Warsaw Formation.

In addition to the geologic cross sections developed for the Site, published geologic cross sections developed by others to display geologic conditions in the St. Louis area, including in the general area of Site, are also provided. Figure 5-15 presents a cross-section of the alluvial deposits in the vicinity of the Site that was developed by the USGS (Emmett and Jeffery, 1968). This figure shows that the alluvial deposits in the general area of the Site consist of approximately 25 to up to nearly 50 feet of clay and silt (previously removed from the Site area during quarrying and landfilling activities) overlying between 0 and approximately 90 feet of sand and gravel. Figure 5-16 presents a geologic cross-section that was developed by the USGS (Harrison, 1997) that displays the bedrock geologic units in an area 1.5 miles to the north of the Site. This figure displays the bedrock geologic units present in the Site area from the lowermost crystalline basement rock up through the uppermost Paleozoic age rocks and alluvial deposits.

The USGS cross-section indicates that the bedrock units dip (are sloped) to the east and that to the east of the Site the bedrock is folded, as evidenced by the presence of the Cheltenham Syncline and the Florissant Dome. Further to the east, the bedrock units are offset by the St. Louis Fault Zone.

5.6 Hydrogeology

This section presents a brief overview of the regional and Site hydrogeology. It is expected that additional details regarding the hydrogeology of the Site will be developed for the upcoming OU-3 (Groundwater) RI; however, a discussion of the hydrogeology is included in this OU-1 RI Addendum as it is part of the update to the prior (2000) RI report and it provides a necessary framework for the evaluations of the extent and fate and transport of radionuclides in environmental media and the conceptual site model presented in later sections of this RI Addendum. In addition, EPA requested that the RI Addendum present the results of all of the additional investigations that have been conducted since the prior RI/FS was completed and the ROD was issued, which includes the results of the four comprehensive groundwater sampling events conducted in 2012-2013.

5.6.1 Regional Hydrogeology

Groundwater is present in both the bedrock units and the unconsolidated materials. The major bedrock aquifer of the St. Louis area is the Ozark aquifer which includes the Cambrian-age Potosi Dolomite and the Ordovician-age Gasconade Dolomite, Roubidoux Formation and St. Peter Sandstone.

The Potosi Dolomite is up to 324 feet thick and occurs at an average depth of 2,240 feet bgs in the St. Louis area. The Gasconade Dolomite and the associated Gunter Sandstone occur in thicknesses of up to 280 feet in the St. Louis area. These units are overlain by the Roubidoux Formation, which ranges from 0 to 177 feet thick in the St. Louis area. The average depth of the Roubidoux Formation is approximately 1,930 feet bgs. The St. Peter Sandstone lies at a depth of approximately 1,450 feet bgs and can be as much as 160 feet thick. It should be noted that the thickness and depth of these formations vary throughout the St. Louis area, and they may not be present in some places. Due to their depth, these formations are generally not used as a source of potable water. The deeper Cambrian and Ordovician-age aquifers are separated from shallower units by the Ordovician-age Maquoketa shale that appears to provide confinement for the underlying deeper aquifers.

Miller et al. (1974) describes the uppermost regional aquifers present in the Silurian, Devonian, Mississippian and Pennsylvanian- age rocks, as yielding small to moderated quantities of water ranging from 0 to 50 gpm. The Mississippian-age Meramecian Series rocks (including the Warsaw, Salem and St. Louis Formations), which underlie and are present immediately to the

west of the Site, are not favorable for groundwater development due to their generally low yield (less than 50 gallons per minute [gpm]) (Miller et al., 1974).

The major alluvial aquifers in the area are differentiated to include the Quaternary-age alluvium and the basal parts of the alluvium underlying the Missouri River floodplain. These floodplain alluvial aquifers are typically exposed at the surface and can be as much as 150 feet thick (Miller et al., 1974). Alluvial wells completed in the Mississippi and Missouri River floodplains are capable of yielding more than 2,000 gpm (Emmett and Jeffery, 1968).

5.6.2 Site Hydrogeology

The description of the Site hydrogeology presented below is based on information previously presented in the OU-1 and OU-2 RI reports (EMSI, 2000 and Herst & Associates, 2005) regarding groundwater occurrences at the Site. Discussions related to the alluvial aquifer are primarily based on information obtained from the McLaren/Hart Groundwater Conditions report (McLaren/Hart, 1996g) and the OU-1 RI investigations as updated to reflect the results of the four groundwater monitoring events that took place in 2012-2013, which as of the date of this RI Addendum represent the most recent Site-wide monitoring results. Investigations of the bedrock aquifer conditions beneath the Site were performed as part of the OU-2 RI/FS effort performed on behalf of Bridgeton Landfill, LLC. Results of these investigations are summarized in the *Physical Characterization Technical Memorandum for the West Lake Landfill, Operable Unit 2, Bridgeton, Missouri* prepared by Golder Associates, Inc. (1996a), the *Site Characterization Summary Report for West Lake Landfill, Operable Unit 2, Bridgeton, Missouri* prepared by Water Management Consultants, Inc. (1997), and the OU-2 RI (Herst & Associates, 2005).

Discussion of the hydrogeologic conditions at and in the vicinity of the Site include the following components:

- Groundwater occurrence;
- Leachate collection;
- Groundwater levels and elevations;
- Hydraulic gradients;
- Hydraulic conductivity and porosity;
- Groundwater flow directions;
- Groundwater flow velocity; and
- Groundwater flux.

Information regarding water levels and hydraulic gradients of the various units based on data obtained during OU-1 RI field investigations and during the four recent (2012 – 2013) comprehensive groundwater monitoring events are presented below. This section also summarizes information previously presented in the OU-1 and OU-2 RI reports (EMSI, 2000 and Herst & Associates, 2005) regarding the hydraulic properties of the various geologic units

beneath the Site. Based on the hydraulic properties, water levels and hydraulic gradients, an assessment of groundwater flow directions, flux rates, and velocities are presented in this section. Finally, this section presents conceptual water balance (water inflow and outflow) evaluations for the South Quarry portion of the Bridgeton Landfill and the alluvial deposits.

5.6.2.1 Groundwater Occurrences at the Site

Briefly summarized, the occurrence of groundwater at the Site is dominated by a water table aquifer contained within the alluvial materials and groundwater present within the limestone and dolomite bedrock units beneath the Site.

Groundwater is present in both the bedrock units and the unconsolidated materials. Groundwater is present within alluvial deposits immediately below the solid waste materials beneath the northern two-thirds of the Site. As discussed above, the alluvial deposits are composed of granular (sand and gravel) and fine-grained (silt and clay) particles; therefore, groundwater occurs in the alluvium within the pore spaces between these particles. Groundwater is also present in limestone and shale bedrock units beneath the alluvial deposits and in the southern one-third of the Site, where no alluvial deposits exist, within the bedrock adjacent to and beneath the North and South Quarry portions of the Bridgeton Landfill. Within the bedrock, groundwater occurs within the interstitial pore spaces, fractures and joints. With respect to the overall scale of the Site and the individual landfill units, the groundwater within fractures in the bedrock units is considered to occur in a manner that is equivalent to groundwater occurrence in a porous medium (*i.e.*, equivalent porous medium). Specifically, on a site-wide scale, groundwater flow within the limestone is expected to be controlled primarily by the hydraulic gradient and that any anisotropy associated with fracturing is not expected to exert significant influence or control on groundwater flow directions at a site-wide scale, although such features may exert control on flow directions on a more localized scale.

During the 1995-1997 OU-1 RI investigations, groundwater was generally encountered in the alluvium beneath the landfill materials. With the exception of the isolated, localized occurrences of perched water identified during the 1995 RI soil boring investigation (McLaren/Hart, 1996h), groundwater generally was not encountered within the solid waste materials in Areas 1 and 2. Continuous groundwater was first encountered in the alluvial materials near or immediately below the base of the landfill debris.

Perched water was identified as being locally present within a few soil borings drilled within the Area 1 and Area 2 landfill deposits during the 1995 soil boring investigation (McLaren/Hart, 1996h). Specifically, during the soil boring investigation (McLaren/Hart, 1996h), isolated bodies of perched water, as evidenced by saturated conditions in soil cuttings and/or soil samples or accumulation of water in soil borings, were encountered in two of the 24 soil borings drilled in Area 1 and six of the 40 soil borings drilled in Area 2. The perched water generally occurred in small isolated units at depths varying from five to 30 feet bgs (see additional discussion in Section 4.6). Perched water was not encountered during any of the more recent drilling

investigations, including the Area 1 Phase 1 investigations, the Additional Characterization of Areas 1 and 2, or the additional borings drilled by Cotter (see additional information contained in the prior discussion in Section 4.6).

5.6.2.2 Leachate Collection

The North and South Quarry portions of the Bridgeton Landfill were constructed with leachate collection systems (Herst & Associates, 2005). There are currently a total of 248 gas/leachate collection points within the Bridgeton Landfill including the following components:

- 7 leachate collection sumps;
- 1 temporary leachate collection sump;
- 34 condensate traps;
- 54 perimeter dual-extraction wells;
- 25 perimeter system toe drain sumps (around the South Quarry);
- 30 leachate trench sumps (in the South Quarry);
- 1 gas interceptor well (12 other gas interceptor wells were converted into heat extraction points for the heat extraction pilot study);
- 6 reinforced concrete pipe (RCP) surface collectors;
- 12 bubble suckers (OLs);
- 40 surface collection monitoring points (SCs);
- 4 lift station/grit chambers; and
- 130 gas extraction wells in the North and South Quarries.

Historically, the volumes of leachate removed from each of these points was not measured; however, the total volume of leachate discharged to the St. Louis Metropolitan Sewage District (MSD) or otherwise sent off-site for disposal was recorded. The total volumes of leachate removed from the North and South Quarry ranged from a high of nearly 90,000,000 gallons in 1997 and again in 2015 to a low of just over 20,000,000 gallons in 2005 (Figure 5-17).

The Bridgeton Landfill operates a leachate pretreatment plant with a capacity of approximately 300,000 gallons per day. The leachate pretreatment plant consists of a 316,000 gallon above-ground storage tank (AST) used for flow and chemical equalization, four 1,000,000 gallon ASTs that are used for activated sludge treatment of the leachate, and an approximately 20,000 square feet process building. Landfill leachate is pumped from the various collection points listed above to the 316,000-gallon equalization tank. From this tank, the leachate is pumped to the pretreatment facility where is subjected to a clarification process and a micro-biological process for treatment. The treated permeate is directly discharged to any of three MSD wastewater treatment facilities including the Bissell Point Wastewater Treatment Plant (WWTP), which is the primary receiving facility, and also the Missouri River WWTP and Coldwater Creek WWTP. Leachate can also be hauled by truck to the treatment plants if necessary.

The leachate collection system potentially is of hydrogeologic importance because it is designed to remove surface water and groundwater that flows into the quarry portions of the Bridgeton Landfill. Historically, the water level within and adjacent to the North and South Quarry pits would have been depressed as a result of dewatering operations conducted in conjunction with the limestone quarrying operations and subsequent landfilling operations in these areas. Upon termination of the dewatering operations, extraction of leachate by the leachate collection system would have continued to draw down the fluid levels within the North and South Quarry areas, to the extent that such extraction exceeded the rate of leachate generation within or groundwater inflow into the North and South Quarry areas. Consequently, the leachate collection system has the potential to affect groundwater levels, hydraulic gradients, groundwater flow directions, groundwater flux, and the overall balance between precipitation recharge and groundwater inflow and groundwater outflow from the Site area. The effect of operation of the leachate collection system on groundwater levels will be evaluated in detail as part of the groundwater (OU-3) RI/FS.

Because the other landfill units at the Site (*e.g.*, Area 1, Area 2, Closed Demolition Landfill and Inactive Sanitary Landfill) pre-date the formation of MDNR and the associated permitting and regulatory requirements, there are no leachate collection systems within these units.

5.6.2.3 Groundwater Levels and Elevations

Monthly groundwater levels were measured in various wells (Figure 4-11) during the first year of the OU-1 RI investigations (November 1994 through November 1995) and on a quarterly basis from November 1995 through October 1996 during the second year of the OU-1 RI investigations. The depth to water measurements and resulting groundwater elevation data are included in Appendix E-3. Additional groundwater level data were obtained as part of the OU-2 RI effort on behalf of Bridgeton Landfill, LLC and are presented in the *Physical Characterization Technical Memorandum for the West Lake Landfill, Operable Unit 2, Bridgeton, Missouri* prepared by Golder Associates, Inc. (1996a) and the OU-2 RI report (Herst & Associates, 2005). Water level values measured during the 2012 – 2013 groundwater monitoring events are included in Appendix E-3.

Water level data obtained as part of the OU-1 RI field investigation indicate that the depths to groundwater varied from 15 to 20 feet in areas adjacent to the Site. Exceptions were noted in wells MW-103 and MW-104 located along Old St. Charles Rock Road, adjacent to the flood control channel, and in wells I-66 and I-67 located along the northeastern boundary of the Site, adjacent to St. Charles Rock Road. Water level depths in these four wells ranged from approximately 5 to 10 feet bgs. Water levels beneath Areas 1 and 2 varied from 20 to 60 feet bgs. The elevation of the water table is the same (generally ranging from 426 to 433 ft amsl) beneath and outside of Areas 1 and 2, and therefore the difference in the depths to groundwater beneath Areas 1 and 2 compared to areas outside of Areas 1 and 2 is the result of the increased elevation of the surface of the Areas 1 and 2 compared to surrounding areas.

Review of the water level data obtained during the OU-1 RI field investigations (Appendix E-3) indicates that the groundwater elevations near the Site vary seasonally. The lowest groundwater levels occurred during the fall and winter (September through March) while the highest levels occurred during the spring and summer (April through August). These variations are consistent with the variations in precipitation discussed in Section 5.1.2.

The data obtained during the OU-1 RI, the OU-2 RI and the 2012-2013 groundwater monitoring events were combined to evaluate water level changes over time. Appendix J presents well hydrographs (plots of water level elevations over time for each monitoring well) extending back to the earliest data through the October 2013 monitoring event for the various monitoring wells/piezometers. The following discussions present an overview of changes in water levels that have been observed over time within the various hydrogeologic units at the Site.

Alluvium – Alluvial piezometers and monitoring wells were first installed in the western and northern portions of the Site in the 1970s, providing about 35 years of alluvial water level data. Review of the alluvial well hydrographs (Appendix J Figures J-1 through J-76) indicates that alluvial water levels have not changed significantly over time. Alluvial water levels appear to vary up to approximately 20 feet overall (Figure J-1) with variations in individual wells on the order of 5 to 10 feet. These variations reflect variations in precipitation recharge to the alluvial aquifer.

St. Louis / Upper Salem – The St. Louis Formation and upper portion of the Salem Formation were treated as one hydrogeologic unit during the OU-2 RI/FS and continue to be considered so during this current evaluation. The St. Louis/Upper Salem unit is a limestone/dolomite that is present outside and beneath the North Quarry portion of the Bridgeton Landfill and outside the upper portion of the South Quarry portion of the Bridgeton Landfill. St. Louis/Upper Salem piezometer water levels near the North Quarry portion measured during the four 2012-2013) comprehensive groundwater sampling events are not significantly different than the levels observed in 1995 (Appendix J Figures J77-A103). This indicates that the water levels in the St. Louis/Upper Salem near the North Quarry portion of the Bridgeton Landfill had already returned to pre-quarry conditions prior to 1995.

Piezometers numbered in the 100-series installed in St. Louis/Upper Salem Formations near the South Quarry portion of the Bridgeton Landfill show about 40 to 110 feet of water level rise between their installation in 1995 and the most recent measurements obtained in 2013 (Appendix J Figures J78-J92). The largest increases are associated with piezometers closest to the South Quarry portion of the Bridgeton Landfill. The St. Louis/Upper Salem water level rises are considered representative of water levels returning to pre-quarry levels. Comparisons of the water levels in the St. Louis/Upper Salem 200-series piezometers located near but farther away from the South Quarry portion of the Bridgeton Landfill to the water levels in the 100-series piezometers generally show about 20 to 50 feet increases in water levels through time (Appendix J Figures J93-J101). The 200-series piezometers were installed about 100 to 200 feet away from the quarry walls to provide comparison data to the 100-series piezometers installed very near the quarry walls. Most of the St. Louis/Upper Salem piezometers around the South Quarry portion

of the Bridgeton Landfill exhibit water level declines over the period from about 2005 to 2009. Landfilling in the South Quarry portion stopped in January 2005 and intermediate cover was placed at that time and final cover placement was also initiated at that time.

Salem Formation – The Salem Formation is a limestone/dolomite that is present near the bottom portion of the South Quarry portion of the Bridgeton Landfill. Time series graphs presented in Appendix J show about 130 feet of water level rise between the time Salem Formation piezometers were installed in 1995 and the most recent data available in 2013 (Appendix J Figures J104-J108). Dewatering activities associated with South Quarry quarrying operations created a large depression (sink) in the groundwater potentiometric surface in this area. Once quarrying operations ceased, groundwater began to refill the quarry. The Salem Formation water level rises through time are considered representative of water levels returning to pre-quarry activity levels. Note that Salem Formation piezometers located outside of the North Quarry portion of the Bridgeton Landfill (*e.g.*, PZ-100-SD and PZ-111-SD as displayed on Appendix J Figures J105 and J108) show very little change over time. The North Quarry pit was excavated to a shallower depth (approximate base elevation of 320 feet amsl) compared to the South Quarry pit (approximate base elevation of 250 feet amsl), and therefore the Salem Formation near the North Quarry portion of the Bridgeton Landfill was probably little influenced by quarry operations.

Keokuk Formation – Piezometers installed in the Keokuk Formation reach depths of about 400 feet bgs and thus this formation is the deepest unit monitored at the Site. The Keokuk Formation consists of limestone and dolomite and is located beneath about 130 to 150 feet of Warsaw Formation limestone and shale. Given the thickness of material that is present between the bottom of the South Quarry portion of the Bridgeton Landfill and the top of the Keokuk Formation, it is likely that water levels within the Keokuk Formation experienced only a slight influence from the quarry operations and subsequent landfilling in the South Quarry portion of the Bridgeton Landfill. Time series graphs for the Keokuk Formation piezometers display about 30 feet of water level rise between the time the piezometers were installed in 1995 and the 2013 water levels (Appendix J Figures J109 – J112). This rise in water levels suggests that water levels in the Keokuk Formation have responded to the cessation of pumping associated with the former quarry operations, although to a much lesser degree than observed in the overlying Salem and St. Louis Formations.

Missouri River Stage – Surface water level elevations in the Missouri River (river stage) are obtained at the USGS St. Charles stream gauge station (station 06935965) located approximately two miles to the northwest of the Site. The elevation of the Missouri River water surface at this location has varied from approximately 419 to 453 ft amsl between 1984 and 2013 but generally fluctuated between 420 and 440 ft amsl (Figure 5-18).

Table 5-2 presents a summary comparison of the average daily river stage and the range of alluvial water levels measured at the Site over the last 28 years. During the majority of the Site water level measurement events, the river stage was below both the highest and the lowest alluvial water level elevations measured at the Site, with the river stage ranging from 1 foot to

about 7 feet below the lowest alluvial water level elevation measured at the Site. The majority of data therefore indicate that potential groundwater flow within the alluvium is from the Site toward the Missouri River. There are occasions when the river stage, while below the highest alluvial water level, was higher than the lowest water level elevation measured in the Site alluvial wells (for example December 29, 1994, January 30, 1995, April 28, 1995, July 26, 1995, April 3, 1996, and October 2, 1996). Finally, during the 1995 flood event (May and June 1995), the river stage exceeded both the minimum and the maximum alluvial water level elevations measured at the Site. Regardless, during all of these events, the river was contained within the boundaries of the Earth City Flood Control District levee system.

Although there appears to be a correlation between the Missouri River stage data and fluctuations in the alluvial groundwater levels, reflective of responses of both the Missouri River stage and the alluvial water levels to increases in precipitation or a pressure response in the alluvial aquifer relative to increased flow in the Missouri River, there is no indication of groundwater flow from the river towards the Site. Evaluation of water level measurement data obtained during the 1995-1997 OU-1 RI monitoring activities, the 2004 OU-1 and OU-2 FS monitoring activities, and the four 2012-2013 groundwater monitoring events all display a northwestward hydraulic gradient, from the Site toward the river. The reverse condition – that is, higher water levels along the northern or western portions of the Site, potentially indicative of a reversed hydraulic gradient beneath the Site – has never been observed.

5.6.2.4 Hydraulic Gradients

Evaluations of the horizontal and vertical hydraulic gradients were presented in the OU-1 and OU-2 RI reports (EMSI, 2000 and Herst & Associates, 2005). A summary of the evaluation of the hydraulic gradient data evaluated during the OU-1 RI is presented below followed by an evaluation of the hydraulic gradients observed during the 2012-2013 site-wide groundwater monitoring events.

5.6.2.4.1 OU-1 and OU-2 RI Hydraulic Gradient Data (1994-1997)

Review of the OU-1 RI water level data (Appendix E-3) indicates that only a very small amount of relief (less than one foot) exists in the water table surface beneath the Site. The horizontal hydraulic gradients within the alluvial materials are very low, ranging from approximately 0.001 to less than 0.0001 feet per foot. Steeper gradients ranging up to 0.005 or more feet per foot were identified to the south-southwest of the Site. The steeper gradients in this area resulted primarily from higher water levels encountered in several off-site, upgradient monitoring wells (MW-107, S-80, and PZ-300AS) that were present in this area. Groundwater may exist in a perched condition in this area, resulting in artificially high water levels. As these wells are located off-site at distances of approximately one-half mile from the Site boundary, the source of the higher water levels in these wells could not be ascertained from the data available at the time the OU-1 RI was prepared.

Maps of the water table level elevation data obtained during the OU-1 field investigations from the uppermost alluvial and bedrock wells completed beneath and near the Site are presented in Appendix K-1. Contours of lines of equal water table elevation (potentiometric contours) have been included on these maps. Only one consistent feature can be identified from review of these maps – that is, the depression in the water table associated with the ongoing leachate extraction from the Bridgeton Landfill (which was still an active landfill during 1994-1997). Due to the low amount of relief and consequently the extremely low hydraulic gradients present beneath the Site area, other "features" that may be identified on any one of the water table maps are not considered to be significant. These "features" are considered to be artifacts of the contour effort and are not reflective of any particular condition associated with the Site. This is supported by the fact that, with the exception of the water table depression associated with the leachate extraction from the Bridgeton Landfill, the shapes of the various contours are not consistent among the various events. Therefore, the shape of the water table contours should not be strictly interpreted as a representation of the water table. The water table beneath the Site area can best be described as extremely flat with little variation or relief.

Review of the water level data (Appendix E-3) obtained during the 41994-1997 OU-1 RI field investigations from the various clusters of wells completed (screened) at different depths within the alluvium indicates that generally there is little, if any, vertical hydraulic gradient present within the alluvium beneath the Site. Most of the well clusters displayed similar water levels for the shallow, intermediate and deep portions of the aquifer. Slight downward gradients (approximately 0.001 feet per foot or less) were identified in some of the well clusters during some of the monitoring events. Strong downward trends were identified in two well clusters, between wells S-80 and I-50 (which are located off-site to the southwest and upgradient of the Site), and at wells S-82, I-9, and D-93 (which are located along the western boundary of the Site near the Earth City flood control channel). Both of these well clusters displayed strong downward gradients on the order of approximately 0.25 feet per foot for the S-80 / I-50 well cluster to approximately 0.02 feet per foot for the S-82 / I-9 / D-93 well cluster.

Additional information on hydraulic gradients was obtained as part of the 1995-1996 RI/FS effort conducted on behalf of Bridgeton Landfill, LLC for OU-2. The measurements obtained and evaluations performed as part of the OU-2 effort also confirm the presence of flat hydraulic gradients within the alluvial aquifer beneath the Site. Measurements made as part of the OU-2 effort (Golder, 1996a) indicated even lower horizontal hydraulic gradients (on the order of 0.0001 feet per foot or less) than those measured as part of the OU-1 effort. Results of the OU-2 evaluations indicated that the vertical hydraulic gradients for the shallow alluvium to the intermediate or deep alluvium were generally negligible, ranging from very slightly downward to very slightly upward (Golder, 1996a).

Golder (1996a) also obtained information on the horizontal and vertical gradients within the bedrock aquifers beneath the Site as part of the OU-2 RI field investigations conducted in 1995-1996. In general, the regional horizontal gradient within the bedrock formations beneath the Site at the time of the OU-2 RI field investigations, based on water level measurements obtained from

wells completed in the Keokuk Formation, was assumed to be to the west and northwest, towards the Missouri River. In the vicinity of the Bridgeton Landfill, groundwater flow within the Salem and St. Louis Formations during the period of the OU-2 investigations was toward the Bridgeton Landfill in response to residual effects of dewatering during quarry operations and the subsequent leachate collection activities at the sanitary landfill. In general, the horizontal hydraulic gradients within the bedrock formations range from 0.004 to 0.04 feet per foot with the steeper gradients present near the then-active Bridgeton Landfill. Vertical hydraulic gradients were found to be upward, ranging from 0.05 to 0.62 feet per foot upward, from the Keokuk Formation through the Warsaw Shale to the Salem Formation. Downward vertical hydraulic gradients of between 0.03 and 0.38 feet per foot were observed between wells/piezometers completed in the St. Louis and the Salem Formations. Additional information on the bedrock hydrogeologic conditions can be found in the *Physical Characterization Technical Memorandum for the West Lake Landfill, Operable Unit 2, Bridgeton, Missouri* prepared by Golder Associates, Inc. (1996a).

5.6.2.4.2 Hydraulic Gradients Based on 2012-2013 Groundwater Monitoring Events

The following discussions present the results of the evaluations of the horizontal and vertical hydraulic gradients based on the water level data obtained during the four groundwater monitoring events that took place in 2012-2013, which as of the date of this RI Addendum, represent the most recent comprehensive set of Site-wide water level monitoring results. Characterization of the hydraulic gradients based on the most recent monitoring results is appropriate for two reasons. First, the 2012-2013 monitoring events are the only events where water levels were obtained from all of the monitoring wells at the Site at one time. Prior events included collection of water levels from subsets of the various wells at the Site such as the monitoring wells located within or adjacent to Areas 1 and 2 (OU-1 wells), monitoring wells located within or adjacent to the other landfill units (OU-2 wells), or monitoring wells located adjacent to the permitted North and South Quarry portions of the Bridgeton Landfill (Subtitle D monitoring program). Second, characterization of the hydraulic gradients based on the 2012-2013 monitoring events is necessary and appropriate for the evaluation of the water quality results obtained from those groundwater monitoring events.

Horizontal Hydraulic Gradients

Potentiometric (water level) surface maps were prepared for uppermost units, the alluvium and St. Louis Formation/Upper Salem Formation, for each of the four monitoring events. Figures displaying each of these potentiometric surface maps are contained in Appendix K-2.

Alluvium – The alluvial monitoring wells at the Site are completed across only portions of the alluvium, generally the upper (shallow), intermediate and lower (deep) portions of the alluvium. Therefore, the alluvial monitoring wells have been subdivided into shallow (S prefix or AS suffix in the well name), intermediate (I prefix or AI suffix in the well name), and deep (D prefix or AD suffix in the well name) intervals. Shallow interval wells are generally completed near

the top of the water level (the uppermost saturated portion of the alluvium), intermediate wells are generally completed near the middle portion of the alluvial materials at a given location, and the deep wells are generally completed in the lower portions of the alluvial materials. Because the depth and thickness of the alluvial deposits increases from south to north, a direct elevation correlation does not exist such that all deep interval wells are completed at a particular elevation interval. Information regarding the elevations of the screened intervals of the various monitoring wells and piezometers is provided in Appendix E-1.

Figures K-2.1 through K-2.4 contained in Appendix K-2 portray the water levels and inferred potentiometric surfaces for the most recent four site-wide monitoring events for wells previously identified as being completed in the alluvium. Review of the potentiometric surfaces shown on these figures indicates that the direction of hydraulic gradient, and thus the inferred direction of groundwater flow within the alluvium is generally from the southeast toward the northwest, consistent with the regional direction of groundwater flow towards the Missouri River. An exception is a small area within the shallow alluvium near well MW-103 in the western portion of the Site near the Earth City Flood Control Channel. This well consistently shows a relatively low water level elevation compared to the water levels in the other alluvial monitoring wells. The lower water levels observed in well MW-103 may be due to maintenance of relatively low water levels in the stormwater retention pond by the Earth City Flood Protection District, resulting in a localized lowering of the alluvial water level in the immediate vicinity of this pond.

St. Louis / Upper Salem - St. Louis/Upper Salem water levels for the most recent four sampling events conducted as part of the site-wide monitoring effort and the resultant inferred potentiometric contours for the St. Louis/Upper Salem unit are also plotted on Figures K-2.1 through K-2.4 in Appendix K-2. These figures indicate that the potentiometric surface for the St. Louis/Upper Salem in the vicinity of the North Quarry portion of the Bridgeton Landfill displays a hydraulic gradient from the southeast toward the northwest, consistent with the regional direction of groundwater flow towards the Missouri River.

The St. Louis/Upper Salem water levels near the South Quarry portion of the Bridgeton Landfill are affected by the presence of the former quarry and landfilling operations, including leachate extraction (i.e., pumping) from the South Quarry portion of the Bridgeton Landfill.

Summary of Horizontal Hydraulic Gradients

As discussed in the next section of this RI Addendum, the vertical hydraulic gradient within the alluvium ranges from upward to downward to no significant gradient. Given the overall similarity of the water levels and potentiometric surfaces over the depth of the alluvium and the lack of consistent vertical hydraulic gradient within the alluvium, water levels for shallow, intermediate, and deep alluvial wells can be combined and evaluated together. Figures K-2.1 through K-2.4 present the combined potentiometric surfaces for the uppermost saturated units (alluvial deposits and St. Louis Formation/Upper Salem Formation) based on the water level measurements obtained during the four 2012 – 2013 groundwater monitoring events.

As shown on Figures K-2.1 through K-2.4, the direction of the hydraulic gradient, and thus the direction of groundwater flow is generally from the southeast toward the northwest, consistent with regional alluvial groundwater flow towards the Missouri River. Similarly, the direction of the horizontal component of the hydraulic gradient for the St. Louis Formation/Upper Salem Formation also is generally from the southeast to the northwest. The overall northwesterly direction of the hydraulic gradients within these units reflects groundwater flow towards the Missouri River which is located approximately 7,100 feet (one and one-third miles) to the northwest from the nearest point (northwest corner of Area 2) at the Site and 10,900 feet (2 miles) to the northwest from the farthest point (southeast corner of the South Quarry portion of the Bridgeton Landfill) at the Site.

An average hydraulic gradient across the Site can be estimated using well pairs located along groundwater flow lines. Table 5-3 summarizes the water levels and horizontal distances between various sets of alluvial wells and the resultant hydraulic gradients. Based on these calculations, the overall hydraulic gradient for the alluvium beneath the Site during the four 2012-2013 monitoring events was approximately 0.0004 ft/ft.

Further evaluation of groundwater levels at the Site and the hydraulic gradients is expected to occur in conjunction with the OU-3 (Groundwater) RI/FS.

Vertical Hydraulic Gradients

Given the horizontal and vertical distribution of piezometers and monitoring wells at the Site, it is possible to evaluate vertical hydraulic gradients for the following combinations:

- Alluvium – Alluvium;
- St. Louis Formation/Upper Salem Formation – Alluvium;
- Salem Formation - St. Louis Formation/Upper Salem Formation; and
- Keokuk Formation - Salem Formation

Specifically, well hydrographs (water levels over time) have been prepared for each set of co-located wells (well clusters) completed in these various units and are presented on Figures J-113 - through J-129 in Appendix J. In addition, for the various alluvial well clusters and the clusters of alluvial and St. Louis/Upper Salem wells, the water level measurements obtained during the four 2012-2013 groundwater monitoring events and the resultant vertical gradients within the alluvium or between the alluvium and the St. Louis/Upper Salem Formation have been calculated and are presented on Table 5-4. Evaluation of vertical hydraulic gradients, along with the evaluation of horizontal hydraulic gradients and hydraulic conductivity, are key aspects relative to evaluations of groundwater flow directions, the Site water balance (groundwater inflow and outflow), and groundwater flow rates.

Alluvium - Alluvium – There are three clusters that include a deep alluvial piezometer, an intermediate alluvial piezometer, and a shallow alluvial piezometer:

- D-3 / I-4 / S-5
- D-12 / I-11 / S-10
- D-93 / I-9 / S-82

At the D-3 / I-4 / S-5 cluster, data generally indicate a downward hydraulic gradient from the shallow alluvium to the intermediate alluvium, and a downward hydraulic gradient from the intermediate alluvium to the deep alluvium (Table 5-4 and Appendix J Figure J-113). At the D-12 / I-11 / S-10 cluster there is generally no significant hydraulic gradient (Table 5-4 and Appendix J Figure J-114). Based on the results of the 2012-2013 monitoring, water levels in the D-93 / I-9 / S-82 cluster (Table 5-4 and Appendix J Figure J-115) are highest in the deep alluvium and the shallow alluvium, suggesting an upward hydraulic gradient from the deep alluvium to the intermediate alluvium and a downward hydraulic gradient from the shallow alluvium to the intermediate alluvium.[51]

There is one cluster that includes a deep alluvial piezometer and an intermediate alluvial piezometer: D-83 and I-62. At this cluster, the majority of the data indicate a slight downward hydraulic gradient from the intermediate alluvium to the deep alluvium (Table 5-4 and Appendix J Figure J-116).

There are two clusters that include a deep alluvial piezometer and a shallow alluvial piezometer, without an intermediate alluvial piezometer:

- D-6 / S-61
- D-85 / S-84

The D-6 / S-61 cluster generally indicates a downward hydraulic gradient from the shallow alluvium to the deep alluvium (Table 5-4 and Appendix J Figure J-117). The D-85 / S-84 cluster generally indicates an upward hydraulic gradient from the deep alluvium to the shallow alluvium (Table 5-4 and Appendix J Figure J-118).

There are three clusters that include an intermediate alluvial piezometer and a shallow alluvial piezometer:

- I-2 / S-1
- PZ-302-AI / PZ-302-AS
- PZ-304-AI / PZ-304-AS

[51] Historic data for the D-93 / I-9 / S-82 cluster (Appendix J Figure J-115) should be treated with caution, as it was determined relatively recently that D-93 and I-9 had been mislabeled at some point in the past, with D-93 labeled as I-9 and I-9 labeled as D-93. It is unknown when the mislabeling occurred. The wells were properly labeled prior to the most recent 2012-2013 groundwater monitoring events.

The I-2 / S-1 piezometers were apparently destroyed by off-site property development activities sometime after 2004. However, the available data indicate a general downward hydraulic gradient from the shallow alluvium to the intermediate alluvium at this location (Appendix J Figure J-119). The PZ-302-AI / PZ-302-AS cluster generally indicates a downward hydraulic gradient from the shallow alluvium to the intermediate alluvium (Table 5-4 and Appendix J Figure J-120). There are few data points available for the PZ-304-AI / PZ-304-AS cluster; however, available data indicates a gradient that ranges from slightly upward from the intermediate alluvium to the shallow alluvium to no significant gradient (Table 5-4 and Appendix J Figure J-121).

St. Louis / Upper Salem - Alluvium – There are three clusters that include both St. Louis/Upper Salem and alluvial piezometers:

- PZ-113-SS / PZ-113-AD (deep alluvium)
- PZ-115-SS / PZ-114-AS (shallow alluvium)
- PZ-205-SS / PZ-205-AS

At PZ-113-SS (St. Louis/Upper Salem) and adjacent PZ-113-AD (deep alluvium) there is no significant vertical gradient (Table 5-4 and Appendix J Figure J-122). Similarly, at PZ-115-SS (St. Louis/Upper Salem) and adjacent PZ-114-AS (shallow alluvium; deep and intermediate alluvium are absent at this location), there has generally been no significant vertical hydraulic gradient (Appendix J Figure J-123). However, for the period 2005 to 2011, which coincides with the initiation of closure activities at the Bridgeton Landfill, there was a consistent upward hydraulic gradient from the St. Louis/Upper Salem to alluvium at this location (Appendix J Figure J-123). During 2012 and 2013, there once again was no significant vertical hydraulic gradient at this location (Table 5-4). At PZ-205-SS (St. Louis/Upper Salem) and PZ-205-AS (shallow alluvium; deep and intermediate alluvium are absent at this location), there has generally been a downward vertical hydraulic gradient (Table 5-4 and Appendix J Figure J-124).

Salem - St. Louis/Upper Salem – There are four clusters of piezometers that include both a Salem piezometer (-SD) and a St. Louis/Upper Salem piezometer (-SS):

- PZ-100-SD / PZ-100-SS
- PZ-104-SD / PZ-104-SS
- PZ-106-SD / PZ-106-SS
- MW-1204 (screened in the Salem Formation) / PZ-116-SS

Based on the water level time series graphs for these well pairs (Figures J-125 through J-128 in Appendix J), these clusters indicate a downward hydraulic gradient from the St. Louis/Upper Salem to the Salem Formation over most of the period of record, although there are times at each cluster where the data indicate an upward hydraulic gradient from the Salem Formation to the St. Louis/Upper Salem.

Keokuk - Salem – There are four piezometer clusters that include both a Keokuk piezometer (-KS) and a Salem piezometer (-SD):

- PZ-100-KS / PZ-100-SD
- PZ-104-KS / PZ-104-SD
- PZ-106-KS / PZ-106-SD
- PZ-111-KS / PZ-111-SD

The water level time-series graphs (Figures J-125 through J-127 and Figure J-129 in Appendix J) indicate a consistent upward hydraulic gradient from the Keokuk Formation to the Salem Formation (the Keokuk Formation water levels are consistently higher than the Salem Formation water levels). As noted previously, the Keokuk Formation lies below approximately 130 to 150 feet of the Warsaw Formation which appears to act as an aquitard and thereby a confining unit for the Keokuk Formation.

Summary of Vertical Hydraulic Gradients

There is a consistent upward hydraulic gradient from the Keokuk Formation to the Salem Formation. There is a general downward hydraulic gradient from the St. Louis/Upper Salem to the Salem Formation, although there are times when the vertical gradient is upward. Based on the three clusters that include both a St. Louis/Upper Salem piezometer and an alluvial piezometer, there is generally no discernible vertical hydraulic gradient at two of the three clusters, but there is a downward vertical hydraulic gradient at the third cluster. There are three clusters that include a shallow, intermediate, and deep alluvial well. One of these three clusters (D-12, I-11 and S-10) indicates no significant vertical hydraulic gradient, one of the clusters (D-3, I-4 and S-5) indicates a downward hydraulic gradient, and based on limited data, the third cluster (D-93, I-9 and S-82) indicates an upward hydraulic gradient from the deep alluvium to the intermediate alluvium along with a downward hydraulic gradient from the shallow alluvium to the intermediate alluvium. Other alluvial piezometer clusters that include combinations of deep / intermediate, intermediate / shallow, and deep / shallow indicate variable vertical hydraulic gradients ranging from downward to upward to no significant vertical gradient.

Further evaluation of groundwater levels at the Site and the hydraulic gradients is expected to occur in conjunction with the OU-3 (Groundwater) RI/FS.

5.6.2.5 Hydraulic Conductivity and Porosity

Hydraulic conductivity (permeability to water – sometimes referred to simply as permeability) is a measure of the ability of geologic materials (soil and rock) to transmit water in response to a hydraulic (pressure) gradient. Hydraulic conductivity is the principal factor affecting the amounts and rates of groundwater flow in the alluvial and bedrock units. As part of the OU-1 and OU-2 RI, hydraulic properties of the various geologic units present at the Site were measured using a variety of methods including packer testing (use of inflatable packers to isolate

the interval to be tested followed by application of pressure to the interval to be tested and subsequent measurement of the rate of pressure decline over time), slug testing (instantaneous or nearly instantaneous removal of a fixed volume or slug from a well resulting in an immediate lowering of the water level in a well followed by measurement of the rate of water level recovery in the well), and laboratory testing (laboratory measurement of the rate of flow of water through soil or rock samples). Hydraulic conductivity is a directional parameter, meaning that the horizontal hydraulic conductivity is not necessarily the same in all directions (horizontal anisotropy) and that the horizontal and vertical hydraulic conductivity within a particular unit may differ greatly (vertical anisotropy). Due to the presence of stratigraphic layering (*i.e.*, the horizontal bedding) in sedimentary rocks, the horizontal hydraulic conductivity of such units is typically much greater than the vertical hydraulic conductivity.

The results of the hydraulic conductivity tests for each of the various hydrogeologic units at the Site are detailed in the OU-1 and OU-2 RI reports (EMSI, 2000 and Herst & Associates, 2005). The following sections provide a summary of the measured hydraulic conductivity values from these tests.

Keokuk Formation – Constant head injection packer tests were performed in the Keokuk Formation borings made as part of the OU-2 RI/FS. Hydraulic conductivity values ranged from 7.6×10^{-7} centimeters per second (cm/sec) to about 4.3×10^{-5} cm/sec. The geometric mean hydraulic conductivity from the constant head injection packer tests was 9.7×10^{-6} cm/sec. Slug tests were also performed on Keokuk Formation piezometers. The range of hydraulic conductivity from the slug tests was 6.0×10^{-7} cm/sec to 3.8×10^{-6} cm/sec, with a geometric mean value of 2.1×10^{-6} cm/sec.

Warsaw Formation – Constant head injection packer tests were performed by isolating portions of the Warsaw Formation during drilling of the borings that extended into the underlying Keokuk Formation. Hydraulic conductivity values ranged from 2.6×10^{-7} cm/sec to 5.6×10^{-5} cm/sec. The geometric mean hydraulic conductivity for the Warsaw Formation was 2.6×10^{-6} cm/sec. Consistent with the EPA-approved OU-2 RI/FS Work Plan, no piezometers were constructed and completed in the Warsaw Formation as part of the OU-2 RI/FS. Consequently, no *in situ* measurements (slug or packer tests) of hydraulic conductivity of the Warsaw Formation were obtained. Two rock core samples from the Warsaw Formation were laboratory tested for vertical permeability. The mean vertical permeability value from the two tests was 1.3×10^{-10} cm/sec. This value is very low and indicates that the Warsaw Formation is relatively impermeable and as such acts as confining unit (aquitard) between the base of the South Quarry portion of the Bridgeton Landfill and the top of the Keokuk Formation.

Salem Formation – Hydraulic conductivity values obtained from constant head injection packer tests in the Salem Formation ranged from 5.8×10^{-8} cm/sec to 2.5×10^{-5} cm/sec, with a geometric mean of 1.6×10^{-6} cm/sec. Slug tests performed on Salem Formation piezometers were evaluated using two different techniques – the Hvorslev method and the Bower & Rice method (refer to the OU-2 RI Report for details). The Hvorslev method yielded hydraulic conductivity values that ranged from 1.0×10^{-7} cm/sec to 1.8×10^{-5} cm/sec, with a geometric

mean value of 8.4 x 10^{-7} cm/sec. The Bower & Rice method yielded hydraulic conductivity values that ranged from 6.8 x 10^{-8} cm/sec to 1.2 x 10^{-5} cm/sec, with a geometric mean value of 6.9 x 10^{-7} cm/sec. The two evaluation methods yielded hydraulic conductivity results that were similar to each other, as well as similar to the packer test results.

St. Louis / Upper Salem – Constant head injection packer tests performed on the saturated intervals of the St. Louis/Upper Salem materials resulted in hydraulic conductivity values that ranged from 3.7 x 10^{-7} cm/sec to 4.4 x 10^{-6} cm/sec. The geometric mean hydraulic conductivity value for the saturated portion of the St. Louis/Upper Salem Formation was 9.6 x 10^{-7} cm/sec. Slug tests performed in St. Louis/Upper Salem materials yielded a geometric mean of 3.0 x 10^{-6} cm/sec (Hvorslev, 1951) and 1.2 x 10^{-6} cm/sec (Bower & Rice, 1976), which are similar to each other and similar to the geometric mean value obtained from the packer tests.

Alluvium – Packer tests are applicable to rock materials but not unconsolidated materials. Accordingly, packer tests were not performed in alluvium. Slug tests were performed in alluvial piezometers.

Aquifer testing performed as part of the OU-1 RI investigations consisted of performing slug tests on 12 newly constructed alluvial wells and six of the pre-existing alluvial wells, including six shallow alluvial wells, six intermediate alluvial wells, and six deep alluvial wells. Data were evaluated using the Bower & Rice method. Details are provided in the *Groundwater Conditions Report, West Lake Landfill Radiological Areas 1 and 2* (McLaren/Hart, 1996g). The hydraulic conductivity of the shallow alluvial materials (average of 8 x 10^{-3} cm/sec) is slightly less than the average hydraulic conductivity results obtained from the intermediate and deep monitoring wells (4 x 10^{-2} cm/sec) (EMSI, 2000). Therefore, an overall value of 3 x 10^{-2} cm/sec (which is equivalent to 85 ft/day) is considered representative of the hydraulic conductivity of the alluvial aquifer.

Slug tests performed as part of the OU-2 RI investigations (Herst & Associates, 2005) indicated that the geometric mean hydraulic conductivity values for the deep alluvium were 6.7 x 10^{-4} cm/sec (Hvorslev method) and 5.0 x 10^{-4} cm/sec (Bower & Rice method). For the intermediate alluvium, the geometric mean hydraulic conductivity value was 1.8 x 10^{-2} cm/sec (Hvorslev method) and 1.2 x 10^{-2} cm/sec (Bower & Rice method). For shallow alluvium, the geometric mean hydraulic conductivity value was 2.5 x 10^{-3} cm/sec (Hvorslev method) and 3.9 x 10^{-3} cm/sec (Bower & Rice method). Undisturbed and remolded samples of alluvial materials were subjected to vertical permeability testing in the laboratory. The vertical permeabilities of the undisturbed alluvial samples ranged from 3 x 10^{-4} cm/sec to 3 x 10^{-7} cm/sec, with a geometric mean value of 2.2 x 10^{-6} cm/sec. Two remolded samples yielded vertical permeabilities of 2 x 10^{-7} cm/sec and 3 x 10^{-7} cm/sec. The difference between the results of the *in-situ* measurements (slug tests) of the horizontal hydraulic conductivity and the laboratory tests of the vertical hydraulic conductivity of the alluvium reflect a difference in the scale of the tests (*i.e.*, volumes of material tested) and the inherent vertical anisotropy of sedimentary materials which results in greater rates of groundwater flow in the horizontal plane compared to the vertical direction.

No direct measurements of the porosity of the alluvium or the bedrock formations were obtained as part of either the OU-1 and OU-2 efforts (owing to the difficulty of performing these types of measurements). Typical total porosity values for unconsolidated sand deposits range from 25 to 50% (Freeze & Cherry, 1979). The effective porosity for groundwater flow cannot be measured directly but for unconsolidated, unconfined aquifers is often approximated as being equivalent to the specific yield. The typical range of specific yield values for unconfined aquifers is from 1 to 30%. As a result, the effective porosity for groundwater flow in the alluvial aquifer is assumed to range from 20 to 30%.

5.6.2.6 Groundwater Flow Directions

Generalized interpretations of the primary direction of groundwater flow can be made based on the water level data obtained from the Site monitoring wells and the location of the Site relative to the Missouri River and its associated alluvium. Based on these conditions, the general direction of alluvial groundwater flow in the vicinity of the Site appears to be to the northwest, parallel to the river valley and the general direction of river flow in this area (Appendix K Figures K-2.1 through K-2.4).

In addition to the general direction of groundwater flow to northwest, the following factors influence localized groundwater flow in the alluvium beneath Areas 1 and 2:

- Dewatering effects associated with the former limestone quarry and the current Bridgeton Landfill leachate collection activities;
- The presence of low permeability cap (ethyl vinyl alcohol – EVOH) installed over the South Quarry and portions of the North Quarry of the Bridgeton Landfill;
- Infiltration and localized ponding of stormwater on the surface of the Site;
- Infiltration through various drainage ditches located on and off of the Site; and
- The water level in the Earth City flood control channel located on the western margin of Area 2.

As a result, localized variations to this general direction of groundwater flow exist in the area of the Site. For example, groundwater flow observed beneath Area 1 during the period the OU-1 RI investigations were performed (1994-1996) appeared to occur primarily in a southern direction toward the Bridgeton Landfill (see Appendix K Figures K-1.1 through K-1.4). More recently, groundwater flow beneath the majority of Area 1 (all except the southernmost portion) has been to the northwest, consistent with the overall regional direction of groundwater flow (see Appendix K Figures K-2.1 to K-2.4). Groundwater flow observed beneath Area 2 during the OU-1 RI (1994-1996) was generally to the north-northwest, consistent with the overall regional groundwater flow direction. With the exception of the immediate areas of the North and South

Quarry portions of the Bridgeton Landfill, where an inward gradient appears to exist, groundwater flow beneath the remainder of the Site is toward the northwest, consistent with the overall regional direction of groundwater flow towards and subparallel to the Missouri River.

5.6.2.7 Groundwater Velocity

The velocity (rate) of groundwater flow can be estimated using the following equation (Freeze & Cherry, 1979):

$$V = Ki / n_e$$

Where:

V = the velocity of groundwater flow (ft/day);
K = the hydraulic conductivity (ft/day);
i = the hydraulic gradient (ft/ft); and
n_e = the effective porosity (%).

The velocity of groundwater flow within the alluvium beneath the Site was estimated based on the values for the various hydraulic properties described earlier (Table 5-5). The resulting estimate of the velocity of groundwater flow within the alluvium beneath the Site is approximately 0.11 to 0.23 ft/day or 41 to 83 ft/year.

These estimates are sensitive to the parameter values used. Based on a range of potential possible values for the various aquifer parameters, the groundwater velocity within the alluvial aquifer could range from a low of approximately 0.028 ft/day to a high of 0.91 ft/day if the minimum and maximum range of values for hydraulic conductivity and hydraulic gradient are used are paired together for these calculations. It is highly unlikely that such a situation would occur because as the hydraulic conductivity increases, the resistance to flow decreases and consequently the potentiometric surface becomes flatter and the hydraulic gradient typically decreases. Conversely, as the hydraulic conductivity decreases, the resistance to flow increases and the hydraulic gradient increases. Therefore, pairing the maximum hydraulic conductivity value with the maximum hydraulic gradient value, or conversely pairing the two minimum values together to estimate the groundwater velocity results in values that are likely to be unrealistic.

5.6.2.8 Groundwater Flux

One key aspect of the conceptual site model is evaluation of the groundwater flux within the alluvium. Groundwater flux is the term used to describe the volume of groundwater flow through a particular formation over a given period of time. Evaluation of groundwater flux within a particular geologic unit is a standard part of development of a conceptual hydrogeologic

model – in particular, the evaluation of recharge and discharge of water into and out of a particular hydrogeologic unit. The flux of groundwater also controls the concentrations of any contamination that may leach from the solid waste units into the groundwater.

Groundwater flux into, out of, or through a particular geologic unit is equal to the hydraulic conductivity multiplied by the hydraulic gradient multiplied by the cross-sectional area of groundwater flow (*i.e.*, the flux through a vertical plane). Specifically, the amount of groundwater flowing beneath the Site (groundwater flux) can be approximated from the following equation (Freeze & Cherry, 1979):

$$Q = K\ i\ A$$

Where:

Q = the flux of groundwater beneath the Site (ft^3/day);
K = the hydraulic conductivity (ft/day);
i = the hydraulic gradient (ft/ft); and
A = the saturated cross-sectional area (ft^2).

The groundwater flux (mass of groundwater) flowing through the alluvial aquifer beneath the Site is approximately 10,200 cubic feet per day (ft^3/day) or 76,000 gallons per day (gpd) (Table 5-6). These estimates are sensitive to the parameter values used. Based on a range of potential possible values for the various aquifer parameters, the groundwater flux could range from 5,100 ft^3/day up to 20,400 ft^3/day reflecting a 50% decrease in the values up to a 50% (saturated thickness) or 100% (hydraulic conductivity and hydraulic gradient) increase in the individual parameter values used in this calculation.

5.6.3 Groundwater Use/Water Supply Wells

Registered private water supply wells were identified using two databases maintained by MDNR. One of the MDNR databases includes wells installed in November 1987 or later, while the second database includes wells installed prior to November 1987. For wells installed in November 1987 or later, the MDNR's Well Information Management System (WIMS)[52] was used. For wells installed before November 1987, data from the MDNR's Water Resources Center was used.[53] Pre-November 1987 wells are identified by a 6-digit numerical "log number." Post-November 1987 wells are identified using a 7-digit numerical "reference number."

The WIMS database contains both groundwater monitoring and water supply wells that have been registered with the MDNR through certification by a state-permitted driller. Registration is

[52] http://dnr.mo.gov/mowells/publicLanding.do
[53] http://www.dnr.mo.gov/env/wrc/logmain/index.html

required for newly installed wells. The WIMS online search service was searched for wells by latitude and latitude. Each latitude-longitude second (1 mile by 1 mile square) that lies wholly or partially within a 2-mile radius of the West Lake Landfill Superfund Site boundary was entered as a search parameter. Wells flagged as "Abandoned" or "Monitoring" were excluded. For each identified water supply well, the WIMS provides a copy of the MDNR well registration form. These forms are not scanned versions of the original, driller-submitted forms, but appear to be based on templates filled out by the MDNR. The well registration form includes construction information, and often (but not always) some limited geological information. However, not all wells in the WIMS include geospatial data, and therefore some wells may not be identified using the search method that was employed.

For wells installed before November 1987, the Water Resources Center prepares maps and summaries for each Missouri county illustrating the locations and log numbers of wells drilled before 1987. Maps from the Water Resources Center do not appear to differentiate between monitoring and supply wells, but the text summaries include notations regarding the purpose and status of some of the individual wells. The St. Louis County map was used to identify wells that lie within a 2-mile radius of the West Lake Landfill Superfund Site boundary. Wells were excluded if the Water Resources Center notations indicated the well was abandoned or drilled for geologic or hydraulic testing/characterization purposes. For each identified supply well that met the above criteria, the Water Resources Center's search function was used to retrieve a scanned copy of the original borehole log diagram, which in some instances includes construction information.

A map of the locations of water supply wells located near the Site, including both post-November 1987 wells and pre-November 1987 wells identified using the above methods, is provided as Figure 5-19. In summary, the information presented on the map includes:

- Post-November 1987: Registered water supply wells in the MDNR WIMS database as of 2014 which have latitude and longitude data and lie within 2 miles of the Site boundary (excludes wells designated by MDNR as abandoned or monitoring wells); and

- Pre-November 1987: Water supply wells identified by the MDNR Water Resources Center which lie within 2 miles of the Site boundary (excludes wells designated by MDNR as abandoned or test/characterization wells).

Table 5-7 summarizes the available information from the Water Resources Center databases about each of these wells. Overall, the wells located to the north and west of the Site (*i.e.*, downgradient) are used for industrial and commercial purposes such as irrigation, construction, and dewatering (levee system operations). None of the wells are used to provide domestic or community (potable) water supplies.

In 2013, EPA requested assistance from the USGS to identify private wells located in the area of the Site. Based on this evaluation, in July 2013 EPA collected samples from six private wells located to the north of the Site that are completed within the Missouri River alluvium. In

October 2013, USGS, on behalf of EPA, collected samples from five private wells including two alluvial wells and one bedrock well located to the south of the Site, and two bedrock wells located in St. Charles County. Herst & Associates, Inc., was retained by EMSI to collect split samples of the USGS samples. The analytical results for the private well samples obtained by EPA, USGS and Herst & Associates, Inc. are contained in Appendix F-5.

5.7 Subsurface Reaction in the South Quarry portion of the Bridgeton Landfill

Bridgeton Landfill, LLC has been addressing a subsurface reaction (SSR) that is occurring in a portion of the South Quarry of the permitted Bridgeton Landfill. In December 2010, Bridgeton Landfill, LLC detected changes in the landfill gas extraction system; specifically, elevated temperatures and elevated carbon monoxide levels (Bridgeton Landfill, LLC, 2013a). Further investigation indicated that the South Quarry portion of the Bridgeton Landfill was experiencing an exothermic (heat-generating) subsurface chemical reaction or event (Bridgeton Landfill, LLC, 2013a).

This exothermic reaction has resulted in elevated temperatures and accelerated decomposition of waste. The highest temperatures have been documented in the zone of 80-150 feet below the South Quarry landfill surface, which is considered to be the primary location of the reaction. This reaction has previously been called a "Subsurface Smoldering Event (SSE)" or by some as a fire. The current understanding of the nature of the reaction, however, is that it is occurring within saturated landfill materials in the absence of oxygen, which indicates that it is not a result of a fire or smoldering (combustion). Accordingly, current references are to an SSR, or subsurface reaction, rather than using the prior SSE terminology. Unlike a fire, the SSR has not produced visible smoke or flames.

The fill within the South Quarry of the Bridgeton Landfill is deep and, as a result, contains dense, compact waste with very little pore space. This condition results in (1) slow heat dissipation (*i.e.*, heat is retained much in the same way insulation holds heat), (2) confinement of pressure caused by water to vapor phase changes, and (3) slowing of the movement of the heat front and propagation of the SSR.

Bridgeton Landfill, LLC has implemented measures to address the occurrence of the SSR, such as installation of an ethylene vinyl alcohol cover, installation of additional landfill gas extraction wells, including dual extraction wells for extraction of leachate and gas, installation and monitoring of temperature probes, and other activities.

Movement of the areas with the highest reaction rates can be tracked over time based on observation of the surface settlement in the South Quarry portion of the Bridgeton Landfill. Historically, only the South Quarry portion of the Bridgeton Landfill has been regularly monitored for surface settlement. Figure 5-20 presents the areas of observed surface settlement within the South Quarry portion of the Bridgeton Landfill over time. Placement of backfill has

also occurred, and this has been accounted for during the course of the monitoring of the surface elevation of the South Quarry portion of the Bridgeton Landfill.

Based upon recent observations, including settlement monitoring, the SSR has moved through portions of the South Quarry and currently appears to be active in the southern portion of the South Quarry. Based on the sequencing of the settlement occurrences, the SSR has migrated from an initial location in the eastern portion of the South Quarry in a counterclockwise direction to the north, then to the west and, most recently, to the southern portion of the South Quarry.

In response to a request from EPA, the OU-1 Respondents conducted an evaluation of possible impacts if an SSR[54] were to occur in Areas 1 or 2 of the West Lake Landfill (EMSI, 2014c). Per an additional request from EPA, Bridgeton Landfill, LLC also evaluated potential options for construction of a thermal isolation barrier (IB) between the North Quarry portion of the Bridgeton Landfill and the adjacent Area 1 of the West Lake Landfill (EMSI et al., 2014b). This report also included an evaluation of the potential impacts if an SSR were to occur in Area 1. Both of these reports concluded that the primary potential impact if an SSR or other type of heat-producing reaction were to occur in Area 1 might be a temporary, localized increase in radon exhalation (emission from the ground surface).

Per EPA's original request, the SSR evaluation (EMSI, 2014c)[55] included only a qualitative evaluation of the potential impacts of an SSR on the ROD-Selected Remedy and therefore did not include a calculation of a potential increase in radon emissions if an SSR were to occur in Area 1. Calculations of the amount of additional radon (if any) that may be emitted from any RIM that may remain on the south side of an IB were subsequently developed for Bridgeton Landfill, LLC by Auxier (Auxier and EMSI, 2016a). EPA is still reviewing these documents.

The Phase 1 investigation was initiated to support evaluation of the location of a potential thermal IB along the southern margin of Area 1, and was subsequently expanded to include an assessment of the extent of RIM in this area. Separately, Bridgeton Landfill, LLC has also been conducting a pilot-scale heat removal test in the northern portion of the Bridgeton Landfill South Quarry to assess the potential effectiveness of heat removal on limiting any potential migration of the reaction from the South Quarry portion of the Bridgeton Landfill (FEI, 2015a and 2015b).

On April 28, 2016, EPA issued an Administrative Settlement Agreement and Order on Consent (ASAOC) to Bridgeton Landfill, LLC that requires, among other things:

1. preparation of a work plan to use inert gas injection as a "hot spot" treatment option to suppress or contain any independent SSR that may occur within the "neck area" between the South and North Quarry portions of the Bridgeton Landfill;

[54] This was referred to as an SSE in this report.
[55] This was referred to as an SSE in this report.

2. preparation of a work plan for the placement of an ethylene vinyl alcohol (EVOH) cover over the North Quarry portion of the Bridgeton Landfill;

3. implementation of a heat extraction system in the neck area of the Bridgeton Landfill; and

4. installation of additional subsurface temperature monitoring probes (TMPs) between the neck area and Area 1 of the West Lake Landfill (EPA, 2016, and FEI, 2015a and 2016).

Bridgeton Landfill, LLC is currently working to implement the requirements of the ASAOC. As of the date of this draft of the RIA, the Inert Gas Injection Work Plan has been submitted and is undergoing EPA review. Engineering plans have been prepared for installation of the EVOH cover over the North Quarry and installation activities have been initiated. A heat extraction system has been installed and is currently operating in the neck area between the North and South Quarry portions of the Bridgeton Landfill, and additional TMPs have been installed in the North Quarry between the neck area and Area 1.

6. NATURE AND EXTENT OF RADIOLOGICALLY-IMPACTED MATERIALS

This section presents information regarding the definition of RIM, the potential sources of the radionuclide occurrences at the Site, the location, extent and composition of the RIM contained within the landfilled wastes in Areas 1 and 2, and the nature and extent of radionuclide occurrences in the Buffer Zone and Crossroads Lot 2A2 (former Ford property). Discussions of the extent of radionuclides in environmental media (e.g., groundwater, air) and evaluation of past migration or potential for future migration of radionuclides from Areas 1 and 2 are presented in the next section (Section 7). Discussion of chemical (non-radiological) occurrences in the waste materials in Areas 1 and 2 and the environmental media near Areas 1 and 2 is presented in Section 8.

Radionuclides have been detected in the soil and waste materials in Areas 1 and 2. The predominant radionuclides that occur in Areas 1 and 2 are thorium-230 and radium-226 of the uranium-238 decay series and their associated decay products. Radionuclides such as uranium, thorium and radium (and their associated decay products) are naturally occurring elements in soil and rock as the result of radioactive decay, or the release or transfer of excess energy of the parent radionuclides U-238 and Th-232 (EPA, 2005a). These elements are naturally present in soil, water, sediment and air in the environment; however, they have been detected at levels above background in the soil and waste materials in Areas 1 and 2. As a result of their initial placement and subsequent anthropogenic and natural processes, the radionuclides are present within a matrix of soil and solid waste materials. For purpose of this report, the mixture of soil and solid waste in Areas 1 and 2 that contains radionuclides is referred to as radiologically-impacted material (RIM).

The occurrence, distribution and volume of RIM in Areas 1 and 2 has been the subject of extensive field investigations, sampling and laboratory analyses, and engineering evaluations, as summarized in the NRC report (RMC, 1982), the OU-1 Soil Boring/Surface Soil Investigation Report (McLaren/Hart, 1996h), the OU-1 Remedial Investigation Report (EMSI, 2000), the OU-1 Feasibility Study (EMSI, 2006a), the EPA's Record of Decision for OU-1 (EPA, 2008a), the Supplemental Feasibility Study (EMSI, 2011), the Bridgeton Landfill Thermal Isolation Barrier Investigation Phase 1 Report (FEI et al., 2014a), and the Comprehensive Phase 1 Report (EMSI et al., 2016b), among others. The presence of RIM and the associated occurrences of uranium, thorium and radium isotopes and their related decay (daughter) products in soil/waste, surface water and sediment, groundwater, and air at the Site has been a primary focus of prior Site investigations and monitoring activities.

6.1 Potential Sources of Radionuclides in Areas 1 and 2

Radionuclides have been identified in soil within the solid waste materials in two areas at the West Lake Landfill OU-1 Site. These two areas have been designated as Area 1 and Area 2 (Figure 3-5). Area 1 encompasses an approximately 17.6-acre portion of the Site immediately to the southeast of the main entrance road. Area 2 encompasses an approximately 47.8-acre portion

of the Site along the northern, northeastern, and northwestern Site boundaries (Figure 3-5). Various investigations and evaluations of radionuclide occurrences at West Lake Landfill (RMC, 1982, NRC, 1988, McLaren Hart, 1996h, and EMSI, 2000, 2006a and 2011) identified these same two areas as locations where RIM is present at the Site. Radionuclides were also previously detected in soil on the Buffer Zone and Crossroads Lot 2A2 (see additional discussion in Section 6.7 below). Together, Area 1, Area 2, the Buffer Zone and Lot 2A2 make up OU-1 of the West Lake Landfill Superfund Site.

The NRC reported (NRC, 1976 and 1988) that disposal of radioactive materials mixed with soil occurred at the West Lake Landfill during 1973. Reportedly, approximately 8,700 tons of leached barium sulfate residues (LBSR) were mixed with approximately 39,000 tons of topsoil from a site located at 9200 Latty Avenue in Hazelwood, MO (the Latty Avenue Site) and subsequently transported to the West Lake Landfill over a three-month period from July 16 through October 9, 1973 (EPA, 2008a; NRC, 1976 and 1988; and RMC, 1982).

The LBSR was derived from uranium ore processing at the Mallinckrodt facility in downtown St. Louis. The generation of the LBSR was described by Harrington and Ruehle (Harrington, C. D. and Ruehle, A. E., 1959, Uranium Production Technology, Mallinckrodt Chemical Works, St Louis, MO, Chapter 3). The LBSR originated from Belgian Congo ore processed at the Mallinckrodt facility in downtown St. Louis. This ore underwent intense leaching using hot, concentrated nitric acid, resulting in a liquid nitric acid solution that contained soluble and highly mobile radionuclides. The first treatment that this solution underwent was the addition of sulfuric acid to precipitate radium and lead sulfates and the production of the “K-65” material. This action was undertaken to concentrate the majority of the soluble radium and lead. The now radium-depleted solution was then further subjected to additional treatment: the addition of barium carbonate to remove sulfate and residual dissolved radium in the co-precipitation of crystalline barium sulfate. These treatment steps were conducted to remove sulfate ions, which also served to reduce the non-uranium radiological content of the extracted ore, thereby reducing the exposure risk to workers who were involved in further processing the uranium-bearing solution.

Previously processed and “unleached” barium sulfate residues were subsequently brought back from the Northern St. Louis storage site for further processing involving additional hot nitric acid and hot sodium carbonate- and sodium bicarbonate-based leaching, which removed even more of the uranium. The LBSR, therefore, is a chemically solidified and stabilized treatment product (EPA 1987), *Removal of Barium and Radium from Groundwater*, Environmental Research Brief, EPA/600/M-86/021, 8 p.).. Prior to 1966, these materials were stored by the Atomic Energy Commission (AEC) on a 21.7-acre tract of land in a then-undeveloped area of north St. Louis County now known as the St. Louis Airport Site (SLAPS) (EPA, 2008a, NRC, 1988 and RMC, 1982). The LBSR, along with certain uranium processing residuals, reportedly were moved from SLAPS to the nearby Latty Avenue Site in 1966 (NRC, 1988). Most of the uranium and radium had previously been removed from the LBSR in multiple extraction steps (EPA, 2008a and NRC, 1988) and the LBSR reportedly contained only approximately 0.05% to 0.1% of uranium (NRC, 1976 at page 2). These extraction processes were very aggressive (Harrington

and Ruehle, 1959). The effectiveness of the uranium removal is demonstrated by the fact that, of all of the materials at the Latty Avenue Site, the LBSR is the only material not transported for onward processing and further uranium recovery.

6.1.1 RIM-Containing Material Sent to West Lake Landfill from Latty Avenue Site

In its March 14, 2017 comments to the draft Remedial Investigation Addendum (RIA), the EPA directed the West Lake Landfill Superfund Site Respondents (Respondents) to elaborate on the nature, source, and composition of the leached barium sulfate residues (LBSR) mixed with topsoil that was reportedly transported from 9200 Latty Avenue in Hazelwood, MO (the Latty Avenue Site or Latty Avenue) to the West Lake Landfill over a three-month period from July 16 through October 9, 1973.[56]

Respondents cannot provide a comprehensive estimate of the volume or precise chemical nature of the contaminants found in the Latty Avenue soils, as this information is known only by Mallinckrodt and Department of Energy (as successor to the AEC), who generated those materials. With those limitations, however, a review of historical aerial photography and contemporaneous documentation has provided the basis for analysis of the potential transport of radiologically impacted materials (RIM) to the West Lake Landfill between late July and early October 1973. Elements of this analysis are described as follows:

During the second half of 1966, certain AEC production residues generated by Mallinckrodt at its St. Louis Downtown Site (SLDS) and stored at the St. Louis Airport Site (SLAPS) were purchased by Continental Mining and Milling Co. (Continental), transferred to the Latty Avenue Site, and placed into five discrete but contiguous piles east of the Latty Avenue Site buildings on natural ground surface (*see* April 22, 1967 aerial photograph). Those materials included Belgian Congo Ore Raffinate Cake, Colorado Concentrate Raffinate Cake, Unleached Barium Sulfate Residue, Leached Barium Sulfate Residue, and C-Liner Slag.

After foreclosure and purchase of those materials by Commercial Discount Corporation (CDC), certain of those materials were sold to Cotter Corporation (N.S.L.) (Cotter) in June 1967, FOB its processing plant in Cañon City, Colorado ("Cañon City"), for purposes of recovery of precious metals (*e.g.*, copper).[57] Cotter's knowledge of what was in these materials was based on the description in the 1960 request for proposal issued by the AEC and the contracts with CDC.

The Unleached Barium Sulfate Residue and C-Liner Slag were white in color, and were easily distinguishable from the underlying soil at the Latty Avenue Site. A stereoscopic inspection (Appendix O-2) of aerial photography from March 7, 1968 (which shows that the elevation of

[56] *See* United States Environmental Protection Agency, Comments II and IV to the draft Remedial Investigation Addendum, March 14, 2017.
[57] Residue Purchase Agreement, between Commercial Discount Corporation (Seller) and Cotter Corporation (N.S.L.) (Buyer), June 9, 1967. The LBSR was excluded from this initial purchase. *Id.*

the Latty Avenue Site where those piles had previously been located is slightly lower than the surrounding area) demonstrates that those piles had been substantially removed from the Latty Avenue Site (and according to Cotter's contract with CDC, transferred to Cotter's Cañon City facility) along with potentially impacted surface soils in contact with those materials by that date.

CDC shipped Belgian Congo Ore Raffinate Cake (AM-7) and Colorado Concentrate Raffinate Cake (AM-10) to Cotter's Cañon City facility between September 1967 and November 1968. On December 29, 1969, Cotter entered into a contract with CDC and the next day obtained an AEC license for the remaining process residues (which included the LBSR). Cotter subsequently entered into a contract with B&K Construction Co. on July 20, 1970, which resumed drying and transfer of AM-7 and other remaining materials to Cañon City.[58]

Cotter, through its contractor, removed soil cleanup material from the AM-7 area (including soils beneath the AM-7 piles), as demonstrated by aerial photographs (Appendix O-2). Specifically, the contractor:

- excavated a trench (see May 4, 1971 aerial photo) to establish the depth of AM-7 pile subsidence; and

- removed additional AM-7 materials to below grade elevations (see depressions in May 4, 1973 aerial photo) to collect remaining AM-7 material that had subsided below ground surface for transport to Cotter's plant (Appendix O-2).

The use of scrapers provides an effective technique for accomplishing this objective without removing significant amounts of underlying soil.

After evaluating both on-site and off-site options for disposal of the remaining AM-10 and LBSR, the remaining AM-10 was shipped by rail to Cañon City, and the LBSR was mixed with on-site surface and stockpiled soils in the southern area of the Latty Avenue Site and was hauled via truck to the West Lake Landfill from late July through early October, 1973. Cotter informed the AEC that the LBSR, along with 38,000-39,000 tons of soil removed from the top 12-18 inches of the Latty Avenue Site, had been removed from that site and disposed of in a St. Louis sanitary landfill.[59]

From this chronology, it is concluded that potential RIM-impacted materials hauled to West Lake consisted of a mixture of:

- an estimated 8,700 wet tons of leached barium sulfate residue;

[58] Bill of Sale, Commercial Discount Corporation to Cotter Corporation (N.S.L.), December 29, 1969; Residue Drying Agreement between B&K Construction Co. and Cotter Corporation (N.S.L.), July 20, 1970.
[59] AEC Investigation Report, No. 040-8035/74-01, May 17, 1974.

- approximately 39,850 tons (the remainder of the total 48,550 tons brought to West Lake Landfill, based on the trucking company weight tickets) of Latty Avenue Site soils, consisting of: (i) on-site stockpiled soil; (ii) surface soils from unimpacted areas south of the former residue piles; and (iii) surface soils scraped from the areas formerly occupied by residue piles.

While these cleanup activities were in progress, new top-soil from off-site sources was delivered to the Latty Avenue Site[60] and initially stockpiled in the area of the former AM-7 pile (see initial topsoil piles on northern area of the Latty Avenue Site in September 19, 1973 aerial photo). After dismantling and shipping the drying equipment and remaining debris to Cañon City and restoring the on-site buildings (subsequent to the removal of the materials to West Lake Landfill),[61] the imported topsoil was spread over the Latty Avenue Site and graded (see May 6, 1974 aerial photo).

Following these decontamination efforts, a radiation monitoring survey of the Latty Avenue Site was performed in April 1974, demonstrating that all values of gross activity recorded were below the allowable level of 0.6 MR/hr.[62] The highest residual activities below that level were found to occur around the former dryer buildings, along the on-site railroad spur (used to ship the materials to Cañon City), and at the perimeter fence line.[63] Accordingly, a certification was submitted to the AEC that Cotter no longer possessed any radioactive source material under its License No. SUB-1022, and license termination was requested.[64] That request was granted by the AEC later in the year.[65]

Although no items of noncompliance with NRC requirements were found during a subsequent investigation of the West Lake disposal, the agency arranged for a survey of the Latty Avenue Site by the Oak Ridge National Laboratory ("ORNL") in June 1977.[66] At the time of that survey, the Latty Avenue Site buildings were being prepared by the current owner for subsequent manufacture of chemical coatings. The survey concluded that surface contamination of the property by radionuclides exceeded the strictest of then-applicable NRC guidelines for release of property for unrestricted use.[67]

[60] September 19, 1973 aerial photography.
[61] *Id.*
[62] Ryckman, Edgerley, Tomlinson and Associates, Inc., Radiation Monitoring Survey, May 1, 1974.
[63] *Id.*
[64] Edward J. McGrath Letter to AEC, Cotter Corporation, Source Material License No. SUB-1022, May 10, 1974.
[65] L.C. Rouse, Chief, Directorate of Licensing, AEC. Letter to Cotter, November 13, 1974.
[66] James G. Knight, Letter to Missouri Department of Natural Resources, June 10, 1977.
[67] Oak Ridge National Laboratory, Interim Report, Radiological Survey of the Property at 9200 Latty Avenue, Hazelwood, Missouri, September 1977.

6.1.2 West Lake Landfill

No contemporaneous reports, drawings or other records from the former Site operators are currently known to exist regarding the construction of the disposal units or the overall types and amounts of wastes that were disposed in the Area 1 and Area 2 landfills during their operation. Several industrial wastes such as foundry sands, coal-fired power plant ash and stack residues, and petroleum drilling wastes are also known to contain radionuclides, although Respondents are not currently aware of any information indicating that any of these types of wastes were disposed at the Site. Radionuclides can also be present in municipal solid waste (MSW).

The radiologically impacted materials within Areas 1 and 2 are intermixed with decomposed MSW within portions of the overall matrix of landfilled solid waste materials, debris and fill materials, and unimpacted soil and quarry spoils in portions of Area 1 and Area 2. According to a report prepared by the NRC, "The manner of placing the 43,000 tons of [soil mixed with LBSR] in the landfill caused it to be mixed with additional soil and other material so that now an appreciably larger amount is involved." (NRC, 1988). In light of the standard MSW operating procedures at that time, it is assumed that the soil mixed with LBSR was most likely used as landfill cover material. Operation of MSW landfills requires placement of soil cover over exposed waste at the end of each day; soil is placed over the compacted but still irregular, non-uniform surface of the disposed waste, resulting in a relatively discontinuous layer of variable thickness. Furthermore, the surface of an active landfill is not flat, but rather is sloped to allow for better compaction of the waste material. Consequently, soil cover material placed over waste materials in an MSW landfill is not a discrete definable layer even when it is initially placed, but rather consists of small areas of irregular sloping surfaces of variable soil thickness. The initial discontinuous nature of the soil cover material is further disrupted during the placement and compaction of additional MSW and other soil material over the top of and adjacent to previously placed waste materials.

NRC noted that ongoing waste disposal activities at the landfill between 1980 and 1981 resulted in placement of approximately four feet of additional sanitary fill in Area 1 and a similar thickness of construction fill over the radiologically-impacted materials in these areas (RMC, 1982). Therefore, any soil that contained radionuclides would have been irregularly distributed and subsequently displaced both during and after placement. The combination of the initial irregular surface of the refuse over which the soil was placed, contemporaneous placement of other soil/quarry spoil material as daily or intermediate cover, inconsistent application of the soil cover material and compaction, and the subsequent placement and additional compaction of additional waste and soil cover material, likely resulted in the materials disposed of in Areas 1 and 2 being dispersed and intermixed at the time of initial placement within portions of the overall matrix of MSW in Areas 1 and 2. Subsequent use of the surfaces of Areas 1 and 2 for stockpiling of quarry materials (see prior discussion in Section 5.5.2.1) would have further differentially compacted the underlying material. In addition, the subsequent natural decomposition, consolidation, and settlement of the MSW over the past 40 years has resulted in further displacement and intermixing of the radioactive materials within the MSW matrix. Consequently, Areas 1 and 2 are comprised of both radiologically impacted and non-

radiologically impacted materials that cannot be visibly distinguished, and both of which are intermixed with solid waste materials. The distribution of radionuclide bearing materials within Areas 1 and 2 is described further in Section 6.5.

6.2 Criteria for Defining RIM Occurrences

EPA previously determined for purposes of evaluating "complete rad removal" alternatives (EPA, 2010b) that RIM would be defined based on the criteria set forth in EPA's regulations (40 CFR Part 192) promulgated pursuant to the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) as modified by subsequent EPA guidance on the use of these regulations at CERCLA sites. Specifically, EPA's Scope of Work (SOW) for the Supplemental Feasibility Study (EPA, 2010b) indicated that "complete rad removal" was defined to mean attainment of risk-based radiological cleanup levels specified in OSWER Directives 9200.4-25 and 9200.4-18 (EPA, 1998a and 1997c). These directives provide guidance for establishing protective cleanup levels for radioactive contamination at CERCLA (Superfund) sites. In particular, they clarify how the UMTRCA soil cleanup criteria can be used as remediation goals at CERCLA sites.

6.2.1 UMTRCA Regulations

Subpart B of the UMTRCA regulations presents standards for cleanup of land and buildings contaminated with residual radioactive materials from inactive uranium processing sites. In particular, Section 192.11(b) of these regulations states: "Land means any surface or subsurface land that is not part of a disposal site and is not covered by an occupiable building." Section 192.12 ("Standards") of the regulations states:

> Remedial actions shall be conducted so as to provide reasonable assurance that, as a result of residual radioactive materials from any designated processing site:
>
> (a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than --
>
> (1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and
>
> (2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

EPA's Office of Solid Waste and Emergency Response (OSWER)[68] previously issued two Directives (EPA, 1998a and 1997c) regarding the use of the UMTRCA regulations at CERCLA

[68] On December 15, 2015, OSWER was renamed the Office of Land and Emergency Management (OLEM).

sites. OSWER Directive 9200.4-25 ("Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites" (EPA, 1998a)) discusses the applicability, relevance and appropriateness, and use of the soil cleanup standards established pursuant to UMTRCA at CERCLA sites. OSWER Directive 9200.4-18 ("Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA, 1997c)) provides clarifying guidance regarding the protection of human health at CERCLA sites containing radionuclides.

6.2.2 EPA OSWER Directive 9200.4-25

In OSWER Directive 9200.4-25, EPA determined that the surface soil standard for cleanup of soil at UMTRCA sites (5 pCi/g plus background) would only be applicable to cleanup of uranium mill tailings at the 24 uranium mill tailing sites designated under Section 102(a)(1) of UMTRCA (Title I sites). The OSWER guidance indicates that these standards may be relevant and appropriate to CERCLA sites that contain soil contaminated with Ra-226, Ra-228 and/or thorium isotopes.

OSWER Directive 9200.4-25 further states that for CERCLA sites where subsurface contamination exists at a level between 5 pCi/g and 15 pCi/g averaged over areas of 100 square meters, conditions would not be sufficiently similar to an UMTRCA site to consider the subsurface soil standard of 15 pCi/g over background as a relevant and appropriate requirement. Under these instances, EPA recommends 5 pCi/g as a suitable cleanup for subsurface contamination, if a site-specific risk assessment demonstrates that 5 pCi/g is protective. The guidance further states that when the UMTRCA standards are found to be relevant and appropriate requirements for a CERCLA site, the 5 pCi/g standard should be applied to the combined levels of Ra-226 and Ra-228. The guidance also states that in order to provide reasonable assurance that the preceding radionuclides in the series will not be left behind at levels that will permit the combined radium activity to build up to levels exceeding 5 pCi/g after completion of the response action, the 5 pCi/g standards should also be used as a relevant and appropriate requirement for cleanup of the combined level of Th-230 and Th-232.

6.2.3 EPA OSWER Directive 9200.4-18

OSWER Directive 9200.4-18 ("Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA, 1997c)) provides clarifying guidance regarding protection of human health at CERCLA sites containing radionuclides. This guidance identifies potential applicable or relevant and appropriate requirements (ARARs) of other regulations related to radionuclide occurrences at CERCLA sites. In particular, this guidance indicates that where ARARs are not available or are not sufficiently protective, EPA generally sets site-specific remediation levels for: (1) carcinogens at a level that represents an exceedance of upper bound lifetime cancer risk to an individual of between and 1×10^{-6} and 1×10^{-4}; and (2) non-carcinogens such that the cumulative risks from exposure will not result in adverse effects to human populations (including sensitive sub-populations) that may be exposed during a lifetime or part

of a lifetime, incorporating an adequate margin of safety. Since all radionuclides are carcinogens, Directive 9200.4-18 addresses carcinogenic risk.

This guidance further states that the UMTRCA regulations are considered potentially relevant and appropriate requirements for sites with radioactive contamination that currently does, or could potentially, result in radon that is caused by site-related contamination migrating from the soil into buildings. This guidance also states that the cleanup of UMTRCA sites using the 5 pCi/g and 15 pCi/g soil standards under 40 CFR Part 192 is consistent with an upper bound standard of 15 mrem/yr effective dose equivalent (EDE) under a rural residential exposure scenario for Ra-226, Ra-228, and Th-232, and is much more stringent for Th-230. EPA has indicated that for land uses other than residential (*e.g.*, commercial/industrial, recreational) the UMTRCA cleanup standards are more stringent for all four radionuclides; this means that a higher value would be appropriate for commercial and industrial land uses.

OSWER Directive 9200.4-18 also provides guidance on the role of land use and institutional controls on determining cleanup levels for radionuclides at CERCLA sites. Specifically, this guidance states that the concentration levels for various media that correspond to the acceptable risk level established for cleanup objectives will depend in part on land use at the Site. Land uses that will be permitted following completion of a response action are determined as part of the remedy selection process considering the reasonably anticipated land use or uses along with other factors. The guidance states that institutional controls (ICs) generally should be included as a component of cleanup alternatives that would require restricted land use in order to ensure the response will be protective over time. The guidance further states that ICs should prevent an unanticipated change in land use that could result in unacceptable exposures to residual contamination, or at a minimum, alert future users to the residual risks and monitor for any changes in use.

6.2.4 Use of MARSSIM

The sum of the ratios method for computation of radiological cleanup levels detailed in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (EPA et al., 1997) is not used in this RI Addendum because that method was not included in EPA's definition of RIM (that definition is instead based on UMTRCA standards as modified by the OSWER Directives discussed in Section 6.2, above). MARSSIM techniques may, however, be used during remedial actions as part of the evaluation of remaining radionuclide occurrences on the Buffer Zone and Crossroads Lot 2A2 or during remedial action to verify that whatever cleanup levels that may be established in a ROD Amendment for OU-1 are achieved by the selected remedial actions.

6.2.5 Background Levels

As discussed above, EPA has directed the OU-1 Respondents to define RIM based on the risk-based radiological cleanup levels specified in OSWER Directives 9200.4-25 and 9200.4-18, which provide EPA's clarification as to the use of the UMTRCA soil cleanup criteria as remediation goals at CERCLA sites. The UMTRCA soil cleanup criteria are based on concentrations above background levels. Similarly, EPA has stated that CERCLA cleanup levels are not set at concentrations below natural background levels (EPA, 2002). As a result, the cleanup standards to be used for the development and evaluation of the "complete rad removal" alternative in the Final Feasibility Study (FFS) are background-based standards. Determination of background levels is an important part of the development of the soil cleanup levels both for the identification of RIM for the RIA and for evaluation of the "complete rad removal" alternative.

As with any set of data, background values are subject to variability. By definition, the mean background value represents the central tendency of the background data set, but does not incorporate any measure of the variability of the background data set. Values greater than the mean value may nonetheless be representative of background conditions. Therefore, some measure of the variability of the background data is necessary to define the uncertainty associated with the mean of the background values. A common type of value for the interval around an estimate is a "confidence interval." A confidence interval may be regarded as combining an interval around an estimate with a probabilistic statement about the unknown parameter. Confidence intervals are based on the standard deviation of the data set and published statistical values defining population distributions.

Background data obtained as part of the Remedial Investigation (McLaren/Hart, 1996h) were used to define background levels for each of the radionuclides. Background concentrations of the various isotopes of radium, thorium and uranium were presented in Section 6.2 of the 2000 RI report (EMSI, 2000). These background concentrations were determined using analytical results from samples collected at four background locations (Figure 6-1). Analytical results for these samples are presented in Appendix D-2. Analytical results for these samples and background data from other Site investigations and investigations of other sites (FUSRAP) in the St. Louis area are summarized on Table 6-1.

In order to account for the variability in the background results, the representative background values used in the prior 2000 RI and SFS and in this RI Addendum are the mean values of the results of four background samples obtained by McLaren/Hart plus two standard deviations above these results. Use of two standard deviations reflects the statistically critical value of 1.96 used to calculate the 95% upper confidence limit (UCL) for a normally distributed population with a large number (greater than 30) of sample results (Mendenhall, 1979). Specifically, through repeated sampling, the true mean value is expected to fall within a range defined by two times the standard deviation 95% of the time. For smaller sample sizes, the statistically critical values are larger. In the case of a sample set consisting of four data values, the statistically critical value would be 2.35. Therefore, use of a statistically critical value of 2.0 is a reasonable,

yet slightly conservative (more protective) method of estimating the variability of the background values.

The mean background concentrations and the mean background concentrations plus two standard deviations were presented in the RI report (EMSI, 2000), are included in Appendix D-2, and are listed below:

Parameter	Mean of the background sample results (pCi/g)	Standard deviation of the background sample results (pCi/g)	Mean value plus two standard deviations (pCi/g)
Radium-226	1.06	0.12	1.30
Radium-228	1.65	0.36	2.37
Thorium-230	1.51	0.47	2.45
Thorium-232	0.90	0.33	1.55
Uranium-238	1.33	0.46	2.24
Uranium-235	0.39	0.38	1.15
Uranium-234	1.47	0.63	2.73

Each of these radionuclides (except U-235) are members of either the U-238 or the Th-232 decay chains. The short-lived members of these chains (isotopes with shorter half-lives compared to other members of the same decay chain) normally are in equilibrium with longer-lived progenitors in the same chain. For example, Th-232 and Ra-228 are members of the Th-232 decay series and should be in equilibrium with each other when naturally occurring. Examining the results listed above, it can be seen that the activity levels for radionuclides in the same decay chain (*e.g.*, U-238, U-234 and Th-230 compared to Ra-226 and Th-232 compared to Ra-228) are slightly different; however, given the low activity levels associated with the background samples and the uncertainties associated with these results, the reported activity levels are in general agreement. The differences may be the result of variations in sampling and analysis.

In order to address the difference in activity levels of the parent and daughter radionuclides, for purposes of the RI Addendum the representative background activities for all members of a decay chain were considered to be equal to the lowest value reported for any member in the chain. This is a small adjustment that results in a slightly lower (more conservative) derived concentration guideline (DCGL). In the case of the Th-232 series, the background concentration of all members of the Th-232 series was set to 1.55 pCi/g (*e.g.*, the background value for Ra-228 was set to 1.55 pCi/g even though the background value for this specific isotope was identified to be 2.37 pCi/g). Applying this same logic to the remaining radionuclides, the background values to be used for series nuclides in this evaluation are as follows:

- Radium-226 = 1.3 pCi/g
- Radium-228 = 1.55 pCi/g

- Thorium-230 = 1.3 pCi/g (parent of Ra-226)
- Thorium-232 = 1.55 pCi/g (parent of Ra-228)
- Uranium-238 = 2.24 pCi/g (parent of U-234)
- Uranium-234 = 2.24 pCi/g (parent of Th-230)

These values are comparable to the following background values identified for SLAPS OU-2 (EPA, 1998b):

- Radium-226 = 2.8 pCi/g
- Radium-228 = not identified
- Thorium-230 = 1.9 pCi/g
- Thorium-232 = not identified
- Uranium-238 = 1.4 pCi/g
- Uranium-234 = not identified

Table 6-1 presents a comparison of the background values presented above to the background value obtained by the NRC investigations at the West Lake Landfill Site and to background values obtained for other radiologically-impacted sites in the St. Louis area. As can be seen on Table 6-1, the background levels for Ra-226 and Th-230 presented above are for the most part less than the background values identified for the other St. Louis area sites. The background values for U-238 presented above are greater than the reported background values for the other St. Louis sites; however, review of the information presented in the St. Louis Downtown Site (SLDS) ROD (USACE, 1998) indicates that the background values presented for SLAPS and SLDS represent average values. In the case of SLDS, background U-238 values ranged from 0.159 to 3.78 pCi/g, indicating that the background U-238 value presented above falls within the range of background U-238 values identified at SLDS.

6.2.6 Definition of RIM

EPA has established a conservative definition of RIM at the West Lake Landfill Site based on application of criteria for unrestricted (*i.e.*, residential) land use. In particular, EPA has determined that the term “RIM” at the West Lake Landfill Site will be applied to any material containing combined Ra-226 plus Ra-228 or combined Th-230 plus Th-232 at levels greater than

5 pCi/g above background (EPA, 2010b). Based on the Site background values cited above, the combined background value for Ra-226 (1.3 pCi/g) plus Ra-228 (1.55 pCi/g) is 2.9 pCi/g, resulting in a criterion for defining RIM of 7.9 pCi/g (5 + 2.9 = 7.9 pCi/g) for combined radium and, by extension per OSWER Directive 9200.4-25, a criterion of 7.9 pCi/g for combined Th-230 plus Th-232.

Neither the SFS SOW nor the OSWER guidance that EPA established as the basis for defining RIM contain any criteria for determining the levels of uranium that would define RIM. The ROD for the SLDS (USACE, 1998) and the 2005 ROD for SLAPS OU 1 (EPA, 2005b) were reviewed relative to the uranium cleanup level established by EPA for other sites in St. Louis area that contained uranium and other radionuclides in soil.

The SLDS ROD determined that the point of departure (10^{-6}) remediation goal for U-238 for this FUSRAP site would be 2.6 pCi/g using standard Risk Assessment Guidance for Superfund (RAGs) methodology (EPA, 1989b, 1991a and 1991b) and site-specific exposure factors (USACE, 1998). The value of 2.6 pCi/g, however, was determined by EPA to be within the range of site background concentrations (0.159 to 3.78 pCi/g for 32 sample detects). EPA also concluded that the point of departure concentration would present significant issues with respect to implementability (USACE, 1998). Therefore, so as to enable field measurement of U-238, preclude the cost for over-excavation of clean soils, and facilitate statistical confirmation of the cleanup, EPA adjusted the remediation goal upward to 50 pCi/g for the SLDS FUSRAP site (USACE, 1998). EPA determined that this level would be protective of human health in that it corresponds to a risk of less than 2×10^{-5} without regard to the presence of clean soil cover that would be placed over the excavation areas (USACE, 1998). EPA further concluded that this value is a valid, supportable remediation criterion for the SLDS given that actual residual concentrations are generally substantially less than the applicable criterion, and is further appropriate given the need to minimize over-excavation of soils and the associated costs (USACE, 1998).

For SLAPS, a site-specific remediation goal for U-238 was derived for this FUSRAP site based on the approach described in 10 CFR Part 40, Appendix A, Criterion 6(6), also referred to as the benchmark dose approach (USACE, 2005). The U-238 remediation goal was established using U-238 as a surrogate for all of the uranium isotopes (including U-234 and U-235) and certain uranium decay products (USACE, 2005). The SLAPS ROD indicates that the remediation goal for U-238 was calculated to be 81 pCi/g when used as a surrogate for total uranium (USACE, 2005). The U-238 remediation goal was revised downward to 50 pCi/g for this FUSRAP site to account for Pa-231 and Ac-227 concentrations that are present above their expected natural abundance (USACE, 2005).

A uranium remediation goal of 50 pCi/g is equivalent to a mass-based uranium concentration of 71 mg/kg. EPA's current non-carcinogenic screening levels for uranium are 230 mg/kg for residential exposures and 3,500 mg/kg for worker exposures (https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-may-2016). Consequently, cleanup of uranium to 50 pCi/g plus background should not pose any non-carcinogenic risks. The risk calculations used to

derive (and that support) this cleanup level were presented in the SLDS and SLAPS OU-1 RODs (USACOE, 1998 and EPA, 2005b).

Based on the uranium remediation goal of 50 pCi/g established for the SLDS and SLAPS, for purposes of identifying RIM in the RI Addendum, the criteria of 50 pCi/g plus background total uranium (U-238 of 2.24 pCi/g plus U-234 of 2.24 pCi/g for a total of 4.5 pCi/g) will be used as a criterion for identification of RIM[69]. Additional discussion regarding the approach used for development of the uranium remediation level is presented in the EPA-approved SFS Work Plan (EMSI, 2010) and in Section 2.8.2.1 of the ROD for SLAPS OU-1 (EPA, 2005b).

The resultant levels to be used to define RIM are the sum of the representative background concentrations and the appropriate risk-based remediation concentrations listed in the OSWER directives for radium and thorium and the methodology used at the SLAPS and SLDS sites for uranium. Based on the Site background values presented above, the criteria to be used to identify RIM are as follows:

- Radium-226+228 = 7.9 pCi/g[70]
- Thorium-230+232 = 7.9 pCi/g
- Combined uranium = 54.5 pCi/g

These values were used to identify the Site soil/waste that would be included within the definition of RIM for purposes of this RI Addendum.

By comparison, the remediation goals established for the North St. Louis County FUSRAP sites were as follows:

Isotope	Surface Soil (pCi/g)	Subsurface Soil (pCi/g)
Radium-226	5	15
Thorium-230	14	15
Uranium-238	50	50

Therefore, the criteria being used to define RIM at the West Lake Landfill Site are more conservative (more stringent) than the criteria being used to identify radionuclide contamination at the North County FUSRAP sites. However, the definition of RIM that the EPA has established at this Site is consistent with *Uranium Mill Tailings Radiation Control Act*

[69] Although this criterion is identified as a basis for delineating RIM, as discussed at the end of the next section (Section 6.3), any intervals that contained combined uranium above this criteria also contained total radium and/or total thorium activities above their respective criteria for identification of RIM and therefore the total uranium levels were not a significant factor for identification of RIM.
[70] Total radium DCGL = 1.3 pCi/g radium-226 + 1.6 pCi/g radium-228 + 5 pCi/g radium cleanup level = 7.9 pCi/g total radium

(UMTRCA) and relevant Office of Land and Emergency Management (OLEM) (formerly OSWER) guidance as discussed in the previous sections.

6.3 Procedures Used to Identify RIM Occurrences

As discussed above, EPA has indicated that RIM is defined based on the radium, thorium and uranium activity levels developed based on the UMTRCA standards and OSWER guidance. Therefore, the primary criteria for identifying occurrences of RIM are the results of laboratory analyses of soil/waste samples. These analytical data are considered direct measurements of potential RIM occurrences. Indirect data potentially indicative of or helpful in identifying RIM include overland gamma survey results, downhole gamma logging, and radon flux measurements.

RIM occurrences in Areas 1 and 2 were identified using:

- Data obtained by the NRC investigation (RMC, 1982);
- OU-1 RI investigations (McLaren/Hart, 1996h and EMSI, 2000);
- EPA split samples obtained during the OU-1 RI investigations (McLaren/Hart, 1996f);
- Phase 1 Investigations (EMSI, et al., 2016b);
- Additional Characterization Investigation (EMSI, 2015e);
- EPA split samples obtained during the Additional Characterization investigation;
- Samples analyzed in conjunction with EPA's pyrolysis and radon attenuation studies (TetraTech, 2016a);
- Additional testing conducted by Cotter;
- EPA's verification testing of the Cotter samples; and
- Surface soil samples obtained in conjunction with construction of the NCC.

Considering all of these investigations, a total of 177 soil borings from which soil samples were collected for laboratory analyses have been drilled in Areas 1 and 2, including 84 soil borings soundings in Area 1 and 88 soil borings and 5 hand auger borings drilled in Area 2.

From these, a total of nearly 500 investigative (*i.e.*, exclusive of duplicate and other QA/QC samples) soil samples have been obtained and submitted for laboratory analyses for radium, thorium and uranium isotopes. This total includes:

- 159 samples during the OU-1 RI field investigations;
- 74 samples during the Phase 1C investigation;
- 42 samples during the Phase 1D investigation;
- 58 samples and 10 EPA split samples during the Additional Characterization of Areas 1 and 2 investigation;
- 6 samples collected by EPA from existing core material or the ground surface for the pyrolysis/radon emanation study;

- 34 (non-duplicate) samples as part of the additional work performed by Cotter plus 12 samples re-analyzed by EPA; and
- 129 surface soil samples collected and analyzed in conjunction with construction of the NCC.

In 1981, RMC, on behalf of NRC, performed on-site and *in-situ* intrinsic germanium (IG) analysis measurements of radionuclide activities including Ra-226; however, the RMC testing program did not include Ra-228, any thorium isotopes, and included only very few uranium values (all of which were only for U-238). The RMC report includes IG analysis results for 40 soil samples, some of which can be approximately located based on the grid coordinate system used by RMC; but for others, no location information is provided. RMC also performed *in-situ* IG analyses in 18 boreholes resulting in 256 measurements of Ra-226 and other radionuclide activity levels. Again, these measurements include only a few U-238 measurements and no results for Ra-228, thorium isotopes, or the other uranium isotopes. Furthermore, these measurements were only performed on boreholes located in Area 2. In addition, RMC reported that it sent 12 surface soil samples and a few core samples to an off-site laboratory for thorium analyses; however, the RMC report only presents results for eight surface soil samples and two boreholes. Descriptions of the sample locations/intervals associated with these data are insufficient to actually locate where these samples were obtained (see prior discussions in Section 4.5.1). Therefore, use of the NRC (RMC) data were limited to evaluation of intervals containing Ra-226 above 7.9 pCi/g based on the results of the IG analyses.

In addition to the hundreds of soil samples that have been analyzed during the various investigations, many other measurements have been performed that can be used to provide an indirect indication of potential RIM occurrences. Most notable are the results of the downhole gamma logging, which provide a continuous set of vertical measurements that can be used to identify intervals possessing elevated gamma levels that are potentially indicative of occurrences of radium or other gamma emitters. Overland gamma surveys were also performed as previously discussed in Section 4.3. Additionally, radon flux measurements were obtained from Areas 1 and 2 as part of the OU-1 RI.

The analytical data were compiled and summarized on tables (Tables 6-2 and 6-3) and graphically portrayed on figures (Figures 6-2 through 6-7). The results of the GCPT soundings, geologic logs, downhole gamma logs, core gamma and alpha scans are included in Appendix C. Composite plots of the subsurface data (GCPT soundings, geologic logs, downhole gamma logs, core gamma and alpha scans) and laboratory analytical results (to the extent each of these types of data were obtained) were developed. These composite plots, referred to as Borehole Summary Sheets, are presented in Appendix L. The downhole gamma logging, core sample gamma scan, and core sample alpha scan data were evaluated to identify intervals of elevated gamma or alpha counts (relative to instrument background and the base level gamma or alpha counts for borehole or core material from each boring) that likely reflect occurrences of RIM. The top and bottom of the intervals interpreted to contain combined Ra-226 plus Ra-228 and/or combined Th-230 plus Th-232 greater than 7.9 pCi/g based on analytical laboratory data, or that are inferred to contain such levels based on interpretation of the downhole gamma logs and/or

the core scans are identified on the Borehole Summary Sheets (Appendix L). The results of these evaluations are also summarized on Tables 6-4 and 6-5.
Based on review and evaluation of the results of all of the data, it was determined that any intervals that contained combined uranium above the 54.5 pCi/g criterion for identification of RIM also contained radium and/or thorium above the 7.9 pCi/g criteria. Therefore, uranium data were not included on the Borehole Summary Sheets due to physical constraints associated with their preparation and presentation. Uranium results are included on the summary tables of the laboratory analytical results (Tables 6-2 and 6-3).

6.4 Occurrences of RIM in Areas 1 and 2

Based on the procedures described above, RIM was identified as being present in 144 of the 331 borings and GCPT soundings evaluated, including 72 of the 231 borings and GCPT soundings located within or adjacent to Area 1 (Table 6-4)[71] and 64 of the 87 borings located in or adjacent to Area 2 (Table 6-5). A total of 16 locations were identified as displaying more than one discrete interval of RIM, including 4 locations in Area 1 (Sonic borings 1D-9, AC-1, AC-2B and AC-3) and 12 locations in Area 2 (AC-24, AC-26A, PVC-4, PVC-5, PVC-6, PVC-7, PVC-10, PVC-40, WL-209, WL-210, WL-214, and WL-235).

Identification of which borings contained RIM, the depths to and elevations of the top and bottom of the RIM intervals, and the data/basis used to identify RIM in each boring and depth interval are summarized on Tables 6-4 and 6-5. More detailed information and basis regarding the locations and intervals identified as containing RIM can be found on the Borehole Summary Sheets in Appendix L.

The minimum, maximum and average values for the depth to the top and bottom and thickness of the RIM intervals were calculated from the values provided on Tables 6-4 (Area 1) and 6-5 (Area 2). The average depth to the top of the identified intervals containing RIM in Area 1 is approximately 28 ft bgs (average elevation of 450.0 ft amsl), ranging from 0 (at the surface) to 89 ft bgs (elevations ranged from 425.4 to 470.5 ft amsl)[72]. The average depth to the base of the RIM intervals in Area 1 is approximately 32 ft bgs (average elevation of 446.0 ft amsl), ranging from 5 to 96 ft bgs (elevations ranged from 420.3 to 462.3 ft amsl). Part of the reason for these depths is that the landfill materials in the southern portion of Area 1 were buried beneath additional landfilled waste that was placed in that area in approximately 2002-2003 in conjunction with disposal in the above-grade portion of the North Quarry portion of the Bridgeton Landfill (Figure 3-8).

[71] These numbers do not include Geoprobe offset borings or occurrences of RIM at multiple depths in some borings at indicated on Table 6-4.
[72] Note that the borings used to define RIM were drilled before construction of the Non-Combustible Cover removal action construction activities and therefore the reported depth intervals discussed in this section do not reflect placement of additional 8-inches or, in some areas, an even greater thickness of material over portions of Areas 1 and 2 in 2016.

The average depth to the top of the intervals identified as containing RIM in Area 2 is approximately 6.6 feet (average elevation of 466.2 ft amsl), ranging from 0 (at the surface) to 42.5 ft bgs (elevations ranged from 434.9 to 486.5 ft amsl). The average depth to base of the RIM intervals in Area 2 is approximately 14 feet, ranging from 1 to 49.5 ft bgs (elevations from 428.3 to 484.5 ft amsl).

The minimum, average and maximum thickness of the RIM intervals identified in Areas 1 and 2 were as follows:

	Area 1	Area 2
Minimum RIM thickness (ft)	0.2	1
Average RIM thickness (ft)	4.3	7.4
Maximum RIM thickness (ft)	19	25

The values cited above for the average and range of depths to the top and bottom of the RIM intervals and the thickness of RIM is based on evaluation of the analytical laboratory results (Tables 6-2 and 6-3) and the downhole gamma logs and core alpha and gamma scans (Appendix C) as documented on the Borehole Summary Sheets (Appendix L) and summarized on Tables 6-4 and 6-5).

Historical aerial photographs were used to prepare topographic surfaces for 1971, 1975, 1977 and 1979. These surfaces were used to evaluate the relationship between ongoing rock quarrying in the North Quarry relative to Area 1 (see prior discussion in Section 3.3.4). These surfaces were also used to identify changes in ground surface elevations between 1971 and 1975, the period of interest relative to disposal of LBSR and associated soil. They were also compared to the current (2016) topography to identify areas of significant changes in surface elevations in order to better understand the depth of the RIM occurrences in Areas 1 and 2.

Figure 6-8 presents a comparison of the 1971 to 1975 topographic surfaces. Comparison of these surfaces indicates that significant fill material (solid waste) was placed in these areas during this period. Fill thicknesses of 20 to 50 feet (purple shaded areas on Figure 6-8) appear to have occurred throughout much of Area 1, and fill thicknesses of 20 to 40 feet in the north-central portion of Area 2, and in isolated areas in the southwest portion of Area 2. Comparison of the 1971 surface to the 2016 surface (Figure 6-9) indicates that large amounts of fill have been placed across Area 1. Large amounts of fill have also been placed across Area 2; however, based on a reduction in ground surface elevations between 1971 and 2016, the northwestern and northeast portions of Area 2 appear to undergone significant settlement and consolidation. Evidence of consolidation and settlement is even more pronounced by the comparison of the 1975 to 2016 topographic surfaces, which indicated that much of the northwestern portion of Area 1 and nearly all of the northern portion of Area 2 experienced a decrease in ground surface elevations of up to approximately 10 feet over this period (Figure 6-10), presumably due to consolidation, decomposition and settlement from stockpiled material, as well as construction of a parking lot in 1979 (visible in the 5/25/1979 aerial photo, which shows that a rectangular

parking area has been constructed along the north side. Filling is also still visible at this time). Comparison of the 1977 topographic surface to the 2016 surface indicates that much, but not all, of this consolidation and settlement occurred after 1977 (Figure 6-11). The observed changes in ground surface elevation shown on Figures 6-8 through 6-11 reflect placement of waste materials in the 1971-1975 time frame, as reflected in an increase in elevation over this period, followed by overall consolidation and settlement.

6.5 Areal Extent of RIM in Areas 1 and 2

Evaluations of the extent of RIM in Areas 1 and 2 were performed using geostatistical methods in support of the RIA and the evaluation of potential remedial alternatives for the FFS. Specifically, the extent of RIM within OU-1 Areas 1 and 2 was estimated in three dimensions (3D) using indicator kriging (IK). The IK method is commonly used to identify regions of the subsurface that exhibit properties that exceed one or more defined threshold criterion – typically a concentration – and as such, is well-suited to delineating RIM. In the case of a single threshold, sample results are indexed according to whether they exceed (index=1) or fall below (index=0) the threshold concentration. The transformed indicators are interpolated using kriging, resulting in a continuous 3D distribution of values that range between zero and one that in the simplest case reflect the probability that the threshold concentration is exceeded at the corresponding location. A complete description of the methods used, data incorporated in the analysis, and the assumptions and limitations of the analysis is provided in the report titled "*Estimated Three-Dimensional Extent of Radiologically Impacted Material, West Lake Landfill, Operable Unit 1, Bridgeton, Missouri*" (S.S. Papadopulos & Assoc., Inc [SSP&A], 2017). All IK calculations presented there and summarized here were completed using a recent release of the Fortran-based Geostatistical Library (GSLIB: Deutsch and Journal, 1992) program IK3D, compiled with dynamic memory allocation. SSP&A (2017) presents the estimated extents and volumes of RIM for Areas 1 and 2 obtained using IK for concentrations of combined radium (i.e., Ra-226 plus Ra-228) *or* combined thorium (i.e., Th-230 plus Th-232) exceeding 7.9 pCi/g - the value defined by EPA for identification of RIM. Estimates of the extent of RIM above other concentration thresholds will be presented in the forthcoming FFS.

The data available to estimate the extent of RIM include concentrations of thorium and radium obtained from laboratory analysis of landfill materials, plus a large number of vertically piecewise-continuous gamma and alpha recordings obtained within boreholes or by scanning retrieved core material. The reported concentrations of thorium and radium comprise direct measurements of the quantity of interest, and are referred to here and by SSP&A (2017) as "hard" data. In contrast, measurements of gamma emissions and alpha radiation are indirect indicators of the presence and likely relative concentration of radiological constituents, including (but not limited to) thorium and radium. As such, counts of radioactivity are referred to here as "soft" data. The IK method enables such soft data to be incorporated into the estimation of the extent of the primary hard variable under the assumption that the soft data exhibit a correlation with the hard data. Given the preponderance of gamma emission versus alpha radiation recordings from previous investigations, the geostatistical analysis focused on the utility of

existing gamma emission data for inferring the presence and concentration of radium and thorium. As demonstrated by SSP&A (2017), correlations can be demonstrated between gamma emissions and concentrations of both radium and thorium, although the relationship between gamma emissions and thorium concentrations is weaker than that with radium concentrations.

The extents of the interpolation grid used for kriging was designed on a vertical and horizontal discretization suitable for providing estimates of the extent and volume of RIM in terms of concentrations of combined radium *or* combined thorium exceeding 7.9 pCi/g. The discretization of the interpolation grid was initially selected based upon UMTRCA guidance, resulting in a grid defined by square blocks of side-length 10 meters (32.8 feet) and thickness 0.15 meters (0.5 feet) consistent with the criteria specified in 40 CFR § 192.12a for cleanup of land containing residual radioactive materials. However, the final calculations presented herein were made on a refined horizontal grid comprising square blocks of side-length 5 meters (16.4 feet) and thickness 0.15 meters (0.5 feet).

Estimates of the areal extent of RIM, defined as above as material containing combined radium *or* combined thorium concentrations greater than 7.9 pCi/g, obtained using IK are shown on Figures 6-12 (Area 1) and 6-13 (Area 2). The maximum areal extent where RIM is present at the surface or in the subsurface in Area 1 is approximately 8.2 acres. The maximum areal extent where RIM is present at the surface or in the subsurface in Area 2 is approximately 24.9 acres. These maximum areal extents represent projections of *any* regions where RIM is present at any depths within Areas 1 and 2. The RIM in Areas 1 and 2 does not consist of continuous layer but rather as discrete bodies of material. To illustrate this concept, the occurrences of RIM at various elevation intervals in Area 1 are displayed on Figures 6-12a and 6-12b. As can be seen on these figures, the areas where RIM occurs and the lateral extent of RIM is highly variable as a function of depth. Figures 6-13a, 6-13b and 6-13c depict the interpolated extent of RIM at several selected depth intervals within Area 2. Again, the occurrences of RIM is highly variable as a function of depth. These figures illustrate that at any depth within the landfill the estimated extent of RIM is much less contiguous than is suggested by the bounding maximum total areal extents shown on Figures 6-12 and 6-13. Cross-sections displaying the vertical occurrences of RIM that are included in Appendix M. These cross-sections depict the top and bottom elevations at which RIM was identified within each Area via indicator kriging. The material that lies between the top and bottom surfaces depicted in these cross-sections comprises intervals of RIM that are separated by intervening intervals of non-RIM.

The best-estimates for the volume of RIM within Area 1 and Area 2 are approximately 52,600 cubic yards for Area 1 and approximately 232,000 cubic yards for Area 2. However, as described by SSP&A (2017) there is significant uncertainty associated with the estimated extent and volume of RIM in Areas 1 and 2. Specifically, SSPA indicated that these estimates are likely biased low and therefore underestimate the actual volume of RIM in Areas 1 and 2.

6.6 Radiological Characterization of RIM

The primary radionuclides detected in Areas 1 and 2 at levels above background concentrations are part of the U-238 decay series. The uranium decay series includes Th-230, Ra-226, and Rn-222, which are the primary radionuclides of concern at the Site. Th-232 and Ra-228 isotopes from the thorium decay series were also present above background levels but at a lesser frequency and relatively lower activity levels than the radionuclides in the U-238 decay series. A total of 218 radium analyses and 213 thorium analyses (including investigative samples, field duplicate samples, and laboratory duplicate analyses) are available for Area 1, and 144 radium and thorium results are available for Area 2, from the OU-1 RI, Phase 1, and Additional Characterization investigations. Table 6-2 summarizes the radium, thorium and uranium results for samples obtained from Area 1 while Table 6-3 summarizes the results for samples obtained from Area 2.

The total number of results, and the average, maximum, and estimated 95% UCL values (based on results for a non-parametric distribution as calculated using ProUCL 5.0 – see additional discussion below) for the radium and thorium data sets are provided on Table 6-6. For purposes of these calculations, lab replicate samples, which are laboratory internal QA/QC samples, were not considered. Also, in order to be consistent with EPA direction, only the maximum reported value for any pair or more of sample results from the same sample interval (*i.e.*, field duplicate samples, EPA split samples, or EPA verification samples) were utilized in the preparation of the risk assessment. In addition, certain data were determined to be unusable based on comparability and representiveness criteria (see Appendix D-12) and therefore are not included in the sets of data used to calculate the radium and thorium statistical values provided on Table 6-6.

It should be noted that although an average value is presented in Table 6-6, the data sets were not composed of single population but appear to be best represented as a bimodal population, and therefore are not normally distributed. Therefore, an arithmetic average is not an appropriate measure of central tendency for such data sets. Similarly, the 95% UCL values listed on Table 6-6, although based on a non-parametric distribution and estimation techniques, are also not considered to be appropriate based on the bimodal distribution of the data sets.

Regardless of whether the data are treated as a single population or as bimodal mixture of two populations, the values provided on Table 6-6 support the conclusion that the RIM is primarily characterized by elevated levels of Th-230 and Ra-226, and that, with the exception of a few values, most of the Th-232 and Ra-228 values are close to or similar to background values. There is also a relatively close correlation between the Ra-226 and Th-230 results obtained from each area (Figures 6-14 and 6-15). Furthermore, review of the data indicates that for all of the results that are greater than the unrestricted use criteria (*i.e.*, 7.9 pCi/g combined Ra-226 + 228 or combined Th-230 + 232), the Th-230 activities are greater than the Ra-226 activities. These analytical data indicate that the Ra-226 activities are not in equilibrium with the Th-230 activity levels and consequently the levels of Ra-226 at the Site will increase over time. Ra-226 is a long-lived daughter of Th-230. Over time, the activity concentrations of Ra-226 will grow into that of its parent, Th-230 (see additional discussion in Section 7.6.1). Out of the nearly 500

sample results, there were only two sample results that did not display Th-230 results greater than the associated Ra-226 results: the sample from the 5-6 ft depth from Area 2 boring AC-19, which displayed similar results for Th-230 (976 pCi/g) and Ra-226 (1,005 pCi/g); and the sample from the 14-15 ft depth from Area 2 boring AC-24, which displayed a Ra-226 level (56.2 pCi/g) approximately 2.5 times the level of Th-230 (20.5 pCi/g).

6.7 Radionuclide Occurrences in the Buffer Zone and Crossroads Lot 2A2

Sampling conducted in conjunction with preparation of the RI (EMSI, 2000) identified the presence of radionuclides in surface soil on the former Ford property (now the Buffer Zone and Crossroads Lot 2A2). Communications with a representative of Rock Road Industries during the RI investigation indicated that the source of the radionuclide occurrences on the former Ford property appeared to have been stormwater erosion of the Area 2 landfill berm prior to establishment of vegetative cover on the berm. Reportedly, after completion of landfilling activities in Area 2 but prior to establishment of a vegetative cover over the landfill berm, erosion of soil from the landfill berm resulted in the transport of radionuclides from Area 2 onto the adjacent former Ford property (EMSI, 2000). The landfill berm and the adjacent properties were subsequently re-vegetated by natural processes such that no evidence of subsequent erosion or other failures were present.

In 1995, McLaren/Hart, as part of the RI field investigations, drilled six soil borings (WL-201 through WL-206) on the former Ford property and collected surface soil samples from two of the borings (WL-203 and WL-206) and subsurface soil samples from all six borings. Only the surface soil sample obtained from WL-206, located immediately below the area where the erosional failure of the landfill slope occurred, displayed radionuclide levels above the unrestricted use criteria. In 1997, EMSI, as part of additional sampling activities for the RI, collected eight surface soil samples (FP-1 through FP-8) from the former Ford property. Samples obtained from FP-1, FP-5 and FP-8 displayed radionuclide levels greater than the unrestricted use criteria. The locations of the various soil borings and surface soil samples collected from the former Ford property are shown on Figure 4-6. Analytical results for the soil samples are summarized on Table 6-7.

Based on the results of sampling performed during the RI, radionuclide occurrences were identified to be present within surface soil (approximately 6 to at most 12 inches deep) beneath that portion of the former Ford property that later became the Buffer Zone and Crossroads Lot 2A2. Radionuclide occurrences were estimated to be present in an area of approximately 196,000 square feet (4.5 acres). Based on an estimated areal extent of 196,000 square feet and a presumed 6-inch thickness, the volume of soil containing radionuclides located on the former Ford property was estimated in the OU-1 RI (EMSI, 2000) to be 3,600 bcy. The overall distribution and surficial nature of the occurrences of radiologically-impacted soil on the former Ford property was determined to be consistent with historic, erosional transport of soil from the Area 2 slope onto the surface of the adjacent property.

In 1998, Ford sold the property to Crossroad Properties, LLC for development of the Crossroads Industrial Park. Lot 2A2 was subsequently developed by AAA Trailer, the owner of much of the property immediately to the north of the Buffer Zone and Area 2. In November 1999, third parties (presumably working for or on the behalf of AAA Trailer) scraped the vegetation and surface soil on Crossroads Lot 2A1 and Lot 2A2 and the Buffer Zone to a depth of approximately 2 to 6 inches. These areas were covered with gravel to allow for parking of tractor trailers in this area. The removed materials were piled in a berm along the southern boundary of the Buffer Zone, adjacent to the northwestern boundary of the West Lake Landfill. A small amount of removed materials was also placed in a small pile on the Crossroads property near the base of the landfill berm along the east side of Lot 2A1 (Figure 6-16).

In February 2000, Herst & Associates, on behalf of the OU-1 Respondents, collected seven additional surface soil samples (RC-01 through RC-07) from the disturbed area and submitted them for laboratory testing. Only one sample (RC-02) obtained from the Buffer Zone, below and adjacent to the area of the former landfill berm slope failure, contained radionuclides (Th-230) above levels that would allow for unrestricted use. The remainder of the samples contained either background levels of radionuclides or levels above background but within levels that would allow for unrestricted use. The results of the additional soil sampling indicated that most of the radiologically-impacted soil that had previously been present on the Buffer Zone and Lot 2A2 of the Crossroads property had been removed and placed in the stockpiles. Evaluation of the soil sampling results obtained prior to and after the 1999 disturbance indicates that approximately one acre of the Buffer Zone still contained some radionuclides above the unrestricted use criteria. Inspection of the area in May 2000 indicated that native vegetation had been re-established over both the disturbed area and the stockpiled materials. The presence of native vegetation over these materials was considered to be sufficient to prevent windblown or rainwater runoff transport of these materials.

A 2004 inspection of this area indicated that additional soil removal/re-grading had been performed on the remaining portion of the Crossroads property and the adjacent Buffer Zone property. These activities appear to have resulted in removal of the soil stockpiles created during the previous regrading activity, removal of any remaining soil on Lot 2A2 and the Buffer Zone not scraped up during the 1999 event, and placement of gravel over the entirety of Lot 2A2 and much of the Buffer Zone. According to AAA Trailer, all of the soil removed during the July 1999 grading work and the May 2003 gravel layer installation was placed in the northeastern corner of the Buffer Zone (terra technologies, 2004). Respondents subsequently installed a fence between the Buffer Zone and Crossroads property to prevent any future disruption of the Buffer Zone by AAA Trailer or any other party.

No sampling has been performed on the Buffer Zone and only very limited sampling has been performed on the Crossroads property since the most recent (May 2003) grading work conducted by AAA Trailer. In 2015, MDNR collected a soil sample from the southwestern portion of Lot 2A2 Parcel C (MDNR, 2016). In 2016, Feezor Engineering, Inc. and EPA collected a soil/sediment sample from southernmost portion of Lot 2A1 (*i.e.*, the AAA Trailer facility property). Other than these two samples, sampling of soil on the Buffer Zone and Lot 2A2 has

not been performed since the most recent (May 2003) grading work. Therefore, the levels and extent of radionuclides, if any, that may remain in the soil on the majority of the Buffer Zone and Lot 2A2 properties are unknot known with certainty. As previously noted, the surfaces of Lot 2A1 and 2A2 were covered with gravel by AAA Trailer to support driving and parking of tractor trailers. I 2016, the vegetation was removed from the Buffer Zone and rock (roadbase material) was placed on the surface as part of the construction of the NCC pursuant to the UAO for Removal Action (Surface Fire Prevention). Additional soil sampling to determine current conditions with respect to radionuclide occurrences in the Crossroads Property soil will be conducted as part of implementation of the selected remedy for this area.

7. RADIONUCLIDE OCCURRENCES IN ENVIRONMENTAL MEDIA

This section of the Remedial Investigation Addendum discusses occurrences of radionuclides in environmental media at the Site and the environmental fate and transport of the various radionuclides. It also describes the current extent of radionuclide occurrences within the various environmental media that could act as pathways for on-site or off-site migration or contaminant exposure. Specifically, this section describes the nature and extent of radionuclides in air, stormwater and surface water, sediment and groundwater.

This section of the RI Addendum also discusses the potential environmental pathways by which the radionuclides present in Areas 1 and 2 and on the former Ford property have or could migrate from these areas to other portions of the Site, to off-site areas, or to other environmental media. Pathways by which radionuclides could migrate from the various source areas include airborne transport, dissolved or suspended transport in surface water runoff, erosional transport of surface soil and sediment, and leaching to groundwater and subsequent groundwater transport. A conceptual model of these various transport pathways and the associated transport mechanisms is presented on Figure 7-1.

In addition, this section includes a discussion the environmental fate and persistence of the various radionuclides present at the Site, including a discussion of the radioactive decay and the subsequent generation of “daughter” radionuclides.

7.1 Radionuclide Occurrences in Air

Radionuclides can be transported to the atmosphere either as a gas (in the case of the various radon isotopes) or as fugitive dust (in the case of the other radionuclides). Both potential pathways are evaluated below based on Site-specific data.

7.1.1 Radon Gas

Radon gas is discharged as a result of the decay of radium. Radon gas generated from radioactive decay of radium present within the RIM could potentially migrate from the various source areas along either one of two possible pathways:

- Radon could migrate upward from the subsurface of the Site and be directly discharged at the surface; and

- Radon could migrate laterally along with other landfill gases until it is able to escape to the surface.

Both potential pathways and the extent of existing radon occurrences are evaluated below.

7.1.1.1 Surface Emission of Radon Gas

Surface emissions (flux) of radon from Areas 1 and 2 have been measured twice, once in 1997 and once in 2016. The results of these measurements are discussed below.

7.1.1.1.1 Radon Flux Measurements – 1997

Radon flux measurements were conducted by EMSI in June 1997 by employing the Large Area Activated Charcoal Canisters (LAACC) method presented in Method 115, Appendix B, 40 C.F.R., Part 61 (EMSI, 1997a, 1997d). This method was established to measure radon flux values on uranium mill tailing piles. The LAACC method involves placing a canister on the surface of the Site in a designated area and allowing radon to collect on charcoal within the canisters for a period of 24 hours. The radon collected on the charcoal is then measured by gamma-ray spectroscopy (*see prior discussion in Section 4.13.2.2)*. Radon flux was measured rather than concentration because no structures are present in either Area 1 or Area 2 that would result in the build-up of radon concentrations. Instead, the potential transport pathway is the migration of the gas from the Site into the atmosphere.

The 1997 radon flux measurements were made at 54 points (Figure 4-21) located adjacent to the various OU-1 RI soil boring locations (*i.e.*, McLaren/ Hart 1995 soil borings) within the grids established by McLaren/Hart for the soil sampling programs within Area 1 (one sample in each of 22 grids) and Area 2 (one sample in each of 32 grids). These locations were developed by McLaren/Hart (1994) using a stratified random technique consisting of both biased and unbiased sampling locations and are thus for the large part statistically unbiased. Each sample location in Area 1 is representative of an approximately 38,250 square feet (sq ft or sf) area within individual 170 foot by 225 foot grids. Each sample in Area 2 is representative of an approximately 67,600 sq ft area within individual 260 foot by 260 foot grids. In addition to the 18 grid locations established by McLaren/Hart for Area 1, four additional locations, coincident with the four additional borings drilled by EMSI in May 1997, were also used for radon flux measurements. The 1997 radon flux monitoring locations are presented on Figure 4-21. The results of the 1997 radon flux measurements are summarized in Table 7-1.

No standards for radon emissions directly applicable to the Site have been established. In 40 C.F.R. Part 61, EPA established a standard of an average of 20 pCi/m^2s for radon emissions for uranium mill tailings from a number of samples (generally 100) collected from the surface of the tailings in a statistically unbiased fashion. Although this standard is only directly applicable to uranium mill tailings, it represents a health-based standard derived by EPA.

Based on the radon flux measurements obtained by EMSI (1997d), the average radon flux from Area 1 in 1997 was 13 pCi/m^2s (Table 7-1). This value is below the EPA standard for uranium mill tailings. Only two discrete radon flux measurements in Area 1, from locations WL-102 (246 pCi/m^2s) and WL-106 (22.3 pCi/m^2s), were above the 20 pCi/m^2s standard for average flux from uranium mill tailing piles. These two locations represent the majority of the total radon flux measured in Area 1 in 1997. Boring WL-102 had down-hole gamma readings with a

maximum peak of approximately 58,000 counts per minute (compared to a baseline level of approximately 6,000 cpm observed during the 1995 OU-1 RI drilling and logging program) at a depth of approximately three feet; however, the soil samples obtained and analyzed from this boring (obtained from depths of 5 and 15 ft bgs) did not contain radionuclides above the levels used to identify RIM (see prior Section 6.2 for a discussion of the criteria used to identify RIM). Boring WL-106 had down-hole gamma readings with a maximum peak of approximately 260,000 counts per minute (compared to a baseline level of approximately 6,000 cpm) at a depth of approximately 6.5 feet (Appendix C-2). Both the surface and the first subsurface soil (5 ft bgs) samples from boring WL-106 contained radionuclides above the levels used to identify RIM (see Tables 6-2 and 6-4). The average flux for all of the other portions of Area 1, exclusive of these two locations, is only 0.87 pCi/m^2s, which is approximately 4% of the EPA standard for uranium mill tailings piles.

Based on the radon flux measurements obtained by EMSI (1997d), the average radon flux for Area 2 in 1997 was 28 pCi/m^2s. This average is above the EPA uranium mill tailings standard; however, this value was due solely to the results obtained from two locations: WL-209 (513.1 pCi/m^2s) and WL-223 (350 pCi/m^2s). The results obtained from these two locations represent the vast majority of the radon flux found in Area 2. Boring WL-209 had down-hole gamma readings with a maximum peak of approximately 740,000 counts per minute (compared to a baseline value of approximately 6,000 cpm) at a depth of 2.5 feet (Appendix C-2). The analytical results obtained from the surface and the first subsurface (5 ft bgs) soil samples from this boring contained radionuclides above the levels used to identify RIM (see Tables 6-3 and 6-5). The maximum down-hole gamma reading displayed in boring WL-223 was only 7,000 counts per minute (compared to a baseline value of approximately 6,000 cpm) at a depth of four feet. In addition, analyses of the soil samples from this boring (from depths of 5 and 25 ft bgs) did not indicate the presence of radionuclides above reference levels. As a result, the source of the higher radon emissions detected at the ground surface at this location is unclear but could be the result from the presence of RIM at or near the ground surface in this area (elevated overland gamma readings were detected near this location, see Appendix A-2) or radon migration from RIM located in the subsurface in close proximity to this boring. The average flux for all of the other portions of Area 2, exclusive of these two locations, was only 0.94 pCi/m^2s, which is approximately 5% of the allowable flux for uranium mill tailings piles.

7.1.1.1.2 Radon Flux Measurements – 2016

Radon flux emissions from the surfaces of Areas 1 and 2 were measured again in 2016 after completion of construction of the non-combustible cover over those portions of Areas 1 and 2 where RIM previously existed at the ground surface (see prior discussion in Section 4.13.2.3). A total of 35 measurements (not including duplicate samples) were obtained from Area 1 and a total of 76 measurements (not including duplicate samples) were obtained from Area 2 (Figure 4-22). The measurements were made using the LAACC method presented in Method 115, Appendix B, 40 C.F.R., Part 61. The results of the measurements are summarized on Table 7-2. Radon was detected in 68 of the 124 samples (111 investigative samples plus 13 duplicates) at concentrations ranging from 0 to 1.5 pCi/m^2/sec. The arithmetic mean value of the results was

0.061 pCi/m^2/sec. Both the mean and maximum detected values were less than the UMTRCA and NESHAP standard of 20 pCi/m^2/sec.

7.1.1.2 Radon Migration with Landfill Gas

A landfill gas collection system is operating for the North Quarry portion of the Bridgeton Landfill located along the south side of Area 1 and overlying the southwest portion of Area 1. Subterranean radon gas produced within Area 1 could conceivably join landfill gases as they move laterally through subsurface landfill strata to the landfill gas collection system. This collection system captures the subsurface gas, feeds it through a series of pipes and manifolds and eventually processes (combusts) and vents the combusted gases to the atmosphere through stacks located approximately 800 feet away from the southern edge of Area 1. Once released, the combusted gas is further mixed with ambient air and dispersed by atmospheric processes as it leaves the Site.

The fraction of subterranean radon potentially released to the atmosphere by this gas collection system is a function of the amount of radon generated in Area 1 that can enter the landfill gas collection system, the volume of landfill gas that the radon mixes with, and the distance and rate of travel of the radon. This last factor, the distance and rate of travel, determines the amount of radon that will be removed by radioactive decay during its journey to the landfill gas extraction system. This decay depletes the radon and the amount of radon removed during such movement depends on the velocity the gas as it moves through soil and the distance the gas has to move to reach a gas extraction intake. The 3.8-day half-life for radon-222, the primary radon radionuclide of concern, can reduce the radon concentration in moving soil gas by approximately 75% during a 7-day period.

Any radon from Area 1 that makes its way to the soil gas collection system will be further reduced by mixing with the rest of the landfill gas during movement within that system. The magnitude of that reduction will depend on the volume of the other landfill gases produced by the landfill.

Exposures from radon in landfill gas exhausted from a Bridgeton Landfill flare have been evaluated on multiple occasions. Radon levels in stack gases were first evaluated by Golder Associates (Golder) in connection with an evaluation of viable exposure pathways and the potential health impact of radioactive materials on on-site workers and off-site receptors (EMSI, 2000). Golder collected samples from the flare and evaluated the resulting radon-222 measurements relative to probable risk. Golder concluded that “recent measurements of radon daughter products, to which on-site workers may be potentially exposed via inhalation, are nearly 10 times below the recommended EPA regulatory limit of 0.03 working level for indoor exposure.”

Radon-222 concentrations measured in samples of gas collected from the intake stream of Bridgeton Landfill Flare #2 gas flare stack ranged from 8.3 ± 0.8 pCi/L to 64.4 ± 6.5 pCi/L

(RSE 2006). This compares well to a recent evaluation of radon gas concentrations in stack gas (Auxier and EMSI 2016a) that calculated Area 1 might produce a 19 pCi/L theoretical increase in stack gas radon. This theoretical stack gas radon release was estimated to produce a radon concentration of 0.0000019 pCi/L in air at the fenceline (Auxier and EMSI 2016a). This radon-222 concentration is well below the EPA health-based standard of 0.5 pCi/L above background provided in 40 CFR 192.02(b)(2). Due to further dispersion and mixing, any radon concentrations in air at nearby businesses and residences would be less than the fenceline concentration.

7.1.1.3 Radon in the Atmosphere

Radon that is emitted from the surface of the Areas 1 and 2, or that migrates from Area 1 into the landfill gas collection system and is subsequently emitted in the discharge from the landfill flare(s), is subject to dilution and dispersion processes active in the atmosphere. The radon flux discussed in Section 7.1.1.1 was measured directly at the ground surface within the confined space of each LAACC. Radon emissions from the Site are immediately dispersed by atmospheric movement as the gas migrates from the ground surface.

Measurements of radon levels in atmospheric air have been conducted at the 13 air monitoring stations installed in 2015 (Figure 4-20) that are operated to obtain baseline air monitoring data for the Site (Auxier, 2014 and Auxier and EMSI, 2016c, d and e and 2017a and b). Radon alpha track detectors were used at the monitoring stations to measure alpha particles emitted from radon and its associated decay products. Radon detectors were installed approximately three feet above the ground surface in housing shelters at the monitoring stations. The radon detectors were collected every three months and sent to an off-site laboratory for analysis[73]. Recorded radon concentrations have ranged from less than 0.4 pCi/L up to 0.7 pCi/L at the 13 perimeter air monitoring stations. Table 7-3 presents a summary of the perimeter air monitoring radon results obtained through October 2016.

Data presented in Table 7-3 indicate the average annual radon concentrations measured at each of the 13 perimeter air monitoring stations between May 1, 2015 and January 7, 2016 are on the order of 0.5 pCi/L or less. To put this in perspective, EPA (2012b) has stated that outside air normally contains approximately 0.4 pCi/L of radon. In the Code of Federal Regulations [40 CFR 192.02(b)(2)] the EPA has indicated that a concentration 0.5 pCi/L above background for radon in air at the perimeter of an inactive uranium processing or depository site that will not pose a substantial present or potential hazard to human health and the environment. Adding EPA's 0.5 pCi/L health-based limit to EPA's nominal background concentration of 0.4 pCi/L yields a concentration limit of 0.9 pCi/L for radon in air (including background) at the property boundary. Concentrations presented in Table 7-3 are less than 0.9 pCi/L.

[73] The track etch detectors were actually deployed for 83 days for the first quarter, 83 days for the second quarter, and 85 days for the third quarter.

EPA has established a standard under UMTRCA (40 C.F.R. § 192.02 (b)(2)) for radon outside of an UMTRCA-regulated disposal facility. The standard specifies that control of residual radioactive materials shall be designed to provide reasonable assurance that releases of Rn-222 from residual radioactive material to the atmosphere will not increase the annual average concentration of Rn-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter. The radon levels measured at the Site (Table 7-3) meet this standard.

EPA also performed air monitoring at five off-site stations, four of which were located in the vicinity of the Site and one of which (EPA station 5) was located in St. Charles, MO. EPA designated station 5 as a reference (or background) station, because it is frequently upwind of the Site and was located further away from the Site than the other stations, but still within the general vicinity so as to be representative of the North St. Louis County and east St. Charles County area (TetraTech, 2015b and 2016a). For the period from April 25, 2015 through February 17, 2015, EPA reported radon levels at its reference (background) station ranging from 0.11 to 1.45 pCi/L with a median value of 0.30 pCi/L (TetraTech, 2015b and 2015g). Results obtained by EPA from all five of the stations ranged from 0.09 up to 1.81 pCi/L (TetraTech, 2015g).

The individual measurement results obtained from the 13 perimeter air monitoring stations located at the Site (*e.g.*, values obtained during any quarter from any stations) ranged from less than 0.4 pCi/L to 0.7 pCi/L (Table 7-3). The average values measured at each of the 13 perimeter air monitoring stations ranged from 0.2 to 0.6 pCi/L (Table 7-3).

The radon levels measured at the 13 air monitoring stations located around the perimeters of Areas 1 and 2 are similar to the levels obtained from the EPA reference (background) station. If the 0.3 pCi/L median value from the EPA reference station were considered to be background, the results from 13 perimeter air monitoring stations at the Site are all within 0.5 pCi/L of the median result obtained by EPA at its reference station. The measured radon levels around the perimeter of the Site therefore comply with the UMTRCA 40 CFR 192.02 (b)(1) standard of not increasing the annual average concentration of radon-222 in air at or above any location outside of the disposal facility by more than one-half pCi/L.

Atoms of radon gas dispersed in air decay, forming atoms of bismuth, polonium, and lead (radon decay products) suspended in the air. These transmuted atoms are formed as electrostatically charged particles that are heavier than the surrounding air. These particles settle out of the atmosphere and are deposited on the ground and other surfaces. If conditions are favorable, the continuing radioactive decay of these transmuted atoms may eventually create a thin layer of elevated lead-210 activity on that exposed surface.

At the same time this atmospheric deposition is occurring at a given location, some of the radon in the soil at that location moves into the air before its decay products can be created. This process, called emanation, can be expected to slightly deplete radon decay products, including lead-210, in the surface soil at the location.

If the soil remains undisturbed, these two competing processes (deposition and emanation) would be expected to produce a multi-layered profile of soils containing slightly different lead-210 concentrations. The lead-210 concentration in the surface layer of this undisturbed layer would, in theory, be slightly elevated while the lead-210 in the soil beneath that would be slightly depleted.

In nature, surface soil is rarely undisturbed. Physical and biological processes like rainfall, plant growth, insect activity and bio-foraging are known to mix the surface soil layer with the soil beneath it. This mixing can be expected to "smear" adjacent surface soil layers into each other.

The USACE has found many types of natural materials at FUSRAP sites including lead-210 (Donakowski, 2015). Elevated Pb-210 in soils is often encountered, due to natural processes involving radon-222 daughter washout from rain events and accumulation, and is not uncommon (Donakowski, 2015). Slightly elevated levels of Pb-210 are commonly found in low lying areas where rain collects and concentrates (Donakowski, 2015). Pb-210 levels ranging up to 20 pCi/g or even higher can be found when analyzing soil and sediment samples collected from these areas (Donakowski, 2015). EPA determined that "[T]he levels of lead-210 found in areas around the West Lake Landfill area are consistent with, and often lower than, naturally occurring levels found in other areas of the United States". (EPA, 2016

7.1.2 Particulate Matter

Airborne particulate matter samples were collected from within Areas 1 and 2 once in 1996 as part of the OU-1 RI investigations. Beginning in May 2015, particulate matter samples have been continuously collected from 13 monitoring stations located around the perimeter of the landfill, primarily around the perimeters of Areas 1 and 2.

7.1.2.1 Fugitive Dust Sampling – 1996

Fugitive dust (particulate matter) sampling was performed by McLaren/Hart on April 11, 1996 as part of the OU-1 RI field investigations. Per the 1996 McLaren/Hart Radon Gas, Landfill Gas and Fugitive Dust report (p. 2-6), sampling in Area 1 was performed upwind and downwind of the radiological hot-spot investigated by soil boring WL-114. Upwind and downwind samples were collected about 40 feet south and 40 feet north of this boring, respectively. In Area 2, sampling was performed upwind and downwind of soil boring WL-210. Upwind and downwind samples were collected about 20 feet south and 30 feet north of this boring, respectively. The McLaren/Hart report states At the time of sampling, the wind was blowing from the south, the wind speed was 14 miles per hour or greater, the temperature ranged between 78 and 82 degrees Fahrenheit, and no rainfall had occurred for three or more days. Sampling was performed approximately 12 inches above the ground surface using a high volume (Hi-Vol) sampler. The Hi-Vol sampler was calibrated before and after the sampling event with a rotameter. The

average flow rate was 4.25 liters per minute. Samples were collected for a duration of 8 hours on closed face filter cassettes.

McLaren/Hart conducted fugitive dust sampling on an extremely windy day (wind speed 14 mph or greater) following a prolonged period with no precipitation to evaluate conditions under an unlikely "worst-case" scenario (McLaren/Hart, 1996d). Fugitive dust sampling was performed at boring location WL-114 in Area 1 and at boring location WL-210 in Area 2 (Figures 4-18 and 4-19). These two areas contained radionuclide activities above the levels used to define RIM (referred to as reference levels during the OU-1 RI) and at or near the highest levels found in any of the surface soil samples obtained in Areas 1 and 2.

Trace levels of both U-238 and Th-232 decay series radionuclides were detected in both the upwind and downwind samples collected from both Area 1 and Area 2 (Appendix H-2). The presence of radionuclides, at or near the minimum detectable activity (MDA) levels, in the fugitive dust samples hampers the evaluation of the results; however, some general observations can be made. Overall, comparison of the results obtained from the upwind and downwind samples indicates that there were few if any differences between the radionuclide levels detected in the upwind and downwind fugitive dust samples. Considering the MDA values and the sigma errors, it can be concluded that the differences in the radiological results between the upwind and downwind locations are very minor.

Review of the U-238 decay series results for Area 1 (Table 7-4) indicates that the Th-230 and Ra-226 levels present in the fugitive dust samples collected in 1996 were similar to or lower at the downwind location compared to the upwind results. A slight increase in the Th-230 level was detected between the upwind and downwind results for Area 2 (Table 7-4). Review of the U-235 decay series results indicates that neither the upwind nor the downwind samples obtained from either Area 1 or Area 2 exceeded the MDA values. Review of the Th-232 decay series results indicates that their activity levels appeared to decrease across the Area 1 fugitive dust sampling location but seemed to increase across the Area 2 sampling location. Based upon the results of the fugitive dust samples, which indicated that the levels at the downwind location were similar or lower to the levels found in the upwind location, there did not appear to be any significant radionuclide transport via fugitive dust occurring in Area 1 at the time of the sampling. There may have been some radionuclide transport via fugitive dust occurring within Area 2 in 1996 at the time the 1996 samples were collected; however, the detected levels were so low, and so close to the MDA values, that meaningful interpretation of the OU-1 RI results was difficult.

Subsequent to the OU-1 RI sampling, the surface of Areas 1 and 2 became heavily vegetated, and inert fill was placed over portions of the surface, both of which reduced the potential for fugitive dust emissions. This reduction is confirmed by the absence of increase levels of radionuclides in the fugitive dust samples currently being collected from around the perimeters of Areas 1 and 2, as discussed below. In addition, those portions of Areas 1 and 2 where RIM was present at the ground surface were recently covered with rock/roadbase material as part of

the construction of the non-combustible cover over these areas, thereby further reducing the potential for emission of radionuclides in fugitive dust.

7.1.2.2 Particulate Matter Monitoring – 2015-2017

Measurements of radionuclides in fugitive dust (particulate samples) have been obtained at the 13 air monitoring stations installed in 2015 and operated to collect baseline air monitoring data for the Site (Auxier, 2014 and Auxier and EMSI, 2016c, d, and e and 2017a and b). Air particulate samples are collected every 28 days and submitted for analysis. Each sample is analyzed for Gross Alpha and Gross Beta levels. The results of the first six quarters (May 2015 through October 2016) of on-site monitoring for gross alpha and gross beta are summarized on Tables 7-5 and 7-6. The results obtained during the first six quarters of operation of the perimeter air monitoring program were compared to the results obtained from the EPA off-site monitoring program over the period from May 2014 through February 2015[74] (Auxier and EMSI, 2016c, d, and e and 2017a and b). The median and maximum concentrations of gross alpha obtained from all 13 Site monitoring locations were approximately three to four times higher than the relative concentrations obtained from EPA's off-site monitoring program. The differences may reflect dust levels, seasonal conditions (pollen levels), differences in precipitation (*i.e.*, soil moisture), or differences in the total particulate levels between the period covered by EPA's air monitoring program and the period covered by the on-site air monitoring program. The gross beta results obtained from the 13 on-site stations are similar to the gross beta results obtained from the EPA off-site monitoring locations.

For the first quarter of sampling (May through July 2015), the May and June 2015 particulate samples were analyzed for isotopic thorium, uranium, and by gamma spectroscopy. Particulate results from September and December 2015 and March, May, and August 2016 (the middle of each respective three-month monitoring period) were also submitted for isotopic analysis and gamma spectroscopy. As expected, the isotopic and the gamma spectroscopy results demonstrate only naturally occurring radioactive materials. Statistics for Th-230, U-238, and combined radium results (the sum of actinium-228 [for Ra-228] and Bi-214 [for Ra-226] from gamma spectrometry) for each station in pCi/m^3 for May, June, September, and December 2015 and March, May and August 2016 are presented on Tables 7-7, 7-8 and 7-9. The results of on-site monitoring for U-238, Th-230, and combined radium were also compared to the results obtained from the EPA off-site monitoring program over the period from May 2014 through February 2015 (Tables 7-7, 7-8 and 7-9). In almost all cases, the isotopic uranium and thorium and combined radium results obtained from the 13 on-site stations are lower than the results obtained from EPA's five off-site stations (Table 7-10). The isotopic results from the Site perimeter air monitoring were converted to µCi/ml and compared to 10 CFR 20 Appendix B Effluent Limits. The results are between one and three orders of magnitude (10 to 1,000 times) below the applicable effluent limits. (Auxier and EMSI, 2016c, d, and e and 2017a and b).

[74] EPA operated four of its monitoring stations over the period from may 2014 through February 2015; however, the fifth station, No. 4 located in the Spanish Village subdivision, was operated through July 2015.

7.1.2.3 Summary of Potential Migration in Particulate Matter

What is now OU-1 was previously an active landfill. As such, the surface conditions would have been variable and subject to the materials handled on any given day. Prior to approximately 1974 or possibly up through 1976, Areas 1 and 2 were used for landfilling of solid wastes and for other activities conducted in conjunction with the then-active limestone quarry operations. When landfill operations ceased in OU-1, natural ecological succession produced a variety of vegetated areas. Based on review of historical aerial photographs, from the time of completion of placement of wastes in Areas 1 and 2 in approximately 1974 or 1976, up through completion of quarry operations in 1985, portions of the surface of Area 1 and large portions of the surface of Area 2 were used for stockpiling of materials generated by the ongoing limestone quarrying operations. Review of the aerial photographs indicates that those portions of Areas 1 and 2 that were not used for stockpile purposes were covered with grasses or other low height vegetation. With the cessation of quarrying operations in 1985, Areas 1 and 2 do not appear to have been used for any purpose. At the time of the OU-1 RI field investigations (1994-1997), only grasses and small shrubs were present on Areas 1 and 2. With the lack of use of these areas and no active maintenance (mowing) program, over time larger vegetation including trees and shrubs began to grow on Areas 1 and 2. By 1995, large trees are present on the northern and western slopes of Area 2 and in isolated portions of Area 2. By 2003, extensive vegetation cover including grasses, shrubs and trees is present over the majority of Areas 1 and 2, although a few areas of bare soil are still present near the entrance to Area 2. The presence of the extensive vegetative cover, there to have limited the potential for radionuclide migration in fugitive dust during or after the OU-1 RI investigations.

In 2016, the vegetation was cleared and geotextile and 8 inches of rock material were placed over areas where RIM was estimated to be present at the ground surface in Areas 1 and 2 as part of the construction of a non-combustible cover over these areas. The presence of the rock cover over areas where RIM was present at the ground surface reduces the potential for radionuclide migration in fugitive dust from Areas 1 and 2. Based on the monitoring results obtained in 1995 in conjunction with the OU-1 RI investigations and the more recent (2015 and 2016) monitoring results, coupled with the presence of the prior vegetative cover and most recently the rock cover over Areas 1 and 2, atmospheric transport of radionuclides in fugitive dust does not appear to have been or currently be a significant pathway for off-site migration, at least over the time period during which the Site has been investigated (approximately 1995 through the present).

7.2 Stormwater Transport

Radionuclides present in Areas 1 and 2 could potentially be transported to other portions of the Site or to off-site areas via precipitation runoff. Erosion by precipitation and subsequent transport in rainwater/snowmelt runoff is a potential pathway by which radionuclides present in Areas 1 and 2 could migrate off-site. Transport of radionuclides in runoff may occur by three possible mechanisms: dissolved transport, transport of suspended sediment, and transport of

bedload sediment. The first two of these mechanisms are discussed in this sub-section. Sediment transport is discussed in the next sub-section.

Transport via rainwater runoff would include both dissolved phase transport and suspended phase transport within the flowing runoff water. Transport of radionuclides by these mechanisms is addressed below. Potential impacts to permanent surface water bodies, as well as the actual or potential receptors of any off-site migration of radionuclides in rainwater runoff, are also addressed in this section. Erosional transport of soil and sediment in conjunction with rainwater runoff or other processes is discussed in the next sub-section of this report.

It should be noted that this section discusses the results of surface water sampling conducted in 1995 – 1997 as part of the OU-1 RI field investigations, which were performed before the extensive vegetation cover developed on Areas 1 and 2, before the inert fill material was placed on the surface of Areas 1 and 2, and before the recent installation of a non-combustible cover over areas where RIM was present at the ground surface in Areas 1 and 2. All of these actions would serve to reduce the potential for radionuclide transport in surface water. This conclusion is supported by the results of the recent stormwater monitoring activities (discussed in Section 7.2.1.2 below) conducted in conjunction with installation of the non-combustible cover.

7.2.1 OU-1 RI Rainwater Runoff Sampling (1995-1997)

Dissolved and total concentrations measured in the rainwater/runoff samples obtained from various locations (Figure 4-13) during the OU-1 RI were compared to published standards and criteria to assist in the identification of contaminant occurrences and to perform an initial evaluation of the magnitude and significance of these occurrences. The primary criteria considered were the drinking water standards for Ra-226, Ra-228 and gross alpha particle radioactivity published in Section 10 CSR 60-4.060 of the Missouri Code of State Regulations. These standards include the following:

> *For radium-226, radium-228 and gross alpha particle radioactivity, the maximum contaminant level (MCL) shall be:*
>
> > *Combining radium-226 and radium-228, five picocuries (5pCi) per liter. A gross alpha particle activity measurement may be substituted for the required radium-226 and radium-228 analysis, but only if the measured gross alpha particle activity does not exceed five (5) pCi/l.*
> >
> > *Measuring gross alpha particle activity, including radium-226 but excluding radon and uranium, fifteen (15) pCi/l. When the gross alpha particle activity exceeds five (5) pCi/l, the same or an equivalent sample must be analyzed for radium-226. If the concentration of radium-226 exceeds three (3) pCi/l the same or an equivalent sample shall be analyzed for radium-228.*

In order to assess the potential for radionuclide migration in rainwater runoff, McLaren/Hart installed weirs at nine locations to obtain runoff flow measurements and samples of rainwater runoff (McLaren/Hart, 1996e). These nine locations included four locations in Area 1 and five locations in Area 2 (Figure 4-13). An additional location (Weir 10) was established by EMSI in Area 2 to assess the effects of mixing of Area 2 runoff with runoff from other areas of the Site outside of Areas 1 and 2 at Weir 9 (Figure 4-13).

The EPA-approved RI/FS Work Plan envisioned that all nine locations would be sampled during the same runoff event; however, during the initial RI field investigations, runoff sufficient to allow for sample collection was not present at all nine locations during any particular precipitation event (McLaren/Hart, 1996e). In addition, the EPA-approved RI/FS Work Plan did not include analysis of the runoff samples for gross alpha radioactivity. Furthermore, the MDA levels achieved during the initial sampling events were not sufficiently low enough to allow for comparison of the results to the drinking water standards. As a result, additional sampling was performed by EMSI pursuant to an ASAP approved by EPA (EMSI, 1997a). Precipitation events occurring after EPA's approval of the ASAP were also not sufficiently intense to permit sampling of all of the runoff locations.

Although neither McLaren/Hart nor EMSI were able to obtain samples from all of the runoff locations during a single sampling event, samples were obtained from nine of the ten runoff locations (all except Weir 6) during the various sampling events. At some of the sample sites (Weirs 8 and 9), flowing water was not present at the time of sample collection; however, ponded water was present at these locations and samples of the ponded water were obtained. The analytical results for rainwater runoff samples collected by McLaren/Hart and EMSI are presented in Appendix G-1.

Review of the rainwater runoff results indicates that radium levels above the drinking water standard were present only in the sample from Weir 9. Specifically, the Ra-226 level detected in the unfiltered sample obtained in April 1996 from this location was 8.85 pCi/L, compared to the drinking water standard of 5 pCi/L. However, the filtered sample obtained from this location during the same sampling event contained only 0.80 pCi/L, indicating that the majority of the Ra-226 detected in the unfiltered sample was present as suspended sediment. Due to high MDA levels, the Ra-228 results for this sampling event did not provide any meaningful data (for purposes of comparison to the MCL). Subsequent sampling of rainwater runoff (both filtered and unfiltered samples) from this location in May 1997 indicated that the combined Ra-226 (0.32 pCi/L) and Ra-228 (<0.87 pCi/L) did not exceed the drinking water standard of 5 pCi/L.

As discussed in Section 7.3 below as part of the evaluation of sediment migration, the fate of any surface water or sediment that migrates from the vicinity of Weir 9 would be to enter the drainage ditch along the interior access road. From the drainage ditch along the interior access road, surface water and transported sediment would potentially flow into the drainage ditch along the north side of the Site access road and ultimately could enter the perimeter drainage ditch along the northeastern boundary of the Site the Northeast Perimeter Drainage Ditch located on

southwestern side of St. Charles Rock Road). Any runoff water or sediment that enters the perimeter drainage ditch would flow into the North Surface Water Body (Figure 4-13). The North Surface Water Body is currently located partially on on-site property and partially on off-site property owned by STL Properties LLC (the former Emerson Electric property), and its composition has changed over time. Specifically, the portion that is located on the landfill property became overgrown and silted in and is now primarily a swamp-like area, except during periods of heavy rainfall, when water ponds in this area (see prior discussion in Section 5.3.3.4).

In addition to Ra-226, McLaren/Hart analyzed rainwater runoff samples from Area 1 for Th-228, -230, and –232 as well as U-235/236 and U-238. With the exception of U-238, the concentrations of these radionuclides were below 1 pCi/L. The concentrations of U-238 varied from 0.36 to 3.66 pCi/L.

The rainwater runoff samples from Area 2 were analyzed by McLaren/Hart for all the radionuclides in the three decay series; however, the MDA levels for Th-234, Pb-214, Bi-214, Pb-210, U-235, Pa-231, Ac-227, Ra-223, Ra-228, Ra-224, Pb-212, and thallium-208 all exceeded 10 pCi/L. The radionuclides measured in the rainwater runoff sample from Weir 5 had concentrations that generally ranged from 1 to 6 pCi/L except for U-234 and U-238, for which the concentrations generally ranged between 40 and 49 pCi/L. The other Area 2 sampling locations displayed radionuclide concentrations that were similar to those measured in the rainwater runoff samples obtained in Area 1.

7.2.2 NCC and OU-1 Stormwater Samples (2016-2017)

As previously discussed in Section 4.12.2.2, pursuant to the initial and the revised plans stormwater monitoring plans for the UAO for Removal Action (Surface Fire Prevention) and EPA's associated comment letters, stormwater monitoring has been performed at up to 11 locations (Figure 4-16) including the following:

- OU-1-001 (formerly NCC-001)
- OU-1-002 (formerly NCC-002)
- OU-1-003A (formerly NCC-003A and also NCC-003)
- OU-1-004 (formerly NCC-004)
- OU-1-005
- OU-1-006
- OU-1-007
- OU-1-008
- OU-1-009
- OU-1-010
- OU-1-011

In addition, the northern and northwestern boundaries of Area 2 are observed for evidence of stormwater runoff (such as erosional channels or sediment deposition areas); however, no indication of any stormwater discharge has ever been observed in these areas.

The results of the laboratory analyses for radionuclides are summarized on Table 7-11. Results of analyses for physical and chemical parameters are summarized on Table 8-2 and discussed in Section 8.6. The laboratory analytical results for these samples are presented in Appendix G-4.

All of the stormwater samples obtained to date, contained only background levels of radium and uranium. The reported activity concentrations of combined Ra-226 plus Ra-228 for these samples were all less than the radium drinking water standard of 5 pCi/L. Total uranium results were all less than the 30 ug/L MCL for drinking water supplies (Table 7-11).

7.2.3 Surface Water Samples

During the OU-1 RI field investigations, McLaren/Hart in 1995 and EMSI in 1997 collected samples of permanent surface water adjacent to the Site into which runoff from the Site may flow. Samples were also collected to assess the nature and extent of contamination at and migrating from Areas 1 and 2. The two surface water bodies adjacent to the Site are the North Surface Water Body and the Earth City Flood Control Channel. The surface water sampling locations associated with these two water bodies are shown on Figure 4-13. As discussed in the previous section, runoff from Areas 1 and 2 could potentially flow into the North Surface Water Body. Based on topographic conditions, runoff from Area 1 and most of Area 2 cannot reach the flood control channel; however, runoff from the northwest portion of Area 2, the Buffer Zone and Crossroads Lot 2A2 could potentially flow to the southwestern portion of Lot 2A1 and reach the culvert that conveys runoff beneath Old St. Charles Rock Road to the flood control channel.

McLaren/Hart and EMSI each collected surface water samples from these two surface water bodies. Sampling point SW-1 was established by McLaren/Hart (1996e) in the Earth City Flood Control Channel near the northwestern boundary of the Area 2 just to the west of Old St. Charles Rock Road. Sampling point SW-2 was established by McLaren/Hart (1996e) in an area of ponded water located at the north end of the drainage ditch on the south side of St. Charles Rock Road which was identified by McLaren/Hart as the “North Surface Water Body.” This second surface water sampling point is located at the north end of the landfill property.

The results of the sampling and analyses of these two surface water locations are included in Appendix G-1. Gross alpha measurements were only obtained in 1997. These results did not exceed the drinking water MCL of 15 pCi/L for gross alpha. Furthermore, none of the radium sample results exceeded the drinking water MCL for combined total for Ra-226 and Ra-228 of 5 pCi/L.

The Ra-228 results obtained by McLaren/Hart (1996e) could not be directly evaluated relative to the MCL because of high MDA levels (>200 pCi/L). The Ra-226 concentrations detected in the

McLaren/Hart samples were generally less than the concentrations detected in the EMSI samples. The activities for Ra-226 and Ra-228 were nearly equal for each sample collected by EMSI. Assuming the Ra-228 concentrations in the McLaren/Hart samples also are approximately equal to the Ra-226 values, then the McLaren/Hart results would not have exceeded the MCL.

7.2.4 Summary and Conclusions Regarding Stormwater Transport

Based on these analytical results, rainwater runoff represents a potential pathway for radionuclide migration from Areas 1 and 2. Rainwater runoff potentially containing dissolved or suspended radionuclides could potentially be transported from Area 1 or the southeastern portion of Area 2 into the drainage ditches at the Site. Depending upon the magnitude and duration of the storm event associated with any rainwater runoff transport, dissolved or suspended radionuclides could be further transported into the Northeast Perimeter Drainage Ditch. From the Northeast Perimeter Drainage Ditch, dissolved or suspended radionuclides could potentially enter the North Surface Water Body depending upon the magnitude and duration of the rainwater runoff. Similarly, rainwater runoff potentially containing dissolved or suspended radionuclides could potentially be transported from the western portions of Area 2, down the landfill slope and onto the Buffer Zone or Lot 2A2 of the Crossroads Industrial Park (currently occupied by AAA Trailer).

In either case, depending upon the magnitude and the duration of the rainwater runoff event, the resultant surface water flow may not extend all the way to the North Surface Water Body or all the way on to the Buffer Zone or Lot 2A2. The extent to which the suspended or dissolved radionuclides are transported via rainwater runoff depends upon the magnitude (intensity and duration) of the precipitation event and the resultant surface water runoff. If continuous surface water flow is not established all the way to the North Surface Water Body or the Buffer Zone or Lot 2A2, the dissolved and suspended radionuclides would be deposited as sediment along the drainage channels. Once deposited, these materials could remain in place, become buried by subsequent sediment deposition, or be eroded and re-suspended or dissolved by a subsequent runoff event and be further transported along the drainage channels. Ultimately, given sufficient flow from a single event or sufficient flow and erosion from multiple events, any radionuclides that are transported by rainwater runoff from Areas 1 and 2 could be deposited along with other sediments in the North Surface Water Body or on the surface of the Buffer Zone or Lot 2A2.

Based on the results of the rainwater/stormwater runoff and surface water sampling performed during the OU-1 RI field investigations and the more recent stormwater monitoring, dissolved or suspended transport in rainwater/stormwater runoff does represent a potential migration pathway for transport of radionuclides from Areas 1 and 2. Given the relatively low levels of radionuclides present in the rainwater/stormwater runoff and the lack of significant impacts in the surface water bodies, this pathway is not considered to be a major mechanism for transport of radionuclides from Areas 1 and 2. Further, installation of the non-combustible cover reduces the

potential for stormwater contact with RIM. The results of the 2016 stormwater monitoring further support this conclusion.

7.3 Sediment Transport

Erosional transport of soil and sediment on-site and off-site is the third migration pathway identified for OU-1. Sediment represents soil material that potentially was eroded by stormwater runoff and transported from the surface of Area 1 or 2 and subsequently deposited in areas adjacent to or down from Areas 1 and 2, principally within stormwater drainage channels downstream of Areas 1 and 2. Potential sediment transport pathways include stormwater drainage channels and erosion of sediment from the northern slope (landfill berm) of Area 2.

Sediment samples were collected by McLaren/Hart in 1995 and EMSI in 1997 as part of the OU-1 RI field investigations. During the OU-1 RI investigations performed by McLaren/Hart in 1995-1996 and EMSI in 1997, sediment transport was evaluated by collecting and analyzing unfiltered rainwater-runoff samples to evaluate the radionuclide and chemical concentrations in suspended sediment. Additionally, in 1997 EMSI collected samples from four locations (SED-1, -2, -3 and -4, see Figure 4-13) where sediment, potentially derived from Area 1 or 2, may accumulate in perimeter drainage channels. Additional sediment samples were obtained in 2016 and 2017 as part of the Additional Characterization of Areas 1 and 2 and as part of stormwater monitoring conducted in conjunction with NCC construction. Sediment samples were collected in 2016 from OU-1 RI sampling locations SED-1, -2 and -4. Sediment samples were also collected from seven additional locations specified by EPA including SEDIMENT-2016-03-16A and SEDIMENT-2016-03-16B and SED-6, -7, -8, -9, and -10 in 2016 and 2017 (Figure 4-14). Additional discussion regarding the collection of sediment samples can be found in Section 4.12.1 and 4.12.2.1.

Analytical results for the sediment samples collected during each of these sampling events are summarized in Appendix G-2 (OU-1 RI field investigation results), G-3 (Additional Characterization sediment sample results), and G-4 (non-combustible cover stormwater monitoring sediment sample results). Results of the radionuclide analyses of the various sediment samples are summarized on Table 7-12.

7.3.1 Sediment Sample Results

Sediment samples were collected from the locations of the various rainwater runoff weirs by McLaren/Hart in 1995 and EMSI in 1997 as part of the OU-1 RI field investigations (Figure 4-13). EMSI also collected sediment samples from four locations along the Site stormwater conveyance ditches in 1997 (Figure 4-13). In 2016, three of these same four locations were re-sampled as part of the Additional Characterization of Areas 1 and 2 (Figure 4-14). Two additional sediment samples were collected as part of the non-combustible cover work: one from Lot 2A2 (AAA Trailer) near the invert to the culvert that conveys stormwater from the AAA

Trailer property and the Buffer Zone to the Earth City Flood Control Channel, and a second from a stormwater channel located along the north side of the Site entrance road, immediately north of the landfill office building (Figure 4-14). Eight additional sediment samples were also obtained in 2016 and 2017 from the Northeast Perimeter Drainage Ditch: three at the location of SED-4, and five additional samples (SED-6 through SED-10) at approximately 100-foot increments to the north (*i.e.*, downstream) of SED-4.

7.3.1.1 Sediment Samples from Surface Drainage Channels (1995-1997)

To assess the potential migration of radionuclides in sediment along the surface water drainage channels, samples were obtained of the sediments present at each of the various rainwater runoff locations. Two sets of sediment samples were collected. The first set of sediment samples was collected by McLaren/Hart from the Area 1 weir locations in May 1995 and from the Area 2 weir locations in April 1996 (McLaren/Hart, 1996e). A second set of sediment samples was collected by EMSI in May 1997. The purpose of collecting these sediment samples was to evaluate the potential for radionuclide transport in sediments at the various weir locations.

The following discussion presents a summary of the OU-1 RI field investigation results for Th-230 and Ra-226 in the sediment samples collected from the various weirs installed to monitor stormwater runoff and sediment transport in Areas 1 and 2. The exit points for sediment from OU-1 differ for Area 1 and Area 2, so they will be discussed separately.

7.3.1.1.1 Area 1 Surface Drainage Sediment

The sediment samples from Weirs 1, 2, 3 and 4, which were located in Area 1, represent soil material eroded from the surface of Area 1. Based upon the surface topography of Area 1, soil eroded from the surface of Area 1 is transported to the north-northwest to the drainage ditch located on the north side of Area 1 along the south side of the main Site access road. Accumulated sediments in the drainage ditch along the north-northwest boundary of Area 1 can potentially be transported to the northeast along the ditch to the Site boundary. From this drainage ditch, transported sediments could migrate into the Northeast Perimeter Drainage Ditch. Water and sediments present in the Northeast Perimeter Drainage Ditch could subsequently migrate to the northwest to the North Surface Water Body located at the north end of the landfill property, extending northward onto the Crossroads Industrial Park.

McLaren/Hart collected sediment samples from each of the four weir locations in Area 1 (Figure 4-13) in May 1995. Results of the analyses of these samples indicated that the sediment that accumulated at Weirs 2 and 3 contained Th-230 activities greater than the 7.9 pCi/g level used to identify RIM (see prior discussion in Section 6.2). Thorium-232 was only detected at levels above approximately 1 pCi/g in samples that contained Th-230 levels greater than 7.9 pCi/g (Appendix G-2)). Sediment that accumulated in Weir 2 in 1995 contained Ra-226 above the 7.9 pCi/g level but this was not the case for the subsequent 1997 sample from this same location

(Appendix G-2). None of the other sediment samples obtained from the Area 1 weirs contained radium above 7.9 pCi/g (Appendix G-2).

7.3.1.1.2 Area 2 Surface Drainage Sediment

Sediment samples were obtained by McLaren/Hart on April 29, 1996 from the five original weir locations (Weirs 5, 6, 7, 8, and 9) in Area 2. Weirs 5, 6 and 7 were located along the northwest portion of Area 2 at the top of the landfill slope above what at the time was the Ford property, and later the Buffer Zone. All three of these locations potentially drain down onto the Buffer Zone. Weirs 8 and 9 were located in the southwestern portion of Area 2. Runoff and sediment from the southwest portion of Area 2 is transported to the southeast along the drainage located adjacent to the internal access road that ultimately joins the drainage ditch along the north side of the Site access road. Any sediments transported from Area 2 along the internal access road drainage to the Site access road drainage ditches could potentially be transported to the Northeast Perimeter Drainage Ditch along St. Charles Rock Road and ultimately could enter the North Surface Water Body.

Review of the analytical results indicates that sediment samples obtained from Weirs 5, 6, 7 and 9 in Area 2 (Figure 4-13) contained Th-230 activities greater than 7.9 pCi/g (Appendix G-2). In addition, as will be discussed below, sediment transport from Area 2 down the landfill berm onto the former Ford property had occurred historically. Based on the results of the soil sampling on the former Ford property (current Buffer Zone and Lot 2A2), erosion of surface soil in Area 2 and subsequent sediment transport onto the former Ford property had occurred. Prior to 2016, a potential existed for further erosion and transport of Area 2 surface soils down the landfill berm and potentially out onto the Buffer Zone or Lot 2A2 of the Crossroads Industrial Park. In 2016, areas where RIM was exposed at the surface were covered with rock (roadbase) and the north slope of Area 2 above the Buffer Zone was covered with a rock buttress. Based on the limited amount of runoff observed in Weirs 5, 6 and 7 during rainwater runoff sampling activities, sediment transport from Area 2 down the landfill berm was an infrequent event that apparently only occurred in response to major storm events. Although the rainwater runoff and sediment sampling results did not indicate that sediment transport from Area 2 onto the Ford property was occurring during the RI field investigations (1995-1997), the potential for such transport in response to significant precipitation events cannot be discounted.

Surface water and sediment transport from Area 2 through the vicinity of Weir 9 would flow along the interior access road to the drainage ditch located along the northern side of the Site access road to the Northeast Perimeter Drainage Ditch. Sample SED-2 (see discussion below), collected from the Northeast Perimeter Drainage Ditch at the confluence with the northern drainage ditch along the Site access road, did not contain radionuclides above background levels; therefore, sediment migration from Weir 9 does not appear to extend to off-site areas. The potential for transport of suspended sediment containing radionuclides via this pathway is discussed further below relative to the results obtained from NCC-003 and NCC/OU-1-003A and sediment sample (2016-03-16A).

7.3.1.1.3 Northeast Perimeter Drainage Ditch and Access Road Drainage Ditch

In order to assess the extent of radionuclide transport in sediments from Area 1, in May 1997 EMSI collected sediment samples from four locations (SED-1, SED-2, SED-3, and SED-4) along the drainage ditches located both north and south of the landfill access road, and from the Northeast Perimeter Drainage Ditch. These four additional sample locations are also shown on Figure 4-13.

Sample SED-1 was located at the intersection of the property boundary and the drainage ditch south of the main landfill access road. An original and a duplicate sample were obtained by EMSI from this location. A laboratory duplicate sample was also analyzed. None of these samples contained thorium or radium activities greater than the criteria used to identify RIM

Samples were also collected in the drainage ditch north of the landfill access road (SED-2) and at two locations in the Northeast Perimeter Drainage Ditch (SED-3 and SED-4, see Figure 4-13). No radionuclides were reported to be present at activities greater than the levels used to define RIM

Based on the results of the 1995-1997 sediment sampling, the 2000 OU-1 RI concluded that erosion of surface soils in Area 1 and subsequent sediment transport to the north-northwest boundary of Area 1 into the Site access road drainage ditch had occurred and continued to occur in response to significant precipitation events. Additional sediment samples were obtained from SED-1, SED-2 and SED-4 in 2016 in conjunction with the Additional Characterization of Areas 1 and 2.

7.3.1.2 Post-ROD Sediment Sample Results (2016)

Additional sediment samples were also obtained in 2016 and 2017 from the Northeast Perimeter Drainage Ditch at the location of SED-4 and at approximately 100-foot increments 100, 200 and 300 feet to the north of SED-4. Analytical results for all of these samples are presented included in Appendix G-3 and summarized on Table 7-12.

Review of these data indicate that the investigative sample and EPA split sample obtained from SED-4 on January 8, 2016, were the only sediment samples that contained thorium at a level greater than that use to identify RIM. A subsequent sample obtained from this location contained thorium activities below the level used to identify RIM. These results may reflect the overall heterogeneity of the thorium occurrences in sediment. None of the five samples obtained downstream of SED-4 contained thorium activities greater than the level used to identify RIM. In addition, none of the sediment samples contained radium activities greater than the level used to identify RIM.

An additional sediment sample (2016-03-16A) was collected in March 2016 from the interior drainage channel located along the north side of the Site access road, immediately to the north of

the landfill office building. With the exception of Potassium-40 (K-40), which is not a known contaminant at the Site, Pb-210 (3.32 pCi/g in the investigative sample and 4.76 pCi/g in the laboratory duplicate analysis) was the only radionuclide detected in this sample at a level near its PRG (4.17 pCi/g).

7.3.2 Potential Migration by Sediment Transport

Although the sediment sampling results do not indicate that significant sediment transport had occurred along the Northeast Perimeter Drainage Ditch north of the culvert beneath the landfill access road, the potential for sediment migration to the northwest along the Northeast Perimeter Drainage Ditch cannot be eliminated. However, to the extent that sediment transport may occur along the Northeast Perimeter Drainage Ditch, any sediments that may be transported along this pathway would accumulate in the North Surface Water Body and, due to the stilling effects of this water body, would be unlikely to be transported further off-site.

After the OU-1 RI sampling took place, extensive vegetation cover developed on Areas 1 and 2 and inert fill material was placed on the surface of Areas 1 and 2. In addition, in 2016 a non-combustible cover consisting of rock and road base material was placed over areas where RIM was present at the ground surface in Areas 1 and 2. All of these actions would serve to reduce the potential for erosion of soil containing radionuclides and transport of such soil as sediment.

7.3.2.1 Sediment Transport from Area 2 Slope Erosion

The northern portion of Area 2 is characterized by a landfill slope/berm of approximately 20 to 30 feet average height. Reportedly, a historic failure of this slope/berm occurred, resulting in transport of radiologically impacted materials from Area 2 onto the adjacent Ford property (which later became the Buffer Zone and Lot 2A2). The exact nature of this historic failure has not been described in any historical reports of conditions at the Site. In addition, the area of this historic failure subsequently became heavily vegetated, as did all of the landfill berm slope, and therefore no visual evidence of this historic failure remains. The presence of the vegetative cover reduced the potential for further erosion, and no evidence of significant erosion was observed during the OU-1 RI investigations in 1994-1997 or after these investigations, including during and immediately after the 500- and 300-year flood events that occurred in 1993 and 1995. This area was also recently covered with a rock buttress as part of the construction of the non-combustible cover over Area 2. The rock buttress isolates soil containing radionuclides in the Area 2 slope from possible erosion.

It had been postulated that the occurrences of radionuclides on the former Ford property possibly were the result of significant mass wasting (landslide or other slope failure) of the landfill slope; however, the available data indicate that this is not correct. Specifically, based upon inspection of the area, review of aerial photographs and reports of individuals present at the time, the reported “slope failure” actually was scouring and erosional transport of soil from the landfill

berm slope down onto the adjacent former Ford property that reportedly occurred a year or two after disposal activities in Area 2 ceased (personal communication with William Whitaker). Specifically, rainwater runoff flowed across and eroded channels in the surface of Area 2 and the landfill berm as a result of the presence of a road along the landfill slope that acted to collect and focus runoff from Area 2 down the face of the landfill berm. This historic erosional scour resulted in transport of soil, some of which contained radionuclides, from Area 2 down onto the adjacent Ford property (current Buffer Zone and Lot 2A2) where it meets the toe of the landfill berm. This runoff and erosion was subsequently stopped through the construction of runoff diversion berms and natural re-vegetation of the landfill slope.

The conclusion that the historic transport of radionuclides onto the former Ford property was the result of erosional processes rather than mass wasting is further supported by observations made and data obtained during the RI. First, occurrences of radionuclides on the Ford property were limited to surficial materials with a depth of six or at most twelve inches or less. The shallow depth of radionuclide occurrences on the Ford property are not consistent with a deep-seated slope failure, but instead are consistent with erosional transport and sediment deposition processes in response to an extreme storm event(s). In addition, the establishment of extensive vegetative growth, including mature trees, along the landfill berm is inconsistent with an unstable slope. Furthermore, no slope failure or significant erosional loss was observed to occur during the record precipitation events recorded in 1993 and 1995.

Regardless of the mechanism of past transport, soil samples collected by McLaren/Hart and by EMSI indicate that transport of radiologically impacted soils from Area 2 onto the Ford property adjacent to Area 2 has historically occurred (see Section 6.7 and Table 6-7). Although the subsequent establishment of vegetation on the landfill berm and construction of surface water diversion berms would have reduced the potential for future erosional transport of Area 2 soils onto the adjacent property, the potential for future transport of Area 2 soils onto the adjacent property still existed prior to 2016. Results of the analyses of the erosional weir sediment samples obtained from this area (weir locations 5, 6 and 7) indicates that some limited transport of soil/sediment potentially could have occurred from the berm along the western portion of Area 2 in response to major storm events as discussed in Section 7.3.1.1 above. Therefore, erosion and subsequent transport of surficial soils within Area 2 continues to represent a potential mechanism for transport of radionuclides from Area 2.

Analytical results from soil samples collected from the Ford property during the OU-1 RI field investigation (previously discussed in Section 6.7) indicated that past transport of radionuclides onto the former Ford property was limited to the upper 6 inches of soil. As discussed in Section 6.7, the current extent of radionuclide occurrences in the Buffer Zone and Crossroads Lots 2A1 and 2A2 is unknown because these areas were graded subsequent to when the most recent samples were collected from these areas; however, all of these areas are currently covered with rock, either as part of the NCC or as part of the trailer parking area on Lot 2A.2.

At some point after this erosion occurred, berms were constructed at the top of the slope off Area 2. No information has been found regarding the dates or design of these berms. The presence of

these berms combined with the natural re-vegetation of Area 2 and the landfill slope have served to reduce the potential for erosional transport of soil from Area 2 onto the adjacent Buffer Zone and Crossroad property.

The potential for future significant erosional failure of the landfill slope prior to implementation of the remedy is minimal based on the following:

- The presence of diversion berms at the top of the landfill slope;
- The surface and vegetative conditions along the slope;
- Evaluation of sediment erosion and deposition mechanisms;
- The lack of discernible erosion on the slope following significant precipitation events in 1993 and 1995; and
- The placement of a rock buttress along that portion of the Area 2 slope that is adjacent to the Buffer Zone as part of construction of the non-combustible cover in 2016.

However, transport of sediments from Area 2 onto the adjacent Buffer Zone or Lot 2A2 of the Crossroads Industrial Park does represent a potential pathway for migration of radionuclides, although the current presence of the NCC serves to reduce that risk by isolating the RIM from contact with stormwater.

It should be noted that an additional sediment sample (2016-03-16A) was collected in March 2016 from near the inlet to the drainage culvert that conveys stormwater from the AAA Trailer property, and during significant storm events potentially from the Buffer Zone, to the Earth City Flood Control Channel (Figure 4-14). With the exception of K-40, which is not a Site-related constituent, no radionuclides were detected in this sample at levels above the EPA PRGs. These results indicate that to the extent that erosional transport from Area 2 may have occurred in the past, it appears that the extent of radionuclides resulting from such transport was limited to the Buffer Zone and Lots 2A1 and 2A2. The areas where RIM was present at the ground surface in Area 2 as well as the Buffer Zone and Lots 2A1 and 2A2 have since been covered in rock and or pavement such that no further erosional transport of radionuclides to or from these areas should occur.

7.4 Radionuclides in Perched Groundwater or the Former Leachate Seep (1995)

The fourth potential migration pathway identified for OU-1 is discharge of perched water or leachate within the landfill to the ground surface or to surface water bodies. During McLaren/Hart's drilling of the various OU-1 RI field investigation borings in Areas 1 and 2 in 1995, shallow perched water was encountered at several locations. In addition to the perched

water, McLaren/Hart identified one leachate seep in the northwest corner of Area 2. Perched water or leachate was not encountered during the 2013 - 2015 drilling of the Phase 1 investigation borings in Area 1 or the 2015 drilling of the Additional Characterization borings or the Cotter investigation borings in Areas 1 and 2. No leachate seeps were identified during any of the 2013-2016 investigations, although after a period of extensive heavy rain in May 2016 seepage into an area of ponded rainwater was observed in the northeast portion of Area 2. This seepage disappeared within two to three days, coincident with a decrease in the amount of rainfall. Because this seepage occurred within a broader, contained area of ponded water on the surface of Area 2, with no potential for discharge, a sample was not collected. The area where the seep was identified to occur in 1995 subsequently became overgrown with vegetation so no subsequent observations of potential seepage were made during or after the OU-1 RI work. The area of the seep was inspected on May 12, 2017, and it was found that seepage was occurring in this area; however, this seepage remains localized and no seepage or flow has ever been observed on the face of the Area 2 slope.

Figure 4-9 presents the distribution of perched water identified within Areas 1 and 2 and the location of the leachate seep observed during the 1995 RI field investigation. As can be seen from Figure 4-9 and as indicated by McLaren/Hart in the Soil Boring/Surface Soil Investigation Report (McLaren/Hart, 1996h), the distribution of perched water was of limited extent and the various perched waters were isolated in nature. Surface seepage of perched water appears to only have occurred in the southwestern corner of Area 2 at the location of the leachate seep identified by McLaren/Hart in 1995.

Four perched water samples, including one from Area 1 and three from Area 2, were collected by McLaren/Hart in 1995 and analyzed for radionuclides. In addition, one sample was obtained from the leachate seep. Results of the perched groundwater and leachate sample radiological analyses are presented in Appendix D-9 along with a compilation of all of the analytical results for the perched water and leachate seep samples.

Results of the radiological analyses indicate that U-238 decay series constituents were present in both the perched water samples and the Area 2 leachate seep. U-238, Th-234, U-234 and Th-230 were detected in the perched water samples. All of the radionuclides were present at levels less than 1 pCi/L except for Th-230 in the WL-220 (1.72 pCi/L) and WL-231 (3.70 pCi/L) perched water samples[75]. U-238, U-234, Th-230, and Ra-226 were all present at levels less than 1 pCi/L in the Area 2 seep samples. No U-235 decay series constituents were detected in the perched water samples. Th-232 decay series constituents were detected in only one of the perched water

[75] A sample of perched water obtained from boring WL-219 reportedly contained 133 pCi/L of thorium-234. McLaren/Hart determined that the reported result for Th-234 for this sample was a false positive. The half-life of thorium-234 is 24 days and therefore thorium-234 should be in secular equilibrium with uranium-238. Review of parent and daughter products of thorium-234 indicate that secular equilibrium conditions exist and that the thorium-234 concentration should approximate 0.35 to 0.39 pCi/L. This is noted on the table of the perched water results included in Appendix D-9. Furthermore, boring WL-219 is not located within Area 2, but instead was drilled in the area of the Inactive Sanitary Landfill (see Figure 4-6).

samples: the sample obtained from boring WL-219 in Area 2. This sample contained low levels of Th-232 (0.042 pCi/L) and Th-228 (0.12 pCi/L).

The levels of the U-238 decay series constituents detected in the leachate seep sample were similar to those found in the background groundwater monitoring wells. In addition, Ra-226 was detected at 0.83 pCi/L in this sample, below the MCL of 5 pCi/L for combined Ra-226 and Ra-228. No analytical results are available for Ra-228 due to elevated MDA values.

7.5 Radionuclides in Groundwater

This section of the RI Addendum presents a summary evaluation of radionuclide occurrences (radium, thorium and uranium isotopes) in groundwater with an emphasis on radium occurrences in groundwater near Areas 1 and 2. Radionuclide water quality results are discussed in terms of radium isotopes, thorium isotopes, and uranium isotopes. Because radium isotopes are the primary radionuclides of concern (in terms of both general occurrences in groundwater, mobility, and potential health risks), the majority of the discussion of the radionuclide water quality results is focused on occurrences of radium in groundwater. The discussions in this RIA are only intended to present the data and preliminary interpretations sufficient to identify potential data gaps that will be addressed in a separate RI/FS for groundwater (OU-3) to be completed in the future.

Groundwater samples have been obtained and analyzed for radionuclides as part of the various OU-1 investigations, including:

- The OU-1 field investigations conducted by McLaren/Hart in 1995 and 1996;
- Additional RI sampling conducted by EMSI in 1997;
- Additional groundwater sampling conducted by Herst & Associates as part of the OU-1 FS; and
- During four additional rounds of Site-wide groundwater sampling conducted by EMSI and Herst & Associates in 2012 and 2013.

EPA, and during some events MDNR, also collected split samples during the four 2012-2013 Site-wide groundwater sampling events. The USGS, on behalf of EPA, also collected groundwater samples from off-site private wells as part of an evaluation of background water quality. In addition, groundwater sampling conducted by Herst & Associates as part of the OU-2 RI/FS included analyses for select radionuclides from select wells. The results of the various groundwater sampling events are summarized in Appendix F.

The most comprehensive data sets were developed during the Site-wide groundwater sampling events conducted in August 2012 and April, July and October 2013. In addition to the four

events requested by EPA, two additional sampling events were conducted to obtain samples from eight new monitoring wells that were installed by Bridgeton Landfill, LLC in October 2013. These eight wells were sampled in November 2013 and February 2014.

A summary of the number of wells sampled during each event is provided below:

Sampling Event	Wells Sampled
August 2012	75 wells (S-53 and PZ-302-AS were not sampled during this event)
April 2013	75 wells (MW-102 and PZ-302-AS were not sampled in this event)
July 2013	75 wells (LR-105 and PZ-302-AS were not sampled during this event)
October 2013	76 wells (well LR-105 was not sampled during this event)
November 2013	8 wells (eight newly installed wells were sampled)
February 2014	8 wells (the eight newly installed wells were re-sampled)

Over the course of these groundwater sampling events, samples were obtained from a total of 85 monitoring wells at the Site. Some wells did not produce sufficient water to allow for collection of samples (listed above). Also, in the case of a few wells, although samples were collected, the wells produced an insufficient volume of water for analyses of the entire analytical suite (*e.g.*, D-14, MW-102, S-53, and PZ-302-AS). Consequently, only some of the analyses could be performed on the samples obtained from these wells.

The data sets developed by these comprehensive sampling events included the largest numbers of monitoring wells sampled by any of the monitoring programs; the greatest spatial coverage of any of the programs; the most accurate, precise and complete data sets developed by any of the monitoring programs; and are the most recent data available for the Site. Therefore, the focus of the discussions presented in this section is largely on the results obtained from the 2012/2013 comprehensive groundwater sampling events. References to and discussions of results from earlier sampling events are included where appropriate.

The laboratory analytical results for the 2012/2013 groundwater monitoring events were previously presented and discussed in summary reports prepared for each of the four events (EMSI, 2012c, 2013c, 2013g, and 2014b). Additional, more comprehensive discussions of the results obtained from the four events as a whole are presented in the following sections. The results are summarized on Tables 7-13 through 7-26, on Figures 7-2 through 7-12, and in more detail on the various figures included in Appendix N-1.

7.5.1 Radium

The groundwater samples were analyzed for total and dissolved Ra-226 and Ra-228. Radium isotope analytical results from the four 2012/2013 monitoring events are presented on Table 7-13 and are plotted on Figures N1 – N10 contained in Appendix N-1.

An evaluation of potential background and upgradient radium levels in groundwater is presented prior to discussing the results of the groundwater monitoring events. This evaluation includes a summary of published studies regarding potential naturally-occurring radium levels in groundwater in Missouri and the results of off-site water supply well sampling. Evaluations of the Site water quality results relative to possible background/upgradient levels are also presented. Evaluation of water quality results obtained from Site monitoring wells located upgradient of Areas 1 and 2, which, although not necessarily representative of regional background water quality, may nonetheless reflect upgradient ("background") water quality relative to possible radium contributions from Areas 1 and 2 to the underlying groundwater.

Subsequent sections present overall summaries of the results for the total and dissolved fractions for the two radium isotopes obtained during all of the monitoring events. The results are compared to the background values and to the EPA MCL for combined Ra-226 plus Ra-228 of 5 pCi/L..

These discussions are followed by comparisons of the radium results obtained during the 2012/2013 sampling events to the prior (RI/FS and pre-RI) sampling results (Section 7.5.1.5). An evaluation of potential trends in the radium results is also presented at the end of this discussion.

It should be noted that both Ra-226 and Ra-228 are naturally occurring. In addition, results of the soil/waste samples obtained from Areas 1 and 2 indicated that the primary radionuclides present in these areas were Th-230 and Ra-226 and related daughter products. Only a few of the OU-1 soil/waste samples contained detectable levels of Th-232 or Ra-228. Consequently, detections of Ra-228 in the groundwater samples may reflect background occurrences of this isotope rather than impacts from Areas 1 and 2.

7.5.1.1 Background Radium Levels

Background/upgradient levels of radium in groundwater relative to Areas 1 and 2 were preliminarily identified by evaluating the following sources of data: (1) Water quality data contained in published technical reports; (2) the results of off-site private water supply well samples; (3) the results of water quality sampling obtained from monitoring wells located at a distance upgradient of all of the landfill cells at the Site; and (4) the results of the water quality data obtained from monitoring wells located upgradient of Areas 1 and 2. More detailed evaluations of groundwater conditions including evaluation of hydraulic gradients (upgradient and downgradient areas) background water quality relative to OU-1 will be performed as part of the groundwater (OU-3) RI/FS.

7.5.1.1.1 Background Values from Published Technical Reports

Reports regarding groundwater quality in the State of Missouri (Mesko and Berkas, 1987) and in St. Louis (Miller, et al., 1974) or nearby areas (Kleeschulte, 1993) were reviewed for information

regarding levels of radionuclides in groundwater. Although the Mesko and Berkas 1987 report acknowledged the presence of naturally occurring radioactivity in groundwater, neither that report nor the Miller, et al. 1974 report contained any specific water quality data or numerical values relative to potential radionuclide levels in groundwater. The third report (Kleeschulte, 1993) contained results for radionuclides in Missouri River alluvial monitoring and water supply wells located near Defiance, Missouri, upstream of the Weldon Spring site. Sampling performed by USGS in conjunction with this report detected Ra-226 in alluvial groundwater at levels ranging from 0.06 to 0.70 pCi/L (mean of 0.39 pCi/L) and Ra-228 at levels ranging from less than 1 to 1.7 pCi/L (estimated mean of 1.0 pCi/L). Some of the data described in these reports may reflect water quality within the Missouri River alluvium but they may also reflect bedrock water quality, possibly associated with different bedrock units than those present at the Site. Site-specific background levels for radionuclides for the West Lake Landfill Site will be determined as part of the groundwater (OU-3) RI/FS.

Several national studies of groundwater quality (DiSimone, 2008) – and in particular studies relative to occurrences of radionuclides (Focazio, et al., 2000) and radium in groundwater (Szabo et al., 2012a) – were also reviewed for information regarding naturally occurring levels of radionuclides, especially radium, in groundwater. Although these studies all identified the presence of naturally occurring radionuclides in groundwater throughout the United States, including radium isotopes, none of these studies contained data obtained from the Site area or from any of the specific geologic units present at the Site. Therefore, these studies were of limited value in determining potential background levels of radionuclides in groundwater for the Site area.

Technical reports regarding groundwater quality at other National Priorities List (NPL) sites in the St. Louis area, including the St. Louis FUSRAP sites (USACOE, 2004 and 2010), the Hazelwood Interim Storage Site (HISS) [Bechtel, 1993], and the Weldon Spring site (DOE, 2011) were reviewed to identify background levels of radium in groundwater at these sites. The background values reported in the studies for these Superfund sites (*i.e.*, site-specific background values unrelated to the West Lake Landfill Superfund Site) are summarized below.

Summary of Published Background Radium Values in Groundwater (pCi/L)

Reference	STL FUSRAP (USACE, 2004)	HISS (Bechtel, 1993)		Weldon Spring Site (USACE, 2011)	
		Value	CSU	Min	Max
Ra-226	4	2.29	0.97	0.040	1.4
		33.8*	10.4		
		0.88	0.48		
		Min	Max		
		0.2	1.9		
Ra-228	Not reported	Not reported		0.20	7.3

CSU = combined standard uncertainty * This value was identified in the report as being anomalous.

Review of these data indicates that, with the exception of the values obtained by the 1993 USGS study (Kleeschulte, 1993), background levels of Ra-226 range from approximately 1 to 4 pCi/L, while background levels of Ra-228 range from approximately 1 to 7 pCi/L.

7.5.1.1.2 Sample Results from Offsite Private Water Supply Wells

The USGS, working on behalf of EPA, identified various water supply wells in the general vicinity of the Site. In July 2013, EPA collected samples from six alluvial wells located approximately one to two miles to the north and northeast of the Site. EPA submitted these samples for analyses for total (unfiltered) radionuclides (Appendix F-5).

Herst & Associates, on behalf of EMSI, subsequently contacted the various well owners and inquired about their willingness to have their wells sampled. Only one owner (that owned two alluvial wells) agreed to allow samples to be collected, and Herst & Associates collected samples from these wells in August 2013.

The USGS, on behalf of EPA, subsequently contacted the various well owners about allowing the USGS to collect samples from the wells. The USGS was able to obtain permission to sample four additional wells, three of which were located 3.5 to 4.75 miles to the south or southwest of the Site (*i.e.*, upgradient or cross-gradient from the Site) including two bedrock wells and one alluvial well, and one additional bedrock well located near the Weldon Spring site, 13.5 miles to the southwest of the West Lake Landfill Site. The USGS subsequently collected samples from these four locations in November 2013 (Appendix F-5). Herst & Associates, on behalf of EMSI, collected split samples from the USGS sampling of these wells (Appendix F-5).

Table 7-14 presents a summary of the results of the samples obtained by Herst & Associates from the private wells. Analytical results obtained by the EPA and USGS are presented in Appendix F-5 report. Review of the results from the alluvial wells indicates that Ra-226 levels varied between non-detect at 0.13 pCi/L up to 0.8 pCi/L in total (unfiltered) fraction samples and between non-detect at 0.05 U up to 0.74 pCi/L in dissolved (filtered) fraction samples. Ra-228 levels in the alluvial well total fraction samples ranged from non-detect at 0.072 pCi/L up to 2.69 pCi/L. Ra-228 results for dissolved fraction samples from the alluvial wells ranged from non-detect at 0.18 pCi/L up to an estimated concentration of 1.45 pCi/L.

Ra-226 results for the samples from the three bedrock wells ranged from non-detect at 0.02 pCi/L up to 3.08 pCi/L for the total fraction and 0.31 to 3.29 pCi/L for the dissolved fraction samples. Ra-228 results for the total fraction samples ranged from non-detect at 0.072 pCi/L up to 0.96 pCi/L. Ra-228 results for the dissolved fraction samples from the private bedrock wells ranged from non-detect at 0.23 pCi/L up to an estimated concentration of 0.95 pCi/L. The results of the limited off-site well sampling were all below the MCL and within the range of background radium values reported for the other Superfund sites in the St. Louis area.

7.5.1.1.3 Radium Results from Site Upgradient Monitoring Wells

Results of the recent and historic groundwater samples obtained from monitoring wells located upgradient (south-southeast) or at a significant distance cross-gradient of Areas 1 and 2 were reviewed to assess the Site-specific "background" levels of radium isotopes in groundwater.

A total of 16 prior and existing monitoring wells located to the south, southeast or southwest (*i.e.*, upgradient or cross-gradient) and away from all of the disposal units at the Site were identified (Table 7-15). Many of these wells were previously abandoned as part of sale of the former soil borrow area property. Only three of these wells – S-53 and the newly installed PZ-212-SS and PZ-212-SD – still exist as of the date of this RI Addendum. The locations of these 16 monitoring wells are shown on Figure 4-10.

Results obtained from these 16 wells (Table 7-16) were evaluated to determine potential background levels of radium in groundwater. Most of these wells were sampled for dissolved Ra-226 and dissolved Ra-228 either prior to or during the early portions of the OU-1 and OU-2 RI field investigations and monitoring activities.

Review of the monitoring data from these 16 upgradient or cross-gradient wells indicates that a total of 32 samples (11 of which were obtained as part of the most recent [2012/2013] groundwater monitoring activities from the three remaining wells) were obtained for dissolved Ra-226 analyses (Table 7-13). Of these, 13 results were less than the MDA level; however, two of the MDA values associated with the earliest samples from now abandoned well S-80 (the November 1995 and February 1996 total fraction samples) were significantly elevated (Table 7-16). The highest detected value reported was 130 pCi/L from the dissolved sample obtained in February 1996 from well S-80; however, a duplicate sample obtained on this same date from this well reported a result less than the MDA of 31 pCi/L and the total fraction sample for this same date from this well reported a value of 3.38 pCi/L. Therefore, the 130 pCi/L value appears to be anomalous and potentially not representative of actual conditions. The next highest results were from dissolved samples including 34.9 pCi/L for S-80 during the November 1995 sampling event. For comparison, the Ra-226 results for the total fraction sample obtained from this well during this event was less than the MDA of 31.3 pCi/L,. Exclusive of these higher results, radium levels in the upgradient wells ranged from non-detect up to 3.21 pCi/L (Table 7-16)

The majority of the historic results for dissolved Ra-228 from the upgradient wells were less than MDA (Table 7-16). Only two detected results of 1.46 and 2.72 pCi/L for the April and October 2013 samples, respectively, from well S-53 were reported (Table 7-13).

7.5.1.1.4 USGS Evaluation of Background Water Quality

In 2014, the USGS evaluated radionuclide background water quality relative to the West Lake Landfill (USGS, 2014). Specifically, the USGS reviewed literature data for the region and obtained groundwater data for St. Louis and St. Charles Counties from various agencies (USGS, MDNR, and U.S. Department of Energy [DOE]) or publications. The USGS also reviewed data

from the 2013 groundwater samples collected by EPA for the USGS from private wells in the vicinity of the West Lake Landfill, 2013-14 data from two monitoring wells (PZ-212-SS and PZ-212-SD) installed about 1,200 feet east of the Bridgeton Landfill, and historical (1990s) samples from seven former off-site monitoring wells located about 1,200 feet south and upgradient from the West Lake Landfill. The USGS developed summary statistics for various groupings of data (for example, by agency and by proximity to the West Lake Landfill Site) for the Missouri River alluvium and the Mississippian-age bedrock aquifer.

The USGS evaluated radionuclide data from 31 public drinking water systems in St. Charles County and Lincoln County (north of St. Charles County) that use groundwater for primary supply. This review concluded that the average total combined radium concentrations in the water systems that primarily use groundwater ranged from 1.3 to 12.6 pCi/L (average of 4.5 pCi/L) and ratios of Ra-228 to Ra-226 (Ra-228/226) in samples where both isotopes were above reporting limits ranging from 0.07 to 7.50 (average of 0.78). All of the systems except one (O'Fallon, St. Charles County, MO) pump water exclusively from bedrock aquifers, with most having wells open to Ordovician-age or Cambrian-age formations, which are known to have high radium (Szabo et al., 2012b), and open to either the St. Peter Sandstone or the Roubidoux Formation (primarily a sandstone). Miller and Vandike (1997) indicated localized occurrences of elevated radionuclides in public-supply wells near the eastern extent of freshwater within the St. Peter Sandstone. None of the public-supply wells pump water from the St. Louis Limestone or Salem Formation, and the one system that withdrew water mostly from Mississippian-age bedrock had average combined radium of 1.3 pCi/L and an average Ra-228/226 ratio of 3.33.

The USGS and EPA sampled 11 private water supply wells completed within the Missouri River alluvium (9 wells) or bedrock (2 wells) with at least part of the uncased interval of the bedrock wells open to Mississippian-age rocks (see prior discussion in Section 7.5.1.1.2 and results in Appendix F-5). Six alluvial wells north of the Site were sampled by the EPA, and two alluvial wells and three bedrock wells south or southwest of the Site were sampled by the USGS.

The USGS also reviewed results from two new background bedrock monitoring wells (PZ-212-SS and PZ-212-SD) located about 1,200 feet east of the Bridgeton Landfill to provide additional background water quality data. The maximum concentrations of dissolved and total combined radium in the first two rounds of samples collected by Bridgeton Landfill, LLC from these monitoring wells were 0.48 and 1.05 pCi/L.

Using data from the November 2013 and February 2014 sampling from the two new bedrock wells (PZ-212-SS and PZ-212-SD) installed east of the Site during 2013, and the 1990s samples from former off-site monitoring well clusters south of the Site, the USGS calculated that the upper limit of background (95th percentile) for dissolved and total combined radium were 1.98 and 2.81 pCi/L for the alluvium, and 3.56 and 3.34 pCi/L for the Mississippian-age bedrock. Ratios of total and dissolved Ra-228/Ra-226 ranged from 1.0 to 4.98 (95^{th} percentile of 4.28 for dissolved and 4.98 for total) for the alluvium and 0.09 to 2.11 (95^{th} percentile of 0.74 for dissolved and 2.11 for total) for the bedrock.

The USGS concluded that the background dataset is small, consisting of only 17 alluvial groundwater and 11 bedrock groundwater samples. Even with inclusion of the 2013 supply-well sample data, the USGS concluded that the small amount of background groundwater data available, especially for radionuclides in the bedrock units of concern at the Site (St. Louis Limestone and Salem Formation), was a limitation to understanding the occurrence of radium above the MCL in groundwater at the Site.

The USGS stated that based on the frequency of chloride, bromide, and iodide concentrations above background in groundwater samples from the WLL Site, 47 of the 83 monitoring wells (37 alluvial wells and 10 bedrock wells) at the WLL Site are affected by landfill leachate. Wells affected by landfill leachate also have increased concentrations of dissolved calcium, magnesium, sodium, potassium, barium, iron, manganese, strontium, total alkalinity, and dissolved combined radium. Wells with the greatest leachate effects tend to have smaller concentrations of sulfate and uranium and produce anoxic groundwater. Concentrations of dissolved combined radium were significantly larger (p value less than 0.0001) in samples from alluvial or bedrock monitoring wells affected by landfill leachate compared to samples from monitoring wells that do not have landfill leachate effects.

The USGS (2014) further concluded that there are four general hypotheses for the origin of dissolved combined radium above the MCL in groundwater at the Site including:

1. leaching of radium from RIM;

2. the radium values detected are within the range of values found in natural groundwater;

3. leaching of radium from non-RIM wastes disposed at the Site; and

4. mobilization of naturally occurring radium from aquifer solids by some component of landfill leachate.

The USGS further states that except for the radium in groundwater samples from the Site being within natural variation in groundwater, no single hypothesis can be invoked to explain all occurrences of radium above the MCL at the Site, and the available data are not adequate to provide definitive conclusions regarding the validity of any hypotheses.

The USGS report indicates that the origin and transport of radium at the Site is complicated by its natural presence in groundwater and aquifer materials, and the tendency of radium to be associated with mineral surfaces such as iron-oxides that are sensitive to changes in redox conditions (USGS, 2014). Changes in redox conditions in groundwater can occur with migration of landfill leachate. There is no singular mechanism, geochemical condition, or phase association that can reliably account for all occurrences of radium above the MCL in groundwater. Rather, the USGS 2014 report states that there likely is a combination of mechanisms occurring across the Site.

The USGS report further states “Using results from soil samples collected from RIM Areas I and 2 during 1996 that contained more the 30 pCi/L <*sic*> of radium-226 (Ra-226) as representative of RIM, the average Ra228/226 in RIM of 0.006 is substantially smaller than Ra228/226 ratios in groundwater samples from monitoring wells at the WLL Site completed within the alluvium (1.0 to 1.98) or bedrock (0.09 to 2.11) indicating that radium leached from RIM is likely not the predominant source of radium concentrations above the MCL in groundwater at the WLL Site.” (USGS, 2014, p. 43).

The USGS identified 7 monitoring wells that had dissolved combined radium above the MCL that the USGS could not rule out as having a RIM origin; however, the USGS stated that this does not indicate that RIM contributes to above-MCL radium detections in groundwater at the Site, only that this origin cannot be conclusively ruled out with the available data. The limited amount of background radionuclide data in groundwater; the absence of data on the distribution of radium isotopes in aquifer solids, "typical" non-RIM wastes, and “typical" landfill leachate; and the potential for landfill leachate to mobilize naturally occurring radium from aquifer solids all limit the ability to conclusively assign an origin of radium in groundwater at the Site. The potential for anoxic landfill leachate to mobilize radium, whether from non-RIM waste sources in the landfill or from aquifer solids (naturally occurring), indicates that radium concentrations above the MCL in groundwater will likely remain commonplace at the WLL Site.

With respect to the leaching of radium from RIM, the USGS states that there is not a strong spatial association of monitoring wells surrounding or downgradient of RIM areas with elevated radium concentrations, as might be expected if RIM areas were releasing substantial quantities of radium to the groundwater. With respect to the mobilization of naturally occurring radium contained in aquifer materials by chemical interaction with landfill leachate, USGS states that this is probably an important mechanism resulting in the occurrence of radium above the MCL in groundwater at the Site (USGS, 2014).

7.5.1.1.5 Summary of Potential Background Radium Levels in Groundwater

Based on the above evaluations, background levels of naturally-occurring Ra-226 in groundwater are expected to range from 1 to 5 pCi/L and background levels of naturally-occurring Ra-228 in groundwater are expected to range from 1 to 7 pCi/L. Additional investigations of upgradient and naturally-occurring levels of radium in groundwater near the Site are expected to be performed as part of the groundwater (OU-3) RI/FS.

7.5.1.2 Radium Results in Site Groundwater

Radium results obtained from the samples collected during the four 2012/2013 comprehensive monitoring events and the additional eight wells during November 2013 and February 2014 are presented on Table 7-13. Maps and cross-sections displaying the data for the two radium isotopes for the total and dissolved fraction samples obtained from each the wells are provided as

Figures N-1.1 through N-1.10 in Appendix N-1. These figures are provided to allow the reader to locate and examine results for both specific wells and the entire set of Site monitoring wells.

These results have been evaluated in terms of the following well groups:

- Upgradient bedrock wells (38 wells)
- Upgradient or cross-gradient alluvial wells (16 wells)
- Area 1 alluvial wells (14 wells)
- Area 1 bedrock wells (2 wells)
- Area 2 alluvial wells (15 wells)

The specific wells included in each of these groups are listed on Table 7-17 and displayed on Figure 7-2.

Table 7-18 presents summary information regarding the radium levels reported for samples obtained from wells in each of these groups. The highest fractions of non-detect results for total and dissolved Ra-226 results were associated with the upgradient bedrock well group. Overall, with the exception of the dissolved samples from the upgradient bedrock well group, the percentage of non-detect results for the samples analyzed for Ra-226 was generally low. The highest fractions of non-detect results for Ra-228 were associated with the Area 1 alluvial wells (dissolved phase) and Area 1 bedrock wells (total phase). The fractions of non-detect results for Ra-228 for all groups were significantly higher than the fractions of non-detect Ra-226 results, and for some groups the fraction of non-detect Ra-228 results approached or exceeded 50% of the total samples.

The highest mean and median values for both total and dissolved Ra-226 are associated with the Area 1 bedrock wells; however, as noted above, this group consists of only two wells, so only limited significance can be drawn from this observation. The highest mean and median values for total Ra-228 were associated with the Area 1 alluvial well group. The highest mean value for dissolved Ra-228 was also associated with this group; however, the highest Ra-228 median value was associated with the Area 2 alluvial wells. Overall, the mean and median values for each of the parameters for each of the groups were generally similar, suggesting that the data sets may approximate normal distributions.

With the exception of dissolved Ra-228, the highest maximum results for total and dissolved Ra-226, total Ra-228 and combined total and combined dissolved radium from all of the groups were obtained from upgradient bedrock wells (*e.g.*, PZ-101-SS, PZ-104-SD, PZ-211-SD, and MW-1204) located along the south and east sides of the North and South Quarry portions of the Bridgeton Landfill, upgradient from Areas 1 and 2 (Table 7-18). The highest dissolved Ra-228 was obtained from the October 2013 field duplicate sample from Area 1 alluvial well PZ-113-AD.

With the possible exception of the Area 1 bedrock well group (again consisting of only two wells), the mean and median values of total and dissolved Ra-226 and Ra-228 were within the

range of background values reported from groundwater monitoring at other Superfund sites in the St. Louis area (see prior discussion in Section 4.2.1.1.1).

7.5.1.2.1 Combined Total Radium-226 Plus Radium-228

EPA has established (40 C.F.R. Part 141) an MCL for combined Ra-226 plus Ra-228 in drinking water supplies. Although such a standard is not applicable to groundwater, it was determined by EPA (2008a) to be a potentially relevant and appropriate requirement for evaluation of groundwater quality. Therefore, the combined radium results from the recent groundwater monitoring events have been compared to the radium MCL.

Combined total Ra-226 plus Ra-228 results are presented in Table 7-19. Appendix N-1 Figure N-1.5 presents the combined total radium results from all of the samples for each of the wells sampled during the recent groundwater monitoring events. Results greater than the 5 pCi/L MCL are highlighted on Figure N-1.5. Graphical displays of the combined total Ra-226 plus Ra-228 results superimposed on the two hydrogeologic cross-sections are presented on Appendix N-1 Figures N-1.6 and N-1.7.

A graphical display of the results of the comparisons of the combined total radium results to the radium MCL is shown on Figure 7-3. Nine monitoring wells contained combined total (unfiltered samples) Ra-226 plus Ra-228 levels greater than 5 pCi/L during all four 2012/2013 monitoring events (Table 7-19 and Figure 7-3). Thirty monitoring wells contained combined total Ra-226 plus Ra-228 levels greater than 5 pCi/L during at least one (but not all four) monitoring events (Table 7-19 and Figure 7-3). The remaining 46 monitoring wells (Table 7-19 and Figure 7-3) never contained combined total Ra-226 plus Ra-228 during any of the monitoring events at levels that would exceed the radium MCL.

Wells that contained combined total radium at levels greater than the MCL (5 pCi/L) during all four of the 2012-2013 sampling events (shown as pink dots on Figure 7-3) were located along the south and west sides of the South Quarry portion of the Bridgeton Landfill and the east side of the North Quarry portion of the Bridgeton Landfill, both of which are upgradient of Areas 1 and 2, and on the east and west sides of Area 1 and on the north and west sides of Area 2. Wells that contained combined total radium above the MCL during at least one (but not all four) events (yellow dots on Figure 7-3) were generally located throughout the Site, including around all sides of the South and North Quarry portions of the Bridgeton Landfill and the Inactive Sanitary Landfill as well as around Area 1 and the south and east sides of Area 2.

7.5.1.2.2 Combined Dissolved Radium-226 Plus Radium-228

Combined dissolved (filtered samples) Ra-226 plus Ra-228 results are presented in Table 7-20 and also on Appendix N-1 Figure N-1.8. Graphical displays of the combined dissolved Ra-226 plus Ra-228 results superimposed on the two hydrogeologic cross-sections are presented on Appendix N-1 Figures N-1.9 and N-1.10.

A graphical display of the results of the comparisons of the combined dissolved radium results to the MCL is shown on Figure 7-4. Five monitoring wells contained combined dissolved Ra-226 plus Ra-228 levels greater than the 5 pCi/L MCL during all four 2012-2013 monitoring events (Table 7-20 and Figure 7-4). Twenty-eight monitoring wells contained combined dissolved Ra-226 plus Ra-228 levels greater than 5 pCi/L during at least one (but not all four) monitoring events (Table 7-20 and Figure 7-4). The remaining 52 monitoring wells never contained combined dissolved Ra-226 plus Ra-228 during any of the 2012-2013 monitoring events at levels that would exceed the radium MCL.

Wells that contained combined dissolved radium at levels greater than the MCL during all four of the 2012-2013 sampling events (shown as pink dots on Figure 7-4) were located along the east and west sides of the South Quarry portion of the Bridgeton Landfill and the east side of the North Quarry portion of the Bridgeton Landfill, both of which are upgradient of Areas 1 and 2, and on the east side of Area 1 and the north side of Area 2. Wells that contained combined dissolved radium above the MCL during at least one (but not all four) events (yellow dots on Figure 7-4) were generally located throughout the Site including around all sides of the South and North Quarry portions of the Bridgeton Landfill and the south and east sides of the Inactive Sanitary Landfill as well as the west side of Area 1 and the east and west sides of Area 2. Overall, the number and distribution of wells containing combined dissolved radium greater than the MCL is slightly less than the number and distribution of wells containing combined total radium greater than the MCL, which is indicative of occurrences of radium in the suspended sediment and/or colloidal material within the total fraction samples.

7.5.1.2.3 Comparison of 2012/2013 Radium Results to Prior Results

Wells sampled during the four most recent groundwater monitoring events included the following:

- Twenty-three wells still in existence from the group of 30 wells that had previously been sampled as part of the OU-1 RI;
- Sixteen wells still in existence from the group of 18 wells that had previously been sampled as part of the OU-1 FS (which were a subset of the wells sampled as part of the OU-1 RI activities);
- The group of 24 wells that had previously been sampled as part of the OU-2 RI investigation but which, prior to the July/August 2012 event, had not been sampled since 1997 and had never been sampled for Ra-228;
- Fourteen of the group of 15 wells that had previously been sampled as part of the OU-2 FS;

- Additional wells associated with Bridgeton Landfill which, prior to the 2012/2013 sampling events, had never been sampled for any radioisotopes and/or did not exist at the time the OU-1 and OU-2 RI/FS investigations were performed; and

- Additional monitoring wells at the Site that had not previously been sampled as part of any of the above listed activities and that had not previously been sampled for radionuclides.

Radium results obtained during the 2012-2013 monitoring events were compared to the results obtained during the RI/FS and, to the extent available, to the pre-RI/FS radium results. Table 7-21 presents a summary of the radium isotope analytical results for the historical (pre-RI/FS and RI/FS) groundwater sampling performed at the Site. The majority of the historical samples were primarily analyzed for Ra-226 – specifically, dissolved levels of Ra-226. Maps summarizing the OU-1 RI/FS (1995-1997 and 2004) total and dissolved Ra-226 results are provided as Figures N-1.11and N-1.12 in Appendix N-1. Appendix N-2 presents summary tables of the recent and older RI/FS radium results for those wells sampled during the recent monitoring events that were also sampled during one or more of the OU-1 and OU-2 RI and FS events and possibly during earlier (pre-RI/FS) events.

A total of 54 wells were sampled during either the pre-RI/FS and/or RI/FS activities and also during the 2012-2013 sampling events. The available results for the prior (pre-RI/FS) sampling for two of the wells (S-53 and I-73) do not specify whether the results were for total or dissolved fractions, and therefore the current results cannot be accurately compared to the historical data for these wells. Historical and current results for the remaining 52 wells are summarized in Appendix N-2.

Two OU-1 monitoring wells (D-3 and D-6) and three OU-2 monitoring wells (PZ-106-SS, PZ-113-SS, and PZ-1201-SS) were identified during the RI/FS activities as having combined radium levels greater than the MCL. Four of these wells were sampled during the 2012-2013 monitoring events. The fifth well, PZ-1201-SS, no longer exists. The 2012-2013 groundwater sampling events detected combined total radium levels in deep alluvial monitoring wells D-3 (Area 1) and D-6 (Area 2) at levels greater than the MCL during all four events. With the exception of the samples obtained in the April 2013 event, the combined dissolved radium levels in these two wells also exceeded the MCL. Combined total radium levels in PZ-106-SS (a St. Louis/Upper Salem well located on the southwest side of the South Quarry portion of the Bridgeton Landfill) exceeded the MCL during two of the 2012-2013 sampling events. The combined dissolved radium levels in this well did not exceed the MCL during any of the monitoring events, indicating that source of the radium exceedance in this well is likely due to the presence of radium in the suspended sediment and/or colloidal material contained in the groundwater at this location. The combined total radium levels in PZ-113-SS (a St. Louis/Upper Salem well located to the west of Area 1) exceeded the MCL during two of the four 2012-2013 sampling events and the combined dissolved radium levels in this well exceeded the MCL during only one (October 2013) of the 2012-2013 monitoring events.

A significantly greater number of wells with combined total Ra-226 plus Ra-228 levels above the MCL were identified during the 2012-2013 monitoring events compared to those identified during the RI/FS (although there were also a significantly greater number of wells monitored during the recent events). See Figure 7-3.

The increase in the total number of monitoring wells identified as containing radium levels above the MCL during the 2012-2013 groundwater monitoring events compared to the smaller number previously identified during the RI/FS is explained by the fact that:

- There were a substantially greater number of monitoring wells (75 - 85) sampled during the recent monitoring events compared to the number of wells sampled during the OU-1 RI (30) and OU-1 FS (18);

- Most of the OU-2 monitoring wells sampled as part of the OU-2 RI/FS efforts were not analyzed for both radium isotopes;

- There have been changes and improvements in the laboratory sample preparation and analytical methods over the ten to twenty-year period between the various RI/FS sampling events and the recent monitoring events, resulting in greater analytical detections; and

- The majority of the monitoring wells that contained combined radium at levels greater than the MCL are bedrock monitoring wells located upgradient of Areas 1 and 2 or alluvial or bedrock monitoring wells located cross-gradient of Areas 1 and 2 such that the presence of radium in groundwater in the vicinity of these wells cannot arise from migration of radium from Areas 1 or 2.

7.5.1.2.4 Time Series Trends in Radium Levels

The radium-isotope results from the historical (pre-RI/FS and RI/FS) groundwater sampling activities conducted at the Site (Table 7-21) and from the 2012/2013 groundwater sampling events (Table 7-13) were reviewed to identify those monitoring wells that have been sampled over time for the radium isotopes. The goal was to identify wells with long periods of radium results and for which significant radium levels (*i.e.*, sufficiently above the MDA values so as to provide some meaningful variation over time) were present.

A total of eight alluvial wells with sufficiently long records of radium results above the MDA values were identified, including the D-3, I-4, S-5 well cluster and well I-68 in Area 1 and the D-93, I-9, S-82 well cluster and well D-6 in Area 2. Plots of radium levels versus date were prepared to evaluate temporal (time series) trends in radium levels within these individual wells. These plots are presented on Figures 7-5 through 7-12 and display the reported radium results with the plus and minus two-sigma combined standard uncertainty (CSU) values for the total and dissolved levels of Ra-226 and Ra-228 for each well over time. Although linear regression of the trend for some of the time series plots display a slight upward trend, the correlation

coefficients associated with these trends are extremely low indicating that these trends are not statistically significant. Furthermore, the reported general trends are still within the range of the overall variability and analytical uncertainties associated with the reported radium results. Overall, these figures indicate that the radium levels in these wells have remained relatively constant over the period of record.

For example, Figure 7-5 presents radium isotope time-series plots for deep alluvial well D-3, located in the western portion of Area 1. This well was first sampled for radium in November 1995; however, the early results obtained from this well were all non-detect with elevated MDA levels. Consequently, the first actual result was obtained in February 1996 for the total fraction and May 1996 for the dissolved fraction Ra-226 in this well. Review of Figure 7-5 indicates that the levels of Ra-226 in groundwater at this location have remained relatively constant between approximately 1 and 4 pCi/L over the last 18 years. This especially true when the CSU values (indicated by black lines extending above and below the results shown on Figure 7-5), which indicate the range of potential uncertainty associated with each of the results, are considered in these comparisons. Dissolved levels of Ra-226 were reportedly on the order of 1 pCi/L in 1996 – 1997 and have been on the order of 1 to 4 pCi/L since 2004. Prior to the most recent groundwater monitoring activities, this well had only been sampled once (June 1997) for total Ra-228 and this result is similar to the results obtained in 2012 – 2013, especially when the uncertainty ranges (plus or minus two-sigma values) are considered. Total Ra-228 levels ranged from approximately 3 to 6 pCi/L at this well. Comparison of the dissolved Ra-228 levels reported for the June 1997 (OU-1 RI Sampling) and March and May 2004 samples (OU-1 FS sampling) to the most recent results indicates that all of the samples obtained from well D-3 over time have displayed similar levels of dissolved Ra-228 over time, ranging from approximately 2 to 7 pCi/L. It should be noted that all of these results are within the range of background values reported for other Superfund sites in the St. Louis area (see prior discussion in Section 7.5.1.1.1).

Figure 7-6 presents similar time-series plots for intermediate depth alluvial well I-4, which is located adjacent to alluvial wells D-3 and S-5 in the western portion of Area 1. Review of these plots also indicates that the levels of total and dissolved Ra-226 and Ra-228 in well I-4 have essentially not changed over the 17 to 18-year period of radium sampling from this well. Again, all of these results are within the range of background values reported for other Superfund sites in the St. Louis area.

Similarly, the levels of total Ra-226 measured in shallow alluvial well S-5 have remained relatively constant at approximately 0.25 to 1.0 pCi/L over the last 18 years (Figure 7-7). Dissolved Ra-226 was not detected in the RI or FS groundwater samples obtained from S-5. Results of the recent sampling ranged from non-detect up to approximately 2.25 pCi/L (Figure 7-7). Only non-detect results for total Ra-228 with elevated MDA values are available for well S-5 prior to the most recent sampling events. Results of the FS sampling of this well detected dissolved Ra-228 at levels of approximately 0.6 to 1.4 pCi/L. Results of the recent sampling activities reported dissolved Ra-226 levels ranging from non-detect to approximately 4 pCi/L. Again, all of the results obtained from this well are similar to the reported background values from other Superfund sites in the St. Louis area.

Similar observations can be made about the results of the radium sampling at intermediate depth alluvial well I-68 (Figure 7-8), which is located along the eastern boundary of Area 1. Review of Figure 7-8 indicates that the levels of total and dissolved Ra-226 in this well have remained unchanged over the last 18 years. Dissolved levels of Ra-228 measured during the 2004 FS sampling are similar to those observed during the 2012-2013 sampling events. Again, all of the results from this well are within the range of background values reported for other Superfund sites in the St. Louis area (see prior discussion in Section 7.5.1.1)

Figure 7-9 presents the radium data obtained from deep alluvial well D-6, located on the western side of Area 2. The total and dissolved levels of Ra-226 and Ra-228 have been relatively constant at this location over the last 17 to 18 years.

Figure 7-10 presents the radium results obtained from deep alluvial well D-93 over time. This well is located in a cluster configuration with intermediate and shallow alluvial wells I-9 and S-82 near the southwestern corner of Area 2. Levels of total and dissolved Ra-226 and Ra-228 have remained unchanged over the last 18 years in well D-93 and all are within the ranges of background values reported for other Superfund sites in the St. Louis area. Similarly, the levels of total and dissolved Ra-226 and dissolved Ra-228 have also remained unchanged in well I-9 over the same period (Figure 7-11) and are also all within the range of reported background values from other St. Louis Superfund sites. With the exception of the August 2012 results, the levels of total and dissolved Ra-226 and Ra-228 have been relatively constant in well S-82 (Figure 7-12). The August 2012 results for total Ra-226 and total and dissolved Ra-228 appear to be somewhat higher than the prior and subsequent results obtained from this well. The August 2012 sample obtained from well S-82 was described as being cloudy indicating that this sample contained suspended sediment and/or colloidal material, whereas the subsequent samples were all described as being clear. Regardless, all of the results from this well are within the range of reported background values from other St. Louis Superfund sites.

7.5.1.3 Geochemical Controls on Combined Radium Occurrences

The following subsections provide an overview of landfill conditions relative to radium geochemistry, a description of radium occurrences in leachate extracted from the North and South Quarry portions of the Bridgeton Landfill, and a summary of the landfill geochemistry relative to observed levels of radium around the North and South Quarry portions of the Bridgeton Landfill.

7.5.1.3.1 MSW Landfill Conditions and Radium Geochemistry

One potential mechanism responsible for the broad distribution of radium at the Site and the isotopic ratio of Radium-226 and 228, which significantly deviate from the isotopic composition of LBSR and are more consistent with the isotopic composition of naturally occurring radium, is mobilization of naturally occurring radium from the soil and rock in response to changes in the

geochemical environment caused by decomposition of the landfilled wastes. Although radioactive materials may be present in solid wastes (Allard, undated) several studies have identified the presence of radium in landfill leachate or in groundwater downgradient of landfills as a result of desorption of naturally occurring radium in soil and rock (CEC, 2005, Tuckfield et al., 2005, Kubilius and Ross, 2005). These studies reported combined radium levels in leachate and groundwater in excess of the MCL solely as a result of desorption of naturally occurring radium.

Adsorption of radium has been tied to the presence of iron oxides and manganese oxides (Vinson, et al., 2009 and Wang, et al., 1993). Desorption of radium has been correlated with the presence of acidic (low pH) conditions (Kubilius and Ross, 2005, and Szabo and dePaul, 1998), salinity (Sturchio, et al., 2001 and Vinson et al., 2009), reducing conditions (Vinson, 2011, Ayotte, et al., 2011a, Vinson, et al., 2009, Al-Hobaib, et al., 2006, Neal and Obereiner, 2003, and Landa, 2003), temperature (Wang, et al., 1993), and mixing of waters with differing geochemical conditions (Ayotte et al., 2011b).

All of these factors occur within and/or adjacent to MSW landfills. The biodegradability of the organic content in the MSW and the compaction of the waste layers results in an anaerobic (oxygen deficient) environment within MSW landfills (Kjeldsen, et al., 2002) for those portions of the landfill below a phreatic surface that can develop. Microbial degradation of MSW results in consumption of oxygen resulting in anoxic (oxygen deficient) conditions and transition to methanogenic (methane producing) conditions within a landfill.

The phases of MSW decomposition have been described by EPA (Tolaymat, et al., 2004). Landfills typically evolve through several stages of MSW decomposition, beginning with an initial adjustment (Phase I) after initial placement of the waste followed by a short-lived transition (Phase II) from an oxic to an anoxic microbial stabilization process (Tolaymat, et al., 2004). This is followed by an acid formation phase (Phase III) during which volatile fatty acid (VFA) concentrations increase in leachate and a corresponding decrease in pH occurs in response to hydrolysis of the biodegradable fraction of the solid waste (Tolaymat, et al., 2004). During the subsequent methane fermentation phase (Phase IV), intermediary products (mainly acetic acid) generated during the acid formation phase are converted to methane and carbon dioxide (Tolaymat, et al., 2004). Oxidation-reduction potential (ORP) declines and remains negative, indicating a reduced environment during this phase. The final stage of waste decomposition is characterized by a lower rate of biological activity, during which methane production is almost negligible and oxygen and oxidized species may slowly reappear with a corresponding increase in ORP (Tolaymat, et al., 2004).

The presence of anoxic conditions within the landfill mass results in reducing conditions in the leachate and in any groundwater in contact with the MSW or impacted by the leachate. The presence of higher concentrations of methane gas and carbon dioxide within the landfill mass can also result in reducing conditions in groundwater beneath or adjacent to landfills even in the absence of direct contact of the groundwater with MSW or leachate (Kerfoot, Baker and Burt, 2004 and Clarke, Mizerany and Dever, 2006). Even in the absence of direct contact between

groundwater and MSW, landfill leachate, or landfill gas, the presence of a low permeability cover over the landfill and the resultant reduction of infiltration of precipitation can result in the occurrence of reducing conditions in groundwater beneath and adjacent to an MSW landfill (Meeroff and Albasri, 2012 and Townsend, et al., 2015). Decomposition of MSW also results in acidic (reduced pH) conditions (Tolaymat, 2004 and Kjeldsen, et al., 2002) and increases in dissolved solids (salinity) content in landfill leachate and potentially in groundwater located beneath or adjacent to the MSW mass.

The presence of reducing conditions results in reductive dissolution of iron and manganese oxides which releases previously adsorbed radium into the water phase and reduces potential adsorption sites for radium in groundwater (Vinson, 2011, Vinson, et al., 2009, and Al-Hobaib et al., 2006). The potential for reductive dissolution of minerals that contain radium was also acknowledged by the USGS (2014), as previously discussed in Section 7.5.1.1.5 above.

7.5.1.3.2 Radium Occurrences in Leachate

Bridgeton Landfill extracts leachate from the North and South Quarry areas of the Bridgeton Landfill (see prior discussion in Section 5.2.2). As part of its leachate management efforts, Bridgeton Landfill, LLC characterizes the quality of its leachate in compliance with permit and discharge authorization requirements. Since late 2007 this has included analyzing the leachate for radium isotopes. Review of the results of radium analyses on leachate samples from the Bridgeton Landfill (Appendix F-7) is consistent with the description of radium occurrences in and around MSW landfills described above. MSD has established a discharge limit of 600 pCi/L for Ra-226, 600 pCi/L for Ra-228, and 2,000 pCi/L for uranium under the current permit. Prior permits included the radiological parameters as monitoring only requirements. Leachate samples are taken prior to discharge to MSD. Prior to 2013 this involved testing of non-treated leachate. Since initiation of treatment in 2013 the samples have been of treated leachate. See Appendix F-7 for the leachate sampling data. Radiological levels in leachate have always been within the limits of applicable permits.

7.5.1.3.3 Landfill Chemistry and Radium Occurrences at the North and South Quarry portions of the Bridgeton Landfill

Overall, the occurrences of radium in and around the North and South Quarry portions of the Bridgeton Landfill are consistent with reductive dissolution of iron and manganese hydroxides and an associated reduction in radium adsorption capacity and a release of previously adsorbed radium to the groundwater system. As described in the published literature, the presence of reducing conditions associated with decomposition of MSW can result in occurrences of radium in groundwater and leachate at MSW landfills.

Although collection of ORP measurements was not part of the four 2012/2013 comprehensive groundwater monitoring events, ORP measurements were obtained in May 2014 from the 14 solid waste (Subtitle D) detection monitoring program wells located around the North and South Quarry portions of the Bridgeton Landfill (Table 7-22), including nine of the 38 bedrock wells

located upgradient of Areas 1 and 2 (Table 7-17). Seven of these nine wells displayed negative ORP values, indicating the presence of reducing conditions. Only two wells (PZ-100-SS and PZ-201A-SS) displayed positive ORP values; however, both of these wells are located over 200 feet from the edge of the North or South Quarry portions of the Bridgeton Landfill.

Based on both the literature regarding chemical conditions at MSW landfills and the field measurements of ORP, it is clear that reducing conditions exist within and adjacent to the North and South Quarry portions of the Bridgeton Landfill. The SSR in the South Quarry portion likely contributed to further increases in reducing conditions in this landfill. Studies of radium geochemistry, natural occurrences of radium in groundwater, and radium occurrences at landfills all indicate that the levels of radium in groundwater increase under reducing conditions.

Radium has been detected in bedrock groundwater around all sides of the North and South Quarry portions of the Bridgeton Landfill. One possible source of the radium occurrences in bedrock groundwater around the North and South Quarry portions of the Bridgeton Landfill is release of naturally occurring radium in the bedrock units due to the presence of reducing conditions or from release of radium that was adsorbed onto iron and manganese oxides and hydroxides which became soluble under reducing conditions. Discussion of observed correlations of iron, manganese, other trace metals and leachate indicator parameters with radium occurrences in selected wells is provided at the end of the water quality evaluation section (see Section 8.6.3 below).

7.5.2 Thorium

The groundwater samples from the four 2012/2013 monitoring events were analyzed for total (unfiltered samples) and dissolved (filtered samples) Th-228, Th-230 and Th-232. Results of the analyses of the thorium isotopes are presented on Table 7-23. There is no MCL or other numeric water quality standards for thorium. Consequently, the results are described in general terms.

The highest thorium activities were reported for the total fraction sample obtained from well S-53 in April 2013 (Table 7-23). This well is located in the southwest corner of the Site, away from the various landfill cells but near the former leachate lagoon. Thorium isotopes were detected at levels between 19 and 20 pCi/L for a combined total thorium activity of 58.6 pCi/L in the April 2013 total fraction sample from this well (Table 7-23). The dissolved fraction sample obtained in April 2013 contained either trace (less than 0.25 pCi/L) or non-detectable levels of thorium, suggesting that the thorium occurrences in the total fraction sample likely arose from the presence of suspended sediment in the groundwater at this location. Groundwater from this well was reported to be gray with a high turbidity level of 524 NTU. This well produces only a very minimal amount of groundwater and therefore it was sampled in April 2013 without purging in order to maximize the volume collected in order to provide the volumes of water necessary to conduct the requested analyses. Prior to April 2013, this well had not been sampled since 1986 (28 years). Subsequent samples obtained in July and October 2013 were either non-detect for any of the thorium isotopes or, where detected, occurred at levels below 1 pCi/L in

both the total or dissolved fraction samples from this well. These results suggest that the presence of the higher thorium levels in April 2013 may have been due to the presence of suspended sediment and/or colloidal material resulting from the long period of inactivity at this well.

Setting aside the April 2013 total fraction results from well S-53, the highest levels of thorium isotopes were detected in samples obtained from bedrock wells PZ-102-SS, PZ-103-SS, PZ-107-SS, PZ-210-SD, and PZ-211-SD and alluvial wells S-61, I-68 D-14, D-85, MW-103, MW-104, and PZ-303-AS (Table 7-23). The five bedrock wells are all located adjacent to the south and east sides of the North and South Quarry portions of the Bridgeton Landfill. Thorium levels in these five bedrock wells (Table 7-23) ranged up to 21.91 pCi/L in the total fraction samples and up to 5.73 pCi/L in the dissolved fraction samples. The six alluvial wells listed above are located in the northeast corner of the Buffer Zone at the toe of Area 2 (S-61), the south side of Area 1 (D-14), the northern corner of Area 1 (D-85) and along the west side of the Inactive Sanitary Landfill (MW-103, MW-104 and PZ-302-AS), which places these three wells cross-gradient or upgradient/cross-gradient from Areas 1 and 2. Combined thorium levels in the total fraction samples from S-61, D-14 and D-85 ranged up to 16.87 pCi/L, while the dissolved fraction levels of combined thorium in these three wells were less than 0.65 pCi/L (Table 7-23). The combined thorium levels in the total fraction samples from the three wells located along the west side of the Inactive Sanitary Landfill ranged up to 10.68 pCi/L, while the dissolved fraction results were less than 0.5 pCi/L.

Overall, the dissolved fraction thorium results for these bedrock and alluvial wells were nearly all non-detect (Table 7-23), suggesting that the thorium occurrences in the total fraction samples are due to the presence of suspended sediment and/or colloidal matter consistent with published literature (IAEA, 2006). Combined thorium levels in the total and dissolved fraction samples obtained from the other Site wells ranged from less than 2 pCi/L to non-detect levels.

There is no MCL or other regulatory standard for thorium in groundwater. Thorium is primarily an alpha emitter and therefore the levels of thorium present in the 2012-2013 groundwater samples were compared to the 15 pCi/L MCL established for gross alpha in drinking water systems. A graphical display of the results of the comparisons of the combined total thorium results to the gross alpha MCL is shown on Figure 7-13. The vast majority of monitoring wells have never contained combined thorium levels above 15 pCi/L. Only three wells (S-53, D-85, and PZ-211-SD) contained combined total thorium above 15 pCi/L during one of the four monitoring events (yellow dots on Figure 7-13). None of the dissolved phase samples collected from any of the monitoring wells during any of the monitoring events contained combined dissolved thorium concentrations greater than 15 pCi/L (Figure 7-14).

7.5.3 Uranium

The 2012/2013 groundwater samples were analyzed for total (unfiltered samples) and dissolved (filtered samples) U-238, U-235 and U-234. Results of the analyses of the uranium isotopes are

presented on Table 7-24. EPA has established an MCL for uranium in drinking water systems of 30 µg/L. Although this standard is not applicable to the groundwater, it is considered to be a relevant and appropriate criterion for evaluation of uranium levels in groundwater. The analytical results for the 2012/2013 groundwater samples were measured in units of activity (pCi/L). These activity values were converted to units of mass (µg/L) using the procedure defined by EPA (2000). The mass-based uranium results are also presented on Table 7-24.

Uranium levels in the majority of the 2012-2014 groundwater samples were less than 10 µg/L. Only two of the nearly 650 groundwater samples obtained during the 2012-2014 monitoring activities contained uranium at concentrations greater than the MCL. The first (April 2013) total fraction sample obtained from well S-53 contained 164.6 µg/L. As was previously discussed, this well had not been sampled in 28 years prior to April 2013 and the water produced from this well was highly turbid. The dissolved fraction sample from this date contained only 14.31 µg/L uranium. The subsequent samples obtained from this well contained uranium at levels ranging from 11.35 (dissolved fraction) to 17.63 (total fraction) pCi/L. Based on the high turbidity of the initial sample, the decline in uranium results observed over the successive sampling events, and the large difference between the total and dissolved fraction results, the reported high level of uranium in the initial (April 2013) sample from this well was due to the presence of uranium in suspended sediment and/or colloidal matter in this sample.

The first (November 2013) total fraction sample obtained from new well PZ-211-SD contained 70.25 µg/L uranium. The corresponding dissolved fraction sample contained 13.75 µg/L uranium. Uranium concentrations in the original and field duplicate total and dissolved fraction samples obtained from this well in February 2014 ranged from 5.15 to 7.53 µg/L.

A graphical display of the results of the comparisons of the combined total uranium results (based on conversions of the activities to mass as provided on Table 7-24) to the uranium MCL of 30 ug/L is shown on Figure 7-15. The vast majority of monitoring wells have never contained combined uranium levels above 30 ug/L. Only two wells (S-53 and PZ-211-SD) contained combined total uranium above the MCL during one of the four monitoring events (yellow dots on Figure 7-15). None of the dissolved phase samples collected from any of the monitoring wells during any of the monitoring events contained uranium concentrations greater than the MCL (Figure 7-16).

7.5.4 Potential Data Gaps Relative to Radionuclide Occurrences in Groundwater

A preliminary evaluation of potential data gaps relative to radionuclide occurrences in groundwater has been developed. Identification of potential data gaps is based on the preliminary evaluations of the radionuclide groundwater monitoring data described in the preceding sections and discussions with EPA. The preliminary list of potential data gaps relative to radionuclide occurrences in groundwater include the following:

1. Background groundwater quality

2. Overall groundwater geochemistry
3. Regional, site and localized hydraulic gradients and flow directions with spatial/temporal data
4. Recharge and discharge
5. Role/impact of leachate extraction system on water levels and gradients
6. Occurrence, if any, and extent of off-site groundwater contamination
7. Adequacy of the groundwater monitoring well network along the perimeters of Areas 1 and 2
8. Aquifer properties
9. Samples from wells after re-development
10. Potential for vapor intrusion

Further evaluation of these potential data gaps is expected to be performed as part of the scoping of the groundwater (OU-3) RI/FS, and all data gaps that are identified will be addressed as part of the OU-3 investigation.

7.6 Radionuclide Fate and Persistence

This section of the RI addresses the radioactive decay of the various radioisotopes present at the Site, the generation of "daughter" products, and the projected changes in radionuclide levels in Areas 1 and 2 over time.

7.6.1 Radioactive Decay

Radioisotopes, like all elements, are composed of smaller particles including protons (positively charged particles with significant mass), electrons (negatively charged particles without significant mass) and neutrons (neutrally charged particles with significant mass). The primary fate of all radioisotopes is radioactive decay, whereby the nucleus of an atom spontaneously decomposes, thereby changing its identity and releasing energy. Radioactive decay results in conversion of one of the three particles of the atom into another type of particle with the consequent release of energy. The type of radiation emitted by the radioactive substances describes the methods of radioactive decay. The three most common types of emissions are alpha, beta, and gamma rays.

Alpha emissions consist of a stream of helium nuclei (a proton) known as alpha particles. With alpha decay, both the atomic number (number of protons) and the atomic mass (number of protons and neutrons) changes. For example, the decay of U-238 to Th-234 occurs through the loss of an alpha particle. The atomic number of the original U-238 is reduced from 92 (uranium) to 90 (thorium) and the atomic weight is reduced from 238 to 234, resulting in generation of Th-234.

A second type of radioactive decay occurs through emission of beta rays. Beta rays consist of a stream of electrons. Emission of beta rays can be thought of as converting a neutron into a proton, thereby increasing the atomic number by one but maintaining the same atomic weight. For example, Th-234 decays to protactinium-234, which decays to U-234, all of which occur through emission of beta particles. The atomic weight of all three isotopes is the same, 234; however, the atomic number of the Th-234 (90) is increased to 91 in the decay to protactinium-234. Decay of the protactinium-234 to U-234 further increases the atomic number to 92.

The third type of radioactive decay is through emission of gamma rays. Gamma rays consist of electromagnetic radiation of very short wavelength (that is, high-energy photons). Emission of gamma rays changes neither the atomic number nor the atomic mass number of a nucleus.

Figures 7-17, 7-18 and 7-19 present the three radioactive decay series of interest to the OU-1 RI/FS: the U-238 decay series, the U-235 decay series and the Th-232 decay series.

7.6.2 Changes in Radionuclide Concentrations

As a result of radioactive decay, some radioisotopes will decrease in concentration over a given period of time while others may increase over the same period of time. The equation defining the rate of decay, or in-growth, is a first order (logarithmic) equation based on the concept of a half-life. The half-life is the amount of time it takes one half of the radioisotope to decay.

The amount of a radioisotope that decays over a given period of time can be calculated as follows:

$$\text{Log } N_o/N_t = k\ t / 2.30$$

Where:

N_o = the initial number of nuclei (initial concentration) at zero time;

N_t = the number of nuclei (concentration) at a given time;

k = the radioactive decay constant; and

t = the time interval of interest.

The radioactive decay constant is defined as follows:

$$k = 0.693 / t_{½}$$

Where $t_{½}$ is the half-life of the radioisotope of interest.

Substituting the formula for the radioactive decay constant into the formula for radioactive decay and substituting concentration for the number of nuclides yields the following:

$$\log c_o / c_t = 0.3\ t / t_{½}$$

This equation can be used, for example, to calculate the amount of Ra-226, which has a half-life of 1,602 years that will remain after thirty years of radioactive decay. For a material with an initial concentration of Ra-226 of 100 picocuries per gram, the amount of Ra-226 remaining at the end of thirty years can be calculated as follows:

$$\log c_o / c_t = 0.3\ (30) / 1602 = 0.0056$$

Therefore,

$$c_o / c_t = 1.013$$

For c_o equal to 100 pCi/g,

$$c_t = 100 / 1.013 = 98.7 \text{ pCi/g}$$

Therefore, the concentration of the radium remaining after thirty years would be 98.7 pCi/g.

This basic equation can be used to calculate not only the decay of a particular radioisotope, but also the in-growth of a daughter product as a result of radioactive decay. The equation for in-growth of a daughter product is as follows (Cember, 1988):

$$A_d = A_{po} (T_p/T_p - T_d) (e^{-\lambda_p t} - e^{-\lambda_d t})$$

Where:

A_d = activity of the daughter product due to decay of the parent

A_{po} = initial activity of the parent

T_p = half-life of the parent (years)

T_d = half-life of the daughter (years)

λ_p = decay constant of the parent

λ_d = decay constant of the daughter

t = time interval of interest (years)

$\lambda = 0.693 / t_{1/2}$

Of particular interest for OU-1 is the prediction of the Ra-226 concentrations that may be present at the Site in the future. Th-230 decays to Ra-226 through alpha decay. Results of all of the investigations at the Site indicate that the activity level of Th-230 exceeds and is not in equilibrium with the activity level of the other radionuclides, notably Ra-226. Consequently, as a result of decay of Th-230, the levels of Ra-226 are expected to increase over time as noted in the NRC reports (RMC, 1982 and NRC, 1988).

The radioactive decay equation was used to predict both the decay of Th-230 to Ra-226 and the decay of Ra-226 to radon-222 to estimate the level of Ra-226 that will be present in the future.

The arithmetic average values of the Th-230 and Ra-226 data for the Area 1 and Area 2 soil/waste samples (see prior discussion in Section 6.6) were used to estimate the anticipated ingrowth of Ra-226 from decay of Th-230 over time. These values were used in the equations presented above to estimate the average amount of Ra-226 that would be present in Areas 1 and 2 in 1,000 years. Accounting for the in-growth of Ra-226 due to the decay of Th-230 results in an estimated average Ra-226 activity level of 607 pCi/g in Area 1 and 775 pCi/g in Area 2 in 1,000 years (Tables 7-25 and 7-26). The expected increases in the Ra-226 levels in Areas 1 and 2 owing to decay of Th-230 over time are graphically presented on Figure 7-16 and 7-17. Peak radium levels are expected to occur in approximately 9,000 years at which time average Ra-226 activities are estimated to be 1344 pCi/g in Area 1 and 1844 pCi/g in Area 2.

7.6.3 Other Fate and Transport Processes

In addition to radioactive decay, other fate and transport processes affect the concentrations of the various radionuclides that may remain at the Site over time. Primary among these are leaching, sorption, and volatilization.

7.6.3.1 Leaching Potential and Sorption

Leaching is the process whereby materials in or attached to a solid phase are separated from the solid phase and are mobilized into a dissolved phase in water. By contrast, sorption is the process whereby a radionuclide becomes attached to the soil matrix. The partitioning of a particular radionuclide (or, for that matter, any element or compound) between the soil or water phase can be estimated based on the distribution coefficient.

Potential leaching of radionuclides was included in the scope of the evaluation of fate and transport processes. These evaluations included laboratory testing and geochemical modeling of the potential leaching of radionuclides under varying conditions. The results of these evaluations are presented in a separate report (SSPA, 2017b). A summary from that report includes the following:

1. Most radiological constituents in RIM are insoluble or sparingly soluble due to their incorporation/encapsulation in stable minerals such as barite.

2. The mass of radionuclides leached from RIM during laboratory leaching is a small fraction of the total. This is consistent with the relatively-low solubility of barite.

3. Dissolved radionuclide concentrations during leaching can be significantly higher than maximum contaminant levels (MCLs) for uranium and radium in groundwater.

4. Dissolved radionuclide concentrations in laboratory tests represent the most-soluble chemical forms of each radionuclide during initial leaching. Long-term leaching rates should decrease over time.

In summary, the laboratory testing and geochemical modeling performed for the Fate and Transport Evaluation demonstrate a potential for leaching of radionuclides from the RIM in Areas 1 and 2. Evaluation of potential leaching and any potential impacts from such leaching will be performed as part of the groundwater (OU-3) RI/FS.

7.6.4 Summary of Fate and Persistence of Radionuclides

The levels of radium at the Site are expected to increase over time as a result of ingrowth of radium from decay of thorium due to the secular disequilibrium between the radium and thorium activity levels in the RIM. Peak radium levels are expected to occur in the RIM in approximately 9,000 years in the future. The increase in radium levels over time will be addressed in both the assessment of potential risks as part of the updated Baseline Risk Assessment and the design of containment systems for the evaluation of remedial alternatives in the Final FS.

Laboratory testing and modeling of potential for leaching of radionuclides were conducted as part of the Fate and Transport Evaluations (SSPA, 2017). Based on the laboratory testing and geochemical modeling performed for the Fate and Transport Evaluation, there is a potential for leaching of radionuclides from the RIM in Areas 1 and 2. Evaluation of potential leaching and any potential impacts from such leaching will be performed as part of the groundwater (OU-3) RI/FS.

8. NON-RADIOLOGICAL CHEMCIAL OCCURRENCES IN AREAS 1 AND 2

This section describes the results of the sampling and analyses of non-radiological contamination within or near the boundaries of Areas 1 and 2. Although OU-1 is focused on occurrences of radiologically impacted materials in Areas 1 and 2, the purpose of the RI/FS as stated in the SOW is to investigate the nature and extent of contamination, which is defined as both radiological and other hazardous substances. Consequently, in the course of the field investigations and laboratory analyses conducted for OU-1, a portion of the samples were analyzed for organic and non-radiological inorganic constituents.

8.1 Occurrences of Non-Radiological Chemical Constituents in Soil/Waste (1995 and 2015)

As part of the investigation of radiological occurrences in Areas 1 and 2, investigations of occurrences of non-radiological, chemical constituents were also performed during the RI. The majority of the chemical analyses of soil/waste samples were performed as part of the OU-1 RI work performed in 1995 as specified in the EPA approved RI/FS Work Plan (McLaren/Hart, 1994). The soil samples collected by McLaren/Hart as part of the 1995 soil boring program (McLaren/Hart, 1996h) were analyzed for the following non-radiological constituents:

- Priority pollutant metals and cyanide,
- Total petroleum hydrocarbons,
- VOCs,
- SVOCs, and
- Pesticides and polychlorinated biphenyls.

As part of the OU-1 RI field investigation and laboratory analyses, 43 soil samples from 28 borings were analyzed for VOCs, SVOCs, pesticides and polychlorinated biphenyls (PCBs), and total petroleum hydrocarbons (TPH). Twelve of these borings were located in Area 1 and 16 were located in Area 2. The criteria used to select specific samples for chemical analyses are discussed in Section 4.5.2.

Seventeen of the soil samples analyzed for organic compounds were collected from Area 1 borings and 23 were collected from Area 2 borings. There were also three field duplicates, for a total of 43 soil samples analyzed for organic compounds. Of the 43 samples collected and analyzed for non-radiological constituents, 15 were of surface soils, including five from Area 1 and 10 from Area 2.

In addition, 37 soil samples from 25 borings were analyzed for the 12 priority pollutant metals, including antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc. Cyanide analyses were also performed on these samples. Nine of these borings were located in Area 1 and 16 were located in Area 2. Eleven of the soil samples analyzed for trace metals were collected from Area 1 borings and 23 were collected from Area 2

borings. There were also three field duplicates, for a total of 37 soil samples analyzed for trace metals. Additional detailed information is contained in the "Soil Boring/Surface Soil Investigation Report" (McLaren/Hart, 1996h).

The only other non-radiological results are for samples collected during the Phase 1D investigation of Area 1, the Additional Characterization of Areas 1 and 2, and the Cotter investigation. These samples were analyzed for Target Analyte List (TAL) trace metals; inorganic parameters including pH, calcium, magnesium, sodium, potassium, alkalinity, chloride, fluoride and sulfate; and three transition metals: scandium, niobium and tantalum. A total of 138 soil samples were collected by these investigations, including 69 samples plus seven duplicate samples from Area 1, and 54 samples plus eight duplicate samples from Area 2.

A summary of the results of the non-radiological analyses (both organic and inorganic) obtained from Areas 1 and 2 during the OU-1 RI is presented in Appendix D-2. Trace metal results for the Phase 1D samples, the Additional Characterization samples, and the Cotter investigation are presented in Appendices D-4, D-5 and D-6, respectively.

Disposal operations at the West Lake Landfill date back to the 1950s and predate the adoption of federal or state regulations prohibiting the disposal of hazardous wastes in solid waste landfills. In addition, during the time period in which wastes were disposed of at the Site, certain household products frequently contained substances that are now regulated as hazardous substances. Accordingly, there is a potential that some of the waste materials at the landfill could display the characteristics of hazardous wastes.

The potential for occurrences of hazardous wastes exhibiting the toxicity characteristic (TC) within Areas 1 and 2 was evaluated by comparing the maximum levels of the 40 designated toxic chemical constituents detected in any of the RI soil samples to the maximum concentration of contaminants using the Toxicity Characteristic Leaching Procedure (TCLP) under the Resource Conservation and Recovery Act (RCRA) (40 C.F.R. Part 261.24) and the Missouri state hazardous waste regulations (10 CSR 25-4.261). Section 1.2 of the TCLP provides that if the total analysis of a waste demonstrates that toxic constituents are present only at concentrations below their respective regulatory levels, the TCLP need not be run. For wastes with no free liquids, this is accomplished by multiplying the TC regulatory limit by 20 (to reflect the 20x weight ratio of extraction fluid to solid in the TCLP protocol) for comparison to the respective constituent concentrations. The results of these comparisons are presented on Table 8-1.

Based on these comparisons, the possibility exists that some of the waste materials contained in Areas 1 and 2 could be classified as hazardous wastes based upon the presence of TC metals, or their benzene, chloroform, or 1-4 dichlorobenzene concentrations. However, this possibility can only be verified by subjecting representative samples to the TCLP for those constituents, since the screening was compared to the highest single value (not necessarily the representative concentration), and the chemical form and/or attenuation by the solid matrix may preclude significant leachability under the procedure. RCRA regulatory authorities do not apply to wastes legally placed into a disposal unit prior to its effective date unless the wastes were excavated or

removed from the disposal unit. Further waste classification is not necessary unless and until such excavation occurs.

Identification of, or testing for, regulated asbestos containing materials (RACM) was not included in the scope of the RI field investigations or the subsequent investigations. Review of the RI soil boring logs (Appendix B-1) does not indicate that pipe insulation, transite panels or other materials that may represent RACM were encountered during drilling; however, as stated above, identification of such materials was not part of the scope of the RI field investigations. Individuals responsible for performance of the Phase 1C, Phase 1D, Additional Characterization and Cotter investigations were required to complete asbestos awareness training and were therefore conscious of the potential for asbestos. No indications of potential RACM were noted during these field investigations. Therefore, although previous investigations did not note the presence of RACM, no definitive information exists regarding the presence of, or locations where, RACM, if any, may be present in Areas 1 and 2.

8.2 Non-Radiological Constituents Detected in Erosional Sediments (1995-1996)

The only erosional sediment samples analyzed for non-radiological constituents were those collected by McLaren/Hart in 1995-1996 as part of the OU-1 RI investigations. These samples were collected from or adjacent to the nine weirs installed by McLaren/Hart, the locations of which are shown on Figure 4-13. These samples were analyzed for priority pollutant metals, petroleum hydrocarbons, semi-volatile organic compounds, pesticides and PCBs. Results of the laboratory analyses for chemical constituents in the OU-1 RI sediment samples are tabulated in Appendix G-2. Sediment samples collected by EMSI in 1997 and as part of the additional characterization work in 2016-2017 were analyzed for radionuclides only.

Non-radiological constituents detected in the 1995-1996 erosional sediment samples obtained from Area 1 included the following:

- SVOCs were detected in sediment samples from three of the four sampling locations (Weirs 1, 2, and 3). The detected concentrations were less than 0.2 parts per million (ppm), except for bis(2-ethylhexyl)phthalate, which ranged as high as 5.8 ppm.

- Pesticides were detected in sediment samples from three of the four sampling locations (Weirs 1, 2, and 3). The detected concentrations ranged from 0.00034 to 0.00082 ppm.

- Motor oil petroleum hydrocarbons were detected in three of the four sediment samples (Weirs 1, 2, and 3). The detected range was 50 to 580 ppm with the highest concentration being detected in the sediment sample collected from Weir 2.

- Trace metal results were generally consistent in all four sediment samples. However, one sediment sample (Weir 2) indicated the presence of substantially higher copper (61 ppm) and nickel (130 ppm) concentrations.

Non-radiological constituents detected in the 1995-1996 Area 2 erosional sediment samples included the following:

- SVOCs were detected in one sediment sample (Weir 7). The detected concentrations ranged from 1.1 to 1.8 mg/kg.

- One pesticide was detected in one of the sediment samples (Weir 5). The detected concentration was 0.00025 mg/kg.

- Motor oil petroleum hydrocarbons were detected in one of the five sediment samples (Weir 5). The detected concentration was 53 mg/kg.

- Trace metal results were generally consistent in all five sediment samples. However, one sediment sample (Weir 5) indicated the presence of substantially higher lead (60 mg/kg) and zinc (95 mg/kg) concentrations.

8.3 Non-Radiological Constituents Detected in Rainwater Runoff Samples (1995-1997)

Rainwater runoff samples collected during the OU-1 RI in 1995-1996 were analyzed for chemical constituents. Rainwater runoff samples were collected from the nine temporary weir locations installed as part of the OU-1 RI field investigations (Figure 4-13).

No trace metals or petroleum hydrocarbons were detected in any of the OU-1 rainwater runoff samples.

Non-radiological constituents detected in the Area 1 rainwater runoff samples included two VOCs (ethylbenzene and xylenes) and one SVOC (2,4-dimethylphenol). These constituents were detected only in the sample collected from Weir 2. The detected VOC concentrations ranged from an estimated value of 2.2 parts per billion (ug/kg) to 13 ppb; the detected SVOC concentration was 75 ug/kg. No other priority pollutant constituents of concern were detected in the four rainwater runoff samples obtained in Area 1.

Review of analytical results for Area 2 rainwater runoff samples (Appendix G-1) indicates that none of the non-radiological constituents were present above detection limits.

8.4 Non-Radiological Constituents Detected in Surface Water Samples (1995)

McLaren Hart collected surface water samples for non-radionuclide, chemical analyses once in November 1995 from the North Surface Water Body and the Earth City Flood Control Channel. These samples were analyzed for priority pollutant trace metals, volatile organic compounds, and semi-volatile organic compounds and petroleum hydrocarbons, total suspended solids, total

dissolved solids, pH, chemical oxygen demand, total organic carbon, and chloride, nitrate, phosphate and ammonia. Review of non-radiological analytical results for the North Surface Water Body obtained during the OU-1 RI investigations (Appendix G-1) indicates that only one metal, lead, was detected in both the unfiltered and filtered samples at concentrations of 18 and 3.9 ppb, respectively. No other non-radiological constituents were detected in the sample from the North Surface Water Body.

No non-radiological constituents were detected in the Flood Control Channel samples.

8.5 Non-Radiological Constituents in Perched Water and Area 2 Seep (1995)

McLaren/Hart encountered perched water in eight soil borings (no specific description of perched water was provided in the McLaren/Hart report but as discussed in Section 4.6 perched water is presumed to occur in thin saturated zones where precipitation infiltration and/or leachate accumulates on top of lower permeability layers within the landfill mass). The locations of the borings that contained perched water are provided on Figure 4-9. In conjunction with the drilling of the various soil borings in Areas 1 and 2 in August and September of 1995, McLaren/Hart collected four samples of perched water encounter during drilling of the soil borings. As was discussed in Section 4.6, the specific locations and depths from which perched water samples were collected include Area 1 boring WL-108 at 22 ft bgs and Area 2 borings WL-219 at 25 ft bgs, WL-220 at 20 ft bgs, and WL-231 at 31 ft bgs.

All of these samples were submitted for radionuclide analyses and three of these samples) all but the sample obtained from WL-220) were submitted for chemical analyses including priority pollutant trace metals, VOCs, SVOCs, pesticides and PCBs and also for leachate indicators (biological oxygen demand, chemical oxygen demand, pH, total dissolved solids, total organic carbon, chlorides, nitrite, nitrate, ammonia, total phosphorous, and sulfide). McLaren/Hart also collected a sample of leachate seepage from the seep identified in the northwestern portion of Area 2 (Figure 4-9). Additional information regarding the occurrences and sampling of the perched water and leachate seep are presented in Section 4.6.

Results of the chemical analyses of the three perched water samples are presented in Appendix D-9. Five metals were detected in the perched water samples (arsenic, chromium, mercury, nickel, and zinc). The detected constituent concentrations ranged from non-detect to 97 ug/L. All of the detected metals were below their respective MCLs. All sample reporting limits were also below the MCLs.

Two metals were detected in the seep that was observed in Area 2 during the Site investigations for the RI (Figure 4-9) (lead and zinc). These metals were detected in only the unfiltered samples at concentrations of 17 ug/L (drinking water action level of 15 ug/L) and 130 ug/L, respectively (drinking water action level of 5,000 ug/L).
Petroleum hydrocarbon compounds in the diesel and motor oil range were detected in the perched water samples. The detected concentrations ranged from 1.3 to 14 mg/L. Petroleum

hydrocarbon compounds in the diesel and motor oil range were also detected in the Area 2 seep sample at concentrations of 0.47 and 0.48 mg/L, respectively.

Aromatic and halogenated VOCs were detected in the perched water samples. Aromatic compounds detected included: benzene (2.0 to 2.8 ug/L); toluene (2.2 to 55 ug/L); ethylbenzene (6 to 47 ug/L); xylenes (17 to 150 ug/L); chlorobenzene (11 to 29 ug/L); and 1,2-dichlorobenzene (4 ug/L). Other VOCs detected included: 2-butanone (<25 to 2,100 ug/L); 4-methyl-2-pentanone; acetone (22 to 1,200 ug/L); and 1,2-dichloroethane (2 ug/L).

Aromatic VOCs were also detected in the Area 2 seep sample, but no halogenated VOCs were detected in this sample. Aromatic VOCs detected included: benzene (2.2 ug/L), chlorobenzene (78 ug/L) and 1,4-dichlorobenzene (11 ug/L).

Thirteen SVOCs were detected in the perched water samples. Of these, six SVOCs were detected in at least two of the three perched water samples analyzed for SVOCs. The detected compounds included: benzoic acid (<75 to 810 ug/L); naphthalene (30 to 63 ug/L); phenol (<30 to 140 ug/L); 4-methyl phenol (3.6 to 310 ug/L); di-n-octyl phthalate (4.2 to 60 ug/L); and bis(2-ethylhexl) phthalate (30 to 260 ug/L).

Two SVOCs were detected in the Area 2 seep sample. These compounds were 1,4-dichlorobenzene (6.5 ug/L) and 2,4-dimethylphenol (75 ug/L).

Eight pesticides were detected in one or more of the perched water samples. The detected concentrations ranged from 0.015 to 0.18 ug/L. Two PCB Aroclors were also detected in the unfiltered samples. PCB Aroclor-1242 was detected in the perched water sample obtained from boring WL-231 at a concentration of 290 ug/L. PCB Aroclor-1248 was detected in the perched water sample obtained from boring WL-219 at a concentration of 3.4 ug/L. No pesticides or Aroclor PCBs were detected in the Area 2 seep sample.

Perched water exhibited many of the conditions indicative of landfill leachate: total dissolved solids (TDS) ranged from 2,300 to 6,300 mg/L; TSS ranged from 1,500 to 6,000 mg/L; chloride concentrations ranged from 510 to 1,500 mg/L; the COD ranged from 690 to 1,400 mg/L; the BOD ranged from <300 to 460 mg/L; and the ammonia concentration ranged from 93 to 220 mg/L.

The Area 2 seep sample had a similar TDS concentration of 2,000 mg/L; however, all of the other landfill leachate indicator parameters were detected at lower concentrations.

8.6 Non-Radiological Constituents Detected in Stormwater Samples (2016-2017)

As was discussed previously in Section 7.2.1.2, stormwater runoff samples have been obtained from eleven locations along internal and perimeter drainage channels that convey runoff from Areas 1 and 2 (Figure 4-1516) in conjunction with the 2016 NCC and later 2016 and 2017 OU-1

stormwater monitoring program. As of the date of this draft RI Addendum report, non-radionuclide (chemical) analytical results from five of these stations (OU-1-001, -002, -003/003A, -004, and -007) had been received and validated.. The results of these analyses are summarized on Table 8-2. Laboratory results for these samples are presented in Appendix G-4. Chemical results for a sixth location (OU-1-008) had been received but not validated at the time this version of the RIA was prepared. The analytical laboratory reports of the results for the samples obtained from this location are also included in Appendix G-4). Results four of the remaining monitoring locations were not received prior to preparation of this draft of the RIA. No flow has ever been observed as monitoring point OU-1-005 and therefore no samples have ever been collected from this location.

8.7 Non-Radiological Constituents Detected in Groundwater Samples

Groundwater samples were collected and analyzed for chemical constituents during the OU-1 RI field investigations conducted in 1995-1997 (see prior summary description in Section 4.11.2) and as part of the four comprehensive sampling events conducted in 2012 and 2013 (see prior summary description of this program previously presented in Section 4.11.4).

8.7.1 OU-1 RI Groundwater Sampling for Chemical Constituents (1995-1997)

McLaren/Hart obtained groundwater samples from 30 alluvial wells located near Areas 1 and 2 for non-radiological analyses. These samples included 12 shallow wells, 10 intermediate depth wells, and eight deep alluvial wells (Table 4-5, Figure 4-12, and Appendix F-1). McLaren/Hart performed two rounds of groundwater sampling during which non-radiological analyses were obtained. These samples were analyzed for radionuclides, priority pollutant metals, VOCs, SVOCs, pesticides and PCBs and for petroleum hydrocarbons. Both filtered and unfiltered samples were collected for metals analyses during the first round of sampling in November 1995. Only filtered samples were obtained for metals analyses during the second round in February 1996. Samples collected in May 1996 during the third round of groundwater sampling performed by McLaren/Hart and samples obtained by EMSI in 1997 were only analyzed for radiological constituents.

The OU-1 RI groundwater samples were analyzed for 13 trace metals including: antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc. Eight metals were detected in the groundwater samples and are discussed below. These metals were detected in both the unfiltered and filtered samples with the detected concentrations being generally similar, but slightly higher for the unfiltered samples. The five metals that were not detected in any of the groundwater samples were antimony, beryllium, cadmium, silver and thallium. The groundwater samples were also analyzed for cyanide, but this compound was not detected in any of the groundwater samples.

Results of the groundwater analyses for trace metals are presented in Appendix F-1. A complete summary of the trace metal analytical results obtained from the OU-1 RI groundwater samples is presented in Appendix F-1. The following is a narrative summary of the trace metals detected in the OU-1 RI groundwater samples:

- Arsenic was detected in about half the samples at concentrations ranging from 10 to 420 micrograms per liter (ug/L).[76] Arsenic was detected at concentrations above 50 ug/L[77] in only four wells (S-10, S-84, MW-F3, and D-14).

- Chromium was detected in about a third of the wells at concentrations ranging from 10 to 62 ug/L. Chromium was generally only detected in the unfiltered samples. Chromium was detected in filtered samples in only two wells (S-5 and S-10) at concentrations ranging from 11 to 22 ug/L.

- Copper was only detected in six wells and only in the unfiltered samples obtained from these wells. The detected concentrations ranged from 23 to 76 ug/L.

- Lead was detected in almost all unfiltered samples at concentrations ranging from 3.1 to 70 ppb. Lead was detected in only two filtered water samples (S-5 and I-4) at concentrations ranging from 4.1 to 7.9 ug/L.

- Mercury was detected in only one unfiltered groundwater sample (D-14) at a concentration of 0.21 ug/L.

- Nickel was detected in about a third of the wells at concentrations ranging from 21 to 110 ppb. Nickel was most frequently detected in the unfiltered samples, and only four wells contained nickel in both the unfiltered and filtered samples (S-5, S-82, D-12, and D-83).

- Selenium was detected in only one well (MW-101) on one occasion at a concentration of 38 ug/L.

- Zinc was detected in most unfiltered samples at concentrations ranging from 28 to 310 ppb. Zinc was only detected in six filtered samples (S-1, S-5, S-82, I-11 D-83, and D-93) at concentrations ranging from 20 to 77 ug/L.

With the exception of arsenic, trace metals generally were only detected in the unfiltered samples of groundwater. The presence of a trace metal in an unfiltered sample can be due to either the actual presence of the trace metal in the dissolved phase and/or the presence of fine-grained soil

[76] Although McLaren/Hart reported the data in ppb in their Groundwater Conditions report (which was also carried over to the 2000 RI), we have changed the units to ug/L or mg/L for purposes of consistency within this RI Addendum.
[77] The arsenic standard at the time the 2000 RI was prepared was 50 µg/l. EPA adopted a standard of 10 µg/L in 2001.

material that is not filtered out by the well screen/sand pack. Consequently, the representativeness of trace metal occurrences in unfiltered groundwater samples is questionable. Therefore, only the areal distribution of arsenic could be examined.

The majority of the arsenic results were either non-detect or similar to the levels found in upgradient well S-80 (see Appendix F-1). The highest levels of arsenic were detected in shallow well MW-F3 located near the southeast corner of Area 2 (see Figure 4-12) where in November 1995 arsenic was detected at 420 µg/L in the unfiltered (total) sample fraction and 400 µg/L in the dissolved (filtered) fraction. None of the other wells located near well MW-F3 contained elevated levels of arsenic. The second highest level of arsenic (49 dissolved and 94 µg/L total) was detected in deep well D-14 located along the southern portion of Area 1. None of the other wells located near well D-14 displayed elevated levels of arsenic. The remaining occurrences of arsenic were less than the drinking water standard of 50 µg/L [78]. It should be noted that none of the groundwater samples obtained from wells located along the northern or western boundary of Area 2 contained detectable levels of arsenic. Therefore, arsenic does not appear to be migrating off-site from the West Lake Landfill. In addition, review of the arsenic occurrences in the various well clusters indicates that although arsenic may be present in the shallow alluvial groundwater, it is generally not detected in the intermediate or deeper portions of the alluvial groundwater system beneath Area 2. This may reflect the control that oxidation-reduction (redox) conditions have on arsenic mobility with the arsenic occurrences in the shallow groundwater which is closer to the waste mass. Reducing conditions around the waste mass may cause increased solubility of arsenic and other redox sensitive species such as iron and manganese while, with distance or increased depth from the waste mass, more oxidizing conditions may prevail resulting in lower solubility and lower concentrations of arsenic in the deeper groundwater.

Petroleum hydrocarbons in the diesel and motor oil range were detected in six wells (S-5, S-8, I-11, I-65, D-14 and D-85). The detected concentrations ranged from 0.53 to 3.5 mg/L (Tables F-1.13 and F-1.19). The distribution of the few monitoring wells that contained detectable levels of petroleum hydrocarbons does not indicate any discernible pattern.

Halogenated and aromatic VOCs were detected in about half the wells. Eleven compounds were detected in the groundwater samples (Appendix F-1), specifically:

- Benzene was detected in three wells (I-2, I-9 and D-93) at concentrations ranging from 5.6 to 11 ug/L.

- Toluene was detected in one well (S-5) at concentrations of 19 and 45 ug/L.

- Ethylbenzene was detected in two wells (S-5 and D-14) at concentrations ranging from 13 to 22 ug/L.

[78] As noted above, the arsenic standard at the time the 2000 RI was prepared was 50 µg/l.

- Xylenes were detected in two wells (S-5 and D-14) at concentrations ranging from 19 to 78 ug/L.

- Chlorobenzene was detected in four wells (S-84, MW-F3, PZ-114-AS and D-14) at concentrations ranging from 6.0 to 170 ug/L.

- 1,2-Dichlorobenzene was detected in two wells (S-5 and MW-F3) at concentrations ranging from 5.1 to 8.1 ug/L.

- 1,4-Dichlorobenzene was detected in three wells (S-5, MW-F3, and D-14) at concentrations ranging from 9.9 to 50 ug/L.

- Cis-1,2-Dichloroethylene was detected in three wells (S-10, S-82, and D-14) at concentrations ranging from 7.2 to 34 ug/L.

- 1,1-Dichloroethane was detected in one well (D-13) at concentrations ranging from 7.6 to 8.0 ug/L.

- 2-Butanone was detected in only one well (D-12) on one occasion at a concentration of 70 ug/L.

- Acetone was detected in three wells (I-11, D-13 and D-14) during the November 1995 sampling round, but not confirmed during the February 1996 sampling round. The detected concentrations ranged from 37 to 44 ug/L.

Due to the limited number of locations containing detectable levels of VOCs, no discernible pattern could be identified.

SVOCs were detected in six wells (MW-F3, I-11, I-62, D-3, D-12, and D-14). The compounds detected were 1,4-dichlorobenzene, 4-methylphenol, di-n-octyl phthalate, and bis(2-ethylhexyl)phthalate and the detected concentrations ranged from 12 to 290 ug/L (Appendix F-1). The only compound detected during both sampling rounds was 1,4-dichlorobenzene (18 to 38 ug/L) in D-14, which was detected using both USEPA Method 8240 for VOCs and USEPA Method 8270 for SVOCs. Concentrations detected by the SVOC analytical method were equal to or less than the concentrations reported by the VOC analytical method. Due to the extraction procedure used in the SVOC analysis, it is possible that some of the 1,4-dichlorobenzene was lost; therefore, the results of the VOC analytical method may be more reliable.

Three pesticides were detected during the November 1995 sampling round but not confirmed during the February 1996 sampling. The three pesticides detected were 4,4-DDD, aldrin, and lindane. The detected concentrations ranged from 0.011 to 0.11 ug/L (Appendix F-1). No PCB Aroclors were detected in any of the groundwater samples.

8.7.2 Post-ROD Groundwater Sampling for Chemical Constituents (2012-2013)

The most extensive program of groundwater sampling and chemical analyses conducted were those associated with the four comprehensive groundwater sampling events conducted in August 2012 and April, July and October 2013. During these events, up to 85 monitoring wells located throughout the entire Site were sampled and submitted for chemical analyses including VOCs, trace metals, inorganic parameters and, during the first event, SVOCs. Summary tables of the results of the chemical analyses of these samples are presented in Appendix F-3. Occurrences of non-radionuclide, chemical parameters including VOCs, SVOCs, trace metals and inorganic parameters in groundwater are discussed below.

8.7.2.1 Volatile Organic Compounds

The groundwater samples collected from all of the Site wells during the 2012 – 2014 groundwater monitoring events (the four Site-wide comprehensive events in 2012 and 2013 and the second round of sampling in February 2014 of the eight wells installed in October 2013) were analyzed for 49 different VOCs. Most of the VOCs were not detected in any of the groundwater samples. The primary VOCs detected in some of the groundwater monitoring wells included benzene and related hydrocarbon compounds (toluene, ethyl benzene, xylenes, methyl tert-butyl ether, and cumene), chlorobenzene and other chlorinated benzenes (1,4-dichlorobenzene), and vinyl chloride and related chlorinated solvents (1,2-dichloroethene). Of these, benzene, chlorobenzene and vinyl chloride were detected at concentrations above their respective groundwater standards (5 µg/L for benzene, 100 µg/L for chlorobenzene and 2 µg/L for vinyl chloride).

Benzene was the most commonly detected VOC and was reported to be present in 26 to 28 wells during the August 2012 and April and July 2013 monitoring events (when approximately 75 wells were sampled) and in 36 wells during the October 2013 monitoring event (when 84 wells were sampled) (see Figure N-3.1 in Appendix N). Benzene data obtained from the 2012 through 2014 groundwater monitoring events is tabulated on Table 8-3. Benzene has been detected at concentrations greater than its MCL of 5 µg/L in the following three distinct areas of the Site (Figure 8-1):

- In bedrock groundwater adjacent to the South Quarry portion of the Bridgeton Landfill (wells PZ-103-SS, PZ-104-SS, PZ-104-SD, PZ-202-SS, PZ-204A-SS, PZ-210-SD and MW-1204);

- In shallow alluvial groundwater along the west side of the South Quarry portion of the Bridgeton Landfill and possibly extending beneath the southern portion of the Inactive Sanitary Landfill (wells PZ-205-AS, I-73, LR-100, LR-105, PZ-303-AS and PZ-304-AS); and

- In alluvial groundwater beneath the southwestern portion of Area 1 (wells D-14, I-4, and PZ-112-AS).

The highest levels of benzene (1,800 – 2,000 µg/L) were found in St. Louis/Upper Salem well PZ-104-SS located near the eastern corner of the South Quarry portion of the Bridgeton Landfill (Figure 8-1 and Appendix N Figure N-3.1). High levels (200 – 1,500 µg/L) of benzene were also detected in alluvial well PZ-205-AS located adjacent to the northwest side of the South Quarry portion of the Bridgeton Landfill. Occurrences of benzene in groundwater adjacent to the South Quarry portion of the Bridgeton Landfill are being addressed through groundwater assessment/corrective action activities being conducted under MDNR supervision pursuant to the Missouri Solid Waste Regulations. An Assessment of Corrective Measures Addendum was submitted to MDNR on February 22, 2016 (Feezor Engineering, Inc., 2016).

Chlorobenzene was detected in 24 to 25 monitoring wells during the 2012 – 2014 groundwater monitoring activities (see Figure N-3.2 in Appendix N). Chlorobenzene was only detected in two monitoring wells (PZ-112-AS and LR-105) at concentrations greater than its MCL of 100 µg/L (Figure 8-2). The highest levels of chlorobenzene were detected in well PZ-112-AS (1,500 – 3,500 µg/L) located near the western corner of Area 1 and well LR-105 (180 - 220 µg/L) located near the west side of the southern portion of the Inactive Sanitary Landfill.

Vinyl chloride was detected in 4 to 10 wells during each event (Figure N-3.3 in Appendix N). Vinyl chloride was only detected in four monitoring wells at concentrations greater than its MCL of 2 µg/L during some but not all of the 2012 – 2014 groundwater monitoring events (Figure 8-3). Other than the August 2012 event, the highest levels (0.52 J – 31 µg/L) of vinyl chloride were detected in well D-93 located along the southwest side of Area 2.

Other VOCs that were detected include toluene, ethyl benzene, xylenes, cumene, methyl tert-butyl ether 1,2-dichlorobenzene, 1,4-dichlorobenzene, cis-1,2-dichloroethene, and chloroethane. None of these VOCs were detected at levels greater than their MCLs for those for which MCLs have been established.

Overall, VOC occurrences in groundwater at the Site are isolated and do not indicate the presence of an extensive area or plume of VOC contamination. Benzene detections in groundwater in the vicinity of the South Quarry portion of the Bridgeton Landfill and the southern portion of the Inactive Sanitary Landfill may represent small areas of contiguous occurrences of benzene in groundwater. Occurrences of all of the other VOCs are isolated, sporadic and discontinuous.

8.7.2.2 Semi-Volatile Organic Compounds

The August 2012 groundwater samples were analyzed for SVOCs. Only a few SVOCs were detected. The most commonly detected SVOC was 1,4-dichlorobenzene, which was detected in 11 of the 73 monitoring wells that were sampled and analyzed for SVOCs. The highest detected

concentration of 1,4-dichlorobenzene was 19 µg/L in LR-105, which is less than the Missouri water quality standard of 75 µg/L. Additional information regarding the SVOCs that were detected and the levels at which they were detected can be found in the report of the August 2012 groundwater sampling event (EMSI, 2012c).

Overall, SVOCs were only detected in a few groundwater samples from the Site and generally at levels below their respective drinking water standards. EPA determined that additional SVOC analyses were not necessary, and therefore these parameters were not included in the analyte lists for the 2013 groundwater sampling events.

8.7.2.3 Trace Metals

Both total (unfiltered) and dissolved (filtered) fraction groundwater samples were collected from all of the Site wells during the 2012 – 2014 groundwater monitoring events. These samples were analyzed for 19 different trace metals. Two additional trace metals, boron and strontium, were included in the last 2013 Site-wide monitoring event at the request of the USGS.

Being naturally occurring, most of the trace metals were detected in most of the groundwater samples; however, many of the trace metals were not detected at concentrations greater than their respective MCLs or were only detected in the total fraction samples at concentrations above the MCLs, indicating that their presence is due to inclusion of suspended sediment/colloidal matter in the unfiltered samples.

The primary trace metals of interest that were detected in the groundwater monitoring wells include arsenic, iron, manganese, and barium. Occurrences of these metals are discussed in the following subsections.

8.7.2.3.1 Arsenic

Figure 8-4 presents a graphical summary of the locations where total (unfiltered) arsenic was detected above its MCL of 10 µg/L. Total arsenic results are summarized on Table 8-4 and graphically portrayed on Figure N-4 in Appendix N. Occurrences of total arsenic at levels above its MCL were generally found near the east and west sides of the South Quarry portion of the Bridgeton Landfill, along the east side of the North Quarry portion of the Bridgeton Landfill, along the east and west side of the Inactive Sanitary Landfill, near Area 1 and on a less frequent basis near Area 2 (Figure 8-4). The highest levels of total arsenic were reported for samples obtained from PZ-114-AS and S-82 near Area 1 and in wells PZ-302-AS and PZ-304-AS located on the west side of the Inactive Sanitary Landfill.

Figure 8-5 presents a graphical summary of the locations where dissolved arsenic was detected above its MCL of 10 µg/L. Analytical results for the dissolved fraction samples are portrayed on Figure N-3.5 in Appendix N and summarized on Table 8-4. With the exception of the east side of the North Quarry portion of the Bridgeton Landfill, occurrences of dissolved arsenic at levels

above its MCL were generally similar to those observed for total arsenic and included areas near the east and west sides of the South Quarry portion of the Bridgeton Landfill, along the east and west side of the Inactive Sanitary Landfill, near Area 1 and on a less frequent basis near Area 2 (Figure 8-5). The highest levels of dissolved arsenic were reported for samples obtained from the same wells as those that contained high levels of total arsenic (*e.g.*, PZ-114-AS, PZ-302-AS, PZ-304-AS, and S-82).

The occurrences of arsenic in groundwater at the Site are consistent with the presence of reducing conditions associated with decomposition of MSW. Biological decay of refuse and other naturally occurring organic matter results in consumption of available oxygen increasing the presence of methanotropic bacteria and overall reducing conditions. Arsenic can exist in different valence states depending upon redox conditions. In addition, arsenic that is contained in iron and manganese bearing minerals can be release to groundwater in conjunction with the increase solubility dissolution of such iron and manganese bearing minerals in the presence of reducing conditions.

Occurrences of higher concentrations of arsenic (*e.g.*, greater than 100 ug/L) in the dissolved and/or total fraction samples generally correspond with occurrences of higher concentrations of iron (*e.g.*, greater than 100,000 ug/L) and in some cases occurrences of higher concentrations of manganese (*e.g.*, greater than 5,000 ug/L). For example, the highest reported arsenic concentrations were found in wells S-82, S-84, I-73, PZ-112-AS, PZ-114-AS, PZ-302-AS, PZ-303-AS, and PZ-304-AS (Table 8-4). Many of these same wells, including S-84, I-73, PZ-302-AS, and PZ-303-AS, contained higher levels of iron (Table 8-5). PZ-303-AS also contained a higher level of manganese. There was also a correlation in increases in arsenic, iron and manganese levels over time observed in well I-73 and between increase in iron and manganese levels observed over time in well MS-1204, as discussed further in Section 8.6.3 below. Occurrences of increased concentrations of arsenic, iron and manganese are commonly observed in the vicinity of MSW landfills due to the presence of reducing conditions arising from the anaerobic (methanogenic) decomposition of MSW.

8.7.2.3.2 Iron

Occurrences of total and dissolved iron at levels above its secondary MCL [79] of 300 µg/L were found throughout the Site area (Table 8-5, Figures 8-6 and 8-7, and Appendix N Figures N-3.6 and N-3.7). The highest levels of iron were generally detected in the vicinity of the Inactive Sanitary Landfill and Area 1. Wells with the highest reported iron concentrations include D-85 and S-84 (Area 1), I-73 and PZ-105-AS (west side of the South Quarry portion of the Bridgeton Landfill), PZ-302-AS, PZ-303-AS and MW-104 (west side of Inactive Sanitary Landfill), S-10 (Area 2), MW-1204 (south side of South Quarry portion of the Bridgeton Landfill), and well S-53 (near the former leachate lagoon).

[79] Secondary MCLs are based on taste and aesthetic (*e.g.*, color) considerations as opposed to Primary MCLs which reflect health-based considerations.

The occurrences of iron in groundwater at the Site are consistent with the presence of reducing conditions associated with MSW decomposition in landfill settings. Biological decay of MSW or natural organic matter results in consumption of available oxygen, resulting in the presence of methanotropic (methane producing) bacteria and overall reducing conditions. Iron occurs in different valence states (ferrous and ferric), depending upon oxidation-reduction (redox) conditions, with iron being significantly more soluble under reducing conditions such as those present in the vicinity of landfills. Many aquifer materials are associated with significant amounts of naturally occurring iron that can be mobilized by reducing conditions associated with landfill wastes and/or natural phenomena.

8.7.2.3.3 Manganese

Occurrences of total and dissolved manganese at levels above its secondary MCL of 50 µg/L were found throughout the Site area (Table 8-6, Figures 8-8 and 8-9, and Appendix N Figures N-3.8 and N-3.9). The highest levels of manganese were generally detected in the vicinity of the Inactive Sanitary Landfill, between the Closed Demolition Landfill and Area 2, near Area 1, beneath the hauling company yard to the east of the North Quarry portion of the Bridgeton Landfill, and near the south corner of the South Quarry portion of the Bridgeton Landfill. Wells with the highest reported manganese concentrations (*e.g.*, greater than 3,000 ug/L) include PZ-302-AS and MW-104 (west side of Inactive Sanitary Landfill), S-10 (Area 2) and I-66 (along the Site perimeter between the Closed Demolition Landfill and Area 2), I-73 and PZ-305-AI (north side of the South Quarry portion of the Bridgeton Landfill), D-85,PZ-113-AS and PZ-114-AS near Area 1, MW-1204 (south corner of the South Quarry portion of the Bridgeton Landfill), PZ-200-SS (in the hauling company yard), and well S-53 (near former leachate lagoon).

The occurrences of manganese in groundwater at the Site are, similar to iron, consistent with the presence of reducing conditions associated with decomposition of MSW. Biological decay of refuse and other naturally occurring organic matter results in consumption of available oxygen increasing the presence of methanotropic bacteria and overall reducing conditions. Manganese can exist in different valence states depending upon redox conditions, with manganese being significantly more soluble under reducing conditions such as those present in the vicinity of landfills. Many aquifer materials are associated with significant amounts of naturally-occurring manganese that can be mobilized by reducing conditions associated with landfill wastes and/or natural phenomena.

8.7.2.3.4 Barium

Occurrences of total and dissolved barium at levels above its MCL of 2,000 µg/L are summarized on Table 8-7 and Figures 8-10 and 8-11. The actual barium results are presented on Appendix N Figures N-3.10 and N-3.11.

Three wells (D-3, D-85, and PZ-113-AD) contained barium in the total fraction (unfiltered) samples at concentrations greater than its MCL of 2,000 µg/L during the 2012-2014 events. All three of these wells are located near Area 1. Three other wells (PZ-112-AS, I-73, and PZ-304-

AS) contained total barium above its MCL during some, but not all, of the 2012-2013 monitoring events. Well PZ-112-AS is located near the west side of Area 1, well I-73 is located along the west side of the South Quarry portion of the Bridgeton Landfill, and well PZ-304-AS is located on the west side of the Inactive Sanitary Landfill. No other wells displayed total barium levels above its MCL.

Six wells contained dissolved barium levels above its MCL during some, but not all four of, the 2012-2014 monitoring events, including D-3, PZ-113-AD and PZ-112-AS near Area 1, I-73 and MW-1204 near the South Quarry portion of the Bridgeton Landfill, and PZ-304-AS along the west side of the Inactive Sanitary Landfill.

It should be noted that none of the groundwater samples obtained from wells located around Area 2 ever detected barium at concentrations greater than its MCL.

8.7.2.4 Inorganic Constituents

Due to its occurrence as a major anion in groundwater and its presence in leached barium sulfate residues, occurrences of sulfate in groundwater were examined. Occurrences of chloride, another major anion and a possible indicator of landfill leachate, were also examined. The entire body of inorganic (major ion) parameters were examined through use of Piper trilinear diagrams. Other potential chemical indicators of occurrences of landfill leachate such as bromide, iodide, boron and strontium were also examined.

8.7.2.4.1 Sulfate

Only four wells contained sulfate at concentrations above its MCL of 250 µg/L, including wells D-12 and S-10 in Area 2, well MW-102 on the west side of Area 2, and well PZ-204A-SS on the southwest side of the South Quarry portion of the Bridgeton Landfill (Figure 8-12 and Appendix N Figure N-3.12). Of these, sulfate was reported at concentrations above its MCL during all 2012-2013 events for wells S-10 and D-12, and during the last two 2013 events for wells MW-102 and PZ-204A-SS.

8.7.2.4.2 Chloride

Chloride is a common constituent of landfill leachate. The highest levels of chloride were detected in wells I-73 (1,700 mg/L in July 2013), MW-1204 (1,400 mg/L in October 2013), and LR-105 (930 mg/L in April 2013). Occurrences of chloride at concentrations greater than its MCL of 250 mg/L were detected in nine of the 85 wells sampled (South Quarry Landfill wells PZ-204A-SS, PZ-107-SS, PZ-205-AS, and I-73; Inactive Sanitary Landfill wells PZ-304-AS and PZ-304-AI; Area 1 wells D-3 and PZ-113-AD; and Area 2 wells D-93 and I-9) during all 2012-2014 events (Figure 8-13 and Appendix N Figure N-3.13). Chloride was detected at concentrations greater than its MCL during one or more, but not all four, events in 14 additional wells (Figure 8-13). Occurrences of chloride above the MCL were generally found in wells

located around the South Quarry portion of the Bridgeton Landfill, the west side of the Inactive Sanitary Landfill, around Area 1, and along the east and south sides of Area 2 (Figure 8-13).

8.7.2.4.3 Trilinear Diagrams of Major Ion Results

The trilinear diagram constitutes a useful tool in water-analysis interpretation (Hem, 1985). Trilinear diagrams are used to determine whether more than one type of water is present in an area or system and to describe geochemical relationships among various groundwater samples. Applications of the diagram include testing groups of water analyses to determine whether a particular water may be a simple mixture of others for which analyses are available or whether it is affected by solution or precipitation of a single salt. It can be shown easily that the analysis of any mixture of waters will plot on a straight line with the areas at each end of the line representing the end-members of the mixing system. Plotting well sample analyses may show linear trends and other relationships that can be interpreted geochemically.

Trilinear diagrams are prepared by first converting the reported chemical concentration data to milliequivalent values and normalizing the resultant molar anion and cation values. The normalized proportions of the anions and cations for each sample are then plotted on triangular plots, one for cations and one for anions. A trilinear diagram includes triangular regions in the lower left and lower right portions of the diagram for the cation and anion plots. The upper central portion of the trilinear diagram is a diamond shaped plotting area. The values for the sample points that are plotted in the triangular regions are extended into the central plotting field (diamond area) by projecting them along lines parallel to the upper edges of the central field. The intersection of these projections represents the composition of the water with respect to the combination of ions shown.

Trilinear diagrams were prepared for each of the four (2012 and three 2013) events and are presented in Appendix N-4. The large number of wells sampled resulted in the sample data having to be plotted on two separate diagrams for each event.

Review of the trilinear diagrams (Appendix N-4) indicates that in general, the groundwater in all four zones (Alluvium, St. Louis/Upper Salem, Deep Salem, Keokuk) exhibit a geochemistry that is either calcium/bicarbonate-dominant or calcium+magnesium/bicarbonate-dominant. Specifically, most of the data plots near the left sides of the triangles and the diamond plot areas indicate a predominance of calcium-bicarbonate type water, with some spread towards the upper right in the lower left triangle and the diamond plot area, indicating a magnesium contribution.

Visual inspection of the diagrams indicates that there are exceptions to these general types of waters in each event. Specifically, there are a few wells that exhibit a geochemistry that is frequently or consistently different from that of the overall calcium/magnesium bicarbonate water that is predominant at the Site, including:

- Alluvial well PZ-204A-SS located to the southwest of the South Quarry portion of the Bridgeton Landfill which consistently displayed a calcium + sodium/potassium – chloride type water;

- Alluvial well PZ-304-AS located along the west side of the Inactive Sanitary Landfill which consistently displayed a sodium/potassium + calcium – bicarbonate water;
- Keokuk Formation wells PZ-100-KS and PZ-111-KS located to the east and west of the North Quarry portion of the Bridgeton Landfill, respectively, which consistently displayed sodium/potassium – bicarbonate type water;

- Shallow well LR-105 located in the southwestern portion of the Inactive Sanitary Landfill which displayed a sodium/potassium – bicarbonate + chloride type water;[80]

- Alluvial well S-5 located in the western portion of Area 1, which consistently displayed a sodium/potassium – bicarbonate type water; and

- Alluvial wells D-12 and S-10 located on the southeast side of Area 2, which generally appear to consist of a calcium-bicarbonate + sulfate type water.

Other observations that can be made based on the trilinear diagrams include the following:

- A tendency for wells I-4, LR-100, PZ-112-AS, PZ-113-AD, PZ-116-SS, PZ-207-AS, and S-82 to contain a higher percentage of sodium/potassium compared to the majority of the Site wells, which were generally more calcium/magnesium rich;

- A trend towards an increase in the percentage of sodium/potassium in wells D-3 and D-14 during the July and October 2013 sampling events compared to more typical calcium/magnesium predominance observed in these two wells during the two earlier events; and

- A trend in water quality in well I-73 which changed from the typical calcium + magnesium – bicarbonate water during the August 2012 and April 2013 events to a calcium/magnesium – chloride/bicarbonate water during the July 2013 event to a sodium/potassium – chloride + bicarbonate water during the October 2013 event.

8.7.2.4.4 Iodide, Bromide, Boron and Strontium

Iodide, bromide, boron and strontium have been identified as potential indicators of landfill leachate (Panno, et. al., 2006). Iodide and bromide analyses were included as part of the monitoring activities conducted during the 2012-2013 monitoring events. Boron and strontium analyses were included as part of the October 2013 monitoring event at the request of the USGS.

[80] Due to poor well yield, samples were only obtained from this well during August 2012 and April 2013.

With the exception of well I-73, iodide was either not detected at a reporting limit of 1 mg/L or was detected at estimated concentrations below the reporting limit in all of the Site wells (Figure N-3.14 in Appendix N). Well I-73 initially (August 2012) contained an estimated iodide concentration of 0.51 J+ mg/L; however, with each successive sampling event the iodide concentrations at this well increased, rising to 2.9 mg/L in April 2013, 11 mg/L in July 2013 and 24 mg/L in October 2013. The significance of this increase in iodide levels in well I-73 is discussed further in context with changes in the levels of other water quality parameters in this well in the next section (Section 8.6.3) of this report.

Similarly, most of the Site wells were either non-detect for bromide or contained trace levels below or near the reporting limit of 0.25 mg/L (Figure N-3.15 in Appendix N). A few notable exceptions were identified. Similar to iodide, well I-73 displayed an increasing trend in bromide levels over the four sampling events from 2.2 mg/L in August 2012, to 4.1 mg/L in April 2013, to 11 mg/L in July 2013, and to 18 mg/L in October 2013. Well MW-1204 contained non-detectable levels of bromide in August 2012 and April 2013, 1.0 mg/L in July 2013; but 170 mg/L in October 2013. This trend is consistent with other trends observed in this well as discussed further below (Section 8.6.3). Other wells with notable bromide concentrations include D-3 (8.4 J- to 17 mg/L), I-4 (1.2 to 4.5 mg/L), S-5 (3.5 to 5.9 J- mg/L) and PZ-113-AD (3.2 to 15 mg/L) in and near Area 1; D-12 (3.9 to 4.8 J+ mg/L), I-9 (4.1 to 4.4 mg/L), D-93 (3.5 to 4.5 J- mg/L), S-82 (2.2 J- to 4.0 mg/L), and D-6 (1.3 J- to 2.9 mg/L) in Area 2; D-87 (4.2 J+ to 5.0 mg/L) adjacent to the Inactive Sanitary Landfill; and PZ-207-AS (2.7 to 3.0 J- mg/L) in the Closed Demolition Landfill. Many of these are the same wells in which chloride, another potential indicator of landfill leachate, was detected at levels above its MCL.

The highest levels of boron (Table 8-8) were reported for the sample obtained from well I-73 (10,000 and 11,000 µg/L) located along the west side of the South Quarry portion of the Bridgeton Landfill. MW-1204 located outside the South Quarry portion of the Bridgeton Landfill also contained high boron levels (4,100 µg/L). Occurrences of boron in these wells are consistent with occurrences of other parameters indicative of landfill leachate (see additional discussion in Section 4.4 below). Other notable occurrences of boron include Area 1 wells S-5 (2,300 and 3,300 µg/L) and I-4 (2,000 and 2,700 µg/L), Area 2 well S-82 (2,600 and 2,700 µg/L) and Inactive Sanitary Landfill well LR-100 (2,100 to 2,200 µg/L).

The highest levels of strontium (Table 8-8) were reported from samples obtained from well MW-1204 (13,000 and 14,000 µg/L). Other South Quarry monitoring wells PZ-103-SS (6,200 to 6,300 µg/L) and PZ-106-KS (5,300 to 5,400 µg/L) also contained strontium levels above those observed in the majority of the Site wells. One of the off-site, upgradient private water supply wells sampled by the USGS also contained what appeared to be high levels of strontium (4,200 µg/L).

8.7.3 Correlation of Radium and Non-Radionuclide Occurrences

The USGS (2014) evaluated potential correlations between radium occurrences and leachate indicators. The following paragraphs present the conclusions reached by the USGS relative to the potential correlation of radium occurrences with indicators of leachate impacts in groundwater.

The USGS concluded that based on the frequency of chloride, bromide, and iodide concentrations above background in groundwater samples from the WLL Site, 47 of the 83 monitoring wells (37 alluvial wells and 10 bedrock wells) at the WLL Site are affected by landfill leachate. Wells affected by landfill leachate also have increased concentrations of dissolved calcium, magnesium, sodium, potassium, barium, iron, manganese, strontium, total alkalinity, and dissolved combined radium. Wells with the greatest leachate effects tend to have smaller concentrations of sulfate and uranium and produce anoxic groundwater. Concentrations of dissolved combined radium were significantly larger (p value less than 0.000 I) in samples from alluvial or bedrock monitoring wells affected by landfill leachate compared to samples from monitoring wells that do not have landfill leachate effects.

Concentrations of dissolved combined radium were significantly larger (p value less than 0.0001) in samples from alluvial or bedrock monitoring wells affected by landfill leachate compared to samples from monitoring wells that do not have landfill leachate effects. Of 83 monitoring wells sampled at the WLL Site during 2012-14, 13 had average dissolved combined radium above the MCL. Five of these wells were deep alluvial wells that also had landfill leachate effects, and two were bedrock wells with no landfill leachate effects (PZ-100-SS and PZ-102-SS). Six of the eight bedrock wells having average dissolved combined radium above the MCL also had landfill leachate effects. While some of these 13 wells are generally downgradient from the RIM areas (such as D-3, D-6, D-83, D-93, PZ-113-AD, PZ-101-SS, PZ- 110-SS, and PZ-115-SS), other wells (PZ-100-SS, PZ-102-SS, PZ-107-SS, PZ-104-SD, and MW-1204) probably are not. Mass-balance models on dissolved Ra228/226 ratios and chloride concentrations were used in conjunction with the location and depth of wells with respect to groundwater flow and RIM areas to determine the likelihood of a RIM origin for the dissolved combined radium in the 13 wells. Of the 13 wells, 6 seem to have no hydrologic or possible physical connection to RIM areas (PZ-100-SS, PZ-102-SS, and PZ-107-SS), or have either ratios of Ra228/226 inconsistent with a RIM source (D-3 and PZ-113-AD) or chloride concentrations inconsistent with RIM/leachate source (D-83), and radium above the MCL in these wells probably is not the result of leaching from RIM. A RIM contribution to radium in the remaining seven wells cannot be ruled out with the available data. Two wells (MW-1204 and PZ-104-SD) have Ra228/226 ratios and chloride concentrations that could be consistent with a RIM origin, but have no hydrologic connection to RIM areas.

Although 7 of the 13 wells that have dissolved combined radium above the MCL cannot be ruled out as having a RIM origin using the isotope and chloride mass balance or excluded as not having a possible hydrologic or physical connection to RIM areas, this does not necessarily indicate that RIM contributes to above-MCL radium detections in groundwater at the Site, only

that this origin cannot be conclusively ruled out with the available data. The limited amount of background radionuclide data in groundwater; the absence of data on the distribution of radium isotopes in aquifer solids, "typical" non-RIM wastes, and “typical" landfill leachate; and the potential for landfill leachate to mobilize naturally occurring radium from aquifer solids all limit the ability to conclusively assign an origin of radium in groundwater at the Site. The potential for anoxic landfill leachate to mobilize radium, whether from non-RIM waste sources in the landfill or from aquifer solids (naturally occurring), indicates that radium concentrations above the MCL in groundwater will likely continue to be present at the WLL Site.

Additional evaluations of potential correlations between radium and chemical constituents are expected to be performed as part of OU-3.

8.7.4 Possible Radionuclide and Chemical Contributions to Groundwater from Areas 1 and 2

Evaluation of potential radium contributions to groundwater from Areas 1 and 2 is influenced by the presence of higher levels of radium in upgradient bedrock wells. All of the radium results obtained from alluvial monitoring wells located within or downgradient of Areas 1 and 2 were less than or similar to the radium levels observed in bedrock and alluvial monitoring wells located upgradient or upgradient/cross-gradient from Areas 1 and 2. This observation is consistent with the conclusion offered by the USGS that “there is not a strong spatial association of monitoring wells surrounding or downgradient of RIM areas with elevated radium concentrations as might be expected if RIM areas were releasing substantial quantities of radium to the groundwater.” (USGS, 2014, p.43).

The USGS (2014) identified four general hypotheses for the origin of dissolved combined radium above the MCL in groundwater at the West Lake Landfill:

1. Leaching of radium from RIM;

2. The radium values detected in groundwater at the Site are within the range of values found in natural groundwater;

3. Leaching of radium from non-RIM; and

4. Mobilization of naturally occurring radium from the aquifer solids by some component of landfill leachate.

The USGS stated that no single hypothesis can be invoked to explain all occurrences of radium above the MCL at the Site, and the available data are not adequate to provide definitive conclusions regarding the validity of any hypotheses. The USGS further concluded that “[b]ased on the available data, mobilization of naturally occurring radium contained in the aquifer materials by chemical interaction with landfill leachate is probably an important mechanism

resulting in occurrence of radium above the MCL in groundwater at the [West Lake Landfill] site." (USGS, 2014).

With the possible exception of benzene occurrences in the southwestern portion of Area 1 (*i.e.*, wells D-14, I-4, and PZ-112-AS), chlorobenzene in PZ-112-AS, and vinyl chloride occurrences in the southwestern portion of Area 2 (*i.e.*, wells I-9 and D-93) there are no VOC impacts to groundwater beneath or immediately downgradient of Areas 1 and 2. The vast majority of wells located in or around Areas 1 and 2 were either non-detect for VOCs or contained low levels of VOCs below their respective MCLs.

Occurrences of arsenic, iron, manganese, barium and sulfate were detected throughout the Site and reflect dissolution of these substances from the landfilled wastes and/or possibly enhanced dissolution of these substances from naturally-occurring minerals within the alluvial and bedrock units due to the presence of reducing conditions associated with waste decomposition within the landfills. Additional evaluations of radium and chemical occurrences in groundwater are expected to be performed as part of OU-3.

9. CONCEPTUAL SITE MODEL

This section presents a Conceptual Site Model (CSM) for the Site. The CSM summarizes:

- Site description and history;
- geology and hydrology;
- nature and sources of radiologically impacted material (RIM), transportation to the landfill, and distribution in the landfill;
- processes that effect the RIM;
- pathways and receptors at the Site and off site; and
- potential data gaps.

Per EPA's RI/FS guidance (EPA, 1988), the CSM should include known, and suspected, sources of contamination, types of contamination and affected media, known and potential routes of migration, and known or potential receptors.

Figure 7-1 depicts the sources of contamination, the potential release mechanisms and migration pathways, routes of exposure, exposure mechanisms, and potential current or future receptors. The evaluation of the potential exposure routes, receptors and potential current and future risks to on-site workers and the general public is being performed as part of the update to the Baseline Risk Assessment (BRA), which is being prepared and submitted concurrently with this RI Addendum.

9.1 Site Description and Setting

The West Lake Landfill Superfund Site is an approximately 200-acre parcel containing multiple solid waste disposal units and related facilities and adjacent properties where radionuclides have been detected (see Section 3.1 and Figure 3-7). The Site is within the western portion of the St. Louis metropolitan area on the east side of the Missouri River (Figures 3-1 and 3-2).

The Site consists of the landfill property and adjacent properties (Buffer Zone and Lot 2A2) where radionuclides have been identified (see Section 3.1). The landfill property contains several areas where solid wastes have been disposed, including: Areas 1 and 2, which contain RIM; an Inactive Sanitary Landfill; a Closed Demolition Landfill; and the North Quarry and South Quarry portions of the Bridgeton Landfill (Figure 3-6). Radionuclides were also previously detected in surficial soil on what is now the Buffer Zone, currently owned by Rock Road Industries, Inc., and Lot 2A2 of the Crossroads Industrial Park, currently owned by Crossroad Properties LLC and used by AAA Trailer for storage of tractor trailers (see Sections 3.4 and 6.7).

Land use near the Site is primarily industrial and commercial with limited retail operations and some residential areas. The closest part of the Site is located within approximately 8,500 ft of

the end of Runway 11 of Lambert St. Louis International Airport and, therefore, the Site is within the takeoff and approach routes for the airport (Section 3.5).

The nearest residential areas are the Terrisan Reste mobile home park, which is to the southeast of the Site, approximately 0.7 mile from Area 1 and 1.1 miles from Area 2, and the Spanish Village subdivision, which is approximately 1 mile to the south of Area 1 and 1.25 miles south of Area 2 (see Section 5.2).

9.2 History of the Landfills

The West Lake Landfill contains multiple areas of differing past operations (see Section 3.3 for additional details). The landfill property was used agriculturally until a limestone quarrying and crushing operation began in 1939. The quarrying operation continued until 1988 and resulted in shallow excavation areas and two quarry pits, the North Quarry Pit and the South Quarry Pit (Figure 3-6).

Areas 1 and 2 plus the adjacent Buffer Zone and Lot 2A2 have been identified by EPA as Operable Unit-1 (OU-1) of the West Lake Landfill Site. All other portions of the landfill property are part of OU-2.

Area 1 encompasses approximately 17.6 acres. Area 2 encompasses approximately 47.8 acres. No contemporaneous reports, drawings or other records from the former site operators are currently known to exist regarding the construction of the disposal units or the overall types and amounts of wastes that were disposed in the Area 1 and Area 2 landfills during their operation. Based on inspection of the drilling cores and samples obtained as part of the RI/FS investigations for OU-1, the waste materials within Area 1 consist primarily of municipal solid waste (MSW) and within Area 2 consists of both construction and demolition waste/debris and MSW. See Sections 3.3.2, 5.5.2.1 and 6.1 for additional information regarding the history of the landfills and the waste materials disposed in Areas 1 and 2.

In approximately 2003-2004, the southwestern portion of Area 1 was covered by the above-grade portion of the North Quarry landfill (see Figure 3-7). In 2006-2008, inert fill was placed in low areas on the surface of Area 1, the adjacent North Quarry portion of the Bridgeton Landfill and on portions of the surface of Area 2 (see Sections 3.3.2.1, 3.3.2.2, 5.3.3 and 5.5.2.1). Pursuant to a Unilateral Administrative Order from EPA, in 2016, vegetation was cleared and road base material (non-combustible cover or NCC) was placed over approximately 2.6 acres of Area 1 and 17.6 acres of Area 2 where radionuclides were present at the ground surface (see Section 3.3.2).

9.3 Site Geology and Hydrogeology

9.3.1 Site Geology

The geology of the Site consists of Missouri alluvial deposits overlying limestone and dolomite bedrock of the St. Louis and Salem Formations. The alluvial deposits range in thickness from 0 to 150 feet. The alluvial deposits typically consist of fine-grained (clay and silt) overbank deposits overlying poorly sorted, coarse-grained (sand and gravel) channel deposits associated with historic flooding and river meanders of the Missouri River. The depth to bedrock and the thickness of the alluvial deposits increases to the west of the Site where the thickness of alluvium (depth to bedrock) was reported to be 120 feet (Herst & Associates, 2005).

9.3.2 Site Hydrology

The Site is on the eastern edge of the Missouri River floodplain in an area that is transitional between the floodplain immediately to the west and the bluffs approximately one-half mile to the east. The Missouri River is approximately two miles to the west of the Site and is oriented north to south near the Site. The river flows in a predominantly north-northeasterly direction in the vicinity of the Site at an elevation of approximately 425 feet above mean sea level (amsl). The river is separated from the surrounding areas by a levee system constructed to provide protection against flood levels associated with a 500-year recurrence interval flood. The landfill property is outside the flood plain while the Buffer Zone and Lot 2A2 are within the area of the 500-year flood plain protected by the levee system. The current (*i.e.*, 2016) surface water runoff patterns for Areas 1 and 2 are presented on Figure 4-15. Additional details of the surface water drainage features, including drainage during the OU-1 RI and the OU-2 RI, are summarized in Section 5.3.2.

Groundwater is present in the unconsolidated alluvial deposits and the bedrock at the Site. Detailed discussions of the hydrogeology of the alluvial groundwater and bedrock groundwater are presented in Section 5.6 of this document and the OU-1 and OU-2 RI reports (EMSI, 2000 and Herst & Associates, 2005).

The regional direction of groundwater flow is generally northerly within the Missouri River alluvial valley, parallel or sub-parallel to the river alignment. The general direction of alluvial groundwater flow in the vicinity of the Site is to the northwest. There are localized variations to this general direction of groundwater flow. The horizontal hydraulic gradient in the alluvium is relatively flat and the hydraulic gradient, and the flow, within the alluvium and bedrock is toward the river. Groundwater within the bedrock flows upward and discharges to the river.

There are no public water supply wells near the landfill. An updated evaluation of the locations of water supply wells was performed by USGS during the performance of the 2012-2013 comprehensive groundwater sampling events. Overall, the wells to the north and west of the Site

(*i.e.*, regionally downgradient) are used for industrial and commercial purposes such as irrigation, construction, and dewatering (levee system operations). None of the wells are used to provide domestic or community (potable) water supplies.

9.4 Radiologically Impacted Material

Radionuclides have been identified in soil within the solid waste materials within portions of the landfill deposits in Area 1 and Area 2. Radionuclides were also previously detected in soil on the Buffer Zone and Crossroads Lot 2A2. Together, Area 1, Area 2, the Buffer Zone and Lot 2A2 make up OU-1 of the West Lake Landfill Superfund Site.
The specific criteria approved by EPA to define RIM at the Site (as further described in Section 6.2.6), are:

- **7.9 pCi/g** of combined Radium-226 plus Radium-228;
- **7.9 pCi/g** of combined Thorium-230 plus Thorium-232; or
- **54.5 pCi/g** of combined uranium activity.

9.4.1 Source of the RIM

Mallinckrodt Chemical Works (Mallinckrodt) processed uranium feed material for the production of uranium chemicals under contract with the Manhattan Engineering District (MED) and the AEC beginning in 1942. This work was performed at the Mallinckrodt Plant, on property known today as the St. Louis Downtown Site (SLDS). In 1947, the MED acquired the 21.7-acre tract of land now known as the St. Louis Airport Site (SLAPs) to store process byproducts and scrap from uranium processing at the Mallinckrodt Plant.

Among the materials generated by Mallinckrodt at SLDS was leached barium sulfate residue (LBSR). The LBSR originated from Belgian Congo ore processed at the Mallinckrodt facility in downtown St. Louis. Most of the uranium and radium had been removed from the leached barium sulfate in previous precipitation steps (EPA, 2008a, NRC, 1988), and accordingly, the LBSR is a chemically solidified and stabilized treatment product (EPA 1987),

The leached barium sulfate and other uranium ore process residues reportedly were moved from SLAPS to nearby 9200 Latty Avenue in Hazelwood, Missouri in 1966 (NRC, 1970, 1988). The different types of material brought to the Latty Avenue Site included C-slag, unleached barium sulfate, leached barium sulfate, Belgian Congo raffinates, and Colorado raffinates (NRC, 1970). An NRC investigation conducted in 1976 concluded that approximately 8,700 tons of leached barium sulfate residues, together with approximately 39,000 tons of soil removed from the top 12 to 18 inches of the Latty Avenue site, were transported to the West Lake Landfill over a three-month period from July 16 through October 9, 1973 (EPA, 2008a and NRC, 1976 and 1988 and RMC, 1982). The other materials that had been brought to the Latty Avenue Site from SLAPS

were shipped to Colorado for onward processing. Information regarding the Latty Avenue site is available at Section 6.1.1 and Appendix O-2.

No contemporaneous reports, drawings or other records from the former Site operators are currently known to exist regarding the construction of the disposal units or the overall types and amounts of wastes that were disposed in the Area 1 and Area 2 landfills during their operation. Radionuclides can be present in municipal solid waste (MSW).

9.4.2 Distribution of the RIM in the Landfill

Earlier interpretations of the RIM portrayed it as a relatively thin, continuous shallow layer within Areas 1 and 2 (see RMC, 1982 and NRC, 1988). The results of the multiple investigations conducted for the OU-1 RI, described in Sections 2 and 4, that have been performed over the subsequent 35 years have resulted in a more detailed understanding of the RIM in Areas 1 and 2. Specifically, 217 additional borings and GCPT soundings were drilled in Areas 1 and 2, providing more comprehensive information and data regarding the extent and distribution of RIM. The RIM is irregularly interspersed within the overall larger matrix of MSW. The distribution of the RIM within the landfilled areas has been impacted by both natural and anthropogenic processes, such as the initial placement and the subsequent 40-plus years of decomposition, consolidation and differential settlement of the MSW over time. Consequently, the RIM is now interspersed within separate areas and intervals of MSW such that RIM cannot be easily distinguished from the surrounding MSW, landfill cover, and native soil matrix within which it is found. RIM is not present as a laterally continuous layer.

RIM has been found to be present at the surface or beneath approximately 8.2 acres in Area 1 and approximately 24.9 acres in Area 2 (Figures 6-12 and 6-13). RIM is present at depths up to 89 ft bgs in Area 1 and 49.5 ft bgs in Area 2 (Tables 6-4 and 6-5). Additional information regarding the nature and distribution of RIM can be found in Section 6.

9.4.3 Occurrence of Radionuclides in the Buffer Zone and Crossroads Lot 2A2

The sampling performed during the RI identified radionuclides in the surface soil (approximately 6 to at most 12 inches deep) beneath that portion of the former Ford property that later became the Buffer Zone and Crossroads Lot 2A2. The locations of the various soil borings and surface soil samples collected from the Buffer Zone and Lot 2A2 are shown on Figure 4-6. The analytical results are summarized on Table 6-7. Radionuclide occurrences on these properties were probably the result of erosional transport from the surface of Area 2.

9.5 Occurrence of Radionuclides in Site Groundwater

As summarized in Section 7.5, groundwater samples have been analyzed for radionuclides as part of the various OU-1 investigations. Most recently (2012-2013), groundwater samples were collected at 85 monitoring wells.

Radionuclides in the groundwater are discussed in terms of three isotopes: radium, thorium, and uranium. A discussion of these constituents is in Section 7.5. Discussions of chemical occurrences in groundwater are presented in Section 8.7.

Radium has been detected in groundwater monitoring wells in most portions of the Site, in both the bedrock and the alluvium. The USGS (2014) identified four general hypotheses for the origin of dissolved combined radium above the MCL in the groundwater including:

- Leaching of radium from the RIM;
- Radium values are within the range found in natural groundwater;
- Leaching of radium from non-RIM wastes disposed at the Site; and
- Mobilization of naturally occurring radium from aquifer solids by some component of landfill leachate.

The USGS further stated that other than the radium in groundwater samples being from the natural variation in groundwater, no single hypothesis can be invoked to explain all of the occurrences of radium above the MCL. Furthermore, the available groundwater data are not adequate to provide definitive conclusions regarding the validity of any hypotheses. Dissolved levels of thorium and uranium have never been detected at levels above the Gross Alpha MCL (relative to thorium) or the uranium MCL. Volatile organic compounds and trace metals have also been detected in groundwater (see Section 8.7). Evaluation of radionuclide and chemical occurrences in groundwater will be conducted as part of the OU-3 investigation.

A preliminary evaluation of potential data gaps has been developed, which includes the following:

- Background groundwater quality
- Groundwater geochemistry
- Regional, Site and local hydraulic gradients
- Recharge and discharge points
- Effect of leachate extraction system on groundwater levels and hydraulic gradients
- Nature and extent of off-site groundwater contamination

- Adequacy of the groundwater monitoring well network along the perimeters of Areas 1 and 2
- Hydraulic properties of the aquifer
- Effect of suspended sediment on groundwater quality
- Potential for vapor intrusion into onsite buildings
- Potential correlations between radium and geochemical indicators
- Evaluation of potential leaching of wastes

Further evaluation of these data gaps will be used in the development of the groundwater (OU-3) RI/FS.

9.6 Potential Migration Pathways

Potential migration pathways at the West Lake Landfill include:

- Airborne transport;
- Stormwater and sediment transport; and
- Leaching to groundwater and groundwater transport.

These pathways are identified in Figure 7-1 and are discussed in the following sections.

9.6.1 Airborne Transport

Radionuclides can be transported to the atmosphere either as a gas (in the case of the various radon isotopes) or as particulate matter (in the case of the other radionuclides). Each is briefly discussed below.

9.6.1.1 Radon Emissions

Surface emissions of radon (radon flux) were measured in 1997 as part of the OU-1 RI field investigations and again in 2016 after the construction of the NCC in Areas 1 and 2 (see Section 7.1.1.1). The results of these two investigations indicate that radon flux, from both Areas 1 and 2, is below the standard of 20 $pCi/m^2/sec$ established for uranium mill tailing piles under UMTRCA and NESHAP.

Perimeter monitoring of radon levels in the ambient air has also been performed at 13 air monitoring stations around the perimeters of Areas 1 and 2 (see Section 7.1.1.3). Results indicate that radon levels at the Site perimeter were less than the standard of 0.5 pCi/L above background concentrations.

9.6.1.2 Particulate Matter

The collection of airborne particulate samples was conducted in 1996, during the OU-1 RI field investigations, and again more recently in 2015 through the present, at the 13 perimeter air monitoring stations around Areas 1 and 2 (see section 7.1.2). Comparison of the results obtained in 1996 from the upwind and downwind samples obtained within Areas 1 and 2 indicated that there were few if any differences between the radionuclide levels detected in the upwind and downwind samples (Appendix H-2).

Results of the perimeter monitoring conducted in 2015-2016 indicated that levels of uranium, thorium and combined radium in the particulate samples were similar to, or less than, the baseline monitoring results obtained by EPA at its five off-site monitoring stations. The NCC covers all of the areas where RIM was identified at the surface, further reducing the potential for entrainment of particulates containing radionuclides.

9.6.2 Stormwater and Sediment Transport

Sampling for radionuclides and chemicals in Site stormwater runoff was conducted as part of the RI investigation and then again, more recently, in 2016-2017. Stormwater monitoring performed in 2016-2017 where stormwater discharges from Areas 1 and 2 indicated that levels of radium and uranium were below drinking water standards. Therefore, although dissolved or suspended sediment transport in rainwater runoff is a potential pathway for radionuclide migration from Areas 1 and 2, this pathway is currently incomplete due to the construction of the NCC, which reduces the potential for stormwater transport of radionuclides from Area 1 and 2.
Some of the sediment samples collected during the OU-1 field investigations from on-site locations contained levels of radionuclides above background. The results of the 2016 sediment sampling detected Th-230 at SED-4 (in the perimeter drainage ditch northeast of Area 2) at a concentration (14.7 pCi/g) above the 7.9 pCi/g established by EPA for identification of RIM. The isolated nature of these occurrences suggests that current transport of radionuclides in sediment, while it could occur, is not a significant migration pathway.

9.6.3 Leaching to Groundwater and Groundwater Transport

Leaching of radionuclides and transport from the RIM in the landfill mass to the groundwater and their subsequent transport, in groundwater, to off-site areas is a potential migration pathway. This pathway will be evaluated as part of the OU-3 investigation.

9.7 Potential Receptors and Exposure Routes

A baseline risk assessment was prepared to evaluate the potential receptors, exposure routes, and potential risks that the Site could pose to potential current and future workers at the Site and the

general public, including offsite residential areas. Figure 9-1 depicts the potential migration pathways, routes of exposure, and potential receptors.

9.7.1 Potential Receptors

The landfill property is fenced and access to Areas 1 and 2, and the Buffer Zone is controlled. Access to Areas 1 and 2 and the Buffer Zone is currently further limited to qualified, trained remediation workers. Therefore, there currently are no receptors in Areas 1 and 2 and the Buffer Zone. Lot 2A2 is fenced and access to this property is controlled by AAA Trailer so it is not accessible to the general public but is accessed by AAA Trailer workers.

The primary receptor of concern for these areas was identified as potential future workers (for 1,000 years in the future) on Areas 1 and 2. This group of receptors is assumed to spend a portion of their time employed on OU-1 (on-site) or adjacent to it (on-property or off-property). Examples of future workers (for 1,000 years in the future) include construction workers, grounds keepers, outdoor storage yard workers, and the commercial building users.
Other potential receptors that were evaluated in the risk assessment include residents, farmers, recreational users and trespassers. As discussed in the Baseline Risk Assessment, the potential exposures to these receptors and the potential risks were less than those for the future (for 1,000 years in the future) onsite workers.

9.7.2 Exposure Routes

Potential exposure routes include inhalation of air containing suspended particulates and gases, such as radon, originating in soil or waste. Receptors may also come into direct contact with contaminated soil, during which time they may be exposed through dermal contact with these contaminated media, or via inadvertent ingestion of a small amount of this material.
Direct exposures from radioactive material can occur when a receptor is near a radioactive source. The magnitude of exposure is inversely related to the distance of the receptor from the source. Exposures can be reduced when shielding, such as soil, is placed between the receptor and the source of radioactivity.

9.8 Summary of Potential Risks

The Baseline Risk Assessment calculated risks to current and future receptors and evaluated those risks in the context of the EPA's acceptable cancer risk range of 10^{-6} to 10^{-4} and the EPA's acceptable non-cancer hazard threshold (HI) of 1.

It is important to note that "future" as used in this BRA represents a point in time 1,000 years in the future, taking into account radionuclide decay and ingrowth and presuming no cover or remedial measures. Hence, "current" encompasses theoretical risks within the lifetime of most

individuals based on conditions at the time this report was prepared. The results of the risk assessment are summarized below.

9.8.1 Current Receptors

Current on-property receptors are represented by the on-property grounds keeper and commercial building user. There are no complete pathways for exposure to chemical COPCs under current conditions and, hence, no unacceptable chemical risks or hazards to on-property receptors. Additionally, radionuclide COPCs do not pose an unacceptable cancer risk to current on-property receptors. Cumulative radionuclide cancer risks are within or below (more health protective than) the EPA's acceptable risk range.

Current off-property receptors are represented by the off-property resident and commercial building user. There are no complete pathways for exposure to chemical COPCs under current conditions and, hence, no unacceptable chemical risks or hazards to off-property receptors. Additionally, radionuclide COPCs do not pose an unacceptable cancer risk to current off-property receptors. Cumulative radionuclide risks are below the EPA's acceptable risk range.

9.8.2 Future (1,000 year) Receptors

Landfill receptors 1,000 years in the future are evaluated based upon the maximally exposed the Landfill grounds keeper and storage yard worker. Evaluation of the future risk for the Baseline Risk Assessment assumes that no cover is present on the Landfill and no remediation has occurred.

Chemical COPCs do not pose an unacceptable cancer risk to future Landfill receptors. Cumulative chemical risks are within or below the EPA's acceptable risk range. Chemical COPC HIs exceed EPA's acceptable threshold of 1 for some future Landfill receptors in OU1, indicating a potential for non-cancer health effects. Zirconium (Areas 1 and 2) and, to a lesser extent, cobalt (Area 2) are the primary contributors to HIs greater than 1. As discussed in the uncertainty assessment, zirconium HQs are likely overestimated due to substantial uncertainties in the reference dose and due to contributions from naturally-occurring background soil. Exposure to lead in soil does not pose an unacceptable risk to future Landfill receptors.

Radionuclide COPCs do not pose an unacceptable cancer risk to future receptors (defined as 1,000 years in the future) that work at the Landfill and periodically access OU-1 (i.e., grounds keepers). Cumulative radionuclide risks are within the EPA's acceptable risk range for these potential future receptors. Radionuclide COPC cancer risks exceed the EPA's acceptable risk range for Landfill receptors that are assumed to spend a portion of each workday on OU-1 (i.e., Landfill storage yard workers). Where risks exceed 10^{-4}, direct contact with radium-226 in soil and inhalation of radon-222 in air are the primary risk drivers.

Potential future risks to off-property receptors 1,000 years in the future, and assuming no cover is present on the Landfill, were calculated taking into account 1,000 years of ingrowth. Chemical COPCs do not pose an unacceptable cancer risk to future off-property receptors. Cumulative chemical risks are within or below the EPA's acceptable risk range. Chemical COPCs do not pose an unacceptable non-cancer hazard to future off-property receptors. Calculated HIs are less than EPA's threshold HI of 1.

Radionuclide COPC cancer risks exceed EPA's acceptable risk range for future off-property farmers to the north and west, and future commercial building users to the north and at Lot 2A2. Radionuclide cancer risks to off-property farmers to the south and southeast, and off-property commercial building users to the west are within the EPA's acceptable risk range. Where cumulative radionuclide risks exceed 10^{-4}, risk is driven by inhalation of radon-222 and its daughter products; as discussed in the uncertainty section of the BRA, modeled radon activity from OU-1 is similar to naturally-occurring activity. Exclusive of radon and its daughter products, radiological risks to off-property receptors are with the EPA's acceptable risk range of 10^{-6} to 10^{-4}.

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Tables

Table 4-1: Summary of OU-1 Soil Borings by Program and Area

Investigation Program	Area 1	Area 2	Buffer Zone	Lot 2A2	Other Areas*	Total
NRC/RMC 1982	10	31				41
OU-1 RI McLaren/Hart 1995	20	35	4	2	4	65
OU-1 RI EMSI 1997	4		2	3	3	12
OU-1 RI/FS Herst/EMSI 2000			2	5		7
Phase 1C FEI 2014	16					16
Phase 1D FEI/EMSI 2015	20					20
Additional Characterization FEI/EMSI 2015	7	19				26
Fate & Transport FEI/SSPA 2015	4	6				10
Cotter Investigation FEI/Arcadis 2015	3	2				5
TOTALS	84	93	8	10	7	202

* McLaren Hart drilled 2 borings on the former Ford property just outside the Area 2 fence (WL-207 and WL-228).
McLaren Hart drilled 2 borings in the Inactive Sanitary Landfill just to the south of Area 2 (WL-219 and WL-220)
EMSI drilled three hand augers in the former Ford property in the area this is now Lot 2A1, the site of the AAA Trailer facility.

Note: The above numbers do not include 112 gamma cone pentrometer (GCPT) soundings advanced in Area 1 and portions of the North Quarry as part of the Phase 1 investigations.

Table 4-2: Soil Boring and GCPT Survey Data

DRAFT

Boring ID No.	Missouri East 1927 (modified) State Plane			Missouri East 1983 State Plane		
	Northing	Easting	Ground Surface Elevation (ft amsl)	Northing	Easting	Ground Surface Elevation (ft amsl)
Area 1						
GCPT 9-4	1069113.510	516407.050	471.410	1069154.480	836581.750	471.008
GCPT 10-1	1069190.539	516433.004	471.077	1069231.509	836607.704	470.675
GCPT 10-2	1069140.593	516449.840	472.326	1069181.563	836624.540	471.924
GCPT 10-3	1069074.641	516465.592	485.347	1069115.611	836640.292	484.945
GCPT 10-3A	1069075.419	516462.854	485.373	1069116.389	836637.554	484.971
GCPT 10-4	1069060.422	516474.665	483.551	1069101.392	836649.365	483.149
GCPT 10-4A	1069061.187	516477.897	483.556	1069102.157	836652.597	483.154
GCPT 1-1	1068826.649	515829.017	471.003	1068867.619	836003.717	470.601
GCPT 111	1069191.523	516592.457	474.000	1069232.493	836767.157	473.598
GCPT 11-1	1069222.929	516503.558	479.814	1069263.899	836678.258	479.412
GCPT 11-2	1069167.995	516518.208	474.796	1069208.965	836692.908	474.394
GCPT 11-3	1069137.542	516551.085	476.620	1069178.512	836725.785	476.218
GCPT 11-4	1069072.777	516565.515	482.682	1069113.747	836740.215	482.280
GCPT 1-1A	1068820.373	515835.155	470.952	1068861.343	836009.855	470.550
GCPT 1-2	1068777.662	515870.573	471.709	1068818.632	836045.273	471.307
GCPT 12-1	1069249.275	516567.619	479.376	1069290.245	836742.319	478.974
GCPT 12-2	1069198.102	516592.800	476.014	1069239.072	836767.500	475.612
GCPT 12-3	1069163.456	516608.867	475.910	1069204.426	836783.567	475.508
GCPT 12-4	1069124.740	516619.657	476.420	1069165.710	836794.357	476.018
GCPT 12-5	1069091.157	516638.742	478.450	1069132.127	836813.442	478.048
GCPT 12-6	1069031.297	516650.636	478.965	1069072.267	836825.336	478.563
GCPT 13-1	1069279.353	516642.002	470.898	1069320.323	836816.702	470.496
GCPT 13-2	1069258.075	516646.324	471.546	1069299.045	836821.024	471.144
GCPT 13-2A	1069256.406	516650.406	471.769	1069297.376	836825.106	471.367
GCPT 13-3	1069242.473	516658.268	472.195	1069283.443	836832.968	471.793
GCPT 13-4	1069194.628	516676.493	474.034	1069235.598	836851.193	473.632
GCPT 13-5	1069148.378	516695.025	475.365	1069189.348	836869.725	474.963
GCPT 13-6	1069094.279	516722.059	475.910	1069135.249	836896.759	475.508
GCPT 13-7	1069028.275	516764.522	474.263	1069069.245	836939.222	473.861
GCPT 14-1	1069289.841	516676.946	474.151	1069330.811	836851.646	473.749
GCPT 14-2	1069248.776	516702.985	474.471	1069289.746	836877.685	474.069
GCPT 14-3	1069218.180	516720.735	473.680	1069259.150	836895.435	473.278
GCPT 14-4	1069177.042	516745.043	474.597	1069218.012	836919.743	474.195
GCPT 14-5	1069125.940	516777.935	473.330	1069166.910	836952.635	472.928
GCPT 14-6	1069077.338	516811.126	472.680	1069118.308	836985.826	472.278
GCPT 14-7	1069029.001	516850.785	473.149	1069069.971	837025.485	472.747
GCPT 15-1	1069362.505	516757.424	453.830	1069403.475	836932.124	453.428
GCPT 15-2	1069277.200	516767.371	477.333	1069318.170	836942.071	476.931
GCPT 15-3	1069247.590	516788.341	473.986	1069288.560	836963.041	473.584
GCPT 15-4	1069209.876	516811.939	473.090	1069250.846	836986.639	472.688
GCPT 15-5	1069166.487	516848.251	469.170	1069207.457	837022.951	468.768
GCPT 15-6	1069125.130	516878.774	468.775	1069166.100	837053.474	468.373
GCPT 15-7	1069083.743	516906.231	472.113	1069124.713	837080.931	471.711
GCPT 15-8	1069045.994	516931.453	473.775	1069086.964	837106.153	473.373
GCPT 16-1	1069393.686	516784.741	451.150	1069434.656	836959.441	450.748
GCPT 16-2	1069364.966	516787.054	453.091	1069405.936	836961.754	452.689
GCPT 16-3	1069262.220	516837.666	471.257	1069303.190	837012.366	470.855
GCPT 16-4	1069234.210	516866.371	472.459	1069275.180	837041.071	472.057

Table 4-2: Soil Boring and GCPT Survey Data

DRAFT

Boring ID No.	Missouri East 1927 (modified) State Plane			Missouri East 1983 State Plane		
	Northing	Easting	Ground Surface Elevation (ft amsl)	Northing	Easting	Ground Surface Elevation (ft amsl)
GCPT 16-5	1069196.904	516903.898	474.011	1069237.874	837078.598	473.609
GCPT 16-6	1069158.015	516935.268	476.777	1069198.985	837109.968	476.375
GCPT 16-7	1069114.104	516970.890	479.817	1069155.074	837145.590	479.415
GCPT 16-8	1069073.911	517002.539	481.927	1069114.881	837177.239	481.525
GCPT 1C-1	1068771.644	515837.945	463.703	1068812.614	836012.645	463.301
GCPT 1C-10	1068797.838	516095.938	496.493	1068838.808	836270.638	496.091
GCPT 1C-11	1068838.882	516151.875	496.895	1068879.852	836326.575	496.493
GCPT 1C-13	1068982.241	516321.892	480.072	1069023.211	836496.592	479.670
GCPT 1C-1A	1068766.648	515841.442	463.588	1068807.618	836016.142	463.186
GCPT 1C-2	1068737.758	515904.377	472.318	1068778.728	836079.077	471.916
GCPT 1C-3	1068778.999	515991.398	486.422	1068819.969	836166.098	486.020
GCPT 1C-4	1068832.903	516068.813	486.098	1068873.873	836243.513	485.696
GCPT 1C-5	1068986.634	516413.538	478.999	1069027.604	836588.238	478.597
GCPT 1C-5A	1068986.634	516413.538	478.999	1069027.604	836588.238	478.597
GCPT 1C-7	1068646.890	515958.200	468.599	1068687.860	836132.900	468.197
GCPT 1C-8	1068728.323	516014.864	491.227	1068769.293	836189.564	490.825
GCPT 1C-9	1068746.456	516049.886	495.235	1068787.426	836224.586	494.833
GCPT 2-1	1068905.795	515882.108	472.776	1068946.765	836056.808	472.374
GCPT 2-2	1068879.341	515916.514	474.933	1068920.311	836091.214	474.531
GCPT 2-2A	1068874.348	515928.265	475.273	1068915.318	836102.965	474.871
GCPT 2-2B	1068874.348	515928.265	475.273	1068915.318	836102.965	474.871
GCPT 2-3	1068819.102	515941.573	476.607	1068860.072	836116.273	476.205
GCPT 2-3A	1068819.102	515941.573	476.607	1068860.072	836116.273	476.205
GCPT 2-4	1068863.196	515948.689	476.643	1068904.166	836123.389	476.241
GCPT 28	1069255.020	516488.890	473.000	1069295.990	836663.590	472.598
GCPT 3-1	1068944.022	515949.289	474.936	1068984.992	836123.989	474.534
GCPT 3-1A	1068944.022	515949.289	474.936	1068984.992	836123.989	474.534
GCPT 3-2	1068866.409	516005.995	479.012	1068907.379	836180.695	478.610
GCPT 4-1	1068941.601	516007.654	474.382	1068982.571	836182.354	473.980
GCPT 4-2	1068880.888	516037.985	479.036	1068921.858	836212.685	478.634
GCPT 5-1	1069052.620	516101.781	473.644	1069093.590	836276.481	473.242
GCPT 5-2	1069012.133	516040.892	473.341	1069053.103	836215.592	472.939
GCPT 5-3	1068985.452	516093.331	474.679	1069026.422	836268.031	474.277
GCPT 5-4	1068925.017	516116.619	478.216	1068965.987	836291.319	477.814
GCPT 5-4A	1068931.178	516116.457	477.965	1068972.148	836291.157	477.563
GCPT 6-2	1069108.868	516196.534	472.997	1069149.838	836371.234	472.595
GCPT 6-3	1069036.469	516180.777	474.043	1069077.439	836355.477	473.641
GCPT 6-4	1068976.421	516208.637	482.702	1069017.391	836383.337	482.300
GCPT 6-5	1068969.612	516218.253	482.621	1069010.582	836392.953	482.219
GCPT 7-1	1069155.521	516310.797	470.865	1069196.491	836485.497	470.463
GCPT 7-2	1069085.747	516269.321	472.588	1069126.717	836444.021	472.186
GCPT 7-3	1069013.045	516308.254	479.220	1069054.015	836482.954	478.818
GCPT 8-1	1069039.242	516366.519	479.726	1069080.212	836541.219	479.324
GCPT 9-1	1069152.039	516357.317	470.278	1069193.009	836532.017	469.876
GCPT 9-2	1069098.604	516379.609	472.123	1069139.574	836554.309	471.721
GCPT 9-3	1069055.624	516401.053	479.625	1069096.594	836575.753	479.223
GCPT 9-3A	1069049.417	516404.583	479.231	1069090.387	836579.283	478.829
GCPT-108	1069142.077	516388.988	470.448	1069183.047	836563.688	470.046
GCPT-111A	1069183.707	516592.402	475.656	1069224.677	836767.102	475.254

Table 4-2: Soil Boring and GCPT Survey Data

DRAFT

Boring ID No.	Missouri East 1927 (modified) State Plane			Missouri East 1983 State Plane		
	Northing	Easting	Ground Surface Elevation (ft amsl)	Northing	Easting	Ground Surface Elevation (ft amsl)
GCPT-119	1069021.032	516294.161	478.577	1069062.002	836468.861	478.175
GCPT-25	1069345.436	516405.360	465.274	1069386.406	836580.060	464.872
GCPT-28A	1069253.583	516490.663	480.478	1069294.553	836665.363	480.076
GCPT-36	1069217.918	516193.669	464.969	1069258.888	836368.369	464.567
GCPT 13-4S	1069195.799	516675.988	474.1	1069236.769	836850.688	473.698
GCPT 13-5S	1069148.524	516697.133	475.5	1069189.494	836871.833	475.098
GCPT 13-6S	1069094.328	516722.082	476.0	1069135.298	836896.782	475.598
GCPT 13-7S	1069028.451	516763.208	474.2	1069069.421	836937.908	473.798
GCPT 14-3S	1069218.942	516719.904	473.7	1069259.912	836894.604	473.298
GCPT 14-5S	1069125.781	516777.333	473.3	1069166.751	836952.033	472.898
GCPT 14-6S	1069077.339	516809.484	472.8	1069118.309	836984.184	472.398
GCPT 1C-12	1068865.907	516200.860	500.1	1068906.877	836375.560	499.698
GCPT 1C-2R	1068733.913	515907.223	472.5	1068774.883	836081.923	472.098
GCPT 1C-6	1068691.769	515934.812	468.8	1068732.739	836109.512	468.398
GCPT 1C-6T	1068685.948	515938.701	468.9	1068726.918	836113.401	468.498
GCPT 1C-6T1	1068684.148	515939.610	468.9	1068725.118	836114.310	468.498
GCPT 2-2C	1068878.507	515931.137	475.3	1068919.477	836105.837	474.898
GCPT 5-5	1068953.892	516113.219	476.7	1068994.862	836287.919	476.298
GCPT 5-6	1068998.386	516126.377	474.7	1069039.356	836301.077	474.298
GCPT 6-6	1069012.482	516193.425	475.2	1069053.452	836368.125	474.798
GP 1-2	1068779.843	515869.220	472.859	1068820.813	836043.920	472.457
GPCT 1C-4R	1068835.119	516070.919	486.000	1068876.089	836245.619	485.598
GP 1C-12	1068867.887	516204.389	500.064	1068908.857	836379.089	499.662
GP 1C-12B	1068863.729	516197.682	499.723	1068904.699	836372.382	499.321
GP 1C-12C	1068862.939	516203.039	500.161	1068903.909	836377.739	499.759
GP 1C-2RA	1068730.068	515908.919	472.398	1068771.038	836083.619	471.996
GP 1C-4R	1068835.529	516073.369	486.107	1068876.499	836248.069	485.705
GP 1C-4RB	1068837.644	516076.741	485.970	1068878.614	836251.441	485.568
GP 1C-6T1	1068681.573	515937.074	468.930	1068722.543	836111.774	468.528
GP 2-2	1068870.734	515929.287	475.250	1068911.704	836103.987	474.848
GP 2-3	1068815.973	515943.908	476.459	1068856.943	836118.608	476.057
GP 8-1	1069036.751	516363.699	479.602	1069077.721	836538.399	479.200
GP 8-1B	1069041.054	516363.853	479.703	1069082.024	836538.553	479.301
GP WL-119	1069018.294	516291.964	478.594	1069059.264	836466.664	478.192
GP WL-119B	1069013.907	516287.796	479.244	1069054.877	836462.496	478.842
GP WL-119C	1069012.752	516291.905	479.148	1069053.722	836466.605	478.746
S1-2	1068783.142	515878.536	472.600	1068824.112	836053.236	472.198
1D-1	1069085.157	515745.035	462.487	1069126.127	835919.735	462.085
S12-5	1069087.130	516641.299	478.9	1069128.100	836815.999	478.498
S13-3	1069232.054	516662.275	472.6	1069273.024	836836.975	472.198
S13-6	1069093.452	516723.784	475.9	1069134.422	836898.484	475.498
S14-2	1069250.965	516701.546	474.6	1069291.935	836876.246	474.198
S14-4	1069179.619	516743.234	474.4	1069220.589	836917.934	473.998
S14-5	1069122.899	516777.908	472.9	1069163.869	836952.608	472.498
S14-7	1069027.735	516848.642	473.3	1069068.705	837023.342	472.898
S15-2	1069281.151	516768.917	476.5	1069322.121	836943.617	476.098
S15-2A	1069279.431	516765.914	476.5	1069320.401	836940.614	476.098
S16-3	1069267.110	516837.299	470.7	1069308.080	837011.999	470.298
S16-6	1069155.378	516938.746	477.1	1069196.348	837113.446	476.698

Table 4-2: Soil Boring and GCPT Survey Data

DRAFT

Boring ID No.	Missouri East 1927 (modified) State Plane			Missouri East 1983 State Plane		
	Northing	Easting	Ground Surface Elevation (ft amsl)	Northing	Easting	Ground Surface Elevation (ft amsl)
S1C-6	1068688.971	515936.009	469.2	1068729.941	836110.709	468.798
S2-2	1068876.813	515926.163	475.2	1068917.783	836100.863	474.798
S5-3	1068986.832	516093.839	474.4	1069027.802	836268.539	473.998
S8-1	1069041.228	516368.555	479.8	1069082.198	836543.255	479.398
S8-1A	1069042.384	516370.586	479.8	1069083.354	836545.286	479.398
SWL-119	1069017.400	516296.369	479.2	1069058.370	836471.069	478.798
1D-10	1068897.481	516306.812	503.702	1068938.451	836481.512	503.300
1D-11	1068732.965	516319.191	522.966	1068773.935	836493.891	522.564
1D-11A	1068728.093	516324.559	522.829	1068769.063	836499.259	522.427
1D-12	1068878.274	516446.247	505.566	1068919.244	836620.947	505.164
1D-13	1068807.791	516405.192	520.176	1068848.761	836579.892	519.774
1D-13A	1068807.910	516397.463	520.165	1068848.880	836572.163	519.763
1D-13B	1068807.560	516392.053	520.392	1068848.530	836566.753	519.990
1D-13C	1068808.169	516414.237	519.931	1068849.139	836588.937	519.529
1D-14	1068737.296	516389.489	522.027	1068778.266	836564.189	521.625
1D-15	1068600.173	516194.976	516.672	1068641.143	836369.676	516.270
1D-16	1068604.580	516049.511	484.823	1068645.550	836224.211	484.421
1D-16A	1068611.344	516048.677	485.168	1068652.314	836223.377	484.766
1D-17	1068872.427	515830.991	472.494	1068913.397	836005.691	472.092
1D-17A	1068870.009	515836.352	472.546	1068910.979	836011.052	472.144
1D-18	1068551.103	516059.874	480.990	1068592.073	836234.574	480.588
1D-18A	1068545.369	516060.390	480.524	1068586.339	836235.090	480.122
1D-1S	1069074.230	515747.359	462.568	1069115.200	835922.059	462.166
1D-2	1068999.089	515778.193	468.382	1069040.059	835952.893	467.980
1D-3	1068972.272	515874.232	472.064	1069013.242	836048.932	471.662
1D-4	1068794.546	516092.056	496.410	1068835.516	836266.756	496.008
1D-5	1068649.773	516043.497	487.632	1068690.743	836218.197	487.230
1D-6	1068727.516	516153.004	512.509	1068768.486	836327.704	512.107
1D-7	1068647.213	516155.853	512.790	1068688.183	836330.553	512.388
1D-8	1068818.180	516243.565	517.157	1068859.150	836418.265	516.755
1D-8A	1068820.740	516250.571	517.322	1068861.710	836425.271	516.920
1D-9	1068667.863	516221.690	518.577	1068708.833	836396.390	518.175
1D-9A	1068662.945	516220.860	518.595	1068703.915	836395.560	518.193
1D-10S	1068898.786	516318.538	503.074	1068939.756	836493.238	502.672
1D-11S	1068739.042	516311.220	522.303	1068780.012	836485.920	521.901
1D-12S	1068880.804	516434.947	505.890	1068921.774	836609.647	505.488
1D-13S	1068786.080	516399.333	520.512	1068827.050	836574.033	520.110
1D-14S	1068730.267	516381.884	522.532	1068771.237	836556.584	522.130
1D-15S	1068611.681	516196.257	516.098	1068652.651	836370.957	515.696
1D-16S	1068620.165	516047.598	485.581	1068661.135	836222.298	485.179
1D-17S	1068865.421	515846.051	472.920	1068906.391	836020.751	472.518
1D-18S	1068573.847	516056.126	482.022	1068614.817	836230.826	481.620
1D-19S	1068620.714	516259.114	521.112	1068661.684	836433.814	520.710
1D-20S	1068540.263	516226.617	517.696	1068581.233	836401.317	517.294
1D-2S	1068990.154	515784.257	468.561	1069031.124	835958.957	468.159
1D-3S	1068968.601	515882.929	472.250	1069009.571	836057.629	471.848
1D-4S	1068804.861	516101.296	496.422	1068845.831	836275.996	496.020
1D-5S	1068657.730	516040.319	487.751	1068698.700	836215.019	487.349
1D-6S	1068732.994	516160.954	512.707	1068773.964	836335.654	512.305

Table 4-2: Soil Boring and GCPT Survey Data

DRAFT

Boring ID No.	Missouri East 1927 (modified) State Plane			Missouri East 1983 State Plane		
	Northing	Easting	Ground Surface Elevation (ft amsl)	Northing	Easting	Ground Surface Elevation (ft amsl)
1D-7S	1068653.591	516157.910	513.346	1068694.561	836332.610	512.944
1D-8S	1068810.599	516238.029	516.742	1068851.569	836412.729	516.340
1D-9S	1068678.246	516223.760	518.893	1068719.216	836398.460	518.491
1D-3-FT	1068969.181	515878.247	472.007	1069010.151	836052.947	471.605
AC-1-FT-A	1069123.367	516013.600	466.650	1069164.337	836188.300	466.248
AC-3-FT-A	1069184.533	516037.268	466.253	1069225.503	836211.968	465.851
GEOPROBE AC-4	1069565.451	516489.640	464.506	1069606.421	836664.340	464.104
WL-114-FT-A	1069396.617	516332.949	467.060	1069437.587	836507.649	466.658
AC-1	1069120.740	516017.324	466.725	1069161.710	836192.024	466.323
AC-2B	1069151.417	515831.894	466.165	1069192.387	836006.594	465.763
AC-3	1069183.583	516040.675	466.425	1069224.553	836215.375	466.023
AC-4B	1069555.665	516492.941	464.661	1069596.635	836667.641	464.259
AC-5	1069483.755	516657.795	451.372	1069524.725	836832.495	450.970
AC-6	1069420.320	516222.713	464.254	1069461.290	836397.413	463.852
AC-7	1069315.677	516025.425	461.529	1069356.647	836200.125	461.127
WL-102A-CT	1069268.672	515969.697	461.866	1069309.642	836144.397	461.464
WL-102-CT	1069271.265	515974.528	461.697	1069312.235	836149.228	461.295
WL-106A-CT	1069300.779	516090.264	463.803	1069341.749	836264.964	463.401
WL-114-CT	1069381.076	516352.442	467.381	1069422.046	836527.142	466.979
PVC-24	1069234.28	516312.81	469.57	1069275.250	836487.510	469.168
PVC-25	1069345.42	516406.58	467.65	1069386.390	836581.280	467.248
PVC-25R	1069345.436	516405.36	465.274	1069386.406	836580.060	464.872
PVC-26	1069464.45	516376.13	465.22	1069505.420	836550.830	464.818
PVC-27	1069460.56	516510.3	469.14	1069501.530	836685.000	468.738
PVC-28	1069255.02	516488.89	473.11	1069295.990	836663.590	472.708
PVC-29	1069125.9	516607.45	473.46	1069166.870	836782.150	473.058
PVC-36	1069217.89	516193.84	466.8	1069258.860	836368.540	466.398
PVC-37	1069146.48	516421.57	473.43	1069187.450	836596.270	473.028
PVC-38	1069315.55	516580.41	470.52	1069356.520	836755.110	470.118
PVC-41	1069213.33	516701.18	474.06	1069254.300	836875.880	473.658
WL-101	1069549.55	516317.21	456.5	1069590.520	836491.910	456.098
WL-102	1069260.46	515974.05	462.8	1069301.430	836148.750	462.398
WL-103	1069407.36	516737.06	450.9	1069448.330	836911.760	450.498
WL-104	1069575.47	516602.77	449.8	1069616.440	836777.470	449.398
WL-105A	1069136.26	515871.62	467.2	1069177.230	836046.320	466.798
WL-105B	1069148.42	515889.5	466.0	1069189.390	836064.200	465.598
WL-105C	1069155.84	515901.03	465.7	1069196.810	836075.730	465.298
WL-106	1069301.64	516082.18	465.4	1069342.610	836256.880	464.998
WL-106A	1069317.25	516061.92	462.8	1069358.220	836236.620	462.398
WL-107	1068909.52	516254.31	486.0	1068950.490	836429.010	485.598
WL-108	1069144.21	516379.68	472.5	1069185.180	836554.380	472.098
WL-109A	1068932.92	516509.67	485.5	1068973.890	836684.370	485.098
WL-109B	1068947.16	516523.17	484.5	1068988.130	836697.870	484.098
WL-109C	1068961.12	516528.43	483.9	1069002.090	836703.130	483.498
WL-109D	1068947.38	516504.97	485.6	1068988.350	836679.670	485.198
WL-110	1068852.431	516664.5787	484.41	1068893.401	836839.279	484.008
WL-111	1069187.35	516583.61	474.5	1069228.320	836758.310	474.098
WL-112	1069379.45	516628.22	467.6	1069420.420	836802.920	467.198
WL-113	1069483.19	516469.95	467.0	1069524.160	836644.650	466.598

Table 4-2: Soil Boring and GCPT Survey Data

DRAFT

Boring ID No.	Missouri East 1927 (modified) State Plane			Missouri East 1983 State Plane		
	Northing	Easting	Ground Surface Elevation (ft amsl)	Northing	Easting	Ground Surface Elevation (ft amsl)
WL-114	1069391.53	516338.57	468.3	1069432.500	836513.270	467.898
WL-115	1069298.98	516395.13	468.9	1069339.950	836569.830	468.498
WL-116	1069083.49	516160.6	474.3	1069124.460	836335.300	473.898
WL-117	1069237.4	516221.33	467.6	1069278.370	836396.030	467.198
WL-118	1069411.09	516304.95	465.8	1069452.060	836479.650	465.398
WL-119	1069031.14	516289.26	477.4	1069072.110	836463.960	476.998
WL-120	1069053.64	516846.57	474.7	1069094.610	837021.270	474.298
WL-121	1068762.531	516241.3237	523.21	1068803.501	836416.024	522.808
WL-122	1068774.622	516110.1811	507.192	1068815.592	836284.881	506.790
WL-123	1068792.759	515934.6518	480.135	1068833.729	836109.352	479.733
WL-124	1069050.704	515857.9832	470.484	1069091.674	836032.683	470.082
Area 2						
AC-16-FT	1070477.83	515442.414	468.322	1070518.800	835617.114	467.920
AC-18-FT	1070433.628	514923.255	469.559	1070474.598	835097.955	469.157
AC-19-FT	1069959.449	514767.875	477.5	1070000.419	834942.575	477.098
AC-21-FT-A	1069647.833	514761.836	477.004	1069688.803	834936.536	476.602
AC-21-FT-W	1069641.908	514755.459	478.182	1069682.878	834930.159	477.780
AC-24-FT	1069787.089	514813.333	477.499	1069828.059	834988.033	477.097
WL-209-FT	1070498.613	514692.573	467.386	1070539.583	834867.273	466.984
AC-WL-114-FT	1069384.878	516348.41	467.547	1069425.848	836523.110	467.145
AC-10	1070422.823	514642.616	467.676	1070463.793	834817.316	467.274
AC-11	1070423.218	514437.378	462.965	1070464.188	834612.078	462.563
AC-12	1070680.095	514526.364	459.587	1070721.065	834701.064	459.185
AC-13	1070614.429	514865.994	468.089	1070655.399	835040.694	467.687
AC-14	1070798.351	515338.175	457.834	1070839.321	835512.875	457.432
AC-15	1070703.032	515525.938	457.237	1070744.002	835700.638	456.835
AC-16	1070482.01	515440.258	468.212	1070522.980	835614.958	467.810
AC-17	1070259.659	515183.215	471.311	1070300.629	835357.915	470.909
AC-18	1070438.51	514922.137	469.529	1070479.480	835096.837	469.127
AC-19	1069959.204	514772.616	477.185	1070000.174	834947.316	476.783
AC-20	1069664.021	514960.169	488.976	1069704.991	835134.869	488.574
AC-21	1069642.253	514760.309	477.569	1069683.223	834935.009	477.167
AC-21A	1069646.973	514754.423	477.393	1069687.943	834929.123	476.991
AC-22	1069738.457	514617.507	483.275	1069779.427	834792.207	482.873
AC-23	1069568.406	514618.063	486.548	1069609.376	834792.763	486.146
AC-24	1069783.774	514810.651	477.384	1069824.744	834985.351	476.982
AC-25	1069622.807	514420.771	479.445	1069663.777	834595.471	479.043
AC-26	1069548.711	515117.415	473.432	1069589.681	835292.115	473.030
AC-26A	1069548.806	515122.279	473.186	1069589.776	835296.979	472.784
AC-8	1069429.271	514606.086	490.616	1069470.241	834780.786	490.214
AC-9	1069593.065	514302.64	469.194	1069634.035	834477.340	468.792
WL-209-CT	1070488.509	514687.354	467.546	1070529.479	834862.054	467.144
WL-234-CT	1069762.441	514435.675	480.017	1069803.411	834610.375	479.615
PVC-10	1069916.35	514518.86	473.75	1069957.320	834693.560	473.348
PVC-11A	1069848.44	514453.6	474.54	1069889.410	834628.300	474.138
PVC-11B	1069844.18	514456.61	475.87	1069885.150	834631.310	475.468
PVC-12	1070528.68	515176.76	468.32	1070569.650	835351.460	467.918
PVC-13	1070515.37	514386.08	464.45	1070556.340	834560.780	464.048

Table 4-2: Soil Boring and GCPT Survey Data

DRAFT

Boring ID No.	Missouri East 1927 (modified) State Plane			Missouri East 1983 State Plane		
	Northing	Easting	Ground Surface Elevation (ft amsl)	Northing	Easting	Ground Surface Elevation (ft amsl)
PVC-18	1070300.94	514677.19	470.72	1070341.910	834851.890	470.318
PVC-19	1070599.18	514961.49	469.55	1070640.150	835136.190	469.148
PVC-20	1070750.51	514806.92	466.65	1070791.480	834981.620	466.248
PVC-33	1070857.78	514810.78	466.31	1070898.750	834985.480	465.908
PVC-34	1070742.95	514647.99	463.31	1070783.920	834822.690	462.908
PVC-35	1070722.28	515029.87	467.11	1070763.250	835204.570	466.708
PVC-39	1070540.52	515388.6	466.67	1070581.490	835563.300	466.268
PVC-4	1070516.46	514691.78	469.91	1070557.430	834866.480	469.508
PVC-40	1070639.64	515256.1	467.09	1070680.610	835430.800	466.688
PVC-5	1070548.99	514548.01	464.99	1070589.960	834722.710	464.588
PVC-6	1070626.94	514760.76	466.08	1070667.910	834935.460	465.678
PVC-7	1070484.08	514749.72	470.99	1070525.050	834924.420	470.588
PVC-8	1070343.56	514871.72	471.41	1070384.530	835046.420	471.008
PVC-9	1070386.31	515127.48	470.92	1070427.280	835302.180	470.518
PVC-14*	1070156.374	514599.5253	445	1070197.344	834774.225	444.598
PVC-15*	1069828.272	514339.8396	443	1069869.242	834514.540	442.598
PVC-16*	1069627.504	514644.9394	485.5	1069668.474	834819.639	485.098
PVC-17*	1069497.893	514697.3029	487.5	1069538.863	834872.003	487.098
PVC-2*	1069705.748	514536.5804	482.25	1069746.718	834711.280	481.848
PVC-21*	1069752.464	514713.8934	474	1069793.434	834888.593	473.598
PVC-22*	1069529.969	514535.7378	486.5	1069570.939	834710.438	486.098
PVC-23*	1069626.242	514356.3096	470	1069667.212	834531.010	469.598
PVC-3*	1070099.014	514675.9803	476	1070139.984	834850.680	475.598
PVC-30*	1069465.427	514471.045	482.25	1069506.397	834645.745	481.848
PVC-31*	1069425.522	514600.0435	491	1069466.492	834774.744	490.598
PVC-32*	1069842.686	514814.893	473	1069883.656	834989.593	472.598
FP1	1070334.31	514134.5	NA	1070375.280	834309.200	NA
FP2	1070234.31	514330.75	NA	1070275.280	834505.450	NA
FP3	1070079.31	514065.75	NA	1070120.280	834240.450	NA
FP4	1069989.31	514234.5	NA	1070030.280	834409.200	NA
FP5	1069909.11	514369.5	NA	1069950.080	834544.200	NA
FP6	1069858.62	513973.49	NA	1069899.590	834148.190	NA
FP7	1069757.56	514085.25	NA	1069798.530	834259.950	NA
FP8	1069624.31	514189.5	NA	1069665.280	834364.200	NA
RC-01	1070321.63	514301.23	NA	1070362.600	834475.930	NA
RC-02	1070165.55	514519.12	NA	1070206.520	834693.820	NA
RC-03	1069839.44	514313.26	NA	1069880.410	834487.960	NA
RC-04	1069899.51	514224.08	NA	1069940.480	834398.780	NA
RC-05	1070056.88	514243.71	NA	1070097.850	834418.410	NA
RC-06	1070227.2	514280.93	NA	1070268.170	834455.630	NA
RC-07	1070399.59	514167.3	NA	1070440.560	834342.000	NA
WL-201	1070378.84	514177.6	444	1070419.810	834352.300	443.598
WL-202	1070102.59	514488.27	444.9	1070143.560	834662.970	444.498
WL-203	1069934.54	514237.48	444.7	1069975.510	834412.180	444.298
WL-204	1069685.83	514205.01	443.3	1069726.800	834379.710	442.898
WL-205	1069698.26	514212.18	443.2	1069739.230	834386.880	442.798
WL-206	1070194.31	514549.5	444.4	1070235.280	834724.200	443.998
WL-207	1070743.05	514299.87	444.5	1070784.020	834474.570	444.098
WL-208	1070141.19	514752.42	474.8	1070182.160	834927.120	474.398

Table 4-2: Soil Boring and GCPT Survey Data

DRAFT

Boring ID No.	Missouri East 1927 (modified) State Plane			Missouri East 1983 State Plane		
	Northing	Easting	Ground Surface Elevation (ft amsl)	Northing	Easting	Ground Surface Elevation (ft amsl)
WL-209	1070492.55	514686.34	467.4	1070533.520	834861.040	466.998
WL-210	1069775.15	514811.55	477.8	1069816.120	834986.250	477.398
WL-211	1070046.08	514684.07	475.3	1070087.050	834858.770	474.898
WL-212	1070025.86	514973.26	472.9	1070066.830	835147.960	472.498
WL-213	1070223.38	514947.61	472.3	1070264.350	835122.310	471.898
WL-214	1070206.86	515241.19	468.5	1070247.830	835415.890	468.098
WL-215	1070432.01	515259.72	470	1070472.980	835434.420	469.598
WL-216A	1069836.29	514936.08	477.4	1069877.260	835110.780	476.998
WL-216B	1069827.87	514931.35	477.5	1069868.840	835106.050	477.098
WL-216C	1069819.16	514925.06	477.6	1069860.130	835099.760	477.198
WL-217	1069961.3	515082.21	474.7	1070002.270	835256.910	474.298
WL-218	1069462.69	514839.09	489.7	1069503.660	835013.790	489.298
WL-219	1069142.47	514545.63	496.7	1069183.440	834720.330	496.298
WL-219A	1069142.47	514545.63	496.7	1069183.440	834720.330	496.298
WL-220	1069258.11	514733.38	503.9	1069299.080	834908.080	503.498
WL-221	1070567.35	514459.37	462.3	1070608.320	834634.070	461.898
WL-222	1070799.38	514618.74	457.8	1070840.350	834793.440	457.398
WL-223	1070745.71	514734.14	462.2	1070786.680	834908.840	461.798
WL-224	1070485.74	515601.73	468.4	1070526.710	835776.430	467.998
WL-225	1070576.93	515632.66	468.2	1070617.900	835807.360	467.798
WL-226	1070536.03	514992.1	467.5	1070577.000	835166.800	467.098
WL-227	1070685.99	515258.39	462	1070726.960	835433.090	461.598
WL-228	1071044.35	514724.16	441.6	1071085.320	834898.860	441.198
WL-229	1069329.26	514268.59	448.5	1069370.230	834443.290	448.098
WL-230	1070716.09	515139.66	463.3	1070757.060	835314.360	462.898
WL-231	1070850.73	515007.27	464.8	1070891.700	835181.970	464.398
WL-232	1069827.87	514931.35	477.5	1069868.840	835106.050	477.098
WL-233	1069542.4	514609.19	489.2	1069583.370	834783.890	488.798
WL-234	1069757.62	514428.12	480	1069798.590	834602.820	479.598
WL-235	1069615.23	514418.87	481.1	1069656.200	834593.570	480.698
WL-236	1069399.29	514384.13	484.3	1069440.260	834558.830	483.898
WL-237	1070069.42	515161.88	473.9	1070110.390	835336.580	473.498
WL-238	1070705.96	514916.28	466.2	1070746.930	835090.980	465.798
WL-239	1070921.77	514829.72	458.9	1070962.740	835004.420	458.498
WL-240	1070320.97	515315.69	468.5	1070361.940	835490.390	468.098
WL-241	1070319.84	515100.73	469.6	1070360.810	835275.430	469.198
WL-242	1070836.39	515098.99	NA	1070877.360	835273.690	NA
WL-243	1070860.46	515113.42	NA	1070901.430	835288.120	NA
WL-244	1070946.92	515215.29	NA	1070987.890	835389.990	NA
WL-245	1070976.4	515093.24	NA	1071017.370	835267.940	NA
WL-246	1071018.3	515193.17	NA	1071059.270	835367.870	NA

NA indicates that elevation is Not Available

* Location and elevation approximate (no survey data available for these borings)

Northings and Eastings in MO-E NAD 27 US feet

Table 4-3a: Summary of Downhole Gamma Logging Results - Area 1

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Total Depth (ft)	Total Depth Elevation (ft amsl)	Depth of Base of Waste (ft)	Elevation of Base of Waste (ft amsl)	Depth of Peak Gamma Value (ft)	Elevation of Peak Gamma Value (ft amsl)	Peak Gamma Value (cpm)	Depth to Top of Elevated Gamma Interval (ft)	Elevation Top of Elevated Gamma Interval (ft amsl)	Depth to Bottom of Elevated Gamma Interval (ft)	Elevation of Bottom of Elevated Gamma Interval (ft amsl)	Thickness of Elevated Gamma Interval (ft)
GCPT 1-1	1068826.6	515829.0	471.0	22.1	448.9			1.1	469.9	6,258					
GCPT 1-1A	1068820.4	515835.2	471.0	39.7	431.3			32.5	438.5	7,464					
GCPT 1-2	1068777.7	515870.6	471.7	40.4	431.3			24.4	447.3	67,878	23.5	448.2	25.2	446.5	1.7
GCPT 2-1	1068905.8	515882.1	472.8	50.9	421.9			3.3	469.5	5,610					
GCPT 2-2	1068879.3	515916.5	474.9	8.7	466.2			1.5	473.4	6,294					
GCPT 2-2A	1068874.3	515928.3	475.3	9.4	465.9			1.5	473.8	5,766					
GCPT 2-3	1068819.1	515941.6	476.6	1	475.6					BKGD					
GCPT 2-3A	1068819.1	515941.6	476.6	39.4	437.2			35.6	441.0	34,722	35	441.6	36.8	439.8	1.8
GCPT 2-2B	1068874.3	515928.3	475.3	43.1	432.2			34	441.3	96,000	33.2	442.1	34.7	440.6	1.5
GCPT 2-2C	1068878.5	515931.1	475.3	44.9	430.4			32.5	442.8	18,906	31.8	443.5	32.7	442.6	0.9
GCPT 2-4	1068863.2	515948.7	476.6	53.3	423.3			29.4	447.2	10,320					
GCPT 3-1	1068944.0	515949.3	474.9	7.4	467.5			4.4	470.5	5,724					
GCPT 3-1A	1068944.0	515949.3	474.9	41.2	433.7			27.7	447.2	78,810	27	447.9	28.5	446.4	1.5
GCPT 3-2	1068866.4	516006.0	479.0	48.1	430.9			1	478.0	6,186					
GCPT 4-1	1068941.6	516007.7	474.4	53.1	421.3			28.9	445.5	488,196	27.5	446.9	31	443.4	3.5
GCPT 4-2	1068880.9	516038.0	479.0	52.8	426.2			34	445.0	40,644	33.5	445.5	34.5	444.5	1.0
GCPT 5-1	1069052.6	516101.8	473.6	41	432.6			25.1	448.5	126,738	23.2	450.4	25.8	447.8	2.6
GCPT 5-2	1069012.1	516040.9	473.3	51.2	422.1			26.2	447.1	114,684	25.2	448.1	27	446.3	1.8
GCPT 5-3	1068985.5	516093.3	474.7	44.3	430.4			29.4	445.3	631,662	25.5	449.2	33	441.7	7.5
GCPT 5-4	1068925.0	516116.6	478.2	7.7	470.5			1.3	476.9	5,310					
GCPT 5-4A	1068931.2	516116.5	478.0	46.3	431.7			11.8	466.2	8,820					
GCPT 5-5	1068953.9	516113.2	476.7	47.9	428.8			32.2	444.5	450,360	30.1	446.6	34.4	442.3	4.3
GCPT 5-6	1068998.4	516126.4	474.7	45.1	429.6			27.4	447.3	405,864	25.5	449.2	29	445.7	3.5
GCPT 6-2	1069108.9	516196.5	473.0	48.7	424.3			13.3	459.7	6,258					
GCPT 6-3	1069036.5	516180.8	474.0	45.1	428.9			27.9	446.1	103,218	27.2	446.8	28.8	445.2	1.6
GCPT 6-4	1068976.4	516208.6	482.7	25.6	457.1			3.1	479.6	4,434					
GCPT 6-5	1068969.6	516218.3	482.6	60	422.6			3.3	479.3	6,108					
GCPT 6-6	1069012.5	516193.4	475.2	41.7	433.5			28.1	447.1	191,856	26	449.2	29	446.2	3.0
GCPT 7-1	1069155.5	516310.8	470.9	52	418.9			7.9	463.0	6,204					
GCPT 7-2	1069085.7	516269.3	472.6	50	422.6			4.9	467.7	6,012					
GCPT 7-3	1069013.0	516308.3	479.2	54.5	424.7			40	439.2	12,558					
GCPT 8-1	1069039.2	516366.5	479.7	57.1	422.6			29	450.7	19,854	27.5	452.2	30	449.7	2.5
GCPT 9-1	1069152.0	516357.3	470.3	47.6	422.7			6.2	464.1	8,280					
GCPT 9-2	1069098.6	516379.6	472.1	54	418.1			16.9	455.2	5,826					
GCPT 9-3	1069055.6	516401.1	479.6	4.9	474.7			1.8	477.8	3,642					
GCPT 9-3A	1069049.4	516404.6	479.2	55.9	423.3			15.3	463.9	6,228					
GCTP 9-4	1069113.5	516407.0	471.4	52.7	418.7			2.1	469.3	5,622					
GCPT 10-1	1069190.5	516433.0	471.1	47.6	423.5			1.6	469.5	6,828					
GCPT 10-2	1069140.6	516449.8	472.3	53.1	419.2			7.5	464.8	6,486					
GCPT 10-3	1069074.6	516465.6	485.3	4.9	480.4			1.6	483.7	4,074					
GCPT 10-3A	1069075.4	516462.9	485.4	7.2	478.2			3.4	482.0	4,890					
GCPT 10-4	1069060.4	516474.7	483.6	2.6	481.0					BKGD					

Table 4-3a: Summary of Downhole Gamma Logging Results - Area 1

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Total Depth (ft)	Total Depth Elevation (ft amsl)	Depth of Base of Waste (ft)	Elevation of Base of Waste (ft amsl)	Depth of Peak Gamma Value (ft)	Elevation of Peak Gamma Value (ft amsl)	Peak Gamma Value (cpm)	Depth to Top of Elevated Gamma Interval (ft)	Elevation Top of Elevated Gamma Interval (ft amsl)	Depth to Bottom of Elevated Gamma Interval (ft)	Elevation of Bottom of Elevated Gamma Interval (ft amsl)	Thickness of Elevated Gamma Interval (ft)
GCPT 10-4A	1069061.2	516477.9	483.6	54.1	429.5			14.9	468.7	6,642					
GCPT 11-1	1069222.9	516503.6	479.8	50.9	428.9			0.2	479.6	9,210					
GCPT 11-2	1069168.0	516518.2	474.8	52.2	422.6			15.4	459.4	7,614					
GCPT 11-3	1069137.5	516551.1	476.6	53.5	423.1			6.1	470.5	6,858					
GCPT 11-4	1069072.8	516565.5	482.7	50.7	432.0			45.9	436.8	9,792					
GCPT 12-1	1069249.3	516567.6	479.4	34.1	445.3			24.1	455.3	308,106	22	457.4	24.9	454.5	2.9
GCPT 12-2	1069198.1	516592.8	476.0	54.1	421.9			1.3	474.7	6,546					
GCPT 12-3	1069163.5	516608.9	475.9	55.4	420.5			4.1	471.8	7,476					
GCPT 12-4	1069124.7	516619.7	476.4	57.4	419.0			38.5	437.9	7,374					
GCPT 12-5	1069091.2	516638.7	478.5	42.2	436.3			7.5	471.0	6,432					
GCPT 12-6	1069031.3	516650.6	479.0	62.7	416.3			23.1	455.9	6,378					
GCPT 13-1	1069279.4	516642.0	470.9	22.1	448.8			15.4	455.5	28,302	15	455.9	16.3	454.6	1.3
GCPT 13-2	1069258.1	516646.3	471.5	3.9	467.6			0.8	470.7	2,490					
GCPT 13-2A	1069256.4	516650.4	471.8	4.8	467.0			1.6	470.2	3,162					
GCPT 13-3	1069242.5	516658.3	472.2	4.1	468.1			1.3	470.9	2,520					
GCPT 13-4	1069194.6	516676.5	474.0	2.3	471.7					BKGD					
GCPT 13-4S	1069195.8	516676.0	474.1	48.6	425.5			36.6	437.5	6,120					
GCPT 13-5	1069148.4	516695.0	475.4	3.1	472.3			0.3	475.1	1,872					
GCPT 13-5S	1069148.5	516697.1	475.5	41.3	434.2			11.5	464.0	5,682					
GCPT 13-6	1069094.3	516722.1	475.9	8.5	467.4			3.4	472.5	5,802					
GCPT 13-6S	1069094.3	516722.1	476.0	59.7	416.3			23.8	452.2	6,552					
GCPT 13-7	1069028.3	516764.5	474.3	14.3	460.0			1.6	472.7	5,964					
GCPT 13-7S	1069028.5	516763.2	474.2	49.4	424.8			20.8	453.4	6,366					
GCPT 14-1	1069289.8	516676.9	474.2	47.6	426.6			18.9	455.3	29,640	18.3	455.9	19.6	454.6	1.3
GCPT 14-2	1069248.8	516703.0	474.5	4.1	470.4			1.1	473.4	3,600					
GCPT 14-3	1069218.2	516720.7	473.7	1.3	472.4					BKGD					
GCPT 14-3S	1069218.9	516719.9	473.7	45.8	427.9			36.6	437.1	6,708					
GCPT 14-4	1069177.0	516745.0	474.6	2.6	472.0					BKGD					
GCPT 14-5	1069125.9	516777.9	473.3	11.5	461.8			1.6	471.7	5,772					
GCPT 14-5S	1069125.8	516777.3	473.3	26.4	446.9			15.4	457.9	5,880					
GCPT 14-6	1069077.3	516811.1	472.7	10.8	461.9			7.4	465.3	6,654					
GCPT 14-6S	1069077.3	516809.5	472.8	76.1	396.7			14.9	457.9	6,330					
GCPT 14-7	1069029.0	516850.8	473.1	2.8	470.3			0.2	472.9	1,338					
GCPT 15-1	1069362.5	516757.4	453.8	35.6	418.2			20.3	433.5	11,940					
GCPT 15-2	1069277.2	516767.4	477.3	4.9	472.4			1.6	475.7	3,222					
GCPT 15-3	1069247.6	516788.3	474.0	36.1	437.9			30.5	443.5	9,828					
GCPT 15-4	1069209.9	516811.9	473.1	40.2	432.9			29.4	443.7	8,400					
GCPT 15-5	1069166.5	516848.3	469.2	60.4	408.8			57.7	411.5	7,098					
GCPT 15-6	1069125.1	516878.8	468.8	42.3	426.5			2.6	466.2	7,098					
GCPT 15-7	1069083.7	516906.2	472.1	56.8	415.3			2.5	469.6	6,444					
GCPT 15-8	1069046.0	516931.5	473.8	29.7	444.1			2.3	471.5	8,724					
GCPT 16-1	1069393.7	516784.7	451.2	31.8	419.4			7.2	444.0	9,228					

Table 4-3a: Summary of Downhole Gamma Logging Results - Area 1

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Total Depth (ft)	Total Depth Elevation (ft amsl)	Depth of Base of Waste (ft)	Elevation of Base of Waste (ft amsl)	Depth of Peak Gamma Value (ft)	Elevation of Peak Gamma Value (ft amsl)	Peak Gamma Value (cpm)	Depth to Top of Elevated Gamma Interval (ft)	Elevation Top of Elevated Gamma Interval (ft amsl)	Depth to Bottom of Elevated Gamma Interval (ft)	Elevation of Bottom of Elevated Gamma Interval (ft amsl)	Thickness of Elevated Gamma Interval (ft)
GCPT 16-2	1069365.0	516787.1	453.1	24.9	428.2			1.8	451.3	6,948					
GCPT 16-3	1069262.2	516837.7	471.3	30.8	440.5			2.3	469.0	6,744					
GCPT 16-4	1069234.2	516866.4	472.5	43.8	428.7			3	469.5	7,446					
GCPT 16-5	1069196.9	516903.9	474.0	22	452.0			4.8	469.2	6,864					
GCPT 16-6	1069158.0	516935.3	476.8	25.4	451.4			13.6	463.2	6,600					
GCPT 16-7	1069114.1	516970.9	479.8	30	449.8			2.6	477.2	6,414					
GCPT 16-8	1069073.9	517002.5	481.9	26.9	455.0			20.7	461.2	6,648					
GCPT 1C-1	1068771.6	515837.9	463.7	19.8	443.9			3	460.7	5,256					
GCPT 1C-1A	1068766.6	515841.4	463.6	19.8	443.8			3.1	460.5	5,988					
GCPT 1C-2	1068737.8	515904.4	472.3	44.1	428.2					BKGD					
GCPT 1C-2R	1068733.9	515907.2	472.5	43.1	429.4			30.3	442.2	31,290	29.6	442.9	32	440.5	2.4
GCPT 1C-3	1068779.0	515991.4	486.4	42.3	444.1			22	464.4	6,576					
GCPT 1C-4	1068832.9	516068.8	486.1	57.7	428.4					BKGD					
GPCT 1C-4R	1068835.1	516070.9	486.0	54.3	431.7			43.8	442.2	22,638	43.4	442.6	44	442.0	0.6
GCPT 1C-5	1068986.6	516413.5	479.0	0.7	478.3					BKGD					
GCPT 1C-5A	1068986.6	516413.5	479.0	53.6	425.4			15.1	463.9	6,516					
GCPT 1C-6	1068691.8	515934.8	468.8	27.1	441.7			22.1	446.7	84,810	21.4	447.4	23.2	445.6	1.8
GCPT 1C-6T	1068685.9	515938.7	468.9	26.2	442.7			22.8	446.1	90,390	22	446.9	24	444.9	2.0
GCPT 1C-6T1	1068684.1	515939.6	468.9	26.6	442.3			23.5	445.4	171,774	22.5	446.4	23.6	445.3	1.1
GCPT 1C-7	1068646.9	515958.2	468.6	36.1	432.5			4.3	464.3	6,978					
GCPT 1C-8	1068728.3	516014.9	491.2	42	449.2			3	488.2	6,144					
GCPT 1C-9	1068746.5	516049.9	495.2	53.6	441.6			10.4	484.8	6,360					
GCPT 1C-10	1068797.8	516095.9	496.5	42.7	453.8			11.8	484.7	6,276					
GCPT 1C-11	1068838.9	516151.9	496.9	36.4	460.5			3	493.9	6,516					
GCPT 1C-12	1068865.9	516200.9	500.1	60.7	439.4			56.3	443.8	57,414	55.7	444.4	57	443.1	1.3
GCPT 1C-13	1068982.2	516321.9	480.1	47.1	433.0			34.1	446.0	6,438					
GCPT-108	1069142.1	516389.0	470.4	57.3	413.1			2	468.4	6,408					
GCPT-111A	1069183.7	516592.4	475.7	52.3	423.4			25.9	449.8	9,564					
GCPT-119	1069021.0	516294.2	478.6	49.9	428.7			45.6	433.0	14,616					
PVC-28	1069255.0	516488.9	473.1					14	459.1	132,000	12	461.1	17	456.1	5.0
GCPT-28A	1069253.6	516490.7	480.5	38.5	442.0			24.9	455.6	82,512	24.2	456.3	25.6	454.9	1.4
GCPT-36	1069217.9	516193.7	465.0	18	447.0			8.5	456.5	19,470	7.8	457.2	8.8	456.2	1.0
GCPT-25	1069345.4	516405.4	465.3	30.8	434.5			8.4	456.9	74,880	7.3	458.0	9.8	455.5	2.5
PVC-25	1069345.0	516406.6	467.7					9	458.7	72,000	7	460.7	11	456.7	4.0
PVC-25R	1069345.4	516405.4	465.3	30	435.3			9.5	455.8	74,562	8.3	457.0	10.9	454.4	2.6
1D-1	1069085.2	515745.0	462.5	35.1	427.4			8.9	453.6	6,288					
1D-2	1068999.1	515778.2	468.4	23.3	445.1			5.9	462.5	5,142					
1D-3	1068972.3	515874.2	472.1	46.1	426.0			27.4	444.7	390,720	25.5	446.6	29.5	442.6	4.0
1D-4	1068794.5	516092.1	496.4	64.5	431.9			55.8	440.6	14,154					
1D-5	1068649.8	516043.5	487.6	70	417.6			55.1	432.5	143,724	54.1	433.5	56.2	431.4	2.1
1D-6	1068727.5	516153.0	512.5	82.8	429.7			3.9	508.6	6,834					
1D-7	1068647.2	516155.9	512.8	87.8	425.0			82.8	430.0	775,560	80.2	432.6	85.5	427.3	5.3

Table 4-3a: Summary of Downhole Gamma Logging Results - Area 1

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Total Depth (ft)	Total Depth Elevation (ft amsl)	Depth of Base of Waste (ft)	Elevation of Base of Waste (ft amsl)	Depth of Peak Gamma Value (ft)	Elevation of Peak Gamma Value (ft amsl)	Peak Gamma Value (cpm)	Depth to Top of Elevated Gamma Interval (ft)	Elevation Top of Elevated Gamma Interval (ft amsl)	Depth to Bottom of Elevated Gamma Interval (ft)	Elevation of Bottom of Elevated Gamma Interval (ft amsl)	Thickness of Elevated Gamma Interval (ft)
1D-8	1068818.2	516243.6	517.2	78.1	439.1			75.3	441.9	44,028	74.7	442.5	75.6	441.6	0.9
1D-8A	1068820.7	516250.6	517.3	79.7	437.6			2.6	514.7	6,318					
1D-9	1068667.9	516221.7	518.6	70.7	447.9			58.6	460.0	13,236					
1D-9A	1068662.9	516220.9	518.6	78.2	440.4			56.8	461.8	14,508					
1D-10	1068897.5	516306.8	503.7	77.8	425.9			38.9	464.8	7,554					
1D-11	1068733.0	516319.2	523.0	83.3	439.7			1.8	521.2	5,970					
1D-11A	1068728.1	516324.6	522.8	72.5	450.3			1.6	521.2	6,648					
1D-12	1068878.3	516446.2	505.6	85.1	420.5			29.4	476.2	6,054					
1D-13	1068807.8	516405.2	520.2	79.9	440.3			36.4	483.8	7,980					
1D-13A	1068807.9	516397.5	520.2	15.4	504.8			2.1	518.1	5,934					
1D-13B	1068807.6	516392.1	520.4	35.6	484.8			7.1	513.3	5,964					
1D-13C	1068808.2	516414.2	519.9	75.3	444.6			2.5	517.4	6,432					
1D-14	1068737.3	516389.5	522.0	97	425.0			2.5	519.5	5,952					
1D-15	1068600.2	516195.0	516.7	93.8	422.9			89.6	427.1	16,194	89.4	427.3	89.7	427.0	0.3
1D-16	1068604.6	516049.5	484.8	51.2	433.6			46.9	437.9	68,700	46	438.8	48	436.8	2.0
1D-16A	1068611.3	516048.7	485.2	52.5	432.7			49.9	435.3	17,712	49.7	435.5	49.9	435.3	0.2
1D-17	1068872.4	515831.0	472.5	26.2	446.3			4.1	468.4	4,938					
1D-17A	1068870.0	515836.4	472.5	40.2	432.3			17.7	454.8	5,496					
1D-18	1068551.1	516059.9	481.0	14.6	466.4			10.2	470.8	7,224					
1D-18A	1068545.4	516060.4	480.5	57.1	423.4			41.3	439.2	6,984					
1-2	1068783.1	515878.5	472.6	43	429.6	30	442.6	33	439.6	4,271					
2-2	1068876.8	515926.2	475.2	54	421.2	48	427.2	32	443.2	4,354					
5-3	1068986.8	516093.8	474.4	53	421.4	48	426.4	29.5	444.9	336,937	26	448.4	32.5	441.9	6.5
8-1	1069041.0	516368.6	479.8	53	426.8	43	436.8	28	451.8	4,821					
12-5	1069087.1	516641.3	478.9	49	429.9	45	433.9	14	464.9	3,864					
13-3	1069232.1	516662.3	472.6	54	418.6	46	426.6	16.5	456.1	3,607					
13-6	1069093.5	516723.8	475.9	89	386.9	86.1	389.8	24.5	451.4	3,902					
14-2	1069251.0	516701.5	474.6	58	416.6	50	424.6	27.5	447.1	4,008					
14-4	1069179.6	516743.2	474.4	48	426.4	38	436.4	9	465.4	3,888					
14-5	1069122.9	516777.9	472.9	89	383.9	86	386.9	13.5	459.4	3,454					
14-7	1069027.7	516848.6	473.3	109	364.3	98	375.3	31.5	441.8	3,637					
15-2	1069281.0	516768.9	476.5	51	425.5	28	448.5	26	450.5	5,184					
16-3	1069267.1	516837.3	470.7	38	432.7	28	442.7	20	450.7	4,118					
16-6	1069155.4	516938.7	477.1	34	443.1	18	459.1	14	463.1	3,841					
1C-6	1068689.0	515936.0	469.2	93	376.2	26	443.2	22.5	446.7	53,732	20	449.2	25.5	443.7	5.5
WL-119	1069018.0	516296.4	479.2	57	422.2	49	430.2	32.5	446.7	7,941					
1D-1S	1069074.2	515747.4	462.6	39	423.6	31	431.6	6.5	456.1	3,382					
1D-2S	1068990.2	515784.3	468.6	39	429.6	31	437.6	19.5	449.1	4,001					
1D-3S	1068968.6	515882.9	472.3	49	423.3	41.5	430.8	27	445.3	204,471	20.5	451.8	30	442.3	9.5
1D-4S	1068804.9	516101.3	496.4	69	427.4	64.5	431.9	12.5	483.9	4,349					
1D-5S	1068657.7	516040.3	487.8	69	418.8	62.5	425.3	53	434.8	12,059	51.5	436.3	56	431.8	4.5
1D-6S	1068733.0	516161.0	512.7	89	423.7	84	428.7	11	501.7	3,749					

Table 4-3a: Summary of Downhole Gamma Logging Results - Area 1

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Total Depth (ft)	Total Depth Elevation (ft amsl)	Depth of Base of Waste (ft)	Elevation of Base of Waste (ft amsl)	Depth of Peak Gamma Value (ft)	Elevation of Peak Gamma Value (ft amsl)	Peak Gamma Value (cpm)	Depth to Top of Elevated Gamma Interval (ft)	Elevation Top of Elevated Gamma Interval (ft amsl)	Depth to Bottom of Elevated Gamma Interval (ft)	Elevation of Bottom of Elevated Gamma Interval (ft amsl)	Thickness of Elevated Gamma Interval (ft)
1D-7S	1068653.6	516157.9	513.3	94	419.3	89	424.3	82.5	430.8	1,503,082	74	439.3	89	424.3	15.0
1D-8S	1068810.6	516238.0	516.7	99	417.7	90	426.7	73	443.7	6,869	72	444.7	74	442.7	2.0
1D-9S	1068678.2	516223.8	518.9	104	414.9	99.5	419.4	87.5	431.4	1,174,844	81.5	437.4	96.5	422.4	15.0
1D-10S	1068898.8	516318.5	503.1	84	419.1	76	427.1	37.5	465.6	3,942					
1D-11S	1068739.0	516311.2	522.3	106	416.3	99	423.3	84	438.3	16,554	82	440.3	85	437.3	3.0
1D-12S	1068880.8	516434.9	505.9	89	416.9	71.5	434.4	29.5	476.4	4,173					
1D-13S	1068786.1	516399.3	520.5	99	421.5	80	440.5	42	478.5	4,304					
1D-14S	1068730.3	516381.9	522.5	89	433.5	79	443.5	43.5	479.0	4,010					
1D-15S	1068611.7	516196.3	516.1	99	417.1	89.5	426.6	85	431.1	20,523	83	433.1	86.5	429.6	3.5
1D-16S	1068620.2	516047.6	485.6	64	421.6	59	426.6	50	435.6	11,886	49.5	436.1	51.5	434.1	2.0
1D-17S	1068865.4	515846.1	472.9	49	423.9	33.5	439.4	16	456.9	3,650					
1D-18S	1068573.8	516056.1	482.0	59	423.0	44	438.0	48.5	433.5	4,480					
1D-19S	1068620.7	516259.1	521.1	94	427.1	85	436.1	44	477.1	3,437					
1D-20S	1068540.3	516226.6	517.7	90	427.7	79	438.7	2.5	515.2	1,576					
AC-01	1069120.7	516017.3	466.7	49	417.7	44	422.7	10.5	456.2	824,868	5	461.7	20	446.7	
AC-02B	1069151.4	515831.9	466.2	39	427.2	29.0	437.2	10.0	456.2	15,570	9.5	456.7	13.5	452.7	
AC-03	1069183.6	516040.7	466.4	49	417.4	39.0	427.4	4.0	462.4	906,839	0	466.4	13	453.4	
AC-04B	1069555.7	516492.9	464.7	36	428.7	33.0	431.7	5.0	459.7	5,114					
AC-05	1069483.8	516657.8	451.4	29	422.4			12.5	438.9	4,656					
AC-06	1069420.3	516222.7	464.3	34	430.3	29.0	435.3	26.0	438.3	4,857					
AC-07	1069315.7	516025.4	461.5	34	427.5			2.5	459.0	24,727	0	461.5	5.5	456.0	
WL-102-CT-A	1069268.7	515969.7	461.9	29	432.9	24.5	437.4	3.0	458.9	4,379					
WL-106A-CT	1069300.8	516090.3	463.8	39	424.8	29.0	434.8	4.5	459.3	27,546	2.5	461.3	6.5	457.3	
WL-114-CT	1069381.1	516352.4	467.4	49	418.4	39.0	428.4	5	462.4	5,669					
WL-101-MH	1069550.0	516317.2	456.5	25	431.5	17	439.5			BKGD					
WL-102-MH	1069260.0	515974.1	462.8	34	428.8	23	439.8	3.25	459.6	60,000	0	462.8	6	456.8	6.0
WL-103-MH	1069407.0	516737.1	450.9							BKGD					
WL-104-MH	1069575.0	516602.8	449.8							BKGD					
WL-105A-MH	1069136.3	515871.6	467.2	109	358.2	30	437.2	9	458.2	180,000	3	464.2	12	455.2	9.0
WL-105B-MH	1069148.0	515889.5	466.0	55	411.0	30	436.0	6.5	459.5	263,000	4	462.0	9	457.0	5.0
WL-105C-MH	1069155.8	515901.0	465.7	43	422.7	30	435.7	3.5	462.2	386,000	0	465.7	7	458.7	7.0
WL-106A-MH	1069317.0	516061.9	462.8	35	427.8	21.4	441.4	4	458.8	25,000	1	461.8	6	456.8	5.0
WL-106-MH	1069302.0	516082.2	465.4	20	445.4					BKGD					
WL-107-MH	1068910.0	516254.3	486.0	52	434.0	50.9	435.1			BKGD					
WL-108-MH	1069550.0	516317.2	456.5	22	434.5					BKGD					
WL-109A-MH	1068933.0	516509.7	485.5							BKGD					
WL-109B-MH	1068947.0	516523.2	484.5	59	425.5	49	435.5			BKGD					
WL-109C-MH	1068961.0	516528.4	483.9	48	435.9	48	435.9			BKGD					
WL-109D-MH	1068947.0	516505.0	485.6	62	423.6	56	429.6			BKGD					
WL-110-MH	1068852.0	516664.6	484.4	56	428.4	50	434.4			BKGD					
WL-111-MH	1069187.0	516583.6	474.5	52	422.5	50	424.5			BKGD					
WL-112-MH	1069379.0	516628.2	467.6	42	425.6	38	429.6	5.5	462.1	10,000	4	463.6	7	460.6	3.0

Table 4-3a: Summary of Downhole Gamma Logging Results - Area 1

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Total Depth (ft)	Total Depth Elevation (ft amsl)	Depth of Base of Waste (ft)	Elevation of Base of Waste (ft amsl)	Depth of Peak Gamma Value (ft)	Elevation of Peak Gamma Value (ft amsl)	Peak Gamma Value (cpm)	Depth to Top of Elevated Gamma Interval (ft)	Elevation Top of Elevated Gamma Interval (ft amsl)	Depth to Bottom of Elevated Gamma Interval (ft)	Elevation of Bottom of Elevated Gamma Interval (ft amsl)	Thickness of Elevated Gamma Interval (ft)
WL-113-MH	1069483.0	516470.0	467.0	45	422.0	42.5	424.5	3.75	463.3	14,000	3	464.0	5	462.0	2.0
WL-114-MH	1069392.0	516338.6	468.3	45	423.3	40	428.3	5	463.3	14,000	3	465.3	6	462.3	3.0
WL-115-MH	1069299.0	516395.1	468.9	41	427.9	34	434.9			BKGD					
WL-116-MH	1069083.0	516160.6	474.3	20	454.3					BKGD					
WL-117-MH	1069237.0	516221.3	467.6	41	426.6	37	430.6	6.5	461.1	16,000	3	464.6	8	459.6	5.0
WL-118-MH	1069411.0	516305.0	465.8	15	450.8			0	465.8	12,000	0	465.8	2	463.8	2.0
WL-119-MH	1069031.0	516289.3	477.4	50	427.4	44	433.4			BKGD					
WL-120-MH	1069054.0	516846.6	474.7	52	422.7					BKGD					
WL-121-MH	1068763.0	516241.3	523.2			62.5	460.7			BKGD					
WL-122-MH	1068775.0	516110.2	507.2			37	470.2			BKGD					
WL-123-MH	1068793.0	515934.7	480.1			42	438.1			BKGD					
WL-124-MH	1069051.0	515858.0	470.5			17	453.5			BKGD					
PVC-24-MH	1069234.0	516312.8	469.6							BKGD					
PVC-26-MH	1069464.0	516376.1	465.2					5	460.2	86,000	3	462.2	10	455.2	7.0
PVC-27-MH	1069461.0	516510.3	469.1							BKGD					
NRC-29*	1069126.0	516607.5	473.5							BKGD					
PVC-36-MH	1069218.0	516193.8	466.8					7.8	459.0	15,780	6	460.8	9.5	457.3	3.5
PVC-37-MH	1069146.0	516421.6	473.4							BKGD					
PVC-38-MH	1069316.0	516580.4	470.5					10	460.5	1,298,000	0	470.5	15	455.5	15.0
PVC-41-MH	1069213.0	516701.2	474.1							BKGD					

* Survey coordinates for the NRC boring location are only approximate estimates.

amsl = above mean sea level

cpm = counts per minute

Borings AC-01, AC-02B and AC-03 displayed more than one interval with elevated gamma levels. Values presented are for the largest interval with the highest gamma level.

Table 4-3b: Summary of Downhole Gamma Logging Results - Area 2

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Total Depth (ft)	Total Depth Elevation (ft amsl)	Depth of Base of Waste (ft)	Elevation of Base of Waste (ft amsl)	Depth of Peak Gamma Value (ft)	Elevation of Peak Gamma Value (ft amsl)	Peak Gamma Value (cpm)	Depth to Top of Elevated Gamma Interval (ft)	Elevation of Top of Elevated Gamma Interval (ft amsl)	Depth to Bottom of Elevated Gamma Interval (ft)	Elevation of Bottom of Elevated Gamma Interval (ft amsl)	Thickness of Elevated Gamma Interval (ft)
AC-08	1069429.3	514606.1	490.6	74	416.6	66.5	424.1	51	439.6	3,917					
AC-09	1069593.1	514302.6	469.2	34	435.2	31	438.2	31	438.2	3,785					
AC-10	1070422.8	514642.6	467.7	39	428.7	35.5	432.2	3	464.7	3,423					
AC-11	1070423.2	514437.4	463.0	34	429.0	28.5	434.5	2	461.0	3,413					
AC-12	1070680.1	514526.4	459.6	38	421.6	31	428.6	2.5	457.1	3,577					
AC-13	1070614.4	514866.0	468.1	49	419.1	43	425.1	18	450.1	500,239	13.5	454.6	21.5	446.6	8.0
AC-14	1070798.4	515338.2	457.8	30	427.8	20	437.8	22	435.8	3,847					
AC-15	1070703.0	515525.9	457.2	34	423.2	26.5	430.7	11.5	445.7	3,803					
AC-16	1070482.0	515440.3	468.2	40	428.2	29.5	438.7	18	450.2	443,815	14.5	453.7	23	445.2	8.5
AC-17	1070259.7	515183.2	471.3	49	422.3	43	428.3	9	462.3	3,519					
AC-18	1070438.5	514922.1	469.5	44	425.5	34	435.5	2	467.5	259,236	0	469.5	9	460.5	9.0
AC-19	1069959.2	514772.6	477.2	49	428.2	42	435.2	2.5	474.7	214,732	0	477.2	6	471.2	6.0
AC-20	1069664.0	514960.2	489.0	59	430.0	48	441.0	21.5	467.5	402,171	18	471.0	25	464.0	7.0
AC-21	1069642.3	514760.3	477.6	50	427.6	46.5	431.1	10.5	467.1	272,024	8	469.6	14.5	463.1	6.5
AC-21A	1069647.0	514754.4	477.4	55	422.4	47.5	429.9	12	465.4	338,865	8.5	468.9	16.5	460.9	8.0
AC-22	1069738.5	514617.5	483.3	68	415.3	58.5	424.8	18	465.3	45,675	16	467.3	19.5	463.8	3.5
AC-23	1069568.4	514618.1	486.5	74	412.5	66.5	420.0	22	464.5	200,376	16.5	470.0	25.5	461.0	9.0
AC-24	1069783.8	514810.7	477.4	69	408.4	55	422.4	2	475.4	470,901	0	477.4	17	460.4	17.0
AC-25	1069622.8	514420.8	479.4	49	430.4	38	441.4	21	458.4	19,802	20	459.4	22.5	456.9	2.5
AC-26A	1069548.8	515122.3	473.2	50	423.2			3.5	469.7	15,245	2	471.2	6	467.2	4.0
WL-209-CT	1070492.5	514686.4	467.5	39	428.5	29	438.5	1.5	466.0	488,730	0	467.5	8	459.5	8.0
WL-234-CT	1069762.4	514435.7	480.0	48	432.0	43.5	436.5	8.5	471.5	894,913	1.5	478.5	20	460.0	18.5
WL-201-MH	1070378.8	514177.6	444.0	15	429.0			2.9	441.1	6,821					
WL-202-MH	1070102.6	514488.3	444.9	15	429.9			2	442.9	6,402					
WL-203-MH	1069934.5	514237.5	444.7	15	429.7			1.9	442.8	6,879					
WL-204-MH	1069685.8	514205.0	443.3	25	418.3			2	441.3	6,120					
WL-205-MH	1069698.3	514212.2	443.2	52	391.2			2.7	440.5	6,183					
WL-206-MH	1070194.3	514549.5	444.4	65	379.4			0.9	443.5	3,847					
WL-207-MH	1070743.1	514299.9	444.5	50	394.5			1.7	442.8	3,693					
WL-208-MH	1070141.2	514752.4	474.8	37	437.8	28	446.8	0	474.8	9,809					
WL-209-MH	1070492.6	514686.3	467.4	30	437.4	28	439.4	0.4	467.0	739,936	0	467.4	11	456.4	11
WL-210-MH	1069775.2	514811.6	477.8	53	424.8	53	424.8	0.1	477.7	507,409	0	477.8	16.5	461.3	16.5
WL-211-MH	1070046.1	514684.1	475.3	28	447.3	25	450.3	0.7	474.6	328,571	0	475.3	13	462.3	13
WL-212-MH	1070025.9	514973.3	472.9	30	442.9	28	444.9	6.3	466.6	4,504					
WL-213-MH	1070223.4	514947.6	472.3	25	447.3	24	448.3	3.7	468.6	5,529					
WL-214-MH	1070206.9	515241.2	468.5	25	443.5	24	444.5	21.7	446.8	5,405					
WL-215-MH	1070432.0	515259.7	470.0	16	454.0	16+									
WL-216A-MH	1069836.3	514936.1	477.4	146.2	331.2	22	455.4	3.9	473.5	23,178	2	475.4	6	471.4	4
WL-216C-MH	1069819.2	514925.1	477.6	93	384.6	26	451.6	3.8	473.8	46,804	0	477.6	9	468.6	9
WL-217-MH	1069961.3	515082.2	474.7	17	457.7	17+		9.3	465.4	4,590					
WL-218-MH	1069462.7	514839.1	489.7	40	449.7	37	452.7	19.9	469.8	5,963					

Table 4-3b: Summary of Downhole Gamma Logging Results - Area 2

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Total Depth (ft)	Total Depth Elevation (ft amsl)	Depth of Base of Waste (ft)	Elevation of Base of Waste (ft amsl)	Depth of Peak Gamma Value (ft)	Elevation of Peak Gamma Value (ft amsl)	Peak Gamma Value (cpm)	Depth to Top of Elevated Gamma Interval (ft)	Elevation of Top of Elevated Gamma Interval (ft amsl)	Depth to Bottom of Elevated Gamma Interval (ft)	Elevation of Bottom of Elevated Gamma Interval (ft amsl)	Thickness of Elevated Gamma Interval (ft)
WL-219A-MH	1069142.5	514545.6	496.7	27	469.7	27+		3.4	493.3	5,876					
WL-220-MH	1069258.1	514733.4	503.9	30	473.9	30+		1.6	502.3	4,801					
WL-221-MH	1070567.4	514459.4	462.3	35	427.3	34	428.3	7.8	454.5	4,440					
WL-222-MH	1070799.4	514618.7	457.8	35	422.8	30	427.8	1	456.8	7,354					
WL-223-MH	1070745.7	514734.1	462.2	23	439.2	22	440.2	4	458.2	14,362	1	461.2	7.5	454.7	6.5
WL-224-MH	1070485.7	515601.7	468.4	135.5	332.9	33	435.4	6.6	461.8	4,669					
WL-224-MH	1070485.7	515601.7	468.4					7	461.4	4,669					
WL-225-MH	1070576.9	515632.7	468.2	37	431.2	37+		9.5	458.7	4,813					
WL-226-MH	1070536.0	514992.1	467.5	43	424.5	42	425.5	10.6	456.9	368,988	0	467.5	17.5	450.0	17.5
WL-227-MH	1070686.0	515258.4	462.0	40	422.0	40	422.0	3	459.0	6,284					
WL-228-MH	1071044.4	514724.2	441.6	29	412.3			2.7	438.9	5,595					
WL-229-MH	1069329.3	514268.6	448.5	56	392.9	5	443.5	9	439.5	3,554					
WL-229-MH	1069329.3	514268.6	448.5					7.8	440.7	3,554					
WL-230-MH	1070716.1	515139.7	463.3	35	428.3	32	431.3	1.5	461.8	7,083	0	463.3	3	460.3	3
WL-231-MH	1070850.7	515007.3	464.8	40	424.8	40+		5.5	459.3	26,646	4	460.8	7.5	457.3	3.5
WL-232-MH	1069827.9	514931.4	477.5	54.5	423.0	22	455.5	22.8	454.7	5,163					
WL-233-MH	1069542.4	514609.2	489.2	42.5	446.7	42.5+		21.8	467.4	89,197	17	472.2	26	463.2	9
WL-234-MH	1069757.6	514428.1	480.0	42	438.0	39	441.0	7.1	472.9	1,102,547	0	480.0	18	462.0	18
WL-235-MH	1069615.2	514418.9	481.1	30	451.1	30+		22.4	458.7	20,250	20.5	460.6	24.5	456.6	4
WL-236-MH	1069399.3	514384.1	484.3	37	447.3	37+		2.8	481.5	4,215					
WL-237-MH	1070069.4	515161.9	473.9	40	433.9	34	439.9	37.7	436.2	5,874					
WL-238-MH	1070706.0	514916.3	466.2	34	432.2	27	439.2	6.1	460.1	130,897	1	465.2	10.5	455.7	9.5
WL-239-MH	1070921.8	514829.7	458.9	30	428.9	30+		23.7	435.2	4,155					
WL-240-MH	1070321.0	515315.7	468.5	11	457.5	11+		2.2	466.3	3,806					
WL-241-MH	1070319.8	515100.7	469.6	40	429.6	40+		5.6	464.0	44,982	1	468.6	9.5	460.1	8.5
PVC-4	1070516.46	514691.8	469.9					1	468.9	1,290,000	0	469.9	5.5	464.4	5.5
PVC-5	1070549.0	514548.0	465.0					5.5	459.5	15,000	1	464.0	7	458.0	6
PVC-6	1070626.94	514760.8	466.1					11	455.1	367,000	0	466.1	16	450.1	16
PVC-7	1070484.08	514749.7	471.0					2	469.0	1,386,000	0	471.0	7	464.0	7
PVC-8	1070343.56	514871.7	471.4					0.5	470.9	24,000	0	471.4	1.5	469.9	1.5
PVC-9	1070386.31	515127.5	470.9					5	465.9	22,000	3	467.9	6.5	464.4	3.5
PVC-10	1069916.35	514518.9	473.8					3	470.8	752,000	0	473.8	13	460.8	13
PVC-11A	1069848.44	514453.6	474.5					2.5	472.0	2,287,000	0	474.5	6	468.5	6
PVC-11B	1069844.18	514456.6	475.9					2.7	473.2	2,144,000	0	475.9	7	468.9	7
PVC-12	1070528.68	515176.8	468.3					2.5	465.8	58,000	0.5	467.8	5.5	462.8	5
PVC-13	1070515.37	514386.1	464.5							6,000					
PVC-18	1070300.94	514677.2	470.7							6,000					
PVC-19	1070599.18	514961.5	469.6					8	461.6	332,000	6	463.6	10.5	459.1	4.5
PVC-20	1070750.51	514806.9	466.7					1.5	465.2	127,000	0	466.7	4	462.7	4
PVC-33	1070857.78	514810.8	466.3					2.5	463.8	10,000	1.5	464.8	3.5	462.8	2
PVC-34	1070743.0	514648.0	463.3					1	462.3	22,000	0	463.3	3	460.3	3

Table 4-3b: Summary of Downhole Gamma Logging Results - Area 2

Boring	Northing	Easting	Ground Surface Elevation (ft amsl)	Total Depth (ft)	Total Depth Elevation (ft amsl)	Depth of Base of Waste (ft)	Elevation of Base of Waste (ft amsl)	Depth of Peak Gamma Value (ft)	Elevation of Peak Gamma Value (ft amsl)	Peak Gamma Value (cpm)	Depth to Top of Elevated Gamma Interval (ft)	Elevation of Top of Elevated Gamma Interval (ft amsl)	Depth to Bottom of Elevated Gamma Interval (ft)	Elevation of Bottom of Elevated Gamma Interval (ft amsl)	Thickness of Elevated Gamma Interval (ft)
PVC-35	1070722.28	515029.9	467.1					4	463.1	745,000	0.5	466.6	8	459.1	7.5
PVC-39	1070540.52	515388.6	466.7					2.5	464.2	14,000	1.5	465.2	4	462.7	2.5
PVC-40	1070639.64	515256.1	467.1					2.5	464.6	120,000	0.5	466.6	9.5	457.6	9
NRC-2*	1069705.75	514536.6	482.3					16	466.3	11,000	15	467.3	17	465.3	2
NRC-3*	1070099.0	514676.0	476					1	475.0	>50,000	0	476.0	2.5	473.5	2.5
NRC-16*	1069627.5	514644.9	485.5					13.5	472.0	>50,000	0	485.5	>19	<466.5	>19
NRC-17*	1069497.89	514697.3	487.5					20	467.5	3,000	19	468.5	21	466.5	2
NRC-21*	1069752.46	514713.9	474					7	467.0	>50,000	4.5	469.5	15.5	458.5	11
NRC-22*	1069530.0	514535.7	486.5					24	462.5	>50,000	18	468.5	>25	<461.5	>7
NRC-23*	1069626.24	514356.3	470					4	466.0	1,300					
NRC-30*	1069465.43	514471.0	482.3					15	467.3	1,200					
NRC-31*	1069425.52	514600.0	491					4	487.0	1,500					
NRC-32*	1069842.69	514814.9	473					1	472.0	>50,000	0	473.0	3.5	469.5	3.5
* Survey coordinates for the NRC boring locations are only approximate estimates.															
amsl = above mean sea level															
cpm = counts per minute															

Table 4-4: Monitoring Well Survey and Construction Data

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				AS-BUILT SURVEY					2012 SURVEY						INSTALLATION DATA							
Env. Control Prefix	Env. Control Point Number	Env. Control Suffix	Install Date	Coordinate System	Northing	Easting	Top of Cap Elev. (ft MSL)	Top of Ground Elev. (ft MSL)	2012 Coordinate System	2012 Northing	2012 Easting	2012 Top of Cap Elevation	2012 Top of Ground Elevation	2012 Cap Ht. Above Grade	Boring Depth (ft)	Bottom Elev. (ft MSL)	Cap Ht. Above Grade (ft)	Solid Length[1] (ft)	Screen Length (ft)	Top Screen Elevation (msl)	Bottom Screen Elevation (msl)	Total Pipe Depth (ft)
D	3	AKA WL-105A	34912	State Plane '83	1069176.97	836046.7	469.918	466.798	State Plane '83	1069177.97	836047	468.338	465.118	3.22	106	360.80	3.12	96	10	370.80	360.80	106.0
D	6	AKA WL-206	34912	State Plane '83	1070234.97	834724.7	447.198	443.998	State Plane '83	1070235.1	834723.492	447.623	444.332	3.291	106	338.00	3.2	96	10	348.00	338.00	106.0
D	12	AKA WL-216A	34973	State Plane '83	1069876.97	835110.7	479.508	476.998	State Plane '83	1069877.227	835110.755	479.736	477.157	2.579	144	333.00	2.51	134	10	343.00	333.00	144.0
D	13	AKA WL-224	34973	State Plane '83	1070526.97	835776.7	470.698	467.998	State Plane '83	1070527.015	835776.562	470.2467	467.7344	2.5123	133	335.00	2.7	123	10	345.00	335.00	133.0
D	14	AKA WL-109B	34973	State Plane '83	1068987.97	836697.7	487.368	484.098	State Plane '83	1068988.873	836700.023	482.9692	480.7088	2.2604	59	425.10	3.7	54	5	430.10	425.10	59.0
D	81	0	30895	State Plane '83	1067378.97	834638.7	450.508	447.398	State Plane '83	1067378.728	834638.553	450.654	448.074	2.58	61.5	385.90	3	48	15	402.40	387.40	60.0
D	83	0	30895	Unknown	70940	4660	447.218	443.998	State Plane '83	1070970.858	834807.792	448.2116	444.8426	3.369	115.3	328.70	3.2	80.2	20	367.00	347.00	97.0
D	85	0	30895	Site	9680	6445	456.748	452.698	State Plane '83	1069667.265	836605.173	457.264	454.257	3.007	84.1	372.65	3	65	20	390.70	370.70	82.0
D	87	0	30895	Site	9210	5400	462.638	459.598	State Plane '83	1069252.38	835579.372	464.472	461.221	3.251	111.7	347.90	3	94	20	368.60	348.60	111.0
D	89	0	30895	Site	6970	5100	456.698	453.698	n/a	n/a	n/a	n/a	n/a	n/a	49	404.70	3	36	15	420.70	405.70	48.0
D	90	0	31260	Site	6160	4300	450.198	445.598	n/a	n/a	n/a	n/a	n/a	n/a	47	398.60	n/a	n/a	n/a	408.60	398.60	47.0
D	91	0	31260	Site	5220	3770	452.968	447.598	n/a	n/a	n/a	n/a	n/a	n/a	45	402.60	5	40	10	412.60	402.60	45.0
D	92	0	31138	Site	9760	5090	474.968	475.098	n/a	n/a	n/a	n/a	n/a	n/a	143.6	331.50	-0.2	122.8	20	352.10	332.10	143.0
D	93	0	31138	State Plane '83	1069358.97	834444.7	449.548	450.298	State Plane '83	1069369.757	834443.556	450.839	448.283	2.556	119.2	337.80	3.3	95.3	20	358.30	338.30	112.0
D	94	0	31138	Unknown	70645	5820	442.278	438.098	n/a	n/a	n/a	n/a	n/a	n/a	109	329.10	2.6	91.6	20	352.10	332.10	106.0
D	95	0	31138	n/a	n/a	n/a	452.688	449.598	n/a	n/a	n/a	n/a	n/a	n/a	101	348.60	3.3	84.3	20	368.60	348.60	101.0
F	1	D	33086	Site	8600	5805	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	79.5	n/a	2.85	76.95	5	n/a	n/a	79.1
F	1	S	33086	Site	8595	5890	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	34	n/a	2.4	24.9	10	n/a	n/a	32.5
F	2	0	33086	State Plane '83	1067725.97	834591.7	449.698	447.498	n/a	n/a	n/a	n/a	n/a	n/a	25	n/a	2.25	12.55	15	437.20	422.20	25.3
F	3	0	33086	Unknown	70380	5880	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	46.5	n/a	2.3	35.1	10	n/a	n/a	42.8
I	2	0	Unknown	State Plane '83	1069738.97	834386.7	446.008	442.798	n/a	n/a	n/a	n/a	n/a	n/a	47	395.80	3.21	37	10	405.80	395.80	47.0
I	4	AKA WL-105B	34912	State Plane '83	1069188.97	836064.7	468.168	465.598	State Plane '83	1069189.97	836064.6	465.74	462.951	2.789	76	389.60	2.57	66	10	399.60	389.60	76.0
I	7	0	Unknown	State Plane '83	1070783.97	834474.7	446.568	444.098	n/a	n/a	n/a	n/a	n/a	n/a	47	397.10	2.47	37	10	407.10	397.10	47.0
I	9	AKA WL-229	34943	State Plane '83	1069369.97	834443.7	450.588	448.098	State Plane '83	1069358.403	834444.232	449.879	447.915	1.964	53	395.10	2.49	43	10	405.10	395.10	53.0
I	11	AKA WL-216C	34912	State Plane '83	1069859.97	835099.7	479.868	477.198	State Plane '83	1069860.187	835099.736	480.108	477.582	2.526	91	386.20	2.67	81	10	396.20	386.20	91.0
I	50	0	30590	Site	5200	3840	453.078	448.598	n/a	n/a	n/a	n/a	n/a	n/a	40.6	408.00	4.48	35.08	10	418.00	408.00	40.6
I	55	0	28642	State Plane '83	1067827.97	834649.7	n/a	471.498	n/a	n/a	n/a	n/a	n/a	n/a	60	n/a	n/a	n/a	n/a	n/a	n/a	60.0
I	56	0	28642	State Plane '83	1068097.97	834661.7	n/a	474.698	n/a	n/a	n/a	n/a	n/a	n/a	60	n/a	n/a	n/a	n/a	n/a	n/a	60 (61.1 well schedule)
I	58	0	28642	State Plane '83	1068914.97	834632.7	n/a	477.098	n/a	n/a	n/a	n/a	n/a	n/a	60	n/a	n/a	n/a	n/a	n/a	n/a	60.0
I	59	0	30590	State Plane '83	1069372.97	834463.7	n/a	444.498	n/a	n/a	n/a	n/a	n/a	n/a	43.5	n/a	n/a	n/a	n/a	n/a	n/a	43.5
I	62	0	30590	Unknown	70960	4675	445.678	443.698	State Plane '83	1070979.147	834821.334	446.1413	444.3429	1.7984	44	399.70	1.98	35.98	10	409.70	399.70	44.0
I	65	0	30590	Unknown	70940	5435	441.398	438.098	State Plane '83	1070994.104	835507.994	441.257	438.9301	2.3269	36	402.10	3.3	29.3	10	412.10	402.10	36.0

Table 4-4: Monitoring Well Survey and Construction Data

DRAFT

				AS-BUILT SURVEY					2012 SURVEY						INSTALLATION DATA							
Env. Control Prefix	Env. Control Point Number	Env. Control Suffix	Install Date	Coordinate System	Northing	Easting	Top of Cap Elev. (ft MSL)	Top of Ground Elev. (ft MSL)	2012 Coordinate System	2012 Northing	2012 Easting	2012 Top of Cap Elevation	2012 Top of Ground Elevation	2012 Cap Ht. Above Grade	Boring Depth (ft)	Bottom Elev. (ft MSL)	Cap Ht. Above Grade (ft)	Solid Length[1] (ft)	Screen Length (ft)	Top Screen Elevation (msl)	Bottom Screen Elevation (msl)	Total Pipe Depth (ft)
I	66	0	30590	Unknown	70520	5935	441.398	437.298	State Plane '83	1070645.385	836025.955	441.696	438.9587	2.7373	36.9	400.40	4.1	31	10	410.40	400.40	36.9
I	67	0	30590	Unknown	70090	6260	438.678	436.098	State Plane '83	1070142.391	836418.549	441.683	439.341	2.342	35.4	400.70	2.58	27.98	10	410.70	400.70	35.4
I	68	0	30590	Site	9570	6690	447.918	440.498	State Plane '83	1069612.97	836861.2	450.199	447.405	2.794	31.2	409.30	7.42	28.62	10	419.30	409.30	31.2
I	72	0	28642	Site	7890	5345	464.998	462.298	n/a	n/a	n/a	n/a	n/a	n/a	50	412.30	2.7	49.7	3	415.30	412.30	50.0
I	73	0	28642	Site	7680	5575	462.198	458.498	State Plane '83	1067735.843	835745.292	461.0784	457.9765	3.1019	50	412.30	3.7	50.7	3	415.30	412.30	50.0
LR	100	0	34973	NGVD	1067334.97	835068.7	468.718	466.798	State Plane '83	1067334.448	835068.653	468.113	465.343	2.77	26	440.80	1.92	21.62, 0.3	4.8	447.10	442.30	24.8
LR	101	0	34973	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
LR	102	0	34973	NGVD	1068977.97	834962.7	513.118	511.598	n/a	n/a	n/a	n/a	n/a	n/a	76	435.60	1.52	56.42, 0.3	4.8	456.70	451.90	60.0
LR	103	0	34973	NGVD	1068567.97	835391.7	460.878	459.698	State Plane '83	1068567.541	835392.182	470.2369	466.8659	3.371	40	419.70	1.1	29.78, 0.3	9.8	431.10	421.30	38.7
LR	104	0	34973	NGVD	1068119.97	835797.7	459.328	457.598	State Plane '83	1068105.763	835808.49	459.6505	457.7914	1.8591	40	417.60	1.73	30.13, 0.3	9.8	429.20	419.40	38.5
LR	105	0	34973	NGVD	1067750.97	834699.7	486.388	483.798	State Plane '83	1067750.35	834699.951	485.205	482.362	2.843	38	445.80	2.59	28.79, 0.3	9.8	456.60	447.80	36.3
MW	41	0	28642	n/a	1069327.97	834551.7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MW	101	0	32964	n/a	n/a	n/a	447.258	444.958	n/a	n/a	n/a	n/a	n/a	n/a	25	419.96	n/a	15	10	429.96	419.96	25.0
MW	102	0	32964	n/a	n/a	n/a	448.578	446.278	State Plane '83	1070135.676	834707.412	447.833	445.66	2.173	24.5	421.78	n/a	14.5	10	431.78	421.78	24.5
MW	103	0	32964	n/a	n/a	n/a	440.758	438.058	State Plane '83	1068668.893	834508.8	438.915	437.065	1.85	15.7	422.36	n/a	5.7	10	432.36	422.36	15.7
MW	104	0	32964	n/a	n/a	n/a	441.478	438.578	State Plane '83	1067565.651	834513.706	440.812	437.809	3.003	17	421.58	n/a	7	10	431.58	421.58	17.0
MW	107	0	32964	n/a	n/a	n/a	448.848	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MW	1201	0	31107	State Plane '83	1067343.97	837077.7	482.438	480.198	n/a	n/a	n/a	n/a	n/a	n/a	250	230.20	2.24	53	197	427.20	230.20	250.0
MW	1202	0	31107	State Plane '83	1067383.97	837049.7	482.178	480.098	n/a	n/a	n/a	n/a	n/a	n/a	250	230.10	2.08	n/a	n/a	n/a	n/a	250.0
MW	1203	0	31229	State Plane '83	1067229.97	837129.7	483.608	480.698	n/a	n/a	n/a	n/a	n/a	n/a	250	230.70	2.91	n/a	n/a	n/a	n/a	250.0
MW	1204	0	33329	State Plane '83	1066461.97	835997.7	485.228	482.898	State Plane '83	1066461.146	835998.972	485.358	483.091	2.267	223.5	259.40	2.33	213.5	10	269.40	259.40	223.5
MW	1205	0	33329	State Plane '83	1067427.97	835795.7	386.368	384.098	n/a	n/a	n/a	n/a	n/a	n/a	123	261.10	2.27	113	10	271.10	261.10	123.0
MW	1206	0	33298	State Plane '83	1067436.97	835798.7	388.078	385.798	n/a	n/a	n/a	n/a	n/a	n/a	73	312.80	2.28	63	10	322.80	312.80	73.0
PZ	100	KS	34731	NGVD	1068882.97	837386.7	485.238	483.398	State Plane '83	1068883.062	837386.265	485.954	484.82	1.134	390	93.40	1.88	375.88, 0.33	9.8	109.36	99.56	384.1
PZ	100	SD	34731	NGVD	1068892.97	837369.7	485.418	483.998	State Plane '83	1068892.808	837369.99	486.084	484.492	1.592	246	238.00	1.47	236.27, 0.33	9.8	249.15	239.35	244.9
PZ	100	SS	34731	NGVD	1068908.97	837349.7	485.438	483.998	State Plane '83	1068908.761	837349.65	486.147	484.835	1.312	94.5	389.50	1.49	75.45, 0.33	19.64	409.99	390.35	93.9
PZ	101	SS	34759	NGVD	1068513.97	836797.7	476.278	474.498	State Plane '83	1068513.92	836797.322	491.161	488.947	2.214	140	334.50	1.79	131.27, 0.33	9.8	345.01	335.21	139.6
PZ	102	R-SS	34851	NGVD	1068172.97	837033.7	485.218	484.098	State Plane '83	1068172.734	837033.545	486.05	484.176	1.874	90.3	394.92	1.12	80.95, 0.33	9.8	404.27	394.47	90.0
PZ	102	SS	34759	NGVD	1068128.97	837062.7	483.448	481.698	State Plane '83	1068128.683	837062.591	484.245	482.06	2.185	90.4	391.30	1.8	81.5, 1.33	9.8	401.95	392.15	90.8
PZ	103	SS	34731	NGVD	1067700.97	836898.7	479.768	477.398	State Plane '83	1067701.303	836897.822	483.803	479.904	3.899	145.5	331.90	2.39	137.09, 0.33	9.8	342.68	332.88	144.8
PZ	104	KS	34851	NGVD	1067033.97	836995.7	483.638	481.898	State Plane '83	1067034.018	836995.216	484.197	481.838	2.359	408	73.90	1.72	399.09 , 0.33	9.8	84.55	74.75	407.5
PZ	104	SD	34851	NGVD	1067053.97	837008.7	483.288	481.698	State Plane '83	1067054.135	837009.268	483.751	481.474	2.277	252.5	229.20	1.59	236.79 , 0.33	9.8	246.50	236.70	245.3

Table 4-4: Monitoring Well Survey and Construction Data

DRAFT

				AS-BUILT SURVEY					2012 SURVEY						INSTALLATION DATA							
Env. Control Prefix	Env. Control Point Number	Env. Control Suffix	Install Date	Coordinate System	Northing	Easting	Top of Cap Elev. (ft MSL)	Top of Ground Elev. (ft MSL)	2012 Coordinate System	2012 Northing	2012 Easting	2012 Top of Cap Elevation	2012 Top of Ground Elevation	2012 Cap Ht. Above Grade	Boring Depth (ft)	Bottom Elev. (ft MSL)	Cap Ht. Above Grade (ft)	Solid Length[1] (ft)	Screen Length (ft)	Top Screen Elevation (msl)	Bottom Screen Elevation (msl)	Total Pipe Depth (ft)
PZ	104	SS	34851	NGVD	1067068.97	837021.7	483.228	481.198	State Plane '83	1067068.815	837021.987	483.596	481.648	1.948	145	336.20	2.07	136.57, 0.33	9.8	346.66	336.86	144.6
PZ	105	SS	34820	NGVD	1066461.97	836404.7	483.208	480.798	State Plane '83	1066462.138	836405.054	483.635	480.805	2.83	149	331.80	2.39	140.89, 0.33	9.8	342.32	332.52	148.6
PZ	106	KS	34759	NGVD	1066744.97	835606.7	463.858	461.398	State Plane '83	1066744.652	835606.899	464.324	462.143	2.181	375	86.40	2.49	366.24, 0.33	9.82	97.62	87.80	373.9
PZ	106	SD	34759	NGVD	1066755.97	835590.7	463.018	461.098	State Plane '83	1066755.685	835590.703	463.435	461.418	2.017	201.1	260.00	1.97	192.76, 0.34	9.8	270.26	260.48	200.9
PZ	106	SS	34790	NGVD	1066766.97	835574.7	462.298	460.598	State Plane '83	1066767.07	835574.642	462.704	460.952	1.752	165.4	295.20	1.75	157.05, 0.33	9.8	305.25	295.45	165.4
PZ	107	SS	34820	NGVD	1067203.97	835429.7	464.258	462.198	State Plane '83	1067204.044	835429.345	465.003	462.852	2.151	103	359.20	2.03	94.63, 0.33	9.8	369.63	359.83	102.7
PZ	108	SS	34759	NGVD	1067718.97	836147.7	455.798	453.698	n/a	n/a	n/a	n/a	n/a	n/a	143.9	309.80	2.08	135.62, 0.33	9.81	320.18	310.37	143.7
PZ	109	SS	34790	NGVD	1068052.97	836318.7	458.098	456.398	State Plane '83	1068052.306	836318.498	458.8977	456.8957	2.002	135.7	320.70	1.73	127.43, 0.33	9.8	330.67	320.87	135.8
PZ	110	SS	34820	NGVD	1068376.97	836094.7	458.508	456.398	State Plane '83	1068376.97	836094.3	461.0591	458.0299	3.0292	111.5	344.90	2.07	102.97, 0.6	9.8	355.54	345.74	111.3
PZ	111	KS	34820	NGVD	1068661.97	836024.7	460.468	458.798	State Plane '83	1068661.958	836025.206	465.3987	461.3366	4.0621	368.8	90.00	1.69	358.84, 0.34	9.81	101.63	91.82	367.3
PZ	111	SD	34790	NGVD	1068678.97	836009.7	461.148	458.798	State Plane '83	1068678.166	836009.004	466.1727	461.9501	4.2226	210	248.80	2.33	201.73, 0.3	9.8	259.42	249.62	209.5
PZ	112	AS	34790	NGVD	1069042.97	835848.7	459.428	457.498	State Plane '83	1069042.848	835849.449	462.132	458.41	3.722	36	421.50	1.9	315., 0.33	4.8	428.13	422.80	34.7
PZ	113	AD	34820	NGVD	1069273.97	835934.7	460.998	459.498	State Plane '83	1069273.97	835934.5	461.835	459.467	2.368	108.7	350.80	1.6	100.2, 0.33	9.8	360.86	351.06	108.7
PZ	113	AS	34790	NGVD	1069264.97	835922.7	461.018	459.498	State Plane '83	1069264.97	835922.4	461.783	459.58	2.203	40	419.50	1.5	30.4, 0.33	9.8	430.62	420.82	39.0
PZ	113	SS	34820	NGVD	1069282.97	835951.7	461.368	459.598	State Plane '83	1069282.97	835951.3	462.255	459.654	2.601	159	300.60	1.81	150.38, 0.33	9.8	310.99	301.19	158.7
PZ	114	AS	34790	NGVD	1069459.97	836942.7	450.908	449.398	State Plane '83	1069459.999	836942.992	451.739	449.564	2.175	30.5	418.90	1.53	21.43, 0.33	9.8	429.48	419.68	30.0
PZ	115	SS	34820	NGVD	1069449.97	836929.7	451.898	450.198	State Plane '83	1069449.628	836929.871	452.497	450.213	2.284	85	365.20	1.69	76.37, 0.33	9.8	375.53	365.73	84.8
PZ	116	SS	34851	NGVD	1066450.97	836018.7	484.468	482.698	State Plane '83	1066451.146	836018.584	486.038	483.548	2.49	162	320.70	1.8	153.2, 0.33	9.6	331.27	321.67	161.3
PZ	200	SS	34731	NGVD	1068536.97	837146.7	485.228	483.198	State Plane '83	1068537.089	837146.557	485.828	483.548	2.28	98.7	384.50	2.02	11.64, 0.33	88.02	473.59	385.57	98.0
PZ	201	A-SS	34790	NGVD	1067872.97	836920.7	479.758	477.998	State Plane '83	1067872.76	837021.163	481.928	479.87	2.058	80	388.00	1.81	81.81, 0.33	9.8	397.95	388.15	90.1
PZ	201	SS	34759	NGVD	1067860.97	837036.7	479.928	477.598	n/a	n/a	n/a	n/a	n/a	n/a	89	388.60	2.32	12.07, 0.33	78.56	467.86	389.30	88.6
PZ	202	SS	34759	NGVD	1067360.97	837276.7	480.768	478.598	State Plane '83	1067361.152	837276.124	481.416	479.474	1.942	90	388.60	2.16	42.36, 0.33	48.9	438.41	389.51	89.4
PZ	203	SS	34851	NGVD	1066702.97	836782.7	486.188	483.798	State Plane '83	1066702.372	836782.546	486.783	484.123	2.66	110	373.80	2.41	102.01, 0.3	9.8	384.18	374.38	109.7
PZ	204	AS	34851	NGVD	1066470.97	835730.7	467.758	466.298	State Plane '83	1066467.304	835708.464	462.6835	462.6835	0	90	376.30	1.5	81, 0.33	9.6	386.76	377.16	89.4
PZ	204	SS	34759	NGVD	1066467.97	835707.7	469.228	466.598	State Plane '83	1066470.424	835731.272	464.8759	464.8759	0	90.3	376.30	2.6	13.55, 0.33	78.4	455.68	377.28	89.7
PZ	205	AS	34820	NGVD	1067504.97	835637.7	460.588	458.898	State Plane '83	1067504.507	835637.878	460.482	458.538	1.944	49	409.90	1.66	40.21, 0.33	9.8	420.38	410.58	48.7
PZ	205	SS	34820	NGVD	1067524.97	835652.7	461.378	459.098	State Plane '83	1067524.521	835652.192	461.872	459.616	2.256	99	360.10	1.66	90.82, 0.33	9.8	370.56	360.76	98.7
PZ	206	SS	34790	NGVD	1068071.97	835983.7	459.798	457.998	State Plane '83	1068071.821	835984.015	460.3876	458.1918	2.1958	125.5	332.50	1.82	116.82, 0.2	9.8	342.98	333.18	125.0
PZ	207	AS	34790	NGVD	1069685.97	836212.7	463.168	461.498	State Plane '83	1069685.45	836212.47	462.244	460.156	2.088	40	421.50	1.69	36.59, 0.33	4.8	426.58	421.78	40.0
PZ	208	SS	34851	NGVD	1069259.97	837343.7	473.848	472.098	State Plane '83	1069260.125	837344.084	474.791	472.48	2.311	99.2	372.90	1.72	90.42, 0.33	9.8	383.43	373.63	98.8
PZ	300	AD	34943	NGVD	1065254.97	834002.7	449.218	447.698	n/a	n/a	n/a	n/a	n/a	n/a	42.2	405.50	1.52	38.62, 0.3	4.8	409.60	405.80	42.2
PZ	300	AS	34943	NGVD	1065238.97	834042.7	450.258	448.098	n/a	n/a	n/a	n/a	n/a	n/a	20	428.10	2.16	12.06, 0.3	9.8	438.20	428.40	20.0

Table 4-4: Monitoring Well Survey and Construction Data

DRAFT

				AS-BUILT SURVEY					2012 SURVEY						INSTALLATION DATA							
Env. Control Prefix	Env. Control Point Number	Env. Control Suffix	Install Date	Coordinate System	Northing	Easting	Top of Cap Elev. (ft MSL)	Top of Ground Elev. (ft MSL)	2012 Coordinate System	2012 Northing	2012 Easting	2012 Top of Cap Elevation	2012 Top of Ground Elevation	2012 Cap Ht. Above Grade	Boring Depth (ft)	Bottom Elev. (ft MSL)	Cap Ht. Above Grade (ft)	Solid Length[1] (ft)	Screen Length (ft)	Top Screen Elevation (msl)	Bottom Screen Elevation (msl)	Total Pipe Depth (ft)
PZ	300	SS	34943	NGVD	1065245.97	834024.7	449.198	447.998	n/a	n/a	n/a	n/a	n/a	n/a	94.5	353.50	1.2	85.08, 0.3	9.82	364.12	354.30	94.0
PZ	301	SS	34943	NGVD	1064842.97	835691.7	514.308	512.698	n/a	n/a	n/a	n/a	n/a	n/a	161.5	351.20	1.61	152.51, 0.3	9.8	361.80	352.00	161.0
PZ	302	AI	34943	NGVD	1067250.97	834894.7	450.748	449.598	NGVD	1067250.868	834895.669	451.194	449.771	1.423	43	406.60	1.15	33.75, 0.3	9.8	417.00	407.20	42.7
PZ	302	AS	34943	NGVD	1067238.97	834911.7	451.018	449.098	State Plane '83	1067238.22	834912.693	451.572	449.355	2.217	22.3	426.80	1.92	14.12, 0.3	9.8	436.90	427.10	22.3
PZ	303	AS	34973	NGVD	1067803.97	834600.7	452.778	450.398	State Plane '83	1067703.94	834600.481	453.277	451.04	2.237	26.5	423.90	2.38	18.38, 0.3	9.8	434.40	424.60	26.1
PZ	304	AI	34973	NGVD	1068166.97	834609.7	453.618	451.198	State Plane '83	1068166.325	834609.398	454.151	451.756	2.395	50	401.20	2.42	41.42, 0.3	9.8	412.20	402.40	49.1
PZ	304	AS	34943	NGVD	1068186.97	834609.7	453.308	450.998	State Plane '83	1068187.019	834609.304	453.89	451.731	2.159	28	423.00	2.31	19.41, 0.3	9.8	433.90	424.10	27.2
PZ	305	AI	34973	NGVD	1068105.97	835808.7	458.878	457.198	State Plane '83	1068119.659	835797.892	459.9808	458.0891	1.8917	64	393.20	1.68	54.88, 0.3	9.8	404.00	394.20	63.3
PZ	1201	SS	34881	NGVD	1067342.97	837078.7	482.018	479.998	n/a	n/a	n/a	n/a	n/a	n/a	250	230.00	2.01	139.71, 0.33	9.6	342.31	332.71	147.6
S	1	0	1981	State Plane '83	1069726.97	834379.7	446.108	442.898	n/a	n/a	n/a	n/a	n/a	n/a	22	420.90	3.21	2	20	440.90	420.90	22.0
S	5	AKA WL-105C	34912	State Plane '83	1069196.97	836075.7	468.248	465.298	State Plane '83	1069196.97	836075.6	466.225	463.022	3.203	40	425.30	2.95	32.95	10	435.30	425.30	40.0
S	8	AKA WI-228	34943	State Plane '83	1071084.97	834898.7	443.628	441.198	State Plane '83	1071085.014	834898.674	443.9346	441.5499	2.3847	27	414.20	2.43	32.43	10	434.20	414.20	27.0
S	10	AKA WL-216C; WL-232	34943	State Plane '83	1069868.97	835105.7	479.878	477.098	State Plane '83	1069868.787	835106.242	480.1	477.603	2.497	52	425.10	2.78	34.78	20	445.10	425.10	52.0
S	51	0	1981	Site	6140	4200	447.318	445.898	n/a	n/a	n/a	n/a	n/a	n/a	25.8	420.10	1.42	24.22	3	423.10	420.10	25.8
S	52	0	1981	Site	6470	4200	446.678	444.298	n/a	n/a	n/a	n/a	n/a	n/a	25.2	419.10	2.38	24.58	3	422.10	419.10	25.2
S	53	0	1981	Site	6880	4500	448.598	444.398	State Plane '83	1066911.169	834671.966	444.099	441.041	3.058	23.7	420.70	4.2	24.9	3	423.70	420.70	23.7
S	54	0	Unknown	State Plane '83	1067646.97	834642.7	n/a	469.598	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	40.4
S	60	0	29768	Site	9750	4310	446.528	442.698	n/a	n/a	n/a	n/a	n/a	n/a	21	421.70	3.83	n/a	n/a	n/a	421.70	21.0
S	61	0	29768	Unknown	70160	4580	449.768	445.198	State Plane '83	1070200.944	834754.559	449.202	445.496	3.706	21.5	423.70	4.57	n/a	n/a	n/a	423.70	21.5
S	75	0	Unknown	Site	7270	4730	459.498	458.398	n/a	n/a	n/a	n/a	n/a	n/a	26	432.40	1.1	24.1	3	435.40	432.40	26.0
S	76	0	28642	State Plane '83	1067446.97	834743.7	n/a	473.998	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	50.0
S	80	0	30895	Site	5190	3870	452.978	447.998	n/a	n/a	n/a	n/a	n/a	n/a	22	426.00	5	15	10	438.00	428.00	20.0
S	82	0	30895	State Plane '83	1069352.97	834447.7	450.258	447.298	State Plane '83	1069352.643	834447.496	450.113	448.172	1.941	26.5	420.80	3	18.5	10	431.80	421.80	25.5
S	84	0	30895	Site	9685	6455	456.518	452.498	State Plane '83	1069674.22	836614.269	457.044	454.24	2.804	31.5	421.00	4	24.9	10	431.60	421.60	30.9
S	88	0	30895	Site	8390	5270	462.328	459.598	n/a	n/a	n/a	n/a	n/a	n/a	41.5	418.10	2.7	33	10	429.60	419.60	40.0

Table 4-5: Summary of Groundwater Monitoring Wells Sampled During the OU-1 RI

Well No.	Interval Monitored	Source of Well
S-1	Shallow	New RI well
S-5	Shallow	New RI well
S-8	Shallow	New RI well
S-10	Shallow	New RI well
S-61	Shallow	Existing well
S-80	Shallow	Existing background well
S-82	Shallow	Existing well
S-84	Shallow	Existing well
MW-101	Shallow	Existing well
MW-107	Shallow	Existing background well
MW-F3	Shallow	New landfill well
PZ-114-AS	Shallow	New landfill well
I-2	Intermediate	New RI well
I-4	Intermediate	New RI well
I-7	Intermediate	New RI well
I-9	Intermediate	New RI well
I-11	Intermediate	New RI well
I-62	Intermediate	Existing well
I-65	Intermediate	Existing well
I-66	Intermediate	Existing well
I-67	Intermediate	Existing well
I-68	Intermediate	Existing well
D-3	Deep	New RI well
D-6	Deep	New RI well
D-12	Deep	New RI well
D-13	Deep	New RI well
D-14	Deep	New RI well
D-83	Deep	Existing well
D-85	Deep	Existing well
D-93	Deep	Existing well

Table 4-6: Wells Sampled and Split Samples Collected (2012 - 2014 events)

	August 2012			April 2013			July 2013			October 2013			February 2014
Monitoring Well	Respondents	EPA Split	MDNR Split	Respondents	EPA Split	MDNR[1] Split	Respondents	EPA Split	MDNR Split	Respondents	EPA Split	MDNR Split	Respondents
S-5 DIS	X		X	X			X			X		X	
S-5 TOT	X		X	X	X		X	X		X		X	
S-8 DIS	X			X			X			X			
S-8 TOT	X			X			X			X			
S-10 DIS	X			X			X			X			
S-10 TOT	X			X			X			X			
S-53 DIS				X			X			X			
S-53 TOT				X			X			X			
S-61 DIS	X	X		X			X			X			
S-61 TOT	X			X			X			X			
S-82 DIS	X			X			X			X		X[2]	
S-82 TOT	X			X	X		X	X		X		X[2]	
S-84 DIS	X			X			X			X + DUP			
S-84 TOT	X			X			X			X + DUP			
I-4 DIS	X		X	X			X + DUP			X			
I-4 TOT	X		X	X			X + DUP	X		X			
I-9 DIS	X + DUP		X	X + DUP			X			X + DUP		X	
I-9 TOT	X + DUP		X	X + DUP	X		X	X		X + DUP		X	
I-11 DIS	X	X		X			X			X			
I-11 TOT	X			X			X			X			
I-62 DIS	X			X + DUP			X + DUP			X			
I-62 TOT	X			X + DUP			X + DUP			X			
I-65 DIS	X			X + DUP			X + DUP			X			
I-65 TOT	X			X + DUP			X + DUP			X			
I-66 DIS	X			X			X			X			
I-66 TOT	X			X			X			X			
I-67 DIS	X			X + DUP			X			X + DUP			
I-67 TOT	X			X + DUP			X			X + DUP			
I-68 DIS	X			X			X			X			
I-68 TOT	X			X			X			X			
I-73 DIS	X			X			X			X			
I-73 TOT	X			X			X			X			
D-3 DIS	X + DUP	X		X			X			X		X	
D-3 TOT	X + DUP			X	X		X	X		X		X	
D-6 DIS	X + DUP	X + DUP		X			X			X		X	
D-6 TOT	X + DUP			X	X		X			X		X	
D-12 DIS	X	X		X + DUP			X + DUP			X			
D-12 TOT	X			X + DUP			X + DUP			X			
D-13 DIS	X + DUP			X			X			X			
D-13 TOT	X + DUP			X			X			X			
D-14 DIS				X			X			X			
D-14 TOT	X			X			X			X			
D-81 DIS	X			X			X + DUP			X			
D-81 TOT	X			X			X + DUP			X			
D-83 DIS	X			X			X + DUP			X		X	
D-83 TOT	X			X	X		X + DUP	X		X		X	
D-85 DIS	X			X			X			X		X[2]	
D-85 TOT	X			X	X		X	X		X		X[2]	
D-87 DIS	X			X			X			X + DUP			
D-87 TOT	X			X			X			X + DUP			
D-93 DIS	X		X	X			X			X		X	
D-93 TOT	X		X	X	X		X	X		X		X	
LR-100 DIS	X			X			X			X + DUP			
LR-100 TOT	X			X			X			X + DUP			
LR-103 DIS	X			X			X			X			
LR-103 TOT	X			X			X			X			
LR-104 DIS	X + DUP			X			X			X			
LR-104 TOT	X + DUP			X			X			X			
LR-105 DIS	X			X									
LR-105 TOT	X			X									
MW-102 DIS	X	X		X			X			X			
MW-102 TOT	X			X			X			X			
MW-103 DIS	X			X			X			X			
MW-103 TOT	X			X			X			X			
MW-104 DIS	X			X			X			X			
MW-104 TOT	X			X			X			X			
MW-1204 DIS	X			X + DUP			X			X			

Table 4-6: Wells Sampled and Split Samples Collected (2012 - 2014 events)

	August 2012			April 2013			July 2013			October 2013			February 2014
Monitoring Well	Respondents	EPA Split	MDNR Split	Respondents	EPA Split	MDNR[1] Split	Respondents	EPA Split	MDNR Split	Respondents	EPA Split	MDNR Split	Respondents
MW-1204 TOT	X			X + DUP			X			X			
PZ-100-KS DIS	X			X			X			X			
PZ-100-KS TOT	X			X			X			X			
PZ-100-SD DIS	X			X			X			X			
PZ-100-SD TOT	X			X			X			X			
PZ-100-SS DIS	X			X			X			X			
PZ-100-SS TOT	X			X			X			X			
PZ-101-SS DIS	X	X		X			X			X		X[2]	
PZ-101-SS TOT	X			X	X		X	X		X		X[2]	
PZ-102R-SS DIS	X			X			X			X			
PZ-102R-SS TOT	X			X			X			X			
PZ-102-SS DIS	X			X			X			X		X[2]	
PZ-102-SS TOT	X			X	X		X			X	X[2]	X[2]	
PZ-103-SS DIS	X			X			X			X			
PZ-103-SS TOT	X			X			X			X			
PZ-104-KS DIS	X			X			X			X			
PZ-104-KS TOT	X			X			X			X			
PZ-104-SD DIS	X			X			X			X		X	
PZ-104-SD TOT	X			X	X		X			X	X	X	
PZ-104-SS DIS	X			X + DUP			X			X			
PZ-104-SS TOT	X			X + DUP			X			X			
PZ-105-SS DIS	X			X			X			X			
PZ-105-SS TOT	X			X			X			X			
PZ-106-KS DIS	X		X	X			X			X + DUP			
PZ-106-KS TOT	X		X + DUP	X			X			X + DUP			
PZ-106-SD DIS	X			X			X			X			
PZ-106-SD TOT	X			X			X			X			
PZ-106-SS DIS	X			X			X			X			
PZ-106-SS TOT	X			X			X			X			
PZ-107-SS DIS	X			X			X + DUP			X			
PZ-107-SS TOT	X			X			X + DUP			X			
PZ-109-SS DIS	X			X			X			X			
PZ-109-SS TOT	X			X			X			X			
PZ-110-SS DIS	X			X			X			X			
PZ-110-SS TOT	X			X			X			X			
PZ-111-KS DIS	X			X			X			X			
PZ-111-KS TOT	X			X			X			X			
PZ-111-SD DIS	X			X			X			X			
PZ-111-SD TOT	X			X			X			X			
PZ-112-AS DIS	X	X		X			X			X			
PZ-112-AS TOT	X			X			X	X		X			
PZ-113-AD DIS	X + DUP			X			X + DUP			X + DUP		X	
PZ-113-AD TOT	X + DUP			X	X		X + DUP	X		X + DUP		X	
PZ-113-AS DIS	X	X		X			X			X			
PZ-113-AS TOT	X			X			X			X			
PZ-113-SS DIS	X			X			X			X			
PZ-113-SS TOT	X			X			X			X			
PZ-114-AS DIS	X			X			X			X			
PZ-114-AS TOT	X			X			X			X			
PZ-115-SS DIS	X			X			X			X			
PZ-115-SS TOT	X			X			X			X			
PZ-116-SS DIS	X			X			X			X			
PZ-116-SS TOT	X			X			X			X			
PZ-200-SS DIS	X + DUP			X			X			X			
PZ-200-SS TOT	X + DUP			X			X			X			
PZ-201A-SS DIS	X + DUP			X			X			X			
PZ-201A-SS TOT	X + DUP			X			X			X			
PZ-202-SS DIS	X			X			X			X			
PZ-202-SS TOT	X			X			X			X			
PZ-203-SS DIS	X			X			X			X			
PZ-203-SS TOT	X			X			X			X			
PZ-204A-SS DIS	X			X			X			X			
PZ-204A-SS TOT	X			X			X			X			
PZ-204-SS DIS	X			X			X			X			
PZ-204-SS TOT	X			X			X			X			
PZ-205-AS DIS	X			X			X			X			
PZ-205-AS TOT	X			X			X			X			
PZ-205-SS DIS	X			X			X			X			

Table 4-6: Wells Sampled and Split Samples Collected (2012 - 2014 events)

	August 2012			April 2013			July 2013			October 2013			February 2014
Monitoring Well	Respondents	EPA Split	MDNR Split	Respondents	EPA Split	MDNR[1] Split	Respondents	EPA Split	MDNR Split	Respondents	EPA Split	MDNR Split	Respondents
PZ-205-SS TOT	X			X			X			X			

Table 4-6: Wells Sampled and Split Samples Collected (2012 - 2014 events)

	August 2012			April 2013			July 2013			October 2013			February 2014
Monitoring Well	Respondents	EPA Split	MDNR Split	Respondents	EPA Split	MDNR[1] Split	Respondents	EPA Split	MDNR Split	Respondents	EPA Split	MDNR Split	Respondents
PZ-206-SS DIS	X	X		X			X		X + DUP	X			
PZ-206-SS TOT	X			X			X		X	X			
PZ-207-AS DIS	X	X		X			X		X	X			
PZ-207-AS TOT	X			X			X		X	X			
PZ-208-SS DIS	X			X			X			X			
PZ-208-SS TOT	X			X			X			X			
PZ-209-SD DIS										X			X
PZ-209-SD TOT										X			X
PZ-209-SS DIS										X			X
PZ-209-SS TOT										X			X
PZ-210-SD DIS										X + DUP			X
PZ-210-SD TOT										X + DUP			X
PZ-210-SS DIS										X			X
PZ-210-SS TOT										X			X
PZ-211-SD DIS										X			X + DUP
PZ-211-SD TOT										X			X + DUP
PZ-211-SS DIS										X			X
PZ-211-SS TOT										X			X
PZ-212-SD DIS										X			X
PZ-212-SD TOT										X			X
PZ-212-SS DIS										X			X
PZ-212-SS TOT										X			X
PZ-302-AI DIS	X			X			X			X			
PZ-302-AI TOT	X			X			X			X			
PZ-302-AS DIS							X			X			
PZ-302-AS TOT							X			X			
PZ-303-AS DIS	X			X			X			X			
PZ-303-AS TOT	X			X			X			X			
PZ-304-AI DIS	X			X			X			X + DUP			
PZ-304-AI TOT	X			X			X			X + DUP			
PZ-304-AS DIS	X			X			X			X			
PZ-304-AS TOT	X			X			X			X			
PZ-305-AI DIS	X	X		X + DUP			X			X			
PZ-305-AI TOT	X			X + DUP			X			X			

Notes:
TOT = total fraction (unfiltered) sample collected; DIS = dissolved fraction (filtered) sample collected; DUP = field duplicate sample collected
[1] MDNR did not collect split samples during the April 2013 event.
[2] Split sample not analyzed for Radium-228

Table 4-7: Summary of Monitoring Wells/Piezometers by Unit and Area

Well	Hydrogeologic Unit	General Area
MW-102	Alluvium - Shallow	Area 2
MW-103	Alluvium - Shallow	Inactive Landfill
MW-104	Alluvium - Shallow	Inactive Landfill
PZ-112-AS	Alluvium - Shallow	Landfill Access Road/Area 1/Inactive Landfill
PZ-113-AS	Alluvium - Shallow	Landfill Access Road/Area 1/Demolition Fill
PZ-114-AS	Alluvium - Shallow	Area 1
PZ-205-AS	Alluvium - Shallow	Inactive Landfill/South Quarry
PZ-207-AS	Alluvium - Shallow	Demolition Landfill
PZ-303-AS	Alluvium - Shallow	Inactive Landfill
PZ-304-AS	Alluvium - Shallow	Inactive Landfill
S-10	Alluvium - Shallow	Area 2
S-5	Alluvium - Shallow	Area 1
S-61	Alluvium - Shallow	Area 2
S-8	Alluvium - Shallow	Area 2
S-82	Alluvium - Shallow	Area 2
S-84	Alluvium - Shallow	Area 1
I-11	Alluvium - Intermediate	Area 2
I-4	Alluvium - Intermediate	Area 1
I-62	Alluvium - Intermediate	Area 2
I-65	Alluvium - Intermediate	Area 2
I-66	Alluvium - Intermediate	Upgradient/Demolition Landfill
I-67	Alluvium - Intermediate	Upgradient/Demolition Landfill
I-68	Alluvium - Intermediate	Area 1
I-73	Alluvium - Intermediate	Inactive Landfill/South Quarry
I-9	Alluvium - Intermediate	Area 2
LR-104	Alluvium - Intermediate	Concrete Plant
PZ-302-AI	Alluvium - Intermediate	Inactive Landfill
PZ-304-AI	Alluvium - Intermediate	Inactive Landfill
PZ-305-AI	Alluvium - Intermediate	Concrete Plant
D-12	Alluvium - Deep	Area 2
D-13	Alluvium - Deep	Area 2
D-14	Alluvium - Deep	Area 1
D-3	Alluvium - Deep	Area 1
D-6	Alluvium - Deep	Area 2
D-81	Alluvium - Deep	Inactive Landfill
D-83	Alluvium - Deep	Area 2
D-85	Alluvium - Deep	Area 1
D-87	Alluvium - Deep	Inactive Landfill
D-93	Alluvium - Deep	Area 2
PZ-113-AD	Alluvium - Deep	Landfill Access Road/Area 1/Demolition Fill

Table 4-7: Summary of Monitoring Wells/Piezometers by Unit and Area

Well	Hydrogeologic Unit	General Area
LR-100	Landfilled Material	Inactive Landfill
LR-103	Landfilled Material	Inactive Landfill
LR-105	Landfilled Material	Inactive Landfill
PZ-100-SS	St. Louis Fm./Upper Salem	Hauling Yard/North Quarry
PZ-101-SS	St. Louis Fm./Upper Salem	North Quarry
PZ-102R-SS	St. Louis Fm./Upper Salem	North Quarry
PZ-102-SS	St. Louis Fm./Upper Salem	North Quarry
PZ-103-SS	St. Louis Fm./Upper Salem	South Quarry
PZ-104-SS	St. Louis Fm./Upper Salem	South Quarry
PZ-105-SS	St. Louis Fm./Upper Salem	South Quarry
PZ-106-SS	St. Louis Fm./Upper Salem	South Quarry
PZ-107-SS	St. Louis Fm./Upper Salem	Inactive Landfill/South Quarry
PZ-109-SS	St. Louis Fm./Upper Salem	Concrete Plant/North Quarry
PZ-110-SS	St. Louis Fm./Upper Salem	Concrete Plant
PZ-113-SS	St. Louis Fm./Upper Salem	Landfill Access Road/Area 1/Demolition Fill
PZ-115-SS	St. Louis Fm./Upper Salem	Area 1
PZ-116-SS	St. Louis Fm./Upper Salem	South Quarry
PZ-200-SS	St. Louis Fm./Upper Salem	Upgradient/Hauling Yard
PZ-201A-SS	St. Louis Fm./Upper Salem	Upgradient/Hauling Yard
PZ-202-SS	St. Louis Fm./Upper Salem	Upgradient/Hauling Yard
PZ-203-SS	St. Louis Fm./Upper Salem	Upgradient/South Quarry
PZ-204A-SS	St. Louis Fm./Upper Salem	Upgradient/South Quarry
PZ-204-SS	St. Louis Fm./Upper Salem	Upgradient/South Quarry
PZ-205-SS	St. Louis Fm./Upper Salem	Inactive Landfill/South Quarry
PZ-206-SS	St. Louis Fm./Upper Salem	Concrete Plant
PZ-208-SS	St. Louis Fm./Upper Salem	Offsite - Upgradient
PZ-209-SS	St. Louis Fm./Upper Salem	Upgradient/South Quarry
PZ-210-SS	St. Louis Fm./Upper Salem	Upgradient/South Quarry
PZ-211-SS	St. Louis Fm./Upper Salem	Upgradient/South Quarry
PZ-212-SS	St. Louis Fm./Upper Salem	Soil Borrow Area - Upgradient
MW-1204	Deep Salem Fm.	South Quarry
PZ-100-SD	Deep Salem Fm.	Hauling Yard/North Quarry
PZ-104-SD	Deep Salem Fm.	South Quarry
PZ-106-SD	Deep Salem Fm.	South Quarry
PZ-209-SD	Deep Salem Fm.	Upgradient/South Quarry
PZ-210-SD	Deep Salem Fm.	Upgradient/South Quarry
PZ-211-SD	Deep Salem Fm.	Upgradient/South Quarry
PZ-212-SD	Deep Salem Fm.	Soil Borrow Area - Upgradient
PZ-100-KS	Keokuk Fm.	Hauling Yard/North Quarry
PZ-104-KS	Keokuk Fm.	South Quarry

Table 4-7: Summary of Monitoring Wells/Piezometers by Unit and Area

Well	Hydrogeologic Unit	General Area
PZ-106-KS	Keokuk Fm.	South Quarry
PZ-111-KS	Keokuk Fm.	Transfer Station
PZ-111-SD	Keokuk Fm.	Transfer Station

Table 4-8: Summary of Historical Aerial Photographs Reviewed for OU-1

EPA EMSL*	Aerial Photographs (Appendix O)	GoogleEarth**
7/30/1941	7/30/1941	
	7/7/1947	
8/14/1953	8/13-14/1953	
	9/7/1953	
5/13/1958	5/13/1958	
	6/3/1960	
	6/14/1962	
	4/10/1964	
	3/27/1965	
	7/11/1965	
10/10/1965	10/10/1965	
	8/11/1966	
	9/23/1966	
	6/11/1967	
	3/7/1968	
	3/17/1968	
	9/30/1968	
	9/16/1969	
	11/24/1969	
	3/12/1971	
5/4/1971	5/4/1971	
	10/5/1971	
	4/26/1972	
	8/29/1972	
	9/11/1972	
	5/4/1973	
	9/19/1973	
5/6/1974	5/6/1974	
	4/6/1975	
	4/12/1976	
	5/9/1976	
4/8/1977		
	8/20/1978	
	5/25/1979	
7/26/1979	7/26/1979	
	12/2/1979	
	10/8/1980	
	6/17/1981	
3/7/1982	3/7/1982	
	5/14/1984	
4/16/1985	4/16/1985 (north and south)	
	5/9/1985	
4/20/1989		

Table 4-8: Summary of Historical Aerial Photographs Reviewed for OU-1 (cont.)

EPA EMSL*	Aerial Photographs (Appendix O)	GoogleEarth**
		4/1990
6/3/1991 (oblique)		
6/7/1991		
	3/28/1993	
	10/23/1993	
	2/25/1995	
		3/1996
	2/24/1997	
	2/24/1998	
	3/1/1999	
	3/17/2000	
	2/10/2001	
		3/2002
		11/2002
		3/2003
		11/2003
		12/2003
		3/2004
		4/2004
		9/2004
		6/2005
		7/2005
		8/2005 (two)
		7/2006
		5/2007
		7/2007
		8/2007
		4/2008
		8/2009
		4/2010
		10/2011
		9/2011
		8/2012
		9/2012
		11/2012
		11/2013
		4/2014 (three)
		10/2014
		11/2014
		8/2015
		1/2016 (three)
		4/2016

Table 4-8: Summary of Historical Aerial Photographs Reviewed for OU-1 (cont.)

* USEPA, 1989a, Aerial Photographic Analysis of the Westlake Landfill Site, Bridgeton, MO, TC-PIC-89787, October; and
USEPA, 1991, Aerial Photographic Analysis of the Westlake Landfill Site, Bridgeton, Missouri, TC-PIC-91789, October.

** Google Earth historical aerial photographic images accessed on May 27, 2017.

Table 5-1: Summary of Plant Species Present in or Near Areas 1 and 2

Scientific Name	Common Name	Area 1	Area 2	North Flood Control Channel	West Flood Control Channel	Ford Property
			Trees/Shrubs			
Acer negundo	Box elder		X			X
Cercis canadensis	Red bud		X			
Cornus amomum	Silky dogwood		X	X		
Fraxinus spp.	Ash		X	X		
Morus spp.	Mulberry		X			
Populus deltoides	Eastern Cottonwood		X	X		X
Rhus typhina	Staghorn Sumac		X	X		X
Salix amygdaloides	Peached-leaved willow		X			
Salix spp.	Willow		X	X		
			Woody Vines			
Toxicodendron radicans	Poison ivy		X	X		X
Vitis spp.	Grape		X	X		X
			Herbs and Grasses			
Andropogon spp.	Bluestem	X				
Ambrosia spp.	Ragweed					X
Ascelpias syriaca	Common milkweed		X			
Carduus crispus	Nodding thistle	X	X			X
Daucus carota	Wild carrot		X			
Erigeron annuus	Daisy fleabane		X			X
Gallium spp.	Bedstraw		X	X		
Graminae	Unknown grasses	X	X	X	X	X
Impatiens capensis	Jewelweed		X			
Juncus spp.	Rush	X				
Meiilotus alba	White sweet clover		X			
Opuntia compressa	Prickly pear		X			
Phytolacca americana	Pokeweed		X	X		
Plantago major	Common plantian	X				X
Polygonum spp.	Smartweed					X
Rumax crispus	Curled-dock	X	X			X
Solidago spp.	Goldenrod	X	X			X
Setaria spp.	Foxtail	X	X			X
Thlaspi arvense	Field pennycress	X	X			X
Trifolium pratense	Red clover		X			
Trifolium procumbens	Yellow sweet clover		X			X
Typha spp.	Cattails	X	X			
Vicia cracca	Cow vetch		X			X

Table 5-2: Comparison of Alluvial Groundwater Elevations to Missouri River Stage

Date	Range of Alluvial Water Levels	River Stage (ft amsl)
December 29, 1994	428.88 to 434.14	423.82
January 30, 1995	429.70 to 435.63	430.33
March 3, 1995	429.40 to 436.15	427.37
March 30, 1995	429.44 to 436.94	427.15
April 28, 1995	430.04 to 436.83	433.29
May 26, 1995	433.95 to 440.41	446.55
June 27, 1995	434.41 to 436.12	440.12
June 30, 1995	433.95 to 439.20	441.07
July 26, 1995	434.33 to 435.41	435.31
August 26, 1995	433.74 to 434.91	430.79
August 31, 1995	432.92 to 438.26	430.30
October 2, 1995	431.37 to 437.29	429.07
October 31, 1995	430.61 to 436.56	428.62
November 18, 1995	431.66 to 435.50	429.03
November 30, 1995	430.28 to 435.34	428.28
December 14, 1995	431.15 to 434.94	426.60
January 3, 1996	429.56 to 434.24	423.74
January 4, 1996	430.98 to 434.11	423.87
February 6, 1996	429.93 to 433.72	423.87
April 2, 1996	428.11 to 434.12	427.68
April 3, 1996	426.75 to 434.02	428.02
May 3, 1996	430.68 to 431.66	433.34
June 13, 1996	432.74 to 434.99	438.16
July 5, 1996	433.04 to 434.92	432.85
July 12, 1996	433.71 to 434.52	433.51
October 2, 1996	431.12 to 432.73	432.08
May 22, 2000	427.30 to 430.31	423.95
July 30, 2012	427.97 to 433.15	422.68
April 2, 2013	426.03 to 428.98	425.47
July 8, 2013	432.02 to 434.49	426.84
September 30, 2013	429.16 to 432.64	422.53

Table 5-3: Hydraulic Gradients in the Alluvium

Date	Upgradient Well	Water Level Elevation (ft amsl)	Downgradient Well	Water Level Elevation (ft amsl)	Distance Between Wells (ft)	Date-Specific Hydraulic Gradient (ft/ft)	Average Gradient for each Well Pair (ft/ft)
	I-68		I-65		1,934		0.00017
7/30/12		429.76		429.28		0.00025	
4/2/13		427.48		427.10		0.00020	
7/8/13		433.51		433.45		0.00003	
9/30/13		430.47		430.04		0.00022	
	S-84		S-8		2,221		0.00014
7/30/12		429.8		429.34		0.00021	
4/2/13		427.35		427.10		0.00011	
7/8/13		433.44		433.29		0.00007	
9/30/13		430.44		430.02		0.00019	
	D-85		D-83		2,220		0.00005
7/30/12		429.77		429.56		0.00009	
4/2/13		427.41		427.40		0.00000	
7/8/13		433.46		433.45		0.00000	
9/30/13		430.43		430.18		0.00011	
	S-5		S-61		1,662		0.00060
7/30/12		430.44		429.35		0.00066	
4/2/13		428.82		427.19		0.00098	
7/8/13		433.63		433.09		0.00032	
9/30/13		430.69		429.99		0.00042	
	D-3		D-6		1,694		0.00034
7/30/12		429.81		429.08		0.00043	
4/2/13		427.37		426.97		0.00024	
7/8/13		433.27		432.81		0.00027	
9/30/13		430.42		429.73		0.00041	
	PZ-305-AI		I-9		1,835		0.00042
7/30/12		430.23		429.49		0.00040	
4/2/13		427.69		428.46		-0.00042	
7/8/13		433.45		432.02		0.00078	
9/30/13		430.82		429.16		0.00090	
	PZ-205-AS		PZ-304-AS		1,234		0.00099
7/30/12		429.67		429.71		-0.00003	
4/2/13		428.98		427.81		0.00095	
7/8/13		434.49		433.02		0.00119	
9/30/13		432.64		430.35		0.00186	
						Overall Minimum	**0.00005**
						Overall Average	**0.00039**
						Overall Maximum	**0.00099**

Table 5-4: Summary of Vertical Groundwater Gradients, 2012 - 2013 Monitoring Events

Well	Vertical Gradient (ft/ft)						
	July 30, 2012	April 2, 2013	July 8, 2013	September 30, 2013	Avg	Min	Max
Alluvial Well Clusters							
S-5	0.0072	0.0390	0.0097	0.0055	0.0153	0.0055	0.0390
I-4	0.0128	0.0014	0.0003	0.0024	0.0043	0.0003	0.0128
D-3	0.0097	0.0223	0.0055	0.0042	0.0104	0.0042	0.0223
MW-102	0.0034	0.0088	0.0025	0.0028	0.0044	0.0025	0.0088
D-6							
S-10	0.0018	0.0016	0.0000	0.0000	0.0009	0.0000	0.0018
I-11	0.0006	-0.0015	0.0011	0.0011	0.0003	-0.0015	0.0011
D-12	0.0011	-0.0001	0.0006	0.0006	0.0006	-0.0001	0.0011
S-8	-0.0168	-0.0188	-0.0142	-0.0178	-0.0169	-0.0188	-0.0142
I-62	0.0005	0.0003	0.0025	0.0040	0.0018	0.0003	0.0040
D-83	-0.0009	-0.0012	-0.0024	-0.0024	-0.0017	-0.0024	-0.0009
S-84	0.0001	-0.0002	0.0214	0.0002	0.0054	-0.0002	0.0214
D-85							
S-82	0.0002	0.0051	-0.0011	0.0369	0.0103	-0.0011	0.0369
I-9	0.0024	0.0640	-0.0300	-0.0623	-0.0065	-0.0623	0.0640
D-93	-0.0003	-0.0059	-0.0163	-0.0152	-0.0094	-0.0163	-0.0003
PZ-302-AS	0.1166	0.0911	0.0352	0.0136	0.0641	0.0136	0.1166
PZ-302-AI							
PZ-304-AS	0.0018	0.0000	-0.0198	-0.0014	-0.0048	-0.0198	0.0018
PZ-304-AI							
Alluvial and Bedrock Well Clusters							
PZ-113-AS	-0.0001	-0.0009	-0.0013	-0.0009	-0.0008	-0.0013	-0.0001
PZ-113-AD	-0.0012	-0.0018	0.0002	-0.0008	-0.0009	-0.0018	0.0002
PZ-113-SS	-0.0006	-0.0013	-0.0007	-0.0008	-0.0008	-0.0013	-0.0006
PZ-205-AS	-0.0110	-0.0347	-0.0299	-0.0454	-0.0303	-0.0454	-0.0110
PZ-205-SS							

Note: Positive values for vertical gradient indicate a downward gradient whereas negative values indicate an upward gradient.

Table 5-5: Groundwater Velocity within the Alluvial Aquifer

Equation $V = K i / n_e$

where: V= groundwater velocity (ft/d)

K = hydraulic conductivity (ft/d)

i = hydraulic gradient (ft/ft)

n_e = effective porosity

For the alluvial aquifer:

K = 85 ft/d (see Section 5.6.2.5)

i = 0.0004 ft/ft (see Appendix K Figures K-2.1 – K-2.4 and Section 5.6.2.4.2)

n_e = 0.15 for silty sand to 0.30 for sand (estimated value based on literature)

Therefore, the estimated groundwater velocity through the alluvium beneath the Site is:

V = 0.23 to 0.11 ft/d or 82.8 to 41.4 ft/yr

The velocity estimate is sensitive to the aquifer parameter values so additional results were calculated b

K = 42.5 or 170 ft/d

i = 0.0002 or 0.0008 ft/ft

Resulting in the following range of estimates for the groundwater flux through the alluvium

V = 0.028 to 0.91 ft^3/d or 10.3 to 331 ft/yr

It should be noted due to the inverse relationship between hydrualic conductivity and hydrualic gradient that is as the hydraulic conductivity increases, the hydrualic gradient typically decreases due to the lesse resistance to flow and vica versa,it is highly unlikely that these extremes would actually occur.

Table 5-5: Groundwater Velocity within the Alluvial Aquifer

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Table 5-6: Groundwater Flux through the Alluvial Aquifer

Equation $Q = KIA = K\ I\ b\ L$

where: Q= groundwater flux (ft^3/d)

K = hydraulic conductivity (ft/d)

i = hydraulic gradient (ft/ft)

A = cross-sectional area perpendicular to the groundwater flow direction (ft^2)

b = saturated thickness (ft)

L = length of section of interest perpendicular to the groundwater flow direction

For the alluvial aquifer:

K =	85	ft/d	(see Section 5.6.2.5)
i =	0.0004	ft/ft	(see Appendix K Figures K-2.1 – K-2.4 and Section 5.6.2.4.2)
b =	100	ft	(see Figures 5-13 and 5-14)
L =	3,000	ft	(distance from PZ-302-AI to the Site entrance)

Therefore, the groundwater flux through the alluvium beneath the Site is:

$Q_{alluvium}$ = 10,200 ft^3/d or 76,300 gpd

The estimated flux is sensitive to the aquifer parameter values used so additional results were calculated based o

K =	42.5	or	170	ft/d
i =	0.0002	or	0.0008	ft/ft
b =	50	or	150	ft

Resulting in the following range of estimates for the groundwater flux through the alluvium

$Q_{alluvium}$ = 5,100 ft^3/d or 20400 ft^3/d equal to 38,200 to 153000 gpd

Table 5-6: Groundwater Flux through the Alluvial Aquifer

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Table 6-1: Summary of Background Radionuclide Values, St. Louis Area Sites

Radionuclide	OU-1 RIA values	RI (McLaren/Hart, 1996h) Mean + 2 Std Dev	RI (McLaren/Hart, 1996h) Maximum	NRC (1982)	SLAPs (EPA, 1998b)	North St. Louis Sites (EPA, 2005b) Surface Soil	North St. Louis Sites (EPA, 2005b) Subsurface Soil	SLDS (USACE, 1998) Average	SLDS (USACE, 1998) Range
Radium-226	1.3	1.3	1.19	2.5 - 2.6	2.8	0.95	1.15	2.8	
Radium-228	1.55	2.37	1.9	N.E.	N.E.	N.E.	N.E.	N.E.	
Thorium-232	1.55	1.55	1.26	N.E.	N.E.	N.E.	N.E.	N.E.	
Thorium-230	1.3	2.45	2.03	N.E.	1.9	1.49	1.83	1.9	
Uranium-238	2.24	2.24	1.85	N.E.	1.4	1.08	1.27	1.4	0.159 - 3.78
Uranium-234	2.24	2.73	2.4	N.E.	N.E.	N.E.	N.E.	N.E.	

Notes: All values are in units of pCi/g
RIA West Lake OU-1 Remedial Investigation Addendum
RI West Lake OU-1 Remedial Investigation
NRC Nuclear Regulatory Commmision
SLAPs St. Louis Airport sites
SLDS St.Louis Downtown Site

References:

McLaren/Hart, 1996h, Soil Boring/Surface Sample Investigation Report West Lake Landfill Radiological Areas 1 and 2, Bridgeton, Missouri, November 26.
NRC, 1982, Radiological Survey of the West Lake Landfill, St. Louis County, Missouri, NUREG CR-2722, May.
EPA, 1998b, Superfund Record of Decision: St. Louis Airport/Hazelwood Interim Storage/Futura Coatings Co., OU-02, EPA/ROD/R07-98/169, August 27.
EPA, 2005b, Superfund Record of Decision: St. Louis Airport/Hazelwood Interim Storage/Futura Coatings Co., OU-01, EPA/ROD/R07-05/045, September 2.
USACE, 1998, Record of Decision for the St. Louis Downtown Site, St. Louis Missouri, October.

Table 6-2: Area 1 Combined Radium, Thorium, and Uranium Results (RI Borings, Phases 1C and 1D, A1 Additional Borings, and Cotter Borings)

DRAFT

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226 Result	Radium-226 Final Q	Radium-226 CSU[1]	Radium-226 CV	Radium-226 MDA	Radium-228 Result	Radium-228 Final Q	Radium-228 CSU[1]	Radium-228 CV	Radium-228 MDA	Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230 Result	Thorium-230 Final Q	Thorium-230 CSU[1]	Thorium-230 CV	Thorium-230 MDA	Thorium-232 Result	Thorium-232 Final Q	Thorium-232 CSU[1]	Thorium-232 CV	Thorium-232 MDA	Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria	Uranium-234 Result	Uranium-234 Final Q	Uranium-234 CSU[1]	Uranium-234 CV	Uranium-234 MDA	Uranium-235 Result	Uranium-235 Final Q	Uranium-235 CSU[1]	Uranium-235 CV	Uranium-235 MDA	Uranium-238 Result	Uranium-238 Final Q	Uranium-238 CSU[1]	Uranium-238 CV	Uranium-238 MDA	Combined Uranium 234 + 235 + 238		Combined Uranium relative to 54.4 pCi/g Unrestricted Use Criteria
McLaren/Hart RI Data																																															
WL-101-MH	5	5	pCi/g	1.04		0.22		0.33	0.95	U			0.95	1.52	*	Less than Criteria	2.18		0.57		0.07	0.89				0.07	3.07		Less than Criteria	1.54		0.44		0.13	0.72	U			0.72	0.88		0.31		0.11	2.78	*	Less than Criteria
WL-101-MH	20	20	pCi/g	0.91		0.19		0.35	1.08	U			1.08	1.45	*	Less than Criteria	1.63		0.57		0.23	1.45		0.53		0.19	3.08		Less than Criteria	1.47		0.46		0.17	0.54	U			0.54	1.63		0.49		0.13	3.37	*	Less than Criteria
WL-102-MH	5	5	pCi/g	1.17		0.22		0.26	0.99	U			0.99	1.67	*	Less than Criteria	4.18		1.02		0.23	0.90		0.38		0.14	5.08		Less than Criteria	1.06		0.37		0.11	0.49	U			0.49	0.88		0.33		0.12	2.19	*	Less than Criteria
WL-102-MH	15	15	pCi/g	0.98		0.23		0.35	1.07	U			1.07	1.52	*	Less than Criteria	1.68		0.58		0.30	1.64		0.56		0.20	3.32		Less than Criteria	1.24		0.41		0.11	0.83	U			0.83	1.34		0.43		0.10	3.00	*	Less than Criteria
WL-103-MH	5	5	pCi/g	1.17		0.26		0.34	1.19	U			1.19	1.77	*	Less than Criteria	1.42		0.51		0.22	0.78		0.36		0.17	2.20		Less than Criteria	1.95		0.55		0.20	0.73	U			0.73	1.60		0.48		0.16	3.92	*	Less than Criteria
WL-103-MH	10	10	pCi/g	0.81		0.34		0.53	1.26	U			1.26	1.44	*	Less than Criteria	7.52		1.65		0.16	0.77				0.09	8.29		Exceeds Criteria	1.41		0.39		0.19	1.41	U			1.41	1.12		0.34		0.14	3.24	*	Less than Criteria
WL-104-MH	5	5	pCi/g	0.78		0.18		0.30	0.84	U			0.84	1.20	*	Less than Criteria	3.08		0.85		0.21	0.94		0.41		0.19	4.02		Less than Criteria	1.19		0.37		0.15	0.55	U			0.55	0.70		0.27		0.14	2.17	*	Less than Criteria
WL-104-MH	20	20	pCi/g	0.39		0.19		0.34	0.92	U			0.92	0.85	*	Less than Criteria	1.26		0.47		0.21	0.77		0.35		0.14	2.03		Less than Criteria	0.52		0.19		0.10	0.56	U			0.56	0.32		0.14		0.11	1.12	*	Less than Criteria
WL-105A-MH	10	10	pCi/g	40.8		2.10		0.60	1.59	U			1.59	41.6	*	Exceeds Criteria	522		95.0		0.09	4.34		2.62		1.36	526		Exceeds Criteria	6.64		1.23		0.16	3.95		0.73		1.97	6.94		1.28		0.14	17.5		Less than Criteria
WL-105A-MH	30	30	pCi/g	0.99		0.23		0.34	1.18	U			1.18	1.58	*	Less than Criteria	1.59		0.56		0.31	1.04		0.42		0.15	2.63		Less than Criteria	1.16		0.36		0.10	0.73	U			0.73	1.10		0.34		0.08	2.63	*	Less than Criteria
WL-106A-MH	0	0	pCi/g	906		37.0		2.00	5.86	U			5.86	909	*	Exceeds Criteria	9,700		1,800		11.8	35.2				11.2	9,735		Exceeds Criteria	105		22.0		3.00	75.5		8.50		8.70	105		22.0		2.00	286		Exceeds Criteria
WL-106A-MH	5	5	pCi/g	18.8		1.30		0.40	1.42				1.07	20.2		Exceeds Criteria	731		135		0.21	3.22				0.20	734		Exceeds Criteria	11.5		4.80		4.00	2.10		0.43		1.12	6.69		3.50		2.73	20.3		Less than Criteria
WL-106A-MH_FD	5	5	pCi/g	128		6.00		1.00	2.69	U			2.69	129	*	Exceeds Criteria	766		142		0.14	4.71				0.12	771		Exceeds Criteria	31.5	U	17.1		35.3	12.1		1.70		3.40	26.4		10.1		17.2	54.3	*	Exceeds Criteria
WL-106A-MH	25	25	pCi/g	1.26		0.25		0.40	1.18	U			1.18	1.85	*	Less than Criteria	2.38		0.55		0.14	0.56				0.09	2.94		Less than Criteria	2.70		0.53		0.06	0.78	U			0.78	2.89		0.56		0.06	5.98	*	Less than Criteria
WL-106A-MH_FD	25	25	pCi/g	2.92		0.35		0.31	1.16	U			1.16	3.50	*	Less than Criteria	6.49		1.37		0.12	0.47				0.09	6.96		Less than Criteria	1.90		0.42		0.18	1.14	U			1.14	2.08		0.45		0.17	4.55	*	Less than Criteria
WL-107-MH	5	5	pCi/g	0.80		0.21		0.29	0.91		0.38		0.68	1.71		Less than Criteria	0.89		0.34		0.13	0.89		0.34		0.09	1.78		Less than Criteria	1.30		0.43		0.11	0.58	U			0.58	0.89		0.34		0.11	2.48	*	Less than Criteria
WL-107-MH	51	51	pCi/g	0.71		0.21		0.36	0.98	U			0.98	1.20	*	Less than Criteria	0.56		0.27		0.15	0.14		0.12		0.09	0.70		Less than Criteria	0.54		0.24		0.08	0.63	U			0.63	0.33		0.18		0.08	1.19	*	Less than Criteria
WL-108-MH	5	5	pCi/g	0.95		0.25		0.37	1.34	U			1.34	1.62	*	Less than Criteria	1.21		0.42		0.16	0.79		0.32		0.12	2.00		Less than Criteria	0.74		0.31		0.10	0.67	U			0.67	1.05		0.38		0.12	2.13	*	Less than Criteria
WL-109D-MH	5	5	pCi/g	0.90		0.21		0.31	1.18		0.40		0.62	2.08		Less than Criteria	0.67		0.30		0.13	0.21		0.16		0.11	0.88		Less than Criteria	0.66		0.25		0.08	0.61	U			0.61	0.66		0.24		0.07	1.63	*	Less than Criteria
WL-109D-MH	50	50	pCi/g	0.95		0.21		0.30	1.36		0.48		0.71	2.31		Less than Criteria	1.10		0.36		0.20	0.58		0.25		0.21	1.68		Less than Criteria	0.57		0.27		0.11	0.77	U			0.77	0.99		0.38		0.12	1.95	*	Less than Criteria
WL-110-MH	5	5	pCi/g	0.87		0.25		0.40	1.27	U			1.27	1.51	*	Less than Criteria	0.66		0.35		0.23	0.37		0.25		0.16	1.03		Less than Criteria	1.25		0.41		0.09	0.84	U			0.84	0.87		0.33		0.09	2.54	*	Less than Criteria
WL-110-MH	50	50	pCi/g	1.01		0.21		0.31	1.02	U			1.02	1.52	*	Less than Criteria	0.87		0.29		0.12	0.87		0.28		0.08	1.74		Less than Criteria	1.17		0.40		0.20	0.74	U			0.74	1.14		0.39		0.23	2.68	*	Less than Criteria
WL-111-MH	0	0	pCi/g	0.91		0.22		0.33	1.05	U			1.05	1.44	*	Less than Criteria	2.12		0.72		0.29	0.68		0.36		0.20	2.80		Less than Criteria	1.70		0.63		0.25	0.70	U			0.70	1.04		0.46		0.18	3.09	*	Less than Criteria
WL-111-MH	5	5	pCi/g	0.61		0.21		0.42	1.02	U			1.02	1.12	*	Less than Criteria	2.76		0.90		0.77	0.38	U	0.39		0.70	2.95	*	Less than Criteria	3.37		1.08		0.97	0.70	U			0.70	1.16		0.65		0.90	4.88	*	Less than Criteria
WL-111-MH	51	51	pCi/g	0.48		0.18		0.33	1.10	U			1.10	1.03	*	Less than Criteria	2.47		1.26		0.79	0.41	U	0.49		0.58	2.68	*	Less than Criteria	0.75		0.47		0.58	0.64	U			0.64	0.33	U	0.32		0.48	1.24	*	Less than Criteria
WL-112-MH	0	0	pCi/g	1.32		0.24		0.41	1.18	U			1.18	1.91	*	Less than Criteria	2.67		0.76		0.25	0.84		0.34		0.19	3.51		Less than Criteria	1.45		0.48		0.13	0.85	U			0.85	1.22		0.43		0.12	3.10	*	Less than Criteria
WL-112-MH	5	5	pCi/g	4.66		0.46		0.42	1.20	U			1.20	5.26	*	Less than Criteria	84.4		15.8		1.90	0.66	U	0.81		1.56	84.7	*	Exceeds Criteria	2.92		1.46		0.89	0.99	U			0.99	3.44		1.58		0.42	6.86	*	Less than Criteria
WL-112-MH	42	42	pCi/g	0.76		0.20		0.34	1.31		0.44		0.58	2.07		Less than Criteria	0.92		0.44		0.42	0.68		0.37		0.30	1.60		Less than Criteria	1.74		1.15		1.06	0.56	U			0.56	1.62		1.09		0.88	3.64	*	Less than Criteria
WL-113-MH	5	5	pCi/g	0.97		0.08		0.06	1.06		0.14		0.13	2.03		Less than Criteria	0.33		0.15		0.11	0.19		0.11		0.08	0.52		Less than Criteria	1.40		0.59		0.32	0.23	U			0.23	1.25		0.54		0.26	2.77	*	Less than Criteria
WL-113-MH_FD	5	5	pCi/g	1.06		0.08		0.06	0.98		0.13		0.13	2.04		Less than Criteria	0.58		0.23		0.15	0.15		0.11		0.08	0.73		Less than Criteria	0.76		0.34		0.16	0.17	U			0.17	0.62		0.30		0.08	1.47	*	Less than Criteria
WL-113-MH	10	10	pCi/g	1.53		0.15		0.12	0.98		0.22		0.24	2.51		Less than Criteria	2.21		0.52		0.13	0.08		0.07		0.08	2.29		Less than Criteria	1.20		0.48		0.22	0.42	U			0.42	1.06		0.44		0.09	2.47	*	Less than Criteria
WL-114-MH	0	0	pCi/g	109		5.00		0.90	2.50	U			2.50	110	*	Exceeds Criteria	7,850		1,470		0.92	18.1		4.60		0.78	7,868		Exceeds Criteria	154		40.0		1.00	17.6		2.10		3.00	147		38.0		0.90	319		Exceeds Criteria
WL-114-MH	5	5	pCi/g	2.59		0.17		0.06	0.39		0.12		0.16	2.98		Less than Criteria	23.2		4.90		0.40	0.25	U	0.22		0.26	23.3	*	Exceeds Criteria	3.43		1.35		0.63	0.32		0.06		0.27	3.54		1.38		0.51	7.29		Less than Criteria
WL-114-MH	15	15	pCi/g	0.98		0.08		0.07	1.04		0.15		0.14	2.02		Less than Criteria	1.08		0.46		0.28	0.14	U	0.16		0.20	1.15	*	Less than Criteria	1.29		0.74		0.56	0.24	U			0.24	1.60		0.82		0.23	3.01	*	Less than Criteria
WL-115-MH	5	5	pCi/g	1.00		0.08		0.06	0.93		0.13		0.12	1.93		Less than Criteria	0.84		0.29		0.18	0.21		0.13		0.11	1.05		Less than Criteria	1.30		0.52		0.29	0.15	U			0.15	1.22		0.49		0.21	2.60	*	Less than Criteria
WL-115-MH	40	40	pCi/g	0.58		0.05		0.05	0.69		0.10		0.10	1.27		Less than Criteria	0.29		0.16		0.12	0.27		0.15		0.09	0.56		Less than Criteria	0.35		0.21		0.16	0.13	U			0.13	0.33		0.20		0.11	0.75	*	Less than Criteria
WL-116-MH	0	0	pCi/g	0.94		0.21		0.33	1.19	U			1.19	1.54	*	Less than Criteria	1.94		0.69		0.52	0.52		0.34		0.46	2.46		Less than Criteria	1.04		0.38		0.20	1.02	U			1.02	0.88		0.34		0.15	2.43	*	Less than Criteria
WL-116-MH	5	5	pCi/g	1.11		0.08		0.06	0.94		0.13		0.14	2.05		Less than Criteria	0.51		0.21		0.13	0.25		0.14		0.04	0.76		Less than Criteria	1.15		0.49		0.36	0.17	U			0.17	1.18		0.50		0.41	2.42	*	Less than Criteria
WL-116-MH_FD	5	5	pCi/g	1.18		0.13		0.13	1.00		0.23		0.28	2.18		Less than Criteria	0.35		0.17		0.11	0.21		0.13		0.07	0.56		Less than Criteria	0.64		0.39		0.28	0.44	U			0.44	1.03		0.51		0.20	1.89	*	Less than Criteria
WL-116-MH	10	10	pCi/g	1.00		0.07		0.05	0.76		0.11		0.11	1.76		Less than Criteria	0.36		0.20		0.21	0.33		0.18		0.13	0.69		Less than Criteria	1.14		0.37		0.17	0.13	U			0.13	1.32		0.41		0.05	2.53	*	Less than Criteria
WL-117-MH	10	10	pCi/g	3.15		0.19		0.07	0.64		0.14		0.16	3.79		Less than Criteria	36.6		7.40		0.13	1.00		0.35		0.12	37.6		Exceeds Criteria	1.72		0.61		0.25	0.30		0.06		0.27	2.90		0.86		0.16	4.92		Less than Criteria
WL-117-MH	25	25	pCi/g	0.62		0.06		0.05	0.64		0.12		0.12	1.26		Less than Criteria	0.70		0.28		0.15	0.20		0.14		0.12	0.90		Less than Criteria	0.56		0.31		0.17	0.20	U			0.20	0.56		0.31		0.10	1.22	*	Less than Criteria
WL-118-MH	5	5	pCi/g	18.4		1.00		0.30	0.73	U			0.73	18.8	*	Exceeds Criteria	425		87.0		2.50	10.3		3.50		2.22	435		Exceeds Criteria	15.6		3.60		0.20	2.40		0.37		1.41	17.8		4.10		0.20	35.8		Less than Criteria
WL-118-MH	10	10	pCi/g	1.31		0.10		0.05	0.49		0.09		0.14	1.80		Less than Criteria	7.19		1.88		0.20	0.35		0.23		0.20	7.54		Less than Criteria	1.18		0.48		0.18	0.18		0.03		0.15	1.14		0.47		0.17	2.50		Less than Criteria
WL-119-MH	5	5	pCi/g	0.89		0.07		0.06	0.73		0.12		0.12	1.62		Less than Criteria	0.60		0.28		0.22	0.26		0.17		0.13	0.86		Less than Criteria	0.51		0.29		0.21	0.15	U			0.15	0.72		0.35		0.17	1.31	*	Less than Criteria
WL-119-MH	50	50	pCi/g	0.46		0.05		0.04	0.41		0.09		0.10	0.87		Less than Criteria	0.67		0.35		0.41	0.32	U	0.26		0.41	0.83	*	Less than Criteria	0.85		0.53		0.50	0.12	U			0.12	0.34	U	0.36		0.58	1.08	*	Less than Criteria
WL-119-MH_FD	50	50	pCi/g	0.45		0.05		0.06	0.50		0.10		0.12	0.95		Less than Criteria	0.22		0.13		0.11	0.10		0.08		0.09	0.32		Less than Criteria	0.57		0.29		0.19	0.13	U			0.13	0.36		0.23		0.25	1.00	*	Less than Criteria
WL-120-MH	5	5	pCi/g	1.00		0.09		0.07	1.08		0.15		0.16	2.08		Less than Criteria	0.48		0.18		0.12	0.14		0.09		0.09	0.62		Less than Criteria	1.15		0.43		0.26	0.24	U			0.24	0.95		0.38		0.18	2.22	*	Less than Criteria
WL-120-MH	50	50	pCi/g	0.92		0.10		0.11	0.91		0.21		0.22	1.83		Less than Criteria	0.32		0.19		0.15	0.23		0.16		0.13	0.55		Less than Criteria	0.46		0.23		0.14	0.37	U			0.37	0.52		0.25		0.12	1.17	*	Less than Criteria
WL-120-MH_FD	50	50	pCi/g	1.07		0.09		0.09	1.04		0.18		0.17	2.11		Less than Criteria	0.38		0.19		0.21	0.25		0.15		0.15	0.63		Less than Criteria	0.98		0.47		0.35	0.25	U			0.25	0.92		0.46		0.38	2.03	*	Less than Criteria
WL-121-MH	0	0	pCi/g	7.28	U			7.28	2.14	U			2.14	Non-detect	*	Non-detect	1.57		0.36		0.10	0.87		0.23		0.09	2.44		Less than Criteria	0.78		0.24		0.13						0.94		0.27		0.17	1.72		Less than Criteria
WL-122-MH	0	0	pCi/g	5.44	U			5.44	1.69	U			1.69	Non-detect	*	Non-detect	1.93		0.43		0.12	1.02		0.26		0.10	2.95		Less than Criteria	0.94		0.26		0.10						0.87		0.25		0.09	1.81		Less than Criteria
WL-123-MH	0	0	pCi/g	5.98	U			5.98	1.82	U			1.82	Non-detect	*	Non-detect	1.45		0.34		0.07	1.06		0.27		0.05	2.51		Less than Criteria	2.94		0.65		0.07						2.33		0.54		0.12	5.27		Less than Criteria
WL-124-MH	0	0	pCi/g	5.22	U			5.22	1.79	U			1.79	Non-detect	*	Non-detect	2.16		0.49		0.07	1.16		0.30		0.07	3.32		Less than Criteria	1.50		0.34		0.06						1.02		0.26		0.06	2.52		Less than Criteria
Phase 1C data (and Cotter samples from Core of Phase 1C borings)																																															
01-2	8	9	pCi/g	1.38		0.20	0.11	0.22	1.31	J	0.22	0.24	0.50	2.69		Less than Criteria	0.68		0.25	0.02	0.10	0.38		0.17	0.10	0.10	1.05		Less than Criteria	0.47		0.16	0.01	0.06	0.04	U	0.06	0.00	0.09	0.43		0.15	0.00	0.05	0.95	*	Less than Criteria
01-2	18	19	pCi/g	1.32		0.20	0.09	0.19	1.34		0.25	0.20	0.43	2.65		Less than Criteria	0.62		0.22	0.00	0.08	0.34		0.15	0.07	0.05	0.96		Less than Criteria	0.40		0.14	0.02	0.06	0.05	U	0.06	0.01	0.08	0.41		0.14	0.00	0.05	0.87	*	Less than Criteria
01-2	20	21	pCi/g	1.22		0.22	0.13	0.27	1.05		0.25	0.23	0.50	2.28		Less than Criteria	0.84		0.27	0.01	0.06	0.57		0.20	0.07	0.08	1.41		Less than Criteria	0.46		0.16	0.01	0.05	0.01	U	0.03	0.01	0.08	0.40		0.15	0.00	0.05	0.86	*	Less than Criteria
01-2	22	23	pCi/g	0.23	UJ	0.33	0.27	0.58	0.44	UJ	0.41	0.39	0.90	Non-detect	*	Non-detect	0.13		0.08	0.00	0.07	0.06	U	0.06	0.06	0.07	0.19	*	Less than Criteria	0.15		0.08	0.02	0.06	0.00	U	0.03	0.01	0.07	0.06	U	0.06	0.02	0.07	0.21	*	Less than Criteria
01-2	23	24	pCi/g	1.35		0.32	0.19	0.40	1.21	J	0.43	0.38	0.81	2.56		Less than Criteria	0.94		0.30	0.01	0.07	0.56		0.21	0.07	0.08	1.51		Less than Criteria	0.44		0.17	0.02	0.07	0.10		0.09	0.00	0.11	0.36		0.16	0.01	0.09	0.89		Less than Criteria
01-2	24	25	pCi/g	1.36		0.20	0.10	0.21	1.13		0.20	0.16	0.34	2.50		Less than Criteria	3.41		0.84	0.01	0.09	1.34		0.38	0.08	0.06	4.74		Less than Criteria	0.76		0.23	0.01	0.06	0.14		0.10	0.00	0.07	1.20		0.30	0.01	0.07	2.09		Less than Criteria
01-2	28	29	pCi/g	0.61		0.16	0.12	0.24	0.35	U	0.20	0.23	0.50	0.97	*	Less than Criteria	1.38		0.46	0.02	0.12	0.71		0.29	0.15	0.15	2.10		Less than Criteria	0.73		0.22	0.01	0.06	0.09		0.09	0.00	0.11	0.57		0.19	0.01	0.09	1.38		Less than Criteria
01-2	33	34	pCi/g	0.62		0.13	0.09	0.18	0.26	U	0.19	0.16	0.33	0.88	*	Less than Criteria	0.28		0.12	0.00	0.06	0.11	U	0.07	0.06	0.05	0.39	*	Less than Criteria	0.50		0.15	0.01	0.05	0.02	U	0.03	0.00	0.05	0.30		0.11	0.00	0.04	0.82	*	Less than Criteria
01-2	38	39	pCi/g	1.02		0.19	0.11	0.24	0.95	J	0.32	0.47	0.76	1.97		Less than Criteria	0.28		0.13	0.01	0.06	0.29		0.13	0.07	0.06	0.57		Less than Criteria	0.31		0.13	0.01	0.05	0.07		0.06	0.00	0.06	0.26		0.11	0.01	0.06	0.65		Less than Criteria
01-2	38	39	pCi/g	1.05		0.25	0.16	0.34	1.20	J	0.42	0.40	0.84	2.25		Less than Criteria	0.40		0.16	0.02	0.08	0.13	U	0.08	0.07	0.06	0.53	*	Less than Criteria	0.30		0.12	0.01	0.05	0.16		0.10	0.00	0.07	0.32		0.13	0.01	0.06	0.79		Less than Criteria
01-2	39	40	pCi/g	4.98		0.48	0.12	0.25	1.28	J	0.37	0.35	0.71	6.26		Less than Criteria	417	QJ	123	0.05	0.80	5.23	QJ	2.46	0.81	0.72	422		Exceeds Criteria	3.56		0.67	0.02	0.06	0.34		0.16	0.00	0.08	3.84		0.71	0.01	0.07	7.74		Less than Criteria
01-2	40	41	pCi/g	0.39		0.10	0.08	0.16	0.44		0.17	0.15	0.32	0.83		Less than Criteria	0.06	U	0.06	0.02	0.08	0.05	U	0.05	0.07	0.05	Non-Detect	*	Non-detect	0.17		0.09	0.01	0.05	0.07	U	0.06	0.01	0.07	0.20		0.10	0.01	0.06	0.44	*	Less than Criteria
01-2GP	23	24	pCi/g	1.45		0.26	0.17	0.35	1.27	J	0.33	0.26	0.55	2.72		Less than Criteria	1.09		0.29	0.00	0.03	0.54		0.16	0.04	0.04	1.63		Less than Criteria	0.53		0.12	0.01	0.04	0.04		0.04	0.00	0.03	0.37		0.10	0.00	0.03	0.94		Less than Criteria
01-2GP	28	29	pCi/g	0.96	J	0.19	0.27	0.55	0.48	UJ	0.33	0.27	0.59	1.44	*	Less than Criteria	3.42		0.84	0.02	0.07	0.15		0.08	0.05	0.05	3.57		Less than Criteria	0.35		0.11	0.01	0.04	0.05		0.04	0.00	0.04	0.37		0.11	0.01	0.04	0.78		Less than Criteria
01-2GP	28	29	pCi/g	1.73		0.34	0.23	0.48	0.83	J	0.37	0.38	0.82	2.56		Less than Criteria	10.4	Q	2.65	0.01	0.07	0.19		0.11	0.07	0.07	10.6		Exceeds Criteria	0.41		0.11	0.01	0.03	0.05		0.04	0.00	0.04	0.43		0.11	0.00	0.02	0.89		Less than Criteria
01-2GP	28	29	pCi/g	0.85		0.24	0.16	0.33	0.23	UJ	0.29	0.24	0.53	1.08	*	Less than Criteria	0.64		0.19	0.01	0.04	0.06	U	0.05	0.04	0.04	0.70	*	Less than Criteria	0.22		0.08	0.01	0.03	0.01	U	0.02	0.00	0.03	0.16		0.06	0.00	0.02	0.40	*	Less than Criteria
01-2GP	29	30	pCi/g	0.58		0.15	0.06	0.14	0.13	U	0.20	0.16	0.36	0.71	*	Less than Criteria	0.81		0.24	0.01	0.05	0.13		0.07	0.05	0.05	0.93		Less than Criteria	0.74		0.17	0.01	0.03	0.06		0.04	0.00	0.03	0.50		0.13	0.00	0.03	1.30		Less than Criteria
02-2	5	6	pCi/g	0.99		0.16	0.10	0.20	1.14		0.19	0.10	0.22	2.14		Less than Criteria	1.24		0.39	0.03	0.12	0.89		0.29	0.09	0.08	2.13		Less than Criteria	0.98		0.25	0.01	0.05	0.10		0.08	0.00	0.09	0.87		0.23	0.00	0.07	1.95		Less than Criteria

Table 6-2: Area 1 Combined Radium, Thorium, and Uranium Results (RI Borings, Phases 1C and 1D, A1 Additional Borings, and Cotter Borings)

DRAFT

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226 Result	Radium-226 Final Q	Radium-226 CSU[1]	Radium-226 CV	Radium-226 MDA	Radium-228 Result	Radium-228 Final Q	Radium-228 CSU[1]	Radium-228 CV	Radium-228 MDA	Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230 Result	Thorium-230 Final Q	Thorium-230 CSU[1]	Thorium-230 CV	Thorium-230 MDA	Thorium-232 Result	Thorium-232 Final Q	Thorium-232 CSU[1]	Thorium-232 CV	Thorium-232 MDA	Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria	Uranium-234 Result	Uranium-234 Final Q	Uranium-234 CSU[1]	Uranium-234 CV	Uranium-234 MDA	Uranium-235 Result	Uranium-235 Final Q	Uranium-235 CSU[1]	Uranium-235 CV	Uranium-235 MDA	Uranium-238 Result	Uranium-238 Final Q	Uranium-238 CSU[1]	Uranium-238 CV	Uranium-238 MDA	Combined Uranium 234 + 235 + 238		Combined Uranium relative to 54.4 pCi/g Unrestricted Use Criteria
02-2	19	20	pCi/g	0.96		0.20	0.13	0.28	0.84		0.27	0.19	0.41	1.79		Less than Criteria	0.16		0.08	0.01	0.06	0.13	U	0.08	0.07	0.08	0.29	*	Less than Criteria	0.36		0.12	0.01	0.04	0.01	U	0.02	0.00	0.05	0.31		0.11	0.00	0.05	0.68	*	Less than Criteria
02-2	20	21	pCi/g	0.32	U	0.18	0.17	0.36	0.66	UJ	0.41	0.36	0.80	Non-detect	*	Non-detect	0.66		0.22	0.00	0.07	0.46		0.17	0.08	0.08	1.12		Less than Criteria	0.32		0.13	0.01	0.06	0.07		0.07	0.00	0.08	0.34		0.13	0.00	0.05	0.73		Less than Criteria
02-2	21	22	pCi/g	1.17		0.21	0.11	0.23	1.44	J	0.28	0.27	0.56	2.62		Less than Criteria	1.36		0.40	0.01	0.08	1.25		0.36	0.08	0.06	2.61		Less than Criteria	0.91		0.24	0.02	0.07	0.07	U	0.07	0.01	0.07	0.77		0.21	0.01	0.06	1.75	*	Less than Criteria
02-2	22	23	pCi/g	1.31	J	0.37	0.31	0.65	1.54	J	0.44	0.36	0.78	2.85		Less than Criteria	0.69		0.23	0.01	0.06	0.68		0.22	0.07	0.05	1.37		Less than Criteria	0.39		0.13	0.01	0.05	0.06	U	0.05	0.01	0.06	0.41		0.13	0.00	0.04	0.86	*	Less than Criteria
02-2	22	23	pCi/g	1.51		0.24	0.12	0.25	1.33	J	0.27	0.24	0.50	2.84		Less than Criteria	0.57		0.19	0.01	0.05	0.44		0.16	0.06	0.07	1.00		Less than Criteria	0.46		0.16	0.03	0.08	0.05	U	0.06	0.01	0.09	0.43		0.15	0.01	0.06	0.95	*	Less than Criteria
02-2	31	32	pCi/g	13.8	J	1.28	0.25	0.52	0.79	UJ	0.58	0.47	0.98	14.6	*	Exceeds Criteria	206		43.4	0.01	0.04	1.39		0.33	0.04	0.04	207		Exceeds Criteria	0.82		0.17	0.01	0.03	0.03		0.03	0.00	0.03	0.71		0.15	0.00	0.03	1.56		Less than Criteria
02-3	34	35	pCi/g	3.23		0.52	0.39	0.19	1.64	J	0.49	0.98	1.95	4.86		Less than Criteria	16.8		3.42	0.01	0.04	0.26		0.09	0.04	0.04	17.0		Exceeds Criteria	0.49		0.12	0.01	0.03	0.04		0.03	0.00	0.03	0.44		0.11	0.02	0.05	0.98		Less than Criteria
02-3	35	36	pCi/g	21.1	J	2.06	0.49	1.02	0.45	UJ	0.78	0.59	1.25	21.5	*	Exceeds Criteria	282		53.2	0.00	0.03	2.60		0.49	0.03	0.02	284		Exceeds Criteria	1.60		0.26	0.00	0.02	0.17		0.07	0.00	0.03	1.63		0.27	0.00	0.03	3.39		Less than Criteria
05-3	25	26	pCi/g	1.28		0.21	0.12	0.25	1.13		0.20	0.22	0.47	2.41		Less than Criteria	4.63		1.01	0.01	0.06	0.43		0.15	0.06	0.05	5.07		Less than Criteria	0.46		0.14	0.02	0.06	0.10		0.07	0.01	0.08	0.40		0.13	0.01	0.05	0.96		Less than Criteria
05-3	25	26	pCi/g	5.32		0.56	0.21	0.42	1.09	J	0.35	0.29	0.62	6.41		Less than Criteria	88.9		18.0	0.00	0.07	0.82		0.25	0.07	0.06	89.7		Exceeds Criteria	0.65		0.17	0.01	0.05	0.06	U	0.06	0.01	0.07	0.71		0.18	0.01	0.06	1.42	*	Less than Criteria
05-3	28	29	pCi/g	1,487	J	121	5.09	10.2	19.8	QJ	6.41	5.36	10.8	1,507		Exceeds Criteria	25,825	QJ	7,538	1.45	17.7	203	QJ	78.6	15.4	15.5	26,028		Exceeds Criteria	429	J	73.2	1.30	5.59	22.9	QJ	12.5	0.35	6.90	431	J	73.5	0.15	8.00	883		Exceeds Criteria
05-3	29	30	pCi/g	5.60		0.55	0.12	0.25	1.19	J	0.28	0.30	0.63	6.79		Less than Criteria	444	QJ	97.7	0.25	1.12	6.76	QJ	2.48	1.51	0.92	450		Exceeds Criteria	2.86		0.50	0.02	0.06	0.19		0.10	0.01	0.07	2.51		0.46	0.04	0.10	5.56		Less than Criteria
05-3	29	30	pCi/g	0.44		0.12	0.09	0.18	0.36	U	0.21	0.21	0.44	0.80	*	Less than Criteria	0.94		0.31	0.01	0.08	0.45		0.19	0.08	0.10	1.38		Less than Criteria	0.62		0.20	0.02	0.07	0.07	U	0.07	0.00	0.10	0.56		0.19	0.02	0.09	1.25	*	Less than Criteria
05-3	33	34	pCi/g	32.6	J	2.44	0.46	0.93	1.96	J	0.43	0.44	0.90	34.6		Exceeds Criteria	1,815	QJ	559	0.54	4.54	14.4	QJ	8.16	3.69	4.00	1,829		Exceeds Criteria	12.4		1.90	0.02	0.06	0.70	Q	0.25	0.00	0.08	11.9		1.84	0.01	0.07	25.0		Less than Criteria
08-1	28	29	pCi/g	1.27		0.21	0.23	0.47	0.88	J	0.19	0.30	0.64	2.15		Less than Criteria	1.81		0.46	0.02	0.08	0.88		0.26	0.07	0.05	2.69		Less than Criteria	0.86		0.24	0.01	0.06	0.11		0.08	0.00	0.07	0.91		0.24	0.00	0.05	1.88		Less than Criteria
08-1	40	41	pCi/g	1.49		0.22	0.13	0.20	1.59		0.27	0.21	0.44	3.08		Less than Criteria	1.57		0.46	0.01	0.09	1.31		0.38	0.09	0.08	2.88		Less than Criteria	0.84		0.23	0.02	0.07	0.08		0.07	0.00	0.07	1.00		0.26	0.00	0.05	1.92		Less than Criteria
08-1	44	45	pCi/g	1.29		0.28	0.20	0.42	1.43	J	0.44	0.36	0.76	2.72		Less than Criteria	77.8		16.9	0.01	0.06	0.48		0.19	0.08	0.06	78.2		Exceeds Criteria	0.57		0.17	0.01	0.05	0.09		0.07	0.00	0.06	0.47		0.15	0.00	0.05	1.13		Less than Criteria
12-5	2	3	pCi/g	1.22		0.16	0.07	0.15	0.88		0.17	0.14	0.29	2.09		Less than Criteria	1.27		0.35	0.01	0.07	0.94		0.27	0.11	0.07	2.21		Less than Criteria	0.53		0.18	0.01	0.06	0.05	U	0.07	0.00	0.10	0.60		0.20	0.00	0.08	1.19	*	Less than Criteria
12-5	12	13	pCi/g	1.15		0.19	0.10	0.21	1.10		0.24	0.16	0.34	2.25		Less than Criteria	1.72		0.49	0.01	0.08	0.87		0.29	0.14	0.07	2.59		Less than Criteria	0.67		0.21	0.02	0.06	0.10		0.09	0.00	0.10	0.76		0.22	0.00	0.06	1.53		Less than Criteria
13-3	19	20	pCi/g	1.50		0.23	0.14	0.30	1.39	J	0.36	0.27	0.56	2.89		Less than Criteria	3.41		0.85	0.01	0.07	1.20		0.36	0.14	0.08	4.61		Less than Criteria	0.95		0.26	0.04	0.10	0.18		0.11	0.01	0.08	0.92		0.25	0.02	0.09	2.05		Less than Criteria
13-3	29	30	pCi/g	0.39	UJ	0.31	0.24	0.50	0.73	J	0.37	0.31	0.68	1.11	*	Less than Criteria	0.79		0.26	0.00	0.06	0.81		0.25	0.11	0.08	1.60		Less than Criteria	0.72		0.21	0.01	0.06	0.04	U	0.06	0.01	0.08	0.88		0.24	0.01	0.06	1.65	*	Less than Criteria
13-6	21	22	pCi/g	1.42		0.22	0.11	0.22	1.24	J	0.25	0.61	0.78	2.66		Less than Criteria	2.75		0.68	0.02	0.10	1.21		0.34	0.08	0.07	3.95		Less than Criteria	0.91		0.24	0.01	0.05	0.11		0.09	0.00	0.09	1.10		0.27	0.00	0.05	2.12		Less than Criteria
13-6	21	22	pCi/g	1.26		0.19	0.11	0.22	1.10		0.21	0.14	0.30	2.35		Less than Criteria	1.40		0.39	0.00	0.08	1.11		0.32	0.07	0.08	2.51		Less than Criteria	1.00		0.27	0.01	0.09	0.10		0.09	0.00	0.07	1.01		0.27	0.00	0.08	2.11		Less than Criteria
13-6	39	40	pCi/g	1.16		0.18	0.10	0.21	1.34		0.24	0.15	0.32	2.50		Less than Criteria	1.38		0.43	0.02	0.11	0.97		0.32	0.13	0.14	2.35		Less than Criteria	0.81		0.32	0.03	0.11	0.09	U	0.11	0.01	0.15	1.04		0.37	0.00	0.16	1.94	*	Less than Criteria
14-2	19	20	pCi/g	1.31		0.18	0.09	0.20	1.33		0.22	0.19	0.40	2.64		Less than Criteria	2.76		0.70	0.01	0.07	1.05		0.32	0.14	0.08	3.81		Less than Criteria	0.75		0.20	0.02	0.06	0.10		0.07	0.00	0.06	0.80		0.21	0.00	0.05	1.64		Less than Criteria
14-2	29	31	pCi/g	1.19		0.19	0.11	0.23	1.14		0.21	0.14	0.31	2.33		Less than Criteria	1.52		0.43	0.01	0.07	1.36		0.38	0.13	0.06	2.88		Less than Criteria	1.03		0.28	0.04	0.11	0.03	U	0.06	0.02	0.11	1.02		0.27	0.01	0.08	2.08	*	Less than Criteria
14-4	5	6	pCi/g	0.90		0.14	0.08	0.17	0.68		0.13	0.21	0.44	1.59		Less than Criteria	1.29		0.39	0.01	0.08	1.10		0.34	0.15	0.09	2.39		Less than Criteria	1.08		0.25	0.03	0.08	0.12		0.08	0.01	0.08	0.73		0.19	0.01	0.06	1.92		Less than Criteria
14-4	28	29	pCi/g	0.82		0.20	0.14	0.29	0.84	J	0.24	0.23	0.51	1.66		Less than Criteria	2.08		0.55	0.00	0.09	1.46		0.39	0.13	0.06	3.54		Less than Criteria	0.94		0.23	0.03	0.08	0.08		0.07	0.00	0.06	1.23		0.28	0.01	0.07	2.25		Less than Criteria
14-5	12	13	pCi/g	1.24		0.22	0.14	0.29	1.22		0.28	0.23	0.48	2.46		Less than Criteria	1.66		0.48	0.01	0.08	1.19		0.36	0.10	0.10	2.86		Less than Criteria	0.80		0.23	0.01	0.05	0.12		0.09	0.01	0.08	0.87		0.24	0.00	0.05	1.79		Less than Criteria
14-5	60	61	pCi/g	1.31	J	0.29	0.24	0.50	1.43	J	0.45	0.34	0.73	2.74		Less than Criteria	1.03		0.32	0.01	0.06	1.12		0.33	0.08	0.09	2.15		Less than Criteria	0.98		0.25	0.01	0.08	0.09		0.08	0.00	0.09	0.86		0.23	0.00	0.08	1.94		Less than Criteria
14-7	13	14	pCi/g	0.90		0.15	0.19	0.39	0.48		0.16	0.15	0.32	1.38		Less than Criteria	1.54		0.49	0.04	0.14	0.89		0.32	0.18	0.11	2.43		Less than Criteria	1.07		0.26	0.01	0.05	0.10		0.08	0.01	0.07	1.01		0.26	0.01	0.06	2.18		Less than Criteria
14-7	39	40	pCi/g	1.32		0.23	0.16	0.33	0.99	J	0.30	0.29	0.61	2.31		Less than Criteria	1.80		0.54	0.03	0.14	1.26		0.40	0.17	0.10	3.05		Less than Criteria	0.86		0.22	0.01	0.05	0.07		0.07	0.00	0.09	0.83		0.22	0.00	0.07	1.76		Less than Criteria
15-2	24	25	pCi/g	4.78		0.51	0.15	0.31	1.48	J	0.29	0.29	0.60	6.26		Less than Criteria	116		23.8	0.02	0.09	1.84		0.46	0.14	0.10	117		Exceeds Criteria	0.98		0.26	0.04	0.10	0.06	U	0.07	0.02	0.11	0.93		0.25	0.01	0.06	1.97	*	Less than Criteria
15-2	43	44	pCi/g	1.40		0.20	0.12	0.24	1.42		0.25	0.16	0.35	2.82		Less than Criteria	1.36		0.44	0.02	0.11	1.33		0.42	0.17	0.08	2.69		Less than Criteria	0.73		0.20	0.02	0.07	0.02	U	0.04	0.01	0.07	0.82		0.21	0.01	0.06	1.56	*	Less than Criteria
16-3	6	7	pCi/g	1.36		0.24	0.14	0.28	1.61		0.32	0.22	0.46	2.98		Less than Criteria	1.86		0.53	0.02	0.11	1.30		0.39	0.15	0.08	3.16		Less than Criteria	0.69		0.22	0.02	0.08	0.05	U	0.07	0.00	0.11	0.75		0.23	0.01	0.07	1.50	*	Less than Criteria
16-3	11	12	pCi/g	1.17		0.19	0.10	0.21	1.67		0.23	0.16	0.34	2.84		Less than Criteria	1.77		0.52	0.01	0.09	1.37		0.41	0.15	0.08	3.14		Less than Criteria	0.90		0.23	0.03	0.08	0.14		0.09	0.01	0.08	1.05		0.26	0.01	0.07	2.09		Less than Criteria
16-3_FD	11	12	pCi/g	1.27		0.19	0.10	0.21	1.25		0.26	0.20	0.43	2.52		Less than Criteria	1.86		0.57	0.03	0.13	1.62		0.50	0.19	0.12	3.47		Less than Criteria	0.85		0.23	0.02	0.08	0.16		0.10	0.01	0.07	0.98		0.25	0.00	0.05	1.99		Less than Criteria
16-6	6	7	pCi/g	1.36		0.21	0.11	0.24	1.41		0.26	0.17	0.37	2.77		Less than Criteria	1.67		0.46	0.00	0.06	1.23		0.35	0.13	0.06	2.90		Less than Criteria	1.11		0.26	0.01	0.05	0.05	U	0.05	0.01	0.08	1.02		0.25	0.01	0.06	2.18	*	Less than Criteria
16-6	21	22	pCi/g	0.93		0.15	0.09	0.05	1.26		0.21	0.18	0.37	2.19		Less than Criteria	1.41		0.41	0.00	0.09	1.50		0.41	0.13	0.06	2.91		Less than Criteria	0.58		0.21	0.04	0.11	0.11		0.09	0.01	0.09	0.59		0.21	0.05	0.14	1.28		Less than Criteria
1C-12BGP	46	47	pCi/g	1.74		0.23	0.10	0.20	0.65		0.19	0.20	0.43	2.39		Less than Criteria	4.45		1.10	0.01	0.06	0.08	U	0.06	0.06	0.05	4.53	*	Less than Criteria	0.88		0.26	0.02	0.07	0.03	U	0.06	0.00	0.10	0.90		0.26	0.01	0.07	1.82	*	Less than Criteria
1C-12BGP	46	47	pCi/g	1.20		0.19	0.11	0.24	0.66		0.24	0.23	0.49	1.86		Less than Criteria	2.03		0.61	0.01	0.06	0.18	U	0.11	0.07	0.08	2.21	*	Less than Criteria	0.55		0.20	0.02	0.07	0.03	U	0.06	0.00	0.10	0.58		0.20	0.01	0.07	1.17	*	Less than Criteria
1C-12BGP	53	54	pCi/g	1.14		0.29	0.20	0.41	0.63	UJ	0.38	0.32	0.70	1.77	*	Less than Criteria	0.66		0.23	0.02	0.08	0.34		0.14	0.06	0.06	0.99		Less than Criteria	0.62		0.15	0.02	0.05	0.03	U	0.04	0.01	0.05	0.72		0.17	0.01	0.04	1.38	*	Less than Criteria
1C-12BGP	54	55	pCi/g	1.86		0.26	0.12	0.25	1.02		0.26	0.20	0.43	2.88		Less than Criteria	9.41		2.17	0.00	0.04	0.39		0.14	0.05	0.04	9.80		Exceeds Criteria	0.52		0.12	0.01	0.04	0.04		0.04	0.00	0.04	0.61		0.14	0.01	0.03	1.17		Less than Criteria
1C-12BGP	55	56	pCi/g	31.0	J	2.47	0.51	1.04	1.25	UJ	0.67	0.60	1.23	32.3	*	Exceeds Criteria	399		92.0	0.00	0.04	2.19		0.55	0.06	0.04	401		Exceeds Criteria	1.83		0.34	0.02	0.05	0.22		0.10	0.00	0.06	1.92		0.35	0.03	0.07	3.97		Less than Criteria
1C-12CGP	28	29	pCi/g	2.17		0.34	0.14	0.18	1.16	J	0.52	0.42	0.90	3.32		Less than Criteria	2.47		0.53	0.00	0.03	0.27		0.09	0.03	0.02	2.73		Less than Criteria	0.47		0.13	0.01	0.04	0.05		0.04	0.00	0.03	0.59		0.14	0.01	0.04	1.10		Less than Criteria
1C-12GP	48	49	pCi/g	1.46	J	0.39	0.29	0.60	1.48	J	0.65	0.61	1.29	2.94		Less than Criteria	1.74		0.52	0.02	0.08	0.14	U	0.10	0.12	0.12	1.88	*	Less than Criteria	0.54		0.14	0.01	0.04	0.01	U	0.02	0.00	0.04	0.56		0.14	0.00	0.03	1.10	*	Less than Criteria
1C-12GP	49	50	pCi/g	1.53		0.24	0.11	0.23	1.01	J	0.33	0.30	0.62	2.54		Less than Criteria	0.43		0.16	0.00	0.04	0.17		0.09	0.05	0.04	0.60		Less than Criteria	0.61		0.13	0.01	0.02	0.06		0.04	0.00	0.03	0.48		0.11	0.00	0.02	1.15		Less than Criteria
1C-6	19	20	pCi/g	1.40		0.19	0.11	0.23	1.13		0.23	0.18	0.37	2.54		Less than Criteria	1.29		0.38	0.01	0.06	1.71		0.45	0.08	0.06	3.00		Less than Criteria	1.26		0.30	0.02	0.07	0.10		0.08	0.01	0.08	1.03		0.26	0.01	0.08	2.39		Less than Criteria
1C-6	24	25	pCi/g	2.65		0.29	0.09	0.19	1.28		0.24	0.23	0.48	3.94		Less than Criteria	51.0		10.8	0.01	0.07	1.43		0.40	0.09	0.09	52.4		Exceeds Criteria	1.46		0.36	0.02	0.07	0.17		0.12	0.00	0.11	1.49		0.36	0.00	0.06	3.12		Less than Criteria
1C-6	25	26	pCi/g	7.04	J	0.94	0.34	0.71	0.13	UJ	0.63	0.46	1.01	7.17	*	Less than Criteria	240		52.0	0.01	0.09	1.09		0.33	0.09	0.07	241		Exceeds Criteria	1.08		0.27	0.02	0.07	0.10		0.08	0.01	0.07	1.04		0.26	0.05	0.12	2.21		Less than Criteria
1C-6	26	27	pCi/g	8.79	J	0.95	0.30	0.62	0.43	UJ	0.71	0.57	1.20	9.22	*	Exceeds Criteria	202		40.0	0.00	0.05	0.88		0.25	0.06	0.07	203		Exceeds Criteria	1.15		0.27	0.01	0.06	0.04	U	0.05	0.00	0.06	1.12		0.27	0.01	0.06	2.31	*	Less than Criteria
1C-6TIGP	22	23	pCi/g	1.45		0.20	0.12	0.16	0.84		0.21	0.17	0.36	2.29		Less than Criteria	0.39		0.14	0.00	0.03	0.21		0.09	0.04	0.05	0.60		Less than Criteria	0.60		0.13	0.01	0.03	0.05		0.04	0.00	0.03	0.53		0.12	0.00	0.02	1.19		Less than Criteria
WL-119CGP	34	35	pCi/g	1.28	J	0.32	0.24	0.51	1.36	J	0.43	0.43	0.91	2.64		Less than Criteria	0.38		0.13	0.01	0.05	0.31		0.11	0.04	0.04	0.69		Less than Criteria	0.60		0.16	0.01	0.04	0.03	U	0.04	0.00	0.05	0.58		0.16	0.00	0.05	1.20	*	Less than Criteria
WL-119CGP	38	39	pCi/g	1.57		0.33	0.23	0.48	1.44	J	0.37	0.38	0.81	3.01		Less than Criteria	0.65		0.19	0.01	0.05	0.56		0.16	0.05	0.05	1.20		Less than Criteria	0.36		0.10	0.01	0.02	0.03	U	0.03	0.00	0.03	0.35		0.10	0.00	0.03	0.73	*	Less than Criteria
WL-119CGP	43	44	pCi/g	1.31		0.20	0.13	0.27	0.98		0.21	0.16	0.35	2.30		Less than Criteria	3.03		0.68	0.00	0.04	0.40		0.13	0.04	0.04	3.44		Less than Criteria	0.48		0.12	0.01	0.02	0.02	U	0.02	0.00	0.03	0.53		0.13	0.00	0.03	1.03	*	Less than Criteria
WL-119CGP	45	46	pCi/g	0.87		0.18	0.16	0.34	0.32	U	0.25	0.21	0.46	1.19	*	Less than Criteria	4.20	Q	1.37	0.01	0.10	0.46		0.23	0.11	0.10	4.67		Less than Criteria	0.48		0.11	0.01	0.03	0.04		0.03	0.00	0.04	0.38		0.10	0.00	0.02	0.89		Less than Criteria
WL-119-Sonic	1	2	pCi/g	1.19		0.18	0.09	0.19	0.77		0.15	0.15	0.31	1.96		Less than Criteria	0.45		0.19	0.01	0.07	0.30		0.14	0.08	0.07	0.76		Less than Criteria	0.61		0.20	0.02	0.09	0.01	U	0.04	0.00	0.07	0.86		0.25	0.01	0.09	1.49	*	Less than Criteria
WL-119-Sonic	5	6	pCi/g	1.35		0.19	0.09	0.19	1.39		0.23	0.17	0.37	2.75		Less than Criteria	1.38		0.38	0.01	0.08	1.29		0.34	0.07	0.06	2.67		Less than Criteria	1.02		0.27	0.03	0.09	0.18		0.11	0.01	0.09	0.96		0.26	0.01	0.07	2.15		Less than Criteria
WL-119-Sonic	9	10	pCi/g	1.31		0.21	0.10	0.21	1.26	J	0.28	0.25	0.53	2.57		Less than Criteria	0.55		0.20	0.01	0.06	0.40		0.16	0.07	0.05	0.95		Less than Criteria	0.76		0.21	0.01	0.06	0.03	U	0.05	0.00	0.09	0.81		0.22	0.00	0.05	1.60	*	Less than Criteria
WL-119-Sonic	20	21	pCi/g	1.08		0.19	0.14	0.28	1.11		0.24	0.23	0.49	2.18		Less than Criteria	0.49		0.18	0.01	0.07	0.42		0.16	0.07	0.07	0.91		Less than Criteria	0.31		0.12	0.01	0.07	0.03	U	0.05	0.00	0.08	0.47		0.15	0.00	0.05	0.81	*	Less than Criteria
WL-119-Sonic	40	41	pCi/g	0.51		0.17	0.15	0.31	0.88		0.22	0.19	0.41	1.39		Less than Criteria	0.31		0.15	0.00	0.09	0.13	U	0.09	0.09	0.08	0.44	*	Less than Criteria	0.22		0.11	0.01	0.06	0.09		0.08	0.00	0.09	0.12		0.08	0.00	0.05	0.43		Less than Criteria
WL-119-Sonic	41	42	pCi/g	1.39		0.23	0.13	0.28	1.24	J	0.26	0.36	0.75	2.63		Less than Criteria	0.63		0.22	0.01	0.06	0.57		0.20	0.07	0.06	1.20		Less than Criteria	0.42		0.15	0.02	0.06	0.11		0.08	0.01	0.08	0.48		0.15	0.00	0.05	1.01		Less than Criteria
WL-119-Sonic	51	52	pCi/g	0.40		0.09	0.07	0.04	0.52		0.12	0.10	0.22	0.92		Less than Criteria	0.57		0.32	0.07	0.25	0.55		0.30	0.19	0.18	1.12		Less than Criteria	0.41		0.14	0.01	0.05	0.06	U	0.06	0.00	0.06	0.42		0.14	0.00	0.05	0.89	*	Less than Criteria
WL-119-Sonic_FD	9	10	pCi/g	1.41		0.21	0.12	0.24	1.32		0.24	0.20	0.42	2.72		Less than Criteria	0.58		0.19	0.01	0.05	0.52		0.17	0.05	0.06	1.10		Less than Criteria	0.58		0.17	0.01	0.05	0.01	U	0.03	0.00	0.05	0.48		0.16	0.00	0.06	1.07	*	Less than Criteria
Phase 1D data (and Cotter samples from Core of Phase 1D borings)																																															
1D-01	7	9	pCi/g	1.08	U	0.20	1.66	0.28	0.95		0.23	0.27	0.57	2.04	*	Less than Criteria	1.65	J+	0.45	0.08	0.08	0.39	J	0.16	0.01	0.07	2.05		Less than Criteria	0.44	J-	0.16	0.03		0.04	J	0.05	0.01		0.37	J	0.14	0.01		0.85		Less than Criteria
1D-01	24	27	pCi/g	1.11	U	0.28	1.56	0.44	0.47	J	0.32	0.28	0.62	1.58	*	Less than Criteria	1.21	J+	0.34	0.07	0.07	0.11	J	0.08	0.01	0.06	1.31		Less than Criteria	0.87	J-	0.22	0.01		0.08	J	0.07	0.00		0.77	J	0.20	0.00		1.72		Less than Criteria
1D-02	20	23	pCi/g	1.26		0.18	1.24	0.30	1.12		0.30	0.26	0.54	2.38		Less than Criteria	0.84	J+	0.25	0.05	0.05	0.45	J	0.16	0.00	0.05	1.29		Less than Criteria	0.31	J-	0.14	0.01		0.05	J	0.06	0.00		0.29	J	0.13	0.01		0.65		Less than Criteria
1D-02	27	30	pCi/g	1.14	U	0.23	1.51	0.34	1.05		0.35	0.27	0.58	2.19	*	Less than Criteria	0.68	J+	0.24	0.07	0.06	0.18	J	0.11	0.01	0.07	0.87		Less than Criteria	0.25	J-	0.14	0.01		0.08	J	0.08	0.01		0.37	J	0.17	0.01		0.70		Less than Criteria
1D-02	36	37	pCi/g	1.01	U	0.30	1.66	0.45	0.85	J	0.45	0.40	0.86	1.86	*	Less than Criteria	0.72	J+	0.26	0.08	0.08	0.70	J	0.25	0.01	0.08	1.42		Less than Criteria	0.25	J-	0.11	0.00		0.04	J	0.06	0.00		0.30	J	0.12	0.00		0.59		Less than Criteria
1D-03	28	29	pCi/g	188	J+	14.1	20.9	3.24	2.14	U	3.05	2.33	4.76	190	*	Exceeds Criteria	616	J+	128	0.08	0.09	4.07		0.92	0.01	0.06	620		Exceeds Criteria	9.36		1.52	0.01		0.73		0.25	0.01		9.27		1.51	0.00		19.4		Less than Criteria
1D-03	41	43	pCi/g	1.22	U	0.23	1.33	0.32	0.74		0.25	0.20	0.45	1.97	*	Less than Criteria	1.59	J+	0.43	0.07	0.07	0.21	J	0.11	0.00	0.07	1.80		Less than Criteria	0.22	J	0.11	0.01		0.00	UJ	0.04	0.00		0.28	J	0.12	0.00		0.50	*	Less than Criteria
1D-03_FD	41	43	pCi/g	0.41	U	0.22	1.50	0.57	0.29	J	0.32	0.26	0.58	0.70	*	Less than Criteria	0.73	J+	0.24	0.06	0.06	0.10	J	0.07	0.00	0.07	0.83		Less than Criteria	0.15	J	0.10	0.00		0.04	J	0.07	0.00		0.06	J	0.06	0.01		0.24		Less than Criteria
1D-04	61	62	pCi/g	1.25	U	0.20	1.31	0.21	1.15		0.27	0.23	0.50	2.40	*	Less than Criteria	1.84	J	0.62	0.18	0.18	1.47	J	0.51	0.01	0.15	3.31		Less than Criteria	2.83		1.26	0.06		0.32	J	0.55	0.01		2.78		1.25	0.10		5.93		Less than Criteria

Table 6-2: Area 1 Combined Radium, Thorium, and Uranium Results (RI Borings, Phases 1C and 1D, A1 Additional Borings, and Cotter Borings)

DRAFT

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226 Result	Radium-226 Final Q	Radium-226 CSU[1]	Radium-226 CV	Radium-226 MDA	Radium-228 Result	Radium-228 Final Q	Radium-228 CSU[1]	Radium-228 CV	Radium-228 MDA	Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230 Result	Thorium-230 Final Q	Thorium-230 CSU[1]	Thorium-230 CV	Thorium-230 MDA	Thorium-232 Result	Thorium-232 Final Q	Thorium-232 CSU[1]	Thorium-232 CV	Thorium-232 MDA	Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria	Uranium-234 Result	Uranium-234 Final Q	Uranium-234 CSU[1]	Uranium-234 CV	Uranium-234 MDA	Uranium-235 Result	Uranium-235 Final Q	Uranium-235 CSU[1]	Uranium-235 CV	Uranium-235 MDA	Uranium-238 Result	Uranium-238 Final Q	Uranium-238 CSU[1]	Uranium-238 CV	Uranium-238 MDA	Combined Uranium 234 + 235 + 238		Combined Uranium relative to 54.4 pCi/g Unrestricted Use Criteria
1D-04	64	65	pCi/g	0.86		0.15	0.77	0.21	0.70		0.18	0.15	0.32	1.56		Less than Criteria	0.77	J	0.25	0.09	0.11	0.66	J	0.22	0.04	0.12	1.43		Less than Criteria	1.42		0.62	0.05		0.37		0.36	0.00		1.78		0.70	0.04		3.58		Less than Criteria
1D-05	51	52	pCi/g	53.9		4.27	7.67	0.75	1.35		0.65	0.70	1.45	55.3		Exceeds Criteria	216	J	42.3	0.06	0.05	1.94	J	0.45	0.01	0.06	218		Exceeds Criteria	0.23		0.13	0.04		0.14		0.11	0.01		0.18		0.13	0.06		0.54		Less than Criteria
1D-05	63	64	pCi/g	1.06	U	0.18	1.18	0.21	0.84		0.22	0.22	0.47	1.90	*	Less than Criteria	0.45		0.19	0.07	0.09	0.19	J	0.11	0.01	0.09	0.65		Less than Criteria	0.27	J	0.18	0.02		0.06	J	0.07	0.01		0.26	J	0.15	0.01		0.59		Less than Criteria
1D-06	80	81	pCi/g	0.59	U	0.22	1.05	0.36	1.11		0.25	0.23	0.50	1.70	*	Less than Criteria	0.42		0.19	0.13	0.14	0.31		0.16	0.05	0.14	0.73		Less than Criteria	2.24		0.45	0.00		0.11		0.09	0.00		2.19		0.44	0.02		4.54		Less than Criteria
1D-06	85	86	pCi/g	0.50	U	0.13	1.09	0.20	0.47		0.22	0.23	0.49	0.97	*	Less than Criteria	0.50	J	0.19	0.08	0.07	0.19	J	0.11	0.01	0.07	0.69		Less than Criteria	0.17	J	0.12	0.02		0.02	J	0.05	0.00		0.31	J	0.16	0.01		0.50		Less than Criteria
1D-07	84	85	pCi/g	3,630		242	105	11.7	31.8		9.45	8.29	16.7	3,662		Exceeds Criteria	16,703		3,437	20.9	23.0	178		53.1	8.73	22.6	16,881		Exceeds Criteria	373		167	9.89		40.9	J	69.7	1.09		223		126	9.38		637		Exceeds Criteria
1D-07	93	94	pCi/g	1.50		0.28	1.37	0.22	0.61		0.31	0.23	0.51	2.11		Less than Criteria	18.0		4.29	0.10	0.10	0.38		0.19	0.02	0.12	18.4		Exceeds Criteria	0.16		0.10	0.00		0.05	J	0.07	0.00		0.22		0.11	0.00		0.43		Less than Criteria
1D-08	75	76	pCi/g	4.54		0.47	1.77	0.40	0.94		0.27	0.24	0.50	5.48		Less than Criteria	3.54	J	0.93	0.13	0.15	0.24	J	0.16	0.02	0.13	3.77		Less than Criteria	0.66	UJ	0.48	0.24		0.26	UJ	0.38	0.09		0.59	UJ	0.68	0.39		Non-detect	*	Non-detect
1D-08	90	91	pCi/g	0.51	U	0.10	0.69	0.13	0.69		0.18	0.17	0.36	1.19	*	Less than Criteria	0.99	J	0.36	0.12	0.12	0.75	J	0.25	0.01	0.07	1.74		Less than Criteria	0.90	J	0.52	0.03		0.25	J	0.30	0.02		0.82	J	0.50	0.03		1.97		Less than Criteria
1D-09	78	79	pCi/g	0.21	U	0.25	2.37	0.43	0.16	U	0.44	0.33	0.74	Non-detect	*	Non-detect	0.34	J+	0.15	0.07	0.07	0.19	J	0.11	0.01	0.07	0.53		Less than Criteria	0.06	J-	0.06	0.01		0.06	J	0.06	0.00		0.04	J	0.05	0.01		0.16		Less than Criteria
1D-09	88	89	pCi/g	40.2	J	9.94	4.59	1.05	3.58	U	2.31	0.49	4.24	43.8	*	Exceeds Criteria	906	J+	181	0.24	0.29	3.76	J	1.08	0.10	0.38	909		Exceeds Criteria	3.41	J-	0.99	0.07		0.62	UJ	0.43	0.11		3.23	J	0.96	0.10		7.25	*	Less than Criteria
1D-09	99	100	pCi/g	0.66	U	0.10	1.25	0.17	0.48		0.13	0.21	0.29	1.14	*	Less than Criteria	3.41	J+	0.82	0.07	0.08	0.19	J	0.11	0.01	0.08	3.60		Less than Criteria	0.28	J-	0.14	0.04		0.13	J	0.10	0.01		0.28	J	0.13	0.01		0.68		Less than Criteria
1D-10	46	49	pCi/g	1.34	U	0.24	1.43	0.34	1.58		0.29	0.25	0.54	2.92	*	Less than Criteria	0.46	J	0.17	0.06	0.06	0.33	J	0.13	0.00	0.05	0.79		Less than Criteria	0.21	J	0.13	0.01		0.06	J+	0.08	0.01		0.46	J	0.20	0.00		0.73		Less than Criteria
1D-10	74	76	pCi/g	0.81	U	0.20	1.14	0.26	0.66		0.23	0.19	0.43	1.47	*	Less than Criteria	0.31		0.13	0.06	0.06	0.32		0.13	0.01	0.06	0.62		Less than Criteria	0.38		0.16	0.02		0.15	J+	0.11	0.01		0.33		0.16	0.05		0.86		Less than Criteria
1D-11	85	86	pCi/g	24.4	J+	1.86	2.84	0.55	1.10		0.44	0.39	0.80	25.5		Exceeds Criteria	119	J+	24.1	0.06	0.07	1.35		0.34	0.00	0.05	120		Exceeds Criteria	1.48		0.33	0.00		0.07	J	0.07	0.00		1.41		0.32	0.01		2.97		Less than Criteria
1D-11	87	88	pCi/g	0.73	U	0.13	0.96	0.17	0.68		0.18	0.14	0.29	1.42	*	Less than Criteria	1.38	J+	0.36	0.05	0.06	0.26	J	0.11	0.00	0.04	1.64		Less than Criteria	0.86		0.24	0.02		0.07	J	0.07	0.01		0.74		0.22	0.03		1.66		Less than Criteria
1D-12	61	62	pCi/g	0.58	U	0.47	2.50	0.74	-0.37	U	0.67	0.36	0.86	Non-detect	*	Non-detect	0.73	J+	0.24	0.07	0.06	0.16	J	0.10	0.00	0.06	0.89		Less than Criteria	0.11	J	0.08	0.00		0.01	J	0.03	0.00		0.08	J	0.07	0.01		0.20		Less than Criteria
1D-12	74	75	pCi/g	1.02	U	0.18	1.58	0.23	1.09		0.23	0.19	0.40	2.11	*	Less than Criteria	0.35	J+	0.14	0.05	0.04	0.17	J	0.09	0.01	0.06	0.51		Less than Criteria	0.23		0.11	0.01		0.03	J	0.04	0.00		0.21	J	0.11	0.04		0.47		Less than Criteria
1D-13	85	86	pCi/g	1.17	U	0.19	1.56	0.28	1.11		0.25	0.25	0.52	2.28	*	Less than Criteria	0.62	J+	0.21	0.06	0.06	0.52	J	0.18	0.00	0.06	1.13		Less than Criteria	0.30	J-	0.18	0.01		0.06	J	0.10	0.00		0.27	J	0.17	0.01		0.63		Less than Criteria
1D-13	93	94	pCi/g	4.22		0.37	1.48	0.28	0.46	J	0.21	0.20	0.36	4.68		Less than Criteria	4.27	J+	0.97	0.11	0.07	0.26	J	0.15	0.01	0.06	4.54		Less than Criteria	2.77	J-	0.58	0.02		0.31	J	0.18	0.01		3.63	J	0.71	0.06		6.71		Less than Criteria
1D-14	54	55	pCi/g	0.40	U	0.30	2.37	0.53	0.14	U	0.51	0.38	0.85	Non-detect	*	Non-detect	0.21	J+	0.10	0.07	0.08	0.02	UJ	0.05	0.03	0.09	0.23	*	Less than Criteria	0.21	J-	0.10	0.00		0.01	J	0.03	0.00		0.09	J	0.07	0.00		0.32		Less than Criteria
1D-14	82	84	pCi/g	1.31	U	0.27	1.52	0.14	0.87		0.32	0.49	1.03	2.18	*	Less than Criteria	0.74	J+	0.24	0.06	0.05	0.34	J	0.14	0.01	0.06	1.08		Less than Criteria	0.40	J-	0.18	0.01		0.02	J	0.07	0.02		0.41	J	0.18	0.01		0.83		Less than Criteria
1D-15	77	80	pCi/g	0.70	U	0.19	1.03	0.30	0.49		0.21	0.26	0.55	1.20	*	Less than Criteria	0.20	J+	0.10	0.05	0.06	0.04	J	0.06	0.04	0.09	0.24		Less than Criteria	0.14	J	0.09	0.01		-0.01	U	0.03	0.01		0.08	J	0.07	0.01		0.22	*	Less than Criteria
1D-15	85	86	pCi/g	8.82	J+	0.85	2.85	0.48	0.24	U	0.42	0.32	0.68	9.06	*	Exceeds Criteria	30.9	J+	6.16	0.05	0.05	0.31	J	0.12	0.01	0.06	31.2		Exceeds Criteria	0.46		0.16	0.01		0.04	J	0.05	0.01		0.48		0.16	0.00		0.98		Less than Criteria
1D-16	50	51	pCi/g	33.5		2.76	5.55	0.84	0.98		0.65	0.74	1.52	34.4		Exceeds Criteria	971	J	198	0.06	0.05	6.45	J	1.31	0.01	0.07	978		Exceeds Criteria	5.03	J	1.00	0.05		0.30	J	0.19	0.04		4.77	J	0.96	0.06		10.1		Less than Criteria
1D-16	59	61	pCi/g	0.58	U	0.21	1.21	0.30	0.66		0.34	0.33	0.70	1.24	*	Less than Criteria	0.61		0.23	0.08	0.07	0.28		0.14	0.01	0.08	0.89		Less than Criteria	0.10	J	0.08	0.01		0.12	J	0.10	0.00		0.18	J	0.10	0.00		0.40		Less than Criteria
1D-16_FD	59	61	pCi/g	0.52	U	0.17	1.20	0.23	0.59		0.28	0.27	0.59	1.11	*	Less than Criteria	0.37		0.24	0.21	0.23	0.27		0.18	0.01	0.13	0.64		Less than Criteria	0.08		0.07	0.01		0.03	J	0.05	0.00		0.29	J	0.13	0.01		0.40		Less than Criteria
1D-17	30	31	pCi/g	0.38	U	0.21	1.46	0.40	0.39	J	0.41	0.35	0.75	0.77	*	Less than Criteria	0.35	J+	0.15	0.06	0.06	0.15	J	0.09	0.01	0.07	0.51		Less than Criteria	0.14	J-	0.09	0.00		0.03	J	0.04	0.00		0.13	J	0.08	0.00		0.30		Less than Criteria
1D-17	33	36	pCi/g	0.75	U	0.26	1.54	0.19	0.41	J	0.36	0.32	0.70	1.16	*	Less than Criteria	4.00	J+	0.97	0.08	0.07	0.18	J	0.12	0.04	0.13	4.18		Less than Criteria	0.85	J-	0.34	0.02		0.04	J	0.10	0.00		0.47	J	0.24	0.01		1.36		Less than Criteria
1D-18	13	14	pCi/g	0.76	U	0.16	1.24	0.20	0.31	J	0.16	0.12	0.27	1.07	*	Less than Criteria	0.56	J+	0.20	0.06	0.05	0.16	J	0.09	0.01	0.06	0.71		Less than Criteria	0.42	J-	0.16	0.01		0.05	J	0.06	0.00		0.21	J	0.11	0.00		0.67		Less than Criteria
1D-18	38	41	pCi/g	0.52	U	0.20	1.58	0.53	0.26	U	0.35	0.29	0.63	Non-detect	*	Non-detect	5.97	J+	1.38	0.07	0.07	0.05	J	0.06	0.00	0.06	6.03		Less than Criteria	0.22	J-	0.12	0.01		0.05	J	0.06	0.00		0.11	J	0.08	0.01		0.38		Less than Criteria
1D-18	44	46	pCi/g	1.34		0.21	1.33	0.22	1.40		0.27	0.25	0.52	2.74		Less than Criteria	1.29	J+	0.38	0.07	0.06	0.78	J	0.26	0.00	0.09	2.07		Less than Criteria	0.31	J-	0.19	0.01		0.12	J	0.13	0.01		0.28	J	0.18	0.01		0.71		Less than Criteria
1D-19	61	63	pCi/g	1.17	U	0.32	2.31	0.43	1.23		0.50	0.46	0.97	2.40	*	Less than Criteria	1.08	J	0.35	0.09	0.08	0.54	J	0.22	0.01	0.09	1.62		Less than Criteria	0.47	J	0.19	0.01		0.16	J+	0.11	0.01		0.55	J	0.21	0.01		1.19		Less than Criteria
1D-19_FD	61	63	pCi/g	1.28	J+	0.18	1.20	0.20	1.08		0.24	0.27	0.55	2.36		Less than Criteria	0.70		0.24	0.09	0.10	0.24	J	0.13	0.02	0.10	0.94		Less than Criteria	0.66	J	0.21	0.00		0.19	J+	0.12	0.00		0.58	J	0.20	0.01		1.43		Less than Criteria
1D-20	80	81	pCi/g	0.71	U	0.10	0.75	0.04	0.08	J	0.10	0.08	0.17	0.80	*	Less than Criteria	1.36	J	0.59	0.23	0.27	0.38	J	0.28	0.04	0.28	1.73		Less than Criteria	1.92	J	0.83	0.13		0.14	UJ	0.40	0.20		0.93	J	0.59	0.16		3.00	*	Less than Criteria
1D-20_FD	80	81	pCi/g	0.83	U	0.13	0.91	0.12	0.05	U	0.15	0.12	0.26	Non-detect	*	Non-detect	1.43		0.51	0.14	0.14	0.14	J	0.12	0.01	0.10	1.57		Less than Criteria	2.10		0.79	0.02		0.47		0.40	0.02		1.04		0.54	0.02		3.62		Less than Criteria
1D-20	89	90	pCi/g	1.33	U	0.19	1.44	0.22	1.15		0.23	0.20	0.42	2.47	*	Less than Criteria	1.43		0.49	0.14	0.11	1.20		0.42	0.02	0.15	2.63		Less than Criteria	3.36		1.55	0.10		0.34	J	0.57	0.07		3.98		1.70	0.12		7.68		Less than Criteria
Area 1 Additional Borings																																															
AC-01	10	11	pCi/g	4,926		343	139	28.7	14.8	U	20.7	15.5	31.3	4,941	*	Exceeds Criteria	7,908	J+	1,823	8.73	11.1	257		69.6	5.04	15.7	8,165		Exceeds Criteria	183		41.4	3.48	8.11	30.5	J+	16.0	0.23	11.4	206	J+	44.9	0.53	9.23	420		Exceeds Criteria
AC-01	30	31	pCi/g	49.5		3.87	5.65	0.99	0.98	J	0.77	0.57	1.17	50.4		Exceeds Criteria	1,946		436	0.10	0.11	10.2		2.21	0.00	0.06	1,956		Exceeds Criteria	5.58		0.87	0.01	0.05	0.28		0.12	0.00	0.05	5.51		0.86	0.00	0.04	11.4		Less than Criteria
AC-02B	10	12	pCi/g	8.95		0.83	2.16	0.38	0.56	J	0.32	0.39	0.80	9.51		Exceeds Criteria	472		111	0.08	0.09	2.91		0.74	0.01	0.08	475		Exceeds Criteria	1.83		0.37	0.01	0.04	0.09	J	0.07	0.00	0.06	1.91		0.38	0.00	0.06	3.82		Less than Criteria
AC-02B	23	26	pCi/g	0.98	U	0.26	1.65	0.41	1.27		0.36	0.37	0.79	2.25	*	Less than Criteria	1.79		0.47	0.07	0.08	0.77		0.23	0.01	0.07	2.56		Less than Criteria	0.62		0.17	0.01	0.05	0.03	J	0.04	0.00	0.05	0.60		0.17	0.01	0.05	1.26		Less than Criteria
AC-03	5	6	pCi/g	2,599		183	113	20.3	6.28	U	16.0	12.0	24.2	2,606	*	Exceeds Criteria	17,784	J+	3,962	8.73	11.3	515		121	2.57	12.0	18,299		Exceeds Criteria	129	J	30.6	3.00	6.94	17.7	J+	10.9	0.43	6.81	140	J+	32.2	1.13	6.91	287		Exceeds Criteria
AC-03	44	45	pCi/g	0.40	U	0.20	1.07	0.31	0.26	J	0.31	0.25	0.55	0.66	*	Less than Criteria	0.59		0.20	0.06	0.07	0.39		0.15	0.01	0.06	0.98		Less than Criteria	0.33	J+	0.13	0.03	0.07	0.05	J	0.06	0.01	0.08	0.34		0.14	0.01	0.06	0.72		Less than Criteria
AC-04B	13	14	pCi/g	0.62	U	0.36	1.96	0.63	0.91		0.41	0.47	1.03	1.53	*	Less than Criteria	1.96		0.51	0.06	0.05	0.24		0.11	0.00	0.05	2.20		Less than Criteria	0.33	J	0.11	0.01	0.06	0.06	J	0.05	0.00	0.05	0.22	J	0.09	0.00	0.04	0.61		Less than Criteria
AC-04B	32	33	pCi/g	1.01	U	0.16	1.12	0.23	1.16		0.19	0.12	0.26	2.17	*	Less than Criteria	4.62	J	1.03	0.06	0.06	0.92	J	0.25	0.01	0.05	5.54		Less than Criteria	0.47	J	0.14	0.01	0.05	0.00	UJ	0.02	0.00	0.05	0.45	J	0.13	0.01	0.04	0.92	*	Less than Criteria
AC-04B_FD	32	33	pCi/g	0.96	U	0.14	0.99	0.16	1.20		0.23	0.21	0.44	2.16	*	Less than Criteria	1.38	J	0.40	0.06	0.06	0.90		0.28	0.00	0.07	2.27		Less than Criteria	0.57	J	0.15	0.01	0.04	0.11	J	0.07	0.00	0.06	0.52	J	0.14	0.01	0.04	1.20		Less than Criteria
AC-05	11	12	pCi/g	1.11	U	0.16	1.17	0.19	1.27		0.23	0.16	0.34	2.38	*	Less than Criteria	3.28		0.81	0.06	0.06	1.04	J	0.30	0.01	0.06	4.32		Less than Criteria	0.80	J	0.20	0.01	0.05	0.05	J	0.05	0.00	0.06	0.85	J	0.21	0.00	0.04	1.70		Less than Criteria
AC-05	25	26	pCi/g	0.80	U	0.13	0.94	0.17	0.84		0.18	0.14	0.30	1.65	*	Less than Criteria	1.20		0.31	0.05	0.05	1.03		0.26	0.00	0.03	2.24		Less than Criteria	0.48	J	0.14	0.04	0.09	0.08	J	0.06	0.01	0.06	0.66	J	0.17	0.01	0.05	1.22		Less than Criteria
AC-06	13	16	pCi/g	1.05	U	0.14	1.28	0.24	1.21		0.21	0.17	0.35	2.26	*	Less than Criteria	0.97		0.31	0.08	0.08	1.25		0.36	0.01	0.08	2.22		Less than Criteria	0.67	J	0.17	0.01	0.04	0.03	J	0.04	0.00	0.07	0.66	J	0.17	0.00	0.04	1.37		Less than Criteria
AC-06	23	26	pCi/g	0.60	U	0.11	0.88	0.12	0.70		0.16	0.14	0.29	1.30	*	Less than Criteria	1.36	J	0.37	0.07	0.07	0.50	J	0.17	0.01	0.06	1.86		Less than Criteria	0.41	J	0.13	0.01	0.06	0.08	J	0.06	0.00	0.05	0.50	J	0.15	0.00	0.04	0.98		Less than Criteria
AC-07	22	23	pCi/g	1.20	U	0.22	1.26	0.30	1.40		0.24	0.30	0.63	2.60	*	Less than Criteria	1.45		0.38	0.05	0.05	1.23		0.32	0.00	0.05	2.68		Less than Criteria	0.83	J	0.20	0.01	0.05	0.07	J	0.05	0.00	0.05	0.80	J	0.19	0.00	0.04	1.70		Less than Criteria
AC-07	32	33	pCi/g	0.73	U	0.21	1.36	0.32	0.90		0.33	0.31	0.66	1.63	*	Less than Criteria	0.86		0.29	0.07	0.07	0.50		0.20	0.03	0.11	1.37		Less than Criteria	0.39	J	0.12	0.01	0.04	0.04	J	0.04	0.00	0.05	0.48	J	0.14	0.01	0.04	0.91		Less than Criteria
Cotter Borings																																															
WL-102A-CT	2	3	pCi/g	1.03		0.15	0.03	0.07	0.14	U	0.25	0.20	0.42	1.17	*	Less than Criteria	5.81	J+	0.42	0.01	0.02	0.83	J	0.16	0.01	0.04	6.64		Less than Criteria	0.64		0.17	0.01	0.03	0.05	J	0.06	0.02	0.07	0.58		0.16	0.01	0.03	1.27		Less than Criteria
WL-102A-CT	4	5	pCi/g	0.58	J+	0.27	0.34	0.14	0.12	UJ	0.43	0.76	0.35	0.70	*	Less than Criteria	4.43	J+	0.38	0.05	0.01	0.58		0.14	0.04	0.01	5.01		Less than Criteria	0.51		0.15	0.03	0.01	0.02	U	0.04	0.07	0.01	0.49		0.14	0.06	0.01	1.02	*	Less than Criteria
WL-102A-CT_FD	4	5	pCi/g	6.75	J+	0.58	0.26	0.11	0.05	UJ	0.24	0.42	0.19	6.80	*	Less than Criteria	1.82	J+	0.24	0.05	0.02	0.68		0.14	0.05	0.01	2.50		Less than Criteria	0.54		0.15	0.03	0.01	0.01	U	0.03	0.06	0.01	0.53		0.15	0.03	0.01	1.08	*	Less than Criteria
WL-102A-CT	22	23	pCi/g	1.41		0.19	0.03	0.08	1.11		0.32	0.19	0.42	2.52		Less than Criteria	1.75	J+	0.24	0.01	0.02	1.23		0.20	0.01	0.04	2.98		Less than Criteria	1.01		0.20	0.01	0.05	0.05	J	0.05	0.01	0.04	1.05		0.21	0.01	0.05	2.11		Less than Criteria
WL-106A-CT	4	6	pCi/g	18.0		0.61	0.03	0.07	0.77		0.29	0.19	0.40	18.8		Exceeds Criteria	401	J+	3.58	0.01	0.05	1.14		0.19	0.01	0.02	402		Exceeds Criteria	11.3	J	0.82	0.01	0.04	0.69	J	0.23	0.01	0.06	12.2	J	0.85	0.01	0.04	24.2		Less than Criteria
WL-106A-CT	10	12	pCi/g	9.64	J+	0.69	0.28	0.12	0.27	UJ	0.31	0.51	0.23	9.91	*	Exceeds Criteria	165	J+	2.60	0.07	0.02	0.83	J	0.18	0.05	0.01	166		Exceeds Criteria	3.94		0.41	0.06	0.01	0.24		0.12	0.07	0.02	4.67		0.44	0.03	0.01	8.85		Less than Criteria
WL-114-CT	7	8	pCi/g	0.98	J+	0.23	0.18	0.07	0.74		0.34	0.51	0.24	1.72		Less than Criteria	4.78	J+	0.40	0.04	0.01	0.89		0.18	0.06	0.02	5.67		Less than Criteria	0.72		0.18	0.07	0.02	0.02	U	0.04	0.06	0.01	0.78		0.18	0.06	0.01	1.52	*	Less than Criteria
WL-114-CT	32	33	pCi/g	0.46		0.10	0.03	0.08	0.51		0.25	0.17	0.37	0.97		Less than Criteria	0.64	J+	0.14	0.02	0.05	0.47		0.12	0.01	0.04	1.11		Less than Criteria	0.43		0.14	0.01	0.05	0.01	J	0.03	0.01	0.04	0.32		0.12	0.01	0.06	0.76		Less than Criteria
Cotter Samples from Core of Non-Cotter Borings																																															
01-2-CT	39	40	pCi/g	0.72	J+	0.22	0.24	0.11	0.51	UJ	0.34	0.53	0.25	1.23	*	Less than Criteria	0.86	J+	0.16	0.04	0.01	0.35		0.10	0.03	0.00	1.20		Less than Criteria	0.39		0.13	0.07	0.02	0.01	U	0.03	0.04	0.01	0.41		0.13	0.06	0.01	0.82	*	Less than Criteria
05-3-CT-A	28	30	pCi/g	33.7	J+	1.23	0.19	0.08	0.57	J	0.35	0.55	0.26	34.3		Exceeds Criteria	3,660	J+	143	7.71	1.76	7.17	U	6.99	9.12	2.48	3,667	*	Exceeds Criteria	6.10		0.54	0.09	0.03	0.34		0.14	0.07	0.01	5.51		0.51	0.08	0.02	11.9		Less than Criteria
05-3-CT-B	33	34	pCi/g	73.9	J+	1.80	0.20	0.08	0.40	U	0.30	0.47	0.22	74.3	*	Exceeds Criteria	2,310	J+	158	8.12	3.42	0.45	U	6.25	17.7	4.81	2,310	*	Exceeds Criteria	12.3		0.80	0.10	0.03	0.67		0.21	0.07	0.01	12.1		0.79	0.10	0.03	25.1		Less than Criteria
1C-6-CT	25	27	pCi/g	26.7	J+	1.16	0.21	0.09	0.29	U	0.33	0.54	0.25	27.0	*	Exceeds Criteria	2,450	J+	95.6	2.79	1.18	2.78	U	3.21	2.78	1.17	2,453	*	Exceeds Criteria	2.09		0.29	0.05	0.01	0.06	U	0.06	0.06	0.01	1.81		0.27	0.06	0.02	3.96	*	Less than Criteria
1D-16-CT	46	47	pCi/g	2.74	J+	0.37	0.26	0.11	0.32	U	0.28	0.46	0.21	3.06	*	Less than Criteria	1.84	J+	0.24	0.02	0.01	0.85		0.16	0.04	0.01	2.69		Less than Criteria	0.69		0.17	0.05	0.01	0.03	U	0.04	0.07	0.02	0.55		0.15	0.06	0.02	1.27	*	Less than Criteria
1D-7-CT	83	84	pCi/g	1,200	J+	9.25	0.29	0.12	4.94	J	0.49	0.36	0.17	1,205		Exceeds Criteria	678,000	J+	15,300	475	109	847	J	538	256	108	678,847		Exceeds Criteria	21.3		1.02	0.06	0.01	0.76		0.21	0.05	0.01	14.6		0.84	0.04	0.01	36.7		Less than Criteria
Cotter Third Phase Samples																																															
AC-01-CT	19	20	pCi/g	38.3		0.82	0.03	0.07	0.37	J+	0.24	0.17	0.36	38.7		Exceeds Criteria	1,350	J+	6.55	0.01	0.04	1.92		0.25	0.01	0.04	1,352		Exceeds Criteria	3.69		0.42	0.02	0.07	0.12	J	0.08	0.01	0.04	4.12		0.44	0.01	0.04	7.93		Less than Criteria

Table 6-2: Area 1 Combined Radium, Thorium, and Uranium Results (RI Borings, Phases 1C and 1D, A1 Additional Borings, and Cotter Borings)

DRAFT

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226 Result	Final Q	CSU[1]	CV	MDA	Radium-228 Result	Final Q	CSU[1]	CV	MDA	Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230 Result	Final Q	CSU[1]	CV	MDA	Thorium-232 Result	Final Q	CSU[1]	CV	MDA	Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria	Uranium-234 Result	Final Q	CSU[1]	CV	MDA	Uranium-235 Result	Final Q	CSU[1]	CV	MDA	Uranium-238 Result	Final Q	CSU[1]	CV	MDA	Combined Uranium 234 + 235 + 238	Combined Uranium relative to 54.4 pCi/g Unrestricted Use Criteria
AC-03-CT	9	10	pCi/g	141	J	1.70	0.05	0.12	0.29	J+	0.22	0.16	0.34	141		Exceeds Criteria	4,130	J+	11.5	0.01	0.02	4.02		0.36	0.01	0.04	4,134		Exceeds Criteria	8.10		0.59	0.01	0.06	0.31		0.13	0.01	0.06	7.45		0.57	0.01	0.03	15.9	Less than Criteria
AC-03-CT	14	19	pCi/g	1.01		0.14	0.02	0.06	0.31	J+	0.24	0.17	0.38	1.32		Less than Criteria	2.02	J+	0.25	0.01	0.04	0.84		0.16	0.01	0.02	2.86		Less than Criteria	0.64		0.18	0.02	0.07	0.03	J	0.04	0.01	0.05	0.69		0.19	0.01	0.06	1.35	Less than Criteria
AC-03-CT	36	39	pCi/g	0.44	J	0.11	0.04	0.09	0.23	J+	0.31	0.23	0.51	0.67		Less than Criteria	0.97	J+	0.18	0.02	0.06	0.37		0.11	0.01	0.04	1.33		Less than Criteria	0.32		0.13	0.02	0.07	0.01	J	0.03	0.01	0.07	0.30		0.13	0.02	0.08	0.63	Less than Criteria
EPA Verification Samples																																													
01-2-CT_(es)	39	40	pCi/g	0.63	U	0.30		1.63	0.36	U	0.10		0.53	Non-detect		Less than Criteria	0.00	U			0.00	0.87		0.15		0.17	0.87	*	Less than Criteria																
01-2-CT_(es)_SD	39	40	pCi/g	1.48	U	0.30		1.70	0.55	U	0.10		0.57	Non-detect		Less than Criteria	1.34	J	0.19		0.21	3.72	J			1.96	5.06		Less than Criteria																
05-3-CT-A_(es)	28	30	pCi/g	37.2		1.84		5.75	1.18	U	0.28		1.40	38.4	*	Exceeds Criteria	0.04				0.01	1.58	U	0.76		2.78	1.62	*	Less than Criteria																
05-3-CT-A_(es)_SD	28	30	pCi/g	29.1		1.65		5.80	0.76	U	0.24		1.20	29.9	*	Exceeds Criteria	813		52.3		2.17	7.15				1.56	820		Exceeds Criteria																
05-3-CT-B_(es)	33	34	pCi/g	126		5.83		15.5	-0.29	U	0.91		4.28	126	*	Exceeds Criteria	0.09				0.00	9.11		1.60		2.24	9.20		Exceeds Criteria																
05-3-CT-B_(es)_SD	33	34	pCi/g	79.9		3.89		12.5	1.18	U	0.49		2.38	81.1	*	Exceeds Criteria	2,350		148		1.79	5.03				2.01	2,355		Exceeds Criteria																
1C-6-CT_(es)	25	27	pCi/g	40.9		2.83		9.49	1.48	U	0.50		2.60	42.4	*	Exceeds Criteria	0.03				0.00	7.91		1.48		1.83	7.94		Exceeds Criteria																
1C-6-CT_(es)_SD	25	27	pCi/g	26.0		2.14		7.19	0.26	U	0.44		2.19	26.3	*	Exceeds Criteria	799		51.7		1.84	1.96	U			1.96	801	*	Exceeds Criteria																
1D-07-CT_(es)	83	84	pCi/g	3,810		221		216	5.86	U	6.36		29.4	3,816	*	Exceeds Criteria	3.73				0.01	208		52.0		88.4	212		Exceeds Criteria																
1D-07-CT_(es)_SD	83	84	pCi/g	3,560		207		208	-0.44	U	6.09		28.1	3,560	*	Exceeds Criteria	45,100		2,900		88.7	78.6				1.92	45,179		Exceeds Criteria																
1D-16-CT_(es)	46	47	pCi/g	2.63		0.48		2.00	1.07		0.11		0.37	3.70		Less than Criteria	0.00	U			0.00	1.06		0.17		0.20	1.06	*	Less than Criteria																
1D-16-CT_(es)_SD	46	47	pCi/g	2.77		0.44		2.46	1.08		0.10		0.37	3.85		Less than Criteria	3.57	J	0.35		0.16	8.19				1.72	11.8		Exceeds Criteria																
WL-102A-CT_(es)	4	5	pCi/g	1.90	U	0.43		2.39	0.92		0.13		0.34	2.82	*	Less than Criteria	0.00	U			0.00	0.65		0.13		0.21	0.65	*	Less than Criteria																
WL-102A-CT_(es)_FD	4	5	pCi/g	1.24	U	0.36		1.96	0.56		0.07		0.33	1.80	*	Less than Criteria	0.00	U			0.00	0.55		0.11		0.16	0.55	*	Less than Criteria																
WL-102A-CT_(es)_FD_SD	4	5	pCi/g	1.73		0.31		1.72	0.61		0.07		0.28	2.34		Less than Criteria	2.02	J	0.24		0.16	5.72				1.63	7.74		Less than Criteria																
WL-102A-CT_(es)_SD	4	5	pCi/g	1.13	U	0.28		1.19	0.48		0.06		0.22	1.61	*	Less than Criteria	4.85		0.44		0.17	5.20				1.94	10.1		Exceeds Criteria																
WL-106A-CT_(es)	10	12	pCi/g	8.12		0.63		2.22	0.22	U	0.12		0.59	8.34	*	Exceeds Criteria	0.01				0.00	0.56		0.17		0.36	0.57		Less than Criteria																
WL-106A-CT_(es)_SD	10	12	pCi/g	10.6		0.83		3.13	0.50	U	0.12		0.62	11.1	*	Exceeds Criteria	111		7.29		0.36	1.68	J			1.66	113		Exceeds Criteria																
WL-114-CT_(es)	7	8	pCi/g	2.37	U	0.45		2.51	0.90		0.09		0.42	3.27	*	Less than Criteria	0.00	U			0.00	1.23		0.19		0.24	1.23	*	Less than Criteria																
WL-114-CT_(es)_SD	7	8	pCi/g	2.94		0.40		2.27	0.87		0.09		0.32	3.81		Less than Criteria	5.70	J	0.52		0.24	6.48				2.00	12.2		Exceeds Criteria																
EPA Split Samples																																												
AC-05_(es)	11	12	pCi/g	1.32		0.29	0.07	0.18	1.31		0.33	0.11	0.29	2.63		Less than Criteria	2.55		0.36	0.01	0.02	1.31		0.33	0.11	0.29	3.86		Less than Criteria										0.82	U	0.84	1.12	2.38	0.82	Less than Criteria
AC-05_(es)	11	12	pCi/g	1.32		0.29	0.07	0.18	1.31		0.33	0.11	0.29	2.63		Less than Criteria	2.55		0.36	0.01	0.02	1.31		0.33	0.11	0.29	3.86		Less than Criteria										0.82	U	0.84	1.12	2.38	0.82	Less than Criteria
AC-05_(es)_SD	11	12	pCi/g																			0.76		0.17	0.01	0.02	0.76		Less than Criteria										0.64		0.16	0.01	0.04	0.64	Less than Criteria
AC-05_(es)_SD	11	12	pCi/g																			0.76		0.17	0.01	0.02	0.76		Less than Criteria										0.64		0.16	0.01	0.04	0.64	Less than Criteria
AC-05_(es)	25	26	pCi/g	0.74		0.20	0.08	0.17	0.85		0.21	0.05	0.13	1.59		Less than Criteria	0.93		0.19	0.01	0.04	0.85		0.21	0.05	0.13	1.79		Less than Criteria										0.93		0.57	0.79	1.67	0.93	Less than Criteria
AC-05_(es)	25	26	pCi/g	0.74		0.20	0.08	0.17	0.85		0.21	0.05	0.13	1.59		Less than Criteria	0.93		0.19	0.01	0.04	0.85		0.21	0.05	0.13	1.79		Less than Criteria										0.93		0.57	0.79	1.67	0.93	Less than Criteria
AC-05_(es)_SD	25	26	pCi/g																			0.92		0.19	0.01	0.02	0.92		Less than Criteria										0.57		0.15	0.01	0.04	0.57	Less than Criteria
AC-05_(es)_SD	25	26	pCi/g																			0.92		0.19	0.01	0.02	0.92		Less than Criteria										0.57		0.15	0.01	0.04	0.57	Less than Criteria
EPA Pyrolosis Samples																																											
1D-07_pyr	84	85	pCi/g	3,430		178		16.0						3,430		Exceeds Criteria	57,400		3,490		34.5	261		37.9		34.4	57,661		Exceeds Criteria																
AC-01_pyr	10	11	pCi/g	4,574		239		24.0						4,574		Exceeds Criteria	58,800		3,580		42.2	119		24.3		33.6	58,919		Exceeds Criteria																
AC-03_pyr	5	6	pCi/g	1,801		95.0		15.0						1,801		Exceeds Criteria	38,200		2,330		33.3	60.8		17.2		33.2	38,261		Exceeds Criteria																

Notes: NDE = gamma log not deep enough. No Log = no log from RI investigation exists. * Indicates that result for one of the two isotopes was non-detect Final Q = final qualifier CSU^1 = combined standard uncertainty (+/- sigma for McLaren/Hart samples) CV = critical value

indicates that combined value is greater than the unrestricted use criteria established by EPA

J = The analyte was analyzed for, and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample.

J+ = Same as J qualification but with an indication of positive bias in the sample concentration.

U = The analyte was analyzed for and is not present above the level of the associated value. The associated numerical value indicates the approximate concentration necessary to detect the analyte in the sample.

For McLaren/Hart RI Soil Boring Data:

In calculated combined Ra and combined Th values, if of the the results was <MDA, one-half of the MDA was used in the calculation and the combined value was noted with an *. If both values were <MDA, combined results reported as "Non-detect".

In calculated combined U values, if one or two of the the results was <MDA, one-half of the MDA was used in the calculation and the combined value was noted with an *. If all three values were <MDA, combined results reported as "Non-detect".

Table 6-3: Area 2 Combined Radium, Thorium, and Uranium Results (RI Borings, A2 Additional Borings, and Cotter Borings)

DRAFT

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226 Result	Final Q	CSU[1]	CV	MDA	Radium-228 Result	Final Q	CSU[1]	CV	MDA	Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230 Result	Final Q	CSU[1]	CV	MDA	Thorium-232 Result	Final Q	CSU[1]	CV	MDA	Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria	Uranium-234 Result	Final Q	CSU[1]	CV	MDA	Uranium-235 Result	Final Q	CSU[1]	CV	MDA	Uranium-238 Result	Final Q	CSU[1]	CV	MDA	Combined Uranium 234 + 235 + 238		Combined Uranium relative to 54.4 pCi/g Unrestricted Use Criteria
McLaren/Hart RI Data																																															
WL-207	5	5	pCi/g	0.93	U			0.93	1.59	U			1.59	Non-detect	*	Non-detect	1.21		0.70		0.54	1.42		0.75		0.39	2.63		Less than Criteria	0.80		0.37		0.22	1.27	U			1.27	0.66		0.33		0.20	2.10	*	Less than Criteria
WL-207	10	10	pCi/g	0.76		0.22		0.33	1.10	U			1.10	1.31	*	Less than Criteria	1.78		1.43		1.45	1.37		1.22		1.17	3.15		Less than Criteria	0.71		0.34		0.21	0.61	U			0.61	0.81		0.36		0.21	1.83	*	Less than Criteria
WL-208	5	5	pCi/g	3.26		0.32		0.37	0.68		0.46		0.66	3.94		Less than Criteria	123		23.0		0.10	1.43		0.42		0.08	124		Exceeds Criteria	2.05		0.59		0.12	1.18	U			1.18	1.60		0.50		0.10	4.24	*	Less than Criteria
WL-208	9	9	pCi/g	1.35		0.23		0.25	0.74	U			0.74	1.72	*	Less than Criteria	10.1		2.00		0.07	0.36		0.16		0.07	10.4		Exceeds Criteria	1.65		0.47		0.19	0.77	U			0.77	1.75		0.48		0.15	3.79	*	Less than Criteria
WL-209	0	0	pCi/g	3,720		142		10.0	21.3	U			21.3	3,731	*	Exceeds Criteria	29,240		5,290		0.10	127		23.0		0.09	29,367		Exceeds Criteria	575		180		0.70	263		33.0		33.0	294		92.0		0.70	1,132		Exceeds Criteria
WL-209	5	5	pCi/g	2,970		123		7.00	16.3	U			16.3	2,978	*	Exceeds Criteria	38,280		7,750		40.2	138		60.0		32.2	38,418		Exceeds Criteria	335		57.0		0.19	74.8		22.9		23.8	249		43.0		0.14	659		Exceeds Criteria
WL-209_FD	5	5	pCi/g	3,140		116		5.00	16.7		9.30		11.3	3,157		Exceeds Criteria	32,680		6,420		29.0	180		65.0		20.2	32,860		Exceeds Criteria	527		87.0		0.20	62.6		25.4		13.4	287		47.0		0.15	877		Exceeds Criteria
WL-209	25	25	pCi/g	0.85		0.18		0.29	0.92	U			0.92	1.31	*	Less than Criteria	26.9		5.40		0.12	0.71		0.27		0.05	27.6		Exceeds Criteria	0.46		0.22		0.23	0.84	U			0.84	0.58		0.23		0.12	1.46	*	Less than Criteria
WL-209_FD	25	25	pCi/g	0.62		0.20		0.27	0.85	U			0.85	1.05	*	Less than Criteria	12.9		3.70		0.72	0.39	U	0.53		0.84	13.0	*	Exceeds Criteria	0.59		0.24		0.09	0.70	U			0.70	0.61		0.24		0.08	1.55	*	Less than Criteria
WL-210	0	0	pCi/g	2,280		89.0		4.00	9.55	U			9.55	2,285	*	Exceeds Criteria	18,190		3,510		15.1	59.2		23.2		17.5	18,249		Exceeds Criteria	216		67.0		0.70	182		22.0		14.0	134		42.0		0.60	532		Exceeds Criteria
WL-210	5	5	pCi/g	520		26.0		3.00	6.72	U			6.72	523	*	Exceeds Criteria	12,400		2,140		0.14	106		19.0		0.06	12,506		Exceeds Criteria	145		25.0		0.18	10.1	U			10.1	65.5		11.2		0.12	216	*	Exceeds Criteria
WL-210_FD	5	5	pCi/g	458		20.0		2.00	4.66	U			4.66	460	*	Exceeds Criteria	15,610		2,700		0.11	120		21.0		0.06	15,730		Exceeds Criteria	267		46.0		0.17	27.2		11.9		5.40	128		22.0		0.14	422		Exceeds Criteria
WL-210	40	40	pCi/g	0.68		0.18		0.31	0.83	U			0.83	1.10	*	Less than Criteria	18.2		3.30		0.12	0.37		0.17		0.08	18.6		Exceeds Criteria	0.69		0.26		0.12	0.78	U			0.78	0.91		0.31		0.11	1.99	*	Less than Criteria
WL-210_FD	40	40	pCi/g	1.66		0.40		0.59	1.45	U			1.45	2.39	*	Less than Criteria	10.8		2.20		0.10	0.82		0.28		0.07	11.6		Exceeds Criteria	0.93		0.32		0.11	1.50	U			1.50	0.54		0.23		0.09	2.22	*	Less than Criteria
WL-211	5	5	pCi/g	8.52		0.58		0.33	1.15	U			1.15	9.10	*	Exceeds Criteria	66.1		11.8		0.15	1.38		0.35		0.08	67.5		Exceeds Criteria	2.30		0.58		0.10	0.75	U			0.75	2.61		0.64		0.11	5.29	*	Less than Criteria
WL-211	25	25	pCi/g	0.42		0.19		0.31	0.85	U			0.85	0.85	*	Less than Criteria	4.97		1.04		0.16	0.32		0.16		0.08	5.29		Less than Criteria	0.68		0.28		0.26	0.79	U			0.79	0.66		0.27		0.26	1.74	*	Less than Criteria
WL-212	5	5	pCi/g	1.26		0.40		0.46	1.16	U			1.16	1.84	*	Less than Criteria	5.73		1.20		0.10	0.29		0.14		0.08	6.02		Less than Criteria	1.57		0.46		0.17	1.15	U			1.15	1.66		0.47		0.12	3.81	*	Less than Criteria
WL-212	10	10	pCi/g	1.77		0.24		0.28	0.90	U			0.90	2.22	*	Less than Criteria	116		20.0		0.23	0.90		0.29		0.13	117		Exceeds Criteria	1.86		0.53		0.14	0.56	U			0.56	1.77		0.51		0.12	3.91	*	Less than Criteria
WL-213	0	0	pCi/g	1.00		0.26		0.37	0.90	U			0.90	1.45	*	Less than Criteria	24.2		4.70		0.20	1.11		0.41		0.20	25.3		Exceeds Criteria	1.64		0.58		0.45	0.88	U			0.88	1.53		0.55		0.42	3.61	*	Less than Criteria
WL-213	5	5	pCi/g	1.26		0.23		0.27	0.92	U			0.92	1.72	*	Less than Criteria	17.3		3.40		0.16	0.89		0.30		0.15	18.2		Exceeds Criteria	1.00		0.38		0.19	0.83	U			0.83	1.53		0.49		0.13	2.95	*	Less than Criteria
WL-213	25	25	pCi/g	0.93		0.33		0.52	1.49	U			1.49	1.68	*	Less than Criteria	3.13		0.75		0.05	0.52		0.21		0.07	3.65		Less than Criteria	1.06		0.36		0.14	1.35	U			1.35	0.45		0.22		0.13	2.19	*	Less than Criteria
WL-214	5	5	pCi/g	0.95		0.18		0.22	0.81	U			0.81	1.36	*	Less than Criteria	44.4		7.80		0.21	0.41		0.20		0.14	44.8		Exceeds Criteria	1.09		0.36		0.12	0.52	U			0.52	0.81		0.30		0.09	2.16	*	Less than Criteria
WL-214	25	25	pCi/g	0.52	U			0.52	0.89	U			0.89	Non-detect	*	Non-detect	12.8		2.50		0.18	0.36		0.19		0.12	13.2		Exceeds Criteria	0.97		0.35		0.11	0.89	U			0.89	0.67		0.28		0.12	2.09	*	Less than Criteria
WL-215	0	0	pCi/g	0.70		0.20		0.29	0.73	U			0.73	1.07	*	Less than Criteria	5.35		1.14		0.07	0.31		0.15		0.07	5.66		Less than Criteria	1.86		0.76		0.48	0.78	U			0.78	1.53		0.68		0.45	3.78	*	Less than Criteria
WL-216	5	5	pCi/g	88.4		5.20		0.90	2.21	U			2.21	89.5	*	Exceeds Criteria	1,131				0.93	3.05		1.45		0.81	1,134		Exceeds Criteria	12.5		4.00		1.90	3.07	U			3.07	11.4		3.80		2.20	25.4	*	Less than Criteria
WL-216	25	25	pCi/g	1.03		0.21		0.39	1.62		0.44		0.54	2.65		Less than Criteria	1.46		0.46		0.17	1.17		0.39		0.10	2.63		Less than Criteria	0.81		0.29		0.09	0.61	U			0.61	0.97		0.32		0.09	2.09	*	Less than Criteria
WL-217	5	5	pCi/g	0.60		0.21		0.31	0.81	U			0.81	1.01	*	Less than Criteria	0.96		0.30		0.13	0.38	U	0.16		0.06	1.15	*	Less than Criteria	0.45		0.20		0.08	0.53	U			0.53	0.51		0.21		0.08	1.23	*	Less than Criteria
WL-217	10	10	pCi/g	1.27		0.24		0.29	1.04	U			1.04	1.79	*	Less than Criteria	8.95		1.90		0.12	0.72		0.31		0.11	9.67		Exceeds Criteria	1.03		0.33		0.17	0.60	U			0.60	0.96		0.31		0.12	2.29	*	Less than Criteria
WL-218	0	0	pCi/g	1.06		0.19		0.24	0.82		0.38		0.66	1.88		Less than Criteria	1.77		0.57		0.14	0.77		0.32		0.07	2.54		Less than Criteria	1.53		0.59		0.24	0.58	U			0.58	1.12		0.48		0.16	2.94	*	Less than Criteria
WL-218	5	5	pCi/g	0.85		0.20		0.41	1.01		0.48		0.70	1.86		Less than Criteria	1.19		0.43		0.14	0.67		0.30		0.12	1.86		Less than Criteria	0.73		0.28		0.12	0.84	U			0.84	0.81		0.30		0.12	1.96	*	Less than Criteria
WL-218	40	40	pCi/g	0.68		0.23		0.43	1.16	U			1.16	1.26	*	Less than Criteria	7.27		1.51		0.10	0.58		0.25		0.09	7.85		Less than Criteria	0.84		0.32		0.12	0.73	U			0.73	0.53		0.24		0.11	1.74	*	Less than Criteria
WL-219	5	5	pCi/g	1.12		0.26		0.33	1.17		0.59		0.77	2.29		Less than Criteria	1.07		0.40		0.15	1.12		0.42		0.14	2.19		Less than Criteria	0.91		0.31		0.09	0.80	U			0.80	1.09		0.35		0.09	2.40	*	Less than Criteria
WL-219	10	10	pCi/g	0.62		0.22		0.41	1.04	U			1.04	1.14	*	Less than Criteria	0.64		0.25		0.08	0.44		0.20		0.07	1.08		Less than Criteria	1.16		0.56		0.39	0.62	U			0.62	0.60		0.38		0.33	2.07	*	Less than Criteria
WL-220	5	5	pCi/g	0.81		0.23		0.36	1.22	U			1.22	1.42	*	Less than Criteria	1.53		0.46		0.11	0.69		0.27		0.10	2.22		Less than Criteria	1.16		0.36		0.09	0.79	U			0.79	1.00		0.33		0.09	2.56	*	Less than Criteria
WL-220	25	25	pCi/g	0.78		0.24		0.38	1.25		0.38		0.56	2.03		Less than Criteria	0.56		0.27		0.11	0.22		0.16		0.10	0.78		Less than Criteria	0.89		0.33		0.12	0.67	U			0.67	0.95		0.34		0.13	2.18	*	Less than Criteria
WL-221	5	5	pCi/g	0.75		0.20		0.34	1.12	U			1.12	1.31	*	Less than Criteria	4.28		0.94		0.24	0.70		0.28		0.24	4.98		Less than Criteria	1.12		0.38		0.13	0.64	U			0.64	0.82		0.31		0.13	2.26	*	Less than Criteria
WL-221	35	35	pCi/g	0.33	U			0.33	1.09	U			1.09	Non-detect	*	Non-detect	1.24		0.41		0.16	0.63		0.27		0.14	1.87		Less than Criteria	0.52		0.21		0.10	0.79	U			0.79	0.50		0.21		0.11	1.42	*	Less than Criteria
WL-222	0	0	pCi/g	2.94		0.59		0.53	1.75	U			1.75	3.82	*	Less than Criteria	131		25.0		0.19	1.31		0.40		0.20	132		Exceeds Criteria	2.26		0.79		0.25	1.99	U			1.99	3.36		1.04		0.42	6.62	*	Less than Criteria
WL-222	5	5	pCi/g	1.80		0.26		0.29	0.83		0.44		0.70	2.63		Less than Criteria	81.4		15.4		0.76	1.30		0.38		0.17	82.7		Exceeds Criteria	1.46		0.43		0.13	0.64	U			0.64	1.21		0.38		0.09	2.99	*	Less than Criteria
WL-222	30	30	pCi/g	0.82		0.39		0.60	1.27	U			1.27	1.46	*	Less than Criteria	0.88		0.32		0.21	1.00		0.34		0.15	1.88		Less than Criteria	0.51		0.26		0.12	1.22	U			1.22	0.40		0.23		0.12	1.52	*	Less than Criteria
WL-223	5	5	pCi/g	1.73		0.27		0.30	1.14	U			1.14	2.30	*	Less than Criteria	9.16		1.97		0.12	0.64		0.30		0.12	9.80		Exceeds Criteria	1.44		0.41		0.11	0.75	U			0.75	1.22		0.36		0.10	3.04	*	Less than Criteria
WL-223	22	22	pCi/g	0.52		0.19		0.33	0.88	U			0.88	0.96	*	Less than Criteria	0.68		0.28		0.12	0.18		0.13		0.10	0.86		Less than Criteria	2.37		0.62		0.14	0.60	U			0.60	1.93		0.54		0.15	4.60	*	Less than Criteria
WL-224	5	5	pCi/g	0.84		0.21		0.28	1.23		0.47		0.67	2.07		Less than Criteria	2.85		1.31		1.15	0.35	U	0.49		0.91	3.03	*	Less than Criteria	0.75		0.50		0.68	0.71	U			0.71	0.63		0.41		0.40	1.74	*	Less than Criteria
WL-224	35	35	pCi/g	1.00		0.22		0.37	1.19		0.41		0.90	2.19		Less than Criteria	4.08		1.71		0.84	0.28	U	0.42		0.62	4.22	*	Less than Criteria	1.13		0.96		0.80	0.69	U			0.69	0.77		0.78		0.52	2.25	*	Less than Criteria
WL-225	5	5	pCi/g	1.07		0.27		0.40	1.18	U			1.18	1.66	*	Less than Criteria	2.84		1.44		1.32	1.76		1.07		0.62	4.60		Less than Criteria	3.17		1.69		1.22	0.75	U			0.75	1.29		1.04		1.01	4.84	*	Less than Criteria
WL-225	35	35	pCi/g	0.51	U			0.51	1.50	U			1.50	Non-detect	*	Non-detect	0.91		0.91		0.23	0.33		0.17		0.16	1.24		Less than Criteria	0.72		0.42		0.40	0.93	U			0.93	0.16	U	0.36		0.77	1.27	*	Less than Criteria
WL-226	10	10	pCi/g	1.40		0.27		0.34	0.95		0.46		0.82	2.35		Less than Criteria	14.1		4.00		1.10	0.32	U	0.51		0.85	14.3	*	Exceeds Criteria	1.38		0.62		0.52	0.80	U			0.80	1.63		0.65		0.29	3.41	*	Less than Criteria
WL-226	20	20	pCi/g	3.26		0.44		0.40	1.12	U			1.12	3.82	*	Less than Criteria	173		31.0		1.00	0.69	U	0.68		0.85	173	*	Exceeds Criteria	6.02		2.20		1.31	0.87	U			0.87	6.32		2.24		0.91	12.8	*	Less than Criteria
WL-227	5	5	pCi/g	1.32		0.22		0.29	1.35		0.43		0.73	2.67		Less than Criteria	20.4		4.70		0.90	0.50	U	0.52		0.53	20.7	*	Exceeds Criteria	1.68		0.67		0.57	0.66	U			0.66	2.01		0.71		0.32	4.02	*	Less than Criteria
WL-227	40	40	pCi/g	0.43		0.18		0.24	0.79	U			0.79	0.83	*	Less than Criteria	2.78		1.32		0.94	0.51	U	0.53		0.55	3.04	*	Less than Criteria	0.66		0.43		0.55	0.54	U			0.54	0.27	U	0.30		0.53	1.07	*	Less than Criteria
WL-228	5	5	pCi/g	0.79		0.20		0.30	1.29		0.41		0.62	2.08		Less than Criteria	2.72		1.45		1.05	0.13	U	0.34		0.79	2.79	*	Less than Criteria	1.50		1.09		1.37	0.51	U			0.51	1.84		1.19		1.30	3.60	*	Less than Criteria
WL-228	15	15	pCi/g	0.64		0.25		0.37	1.12	U			1.12	1.20	*	Less than Criteria	2.13		0.76		0.46	0.62		0.39		0.37	2.75		Less than Criteria	0.60	U	0.46		0.74	0.75	U			0.75	0.26	U	0.39		0.78	Non-detect	*	Non-detect
WL-229	5	5	pCi/g	1.15		0.28		0.70	1.24	U			1.24	1.77	*	Less than Criteria	4.97		1.89		0.97	1.47		0.97		0.89	6.44		Less than Criteria	0.82		0.47		0.52	0.64	U			0.64	1.45		0.60		0.39	2.59	*	Less than Criteria
WL-229	20	20	pCi/g	0.38		0.19		0.34	0.96	U			0.96	0.86	*	Less than Criteria	1.17		0.89		1.02	0.55	U	0.58		0.69	1.45	*	Less than Criteria	0.79		0.46		0.56	0.64	U			0.64	0.54		0.36		0.39	1.65	*	Less than Criteria
WL-230	5	5	pCi/g	1.67		0.26		0.34	1.16	U			1.16	2.25	*	Less than Criteria	26.8		6.40		1.30	0.51	U	0.63		0.87	27.1	*	Exceeds Criteria	2.23		0.81		0.49	0.63	U			0.63	0.92		0.48		0.16	3.47	*	Less than Criteria
WL-230	35	35	pCi/g	0.53		0.22		0.36	0.89	U			0.89	0.98	*	Less than Criteria	1.33		0.98		1.25	0.10	U	0.29		0.75	1.38	*	Less than Criteria	1.75		1.18		1.18	0.69	U			0.69	2.05		1.23		0.46	4.15	*	Less than Criteria
WL-231	0	0	pCi/g	0.91		0.22		0.29	0.92	U			0.92	1.37	*	Less than Criteria	1.21		0.39		0.20	0.08	U	0.10		0.19	1.25	*	Less than Criteria	3.18		1.06		0.32	0.85	U			0.85	2.04		0.79		0.26	5.65	*	Less than Criteria
WL-231	5	5	pCi/g	4.06		0.37		0.28	1.02	U			1.02	4.57	*	Less than Criteria	94.5		17.4		1.00	1.11		0.85		0.83	95.6		Exceeds Criteria	6.97		2.76		2.14	0.73	U			0.73	3.86		2.03		2.18	11.2	*	Less than Criteria
WL-231	10	10	pCi/g	1.37		0.24		0.40	0.75	U			0.75	1.75	*	Less than Criteria	10.2		3.00		1.40	0.06	U	0.28		0.87	10.2	*	Exceeds Criteria	2.29		0.82		0.53	0.79	U			0.79	2.01		0.74		0.15	4.70	*	Less than Criteria
WL-233	27	27	pCi/g	4.44		0.46		0.38	1.11	U			1.11	5.00	*	Less than criteria	427		80.0		0.70	1.19		0.83		0.56	428		Exceeds Criteria	4.58		2.18		1.64	1.02	U			1.02	4.48		2.17		1.80	9.57	*	Less than Criteria
WL-233	30	30	pCi/g	0.79		0.20		0.41	1.05	U			1.05	1.32	*	Less than Criteria	9.93		2.72		0.90	0.82		0.64		0.49	10.8		Exceeds Criteria	2.60		1.76		2.34	0.64	U			0.64	1.99		1.49		1.93	4.91	*	Less than Criteria
WL-234	10	10	pCi/g	3,060		116		4.00	14.5		7.90		10.3	3,075		Exceeds Criteria	57,300		19,300		238	148	U	173		240	57,374	*	Exceeds Criteria	128		39.0		5.00	774		150		12.0	138		42.0		5.00	1,040		Exceeds Criteria
WL-234_FD	10	10	pCi/g	1,260		49.0		3.00	6.62	U			6.62	1,263	*	Exceeds Criteria	12,000		3,670		116	58.1	U	84.6		98.7	12,029	*	Exceeds Criteria	45.4		9.70		0.50	97.6		11.2		7.90	60.7		12.4		1.10	204		Exceeds Criteria
WL-234	20	20	pCi/g	0.66	U			0.66	1.25	U			1.25	Non-detect	*	Non-detect	16.2		3.20		0.04	0.67		0.23		0.07	16.9		Exceeds Criteria	0.94		0.45		0.37	0.86	U			0.86	0.98		0.44		0.28	2.35	*	Less than Criteria
WL-234_FD	20	20	pCi/g	1.18		0.26		0.39	1.23	U			1.23	1.80	*	Less than Criteria	11.3		2.20		0.50	0.85		0.43		0.38	12.2		Exceeds Criteria	1.64		1.29		0.99	0.85	U			0.85	2.11		1.47		0.99	4.18	*	Less than Criteria
WL-235	0	0	pCi/g	0.90		0.21		0.32	1.19		0.45		0.56	2.09		Less than Criteria	12.4		2.48		0.13	1.03		0.31		0.10	13.4		Exceeds Criteria	0.97		0.45		0.31	0.56	U			0.56	0.77		0.40		0.37	2.02	*	Less than Criteria
WL-235	5	5	pCi/g	0.74		0.46		0.56	1.58	U			1.58	1.53	*	Less than Criteria	3.21		1.45		1.16	0.18	U	0.38		0.83	3.30	*	Less than Criteria	1.47		0.66		0.61	1.63	U			1.63	0.91		0.50		0.50	3.20	*	Less than Criteria
WL-235	30	30	pCi/g	1.09		0.25		0.43	0.93	U			0.93	1.56	*	Less than Criteria	3.15		1.43		1.00	0.01	U	0.28		0.94	3.16	*	Less than Criteria	1.25		0.53		0.41	0.84	U			0.84	1.31		0.53		0.24	2.98	*	Less than Criteria
WL-236	5	5	pCi/g	1.03		0.23		0.34	1.00	U			1.00	1.53	*	Less than Criteria	5.92		1.49		0.97	0.62	U	0.46		0.69	6.23	*	Less than Criteria	1.43		1.22		1.41	0.72	U			0.72	1.56		1.21		0.60	3.35	*	Less than Criteria
WL-236	35	35	pCi/g	1.01		0.24		0.35	1.23	U			1.23	1.63	*	Less than Criteria	4.90		1.33		1.01	0.90	U	0.63		1.02	5.35	*	Less than Criteria	2.37		1.43		0.54	0.69	U			0.69	1.95		1.29		0.82	4.67	*	Less than Criteria
WL-239	5	5	pCi/g	0.96		0.11		0.10	1.13		0.19		0.17	2.09		Less than Criteria	0.50		0.20		0.12	0.26		0.13		0.07	0.76		Less than Criteria	1.24		0.46		0.19	0.35	U			0.35	1.22		0.45		0.14	2.64	*	Less than Criteria
WL-239	25	25	pCi/g	0.90		0.08		0.06	0.72		0.13		0.12	1.62		Less than Criteria	0.58		0.26		0.25	0.31		0.17		0.14	0.89		Less than Criteria	0.83		0.46		0.46	0.25	U			0.25	0.48		0.36		0.47	1.44	*	Less than Criteria
WL-241	5	5	pCi/g	12.9		0.54		0.10	0.24	U			0.24	13.0	*	Exceeds Criteria	343		66.0		0.11	3.84		0.90		0.05	347		Exceeds Criteria	4.51		1.20		0.15	0.38	U			0.38	3.90		1.07		0.18	8.60	*	Less than Criteria
WL-241	15	15	pCi/g	1.04		0.09		0.07	0.96		0.16		0.16	2.00		Less than Criteria	0.57		0.21		0.13	0.18		0.11		0.08	0.75		Less than Criteria	0.59		0.29		0.20	0.23	U			0.23	0.64		0.30		0.13	1.35	*	Less than Criteria
WL-242	0	0	pCi/g	1.57		0.26		0.51	0.77	U			0.77	1.96	*	Less than Criteria	8.63		2.62		0.76	0.00	U	0.00		0.34	8.63	*	Exceeds Criteria	1.83		0.50		0.17						1.63		0.46		0.13	3.46		Less than Criteria
WL-242	2	2	pCi/g	2.42		0.45		0.59	1.57	U			1.57	3.21	*	Less than Criteria	21.3		5.30		1.11	0.52	U	0.58		0.75	21.6	*	Exceeds Criteria	1.35		0.43		0.10						0.75		0.30		0.10	2.10		Less than Criteria
WL-243	0	0	pCi/g	4.78		0.44		0.33	1.13		0.54		0.84	5.91		Less than criteria	265		50.0		0.22	6.73		1.36		0.15	272		Exceeds Criteria	3.99		0.98		0.24						3.63		0.91		0.18	7.62		Less than Criteria
WL-244	0	0	pCi/g	1.54		0.22		0.33	1.05	U			1.05	2.07	*	Less than Criteria	20.8		4.10		0.71	0.78		0.68		0.65	21.6		Exceeds Criteria	0.88		0.30		0.12						1.35		0.40		0.09	2.23		Less than Criteria
WL-245	0	0	pCi/g	0.95		0.26		0.34	1.20	U			1.20	1.55	*	Less than Criteria	3.92		0.93		0.16	0.38		0.20		0.11	4.30		Less than Criteria	0.93		0.32		0.23						0.71		0.27		0.18	1.64		Less than Criteria
WL-246	0	0	pCi/g	1.04		0.26		0.37	1.07	U			1.07	1.58	*	Less than Criteria	2.91		0.82		0.30	0.63		0.31		0.15	3.54		Less than Criteria	0.94		0.32		0.14						0.73		0.28		0.18	1.67		Less than Criteria
A2 Additional Borings (and Cotter samples from A2 Additional Borings)																																															
AC-08	24	26	pCi/g	1.21	U	0.30	2.79	0.34	1.32		0.34	0.22	0.49	2.52	*	Less than Criteria	2.17	J+	0.54	0.06	0.07	0.75	J+	0.23	0.01	0.06	2.93		Less than Criteria	0.69		0.19	0.02	0.05	0.19	J	0.10	0.00	0.06	0.70		0.19	0.01	0.05	1.58		Less than Criteria
AC-08	35	36	pCi/g	0.70	U	0.13	0.92	0.16	0.43		0.13	0.10	0.22	1.14	*	Less than Criteria	0.71	J+	0.26	0.07	0.08	0.35	J+	0.16	0.02	0.09	1.07		Less than Criteria	0.51		0.16	0.03	0.07	0.12	J	0.08	0.01	0.08	0.53		0.17	0.03	0.08	1.15		Less than Criteria
AC-09	25	28	pCi/g	0.90	U	0.18	1.12	0.26	0.97		0.22	0.17	0.36	1.86	*	Less than Criteria	0.37	J	0.15	0.06	0.07	0.13	J	0.09	0.03	0.09	0.50		Less than Criteria	0.21	J	0.10	0.01	0.06	0.02	J	0.03	0.00	0.05	0.24	J	0.10	0.01	0.05	0.47		Less than Criteria

Table 6-3: Area 2 Combined Radium, Thorium, and Uranium Results (RI Borings, A2 Additional Borings, and Cotter Borings)

DRAFT

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226 Result	Radium-226 Final Q	Radium-226 CSU[1]	Radium-226 CV	Radium-226 MDA	Radium-228 Result	Radium-228 Final Q	Radium-228 CSU[1]	Radium-228 CV	Radium-228 MDA	Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230 Result	Thorium-230 Final Q	Thorium-230 CSU[1]	Thorium-230 CV	Thorium-230 MDA	Thorium-232 Result	Thorium-232 Final Q	Thorium-232 CSU[1]	Thorium-232 CV	Thorium-232 MDA	Combined Thorium 230 + 232		Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria	Uranium-234 Result	Uranium-234 Final Q	Uranium-234 CSU[1]	Uranium-234 CV	Uranium-234 MDA	Uranium-235 Result	Uranium-235 Final Q	Uranium-235 CSU[1]	Uranium-235 CV	Uranium-235 MDA	Uranium-238 Result	Uranium-238 Final Q	Uranium-238 CSU[1]	Uranium-238 CV	Uranium-238 MDA	Combined Uranium 234 + 235 + 238		Combined Uranium relative to 54.4 pCi/g Unrestricted Use Criteria
AC-09_FD	25	28	pCi/g	0.73	U	0.19	1.42	0.34	0.80		0.23	0.19	0.42	1.53	*	Less than Criteria	0.41	J	0.14	0.04	0.04	0.23		0.10	0.00	0.04	0.64		Less than Criteria	0.20	J	0.09	0.02	0.06	0.03	J	0.04	0.01	0.06	0.16	J	0.08	0.01	0.06	0.39		Less than Criteria
AC-09	32	33	pCi/g	1.02	U	0.31	2.01	0.17	0.70	J	0.49	0.42	0.90	1.72	*	Less than Criteria	0.85		0.25	0.04	0.05	0.85		0.24	0.01	0.06	1.70		Less than Criteria	0.67	J	0.16	0.01	0.05	0.07	J	0.05	0.00	0.04	0.64	J	0.16	0.01	0.05	1.38		Less than Criteria
AC-10	12	13	pCi/g	1.66		0.22	1.17	0.23	0.48		0.21	0.17	0.37	2.15		Less than Criteria	12.2	J+	3.02	0.10	0.12	0.37	J+	0.17	0.05	0.13	12.6		Exceeds Criteria	1.28		0.30	0.05	0.10	0.18	J	0.11	0.01	0.09	1.55	J+	0.34	0.01	0.05	3.01		Less than Criteria
AC-10	26	28	pCi/g	0.77	U	0.14	1.09	0.18	0.66		0.16	0.10	0.22	1.44	*	Less than Criteria	0.62	J+	0.19	0.05	0.05	0.41	J+	0.14	0.01	0.05	1.03		Less than Criteria	0.52	J	0.24	0.05	0.12	0.05	J	0.08	0.01	0.14	0.77	J+	0.30	0.01	0.14	1.34		Less than Criteria
AC-11	8	9	pCi/g	0.57	U	0.23	1.89	0.44	0.13	U	0.35	0.27	0.61	Non-detect	*	Non-detect	0.29	J	0.12	0.05	0.05	0.14	J	0.08	0.01	0.05	0.42		Less than Criteria	0.33	J+	0.11	0.01	0.05	0.03	J	0.03	0.00	0.04	0.16	J	0.07	0.00	0.05	0.52		Less than Criteria
AC-11	17	19	pCi/g	0.95	U	0.18	1.22	0.24	0.72		0.23	0.22	0.47	1.67	*	Less than Criteria	0.49	J	0.16	0.06	0.07	0.30	J	0.12	0.03	0.08	0.79		Less than Criteria	0.48	J+	0.14	0.02	0.05	0.05	J	0.05	0.01	0.06	0.41	J	0.13	0.00	0.04	0.94		Less than Criteria
AC-12	2	4	pCi/g	2.85		0.28	1.19	0.19	0.36		0.16	0.17	0.35	3.21		Less than Criteria	44.0	J	10.9	0.09	0.10	0.41	J	0.19	0.01	0.09	44.4		Exceeds Criteria	1.04	J+	0.24	0.05	0.09	0.04	J	0.04	0.01	0.06	0.87	J	0.21	0.01	0.04	1.95		Less than Criteria
AC-12	10	11	pCi/g	0.88	U	0.15	0.93	0.17	0.58		0.17	0.17	0.35	1.46	*	Less than Criteria	4.44	J	0.96	0.06	0.07	0.23	J	0.10	0.01	0.06	4.68		Less than Criteria	0.51	J+	0.16	0.02	0.06	0.01	J	0.02	0.00	0.05	0.48		0.15	0.01	0.05	1.00		Less than Criteria
AC-13	20	22	pCi/g	8.46		0.90	3.78	0.78	0.33	U	0.54	0.42	0.91	8.78	*	Exceeds Criteria	104	J+	20.7	0.04	0.05	0.66	J+	0.18	0.00	0.04	105		Exceeds Criteria	1.97		0.33	0.02	0.04	0.33		0.11	0.00	0.04	1.80		0.31	0.00	0.03	4.10		Less than Criteria
AC-13	31	33	pCi/g	0.68	U	0.37	2.02	0.56	-0.03	U	0.17	0.44	0.98	Non-detect	*	Non-detect	2.01	J+	0.46	0.05	0.05	0.21	J+	0.09	0.02	0.06	2.21		Less than Criteria	0.29		0.11	0.03	0.06	0.10	J	0.07	0.00	0.06	0.31		0.11	0.00	0.04	0.69		Less than Criteria
AC-14	13	14	pCi/g	0.71	U	0.32	3.18	0.81	0.05	U	0.58	0.43	0.96	Non-detect	*	Non-detect	2.99	J	1.26	0.47	0.60	2.57	J	1.12	0.03	0.42	5.56		Less than Criteria	0.33	J+	0.12	0.02	0.05	0.07	J	0.06	0.00	0.05	0.21		0.10	0.02	0.07	0.61		Less than Criteria
AC-14	25	26	pCi/g	0.28	U	0.08	0.77	0.17	0.55		0.13	0.09	0.20	0.84	*	Less than Criteria	0.48	J	0.17	0.05	0.05	0.40	J	0.15	0.01	0.05	0.89		Less than Criteria	0.43	J+	0.13	0.02	0.05	0.05	J	0.05	0.01	0.06	0.37	J	0.12	0.00	0.05	0.85		Less than Criteria
AC-15	26	27	pCi/g	0.66	U	0.18	1.53	0.32	0.62		0.27	0.21	0.45	1.28	*	Less than Criteria	0.18		0.08	0.04	0.04	0.09	J	0.06	0.00	0.04	0.27		Less than Criteria	0.38	J+	0.12	0.03	0.06	0.05	J	0.04	0.00	0.05	0.25		0.09	0.01	0.04	0.67		Less than Criteria
AC-15	32	34	pCi/g	0.56	U	0.18	1.05	0.27	0.35	J	0.29	0.25	0.55	0.91	*	Less than Criteria	1.45	J	0.39	0.06	0.06	0.34	J	0.14	0.01	0.06	1.79		Less than Criteria	0.30	J+	0.11	0.03	0.06	0.11	J	0.07	0.00	0.04	0.28	J	0.10	0.02	0.07	0.69		Less than Criteria
AC-15_FD	32	34	pCi/g	0.31	U	0.12	0.59	0.20	0.33	J	0.16	0.15	0.32	0.64	*	Less than Criteria	0.44	J	0.16	0.06	0.06	0.50	J	0.17	0.01	0.07	0.94		Less than Criteria	0.47	J+	0.14	0.03	0.06	0.05	J	0.05	0.00	0.05	0.41	J	0.13	0.01	0.04	0.93		Less than Criteria
AC-16	19	20	pCi/g	554		39.5	21.0	4.76	13.8		2.52	2.57	5.18	568		Exceeds Criteria	8,710		1,811	6.23	7.84	43.7		17.3	2.11	9.28	8,753		Exceeds Criteria	310	J+	53.7	5.25	9.90	29.7	J	13.4	0.93	7.87	266	J	47.9	4.21	10.4	606		Exceeds Criteria
AC-16	22	23	pCi/g	358		23.8	13.0	1.71	8.01		1.40	1.35	2.71	366		Exceeds Criteria	5,166	J	1,048	6.75	6.74	30.5	J	14.0	2.93	10.2	5,197		Exceeds Criteria	294	J+	55.6	2.74	5.90	14.8	J	10.5	0.93	9.16	248	J	49.0	0.73	5.88	557		Exceeds Criteria
AC-16_FD	22	23	pCi/g	317		24.7	25.0	4.34	10.6		3.50	4.32	8.28	327		Exceeds Criteria	12,250	J	2,514	7.26	7.52	68.7	J	22.9	1.93	9.12	12,319		Exceeds Criteria	442	J+	72.6	3.07	7.06	24.7	J	12.9	0.18	9.26	432	J	71.2	1.07	6.54	899		Exceeds Criteria
AC-16	29	30	pCi/g	1.17		0.19	1.16	0.26	0.97		0.21	0.17	0.35	2.14		Less than Criteria	15.9	J	3.84	0.08	0.08	1.07	J	0.34	0.02	0.09	17.0		Exceeds Criteria	0.92	J+	0.21	0.02	0.05	0.10	J	0.07	0.00	0.05	0.76	J	0.19	0.00	0.04	1.77		Less than Criteria
AC-17	8	10	pCi/g	0.83		0.14	0.82	0.08	0.32	J	0.20	0.17	0.38	1.16		Less than Criteria	1.61	J	0.56	0.11	0.11	0.30	J	0.17	0.01	0.10	1.91		Less than Criteria	0.88	J+	0.25	0.03	0.06	0.05	J	0.07	0.00	0.10	0.74		0.23	0.01	0.06	1.68		Less than Criteria
AC-17	32	33	pCi/g	0.39	U	0.18	1.30	0.34	0.39	J	0.27	0.25	0.55	0.78	*	Less than Criteria	0.45	J+	0.16	0.07	0.08	0.14	J+	0.08	0.04	0.09	0.59		Less than Criteria	0.27		0.12	0.03	0.07	0.10	J	0.08	0.02	0.09	0.29		0.12	0.02	0.08	0.67		Less than Criteria
AC-17	2	5	pCi/g	206	J	14.0	12.5	2.17	8.16		1.44	1.50	3.03	215		Exceeds Criteria	1,752	J+	368	7.28	7.73	23.0	J+	11.5	0.34	5.38	1,775		Exceeds Criteria	116	J	30.1	3.40	7.82	25.4	J	13.9	0.47	7.68	112	J	29.5	1.02	7.10	253		Exceeds Criteria
AC-18_FD	2	5	pCi/g	333	J	22.2	17.3	1.66	9.19		1.62	1.30	2.62	343		Exceeds Criteria	2,167	J+	449	6.71	6.65	31.2	J+	13.7	0.55	6.05	2,199		Exceeds Criteria	180	J	42.1	2.95	9.99	32.5	J	16.7	0.53	8.58	208	J	46.3	1.99	9.94	420		Exceeds Criteria
AC-18	10	11	pCi/g	184		14.8	19.1	2.97	6.53		2.39	2.06	4.17	190		Exceeds Criteria	3,414	J+	743	7.26	7.18	22.5	J+	12.6	3.61	11.5	3,436		Exceeds Criteria	133		30.9	3.30	7.55	16.6	J	10.4	0.61	7.43	154		34.0	0.65	5.24	303		Exceeds Criteria
AC-19	5	6	pCi/g	1,005		66.3	19.3	2.47	8.07		1.99	1.70	3.41	1,013		Exceeds Criteria	976	J+	201	5.63	5.29	9.76	J+	6.73	0.29	4.61	986		Exceeds Criteria	74.8		23.1	3.80	8.76	4.49	J	6.25	0.96	9.47	75.0	J+	23.0	1.25	7.65	154		Exceeds Criteria
AC-19	36	37	pCi/g	1.20		0.18	1.13	0.24	1.17		0.21	0.19	0.41	2.37		Less than Criteria	1.39	J+	0.38	0.06	0.06	1.07	J+	0.30	0.01	0.05	2.46		Less than Criteria	0.77		0.21	0.02	0.06	0.12	J	0.08	0.00	0.05	0.76		0.20	0.01	0.05	1.64		Less than Criteria
AC-20	23	24	pCi/g	580		38.5	18.2	3.74	8.43		1.74	2.00	4.02	588		Exceeds Criteria	6,737	J+	1,397	7.63	8.09	40.4	J+	16.6	1.51	8.50	6,777		Exceeds Criteria	423		83.6	5.59	12.4	39.1	J	19.6	0.61	9.69	391	J+	78.5	1.62	9.83	853		Exceeds Criteria
AC-20	47	49	pCi/g	1.33		0.20	1.05	0.25	1.55		0.25	0.19	0.40	2.88		Less than Criteria	1.54	J+	0.38	0.04	0.04	1.06	J+	0.27	0.01	0.04	2.60		Less than Criteria	0.85	J	0.21	0.02	0.05	0.10	J	0.07	0.01	0.06	0.78	J+	0.20	0.02	0.07	1.73		Less than Criteria
AC-20_FD	47	49	pCi/g	1.40	U	0.37	2.67	0.46	1.56		0.44	0.40	0.86	2.95	*	Less than Criteria	1.32	J+	0.34	0.05	0.05	1.20	J+	0.30	0.02	0.07	2.52		Less than Criteria	0.89		0.22	0.02	0.04	0.11	J	0.08	0.00	0.05	0.72	J+	0.20	0.00	0.06	1.72		Less than Criteria
AC-21	12	13	pCi/g	272		18.8	27.1	3.26	8.48		2.28	2.37	4.82	280		Exceeds Criteria	3,491	J+	788	6.81	10.6	137		41.3	0.87	8.75	3,628		Exceeds Criteria	956		144	3.38	7.87	66.8	J+	22.8	0.45	7.18	869	J+	132	0.95	6.64	1,892		Exceeds Criteria
AC-21	30	32	pCi/g	1.11	U	0.32	2.34	0.44	0.75		0.35	0.50	1.04	1.86	*	Less than Criteria	22.6	J+	4.71	0.12	0.10	1.17	J+	0.39	0.01	0.10	23.8		Exceeds Criteria	4.56		0.91	0.07	0.15	0.55	J	0.28	0.01	0.16	4.03		0.83	0.03	0.16	9.14		Less than Criteria
AC-21	40	42	pCi/g	0.80	U	0.12	1.07	0.18	0.49		0.18	0.16	0.35	1.29	*	Less than Criteria	5.61	J+	1.21	0.04	0.04	0.53	J+	0.16	0.00	0.05	6.14		Less than Criteria	1.09	J	0.24	0.03	0.06	0.10	J	0.07	0.01	0.06	1.07	J	0.23	0.01	0.05	2.26		Less than Criteria
AC-21A	13	14	pCi/g	376		30.4	51.9	7.58	6.84	J	6.11	4.74	9.69	383		Exceeds Criteria	4,112	J+	908	7.61	9.60	102	J	32.6	2.37	11.1	4,214		Exceeds Criteria	1,711	J	263	6.59	13.6	203	J+	50.0	1.45	12.1	1,823	J+	279	3.86	13.1	3,736		Exceeds Criteria
AC-21A	47	48	pCi/g	1.55		0.20	1.07	0.20	1.01		0.21	0.17	0.36	2.55		Less than Criteria	1.96	J+	0.48	0.05	0.05	0.87	J	0.24	0.01	0.05	2.82		Less than Criteria	0.51	J	0.14	0.02	0.05	0.05	J+	0.05	0.01	0.06	0.43	J+	0.13	0.01	0.05	0.99		Less than Criteria
AC-22	18	19	pCi/g	14.8		1.17	2.89	0.40	0.58	J	0.36	0.30	0.63	15.4		Exceeds Criteria	129		26.3	0.05	0.06	0.69		0.20	0.02	0.07	129		Exceeds Criteria	3.70	J+	0.57	0.02	0.04	0.25	J	0.10	0.00	0.05	3.44	J	0.53	0.00	0.03	7.40		Less than Criteria
AC-22	41	42	pCi/g	1.26	U	0.36	1.87	0.63	1.65		0.55	0.51	1.09	2.90	*	Less than Criteria	1.58		0.40	0.04	0.04	1.13		0.29	0.00	0.04	2.72		Less than Criteria	0.87	J+	0.23	0.05	0.10	0.10	J	0.08	0.01	0.08	0.65		0.20	0.04	0.10	1.63		Less than Criteria
AC-23	23	24	pCi/g	344		24.3	22.6	3.52	1.51	U	3.11	2.34	4.74	346	*	Exceeds Criteria	1,458	J+	314	8.57	9.68	12.7	J+	9.39	3.27	10.8	1,471		Exceeds Criteria	47.1		18.1	3.96	9.06	10.6	J	9.12	0.74	8.92	42.9	J+	17.0	1.30	7.90	101		Exceeds Criteria
AC-23	67	68	pCi/g	0.47	U	0.10	0.61	0.15	0.38		0.12	0.14	0.29	0.84	*	Less than Criteria	4.77	J+	1.10	0.05	0.06	0.33	J+	0.13	0.01	0.06	5.11		Less than Criteria	0.38	J	0.14	0.02	0.06	0.11	J	0.08	0.00	0.06	0.34	J+	0.13	0.01	0.05	0.83		Less than Criteria
AC-24	4	5	pCi/g	1,188		78.3	21.1	3.17	9.53		2.22	1.87	3.75	1,198		Exceeds Criteria	6,029	J+	902	7.36	6.86	54.1	J+	18.4	0.38	5.97	6,083		Exceeds Criteria	48.4		17.7	4.10	9.17	10.6	J	9.11	1.39	10.3	56.8	J+	19.2	1.90	8.73	116		Exceeds Criteria
AC-24	14	15	pCi/g	56.2		4.19	7.60	1.50	29.1		2.34	1.83	3.70	85.3		Exceeds Criteria	20.5	J+	4.72	0.26	0.22	10.0	J+	2.27	0.11	0.37	30.5		Exceeds Criteria	5.92		1.43	0.12	0.25	0.70	J	0.47	0.04	0.39	7.56	J+	1.68	0.03	0.25	14.2		Less than Criteria
AC-24	39	41	pCi/g	1.08	U	0.26	2.46	0.39	1.11		0.44	0.37	0.79	2.19	*	Less than Criteria	0.99	J+	0.28	0.05	0.04	0.80	J+	0.22	0.00	0.04	1.79		Less than Criteria	0.75		0.21	0.03	0.07	0.08	J	0.07	0.01	0.06	0.85	J+	0.22	0.01	0.05	1.67		Less than Criteria
AC-24	47	48	pCi/g	0.51	U	0.26	1.74	0.39	0.60		0.29	0.23	0.52	1.11	*	Less than Criteria	0.56	J+	0.19	0.05	0.05	0.35	J+	0.14	0.00	0.06	0.90		Less than Criteria	0.80		0.22	0.03	0.06	0.19	J	0.10	0.00	0.06	0.76	J+	0.21	0.01	0.06	1.75		Less than Criteria
AC2-25	37	38	pCi/g	1.25	U	0.20	1.53	0.28	1.50		0.27	0.19	0.41	2.75	*	Less than Criteria	0.79	J+	0.22	0.05	0.05	0.27	J+	0.11	0.02	0.07	1.07		Less than Criteria	0.61		0.17	0.02	0.04	0.10	J	0.07	0.00	0.07	0.47		0.14	0.01	0.04	1.18		Less than Criteria
AC2-25	43	45	pCi/g	1.27	U	0.21	1.74	0.24	1.19		0.29	0.23	0.50	2.46	*	Less than Criteria	4.52	J+	1.00	0.05	0.05	1.03	J+	0.27	0.01	0.05	5.55		Less than Criteria	0.62		0.18	0.03	0.06	0.19	J	0.11	0.00	0.08	0.67		0.19	0.01	0.05	1.48		Less than Criteria
AC-26A	4	5	pCi/g	12.5		1.48	4.14	0.74	0.94	J	0.62	0.52	1.09	13.4		Exceeds Criteria	246	J+	58.2	0.06	0.06	2.09		0.57	0.01	0.08	248		Exceeds Criteria	4.93		0.77	0.03	0.07	0.36	J+	0.14	0.01	0.07	4.83	J+	0.75	0.01	0.05	10.1		Less than Criteria
AC-26A	37	38	pCi/g	2.41		0.28	1.38	0.26	1.40		0.30	0.26	0.54	3.81		Less than Criteria	10.1	J+	2.30	0.05	0.05	1.49		0.39	0.00	0.05	11.6		Exceeds Criteria	0.75	J	0.18	0.02	0.05	0.06	J+	0.05	0.00	0.05	0.89	J+	0.20	0.01	0.05	1.70		Less than Criteria
Cotter Borings																																															
WL-209-CT	1	3	pCi/g	882	J+	4.87	0.15	0.07	5.48	J	0.49	0.35	0.16	887		Exceeds Criteria	1,470,000	J+	19,600	363	82.9	1,150		556	361	82.5	1,471,150		Exceeds Criteria	107	J	3.62	0.21	0.06	5.22	J	0.90	0.22	0.05	102	J	3.53	0.20	0.05	214		Exceeds Criteria
WL-209-CT_FD	1	3	pCi/g	855	J+	4.86	0.14	0.06	4.57	J	0.45	0.35	0.16	860		Exceeds Criteria	256,000	J+	7,560	308	70.5	420	J	305	166	70.1	256,420		Exceeds Criteria	101	J	3.58	0.23	0.06	5.15	J	0.90	0.12	0.03	107	J	3.68	0.09	0.02	213		Exceeds Criteria
WL-209-CT	9	10	pCi/g	460	J	3.84	0.08	0.19	45.0	J	1.37	0.19	0.42	505		Exceeds Criteria	9,330	J+	121	0.51	2.18	5.51	J	2.96	0.36	1.88	9,336		Exceeds Criteria	0.29		0.11	0.01	0.05	0.03	J	0.04	0.01	0.04	0.51		0.15	0.01	0.03	0.82		Less than Criteria
WL-209-CT	21	23	pCi/g	0.76	J	0.14	0.05	0.11	0.23	J	0.24	0.18	0.39	0.99		Less than Criteria	0.80	J+	0.16	0.01	0.05	0.63		0.14	0.01	0.02	1.43		Less than Criteria	0.48	J	0.14	0.01	0.06	0.00	U	0.01	0.01	0.07	0.55		0.15	0.01	0.05	1.03	*	Less than Criteria
WL-209-CT_FD	21	23	pCi/g	0.59		0.12	0.04	0.09	0.42	J	0.23	0.15	0.34	1.01		Less than Criteria	0.79	J+	0.16	0.02	0.06	0.66		0.14	0.01	0.04	1.45		Less than Criteria	0.22	J	0.09	0.01	0.05	0.03	J	0.04	0.01	0.04	0.51		0.14	0.01	0.05	0.75		Less than Criteria
WL-209-CT	26	27	pCi/g	0.49	J	0.12	0.05	0.11	0.55	J	0.24	0.16	0.34	1.04		Less than Criteria	0.55	J+	0.13	0.01	0.04	0.46		0.12	0.01	0.04	1.01		Less than Criteria	0.44		0.13	0.01	0.05	0.01	J	0.03	0.01	0.04	0.35		0.12	0.01	0.05	0.81		Less than Criteria
WL-234-CT	8	10	pCi/g	1,040	J+	8.62	0.26	0.10	3.82	J	0.46	0.40	0.18	1,044		Exceeds Criteria	644,000	J+	9,870	113	47.8	662		321	208	47.6	644,662		Exceeds Criteria	53.8	J	2.22	0.12	0.03	2.81	J	0.57	0.09	0.02	50.1	J	2.14	0.14	0.04	107		Exceeds Criteria
WL-234-CT_FD	8	10	pCi/g	757	J+	7.00	0.24	0.10	1.92	J	0.35	0.38	0.17	759		Exceeds Criteria	65,500	J+	2,850	267	87.4	202	J	165	170	38.9	65,702		Exceeds Criteria	44.2	J	1.92	0.13	0.03	2.05	J	0.46	0.12	0.02	43.3	J	1.90	0.12	0.03	89.6		Exceeds Criteria
WL-234-CT	18	19	pCi/g	110	J	1.60	0.05	0.12	0.63	J	0.25	0.16	0.35	111		Exceeds Criteria	4,290	J+	81.5	0.50	2.17	3.81	J	2.44	0.24	1.64	4,294		Exceeds Criteria	0.20		0.09	0.01	0.03	0.03	J	0.05	0.02	0.08	0.19		0.09	0.01	0.05	0.42		Less than Criteria
WL-234-CT	44	45	pCi/g	0.99		0.15	0.03	0.08	0.39	J	0.22	0.15	0.33	1.38		Less than Criteria	1.18	J+	0.19	0.01	0.04	0.98		0.18	0.01	0.02	2.16		Less than Criteria	0.55		0.15	0.01	0.05	0.01	J	0.03	0.01	0.04	0.72		0.17	0.01	0.05	1.28		Less than Criteria
Cotter Samples from Core of Non-Cotter Borings																																															
WL-210-CT (AC-24)	4	5	pCi/g	633	J+	4.06	0.12	0.05	1.50	J	0.31	0.37	0.17	635		Exceeds Criteria	57,000	J+	2,070	104	23.8	318	J	157	103	23.6	57,318		Exceeds Criteria	58.9	J	2.32	0.10	0.02	2.84	J	0.57	0.15	0.03	58.7	J	2.32	0.14	0.04	120		Exceeds Criteria
WL-210-CT (AC-24)	45	46	pCi/g	0.49		0.11	0.03	0.08	0.25	J	0.22	0.16	0.36	0.74		Less than Criteria	0.52	J+	0.13	0.01	0.04	0.20		0.08	0.01	0.02	0.72		Less than Criteria	0.80		0.18	0.01	0.06	0.05	J	0.05	0.01	0.04	1.08		0.21	0.01	0.03	1.93		Less than Criteria
WL-210-CT (AC-24)	21	22	pCi/g	0.99		0.16	0.04	0.10	0.67		0.27	0.17	0.37	1.67		Less than Criteria	4.24	J+	0.36	0.01	0.04	1.02		0.18	0.01	0.04	5.26		Less than Criteria	0.77		0.19	0.01	0.06	0.05	J	0.06	0.01	0.06	0.89		0.20	0.01	0.03	1.72		Less than Criteria
Cotter Third Phase Samples																																															
AC-08-CT	4	10	pCi/g	0.75		0.12	0.03	0.07	0.46	J+	0.28	0.20	0.43	1.21		Less than Criteria	1.23	J+	0.21	0.01	0.04	0.75		0.16	0.01	0.05	1.98		Less than Criteria	0.61		0.17	0.02	0.07	0.04	J	0.05	0.01	0.07	0.86		0.20	0.01	0.06	1.51		Less than Criteria
AC-10-CT	12	13	pCi/g	1.64		0.17	0.02	0.06	0.24	J+	0.23	0.17	0.36	1.88		Less than Criteria	9.63	J+	0.54	0.01	0.04	0.62		0.14	0.01	0.03	10.2		Exceeds Criteria	1.22		0.24	0.01	0.06	0.11	J	0.08	0.01	0.05	1.62		0.28	0.02	0.07	2.95		Less than Criteria
AC-13-CT	4	6	pCi/g	2.85		0.23	0.02	0.06	0.21	J+	0.22	0.16	0.36	3.06		Less than Criteria	55.6	J+	1.45	0.01	0.05	0.22		0.09	0.02	0.06	55.8		Exceeds Criteria	1.49		0.27	0.02	0.08	0.12	J	0.09	0.03	0.10	1.40		0.26	0.02	0.07	3.01		Less than Criteria
AC-15-CT	29	30	pCi/g	0.26		0.08	0.03	0.07	0.21	J+	0.24	0.18	0.39	0.47		Less than Criteria	0.56	J+	0.13	0.01	0.02	0.48		0.12	0.01	0.04	1.04		Less than Criteria	0.42		0.14	0.01	0.06	0.01	J	0.03	0.01	0.07	0.34		0.13	0.01	0.06	0.77		Less than Criteria
AC-16-CT	11	14	pCi/g	1.27		0.15	0.03	0.06	0.42	J+	0.23	0.15	0.34	1.69		Less than Criteria	5.38	J+	0.41	0.01	0.04	0.88		0.17	0.01	0.04	6.26		Less than Criteria	1.19		0.23	0.02	0.07	0.03	J	0.04	0.01	0.07	1.22		0.24	0.02	0.07	2.44		Less than Criteria
AC-16-CT	19	20	pCi/g	273		2.31	0.03	0.07	2.51	J+	0.38	0.18	0.38	276		Exceeds Criteria	7,420	J+	15.7	0.01	0.04	11.2		0.61	0.01	0.02	7,431		Exceeds Criteria	115	J	3.77	0.04	0.18	5.87	J	0.95	0.04	0.20	116	J	3.79	0.02	0.09	237		Exceeds Criteria
AC-16-CT_FD	11	14	pCi/g	1.81		0.19	0.03	0.08	3.81	J+	0.46	0.18	0.38	5.62		Less than criteria	31.1	J+	0.99	0.01	0.04	1.01		0.18	0.01	0.05	32.1		Exceeds Criteria	0.94		0.21	0.04	0.11	0.04	J	0.06	0.03	0.09	1.10		0.23	0.02	0.07	2.09		Less than Criteria
AC-21-CT	20	24	pCi/g	45.0		0.93	0.03	0.07	0.68	J+	0.27	0.18	0.39	45.7		Exceeds Criteria	1,240	J+	6.34	0.01	0.05	1.96		0.25	0.01	0.02	1,242		Exceeds Criteria	102	J	3.42	0.04	0.17	5.80	J	0.91	0.03	0.11	107	J	3.50	0.02	0.13	215		Exceeds Criteria
EPA Verification Samples																																															
WL-210-CT_(es)	4	5	pCi/g	704		21.1		26.0	2.98	U	1.13		5.25	707	*	Exceeds Criteria	0.78				0.01	41.6		10.1		16.8	42.4		Exceeds Criteria																		
WL-210-CT_(es)_SD	4	5	pCi/g	596		18.0		24.1	0.90	U	0.99		4.60	597	*	Exceeds Criteria	8,410		540		21.0	22.5				1.73	8,433		Exceeds Criteria																		
WL-209-CT_(es)	1	3	pCi/g	2,390		69.3		55.6	9.86	U	2.24		10.3	2,400	*	Exceeds Criteria	2.55				0.01	75.5		20.9		54.6	78.1		Exceeds Criteria																		
WL-209-CT_(es)_FD	1	3	pCi/g	1,880		54.4		39.4	8.26	U	1.88		8.62	1,888	*	Exceeds Criteria	2.02				0.01	107		25.2		48.6	109		Exceeds Criteria																		
WL-209-CT_(es)_FD_SD	1	3	pCi/g	1,650		48.3		44.5	4.92	U	1.73		8.01	1,655	*	Exceeds Criteria	36,600		2,330		38.9	44.0				1.82	36,644		Exceeds Criteria																		
WL-209-CT_(es)_SD	1	3	pCi/g	1,570		45.6		36.8	5.51	U	1.64		7.56	1,576	*	Exceeds Criteria	25,200		1,600		54.8	54.9				1.85	25,255		Exceeds Criteria																		
WL-234-CT_(es)	8	10	pCi/g	1,310		38.7		41.5	1.48	U	1.65		7.64	1,311	*	Exceeds Criteria	1.48				0.01	114		23.8		33.5	115		Exceeds Criteria																		
WL-234-CT_(es)_FD	8	10	pCi/g	979		28.9		28.5	4.14	U	1.46		6.81	983	*	Exceeds Criteria	1.01				0.01	25.7	U	8.71		26.3	26.7	*	Exceeds Criteria																		
WL-234-CT_(es)_FD_SD	8	10	pCi/g	771		23.1		28.5	2.25	U	1.16		5.37	773	*	Exceeds Criteria	5,150		337		20.6	20.4				1.79	5,170		Exceeds Criteria																		
WL-234-CT_(es)_SD	8	10	pCi/g	1,200		35.3		34.4	1.05	U	1.48		6.86	1,201	*	Exceeds Criteria	11,100		726		33.6	29.2				1.60	11,129		Exceeds Criteria																		

Table 6-3: Area 2 Combined Radium, Thorium, and Uranium Results (RI Borings, A2 Additional Borings, and Cotter Borings)

DRAFT

Sample Designation	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226 Result	Final Q	CSU[1]	CV	MDA	Radium-228 Result	Final Q	CSU[1]	CV	MDA	Combined Radium 226 + 228	Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230 Result	Final Q	CSU[1]	CV	MDA	Thorium-232 Result	Final Q	CSU[1]	CV	MDA	Combined Thorium 230 + 232	Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria	Uranium-234 Result	Final Q	CSU[1]	CV	MDA	Uranium-235 Result	Final Q	CSU[1]	CV	MDA	Uranium-238 Result	Final Q	CSU[1]	CV	MDA	Combined Uranium 234 + 235 + 238		Combined Uranium relative to 54.4 pCi/g Unrestricted Use Criteria
EPA Split Samples																																												
AC-10_(es)	26	28	pCi/g	0.99		0.23	0.07	0.17	0.37		0.22	0.14	0.32	1.36	Less than Criteria	0.78		0.16	0.01	0.03	0.37		0.22	0.14	0.32	1.15	Less than Criteria										0.74	U	0.58	0.89	1.89	0.74	*	Less than Criteria
AC-10_(es)_SD	26	28	pCi/g																		0.34		0.10	0.01	0.02	0.34	Less than Criteria										0.36		0.11	0.01	0.02	0.36		Less than Criteria
AC-13_(es)	20	22	pCi/g	4.51		0.71	0.12	0.28	0.21	U	0.31	0.31	0.69	4.72	* Less than Criteria	128		16.1	0.25	1.34	0.21	U	0.31	0.31	0.69	128	* Exceeds Criteria										0.90	U	1.50	2.39	5.00	0.90	*	Less than Criteria
AC-13_(es)_SD	20	22	pCi/g																		0.17	U	0.58	0.31	1.45	0.17	* Less than Criteria										1.73		0.28	0.01	0.02	1.73		Less than Criteria
AC-14_(es)	25	26	pCi/g	0.49		0.13	0.03	0.08	0.48		0.18	0.04	0.12	0.97	Less than Criteria	0.50		0.13	0.01	0.02	0.48		0.18	0.04	0.12	0.98	Less than Criteria										1.68		1.37	0.84	1.78	1.68		Less than Criteria
AC-14_(es)_SD	25	26	pCi/g																		0.40		0.12	0.01	0.04	0.40	Less than Criteria										0.34		0.11	0.01	0.05	0.34		Less than Criteria
AC-18_(es)	2	5	pCi/g	276		29.0	0.86	1.75	4.61		2.31	1.27	2.62	281	Exceeds Criteria	9,650		1,140	30.7	112	4.61		2.31	1.27	2.62	9,655	Exceeds Criteria										176		27.1	13.0	26.3	176		Exceeds Criteria
AC-18_(es)_SD	2	5	pCi/g																		-8.31	U	11.8	21.6	93.1	Non-detect	Less than Criteria										161		17.3	0.20	0.94	161		Exceeds Criteria
AC-19_(es)	5	6	pCi/g	483		50.3	0.76	1.54	6.97		1.45	1.56	3.16	490	Exceeds Criteria	19,600		2,360	33.6	110	6.97		1.45	1.56	3.16	19,607	Exceeds Criteria										27.4		7.69	13.0	26.1	27.4		Less than Criteria
AC-19_(es)_SD	5	6	pCi/g																		72.7		103	33.4	109	72.7	Exceeds Criteria										55.8		5.07	0.03	0.10	55.8		Exceeds Criteria
AC-23_(es)	23	24	pCi/g	217		22.7	0.49	1.00	2.72		1.77	0.88	1.79	220	Exceeds Criteria	7,970		985	15.1	49.1	2.72		1.77	0.88	1.79	7,973	Exceeds Criteria										22.1		5.42	7.99	16.1	22.1		Less than Criteria
AC-23_(es)_SD	23	24	pCi/g																		0.00	U	8.14	15.0	48.9	Non-detect	Less than Criteria										33.0		3.05	0.02	0.07	33.0		Less than Criteria
AC-24_(es)	4	5	pCi/g	618		64.4	0.98	1.99	9.52		1.82	2.20	4.45	628	Exceeds Criteria	26,700		3,100	67.4	262	9.52		1.82	2.20	4.45	26,710	Exceeds Criteria										21.1		7.58	11.8	23.7	21.1		Less than Criteria
AC-24_(es)_SD	4	5	pCi/g																		84.2		119	38.7	126	84.2	Exceeds Criteria										49.6		4.54	0.01	0.05	49.6		Less than Criteria
AC-25_(es)	37	38	pCi/g	1.08		0.26	0.09	0.20	1.48		0.36	0.13	0.31	2.56	Less than Criteria	1.22		0.22	0.01	0.05	1.48		0.36	0.13	0.31	2.70	Less than Criteria										1.31		0.76	1.14	2.41	1.31		Less than Criteria
AC-25_(es)_SD	37	38	pCi/g																		0.86		0.18	0.01	0.02	0.86	Less than Criteria										0.99		0.19	0.01	0.02	0.99		Less than Criteria
EPA Pyrolosis Split Samples																																												
A2-S1_pyr	0	0	pCi/g	2,514		134		18.0						2,514	Exceeds Criteria	51,800		3,150		33.7	118		24.3		33.6	51,918	Exceeds Criteria																	
AC-21_pyr	12	13	pCi/g	196		11.4		5.00						196	Exceeds Criteria	6,680		410		14.5	9.85		3.16		6.85	6,690	Exceeds Criteria																	
WL-234-CT_pyr	8	10	pCi/g	1,210		64.0		10.0						1,210	Exceeds Criteria	26,200		1,610		34.0	48.7		15.6		33.9	26,249	Exceeds Criteria																	
Missouri Department of Natural Resources Sample																																												
S10	0	0	pCi/g	3.28		0.88		0.36	0.55	U	0.53		1.08	3.83	Less than Criteria	22.6		4.01		0.10	1.95		0.47		0.08	24.6	Exceeds Criteria	0.90		0.27		0.10	0.10	U	0.09		0.10	1.01		0.28		0.08	2.01		Less than Criteria

Notes: NDE = gamma log not deep enough. No Log = no log from RI investigation exists. * Indicates that result for one of the two isotopes was non-detect Final Q = final qualifier CSU[1] = combined standard uncertainty (+/- sigma for McLaren/Hart samples) CV = critical value
indicates that combined value is greater than the unrestricted use criteria established by EPA
J = The analyte was analyzed for, and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample.
J+ = Same as J qualification but with an indication of positive bias in the sample concentration.
U = The analyte was analyzed for and is not present above the level of the associated value. The associated numerical value indicates the approximate concentration necessary to detect the analyte in the sample.
For McLaren/Hart RI Soil Boring Data:
- In calculated combined Ra and combined Th values, if of the the results was <MDA, one-half of the MDA was used in the calculation and the combined value was noted with an *. If both values were <MDA, combined results reported as "Non-detect".
- In calculated combined U values, if one or two of the the results was <MDA, one-half of the MDA was used in the calculation and the combined value was noted with an *. If all three values were <MDA, combined results reported as "Non-detect".

Table 6-4: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 1

DRAFT

Boring	Maximum Downhole Gamma Value (cpm)	Depth to Max Gamma (ft)	Elevation of Max Gamma (ft amsl)	Maximum Core Gamma (cpm)	Depth to Max Core Gamma (ft)	Elevation of Max Core Gamma (ft amsl)	Maximum Core Alpha (cpm)	Depth to Max Core Alpha (ft)	Elevation of Max Core Alpha (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval					
																Down-hole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
NRC (1981)																					
PVC-24-MH	BKGD									No						-	NA	NA	NA	NA	NA
PVC-25-MH	72,000	9	458.7							Yes	7	460.7	11	456.7	4.0	X	NA	NA	-	-	-
PVC-26-MH	86,000	5	460.2							Yes	3	462.2	10	455.2	7.0	X	NA	NA	-	-	-
PVC-27-MH	BKGD									No						-	NA	NA	NA	NA	NA
PVC-28-MH	132,000	14	459.1							Yes	12	461.1	17	456.1	5.0	X	NA	NA	-	-	-
PVC-36-MH	15,780	7.8	459.0							Yes	6	460.8	9.5	457.3	3.5	X	NA	NA	-	-	-
PVC-37-MH	BKGD									No						-	NA	NA	NA	NA	NA
PVC-38-MH	1,298,000	10	460.5							Yes	0	470.5	15	455.5	15.0	X	NA	NA	-	-	-
PVC-41-MH	BKGD									No						-	NA	NA	NA	NA	NA
NRC-29	2,000	9	464.46							No						-	NA	NA	NA	NA	NA
(1995)																					
WL-101-MH	BKGD									No						-	NA	NA	-	-	-
WL-102-MH	60,000	3.25	459.6							Yes	0	462.8	6	456.8	6.0	X	NA	NA	-	-	-
WL-103-MH	BKGD									Yes	9	441.9	11	439.9	2.0	-	NA	NA	-	X	-
WL-104-MH	BKGD									No						-	NA	NA	-	-	-
WL-105A-MH	180,000	9	458.2							Yes	5.5	461.7	12	455.2	6.5	X	NA	NA	X	X	-
WL-105B-MH	263,000	6.5	459.5							Yes	5.5	460.5	10.5	455.5	5.0	X	NA	NA	-	-	-
WL-105C-MH	386,000	3.5	462.2							Yes	2	463.7	5	460.7	3.0	X	NA	NA	-	-	-
WL-106A-MH	25,000	4	458.8							Yes	0	462.8	6	456.8	6.0	-	NA	NA	X	X	X
WL-106-MH	25,000	4	461.4							Yes	1	464.4	5.5	459.9	4.5	X	NA	NA	-	-	-
WL-107-MH	BKGD									No						-	NA	NA	-	-	-
WL-108-MH	BKGD									No						-	NA	NA	-	-	-
WL-109A-MH	BKGD									No						-	NA	NA	-	-	-
WL-109B-MH	BKGD									No						-	NA	NA	-	-	-
WL-109C-MH	BKGD									No						-	NA	NA	-	-	-
WL-109D-MH	BKGD									No						-	NA	NA	-	-	-
WL-110-MH	BKGD									No						-	NA	NA	-	-	-
WL-111-MH	BKGD									No						-	NA	NA	-	-	-
WL-112-MH	10,000	5.5	462.1							Yes	4	463.6	7	460.6	3.0	X	NA	NA	-	X	-
WL-113-MH	14,000	3.75	463.3							Yes	3	464.0	5	462.0	2.0	X	NA	NA	-	-	-
WL-114-MH	14,000	5	463.3							Yes	0	468.3	6	462.3	6.0	X	NA	NA	X	X	X
WL-115-MH	BKGD									No						-	NA	NA	-	-	-
WL-116-MH	BKGD									No						-	NA	NA	-	-	-
WL-117-MH	16,000	6.5	461.1							Yes	3	464.6	11	456.6	8.0	X	NA	NA	-	X	-
WL-118-MH	12,000	0	465.8							Yes	0	465.8	7	458.8	7.0	X	NA	NA	X	X	-
WL-119-MH	BKGD									No						-	NA	NA	-	-	-
WL-120-MH	BKGD									No						-	NA	NA	-	-	-
WL-121-MH	BKGD									No						-	NA	NA	-	-	-
WL-122-MH	BKGD									No						-	NA	NA	-	-	-
WL-123-MH	BKGD									No						-	NA	NA	-	-	-
WL-124-MH	BKGD									No						-	NA	NA	-	-	-
(2013)/Phase 1B																					
GCPT 1-1	6,258	1.1	469.9							No						-	NA	NA	NA	NA	NA
GCPT 1-1A	7,464	32.5	438.5							No						-	NA	NA	NA	NA	NA

Table 6-4: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 1

DRAFT

Boring	Maximum Downhole Gamma Value (cpm)	Depth to Max Gamma (ft)	Elevation of Max Gamma (ft amsl)	Maximum Core Gamma (cpm)	Depth to Max Core Gamma (ft)	Elevation of Max Core Gamma (ft amsl)	Maximum Core Alpha (cpm)	Depth to Max Core Alpha (ft)	Elevation of Max Core Alpha (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval					
																Down-hole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
GCPT 1-2	67,878	24.4	447.3							Yes	23.5	448.2	25.2	446.5	1.7	X	NA	NA	NA	NA	NA
GCPT 2-1	5,610	3.3	469.5							No						-	NA	NA	NA	NA	NA
GCPT 2-2	6,294	1.5	473.4							No						-	NA	NA	NA	NA	NA
GCPT 2-2A	5,766	1.5	473.8							No						-	NA	NA	NA	NA	NA
GCPT 2-3	BKGD									No						-	NA	NA	NA	NA	NA
GCPT 2-3A	34,722	35.6	441.0							Yes	35	441.6	36.8	439.8	1.8	X	NA	NA	NA	NA	NA
GCPT 2-2B	96,000	34	441.3							Yes	33.2	442.1	34.7	440.6	1.5	X	NA	NA	NA	NA	NA
GCPT 2-2C	18,906	32.5	442.8							Yes	31.8	443.5	32.7	442.6	0.9	X	NA	NA	NA	NA	NA
GCPT 2-4	10,320	29.4	447.2							No						-	NA	NA	NA	NA	NA
GCPT 3-1	5,724	4.4	470.5							No						-	NA	NA	NA	NA	NA
GCPT 3-1A	78,810	27.7	447.2							Yes	27	447.9	28.5	446.4	1.5	X	NA	NA	NA	NA	NA
GCPT 3-2	6,186	1	478.0							No						-	NA	NA	NA	NA	NA
GCPT 4-1	488,196	28.9	445.5							Yes	27.5	446.9	31	443.4	3.5	X	NA	NA	NA	NA	NA
GCPT 4-2	40,644	34	445.0							Yes	33.5	445.5	34.5	444.5	1.0	X	NA	NA	NA	NA	NA
GCPT 5-1	126,738	25.1	448.5							Yes	23.2	450.4	25.8	447.8	2.6	X	NA	NA	NA	NA	NA
GCPT 5-2	114,684	26.2	447.1							Yes	25.2	448.1	27	446.3	1.8	X	NA	NA	NA	NA	NA
GCPT 5-3	631,662	29.4	445.3							Yes	25.5	449.2	33	441.7	7.5	X	NA	NA	NA	NA	NA
GCPT 5-4	5,310	1.3	476.9							No						-	NA	NA	NA	NA	NA
GCPT 5-4A	8,820	11.8	466.2							No						-	NA	NA	NA	NA	NA
GCPT 5-5	450,360	32.2	444.5							Yes	30.1	446.6	34.4	442.3	4.3	X	NA	NA	NA	NA	NA
GCPT 5-6	405,864	27.4	447.3							Yes	25.5	449.2	29	445.7	3.5	X	NA	NA	NA	NA	NA
GCPT 6-2	6,258	13.3	459.7							No						-	NA	NA	NA	NA	NA
GCPT 6-3	103,218	27.9	446.1							Yes	27.2	446.8	28.8	445.2	1.6	X	NA	NA	NA	NA	NA
GCPT 6-4	4,434	3.1	479.6							No						-	NA	NA	NA	NA	NA
GCPT 6-5	6,108	3.3	479.3							No						-	NA	NA	NA	NA	NA
GCPT 6-6	191,856	28.1	447.1							Yes	26	449.2	29	446.2	3.0	X	NA	NA	NA	NA	NA
GCPT 7-1	6,204	7.9	463.0							No						-	NA	NA	NA	NA	NA
GCPT 7-2	6,012	4.9	467.7							No						-	NA	NA	NA	NA	NA
GCPT 7-3	12,558	40	439.2							No						-	NA	NA	NA	NA	NA
GCPT 8-1	19,854	29	450.7							Yes	27.5	452.2	30	449.7	2.5	X	NA	NA	NA	NA	NA
GCPT 9-1	8,280	6.2	464.1							No						-	NA	NA	NA	NA	NA
GCPT 9-2	5,826	16.9	455.2							No						-	NA	NA	NA	NA	NA
GCPT 9-3	3,642	1.8	477.8							No						-	NA	NA	NA	NA	NA
GCPT 9-3A	6,228	15.3	463.9							No						-	NA	NA	NA	NA	NA
GCTP 9-4	5,622	2.1	469.3							No						-	NA	NA	NA	NA	NA
GCPT 10-1	6,828	1.6	469.5							No						-	NA	NA	NA	NA	NA
GCPT 10-2	6,486	7.5	464.8							No						-	NA	NA	NA	NA	NA
GCPT 10-3	4,074	1.6	483.7							No						-	NA	NA	NA	NA	NA
GCPT 10-3A	4,890	3.4	482.0							No						-	NA	NA	NA	NA	NA
GCPT 10-4	BKGD									No						-	NA	NA	NA	NA	NA
GCPT 10-4A	6,642	14.9	468.7							No						-	NA	NA	NA	NA	NA
GCPT 11-1	9,210	0.2	479.6							No						-	NA	NA	NA	NA	NA
GCPT 11-2	7,614	15.4	459.4							No						-	NA	NA	NA	NA	NA
GCPT 11-3	6,858	6.1	470.5							No						-	NA	NA	NA	NA	NA
GCPT 11-4	9,792	45.9	436.8							No						-	NA	NA	NA	NA	NA
GCPT 12-1	308,106	24.1	455.3							Yes	22	457.4	24.9	454.5	2.9	X	NA	NA	NA	NA	NA

Table 6-4: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 1

DRAFT

Boring	Maximum Downhole Gamma Value (cpm)	Depth to Max Gamma (ft)	Elevation of Max Gamma (ft amsl)	Maximum Core Gamma (cpm)	Depth to Max Core Gamma (ft)	Elevation of Max Core Gamma (ft amsl)	Maximum Core Alpha (cpm)	Depth to Max Core Alpha (ft)	Elevation of Max Core Alpha (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval					
																Down-hole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
GCPT 12-2	6,546	1.3	474.7							No						-	NA	NA	NA	NA	NA
GCPT 12-3	7,476	4.1	471.8							No						-	NA	NA	NA	NA	NA
GCPT 12-4	7,374	38.5	437.9							No						-	NA	NA	NA	NA	NA
GCPT 12-5	6,432	7.5	471.0							No						-	NA	NA	NA	NA	NA
GCPT 12-6	6,378	23.1	455.9							No						-	NA	NA	NA	NA	NA
GCPT 13-1	28,302	15.4	455.5							Yes	15	455.9	16.3	454.6	1.3	X	NA	NA	NA	NA	NA
GCPT 13-2	2,490	0.8	470.7							No						-	NA	NA	NA	NA	NA
GCPT 13-2A	3,162	1.6	470.2							No						-	NA	NA	NA	NA	NA
GCPT 13-3	2,520	1.3	470.9							No						-	NA	NA	NA	NA	NA
GCPT 13-4	BKGD									No						-	NA	NA	NA	NA	NA
GCPT 13-4S	6,120	36.6	437.5							No						-	NA	NA	NA	NA	NA
GCPT 13-5	1,872	0.3	475.1							No						-	NA	NA	NA	NA	NA
GCPT 13-5S	5,682	11.5	464.0							No						-	NA	NA	NA	NA	NA
GCPT 13-6	5,802	3.4	472.5							No						-	NA	NA	NA	NA	NA
GCPT 13-6S	6,552	23.8	452.2							No						-	NA	NA	NA	NA	NA
GCPT 13-7	5,964	1.6	472.7							No						-	NA	NA	NA	NA	NA
GCPT 13-7S	6,366	20.8	453.4							No						-	NA	NA	NA	NA	NA
GCPT 14-1	29,640	18.9	455.3							Yes	18.3	455.9	19.6	454.6	1.3	X	NA	NA	NA	NA	NA
GCPT 14-2	3,600	1.1	473.4							No						-	NA	NA	NA	NA	NA
GCPT 14-3	BKGD									No						-	NA	NA	NA	NA	NA
GCPT 14-3S	6,708	36.6	437.1							No						-	NA	NA	NA	NA	NA
GCPT 14-4	BKGD									No						-	NA	NA	NA	NA	NA
GCPT 14-5	5,772	1.6	471.7							No						-	NA	NA	NA	NA	NA
GCPT 14-5S	5,880	15.4	457.9							No						-	NA	NA	NA	NA	NA
GCPT 14-6	6,654	7.4	465.3							No						-	NA	NA	NA	NA	NA
GCPT 14-6S	6,330	14.9	457.9							No						-	NA	NA	NA	NA	NA
GCPT 14-7	1,338	0.2	472.9							No						-	NA	NA	NA	NA	NA
GCPT 15-1	11,940	20.3	433.5							No						-	NA	NA	NA	NA	NA
GCPT 15-2	3,222	1.6	475.7							No						-	NA	NA	NA	NA	NA
GCPT 15-3	9,828	30.5	443.5							No						-	NA	NA	NA	NA	NA
GCPT 15-4	8,400	29.4	443.7							No						-	NA	NA	NA	NA	NA
GCPT 15-5	7,098	57.7	411.5							No						-	NA	NA	NA	NA	NA
GCPT 15-6	7,098	2.6	466.2							No						-	NA	NA	NA	NA	NA
GCPT 15-7	6,444	2.5	469.6							No						-	NA	NA	NA	NA	NA
GCPT 15-8	8,724	2.3	471.5							No						-	NA	NA	NA	NA	NA
GCPT 16-1	9,228	7.2	444.0							No						-	NA	NA	NA	NA	NA
GCPT 16-2	6,948	1.8	451.3							No						-	NA	NA	NA	NA	NA
GCPT 16-3	6,744	2.3	469.0							No						-	NA	NA	NA	NA	NA
GCPT 16-4	7,446	3	469.5							No						-	NA	NA	NA	NA	NA
GCPT 16-5	6,864	4.8	469.2							No						-	NA	NA	NA	NA	NA
GCPT 16-6	6,600	13.6	463.2							No						-	NA	NA	NA	NA	NA
GCPT 16-7	6,414	2.6	477.2							No						-	NA	NA	NA	NA	NA
GCPT 16-8	6,648	20.7	461.2							No						-	NA	NA	NA	NA	NA
Phase 1C (2014)																					
GCPT 1C-1	5,256	3	460.7							No						-	NA	NA	NA	NA	NA
GCPT 1C-1A	5,988	3.1	460.5							No						-	NA	NA	NA	NA	NA

Table 6-4: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 1

DRAFT

Boring	Maximum Downhole Gamma Value (cpm)	Depth to Max Gamma (ft)	Elevation of Max Gamma (ft amsl)	Maximum Core Gamma (cpm)	Depth to Max Core Gamma (ft)	Elevation of Max Core Gamma (ft amsl)	Maximum Core Alpha (cpm)	Depth to Max Core Alpha (ft)	Elevation of Max Core Alpha (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval					
																Down-hole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
GCPT 1C-2	BKGD									No						-	NA	NA	NA	NA	NA
GCPT 1C-2R	31,290	30.3	442.2							Yes	29.6	442.9	32	440.5	2.4	**X**	NA	NA	NA	NA	NA
GCPT 1C-3	6,576	22	464.4							No						-	NA	NA	NA	NA	NA
GCPT 1C-4	1,851	27.7								No						-	NA	NA	NA	NA	NA
GPCT 1C-4R	22,638	43.8	442.2							Yes	43.4	442.6	44	442.0	0.6	**X**	NA	NA	NA	NA	NA
GCPT 1C-5	BKGD									No						-	NA	NA	NA	NA	NA
GCPT 1C-5A	6,516	15.1	463.9							No						-	NA	NA	NA	NA	NA
GCPT 1C-6	84,810	22.1	446.7							Yes	21.4	447.4	23.2	445.6	1.8	**X**	NA	NA	NA	NA	NA
GCPT 1C-6T	90,390	22.8	446.1							Yes	22	446.9	24	444.9	2.0	**X**	NA	NA	NA	NA	NA
GCPT 1C-6T1	171,774	23.5	445.4							Yes	22.5	446.4	23.6	445.3	1.1	**X**	NA	NA	NA	NA	NA
GCPT 1C-7	6,978	4.3	464.3							No						-	NA	NA	NA	NA	NA
GCPT 1C-8	6,144	3	488.2							No						-	NA	NA	NA	NA	NA
GCPT 1C-9	6,360	10.4	484.8							No						-	NA	NA	NA	NA	NA
GCPT 1C-10	6,276	11.8	484.7							No						-	NA	NA	NA	NA	NA
GCPT 1C-11	6,516	3	493.9							No						-	NA	NA	NA	NA	NA
GCPT 1C-12	57,414	56.3	443.8							Yes	55.7	444.4	57	443.1	1.3	**X**	NA	NA	NA	NA	NA
GCPT 1C-13	6,438	34.1	446.0							No						-	NA	NA	NA	NA	NA
GCPT-108	6,408	2	468.4							No						-	NA	NA	NA	NA	NA
GCPT-111A	9,564	25.9	449.8							No						-	NA	NA	NA	NA	NA
GCPT-119	14,616	45.6	433.0							No						-	NA	NA	NA	NA	NA
GCPT-28A	82,512	24.9	455.6							Yes	24.2	456.3	25.6	454.9	1.4	**X**	NA	NA	NA	NA	NA
GCPT-36	19,470	8.5	456.5							Yes	7.8	457.2	8.8	456.2	1.0	**X**	NA	NA	NA	NA	NA
GCPT-25	74,880	8.4	456.9							Yes	7.3	458.0	9.8	455.5	2.5	**X**	NA	NA	NA	NA	NA
PVC-25R	74,562	9.5	455.8							Yes	8.3	457.0	10.9	454.4	2.6	**X**	NA	NA	NA	NA	NA
1-2	4,271	33	439.6	11,838	2	470.6				No						-	-	NA	-	-	-
2-2	4,354	32	443.2	14,862	22	453.2				No						-	-	NA	-	-	-
5-3	336,937	29.5	444.9	368,717	28	446.4				Yes	26	448.4	34	440.4	8.0	**X**	**X**	NA	**X**	**X**	**X**
5-3	44,163	51.5	422.9							Yes	49	425.4	53?	421.4?	4?	**X**	-	NA	-	-	-
8-1	4,821	28	451.8	15,541	44	435.8				No						-	-	NA	-	-	-
12-5	3,864	14	464.9	13,053	49	429.9				No						-	-	NA	-	-	-
13-3	3,607	16.5	456.1	13,869	43	429.6				No						-	-	NA	-	-	-
13-6	3,902	24.5	451.4	12,293	21	454.9				No						-	-	NA	-	-	-
14-2	4,008	27.5	447.1	16,548	29	445.6				No						-	-	NA	-	-	-
14-4	3,888	9	465.4	11,662	40	434.4				No						-	-	NA	-	-	-
14-5	3,454	13.5	459.4	11,457	12	460.9				No						-	-	NA	-	-	-
14-7	3,637	31.5	441.8	13,227	31	442.3				No						-	-	NA	-	-	-
15-2	5,184	26	450.5	13,899	24	452.5				Yes	22	454.5	27	449.5	5.0	-	-	NA	-	**X**	-
16-3	4,118	20	450.7	13,165	10	460.7				No						-	-	NA	-	-	-
16-6	3,841	14	463.1	13,051	21	456.1				No						-	-	NA	-	-	-
1C-6	53,732	22.5	446.7	15,025	26	443.2				Yes	20	449.2	27	442.2	7.0	**X**	-	NA	**X**	**X**	-
WL-119	7,941	32.5	446.7	13,679	1	478.2				Yes	31.5	447.7	33	446.2	1.5	**X**	-	NA	-	-	-
1-2-Geoprobe	NA									No						NA	NA	NA	-	-	-
2-2-Geoprobe	NA									Yes	30	445.250	34	441.250	4.0	NA	NA	NA	**X**	**X**	-
2-3-Geoprobe	NA									Yes	33	443.459	38	438.459	5.0	NA	NA	NA	**X**	**X**	-
8-1B-Geoprobe	NA									No						NA	NA	NA	-	-	-

Table 6-4: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 1

DRAFT

Boring	Maximum Downhole Gamma Value (cpm)	Depth to Max Gamma (ft)	Elevation of Max Gamma (ft amsl)	Maximum Core Gamma (cpm)	Depth to Max Core Gamma (ft)	Elevation of Max Core Gamma (ft amsl)	Maximum Core Alpha (cpm)	Depth to Max Core Alpha (ft)	Elevation of Max Core Alpha (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval					
																Down-hole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
1C-12-Geoprobe	NA									No						NA	NA	NA	-	-	-
1C-12B-Geoprobe	NA									Yes	54	445.723	56	443.723	2.0	NA	NA	NA	-	X	-
1C-12C-Geoprobe	NA									Yes	53	447.161	58	442.161	5.0	NA	NA	NA	X	X	-
1C-2RA-Geoprobe	NA									No						NA	NA	NA	-	-	-
1C-4R-Geoprobe	NA									No						NA	NA	NA	-	-	-
1C-4RB-Geoprobe	NA									No						NA	NA	NA	-	-	-
1C-6T1-Geoprobe	NA									No						NA	NA	NA	-	-	-
WL-119-Geoprobe	NA									No						NA	NA	NA	-	-	-
WL-119B-Geoprobe	NA									No						NA	NA	NA	-	-	-
WL-119C-Geoprobe	NA									No						NA	NA	NA	-	-	-
Phase 1D (2015)																					
1D-1	6,288	8.9	453.6	13,570	8	454.5	3 (m)	16	446.5	No						-	NA	NA	NA	NA	NA
1D-2	5,142	5.9	462.5	13,261	36	432.4	7	3	465.4	No						-	NA	NA	NA	NA	NA
1D-3	390,720	27.4	444.7	67,177	28	444.1	125	28	444.1	Yes	25.5	446.6	29.5	442.6	4.0	X	NA	NA	NA	NA	NA
1D-4	14,154	55.8	440.6	15,010	11	485.4	3 (m)	14	482.4	No						-	NA	NA	NA	NA	NA
1D-5	143,724	55.1	432.5	20,707	51	436.6	33	51	436.6	Yes	54.1	433.5	56.2	431.4	2.1	X	NA	NA	NA	NA	NA
1D-6	6,834	3.9	508.6	20,707	51	461.5	33	51	461.5	No						-	NA	NA	NA	NA	NA
1D-7	775,560	82.8	430.0	1,995,300	83	429.8	3270	82	430.8	Yes	80.2	432.6	85.5	427.3	5.3	X	NA	NA	NA	NA	NA
1D-8	44,028	75.3	441.9	19,108	75	442.2	6	85	432.2	Yes	74.7	442.5	75.6	441.6	0.9	X	NA	NA	NA	NA	NA
1D-8A	6,318	2.6	514.7							No						-	NA	NA	NA	NA	NA
1D-9	13,236	58.6	460.0	18,794	87	431.6	10 (m)	84	434.6	No						-	NA	NA	NA	NA	NA
1D-9A	14,508	56.8	461.8							No						-	NA	NA	NA	NA	NA
1D-10	7,554	38.9	464.8	12,827	6	497.7	3	48	455.7	No						-	NA	NA	NA	NA	NA
1D-11	5,970	1.8	521.2	24,281	85	438.0	38	85	438.0	No						-	NA	NA	NA	NA	NA
1D-11A	6,648	1.6	521.2							No						-	NA	NA	NA	NA	NA
1D-12	6,054	29.4	476.2	13,843	61	444.6	4	59	446.6	No						-	NA	NA	NA	NA	NA
1D-13	7,980	36.4	483.8	13,515	93	427.2	2	53	467.2	No						-	NA	NA	NA	NA	NA
1D-13A	5,934	2.1	518.1							No						-	NA	NA	NA	NA	NA
1D-13B	5,964	7.1	513.3							No						-	NA	NA	NA	NA	NA
1D-13C	6,432	2.5	517.4							No						-	NA	NA	NA	NA	NA
1D-14	5,952	2.5	519.5	14,725	54	468.0	2 (m)	46	476.0	No						-	NA	NA	NA	NA	NA
1D-15	16,194	89.6	427.1	13,352	85	431.7	15	85	431.7	Yes	89.4	427.3	89.7	427.0	0.3	X	NA	NA	NA	NA	NA
1D-16	68,700	46.9	437.9	24,411	50	434.8	17	50	434.8	Yes	46	438.8	48	436.8	2.0	X	NA	NA	NA	NA	NA
1D-16A	17,712	49.9	435.3							Yes	49.7	435.5	49.9	435.3	0.2	X	NA	NA	NA	NA	NA
1D-17	4,938	4.1	468.4	13,040	18	454.5	4	45	427.5	No						-	NA	NA	NA	NA	NA
1D-17A	5,496	17.7	454.8							No						-	NA	NA	NA	NA	NA
1D-18	7,224	10.2	470.8	13,803	12	469.0	4 (m)	19	462.0	No						-	NA	NA	NA	NA	NA
1D-18A	6,984	41.3	439.2							No						-	NA	NA	NA	NA	NA
1D-1S	3,382	6.5	456.1							No						-	-	-	-	-	-
1D-2S	4,001	19.5	449.1							No						-	-	-	-	-	-
1D-3S	204,471	27	445.3							Yes	23	449.3	31	441.3	8.0	X	X	X	X	X	-
1D-4S	4,349	12.5	483.9							No						-	-	-	-	-	-
1D-5S	12,059	53	434.8							Yes	51	436.8	56	431.8	5.0	X	X	X	X	X	-
1D-6S	3,749	11	501.7							No						-	-	-	-	-	-
1D-7S	1,503,082	82.5	430.8							Yes	76	437.3	93	420.3	17.0	X	X	X	X	X	-

Table 6-4: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 1

DRAFT

Boring	Maximum Downhole Gamma Value (cpm)	Depth to Max Gamma (ft)	Elevation of Max Gamma (ft amsl)	Maximum Core Gamma (cpm)	Depth to Max Core Gamma (ft)	Elevation of Max Core Gamma (ft amsl)	Maximum Core Alpha (cpm)	Depth to Max Core Alpha (ft)	Elevation of Max Core Alpha (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval					
																Down-hole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
1D-8S	6,869	73	443.7							Yes	72	444.7	74	442.7	2.0	X	-	-	-	-	-
1D-9S	16,313	71.5	447.4							Yes	70	448.9	72.5	446.4	2.5	X	-	-	-	-	-
1D-9S	1,174,844	87.5	431.4							Yes	82	436.9	96	422.9	14.0	X	X	X	X	X	-
1D-10S	3,942	37.5	465.6							No						-	-	-	-	-	-
1D-11S	16,554	84	438.3							Yes	82	440.3	86	436.3	4.0	X	X	X	X	X	-
1D-12S	4,173	29.5	476.4							No						-	-	-	-	-	-
1D-13S	4,304	42	478.5							No						-	-	-	-	-	-
1D-14S	4,010	43.5	479.0							No						-	-	-	-	-	-
1D-15S	20,523	85	431.1							Yes	83.5	432.6	86	430.1	2.5	X	X	X	X	X	-
1D-16S	11,886	50	435.6							Yes	49.5	436.1	51.5	434.1	2.0	X	X	X	X	X	-
1D-17S	3,650	16	456.9							No						-	-	-	-	-	-
1D-18S	4,480	48.5	433.5							No						-	-	-	-	-	-
1D-19S	3,437	44	477.1							No						-	-	-	-	-	-
1D-20S	1,576	2.5	515.2							No						-	-	-	-	-	-
Characterization																					
AC-1a	824,868	10.5	456.2	1,128,112	10	456.7	2596	10	456.7	Yes	4.5	462.2	22	444.7	17.5	X	X	X	X	X	X
AC-1b	3,686	29.0	437.7							Yes	29	437.7	32	434.7	3.0	-	X	X	X	X	-
AC-1c	20,364	38.5	428.2							Yes	35	431.7	41	425.7	6.0	X	-	-	-	-	-
AC-2Ba	7,931	4.5	461.7	21,345	10	456.2	11	10	456.2	Yes	2	464.2	6.5	459.7	4.5	X	-	-	-	-	-
AC-2Bb	15,570	10.0	456.2							Yes	9.5	456.7	13.5	452.7	4.0	X	X	X	X	X	-
AC-3a	906,839	4.0	462.4	979,494	5	461.4	1013	3	463.4	Yes	0	466.4	19	447.4	19.0	X	X	X	X	X	X
AC-3b	46,921	38.5	427.9							Yes	32.5	433.9	39.5	426.9	7.0	X	-	-	-	-	-
AC-4B	5,114	5.0	459.7	13,302	32	432.7	4	25	439.7	No						-	-	-	-	-	-
AC-5	4,656	12.5	438.9	15,408	11	440.4	5	11	440.4	No						-	-	-	-	-	-
AC-6	4,857	26.0	438.3	14,908	23	441.3	4 (m)	7	457.3	No						-	-	-	-	-	-
AC-7	24,727	2.5	459.0	17,700	32	429.5	4	32	429.5	Yes	0.5	461.0	5	456.5	4.5	X	-	-	-	-	-
Cotter (2015)																					
WL-102-CT	4,379	3.0	458.7	13,625	12	449.7	10 (m)	2	459.7	No						-	-	X	-	-	-
WL-106A-CT	27,546	4.5	459.3	30,545	10	453.8	54	11	452.8	Yes	2	461.8	12	451.8	10.0	X	X	X	X	X	-
WL-114-CT	5,669	5.0	462.4	14,300	6	461.4	14	32	435.4	Yes	2	465.4	6	461.4	4.0	-	X	-	-	-	-

Notes:

amsl = above mean sea level cpm = counts per minute

NA - Data were not collected or are otherwise not available.

X - Data support the presence of RIM in the indicated interval

- Data do not indicate the presence of RIM at this location/interval

(m) - multiple intervals with same detections; see Appendix L for details; only uppermost elevation shown

See Borehole Summary Sheets in Appendix L for supporting documentation for this table

Table 6-5: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 2

DRAFT

Boring	Maximum Downhole Gamma Value (cpm)	Depth to Max Gamma (ft)	Elevation of Max Gamma (ft amsl)	Maximum Core Alpha (cpm)	Depth to Max Core Alpha (ft)	Elevation of Max Core Alpha (ft amsl)	Maximum Core Gamma (cpm)	Depth to Max Core Gamma (ft)	Elevation of Max Core Gamma (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation of Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval					
																Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
							1														
NRC (1981)																					
PVC-4	1,290,000	1	468.91							Yes	0	469.91	5.5	464.41	5.5	X	NA	NA	X	NA	X
PVC-4	14,000	11.5	458.41							Yes	11	458.91	13	456.91	2	X	NA	NA	-	NA	NA
PVC-5	15,000	5.5	459.49							Yes	1	463.99	7	457.99	6	X	NA	NA	-	NA	NA
PVC-5	14,000	11.5	453.49							Yes	9.5	455.49	14.5	450.49	5	X	NA	NA	-	NA	NA
PVC-6	367,000	11	455.08							Yes	0	466.08	16	450.08	16	X	NA	NA	X	NA	-
PVC-6	23,000	20.5	445.58							Yes	19	447.08	22.5	443.58	3.5	X	NA	NA	NA	NA	NA
PVC-7	1,386,000	2	468.99							Yes	0	470.99	7	463.99	7	X	NA	NA	NA	NA	NA
PVC-7	22,000	19.5	451.49							Yes	17	453.99	22	448.99	5	X	NA	NA	NA	NA	NA
PVC-8	24,000	0.5	470.91							Yes	0	471.41	1.5	469.91	1.5	X	NA	NA	-	NA	NA
PVC-9	22,000	5	465.92							Yes	1	469.92	6.5	464.42	5.5	X	NA	NA	X	NA	-
PVC-10	752,000	3	470.75							Yes	0	473.75	7	466.75	7	X	NA	NA	X	NA	NA
PVC-10	152,000	9.5	464.25							Yes	7	466.75	13	460.75	6	X	NA	NA	X	NA	X
PVC-11B	2,144,000	3	472.87							Yes	0	475.87	10.5	465.37	10.5	X	NA	NA	X	NA	X
PVC-12	58,000	2.5	465.82							Yes	0.5	467.82	5.5	462.82	5	X	NA	NA	NA	NA	NA
PVC-13	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	NA	NA	NA
PVC-18	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	-	NA	NA
PVC-19	332,000	8	461.55							Yes	6	463.55	10.5	459.05	4.5	X	NA	NA	X	NA	-
PVC-20	127,000	1.5	465.15							Yes	0	466.65	4	462.65	4	X	NA	NA	X	NA	NA
PVC-33	10,000	2.5	463.81							Yes	1.5	464.81	3.5	462.81	2	X	NA	NA	NA	NA	NA
PVC-34	22,000	1	462.31							Yes	0	463.31	3	460.31	3	X	NA	NA	NA	NA	NA
PVC-35	745,000	4	463.11							Yes	0.5	466.61	8	459.11	7.5	X	NA	NA	NA	NA	NA
PVC-39	14,000	2.5	464.17							Yes	1.5	465.17	4	462.67	2.5	X	NA	NA	NA	NA	NA
PVC-40	120,000	2.5	464.59							Yes	0.5	466.59	5	462.09	4.5	X	NA	NA	NA	NA	NA
PVC-40	46,000	7	460.09							Yes	6	461.09	9	458.09	3	X	NA	NA	NA	NA	NA
NRC-2	11,000	16	466.25							Yes	15	467.25	18	464.25	3	X	NA	NA	NA	NA	NA
NRC-3	> 50,000	0	476							Yes	0	476	3	473	3	X	NA	NA	NA	NA	NA
NRC-16	> 50,000	11	474.5							Yes	0	485.5	19 +	< 466.5	19 +	X	NA	NA	NA	NA	NA
NRC-17	3,000	20	467.5							Yes	20	467.5	21	466.5	1	X	NA	NA	NA	NA	NA
NRC-21	14,000	0	474							Yes	0	474	2	472	2	X	NA	NA	NA	NA	NA
NRC-21	> 50,000	6	468							Yes	5	469	12	462	7	X	NA	NA	NA	NA	NA
NRC-21	10,000	15	459							Yes	14	460	16	458	2	X	NA	NA	NA	NA	NA
NRC-22	13,000	1	485.5							Yes	0	486.5	2	484.5	2	X	NA	NA	NA	NA	NA
NRC-22	9,000	15	471.5							Yes	8	478.5	17	469.5	9	X	NA	NA	NA	NA	NA
NRC-22	> 50,000	23	463.5							Yes	18	468.5	25 +	< 461.5	7 +	X	NA	NA	NA	NA	NA
NRC-30	1,200	15	467.25							No	None	None	None	None	None	-	NA	NA	NA	NA	NA
NRC-31	1,500	4	487							No	None	None	None	None	None	-	NA	NA	NA	NA	NA
NRC-32	> 50,000	1	472							Yes	0	473	2	471	2	X	NA	NA	NA	NA	NA
McLaren/Hart RI (1995)																					
WL-207	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	-	-	-
WL-208	12,000	No peak	None							Yes	0	474.8	10	464.8	10	-	NA	NA	-	X	-
WL-209	744,000	0	467.4							Yes	0	467.4	11	456.4	11	X	NA	NA	X	X	X

Table 6-5: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 2

DRAFT

Boring	Maximum Downhole Gamma Value (cpm)	Depth to Max Gamma (ft)	Elevation of Max Gamma (ft amsl)	Maximum Core Alpha (cpm)	Depth to Max Core Alpha (ft)	Elevation of Max Core Alpha (ft amsl)	Maximum Core Gamma (cpm)	Depth to Max Core Gamma (ft)	Elevation of Max Core Gamma (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation of Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval					
																Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
							1														
WL-209	6,000	No peak	None							Yes	24	443.4	26	441.4	2	-	NA	NA	-	X	-
WL-210	509,000	0	477.8							Yes	0	477.8	16.5	461.3	16.5	X	NA	NA	X	X	X
WL-210	88,000	47.5	430.3							Yes	39	438.8	49.5	428.3	10.5	X	NA	NA	-	X	-
WL-211	330,000	0.75	474.55							Yes	0	475.3	13	462.3	13	X	NA	NA	X	X	-
WL-212	6,000	No peak	None							Yes	8	464.9	12	460.9	4	-	NA	NA	-	X	-
WL-213	6,000	No peak	None							Yes	0	472.3	6	466.3	6	-	NA	NA	-	X	-
WL-214	6,000	No peak	None							Yes	4	464.5	6	462.5	2	-	NA	NA	-	X	-
WL-214	6,000	No peak	None							Yes	24	444.5	26	442.5	2	-	NA	NA	-	X	-
WL-215	Not logged	NA	NA							No	NA	NA	NA	NA	NA	NA	NA	NA	-	-	-
WL-216A	24,000	3.5	473.9							Yes	0	477.4	10	467.4	10	X	NA	NA	X	X	-
WL-216B	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	-	-	-
WL-216C	48,000	3.5	474.1							Yes	0	477.6	8	469.6	8	X	NA	NA	NA	NA	NA
WL-217	6,000	No peak	None							Yes	9	465.7	11	463.7	2	-	NA	NA	-	X	-
WL-218	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	-	-	-
WL-219	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	-	-	-
WL-220	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	-	-	-
WL-221	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	-	-	-
WL-222	6,000	No peak	None							Yes	0	457.8	7	450.8	7	-	NA	NA	-	X	-
WL-223	15,000	4	458.2							Yes	1	461.2	7.5	454.7	6.5	X	NA	NA	-	X	-
WL-224	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	-	-	-
WL-225	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	-	-	-
WL-226	370,000	10.5	457							Yes	0	467.5	22	445.5	22	X	NA	NA	-	X	-
WL-227	8,000	No peak	None							Yes	4	458	6	456	2	-	NA	NA	-	X	-
WL-228	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	-	-	-
WL-229	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	-	-	-
WL-230	10,000	1.5	461.8							Yes	0	463.3	6	457.3	6	X	NA	NA	-	X	-
WL-231	29,000	5.5	459.3							Yes	3	461.8	11	453.8	8	X	NA	NA	-	X	-
WL-233	90,000	22	467.2							Yes	17	472.2	31	458.2	14	X	NA	NA	-	X	-
WL-234	1,104,000	7	473							Yes	0	480	21	459	21	X	NA	NA	X	X	X
WL-235	6,000	No peak	None							Yes	0	481.1	1	480.1	1	-	NA	NA	-	X	-
WL-235	20,000	22.5	458.6							Yes	20.5	460.6	24.5	456.6	4	X	NA	NA	-	-	-
WL-236	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	-	-	-
WL-237	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	NA	NA	NA
WL-238	130,000	6	460.2							Yes	1	465.2	10.5	455.7	9.5	X	NA	NA	NA	NA	NA
WL-239	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	-	-	-
WL-240	6,000	No peak	None							No	None	None	None	None	None	-	NA	NA	NA	NA	NA
WL-241	46,000	5.5	464.1							Yes	1	468.6	9.5	460.1	8.5	X	NA	NA	X	X	-
WL-242	Not logged	NA	NA							Yes	0	NA	3	NA	3	NA	NA	NA	-	X	-
WL-243	Not logged	NA	NA							Yes	0	NA	2	NA	2	NA	NA	NA	-	X	-
WL-244	Not logged	NA	NA							Yes	0	NA	1	NA	1	NA	NA	NA	-	X	-
WL-245	Not logged	NA	NA							No	None	None	None	None	None	NA	NA	NA	-	-	-
WL-246	Not logged	NA	NA							No	None	None	None	None	None	NA	NA	NA	-	-	-

Table 6-5: Summary of Occurrences of Radiologically-Impacted Material (RIM) in Area 2

DRAFT

Boring	Maximum Downhole Gamma Value (cpm)	Depth to Max Gamma (ft)	Elevation of Max Gamma (ft amsl)	Maximum Core Alpha (cpm)	Depth to Max Core Alpha (ft)	Elevation of Max Core Alpha (ft amsl)	Maximum Core Gamma (cpm)	Depth to Max Core Gamma (ft)	Elevation of Max Core Gamma (ft amsl)	RIM Present ?	Depth to Top of RIM Interval (ft)	Elevation of Top of RIM Interval (ft amsl)	Depth to Bottom of RIM Interval (ft)	Elevation of Bottom of RIM Interval (ft amsl)	Thickness of RIM (ft)	Basis for RIM Interval					
																Downhole Gamma	Core Gamma	Core Alpha	Radium	Thorium	Uranium
							1														
Area 2 - Additional Characterization (2015)																					
AC-8	3,917	51	439.616	6 (m)	7	483.2	19,193	24	466.6	No	None	None	None	None	None	-	-	-	-	-	-
AC-9	3,785	31	438.194	5	11	458.2	13,770	26	443.2	No	None	None	None	None	None	-	-	-	-	-	-
AC-10	3,423	3	464.676	4	18	449.7	16,542	26	441.7	Yes	11	456.676	14	453.676	3	-	-	-	-	X	-
AC-11	3,413	2	460.965	4 (m)	6	459.0	22,103	17	446.0	No	NA	NA	NA	NA	NA	-	-	-	-	-	-
AC-12	3,577	2.5	457.087	10	7	452.6	15,244	3	456.6	Yes	1	458.587	5	454.587	4	X	X	-	-	X	-
AC-13	500,239	18	450.089	39	20	448.1	20,359	20	448.1	Yes	14	454.089	24	444.089	10	X	X	X	X	X	-
AC-14	3,847	22	435.834	3 (m)	24	433.8	17,479	25	432.8	No	None	None	None	None	None	-	-	-	-	-	-
AC-15	3,803	11.5	445.737	3	29	428.2	15,479	33	424.2	No	None	None	None	None	None	-	-	-	-	-	-
AC-16	443,815	18	450.212	299	22	446.2	313,137	22	446.2	Yes	10	458.212	30	438.212	20	X	X	X	X	X	X
AC-17	3,519	9	462.311	8	20	451.3	24,716	8	463.3	No	None	None	None	None	None	-	-	-	-	-	-
AC-18	259,236	2	467.529	1089	3	466.5	322,829	3	466.5	Yes	0	469.529	15	454.529	15	X	X	X	X	X	X
AC-19	214,732	2.5	474.685	497	5	472.2	552,251	5	472.2	Yes	0	477.185	14	463.185	14	X	X	X	X	X	X
AC-20	402,171	21.5	467.476	409	23	466.0	486,707	23	466.0	Yes	19	469.976	29	459.976	10	X	X	X	X	X	X
AC-21	272,024	10.5	467.069	180	11	466.6	214,291	12	465.6	Yes	8	469.569	33	444.569	25	X	X	X	X	X	X
AC-21A	338,865	12	465.393	122	13	464.4	266,471	13	464.4	Yes	6	471.393	17	460.393	11	X	X	X	X	X	X
AC-22	45,675	18	465.275	4	22	461.3	20,553	18	465.3	Yes	16	467.275	20	463.275	4	X	X	X	X	X	-
AC-23	200,376	22	464.548	274	23	463.5	290,095	23	463.5	Yes	17	469.548	29	457.548	12	X	X	X	X	X	X
AC-24	470,901	2	475.384	1540	4	473.4	618,351	4	473.4	Yes	0	477.384	17	460.384	17	X	X	X	X	X	X
AC-24	40,193	44.5	432.884							Yes	42.5	434.884	46	431.384	3.5	X	-	-	NA	NA	NA
AC-25	19,802	21	458.445	5	37	442.4	23,014	3	476.4	Yes	20	459.445	22.5	456.945	2.5	X	-	-	NA	NA	NA
AC-26A	15,245	3.5	469.686	15	4	469.2	23,117	4	469.2	Yes	2.5	470.686	6	467.186	3.5	X	X	X	X	X	-
AC-26A	4,134	36	437.186							Yes	36	437.186	39	434.186	3	-	-	-	-	X	-
Cotter (2015)																					
WL-209-CT	488,730	1.5	466.046	1355	1	466.5	968,950	2	465.5	Yes	0	467.546	12	455.546	12	X	X	X	X	X	X
WL-234-CT	894,913	9	471.017	1567	9	471.0	518,715	9	471.0	Yes	1	479.017	22	458.017	21	X	X	X	X	X	X

Notes:

amsl = above mean sea level cpm = counts per minute

NA - Data were not collected or are otherwise not available.

X - Data support the presence of RIM in the indicated interval

- Data do not indicate the presence of RIM at this location/interval

(m) - multiple intervals with same detections; see Appendix L for details; only uppermost elevation shown

See Borehole Summary Sheets in Appendix L for supporting documentation for this table

Table 6-6: Summary Statistics for Radium and Thorium Results - Areas 1 and 2

	Radium-226	Radium-228	Thorium-230	Thorium-232
Area 1				
Number of values	153	152	210	206
Frequency of Detection	72.6%	70.4%	99.5%	94.7%
Median of Detects	1	0.92	1.607	0.773
Mean of Detects	153.9	1.18	446.9	7.203
Standard Deviation of Detects	720.1	3.01	3,627	45.78
Maximum value	4,926	31.8	45,100	514.9
95% Upper Confidence Limit	210	1.913	882	12.98
Area 2				
Number of values	216	216	194	197
Frequency of Detection	89.8%	72.2%	100%	100%
Median of Detects	1.297	1.966	6.22	0.77
Mean of Detects	119.6	0.893	1,365	10.5
Standard Deviation of Detects	497.1	4.867	5,389	26
Maximum value	3,720	45	38,300	180
95% Upper Confidence Limit	161.1	2.819	2,138	1.113

All results except for number of values are in units of pCi/g.

Table 6-7: Buffer Zone Crossroad Property Combined Radium, Thorium, and Uranium Results

DRAFT

Sample Site	Upper Sample Depth (feet)	Lower Sample Depth (feet)	Units	Radium-226 Result	Final Q	+/- Sigma	CV	MDA	Radium-228 Result	Final Q	+/- Sigma	CV	MDA	Combined Radium 226 + 228		Combined Radium relative to 7.9 pCi/g Unrestricted Use Criteria	Thorium-230 Result	Final Q	+/- Sigma	CV	MDA	Thorium-232 Result	Final Q	+/- Sigma	CV	MDA	Combined Thorium 230 + 232	Combined Thorium relative to 7.9 pCi/g Unrestricted Use Criteria	Uranium-234 Result	Final Q	+/- Sigma	CV	MDA	Uranium-235 Result	Final Q	+/- Sigma	CV	MDA	Uranium-238 Result	Final Q	+/- Sigma	CV	MDA	Combined Uranium 234 + 235 + 238		Combined Uranium relative to 54.4 pCi/g Unrestricted Use Criteria
McLaren/Hart RI Data																																												
FP-1	0.25	0.25	pCi/g	7.23	U			7.23	2.13	U			2.13	Non-detect	*	Non-detect	12.8		2.80	0.20	1.10		0.38	0.22	13.9	Exceeds Criteria	0.73		0.19	0.08	0.15		0.08	0.07	0.81		0.21	0.09	1.69		Less than Criteria
FP-1	0.25	0.25	pCi/g	7.19		3.98		4.63	2.06	U			2.06	8.22	*	Exceeds Criteria	1.39		0.33	0.06	1.06		0.27	0.05	2.45	Less than Criteria	0.84		0.20	0.07	0.15		0.07	0.05	0.80		0.19	0.06	1.79		Less than Criteria
FP-1	2	2	pCi/g	4.94	U			4.94	2.29	U			2.29	Non-detect	*	Non-detect	1.16		0.29	0.06	0.84		0.23	0.05	2.00	Less than Criteria	0.69		0.18	0.04	0.13		0.07	0.05	0.75		0.19	0.06	1.57		Less than Criteria
FP-2	0.25	0.25	pCi/g	6.28	U			6.28	2.85	U			2.85	Non-detect	*	Non-detect	2.92		0.63	0.10	1.08		0.29	0.14	4.00	Less than Criteria	1.08		0.24	0.07	0.14		0.08	0.10	1.17		0.26	0.09	2.39		Less than Criteria
FP-2	2	2	pCi/g	7.99		4.85		4.93	2.61	U			2.61	9.30	*	Exceeds Criteria	1.24		0.31	0.12	1.13		0.29	0.10	2.37	Less than Criteria	0.78		0.21	0.10	0.26		0.11	0.08	0.94		0.24	0.10	1.98		Less than Criteria
FP-3	0.25	0.25	pCi/g	6.23	U			6.23	2.05	U			2.05	Non-detect	*	Non-detect	1.26		0.31	0.11	0.85		0.23	0.10	2.11	Less than Criteria	0.69		0.18	0.07	0.06		0.05	0.06	0.79		0.20	0.05	1.54		Less than Criteria
FP-3	2	2	pCi/g	4.24	U			4.24	1.66	U			1.66	Non-detect	*	Non-detect	1.26		0.31	0.07	0.91		0.24	0.05	2.17	Less than Criteria	1.94		0.40	0.07	0.38		0.13	0.05	2.62		0.51	0.07	4.94		Less than Criteria
FP-4	0.25	0.25	pCi/g	9.06		3.81		3.62	2.60	U			2.60	10.4	*	Exceeds Criteria	2.61		0.57	0.07	1.16		0.30	0.06	3.77	Less than Criteria	1.01		0.23	0.04	0.11		0.07	0.06	0.96		0.23	0.05	2.08		Less than Criteria
FP-4	2	2	pCi/g	5.58	U			5.58	1.73	U			1.73	Non-detect	*	Non-detect	2.20		0.49	0.07	1.28		0.32	0.05	3.5	Less than Criteria	0.71		0.19	0.06	0.10		0.06	0.06	0.84		0.21	0.06	1.65		Less than Criteria
FP-5	0.25	0.25	pCi/g	4.08		3.10		2.99	0.94	U			0.94	4.55	*	Less than Criteria	28.6		5.20	0.08	1.38		0.34	0.08	30.0	Exceeds Criteria	0.84		0.20	0.05	0.06		0.05	0.05	1.05		0.23	0.04	1.95		Less than Criteria
FP-5	2	2	pCi/g	6.04	U			6.04	1.96	U			1.96	Non-detect	*	Non-detect	5.31		1.03	0.09	1.20		0.30	0.02	6.5	Less than Criteria	1.11		0.32	0.08	0.22		0.13	0.09	1.20		0.33	0.09	2.53		Less than Criteria
FP-6	0.25	0.25	pCi/g	5.59	U			5.59	1.56	U			1.56	Non-detect	*	Non-detect	1.20		0.29	0.06	0.95		0.24	0.06	2.2	Less than Criteria	0.73		0.18	0.07	0.07		0.06	0.10	0.91		0.21	0.06	1.71		Less than Criteria
FP-6	2	2	pCi/g	3.25	U			3.25	1.95	U			1.95	Non-detect	*	Non-detect	1.80		0.39	0.05	1.20		0.28	0.05	3.0	Less than Criteria	0.86		0.21	0.04	0.09		0.06	0.03	1.07		0.25	0.05	2.02		Less than Criteria
FP-7	0.25	0.25	pCi/g	4.72		2.89		3.49	1.78	U			1.78	5.61	*	Less than Criteria	2.08		0.43	0.07	1.14		0.27	0.05	3.22	Less than Criteria	0.88		0.26	0.06	0.15		0.10	0.04	0.82		0.25	0.07	1.85		Less than Criteria
FP-7	2	2	pCi/g	6.63	U			6.63	2.13	U			2.13	Non-detect	*	Non-detect	1.51		0.32	0.03	0.10		0.23	0.03	1.61	Less than Criteria	0.65		0.25	0.15	0.05		0.08	0.14	0.71		0.26	0.13	1.41		Less than Criteria
FP-8	0.25	0.25	pCi/g	5.22	U			5.22	1.68	U			1.68	Non-detect	*	Non-detect	21.8		3.80	0.09	1.57		0.35	0.09	23.37	Exceeds Criteria	0.95		0.28	0.06	0.11		0.09	0.08	0.81		0.25	0.08	1.87		Less than Criteria
FP-8	2	2	pCi/g	5.78	U			5.78	2.92	U			2.92	Non-detect	*	Non-detect	2.04		0.42	0.08	1.29		0.29	0.07	3.33	Less than Criteria	0.93		0.34	0.21	0.07		0.18	0.32	1.30		0.42	0.24	2.30		Less than Criteria
WL-201	5	5	pCi/g	1.06		0.22		0.34	1.13	U			1.13	1.63	*	Less than Criteria	1.06		0.31	0.15	0.32		0.15	0.13	1.38	Less than Criteria	1.30	U		1.30	0.22	U	0.17	0.22	1.19		0.40	0.17	1.95	*	Less than Criteria
WL-201	15	15	pCi/g	0.47		0.16		0.24	0.73	U			0.73	0.84	*	Less than Criteria	0.63		0.23	0.11	0.28		0.15	0.08	0.91	Less than Criteria	2.35	U		2.35	0.13	U	0.08	0.13	0.31		0.18	0.12	1.55	*	Less than Criteria
WL-202	5	5	pCi/g	0.75		0.41		0.54	1.59	U			1.59	1.55	*	Less than Criteria	0.83		0.29	0.11	0.44		0.20	0.09	1.27	Less than Criteria	1.27		0.77	1.02	0.17	U	0.08	0.17	0.88		0.37	0.12	2.24	*	Less than Criteria
WL-202	15	15	pCi/g	0.81	U			0.81	1.18	U			1.18	Non-detect	*	Non-detect	0.26		0.14	0.08	0.16		0.11	0.08	0.42	Less than Criteria	3.75	U		3.75	0.12	U	0.00	0.12	0.24		0.16	0.10	2.18	*	Less than Criteria
WL-203	0	0	pCi/g	1.07		0.24		0.38	1.28	U			1.28	1.71	*	Less than Criteria	3.03		0.88	0.15	0.43		0.24	0.12	3.46	Less than Criteria	1.46		1.06	1.43	0.31		0.25	0.27	1.95		0.63	0.20	3.72		Less than Criteria
WL-203	5	5	pCi/g	0.94		0.22		0.33	0.99	U			0.99	1.44	*	Less than Criteria	0.80		0.27	0.10	0.14		0.10	0.06	0.9	Less than Criteria	1.48	U		1.48	0.18		0.17	0.15	0.95		0.38	0.11	1.87	*	Less than Criteria
WL-203	15	15	pCi/g	0.53		0.21		0.33	0.98	U			0.98	1.02	*	Less than Criteria	0.41		0.18	0.11	0.23		0.13	0.08	0.64	Less than Criteria	1.86	U		1.86	0.16	U	0.11	0.16	0.60		0.27	0.12	1.61	*	Less than Criteria
WL-204	5	5	pCi/g	1.06		0.22		0.31	0.99		0.45		0.56	2.05		Less than Criteria	0.77		0.26	0.09	0.47		0.20	0.06	1.24	Less than Criteria	1.03	U		1.03	0.22		0.18	0.15	0.77		0.33	0.08	1.51	*	Less than Criteria
WL-204	25	25	pCi/g	0.77		0.20		0.36	0.85		0.36		0.72	1.62		Less than Criteria	0.43		0.19	0.08	0.32		0.16	0.07	0.75	Less than Criteria	1.04	U		1.04	0.11	U	0.06	0.11	0.36		0.20	0.09	0.94	*	Less than Criteria
WL-205	5	5	pCi/g	0.95		0.22		0.26	1.19	U			1.19	1.55	*	Less than Criteria	0.80		0.28	0.11	0.66		0.25	0.08	1.46	Less than Criteria	1.48		0.81	0.92	0.15		0.14	0.15	1.76		0.50	0.09	3.39		Less than Criteria
WL-205	15	15	pCi/g	0.90		0.26		0.34	0.95	U			0.95	1.38	*	Less than Criteria	1.01			0.25	0.95		0.38	0.15	1.96	Less than Criteria	1.76		1.18	1.52	0.18		0.15	0.14	0.95		0.34	0.10	2.89		Less than Criteria
WL-206	0	0	pCi/g	17.2		1.20		0.40	1.21	U			1.21	17.8	*	Exceeds Criteria	429		135	0.70	11.2		4.40	0.60	440	Exceeds Criteria	2.53	U		2.53	0.33	U	0.22	0.33	4.17		1.04	0.26	5.60	*	Less than Criteria
WL-206	5	5	pCi/g	1.20		0.37		0.57	1.58	U			1.58	1.99	*	Less than Criteria	7.51		1.54	0.23	1.12		0.40	0.15	8.63	Exceeds Criteria	4.01	U		4.01	0.19		0.10	0.06	1.17		0.27	0.06	3.37	*	Less than Criteria
WL-206	10	10	pCi/g	0.72		0.18		0.28	0.96	U			0.96	1.20	*	Less than Criteria	1.66		0.51	0.21	0.82		0.33	0.16	2.48	Less than Criteria	1.83		0.79	1.04	0.06	U	0.05	0.06	0.60		0.17	0.04	2.46	*	Less than Criteria
RC-01	0	0.25	pCi/g	0.15	U			0.15	1.83		1.83		0.71	1.91	*	Less than Criteria	2.75		2.75	0.09	1.40		1.40	0.07	4.2	Less than Criteria	1.00		1.00	0.15	0.13	U		0.13	0.92		0.92	0.10	1.99	*	Less than Criteria
RC-02	0	0.25	pCi/g	0.13	U			0.13	1.47		1.47		0.68	1.54	*	Less than Criteria	30.6		30.6	0.10	1.28		1.28	0.14	31.9	Exceeds Criteria	1.06		1.06	0.05	0.14		0.14	0.10	1.08		1.08	0.05	2.28		Less than Criteria
RC-03	0	0.25	pCi/g	0.14	U			0.14	1.67		1.67		0.68	1.74	*	Less than Criteria	6.30		6.30	0.20	0.97		0.97	0.23	7.3	Less than Criteria	0.80		0.80	0.11	0.12	U		0.12	0.89		0.89	0.08	1.75	*	Less than Criteria
RC-04	0	0.25	pCi/g	0.13	U			0.13	1.92		1.92		0.69	1.99	*	Less than Criteria	2.60		2.60	0.18	1.25		1.25	0.07	3.9	Less than Criteria	0.93		0.93	0.14	0.06		0.06	0.06	0.94		0.94	0.05	1.93		Less than Criteria
RC-05	0	0.25	pCi/g	0.10	U			0.10	1.59		1.59		0.66	1.64	*	Less than Criteria	2.48		2.48	0.08	1.21		1.21	0.09	3.69	Less than Criteria	0.91		0.91	0.16	0.14		0.14	0.14	0.69		0.69	0.09	1.74		Less than Criteria
RC-06	0	0.25	pCi/g	0.12	U			0.12	1.26		1.26		0.72	1.32	*	Less than Criteria	4.60		4.60	0.10	1.18		1.18	0.04	5.8	Less than Criteria	0.97		0.97	0.13	0.18	U		0.18	0.96		0.96	0.05	2.02	*	Less than Criteria
RC-07	0	0.25	pCi/g	0.12	U	0.38		0.12	0.96		0.96		0.68	1.02	*	Less than Criteria	2.84		2.84	0.16	1.56		1.56	0.08	4.40	Less than Criteria	0.63		0.63	0.13	0.05	U		0.05	0.90		0.90	0.32	1.55	*	Less than Criteria

Table 7-1: Radon Flux Measurement Results, OU-1 RI

Area 1		Area 2	
Boring Location	Radon Flux (pCi/m^2s)	Boring Location	Radon Flux (pCi/m^2s)
WL-101	0.3	WL-201	0.5
WL-102	245.9	WL-202	0.3
WL-103	0.6	WL-203	0.4
WL-104	0.2	WL-204/205	0.3
WL-105	0.2	WL-206	0.9
WL-106	22.3	WL-207	0.5
WL-107	0.2	WL-208	3.2
WL-108	0.5	WL-209	513.1
WL-109	0.1	WL-210	14.2
WL-110	0.2	WL-211	0.1
WL-111	0.3	WL-212	0
WL-112	1.9	WL-213	0.1
WL-113	0.5	WL-214	0.2
WL-114	8	WL-215	0.3
WL-115	1.4	WL-216	0.1
WL-116	0.2	WL-217	0.2
WL-117	1.3	WL-218	1.6
WL-120	0.3	WL-219	0.3
WL-121	0.3	WL-220	0.1
WL-122	0.5	WL-221	0.8
WL-123	0.1	WL-222	1.3
WL-124	0.2	WL-223	350.2
		WL-224	0.2
		WL-225	0.3
		WL-226	0.2
		WL-227	0.5
		WL-230	0.2
		WL-231	0.2
		WL-233	0.1
		WL-234	0.6
		WL-236	0.1
		WL-239	0.4
Averages	13		28

Table 7-2: 2016 NCC Radon Flux Measurements

Sample Location	Radon Flux ± CSU ($pCi/m^2/s$)
Area 1	
1-01	0.069 ± 0.009
1-02	0.022 ± 0.007
1-03	< 0.035 (0.013 ± 0.012)
1-04	< 0.077 (0.000 ± 0.020)
1-05	0.024 ± 0.006
1-06	0.021 ± 0.007
1-07	0.029 ± 0.009
1-08	0.119 ± 0.024
1-09	0.025 ± 0.006
1-10	0.074 ± 0.010
1-11	0.091 ± 0.013
1-112	< 0.067 (0.010 ± 0.012)
1-113	0.033 ± 0.007
1-114	< 0.042 (-0.004 ± 0.006)
1-115	< 0.037 (0.010 ± 0.006)
1-12	< 0.092 (0.053 ± 0.024)
1-13	0.173 ± 0.020
1-14	0.198 ± 0.023
1-15	0.124 ± 0.023
1-16	0.106 ± 0.011
1-17	< 0.050 (0.021 ± 0.009)
1-18	0.046 ± 0.008
1-19	0.093 ± 0.019
1-20	0.026 ± 0.007
1-23	0.124 ± 0.016
1-24	0.138 ± 0.017
1-25	0.033 ± 0.008
1-26	< 0.102 (0.048 ± 0.031)
1-27	0.084 ± 0.012
1-28	< 0.037 (0.034 ± 0.009)
1-29	< 0.031 (0.020 ± 0.011)
1-30	< 0.058 (-0.006 ± 0.028)
1-31	< 0.026 (0.025 ± 0.007)
1-32	0.067 ± 0.012
1-33	0.091 ± 0.014
1-34	0.067 ± 0.016
1-35	0.040 ± 0.008
1-21	0.108 ± 0.015
1-22	0.052 ± 0.009
Area 2	
2-01	0.067 ± 0.018
2-02	0.091 ± 0.022
2-03	0.131 ± 0.046
2-04	0.069 ± 0.018
2-05	< 0.074 (0.064 ± 0.022)
2-06	< 0.083 (0.052 ± 0.024)
2-07	< 0.218 (0.132 ± 0.046)
2-08	0.067 ± 0.016
2-09	0.102 ± 0.024

Table 7-2: 2016 NCC Radon Flux Measurements

Sample Location	Radon Flux ± CSU (pCi/m^2/s)
Area 2 (continued)	
2-10	0.128 ± 0.028
2-11	< 0.106 (-0.032 ± 0.039)
2-116	< 0.074 (0.042 ± 0.024)
2-117	0.085 ± 0.020
2-118	< 0.140 (0.097 ± 0.038)
2-12	< 0.059 (0.020 ± 0.015)
2-124	< 0.074 (0.019 ± 0.030)
2-13	< 0.031 (0.028 ± 0.012)
2-14	< 0.073 (0.064 ± 0.022)
2-15	< 0.054 (0.047 ± 0.017)
2-16	0.117 ± 0.026
2-24	0.063 ± 0.015
2-32	0.108 ± 0.032
2-42	< 0.082 (0.014 ± 0.022)
2-63	0.053 ± 0.010
2-64	< 0.119 (-0.018 ± 0.012)
2-65	< 0.023 (0.019 ± 0.007)
2-66	< 0.048 (0.023 ± 0.019)
2-70	< 0.043 (0.010 ± 0.013)
2-71	< 0.059 (-0.016 ± 0.023)
2-72	< 0.036 (0.024 ± 0.009)
2-73	< 0.045 (0.022 ± 0.013)
2-74	< 0.103 (0.053 ± 0.024)
2-75	0.074 ± 0.012
2-76	< 0.054 (0.043 ± 0.015)
2-17	0.031 ± 0.009
2-18	< 0.050 (0.014 ± 0.010)
2-19	0.098 ± 0.021
2-20	0.017 ± 0.006
2-21	0.037 ± 0.010
2-22	< 0.049 (0.019 ± 0.009)
3-23	< 0.098 (-0.002 ± 0.032)
2-25	0.023 ± 0.007
2-26	0.050 ± 0.009
2-27	< 0.050 (0.036 ± 0.012)
2-28	0.075 ± 0.018
2-29	0.024 ± 0.007
2-30	< 0.033 (0.025 ± 0.009)
2-31	< 0.035 (0.032 ± 0.012)
2-33	< 0.030 (0.018 ± 0.007)
2-34	< 0.040 (0.017 ± 0.012)
2-35	< 0.062 (0.058 ± 0.016)
2-36	< 0.093 (-0.008 ± 0.032)
2-37	0.039 ± 0.008
2-38	0.068 ± 0.013
2-39	0.044 ± 0.009
2-40	< 0.104 (0.000 ± 0.042)
2-41	0.092 ± 0.014
2-43	< 0.046 (0.010 ± 0.011)
2-44	< 0.068 (-0.005 ± 0.019)

Table 7-2: 2016 NCC Radon Flux Measurements

Sample Location	Radon Flux ± CSU ($pCi/m^2/s$)
Area 2 (continued)	
2-45	< 0.034 (0.017 ± 0.007)
2-46	< 0.045 (0.009 ± 0.012)
2-47	0.035 ± 0.007
2-48	0.098 ± 0.026
2-49	< 0.056 (0.025 ± 0.016)
2-50	0.112 ± 0.015
2-51	< 0.044 (0.034 ± 0.012)
2-52	< 0.086 (0.023 ± 0.025)
2-53	0.050 ± 0.009
2-54	< 0.038 (0.011 ± 0.006)
2-55	0.059 ± 0.015
2-56	< 0.024 (0.018 ± 0.005)
2-57	0.034 ± 0.008
2-58	0.018 ± 0.006
2-59	< 0.084 (-0.019 ± 0.032)
2-60	0.040 ± 0.009
2-61	0.063 ± 0.012
2-62	0.074 ± 0.021
2-67	1.506 ± 0.132
2-68	0.098 ± 0.014
2-69	0.130 ± 0.025
2-119	0.037 ± 0.009
2-120	0.052 ± 0.011
2-121	< 0.047 (0.027 ± 0.011)
2-122	< 0.068 (-0.027 ± 0.027)
2-123	0.051 ± 0.009

Summary Statistics

Statistic	Value	Units
Number of Samples	124	measurements
Number of Detections	68	detections
Results Range	-0.032 - 1.506	$pCi/m^2/s$
Arithmetic Mean	0.061	$pCi/m^2/s$
Standard Deviation	0.137	$pCi/m^2/s$

Notes:
CSU = combined standard uncertainty
For statistics, all lab and field QC results were removed including spikes, method blanks, field blanks and field duplicates.

Table 7-3: Baseline Perimeter Air Monitoring Results for Radon

DRAFT

On-Site Perimeter Monitoring Stations

Station No.	Test Duration 5/1/15 7/23/15 Result (pCi/L)	Test Duration 7/23/15 10/14/15 Result (pCi/L)	Test Duration 10/14/15 1/7/16 Result (pCi/L)	Test Duration 1/7/16 4/13/16 Result (pCi/L)	Test Duration 4/13/16 7/20/16 Result (pCi/L)	Test Duration 7/20/16 10/26/16 Result (pCi/L)	Average (1/2 RL for NDs)	Average (RLs for NDs)
1	<0.4	<0.4	0.5	<0.4	<0.4	0.5	0.30	1.63
2	<0.4	0.7	0.6	0.6	<0.4	<0.4	1.32	2.02
3	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.20	1.60
4	<0.4	0.4	<0.4	0.5	<0.4	<0.4	1.03	1.77
5	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.20	1.60
6	<0.4	0.5	0.4	0.4	<0.4	<0.4	0.92	1.62
7	<0.4	0.7	0.5	<0.4	<0.4	<0.4	0.33	1.67
8	<0.4	0.5	<0.4	0.5	<0.4	<0.4	0.30	1.03
9	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.20	1.60
10	<0.4	0.5	0.4	<0.4	<0.4	0.4	0.30	1.62
10 DUP			<0.4					
11	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.22	1.60
11 DUP		0.4						
12	<0.4	<0.4	0.5	<0.4	<0.4	<0.4	0.25	1.62
12 DUP	<0.4							
13	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.20	1.60
13 DUP				0.6				

EPA Off-Site (TetraTech, 2015)

Summary Statistic	Station 1	Station 2	Station 3	Station 4	Station 5 (reference)
Number of Measurements	43	43	43	41	42
Minimum Concentration	0.19	0.15	0.12	0.09	0.11
Median Concentration	0.28	0.24	0.27	0.21	0.3
Maximum Concentration	1.01	1.81	1.88	0.95	1.45

Note: All concentrations are in pCi/L

Table 7-4 : Fugutive Dust Analytical Results

Uranium - 238 Decay Series

Sample	Uranium-238			Uranium-234			Thorium-230			Radium-226		
	Result	MDA	+/- Sigma Error	Result	MDA	+/- Sigma Error	Result	MDA	+/- Sigma Error	Result	MDA	+/- Sigma Error
Area 1												
Upwind	< MDA	0.00164	NA	< MDA	0.00148	NA	0.00256	0.00042	0.00087	0.00043	0.00037	0.00027
Downwind	0.00071	0.00020	0.00038	0.00079	0.00024	0.00040	0.00071	0.00034	0.00033	< MDA	0.00049	NA
Area 2												
Upwind	0.00005	0.00004	0.00004	0.00007	0.00004	0.00005	0.00011	0.00006	0.00006	0.00011	0.00006	0.00005
Downwind	< MDA	0.00056	NA	< MDA	0.00049	NA	0.00055	0.00023	0.00027	< MDA	0.00035	NA

Uranium - 235 Decay Series

Sample	Uranium-235/236		
	Result	MDA	+/- Sigma Error
Area 1			
Upwind	< MDA	0.00237	NA
Downwind	< MDA	0.00030	NA
Area 2			
Upwind	< MDA	0.00007	NA
Downwind	< MDA	0.00068	NA

Thorium - 232 Decay Series

Sample	Thorium-232			Radium-228			Thorium-228		
	Result	MDA	+/- Sigma Error	Result	MDA	+/- Sigma Error	Result	MDA	+/- Sigma Error
Area 1									
Upwind	< MDA	0.00027	NA	< MDA	0.00113	NA	0.00270	0.00044	0.00090
Downwind	< MDA	0.00024	NA	< MDA	0.00097	NA	0.00191	0.00017	0.00058
Area 2									
Upwind	< MDA	0.00004	NA	< MDA	0.00017	NA	0.00037	0.00007	0.00013
Downwind	< MDA	0.00026	NA	0.00091	0.00090	0.00056	0.00154	0.00029	0.00049

All values expressed as picocuries per liter (pCi/L)
MDA = Minimum Detectable Activity
NA= Not applicable
Sampling conducted April 11, 1996.

Table 7-5: Summary of Gross Alpha Results in Particulate Air Samples

On-Site Perimeter Monitoring Stations

Summary Statistic	Station A-1 (pCi/m^3)	Station A-2 (pCi/m^3)	Station A-3 (pCi/m^3)	Station A-4 (pCi/m^3)	Station A-5 (pCi/m^3)	Station A- 6 (pCi/m^3)	Station A-7 (pCi/m^3)
Detections	19/19	15/15	19/19	19/19	19/19	19/19	19/19
Minimum Concentration	1.39E-03 J	1.41E-03	1.23E-03	1.28E-03	1.40E-03	5.27E-04 J+	1.37E-03
Median Concentration	3.49E-03	3.15E-03	3.38E-03	3.40E-03	3.69E-03	3.45E-03	3.04E-03
Maximum Concentration	5.31E-03 J+	4.60E-03 J+	5.95E-03 J+	6.09E-03 J+	5.46E-03 J+	5.11E-03 J+	5.70E-03 J+

Summary Statistic	Station A-8 (pCi/m^3)	Station A- 9 (pCi/m^3)	Station A-10 (pCi/m^3)	Station A- 11 (pCi/m^3)	Station A-12 (pCi/m^3)	Station A-13 (pCi/m^3)
Detections	19/19	18/18 [2]	19/19	19/19	19/19	19/19
Minimum Concentration	1.50E-03	1.46E-03	1.09E-03	6.56E-04	1.58E-03	1.40E-03
Median Concentration	3.70E-03	3.32E-03	3.13E-03	3.56E-03	3.48E-03	3.55E-03
Maximum Concentration	5.82E-03 J+	4.57E-03 J+	5.82E-03 J+	6.16E-03 J+	5.72E-03 J+	5.61E-03 J+

Represents results for monitoring performed from May 2015 through October 2016

EPA Off-Site (TetraTech, 2015)

Summary Statistic	Station 1 (pCi/m^3)	Station 2 (pCi/m^3)	Station 3 (pCi/m^3)	Station 4 (pCi/m^3)	Station 5 (background) (pCi/m^3)
Detections	36/44	34/44	30/44	40/64	32/44
Minimum Concentration	1.99E-04 U	1.93E-04 U	1.02E-04 U	1.17E-04 U	1.10E-04 U
Median Concentration	6.42E-04	6.25E-04	6.32E-04	6.06E-04	6.97E-04
Maximum Concentration	1.63E-03 J	1.68E-03 J	1.58E-03 J	1.38E-03 J	1.65E-03 J

Notes: U - Not detected; J - Estimated value; J+ - Estimated value, biased high

Table 7-6: Summary of Gross Beta Results in Particulate Air Samples

On-Site Perimeter Monitoring Stations

Summary Statistic	Station A-1 (pCi/m^3)	Station A-2 (pCi/m^3)	Station A-3 (pCi/m^3)	Station A-4 (pCi/m^3)	Station A-5 (pCi/m^3)	Station A-6 (pCi/m^3)	Station A-7 (pCi/m^3)
Detections	19/19	15/15 [1]	19/19	19/19	19/19	19/19	19/19
Minimum Concentration	9.25E-03	1.03E-02	1.14E-02	1.11E-02	1.17E-02	4.06E-03 J+	1.13E-02
Median Concentration	2.64E-02	2.41E-02	2.72E-02	2.52E-02	2.77E-02	2.78E-02	2.12E-02
Maximum Concentration	4.45E-02 J+	3.93E-02 J+	4.60E-02 J+	4.77E-02 J+	4.31E-02 J+	4.43E-02 J+	4.35E-02 J+

Summary Statistic	Station A-8 (pCi/m^3)	Station A-9 (pCi/m^3)	Station A-10 (pCi/m^3)	Station A-11 (pCi/m^3)	Station A-12 (pCi/m^3)	Station A-13 (pCi/m^3)
Detections	19/19	18/18 [2]	19/19	19/19	19/19	19/19
Minimum Concentration	1.33E-02	9.97E-03	9.79E-03	1.19E-02	1.54E-02	1.86E-02 J+
Median Concentration	2.69E-02	2.56E-02	2.22E-02	2.65E-02	2.66E-02	2.61E-02
Maximum Concentration	4.63E-02 J+	4.01E-02 J+	3.84E-02 J+	4.76E-02 J+	4.46E-02 J+	4.43E-02 J+

Represents results for monitoring performed from May 2015 through October 2016

EPA Off-Site (TetraTech, 2015)

Summary Statistic	Station 1 (pCi/m^3)	Station 2 (pCi/m^3)	Station 3 (pCi/m^3)	Station 4 (pCi/m^3)	Station 5 (pCi/m^3)
Detections	44/44	44/44	44/44	64/64	44/44
Minimum Concentration	1.15E-02	4.13E-03 J	1.32E-02 J	1.16E-02 J	1.21E-02 J
Median Concentration	1.98E-02	2.05E-02	2.04E-02	1.87E-02	1.93E-02
Maximum Concentration	3.95E-02	4.36E-02	3.96E-02	4.15E-02	4.31E-02

Notes: U - Not detected; J - Estimated value; J+ - Estimated value, biased high

Table 7-7: Thorium-230 Statistics for Particulate Air Samples

On-Site Perimeter Monitoring Stations

Summary Statistic	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11	Station 12	Station 13
	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)
Detections	6/7	4/6[1]	7/7	7/7	7/7	7/7	7/7	7/7	6/6[2]	7/7	7/7	7/7	7/7
Minimum Concentration	1.18E-05	7.20E-06	1.90E-05	1.41E-05	1.67E-05	1.05E-05	1.60E-05	1.15E-05	1.32E-05	1.00E-05	1.10E-05	8.97E-06	1.45E-05
Median Concentration	1.77E-05	1.50E-05	2.76E-05	3.14E-05	2.85E-05	1.96E-05	3.67E-05	2.06E-05	2.70E-05	2.66E-05	2.23E-05	3.56E-05	2.21E-05
Maximum Concentration	6.58E-05	5.18E-05	7.03E-05	4.94E-05	7.02E-05	8.06E-05	7.22E-05	5.87E-05	4.84E-05	7.20E-05	8.19E-05	8.64E-05	4.39E-05

Sampling results from May, June, September and December, 2015, and March, May, and August, 2016.

[1] Station A-2 was out of service for a 4 month period due to flooding.

[2] Station A-9 was out of service for 1 month due to power failure.

EPA Off-Site (TetraTech, 2015)

Summary Statistic	Station 1	Station 2	Station 3	Station 4	Station 5 (reference)
Detections	42/44	39/44	42/44	55/64	42/44
Minimum Concentration	1.77E-04 U	2.63E-04 J	1.37E-04 J	1.81E-04 J	2.71E-04 U
Median Concentration	4.71E-04	5.66E-04	5.10E-04	5.38E-04	5.17E-04
Maximum Concentration	4.37E-03	1.36E-03 J	8.86E-04 J	1.80E-03 J	1.99E-03 J

Notes: All concentrations in picoCuries per cubic meter (pCi/m^3)

J Indicates an estimated result

U Indicates a non-detected result

Table 7-8 Uranium-238 Statistics for Particulate Air Samples

On-Site Perimeter Monitoring Stations

Summary Statistic	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11	Station 12	Station 13
	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)
Detections	6/6	5/5[1]	6/6	6/6	6/6	6/6	6/6	6/6	5/5[2]	6/6	6/6	6/6	6/6
Minimum Concentration	1.34E-05	1.84E-05	2.50E-05	1.60E-05	1.38E-05	1.94E-05	1.77E-05	1.30E-05	1.71E-05	1.79E-05	1.93E-05	1.87E-05	1.69E-05
Median Concentration	3.07E-05	2.56E-05	2.99E-05	2.73E-05	2.33E-05	2.54E-05	2.92E-05	2.70E-05	2.66E-05	3.09E-05	2.51E-05	2.53E-05	2.72E-05
Maximum Concentration	3.36E-05	6.00E-05	5.08E-05	3.65E-05	4.28E-05	3.71E-05	4.51E-05	4.61E-05	3.57E-05	4.34E-05	3.96E-05	4.13E-05	3.60E-05

Sampling results from May, June, September and December, 2015, and March, May, and August, 2016.

[1] Station A-2 was out of service for a 4 month period due to flooding.

[2] Station A-9 was out of service for 1 month due to power failure.

EPA Off-Site (TetraTech, 2015)

Summary Statistic	Station 1	Station 2	Station 3	Station 4	Station 5 (reference)
Detections	19/44	24/44	22/44	21/64	14/44
Minimum Concentration	-1.61E-04 U	-8.55E-05 U	-4.42E-05 U	-1.34E-05 U	-2.39E-05 U
Median Concentration	9.38E-05	1.24E-04	1.12E-04	1.03E-04	1.02E-04
Maximum Concentration	6.22E-04 J	1.08E-03 J	3.86E-04 J	3.07E-04 J	2.25E-04 J

Notes: All concentrations in picoCuries per cubic meter (pCi/m^3)

J Indicates an estimated result

U Indicates a non-detected result

Table 7-9: Total Radium Statistics for Particulate Air Samples

On-Site Perimeter Monitoring Stations

Summary Statistic	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11	Station 12	Station 13
	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)	(pCi/m3)
Detections	4/7	5/7[1]	4/7	6/7	4/7	5/7	5/7	6/7	2/6[2]	5/7	6/7	3/7	5/7
Minimum Concentration	2.07E-05	1.27E-04	7.11E-05	9.83E-05	3.71E-05	4.51E-05	1.50E-04	6.86E-05	2.75E-05	1.11E-05	1.95E-04	3.63E-05	1.15E-04
Median Concentration	7.98E-05	2.02E-04	1.70E-04	2.38E-04	1.22E-04	2.43E-04	2.83E-04	2.16E-04	8.92E-05	1.66E-04	2.88E-04	1.44E-04	1.70E-04
Maximum Concentration	3.26E-04	3.27E-04	3.41E-04	3.36E-04	5.51E-04	5.36E-04	4.20E-04	4.54E-04	2.26E-04	3.67E-04	5.76E-04	6.14E-04	3.50E-04

Sampling results from May, June, September and December, 2015, and March, May, and August, 2016.

[1] Station A-2 was out of service for a 4 month period due to flooding.

[2] Station A-9 was out of service for 1 month due to power failure.

EPA Off-Site (TetraTech, 2015)

Summary Statistic	Station 1	Station 2	Station 3	Station 4	Station 5 (reference)
Detections	3/43	4/43	3/43	3/63	2/43
Minimum Concentration	-2.50E-04 U	-6.83E-04 U	-1.56E-04 U	-4.86E-04 U	-4.34E-04 U
Median Concentration	4.49E-04	4.55E-04	3.50E-04	4.58E-04	4.68E-04
Maximum Concentration	1.10E-03 J	1.80E-03 J	2.01E-03	1.38E-03 J	4.40E-03

Notes: All concentrations in picoCuries per cubic meter (pCi/m^3)

J Indicates an estimated result

U Indicates a non-detected result

Table 7-10: Summary of EPA Off-site Air Monitoring Results

SUMMARY STATISTICS OF GROSS ALPHA RESULTS

Summary Statistic	Station 1	Station 2	Station 3	Station 4	Station 5 (background)
Detections[1]	36/44	34/44	30/44	40/64	32/44
Minimum Concentration[2]	1.99E-04 U	1.93E-04 U	1.02E-04 U	1.17E-04 U	1.10E-04 U
Median Concentration[3]	6.42E-04	6.25E-04	6.32E-04	6.06E-04	6.97E-04
Maximum Concentration[4]	1.63E-03 J	1.68E-03 J	1.58E-03 J	1.38E-03 J	1.65E-03 J

Notes:

All concentrations in picoCuries per cubic meter (pCi/m^3)

J Indicates an estimated result
U Indicates a non-detected result

1 Number of detections / number of samples. U-coded results were counted as not detected.
2 Includes lowest reported value among both U-coded and non-U-coded results.
3 Median concentration among U-coded and non-U-coded results.
4 Maximum detected (non-U-coded) concentration.

SUMMARY STATISTICS OF GROSS BETA RESULTS

Summary Statistic	Station 1	Station 2	Station 3	Station 4	Station 5 (reference)
Detections[1]	44/44	44/44	44/44	64/64	44/44
Minimum Concentration	1.15E-02	4.13E-03 J	1.32E-02 J	1.16E-02 J	1.21E-02 J
Median Concentration	1.98E-02	2.05E-02	2.04E-02	1.87E-02	1.93E-02
Maximum Concentration	3.95E-02	4.36E-02	3.96E-02	4.15E-02	4.31E-02

Notes:

All concentrations in picoCuries per cubic meter (pCi/m^3)

J Indicates an estimated result

1 Number of detections / number of samples (no gross beta results are U-coded).

SUMMARY STATISTICS OF URANIUM-238 RESULTS

Summary Statistic	Station 1	Station 2	Station 3	Station 4	Station 5 (reference)
Detections[1]	19/44	24/44	22/44	21/64	14/44
Minimum Concentration[2]	-1.61E-04 U	-8.55E-05 U	-4.42E-05 U	-1.34E-05 U	-2.39E-05 U
Median Concentration[3]	9.38E-05	1.24E-04	1.12E-04	1.03E-04	1.02E-04
Maximum Concentration[4]	6.22E-04 J	1.08E-03 J	3.86E-04 J	3.07E-04 J	2.25E-04 J

Notes:

All concentrations in picoCuries per cubic meter (pCi/m^3)

J Indicates an estimated result
U Indicates a non-detected result

1 Number of detections / number of samples. U-coded results were counted as not detected.
2 Includes lowest reported value among both U-coded and non-U-coded results.
3 Median concentration among U-coded and non-U-coded results.
4 Maximum detected (non-U-coded) concentration.

Table 7-10: Summary of EPA Off-site Air Monitoring Results

SUMMARY STATISTICS OF THORIUM-230 RESULTS

Summary Statistic	Station 1	Station 2	Station 3	Station 4	Station 5 (reference)
Detections[1]	42/44	39/44	42/44	55/64	42/44
Minimum Concentration[2]	1.77E-04 U	2.63E-04 J	1.37E-04 J	1.81E-04 J	2.71E-04 U
Median Concentration[3]	4.71E-04	5.66E-04	5.10E-04	5.38E-04	5.17E-04
Maximum Concentration[4]	4.37E-03	1.36E-03 J	8.86E-04 J	1.80E-03 J	1.99E-03 J

Notes:

All concentrations in picoCuries per cubic meter (pCi/m^3)

J Indicates an estimated result
U Indicates a non-detected result

1 Number of detections / number of samples. U-coded results were counted as not detected.
2 Includes lowest reported value among both U-coded and non-U-coded results.
3 Median concentration among U-coded and non-U-coded results.
4 Maximum detected (non-U-coded) concentration.

SUMMARY STATISTICS OF TOTAL ALPHA-EMITTING RADIUM RESULTS

Summary Statistic	Station 1	Station 2	Station 3	Station 4	Station 5 (reference)
Detections[1]	3/43	4/43	3/43	3/63	2/43
Minimum Concentration[2]	-2.50E-04 U	-6.83E-04 U	-1.56E-04 U	-4.86E-04 U	-4.34E-04 U
Median Concentration[3]	4.49E-04	4.55E-04	3.50E-04	4.58E-04	4.68E-04
Maximum Concentration[4]	1.10E-03 J	1.80E-03 J	2.01E-03	1.38E-03 J	4.40E-03

Notes:

All concentrations in picoCuries per cubic meter (pCi/m^3)
J Indicates an estimated result
U Indicates a non-detected result

1 Number of detections / number of samples. U-coded results were counted as not detected.
2 Includes lowest reported value among both U-coded and non-U-coded results.
3 Median concentration among U-coded and non-U-coded results.
4 Maximum detected (non-U-coded) concentration.

Table 7-10: Summary of EPA Off-site Air Monitoring Results

SUMMARY STATISTICS OF RADON-222 RESULTS

Summary Statistic	Station 1	Station 2	Station 3	Station 4	Station 5 (reference)
Number of Measurements	43	43	43	41	42
Minimum Concentration	0.19	0.15	0.12	0.09	0.11
Median Concentration	0.28	0.24	0.27	0.21	0.30
Maximum Concentration	1.01	1.81 LV2	1.88 LV1	0.95 E1	1.45 LV1

Notes:

All concentrations in picoCuries per liter (pCi/L)

E Indicates one of three replicate measurements yielded a negative radon concentration. The negative radon value was not included in the reported mean radon concentration.

LV Indicates one (LV1) or two (LV2) of the three replicate measurements were not used in the calculation of the reported mean ^{222}Rn concentration because the measurement derived from an electret showing a reading below 200 volts.

Table 7-11- Stormwater Monitoring Results - Radionuclides

Sample	Sample	Gross Alpha				Gross Beta				Actinium-227				Radium-226				Radium-228			
Point	Date	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV
NCC-001	3/10/16													0.86	J	0.59	0.01	-0.04	UJ	0.82	0.19
NCC-001	4/6/16	16.54		5.31	3.70	14.68		4.18	13.77	0.04	J	0.09	0.02	0.14	J	0.34	0.08	1.47	J	0.89	1.34
NCC-001	5/10/16	13.73	J	4.71	0.48	20.76	S-	4.73	9.25					0.47	J	0.31	0.01	0.54	U	0.56	0.84
NCC-001	7/6/16	10.27	J	5.52	1.83	13.60	U	5.59	16.98					0.44	J	0.36	0.03	0.93	J	0.51	0.74
NCC-001	8/15/16	6.89	J	3.70	1.31	9.60	U	4.06	18.55					0.12	J	0.21	0.03	-0.07	U	0.23	0.71
NCC-001	9/9/16	4.50	U	3.08	4.55	7.73	U	2.89	9.07					0.58	J	0.36	0.01	0.41	J+	0.39	0.09
NCC-001	11/3/16	4.10	J	3.75	0.71	13.46		3.48	10.37					0.58	J+	0.36	0.02	2.27	J+	0.76	0.13
OU-1-001	1/20/17	7.89	J	8.64	2.40	22.33	U	9.30	25.61					0.30	J	0.27	0.02	2.04		0.73	0.13
OU-1-001	2/21/17	-3.90	UJ+	8.56	9.99	28.91	U	10.10	35.72					0.37	J	0.33	0.02	0.42	U	0.51	0.78
OU-1-001	3/1/17	0.00	U	6.88	8.46	13.52	U	7.65	23.19					0.37	J	0.29	0.01	0.82	J+	0.49	0.10
NCC-002	3/30/16													0.62	J	0.37	0.01	0.57	U	0.49	0.81
NCC-002	4/11/16	38.99	J	13.20	7.85	22.48	U	8.71	32.58	0.29	J	0.29	0.07	1.02	J	0.52	0.03	0.24	J	0.38	0.09
NCC-002	5/11/16	17.15	U	20.67	17.59	44.91	UJ-	34.07	130.43					0.71	J	0.43	0.03	0.74	J	0.48	0.63
NCC-002	7/6/16	40.22		11.98	1.21	53.07		10.66	15.56					0.59	J	0.38	0.03	0.43	UJ	0.39	0.73
NCC-002	8/15/16	16.96		7.28	1.72	19.55	U	6.27	23.54					1.19	J	0.54	0.01	0.32	UJ	0.26	0.62
NCC-002	9/9/16	10.83		4.27	4.48	16.16		4.73	11.73					0.77	J	0.41	0.01	0.71	J+	0.42	0.09
NCC-002	11/3/16	14.56		6.65	1.19	17.60	U	5.64	19.53					2.97	J+	1.20	0.01	0.85	J+	0.54	0.13
OU-1-002	1/20/17	17.91	J	9.25	2.62	19.82	U	8.55	28.46					0.76	J	0.52	0.02	0.62	J	0.69	0.17
OU-1-002	3/27/17	13.23	J	8.23	1.96	22.74		6.97	19.25					0.59	J	0.42	0.05	-0.24	U	0.48	0.64
NCC-003	3/30/16													0.37	J	0.36	0.03	0.46	UJ	0.86	1.40
NCC-003	4/6/16	7.19	J	6.21	5.48	12.32	U	5.18	20.60	0.09	J	0.13	0.04	0.96	J	0.58	0.01	0.90	UJ	0.74	1.07
NCC-003	5/11/16	38.35		11.34	1.57	34.00	J-	8.31	19.78					1.91	J	0.93	0.03	2.97		1.13	1.37
NCC-003	7/6/16	89.20		26.03	4.91	97.12		20.73	41.41					2.95		1.30	0.06	1.64	J	0.94	1.46
NCC-003	8/15/16	3.51	J	1.81	0.84	6.18	U	2.10	9.10					-0.01	UJ	0.14	0.04	0.48	U	0.39	0.69
NCC-003	9/9/16	11.69		4.09	3.10	16.58		3.82	8.70					0.86	J	0.44	0.01	0.83	J+	0.44	0.09
NCC-003a	9/16/16	7.08	J	4.70	4.87	15.00		4.11	9.60					0.37	J	0.30	0.03	0.76	J	0.45	0.10
NCC-003A	11/3/16	15.97		4.64	0.57	19.51		4.11	9.63					0.24	J+	0.22	0.01	2.95	J+	0.87	0.12
OU-1-003A	1/20/17	14.72	J	9.77	2.33	12.53	U	7.35	24.63					0.35	J	0.28	0.03	0.38	J	0.38	0.10
OU-1-003A	3/1/17	8.48	J	5.12	4.84	11.61	U	5.47	14.60					0.36	J	0.28	0.01	1.08	J+	0.50	0.10
NCC-004	5/12/16	39.59		10.78	1.71	45.02	J	10.36	31.61					2.06	J	0.74	0.04	1.80	J	0.63	0.09

Table 7-11- Stormwater Monitoring Results - Radionuclides

Sample	Sample	Gross Alpha				Gross Beta				Actinium-227				Radium-226				Radium-228			
Point	Date	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV
NCC-007	11/3/16	5.28	J	2.79	0.55	15.05		3.18	8.36					-0.34	UJ+	1.04	0.13	2.02	J+	0.76	0.14
OU-1-007	1/20/17	7.35	J	4.51	0.73	13.34		3.71	8.38					0.30	J	0.30	0.02	1.98	J	0.85	0.18
OU-1-007	2/21/17	2.35	UJ+	4.97	5.33	29.89		7.14	22.28					0.32	J	0.29	0.04	0.38	UJ	0.38	0.67
OU-1-007	3/1/17	2.21	J	2.53	1.73	15.09		3.29	6.59					0.14	J	0.15	0.00	0.56	J+	0.48	0.10
OU-1-008	3/30/17	3.14	J	3.57	0.70	19.21		3.82	5.93					0.10	J	0.14	0.02	0.60	J	0.41	0.57
BUFFER ZONE	4/26/16	5.30		2.52	1.60	10.37		2.66	7.94	0.16	J	0.14	0.01	1.20		0.54	0.02	1.04	J	0.59	0.87

Note: All results are in units of pCi/L except total uranium which is ug/L.

Table 7-11- Stormwater Monitoring Results - Radionuclides

Sample	Sample	Thorium-228				Thorium-230				Thorium-232				Uranium-234				Uranium-235			
Point	Date	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV
NCC-001	3/10/16													1.75	J	0.53	0.06	0.21	J	0.19	0.03
NCC-001	4/6/16	0.31	J	0.20	0.02	1.34	J	0.48	0.15	0.11	J	0.12	0.01	2.47	J+	0.78	0.08	0.12	J	0.18	0.02
NCC-001	5/10/16	0.61	J	0.48	0.17	1.29	J+	0.67	0.38	0.49	J	0.44	0.22	1.54	J-	0.51	0.04	0.03	J	0.09	0.02
NCC-001	7/6/16	-0.02	U	0.07	0.05	0.22	J+	0.17	0.18	0.02	J	0.06	0.01	2.29	J+	0.87	0.04	0.71	J	0.53	0.01
NCC-001	8/15/16	0.11	J	0.15	0.05	0.32	J	0.23	0.20	0.06	J	0.10	0.01	2.73	J+	0.66	0.04	0.09	J	0.12	0.01
NCC-001	9/9/16	0.06	J	0.10	0.03	0.66	J	0.31	0.15	0.07	J	0.10	0.02	1.90	J+	0.62	0.05	0.03	J	0.10	0.02
NCC-001	11/3/16	0.06	J+	0.10	0.04	0.14	UJ+	0.13	0.14	0.01	UJ+	0.08	0.06	2.81	J+	0.70	0.07	0.41	J+	0.25	0.01
OU-1-001	1/20/17	0.04	J+	0.09	0.03	0.25	J	0.20	0.19	0.04	U	0.12	0.06	6.23	J+	1.24	0.03	0.20	J	0.19	0.00
OU-1-001	2/21/17	2.10		0.61	0.02	6.83	J+	1.62	0.13	2.17		0.62	0.01	3.88	J+	1.12	0.08	0.17	J	0.23	0.03
OU-1-001	3/1/17	0.06	J+	0.12	0.05	0.31	J+	0.22	0.16	0.03	J+	0.10	0.00	3.12	J+	0.73	0.03	0.17	J	0.16	0.01
NCC-002	3/30/16													0.86		0.38	0.07	0.05	J	0.13	0.04
NCC-002	4/11/16	0.09	UJ	0.21	0.09	0.72	J	0.44	0.32	0.05	J	0.11	0.02	18.49		3.20	0.13	0.55	J	0.40	0.02
NCC-002	5/11/16	0.04	UJ+	0.11	0.05	0.23	J+	0.18	0.18	0.00	UJ	0.06	0.01	6.10	J-	1.16	0.03	0.22	J	0.19	0.02
NCC-002	7/6/16	0.06	UJ	0.13	0.10	0.13	UJ+	0.14	0.17	0.00	UJ	0.05	0.03	13.87	J+	2.59	0.05	0.77	J	0.49	0.04
NCC-002	8/15/16	0.10	J	0.16	0.04	0.08	UJ	0.16	0.27	0.07	J	0.13	0.02	6.03	J+	1.33	0.07	0.31	J	0.26	0.03
NCC-002	9/9/16	0.17	J	0.15	0.04	0.12	U	0.13	0.16	0.22	J	0.16	0.01	4.21	J+	0.88	0.05	0.27	J	0.19	0.01
NCC-002	11/3/16	0.03	J+	0.07	0.02	0.37	J+	0.20	0.13	-0.01	UJ+	0.05	0.01	7.32	J+	1.38	0.06	0.19	J+	0.19	0.03
OU-1-002	1/20/17	0.22	J+	0.20	0.06	0.97		0.42	0.18	0.00	U	0.13	0.10	10.91	J+	1.75	0.03	0.58	J	0.28	0.03
OU-1-002	3/27/17	-0.03	UJ+	0.06	0.03	0.31	J	0.20	0.15	-0.02	UJ+	0.06	0.02	10.13	J+	1.75	0.03	0.53	J	0.28	0.01
NCC-003	3/30/16													3.93	J	0.84	0.06	0.13	J	0.14	0.01
NCC-003	4/6/16	0.12	J	0.14	0.05	1.14		0.44	0.17	0.11	J	0.14	0.05	5.11	J+	1.16	0.10	0.50	J	0.35	0.02
NCC-003	5/11/16	1.64	J+	0.66	0.07	2.53	J+	0.87	0.32	1.61	J	0.63	0.01	3.92	J-	1.06	0.07	0.38	J	0.34	0.04
NCC-003	7/6/16	2.91		1.02	0.15	7.62	J+	2.08	0.39	2.40		0.88	0.09	2.37	J+	0.80	0.10	0.10	J	0.20	0.04
NCC-003	8/15/16	0.09	J	0.12	0.02	0.34	J	0.23	0.18	0.03	J	0.07	0.01	2.74	J+	0.81	0.11	0.54	J	0.36	0.01
NCC-003	9/9/16	0.59	J	0.27	0.00	1.23	J	0.42	0.13	0.27	J	0.17	0.01	1.57	J+	0.43	0.02	0.13	J	0.13	0.02
NCC-003a	9/16/16	0.15	J	0.16	0.05	0.08	UJ	0.11	0.17	0.02	UJ	0.06	0.02	4.34	J	0.91	0.09	0.09	J	0.12	0.01
NCC-003A	11/3/16	0.10	J+	0.12	0.03	0.23	J+	0.17	0.14	0.05	J+	0.08	0.01	5.80	J+	1.18	0.05	0.80	J+	0.37	0.01
OU-1-003A	1/20/17	0.15	J+	0.16	0.06	1.59		0.55	0.20	0.22	J	0.18	0.05	10.90	J+	1.75	0.03	0.50	J	0.26	0.00
OU-1-003A	3/1/17	-0.04	UJ+	0.09	0.04	0.48	J+	0.32	0.24	-0.01	UJ+	0.09	0.01	4.63	J+	1.05	0.06	0.27	J	0.23	0.00
NCC-004	5/12/16	2.54	J+	0.84	0.03	3.90	J	1.16	0.26	2.99	J	0.93	0.03	2.40		0.80	0.05	0.47	J	0.38	0.03

Table 7-11- Stormwater Monitoring Results - Radionuclides

Sample	Sample	Thorium-228				Thorium-230				Thorium-232				Uranium-234				Uranium-235			
Point	Date	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV
NCC-007	11/3/16	0.10	J+	0.12	0.02	0.27	J+	0.19	0.16	-0.01	UJ+	0.06	0.04	1.93	J+	0.57	0.04	0.17	J+	0.18	0.03
OU-1-007	1/20/17	0.67	J+	0.32	0.03	0.52	J	0.28	0.16	0.17	J	0.15	0.02	3.30	J+	0.74	0.03	0.16	J	0.15	0.01
OU-1-007	2/21/17	2.66	J	0.82	0.00	3.18	J+	0.96	0.18	2.62	J	0.80	0.02	4.12	J+	1.37	0.16	0.35	J	0.38	0.04
OU-1-007	3/1/17	0.14	J+	0.14	0.02	0.41	J+	0.25	0.18	0.02	UJ+	0.06	0.02	1.62	J+	0.45	0.05	0.10	J	0.12	0.02
OU-1-008	3/30/17	0.03	UJ+	0.10	0.04	0.51	J	0.28	0.16	0.08	J+	0.11	0.02	3.08	J+	0.77	0.04	0.50	J	0.29	0.01
BUFFER ZONE	4/26/16	0.20	J	0.17	0.04	0.19	J	0.16	0.18	0.08	J	0.13	0.07	2.93		0.86	0.12	0.17	J	0.22	0.03

Note: All results are in u

Table 7-11- Stormwater Monitoring Results - Radionuclides

Sample	Sample	Uranium-238				Total Uranium (Eberline)					Total Uranium (Pace)				
Point	Date	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	MDA	Result	Final Q	CSU	CV	MDA
NCC-001	3/10/16	1.53		0.49	0.01										
NCC-001	4/6/16	1.30	J	0.54	0.03										
NCC-001	5/10/16	1.10		0.42	0.04	2.42		0.28	1.08	1.08					
NCC-001	7/6/16	1.33		0.64	0.07	2.71		0.85	1.00	1.00	3.00		0.06	0.02	0.19
NCC-001	8/15/16	1.15	J	0.39	0.03	5.31		1.65	1.00	1.00	5.40		0.11	0.02	0.19
NCC-001	9/9/16	0.84		0.39	0.03	3.35		1.04	1.00	1.00	1.63		0.04		0.19
NCC-001	11/3/16	2.14	J+	0.58	0.03	5.50		1.71	1.00	1.00	5.00		0.12		0.19
OU-1-001	1/20/17	2.78		0.70	0.02	10.91		3.46	1.00	1.00	7.33		0.20	0.04	0.19
OU-1-001	2/21/17	1.34	J	0.58	0.03	2.08		0.65	1.00	1.00	2.67		0.07	0.04	0.19
OU-1-001	3/1/17	1.84	J	0.52	0.01	4.27		1.33	1.00	1.00					
NCC-002	3/30/16	0.81		0.37	0.04										
NCC-002	4/11/16	11.33		2.19	0.06										
NCC-002	5/11/16	3.81		0.83	0.03	10.49		1.19	1.09	1.09					
NCC-002	7/6/16	7.55		1.67	0.05	27.77		9.01	1.00	1.00	21.70		0.42	0.02	0.96
NCC-002	8/15/16	3.39	J	0.89	0.04	8.21		2.56	1.00	1.00	10.50		0.21	0.02	0.39
NCC-002	9/9/16	1.98	J	0.53	0.03	7.36		2.29	1.00	1.00	6.43		1.61		0.19
NCC-002	11/3/16	4.68	J+	0.99	0.05	10.10		3.14	1.00	1.00	10.40		0.25		0.39
OU-1-002	1/20/17	7.21	J	1.25	0.02	27.78		8.77	1.00	1.00	21.90		0.59	0.04	0.77
OU-1-002	3/27/17	6.33	J	1.21	0.01	21.91		6.82		1.00					
NCC-003	3/30/16	2.42	J	0.61	0.05										
NCC-003	4/6/16	3.26		0.88	0.05										
NCC-003	5/11/16	3.30	J	0.95	0.06	5.05		0.58	1.09	1.09					
NCC-003	7/6/16	2.99		0.91	0.09	2.83		0.88	1.00	1.00	6.19		0.14	0.02	1.93
NCC-003	8/15/16	1.02	J	0.44	0.05	3.64		1.13	1.00	1.00	3.15		0.06	0.02	0.19
NCC-003	9/9/16	0.79	J	0.29	0.02	2.92		0.91	1.00	1.00	2.11		0.06		0.19
NCC-003a	9/16/16	2.20	J	0.58	0.06	6.19		1.93	1.00	1.00	5.98		0.14		0.19
NCC-003A	11/3/16	4.35	J+	0.96	0.06	10.30		3.23	1.00	1.00	10.10		0.24		0.39
OU-1-003A	1/20/17	6.78	J	1.20	0.01	24.16		7.63	1.00	1.00	21.40		0.58	0.04	0.77
OU-1-003A	3/1/17	2.83		0.75	0.03	8.74		2.72	1.00	1.00					
NCC-004	5/12/16	2.23		0.77	0.04	1.87		0.22	1.05	1.05					

Table 7-11- Stormwater Monitoring Results - Radionuclides

Sample	Sample	Uranium-238				Total Uranium (Eberline)					Total Uranium (Pace)				
Point	Date	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	MDA	Result	Final Q	CSU	CV	MDA
NCC-007	11/3/16	1.45	J+	0.48	0.04	3.00		0.94	1.00	1.00	3.53		0.08		0.19
OU-1-007	1/20/17	2.08	J	0.55	0.04	11.63		3.62	1.00	1.00	6.10		0.16	0.04	0.19
OU-1-007	2/21/17	0.67	J	0.47	0.03	0.89	U	0.28	1.00	1.00	1.06	J+	0.03	0.04	0.19
OU-1-007	3/1/17	0.65	J	0.27	0.03	2.02		0.63	1.00	1.00					
OU-1-008	3/30/17	2.35	J	0.65	0.03	6.57		2.05		1.00					
BUFFER ZONE	4/26/16	1.25		0.53	0.03										

Note: All results are in u

Table 7-12: 2016-2017 Radionuclide Results for Sediment Samples

Client ID	Sample Date	Actinium-227				Actinium-228				Bismuth-214			
		Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV
SED-1	1/8/2016	0.10	J	0.08	0.00	0.81		0.21	0.19	1.04	J+	0.18	0.11
SED-1_(ES)	1/8/2016	0.25	U	0.76	0.61	0.62		0.27	0.20	1.08		0.23	0.06
SED-2	1/8/2016	0.03	J	0.05	0.01	0.78		0.21	0.18	1.05	J+	0.18	0.10
SED-2_(ES)	1/8/2016	0.39	U	0.72	0.56	1.08		0.30	0.04	1.50		0.30	0.07
SED-2	11/3/2016	0.03	J	0.05	0.01	0.78		0.21	0.34	1.00		0.19	0.11
SED-2 (Nov 16)_(ES)	11/3/2016	-0.38	U	1.01	0.82	0.85		0.24	0.15	0.97		0.21	0.05
SED-2 FD	11/3/2016	0.14	J	0.10	0.03	0.88		0.29	0.29	1.36		0.24	0.14
SED-2 (Nov 16)_FD_(ES)	11/3/2016	0.07	U	1.03	0.71	1.04		0.35	0.06	1.17		0.32	0.11
SED-4	1/8/2016	0.15	J	0.10	0.01	0.79		0.22	0.17	1.61	J+	0.22	0.11
SED-4 (Jan 2016)_(ES)	1/8/2016	0.14	U	0.78	0.63	0.89		0.25	0.12	1.68		0.34	0.09
SED-4	6/10/2016	0.11	J	0.07	0.01	0.98		0.22	0.19	1.27		0.18	0.11
SED-4 (June 2016)_(ES)	6/10/2016	0.35	U	0.74	0.78	1.17		0.30	0.06	1.14		0.30	0.10
SED-6	6/10/2016	0.19	J	0.09	0.00	0.91		0.21	0.16	1.09		0.18	0.11
SED-6_(ES)	6/10/2016	0.41	U	0.56	0.43	0.78		0.24	0.11	0.96		0.22	0.07
SED-6 FD	6/10/2016	0.08	J	0.06	0.00	1.31		0.49	0.43	1.25		0.32	0.23
SED-7	6/10/2016	0.15	J	0.08	0.02	0.84		0.24	0.17	0.91		0.17	0.09
SED-7_(ES)	6/10/2016	0.60	U	1.27	1.03	0.75		0.26	0.19	1.07		0.27	0.09
SED-8	6/10/2016	0.11	J	0.06	0.01	1.16		0.42	0.48	1.71		0.38	0.24
SED-8_(ES)	6/10/2016	1.14		1.09	0.68	0.92		0.33	0.14	1.42		0.34	0.10
SED-9	1/19/2017	0.17	J	0.11	0.01	1.04		0.31	0.28	1.16		0.21	0.13
SED-9_(ES)	1/19/2017	-0.12	U	0.24	1.56	0.94		0.44	0.25	1.31		0.30	0.10
SED-10	1/19/2017	0.06	J	0.06	0.01	0.86		0.26	0.19	1.20		0.21	0.16
SED-10_(ES)	1/19/2017	0.38	U	0.78	0.94	0.51	U	0.49	0.27	1.38		0.40	0.15
SEDIMENT 2016-03-16A	3/16/2016	0.20	J	0.11	0.01	1.30		0.30	0.27	1.70		0.24	0.11
SEDIMENT 2016-03-16A_(ES)	3/16/2016	0.05	U	1.00	0.82	0.52		0.33	0.24	1.52		0.33	0.06
SEDIMENT 2016-03-16B	3/16/2016	0.30	J	0.15	0.01	1.08		0.21	0.18	1.13		0.19	0.12
SEDIMENT 2016-03-16B_(ES)	3/16/2016	-0.13	U	0.64	0.52	0.62		0.29	0.15	1.11		0.24	0.04
SEDIMENT 2016-03-16B FD	3/16/2016	0.20	J	0.13	0.04	0.92		0.25	0.24	1.32		0.22	0.12

Notes: All results in pCi/g

Table 7-12: 2016-2017 Radionuclide Results for Sediment Samples

Client ID	Sample Date	Lead-210				Lead-212				Lead-214			
		Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV
SED-1	1/8/2016	1.94	J	1.56	1.25	0.85		0.13	0.11	1.24		0.18	0.11
SED-1_(ES)	1/8/2016	1.99	J	1.70	1.19	0.77		0.19	0.08	1.27		0.24	0.09
SED-2	1/8/2016	4.69		2.25	1.71	0.74		0.13	0.12	1.01		0.16	0.12
SED-2_(ES)	1/8/2016	3.91	J	1.86	1.20	0.73		0.23	0.09	1.33		0.25	0.09
SED-2	11/3/2016	4.33		1.70	1.27	1.08	J	0.22	0.11	1.04	J	0.20	0.10
SED-2 (Nov 16)_(ES)	11/3/2016	1.98		1.26	0.79	0.59		0.13	0.05	1.12		0.20	0.02
SED-2 FD	11/3/2016	6.54		2.33	1.71	1.10		0.18	0.14	1.36		0.23	0.19
SED-2 (Nov 16)_FD_(ES)	11/3/2016	3.82		2.30	1.33	0.63		0.17	0.08	1.01		0.26	0.13
SED-4	1/8/2016	4.68		2.32	1.78	0.90		0.14	0.11	1.66		0.26	0.23
SED-4 (Jan 2016)_(ES)	1/8/2016	3.95	J	2.27	1.40	0.78		0.19	0.07	1.94		0.34	0.09
SED-4	6/10/2016	2.07		0.96	0.76	1.03		0.18	0.10	1.21		0.20	0.10
SED-4 (June 2016)_(ES)	6/10/2016	0.04	U	2.66	1.87	0.88		0.19	0.06	1.17		0.26	0.10
SED-6	6/10/2016	2.36	J	1.57	1.25	0.95		0.14	0.11	1.16		0.18	0.15
SED-6_(ES)	6/10/2016	1.13	U	1.68	1.30	0.91		0.19	0.06	1.21		0.26	0.09
SED-6 FD	6/10/2016	1.28	J	1.00	0.81	1.03		0.22	0.17	0.99		0.29	0.24
SED-7	6/10/2016	1.58	J	1.44	1.16	0.99		0.14	0.12	0.81		0.17	0.14
SED-7_(ES)	6/10/2016	-1.56	U	1.74	2.73	0.76		0.17	0.06	1.39		0.24	0.08
SED-8	6/10/2016	1.82	J	1.03	0.81	1.53		0.36	0.23	1.23		0.34	0.29
SED-8_(ES)	6/10/2016	3.66		2.66	1.62	1.04		0.24	0.08	1.62		0.31	0.12
SED-9	1/19/2017	3.03		1.30	0.99	1.17		0.17	0.16	1.29		0.19	0.16
SED-9_(ES)	1/19/2017	6.70		3.24	1.80	1.08		0.24	0.10	1.70		0.32	0.12
SED-10	1/19/2017	5.91		2.14	1.54	0.95		0.16	0.13	1.04		0.19	0.12
SED-10_(ES)	1/19/2017	6.40		3.09	1.79	0.71		0.25	0.15	1.32		0.32	0.11
SEDIMENT 2016-03-16A	3/16/2016	3.32	J	2.15	1.71	1.21		0.19	0.17	1.86		0.26	0.16
SEDIMENT 2016-03-16A_(ES)	3/16/2016	4.98		2.68	1.37	0.96		0.28	0.11	1.61		0.35	0.09
SEDIMENT 2016-03-16B	3/16/2016	2.84		1.41	1.08	0.97		0.15	0.12	1.20		0.16	0.12
SEDIMENT 2016-03-16B_(ES)	3/16/2016	3.00		1.69	1.01	0.83		0.18	0.06	1.30		0.24	0.08
SEDIMENT 2016-03-16B FD	3/16/2016	1.59	J	1.61	1.31	1.09		0.15	0.13	1.38		0.18	0.12

Notes: All results in pCi/g

Table 7-12: 2016-2017 Radionuclide Results for Sediment Samples

Client ID	Sample Date	Potassium-40				Protactinium-231				Thallium-208			
		Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV
SED-1	1/8/2016	13.68		1.94	0.50	-0.25	U	1.33	1.01	0.91		0.21	0.18
SED-1_(ES)	1/8/2016	9.17		2.03	0.74	-0.15	U	1.40	1.14	0.32		0.09	0.04
SED-2	1/8/2016	11.66		1.92	0.52	-0.21	U	1.93	1.17	0.65		0.16	0.18
SED-2_(ES)	1/8/2016	10.00		2.06	0.51	0.23	U	0.50	1.06	0.28		0.09	0.02
SED-2	11/3/2016	11.78		1.81	0.22	-3.05	U	2.38	1.20	0.73		0.16	0.14
SED-2 (Nov 16)_(ES)	11/3/2016	9.96		2.22	0.60	-0.92	U	3.06	2.49	0.24	J	0.07	0.02
SED-2 FD	11/3/2016	14.95		2.36	0.51	2.55	J	2.32	1.82	0.85		0.21	0.19
SED-2 (Nov 16)_FD_(ES)	11/3/2016	10.70		2.50	0.45	-0.86	U	4.55	3.72	0.31	J	0.11	0.04
SED-4	1/8/2016	17.55		2.50	0.43	-2.73	U	2.28	1.22	0.75		0.15	0.16
SED-4 (Jan 2016)_(ES)	1/8/2016	15.00		2.66	0.40	0.69	U	1.70	1.35	0.24		0.09	0.03
SED-4	6/10/2016	17.92		2.38	0.40	0.13	U	1.05	0.97	0.88		0.16	0.10
SED-4 (June 2016)_(ES)	6/10/2016	13.50		2.74	0.44	-1.65	U	4.78	3.88	0.37	J	0.12	0.04
SED-6	6/10/2016	15.07		2.17	0.59	1.38	J	1.74	1.31	0.70		0.17	0.16
SED-6_(ES)	6/10/2016	17.00		2.73	0.42	0.00	U	3.54	2.92	0.36	J	0.12	0.04
SED-6 FD	6/10/2016	15.87		3.29	1.35	-1.06	U	2.50	2.17	0.97		0.26	0.22
SED-7	6/10/2016	16.25		2.37	0.72	0.13	U	1.83	1.28	0.79		0.17	0.16
SED-7_(ES)	6/10/2016	16.20		2.79	0.26	0.57	U	2.29	3.56	0.34	J	0.10	0.03
SED-8	6/10/2016	17.31		3.52	1.20	0.03	U	3.21	2.57	1.14		0.32	0.35
SED-8_(ES)	6/10/2016	17.00		3.43	0.54	-1.57	U	4.39	3.54	0.40	J	0.11	0.02
SED-9	1/19/2017	15.38		2.26	0.75	3.03	J	2.11	1.63	1.04		0.22	0.22
SED-9_(ES)	1/19/2017	16.50		3.03	0.49	0.83	U	2.79	3.82	0.43		0.12	0.04
SED-10	1/19/2017	12.87		2.23	0.68	-1.43	U	2.37	1.34	0.92		0.20	0.14
SED-10_(ES)	1/19/2017	13.20		2.98	0.62	1.19	U	2.66	2.94	0.40		0.13	0.04
SEDIMENT 2016-03-16A	3/16/2016	15.89		2.36	0.44	0.58	U	1.00	1.89	0.94		0.22	0.21
SEDIMENT 2016-03-16A_(ES)	3/16/2016	10.90		2.61	0.66	0.05	U	0.70	1.83	0.31		0.11	0.04
SEDIMENT 2016-03-16B	3/16/2016	13.22		2.00	0.50	1.15	U	1.64	1.35	0.70		0.15	0.19
SEDIMENT 2016-03-16B_(ES)	3/16/2016	9.11		2.01	0.59	0.23	U	0.56	1.12	0.34		0.10	0.03
SEDIMENT 2016-03-16B FD	3/16/2016	14.34		2.05	0.18	1.09	U	2.06	1.50	0.73		0.18	0.20

Notes: All results in pCi/g

Table 7-12: 2016-2017 Radionuclide Results for Sediment Samples

Client ID	Sample Date	Radium-226				Radium-228				Thorium-228			
		Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV
SED-1	1/8/2016	1.04	J+	0.18	0.11	0.81		0.21	0.19	0.67	J	0.23	0.02
SED-1_(ES)	1/8/2016	1.08		0.23	0.06	0.62		0.27	0.20	0.70		0.16	0.02
SED-2	1/8/2016	1.05	J+	0.18	0.10	0.78		0.21	0.18	0.65	J	0.24	0.02
SED-2_(ES)	1/8/2016	1.50		0.30	0.07	1.08		0.30	0.04	0.74		0.17	0.03
SED-2	11/3/2016	1.00		0.19	0.11	0.78		0.21	0.34	0.79	J	0.28	0.02
SED-2 (Nov 16)_(ES)	11/3/2016	0.97		0.21	0.05	0.85		0.24	0.15	0.80	J	0.18	0.03
SED-2 FD	11/3/2016	1.36		0.24	0.14	0.88		0.29	0.29	0.81	J	0.27	0.07
SED-2 (Nov 16)_FD_(ES)	11/3/2016	1.17		0.32	0.11	1.04		0.35	0.06	0.73	J	0.17	0.03
SED-4	1/8/2016	1.61	J+	0.22	0.11	0.79		0.22	0.17	0.91	J	0.27	0.02
SED-4 (Jan 2016)_(ES)	1/8/2016	1.68		0.34	0.09	0.89		0.25	0.12	0.90		0.19	0.02
SED-4	6/10/2016	1.27		0.18	0.11	0.98		0.22	0.19	0.78		0.23	0.01
SED-4 (June 2016)_(ES)	6/10/2016	1.14		0.30	0.10	1.17		0.30	0.06	1.01	J	0.17	0.03
SED-6	6/10/2016	1.09		0.18	0.11	0.91		0.21	0.16	0.68	J	0.20	0.01
SED-6_(ES)	6/10/2016	0.96		0.22	0.07	0.78		0.24	0.11	1.07	J	0.18	0.02
SED-6 FD	6/10/2016	1.25		0.32	0.23	1.31		0.49	0.43	0.73	J	0.21	0.01
SED-7	6/10/2016	0.91		0.17	0.09	0.84		0.24	0.17	0.76		0.22	0.03
SED-7_(ES)	6/10/2016	1.07		0.27	0.09	0.75		0.26	0.19	0.73	J	0.13	0.02
SED-8	6/10/2016	1.71		0.38	0.24	1.16		0.42	0.48	0.70	J	0.20	0.01
SED-8_(ES)	6/10/2016	1.42		0.34	0.10	0.92		0.33	0.14	1.07	J	0.18	0.02
SED-9	1/19/2017	1.16		0.21	0.13	1.04		0.31	0.28	0.88	J	0.30	0.01
SED-9_(ES)	1/19/2017	1.31		0.30	0.10	0.94		0.44	0.25	1.03		0.21	0.03
SED-10	1/19/2017	1.20		0.21	0.16	0.86		0.26	0.19	0.76		0.25	0.01
SED-10_(ES)	1/19/2017	1.38		0.40	0.15	0.51	U	0.49	0.27	0.76		0.16	0.03
SEDIMENT 2016-03-16A	3/16/2016	1.70		0.24	0.11	1.30		0.30	0.27	0.68	J	0.22	0.02
SEDIMENT 2016-03-16A_(ES)	3/16/2016	1.52		0.33	0.06	0.52		0.33	0.24	1.14	J	0.21	0.03
SEDIMENT 2016-03-16B	3/16/2016	1.13		0.19	0.12	1.08		0.21	0.18	1.08	J	0.33	0.01
SEDIMENT 2016-03-16B_(ES)	3/16/2016	1.11		0.24	0.04	0.62		0.29	0.15	0.84	J	0.18	0.03
SEDIMENT 2016-03-16B FD	3/16/2016	1.32		0.22	0.12	0.92		0.25	0.24	0.62	J	0.24	0.06

Notes: All results in pCi/g

Table 7-12: 2016-2017 Radionuclide Results for Sediment Samples

Client ID	Sample Date	Thorium-230				Thorium-232				Thorium-234			
		Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV
SED-1	1/8/2016	2.70		0.67	0.07	0.92		0.28	0.01	2.40	J	1.35	0.92
SED-1_(ES)	1/8/2016	3.25		0.42	0.02	0.69		0.16	0.01	1.28		1.52	1.22
SED-2	1/8/2016	2.74	J	0.70	0.08	0.81	J	0.27	0.01	1.73	J	1.67	1.36
SED-2_(ES)	1/8/2016	3.33		0.44	0.01	0.65		0.16	0.01	0.22	U	0.43	1.37
SED-2	11/3/2016	2.93		0.77	0.09	1.07	J	0.34	0.02	2.04		0.88	0.73
SED-2 (Nov 16)_(ES)	11/3/2016	2.39		0.35	0.01	0.66		0.16	0.01	1.08	U	1.03	0.78
SED-2 FD	11/3/2016	3.14	J	0.76	0.10	0.85	J	0.27	0.01	4.23	J	2.41	1.93
SED-2 (Nov 16)_FD_(ES)	11/3/2016	2.60		0.36	0.01	0.69		0.16	0.01	1.00	U	0.80	1.13
SED-4	1/8/2016	14.70	J	3.06	0.07	1.46	J	0.38	0.00	1.21	J	0.96	0.75
SED-4 (Jan 2016)_(ES)	1/8/2016	19.80		1.84	0.02	0.83		0.18	0.01	0.47	U	0.88	1.35
SED-4	6/10/2016	3.23		0.75	0.05	0.65	J	0.19	0.01	1.05	J	0.89	0.68
SED-4 (June 2016)_(ES)	6/10/2016	3.56		0.40	0.01	1.04		0.17	0.01	2.37		1.75	1.03
SED-6	6/10/2016	2.12	J	0.51	0.05	0.74	J	0.21	0.00	3.25		1.22	0.86
SED-6_(ES)	6/10/2016	2.82		0.34	0.01	1.19		0.19	0.01	0.83	U	0.75	1.00
SED-6 FD	6/10/2016	2.15	J	0.52	0.05	0.71	J	0.20	0.00	1.60	J	1.22	0.95
SED-7	6/10/2016	2.38		0.57	0.07	0.64		0.19	0.01	0.85	U	1.37	0.87
SED-7_(ES)	6/10/2016	2.45	J	0.30	0.01	0.66	J	0.12	0.01	0.97	U	0.75	0.97
SED-8	6/10/2016	3.27	J	0.73	0.04	0.75	J	0.21	0.01	2.51	J	2.10	1.72
SED-8_(ES)	6/10/2016	3.77		0.42	0.01	1.11		0.18	0.01	-1.10	U	1.68	1.87
SED-9	1/19/2017	4.46	J+	1.09	0.08	1.04	J+	0.33	0.01	2.43	J	1.46	1.00
SED-9_(ES)	1/19/2017	4.50		0.54	0.01	0.84		0.18	0.01	1.22	U	1.81	1.40
SED-10	1/19/2017	2.32	J+	0.59	0.07	1.18	J+	0.33	0.01	1.94	J	1.63	1.31
SED-10_(ES)	1/19/2017	2.35		0.32	0.01	0.78		0.16	0.01	1.56	U	2.09	1.43
SEDIMENT 2016-03-16A	3/16/2016	6.98	J+	1.49	0.07	0.82	J	0.24	0.01	1.43	J	1.67	1.09
SEDIMENT 2016-03-16A_(ES)	3/16/2016	5.87		0.65	0.01	0.70		0.16	0.01	3.27		1.82	1.39
SEDIMENT 2016-03-16B	3/16/2016	4.53	J+	1.08	0.08	0.74		0.25	0.00	1.09	J	1.46	0.93
SEDIMENT 2016-03-16B_(ES)	3/16/2016	3.85		0.47	0.01	0.60		0.15	0.01	1.32		1.31	1.05
SEDIMENT 2016-03-16B FD	3/16/2016	4.39	J+	1.06	0.10	0.84		0.28	0.03	2.01	J	1.71	1.39

Notes: All results in pCi/g

Table 7-12: 2016-2017 Radionuclide Results for Sediment Samples

Client ID	Sample Date	Uranium-234				Uranium-235				Uranium-238			
		Result	Final Q	CSU	CV	Result	Final Q	CSU	CV	Result	Final Q	CSU	CV
SED-1	1/8/2016	1.10	J	0.34	0.06	0.10	J	0.11	0.00	1.06		0.33	0.02
SED-1_(ES)	1/8/2016	0.75		0.19	0.02	0.03		0.05	0.02	0.74		0.19	0.01
SED-2	1/8/2016	0.88		0.27	0.04	0.28	J	0.16	0.01	0.90		0.27	0.01
SED-2_(ES)	1/8/2016	0.97		0.23	0.02	0.03		0.04	0.01	0.94		0.23	0.02
SED-2	11/3/2016	1.05	J	0.28	0.02	0.12	J	0.10	0.01	1.23	J+	0.31	0.01
SED-2 (Nov 16)_(ES)	11/3/2016	0.86		0.24	0.01	0.11	U	0.09	0.01	0.70		0.22	0.01
SED-2 FD	11/3/2016	0.87	J	0.24	0.01	0.06	J	0.06	0.00	1.01	J+	0.26	0.01
SED-2 (Nov 16)_FD_(ES)	11/3/2016	1.02		0.28	0.04	0.03	U	0.06	0.03	0.76		0.24	0.05
SED-4	1/8/2016	0.89	J	0.25	0.06	0.18	J	0.11	0.01	0.96	J	0.26	0.02
SED-4 (Jan 2016)_(ES)	1/8/2016	0.78		0.20	0.02	0.03		0.05	0.02	0.88		0.21	0.01
SED-4	6/10/2016	0.83	J+	0.22	0.01	0.05	J	0.05	0.00	0.70		0.19	0.01
SED-4 (June 2016)_(ES)	6/10/2016	0.77		0.15	0.02	0.05		0.04	0.01	0.81		0.15	0.01
SED-6	6/10/2016	0.94	J+	0.21	0.01	0.06	J	0.05	0.00	0.80	J	0.19	0.01
SED-6_(ES)	6/10/2016	0.66		0.13	0.01	0.04		0.03	0.01	0.82		0.15	0.01
SED-6 FD	6/10/2016	0.67	J+	0.18	0.01	0.13	J	0.08	0.00	0.70		0.19	0.01
SED-7	6/10/2016	0.53	J+	0.15	0.01	0.05	J	0.05	0.00	0.62	J	0.16	0.01
SED-7_(ES)	6/10/2016	0.51		0.12	0.01	0.03		0.03	0.01	0.79		0.16	0.01
SED-8	6/10/2016	0.78	J+	0.20	0.01	0.15	J	0.09	0.00	0.66	J	0.18	0.01
SED-8_(ES)	6/10/2016	0.76		0.16	0.02	0.03		0.03	0.01	0.83		0.16	0.01
SED-9	1/19/2017	1.19	J+	0.35	0.02	0.05	J	0.08	0.00	0.95	J	0.30	0.01
SED-9_(ES)	1/19/2017	1.04		0.22	0.01	0.05		0.05	0.01	1.09		0.23	0.01
SED-10	1/19/2017	1.26	J+	0.31	0.02	0.14	J	0.10	0.01	0.92	J	0.25	0.01
SED-10_(ES)	1/19/2017	1.05		0.22	0.01	0.08		0.06	0.01	1.10		0.22	0.01
SEDIMENT 2016-03-16A	3/16/2016	0.95	J	0.26	0.03	0.10	J	0.09	0.01	1.11	J	0.29	0.01
SEDIMENT 2016-03-16A_(ES)	3/16/2016	1.16		0.24	0.02	0.07		0.07	0.02	0.95		0.22	0.02
SEDIMENT 2016-03-16B	3/16/2016	0.93		0.27	0.04	0.11	J	0.10	0.01	1.00	J	0.28	0.01
SEDIMENT 2016-03-16B_(ES)	3/16/2016	0.62		0.17	0.03	0.02	U	0.04	0.02	0.62		0.17	0.02
SEDIMENT 2016-03-16B FD	3/16/2016	0.93		0.29	0.06	0.16	J	0.12	0.01	0.68	J	0.23	0.01

Notes: All results in pCi/g

Table 7-13: Summary of Radium Isotope Results: 2012 - 2013 Groundwater Sampling Events

DRAFT

Sample ID	August 2012										April 2013										July 2013										October 2013										February 2014									
	Radium-226				Radium-228				Combined		Radium-226				Radium-228				Combined		Radium-226				Radium-228				Combined	Combined	Radium-226				Radium-228				Combined		Radium-226				Radium-228				Combined	
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228		Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228		Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228	Radium relative to 5 pCi/L MCL	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228		Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228	
S-5 DIS	1.29	0.85	0.90	J	2.03	1.25	2.26	UJ	1.29	*	0.04	0.07	0.11	U	0.45	0.43	0.83	UJ+	Non-Detect		0.83	0.64	0.66	J	4.01	1.1	0.15	J+	4.84	Less Than MCL	0.39	0.23	0.17	J	-0.10	1.26	2.69	UJ	0.39	*	Less Than MCL									
S-5 MDNR DIS	2.25	1.22	0.96		2.98	1.37	2.59	J	5.23																						1.62	0.91	0.91	J	2.05	1.38	2.73	J	3.67		Less Than MCL									
S-5 TOT	0.67	0.61	0.63	J	2.25	1.39	2.51	UJ	0.67	*	1.10	0.57	0.26	J	5.03	1.81	2.44	J+	6.13		0.98	0.7	0.8	J	5.52	1.48	0.17	J+	6.50	Exceeds MCL	0.37	0.21	0.16	J	0.31	1.25	2.63	UJ	0.37	*	Less Than MCL									
S-5 EPA TOT											0.438		0.065		0.418	0.293	0.450	U	0.44	*	0.650	0.280	0.318		0.830	0.503	0.742		1.48	Less Than MCL																				
S-5 MDNR TOT	0.81	0.53	0.44	J	5.96	1.36	2.22		6.77																						0.56	0.51	0.59	J	8.20	2.39	4.47		8.76		Exceeds MCL									
S-8 DIS	0.56	0.32	0.25	J	2.02	0.80	1.16	J+	2.58		0.45	0.23	0.12	J	1.00	0.49	0.81	J+	1.45		0.24	0.2	0.17	J	1.03	0.81	1.55	U	0.24	* Less Than MCL	0.30	0.22	0.20	J	1.48	0.81	1.41	J	1.78		Less Than MCL									
S-8 TOT	0.65	0.35	0.26	J	1.70	0.83	1.39	J+	2.34		0.45	0.24	0.15	J	1.18	0.50	0.77	J+	1.63		0.35	0.31	0.39	U	0.67	0.66	1.29	U	Non-Detect	Less Than MCL	0.47	0.29	0.19	J	3.45	1.01	1.00		3.92		Less Than MCL									
S-10 DIS	0.06	0.13	0.25	U	0.67	0.61	1.18	UJ	Non-Detect		0.01	0.04	0.09	UJ	0.37	0.37	0.73	U	Non-Detect		0.14	0.15	0.18	U	1.39	0.77	1.34	J	1.39	* Less Than MCL	0.17	0.16	0.16	J	1.05	0.78	1.47	U	0.17	*	Less Than MCL									
S-10 TOT	0.14	0.18	0.29	U	0.55	0.60	1.19	UJ	Non-Detect		0.03	0.05	0.10	U	0.06	0.51	1.09	UJ	Non-Detect		0.43	0.25	0.14	J	2.55	0.97	1.38		2.98	Less Than MCL	0.13	0.14	0.21	UJ	2.95	0.98	1.17		2.95	*	Less Than MCL									
S-53 DIS											0.84	0.37	0.14		1.46	0.70	1.15	J+	2.30		0.22	0.24	0.33	UJ+	0.94	0.74	1.42	U	Non-Detect	Less Than MCL	0.27	0.20	0.14	J	2.72	0.90	1.15	J	2.99		Less Than MCL									
S-53 TOT											0.14	0.31	0.62	UJ	-2.53	4.74	10.3	UJ+	Non-Detect		4.04	1.36	0.4	J+	2.66	1.03	1.51		6.70	Exceeds MCL	0.40	0.27	0.22	J	0.37	0.75	1.56	UJ	0.40	*	Less Than MCL									
S-61 DIS	0.35	0.23	0.20	J	1.26	0.72	1.25	J	1.61		0.37	0.20	0.14	J	0.89	0.54	0.98	UJ	0.37	*	0.31	0.22	0.2	J	1.53	0.76	1.28		1.84	Less Than MCL	0.75	0.37	0.20	J	1.13	0.67	1.20	UJ+	0.75	*	Less Than MCL									
S-61 EPA DIS	0.51	0.17	0.14		0.33	0.24	0.37	U	0.51	*																																						
S-61 TOT	0.55	0.30	0.26	J	0.80	0.68	1.30	U	0.55	*	1.93	0.59	0.18	J	1.21	0.51	0.77		3.14		1.29	0.51	0.2		1.27	0.7	1.22	J	2.56	Less Than MCL	1.05	0.51	0.24	J	1.28	0.84	1.55	UJ+	1.05	*	Less Than MCL									
S-82 DIS	1.32	0.57	0.31		6.08	1.72	1.62	J	7.40		0.64	0.31	0.16		1.17	0.62	1.06	J	1.81		1.07	0.47	0.19		1.84	0.82	1.31	J+	2.91	Less Than MCL	1.33	0.54	0.32		1.91	0.79	1.20	J+	3.24		Less Than MCL									
S-82 MDNR DIS																															1.18	0.50	0.23						1.18		Less Than MCL									
S-82 TOT	3.11	1.03	0.34		6.89	1.94	1.83	J	10.00		1.63	0.55	0.17		2.04	0.74	1.01		3.67		1.48	0.61	0.27		1.18	0.9	1.71	UJ+	1.48	* Less Than MCL	2.00	0.75	0.39		2.77	1.04	1.52	J+	4.77		Less Than MCL									
S-82 EPA TOT											1.18		0.058		1.65	0.381	0.414		2.83		0.741	0.228	0.212		1.08	0.297	0.344		1.82	Less Than MCL																				
S-82 MDNR TOT																															1.29	0.54	0.27						1.29		Less Than MCL									
S-84 DIS	0.51	0.32	0.24	J	1.67	1.02	1.83	UJ	0.51	*	0.11	0.12	0.17	U	0.63	0.57	1.11	UJ+	Non-Detect		0.67	0.35	0.17	J	3.35	1.02	1.08	J+	4.02	Less Than MCL	0.35	0.29	0.29	J	1.88	0.80	1.24		2.23		Less Than MCL									
S-84 FD DIS																															0.27	0.21	0.19	J	4.58	1.28	1.17		4.85		Less Than MCL									
S-84 TOT	1.29	0.52	0.25		1.98	0.95	1.59	J	3.26		0.24	0.19	0.23	J	1.92	0.68	0.93	J+	2.16		1.3	0.61	0.27	J+	2.88	1.02	1.36	J+	4.18	Less Than MCL	0.53	0.33	0.32	J	2.22	0.77	0.99		2.75		Less Than MCL									
S-84 FD TOT																															1.40	0.65	0.37		5.80	1.55	1.20		7.20		Exceeds MCL									
I-4 DIS	1.94	0.72	0.27		4.23	1.40	1.73		6.17		0.11	0.11	0.14	U	0.43	0.39	0.75	UJ+	Non-Detect		0.96	0.54	0.31	J	5.89	1.49	0.13	J+	6.85	Exceeds MCL	0.39	0.43	0.50	UJ	0.14	0.74	1.55	UJ	Non-Detect		Less Than MCL									
I-4 FD DIS																					1.56	0.67	0.36	J	2.23	0.85	1.22	J+	3.79	Less Than MCL																				
I-4 MDNR DIS	3.15	0.77	0.30		3.11	0.89	1.60		6.26																																						
I-4 TOT	2.83	0.98	0.39		3.68	1.45	2.15	J	6.51		0.65	0.30	0.18		1.15	0.52	0.83	J+	1.80		1.37	0.6	0.28		5.2	1.32	0.11	J+	6.57	Exceeds MCL	0.16	0.16	0.19	UJ	7.69	2.09	1.73	J	7.69	*	Exceeds MCL									
I-4 FD TOT																					1.18	0.52	0.21	J	2.38	0.81	0.99	J+	3.56	Less Than MCL																				
I-4 EPA TOT																					1.04	0.214	0.126		1.10	0.312	0.356		2.14	Less Than MCL																				
I-4 MDNR TOT	2.33	0.60	0.22		4.48	0.88	1.46		6.81																																						
I-9 DIS	2.14	0.76	0.20		4.21	1.40	1.75	J	6.34		0.67	0.33	0.20		1.49	0.69	1.12	J	2.16		1.01	0.47	0.23		4.21	1.19	1.05	J+	5.22	Exceeds MCL	1.26	0.53	0.22		3.23	1.13	1.51	J+	4.49		Less Than MCL									
I-9 FD DIS	2.38	0.80	0.18		5.06	1.59	1.82	J	7.44		0.85	0.38	0.23		1.79	0.81	1.31	J+	2.64												1.83	0.74	0.29		2.58	0.96	1.37	J+	4.41		Less Than MCL									
I-9 MDNR DIS	3.08	0.88	0.38		4.59	0.96	1.62		7.66																						-0.01	0.10	0.21	U	4.48	1.30	2.33		4.48	*	Less Than MCL									
I-9 TOT	2.35	0.80	0.19		4.48	1.35	1.40		6.83		1.48	0.53	0.20		3.81	1.16	1.30	J	5.29		1.14	0.51	0.28		2.41	0.95	1.42	J+	3.55	Less Than MCL	2.11	0.78	0.25		3.27	1.23	1.80	J+	5.38		Exceeds MCL									
I-9 FD TOT	2.22	0.75	0.18		3.81	1.36	1.84		6.03		1.27	0.51	0.24		2.45	0.85	1.12	J+	3.72												2.22	0.79	0.34	J	2.79	0.93	1.17	J+	5.01		Exceeds MCL									
I-9 EPA TOT											1.24		0.052		1.81	0.356	0.315		3.05		1.41	0.304	0.192		1.60	0.324	0.297		3.01	Less Than MCL																				
I-9 MDNR TOT	2.32	0.59	0.20		3.96	0.86	1.46		6.28																						2.01	0.64	0.22		3.52	0.88	1.50		5.53		Exceeds MCL									
I-11 DIS	1.01	0.45	0.22		2.99	1.03	1.34		3.99		1.24	0.49	0.23		0.88	0.64	1.21	UJ+	1.24	*	1.43	0.56	0.3		2.91	1.08	1.52		4.34	Less Than MCL	0.80	0.40	0.23		3.47	1.14	1.39		4.27		Less Than MCL									
I-11 EPA DIS	0.95	0.23	0.17		2.49	0.46	0.40		3.44																																						
I-11 TOT	1.31	0.52	0.22		3.55	1.11	1.26		4.86		1.02	0.42	0.24	J	2.37	0.83	1.08	J+	3.39		1.44	0.54	0.25		1.82	0.87	1.45		3.26	Less Than MCL	1.02	0.46	0.17		2.84	0.99	1.28		3.86		Less Than MCL									
I-62 DIS	0.32	0.22	0.20	J	2.03	0.80	1.16	J+	2.35		0.40	0.22	0.14	J	1.01	0.69	1.28	U	0.40	*	0.44	0.27	0.2	J	0.7	0.72	1.42	U	0.44	* Less Than MCL	0.56	0.32	0.20	J	0.97	0.80	1.55	U	0.56	*	Less Than MCL									
I-62 FD DIS											0.19	0.14	0.11	J	0.65	0.47	0.89	UJ	0.19	*	0.2	0.2	0.24	U	1.2	0.72	1.3	U	Non-Detect	Less Than MCL																				
I-62 TOT	0.83	0.38	0.20	J	0.75	0.68	1.33	UJ+	0.83	*	0.46	0.24	0.18	J	1.27	0.68	1.18	J	1.73		0.66	0.34	0.16	J	1.38	0.78	1.38	J	2.04	Less Than MCL	0.38	0.25	0.23	J	0.60	0.74	1.49	U	0.38	*	Less Than MCL									
I-62 FD TOT											0.32	0.18	0.12	J	0.89	0.47	0.81	J	1.21		0.27	0.22	0.23	J	1.85	0.84	1.36		2.12	Less Than MCL																				
I-65 DIS	0.22	0.20	0.25	U	0.96	0.73	1.38	UJ	Non-Detect		0.30	0.18	0.13	J	0.81	0.49	0.88	UJ+	0.30	*	0.29	0.21	0.15	J+	1.24	0.71	1.25	U	0.29	* Less Than MCL	0.14	0.14	0.16	U	0.06	0.70	1.49	UJ	Non-Detect		Less Than MCL									
I-65 FD DIS											0.25	0.18	0.16	J	0.85	0.52	0.94	UJ+	0.25	*	0.2	0.18	0.17	J	0.53	0.89	1.82	U	0.20	* Less Than MCL																				
I-65 TOT	0.88	0.41	0.25		2.73	1.02	1.45	J	3.61		0.54	0.25	0.11		0.61	0.43	0.81	UJ+	0.54	*	1.4	0.65	0.45	J+	1.12	0.74	1.37	U	1.40	* Less Than MCL	0.40	0.24	0.17	J	1.15	0.77	1.42	UJ	0.40	*	Less Than MCL									
I-65 FD TOT											0.47	0.23	0.15		0.91	0.50	0.88	J+	1.38		0.63	0.31	0.15		1.44	0.84	1.49	U	0.63	* Less Than MCL																				
I-66 DIS	0.12	0.17	0.28	UJ	0.46	0.73	1.49	U	Non-Detect		0.20	0.15	0.14	J	1.42	0.63	0.98		1.62		0.33	0.25	0.23	J	0.85	0.75	1.45	U	0.33	* Less Than MCL	0.39	0.27	0.24	J	0.96	0.71	1.35	UJ+	0.39	*	Less Than MCL									
I-66 TOT	0.26	0.22	0.24	J	1.24	0.82	1.51	UJ	0.26	*	0.23	0.16	0.13	J	0.27	0.64	1.33	UJ	0.23	*	0.33	0.27	0.31	J	1.59	0.77	1.27		1.92	Less Than MCL	0.28	0.24	0.28	J	0.95	0.65	1.20	UJ+	0.28	*	Less Than MCL									
I-67 DIS	0.55	0.33	0.27	J	0.64	0.68	1.34	U	0.55	*	0.46	0.23	0.10		0.60	0.47	0.89	U	0.46	*	0.47	0.28	0.23	J	1.28	0.67	1.14	J	1.75	Less Than MCL	0.45	0.28	0.19	J	4.10	1.19	1.13	J+	4.55		Less Than MCL									
I-67 FD DIS											0.21	0.15	0.14	J	0.90	0.71	1.36	UJ	0.21	*											0.38	0.24	0.15	J	1.85	0.69	0.95	J+	2.23		Less Than MCL									
I-67 TOT	0.60	0.36	0.29	J	0.46	0.69	1.41	U	0.60	*	0.69	0.30	0.15	J	0.55	0.51	0.99	UJ	0.69	*	0.49	0.28	0.22	J	1.19	0.68	1.2	U	0.49	* Less Than MCL	1.10	0.46	0.19	J	1.39	0.69	1.17	J+	2.49		Less Than MCL									
I-67 FD TOT											0.73	0.30	0.17		0.73	0.79	1.56	UJ	0.73	*											0.90	0.40	0.15	J	1.44	0.67	1.08	J+	2.34		Less Than MCL									
I-68 DIS	0.52	0.30	0.23	J	3.46	1.09	1.24		3.98		0.67	0.31	0.14		1.37	0.61	0.97		2.04		0.76	0.4	0.23	J	1.65	0.77	1.25		2.41	Less Than MCL	0.81	0.40	0.29	J	2.87	1.07	1.49	J+	3.68		Less Than MCL									
I-68 TOT	2.12	0.72	0.22		2.60	1.06	1.61	J	4.72		3.34	1.05	0.35	J	1.97	0.78	1.16	J	5.31		1.4	0.53	0.19		3.67	1.17	1.38		5.07	Exceeds MCL	0.65	0.31	0.13	J	3.69	1.58	2.42	J+	4.34		Less Than MCL									
I-73 DIS	0.71	0.39	0.27	J	0.97	0.97	1.92	UJ	0.71	*	1.04	0.41	0.17		1.03	0.57	1.01	J+	2.07		2.83	1.62	0.85	J	1.97	1.15	2.05	U	2.83	* Less Than MCL	3.05	1.43	1.06	J	5.8	1.99	2.59	J+	8.85		Exceeds MCL									
I-73 TOT	0.95	0.42	0.15		1.17	0.85	1.59	U	0.95	*	1.79	0.62	0.18	J	2.55	0.90	1.24	J+	4.34		1.9	1.36	1.05	J	1.07	1.19	2.36	U	1.90	* Less Than MCL	4.47	1.79	0.93	J	5.5	1.93	2.58	J+	9.97		Exceeds MCL									
D-3 DIS	2.55	0.91	0.31		5.06	1.50	1.54	J	7.61		2.12	0.74	0.33		2.72	0.79	0.79	J+	4.84		3.72	1.27	0.49		6.18	1.74	1.6	J+	9.90	Exceeds MCL	2.81	0.94	0.20	J	4.43	1.28	1.28	J	7.24		Exceeds MCL									
D-3 FD DIS	3.06	1.06	0.39		6.72	1.74	1.15	J	9.78																																						
D-3 EPA DIS	1.74	0.33	0.18		5.16	0.67	0.29		6.90																																						
D-3 MDNR DIS																															2.84	0.83	0.48		6.55	1.02	1.55		9.39		Exceeds MCL									
D-3 TOT	4.17	1.29	0.35		6.05	1.66	1.42		10.22		2.82	0.93	0.24	J	4.38	1.18	0.98	J+	7.20		3.53	1.2	0.3		4.81	1.45	1.6	J+	8.34	Exceeds MCL	1.77	0.70	0.30	J	5.36	1.5	1.35	J	7.13		Exceeds MCL									
D-3 FD TOT	2.52	0.88	0.30	J	4.13	1.21	1.27		6.65																																						
D-3 EPA TOT											1.90		0.057		5.19	0.674	0.351		7.09		2.55	0.362	0.121		4.97	0.674	0.351		7.52	Exceeds MCL																				
D-3 MDNR TOT																															2.96	0.87	0.42		5.01	0.96	1.55		7.97		Exceeds MCL									
D-6 DIS	2.54	0.83	0.24		3.71	1.15	1.29	J	6.25		1.75	0.60	0.24		2.70	0.86	1.01	J+	4.45		2.88	0.95	0.26		4.07	1.3	1.57		6.95	Exceeds MCL	2.96	0.95	0.32		3.32	1.06	1.23	J+	6.28		Exceeds MCL									
D-6 FD DIS	3.09	0.99	0.30	J	3.81	1.12	1.09		6.90																																						
D-6 EPA DIS	2.00	0.35	0.14		4.09	0.60	0.38		6.09																																						
D-6 EPA FD DIS	1.72	0.31	0.15		3.18	0.50	0.36		4.90																																						
D-6 MDNR DIS																															2.30	0.68	0.42		4.70	0.91	1.43		7.00		Exceeds MCL									
D-6 TOT	3.39	1.05	0.23		4.76	1.38	1.31	J	8.15		1.91	0.64	0.21		5.89	1.70	1.66	J+	7.80		3.1	0.98	0.2		3.13	1.13	1.59		6.23	Exceeds MCL	2.40	0.80	0.27		4.00	1.19	1.21	J+	6.40		Exceeds MCL									
D-6 FD TOT	3.26	1.03	0.26		3.24	1.11	1.46		6.50																																						
D-6 EPA TOT											2.01		0.054		3.04	0.476	0.326		5.05																														
D-6 MDNR TOT																															2.96	0.87	0.42		3.46	0.86	1.48		6.42		Exceeds MCL									

Table 7-13: Summary of Radium Isotope Results: 2012 - 2013 Groundwater Sampling Events

DRAFT

Sample ID	August 2012									April 2013									July 2013										October 2013									February 2014								
	Radium-226				Radium-228				Combined	Radium-226				Radium-228				Combined	Radium-226				Radium-228				Combined	Combined	Radium-226				Radium-228				Combined	Combined	Radium-226				Radium-228				Combined
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228	Radium relative to 5 pCi/L MCL	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228	Radium relative to 5 pCi/L MCL	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228
D-12 DIS	0.68	0.36	0.22		0.51	0.59	1.17	UJ	0.68 *	0.19	0.18	0.24	U	1.37	0.57	0.86	J+	1.37 *	0.47	0.3	0.29	J	1.74	0.79	1.26	J+	2.21	Less Than MCL	0.47	0.30	0.21	J	3.00	1.01	1.3		3.47	Less Than MCL								
D-12 FD DIS										0.12	0.11	0.13	U	0.85	0.54	0.97	U	Non-Detect	0.44	0.34	0.39	J	1.44	0.79	1.37	J+	1.88	Less Than MCL																			
D-12 EPA DIS	0.66	0.20	0.19		0.58	0.24	0.32		1.24																																				
D-12 TOT	0.80	0.39	0.25		1.13	0.63	1.10	J	1.93	0.96	0.40	0.17	J	0.56	0.52	1.01	UJ+	0.96 *	0.29	0.23	0.23	J	1.13	0.72	1.3	UJ+	0.29 *	Less Than MCL	0.31	0.26	0.27	J	2.59	0.89	1.17		2.90	Less Than MCL								
D-12 FD TOT										0.45	0.23	0.17	J	1.61	0.60	0.85	J	2.06	0.36	0.23	0.16	J	0.97	0.73	1.39	UJ+	0.36 *	Less Than MCL																			
D-13 DIS	1.21	0.49	0.17		2.19	0.90	1.36	J+	3.40	0.92	0.36	0.13		1.22	0.54	0.87	J+	2.14	1.09	0.46	0.24	J+	2.3	0.86	1.21		3.39	Less Than MCL	0.90	0.41	0.19	J	1.68	0.81	1.36	J	2.58	Less Than MCL								
D-13 FD DIS	0.93	0.41	0.22	J	5.34	1.46	1.21		6.27																																				
D-13 TOT	1.41	0.54	0.23		4.49	1.35	1.45	J+	5.90	1.20	0.44	0.19	J	2.52	0.82	1.01	J+	3.72	0.78	0.38	0.21	J+	1.87	0.77	1.18		2.65	Less Than MCL	0.91	0.42	0.30	J	2.94	1.03	1.4	J	3.85	Less Than MCL								
D-13 FD TOT	0.63	0.34	0.30	J	2.04	0.94	1.52	J	2.67																																				
D-14 DIS										0.79	0.34	0.22		1.39	0.55	0.80	J+	2.18	1.21	0.58	0.41	J+	2.4	0.85	1.1		3.61	Less Than MCL	0.85	0.36	0.12		1.89	1.26	2.32	UJ	0.85 *	Less Than MCL								
D-14 TOT	2.18	0.75	0.33	J	2.99	1.34	2.15	J+	5.17	1.97	0.62	0.17		1.74	0.68	1.00	J+	3.71	2.22	0.9	0.32	J+	3.13	1.11	1.48		5.35	Exceeds MCL	0.90	0.44	0.25		2.26	1.05	1.71	J	3.16	Less Than MCL								
D-81 DIS	0.62	0.33	0.19	J	2.04	0.88	1.37	J+	2.66	0.18	0.16	0.21	U	0.86	0.52	0.93	U	Non-Detect	0.84	0.4	0.21		1.15	0.65	1.14	J	1.99	Less Than MCL	0.26	0.21	0.18	J	3.14	1.18	1.7	J+	3.40	Less Than MCL								
D-81 FD DIS																			0.77	0.42	0.34	J+	1.44	0.77	1.34	J	2.21	Less Than MCL																			
D-81 TOT	0.63	0.33	0.21		3.41	1.10	1.26	J+	4.03	0.87	0.39	0.22		1.59	0.65	0.98		2.46	0.30	0.29	0.39	U	1.22	0.68	1.21	J	1.22 *	Less Than MCL	0.73	0.38	0.29	J	5.4	1.59	1.67	J+	6.13	Exceeds MCL								
D-81 FD TOT																			0.39	0.29	0.32	J+	0.54	0.64	1.28	U	0.39 *	Less Than MCL																			
D-83 DIS	3.23	1.00	0.27		3.48	1.15	1.42	J+	6.70	1.79	0.62	0.16		3.78	1.13	1.20	J+	5.57	3.54	1.18	0.35		5.01	1.4	1.27	J+	8.55	Exceeds MCL	2.86	0.95	0.29		2.81	1.02	1.41	J+	5.67	Exceeds MCL								
D-83 FD DIS																			4.04	1.3	0.42		4.29	1.24	1.25		8.33	Exceeds MCL																			
D-83 MDNR DIS																													1.53	0.52	0.22		4.53	0.98	1.66		6.06	Exceeds MCL								
D-83 TOT	2.80	0.93	0.25	J	3.21	1.07	1.33	J+	6.01	3.17	0.99	0.32		5.53	1.42	0.89	J+	8.70	3.04	0.98	0.32		4.3	1.3	1.43	J+	7.34	Exceeds MCL	3.26	1.04	0.29	J	3.14	1.01	1.2	J+	6.40	Exceeds MCL								
D-83 FD TOT																			3.10	1.02	0.45		4.43	1.26	1.21		7.53	Exceeds MCL																			
D-83 EPA TOT										2.73		0.049		4.28	0.573	0.298		7.01	2.61	0.435	0.170		3.50	0.508	0.306		6.11	Exceeds MCL																			
D-83 MDNR TOT																													3.20	0.74	0.23		5.61	0.92	1.37		8.80	Exceeds MCL								
D-85 DIS	1.65	0.65	0.28		2.80	1.04	1.45	J	4.45	0.91	0.40	0.19		1.26	0.57	0.93	J+	2.17	1.56	0.68	0.49	J	4.8	1.4	1.4	J+	6.36	Exceeds MCL	1.42	0.61	0.31		0.87	0.72	1.39	UJ+	1.42 *	Less Than MCL								
D-85 MDNR DIS																													1.61	0.66	0.51						1.61	Less Than MCL								
D-85 TOT	6.84	1.92	0.31	J	6.95	2.45	3.30	J	13.79	9.67	2.63	0.50	J	6.41	1.77	1.57	J+	16.08	4.64	1.41	0.33	J	4.91	2.31	3.81	J+	9.55	Exceeds MCL	4.46	1.43	0.56	J	1.65	1.07	1.96	UJ+	4.46 *	Less Than MCL								
D-85 EPA TOT										3.86		0.143		3.90	0.994	1.13	G	7.76	4.10	0.649	0.203		3.49	0.839	0.897		7.59	Exceeds MCL																			
D-85 MDNR TOT																													2.22	0.83	0.51						2.22	Less Than MCL								
D-87 DIS	1.42	0.56	0.20	J+	3.93	1.19	1.27	J+	5.35	0.75	0.35	0.22		0.95	0.53	0.93	J	1.70	2.26	0.89	0.44	J+	3.26	1.11	1.44		5.52	Exceeds MCL	1.77	0.67	0.19		4.67	1.26	1.02	J+	6.44	Exceeds MCL								
D-87 FD DIS																													2.24	0.78	0.21	J	3.62	1.05	1.04	J+	5.86	Exceeds MCL								
D-87 TOT	1.70	0.60	0.24	J+	3.99	1.15	1.09	J+	5.69	1.33	0.50	0.21		2.99	0.90	0.94		4.32	2.52	0.93	0.28	J+	3.37	1.11	1.38		5.89	Exceeds MCL	2.40	0.82	0.25		3.71	1.06	0.98	J+	6.11	Exceeds MCL								
D-87 FD TOT																													1.82	0.69	0.24	J	3.82	1.12	1.12	J+	5.64	Exceeds MCL								
D-93 DIS	1.79	0.66	0.25		3.45	1.34	2.00		5.24	1.93	0.63	0.21		2.89	0.88	0.97		4.82	2.05	0.72	0.27		4.18	1.22	1.24	J+	6.23	Exceeds MCL	3.08	0.97	0.23		3.15	0.96	1.07	J+	6.23	Exceeds MCL								
D-93 MDNR DIS	1.50	0.52	0.24		3.56	0.80	1.34		5.06																				1.97	0.58	0.28		4.85	1.30	2.32		6.82	Exceeds MCL								
D-93 TOT	1.22	0.53	0.23		1.81	0.97	1.68	J	3.03	3.02	0.95	0.31		4.79	1.31	1.12	J	7.81	2.37	0.82	0.27		1.35	0.77	1.37	UJ+	2.37 *	Less Than MCL	3.28	1.03	0.27		4.26	1.18	1.05	J+	7.54	Exceeds MCL								
D-93 EPA TOT										1.95		0.052		4.59	0.625	0.352		6.54	2.43	0.419	0.198		4.06	0.568	0.339		6.49	Exceeds MCL																			
D-93 MDNR TOT	2.52	0.68	0.21		2.77	0.83	1.49		5.29																				2.12	0.62	0.19		2.91	1.24	2.37	J	5.03	Exceeds MCL								
LR-100 DIS	0.83	0.40	0.28		0.89	0.92	1.82	UJ	0.83 *	0.14	0.15	0.22	U	0.68	0.51	0.96	U	Non-Detect	0.36	0.25	0.18	J	0.51	0.66	1.34	U	0.36 *	Less Than MCL	0.56	0.32	0.2	J	1.46	0.75	1.29	J+	2.02	Less Than MCL								
LR-100 FD DIS																													0.43	0.26	0.16	J	2.36	0.76	0.89	J+	2.79	Less Than MCL								
LR-100 TOT	0.54	0.34	0.35	J	1.06	1.01	1.97	UJ	0.54 *	0.44	0.26	0.24	J	0.37	0.55	1.12	UJ	0.44 *	0.58	0.35	0.31	J	-0.17	0.6	1.3	U	0.58 *	Less Than MCL	0.38	0.25	0.23	J	0.87	0.53	0.95	UJ+	0.38 *	Less Than MCL								
LR-100 FD TOT																													0.45	0.26	0.13	J	1.93	0.74	1.09	J+	2.38	Less Than MCL								
LR-103 DIS	1.10	0.51	0.24		1.62	0.92	1.62	J	2.73	0.52	0.28	0.16	J	1.62	0.78	1.29	J	2.14	1.05	0.52	0.35		1.99	0.87	1.37		3.04	Less Than MCL	1.1	0.48	0.19		4.33	1.34	1.51	J+	5.43	Exceeds MCL								
LR-103 TOT	1.44	0.62	0.32		1.03	1.01	1.98	UJ	1.44 *	0.97	0.40	0.14		0.59	0.65	1.29	U	0.97 *	0.71	0.39	0.29	J	0.72	0.78	1.55	U	0.71 *	Less Than MCL	0.71	0.36	0.16	J	3.78	1.18	1.33	J+	4.49	Less Than MCL								
LR-104 DIS	0.48	0.33	0.33	J	1.62	0.86	1.49	J	2.10	0.39	0.19	0.10		1.00	0.52	0.88	J	1.39	0.58	0.32	0.24	J	0.94	0.61	1.12	U	0.58 *	Less Than MCL	0.52	0.29	0.19	J	3.43	1.06	1.23	J+	3.95	Less Than MCL								
LR-104 FD DIS	0.71	0.37	0.25	J	1.21	0.82	1.52	UJ	0.71 *																																				
LR-104 TOT	0.53	0.34	0.36	J	2.14	1.00	1.65		2.67	0.63	0.28	0.12		1.58	0.58	0.80	J	2.21	0.62	0.34	0.17	J	1.57	0.76	1.25		2.19	Less Than MCL	0.3	0.23	0.23	J	3.62	1.08	1.15	J+	3.92	Less Than MCL								
LR-104 FD TOT	0.52	0.33	0.31	J	1.16	0.77	1.41	U	0.52 *																																				
LR-105 DIS	1.14	0.47	0.20	J+	1.81	0.83	1.34	J+	2.95	1.04	0.42	0.20		0.95	0.64	1.18	U	1.04 *																												
LR-105 TOT	0.91	0.44	0.29	J+	0.76	0.95	1.91	UJ+	0.91 *	0.69	0.33	0.21		0.55	0.53	1.04	U	0.69 *																												
MW-102 DIS	0.86	0.41	0.24		0.68	0.67	1.31	U	0.86 *										0.33	0.23	0.17	J	1.57	0.84	1.45	J	1.90	Less Than MCL	0.15	0.15	0.16	UJ	1.12	0.67	1.21	UJ+	Non-Detect	Less Than MCL								
MW-102 EPA DIS	0.63	0.18	0.14		0.58	0.24	0.33		1.21																																				
MW-102 TOT	0.53	0.29	0.15	J	1.31	0.80	1.45	U	0.53 *										1.09	0.48	0.3		1.8	1.01	1.78	J	2.89	Less Than MCL	2.23	0.77	0.18	J	1.47	0.83	1.47	J+	3.70	Less Than MCL								
MW-103 DIS	0.27	0.21	0.21	J	4.32	1.27	1.28		4.59	0.24	0.15	0.09	J	1.08	0.62	1.09	U	0.24 *	0.21	0.22	0.27	U	1.24	0.83	1.54	U	Non-Detect	Less Than MCL	0.32	0.22	0.21	J	0.95	0.8	1.54	UJ+	0.32 *	Less Than MCL								
MW-103 TOT	5.44	1.57	0.37	J	5.36	1.83	2.38	J	10.79	0.78	0.30	0.12		0.88	0.53	0.96	U	0.78 *	0.7	0.4	0.35	J	1.73	0.83	1.38		2.43	Less Than MCL	0.97	0.42	0.15	J	2.08	0.94	1.51	J+	3.05	Less Than MCL								
MW-104 DIS	0.46	0.29	0.19	J	0.70	0.80	1.61	UJ+	0.46 *	0.25	0.17	0.14	J	1.34	0.61	0.99	J	1.59	0.24	0.22	0.28	U	0.85	0.75	1.46	UJ+	Non-Detect	Less Than MCL	0.5	0.29	0.19	J	1.94	0.85	1.32	J+	2.44	Less Than MCL								
MW-104 TOT	1.59	0.65	0.29	J	3.34	1.44	2.26	J+	4.93	0.37	0.22	0.15	J	1.33	0.59	0.95	J	1.70	0.98	0.49	0.26		1.72	0.88	1.49	J+	2.70	Less Than MCL	3.14	1.03	0.26	J	4.15	1.35	1.61	J+	7.29	Exceeds MCL								
MW-1204 DIS	2.79	0.88	0.27	J	1.84	0.87	1.43		4.63	2.90	0.83	0.15		1.96	0.73	1.05	J+	4.86	7.42	1.94	0.18		3.46	1.17	1.54	J+	10.88	Exceeds MCL	0.04	0.06	0.09	U	-0.07	0.66	1.42	U	Non-Detect	Less Than MCL								
MW-1204 FD DIS										2.31	0.77	0.21		2.47	0.79	0.95	J+	4.78																												
MW-1204 TOT	4.24	1.24	0.21	J	2.44	0.99	1.48		6.68	3.34	1.08	0.25	J	2.93	1.33	2.13	J+	6.27	4.97	1.39	0.2		3.21	1.06	1.3	J+	8.18	Exceeds MCL	26.93	6.28	0.4		11.04	2.74	1.25		37.97	Exceeds MCL								
MW-1204 FD TOT										4.11	1.19	0.21	J	1.80	0.76	1.20	J+	5.91																												
PZ-100-KS DIS	0.21	0.21	0.25	U	-0.04	1.27	2.73	UJ	Non-Detect	0.26	0.17	0.14	J	0.96	0.43	0.69	J+	1.22	0.21	0.21	0.29	U	1.11	0.71	1.29	U	Non-Detect	Less Than MCL	0.33	0.24	0.2	J	1.05	0.65	1.15	UJ	0.33 *	Less Than MCL								
PZ-100-KS TOT	0.55	0.31	0.22	J	0.70	1.04	2.13	U	0.55 *	0.16	0.14	0.12	J	0.84	0.57	1.05	UJ+	0.16 *	0.22	0.19	0.2	J	0.19	0.64	1.34	U	0.22 *	Less Than MCL	0.37	0.24	0.2	J	-0.32	0.62	1.36	UJ	0.37 *	Less Than MCL								
PZ-100-SD DIS	2.69	0.87	0.28		0.37	0.67	1.37	U	2.69 *	2.41	0.69	0.17		0.40	0.45	0.91	U	2.41 *	1.85	0.61	0.12		0.67	0.64	1.25	UJ+	1.85 *	Less Than MCL	1.87	0.64	0.2		0.6	0.55	1.08	UJ+	1.87 *	Less Than MCL								
PZ-100-SD TOT	2.74	0.88	0.31		1.03	0.60	1.05	U	2.74 *	2.40	0.70	0.12	J	1.20	0.58	0.96	J	3.60	1.87	0.64	0.18		1.35	0.73	1.27	J+	3.22	Less Than MCL	1.95	0.66	0.16		-0.29	0.54	1.18	UJ+	1.95 *	Less Than MCL								
PZ-100-SS DIS	3.95	1.15	0.27		1.12	0.72	1.33	U	3.95 *	3.80	1.00	0.12		1.08	0.59	1.04	J	4.88	3.19	0.93	0.2		0.74	0.68	1.33	UJ+	3.19 *	Less Than MCL	2.6	0.82	0.21		3.99	1.15	1.16	J+	6.59	Exceeds MCL								
PZ-100-SS TOT	2.95	0.89	0.21	J	1.28	0.65	1.09	J	4.23	4.60	1.21	0.12	J	1.37	0.66	1.10	J	5.97	4.04	1.17	0.23		1.99	0.96	1.6	J+	6.03	Exceeds MCL	2.58	0.81	0.17		3.94	1.19	1.33	J+	6.52	Exceeds MCL								
PZ-101-SS DIS	28.87	6.55	0.24		3.13	1.10	1.47	J	32.01	23.28	5.24	0.12		2.49	0.81	1.00	J+	25.77	27.91	6.36	0.21		2.74	1.02	1.45		30.65	Exceeds MCL	17.4	4.09	0.18		0.99	0.67	1.23	UJ+	17.40 *	Exceeds MCL								
PZ-101-SS EPA DIS	16.9	1.7	0.1		1.78	0.37	0.35		18.68																																				
PZ-101-SS MDNR DIS																													23.62	2.15	0.37						23.62	Exceeds MCL								
PZ-101-SS TOT	12.52	2.99	0.24	J	3.68	1.11	1.17		16.19	21.89	4.97	0.25	J	2.12	0.71	0.89	J+	24.01	23.66	5.4	0.24		3.48	1.08	1.21		27.14	Exceeds MCL	15.7	3.72	0.25		-0.52	0.63	1.38	UJ+	15.70 *	Exceeds MCL								
PZ-101-SS EPA TOT										18.00		0.059		1.87	0.380	0.364		19.87	15.9	1.55	0.0927		1.39	0.328	0.337		17.29	Exceeds MCL																			
PZ-101-SS MDNR TOT																													24.23	2.21	0.32						24.23	Exceeds MCL								
PZ-102R-SS DIS	3.62	1.08	0.25		1.69	0.88	1.52	J	5.32	1.88	0.58	0.13		1.50	1.01	1.87	UJ+	1.88 *	1.98	0.69	0.28		2.25	0.94	1.43		4.23	Less Than MCL	1.4	0.54	0.15		0.9	0.59	1.09	UJ+	1.4 *	Less Than MCL								
PZ-102R-SS TOT	2.65	0.82	0.15	J	1.87	0.76	1.14		4.52	3.18	1.29	0.57	J	0.40	2.08	4.41	UJ+	3.18 *	3.25	1.01	0.28		1.32	1.05	2.02	U	3.25 *	Less Than MCL	2.54	0.8	0.19		1.81	0.73	1.07	J+	4.35	Less Than MCL								
PZ-102-SS DIS	3.63	1.06	0.20	J	2.12	0.89	1.38		5.75	4.58	1.18	0.13		2.35	0.81	1.04	J+	6.93	3.12	0.93	0.18	J	1.88	0.76	1.15		5.00	Exceeds MCL	2.96	0.91	0.16		0.99	0.62	1.11	UJ+	2.96 *	Less Than MCL								
PZ-102-SS MDNR DIS																													3.18	0.67	0.17						3.18	Less Than MCL								

Table 7-13: Summary of Radium Isotope Results: 2012 - 2013 Groundwater Sampling Events

DRAFT

Sample ID	August 2012									April 2013									July 2013										October 2013									February 2014								
	Radium-226				Radium-228				Combined	Radium-226				Radium-228				Combined	Radium-226				Radium-228				Combined	Combined	Radium-226				Radium-228				Combined	Combined	Radium-226				Radium-228				Combined
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228	Radium relative to 5 pCi/L MCL	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228	Radium relative to 5 pCi/L MCL	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228
PZ-102-SS TOT	5.96	1.76	0.38	J	3.42	1.52	2.43	J	9.38	8.05	1.95	0.18	J	7.98	2.42	2.67	J+	16.03	7.69	2	0.31	J	5.39	2.24	3.39	J	13.08	Exceeds MCL	9.93	2.49	0.26		3.44	1.18	1.51	J+	13.37	Exceeds MCL									
PZ-102-SS EPA TOT										8.30		0.123		2.69	0.734	0.834		10.99											5.72	1.06	0.38						5.72	Exceeds MCL									
PZ-102-SS MDNR TOT																													5.04	0.88	0.20						5.04	Exceeds MCL									
PZ-103-SS DIS	3.09	1.00	0.24		1.96	0.83	1.26	J	5.05	3.89	1.08	0.18	J	1.53	0.63	0.95	J	5.42	3.44	1.12	0.43		1.14	0.85	1.59	U	3.44 *	Less Than MCL	2.41	0.83	0.34	J	2.32	1.03	1.65	J+	4.73	Less Than MCL									
PZ-103-SS TOT	4.72	1.39	0.22		1.34	0.73	1.25	J	6.06	16.68	3.93	0.25	J	5.28	1.41	1.01	J	21.96	3.87	1.18	0.28		7.01	1.88	1.48		10.88	Exceeds MCL	2.29	0.89	0.37	J	1.73	0.96	1.67	J+	4.02	Less Than MCL									
PZ-104-KS DIS	0.28	0.23	0.24	J	0.35	1.12	2.36	UJ	0.28 *	0.07	0.10	0.15	U	0.73	0.47	0.86	UJ+	Non-Detect	0.1	0.13	0.18	U	0.28	0.78	1.62	U	Non-Detect	Less Than MCL	0.22	0.19	0.18	J	0.78	0.59	1.11	UJ+	0.22 *	Less Than MCL									
PZ-104-KS TOT	0.17	0.18	0.20	U	0.29	1.08	2.28	UJ	Non-Detect	0.32	0.19	0.13	J	0.18	0.43	0.90	UJ+	0.32 *	0.26	0.21	0.16	J	0.12	0.69	1.46	U	0.26 *	Less Than MCL	0.19	0.18	0.22	U	2.27	0.76	0.93	J+	2.27 *	Less Than MCL									
PZ-104-SD DIS	9.74	2.73	0.46	J	4.68	1.59	2.02	J	14.42	3.76	1.01	0.14		1.90	0.66	0.85	J+	5.66	7.39	2.16	0.51		2.5	1.05	1.62		9.89	Exceeds MCL	6.29	2.11	0.45	J	8.08	2.04	1.24	J	14.37	Exceeds MCL									
PZ-104-SD MDNR DIS																													5.26	1.01	0.20		1.60	1.01	1.98	J	6.86	Exceeds MCL									
PZ-104-SD TOT	4.50	1.26	0.18		0.52	0.89	1.83	U	4.50 *	5.72	1.50	0.16	J	2.72	1.19	1.88	J+	8.44	4.08	1.22	0.22		-0.15	1.06	2.28	U	4.08 *	Less Than MCL	2.84	0.84	0.16	J	8.05	2.05	1.29	J	10.89	Exceeds MCL									
PZ-104-SD EPA TOT										7.58		0.062		2.84	0.493	0.373		10.42											3.44	0.70	0.28		1.40	0.69	1.31	J	4.84	Less Than MCL									
PZ-104-SD MDNR TOT																													4.15	0.87	0.22		2.47	0.75	1.32		6.62	Exceeds MCL									
PZ-104-SS DIS	1.60	0.58	0.21	J	0.92	0.62	1.15	UJ	1.60 *	0.81	0.32	0.14		1.58	0.72	1.17	J+	2.39	1.76	0.68	0.28		1.15	0.82	1.54	U	1.76 *	Less Than MCL	1.76	0.65	0.26		1.63	0.81	1.37		3.39	Less Than MCL									
PZ-104-SS FD DIS										1.10	0.40	0.13		1.03	0.50	0.82	J+	2.13																													
PZ-104-SS TOT	1.62	0.57	0.14		1.47	0.79	1.35	J	3.09	1.19	0.41	0.14		0.80	0.50	0.90	UJ+	1.19 *	1.99	0.65	0.22		1.23	0.73	1.3	U	1.99 *	Less Than MCL	1.67	0.63	0.34		1.89	0.75	1.13		3.56	Less Than MCL									
PZ-104-SS FD TOT										1.53	0.50	0.12		0.86	0.44	0.75	J+	2.39																													
PZ-105-SS DIS	1.92	0.65	0.28	J+	1.14	0.61	1.06	J+	3.06	1.22	0.42	0.17		1.03	0.48	0.77	J	2.25	1.48	0.54	0.16		1.89	0.81	1.28		3.37	Less Than MCL	1.23	0.52	0.21		4.12	1.17	1.1		5.35	Exceeds MCL									
PZ-105-SS TOT	1.84	0.62	0.18	J+	1.01	0.65	1.17	UJ+	1.84 *	1.79	0.55	0.14		0.87	0.50	0.88	UJ	1.79 *	1.54	0.56	0.24		0.92	0.7	1.32	U	1.54 *	Less Than MCL	1.68	0.62	0.19		2.24	0.79	1.06		3.92	Less Than MCL									
PZ-106-KS DIS	0.27	0.22	0.24	J	0.46	0.81	1.66	U	0.27 *	0.32	0.20	0.15	J	0.43	0.44	0.87	UJ+	0.32 *	0.35	0.25	0.21	J	2.73	0.94	1.23		3.08	Less Than MCL	0.37	0.27	0.29	J	1.02	0.62	1.11	UJ	0.37 *	Less Than MCL									
PZ-106-KS FD DIS																													0.24	0.21	0.22	J	0.75	0.61	1.16	UJ	0.24 *	Less Than MCL									
PZ-106-KS MDNR DIS	0.43	0.25	0.20	J	2.96	0.86	1.56		3.39																																					
PZ-106-KS TOT	0.23	0.24	0.33	U	1.46	0.99	1.83	UJ	Non-Detect	0.38	0.22	0.16	J	0.31	0.44	0.89	UJ+	0.38 *	0.33	0.24	0.18	J	0.22	0.61	1.27	U	0.33 *	Less Than MCL	0.42	0.28	0.27	J	1.36	0.7	1.19	J	1.78	Less Than MCL									
PZ-106-KS FD TOT																													0.44	0.28	0.22	J	2.31	0.77	0.97	J	2.75	Less Than MCL									
PZ-106-KS MDNR TOT	0.43	0.24	0.21	J	1.61	0.60	1.09	J	2.04																																					
PZ-106-KS MDNR FD TOT	0.47	0.27	0.25	J	1.23	0.59	1.12	J	1.70																																					
PZ-106-SD DIS	1.28	0.52	0.23		1.08	0.71	1.30	U	1.28 *	0.61	0.27	0.14		0.89	0.56	1.02	U	0.61 *	0.8	0.45	0.41	J	1.79	0.86	1.44	J+	2.59	Less Than MCL	0.9	0.43	0.31		0.81	0.55	1.02	UJ+	0.90 *	Less Than MCL									
PZ-106-SD TOT	1.06	0.44	0.18		0.94	0.62	1.14	U	1.06 *	1.04	0.38	0.16		0.34	0.55	1.14	U	1.04 *	0.66	0.33	0.23	J	1.62	0.87	1.52	J+	2.28	Less Than MCL	1.01	0.45	0.16		1.1	0.58	0.99	J+	2.11	Less Than MCL									
PZ-106-SS DIS	2.90	0.91	0.28		0.90	0.76	1.47	U	2.90 *	3.12	0.87	0.13		0.51	0.58	1.16	UJ	3.12 *	3.55	1.03	0.17	J	1.08	0.68	1.22	UJ+	3.55 *	Less Than MCL	1.04	0.42	0.2	J	3.56	1.14	1.36	J	4.60	Less Than MCL									
PZ-106-SS TOT	3.93	1.13	0.18		1.27	0.70	1.22	J	5.20	2.80	0.80	0.12		0.71	0.56	1.07	U	2.80 *	3.31	0.98	0.2	J	0.85	0.68	1.3	UJ+	3.31 *	Less Than MCL	3.35	0.98	0.16	J	3.63	1.12	1.23	J	6.98	Exceeds MCL									
PZ-107-SS DIS	5.02	1.39	0.22	J	2.28	0.88	1.27		7.30	5.80	1.46	0.11		1.88	0.65	0.84	J+	7.68	5.33	1.43	0.19	J	2.38	0.83	1.08		7.71	Exceeds MCL	10.01	2.51	0.33	J	2.3	1.01	1.6	J+	12.31	Exceeds MCL									
PZ-107-SS FD DIS																			5.09	1.44	0.32	J	2.68	0.95	1.26		7.77	Exceeds MCL																	
PZ-107-SS TOT	6.33	1.73	0.33		2.62	1.13	1.78	J	8.95	7.72	1.99	0.17	J	3.36	1.27	1.81	J+	11.08	6.39	1.82	0.35	J	3.03	1.08	1.44	J	9.42	Exceeds MCL	7.73	1.99	0.24	J	11.1	2.88	2.03	UJ+	7.73 *	Exceeds MCL									
PZ-107-SS FD TOT																			5.32	1.48	0.18	J	3.84	1.23	1.47		9.16	Exceeds MCL																	
PZ-109-SS DIS	2.35	0.80	0.35	J	2.06	0.90	1.43		4.41	2.29	0.67	0.16		0.60	0.44	0.84	UJ+	2.29 *	2.15	0.74	0.24		1.88	0.84	1.34		4.03	Less Than MCL	3.02	0.98	0.22		-0.21	0.66	1.44	UJ+	3.02 *	Less Than MCL									
PZ-109-SS TOT	2.58	0.83	0.22	J	2.72	0.98	1.28	J	5.30	2.15	0.67	0.16	J	0.84	0.56	1.04	UJ+	2.15 *	1.46	0.54	0.21		1.34	0.68	1.14	J	2.80	Less Than MCL	1.96	0.71	0.21		0.91	0.72	1.37	UJ+	1.96 *	Less Than MCL									
PZ-110-SS DIS	5.01	1.36	0.19	J	2.11	0.90	1.39		7.13	3.76	1.05	0.15		1.70	0.78	1.24	J	5.46	3.43	1.01	0.21		5.2	1.32	0.11	J+	8.63	Exceeds MCL	2.64	0.83	0.3		1.46	0.88	1.6	UJ+	2.64 *	Less Than MCL									
PZ-110-SS TOT	4.38	1.18	0.21	J	2.21	0.88	1.27		6.59	4.00	1.07	0.15		1.15	0.63	1.09	J+	5.15	4.12	1.18	0.23		4.11	1.08	0.12	J+	8.23	Exceeds MCL	3.89	1.14	0.17		1.15	0.85	1.6	UJ+	3.89 *	Less Than MCL									
PZ-111-KS DIS	0.32	0.25	0.22	J	0.09	0.76	1.61	UJ	0.32 *	0.31	0.18	0.13	J	0.73	0.51	0.94	UJ+	0.31 *	0.37	0.24	0.19	J	0.57	0.58	1.15	U	0.37 *	Less Than MCL	0.27	0.21	0.19	J	0.96	0.65	1.21	UJ+	0.27 *	Less Than MCL									
PZ-111-KS TOT	0.63	0.34	0.21	J	0.96	0.84	1.62	UJ	0.63 *	0.35	0.19	0.11	J	1.08	0.48	0.75	J+	1.43	0.21	0.2	0.25	U	0.52	0.64	1.28	U	Non-Detect	Less Than MCL	0.33	0.26	0.23	J	0.85	0.66	1.25	UJ+	0.33 *	Less Than MCL									
PZ-111-SD DIS	1.26	0.47	0.15	J+	1.37	0.86	1.57	UJ+	1.26 *	1.17	0.41	0.12		0.93	0.49	0.82	J+	2.10	1.53	0.57	0.24		4.77	1.22	0.11	J+	6.30	Exceeds MCL	1.52	0.59	0.27	J	1.43	0.69	1.15	J	2.95	Less Than MCL									
PZ-111-SD TOT	1.34	0.52	0.21	J+	0.34	0.70	1.45	UJ+	1.34 *	0.91	0.35	0.20	J	0.26	0.45	0.93	UJ+	0.91 *	1.05	0.43	0.16		3.72	0.98	0.11	J+	4.77	Less Than MCL	1.27	0.48	0.13	J	1.93	0.75	1.09	J	3.20	Less Than MCL									
PZ-112-AS DIS	3.08	1.04	0.36		2.19	0.91	1.39		5.27	0.74	0.35	0.16		1.05	0.50	0.82	J+	1.79	1.19	0.58	0.38		1.96	0.87	1.4	J+	3.15	Less Than MCL	0.99	0.47	0.22		2.97	0.9	0.98	J+	3.96	Less Than MCL									
PZ-112-AS EPA DIS	1.93	0.35	0.19		1.96	0.39	0.39		3.89																																					
PZ-112-AS TOT	2.76	1.01	0.40	J	2.86	1.03	1.42	J	5.62	0.95	0.43	0.17		2.24	0.71	0.84	J+	3.19	2.27	0.88	0.26		3.39	1.03	1.09	J+	5.66	Exceeds MCL	1.94	0.71	0.23		2.5	0.89	1.21	J+	4.44	Less Than MCL									
PZ-112-AS EPA TOT																			1.54	0.263	0.137		1.62	0.345	0.321		3.16	Less Than MCL																	
PZ-113-AD DIS	4.51	1.40	0.31	J	7.70	1.98	1.26		12.20	1.59	0.56	0.20		2.83	0.83	0.84	J+	4.42	2.56	0.88	0.27	J	6.09	1.61	1.18	J+	8.65	Exceeds MCL	2.3	0.86	0.39		6.2	1.57	0.95	J+	8.5	Exceeds MCL									
PZ-113-AD FD DIS	1.21	0.56	0.24	J	1.29	0.86	1.60	UJ	1.21 *										3.45	1.08	0.28		7.98	2.14	1.76		11.43	Exceeds MCL	2.38	0.91	0.26		8.44	2.05	0.88	J+	10.82	Exceeds MCL									
PZ-113-AD MDNR DIS																													2.81	0.80	0.30		7.71	1.25	2.00		10.52	Exceeds MCL									
PZ-113-AD TOT	3.41	1.19	0.44	J	7.71	2.05	1.62	J	11.12	2.27	0.77	0.24	J	7.01	1.74	0.85	J+	9.28	2.85	1.03	0.35	J	5.11	1.38	1.11	J+	7.96	Exceeds MCL	2.82	0.95	0.21		6.06	1.55	1.01	J+	8.88	Exceeds MCL									
PZ-113-AD FD TOT	1.05	0.51	0.30	J	1.01	0.68	1.26	U	1.05 *										2.78	0.93	0.38		7.16	1.87	1.3		9.94	Exceeds MCL	2.74	0.98	0.48		6.35	1.6	0.89	J+	9.09	Exceeds MCL									
PZ-113-AD EPA TOT										2.43		0.056		6.73	0.813	0.320		9.16	2.83	0.390	0.122		6.37	0.812	0.388		9.20	Exceeds MCL																	
PZ-113-AD MDNR TOT																													2.93	0.76	0.31		7.08	1.14	1.83		10.01	Exceeds MCL									
PZ-113-AS DIS	0.73	0.42	0.39	J	1.24	0.74	1.33	U	0.73 *	0.49	0.26	0.21	J	1.34	0.61	0.98	J+	1.83	0.43	0.29	0.22	J	1.39	0.65	1.06		1.82	Less Than MCL	0.75	0.38	0.19	J	1.17	0.54	0.88	J+	1.92	Less Than MCL									
PZ-113-AS EPA DIS	0.48	0.17	0.17		0.86	0.28	0.36		1.34																																					
PZ-113-AS TOT	0.64	0.36	0.27		1.37	0.84	1.53	U	0.64 *	0.61	0.29	0.14	J	2.36	0.77	0.94	J+	2.97	0.65	0.33	0.19	J	0.53	0.56	1.1	U	0.65 *	Less Than MCL	0.83	0.45	0.29	J	1.68	0.71	1.1	J+	2.51	Less Than MCL									
PZ-113-SS DIS	1.94	0.64	0.15	J	1.93	0.93	1.54		3.87	2.48	0.74	0.15		1.60	0.65	0.97	J+	4.08	1.99	0.66	0.21		1.79	0.75	1.16		3.78	Less Than MCL	2.22	0.75	0.25	J	4.46	1.32	1.42	J+	6.68	Exceeds MCL									
PZ-113-SS TOT	1.91	0.67	0.21		-0.32	0.88	1.91	U	1.91 *	4.92	1.27	0.17	J	2.04	0.84	1.28	J+	6.96	2.12	0.68	0.17		1.31	0.75	1.33	U	2.12 *	Less Than MCL	3.67	1.1	0.18	J	3.21	1.07	1.38	J+	6.88	Exceeds MCL									
PZ-114-AS DIS	0.72	0.36	0.19		1.59	0.84	1.45	J	2.30	0.18	0.16	0.19	UJ	0.17	0.49	1.02	UJ	Non-Detect	0.19	0.2	0.28	U	1.09	0.73	1.34	U	Non-Detect	Less Than MCL	0.28	0.22	0.2	J	0.92	0.74	1.42	UJ+	0.28 *	Less Than MCL									
PZ-114-AS TOT	0.41	0.25	0.22	J	0.82	0.78	1.52	UJ	0.41 *	0.43	0.23	0.15	J	0.86	0.67	1.28	UJ	0.43 *	0.54	0.33	0.29	J	1.34	0.83	1.5	U	0.54 *	Less Than MCL	0.37	0.28	0.25	J	0.77	0.76	1.51	UJ+	0.37 *	Less Than MCL									
PZ-115-SS DIS	6.49	1.71	0.33		0.92	0.67	1.26	U	6.49 *	7.35	1.77	0.11		1.31	0.52	0.75		8.66	6.46	1.71	0.24		0.99	0.71	1.34	UJ+	6.46 *	Exceeds MCL	5.6	1.49	0.19		0.56	0.63	1.27	UJ+	5.6 *	Exceeds MCL									
PZ-115-SS TOT	6.20	1.63	0.21		0.59	0.64	1.28	U	6.20 *	7.70	1.87	0.13	J	0.85	0.51	0.92	U	7.70 *	6.27	1.66	0.21	J	1.44	0.66	1.06	J+	7.71	Exceeds MCL	8.89	2.28	0.19		-0.17	0.79	1.71	UJ+	8.89 *	Exceeds MCL									
PZ-116-SS DIS	0.19	0.24	0.39	UJ	-0.14	0.68	1.47	U	Non-Detect	0.21	0.16	0.15	J	1.29	0.48	0.66	J+	1.50	0.19	0.18	0.2	U	5.19	1.41	1.14	J+	5.19 *	Exceeds MCL	0.36	0.25	0.17	J	1.76	0.82	1.34		2.12	Less Than MCL									
PZ-116-SS TOT	0.54	0.32	0.23	J	0.83	0.67	1.28	U	0.54 *	0.83	0.34	0.15	J	0.76	0.45	0.81	UJ+	0.83 *	0.32	0.25	0.25	J	0.17	0.74	1.56	UJ+	0.32 *	Less Than MCL	0.33	0.24	0.2	J	0.48	0.6	1.2	U	0.33 *	Less Than MCL									
PZ-200-SS DIS	3.12	0.97	0.28	J	3.03	1.07	1.44		6.15	1.84	0.59	0.22		1.37	0.68	1.12		3.21	1.8	0.67	0.29	J	1.77	0.72	1.08		3.57	Less Than MCL	2.86	0.94	0.37		2.03	0.74	1.03	J+	4.89	Less Than MCL									
PZ-200-SS FD DIS	4.50	1.28	0.17	J	1.20	0.91	1.73	UJ	4.50 *																																					
PZ-200-SS TOT	4.94	1.42	0.37	J	2.80	1.01	1.37		7.74	2.44	0.77	0.25	J	1.38	0.94	1.73	UJ	2.44 *	0.97	0.44	0.26	J	1.95	0.85	1.3		2.92	Less Than MCL	1.89	0.69	0.25		5.17	1.44	1.26	J+	7.06	Exceeds MCL									
PZ-200-SS FD TOT	4.69	1.32	0.23	J	1.95	0.90	1.46		6.65																																					
PZ-201A-SS DIS	0.45	0.27	0.23	J+	0.80	0.67	1.29	UJ+	0.45 *	0.32	0.18	0.13	J	0.93	0.54	0.96	UJ	0.32 *	0.37	0.26	0.29	J	0.77	0.54	0.99	UJ+	0.37 *	Less Than MCL	0.2	0.18	0.21	U	1.48	0.71	1.18		1.48 *	Less Than MCL									
PZ-201A-SS FD DIS	0.15	0.15	0.18	UJ+	1.57	0.84	1.45	J+	1.57 *																																					
PZ-201A-SS TOT	0.31	0.22	0.20	J+	0.87	0.67	1.27	UJ+	0.31 *	0.32	0.18	0.12	J	1.11	0.65	1.16	UJ	0.32 *	0.5	0.3	0.24	J	1.16	0.69	1.23	UJ+	0.50 *	Less Than MCL	0.3	0.24	0.27	J	1.71	0.71	1.09		2.01	Less Than MCL									
PZ-201A-SS FD TOT	0.29	0.17	0.09	J+	1.40	0.77	1.33	J+	1.69																																					
PZ-202-SS DIS	0.67	0.37	0.28	J	2.02	0.91	1.46		2.69	0.38	0.22	0.17	J	0.86	0.46	0.78	J+	1.24	1.13	0.47	0.24		2.32	0.8	1.02	J+	3.45	Less Than MCL	0.98	0.48	0.25		0.43	0.58	1.17	UJ	0.98 *	Less Than MCL									
PZ-202-SS TOT	1.97	0.70	0.24	J	2.61	1.02	1.47		4.58	0.85	0.35	0.15		0.69	0.47	0.86	UJ+	0.85 *	1.03	0.43	0.19		1.04	0.65	1.19	UJ+	1.03 *	Less Than MCL	1.19	0.52	0.33		1.84	0.78	1.21	J	3.03	Less Than MCL									
PZ-203-SS DIS	1.08	0.45	0.23	J+	0.95	0.67	1.24	UJ+	1.08 *	1.44	0.47	0.13		0.37	0.56	1.14	U	1.44 *	1.36	0.55	0.28	J+	0.79	0.62	1.19	U	1.36 *	Less Than MCL	2	0.69	0.2		3.73	1.07	1.01	J+	5.73	Exceeds MCL									
PZ-203-SS TOT	0.95	0.40	0.25	J+	1.89	0.72	1.01	J+	2.84	1.22	0.44	0.11	J	1.08	0.65	1.17	UJ	1.22 *	2.31	0.77	0.17	J+	1.19	0.62	1.04	J	3.50	Less Than MCL	1.32	0.52	0.2		2.35	0.86	1.23	J+	3.67	Less Than MCL									
PZ-204A-SS DIS	0.72	0.37	0.24	J	1.48	0.84	1.48	J	2.20	0.67	0.30	0.14	J	0.46	0.47	0.94	UJ	0.67 *	1.07	0.45	0.18		1.59	0.81	1.37	J+	2.66	Less Than MCL	1.4	0.57	0.22		1.55	0.84	1.48	J+	2.95	Less Than MCL									

Table 7-13: Summary of Radium Isotope Results: 2012 - 2013 Groundwater Sampling Events

DRAFT

Sample ID	August 2012										April 2013										July 2013										October 2013										February 2014									
	Radium-226				Radium-228				Combined		Radium-226				Radium-228				Combined		Radium-226				Radium-228				Combined	Combined	Radium-226				Radium-228				Combined		Radium-226				Radium-228				Combined	
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228		Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228		Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228	Radium relative to 5 pCi/L MCL	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228		Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Radium 226 + 228	
PZ-204A-SS TOT	2.34	0.78	0.21	J	0.19	0.93	1.97	UJ	2.34	*	1.46	0.50	0.17	J	1.30	0.62	1.03	J	2.76		1.82	0.65	0.23		0.57	0.74	1.5	UJ+	1.82	* Less Than MCL	1.65	0.6	0.19		3.53	1.02	0.98	J+	5.18	Exceeds MCL										
PZ-204-SS DIS	1.41	0.62	0.35		1.02	0.82	1.58	UJ	1.41	*	0.87	0.37	0.22		0.74	0.49	0.91	UJ	0.87	*	0.58	0.31	0.15	J	1.34	0.82	1.48	UJ	0.58	* Less Than MCL	0.4	0.26	0.18	J	0.14	0.53	1.11	UJ+	0.4	* Less Than MCL										
PZ-204-SS TOT	1.10	0.54	0.40		0.63	0.77	1.55	U	1.10	*	1.26	0.44	0.16		1.16	0.50	0.78		2.42		0.88	0.44	0.26		0.2	0.81	1.69	U	0.88	* Less Than MCL	1.35	0.54	0.2		0.45	0.52	1.04	UJ+	1.35	* Less Than MCL										
PZ-205-AS DIS	1.33	0.57	0.24	J	0.88	0.76	1.47	U	1.33	*	0.57	0.28	0.15	J	1.04	0.55	0.94	J	1.61		1.31	0.56	0.33	J+	1.24	0.79	1.45	U	1.31	* Less Than MCL	1.16	0.52	0.28		1.39	0.81	1.45	UJ	1.16	* Less Than MCL										
PZ-205-AS TOT	1.20	0.51	0.28		1.51	0.82	1.43	J	2.70		1.15	0.47	0.21	J	1.81	0.68	0.96	J	2.96		2.94	0.99	0.28	J+	0.92	0.7	1.33	U	2.94	* Less Than MCL	0.99	0.46	0.27		1.5	0.83	1.47	J	2.49	Less Than MCL										
PZ-205-SS DIS	1.54	0.59	0.22	J	1.46	0.82	1.45	J	3.00		1.33	0.44	0.12	J	1.13	0.56	0.94	J	2.46		0.93	0.41	0.29		0.77	0.76	1.49	U	0.93	* Less Than MCL	1.01	0.44	0.25		1.47	0.66	1.05		2.48	Less Than MCL										
PZ-205-SS TOT	1.73	0.64	0.24	J	1.30	0.92	1.72	UJ	1.73	*	1.39	0.48	0.12	J	1.31	0.68	1.15	J	2.70		1.06	0.44	0.21		1.21	0.68	1.18	J	2.27	Less Than MCL	1.38	0.55	0.26		2.38	0.91	1.3		3.76	Less Than MCL										
PZ-206-SS DIS	0.91	0.40	0.20		1.56	0.76	1.26	J	2.47		1.13	0.41	0.15	J	0.72	0.75	1.48	UJ	1.13	*	1.04	0.46	0.27		0.63	0.84	1.71	UJ	1.04	* Less Than MCL	1.46	0.64	0.23	J	1.58	0.66	1	J	3.04	Less Than MCL										
PZ-206-SS EPA DIS	0.60	0.17	0.14		0.29	0.21	0.33	U	0.60	*																																							
PZ-206-SS MDNR DIS																					1.32	0.45	0.22		-0.11	0.69	1.48	U	1.32	* Less Than MCL																					
PZ-206-SS MDNR FD DIS																					1.46	0.46	0.20		-0.16	0.62	1.35	U	1.46	* Less Than MCL																					
PZ-206-SS TOT	1.44	0.52	0.22		1.12	0.72	1.31	U	1.44	*	1.12	0.37	0.12	J	1.10	0.72	1.31	UJ	1.12	*	2.3	0.77	0.19		1.63	0.81	1.35		3.93	Less Than MCL	1.61	0.59	0.3	J	1.33	0.64	1.05	J	2.94	Less Than MCL										
PZ-206-SS MDNR TOT																					1.39	0.44	0.17		0.89	0.60	1.17	J	2.28	Less Than MCL																					
PZ-207-AS DIS	0.73	0.38	0.26	J	0.97	0.71	1.33	U	0.73	*	0.49	0.25	0.11	J	1.16	0.64	1.11	J	1.65		0.82	0.42	0.35	J	1.3	0.85	1.56	U	0.82	* Less Than MCL	0.64	0.36	0.23	J	1.53	0.67	1.06	J+	2.17	Less Than MCL										
PZ-207-AS EPA DIS	0.86	0.28	0.25		1.58	0.49	0.60		2.44																																							
PZ-207-AS MDNR DIS																					0.86	0.41	0.29		1.66	0.63	1.15	J	2.52	Less Than MCL																					
PZ-207-AS TOT	0.66	0.36	0.24	J	2.50	0.89	1.20		3.16		1.12	0.46	0.19		0.68	0.75	1.49	UJ	1.12	*	0.88	0.44	0.34		1.88	0.86	1.37		2.76	Less Than MCL	0.63	0.34	0.22	J	2.05	0.7	0.89	J+	2.68	Less Than MCL										
PZ-207-AS MDNR TOT																					1.11	0.43	0.24		1.26	0.74	1.43	J	2.37	Less Than MCL																					
PZ-208-SS DIS	0.52	0.27	0.14	J+	1.90	0.88	1.41	J+	2.42		1.06	0.39	0.15		1.19	0.56	0.91	J+	2.25		0.45	0.26	0.19	J	1.1	0.74	1.37	UJ+	0.45	* Less Than MCL	0.4	0.25	0.15	J	1.15	0.53	0.84	J+	1.55	Less Than MCL										
PZ-208-SS TOT	0.83	0.37	0.18	J+	0.26	0.76	1.58	UJ+	0.83	*	1.14	0.41	0.14	J	1.31	0.63	1.05	J+	2.45		0.71	0.35	0.2		2.37	0.97	1.46	J+	3.08	Less Than MCL	1.07	0.44	0.21		1.13	0.55	0.91	J+	2.20	Less Than MCL										
PZ-209-SD DIS																															0.09	0.12	0.14	U	1.18	0.79	1.47	UJ+	Non-Detect	Less Than MCL	0.05	0.15	0.30	U	0.95	0.81	1.56	U	Non-Detect	
PZ-209-SD TOT																															0.14	0.14	0.16	U	14.81	3.54	1.32	J+	14.81	* Exceeds MCL	-0.04	0.12	0.32	U	0.64	0.73	1.45	U	Non-Detect	
PZ-209-SS DIS																															1.05	0.44	0.15		0.84	0.63	1.19	UJ+	1.05	* Less Than MCL	0.15	0.15	0.18	U	0.96	0.64	1.19	U	Non-Detect	
PZ-209-SS TOT																															1.08	0.46	0.24		1.37	0.87	1.59	UJ+	1.08	* Less Than MCL	0.05	0.11	0.21	U	0.78	0.96	1.94	U	Non-Detect	
PZ-210-SD DIS																															0.5	0.28	0.2	J	0.85	0.72	1.4	UJ+	0.5	* Less Than MCL	0.04	0.11	0.21	U	0.75	0.64	1.22	U	Non-Detect	
PZ-210-SD FD DIS																															1.42	0.53	0.18		1.7	0.97	1.72	UJ+	1.42	* Less Than MCL										
PZ-210-SD TOT																															0.58	0.3	0.19	J	0.07	0.62	1.31	UJ+	0.58	* Less Than MCL	0.22	0.18	0.16	J	0.30	0.59	1.21	UJ	0.22	*
PZ-210-SD FD TOT																															0.73	0.34	0.14	J	1.69	0.9	1.55	J+	2.42	Less Than MCL										
PZ-210-SS DIS																															0.52	0.31	0.22	J	0.49	0.56	1.11	UJ-	0.52	* Less Than MCL	0.11	0.14	0.19	U	0.95	0.76	1.46	UJ	Non-Detect	
PZ-210-SS TOT																															0.61	0.37	0.26	J	-0.29	0.52	1.13	UJ-	0.61	* Less Than MCL	0.05	0.10	0.20	U	0.28	1.19	2.50	UJ	Non-Detect	
PZ-211-SD DIS																															0.53	0.34	0.24	J	5.65	1.71	1.91	J+	6.18	Exceeds MCL	0.06	0.12	0.23	U	0.55	0.61	1.23	U	Non-Detect	
PZ-211-SD FD DIS																																									0.29	0.21	0.15	J	0.88	0.69	1.31	U	0.29	*
PZ-211-SD TOT																															22.71	5.21	0.31		25.8	6.18	2.23	J+	48.51	Exceeds MCL	0.06	0.11	0.21	U	0.68	0.61	1.19	U	Non-Detect	
PZ-211-SD FD TOT																																									-0.01	0.07	0.15	U	1.14	0.68	1.21	U	Non-Detect	
PZ-211-SS DIS																															0.57	0.33	0.29	J	0.12	0.49	1.03	UJ-	0.57	* Less Than MCL	0.05	0.15	0.32	U	0.60	0.54	1.05	UJ	Non-Detect	
PZ-211-SS TOT																															0.56	0.3	0.2	J	0.58	0.47	0.89	UJ-	0.56	* Less Than MCL	0.06	0.16	0.32	U	1.16	0.81	1.52	U	Non-Detect	
PZ-212-SD DIS																															0.2	0.17	0.19	J	-0.33	0.53	1.17	UJ-	0.2	* Less Than MCL	0.06	0.09	0.13	UJ	0.05	0.60	1.27	UJ	Non-Detect	
PZ-212-SD TOT																															0.48	0.26	0.18	J	0.18	0.47	0.99	UJ-	0.48	* Less Than MCL	-0.04	0.08	0.25	U	0.59	0.74	1.49	UJ	Non-Detect	
PZ-212-SS DIS																															0.05	0.1	0.18	UJ	0.43	0.53	1.06	UJ+	Non-Detect	Less Than MCL	0.04	0.12	0.26	U	-0.37	0.61	1.34	U	Non-Detect	
PZ-212-SS TOT																															0.04	0.12	0.26	U	-0.34	0.55	1.21	UJ+	Non-Detect	Less Than MCL	0.01	0.15	0.37	U	1.04	0.82	1.58	U	Non-Detect	
PZ-302-AI DIS	0.47	0.29	0.25	J	1.42	0.70	1.17	J+	1.90		0.39	0.22	0.16	J	0.86	0.56	1.02	U	0.39	*	0.69	0.37	0.24	J	1.34	0.93	1.74	UJ+	0.69	* Less Than MCL	0.42	0.3	0.33	J	1.26	0.67	1.15	J+	1.68	Less Than MCL										
PZ-302-AI TOT	1.08	0.48	0.25		2.22	0.85	1.20	J+	3.30		0.60	0.27	0.13	J	1.20	0.53	0.84		1.80		0.8	0.38	0.18		0.85	0.78	1.53	UJ+	0.80	* Less Than MCL	0.5	0.32	0.3	J	1.18	0.72	1.3	UJ+	0.5	* Less Than MCL										
PZ-302-AS DIS																					0.34	0.27	0.26	J	1.43	0.87	1.57	UJ	0.34	* Less Than MCL	0.26	0.22	0.24	J	6.71	1.66	0.78	J+	6.97	Exceeds MCL										
PZ-302-AS TOT																					0.85	0.44	0.34	J	1.26	0.7	1.23	J	2.11	Less Than MCL	1.88	0.69	0.21		2.47	0.9	1.27	J+	4.35	Less Than MCL										
PZ-303-AS DIS	0.36	0.23	0.20	J	2.44	1.26	2.15	J+	2.80		0.44	0.23	0.14	J	0.78	0.60	1.14	UJ+	0.44	*	0.54	0.34	0.27	J	1.61	0.91	1.62	U	0.54	* Less Than MCL	0.69	0.36	0.21	J	2.34	1.09	1.78	J+	3.03	Less Than MCL										
PZ-303-AS TOT	0.63	0.35	0.25	J	3.82	1.32	1.75	J+	4.46		1.38	0.49	0.15	J	1.61	0.81	1.37	J+	2.99		1.01	0.5	0.21		1.54	0.8	1.36	J	2.55	Less Than MCL	0.47	0.31	0.24	J	2.69	1.24	2.02	J+	3.16	Less Than MCL										
PZ-304-AI DIS	1.93	0.76	0.35	J	2.76	1.01	1.44		4.69		0.62	0.31	0.24	J	1.23	0.53	0.81	J+	1.85		1.15	0.51	0.3		2.43	0.97	1.44	J+	3.58	Less Than MCL	1.23	0.53	0.21		3.22	1.12	1.48		4.45	Less Than MCL										
PZ-304-AI FD DIS																															1.63	0.67	0.25		2.89	1.1	1.61		4.52	Less Than MCL										
PZ-304-AI TOT	1.52	0.69	0.51		4.84	1.34	1.12		6.35		1.23	0.51	0.24	J	1.96	0.64	0.77	J+	3.19		1.64	0.73	0.26		2.52	0.95	1.33	J+	4.16	Less Than MCL	1.15	0.51	0.19		2.22	0.89	1.31		3.37	Less Than MCL										
PZ-304-AI FD TOT																															1.21	0.54	0.28		3.98	1.26	1.49		5.19	Exceeds MCL										
PZ-304-AS DIS	1.61	0.68	0.32		2.46	0.95	1.36	J	4.07		0.47	0.27	0.19	J	0.96	0.45	0.72	J+	1.43		1.68	0.74	0.45		1.93	0.91	1.49	J+	3.61	Less Than MCL	1.52	0.64	0.21		1.91	0.9	1.48		3.43	Less Than MCL										
PZ-304-AS TOT	2.19	0.84	0.35		3.38	1.13	1.39	J	5.56		1.34	0.52	0.22	J	1.76	0.66	0.94	J+	3.10		2	0.84	0.45		1.79	0.81	1.28	J+	3.79	Less Than MCL	1.73	0.71	0.33		2	0.94	1.54		3.73	Less Than MCL										
PZ-305-AI DIS	0.70	0.43	0.42	J	0.27	0.72	1.50	UJ	0.70	*	0.27	0.17	0.11	J	0.72	0.78	1.54	UJ	0.27	*	1.43	0.58	0.2		1.51	0.74	1.23		2.94	Less Than MCL	0.84	0.4	0.21		4.02	1.2	1.29	J+	4.86	Less Than MCL										
PZ-305-AI FD DIS											0.27	0.17	0.11	J	0.53	0.75	1.53	UJ	0.27	*																												
PZ-305-AI EPA DIS	0.60				0.75				1.35																																							
PZ-305-AI TOT	2.18	0.79	0.27		2.10	0.88	1.35	J	4.28		1.13	0.44	0.16		3.02	0.95	1.10	J	4.15		0.95	0.5	0.35	J	1.19	0.74	1.34	U	0.95	* Less Than MCL	0.48	0.3	0.27	J	3.06	1.03	1.32	J+	3.54	Less Than MCL										
PZ-305-AI FD TOT											0.79	0.33	0.11		1.98	0.84	1.31	J	2.77																												

Notes:

All values are in units of picoCuries per liter (pCi/L). EPA and MDNR data were not validated.

DIS = dissolved (filtered) sample; TOT = total (unfiltered) sample

CSU = Combined Standard Uncertainty (2-sigma); MDA = Minimum Detectable Activity — Indicates that CSUs and MDAs were not available for the EPA split sample results.

Data Validation Qualifiers (Final Q) include: U = Non-detect at the reported value, UJ = Non-Detect at the estimated reported value,

UJ+ = Non-Detect at the estimated reported value which may be biased high;

UJ- = Non-Detect at the estimated reported value which may be biased low;

J = estimated result; J+ = estimated result which may be biased high; R = rejected, data not usable.

Combined Radium-226 plus Radium-228 = the sum of the Ra-226 and Ra-228 results unless one of results was non-detect, in which case is only the detected result shown and the value is flagged with a *. — Indicates that Combined Radium-226 plus Radium-228 exceeds the Maximum Contaminant Level of 5 pCi/L.

Non-Detect = neither Radium-226 nor Radium-228 were detected in the sample

MCL = Maximum Contaminant Level for drinking water systems of 5 pCi/L for combined Radium-226 plus Radium-228

FD - Field duplicate sample

Table 7-14: Summary of Offsite Radium Isotope Results - November 2013 Groundwater Sampling Event

Sample ID	Sample Date	Radium-226				Radium-228				Combined Radium 226 + 228		Combined Radium relative to 5 pCi/L MCL
		Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q			
USGS-E1 DIS	11/7/2013	0.05	0.11	0.22	U	0.35	0.54	1.1	UJ-	Non-Detect		Less Than MCL
USGS-E1 TOT	11/7/2013	0.13	0.15	0.19	U	0.18	0.8	1.69	UJ-	Non-Detect		Less Than MCL
USGS-B4-S DIS	11/7/2013	0.55	0.29	0.16	J	1.25	0.97	1.85	UJ-	0.55	*	Less Than MCL
USGS-B4-S TOT	11/7/2013	0.51	0.29	0.14	J	0.6	0.7	1.39	UJ-	0.51	*	Less Than MCL
USGS-A5 DIS	11/7/2013	2.34	0.78	0.29		0.65	0.59	1.14	UJ-	2.34	*	Less Than MCL
USGS-A5 TOT	11/7/2013	3.08	0.94	0.26		-0.33	0.64	1.4	UJ-	3.08	*	Less Than MCL
USGS-B3 DIS	11/7/2013	0.64	0.38	0.32	J	0.55	0.63	1.25	UJ-	0.64	*	Less Than MCL
USGS-B3 TOT	11/7/2013	0.51	0.3	0.24	J	0.88	0.69	1.31	UJ-	0.51	*	Less Than MCL
USGS-D1 DIS	11/20/2013	0.48	0.26	0.17	J	0.58	0.44	0.84	UJ+	0.48	*	Less Than MCL
USGS-D1 TOT	11/20/2013	0.95	0.44	0.29	J	0.95	0.52	0.89	J+	1.90		Less Than MCL

Notes:

All values are in units of picoCuries per liter (pCi/L)

DIS = dissolved (filtered) sample; TOT = total (unfiltered) sample

CSU = Combined Standard Uncertainty (2-sigma); MDA = Minimum Detectable Activity

Data Validation Qualifiers (Final Q) include: U = Non-detect at the reported value, UJ = Non-Detect at the estimated reported value,

UJ+ = Non-Detect at the estimated reported value which may be biased high;

UJ- = Non-Detect at the estimated reported value which may be biased low;

J = estimated result; J+ = estimated result which may be biased high.

Combined Radium-226 plus Radium-228 = the sum of the Ra-226 and Ra-228 results unless one of results was non-detect, in which case is only the detected result shown and the value is flagged with a *.

Non-Detect = neither Radium-226 nor Radium-228 were detected in the sample

MCL = Maximum Contaminant Level for drinking water systems of 5 pCi/L for combined Radium-226 plus Radium-228

FB - Field blank

FD - Field duplicate sample

Table 7-15: Prior and Existing Upgradient Monitoring Wells at the Site

Well Number	Description
S-51	Previously abandoned shallow alluvial well located near the former leachate lagoon to the southwest of the site
S-52	Previously abandoned shallow alluvial well located near the former leachate lagoon to the southwest of the site
S-53	Existing shallow alluvial well located near the former leachate lagoon to the southwest of the site
D-90	Previously abandoned deep alluvial well located near the former leachate lagoon to the southwest of the site
S-80	Previously abandoned shallow alluvial well located near the former soil borrow area to the southwest of the site
I-50	Previously abandoned intermediate depth alluvial well located near the former soil borrow area to the southwest of the site
D-91	Previously abandoned deep alluvial well located near the former soil borrow area to the southwest of the site
PZ-300-AS	Previously abandoned shallow alluvial well located near the former soil borrow area to the southwest of the site
PZ-300-AD	Previously abandoned shallow alluvial well located near the former soil borrow area to the southwest of the site
PZ-300-SS	Previously abandoned St. Louis/Upper Salem Fm. well located near the former soil borrow area to the southwest of the site
PZ-301-SS	Previously abandoned St. Louis/Upper Salem Fm. well located on the Boenker farm property south of the site
MW-105	Alluvial well (current status unknown but presumed to have been abandoned) previously located at the Earth City Industrial Park west of the site
MW-106	Alluvial well (current status unknown but presumed to have been abandoned) previously located at the Earth City Industrial Park southwest of the site
MW-107	Alluvial well (current status unknown but presumed to have been abandoned) previously located at the Earth City Industrial Park southwest of the site
PZ-212-SS	New St. Louis/Upper Salem Fm. well located in the soil stockpile area, southeast of the disposal units at the site
PZ-212-SS	New Salem Fm. well located in the soil stockpile area, southeast of the disposal units at the site

Table 7-16: Radium Results from Prior and Existing Upgradient Monitoring Wells at the Site

DRAFT

		Radium-226				Radium-228					Total Radium			
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228	Result	CSU	MDA	FINAL Q
S-53 UNSP	May 1986	0.4	0.2			1.7	0.6			2.1				
S-80 TOT	February 1996	3.38	0.39	0.16									3	U
S-80 TOT	November 1995	31.3		31.3	U									
S-80 TOT	December 1995	0.44	0.06	0.04		0.65		0.65	U	0.44 *				
S-80 DIS	February 1996	130	16	21										
S-80 DIS	November 1994	0.27												
S-80 DIS	November 1995	34.9	13.5	24.3										
S-80 DIS	December 1995	0.19	0.04	0.04		0.42		0.42	U	0.19 *				
S-80 FD DIS	February 1996	31.0		31.0	U									
I-50 TOT	December 1995	0.42	0.06			0.40		0.40	U	0.42 *				
I-50 DIS	December 1995	0.29	0.04			0.48		0.48	U	0.29 *				
I-50 UNSP	November 1983										3			
MW-105 TOT	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-105 TOT	April 1991	1.0		1.0	U	1.3		1.3	U	Non-Detect				
MW-105 DIS	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-105 DIS	April 1991	1.0		1.0	U	1.0		1.0	U	Non-Detect				
MW-106 TOT	April 1990	1.4	0.29			3.0		3.0	U	1.4 *				
MW-106 TOT	April 1991	1.4	0.3			1.2	0.6							
MW-106 DIS	April 1990	1.05	0.25			3.0		3.0	U	1.05 *				
MW-106 DIS	April 1991	1.0		1.0	U	1.1		1.1	U	Non-Detect				
MW-107 TOT	December 1995	0.066		0.066	U	0.068		0.068	U	Non-Detect				
MW-107 TOT	February - March 1997	3.38	0.992	0.836										
MW-107 FD TOT	February - March 1997	2.34	0.935	1.1										
MW-107 TOT	May - June 1997	0.441		0.441	U									
MW-107 TOT	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-107 TOT	April 1991	1.0		1.0	U	1.1		1.1	U	Non-Detect				
MW-107 DIS	December 1995	0.069	0.029	0.043		0.039		0.039	U	0.07 *				

Table 7-16: Radium Results from Prior and Existing Upgradient Monitoring Wells at the Site

DRAFT

		Radium-226				Radium-228						Total Radium			
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228		Result	CSU	MDA	FINAL Q
MW-107 DIS	February - March 1997	1.65	0.802	1.03											
MW-107 FD DIS	February - March 1997	2.16	0.821	0.786											
MW-107 DIS	May - June 1997	0.528		0.528	U										
MW-107 DIS	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect					
MW-107 DIS	April 1991	1.0		1.0	U	1.1		1.1	U	Non-Detect					
PZ-212-SS TOT	October 2013	0.04	0.12	0.26	U	-0.34	0.55	1.21	UJ+	Non-Detect					
PZ-212-SS TOT	February 2014	0.01	0.15	0.37	U	1.04	0.82	1.58	U	Non-Detect					
PX-212-SS DIS	October 2013	0.05	0.1	0.18	UJ	0.43	0.53	1.06	UJ+	Non-Detect					
PX-212-SS DIS	February 2014	0.04	0.12	0.26	U	-0.37	0.61	1.34	U	Non-Detect					
PZ-300-AS TOT	December 1995	0.31	0.05	0.05		0.55		0.55	U	0.31	*				
PZ-300-AS DIS	December 1995	0.20	0.03	0.02		0.32		0.32	U	0.20	*				
PZ-300-AD TOT	December 1995	0.51	0.07	0.03		1.00	0.54			1.51					
PZ-300-AD DIS	December 1995	0.35	0.05	0.03		0.41		0.41	U	0.35	*				
PZ-300-SS TOT	December 1995	0.78	0.09	0.02		0.39	0.37			1.17					
PZ-300-SS DIS	December 1995	0.60	0.08	0.04		0.43		0.43	U	0.60	*				
PZ-301-SS TOT	February - March 1997	3.21	0.916	0.793											
PZ-301-SS TOT	May - June 1997	3.33	0.769	0.595											
PZ-301-SS DIS	February - March 1997	2	0.784	0.88											
PZ-301-SS DIS	May - June 1997	1.42	0.563	0.581											

Notes:

No results are available for wells S-51, S-52, D-90, and D-91.

All values are in units of picoCuries per liter (pCi/L)

DIS = dissolved sample (field filtered sample); TOT = total sample (unfiltered sample); FD = Field duplicate sample;

UNSP = historical documentation unspecified whether filtered or unfiltered sample

CSU = Combined Standard Uncertainty (2-sigma); MDA = Minimum Detectable Activity

Data Validation Qualifiers (Final Q) include: U = Non-detect at the reported value; J = estimated result; UJ = Non-Detect at the estimated reported value.

Indicates that CSUs and/or MDAs were not available from the lab reports.

Table 7-17: Site Well Groups for Evaluation of Radium Results

Upgradient Bedrock	Up-/Cross-Gradient Alluvial	Area 1 Alluvial	Area 1 Bedrock	Area 2 Alluvial
MW-1204	S-53	S-5	PZ-113-SS	S-10
PZ-100-KS	I-73	S-84	PZ-115-SS	S-61
PZ-100-SD	D-81	I-4		S-8
PZ-100-SS	LR-100	I-67		S-82
PZ-101-SS	LR-103	I-68		I-11
PZ-102R-SS	LR-104	D-14		I-62
PZ-102-SS	LR-105	D-3		I-65
PZ-103-SS	MW-103	D-85		I-66
PZ-104-KS	MW-104	D-87		I-9
PZ-104-SD	PZ-205-AS	PZ-112-AS		D-12
PZ-104-SS	PZ-302-AI	PZ-113-AD		D-13
PZ-105-SS	PZ-302-AS	PZ-113-AS		D-6
PZ-106-KS	PZ-303-AS	PZ-114-AS		D-83
PZ-106-SD	PZ-304-AI	PZ-207-AS		D-93
PZ-106-SS	PZ-304-AS			MW-102
PZ-107-SS	PZ-305-AI			
PZ-109-SS				
PZ-110-SS				
PZ-111-KS				
PZ-111-SD				
PZ-116-SS				
PZ-200-SS				
PZ-201A-SS				
PZ-202-SS				
PZ-203-SS				
PZ-204A-SS				
PZ-204-SS				
PZ-205-SS				
PZ-206-SS				
PZ-208-SS				
PZ-209-SD				
PZ-209-SS				
PZ-210-SD				
PZ-210-SS				
PZ-211-SD				
PZ-211-SS				
PZ-212-SD				
PZ-212-SS				

Table 7-18: Summary Statistics of Radium Results for Site Well Groups

Well Group	Number Wells	Number Samples	Non-Detects		Detects							
			Samples	%	Samples	%	Min	25th%	Median 50th%	75th%	Mean	Max
Upgradient Bedrock	**32**											
Ra226 Total		134	7	*5%*	127	*95%*	0.22	1.11	1.97	4.19	3.94	26.93
Ra226 Dissolved		130	58	*45%*	72	*55%*	0.15	1.09	2.08	3.82	4.09	28.87
Ra228 Total		133	56	*42%*	77	*58%*	0.86	1.39	1.99	3.36	3.06	25.80
Ra228 Dissolved		130	60	*46%*	70	*54%*	0.86	1.55	1.89	2.45	2.28	8.08
Combined Ra226 + Ra228 > 5 pCi/L MCL												
Total					43		5.15	6.60	8.95	14.09	11.99	48.51
Dissolved					32		5.00	5.71	7.03	11.24	10.17	32.01
Up-/Cross-Gradient Alluvia	**15**											
Ra226 Total		61	1	*2%*	60	*98%*	0.30	0.62	0.95	1.39	1.19	5.44
Ra226 Dissolved		62	4	*6%*	58	*94%*	0.24	0.43	0.62	1.10	0.83	3.05
Ra228 Total		61	18	*30%*	43	*70%*	1.20	1.67	2.10	3.36	2.56	5.50
Ra228 Dissolved		62	25	*40%*	37	*60%*	0.75	1.42	1.93	2.76	2.29	6.71
Combined Ra226 + Ra228 > 5 pCi/L MCL												
Total					7		5.19	5.85	6.35	8.63	7.33	10.79
Dissolved					3		5.43	6.20	6.97	7.91	7.08	8.85
Area 1 Alluvial	**14**											
Ra226 Total		82	1	*1%*	81	*99%*	0.24	0.69	1.40	2.55	1.87	9.67
Ra226 Dissolved		75	6	*8%*	69	*92%*	0.21	0.67	0.96	1.94	1.38	4.51
Ra228 Total		81	16	*20%*	65	*80%*	0.83	2.26	3.69	5.36	3.97	8.20
Ra228 Dissolved		74	55	*74%*	19	*26%*	0.86	1.62	2.87	4.63	3.38	8.44
Combined Ra226 + Ra228 > 5 pCi/L MCL												
Total					41		5.07	6.13	7.20	9.09	7.80	16.08
Dissolved					22		5.23	6.19	7.07	9.68	7.83	12.20
Area 1 Bedrock	**2**											
Ra226 Total		8	0	*0%*	8	*100%*	1.91	3.28	5.56	6.63	5.21	8.89
Ra226 Dissolved		8	0	*0%*	8	*100%*	1.94	2.16	4.04	6.47	4.32	7.35
Ra228 Total		8	5	*63%*	3	*38%*	1.44	1.74	2.04	2.63	2.23	3.21
Ra228 Dissolved		8	3	*38%*	5	*63%*	1.31	1.60	1.79	1.93	2.22	4.46
Combined Ra226 + Ra228 > 5 pCi/L MCL												
Total					6		6.20	6.90	7.33	7.71	7.39	8.89
Dissolved					5		5.60	6.46	6.49	6.68	6.78	8.66
Area 2 Alluvial	**15**											
Ra226 Total		87	4	*5%*	83	*95%*	0.23	0.63	1.29	2.27	1.51	3.39
Ra226 Dissolved		84	11	*13%*	73	*87%*	0.17	0.44	0.93	1.79	1.24	4.04
Ra228 Total		86	20	*23%*	66	*77%*	0.89	1.81	2.82	3.81	2.92	6.89
Ra228 Dissolved		83	26	*31%*	57	*69%*	0.58	1.68	2.91	4.07	2.90	6.08
Combined Ra226 + Ra228 > 5 pCi/L MCL												
Total					30		5.01	5.93	6.41	7.48	6.65	10.00
Dissolved					23		5.06	6.07	6.28	6.97	6.53	8.55

Table 7-19: Summary of Combined Total Radium Results Relative to 5 pCi/L MCL

DRAFT

Wells with Combined Total Ra > 5 pCi/L During All 4 Events	Hydro-geologic Unit	Site Area	Minimum Value (pCi/L)	Maximum Value (pCi/L)
PZ-107-SS	SS	SQ	7.73	11.08
MW-1204	SD	SQ	5.91	37.97
PZ-101-SS	SS	NQ	15.7	27.14
PZ-102-SS	SS	NQ	5.04	16.03
PZ-115-SS	SS	A1	6.20	8.89
D-3	AD	A1	6.65	10.22
PZ-113-AD	AD	A1	7.96	11.12
D-6	AD	A2	5.50	8.15
D-83	AD	A2	6.01	8.80

Wells with Combined Total Ra > 5 pCi/L During 1 or more but not all 4 Events	Hydro-geologic Unit	Site Area	Minimum Value (pCi/L)	Maximum Value (pCi/L)
S-53	AS	Up	ND	6.70
PZ-106-SS	SS	SQ	2.80	6.98
PZ-204A-SS	SS	SQ	1.82	5.18
PZ-104-SD	SD	SQ	4.08	10.89
PZ-209-SD	SD	SQ	ND	14.81
PZ-211-SD	SD	SQ	ND	48.51
I-73	AI	SQ	0.95	9.97
PZ-103-SS	SS	neck	4.02	21.96
PZ-109-SS	SS	neck	1.96	5.3
PZ-100-SS	SS	NQ	4.23	6.52
PZ-110-SS	SS	NQ	3.89	8.23
PZ-200-SS	SS	NQ	2.44	7.74
MW-104	AS	ISL	1.70	7.29
PZ-304-AS	AS	ISL	3.10	5.56
MW-103	AS	ISL	0.78	10.79
PZ-304-AI	AI	ISL	3.19	6.35
D-81	AD	ISL	0.39	6.13
D-87	AD	ISL	4.32	6.11
PZ-113-SS	SS	A1	1.91	6.96
S-53	AS	A1	0.37	8.76
S-84	AS	A1	2.16	7.20
PZ-112-AS	AS	A1	3.16	5.66
I-68	AI	A1	4.34	5.31
I-4	AI	A1	1.80	7.69
D-14	AD	A1	3.16	5.35
D-85	AD	A1	0.22	16.08
S-82	AS	A2	1.29	10.00
I-9	AI	A2	3.01	6.83
D-93	AD	A2	2.37	7.81
D-13	AD	A2	2.65	5.90

Wells That Never Contained Combined Total Radium > 5 pCi/L During Any of the Events	
PZ-100-SD	S-8
PZ-100-KS	S-10
PZ-102R-SS	S-61
PZ-104-SS	PZ-113-AS
PZ-104-KS	PZ-114-AS
PZ-105-SS	PZ-205-AS
PZ-106-SD	PZ-207-AS
PZ-106-KS	PZ-302-AS
PZ-111-SD	PZ-303-AS
PZ-111-KS	LR-100
PZ-116-SS	LR-103
PZ-201A-SS	LR-104
PZ-202-SS	LR-105
PZ-203-SS	MW-102
PZ-204-SS	I-11
PZ-205-SS	I-62
PZ-206-SS	I-65
PZ-208-SS	I-66
PZ-209-SS	I-67
PZ-210-SS	PZ-302-AI
PZ-210-SD	PZ-305-AI
PZ-211-SS	D-12
PZ-212-SS	
PZ-212-SD	

Legend

Areas

SQ	South Quarry Landfill
NQ	North Quarry Landfill
neck	Neck area between NQ and SQ
ISL	Inactive Sanitary Landfill
A1	Area 1
A2	Area 2

Hydrogeologic Units

AS	Alluvium-Shallow
AI	Alluvium-Intermediate
AD	Alluvium-Deep
SS	St. Louis/Upper Salem
SD	Salem Fm.
KS	Keokuk Fm.

Table 7-20: Summary of Combined Dissolved Radium Results Relative to 5 pCi/L MCL

DRAFT

Wells with Combined Dissolved Ra > 5 pCi/L During All 4 Events	Hydro-geologic Unit	Site Area	Minimum Value (pCi/L)	Maximum Value pCi/L
PZ-107-SS	SS	SQ	7.30	12.31
PZ-104-SD	SD	SQ	5.66	14.42
PZ-101-SS	SS	NQ	17.40	32.01
PZ-115-SS	SS	A1	5.60	8.66
D-83	AD	A2	5.57	8.55

Wells with Combined Dissolved Ra > 5 pCi/L During 1 or more but not all 4 Events	Hydro-geologic Unit	Site Area	Minimum Value (pCi/L)	Maximum Value pCi/L
PZ-105-SS	SS	SQ	2.25	5.35
PZ-116-SS	SS	SQ	ND	5.19
PZ-203-SS	SS	SQ	1.08	5.73
MW-1204	SD	SQ	ND	10.88
PZ-211-SD	SD	SQ	ND	6.18
I-73	AI	SQ	0.71	8.85
PZ-103-SS	SS	neck	3.44	5.42
PZ-100-SS	SS	NQ	3.19	6.59
PZ-102R-SS	SS	NQ	1.40	5.32
PZ-102-SS	SS	NQ	2.96	6.93
PZ-110-SS	SS	NQ	2.64	8.63
PZ-200-SS	SS	NQ	3.21	6.15
PZ-111-SD	SD	NQ	1.26	6.30
LR-103	AS	ISL	2.14	5.43
PZ-302-AS	AS	ISL	0.34	6.97
D-87	AD	ISL	1.70	6.44
PZ-113-SS	SS	A1	3.78	6.68
PZ-112-AS	AS	A1	1.79	5.27
S-5	AS	A1	ND	5.23
I-4	AI	A1	ND	6.85
D-3	AD	A1	4.84	9.90
D-85	AD	A1	1.42	6.36
PZ-113-AD	AD	A1	1.21	12.20
S-82	AS	A2	1.18	7.40
I-9	AI	A2	2.16	7.66
D-13	AD	A2	2.14	6.27
D-6	AD	A2	4.45	7.00
D-93	AD	A2	4.82	6.82

Wells That Never Contained Combined Dissolved Radium > 5 pCi/L During Any of the Events	
PZ-100-SD	S-8
PZ-100-KS	S-10
PZ-104-SS	S-53
PZ-104-KS	S-61
PZ-106-SS	S-84
PZ-106-SD	PZ-113-AS
PZ-106-KS	PZ-114-AS
PZ-109-SS	PZ-205-AS
PZ-111-KS	PZ-207-AS
PZ-201A-SS	PZ-303-AS
PZ-202-SS	PZ-304-AS
PZ-204-SS	LR-100
PZ-204A-SS	LR-104
PZ-205-SS	LR-105
PZ-206-SS	MW-102
PZ-208-SS	MW-103
PZ-209-SS	MW-104
PZ-209-SD	I-11
PZ-210-SS	I-62
PZ-210-SD	I-65
PZ-211-SS	I-66
PZ-212-SS	I-67
PZ-212-SD	I-68
	PZ-302-AI
	PZ-304-AI
	PZ-305-AI
	D-12
	D-14
	D-81

Legend

Areas

SQ	South Quarry Landfill
NQ	North Quarry Landfill
neck	Neck area between NQ and SQ
ISL	Inactive Sanitary Landfill
A1	Area 1
A2	Area 2

Hydrogeologic Units

AS	Alluvium-Shallow
AI	Alluvium-Intermediate
AD	Alluvium-Deep
SS	St. Louis/Upper Salem
SD	Salem Fm.
KS	Keokuk Fm.

Table 7-21: Historical Pre-RI/FS and RI/FS Radium Isotope Results: 1983-2004

Pre-RI Sampling Results

		Radium-226				Radium-228					Total Radium				
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228		Result	CSU	MDA	FINAL Q
S-5 DIS	November 1995	32.5		32.5	U										
S-5 DIS	February 1996	41.7		41.7	U										
S-5 DIS	May 1996	0.11	0.08	0.13	U										
S-5 DIS	March 2004	-0.06	0.18	0.37	U	1.35	0.67	0.97		1.35	*				
S-5 DIS	May 2004	0.22	0.17	0.25	U	0.58	0.32	0.47		0.58	*				
S-8 DIS	November 1995	35.7		35.7	U										
S-8 DIS	February 1996	32.2		32.2	U										
S-8 DIS	May 1996	0.21	0.09	0.13											
S-10 DIS	November 1995	35.5		35.5	U										
S-10 DIS	February 1996	29.2		29.2	U										
S-10 DIS	May 1996	0.32	0.22	0.32											
S-10 DIS	March 2004	0.02	0.12	0.22	U	0.38	0.42	0.68	U	Non-Detect					
S-10 DIS	May 2004	0.23	0.14	0.19		0.57	0.33	0.5		0.8					
S-61 DIS	November 1995	25.7		25.7	U										
S-61 DIS	February 1996	28		28	U										
S-61 DIS	May 1996	0.29	0.09	0.12											
S-61 DIS	March 2004	0.25	0.16	0.22		0.30	0.44	0.73	U	0.25	*				
S-61 DIS	May 2004	0.03	0.13	0.24	U	0.45	0.65	1.1	U	Non-Detect					
S-80 DIS	November 1994	0.27													
S-80 DIS	November 1995	34.9	13.5	24.3											
S-80 DIS	December 1995	0.19	0.04	0.04		0.42		0.42	U	0.19	*				
S-80 DIS	February 1996	130	16	21											
S-82 DIS	November 1995	12.8		12.8	U										
S-82 DIS	February 1996	39.2		39.2	U										
S-82 DIS	May 1996	0.88	0.14	0.09											
S-82 DIS	May - June 1997	1.07	0.14	0.062		1.39	0.45	0.64		2.46					
S-82 DIS	March 2004	0.58	0.20	0.19		0.87	0.47	0.70		1.45					

Table 7-21: Historical Pre-RI/FS and RI/FS Radium Isotope Results: 1983-2004

		Radium-226				Radium-228					Total Radium			
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228	Result	CSU	MDA	FINAL Q
S-82 DIS	May 2004	0.5	0.17	0.16		0.75	0.53	0.81	U	0.5 *				
S-84 DIS	November 1995	28.8		28.8	U									
S-84 DIS	February 1996	28.7		28.7	U									
S-84 DIS	May 1996	0.34	0.18	0.21										
S-84 DIS	March 2004	0.51	0.37	0.52	U	1.01	0.9	1.4	U	Non-Detect				
S-84 DIS	May 2004	0.63	0.24	0.25		0.44	0.3	0.47	U	0.63 *				
S-88 DIS	November 1994	0.5												
I-4 DIS	November 1995	41.4		41.4	U									
I-4 DIS	February 1996	37.8		37.8	U									
I-4 DIS	May 1996	0.87	0.28	0.27										
I-4 DIS	May - June 1997	0.81	0.11	0.058		1.11	0.40	0.60		1.92				
I-4 DIS	March 2004	0.03	0.10	0.19	U	0.38	0.31	0.49	U	Non-Detect				
I-4 DIS	May 2004	1.26	0.29	0.19		1.83	0.42	0.43		3.09				
I-7 DIS	November 1995	24.7		24.7	U									
I-7 DIS	February 1996	47.8		47.8	U									
I-7 DIS	May 1996	0.18	0.08	0.11										
I-9 DIS	November 1995	12.7		12.7	U									
I-9 DIS	February 1996	31.1		31.1	U									
I-9 DIS	May 1996	0.54	0.10	0.09										
I-9 DIS	March 2004	1.60	0.31	0.14		1.69	0.48	0.60		3.29				
I-9 DIS	May 2004	0.94	0.29	0.27		3.71	0.84	0.90		4.65				
I-11 DIS	November 1995	25.5		25.5	U									
I-11 DIS	February 1996	28.3		28.3	U									
I-11 DIS	May 1996	0.50	0.11	0.11										
I-11 DIS	March 2004	0.59	0.20	0.20		1.58	0.50	0.69		2.17				
I-11 DIS	May 2004	0.85	0.31	0.31		3.16	0.80	0.95		4.01				
I-50 DIS	December 1995	0.29	0.04			0.48		0.48	U	0.29 *				
I-62 DIS	November 1983										3		3	U
I-62 DIS	November 1995	17.1		17.1	U									
I-62 DIS	February 1996	26.6		26.6	U									
I-62 DIS	May 1996	0.05	0.08	0.14	U									

Table 7-21: Historical Pre-RI/FS and RI/FS Radium Isotope Results: 1983-2004

		Radium-226				Radium-228					Total Radium			
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228	Result	CSU	MDA	FINAL Q
I-65 DIS	November 1983										3		3	U
I-65 DIS	November 1995	23.3		23.3	U									
I-65 DIS	February 1996	41.5		41.5	U									
I-65 DIS	May 1996	0.29	0.28	0.44	U									
I-66 DIS	November 1983										3		3	U
I-66 DIS	November 1995	31.3		31.3	U									
I-66 DIS	February 1996	33.6		33.6	U									
I-66 DIS	May 1996	0.24	0.22	0.34	U									
I-67 DIS	November 1983										3		3	U
I-67 DIS	November 1995	23.9		23.9	U									
I-67 DIS	February 1996	42		42	U									
I-67 DIS	May 1996	0.52	0.22	0.24										
I-68 DIS	November 1983										3		3	U
I-68 DIS	November 1995	28.6		28.6	U									
I-68 DIS	February 1996	36.5		36.5	U									
I-68 DIS	May 1996	0.44	0.22	0.26										
I-68 DIS	March 2004	0.38	0.19	0.22		1.34	0.56	0.82		1.72				
I-68 DIS	May 2004	0.46	0.18	0.2		2.04	0.73	0.97		2.5				
D-3 DIS	November 1995	39.8		39.8	U									
D-3 DIS	February 1996	27.2		27.2	U									
D-3 DIS	May 1996	0.78	0.14	0.13										
D-3 DIS	May - June 1997	0.75	0.11	0.083		2.55	0.51	0.60		3.3				
D-3 DIS	March 2004	2.47	0.44	0.22		5.28	0.85	0.65		7.75				
D-3 DIS	May 2004	2.54	0.46	0.25		5.41	0.82	0.53		7.95				
D-6 DIS	November 1995	28.6		28.6	U									
D-6 DIS	February 1996	36.7		36.7	U									
D-6 DIS	May 1996	1.66	0.21	0.10										
D-6 DIS	May - June 1997	1.80	0.21	0.093		3.60	0.60	0.60		5.40				
D-6 DIS	March 2004	2.61	0.49	0.26		4.42	0.80	0.81		7.03				
D-6 DIS	May 2004	2.56	0.48	0.27		5.62	0.81	0.47		8.18				
D-12 DIS	November 1995	15.4		15.4	U									

Table 7-21: Historical Pre-RI/FS and RI/FS Radium Isotope Results: 1983-2004

		Radium-226				Radium-228					Total Radium			
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228	Result	CSU	MDA	FINAL Q
D-12 DIS	February 1996	44.7		44.7	U									
D-12 DIS	May 1996	0.36	0.11	0.15										
D-12 DIS	May - June 1997	0.49	0.12	0.14		0.47	0.72	1.21	U	0.49 *				
D-12 DIS	March 2004	0.57	0.19	0.18		1.02	0.44	0.66		1.59				
D-12 DIS	May 2004	0.65	0.22	0.21		0.86	0.35	0.49		1.51				
D-13 DIS	November 1995	23.9		23.9	U									
D-13 DIS	February 1996	24.6		24.6	U									
D-13 DIS	May 1996	0.58	0.13	0.15										
D-13 DIS	March 2004	1.00	0.29	0.24		2.27	0.59	0.74		3.27				
D-13 DIS	May 2004	1.26	0.26	0.14		2.96	0.81	0.97		4.22				
D-14 DIS	November 1995	31.3		31.3	U									
D-14 DIS	February 1996	96.7	14.8	19.3										
D-83 DIS	November 1995	14.0		14.0	U									
S-5 TOT	November 1995	31.5		31.5	U									
S-5 TOT	February 1996	0.6	0.22	0.24										
S-5 TOT	May 1996	0.23	0.08	0.10										
S-8 TOT	November 1995	57.8		57.8	U									
S-8 TOT	February 1996	0.91	0.36	0.34										
S-8 TOT	May 1996	0.37	0.12	0.17										
S-10 TOT	November 1995	38.8		38.8	U									
S-10 TOT	February 1996	0.34	0.26	0.37	U									
S-10 TOT	May 1996	0.34	0.11	0.14										
S-10 FD DIS	May 2004	0.45	0.25	0.31		1.23	0.73	1.1		1.68				
S-53 UNSP	May 1986	0.4	0.2			1.7	0.6			2.1				
S-60 UNSP	May 1986	2.5	0.3			1.6	0.5			4.1				
S-61 TOT	November 1995	30.6		30.6	U									
S-61 TOT	February 1996	0.71	0.28	0.28										
S-61 TOT	May 1996	0.29	0.08	0.10										
S-80 TOT	November 1995	31.3		31.3	U									
S-80 TOT	December 1995	0.44	0.06	0.04		0.65		0.65	U	0.44 *				
S-80 TOT	February 1996	3.38	0.39	0.16										

Table 7-21: Historical Pre-RI/FS and RI/FS Radium Isotope Results: 1983-2004

		Radium-226				Radium-228					Total Radium			
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228	Result	CSU	MDA	FINAL Q
S-80 FD DIS	February 1996	31		31	U									
S-82 TOT	November 1995	25.1		25.1	U									
S-82 TOT	February 1996	1.09	0.39	0.4										
S-82 TOT	May 1996	1.39	0.22	0.18										
S-82 TOT	May - June 1997	1.06	0.17	0.11		1.07	0.81	1.33	U	1.06 *				
S-82 FD TOT	May - June 1997	0.76	0.14	0.14		1.31	0.74	1.18		2.07				
S-82 UNSP	May 1986	0.3	0.1			0.4	0.5			0.7				
S-84 TOT	November 1995	30.3		30.3	U									
S-84 TOT	February 1996	0.64	0.26	0.25										
S-84 TOT	May 1996	0.34	0.09	0.09										
S-84 FD TOT	November 1995	33.5		33.5	U									
S-84 FD DIS	November 1995	23.2		23.2	U									
S-84 UNSP	May 1986	1.7	0.2			5.8	0.7			7.5				
S-88 DIS FD	November 1994	0.58		0.58	U									
S-88 UNSP	May 1986	2.3	0.3			0.2	0.4			2.5				
I-4 TOT	November 1995	25.4		25.4	U									
I-4 TOT	February 1996	2.4	0.4	0.2										
I-4 TOT	May 1996	1.50	0.22	0.14										
I-4 TOT	May - June 1997	1.04	0.14	0.058		2.21	0.50	0.63		3.25				
I-4 FD TOT	November 1995	29.6		29.6	U									
I-4 FD DIS	November 1995	28.3		28.3	U									
I-7 TOT	November 1995	42.7		42.7	U									
I-7 TOT	February 1996	0.7	0.3	0.3										
I-7 TOT	May 1996	0.35	0.13	0.18										
I-9 TOT	November 1995	25.1		25.1	U									
I-9 TOT	February 1996	1.1	0.4	0.4										
I-9 TOT	May 1996	0.64	0.12	0.10										
I-11 TOT	November 1995	34.9		34.9	U									
I-11 TOT	February 1996	0.9	0.3	0.3										
I-11 TOT	May 1996	0.59	0.14	0.14										
I-50 TOT	December 1995	0.42	0.06			0.4		0.4	U	0.42 *				

Table 7-21: Historical Pre-RI/FS and RI/FS Radium Isotope Results: 1983-2004

		Radium-226				Radium-228					Total Radium			
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228	Result	CSU	MDA	FINAL Q
I-50 UNSP	November 1983										3			
I-56 UNSP	May 1986	0.2	0.1			0.3		0.3	U	0.2 *				
I-58 UNSP	May 1986	0.3	0.01			2.9	0.6			3.2				
I-59 UNSP	November 1983										3			
I-59 UNSP	May 1986	0.3	0.1			0.5	0.5			0.8				
I-62 TOT	November 1983										3		3	U
I-62 TOT	November 1995	14.2		14.2	U									
I-62 TOT	February 1996	0.4	0.3	0.3										
I-62 TOT	May 1996	0.35	0.10	0.11										
I-62 UNSP	November 1983										3			
I-62 UNSP	May 1986	0.8	0.2			0.6	0.4			1.4				
I-65 TOT	November 1983										3		3	U
I-65 TOT	November 1995	24.6		24.6	U									
I-65 TOT	February 1996	0.8	0.3	0.3										
I-65 TOT	May 1996	-0.02	0.08	0.15	U									
I-65 UNSP	November 1983										3			
I-66 TOT	November 1983										3		3	U
I-66 TOT	November 1995	28.2		28.2	U									
I-66 TOT	February 1996	0.6	0.3	0.4										
I-66 TOT	May 1996	0.01	0.10	0.18	U									
I-66 FD TOT	November 1983										3			
I-66 FD TOT	February 1996	0.5	0.2	0.2										
I-66 UNSP	November 1983										3			
I-67 TOT	November 1983										3		3	U
I-67 TOT	November 1995	28.5		28.5	U									
I-67 TOT	February 1996	0.54	0.20	0.23										
I-67 TOT	May 1996	0.22	0.08	0.11										
I-67 UNSP	November 1983										3			
I-67 UNSP	May 1986	0.7	0.1			0.3		0.3	U	0.7 *				
I-68 TOT	November 1983										3		3	U
I-68 TOT	November 1995	27.7		27.7	U									

Table 7-21: Historical Pre-RI/FS and RI/FS Radium Isotope Results: 1983-2004

		Radium-226				Radium-228					Total Radium				
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228		Result	CSU	MDA	FINAL Q
I-68 TOT	February 1996	0.72	0.20	0.16											
I-68 TOT	May 1996	0.66	0.13	0.12											
I-68 FD TOT	November 1983											3			
I-68 FD TOT	May 1996	0.60	0.12	0.12											
I-68 FD DIS	November 1983											3			
I-68 FD DIS	May 1996	0.47	0.23	0.29											
I-68 UNSP	November 1983											3			
I-73 UNSP	May 1986	0.3	0.1			0.9	0.7			1.2					
D-3 TOT	November 1995	28.1		28.1	U										
D-3 TOT	February 1996	2.70	0.47	0.28											
D-3 TOT	May 1996	1.19	0.17	0.09											
D-3 TOT	May - June 1997	1.50	0.19	0.089		3.43	0.59	0.60		4.93					
D-3 FD TOT	May 1996	1.21	0.18	0.11											
D-3 FD DIS	May 1996	1.17	0.18	0.10											
D-6 TOT	November 1995	28.2		28.2	U										
D-6 TOT	February 1996	1.78	0.45	0.29											
D-6 TOT	May 1996	1.88	0.23	0.09											
D-6 TOT	May - June 1997	2.05	0.23	0.053		3.93	0.65	0.67		5.98					
D-6 FD DIS	March 2004	2.08	0.40	0.18		4.33	0.77	0.76		6.41					
D-12 TOT	November 1995	16.1		16.1	U										
D-12 TOT	February 1996	0.50	0.27	0.32											
D-12 TOT	May 1996	0.73	0.15	0.16											
D-12 TOT	May - June 1997	0.54	0.09	0.077		0.62	0.36	0.58		1.16					
D-12 FD DIS	May - June 1997	0.26	0.09	0.11		0.67	0.69	1.14	U	0.26	*				
D-13 TOT	November 1995	30.2		30.2	U										
D-13 TOT	February 1996	1.33	0.36	0.25											
D-13 TOT	May 1996	0.86	0.14	0.12											
D-14 TOT	November 1995	69.8	14.2	23.4											
D-14 TOT	February 1996	1.50	0.22	0.13											
D-81 UNSP	May 1986	0.8	0.2			0.4		0.4	U	0.8	*				
D-83 TOT	November 1995	25.8		25.8	U										

Table 7-21: Historical Pre-RI/FS and RI/FS Radium Isotope Results: 1983-2004

		Radium-226				Radium-228					Total Radium			
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228	Result	CSU	MDA	FINAL Q
D-83 TOT	February 1996	1.25	0.40	0.36										
D-83 TOT	May 1996	0.81	0.14	0.13										
D-83 DIS	February 1996	30.5		30.5	U									
D-83 DIS	May 1996	0.82	0.14	0.14										
D-83 UNSP	May 1986	3.4	0.3			4.6	0.6			8.0				
D-85 TOT	November 1995	25.9		25.9	U									
D-85 TOT	February 1996	0.58	0.26	0.29										
D-85 TOT	May 1996	0.16	0.10	0.15										
D-85 FD TOT	November 1995	27.0		27.0	U									
D-85 DIS	November 1995	31.4		31.4	U									
D-85 DIS	February 1996	54.4		54.4	U									
D-85 DIS	May 1996	0.54	0.23	0.25										
D-85 DIS	March 2004	0.50	0.26	0.30		1.29	0.69	1.0		1.79				
D-85 DIS	May 2004	0.52	0.21	0.23		0.80	0.36	0.50		1.32				
D-85 FD DIS	November 1995	33.9		33.9	U									
D-92 UNSP	May 1986	1.0	0.2			0.8	0.5			1.8				
D-93 TOT	November 1995	26.5		26.5	U									
D-93 TOT	February 1996	1.43	0.43	0.43										
D-93 TOT	May 1996	2.09	0.26	0.11										
D-93 TOT	May - June 1997	1.34	0.16	0.083		2.61	0.54	0.65		3.95				
D-93 FD TOT	February 1996	1.21	0.38	0.32										
D-93 DIS	November 1995	28.6		28.6	U									
D-93 DIS	February 1996	29.6		29.6	U									
D-93 DIS	May 1996	0.95	0.14	0.09										
D-93 DIS	May - June 1997	1.18	0.15	0.065		2.59	0.51	0.59		3.77				
D-93 DIS	March 2004	1.30	0.28	0.18		2.08	0.56	0.69		3.38				
D-93 DIS	May 2004	1.02	0.27	0.2		2.83	0.77	0.92		3.85				
D-93 FD DIS	February 1996	46.0		46.0	U									
D-93 FD DIS	May 2004	0.95	0.25	0.21		3.9	1.1	1.2		4.85				
D-93 UNSP	May 1986	1.6	0.2			1.4	0.5			3.0				
LR-100 TOT	February - March 1997	2.63	1.12	1.31										

Table 7-21: Historical Pre-RI/FS and RI/FS Radium Isotope Results: 1983-2004

		Radium-226				Radium-228					Total Radium			
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228	Result	CSU	MDA	FINAL Q
LR-103 TOT	February - March 1997	4.81	1.27	0.932										
LR-104 TOT	February - March 1997	3.08	1.08	0.972										
LR-104 FD TOT	February - March 1997	1.8	0.793	0.833										
LR-105 TOT	February - March 1997	3.67	1.24	1.2										
LR-105 DIS	February - March 1997	1.58	0.23											
MW-101 TOT	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-101 TOT	April 1991	1.0		1.0	U	1.1		1.1	U	Non-Detect				
MW-101 TOT FD	April 1991	1.6	0.3			1.1		1.1	U	1.6 *				
MW-101 DIS	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-101 DIS	April 1991	1.0		1.0	U	1.0		1.0	U	Non-Detect				
MW-102 TOT	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-102 TOT	April 1991	1.1	0.3			1.4		1.4	U	1.1 *				
MW-102 TOT FD	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-102 TOT EPA	April 1990	1.5	1.0			1.0		1.0	U	1.5 *				
MW-102 DIS	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-102 DIS	April 1991	1.0		1.0	U	2.1		2.1	U	Non-Detect				
MW-102 DIS	March 2004	0.09	0.15	0.25	U	0.63	0.54	0.86	U	Non-Detect				
MW-102 DIS	May 2004	0	0.16	0.2	U	0.28	0.33	0.54	U	Non-Detect				
MW-102 DIS FD	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-102 DIS EPA	April 1990	0.6		0.6	U	1.0		1.0	U	Non-Detect				
MW-103 TOT	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-103 TOT	April 1991	1.0		1.0	U	1.5		1.5	U	Non-Detect				
MW-103 TOT	February - March 1997	0.899		0.899	U									
MW-103 TOT	February - March 1997	0.15		0.15	U									
MW-103 TOT	May - June 1997	1.17	0.457	0.419	U*									
MW-103 FD TOT	April 1991	1.0		1.0	U	1.0		1.0	U	Non-Detect				
MW-103 FD TOT	February - March 1997	0.25	0.34											
MW-103 FD TOT	May - June 1997	0.515		0.515	U									
MW-103 DIS	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-103 DIS	April 1991	1.0		1.0	U	1.0		1.0	U	Non-Detect				
MW-103 DIS	February - March 1997	1.77	0.765	0.92	U*									

Table 7-21: Historical Pre-RI/FS and RI/FS Radium Isotope Results: 1983-2004

		Radium-226				Radium-228					Total Radium			
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228	Result	CSU	MDA	FINAL Q
MW-103 DIS	February - March 1997	0.2	0.05											
MW-103 DIS	May - June 1997	0.502	0.33	0.415	U*									
MW-103 FD DIS	February - March 1997	0.14		0.14	U									
MW-103 FD DIS	May - June 1997	0.947	0.439	0.496	U*									
MW-104 TOT	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-104 TOT	April 1991	1.5	0.3			1.1		1.1	U	1.5 *				
MW-104 DIS	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-104 DIS	April 1991	1.0		1.0	U	1.0		1.0	U	Non-Detect				
MW-105 TOT	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-105 TOT	April 1991	1.0		1.0	U	1.3		1.3	U	Non-Detect				
MW-105 DIS	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-105 DIS	April 1991	1.0		1.0	U	1.0		1.0	U	Non-Detect				
MW-106 TOT	April 1990	1.4	0.29			3.0		3.0	U	1.4 *				
MW-106 TOT	April 1991	1.4	0.3			1.2	0.6							
MW-106 DIS	April 1990	1.05	0.25			3.0		3.0	U	1.05 *				
MW-106 DIS	April 1991	1.0		1.0	U	1.1		1.1	U	Non-Detect				
MW-107 TOT	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-107 TOT	April 1991	1.0		1.0	U	1.1		1.1	U	Non-Detect				
MW-107 TOT	December 1995	0.066		0.066	U	0.068		0.068	U	Non-Detect				
MW-107 TOT	February - March 1997	3.38	0.992	0.836										
MW-107 TOT	May - June 1997	0.441		0.441	U									
MW-107 FD TOT	February - March 1997	2.34	0.935	1.1										
MW-107 DIS	April 1990	1.0		1.0	U	3.0		3.0	U	Non-Detect				
MW-107 DIS	April 1991	1.0		1.0	U	1.1		1.1	U	Non-Detect				
MW-107 DIS	December 1995	0.069	0.029	0.043		0.039		0.039	U	0.07 *				
MW-107 DIS	February - March 1997	1.65	0.802	1.03										
MW-107 DIS	May - June 1997	0.528		0.528	U									
MW-107 FD DIS	February - March 1997	2.16	0.821	0.786										
MW-1204 TOT	February - March 1997	3.56	0.95	0.7	U*									
MW-1204 TOT	May - June 1997	2.36	0.999	1.21										
MW-1204 FD TOT	May - June 1997	0.938		0.938	U									

Table 7-21: Historical Pre-RI/FS and RI/FS Radium Isotope Results: 1983-2004

		Radium-226				Radium-228					Total Radium			
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228	Result	CSU	MDA	FINAL Q
MW-1204 DIS	February - March 1997	3.03	1.03	1.1	U*									
MW-1204 DIS	May - June 1997	2.19	0.677	0.56										
MW-1204 FD DIS	May - June 1997	2.38	0.729	0.687										
PZ-100-SD TOT	February - March 1997	2.5	0.919	1.05	U*									
PZ-100-SD TOT	May - June 1997	2.98	0.898	0.807										
PZ-100-SD DIS	February - March 1997	2.18	0.904	1.08	U*									
PZ-100-SD DIS	May - June 1997	1.39	0.6	0.721										
PZ-100-SS TOT	February - March 1997	3.85	0.976	0.837	U*									
PZ-100-SS TOT	May - June 1997	1.82	0.721	0.891										
PZ-100-SS DIS	February - March 1997	1.9	0.839	1.03	U*									
PZ-100-SS DIS	May - June 1997	2.4	0.677	0.553										
PZ-102R-SS TOT	February - March 1997	2.12	1.04	1.3	U*									
PZ-102R-SS TOT	May - June 1997	2.06	0.591	0.426	U*									
PZ-102R-SS DIS	February - March 1997	2.03	1.02	1.25	U*									
PZ-102R-SS DIS	May - June 1997	1.05	0.439	0.42	U*									
PZ-104-SD TOT	February - March 1997	3.26	0.866	0.678	U*									
PZ-104-SD TOT	May - June 1997	1.03	0.672	0.985										
PZ-104-SD DIS	February - March 1997	2.39	0.906	0.971	U*									
PZ-104-SD DIS	May - June 1997	1.27	0.577	0.682										
PZ-104-SS TOT	February - March 1997	4.62	1.06	0.816	U*									
PZ-104-SS TOT	May - June 1997	1.53	0.668	0.857										
PZ-104-SS DIS	February - March 1997	2.55	0.844	0.861	U*									
PZ-104-SS DIS	May - June 1997	1.15	0.581	0.722										
PZ-106-SD TOT	February - March 1997	4.39	1.16	1.1	U*									
PZ-106-SD TOT	May - June 1997	1.33	0.559	0.571										
PZ-106-SD DIS	February - March 1997	1.84	0.851	1.07	U*									
PZ-106-SD DIS	May - June 1997	0.706		0.706	U									
PZ-106-SS TOT	February - March 1997	6.33	1.26	0.864										
PZ-106-SS TOT	May - June 1997	2.8	0.785	0.67										
PZ-106-SS-DIS	February - March 1997	2.62	0.904	0.944	U*									
PZ-106-SS-DIS	May - June 1997	2.53	0.733	0.613										

Table 7-21: Historical Pre-RI/FS and RI/FS Radium Isotope Results: 1983-2004

		Radium-226				Radium-228					Total Radium			
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228	Result	CSU	MDA	FINAL Q
PZ-107-SS TOT	February 1996	0.066		0.066	U									
PZ-107-SS DIS	February 1996	0.069	0.029	0.043										
PZ-110-SS TOT	February - March 1997	4.92	1.05	0.642	U*								3	U
PZ-110-SS TOT	May - June 1997	3.59	0.803	0.672	U*									
PZ-110-SS DIS	February - March 1997	4.9	1.25	1.17	U*									
PZ-110-SS DIS	May - June 1997	3.43	0.76	0.516	U*									
PZ-111-SD TOT	February - March 1997	1.57	0.681	0.804	U*									
PZ-111-SD TOT	May - June 1997	1.31	0.58	0.677									3	U
PZ-111-SD DIS	February - March 1997	2.07	0.829	0.959	U*									
PZ-111-SD DIS	May - June 1997	1.34	0.607	0.745										
PZ-113-AD TOT	February - March 1997	2.44	1.11	1.36	U*									
PZ-113-AD TOT	May - June 1997	2.31	0.803	0.673									3	U
PZ-113-AD FD TOT	February - March 1997	3.58	0.975	0.73	U*									
PZ-113-AD DIS	February - March 1997	2.5	0.981	1.16	U*									
PZ-113-AD DIS	May - June 1997	1.39	0.6	0.732										
PZ-113-AD FD DIS	February - March 1997	2.92	1.06	1.18	U*									
PZ-113-AS TOT	February - March 1997	3.56	1.14	0.972	U*									
PZ-113-AS TOT	May - June 1997	0.794	0.426	0.52									3	U
PZ-113-AS DIS	February - March 1997	1.09	0.729	1.05	U*									
PZ-113-AS DIS	May - June 1997	0.773	0.402	0.483	U*									
PZ-113-SS TOT	February - March 1997	5.8	1.33	0.87	U*								3	U
PZ-113-SS TOT	May - June 1997	0.895	0.416	0.485	U*								3	U
PZ-113-SS DIS	February - March 1997	2.24	0.914	1.09	U*									
PZ-113-SS DIS	May - June 1997	0.68		0.68	U									
PZ-114-AS TOT	November 1995	27.2		27.2	U									
PZ-114-AS TOT	February 1996	0.68	0.22	0.24									3	U
PZ-114-AS TOT	May 1996	0.17	0.10	0.17										
PZ-114-AS DIS	November 1995	24.6		24.6	U									
PZ-114-AS DIS	February 1996	35.8		35.8	U									
PZ-114-AS DIS	May 1996	0.51	0.21	0.22										
PZ-201A-SS TOT	February - March 1997	2.69	0.867	0.87	U*									

Table 7-21: Historical Pre-RI/FS and RI/FS Radium Isotope Results: 1983-2004

		Radium-226				Radium-228					Total Radium			
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228	Result	CSU	MDA	FINAL Q
PZ-201A-SS TOT	May - June 1997	2.71	0.827	0.843										
PZ-201A-SS DIS	February - March 1997	0.907		0.907	U									
PZ-201A-SS DIS	May - June 1997	0.893	0.463	0.536										
PZ-204A-SS TOT	February - March 1997	1.92	0.728	0.802	U*									
PZ-204A-SS TOT	May - June 1997	2.61	0.671	0.561	J									
PZ-204A-SS DIS	February - March 1997	1.11	0.647	0.88	U*									
PZ-204A-SS DIS	May - June 1997	0.43		0.43	UJ									
PZ-206-SS TOT	February - March 1997	2.02	0.858	0.98	U*									
PZ-206-SS TOT	May - June 1997	1.61	0.656	0.766									3	U
PZ-206-SS DIS	February - March 1997	1.9	0.904	1.12	U*									
PZ-206-SS DIS	May - June 1997	1.19	0.566	0.669										
PZ-208-SS TOT	February - March 1997	2.25	0.784	0.775	U*									
PZ-208-SS TOT	May - June 1997	1.61	0.56	0.469	U*								3	U
PZ-208-SS DIS	February - March 1997	1.48	0.724	0.905	U*									
PZ-208-SS DIS	May - June 1997	1.15	0.45	0.412	U*									
PZ-303-AD TOT	December 1995	0.51	0.07	0.03		1.00	0.54			1.51				
PZ-303-AD DIS	December 1995	0.35	0.05	0.03		0.41		0.41	U	0.35	*			
PZ-303-AS TOT	December 1995	0.31	0.05	0.05		0.55		0.55	U	0.31	*		3	U
PZ-303-AS TOT	February - March 1997	2.48	0.751	0.703	U*									
PZ-303-AS TOT	May - June 1997	2.13		2.13	U									
PZ-303-AS DIS	December 1995	0.20	0.03	0.02		0.32		0.32	U	0.20	*			
PZ-303-AS DIS	February - March 1997	1.31	0.694	0.91	U*									
PZ-303-AS DIS	May - June 1997	1.15	0.475	0.502	U*									
PZ-303-SS TOT	December 1995	0.78	0.09	0.02		0.39	0.37			1.17				
PZ-303-SS DIS	December 1995	0.60	0.08	0.04		0.43		0.43	U	0.60	*			
PZ-304-AI TOT	February - March 1997	1.58	0.734	0.878	U*									
PZ-304-AI TOT	May - June 1997	0.7		0.7	U									
PZ-304-AI FD TOT	February - March 1997	1.89	0.726	0.762	U*									
PZ-304-AI FD TOT	May - June 1997	1.56	0.646	0.559										
PZ-304-AI DIS	February - March 1997	1.31	0.831	1.15	U*									
PZ-304-AI DIS	May - June 1997	0.87	0.482	0.613										

Table 7-21: Historical Pre-RI/FS and RI/FS Radium Isotope Results: 1983-2004

		Radium-226				Radium-228					Total Radium			
Sample ID	Date	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Combined Radium 226 + 228	Result	CSU	MDA	FINAL Q
PZ-304-AI FD DIS	February - March 1997	1.91	0.793	0.917	U*									
PZ-304-AI FD DIS	May - June 1997	1.38	0.548	0.566										
PZ-304-AS TOT	February - March 1997	2.2	0.742	0.688	U*									
PZ-304-AS TOT	May - June 1997	0.642	0.419	0.561										
PZ-304-AS DIS	February - March 1997	2.34	0.872	0.926	U*									
PZ-304-AS DIS	May - June 1997	0.896	0.621	0.888										

Notes:

All values are in units of picoCuries per liter (pCi/L)

Indicates that Combined Radium-226 plus Radium-228 exceeds the Maximum Contaminant Level of 5 pCi/L.

DIS = dissolved sample (field filtered sample); TOT = total sample (unfiltered sample); FD = Field duplicate sample;

UNSP = historical documentation unspecified whether filtered or unfiltered sample

CSU = Combined Standard Uncertainty (2-sigma); MDA = Minimum Detectable Activity

Data Validation Qualifiers (Final Q) include: U = Non-detect at the reported value; J = estimated result; UJ = Non-Detect at the estimated reported value.

U* indicates that the U qualifier was not provided in the database, but the U qualifier was included on the Southwest Laboratory of Oklahoma lab report.

CSUs not on SW Lab of OK lab report, but were on database provided to EMSI.

Indicates that CSUs and MDAs were not available from the lab reports.

Table 7-22: Oxidation-Reduction Potential Monitoring Results - May 2014

Well ID	Oxidation-Reduction Potential (mV)
PZ-100-SD	-96
PZ-100-SS	74
PZ-104-SD	-175
PZ-104-SS	-169
PZ-105-SS	-20
PZ-106-SD	-68
PZ-106-SS	-83
PZ-109-SS	42
PZ-110-SS	-57
PZ-111-SD	38
PZ-114-AS	-121
PZ-115-SS	-24
PZ-201A-SS	89
PZ-205-SS	28

Notes:
Measurements were made using a WTW pH/Oxi 3400i meter. Serial Number: 09480084
Beginning of Day Calibration:
5/28/2014 08:40 - ORP standard 207 mV @ 25.6°C = 207 mV
End of Day Calibration Check:
5/28/2014 17:40 - ORP standard 193 mV @ 43.8°C = 179 mV

Table 7-23: Summary of Thorium Isotope Results: 2012 - 2013 Groundwater Sampling Events

DRAFT

August 2012

Sample ID	Thorium-228				Thorium-230				Thorium-232				TOTAL	
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Thorium 228 + 230 + 232	
S-5 DIS	0.06	0.11	0.20	U	-0.04	0.07	0.22	UJ+	-0.05	0.07	0.23	U	ND	*
S-5 MDNR DIS	0.13	0.14	0.15	U	0.36	0.23	0.15	J	-0.01	0.07	0.15	U	0.36	*
S-5 TOT	0.13	0.17	0.27	U	0.45	0.32	0.35	J+	0.13	0.17	0.26	U	0.45	*
S-5 EPA TOT														
S-5 MDNR TOT	-0.04	0.10	0.34	U	0.28	0.23	0.23	J	0.02	0.09	0.23	U	0.28	*
S-8 DIS	-0.01	0.07	0.15	U	0.09	0.11	0.14	U	0.06	0.09	0.14	U	ND	*
S-8 TOT	0.48	0.25	0.13		0.20	0.16	0.17	J	0.07	0.10	0.15	U	0.67	*
S-10 DIS	0.05	0.10	0.19	U	0.28	0.21	0.15	J	0.07	0.12	0.22	U	0.28	*
S-10 TOT	0.06	0.16	0.33	U	0.53	0.36	0.22	J	-0.08	0.12	0.38	U	0.53	*
S-53 DIS														
S-53 TOT														
S-61 DIS	-0.03	0.09	0.24	UJ	0.20	0.15	0.15	J	0.00	0.05	0.16	UJ	0.20	*
S-61 EPA DIS	-0.02			U	0.48				-0.022			U	0.48	*
S-61 TOT	0.02	0.22	0.50	UJ	2.11	0.84	0.29	J	0.10	0.18	0.33	UJ	2.11	*
S-82 DIS	0.02	0.06	0.14	U	0.18	0.15	0.14	J-	0.08	0.11	0.14	U	0.18	*
S-82 MDNR DIS														
S-82 TOT	0.86	0.34	0.20	J	0.29	0.18	0.13	J-	0.24	0.16	0.13	J	1.40	
S-82 EPA TOT														
S-82 MDNR TOT														
S-84 DIS	0.01	0.10	0.23	UJ	0.15	0.13	0.11	J	0.07	0.09	0.11	UJ	0.15	*
S-84 FD DIS														
S-84 TOT	0.18	0.27	0.46	UJ	1.33	0.58	0.27	J	0.36	0.28	0.30	J	1.68	*
S-84 FD TOT														
I-4 DIS	0.23	0.21	0.26	U	0.55	0.32	0.20	J+	1.48	0.56	0.23		2.04	*
I-4 FD DIS														
I-4 MDNR DIS	0.00	0.11	0.31	U	0.05	0.14	0.30	U	-0.09	0.12	0.37	U	ND	*
I-4 TOT	0.49	0.26	0.18	J	0.83	0.35	0.15	J+	0.04	0.08	0.15	UJ	1.33	*
I-4 FD TOT														
I-4 EPA TOT														
I-4 MDNR TOT	0.40	0.28	0.25	J	1.20	0.51	0.27		0.13	0.17	0.26	U	1.60	*
I-9 DIS	0.00	0.14	0.33	U	0.06	0.13	0.23	UJ+	-0.04	0.08	0.23	U	ND	*
I-9 FD DIS	0.09	0.12	0.15	U	0.26	0.20	0.20	J+	-0.01	0.07	0.15	U	0.26	*
I-9 MDNR DIS	0.09	0.15	0.27	U	0.09	0.15	0.27	U	-0.08	0.10	0.33	U	ND	*
I-9 TOT	0.07	0.18	0.36	U	0.12	0.16	0.24	UJ+	-0.01	0.08	0.25	U	ND	*
I-9 FD TOT	-0.01	0.04	0.10	UJ	0.11	0.11	0.13	UJ+	0.04	0.07	0.13	UJ	ND	*
I-9 EPA TOT														
I-9 MDNR TOT	0.09	0.12	0.15	U	0.19	0.17	0.15	J	-0.01	0.07	0.15	U	0.19	*
I-11 DIS	-0.01	0.08	0.17	U	0.22	0.19	0.17	J	0.03	0.08	0.17	U	0.22	*
I-11 EPA DIS	-0.11			U	1.05				0.13			U	1.05	*
I-11 TOT	0.19	0.22	0.29	UJ	0.21	0.22	0.28	UJ	0.04	0.10	0.21	UJ	ND	*
I-62 DIS	0.10	0.13	0.21	UJ	0.11	0.11	0.15	UJ	0.04	0.07	0.13	UJ	ND	*
I-62 FD DIS														
I-62 TOT	0.19	0.22	0.30	UJ	0.22	0.21	0.21	J	0.18	0.19	0.21	UJ	0.22	*
I-62 FD TOT														
I-65 DIS	0.03	0.10	0.21	U	0.03	0.07	0.14	U	0.06	0.10	0.14	U	ND	*
I-65 FD DIS														
I-65 TOT	0.60	0.37	0.34	J	0.20	0.19	0.20	UJ	0.20	0.19	0.18	J	0.81	*
I-65 FD TOT														
I-66 DIS	-0.04	0.07	0.22	UJ	0.15	0.16	0.24	UJ-	-0.01	0.06	0.16	UJ	ND	*
I-66 TOT	0.09	0.12	0.18	UJ	0.34	0.20	0.13	J-	0.01	0.05	0.13	UJ	0.34	*
I-67 DIS	0.08	0.19	0.37	U	0.20	0.20	0.25	UJ-	0.15	0.18	0.26	U	ND	*
I-67 FD DIS														
I-67 TOT	0.11	0.12	0.18	UJ	1.53	0.48	0.14	J-	-0.01	0.05	0.11	UJ	1.53	*
I-67 FD TOT														
I-68 DIS	0.04	0.11	0.22	U	0.36	0.24	0.15	J	-0.06	0.08	0.26	U	0.36	*
I-68 TOT	2.08	0.65	0.14		1.82	0.61	0.19		0.70	0.32	0.13		4.60	
I-73 DIS	0.03	0.07	0.14	U	0.33	0.23	0.20	J	0.03	0.07	0.14	U	0.33	*
I-73 TOT	0.08	0.11	0.15	U	0.43	0.25	0.13	J	0.15	0.14	0.15	U	0.43	*
D-3 DIS	0.13	0.15	0.20	U	0.07	0.11	0.20	U	-0.03	0.08	0.25	U	ND	*
D-3 FD DIS	0.09	0.12	0.19	U	0.20	0.17	0.16	J	0.03	0.09	0.18	U	0.20	*
D-3 EPA DIS	0.12			U	0.29			U	0.04			U	ND	*
D-3 MDNR DIS														
D-3 TOT	0.08	0.13	0.21	U	0.25	0.21	0.22	J	0.00	0.10	0.21	U	0.25	*
D-3 FD TOT	0.11	0.11	0.12	UJ	0.22	0.17	0.16	J	0.05	0.09	0.16	UJ	0.22	*
D-3 EPA TOT														
D-3 MDNR TOT														
D-6 DIS	0.22	0.25	0.32	UJ	0.24	0.27	0.36	UJ	0.10	0.17	0.29	UJ	ND	*
D-6 FD DIS	0.09	0.14	0.24	U	0.20	0.20	0.27	U	0.02	0.07	0.17	U	ND	*
D-6 EPA DIS	0.11			U	0.38			U	-0.021			U	ND	*
D-6 EPA FD DIS	0.43			U	0.8				0.04			U	0.8	*
D-6 MDNR DIS														
D-6 TOT	0.22	0.22	0.27	UJ	0.11	0.15	0.23	UJ	0.13	0.18	0.26	UJ	ND	*
D-6 FD TOT	0.29	0.26	0.31	UJ	0.37	0.27	0.22	J	0.11	0.15	0.22	UJ	0.37	*
D-6 EPA TOT														
D-6 MDNR TOT														
D-12 DIS	-0.01	0.09	0.18	UJ	0.34	0.25	0.18	J	-0.01	0.09	0.18	UJ	0.34	*
D-12 FD DIS														
D-12 EPA DIS	-0.087			U	0.76				0.05			U	0.76	*
D-12 TOT	0.09	0.12	0.16	U	0.27	0.21	0.21	J	0.02	0.10	0.23	U	0.27	*
D-12 FD TOT														
D-13 DIS	0.07	0.11	0.18	UJ	0.27	0.20	0.19	J	0.03	0.08	0.18	UJ	0.27	*
D-13 FD DIS	0.03	0.08	0.17	UJ	0.33	0.21	0.17	J-	0.00	0.08	0.21	UJ	0.33	*
D-13 TOT	0.34	0.23	0.16		0.44	0.26	0.15	J	0.09	0.12	0.15	U	0.78	*
D-13 FD TOT	0.52	0.35	0.29	J	0.30	0.27	0.31	UJ-	0.05	0.14	0.30	UJ	0.52	*
D-14 DIS														
D-14 TOT	1.95	0.70	0.28		2.19	0.77	0.21		1.91	0.68	0.21		6.06	
D-81 DIS	0.02	0.12	0.27	U	0.16	0.14	0.15	J	0.00	0.08	0.17	U	0.16	*
D-81 FD DIS														
D-81 TOT	0.05	0.10	0.19	UJ	0.33	0.19	0.15	J	0.08	0.09	0.12	UJ	0.33	*
D-81 FD TOT														
D-83 DIS	0.15	0.22	0.36	UJ	0.03	0.11	0.28	UJ	0.03	0.11	0.28	UJ	ND	*
D-83 FD DIS														
D-83 MDNR DIS														
D-83 TOT	0.22	0.20	0.25	U	0.26	0.19	0.15	J	0.02	0.07	0.17	U	0.26	*
D-83 FD TOT														
D-83 EPA TOT														
D-83 MDNR TOT														
D-83 MDNR FD TOT														
D-85 DIS	-0.02	0.13	0.31	UJ	0.12	0.18	0.26	UJ	0.04	0.13	0.30	UJ	ND	*

April 2013

Sample ID	Thorium-228				Thorium-230				Thorium-232				TOTAL	
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Thorium 228 + 230 + 232	
S-5 DIS	0.07	0.06	0.06	J+	0.10	0.07	0.06	J	0.01	0.03	0.05	UJ	0.17	*
S-5 MDNR DIS														
S-5 TOT	0.05	0.06	0.06	UJ+	0.18	0.11	0.08	J	-0.01	0.03	0.07	U	0.18	*
S-5 EPA TOT	0.163		1.43	UG	1.36		0.866		-0.061		0.786	U	1.36	*
S-5 MDNR TOT														
S-8 DIS	0.00	0.07	0.15	UJ	0.99	0.39	0.10	J+	0.02	0.05	0.12	UJ	0.99	*
S-8 TOT	0.09	0.09	0.11	U	0.24	0.13	0.08	J+	0.00	0.03	0.08	U	0.24	*
S-10 DIS	0.05	0.11	0.21	U	0.10	0.12	0.16	UJ	0.01	0.05	0.12	UJ	ND	*
S-10 TOT	0.03	0.09	0.18	U	0.26	0.15	0.11	J	0.12	0.10	0.10	J	0.38	*
S-53 DIS	0.03	0.05	0.09	U	0.22	0.12	0.07	J+	0.11	0.08	0.07	J	0.33	*
S-53 TOT	20.0	4.35	0.12	J	19.6	4.55	0.13	J+	19.1	4.11	0.18	J	58.6	
S-61 DIS	0.01	0.03	0.05	U	0.09	0.07	0.06	J+	0.03	0.04	0.08	U	0.09	*
S-61 EPA DIS														
S-61 TOT	0.08	0.07	0.07	J	0.31	0.14	0.06	J+	0.02	0.04	0.06	U	0.39	*
S-82 DIS	0.00	0.03	0.08	UJ	0.08	0.07	0.06	J	0.00	0.02	0.06	UJ	0.08	*
S-82 MDNR DIS														
S-82 TOT	0.12	0.10	0.12	J	0.24	0.13	0.07	J	0.11	0.09	0.10	J	0.47	
S-82 EPA TOT	0.246		0.242		0.242		0.132		0.075		0.166	U	0.49	*
S-82 MDNR TOT														
S-84 DIS	-0.01	0.03	0.08	UJ+	0.17	0.10	0.08	J	0.00	0.04	0.08	U	0.17	*
S-84 FD DIS														
S-84 TOT	0.12	0.10	0.13	UJ+	0.10	0.08	0.08	J	0.06	0.06	0.08	U	0.10	*
S-84 FD TOT														
I-4 DIS	0.01	0.08	0.18	UJ+	0.21	0.14	0.12	J+	0.06	0.08	0.12	UJ	0.21	*
I-4 FD DIS														
I-4 MDNR DIS														
I-4 TOT	0.08	0.08	0.11	UJ+	0.29	0.14	0.10	J+	-0.01	0.03	0.09	U	0.29	*
I-4 FD TOT														
I-4 EPA TOT														
I-4 MDNR TOT														
I-9 DIS	-0.01	0.11	0.28	UJ	0.15	0.15	0.18	UJ	0.10	0.12	0.16	UJ	ND	*
I-9 FD DIS	0.06	0.08	0.13	UJ+	0.09	0.08	0.10	UJ+	0.01	0.03	0.09	U	ND	*
I-9 MDNR DIS														
I-9 TOT	0.15	0.11	0.13	J	0.11	0.09	0.10	J	-0.02	0.03	0.10	U	0.26	*
I-9 FD TOT	0.05	0.06	0.08	UJ+	0.13	0.08	0.07	J+	0.03	0.04	0.07	UJ	0.13	*
I-9 EPA TOT	0.119		0.178	U	0.127		0.14	U	0.0111		0.132	U	ND	*
I-9 MDNR TOT														
I-11 DIS	0.04	0.07	0.13	U	0.49	0.20	0.07	J+	0.03	0.05	0.10	U	0.49	*
I-11 EPA DIS														
I-11 TOT	0.01	0.07	0.14	U	0.19	0.12	0.11	J+	0.02	0.04	0.07	U	0.19	*
I-62 DIS	0.01	0.05	0.13	UJ	0.21	0.15	0.13	J	0.02	0.05	0.10	UJ	0.21	*
I-62 FD DIS	0.01	0.03	0.07	U	0.10	0.08	0.09	J	-0.04	0.03	0.12	U	0.10	*
I-62 TOT	0.25	0.12	0.05	J	0.21	0.11	0.06	J	0.05	0.05	0.07	UJ	0.46	*
I-62 FD TOT	0.08	0.09	0.13	U	0.19	0.13	0.10	J	0.05	0.06	0.10	U	0.19	*
I-65 DIS	-0.03	0.03	0.12	UJ+	0.13	0.09	0.07	J+	0.01	0.03	0.07	UJ	0.13	*
I-65 FD DIS	0.01	0.03	0.06	UJ+	0.07	0.06	0.05	J+	0.02	0.04	0.07	UJ	0.07	*
I-65 TOT	0.25	0.14	0.11	J+	0.09	0.08	0.10	UJ+	0.04	0.05	0.06	U	0.25	*
I-65 FD TOT	0.30	0.15	0.12	J+	0.17	0.11	0.09	J+	0.03	0.04	0.07	U	0.47	*
I-66 DIS	0.04	0.04	0.05	UJ	0.16	0.10	0.08	J+	0.04	0.05	0.08	UJ	0.16	*
I-66 TOT	0.04	0.06	0.11	U	0.12	0.10	0.07	J+	-0.01	0.04	0.09	U	0.12	*
I-67 DIS	0.02	0.04	0.07	U	0.13	0.09	0.07	J+	0.00	0.03	0.06	U	0.13	*
I-67 FD DIS	0.03	0.05	0.09	U	0.08	0.07	0.07	J	-0.01	0.03	0.07	U	0.08	*
I-67 TOT	0.05	0.07	0.09	U	0.61	0.23	0.08	J+	0.00	0.04	0.10	U	0.61	*
I-67 FD TOT	0.16	0.10	0.10	J	1.47	0.40	0.09	J	0.06	0.06	0.09	UJ	1.63	*
I-68 DIS	0.00	0.04	0.09	U	0.11	0.09	0.09	J	0.03	0.04	0.06	U	0.11	*
I-68 TOT	2.66	0.70	0.08		4.14	1.06	0.08		0.80	0.29	0.08		7.60	
I-73 DIS	0.02	0.04	0.08	U	0.13	0.09	0.06	J+	0.01	0.04	0.08	U	0.13	*
I-73 TOT	0.41	0.21	0.10	J	0.55	0.26	0.11	J+	0.45	0.22	0.09	J	1.41	
D-3 DIS	0.01	0.06	0.12	UJ+	0.17	0.10	0.08	J	0.05	0.06	0.08	UJ	0.17	*
D-3 FD DIS														
D-3 EPA DIS														
D-3 MDNR DIS														
D-3 TOT	0.07	0.08	0.11	UJ+	0.17	0.10	0.07	J	0.01	0.02	0.06	UJ	0.17	*
D-3 FD TOT														
D-3 EPA TOT	0.525		1.02	UG	0.734		0.912	U	-0.06		0.846	U	ND	*
D-3 MDNR TOT														
D-6 DIS	0.02	0.05	0.10	UJ+	0.07	0.06	0.08	U	0.02	0.04	0.08	UJ	ND	*
D-6 FD DIS														
D-6 EPA DIS														
D-6 EPA FD DIS														
D-6 MDNR DIS														
D-6 TOT	0.14	0.10	0.13	J+	0.13	0.08	0.07	J+	0.04	0.05	0.07	UJ	0.27	*
D-6 FD TOT														
D-6 EPA TOT	0.0409		0.253	U	0.102		0.161	U	0.0296		0.08	U	ND	*
D-6 MDNR TOT														
D-12 DIS	0.00	0.03	0.06	U	0.26	0.13	0.09	J+	0.00	0.03	0.07	U	0.26	*
D-12 FD DIS	0.01	0.03	0.06	U	0.15	0.10	0.09	J	0.00	0.04	0.09	U	0.15	*
D-12 EPA DIS														
D-12 TOT	0.11	0.13	0.16	UJ	0.34	0.25	0.23	J+	-0.02	0.08	0.20	UJ	0.34	*
D-12 FD TOT	0.10	0.12	0.16	U	0.17	0.14	0.11	J	0.07	0.09	0.12	UJ	0.17	*
D-13 DIS	-0.01	0.04	0.09	U	0.44	0.20	0.08	J+	0.00	0.04	0.08	U	0.44	*
D-13 FD DIS														
D-13 TOT	0.39	0.16	0.06		0.37	0.16	0.08	J+	0.07	0.07	0.08	U	0.76	*
D-13 FD TOT														
D-14 DIS	0.05	0.07	0.12	U	0.16	0.10	0.08	J+	0.00	0.03	0.06	U	0.16	*
D-14 TOT	0.99	0.29	0.12		1.15	0.33	0.05	J+	1.17	0.32	0.07		3.31	
D-81 DIS	0.29	0.23	0.22	J	0.10	0.13	0.15	UJ	-0.01	0.07	0.17	UJ	0.29	*
D-81 FD DIS														
D-81 TOT	0.04	0.09	0.16	UJ	0.13	0.11	0.11	J	0.03	0.06	0.12	UJ	0.13	*
D-81 FD TOT														
D-83 DIS	0.03	0.07	0.13	UJ+	0.21	0.13	0.08	J+	-0.02	0.04	0.11	U	0.21	*
D-83 FD DIS														
D-83 MDNR DIS														
D-83 TOT	0.20	0.13	0.14	J+	0.47	0.20	0.10	J+	-0.01	0.03	0.10	UJ	0.67	*
D-83 FD TOT														
D-83 EPA TOT	0.153		0.193	U	0.0794		0.126	U	0.0188		0.099	U	ND	*
D-83 MDNR TOT														
D-83 MDNR FD TOT														
D-85 DIS	-0.01	0.05	0.14	UJ+	0.12	0.09	0.08	J	-0.01	0.03	0.08	U	0.12	*

July 2013

Sample ID	Thorium-228				Thorium-230				Thorium-232				TOTAL	
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Thorium 228 + 230 + 232	
S-5 DIS	0.07	0.09	0.15	U	0.01	0.05	0.11	UJ+	-0.01	0.04	0.11	UJ	ND	*
S-5 MDNR DIS														
S-5 TOT	0.15	0.13	0.17	UJ	0.1	0.11	0.15	UJ+	0.18	0.13	0.12	J	0.18	*
S-5 EPA TOT	0.458	1.42	2.76	UG	0.0764	0.589	1.58	UG	0.0169	0.587	1.67	UG	ND	*
S-5 MDNR TOT														
S-8 DIS	0.03	0.07	0.14	U	0.28	0.15	0.09	J+	0.09	0.09	0.1	U	0.28	*
S-8 TOT	-0.02	0.04	0.11	U	0.4	0.19	0.11	J+	0.08	0.08	0.11	U	0.4	*
S-10 DIS	0.08	0.08	0.11	U	0.58	0.24	0.09	J+	0.05	0.07	0.11	U	0.58	*
S-10 TOT	0.05	0.06	0.08	U	0.41	0.17	0.08	J+	0.18	0.1	0.07	J	0.59	*
S-53 DIS	0	0.05	0.17	UJ	0.51	0.25	0.12	J+	0.12	0.11	0.1	J	0.63	*
S-53 TOT	2.02	0.58	0.08	J	2.52	0.71	0.12	J+	1.9	0.55	0.08	J	6.44	
S-61 DIS	0.01	0.11	0.24	UJ	0.65	0.29	0.14	J+	0.12	0.12	0.13	UJ	0.65	*
S-61 EPA DIS														
S-61 TOT	0.73	0.26	0.14		5.72	1.35	0.09	J+	0.74	0.25	0.08		7.19	
S-82 DIS	0.15	0.11	0.13	J	0.51	0.2	0.06	J+	0.05	0.06	0.09	UJ	0.66	*
S-82 MDNR DIS														
S-82 TOT	0.02	0.06	0.12	UJ	0.11	0.08	0.06	J+	0.02	0.04	0.07	UJ	0.11	*
S-82 EPA TOT	-0.0057	0.143	0.185	U	0.294	0.335	0.0976		-0.013	0.0297	0.123	U	0.29	*
S-82 MDNR TOT														
S-84 DIS	0.1	0.07	0.07	J	0.16	0.09	0.06	J	0.04	0.04	0.05	U	0.26	*
S-84 FD DIS														
S-84 TOT	0.56	0.26	0.11	J	0.7	0.3	0.1	J	0.62	0.28	0.11	J	1.88	
S-84 FD TOT														
I-4 DIS	0.06	0.06	0.09	UJ	0.11	0.08	0.08	J+	0.04	0.05	0.06	UJ	0.11	*
I-4 FD DIS	0.05	0.07	0.1	UJ	0.2	0.13	0.09	J	0.02	0.04	0.08	UJ	0.2	*
I-4 MDNR DIS														
I-4 TOT	0.01	0.07	0.14	U	0.06	0.07	0.11	UJ+	0.01	0.03	0.07	U	ND	*
I-4 FD TOT	0.03	0.05	0.08	U	0.19	0.1	0.07	J	0	0.03	0.05	U	0.19	*
I-4 EPA TOT	0.177	0.358	0.666	U	0.471	0.498	0.526	U	0.0998	0.250	0.523	U	ND	*
I-4 MDNR TOT														
I-9 DIS	0.06	0.08	0.13	U	0.29	0.18	0.15	J+	-0.01	0.05	0.17	U	0.29	*
I-9 FD DIS														
I-9 MDNR DIS														
I-9 TOT	0.08	0.1	0.16	U	0.19	0.12	0.1	J+	0.07	0.07	0.08	U	0.19	*
I-9 FD TOT														
I-9 EPA TOT	0.0686	0.191	0.152	U	0.0130	0.0858	0.102	U	-0.004	0.0155	0.0878	U	ND	*
I-9 MDNR TOT														
I-11 DIS	0.2	0.19	0.26	UJ	0.69	0.32	0.18	J+	0.01	0.05	0.14	UJ	0.69	*
I-11 EPA DIS														
I-11 TOT	0.2	0.15	0.17	J+	0.76	0.3	0.13	J+	0.04	0.07	0.11	UJ	0.96	*
I-62 DIS	0	0.06	0.15	U	0.53	0.22	0.11	J+	0.06	0.07	0.07	U	0.53	*
I-62 FD DIS	0.03	0.05	0.07	UJ	0.29	0.14	0.06	J+	0.1	0.07	0.05	J	0.39	*
I-62 TOT	0.12	0.11	0.16	U	0.4	0.19	0.13	J+	0.12	0.09	0.08	J	0.52	*
I-62 FD TOT	0.06	0.07	0.08	U	0.33	0.16	0.07	J+	0.07	0.07	0.08	U	0.33	*
I-65 DIS	0.02	0.04	0.08	UJ	0.49	0.22	0.13	J+	0.01	0.07	0.16	UJ	0.49	*
I-65 FD DIS	0.03	0.06	0.11	UJ	0.21	0.13	0.09	J	0.07	0.08	0.08	UJ	0.21	*
I-65 TOT	0.39	0.2	0.12	J	0.44	0.21	0.11	J+	0.15	0.11	0.09	J	0.98	
I-65 FD TOT	0.48	0.25	0.15	J	0.41	0.22	0.1	J	0.14	0.12	0.1	J	1.03	
I-66 DIS	0.06	0.09	0.16	UJ	0.26	0.16	0.09	J+	0.06	0.08	0.09	UJ	0.26	*
I-66 TOT	0.24	0.18	0.16	J+	0.75	0.35	0.16	J+	0.03	0.08	0.17	UJ	0.99	*
I-67 DIS	0.05	0.07	0.11	U	0.46	0.2	0.08	J+	0.1	0.09	0.1	J	0.56	*
I-67 FD DIS														
I-67 TOT	0.03	0.06	0.13	UJ	0.87	0.39	0.18	J+	0.05	0.08	0.12	UJ	0.87	*
I-67 FD TOT														
I-68 DIS	0.03	0.05	0.08	U	0.23	0.12	0.07	J+	0.06	0.06	0.08	U	0.23	*
I-68 TOT	1.27	0.4	0.08		1.63	0.5	0.07	J+	0.95	0.32	0.08		3.85	
I-73 DIS	0.14	0.12	0.12	J	0.57	0.26	0.1	J	0.06	0.07	0.09	UJ	0.71	*
I-73 TOT	0.34	0.17	0.08		0.49	0.21	0.07	J	0.08	0.08	0.08	J	0.91	
D-3 DIS	0.18	0.11	0.09	J	0.09	0.07	0.06	J+	0.03	0.05	0.08	U	0.27	*
D-3 FD DIS														
D-3 EPA DIS														
D-3 MDNR DIS														
D-3 TOT	0.15	0.13	0.13	J	0.15	0.12	0.13	J+	0	0.04	0.09	UJ	0.30	*
D-3 FD TOT														
D-3 EPA TOT	0.164	0.545	1.08	UG	0.0501	0.241	0.618	U	-0.043	0.0605	0.558	U	ND	*
D-3 MDNR TOT														
D-6 DIS	0.17	0.15	0.16	J	0.68	0.34	0.14	J+	0.06	0.09	0.13	UJ	0.85	*
D-6 FD DIS														
D-6 EPA DIS														
D-6 EPA FD DIS														
D-6 MDNR DIS														
D-6 TOT	0.13	0.09	0.08	J	0.36	0.15	0.07	J+	0.07	0.06	0.05	J	0.56	
D-6 FD TOT														
D-6 EPA TOT														
D-6 MDNR TOT														
D-12 DIS	-0.03	0.07	0.19	UJ	0.54	0.29	0.13	J+	0.1	0.12	0.18	UJ	0.54	*
D-12 FD DIS	-0.02	0.06	0.16	U	0.54	0.22	0.09	J+	-0.01	0.03	0.09	U	0.54	*
D-12 EPA DIS														
D-12 TOT	0.11	0.1	0.12	UJ	0.54	0.24	0.08	J+	0.12	0.1	0.08	J	0.66	*
D-12 FD TOT	0.03	0.07	0.14	UJ	0.54	0.23	0.09	J+	0.17	0.12	0.08	J	0.71	*
D-13 DIS	0.17	0.13	0.13	J	0.98	0.36	0.12	J+	0.22	0.15	0.12	J	1.37	
D-13 FD DIS														
D-13 TOT	0.24	0.16	0.13	J	0.89	0.35	0.1	J+	0.09	0.1	0.14	UJ	1.13	*
D-13 FD TOT														
D-14 DIS	0.08	0.09	0.11	U	0.87	0.32	0.09	J+	0.09	0.09	0.08	J	0.96	*
D-14 TOT	0.66	0.25	0.1		0.97	0.33	0.09	J+	0.72	0.26	0.11		2.35	
D-81 DIS	0.07	0.08	0.13	UJ	0.3	0.15	0.12	J	0.04	0.05	0.08	UJ	0.3	*
D-81 FD DIS	0.1	0.1	0.12	U	0.53	0.25	0.13	J+	0.09	0.09	0.09	J	0.62	*
D-81 TOT	0.06	0.07	0.08	U	0.37	0.18	0.1		0.04	0.06	0.08	U	0.37	*
D-81 FD TOT	0.05	0.09	0.16	U	0.43	0.23	0.13	J+	0.17	0.14	0.15	J	0.60	*
D-83 DIS	0.11	0.08	0.06	J	0.14	0.1	0.08	J+	0.01	0.03	0.06	UJ	0.25	*
D-83 FD DIS	0.17	0.11	0.07	J	0.47	0.2	0.09	J+	0.04	0.05	0.07	U	0.64	*
D-83 MDNR DIS														
D-83 TOT	0.14	0.11	0.14	J	0.14	0.09	0.08	J+	0.06	0.06	0.08	U	0.28	*
D-83 FD TOT	0.26	0.14	0.08	J	0.41	0.18	0.08	J+	0	0.05	0.1	U	0.67	*
D-83 EPA TOT	0.197	0.290	0.138		0.0491	0.201	0.186	U	-0.013	0.0309	0.128	U	0.197	*
D-83 MDNR TOT														
D-83 MDNR FD TOT														
D-85 DIS	0.05	0.07	0.11	U	0.06	0.07	0.08	U	0.05	0.07	0.1	U	ND	*

October 2013

Sample ID	Thorium-228				Thorium-230				Thorium-232				TOTAL	
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Thorium 228 + 230 + 232	
S-5 DIS	-0.01	0.07	0.14	U	0.2	0.17	0.14	J	0.13	0.15	0.2	U	0.2	*
S-5 MDNR DIS	-0.05	0.08	0.26	U	0.38	0.25	0.16	J	0.03	0.08	0.16	U	0.38	*
S-5 TOT	0.02	0.1	0.24	U	0.35	0.24	0.24	J	0.09	0.12	0.14	U	0.35	*
S-5 EPA TOT														
S-5 MDNR TOT	0.10	0.12	0.15	U	0.45	0.24	0.12		0.06	0.10	0.17	U	0.45	*
S-8 DIS	0.07	0.12	0.21	U	0.21	0.19	0.21	J	0	0.1	0.21	U	0.21	*
S-8 TOT	0.03	0.07	0.15	UJ	0.25	0.17	0.16	J	0.04	0.07	0.12	UJ	0.25	*
S-10 DIS	-0.02	0.09	0.22	UJ	0.2	0.19	0.17	J	0.08	0.12	0.17	UJ	0.2	*
S-10 TOT	0.05	0.12	0.25	UJ	0.19	0.19	0.2	UJ	0.04	0.12	0.25	UJ	ND	*
S-53 DIS	0.2	0.27	0.36	UJ	0.14	0.21	0.31	UJ	0.07	0.21	0.44	UJ	ND	*
S-53 TOT	0.39	0.22	0.15	J	0.49	0.24	0.13		0.4	0.21	0.11	J	1.28	
S-61 DIS	0.02	0.09	0.2	U	0.16	0.16	0.22	U	-0.06	0.1	0.3	U	ND	*
S-61 EPA DIS														
S-61 TOT	0.86	0.35	0.19		6.97	1.64	0.16		0.64	0.29	0.16		8.47	
S-82 DIS	0.03	0.08	0.19	U	0.09	0.13	0.21	U	0.04	0.1	0.23	U	ND	*
S-82 MDNR DIS	0.19	0.17	0.16	J	0.20	0.17	0.14	J	0.03	0.09	0.20	U	0.39	*
S-82 TOT	0.08	0.18	0.35	UJ	0.06	0.17	0.36	UJ	-0.03	0.12	0.31	UJ	ND	*
S-82 EPA TOT														
S-82 MDNR TOT	0.02	0.08	0.21	U	0.11	0.14	0.17	U	-0.01	0.08	0.17	U	ND	*
S-84 DIS	0.08	0.18	0.36	UJ	0.24	0.25	0.26	UJ	-0.02	0.14	0.43	UJ	ND	*
S-84 FD DIS	-0.02	0.07	0.19	U	0.45	0.27	0.18	J	-0.02	0.07	0.18	U	0.45	*
S-84 TOT	0.87	0.38	0.22		0.8	0.36	0.18		0.75	0.35	0.2		2.42	
S-84 FD TOT	0.44	0.22	0.17	J	0.46	0.23	0.17	J	0.45	0.22	0.18	J	1.35	
I-4 DIS	0.07	0.12	0.22	U	0.27	0.21	0.2	J	0.03	0.07	0.14	U	0.27	*
I-4 FD DIS														
I-4 MDNR DIS														
I-4 TOT	0.04	0.1	0.2	U	0.26	0.17	0.13	J	0.1	0.11	0.11	U	0.26	*
I-4 FD TOT														
I-4 EPA TOT														
I-4 MDNR TOT														
I-9 DIS	0.03	0.08	0.18	U	0.1	0.11	0.11	U	0	0.08	0.16	U	ND	*
I-9 FD DIS	0.12	0.22	0.39	UJ	0.13	0.16	0.19	UJ	0.11	0.16	0.24	UJ	ND	*
I-9 MDNR DIS	0.09	0.11	0.16	U	0.13	0.13	0.18	U	-0.09	0.06	0.23	U	ND	*
I-9 TOT	0.2	0.15	0.13	J	0.46	0.24	0.12	J	0.02	0.05	0.11	U	0.66	*
I-9 FD TOT	0.17	0.19	0.29	U	0.19	0.17	0.2	U	0.02	0.08	0.19	U	ND	*
I-9 EPA TOT														
I-9 MDNR TOT	0.07	0.11	0.19	U	0.27	0.18	0.16	J	0.03	0.07	0.16	U	0.27	*
I-11 DIS	0.06	0.09	0.15	UJ	0.25	0.16	0.11	J	0	0.07	0.15	UJ	0.25	*
I-11 EPA DIS														
I-11 TOT	-0.08	0.15	0.46	UJ	0.48	0.4	0.41	J	0.15	0.24	0.41	UJ	0.48	*
I-62 DIS	0.1	0.14	0.22	U	0.13	0.14	0.16	U	0	0.09	0.2	U	ND	*
I-62 FD DIS														
I-62 TOT	-0.02	0.07	0.23	U	0.22	0.17	0.13	J	0.06	0.11	0.19	U	0.22	*
I-62 FD TOT														
I-65 DIS	0.03	0.09	0.19	U	0.38	0.24	0.19	J	0.09	0.13	0.19	U	0.38	*
I-65 FD DIS														
I-65 TOT	0.19	0.15	0.17	J	0.21	0.16	0.16	J	0.14	0.13	0.14	J	0.54	
I-65 FD TOT														
I-66 DIS	0.05	0.09	0.16	U	0.15	0.15	0.18	U	0.05	0.09	0.16	U	ND	*
I-66 TOT	0.28	0.2	0.19	J	0.07	0.11	0.17	U	0.06	0.11	0.18	U	0.28	*
I-67 DIS	0.03	0.08	0.16	U	0.15	0.13	0.13	J	0.05	0.08	0.11	U	0.15	*
I-67 FD DIS	0.02	0.08	0.18	U	0.14	0.14	0.19	UJ	-0.02	0.1	0.26	U	ND	*
I-67 TOT	0.11	0.15	0.23	U	1.34	0.57	0.18	J	0.08	0.12	0.18	U	1.34	*
I-67 FD TOT	0.08	0.12	0.2	U	0.45	0.25	0.17	J	0.11	0.13	0.17	U	0.45	*
I-68 DIS	0.12	0.13	0.17	UJ	0.25	0.16	0.11	J	0.07	0.09	0.1	UJ	0.25	*
I-68 TOT	0.86	0.39	0.19		2.25	0.73	0.14	J	0.42	0.26	0.21	J	3.53	
I-73 DIS	0.04	0.1	0.21	U	0.08	0.12	0.21	U	0.17	0.16	0.15	J	0.17	*
I-73 TOT	0.11	0.15	0.25	U	0.33	0.22	0.14	J	0.12	0.13	0.16	U	0.33	*
D-3 DIS	0.04	0.11	0.22	U	0.15	0.14	0.13	J	0.05	0.08	0.14	U	0.15	*
D-3 FD DIS														
D-3 EPA DIS														
D-3 MDNR DIS	0.12	0.15	0.22	U	0.21	0.18	0.18	J	-0.01	0.07	0.15	U	0.21	*
D-3 TOT	-0.01	0.1	0.31	UJ	0.22	0.21	0.19	J	0.27	0.23	0.19	J	0.49	*
D-3 FD TOT														
D-3 EPA TOT														
D-3 MDNR TOT	0.08	0.11	0.16	U	0.18	0.15	0.13	J	0.06	0.09	0.13	U	0.18	*
D-6 DIS	0.11	0.15	0.24	U	0.3	0.2	0.2	J	0.1	0.11	0.13	U	0.3	*
D-6 FD DIS														
D-6 EPA DIS														
D-6 EPA FD DIS														
D-6 MDNR DIS	0.08	0.12	0.20	U	0.41	0.25	0.17	J	0.10	0.12	0.15	U	0.41	*
D-6 TOT	0.09	0.13	0.21	UJ	0.14	0.13	0.16	UJ	0.09	0.1	0.13	UJ	ND	*
D-6 FD TOT														
D-6 EPA TOT														
D-6 MDNR TOT	0.12	0.13	0.17	U	0.25	0.16	0.10	J	0.13	0.11	0.11	J	0.38	*
D-12 DIS	0.08	0.15	0.26	UJ	0.28	0.22	0.17	J	0.03	0.08	0.2	UJ	0.28	*
D-12 FD DIS														
D-12 EPA DIS														
D-12 TOT	0.04	0.15	0.32	UJ	0.57	0.31	0.15	J	0.01	0.07	0.2	U	0.57	*
D-12 FD TOT														
D-13 DIS	-0.08	0.1	0.33	UJ	0.07	0.12	0.2	UJ	0.03	0.09	0.2	UJ	ND	*
D-13 FD DIS														
D-13 TOT	0.27	0.21	0.23	J	0.15	0.15	0.18	U	-0.1	0.09	0.33	U	0.27	*
D-13 FD TOT														
D-14 DIS	0.34	0.24	0.24	J	0.96	0.4	0.13		0.1	0.13	0.19	U	1.30	*
D-14 TOT	0.15	0.16	0.24	U	0.5	0.26	0.17	J	0.11	0.11	0.12	U	0.5	*
D-81 DIS	0.01	0.08	0.2	U	0.08	0.1	0.11	U	-0.01	0.06	0.13	U	ND	*
D-81 FD DIS														
D-81 TOT	-0.02	0.09	0.25	U	0.18	0.16	0.2	U	0.06	0.11	0.2	U	ND	*
D-81 FD TOT														
D-83 DIS	0.18	0.18	0.21	U	0.34	0.25	0.19	J	0.22	0.2	0.19	J	0.56	*
D-83 FD DIS														
D-83 MDNR DIS	0.16	0.18	0.27	U	0.32	0.22	0.22	J	0.10	0.14	0.22	U	0.32	*
D-83 TOT	0.43	0.29	0.35	J	0.25	0.19	0.19	J	0.05	0.09	0.15	U	0.68	*
D-83 FD TOT														
D-83 EPA TOT														
D-83 MDNR TOT	0.12	0.16	0.26	U	0.06	0.12	0.22	U	0.02	0.07	0.16	U	ND	*
D-83 MDNR FD TOT	0.14	0.15	0.22	U	0.18	0.15	0.16	J	0.02	0.06	0.13	U	0.18	*
D-85 DIS	0.05	0.1	0.17	U	0.03	0.07	0.16	U	0.05	0.07	0.11	U	ND	*

February 2014

Sample ID	Thorium-228				Thorium-230				Thorium-232				TOTAL	
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Thorium 228 + 230 + 232	
S-5 DIS														
S-5 MDNR DIS														
S-5 TOT														
S-5 EPA TOT														
S-5 MDNR TOT														
S-8 DIS														
S-8 TOT														
S-10 DIS														
S-10 TOT														
S-53 DIS														
S-53 TOT														
S-61 DIS														
S-61 EPA DIS														
S-61 TOT														
S-82 DIS														
S-82 MDNR DIS														
S-82 TOT														
S-82 EPA TOT														
S-82 MDNR TOT														
S-84 DIS														
S-84 FD DIS														
S-84 TOT														
S-84 FD TOT														
I-4 DIS														
I-4 FD DIS														
I-4 MDNR DIS														
I-4 TOT														
I-4 FD TOT														
I-4 EPA TOT														
I-4 MDNR TOT														
I-9 DIS														
I-9 FD DIS														
I-9 MDNR DIS														
I-9 TOT														
I-9 FD TOT														
I-9 EPA TOT														
I-9 MDNR TOT														
I-11 DIS														
I-11 EPA DIS														
I-11 TOT														
I-62 DIS														
I-62 FD DIS														
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I-67 FD TOT														
I-68 DIS														
I-68 TOT														
I-73 DIS														
I-73 TOT														
D-3 DIS														
D-3 FD DIS														
D-3 EPA DIS														
D-3 MDNR DIS														
D-3 TOT														
D-3 FD TOT														
D-3 EPA TOT														
D-3 MDNR TOT														
D-6 DIS														
D-6 FD DIS														
D-6 EPA DIS														
D-6 EPA FD DIS														
D-6 MDNR DIS														
D-6 TOT														
D-6 FD TOT														
D-6 EPA TOT														
D-6 MDNR TOT														
D-12 DIS														
D-12 FD DIS														
D-12 EPA DIS														
D-12 TOT														
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D-81 DIS														
D-81 FD DIS														
D-81 TOT														
D-81 FD TOT														
D-83 DIS														
D-83 FD DIS														
D-83 MDNR DIS														
D-83 TOT														
D-83 FD TOT														
D-83 EPA TOT														
D-83 MDNR TOT														
D-83 MDNR FD TOT														
D-85 DIS														

Table 7-23: Summary of Thorium Isotope Results: 2012 - 2013 Groundwater Sampling Events

DRAFT

August 2012

Sample ID	Thorium-228				Thorium-230				Thorium-232				TOTAL	
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Thorium 228 + 230 + 232	
D-85 MDNR DIS														
D-85 TOT	4.49	1.15	0.13		7.84	1.92	0.13		4.54	1.14	0.13		16.87	
D-85 EPA TOT														
D-85 MDNR TOT														
D-87 DIS	-0.05	0.10	0.36	UJ	0.88	0.44	0.21	J+	-0.01	0.09	0.19	UJ	0.88	*
D-87 FD DIS														
D-87 TOT	0.09	0.13	0.22	U	0.17	0.14	0.11	J+	0.10	0.10	0.11	U	0.17	*
D-87 FD TOT														
D-93 DIS	0.16	0.16	0.23	U	0.46	0.23	0.11	J+	0.03	0.07	0.15	U	0.46	*
D-93 MDNR DIS	0.27	0.16	0.13	J	0.26	0.16	0.10		0.17	0.13	0.10	J	0.70	
D-93 TOT	0.15	0.14	0.18	UJ	0.17	0.14	0.15	J+	0.06	0.08	0.12	UJ	0.17	*
D-93 EPA TOT														
D-93 MDNR TOT	0.24	0.26	0.29	U	0.11	0.18	0.29	U	0.05	0.13	0.29	U	ND	*
LR-100 DIS	0.06	0.10	0.17	UJ	0.36	0.22	0.17	J+	0.05	0.08	0.12	UJ	0.36	*
LR-100 FD DIS														
LR-100 TOT	0.11	0.11	0.13	UJ	0.29	0.19	0.14	J+	0.11	0.12	0.17	UJ	0.29	*
LR-100 FD TOT														
LR-103 DIS	0.05	0.09	0.14	U	0.27	0.19	0.18	J+	0.02	0.06	0.13	U	0.27	*
LR-103 TOT	0.15	0.13	0.12	J	0.51	0.25	0.15	J+	0.15	0.13	0.15	J	0.81	
LR-104 DIS	-0.02	0.07	0.19	U	0.24	0.19	0.19	J+	0.05	0.09	0.17	U	0.24	*
LR-104 FD DIS	-0.02	0.08	0.25	U	0.26	0.20	0.19	J+	0.06	0.09	0.15	U	0.26	*
LR-104 TOT	0.10	0.12	0.17	UJ	0.31	0.21	0.19	J+	-0.09	0.08	0.26	UJ	0.31	*
LR-104 FD TOT	0.06	0.08	0.13	UJ	0.28	0.17	0.11	J+	0.07	0.09	0.14	UJ	0.28	*
LR-105 DIS	0.23	0.20	0.20	J	1.05	0.47	0.17	J+	-0.01	0.08	0.19	UJ	1.28	*
LR-105 TOT	0.07	0.10	0.15	U	0.83	0.39	0.15	J+	0.14	0.15	0.15	U	0.83	*
MW-102 DIS	0.20	0.29	0.47	UJ	0.24	0.28	0.36	UJ	-0.03	0.14	0.36	UJ	ND	*
MW-102 EPA DIS	0.2			U	1.1				-0.022			U	1.1	*
MW-102 TOT	0.20	0.24	0.35	UJ	0.40	0.29	0.21	J	0.12	0.16	0.24	UJ	0.40	*
MW-103 DIS	0.06	0.10	0.18	U	0.30	0.20	0.17	J-	0.05	0.08	0.13	U	0.30	*
MW-103 TOT	3.50	0.94	0.14		3.78	1.04	0.18	J-	3.40	0.91	0.14		10.68	
MW-104 DIS	-0.03	0.10	0.28	U	0.27	0.20	0.19	J	0.02	0.09	0.20	U	0.27	*
MW-104 TOT	0.99	0.38	0.20	J	0.89	0.35	0.16	J	0.85	0.33	0.12	J	2.73	
MW-1204 DIS	0.15	0.71	1.65	UJ	0.23	0.69	1.48	UJ-	0.04	0.49	1.41	UJ	ND	*
MW-1204 FD DIS														
MW-1204 TOT	0.17	0.18	0.26	U	0.00	0.00	0.40	UJ-	-0.02	0.06	0.16	U	ND	*
MW-1204 FD TOT														
PZ-100-KS DIS	-0.01	0.06	0.15	U	0.20	0.16	0.17	J+	0.00	0.08	0.17	U	0.20	*
PZ-100-KS TOT	0.02	0.08	0.20	U	0.11	0.15	0.22	UJ+	-0.02	0.08	0.19	U	ND	*
PZ-100-SD DIS	0.12	0.18	0.30	UJ	0.91	0.45	0.27	J	-0.04	0.09	0.26	UJ	0.91	*
PZ-100-SD TOT	-0.02	0.10	0.29	UJ	1.05	0.43	0.18	J	0.05	0.09	0.17	UJ	1.05	*
PZ-100-SS DIS	0.08	0.16	0.30	U	1.11	0.47	0.16	J	0.01	0.08	0.22	U	1.11	*
PZ-100-SS TOT	-0.02	0.07	0.21	U	0.10	0.12	0.14	UJ	0.02	0.06	0.12	U	ND	*
PZ-101-SS DIS	0.06	0.09	0.13	U	0.34	0.22	0.19	J	0.03	0.09	0.19	U	0.34	*
PZ-101-SS EPA DIS	0.13			U	0.96				-0.026			U	0.96	*
PZ-101-SS MDNR DIS														
PZ-101-SS TOT	0.08	0.12	0.18	U	0.13	0.13	0.14	U	0.00	0.09	0.20	U	ND	*
PZ-101-SS EPA TOT														
PZ-101-SS MDNR TOT														
PZ-102R-SS DIS	0.12	0.13	0.18	U	0.35	0.22	0.18	J-	0.03	0.11	0.22	U	0.35	*
PZ-102R-SS TOT	-0.01	0.06	0.13	UJ	0.13	0.12	0.12	J-	0.10	0.11	0.12	UJ	0.13	*
PZ-102-SS DIS	0.05	0.09	0.18	UJ	0.68	0.29	0.13	J+	0.03	0.07	0.15	UJ	0.68	*
PZ-102-SS MDNR DIS														
PZ-102-SS MDNR FD DIS														
PZ-102-SS TOT	0.64	0.30	0.19	J	0.72	0.33	0.15	J+	0.66	0.30	0.15	J	2.02	
PZ-102-SS EPA TOT														
PZ-102-SS MDNR TOT														
PZ-103-SS DIS	0.01	0.13	0.30	U	0.15	0.17	0.25	U	0.00	0.10	0.21	U	ND	*
PZ-103-SS TOT	0.33	0.23	0.18	J	0.88	0.39	0.16		0.20	0.18	0.20		1.41	
PZ-104-KS DIS	0.12	0.13	0.18	U	0.21	0.17	0.18	J+	0.02	0.06	0.13	U	0.21	*
PZ-104-KS TOT	0.02	0.06	0.13	UJ	0.18	0.15	0.14	J+	0.14	0.14	0.17	UJ	0.18	*
PZ-104-SD DIS	0.05	0.12	0.25	UJ	0.24	0.20	0.17	J	0.00	0.00	0.11	UJ	0.24	*
PZ-104-SD MDNR DIS														
PZ-104-SD TOT	0.11	0.13	0.16	U	0.19	0.19	0.23	UJ	0.07	0.11	0.16	U	ND	*
PZ-104-SD EPA TOT														
PZ-104-SD MDNR TOT														
PZ-104-SS DIS	0.16	0.19	0.23	UJ	0.27	0.27	0.32	UJ	0.00	0.15	0.32	UJ	ND	*
PZ-104-SS FD DIS														
PZ-104-SS TOT	-0.02	0.07	0.18	U	0.30	0.21	0.14	J	0.03	0.09	0.20	U	0.30	*
PZ-104-SS FD TOT														
PZ-105-SS DIS	0.13	0.18	0.29	U	0.98	0.45	0.23	J+	0.05	0.11	0.22	U	0.98	*
PZ-105-SS TOT	0.00	0.11	0.27	U	0.20	0.19	0.25	UJ+	0.05	0.11	0.22	U	ND	*
PZ-106-KS DIS	0.04	0.09	0.19	U	0.25	0.18	0.14	J+	0.05	0.09	0.16	U	0.25	*
PZ-106-KS FD DIS														
PZ-106-KS MDNR DIS	0.08	0.14	0.24	U	0.17	0.18	0.23	U	0.03	0.08	0.18	U	ND	*
PZ-106-KS MDNR FD DIS	-0.01	0.07	0.22	U	0.36	0.24	0.25	J	0.08	0.11	0.16	U	0.36	*
PZ-106-KS TOT	0.07	0.11	0.18	UJ	0.21	0.18	0.20	J+	0.00	0.11	0.28	UJ	0.21	*
PZ-106-KS FD TOT														
PZ-106-KS MDNR TOT	0.20	0.16	0.13	J	0.23	0.17	0.17	J	0.05	0.08	0.13	U	0.43	*
PZ-106-SD DIS	0.08	0.09	0.11	UJ	0.07	0.09	0.14	UJ	-0.01	0.05	0.16	UJ	ND	*
PZ-106-SD TOT	0.17	0.17	0.20	U	1.39	0.54	0.15	J	0.18	0.17	0.15	J	1.57	*
PZ-106-SS DIS	0.02	0.07	0.16	U	0.13	0.13	0.14	UJ	0.02	0.07	0.16	U	ND	*
PZ-106-SS TOT	0.08	0.10	0.12	U	0.11	0.11	0.12	UJ	0.05	0.08	0.12	U	ND	*
PZ-107-SS DIS	0.14	0.13	0.12	J	0.13	0.12	0.12	J	0.08	0.10	0.12	U	0.27	*
PZ-107-SS FD DIS														
PZ-107-SS TOT	0.41	0.23	0.16	J	0.69	0.30	0.11	J	1.06	0.38	0.11	J	2.16	
PZ-107-SS FD TOT														
PZ-109-SS DIS	-0.07	0.06	0.24	UJ	0.06	0.09	0.14	UJ-	-0.03	0.05	0.16	UJ	ND	*
PZ-109-SS TOT	0.03	0.11	0.23	UJ	0.13	0.13	0.16	UJ-	0.03	0.08	0.16	UJ	ND	*
PZ-110-SS DIS	-0.04	0.06	0.22	UJ	0.11	0.13	0.19	UJ-	0.00	0.07	0.15	UJ	ND	*
PZ-110-SS TOT	-0.02	0.06	0.16	UJ	0.29	0.20	0.15	J-	0.09	0.12	0.18	UJ	0.29	*
PZ-111-KS DIS	0.07	0.09	0.14	UJ	0.29	0.19	0.16	J+	-0.01	0.05	0.14	UJ	0.29	*
PZ-111-KS TOT	-0.02	0.07	0.17	U	0.26	0.20	0.19	J+	0.03	0.09	0.19	U	0.26	*
PZ-111-SD DIS	0.07	0.12	0.20	U	0.33	0.26	0.26	J+	0.03	0.12	0.28	U	0.33	*
PZ-111-SD TOT	0.10	0.12	0.15	UJ	0.14	0.13	0.12	J+	0.05	0.08	0.12	UJ	0.14	*
PZ-112-AS DIS	0.03	0.09	0.20	UJ	0.09	0.15	0.26	UJ	-0.01	0.09	0.20	UJ	ND	*
PZ-112-AS EPA DIS	-0.18			U	0.56				-0.05			U	0.56	*
PZ-112-AS TOT	0.21	0.19	0.20	J	0.10	0.13	0.17	UJ	0.03	0.08	0.17	UJ	0.21	*
PZ-112-AS EPA TOT														
PZ-113-AD DIS	0.15	0.15	0.21	UJ	0.16	0.14	0.12	J	0.01	0.06	0.16	UJ	0.16	*
PZ-113-AD FD DIS	0.02	0.06	0.14	UJ	0.19	0.16	0.18	J	-0.04	0.06	0.19	UJ	0.19	*

April 2013

Sample ID	Thorium-228				Thorium-230				Thorium-232				TOTAL	
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Thorium 228 + 230 + 232	
D-85 MDNR DIS														
D-85 TOT	3.15	0.70	0.10	J+	5.81	1.27	0.06		2.79	0.62	0.07		11.75	
D-85 EPA TOT	3.09		1.31	G	6.53		0.838		2.71		1.04	G	6.53	*
D-85 MDNR TOT														
D-87 DIS	0.07	0.07	0.08	UJ	0.11	0.08	0.08	J	0.01	0.04	0.08	UJ	0.11	*
D-87 FD DIS														
D-87 TOT	0.22	0.13	0.09	J	0.40	0.18	0.09		0.06	0.06	0.07	U	0.62	*
D-87 FD TOT														
D-93 DIS	0.05	0.06	0.09	UJ	0.16	0.09	0.05	J	0.03	0.04	0.06	UJ	0.16	*
D-93 MDNR DIS														
D-93 TOT	0.16	0.11	0.13	J	0.09	0.08	0.09	J	0.01	0.04	0.09	U	0.25	*
D-93 EPA TOT	0.113		0.122	U	0.0399		0.12	U	0.0199		0.104	U	ND	*
D-93 MDNR TOT														
LR-100 DIS	0.13	0.22	0.39	UJ	0.28	0.28	0.32	UJ	-0.02	0.12	0.37	UJ	ND	*
LR-100 FD DIS														
LR-100 TOT	-0.03	0.04	0.12	U	0.14	0.10	0.09	J	0.03	0.04	0.06	U	0.14	*
LR-100 FD TOT														
LR-103 DIS	0.35	0.31	0.34	J	0.54	0.37	0.24	J	0.02	0.10	0.28	UJ	0.89	*
LR-103 TOT	0.03	0.05	0.07	U	0.11	0.08	0.09	J	-0.04	0.03	0.13	U	0.11	*
LR-104 DIS	0.03	0.07	0.12	U	0.06	0.07	0.10	U	-0.01	0.03	0.11	U	ND	*
LR-104 FD DIS														
LR-104 TOT	0.08	0.08	0.09	U	0.16	0.10	0.08	J	0.05	0.06	0.07	U	0.16	*
LR-104 FD TOT														
LR-105 DIS	-0.01	0.08	0.18	UJ	0.10	0.13	0.15	UJ	-0.01	0.07	0.15	UJ	ND	*
LR-105 TOT	0.05	0.05	0.05	J	0.30	0.14	0.07	J	0.03	0.04	0.07	UJ	0.35	*
MW-102 DIS														
MW-102 EPA DIS														
MW-102 TOT														
MW-103 DIS	-0.02	0.06	0.18	U	0.12	0.10	0.12	J	0.07	0.08	0.09	U	0.12	*
MW-103 TOT	1.38	0.38	0.09		1.22	0.36	0.06	J	1.19	0.34	0.06	J	3.79	
MW-104 DIS	0.01	0.03	0.05	UJ	0.18	0.10	0.05	J+	0.02	0.04	0.07	UJ	0.18	*
MW-104 TOT	0.21	0.11	0.05	J	0.34	0.15	0.08	J+	0.18	0.10	0.08	J	0.73	
MW-1204 DIS	0.06	0.07	0.11	UJ	0.14	0.09	0.06	J+	0.02	0.04	0.06	UJ	0.14	*
MW-1204 FD DIS	-0.01	0.04	0.11	UJ	0.11	0.08	0.07	J+	-0.01	0.03	0.07	UJ	0.11	*
MW-1204 TOT	0.08	0.07	0.09	UJ	0.12	0.08	0.08	J+	0.01	0.02	0.05	UJ	0.12	*
MW-1204 FD TOT	0.10	0.08	0.10	J	0.10	0.08	0.09	J+	0.01	0.03	0.06	UJ	0.20	*
PZ-100-KS DIS	0.02	0.04	0.09	U	0.08	0.07	0.06	J+	0.00	0.03	0.06	U	0.08	*
PZ-100-KS TOT	0.09	0.08	0.08	J	0.39	0.17	0.07	J+	0.03	0.05	0.09	U	0.48	*
PZ-100-SD DIS	0.00	0.03	0.08	UJ	0.07	0.06	0.06	J+	0.00	0.03	0.06	UJ	0.07	*
PZ-100-SD TOT	0.02	0.04	0.06	U	0.15	0.10	0.06	J+	0.04	0.05	0.06	U	0.15	*
PZ-100-SS DIS	-0.01	0.03	0.07	U	0.10	0.08	0.09	J+	-0.02	0.03	0.12	U	0.10	*
PZ-100-SS TOT	0.02	0.04	0.09	UJ	0.10	0.09	0.10	J+	0.02	0.06	0.12	UJ	0.10	*
PZ-101-SS DIS	0.01	0.05	0.11	U	0.15	0.10	0.08	J+	0.00	0.03	0.07	U	0.15	*
PZ-101-SS EPA DIS														
PZ-101-SS MDNR DIS														
PZ-101-SS TOT	0.05	0.10	0.18	U	0.33	0.19	0.14	J+	0.08	0.09	0.13	U	0.33	*
PZ-101-SS EPA TOT	0.269		0.694	U	1.05		0.509		-0.067		0.642	U	1.05	*
PZ-101-SS MDNR TOT														
PZ-102R-SS DIS	0.01	0.02	0.06	UJ+	0.06	0.05	0.06	J+	0.01	0.02	0.05	UJ	0.06	*
PZ-102R-SS TOT	0.25	0.13	0.06	J+	0.27	0.13	0.08	J+	0.36	0.15	0.07		0.88	
PZ-102-SS DIS	0.10	0.07	0.07	J+	0.12	0.08	0.06	J+	0.03	0.04	0.07	UJ	0.22	*
PZ-102-SS MDNR DIS														
PZ-102-SS MDNR FD DIS														
PZ-102-SS TOT	3.24	0.78	0.13	J+	3.03	0.77	0.09	J+	4.35	0.98	0.09		10.62	
PZ-102-SS EPA TOT	2.28		1.36	G	2.56		0.789		2.3		0.62		4.86	*
PZ-102-SS MDNR TOT														
PZ-103-SS DIS	0.06	0.06	0.10	UJ	0.09	0.07	0.08	J	0.00	0.02	0.07	UJ	0.09	*
PZ-103-SS TOT	2.96	0.70	0.09	J	6.03	1.38	0.09	J	2.47	0.59	0.09	J	11.46	
PZ-104-KS DIS	0.04	0.05	0.08	UJ+	0.17	0.10	0.07	J	-0.01	0.02	0.07	UJ	0.17	*
PZ-104-KS TOT	0.10	0.07	0.06	J+	0.18	0.10	0.07	J	0.08	0.07	0.09	UJ	0.28	*
PZ-104-SD DIS	0.02	0.04	0.07	UJ+	0.16	0.10	0.07	J+	0.00	0.03	0.07	U	0.16	*
PZ-104-SD MDNR DIS														
PZ-104-SD TOT	0.05	0.06	0.07	UJ+	0.17	0.11	0.08	J+	0.02	0.04	0.10	U	0.17	*
PZ-104-SD EPA TOT	-0.04		0.934	U	0.689		0.852	U	-0.051		0.672	U	ND	*
PZ-104-SD MDNR TOT														
PZ-104-SS DIS	0.03	0.06	0.12	UJ+	0.08	0.07	0.09	U	-0.02	0.03	0.08	UJ	ND	*
PZ-104-SS FD DIS	0.01	0.06	0.14	UJ+	0.22	0.12	0.08	J+	-0.01	0.03	0.07	UJ	0.22	*
PZ-104-SS TOT	0.05	0.05	0.06	UJ+	0.16	0.10	0.08	J+	-0.03	0.03	0.10	U	0.16	*
PZ-104-SS FD TOT	0.10	0.08	0.07	J+	0.07	0.06	0.06	J+	0.00	0.02	0.06	UJ	0.17	*
PZ-105-SS DIS	0.01	0.05	0.12	U	0.24	0.13	0.08	J	0.03	0.05	0.08	U	0.24	*
PZ-105-SS TOT	0.04	0.06	0.10	U	0.08	0.07	0.08	J	0.01	0.02	0.06	UJ	0.08	*
PZ-106-KS DIS	0.04	0.05	0.08	U	0.16	0.10	0.06	J+	0.01	0.04	0.09	U	0.16	*
PZ-106-KS FD DIS														
PZ-106-KS MDNR DIS														
PZ-106-KS MDNR FD DIS														
PZ-106-KS TOT	-0.01	0.04	0.12	U	0.09	0.08	0.09	J+	0.04	0.05	0.07	U	0.09	*
PZ-106-KS FD TOT														
PZ-106-KS MDNR TOT														
PZ-106-SD DIS	0.00	0.06	0.14	UJ	0.34	0.16	0.10	J	-0.01	0.03	0.10	UJ	0.34	*
PZ-106-SD TOT	0.21	0.12	0.10	J	0.13	0.09	0.08	J	0.14	0.09	0.09	J	0.48	
PZ-106-SS DIS	0.01	0.05	0.12	U	0.15	0.10	0.09	J	0.01	0.04	0.09	U	0.15	*
PZ-106-SS TOT	0.04	0.06	0.10	UJ	0.16	0.10	0.08	J	0.02	0.04	0.07	UJ	0.16	*
PZ-107-SS DIS	0.00	0.03	0.08	U	0.11	0.08	0.06	J+	0.00	0.03	0.06	U	0.11	*
PZ-107-SS FD DIS														
PZ-107-SS TOT	1.01	0.29	0.08		0.78	0.25	0.09	J+	1.11	0.31	0.12		2.90	
PZ-107-SS FD TOT														
PZ-109-SS DIS	0.01	0.02	0.05	UJ+	0.10	0.07	0.05	J	0.00	0.02	0.05	UJ	0.10	*
PZ-109-SS TOT	0.01	0.03	0.06	UJ+	0.17	0.10	0.06	J	0.01	0.04	0.08	UJ	0.17	*
PZ-110-SS DIS	0.00	0.05	0.10	UJ	0.21	0.15	0.14	J+	0.08	0.09	0.11	UJ	0.21	*
PZ-110-SS TOT	0.03	0.04	0.07	U	0.16	0.11	0.09	J	0.02	0.04	0.08	U	0.16	*
PZ-111-KS DIS	-0.01	0.06	0.14	UJ+	0.14	0.10	0.08	J+	0.01	0.03	0.08	U	0.14	*
PZ-111-KS TOT	0.11	0.08	0.09	J+	0.20	0.10	0.05	J+	0.13	0.08	0.06	J	0.44	
PZ-111-SD DIS	0.01	0.05	0.13	UJ	0.45	0.24	0.13	J+	0.00	0.05	0.10	UJ	0.45	*
PZ-111-SD TOT	0.05	0.06	0.07	U	0.13	0.10	0.08	J+	0.00	0.05	0.10	U	0.13	*
PZ-112-AS DIS	0.01	0.08	0.17	U	0.20	0.13	0.10	J+	0.03	0.06	0.12	U	0.20	*
PZ-112-AS EPA DIS														
PZ-112-AS TOT	0.11	0.11	0.16	U	0.19	0.12	0.10	J+	0.05	0.07	0.10	U	0.19	*
PZ-112-AS EPA TOT														
PZ-113-AD DIS	0.04	0.05	0.07	UJ+	0.12	0.08	0.07	J	0.01	0.03	0.05	UJ	0.12	*
PZ-113-AD FD DIS														

July 2013

Sample ID	Thorium-228				Thorium-230				Thorium-232				TOTAL	
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Thorium 228 + 230 + 232	
D-85 MDNR DIS														
D-85 TOT	2.68	0.9	0.13	J	4.26	1.35	0.19	J	2.5	0.84	0.13	J	9.44	
D-85 EPA TOT	1.63	2.17	1.33	G	4.87	3.28	1.02	G	1.23	1.61	0.696		1.23	*
D-85 MDNR TOT														
D-87 DIS	0.06	0.1	0.17	UJ	0.89	0.32	0.09	J+	0.09	0.09	0.12	UJ	0.89	*
D-87 FD DIS														
D-87 TOT	0.55	0.24	0.16		1.45	0.45	0.13	J+	0.51	0.22	0.12		2.51	
D-87 FD TOT														
D-93 DIS	0.12	0.12	0.18	U	0.17	0.13	0.16	J+	0.05	0.08	0.13	U	0.17	*
D-93 MDNR DIS														
D-93 TOT	0.2	0.14	0.13	J	0.18	0.13	0.12	J+	0.07	0.08	0.09	U	0.38	*
D-93 EPA TOT	0.0504	0.159	0.130	U	0.216	0.287	0.110		0.0321	0.130	0.120	U	0.22	*
D-93 MDNR TOT														
LR-100 DIS	0.05	0.07	0.11	U	0.41	0.2	0.11		0.04	0.05	0.08	U	0.41	*
LR-100 FD DIS														
LR-100 TOT	0	0.08	0.2	U	0.55	0.24	0.11		-0.01	0.04	0.11	U	0.55	*
LR-100 FD TOT														
LR-103 DIS	0.02	0.06	0.13	U	0.55	0.22	0.11		0.09	0.08	0.1	U	0.55	*
LR-103 TOT	0.06	0.09	0.14	U	0.52	0.23	0.1		0.06	0.07	0.11	U	0.52	*
LR-104 DIS	0.05	0.07	0.1	U	0.09	0.08	0.07	J	0	0.03	0.09	U	0.09	*
LR-104 FD DIS														
LR-104 TOT	0.06	0.06	0.07	UJ	0.1	0.07	0.05	J	0.01	0.02	0.05	UJ	0.1	*
LR-104 FD TOT														
LR-105 DIS														
LR-105 TOT														
MW-102 DIS	0.1	0.13	0.19	UJ	0.25	0.2	0.2	J+	0.15	0.14	0.13	J+	0.40	*
MW-102 EPA DIS														
MW-102 TOT	0.09	0.12	0.18	UJ	0.29	0.19	0.14	J+	0.12	0.13	0.17	UJ	0.29	*
MW-103 DIS	0.06	0.07	0.08	UJ	0.37	0.19	0.14	J+	0.03	0.08	0.17	UJ	0.37	*
MW-103 TOT	1.18	0.4	0.11	J+	1.8	0.55	0.09	J+	0.91	0.32	0.08	J+	3.89	
MW-104 DIS	0	0.04	0.11	UJ	0.46	0.21	0.1	J+	0.05	0.06	0.09	UJ	0.46	*
MW-104 TOT	0.71	0.26	0.09		1.15	0.37	0.1	J+	0.6	0.23	0.07		2.46	
MW-1204 DIS	0.02	0.05	0.11	U	0.44	0.2	0.08	J+	0.05	0.06	0.08	U	0.44	*
MW-1204 FD DIS														
MW-1204 TOT	0.09	0.1	0.14	U	0.29	0.15	0.09	J+	0.05	0.07	0.12	U	0.29	*
MW-1204 FD TOT														
PZ-100-KS DIS	-0.05	0.03	0.11	UJ	0.13	0.08	0.06	J	-0.01	0.02	0.06	UJ	0.13	*
PZ-100-KS TOT	0.02	0.05	0.1	U	0.04	0.05	0.07	U	0	0.03	0.06	U	ND	*
PZ-100-SD DIS	0.03	0.06	0.11	U	0.09	0.08	0.08	J+	0.02	0.05	0.08	U	0.09	*
PZ-100-SD TOT	0.02	0.04	0.08	UJ	0.1	0.07	0.06	J+	0.01	0.02	0.05	UJ	0.10	*
PZ-100-SS DIS	0.05	0.07	0.1	U	0.02	0.05	0.1	UJ+	0.05	0.06	0.07	U	ND	*
PZ-100-SS TOT	0.04	0.06	0.09	U	0.17	0.11	0.07	J+	0.03	0.05	0.09	U	0.17	*
PZ-101-SS DIS	0.08	0.08	0.1	U	0.19	0.11	0.09	J	0.04	0.05	0.07	UJ+	0.19	*
PZ-101-SS EPA DIS														
PZ-101-SS MDNR DIS														
PZ-101-SS TOT	-0.01	0.07	0.19	U	0.24	0.16	0.09	J	0.05	0.08	0.13	UJ+	0.24	*
PZ-101-SS EPA TOT	0.0943	0.388	0.361	U	0.563	0.719	0.283		0.0570	0.277	0.281	U	0.56	*
PZ-101-SS MDNR TOT														
PZ-102R-SS DIS	0	0.04	0.11	UJ	0.14	0.11	0.08	J	0.05	0.06	0.08	UJ	0.14	*
PZ-102R-SS TOT	0.4	0.2	0.17	J	0.49	0.22	0.14	J	0.53	0.23	0.13	J	1.42	
PZ-102-SS DIS	-0.01	0.06	0.16	UJ	0.19	0.13	0.13	J-	-0.02	0.04	0.11	U	0.19	*
PZ-102-SS MDNR DIS														
PZ-102-SS MDNR FD DIS														
PZ-102-SS TOT	2.99	0.71	0.07	J	2.88	0.72	0.09	J-	2.71	0.65	0.08		8.58	
PZ-102-SS EPA TOT														
PZ-102-SS MDNR TOT														
PZ-103-SS DIS	0.06	0.14	0.27	U	0.04	0.1	0.2	UJ	0.06	0.1	0.16	U	ND	*
PZ-103-SS TOT	0.62	0.5	0.64	U	1.3	0.66	0.43	J	0.31	0.31	0.36	U	1.3	*
PZ-104-KS DIS	0	0.05	0.13	UJ	0.24	0.15	0.12	J	0.04	0.06	0.1	UJ	0.24	*
PZ-104-KS TOT	0.02	0.05	0.09	U	0.24	0.14	0.1	J	0.03	0.04	0.07	U	0.24	*
PZ-104-SD DIS	0.03	0.05	0.09	U	0.12	0.09	0.09	J	0.08	0.07	0.07	J+	0.20	*
PZ-104-SD MDNR DIS														
PZ-104-SD TOT	-0.04	0.07	0.22	UJ	0.09	0.1	0.15	UJ	-0.04	0.05	0.17	UJ+	ND	*
PZ-104-SD EPA TOT														
PZ-104-SD MDNR TOT														
PZ-104-SS DIS	0.02	0.07	0.15	U	0.05	0.06	0.07	U	0.04	0.06	0.09	UJ+	ND	*
PZ-104-SS FD DIS														
PZ-104-SS TOT	0.05	0.06	0.08	UJ	0.11	0.08	0.06	J	0.03	0.04	0.06	UJ+	0.11	*
PZ-104-SS FD TOT														
PZ-105-SS DIS	0.06	0.08	0.12	U	0.45	0.19	0.07	J+	0.12	0.09	0.08	J	0.57	*
PZ-105-SS TOT	-0.03	0.04	0.14	U	0.45	0.19	0.11	J+	0.06	0.07	0.09	U	0.45	*
PZ-106-KS DIS	0.04	0.13	0.28	UJ	0.06	0.12	0.23	UJ-	0.05	0.12	0.26	UJ	ND	*
PZ-106-KS FD DIS														
PZ-106-KS MDNR DIS														
PZ-106-KS MDNR FD DIS														
PZ-106-KS TOT	-0.01	0.06	0.16	UJ	0.14	0.1	0.09	J-	0.03	0.06	0.12	U	0.14	*
PZ-106-KS FD TOT														
PZ-106-KS MDNR TOT														
PZ-106-SD DIS	-0.01	0.03	0.08	U	0.04	0.05	0.08	U	0.01	0.04	0.09	U	ND	*
PZ-106-SD TOT	-0.01	0.03	0.07	U	0.18	0.11	0.06	J	0.08	0.07	0.07		0.26	*
PZ-106-SS DIS	0.05	0.05	0.06	U	0.2	0.11	0.08	J	0.04	0.05	0.05	U	0.2	*
PZ-106-SS TOT	0.04	0.07	0.12	UJ	0.07	0.08	0.1	UJ	0.06	0.08	0.11	UJ	ND	*
PZ-107-SS DIS	-0.04	0.14	0.39	UJ	0.32	0.28	0.32	J-	0.04	0.13	0.29	UJ	0.32	*
PZ-107-SS FD DIS	0.16	0.13	0.1	J	0.25	0.16	0.14	J-	0.04	0.06	0.09	UJ	0.41	*
PZ-107-SS TOT	1.13	0.36	0.14	J	1.66	0.49	0.1	J-	1.38	0.41	0.1		4.17	
PZ-107-SS FD TOT	1.15	0.38	0.1	J	1.33	0.43	0.12	J-	1.57	0.47	0.08		4.05	
PZ-109-SS DIS	0.05	0.07	0.12	U	0.13	0.09	0.09	j	0.02	0.04	0.05	UJ+	0.13	*
PZ-109-SS TOT	0.06	0.08	0.14	U	0.05	0.07	0.11	U	0.04	0.05	0.07	UJ+	ND	*
PZ-110-SS DIS	-0.01	0.04	0.11	UJ	0.1	0.08	0.07	J+	0.06	0.06	0.07	UJ	0.1	*
PZ-110-SS TOT	0.05	0.07	0.09	UJ	0.2	0.13	0.08	J+	0.02	0.05	0.11	UJ	0.2	*
PZ-111-KS DIS	0	0.04	0.11	UJ	0.49	0.21	0.09	J	0	0.03	0.1	UJ	0.49	*
PZ-111-KS TOT	0.02	0.06	0.13	U	0.42	0.18	0.07		-0.02	0.03	0.1	U	0.42	*
PZ-111-SD DIS	0.01	0.05	0.11	U	0.11	0.08	0.06	J+	-0.01	0.03	0.08	U	0.11	*
PZ-111-SD TOT	0.02	0.05	0.09	U	0.07	0.07	0.1	UJ+	0.02	0.05	0.08	U	ND	*
PZ-112-AS DIS	0.07	0.08	0.09	U	0.13	0.1	0.1	J+	-0.04	0.05	0.17	U	0.13	*
PZ-112-AS EPA DIS														
PZ-112-AS TOT	0.06	0.07	0.07	U	0.16	0.11	0.1	J+	0.02	0.05	0.1	U	0.16	*
PZ-112-AS EPA TOT	-0.0282	0.0323	0.267	U	0.337	0.283	0.320		-0.009	0.0184	0.208	U	0.34	*
PZ-113-AD DIS	0.08	0.1	0.15	U	0.12	0.1	0.11	J	-0.01	0.04	0.11	U	0.12	*
PZ-113-AD FD DIS	0.07	0.08	0.13	UJ	0.09	0.07	0.07	J	0	0.03	0.07	UJ+	0.09	*

October 2013

Sample ID	Thorium-228				Thorium-230				Thorium-232				TOTAL	
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Thorium 228 + 230 + 232	
D-85 MDNR DIS	0.15	0.20	0.32	U	0.45	0.27	0.24	J	0.18	0.16	0.17	J	0.63	*
D-85 TOT	3.01	0.86	0.16	J	4.37	1.19	0.14	J	2.67	0.78	0.17	J	10.05	
D-85 EPA TOT														
D-85 MDNR TOT	1.58	0.48	0.19		2.30	0.61	0.17		1.62	0.49	0.16		5.49	
D-87 DIS	0.15	0.15	0.18	U	0.15	0.14	0.18	U	0.15	0.14	0.18	U	ND	*
D-87 FD DIS	0.03	0.1	0.23	U	0.33	0.22	0.14	J	0.06	0.09	0.14	U	0.33	*
D-87 TOT	0.43	0.25	0.18	J	1.63	0.55	0.19		0.71	0.32	0.14		2.77	
D-87 FD TOT	0.37	0.21	0.14	J	0.81	0.34	0.11		0.22	0.16	0.16	J	1.40	
D-93 DIS	0.33	0.24	0.26	J	0.55	0.3	0.15	J	0.03	0.1	0.21	U	0.88	*
D-93 MDNR DIS	0.17	0.17	0.23	U	0.18	0.15	0.15	J	0.06	0.09	0.13	U	0.18	*
D-93 TOT	0.38	0.24	0.24	J	0.44	0.24	0.17	J	0.05	0.08	0.12	U	0.82	*
D-93 EPA TOT														
D-93 MDNR TOT	0.24	0.19	0.23	J	0.38	0.22	0.14		0.08	0.10	0.14	U	0.62	*
LR-100 DIS	0	0.05	0.14	UJ	0.04	0.06	0.11	UJ	0	0.04	0.09	UJ	ND	*
LR-100 FD DIS	0.03	0.09	0.19	U	0.15	0.14	0.13	J	0.02	0.06	0.14	U	0.15	*
LR-100 TOT	-0.01	0.06	0.15	U	0.16	0.15	0.17	U	0.04	0.08	0.15	U	ND	*
LR-100 FD TOT	0.03	0.13	0.28	U	0.09	0.11	0.13	U	0.07	0.11	0.18	U	ND	*
LR-103 DIS	0.02	0.11	0.23	UJ	0.19	0.15	0.13	J	0.06	0.09	0.14	UJ	0.19	*
LR-103 TOT	0.15	0.2	0.29	UJ	0.23	0.22	0.2	J	0.14	0.17	0.2	UJ	0.23	*
LR-104 DIS	-0.03	0.06	0.19	U	0.26	0.17	0.12	J	0.01	0.05	0.14	U	0.26	*
LR-104 FD DIS														
LR-104 TOT	-0.03	0.08	0.23	U	0.22	0.17	0.18	J	0.05	0.09	0.16	U	0.22	*
LR-104 FD TOT														
LR-105 DIS														
LR-105 TOT														
MW-102 DIS	-0.09	0.12	0.38	UJ	0.09	0.15	0.25	UJ	0.04	0.1	0.21	UJ	ND	*
MW-102 EPA DIS														
MW-102 TOT	1.26	0.46	0.23		0.7	0.32	0.14		0.55	0.27	0.14		2.51	
MW-103 DIS	-0.02	0.06	0.19	U	0.25	0.17	0.12	J	0.1	0.1	0.11	U	0.25	*
MW-103 TOT	1.11	0.42	0.22		1.08	0.41	0.14	J	1.22	0.43	0.14		3.41	
MW-104 DIS	0.15	0.15	0.2	UJ	0.28	0.18	0.14	J	0.09	0.1	0.12	UJ	0.28	*
MW-104 TOT	1.94	0.6	0.16		2.04	0.64	0.18		1.77	0.56	0.18		5.75	
MW-1204 DIS	3.34	5.03	7.07	R	8.52	8.38	4.54	R	7.6	7.91	6.51	R	R	
MW-1204 FD DIS														
MW-1204 TOT	0.17	0.31	0.55	UJ	0.35	0.33	0.3	J	0	0.2	0.43	UJ	0.35	*
MW-1204 FD TOT														
PZ-100-KS DIS	0.11	0.14	0.19	U	0.32	0.22	0.18	J	0.12	0.13	0.18	U	0.32	*
PZ-100-KS TOT	0.23	0.27	0.4	UJ	0.32	0.31	0.42	UJ	0.09	0.22	0.44	UJ	ND	*
PZ-100-SD DIS	-0.03	0.06	0.19	UJ	0.26	0.17	0.14	J	0.04	0.07	0.1	UJ	0.26	*
PZ-100-SD TOT	0.11	0.11	0.14	UJ	0.19	0.14	0.13	J	0.03	0.07	0.14	UJ	0.19	*
PZ-100-SS DIS	0.07	0.13	0.24	U	0.34	0.23	0.2	J	-0.01	0.06	0.13	U	0.34	*
PZ-100-SS TOT	0.01	0.09	0.25	U	0.07	0.11	0.19	U	0.08	0.14	0.24	U	ND	*
PZ-101-SS DIS	0.27	0.21	0.27	J	0.13	0.14	0.19	U	-0.01	0.06	0.18	U	0.27	*
PZ-101-SS EPA DIS														
PZ-101-SS MDNR DIS	-0.01	0.14	0.33	U	0.45	0.25	0.22	J	0.07	0.12	0.21	U	0.45	*
PZ-101-SS TOT	0.28	0.2	0.24	J	0.23	0.17	0.14	J	0.13	0.13	0.17	U	0.51	*
PZ-101-SS EPA TOT														
PZ-101-SS MDNR TOT	0.03	0.14	0.29	U	0.49	0.25	0.18		0.10	0.12	0.16	U	0.49	*
PZ-102R-SS DIS	0.14	0.15	0.22	U	0.09	0.1	0.13	U	0.05	0.09	0.14	U	ND	*
PZ-102R-SS TOT	0.13	0.13	0.17	UJ	0.31	0.19	0.13	J	0.36	0.2	0.11	J	0.67	*
PZ-102-SS DIS	0.14	0.15	0.21	U	0.21	0.18	0.19	J	0.03	0.07	0.14	U	0.21	*
PZ-102-SS MDNR DIS	0.05	0.11	0.21	U	0.17	0.16	0.17	J	0.07	0.10	0.15	U	0.17	*
PZ-102-SS MDNR FD DIS	0.11	0.14	0.23	U	0.06	0.11	0.19	U	0.03	0.09	0.19	U	ND	*
PZ-102-SS TOT	3.03	0.8	0.13		2.97	0.82	0.11		2.91	0.77	0.11		8.91	
PZ-102-SS EPA TOT														
PZ-102-SS MDNR TOT	0.63	0.30	0.23		0.81	0.34	0.13		0.66	0.30	0.14		2.10	
PZ-103-SS DIS	0.06	0.11	0.19	U	0.17	0.15	0.18	UJ	0.02	0.05	0.11	U	ND	*
PZ-103-SS TOT	0.23	0.16	0.16	J	1	0.37	0.15	J	0.37	0.2	0.1	J	1.60	
PZ-104-KS DIS	0.14	0.2	0.3	UJ	0.07	0.14	0.25	UJ	0.05	0.14	0.29	UJ	ND	*
PZ-104-KS TOT	0.06	0.1	0.18	U	0.24	0.16	0.12	J	0	0.07	0.19	U	0.24	*
PZ-104-SD DIS	0.22	0.17	0.19	J	0.17	0.15	0.17	J	0.03	0.08	0.17	U	0.39	*
PZ-104-SD MDNR DIS	-0.09	0.09	0.30	U	0.25	0.18	0.20	J	-0.02	0.06	0.20	U	0.25	*
PZ-104-SD TOT	0.12	0.13	0.18	U	0.21	0.17	0.17	J	0.05	0.08	0.12	U	0.21	*
PZ-104-SD EPA TOT														
PZ-104-SD MDNR TOT	0.10	0.14	0.24	U	0.02	0.07	0.15	U	-0.02	0.05	0.14	U	ND	*
PZ-104-SS DIS	0.05	0.1	0.19	U	0.22	0.17	0.12	J	0.11	0.11	0.12	U	0.22	*
PZ-104-SS FD DIS														
PZ-104-SS TOT	0.1	0.12	0.15	U	0.39	0.23	0.17	J	0.01	0.06	0.15	U	0.39	*
PZ-104-SS FD TOT														
PZ-105-SS DIS	0	0.06	0.18	U	0.16	0.15	0.17	U	0	0.06	0.18	U	ND	*
PZ-105-SS TOT	-0.05	0.09	0.28	UJ	0.17	0.19	0.26	UJ	-0.01	0.09	0.18	UJ	ND	*
PZ-106-KS DIS	-0.02	0.09	0.23	UJ	0.29	0.25	0.26	J	0.05	0.13	0.27	UJ	0.29	*
PZ-106-KS FD DIS	0.12	0.24	0.44	UJ	0.18	0.23	0.27	UJ	0.12	0.18	0.27	UJ	ND	*
PZ-106-KS MDNR DIS														
PZ-106-KS MDNR FD DIS														
PZ-106-KS TOT	-0.02	0.07	0.19	UJ	0.22	0.18	0.19	J	0.05	0.09	0.17	UJ	0.22	*
PZ-106-KS FD TOT	0.06	0.11	0.19	U	0.54	0.31	0.22	J	0.05	0.1	0.19	U	0.54	*
PZ-106-KS MDNR TOT														
PZ-106-SD DIS	0	0.08	0.18	U	0.17	0.15	0.17	J	0.03	0.08	0.17	U	0.17	*
PZ-106-SD TOT	0.1	0.14	0.21	U	0.17	0.16	0.19	U	0.08	0.11	0.17	U	ND	*
PZ-106-SS DIS	0.07	0.13	0.24	UJ	0.17	0.18	0.19	UJ	0.13	0.18	0.27	UJ	ND	*
PZ-106-SS TOT	0.04	0.1	0.2	U	0.09	0.11	0.16	U	0.03	0.07	0.14	U	ND	*
PZ-107-SS DIS	0	0.06	0.19	U	0.47	0.26	0.18	J	0.06	0.1	0.18	U	0.47	*
PZ-107-SS FD DIS														
PZ-107-SS TOT	0.5	0.27	0.14	J	0.99	0.42	0.14		1	0.41	0.2		2.49	
PZ-107-SS FD TOT														
PZ-109-SS DIS	0.02	0.2	0.43	UJ	0.14	0.19	0.3	UJ	0.06	0.12	0.22	UJ	ND	*
PZ-109-SS TOT	-0.04	0.11	0.31	U	0.13	0.15	0.21	U	0.04	0.1	0.19	U	ND	*
PZ-110-SS DIS	0.07	0.12	0.21	U	0.14	0.13	0.12	J	-0.01	0.06	0.14	U	0.14	*
PZ-110-SS TOT	0	0.06	0.17	UJ	0.25	0.17	0.12	J	0.1	0.1	0.11	UJ	0.25	*
PZ-111-KS DIS	0.07	0.12	0.2	U	0.41	0.25	0.2	J	0.06	0.09	0.14	U	0.41	*
PZ-111-KS TOT	-0.06	0.08	0.25	U	0.26	0.2	0.14	J	0.02	0.07	0.16	U	0.26	*
PZ-111-SD DIS	-0.08	0.12	0.36	U	0.11	0.15	0.23	U	0.12	0.14	0.2	U	ND	*
PZ-111-SD TOT	0.05	0.11	0.21	UJ	0.25	0.2	0.18	J	0.07	0.1	0.15	UJ	0.25	*
PZ-112-AS DIS	0.06	0.09	0.16	U	0.1	0.11	0.13	U	0.05	0.07	0.11	U	ND	*
PZ-112-AS EPA DIS														
PZ-112-AS TOT	0.17	0.15	0.16	J	0.21	0.17	0.19	J	0.1	0.12	0.17	U	0.38	*
PZ-112-AS EPA TOT														
PZ-113-AD DIS	0.29	0.19	0.13	J	0.1	0.11	0.11	U	0	0.05	0.11	U	0.29	*
PZ-113-AD FD DIS	0.31	0.23	0.21	J	0.16	0.15	0.16	J	0.06	0.1	0.14	U	0.47	*

February 2014

Sample ID	Thorium-228				Thorium-230				Thorium-232				TOTAL	
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Thorium 228 + 230 + 232	
D-85 MDNR DIS														
D-85 TOT														
D-85 EPA TOT														
D-85 MDNR TOT														
D-87 DIS														
D-87 FD DIS														
D-87 TOT														
D-87 FD TOT														
D-93 DIS														
D-93 MDNR DIS														
D-93 TOT														
D-93 EPA TOT														
D-93 MDNR TOT														
LR-100 DIS														
LR-100 FD DIS														
LR-100 TOT														
LR-100 FD TOT														
LR-103 DIS														
LR-103 TOT														
LR-104 DIS														
LR-104 FD DIS														
LR-104 TOT														
LR-104 FD TOT														
LR-105 DIS														
LR-105 TOT														
MW-102 DIS														
MW-102 EPA DIS														
MW-102 TOT														
MW-103 DIS														
MW-103 TOT														
MW-104 DIS														
MW-104 TOT														
MW-1204 DIS														
MW-1204 FD DIS														
MW-1204 TOT														
MW-1204 FD TOT														
PZ-100-KS DIS														
PZ-100-KS TOT														
PZ-100-SD DIS														
PZ-100-SD TOT														
PZ-100-SS DIS														
PZ-100-SS TOT														
PZ-101-SS DIS														
PZ-101-SS EPA DIS														
PZ-101-SS MDNR DIS														
PZ-101-SS TOT														
PZ-101-SS EPA TOT														
PZ-101-SS MDNR TOT														
PZ-102R-SS DIS														
PZ-102R-SS TOT														
PZ-102-SS DIS														
PZ-102-SS MDNR DIS														
PZ-102-SS MDNR FD DIS														
PZ-102-SS TOT														
PZ-102-SS EPA TOT														
PZ-102-SS MDNR TOT														
PZ-103-SS DIS														
PZ-103-SS TOT														
PZ-104-KS DIS														
PZ-104-KS TOT														
PZ-104-SD DIS														
PZ-104-SD MDNR DIS														
PZ-104-SD TOT														
PZ-104-SD EPA TOT														
PZ-104-SD MDNR TOT														
PZ-104-SS DIS														
PZ-104-SS FD DIS														
PZ-104-SS TOT														
PZ-104-SS FD TOT														
PZ-105-SS DIS														
PZ-105-SS TOT														
PZ-106-KS DIS														
PZ-106-KS FD DIS														
PZ-106-KS MDNR DIS														
PZ-106-KS MDNR FD DIS														
PZ-106-KS TOT														
PZ-106-KS FD TOT														
PZ-106-KS MDNR TOT														
PZ-106-SD DIS														
PZ-106-SD TOT														
PZ-106-SS DIS														
PZ-106-SS TOT														
PZ-107-SS DIS														
PZ-107-SS FD DIS														
PZ-107-SS TOT														
PZ-107-SS FD TOT														
PZ-109-SS DIS														
PZ-109-SS TOT														
PZ-110-SS DIS														
PZ-110-SS TOT														
PZ-111-KS DIS														
PZ-111-KS TOT														
PZ-111-SD DIS														
PZ-111-SD TOT														
PZ-112-AS DIS														
PZ-112-AS EPA DIS														
PZ-112-AS TOT														
PZ-112-AS EPA TOT														
PZ-113-AD DIS														
PZ-113-AD FD DIS														

Table 7-23: Summary of Thorium Isotope Results: 2012 - 2013 Groundwater Sampling Events

DRAFT

August 2012

Sample ID	Thorium-228 Result	CSU	MDA	FINAL Q	Thorium-230 Result	CSU	MDA	FINAL Q	Thorium-232 Result	CSU	MDA	FINAL Q	TOTAL Thorium 228 + 230 + 232	
PZ-113-AD MDNR DIS														
PZ-113-AD TOT	0.07	0.12	0.22	UJ	0.11	0.12	0.14	UJ	0.02	0.06	0.12	UJ	ND	*
PZ-113-AD FD TOT	0.21	0.16	0.14	J	0.67	0.30	0.11	J	0.02	0.05	0.11	UJ	0.87	*
PZ-113-AD EPA TOT														
PZ-113-AD MDNR TOT														
PZ-113-AS DIS	0.11	0.11	0.13	UJ	0.13	0.13	0.13	J	-0.01	0.06	0.13	UJ	0.13	*
PZ-113-AS EPA DIS	-0.05			U	0.5				-0.023			U	0.5	*
PZ-113-AS TOT	0.06	0.11	0.21	UJ	0.07	0.09	0.14	UJ	0.04	0.08	0.14	UJ	ND	*
PZ-113-SS DIS	0.01	0.06	0.15	U	0.28	0.19	0.12	J	0.03	0.08	0.17	U	0.28	*
PZ-113-SS TOT	0.01	0.09	0.24	UJ	0.15	0.16	0.17	UJ	-0.06	0.09	0.29	UJ	ND	*
PZ-114-AS DIS	0.12	0.20	0.34	U	0.52	0.32	0.31	J	-0.02	0.08	0.27	U	0.52	*
PZ-114-AS TOT	0.00	0.00	0.08	U	0.68	0.32	0.14	J	0.06	0.08	0.13	U	0.68	*
PZ-115-SS DIS	0.04	0.18	0.40	UJ	0.43	0.32	0.32	J	-0.03	0.10	0.27	UJ	0.43	*
PZ-115-SS TOT	0.18	0.21	0.31	U	0.75	0.40	0.25	J	0.01	0.09	0.23	U	0.75	*
PZ-116-SS DIS	0.01	0.09	0.21	UJ	0.35	0.21	0.17	J	-0.02	0.06	0.16	UJ	0.35	*
PZ-116-SS TOT	0.03	0.11	0.23	UJ	0.02	0.09	0.21	UJ	0.01	0.07	0.18	UJ	ND	*
PZ-200-SS DIS	0.11	0.16	0.26	U	0.43	0.24	0.13	J-	0.06	0.09	0.13	U	0.43	*
PZ-200-SS FD DIS	-0.03	0.07	0.24	U	0.18	0.15	0.13	J-	-0.02	0.06	0.18	U	0.18	*
PZ-200-SS TOT	0.14	0.15	0.23	UJ	0.40	0.21	0.14	J-	0.11	0.11	0.15	UJ	0.40	*
PZ-200-SS FD TOT	0.01	0.12	0.31	UJ	0.31	0.24	0.19	J-	0.07	0.11	0.17	UJ	0.31	*
PZ-201A-SS DIS	-0.05	0.07	0.23	U	0.21	0.17	0.15	J+	0.00	0.00	0.08	U	0.21	*
PZ-201A-SS FD DIS	0.09	0.12	0.17	U	0.17	0.14	0.12	J+	0.04	0.10	0.20	U	0.17	*
PZ-201A-SS TOT	0.13	0.17	0.25	U	0.18	0.18	0.23	UJ+	-0.03	0.08	0.22	U	ND	*
PZ-201A-SS FD TOT	0.06	0.09	0.13	U	0.19	0.17	0.19	J+	-0.01	0.06	0.13	U	0.19	*
PZ-202-SS DIS	0.00	0.12	0.29	U	0.28	0.22	0.27	J-	0.02	0.10	0.23	U	0.28	*
PZ-202-SS TOT	0.81	0.35	0.22		0.44	0.24	0.14	J-	0.90	0.36	0.12		2.15	
PZ-203-SS DIS	0.01	0.10	0.24	UJ	0.21	0.16	0.15	J+	0.13	0.13	0.15	UJ	0.21	*
PZ-203-SS TOT	0.17	0.19	0.28	U	0.20	0.19	0.23	UJ+	0.05	0.10	0.20	U	ND	*
PZ-204A-SS DIS	-0.04	0.09	0.30	U	0.17	0.18	0.24	UJ-	0.08	0.13	0.20	U	ND	*
PZ-204A-SS TOT	0.35	0.22	0.21	J	0.42	0.24	0.17	J-	0.06	0.10	0.16	UJ	0.77	*
PZ-204-SS DIS	-0.05	0.08	0.30	U	0.19	0.17	0.18	J	-0.02	0.07	0.18	U	0.19	*
PZ-204-SS TOT	0.11	0.15	0.24	UJ	0.11	0.13	0.20	UJ	0.13	0.13	0.17	UJ	ND	*
PZ-205-AS DIS	0.00	0.12	0.31	U	0.80	0.39	0.19		0.03	0.08	0.16	U	0.80	*
PZ-205-AS TOT	0.15	0.15	0.22	UJ	0.15	0.13	0.11	J	0.07	0.09	0.11	UJ	0.15	*
PZ-205-SS DIS	0.12	0.15	0.21	UJ	1.23	0.54	0.27	J-	0.03	0.12	0.29	UJ	1.23	*
PZ-205-SS TOT	0.18	0.21	0.27	UJ	2.76	1.01	0.21	J-	-0.01	0.10	0.21	UJ	2.76	*
PZ-206-SS DIS	0.00	0.13	0.30	U	0.10	0.13	0.20	U	-0.04	0.07	0.22	U	ND	*
PZ-206-SS EPA DIS	0			U	0.53				0.06			U	0.53	*
PZ-206-SS MDNR DIS														
PZ-206-SS TOT	0.14	0.14	0.19	UJ	0.41	0.22	0.15	J	0.07	0.09	0.11	UJ	0.41	*
PZ-206-SS MDNR TOT														
PZ-207-AS DIS	0.05	0.09	0.13	U	0.11	0.12	0.13	U	-0.01	0.06	0.13	U	ND	*
PZ-207-AS EPA DIS	0.18			U	0.49				-0.02			U	0.49	*
PZ-207-AS MDNR DIS														
PZ-207-AS TOT	0.08	0.14	0.24	U	0.23	0.21	0.24	U	0.00	0.12	0.29	U	ND	*
PZ-207-AS MDNR TOT														
PZ-207-AS MDNR FD TOT														
PZ-208-SS DIS	-0.01	0.13	0.26	UJ	0.37	0.34	0.37	J+	0.00	0.17	0.37	UJ	0.37	*
PZ-208-SS TOT	0.07	0.10	0.16	U	0.47	0.25	0.12	J+	0.06	0.10	0.18	U	0.47	*
PZ-209-SD DIS														
PZ-209-SD TOT														
PZ-209-SS DIS														
PZ-209-SS TOT														
PZ-210-SD DIS														
PZ-210-SD FD DIS														
PZ-210-SD TOT														
PZ-210-SD FD TOT														
PZ-210-SS DIS														
PZ-210-SS TOT														
PZ-211-SD DIS														
PZ-211-SD FD DIS														
PZ-211-SD TOT														
PZ-211-SD FD TOT														
PZ-211-SS DIS														
PZ-211-SS TOT														
PZ-212-SD DIS														
PZ-212-SD TOT														
PZ-212-SS DIS														
PZ-212-SS TOT														
PZ-302-AI DIS	-0.04	0.07	0.23	UJ	0.19	0.15	0.15	J	0.01	0.06	0.15	UJ	0.19	*
PZ-302-AI TOT	0.11	0.14	0.23	U	0.29	0.20	0.21	J	0.06	0.10	0.17	U	0.29	*
PZ-302-AS DIS														
PZ-302-AS TOT														
PZ-303-AS DIS	0.03	0.11	0.23	UJ	0.34	0.21	0.15	J	0.02	0.06	0.15	UJ	0.34	*
PZ-303-AS TOT	0.02	0.10	0.24	U	0.44	0.28	0.27	J	0.19	0.17	0.18	J	0.62	*
PZ-304-AI DIS	0.09	0.13	0.22	U	0.37	0.23	0.17	J-	0.11	0.13	0.17	U	0.37	*
PZ-304-AI FD DIS														
PZ-304-AI TOT	0.18	0.15	0.18	UJ	0.38	0.20	0.11	J-	-0.01	0.05	0.13	UJ	0.38	*
PZ-304-AI FD TOT														
PZ-304-AS DIS	-0.01	0.11	0.26	UJ	0.31	0.20	0.14	J-	0.03	0.08	0.16	UJ	0.31	*
PZ-304-AS TOT	0.13	0.15	0.22	U	0.21	0.16	0.16	J-	-0.01	0.05	0.14	U	0.21	*
PZ-305-AI DIS	-0.01	0.07	0.15	U	0.76	0.37	0.22	J	-0.01	0.07	0.15	U	0.76	*
PZ-305-AI FD DIS														
PZ-305-AI EPA DIS	0.26			U	0.61				0.09			U	0.61	*
PZ-305-AI TOT	0.61	0.27	0.12	J	0.71	0.30	0.11	J	0.63	0.27	0.12	J	1.94	
PZ-305-AI FD TOT														

April 2013

Sample ID	Thorium-228 Result	CSU	MDA	FINAL Q	Thorium-230 Result	CSU	MDA	FINAL Q	Thorium-232 Result	CSU	MDA	FINAL Q	TOTAL Thorium 228 + 230 + 232	
PZ-113-AD MDNR DIS														
PZ-113-AD TOT	0.12	0.09	0.09	J+	0.14	0.10	0.09	J	0.06	0.06	0.06	J	0.32	
PZ-113-AD FD TOT														
PZ-113-AD EPA TOT	0.204		0.624	U	0.637		0.782	U	-0.003		0.679	U	ND	*
PZ-113-AD MDNR TOT														
PZ-113-AS DIS	0.01	0.04	0.07	UJ	0.16	0.09	0.05	J+	0.02	0.03	0.05	UJ	0.16	*
PZ-113-AS EPA DIS														
PZ-113-AS TOT	0.10	0.08	0.07	J	0.23	0.12	0.06	J+	0.04	0.05	0.08	UJ	0.33	*
PZ-113-SS DIS	0.09	0.08	0.08	J	0.18	0.11	0.06	J+	0.03	0.05	0.08	U	0.27	*
PZ-113-SS TOT	1.09	0.32	0.10		2.37	0.59	0.08	J+	0.87	0.27	0.06		4.33	
PZ-114-AS DIS	-0.05	0.04	0.15	U	0.07	0.07	0.10	U	0.01	0.04	0.10	U	ND	*
PZ-114-AS TOT	0.03	0.06	0.11	UJ	0.13	0.08	0.07	J	0.02	0.03	0.06	UJ	0.13	*
PZ-115-SS DIS	0.04	0.06	0.09	U	0.21	0.12	0.06	J+	0.07	0.06	0.07	J	0.28	*
PZ-115-SS TOT	0.02	0.04	0.07	U	0.01	0.04	0.08	UJ+	-0.01	0.04	0.11	U	ND	*
PZ-116-SS DIS	0.03	0.05	0.07	U	0.08	0.08	0.07	J+	0.02	0.05	0.10	U	0.08	*
PZ-116-SS TOT	0.03	0.04	0.06	U	0.15	0.10	0.08	J+	0.03	0.05	0.09	U	0.15	*
PZ-200-SS DIS	0.03	0.07	0.13	U	0.10	0.08	0.07	J	-0.01	0.03	0.08	U	0.10	*
PZ-200-SS FD DIS														
PZ-200-SS TOT	0.00	0.06	0.15	U	0.14	0.10	0.11	J	0.01	0.04	0.10	U	0.14	*
PZ-200-SS FD TOT														
PZ-201A-SS DIS	0.03	0.07	0.13	U	0.08	0.08	0.10	U	-0.01	0.03	0.11	U	ND	*
PZ-201A-SS FD DIS														
PZ-201A-SS TOT	0.04	0.08	0.14	U	0.10	0.08	0.08	J	0.02	0.04	0.08	UJ	0.10	*
PZ-201A-SS FD TOT														
PZ-202-SS DIS	0.10	0.09	0.11	U	0.13	0.09	0.08	J+	0.01	0.03	0.06	U	0.13	*
PZ-202-SS TOT	0.16	0.11	0.13	J	0.39	0.17	0.10	J+	0.10	0.09	0.09	J	0.65	
PZ-203-SS DIS	0.02	0.04	0.07	U	0.22	0.12	0.06	J+	0.04	0.05	0.07	U	0.22	*
PZ-203-SS TOT	0.02	0.03	0.05	UJ	0.09	0.07	0.07	J+	0.03	0.04	0.05	UJ	0.09	*
PZ-204A-SS DIS	0.02	0.06	0.13	U	0.11	0.09	0.08	J	0.02	0.05	0.10	U	0.11	*
PZ-204A-SS TOT	0.37	0.19	0.17	J	0.39	0.19	0.12		0.12	0.11	0.12	J	0.88	
PZ-204-SS DIS	0.04	0.07	0.12	U	0.10	0.09	0.11	U	0.02	0.05	0.11	U	ND	*
PZ-204-SS TOT	0.22	0.11	0.06	J	0.22	0.11	0.07	J	0.08	0.07	0.09	UJ	0.44	*
PZ-205-AS DIS	-0.02	0.03	0.12	U	0.10	0.08	0.09	J	-0.01	0.03	0.08	U	0.10	*
PZ-205-AS TOT	0.31	0.15	0.11		0.36	0.17	0.09		0.10	0.08	0.09	J	0.77	
PZ-205-SS DIS	0.03	0.05	0.08	U	0.06	0.07	0.08	U	0.00	0.04	0.09	U	ND	*
PZ-205-SS TOT	-0.01	0.04	0.11	U	0.09	0.08	0.08	J	0.05	0.06	0.08	UJ	0.09	*
PZ-206-SS DIS	0.05	0.05	0.06	UJ	0.10	0.08	0.06	J	0.01	0.03	0.05	UJ	0.10	*
PZ-206-SS EPA DIS														
PZ-206-SS MDNR DIS														
PZ-206-SS TOT	0.10	0.08	0.06	J	0.13	0.09	0.08	J	0.01	0.03	0.07	UJ	0.23	*
PZ-206-SS MDNR TOT														
PZ-207-AS DIS	-0.01	0.06	0.13	UJ	0.15	0.14	0.13	J	0.02	0.06	0.13	UJ	0.15	*
PZ-207-AS EPA DIS														
PZ-207-AS MDNR DIS														
PZ-207-AS TOT	0.12	0.09	0.09	J	0.13	0.09	0.08	J	0.01	0.03	0.07	U	0.25	*
PZ-207-AS MDNR TOT														
PZ-207-AS MDNR FD TOT														
PZ-208-SS DIS	0.07	0.10	0.18	U	0.27	0.16	0.11	J+	-0.01	0.04	0.13	U	0.27	*
PZ-208-SS TOT	0.34	0.15	0.13	J	0.36	0.15	0.08	J+	0.36	0.15	0.09	J	1.06	
PZ-209-SD DIS														
PZ-209-SD TOT														
PZ-209-SS DIS														
PZ-209-SS TOT														
PZ-210-SD DIS														
PZ-210-SD FD DIS														
PZ-210-SD TOT														
PZ-210-SD FD TOT														
PZ-210-SS DIS														
PZ-210-SS TOT														
PZ-211-SD DIS														
PZ-211-SD FD DIS														
PZ-211-SD TOT														
PZ-211-SD FD TOT														
PZ-211-SS DIS														
PZ-211-SS TOT														
PZ-212-SD DIS														
PZ-212-SD TOT														
PZ-212-SS DIS														
PZ-212-SS TOT														
PZ-302-AI DIS	0.08	0.11	0.17	UJ	0.26	0.18	0.18	J	0.00	0.05	0.10	UJ	0.26	*
PZ-302-AI TOT	-0.04	0.06	0.20	UJ	0.25	0.17	0.13	J	0.06	0.08	0.11	UJ	0.25	*
PZ-302-AS DIS														
PZ-302-AS TOT														
PZ-303-AS DIS	-0.01	0.12	0.35	UJ	0.19	0.22	0.25	UJ+	-0.04	0.11	0.30	UJ	ND	*
PZ-303-AS TOT	1.03	0.50	0.21	J	1.70	0.72	0.26	J+	0.69	0.41	0.37	J	3.42	
PZ-304-AI DIS	-0.03	0.05	0.14	U	0.16	0.10	0.11	J+	0.00	0.03	0.08	U	0.16	*
PZ-304-AI FD DIS														
PZ-304-AI TOT	0.01	0.07	0.16	U	0.41	0.19	0.08	J+	0.01	0.03	0.08	U	0.41	*
PZ-304-AI FD TOT	0.00	0.05	0.11	U	0.29	0.19	0.11	J+	0.02	0.05	0.11	U	0.29	*
PZ-304-AS DIS	0.00	0.05	0.11	U	0.29	0.19	0.11	J+	0.02	0.05	0.11	U	0.29	*
PZ-304-AS TOT	0.04	0.06	0.11	U	0.17	0.12	0.10	J+	0.03	0.05	0.08	U	0.17	*
PZ-305-AI DIS	0.01	0.05	0.11	U	0.13	0.10	0.10	J	0.06	0.06	0.08	U	0.13	*
PZ-305-AI FD DIS	-0.01	0.04	0.09	U	0.05	0.06	0.09	U	0.05	0.06	0.08	U	ND	*
PZ-305-AI EPA DIS														
PZ-305-AI TOT	0.24	0.14	0.13	J	0.26	0.14	0.11	J	0.19	0.11	0.08	J	0.69	
PZ-305-AI FD TOT	0.29	0.14	0.08		0.33	0.15	0.07		0.28	0.14	0.08		0.90	

July 2013

Sample ID	Thorium-228 Result	CSU	MDA	FINAL Q	Thorium-230 Result	CSU	MDA	FINAL Q	Thorium-232 Result	CSU	MDA	FINAL Q	TOTAL Thorium 228 + 230 + 232	
PZ-113-AD MDNR DIS														
PZ-113-AD TOT	0.2	0.11	0.07	J	0.1	0.08	0.08	J	-0.04	0.04	0.14	U	0.3	*
PZ-113-AD FD TOT	0.19	0.11	0.12	J	0.12	0.09	0.08		0.02	0.04	0.07	UJ+	0.31	*
PZ-113-AD EPA TOT	0.0497	0.390	0.416	U	0.260	0.576	0.146	U	0.0428	0.215	0.224	U	ND	*
PZ-113-AD MDNR TOT														
PZ-113-AS DIS	0.09	0.08	0.09	J	0.1	0.07	0.06	J	0.04	0.05	0.07	UJ+	0.19	*
PZ-113-AS EPA DIS														
PZ-113-AS TOT	0.06	0.07	0.09	UJ	0.21	0.12	0.09	J	0.12	0.09	0.09	J+	0.33	*
PZ-113-SS DIS	0.05	0.07	0.12	U	0.12	0.08	0.07	J	0.03	0.06	0.1	UJ+	0.12	*
PZ-113-SS TOT	0.2	0.11	0.06	J	0.32	0.15	0.09	J	0.17	0.1	0.06	J+	0.69	
PZ-114-AS DIS	0.08	0.13	0.23	U	0.52	0.32	0.2	J+	0	0.11	0.23	U	0.52	*
PZ-114-AS TOT	0	0.04	0.13	UJ	0.35	0.18	0.12	J+	0.04	0.07	0.12	UJ	0.35	*
PZ-115-SS DIS	0.05	0.06	0.07	U	0.18	0.1	0.06	J+	0.04	0.05	0.07	U	0.18	*
PZ-115-SS TOT	0.02	0.05	0.1	U	0.12	0.09	0.08	J+	0.03	0.05	0.1	U	0.12	*
PZ-116-SS DIS	0.04	0.09	0.18	U	0.16	0.12	0.12	J+	0.01	0.05	0.13	U	0.16	*
PZ-116-SS TOT	0.03	0.05	0.1	U	0.22	0.12	0.08	J+	0.04	0.05	0.07	U	0.22	*
PZ-200-SS DIS	0.07	0.09	0.14	UJ	0.14	0.11	0.12	J-	0.02	0.05	0.08	UJ	0.14	*
PZ-200-SS FD DIS														
PZ-200-SS TOT	0.17	0.11	0.07	J	0.46	0.19	0.09	J-	0.24	0.12	0.07	J	0.87	
PZ-200-SS FD TOT														
PZ-201A-SS DIS	-0.02	0.05	0.15	U	0.11	0.09	0.08	J	0.02	0.04	0.08	U	0.11	*
PZ-201A-SS FD DIS														
PZ-201A-SS TOT	0	0.06	0.14	U	0.22	0.13	0.09	J	0.04	0.05	0.08	U	0.22	*
PZ-201A-SS FD TOT														
PZ-202-SS DIS	0.06	0.11	0.19	UJ	0.34	0.19	0.12	J+	0.05	0.07	0.11	UJ	0.34	*
PZ-202-SS TOT	0.05	0.07	0.1	UJ	0.09	0.09	0.09	J+	0.03	0.05	0.08	UJ	0.09	*
PZ-203-SS DIS	-0.02	0.05	0.15	U	0.74	0.29	0.11	J+	0.1	0.1	0.12	U	0.74	*
PZ-203-SS TOT	-0.01	0.05	0.14	U	0.58	0.23	0.11	J+	0.1	0.09	0.1	J	0.68	*
PZ-204A-SS DIS	0.04	0.06	0.1	U	0.42	0.19	0.08	J+	0.12	0.09	0.07	J	0.54	*
PZ-204A-SS TOT	0.37	0.21	0.15	J	0.49	0.25	0.14	J+	0.18	0.14	0.11	J	1.04	
PZ-204-SS DIS	0.01	0.07	0.16	U	0.55	0.24	0.13		0.06	0.08	0.11	U	0.55	*
PZ-204-SS TOT	0.09	0.07	0.06	J	0.29	0.14	0.08	J	0.03	0.05	0.07	UJ	0.38	*
PZ-205-AS DIS	0.02	0.05	0.1	U	0.62	0.24	0.09	J+	0.11	0.09	0.08	J	0.73	*
PZ-205-AS TOT	0.9	0.32	0.11		1.44	0.45	0.11	J+	0.79	0.29	0.08		3.13	
PZ-205-SS DIS	0.01	0.03	0.08	U	0.14	0.1	0.07	J	0.06	0.06	0.06	J+	0.20	*
PZ-205-SS TOT	0.03	0.06	0.11	U	0.04	0.06	0.09	U	0	0.03	0.07	UJ+	ND	*
PZ-206-SS DIS	0.07	0.07	0.07	J	0.13	0.11	0.12	J	0.03	0.07	0.15	U	0.20	*
PZ-206-SS EPA DIS														
PZ-206-SS MDNR DIS	0.03	0.08	0.17	U	0.77	0.32	0.18		0.11	0.11	0.12	U	0.77	*
PZ-206-SS TOT	0.15	0.09	0.07	J	0.17	0.09	0.06	J	0.1	0.07	0.05	J	0.42	
PZ-206-SS MDNR TOT	0.06	0.11	0.21	U	0.65	0.28	0.15		0.20	0.15	0.14	J	0.85	*
PZ-207-AS DIS	0.05	0.07	0.1	U	0.24	0.14	0.1	J	0.05	0.06	0.1	U	0.24	*
PZ-207-AS EPA DIS														
PZ-207-AS MDNR DIS	0.00	0.13	0.28	U	0.95	0.47	0.33		0.07	0.19	0.39	U	0.95	*
PZ-207-AS TOT	0.04	0.06	0.1	U	0.22	0.13	0.07	J	0	0.04	0.11	U	0.22	*
PZ-207-AS MDNR TOT	0.04	0.09	0.18	U	0.95	0.38	0.15		0.31	0.21	0.13	J	1.27	*
PZ-207-AS MDNR FD TOT	0.02	0.09	0.20	U	0.87	0.35	0.16		0.25	0.18	0.19	J	1.13	*
PZ-208-SS DIS	0.09	0.08	0.08	J	0.43	0.18	0.09	J+	0.09	0.08	0.06	J	0.61	
PZ-208-SS TOT	0.21	0.14	0.11	J	0.7	0.28	0.11	J+	0.25	0.15	0.08	J	1.16	
PZ-209-SD DIS														
PZ-209-SD TOT														
PZ-209-SS DIS														
PZ-209-SS TOT														
PZ-210-SD DIS														
PZ-210-SD FD DIS														
PZ-210-SD TOT														
PZ-210-SD FD TOT														
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PZ-211-SD DIS														
PZ-211-SD FD DIS														
PZ-211-SD TOT														
PZ-211-SD FD TOT														
PZ-211-SS DIS														
PZ-211-SS TOT														
PZ-212-SD DIS														
PZ-212-SD TOT														
PZ-212-SS DIS														
PZ-212-SS TOT														
PZ-302-AI DIS	0	0.03	0.07	U	0.57	0.22	0.06	J+	0.07	0.07	0.07	J	0.64	*
PZ-302-AI TOT	0.12	0.09	0.07	J	0.59	0.24	0.1	J+	0.15	0.11	0.1	J	0.86	
PZ-302-AS DIS	0.01	0.04	0.1	U	0.26	0.13	0.07		0.05	0.06	0.06	U	0.26	*
PZ-302-AS TOT	0.17	0.12	0.11	J	0.43	0.2	0.08	J	0.22	0.14	0.11	J	0.82	
PZ-303-AS DIS	0.01	0.06	0.15	U	0.35	0.17	0.09	J+	0.01	0.03	0.08	U	0.35	*
PZ-303-AS TOT	0.07	0.09	0.13	U	0.66	0.26	0.09	J+	0.13	0.11	0.11	J	0.79	*
PZ-304-AI DIS	0.07	0.08	0.11	U	0.25	0.14	0.08	J+	0.06	0.07	0.07	U	0.25	*
PZ-304-AI FD DIS														
PZ-304-AI TOT	0.1	0.09	0.07	J	0.62	0.25	0.1	J+	0.05	0.06	0.07	U	0.72	*
PZ-304-AI FD TOT														
PZ-304-AS DIS	0.09	0.1	0.12	UJ	0.64	0.27	0.1	J+	0.1	0.09	0.09	J	0.74	*
PZ-304-AS TOT	0.03	0.06	0.12	UJ	0.64	0.27	0.11	J+	0.15	0.12	0.13	J	0.79	*
PZ-305-AI DIS	-0.03	0.04	0.14	U	0.04	0.07	0.12	U	-0.02	0.04	0.11	U	ND	*
PZ-305-AI FD DIS														
PZ-305-AI EPA DIS														
PZ-305-AI TOT	-0.02	0.09	0.24	UJ	0.05	0.1	0.17	UJ	-0.02	0.05	0.14	UJ	ND	*
PZ-305-AI FD TOT														

October 2013

Sample ID	Thorium-228 Result	CSU	MDA	FINAL Q	Thorium-230 Result	CSU	MDA	FINAL Q	Thorium-232 Result	CSU	MDA	FINAL Q	TOTAL Thorium 228 + 230 + 232	
PZ-113-AD MDNR DIS	0.14	0.14	0.16	U	0.03	0.08	0.16	U	0.05	0.08	0.11	U	ND	*
PZ-113-AD TOT	0.09	0.12	0.18	UJ	0.16	0.13	0.14	J	0.04	0.06	0.09	UJ	0.16	*
PZ-113-AD FD TOT	0.06	0.11	0.19	U	0.25	0.18	0.17	J	0.05	0.08	0.12	U	0.25	*
PZ-113-AD EPA TOT														
PZ-113-AD MDNR TOT	0.01	0.12	0.29	U	0.15	0.16	0.16	U	-0.01	0.08	0.19	U	ND	*
PZ-113-AS DIS	0.05	0.09	0.16	U	0.25	0.16	0.11	J	0.12	0.11	0.12	J	0.37	*
PZ-113-AS EPA DIS														
PZ-113-AS TOT	0.06	0.13	0.25	U	0.14	0.13	0.12	J	-0.02	0.06	0.16	U	0.14	*
PZ-113-SS DIS	0.02	0.1	0.23	U	0.18	0.17	0.23	U	0.06	0.09	0.13	U	ND	*
PZ-113-SS TOT	0.16	0.15	0.17	U	0.43	0.23	0.16	J	0.18	0.14	0.11	J	0.61	*
PZ-114-AS DIS	-0.01	0.14	0.34	U	0.29	0.23	0.24	J	-0.01	0.07	0.18	U	0.29	*
PZ-114-AS TOT	0.1	0.12	0.17	U	0.34	0.2	0.14	J	0.02	0.05	0.11	U	0.34	*
PZ-115-SS DIS	-0.01	0.09	0.21	UJ	0.1	0.15	0.24	UJ	0	0.12	0.25	UJ	ND	*
PZ-115-SS TOT	0.18	0.17	0.19	U	0.19	0.17	0.18	J	0.07	0.11	0.2	U	0.19	*
PZ-116-SS DIS	0	0.14	0.31	UJ	0.3	0.27	0.3	J	0.15	0.2	0.3	UJ	0.30	*
PZ-116-SS TOT	0.03	0.09	0.19	U	0.27	0.19	0.18	J	0.04	0.08	0.15	U	0.27	*
PZ-200-SS DIS	0	0.06	0.18	U	0.18	0.15	0.14	J	0.03	0.08	0.16	U	0.18	*
PZ-200-SS FD DIS														
PZ-200-SS TOT	0.21	0.19	0.23	U	0.25	0.19	0.15	J	0.19	0.19	0.25	U	0.25	*
PZ-200-SS FD TOT														
PZ-201A-SS DIS	0.1	0.17	0.28	UJ	0.16	0.2	0.24	UJ	0	0.16	0.35	UJ	ND	*
PZ-201A-SS FD DIS														
PZ-201A-SS TOT	-0.02	0.07	0.2	U	0.3	0.22	0.18	J	0.06	0.1	0.15	U	0.30	*
PZ-201A-SS FD TOT														
PZ-202-SS DIS	-0.02	0.06	0.17	U	0.12	0.12	0.15	U	0	0.06	0.16	U	ND	*
PZ-202-SS TOT	0.06	0.16	0.36	U	0.11	0.19	0.33	U	0.05	0.11	0.23	U	ND	*
PZ-203-SS DIS	0.01	0.08	0.22	U	0.03	0.07	0.15	U	0.04	0.1	0.22	U	ND	*
PZ-203-SS TOT	-0.03	0.05	0.16	UJ	0.17	0.13	0.14	J	-0.02	0.05	0.14	UJ	0.17	*
PZ-204A-SS DIS	0.09	0.15	0.25	UJ	0.42	0.32	0.31	J	0.05	0.14	0.31	UJ	0.42	*
PZ-204A-SS TOT	0.42	0.23	0.17	J	0.29	0.19	0.13	J	0.02	0.05	0.11	U	0.71	*
PZ-204-SS DIS	0.17	0.16	0.2	U	0.45	0.24	0.16	J	-0.01	0.08	0.22	U	0.45	*
PZ-204-SS TOT	0.17	0.15	0.17	J	0.35	0.2	0.11	J	0.22	0.16	0.16	J	0.74	
PZ-205-AS DIS	0.02	0.07	0.15	U	0.07	0.11	0.18	U	0.03	0.09	0.19	U	ND	*
PZ-205-AS TOT	0.64	0.28	0.14	J	0.81	0.32	0.15	J	0.45	0.23	0.13	J	1.90	
PZ-205-SS DIS	0.13	0.28	0.53	UJ	0.08	0.21	0.43	UJ	0.15	0.2	0.31	UJ	ND	*
PZ-205-SS TOT	0.22	0.19	0.24	U	0.33	0.22	0.19	J	0.03	0.06	0.13	U	0.33	*
PZ-206-SS DIS	0.07	0.13	0.24	U	0.4	0.28	0.19	J	0.22	0.2	0.19	J	0.62	*
PZ-206-SS EPA DIS														
PZ-206-SS MDNR DIS														
PZ-206-SS TOT	-0.01	0.13	0.31	U	0.18	0.16	0.2	U	0.06	0.11	0.2	U	ND	*
PZ-206-SS MDNR TOT														
PZ-207-AS DIS	0.05	0.09	0.17	U	0.05	0.09	0.15	U	0.03	0.09	0.19	U	ND	*
PZ-207-AS EPA DIS														
PZ-207-AS MDNR DIS														
PZ-207-AS TOT	0	0.06	0.18	U	0.07	0.1	0.13	U	0.08	0.11	0.17	U	ND	*
PZ-207-AS MDNR TOT														
PZ-207-AS MDNR FD TOT														
PZ-208-SS DIS	0.02	0.06	0.15	U	0.25	0.18	0.17	J	0.03	0.08	0.18	U	0.25	*
PZ-208-SS TOT	0.08	0.12	0.19	U	0.28	0.2	0.17	J	0.29	0.21	0.2	J	0.57	*
PZ-209-SD DIS	0.15	0.14	0.13	J	0.16	0.15	0.19	UJ	0.06	0.11	0.19	U	0.15	*
PZ-209-SD TOT	0.24	0.23	0.21	J	0.3	0.27	0.3	J	0.09	0.14	0.21	UJ	0.54	*
PZ-209-SS DIS	0.05	0.09	0.16	U	0.32	0.19	0.11	J	0.05	0.07	0.11	U	0.32	*
PZ-209-SS TOT	-0.03	0.16	0.5	UJ	0.28	0.3	0.3	UJ	0.15	0.25	0.43	UJ	ND	*
PZ-210-SD DIS	0.12	0.13	0.16	U	0.33	0.22	0.18	J	0.04	0.09	0.18	U	0.33	*
PZ-210-SD FD DIS	1.59	0.84	0.48	J	2.74	1.22	0.47	J	1.4	0.76	0.33	J	5.73	
PZ-210-SD TOT	0.03	0.09	0.19	U	0.16	0.14	0.14	J	-0.04	0.08	0.24	U	0.16	*
PZ-210-SD FD TOT	0.03	0.08	0.17	U	0.25	0.18	0.14	J	-0.01	0.06	0.14	U	0.25	*
PZ-210-SS DIS	0.03	0.09	0.2	U	0.13	0.14	0.19	U	-0.01	0.06	0.14	U	ND	*
PZ-210-SS TOT	0	0.06	0.17	U	0.25	0.18	0.14	J	0.02	0.06	0.14	U	0.25	*
PZ-211-SD DIS	0.57	0.29	0.23	J	0.95	0.39	0.18	J	0.85	0.35	0.14		2.37	
PZ-211-SD FD DIS														
PZ-211-SD TOT	6.82	1.87	0.35	J	7.98	2.22	0.27	J	7.11	1.91	0.19	J	21.91	
PZ-211-SD FD TOT														
PZ-211-SS DIS	-0.02	0.09	0.24	UJ	0.01	0.09	0.25	UJ	0.04	0.09	0.19	UJ	ND	*
PZ-211-SS TOT	-0.03	0.06	0.22	U	0.14	0.13	0.16	U	0.02	0.05	0.11	U	ND	*
PZ-212-SD DIS	0.11	0.12	0.15	U	0.26	0.19	0.17	J	0.01	0.06	0.17	U	0.26	*
PZ-212-SD TOT	0.23	0.26	0.39	UJ	0.28	0.26	0.29	UJ	0.01	0.22	0.5	UJ	ND	*
PZ-212-SS DIS	0.01	0.07	0.18	UJ	0.17	0.13	0.1	J	0.02	0.05	0.12	UJ	0.17	*
PZ-212-SS TOT	0.36	0.21	0.18	J	0.25	0.17	0.13	J	0	0.06	0.16	UJ	0.61	*
PZ-302-AI DIS	0.09	0.13	0.2	U	0.27	0.19	0.13	J	0.09	0.1	0.13	U	0.27	*
PZ-302-AI TOT	0.12	0.12	0.14	UJ	0.17	0.14	0.11	J	0.13	0.12	0.15	UJ	0.17	*
PZ-302-AS DIS	0.06	0.1	0.17	UJ	0.16	0.14	0.13	J	0	0.08	0.17	UJ	0.16	*
PZ-302-AS TOT	1.06	0.45	0.18		0.94	0.43	0.22		0.73	0.36	0.22		2.73	
PZ-303-AS DIS	0.01	0.07	0.2	U	0.15	0.15	0.16	UJ	-0.01	0.07	0.14	U	ND	*
PZ-303-AS TOT	0.13	0.13	0.14	U	0.32	0.21	0.13	J	0.16	0.16	0.19	U	0.32	*
PZ-304-AI DIS	0.04	0.09	0.19	U	0.33	0.22	0.15	J	0.03	0.06	0.13	U	0.33	*
PZ-304-AI FD DIS	0.2	0.16	0.18	J	0.16	0.14	0.12	J	0.07	0.1	0.13	U	0.36	*
PZ-304-AI TOT	0.09	0.13	0.19	UJ	0.4	0.26	0.23	J	0.05	0.1	0.2	UJ	0.4	*
PZ-304-AI FD TOT	0	0.09	0.21	UJ	0.09	0.09	0.1	UJ	0.01	0.05	0.13	UJ	ND	*
PZ-304-AS DIS	-0.03	0.07	0.21	U	0.24	0.19	0.17	J	0	0.07	0.19	U	0.24	*
PZ-304-AS TOT	0.16	0.18	0.26	U	0.21	0.18	0.15	J	-0.04	0.08	0.28	U	0.21	*
PZ-305-AI DIS	-0.06	0.08	0.25	UJ	0.22	0.18	0.21	J	0.06	0.08	0.13	UJ	0.22	*
PZ-305-AI FD DIS														
PZ-305-AI EPA DIS														
PZ-305-AI TOT	0.17	0.15	0.2	UJ	0.22	0.15	0.12	J	0.06	0.09	0.14	UJ	0.22	*
PZ-305-AI FD TOT														

February 2014

Sample ID	Thorium-228 Result	CSU	MDA	FINAL Q	Thorium-230 Result	CSU	MDA	FINAL Q	Thorium-232 Result	CSU	MDA	FINAL Q	TOTAL Thorium 228 + 230 + 232	
PZ-113-AD MDNR DIS														
PZ-113-AD TOT														
PZ-113-AD FD TOT														
PZ-113-AD EPA TOT														
PZ-113-AD MDNR TOT														
PZ-113-AS DIS														
PZ-113-AS EPA DIS														
PZ-113-AS TOT														
PZ-113-SS DIS														
PZ-113-SS TOT														
PZ-114-AS DIS														
PZ-114-AS TOT														
PZ-115-SS DIS														
PZ-115-SS TOT														
PZ-116-SS DIS														
PZ-116-SS TOT														
PZ-200-SS DIS														
PZ-200-SS FD DIS														
PZ-200-SS TOT														
PZ-200-SS FD TOT														
PZ-201A-SS DIS														
PZ-201A-SS FD DIS														
PZ-201A-SS TOT														
PZ-201A-SS FD TOT														
PZ-202-SS DIS														
PZ-202-SS TOT														
PZ-203-SS DIS														
PZ-203-SS TOT														
PZ-204A-SS DIS														
PZ-204A-SS TOT														
PZ-204-SS DIS														
PZ-204-SS TOT														
PZ-205-AS DIS														
PZ-205-AS TOT														
PZ-205-SS DIS														
PZ-205-SS TOT														
PZ-206-SS DIS														
PZ-206-SS EPA DIS														
PZ-206-SS MDNR DIS														
PZ-206-SS TOT														
PZ-206-SS MDNR TOT														
PZ-207-AS DIS														
PZ-207-AS EPA DIS														
PZ-207-AS MDNR DIS														
PZ-207-AS TOT														
PZ-207-AS MDNR TOT														
PZ-207-AS MDNR FD TOT														
PZ-208-SS DIS														
PZ-208-SS TOT														
PZ-209-SD DIS	0.13	0.10	0.11	J	0.06	0.07	0.10	U	0.07	0.07	0.07	J	0.20	*
PZ-209-SD TOT	0.12	0.16	0.21	UJ	0.10	0.15	0.25	UJ	0.13	0.18	0.26	UJ	ND	*
PZ-209-SS DIS	0.03	0.07	0.13	U	0.20	0.13	0.08	J	0.03	0.05	0.09	U	0.20	*
PZ-209-SS TOT	0.01	0.03	0.08	U	0.08	0.08	0.09	U	0.02	0.04	0.08	U	ND	*
PZ-210-SD DIS	0.02	0.05	0.11	U	0.05	0.07	0.11	U	0.02	0.05	0.11	U	ND	*
PZ-210-SD FD DIS														
PZ-210-SD TOT	0.05	0.08	0.14	U	0.34	0.17	0.07		0.06	0.07	0.09	U	0.34	*
PZ-210-SD FD TOT														
PZ-210-SS DIS	0.05	0.08	0.13	U	0.08	0.09	0.11	U	0.03	0.05	0.10	U	ND	*
PZ-210-SS TOT	0.04	0.08	0.14	U	0.09	0.10	0.13	U	0.15	0.12	0.13	J	0.15	*
PZ-211-SD DIS	0.07	0.07	0.09	U	0.08	0.07	0.08	J	0.00	0.03	0.07	U	0.08	*
PZ-211-SD FD DIS	0.03	0.08	0.16	U	0.02	0.06	0.14	U	0.04	0.08	0.14	U	ND	*
PZ-211-SD TOT	0.04	0.07	0.12	U	0.06	0.07	0.09	U	0.10	0.08	0.09	J	0.10	*
PZ-211-SD FD TOT	0.12	0.11	0.12	J	0.22	0.14	0.12	J	0.15	0.11	0.08	J	0.49	
PZ-211-SS DIS	-0.07	0.04	0.17	U	0.08	0.08	0.10	U	0.03	0.05	0.09	U	ND	*
PZ-211-SS TOT	0.03	0.07	0.13	U	0.05	0.07	0.10	U	0.02	0.04	0.09	U	ND	*
PZ-212-SD DIS	0.08	0.09	0.12	U	0.05	0.07	0.08	U	0.05	0.07	0.09	U	ND	*
PZ-212-SD TOT	0.10	0.09	0.11	U	0.09	0.09	0.11	U	0.16	0.11	0.09	J	0.16	*
PZ-212-SS DIS	-0.01	0.04	0.12	U	0.09	0.08	0.08	J	0.04	0.06	0.08	U	0.09	*
PZ-212-SS TOT	0.01	0.05	0.11	U	0.16	0.11	0.10	J	0.11	0.09	0.08	J	0.27	*
PZ-302-AI DIS														
PZ-302-AI TOT														
PZ-302-AS DIS														
PZ-302-AS TOT														
PZ-303-AS DIS														
PZ-303-AS TOT														
PZ-304-AI DIS														
PZ-304-AI FD DIS														
PZ-304-AI TOT														
PZ-304-AI FD TOT														
PZ-304-AS DIS														
PZ-304-AS TOT														
PZ-305-AI DIS														
PZ-305-AI FD DIS														
PZ-305-AI EPA DIS														
PZ-305-AI TOT														
PZ-305-AI FD TOT														

Notes:

All values are in units of picoCuries per liter (pCi/L). EPA and MDNR data are not validated.

DIS = dissolved (filtered) sample; TOT = total (unfiltered) sample

[yellow box] Indicates that CSUs and MDAs were not available for the EPA split sample results.

CSU = Combined Standard Uncertainty (2-sigma); MDA = Minimum Detectable Activity

Data Validation Qualifiers (Final Q) include: U = Non-detect at the reported value, UJ = Non-Detect at the estimated reported value,
UJ+ = Non-Detect at the estimated reported value which may be biased high;
UJ- = Non-Detect at the estimated reported value which may be biased low;
J = estimated result; J+ = estimated result which may be biased high; R = rejected, data not usable; G = the sample MDA is greater than the requested reporting limit

Total Thorium-228 plus Thorium-230 plus Thorium-232 = the sum of the Th-228, Th-230, and Th-232 results unless one or more of the results was non-detect, in which case only the detected results are included in the sum and the Total Thorium-228 plus Thorium-230 plus Thorium-232 value is flagged with a *.

ND = Non-Detect, indicating that Thorium-228, Thorium-230, and Thorium-232 were not detected in the sample.

Table 7-24: Summary of Uranium Isotope Results: 2012 - 2013 Groundwater Sampling Events

DRAFT

August 2012

Sample ID	U-234 Result	U-234 CSU	U-234 MDA	U-234 FINAL Q	U-235 Result	U-235 CSU	U-235 MDA	U-235 FINAL Q	U-238 Result	U-238 CSU	U-238 MDA	U-238 FINAL Q	TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)
S-5 DIS	0.29	0.32	0.43	UJ	0.09	0.25	0.53	UJ	0.11	0.21	0.37	UJ	ND	*	ND
S-5 MDNR DIS	0.20	0.19	0.19	J	0.15	0.18	0.24	U	0.16	0.17	0.19	U	0.20	*	0.68
S-5 TOT	0.99	0.72	0.66	J	0.00	0.38	0.81	UJ	0.19	0.31	0.49	UJ	0.99	*	1.84
S-5 EPA TOT															
S-5 MDNR TOT	-0.01	0.08	0.17	U	0.00	0.13	0.28	U	0.00	0.10	0.22	U	ND		ND
S-8 DIS	0.79	0.33	0.22		0.29	0.22	0.17	J	0.74	0.32	0.18		1.82		2.33
S-8 TOT	1.79	0.91	0.50	J	0.06	0.25	0.62	UJ	2.36	1.06	0.50	J	4.15	*	7.31
S-10 DIS	0.73	0.37	0.21	J	0.16	0.21	0.32	UJ	0.78	0.39	0.26	J	1.51	*	2.49
S-10 TOT	1.00	0.44	0.22	J	0.20	0.21	0.22	UJ	0.83	0.39	0.20	J	1.84	*	2.59
S-53 DIS															
S-53 TOT															
S-61 DIS	1.32	0.44	0.16		0.22	0.19	0.16	J	0.86	0.35	0.19		2.40		2.68
S-61 EPA DIS	0.96				0.048			U	0.84				1.80	*	need MDAs
S-61 TOT	1.47	0.46	0.18		0.04	0.10	0.22	U	1.28	0.42	0.13		2.76	*	3.93
S-82 DIS	0.34	0.30	0.32	J	0.04	0.16	0.40	UJ	0.17	0.21	0.27	UJ	0.34	*	1.00
S-82 MDNR DIS															
S-82 TOT	1.21	0.52	0.29	J	0.06	0.17	0.37	UJ	0.98	0.46	0.22	J	2.18	*	3.08
S-82 EPA TOT															
S-84 DIS	0.09	0.11	0.13	U	-0.01	0.08	0.19	U	0.01	0.07	0.18	U	ND		ND
S-84 FD DIS															
S-84 TOT	0.57	0.30	0.21	J	0.06	0.12	0.23	UJ	0.33	0.22	0.20	J	0.89	*	1.07
S-84 FD TOT															
I-4 DIS	0.12	0.34	0.73	UJ	0.00	0.42	0.90	UJ	0.00	0.34	0.73	UJ	ND		ND
I-4 FD DIS															
I-4 MDNR DIS	0.10	0.12	0.19	U	0.03	0.07	0.15	U	0.03	0.08	0.16	U	ND		ND
I-4 MDNR FD DIS	0.00	0.22	0.47	U	0.00	0.27	0.57	U	-0.04	0.16	0.40	U	ND		ND
I-4 TOT	0.22	0.38	0.67	UJ	0.00	0.38	0.83	UJ	0.11	0.31	0.67	UJ	ND		ND
I-4 FD TOT															
I-4 EPA TOT															
I-4 MDNR TOT	0.28	0.19	0.17	J	-0.02	0.08	0.21	U	0.02	0.07	0.17	U	0.28	*	0.60
I-9 DIS	0.37	0.29	0.24	J	0.00	0.19	0.40	UJ	0.00	0.15	0.33	UJ	0.37	*	1.16
I-9 FD DIS	0.32	0.24	0.19	J	-0.04	0.11	0.30	UJ	0.02	0.09	0.22	UJ	0.32	*	0.78
I-9 MDNR DIS	0.36	0.29	0.24	J	0.12	0.19	0.30	U	0.15	0.18	0.24	U	0.36	*	0.85
I-9 TOT	0.20	0.17	0.16	J	0.04	0.12	0.26	U	0.11	0.14	0.21	UJ	0.20	*	0.75
I-9 FD TOT	0.37	0.24	0.18	J	-0.02	0.09	0.23	U	0.11	0.14	0.22	U	0.37	*	0.76
I-9 EPA TOT															
I-9 MDNR TOT	0.44	0.26	0.17		-0.01	0.10	0.31	U	0.07	0.10	0.17	U	0.44	*	0.64
I-11 DIS	0.58	0.31	0.18	J	0.04	0.10	0.22	U	0.73	0.35	0.17		1.31	*	2.28
I-11 EPA DIS	0.94				0.1				0.62				1.66		need MDAs
I-11 TOT	1.19	0.53	0.23	J	0.06	0.18	0.39	UJ	0.94	0.47	0.31	J	2.13	*	2.97
I-62 DIS	0.31	0.20	0.19	J	0.13	0.14	0.16	U	0.19	0.15	0.13	J	0.50	*	0.65
I-62 FD DIS															
I-62 TOT	0.37	0.24	0.21	J	0.08	0.12	0.20	U	0.31	0.23	0.24	J	0.68	*	1.02
I-62 FD TOT															
I-65 DIS	0.82	0.30	0.18	J	0.05	0.08	0.14	UJ	0.71	0.28	0.16	J	1.53	*	2.18
I-65 FD DIS															
I-65 TOT	1.34	0.41	0.11	J	0.05	0.09	0.17	UJ	1.10	0.36	0.13	J	2.44	*	3.35
I-65 FD TOT															
I-66 DIS	0.71	0.28	0.15	J	0.06	0.09	0.14	UJ	0.29	0.18	0.15	J	1.00	*	0.92
I-66 TOT	0.88	0.35	0.14		0.03	0.08	0.17	U	0.55	0.27	0.18		1.43	*	1.72
I-67 DIS	0.75	0.31	0.17	J	0.00	0.10	0.21	UJ	0.82	0.32	0.15	J	1.57	*	2.53
I-67 FD DIS															
I-67 TOT	0.85	0.34	0.20		0.07	0.13	0.22	U	0.74	0.32	0.21		1.59	*	2.32
I-67 FD TOT															
I-68 DIS	1.24	0.46	0.20		0.19	0.20	0.25	U	0.89	0.38	0.24		2.13	*	2.77
I-68 TOT	2.47	1.49	1.05	J	-0.11	0.44	1.13	UJ	3.04	1.67	0.91	J	5.52	*	9.60
I-73 DIS	1.32	0.45	0.14		0.02	0.08	0.21	U	0.76	0.33	0.15		2.08	*	2.37
I-73 TOT	1.39	0.50	0.16	J	0.12	0.16	0.22	UJ	0.99	0.41	0.21	J	2.39	*	3.06
D-3 DIS	0.08	0.14	0.26	UJ	0.03	0.13	0.32	UJ	0.14	0.17	0.22	UJ	ND		ND
D-3 FD DIS	0.17	0.17	0.20	UJ	-0.01	0.09	0.19	UJ	0.07	0.10	0.15	UJ	ND		ND
D-3 EPA DIS	0.18				0			U	0.065			U	0.18	*	need MDAs
D-3 MDNR DIS															
D-3 TOT	0.19	0.26	0.40	UJ	-0.04	0.16	0.41	UJ	0.16	0.26	0.45	UJ	ND		ND
D-3 FD TOT	0.16	0.22	0.34	UJ	0.18	0.23	0.32	UJ	-0.20	0.15	0.56	UJ	ND		ND
D-3 EPA TOT															
D-3 MDNR TOT															
D-6 DIS	0.25	0.22	0.26	U	0.03	0.10	0.24	U	0.05	0.21	0.43	U	ND		ND
D-6 FD DIS	0.33	0.22	0.20	J	0.11	0.14	0.18	U	0.14	0.15	0.19	U	0.33	*	0.66
D-6 EPA DIS	0.16				0			U	0.103				0.26	*	need MDAs
D-6 EPA FD DIS	0.15				0			U	0.1			U	0.15	*	need MDAs
D-6 MDNR DIS															
D-6 TOT	0.19	0.17	0.16	J	0.13	0.17	0.25	U	0.07	0.12	0.21	U	0.19	*	0.73
D-6 FD TOT	0.36	0.21	0.13	J	-0.01	0.07	0.16	U	0.17	0.15	0.17	J	0.53	*	0.58
D-6 EPA TOT															
D-6 MDNR TOT															
D-12 DIS	0.12	0.16	0.23	U	-0.02	0.10	0.25	U	0.21	0.19	0.20	J	0.21	*	0.75
D-12 FD DIS															
D-12 EPA DIS	0.15			U	0.009			U	0.12			U	ND		need MDAs
D-12 TOT	0.05	0.11	0.22	U	0.19	0.19	0.20	U	0.12	0.16	0.24	U	ND		ND
D-12 FD TOT															
D-13 DIS	0.27	0.23	0.24	J	0.10	0.18	0.31	UJ	-0.01	0.08	0.19	UJ	0.27	*	0.71
D-13 FD DIS	0.11	0.15	0.22	UJ	0.08	0.15	0.27	UJ	0.07	0.12	0.19	UJ	ND		ND
D-13 TOT	0.17	0.15	0.17	J	-0.01	0.07	0.16	U	0.04	0.08	0.16	U	0.17	*	0.56
D-13 FD TOT	0.12	0.13	0.18	U	0.02	0.07	0.19	U	0.10	0.13	0.20	U	ND		ND
D-14 DIS															
D-14 TOT	1.36	0.68	0.43	J	0.00	0.25	0.55	UJ	1.51	0.72	0.39	J	2.87	*	4.77
D-81 DIS	1.67	0.49	0.15	J	0.33	0.23	0.22	J	1.22	0.41	0.15	J	3.21		3.78
D-81 FD DIS															
D-81 TOT	1.92	0.61	0.21		0.12	0.17	0.25	U	1.36	0.50	0.21		3.28	*	4.16
D-81 FD TOT															
D-83 DIS	0.05	0.18	0.40	UJ	0.15	0.25	0.44	UJ	-0.08	0.13	0.42	UJ	ND		ND
D-83 FD DIS															
D-83 MDNR DIS															
D-83 TOT	-0.07	0.11	0.33	UJ	0.00	0.12	0.36	UJ	0.06	0.13	0.27	UJ	ND		ND
D-83 FD TOT															
D-83 EPA TOT															
D-83 MDNR TOT															
D-85 DIS	0.16	0.14	0.17	UJ	0.07	0.10	0.15	UJ	0.03	0.08	0.17	UJ	ND		ND
D-85 TOT	3.68	0.80	0.19	J	0.32	0.22	0.21	J	4.50	0.92	0.15	J	8.51		13.57
D-85 EPA TOT															
D-87 DIS	0.11	0.16	0.24	UJ	-0.01	0.11	0.23	UJ+	0.08	0.13	0.19	UJ	ND		ND
D-87 FD DIS															
D-87 TOT	0.14	0.16	0.22	U	0.04	0.12	0.27	UJ+	0.28	0.20	0.15	J	0.28	*	0.96

April 2013

Sample ID	U-234 Result	U-234 CSU	U-234 MDA	U-234 FINAL Q	U-235 Result	U-235 CSU	U-235 MDA	U-235 FINAL Q	U-238 Result	U-238 CSU	U-238 MDA	U-238 FINAL Q	TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)
S-5 DIS	0.01	0.14	0.41	UJ	0.18	0.30	0.50	UJ	0.03	0.14	0.36	UJ	ND		ND
S-5 MDNR DIS															
S-5 TOT	-0.06	0.20	0.53	UJ	0.13	0.34	0.70	UJ	-0.11	0.22	0.75	UJ	ND		ND
S-5 EPA TOT	-0.0684		0.733	U	-0.0232		0.528	U	0.106		0.614	U	ND		ND
S-5 MDNR TOT															
S-8 DIS	0.85	0.25	0.06	J	0.09	0.09	0.11	U	0.55	0.19	0.07		1.40	*	1.69
S-8 TOT	0.84	0.25	0.09		0.09	0.08	0.08	J	0.94	0.26	0.09		1.87		2.84
S-10 DIS	0.13	0.10	0.11	J	0.02	0.04	0.09	U	0.09	0.09	0.11	U	0.13	*	0.37
S-10 TOT	0.23	0.12	0.08	J	0.03	0.05	0.08	U	0.24	0.12	0.08		0.47	*	0.75
S-53 DIS	5.90	0.92	0.07	J	0.40	0.16	0.08	J	4.74	0.77	0.05	J	11.04		14.31
S-53 TOT	45.30	20.2	3.63	J	11.37	7.58	4.81	J	53.49	23.2	3.29	J	110.2		164.6
S-61 DIS	0.85	0.25	0.07		0.13	0.10	0.08	J	0.71	0.23	0.07		1.69		2.18
S-61 EPA DIS															
S-61 TOT	0.76	0.24	0.09		0.03	0.07	0.12	U	0.74	0.24	0.13		1.50	*	2.26
S-82 DIS	0.91	0.32	0.14	J	0.02	0.06	0.12	UJ	0.81	0.30	0.14	J	1.72	*	2.47
S-82 MDNR DIS															
S-82 TOT	1.26	0.42	0.17	J	0.12	0.13	0.17	UJ	1.09	0.38	0.11	J	2.35	*	3.33
S-82 EPA TOT	1.08		0.166		0.088		0.119	U	0.787		0.105		1.87	*	2.40
S-84 DIS	0.05	0.08	0.13	UJ	0.02	0.06	0.13	UJ	0.06	0.09	0.15	UJ	0.06	*	0.19
S-84 FD DIS															
S-84 TOT	0.24	0.16	0.13	J	-0.01	0.06	0.13	UJ	0.19	0.14	0.13	J	0.19	*	0.56
S-84 FD TOT															
I-4 DIS	0.09	0.29	0.61	U	0.25	0.34	0.52	UJ	-0.08	0.17	0.51	UJ	ND		ND
I-4 FD DIS															
I-4 MDNR DIS															
I-4 MDNR FD DIS															
I-4 TOT	1.05	0.58	0.32	J	0.27	0.32	0.39	U	0.14	0.27	0.50	U	1.05	*	1.67
I-4 FD TOT															
I-4 EPA TOT															
I-4 MDNR TOT															
I-9 DIS	0.20	0.12	0.07	J	0.10	0.09	0.09	J	0.19	0.12	0.07	J	0.49		0.61
I-9 FD DIS	0.14	0.12	0.14	J	0.06	0.10	0.17	UJ	0.13	0.11	0.10	J	0.27	*	0.47
I-9 MDNR DIS															
I-9 TOT	0.14	0.12	0.11	J	0.00	0.08	0.18	UJ	0.04	0.07	0.10	UJ	0.14	*	0.38
I-9 FD TOT	0.29	0.16	0.09	J	0.10	0.12	0.16	UJ	0.21	0.14	0.13	J	0.50	*	0.70
I-9 EPA TOT	0.147		0.08		-0.00879		0.115	U	0.147		0.08		0.29	*	0.49
I-9 MDNR TOT															
I-11 DIS	1.24	0.43	0.18	J	0.07	0.10	0.15	UJ	1.08	0.39	0.12	J	2.32	*	3.29
I-11 EPA DIS															
I-11 TOT	1.07	0.35	0.09	J	0.06	0.09	0.17	UJ	0.71	0.27	0.14	J	1.78	*	2.19
I-62 DIS	0.18	0.10	0.05	J	0.09	0.08	0.09	J	0.22	0.11	0.08		0.49		0.70
I-62 FD DIS	0.20	0.11	0.07	J	0.03	0.06	0.10	U	0.14	0.09	0.08	J	0.34	*	0.46
I-62 TOT	0.22	0.11	0.10		0.05	0.06	0.09	UJ	0.22	0.11	0.08		0.44	*	0.70
I-62 FD TOT	0.26	0.11	0.05	J	0.01	0.03	0.06	UJ	0.12	0.07	0.05	J	0.38	*	0.39
I-65 DIS	0.64	0.24	0.12	J	0.05	0.07	0.10	UJ	0.57	0.23	0.10	J	1.21	*	1.74
I-65 FD DIS	0.60	0.19	0.07	J	0.04	0.05	0.07	UJ	0.57	0.18	0.06	J	1.17	*	1.73
I-65 TOT	0.91	0.26	0.07		0.00	0.05	0.11	U	0.85	0.25	0.09	J	1.76	*	2.58
I-65 FD TOT	0.67	0.22	0.10		0.08	0.08	0.09	U	0.51	0.19	0.13	J	1.18	*	1.56
I-66 DIS	0.76	0.23	0.07		0.10	0.09	0.07	J	0.60	0.20	0.06		1.46		1.83
I-66 TOT	0.76	0.22	0.06	J	0.26	0.14	0.10	J	0.58	0.19	0.08	J	1.60		1.85
I-67 DIS	0.51	0.18	0.08		0.16	0.11	0.08	J	0.43	0.16	0.07		1.10		1.36
I-67 FD DIS	0.97	0.29	0.09	J	0.10	0.10	0.14	U	0.79	0.25	0.11		1.76	*	2.42
I-67 TOT	0.86	0.25	0.08		0.05	0.06	0.08	U	0.60	0.20	0.06		1.46	*	1.82
I-67 FD TOT	0.59	0.20	0.07	J	0.05	0.06	0.08	U	0.82	0.24	0.06		1.41	*	2.48
I-68 DIS	2.58	0.53	0.09		0.18	0.12	0.12	J	2.23	0.48	0.12		4.99		6.73
I-68 TOT	2.73	0.59	0.10		0.24	0.15	0.11	J	2.42	0.54	0.12	J	5.39		7.32
I-73 DIS	0.99	0.36	0.19	J	0.36	0.22	0.16	J	0.65	0.28	0.16	J	2.00		2.10
I-73 TOT	1.50	0.38	0.07		0.29	0.16	0.09	J	1.64	0.40	0.11		3.43		5.02
D-3 DIS	0.15	0.12	0.13	J	0.10	0.10	0.12	UJ	0.07	0.08	0.12	UJ	0.15	*	0.41
D-3 FD DIS															
D-3 EPA DIS															
D-3 MDNR DIS															
D-3 TOT	-0.02	0.07	0.18	UJ	0.11	0.14	0.17	UJ	0.02	0.06	0.15	UJ	ND		ND
D-3 FD TOT															
D-3 EPA TOT	0.39		0.593	U	-0.0224		0.508	U	0.0957		0.259	U	ND		ND
D-3 MDNR TOT															
D-6 DIS	0.25	0.12	0.06		0.00	0.03	0.07	U	0.25	0.12	0.06		0.50	*	0.78
D-6 FD DIS															
D-6 EPA DIS															
D-6 EPA FD DIS															
D-6 MDNR DIS															
D-6 TOT	0.22	0.12	0.08	J	0.02	0.06	0.13	U	0.12	0.09	0.07	J	0.34	*	0.42
D-6 FD TOT															
D-6 EPA TOT	0.0802		0.122	U	-0.00461		0.105	U	0.107		0.106		0.11	*	0.37
D-6 MDNR TOT															
D-12 DIS	0.24	0.16	0.12	J	0.08	0.10	0.14	UJ	0.09	0.10	0.10	UJ	0.24	*	0.36
D-12 FD DIS	0.18	0.10	0.07	J	0.12	0.09	0.07	J	0.13	0.09	0.07	J	0.43		0.44
D-12 EPA DIS															
D-12 TOT	0.13	0.13	0.16	UJ	0.07	0.11	0.20	UJ	0.07	0.09	0.11	UJ	ND		ND
D-12 FD TOT	0.16	0.10	0.08	J	0.01	0.04	0.10	U	0.10	0.09	0.12	U	0.16	*	0.40
D-13 DIS	0.17	0.10	0.06	J	0.04	0.05	0.07	UJ	0.11	0.08	0.05	J	0.28	*	0.36
D-13 FD DIS															
D-13 TOT	0.23	0.13	0.09	J	0.02	0.06	0.13	U	0.25	0.14	0.08	J	0.48	*	0.81
D-13 FD TOT															
D-14 DIS	0.27	0.59	1.15	UJ	0.21	0.50	1.05	UJ	0.71	0.82	1.07	UJ	ND		ND
D-14 TOT	0.75	0.40	0.26	J	-0.02	0.11	0.26	UJ	1.05	0.47	0.18	J	1.80	*	3.25
D-81 DIS	1.49	0.33	0.06	J	0.20	0.12	0.09	J	1.27	0.30	0.07		2.96		3.88
D-81 FD DIS															
D-81 TOT	1.57	0.33	0.05	J	0.14	0.09	0.06	J	1.21	0.27	0.05	J	2.92		3.67
D-81 FD TOT															
D-83 DIS	0.04	0.08	0.15	UJ	0.02	0.07	0.19	UJ	0.05	0.08	0.14	UJ	ND		ND
D-83 FD DIS															
D-83 MDNR DIS															
D-83 TOT	0.03	0.08	0.16	UJ	-0.02	0.07	0.18	UJ	-0.05	0.09	0.27	UJ	ND		ND
D-83 FD TOT															
D-83 EPA TOT	0.0514		0.096	U	0.0198		0.104	U	0		0.053	U	ND		ND
D-83 MDNR TOT															
D-85 DIS	0.37	0.15	0.06		0.01	0.03	0.07	U	0.14	0.09	0.06	J	0.51	*	0.45
D-85 TOT	1.73	0.38	0.09		0.24	0.13	0.09	J	2.62	0.51	0.06		4.59		7.92
D-85 EPA TOT	1.17		0.652		0.263		0.355	U	1.61		0.612		2.78	*	4.96
D-87 DIS	0.26	0.15	0.10	J	0.02	0.05	0.12	U	0.11	0.10	0.12	U	0.26	*	0.41
D-87 FD DIS															
D-87 TOT	0.40	0.20	0.14	J	0.03	0.08	0.17	UJ	0.10	0.10	0.12	UJ	0.40	*	0.44

July 2013

Sample ID	U-234 Result	U-234 CSU	U-234 MDA	U-234 FINAL Q	U-235 Result	U-235 CSU	U-235 MDA	U-235 FINAL Q	U-238 Result	U-238 CSU	U-238 MDA	U-238 FINAL Q	TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)
S-5 DIS	0.17	0.19	0.22	J	0.16	0.2	0.24	U	0.29	0.25	0.28	J	0.46	*	0.98
S-5 MDNR DIS															
S-5 TOT	1.1	0.91	0.79	R	0.17	0.41	0.85	U	-0.06	0.33	0.79	U	1.10	*	2.75
S-5 EPA TOT	0.470	0.628	0.948	U	0.0119	0.414	1.18	UG	-0.201	0.153	1.04	UG	ND		ND
S-5 MDNR TOT															
S-8 DIS	1.14	0.32	0.11		0.2	0.14	0.11	J	0.63	0.22	0.09		1.97		1.97
S-8 TOT	1	0.37	0.16	J	0.37	0.24	0.18	J	0.72	0.31	0.15	J	2.09		2.32
S-10 DIS	0.38	0.2	0.11	J	0.26	0.19	0.18	J+	0.25	0.16	0.11	J	0.89		0.87
S-10 TOT	0.62	0.24	0.09	J	0.38	0.2	0.11	J+	0.37	0.18	0.1	J	1.37		1.28
S-53 DIS	5.19	0.88	0.07	J+	0.62	0.22	0.07		5.06	0.86	0.09	J	10.87		15.36
S-53 TOT	5.9	1.08	0.11	J+	1.31	0.39	0.1	J	5.18	0.97	0.1	J	12.39		16.04
S-61 DIS	1.12	0.41	0.13	J+	0.22	0.2	0.22	J+	0.63	0.3	0.18	J	1.97		1.98
S-61 EPA DIS															
S-61 TOT	1.26	0.4	0.18		0.24	0.18	0.17	J	0.79	0.31	0.22		2.29		2.46
S-82 DIS	0.42	0.23	0.17	J	0.1	0.14	0.21	UJ	0.33	0.2	0.12	J	0.75	*	1.08
S-82 MDNR DIS															
S-82 TOT	0.67	0.26	0.09	J	0.11	0.11	0.11	J	0.31	0.18	0.13	J	1.09		0.97
S-82 EPA TOT	0.533	0.471	0.160		-0.0110	0.0311	0.143	U	0.334	0.369	0.136		0.87	*	1.06
S-84 DIS	1.69	1.02	0.91	J+	1	0.86	0.97	J	0.42	0.48	0.62	U	1.69	*	2.31
S-84 FD DIS															
S-84 TOT	1.33	0.75	0.48	J+	0.39	0.45	0.59	UJ	1.32	0.74	0.48	J	2.65	*	4.21
S-84 FD TOT															
I-4 DIS	1.47	0.84	0.58	J	0.67	0.63	0.71	U	0.18	0.36	0.67	U	1.47	*	2.33
I-4 FD DIS	0.78	1.05	1.56	R	-0.05	0.64	1.34	R	0	0.72	1.55	U	0.78	*	4.59
I-4 MDNR DIS															
I-4 MDNR FD DIS															
I-4 TOT	0.6	0.51	0.43	J	0.32	0.44	0.67	U	0.17	0.29	0.49	U	0.60	*	1.77
I-4 FD TOT	1.02	1.01	1.04	R	0.4	0.77	1.41	R	0.58	0.76	1.04	U	1.02	*	3.28
I-4 EPA TOT	0.237	0.465	0.849	U	0.000	0.052	0.375	U	0.0278	0.238	0.646	U	ND		ND
I-4 MDNR TOT															
I-9 DIS	0.37	0.19	0.1	J	0.07	0.1	0.15	UJ	0.13	0.11	0.11	J	0.50	*	0.46
I-9 FD DIS															
I-9 MDNR DIS															
I-9 TOT	0.34	0.17	0.09	J	0.09	0.09	0.1	UJ	0.17	0.12	0.09	J	0.51	*	0.55
I-9 FD TOT															
I-9 EPA TOT	0.184	0.286	0.152		0.0237	0.119	0.124	U	0.127	0.232	0.126		0.31	*	0.44
I-9 MDNR TOT															
I-11 DIS	1.26	0.34	0.13		0.2	0.13	0.11	J+	0.81	0.26	0.1		2.27		2.51
I-11 EPA DIS															
I-11 TOT	1.19	0.32	0.11		0.19	0.13	0.11	J+	0.63	0.22	0.11		2.01		1.97
I-62 DIS	0.58	0.24	0.12	J	0.16	0.14	0.16	J	0.31	0.17	0.09	J	1.05		1.00
I-62 FD DIS	0.47	0.2	0.12	J	0.14	0.12	0.1	J	0.35	0.17	0.12	J	0.96		1.11
I-62 TOT	0.38	0.18	0.12		0.33	0.18	0.13	J	0.18	0.12	0.13	J	0.89		0.69
I-62 FD TOT	0.38	0.2	0.11	J	0.1	0.11	0.15	UJ	0.2	0.14	0.11	J	0.58	*	0.67
I-65 DIS	1.09	0.28	0.06	J+	0.17	0.11	0.07	J	0.93	0.26	0.08	J	2.19		2.85
I-65 FD DIS	1.16	0.31	0.07	J+	0.33	0.16	0.08		0.93	0.27	0.07	J	2.42		2.92
I-65 TOT	1.62	0.44	0.1	J+	0.6	0.27	0.16	J	1.28	0.38	0.1	J	3.50		4.09
I-65 FD TOT	1.38	0.34	0.09	J+	0.34	0.17	0.11		0.77	0.24	0.09	J	2.49		2.45
I-66 DIS	1.1	0.43	0.19	J	0.2	0.19	0.17	J+	0.4	0.25	0.22	J	1.70		1.28
I-66 TOT	0.72	0.23	0.08		0.17	0.12	0.11	J+	0.59	0.2	0.09		1.48		1.84
I-67 DIS	0.67	0.25	0.11	J	0.28	0.18	0.15	J	0.43	0.2	0.1	J	1.38		1.41
I-67 FD DIS															
I-67 TOT	0.89	0.33	0.11	J	0.22	0.18	0.19	J	0.56	0.26	0.15	J	1.67		1.77
I-67 FD TOT															
I-68 DIS	0.9	0.29	0.09		0.26	0.16	0.1	J	0.61	0.23	0.08		1.77		1.94
I-68 TOT	1.54	0.44	0.11	J	0.5	0.25	0.17	J	1.67	0.46	0.11	J	3.71		5.21
I-73 DIS	0.97	0.44	0.18	J+	0.1	0.18	0.31	UJ	0.87	0.42	0.2	J	1.84	*	2.74
I-73 TOT	1.56	0.59	0.18	J+	0.67	0.39	0.22	J	1.1	0.48	0.25	J	3.33		3.59
D-3 DIS	0.19	0.18	0.19	J	0.14	0.17	0.21	U	0.04	0.11	0.24	U	0.19	*	0.81
D-3 FD DIS															
D-3 EPA DIS															
D-3 MDNR DIS															
D-3 TOT	0.18	0.19	0.24	UJ	0.1	0.15	0.22	U	0.09	0.17	0.32	U	ND		ND
D-3 FD TOT															
D-3 EPA TOT	0.189	0.298	0.444	U	0.000	0.0486	0.351	U	0.149	0.302	0.561	U	ND		ND
D-3 MDNR TOT															
D-6 DIS	0.32	0.17	0.13	J	0.06	0.09	0.14	UJ	0.23	0.15	0.13	J	0.55	*	0.75
D-6 FD DIS															
D-6 EPA DIS															
D-6 EPA FD DIS															
D-6 MDNR DIS															
D-6 TOT	0.37	0.21	0.18	J+	0.01	0.09	0.22	UJ	0.05	0.08	0.14	UJ	0.37	*	0.52
D-6 FD TOT															
D-6 EPA TOT															
D-6 MDNR TOT															
D-12 DIS	0.34	0.19	0.1	J+	0.22	0.17	0.17	J+	0.12	0.11	0.1	J+	0.68		0.46
D-12 FD DIS	0.46	0.18	0.11	J+	0.28	0.15	0.12	J+	0.26	0.13	0.08	J+	1.00		0.90
D-12 EPA DIS															
D-12 TOT	0.58	0.21	0.07	J+	0.38	0.18	0.08	J+	0.4	0.17	0.08	J+	1.36		1.37
D-12 FD TOT	0.66	0.25	0.1	J+	0.22	0.16	0.15	J+	0.26	0.15	0.12	J+	1.14		0.88
D-13 DIS	0.44	0.19	0.09	J+	0.27	0.16	0.12	J	0.2	0.12	0.1	J	0.91		0.72
D-13 FD DIS															
D-13 TOT	0.29	0.14	0.06	J+	0.15	0.11	0.11	J	0.1	0.08	0.07	J	0.54		0.37
D-13 FD TOT															
D-14 DIS	0.99	0.47	0.22	J+	0.34	0.3	0.34	J	0.32	0.26	0.29	J	1.65		1.11
D-14 TOT	0.55	0.29	0.23	J+	0.3	0.23	0.23	J	0.68	0.33	0.23	J	1.53		2.17
D-81 DIS	2.1	0.54	0.15	J+	1.28	0.42	0.16	J	1.8	0.49	0.16	J	5.18		5.96
D-81 FD DIS	1.65	0.42	0.08	J+	0.43	0.21	0.14		1.45	0.38	0.09	J	3.53		4.52
D-81 TOT	1.66	0.48	0.12	J+	0.73	0.32	0.13	J	1.39	0.43	0.15	J	3.78		4.48
D-81 FD TOT	1.58	0.37	0.07	J+	0.25	0.14	0.11	J	1.35	0.33	0.09	J	3.18		4.14
D-83 DIS	0.15	0.12	0.13	J	0.06	0.09	0.15	UJ	-0.04	0.07	0.2	UJ	0.15	*	0.67
D-83 FD DIS	0.73	0.46	0.3	J	0.16	0.27	0.47	U	0.19	0.25	0.38	U	0.73	*	1.35
D-83 MDNR DIS															
D-83 TOT	0.12	0.14	0.19	UJ	0.03	0.08	0.16	UJ	0.12	0.14	0.19	UJ	ND		ND
D-83 FD TOT	0.19	0.15	0.13	J	0.13	0.14	0.14	U	0.13	0.12	0.13	J	0.32	*	0.45
D-83 EPA TOT	0.0635	0.170	0.119	UJ	-0.00564	0.0226	0.128	U	0.0588	0.170	0.130	U	ND		ND
D-83 MDNR TOT															
D-85 DIS	1.05	0.48	0.21	J+	0.36	0.3	0.26	J	0.4	0.3	0.3	J	1.81		1.36
D-85 TOT	2.95	1.27	0.44	J+	1.31	0.9	0.78	J	2.39	1.12	0.5		6.65		7.73
D-85 EPA TOT	1.61	1.73	0.540		0.000	0.103	0.371	U	1.19	1.48	0.469		2.80	*	3.72
D-87 DIS	0.49	0.25	0.17	J+	0.31	0.21	0.15	J	0.32	0.2	0.15	J	1.12		1.10
D-87 FD DIS															
D-87 TOT	1.05	0.29	0.06	J+	0.13	0.11	0.11	J	0.47	0.18	0.06	J	1.65		1.46

October 2013

Sample ID	U-234 Result	U-234 CSU	U-234 MDA	U-234 FINAL Q	U-235 Result	U-235 CSU	U-235 MDA	U-235 FINAL Q	U-238 Result	U-238 CSU	U-238 MDA	U-238 FINAL Q	TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)
S-5 DIS	0	0.53	1.15	R	0	0.65	1.41	R	0.54	0.67	0.79	R	R	*	R
S-5 MDNR DIS	0.56	0.84	1.36	U	-0.20	0.62	1.67	U	0.68	0.83	1.00	U	ND		ND
S-5 TOT	0.58	0.78	1.16	R	0	0.66	1.44	R	0	0.54	1.16	R	R	*	R
S-5 EPA TOT	-0.27	0.46	1.62	U	0.20	0.71	1.60	U	0.39	0.69	1.24	U	ND		ND
S-5 MDNR TOT	-0.25	0.63	1.78	U	0.73	1.26	2.20	U	-0.05	0.59	1.24	U	ND		ND
S-8 DIS	1.19	0.4	0.16	J	0.11	0.14	0.21	UJ	0.77	0.31	0.17	J	1.96	*	2.39
S-8 TOT	1.16	0.37	0.19	J	0.22	0.17	0.17	J	1.18	0.37	0.15	J	2.56		3.62
S-10 DIS	0.32	0.24	0.24	J	0.14	0.17	0.2	U	0.17	0.18	0.22	U	0.32	*	0.75
S-10 TOT	0.63	0.34	0.27	J	0.15	0.2	0.31	U	0.82	0.38	0.19		1.45	*	2.59
S-53 DIS	4.44	0.99	0.22	J+	0.2	0.19	0.2	J	3.78	0.89	0.2		8.42		11.35
S-53 TOT	6.83	1.35	0.2	J+	0.5	0.31	0.27	J	5.84	1.2	0.22		13.17		17.63
S-61 DIS	0.98	0.34	0.15	J	0.16	0.15	0.19	UJ	0.79	0.3	0.11	J	1.77	*	2.44
S-61 EPA DIS															
S-61 TOT	0.91	0.33	0.11		0.16	0.15	0.14	J	0.82	0.31	0.13		1.89		2.52
S-82 DIS	1.25	0.42	0.16	J	0.25	0.2	0.18	J	0.47	0.24	0.14	J	1.97		1.52
S-82 MDNR DIS															
S-82 TOT	0.62	0.29	0.17		0.18	0.17	0.16	J	0.23	0.17	0.15	J	1.03		0.77
S-82 EPA TOT															
S-84 DIS	0.14	0.17	0.2	UJ	-0.01	0.12	0.25	UJ	-0.02	0.1	0.23	UJ	ND		ND
S-84 FD DIS	0.55	0.38	0.26	J	0.06	0.15	0.32	UJ	0.11	0.17	0.26	UJ	0.55	*	0.92
S-84 TOT	0.56	0.28	0.23	J	-0.04	0.08	0.24	U	0.44	0.25	0.22	J	1.00	*	1.42
S-84 FD TOT	0.33	0.28	0.34	UJ	-0.03	0.12	0.32	UJ	0.18	0.25	0.4	UJ	ND		ND
I-4 DIS	0.41	0.41	0.48	UJ	0.05	0.23	0.59	UJ	0.23	0.31	0.47	UJ	ND		ND
I-4 FD DIS															
I-4 MDNR DIS															
I-4 MDNR FD DIS															
I-4 TOT	0.58	0.46	0.36	J	0.52	0.51	0.63	UJ	0.24	0.29	0.35	UJ	0.58	*	1.33
I-4 FD TOT															
I-4 EPA TOT															
I-4 MDNR TOT															
I-9 DIS	0.28	0.21	0.21	J	0.21	0.21	0.26	U	0.17	0.17	0.21	U	0.28	*	0.75
I-9 FD DIS	0.35	0.26	0.19	J	0.16	0.19	0.23	UJ	0.13	0.18	0.27	UJ	0.35	*	0.91
I-9 MDNR DIS	0.14	0.14	0.17	U	-0.01	0.07	0.14	U	0.22	0.16	0.12	J	0.22	*	0.72
I-9 TOT	0.14	0.16	0.21	UJ	0.18	0.2	0.24	UJ	0.2	0.18	0.17	J	0.20	*	0.71
I-9 FD TOT	0.27	0.2	0.21	J	0.04	0.12	0.26	U	0.19	0.16	0.16	J	0.46	*	0.69
I-9 EPA TOT															
I-9 MDNR TOT	0.25	0.20	0.22	J	0.09	0.15	0.27	U	0.17	0.16	0.15	J	0.43	*	0.64
I-11 DIS	1.45	0.58	0.21	J	0.14	0.22	0.35	UJ	1.05	0.49	0.3	J	2.50	*	3.29
I-11 EPA DIS															
I-11 TOT	1.34	0.43	0.12		0.36	0.24	0.22	J	1.4	0.44	0.17		3.10		4.34
I-62 DIS	0.15	0.12	0.11	J	0.09	0.11	0.13	U	0.18	0.14	0.14	J	0.33	*	0.60
I-62 FD DIS															
I-62 TOT	0.38	0.21	0.16	J	0.09	0.12	0.18	U	0.21	0.16	0.15	J	0.59	*	0.71
I-62 FD TOT															
I-65 DIS	1.04	0.38	0.18	J+	-0.01	0.07	0.15	U	0.79	0.32	0.14		1.83	*	2.42
I-65 FD DIS															
I-65 TOT	1.45	0.47	0.15	J+	0.31	0.22	0.16	J	1.06	0.39	0.15		2.82		3.30
I-65 FD TOT															
I-66 DIS	0.72	0.28	0.1	J	0.03	0.08	0.18	UJ	0.45	0.21	0.12	J	1.17	*	1.42
I-66 TOT	0.43	0.21	0.1	J	0.15	0.14	0.18	UJ	0.54	0.23	0.1	J	0.97	*	1.69
I-67 DIS	1.03	0.39	0.25		0.17	0.19	0.26	U	0.33	0.21	0.2	J	1.36	*	1.10
I-67 FD DIS	0.86	0.36	0.17		0.34	0.26	0.26	J	0.73	0.33	0.21		1.93		2.33
I-67 TOT	0.89	0.31	0.15	J	0.23	0.16	0.12	J	0.81	0.29	0.11	J	1.93		2.52
I-67 FD TOT	0.86	0.31	0.18	J	0.13	0.13	0.17	UJ	0.65	0.27	0.2	J	1.51	*	2.02
I-68 DIS	0.59	0.24	0.09	J	0.17	0.15	0.17	J	0.47	0.22	0.14	J	1.23		1.48
I-68 TOT	1.63	0.48	0.17		0.11	0.14	0.21	U	1.36	0.43	0.12		2.99	*	4.15
I-73 DIS	-0.11	1.24	3.79	UJ	-0.48	1.47	4.01	UJ	1.9	2.32	3.23	UJ	ND		ND
I-73 TOT	-0.45	0.94	2.77	UJ	0.54	1.51	3.26	UJ	0.8	1.23	1.83	UJ	ND		ND
D-3 DIS	0.27	0.24	0.26	J	0.28	0.27	0.29	UJ	0.15	0.19	0.29	UJ	0.27	*	1.00
D-3 FD DIS															
D-3 EPA DIS															
D-3 MDNR DIS	0.18	0.26	0.39	U	0.03	0.19	0.52	U	0.27	0.29	0.35	U	ND		ND
D-3 TOT	0.28	0.27	0.29	UJ	0.27	0.3	0.36	UJ	0.04	0.12	0.29	UJ	ND		ND
D-3 FD TOT															
D-3 EPA TOT															
D-3 MDNR TOT	0.20	0.17	0.21	J	0.12	0.16	0.24	U	0.09	0.11	0.14	U	0.20	*	0.52
D-6 DIS	0.23	0.18	0.19	J	0.24	0.19	0.17	J	0.15	0.14	0.18	U	0.23	*	0.65
D-6 FD DIS															
D-6 EPA DIS															
D-6 EPA FD DIS															
D-6 MDNR DIS	0.16	0.13	0.17	J	0.06	0.10	0.15	U	-0.02	0.07	0.19	U	0.16	*	0.64
D-6 TOT	0.55	0.27	0.18		0.04	0.11	0.24	U	0.05	0.11	0.2	U	0.55	*	0.71
D-6 FD TOT															
D-6 EPA TOT															
D-6 MDNR TOT	0.24	0.18	0.19	J	0.02	0.08	0.20	U	0.07	0.10	0.17	U	0.24	*	0.60
D-12 DIS	0.2	0.15	0.14	J	0.28	0.2	0.16	J	0.19	0.15	0.15	J	0.67		0.70
D-12 FD DIS															
D-12 EPA DIS															
D-12 TOT	0.19	0.15	0.12	J	0.03	0.1	0.21	U	0.11	0.11	0.12	U	0.19	*	0.45
D-12 FD TOT															
D-13 DIS	0.34	0.2	0.17	J	0.03	0.1	0.21	U	0.16	0.14	0.12	J	0.50	*	0.57
D-13 FD DIS															
D-13 TOT	0.3	0.17	0.1	J	0.06	0.09	0.13	UJ	0.09	0.1	0.12	UJ	0.30	*	0.42
D-13 FD TOT															
D-14 DIS	0.4	0.35	0.34	J+	0.09	0.24	0.53	UJ	0.14	0.24	0.43	UJ	0.40	*	1.53
D-14 TOT	0.71	0.64	0.75	UJ+	-0.02	0.29	0.61	UJ	-0.18	0.38	1.11	UJ	ND		ND
D-81 DIS	1.72	0.46	0.15	J	0.15	0.14	0.18	UJ	1.13	0.35	0.1	J	2.85	*	3.45
D-81 FD DIS															
D-81 TOT	1.44	0.4	0.13	J	0.17	0.15	0.17	J	1.34	0.38	0.09	J	2.95		4.07
D-81 FD TOT															
D-83 DIS	0.14	0.21	0.31	UJ	0.18	0.32	0.55	UJ	0.07	0.21	0.45	UJ	ND		ND
D-83 FD DIS															
D-83 MDNR DIS	0.24	0.23	0.29	J	0.05	0.12	0.25	U	-0.02	0.10	0.23	U	0.24	*	0.80
D-83 TOT	-0.01	0.12	0.24	UJ	0.14	0.24	0.43	UJ	0.15	0.2	0.28	UJ	ND		ND
D-83 FD TOT															
D-83 EPA TOT															
D-83 MDNR TOT	0.31	0.20	0.13	J	0.02	0.08	0.20	U	0.11	0.12	0.15	U	0.31	*	0.54
D-85 DIS	0.37	0.19	0.14	J	0.05	0.08	0.12	UJ	0.04	0.06	0.11	UJ	0.37	*	0.38
D-85 TOT	1.06	0.35	0.12	J	0.21	0.17	0.13	J	1.06	0.35	0.12	J	2.33		3.26
D-85 EPA TOT															
D-87 DIS	0.31	0.23	0.25	J	-0.05	0.1	0.28	U	0.17	0.16	0.17	J	0.48	*	0.64
D-87 FD DIS	0.22	0.17	0.14	J	0.04	0.1	0.22	U	0.23	0.16	0.12	J	0.45	*	0.79
D-87 TOT	1.14	0.4	0.13	J	0.05	0.11	0.21	UJ	0.63	0.29	0.18	J	1.77	*	1.97

February 2014

Sample ID	U-234 Result	U-234 CSU	U-234 MDA	U-234 FINAL Q	U-235 Result	U-235 CSU	U-235 MDA	U-235 FINAL Q	U-238 Result	U-238 CSU	U-238 MDA	U-238 FINAL Q	TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)

Uranium: 4 events 2012-13 plus Feb 2014

7/27/16

Table 7-24: Summary of Uranium Isotope Results: 2012 - 2013 Groundwater Sampling Events

DRAFT

August 2012

Sample ID	Uranium-234				Uranium-235				Uranium-238				TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q			
D-87 FD TOT															
D-93 DIS	0.21	0.20	0.25	UJ	0.05	0.14	0.31	UJ	0.16	0.17	0.19	UJ	ND		ND
D-93 MDNR DIS	0.31	0.23	0.21	J	0.05	0.14	0.30	U	0.18	0.18	0.21	U	0.31	*	0.77
D-93 TOT	0.78	0.44	0.26	J	0.04	0.15	0.37	U	0.20	0.23	0.30	UJ	0.78	*	1.05
D-93 EPA TOT															
D-93 MDNR TOT	0.20	0.15	0.14	J	0.08	0.11	0.17	U	0.20	0.15	0.14	J	0.40	*	0.68
LR-100 DIS	0.10	0.17	0.30	UJ	-0.03	0.12	0.30	UJ	-0.04	0.11	0.36	UJ	ND		ND
LR-100 FD DIS															
LR-100 TOT	1.24	0.88	0.77	J	0.09	0.34	0.86	UJ	0.20	0.38	0.69	UJ	1.24	*	2.46
LR-100 FD TOT															
LR-103 DIS	0.30	0.24	0.20	J	0.10	0.16	0.25	UJ	0.11	0.16	0.23	UJ	0.30	*	0.81
LR-103 TOT	0.77	0.48	0.39	J	0.23	0.29	0.38	UJ	0.64	0.44	0.35	J	1.41	*	2.09
LR-104 DIS	2.14	0.78	0.35	J	0.84	0.51	0.43	J	2.21	0.79	0.29	J	5.19		6.99
LR-104 FD DIS	2.88	0.85	0.24	J	0.48	0.34	0.30	J	2.14	0.70	0.21	J	5.51		6.61
LR-104 TOT	2.99	0.91	0.32	J	0.45	0.36	0.36	J	2.44	0.80	0.26	J	5.88		7.49
LR-104 FD TOT	2.88	0.76	0.22		0.04	0.12	0.27	U	2.54	0.70	0.16	J	5.42	*	7.68
LR-105 DIS	0.02	0.14	0.38	UJ	-0.06	0.17	0.47	UJ+	-0.01	0.15	0.45	UJ	ND		ND
LR-105 TOT	0.01	0.17	0.48	UJ	0.05	0.20	0.52	UJ+	0.00	0.00	0.22	UJ	ND		ND
MW-102 DIS	2.14	0.59	0.21	J	0.12	0.15	0.23	U	1.85	0.55	0.29		3.99	*	5.62
MW-102 EPA DIS	2.57				0.11				2.38				5.06		7.14
MW-102 TOT	3.31	0.84	0.17	J	0.24	0.23	0.27	U	2.40	0.68	0.17		5.71	*	7.29
MW-103 DIS	5.20	1.11	0.21		0.17	0.19	0.26	U	3.12	0.78	0.18		8.32	*	9.42
MW-103 TOT	6.96	1.37	0.16		0.34	0.26	0.26	J	6.21	1.26	0.15		13.51		18.66
MW-104 DIS	0.46	0.33	0.32	J	0.12	0.19	0.30	UJ	0.32	0.27	0.25	J	0.77	*	1.08
MW-104 TOT	1.34	0.63	0.36	J	0.02	0.16	0.45	UJ	1.09	0.56	0.36	J	2.43	*	3.44
MW-1204 DIS	0.15	0.16	0.22	UJ	0.10	0.12	0.17	UJ	0.11	0.13	0.19	UJ	ND		ND
MW-1204 FD DIS															
MW-1204 TOT	0.14	0.21	0.31	UJ	-0.05	0.19	0.49	UJ	0.12	0.21	0.36	UJ	ND		ND
MW-1204 FD TOT															
PZ-100-KS DIS	0.05	0.15	0.32	UJ	-0.04	0.13	0.36	UJ	0.03	0.11	0.27	UJ	ND		ND
PZ-100-KS TOT	0.23	0.16	0.14	J	0.07	0.11	0.20	UJ	-0.01	0.06	0.14	UJ	0.23	*	0.51
PZ-100-SD DIS	0.27	0.19	0.17	J	0.03	0.08	0.16	U	0.38	0.22	0.13	J	0.65	*	1.20
PZ-100-SD TOT	0.59	0.40	0.37	J	-0.02	0.15	0.35	UJ	0.07	0.30	0.61	UJ	0.59	*	1.98
PZ-100-SS DIS	5.41	1.12	0.20		0.16	0.18	0.24	U	2.05	0.58	0.14		7.46	*	6.22
PZ-100-SS TOT	5.06	0.91	0.13	J	0.06	0.09	0.17	UJ	2.35	0.54	0.12	J	7.41	*	7.08
PZ-101-SS DIS	1.33	0.93	0.74	J	0.14	0.35	0.72	UJ	1.35	0.93	0.67	J	2.68	*	4.35
PZ-101-SS EPA DIS	1.39				0.021			U	0.52				1.91	*	need MDAs
PZ-101-SS TOT	0.53	0.46	0.44	J	0.00	0.32	0.69	UJ	-0.02	0.20	0.61	UJ	0.53	*	2.13
PZ-101-SS EPA TOT															
PZ-102R-SS DIS	4.61	0.92	0.12	J	0.33	0.21	0.15	J	3.69	0.78	0.12	J	8.63		11.16
PZ-102R-SS TOT	2.10	0.51	0.11	J	0.23	0.17	0.17	J	1.21	0.37	0.14	J	3.55		3.72
PZ-102-SS DIS	3.35	0.75	0.15		0.49	0.27	0.21	J	2.10	0.55	0.15	J	5.93		6.47
PZ-102-SS TOT	1.24	0.43	0.19		0.16	0.17	0.23	U	1.00	0.38	0.14	J	2.24	*	3.09
PZ-102-SS EPA TOT															
PZ-103-SS DIS	0.11	0.11	0.13	UJ	0.08	0.10	0.13	UJ	0.09	0.10	0.10	UJ	ND		ND
PZ-103-SS TOT	0.15	0.12	0.10	J	0.06	0.09	0.13	UJ	0.40	0.21	0.15	J	0.55	*	1.25
PZ-104-KS DIS	0.21	0.17	0.18	J	0.04	0.10	0.22	U	0.11	0.12	0.14	UJ	0.21	*	0.51
PZ-104-KS TOT	0.56	0.23	0.12	J	0.08	0.11	0.17	UJ	0.37	0.19	0.13	J	0.93	*	1.18
PZ-104-SD DIS	1.02	0.95	0.98	J	-0.04	0.46	0.96	UJ	0.15	0.37	0.78	UJ	1.02	*	2.76
PZ-104-SD MDNR DIS															
PZ-104-SD TOT	0.53	0.36	0.32	J	0.07	0.18	0.39	UJ	0.58	0.36	0.22	J	1.11	*	1.90
PZ-104-SD EPA TOT															
PZ-104-SD MDNR TOT															
PZ-104-SS DIS	0.91	0.31	0.15	J	0.07	0.10	0.13	UJ	0.50	0.22	0.12	J	1.41	*	1.56
PZ-104-SS FD DIS															
PZ-104-SS TOT	0.86	0.32	0.18	J	0.08	0.11	0.18	UJ	0.63	0.27	0.15	J	1.49	*	1.98
PZ-104-SS FD TOT															
PZ-105-SS DIS	3.06	0.70	0.19		0.19	0.16	0.16	J+	1.88	0.51	0.14		5.14		5.70
PZ-105-SS TOT	3.42	0.77	0.20		0.05	0.10	0.20	UJ+	1.84	0.52	0.16		5.26	*	5.56
PZ-106-KS DIS	2.34	0.65	0.20		0.12	0.15	0.19	U	0.83	0.36	0.20		3.17	*	2.56
PZ-106-KS FD DIS															
PZ-106-KS MDNR DIS	2.08	0.47	0.15		0.10	0.11	0.12	U	0.78	0.27	0.10		2.86	*	2.38
PZ-106-KS TOT	2.41	0.65	0.15		0.32	0.23	0.19	J	0.90	0.37	0.20		3.63		2.84
PZ-106-KS FD TOT															
PZ-106-KS MDNR TOT	2.51	0.82	0.31		0.05	0.13	0.30	U	0.85	0.46	0.36		3.36	*	2.68
PZ-106-SD DIS	0.12	0.13	0.18	UJ	0.02	0.07	0.17	UJ	0.05	0.08	0.14	UJ	ND		ND
PZ-106-SD TOT	0.54	0.49	0.52	J	-0.02	0.24	0.51	UJ	0.00	0.21	0.62	UJ	0.54	*	2.07
PZ-106-SS DIS	1.14	0.45	0.18	J	0.00	0.13	0.28	UJ	0.57	0.31	0.23	J	1.72	*	1.84
PZ-106-SS TOT	1.12	0.38	0.12		0.03	0.10	0.21	U	0.31	0.19	0.17	J	1.42	*	1.01
PZ-107-SS DIS	1.88	0.53	0.18		0.13	0.15	0.19	U	1.37	0.44	0.17		3.25	*	4.18
PZ-107-SS FD DIS															
PZ-107-SS TOT	2.50	0.73	0.31	J	0.53	0.33	0.20	J	2.35	0.69	0.22	J	5.38		7.23
PZ-107-SS FD TOT															
PZ-109-SS DIS	1.43	0.57	0.23	J	0.06	0.17	0.36	UJ	0.96	0.46	0.29	J	2.39	*	3.03
PZ-109-SS TOT	1.31	0.53	0.20	J	0.06	0.16	0.35	UJ	0.75	0.40	0.28	J	2.06	*	2.39
PZ-110-SS DIS	0.18	0.17	0.21	U	-0.01	0.09	0.21	U	-0.01	0.07	0.17	U	ND		ND
PZ-110-SS TOT	0.10	0.13	0.20	UJ	-0.01	0.10	0.20	UJ	0.08	0.14	0.24	UJ	ND		ND
PZ-111-KS DIS	8.33	1.63	0.17		0.74	0.39	0.28	J	2.80	0.75	0.17	J	11.87		8.68
PZ-111-KS TOT	6.95	1.28	0.13	J	0.75	0.34	0.16	J	2.94	0.70	0.17	J	10.64		9.10
PZ-111-SD DIS	0.32	0.20	0.16	J	0.06	0.10	0.15	UJ+	0.34	0.21	0.17	J	0.67	*	1.09
PZ-111-SD TOT	0.38	0.24	0.21	J	0.05	0.12	0.24	UJ+	0.28	0.20	0.17	J	0.66	*	0.93
PZ-112-AS DIS	0.03	0.10	0.21	UJ	0.04	0.12	0.25	U	-0.02	0.07	0.18	U	ND		ND
PZ-112-AS EPA DIS	0.063				0.026			U	0.005			U	0.063	*	need MDAs
PZ-112-AS TOT	0.12	0.15	0.19	UJ	0.05	0.15	0.31	UJ	0.03	0.09	0.19	UJ	ND		ND
PZ-112-AS EPA TOT															
PZ-113-AD DIS	-0.03	0.12	0.31	UJ	0.06	0.14	0.30	UJ	-0.01	0.12	0.24	UJ	ND		ND
PZ-113-AD FD DIS	1.36	0.61	0.39	J	0.62	0.43	0.34	J	0.31	0.28	0.30	J	2.29		1.22
PZ-113-AD MDNR DIS															
PZ-113-AD TOT	0.14	0.19	0.28	UJ	0.00	0.16	0.35	UJ	-0.01	0.09	0.20	UJ	ND		ND
PZ-113-AD FD TOT	0.58	0.28	0.20		0.08	0.13	0.21	U	0.13	0.13	0.17	U	0.58	*	0.59
PZ-113-AD EPA TOT															
PZ-113-AD MDNR TOT															
PZ-113-AS DIS	1.02	0.51	0.32	J	-0.03	0.14	0.36	UJ	0.71	0.41	0.25	J	1.73	*	2.28
PZ-113-AS EPA DIS	0.58				0.021			U	0.43				1.01	*	need MDAs
PZ-113-AS TOT	0.77	0.41	0.29	J	0.00	0.17	0.37	UJ	0.64	0.37	0.22	J	1.41	*	2.07
PZ-113-SS DIS	1.57	0.46	0.18	J	0.18	0.17	0.20	UJ	0.84	0.32	0.14	J	2.41	*	2.60
PZ-113-SS TOT	3.65	1.13	0.46	J	1.85	0.80	0.36	J	1.26	0.60	0.40	J	6.75		4.60
PZ-114-AS DIS	0.19	0.18	0.20	UJ	0.05	0.14	0.30	UJ	0.07	0.14	0.27	UJ	ND		ND
PZ-114-AS TOT	0.10	0.15	0.25	UJ	0.18	0.22	0.30	UJ	0.12	0.18	0.29	UJ	ND		ND
PZ-115-SS DIS	1.90	0.62	0.20		0.10	0.17	0.30	U	1.26	0.49	0.24		3.16	*	3.89
PZ-115-SS TOT	1.93	0.74	0.30	J	0.20	0.24	0.30	UJ	0.67	0.41	0.27	J	2.60	*	2.13
PZ-116-SS DIS	6.40	1.26	0.17		1.25	0.48	0.17		2.20	0.61	0.21		9.85		7.12
PZ-116-SS TOT	5.93	1.03	0.14	J	0.31	0.19	0.17	J	1.76	0.45	0.09	J	7.99		5.39
PZ-200-SS DIS	0.18	0.17	0.22	U	0.01	0.08	0.22	U	0.55	0.28	0.18	J	0.55	*	1.76

April 2013

Sample ID	Uranium-234				Uranium-235				Uranium-238				TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q			
D-87 FD TOT															
D-93 DIS	0.30	0.14	0.08		0.04	0.06	0.09	U	0.15	0.10	0.07	J	0.45	*	0.49
D-93 MDNR DIS															
D-93 TOT	0.39	0.16	0.09		0.03	0.05	0.10	U	0.16	0.12	0.15	J	0.55	*	0.52
D-93 EPA TOT	0.145		0.079		0		0.0625	U	0.134		0.108		0.28	*	0.43
D-93 MDNR TOT															
LR-100 DIS	0.08	0.07	0.07	J	0.12	0.10	0.11	J	0.17	0.10	0.06	J	0.37		0.56
LR-100 FD DIS															
LR-100 TOT	0.14	0.14	0.15	UJ	0.09	0.15	0.27	UJ	0.06	0.10	0.17	UJ	ND		ND
LR-100 FD TOT															
LR-103 DIS	0.22	0.14	0.12	J	0.05	0.07	0.10	U	0.36	0.18	0.12		0.58	*	1.12
LR-103 TOT	0.07	0.09	0.12	UJ	0.02	0.06	0.15	UJ	0.19	0.14	0.10	J	0.19	*	0.64
LR-104 DIS	2.72	0.49	0.06	J	0.16	0.10	0.09	J	1.94	0.38	0.05		4.82		5.85
LR-104 FD DIS															
LR-104 TOT	2.60	0.48	0.05	J	0.16	0.10	0.09	J	2.11	0.41	0.06		4.87		6.36
LR-104 FD TOT															
LR-105 DIS	0.31	0.23	0.19	J	0.04	0.10	0.21	UJ	0.02	0.08	0.21	UJ	0.31	*	0.72
LR-105 TOT	0.04	0.24	0.66	UJ	-0.10	0.30	0.82	UJ	-0.30	0.29	0.98	UJ	ND		ND
MW-102 DIS															
MW-102 EPA DIS															
MW-102 TOT															
MW-103 DIS	3.17	0.60	0.06		0.27	0.14	0.11	J	3.00	0.57	0.09		6.44		9.06
MW-103 TOT	4.07	0.73	0.12		0.37	0.17	0.10		3.72	0.68	0.09		8.16		11.25
MW-104 DIS	1.42	0.41	0.13	J	0.16	0.14	0.16	J	1.18	0.36	0.13	J	2.76		3.59
MW-104 TOT	1.45	0.37	0.08		0.14	0.11	0.09	J	1.13	0.31	0.07		2.72		3.43
MW-1204 DIS	0.05	0.08	0.15	UJ	0.07	0.09	0.12	UJ	0.05	0.07	0.12	UJ	ND		ND
MW-1204 FD DIS	0.23	0.19	0.17	J	0.04	0.12	0.26	UJ	0.13	0.14	0.15	UJ	0.23	*	0.57
MW-1204 TOT	0.06	0.07	0.11	U	0.01	0.05	0.12	U	0.06	0.07	0.10	U	ND		ND
MW-1204 FD TOT	0.16	0.16	0.17	UJ	-0.01	0.10	0.21	UJ	0.03	0.08	0.17	UJ	ND		ND
PZ-100-KS DIS	0.07	0.06	0.05	J	0.01	0.03	0.06	UJ	0.10	0.07	0.07	J	0.17	*	0.33
PZ-100-KS TOT	0.16	0.09	0.07	J	0.03	0.04	0.07	U	0.06	0.06	0.06	J	0.22	*	0.21
PZ-100-SD DIS	0.36	0.13	0.05	J	0.01	0.03	0.06	UJ	0.36	0.13	0.05	J	0.72	*	1.10
PZ-100-SD TOT	0.45	0.16	0.06	J	0.01	0.03	0.07	UJ	0.27	0.12	0.07	J	0.72	*	0.84
PZ-100-SS DIS	6.01	0.90	0.05	J	0.21	0.11	0.08	J	2.35	0.43	0.07	J	8.57		7.10
PZ-100-SS TOT	5.70	0.90	0.06	J	0.32	0.14	0.06	J	2.30	0.44	0.06	J	8.32		7.00
PZ-101-SS DIS	1.29	0.58	0.27	J	0.13	0.21	0.38	UJ	0.44	0.31	0.24	J	1.73	*	1.49
PZ-101-SS EPA DIS															
PZ-101-SS TOT	0.73	0.45	0.34	J	0.17	0.24	0.37	UJ	0.55	0.37	0.23	J	1.28	*	1.81
PZ-101-SS EPA TOT	1.35		0.551		-0.0664		0.637	U	0.645		0.403		2.00	*	2.22
PZ-102R-SS DIS	5.54	0.87	0.07	J	0.44	0.17	0.09	J	3.40	0.59	0.06	J	9.38		10.33
PZ-102R-SS TOT	4.85	0.77	0.06	J	0.30	0.14	0.09	J	3.17	0.55	0.09	J	8.32		9.58
PZ-102-SS DIS	5.76	0.94	0.08	J	0.25	0.13	0.10	J	3.35	0.61	0.08	J	9.36		10.10
PZ-102-SS TOT	5.70	0.91	0.06	J	0.33	0.15	0.07	J	4.73	0.78	0.05	J	10.76		14.25
PZ-102-SS EPA TOT	3.98		0.806		-0.0828		0.794	U	3.98		0.804		7.96	*	12.23
PZ-103-SS DIS	1.05	0.25	0.06	J	0.07	0.06	0.06	J	0.74	0.20	0.06	J	0.74	*	2.24
PZ-103-SS TOT	4.47	0.71	0.05	J	0.36	0.14	0.06	J	4.77	0.74	0.05	J	9.60		14.38
PZ-104-KS DIS	0.49	0.17	0.08		0.02	0.05	0.09	U	0.20	0.10	0.06		0.69	*	0.64
PZ-104-KS TOT	0.43	0.16	0.08	J	-0.01	0.03	0.07	UJ	0.21	0.11	0.07	J	0.64	*	0.66
PZ-104-SD DIS	0.26	0.25	0.28	UJ	0.05	0.12	0.25	UJ	0.23	0.22	0.23	J	0.23	*	0.80
PZ-104-SD MDNR DIS															
PZ-104-SD TOT	0.18	0.35	0.65	UJ	0.46	0.60	0.91	UJ	0.20	0.35	0.59	UJ	ND		ND
PZ-104-SD EPA TOT	0.357		0.723	U	-0.0476		0.622	U	0.432		0.591	U	ND		ND
PZ-104-SD MDNR TOT															
PZ-104-SS DIS	0.13	0.08	0.06	J	0.02	0.04	0.07	UJ	0.17	0.09	0.04	J	0.30	*	0.54
PZ-104-SS FD DIS	0.41	0.28	0.22	J	0.09	0.16	0.30	UJ	0.27	0.23	0.19	J	0.68	*	0.94
PZ-104-SS TOT	0.22	0.11	0.07	J	0.01	0.03	0.07	UJ	0.09	0.07	0.07	J	0.31	*	0.30
PZ-104-SS FD TOT	0.77	0.55	0.54	J	0.26	0.37	0.56	UJ	0.18	0.30	0.51	UJ	0.77	*	1.78
PZ-105-SS DIS	2.58	0.48	0.07	J	0.08	0.07	0.09	UJ	1.42	0.32	0.09	J	4.00	*	4.27
PZ-105-SS TOT	2.62	0.49	0.08	J	0.11	0.09	0.09	J	1.64	0.35	0.06	J	4.37		4.94
PZ-106-KS DIS	2.02	0.40	0.06	J	0.09	0.08	0.09	J	0.73	0.20	0.07	J	2.84		2.22
PZ-106-KS FD DIS															
PZ-106-KS MDNR DIS															
PZ-106-KS TOT	2.25	0.43	0.05	J	0.07	0.07	0.09	UJ	0.86	0.23	0.07	J	3.11	*	2.60
PZ-106-KS FD TOT															
PZ-106-KS MDNR TOT															
PZ-106-SD DIS	0.43	0.16	0.08	J	0.03	0.05	0.08	UJ	0.20	0.11	0.08	J	0.63	*	0.63
PZ-106-SD TOT	0.32	0.13	0.07	J	0.06	0.06	0.07	UJ	0.31	0.13	0.06	J	0.63	*	0.96
PZ-106-SS DIS	0.61	0.17	0.05	J	0.12	0.08	0.05	J	0.34	0.13	0.04	J	1.07		1.07
PZ-106-SS TOT	0.59	0.17	0.05	J	0.05	0.05	0.06	UJ	0.38	0.14	0.05	J	0.97	*	1.16
PZ-107-SS DIS	1.64	0.41	0.12		0.19	0.13	0.10	J	1.05	0.31	0.16		2.88		3.22
PZ-107-SS FD DIS															
PZ-107-SS TOT	1.68	0.37	0.08		0.16	0.10	0.07	J	1.27	0.30	0.07		3.11		3.86
PZ-107-SS FD TOT															
PZ-109-SS DIS	1.38	0.31	0.07	J	0.04	0.05	0.06	UJ	0.66	0.20	0.06	J	2.04	*	1.99
PZ-109-SS TOT	1.18	0.28	0.06	J	0.12	0.09	0.07	J	0.52	0.17	0.07	J	1.82		1.60
PZ-110-SS DIS	0.08	0.08	0.12	U	0.04	0.07	0.13	U	0.08	0.08	0.09	U	ND		ND
PZ-110-SS TOT	0.13	0.10	0.09	J	0.10	0.09	0.10	J	0.14	0.10	0.10	J	0.37		0.46
PZ-111-KS DIS	7.01	1.02	0.05	J	0.26	0.12	0.06	J	2.79	0.48	0.04	J	10.06		8.43
PZ-111-KS TOT	7.07	1.05	0.05	J	0.30	0.14	0.07	J	3.10	0.54	0.05	J	10.47		9.38
PZ-111-SD DIS	0.43	0.15	0.06	J	0.02	0.04	0.07	UJ	0.27	0.12	0.07	J	0.70	*	0.84
PZ-111-SD TOT	0.41	0.15	0.07	J	0.03	0.04	0.06	UJ	0.18	0.10	0.07	J	0.59	*	0.56
PZ-112-AS DIS	0.26	0.27	0.28	U	0.00	0.23	0.50	U	0.27	0.30	0.41	U	ND		ND
PZ-112-AS EPA DIS															
PZ-112-AS TOT	0.08	0.24	0.51	U	0.06	0.17	0.40	U	0.09	0.19	0.38	U	ND		ND
PZ-112-AS EPA TOT															
PZ-113-AD DIS	0.06	0.07	0.10	U	0.09	0.10	0.14	U	-0.02	0.04	0.15	U	ND		ND
PZ-113-AD FD DIS															
PZ-113-AD MDNR DIS															
PZ-113-AD TOT	0.29	0.27	0.30	UJ	-0.02	0.13	0.32	UJ	0.15	0.22	0.35	UJ	ND		ND
PZ-113-AD FD TOT															
PZ-113-AD EPA TOT	0.0806		0.904	U	0.154		0.718	U	-0.056		0.534	U	ND		ND
PZ-113-AD MDNR TOT															
PZ-113-AS DIS	0.61	0.20	0.07		0.07	0.08	0.11	U	0.48	0.18	0.09		1.09	*	1.48
PZ-113-AS EPA DIS															
PZ-113-AS TOT	0.92	0.27	0.07		0.22	0.14	0.12	J	0.79	0.25	0.10		1.93		2.46
PZ-113-SS DIS	1.83	0.37	0.06	J	0.10	0.08	0.08	J	1.21	0.28	0.05	J	3.14		3.65
PZ-113-SS TOT	2.60	0.48	0.08	J	0.29	0.14	0.08	J	1.76	0.36	0.07	J	4.65		5.38
PZ-114-AS DIS	0.08	0.10	0.13	UJ	0.03	0.08	0.18	UJ	0.07	0.11	0.19	UJ	ND		ND
PZ-114-AS TOT	0.20	0.12	0.10	J	0.06	0.07	0.10	U	0.10	0.09	0.12	U	0.20	*	0.40
PZ-115-SS DIS	2.30	0.45	0.06	J	0.18	0.11	0.10	J	1.55	0.35	0.08	J	4.03		4.70
PZ-115-SS TOT	2.51	0.47	0.05	J	0.14	0.10	0.09	J	1.69	0.36	0.07	J	4.34		5.10
PZ-116-SS DIS	5.29	0.81	0.05	J	0.40	0.15	0.06	J	1.78	0.35	0.07	J	7.47		5.49
PZ-116-SS TOT	5.69	0.89	0.06	J	0.41	0.16	0.06	J	1.62	0.34	0.06	J	7.72		5.02
PZ-200-SS DIS	0.53	0.18	0.09		0.04	0.06	0.09	U	0.58	0.19	0.06		1.11	*	1.77

July 2013

Sample ID	Uranium-234				Uranium-235				Uranium-238				TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q			
D-87 FD TOT															
D-93 DIS	0.25	0.13	0.1	J	0.06	0.08	0.12	U	0.12	0.09	0.1	J	0.37	*	0.41
D-93 MDNR DIS															
D-93 TOT	0.22	0.14	0.14	J	0.04	0.08	0.15	U	0.15	0.11	0.09	J	0.37	*	0.52
D-93 EPA TOT	0.224	0.327	0.178		-0.0225	0.0452	0.174	U	0.227	0.308	0.130		0.45	*	0.76
D-93 MDNR TOT															
LR-100 DIS	0.38	0.3	0.29	J+	0.31	0.29	0.27	J	0.08	0.15	0.27	UJ	0.38	*	0.95
LR-100 FD DIS															
LR-100 TOT	0.35	0.33	0.3	J+	0	0.24	0.53	UJ	0.12	0.2	0.34	UJ	0.35	*	1.26
LR-100 FD TOT															
LR-103 DIS	0.18	0.14	0.12	J+	0.12	0.13	0.18	UJ	0.14	0.12	0.11	J	0.32	*	0.50
LR-103 TOT	0.83	0.37	0.15	J+	0.53	0.32	0.19	J	0.64	0.32	0.15	J	2.00		2.15
LR-104 DIS	2.35	1.14	0.52	R	0.06	0.23	0.6	R	1.24	0.76	0.48	R	3.65		3.72
LR-104 FD DIS															
LR-104 TOT	2.94	0.61	0.11		0.14	0.12	0.12	J	2.02	0.47	0.11		5.10		6.08
LR-104 FD TOT															
LR-105 DIS															
LR-105 TOT															
MW-102 DIS	5.63	0.96	0.08		0.95	0.29	0.08	J+	4.33	0.77	0.07		10.91		13.34
MW-102 EPA DIS															
MW-102 TOT	5.58	0.99	0.09		1.05	0.32	0.09	J+	4.63	0.85	0.11		11.26		14.28
MW-103 DIS	2.48	0.54	0.09		0.39	0.19	0.11	J+	2.27	0.51	0.09		5.14		6.94
MW-103 TOT	3	0.6	0.07		0.67	0.25	0.12	J+	2.79	0.57	0.07		6.46		8.62
MW-104 DIS	2.21	0.52	0.1	J+	0.36	0.2	0.14	J+	1.65	0.43	0.12	J+	4.22		5.08
MW-104 TOT	2.89	0.63	0.12	J+	0.74	0.28	0.12	J+	2.39	0.54	0.08	J+	6.02		7.46
MW-1204 DIS	0.18	0.22	0.34	UJ+	0.21	0.24	0.32	UJ	0.02	0.1	0.26	UJ	ND		ND
MW-1204 FD DIS															
MW-1204 TOT	0.19	0.18	0.19	J	0.04	0.1	0.21	UJ	0	0.09	0.25	UJ	0.19	*	0.84
MW-1204 FD TOT															
PZ-100-KS DIS	0.05	0.05	0.05	J	0.07	0.07	0.07	J	0.03	0.04	0.06	UJ	0.05	*	0.21
PZ-100-KS TOT	0.05	0.06	0.09	UJ	0.05	0.06	0.09	UJ	-0.02	0.05	0.14	UJ	ND		ND
PZ-100-SD DIS	0.44	0.2	0.14		0.03	0.07	0.15	U	0.34	0.18	0.11	J	0.78	*	1.08
PZ-100-SD TOT	0.42	0.16	0.07	J	0.05	0.06	0.07	U	0.34	0.15	0.07		0.76	*	1.05
PZ-100-SS DIS	4.82	0.89	0.11		0.26	0.16	0.13	J	1.86	0.44	0.07		6.94		5.66
PZ-100-SS TOT	4.99	0.87	0.12		0.4	0.18	0.11		2.22	0.47	0.09		7.61		6.80
PZ-101-SS DIS	0.53	0.25	0.14	J	0	0.09	0.19	UJ	0.48	0.24	0.12	J	1.01	*	1.52
PZ-101-SS EPA DIS															
PZ-101-SS TOT	0.55	0.42	0.3	J	0.09	0.24	0.52	UJ	0.28	0.32	0.42	UJ	0.55	*	1.49
PZ-101-SS EPA TOT	0.387	0.448	0.209		0.0341	0.137	0.0923	U	0.363	0.416	0.159		0.75	*	1.12
PZ-102R-SS DIS	3.47	0.7	0.1	J+	0.72	0.26	0.14		2.25	0.5	0.09	J	6.44		7.04
PZ-102R-SS TOT	4.13	0.85	0.11	J+	0.76	0.27	0.12		3.53	0.75	0.1	J	8.42		10.87
PZ-102-SS DIS	5.84	0.98	0.08	J+	0.98	0.3	0.12		3.85	0.7	0.08		10.67		11.92
PZ-102-SS TOT	4.67	0.82	0.08	J+	0.64	0.23	0.11		4.43	0.79	0.09		9.74		13.50
PZ-102-SS EPA TOT															
PZ-103-SS DIS	0.33	0.14	0.07	J+	0.14	0.1	0.09	J	0.14	0.09	0.08	J	0.61		0.48
PZ-103-SS TOT	0.63	0.4	0.28	J+	0.13	0.21	0.31	UJ	1.01	0.51	0.36	J	1.64	*	3.15
PZ-104-KS DIS	0.56	0.19	0.06	J+	0.3	0.15	0.1		0.29	0.13	0.06	J	1.15		1.00
PZ-104-KS TOT	0.62	0.2	0.07	J+	0.27	0.14	0.1	J	0.18	0.1	0.08	J	1.07		0.66
PZ-104-SD DIS	0.21	0.24	0.28	UJ	-0.01	0.14	0.3	UJ	0.17	0.2	0.24	UJ	ND		ND
PZ-104-SD MDNR DIS															
PZ-104-SD TOT	0.1	0.17	0.29	UJ	0	0.21	0.46	UJ	0.22	0.25	0.29	UJ	ND		ND
PZ-104-SD EPA TOT															
PZ-104-SD MDNR TOT															
PZ-104-SS DIS	0.31	0.13	0.05		0.02	0.05	0.1	U	0.12	0.08	0.08	J	0.43	*	0.40
PZ-104-SS FD DIS															
PZ-104-SS TOT	0.52	0.18	0.06		0.11	0.09	0.07	J	0.22	0.11	0.08		0.85		0.71
PZ-104-SS FD TOT															
PZ-105-SS DIS	2.78	0.54	0.08		0.55	0.21	0.11	J+	1.78	0.4	0.1		5.11		5.56
PZ-105-SS TOT	2.81	0.56	0.06		0.25	0.14	0.11	J+	1.54	0.37	0.06		4.60		4.70
PZ-106-KS DIS	2.02	0.53	0.14	J+	0.22	0.16	0.14	J	0.78	0.3	0.21		3.02		2.43
PZ-106-KS FD DIS															
PZ-106-KS MDNR DIS															
PZ-106-KS TOT	2.04	0.45	0.09	J+	0.31	0.16	0.1	J	0.93	0.27	0.08		3.28		2.91
PZ-106-KS FD TOT															
PZ-106-KS MDNR TOT															
PZ-106-SD DIS	1.24	0.55	0.31	J+	0.64	0.43	0.38	J	0.1	0.18	0.31	U	1.24	*	1.22
PZ-106-SD TOT	1.11	0.53	0.33	J+	0.62	0.44	0.41	J	0.77	0.43	0.23	J	2.50		2.58
PZ-106-SS DIS	1.94	0.64	0.2	J+	0.62	0.37	0.22	J	0.54	0.31	0.2	J	3.10		1.90
PZ-106-SS TOT	1.18	0.53	0.34	J+	0.37	0.33	0.39	UJ	0.59	0.37	0.33	J	1.77	*	1.94
PZ-107-SS DIS	1.85	0.57	0.19	J+	0.16	0.17	0.21	UJ	0.83	0.35	0.18	J	2.68	*	2.57
PZ-107-SS FD DIS	1.57	0.46	0.15	J+	0.24	0.18	0.18	J	0.93	0.33	0.12	J	2.74		2.88
PZ-107-SS TOT	1.65	0.38	0.09	J+	0.18	0.12	0.11	J	1.42	0.34	0.06		3.25		4.31
PZ-107-SS FD TOT	1.74	0.6	0.16	J+	0.31	0.25	0.22	J	1.51	0.54	0.18	J	3.56		4.64
PZ-109-SS DIS	1.4	0.32	0.05	J	0.13	0.09	0.09	J	0.61	0.19	0.08	J	2.14		1.88
PZ-109-SS TOT	1.36	0.32	0.06		0.17	0.11	0.1	J	0.54	0.18	0.08		2.07		1.69
PZ-110-SS DIS	0.08	0.08	0.1	UJ	0.01	0.05	0.12	U	0.06	0.07	0.1	U	ND		ND
PZ-110-SS TOT	0.1	0.09	0.11	U	0.11	0.09	0.1	J	0.02	0.04	0.1	U	0.02	*	0.35
PZ-111-KS DIS	8.15	1.6	0.11	J+	0.99	0.39	0.19	J	3.47	0.82	0.12	J	12.61		10.80
PZ-111-KS TOT	7.02	1.25	0.08	J+	0.82	0.3	0.1	J	2.41	0.55	0.11		10.25		7.56
PZ-111-SD DIS	0.3	0.13	0.06		0.05	0.06	0.08	U	0.18	0.1	0.08	J	0.48	*	0.57
PZ-111-SD TOT	0.35	0.14	0.09	J	0.06	0.07	0.1	U	0.26	0.12	0.07		0.61	*	0.82
PZ-112-AS DIS	0.25	0.19	0.15	J	0.15	0.16	0.19	U	-0.03	0.07	0.19	U	0.25	*	0.65
PZ-112-AS EPA DIS															
PZ-112-AS TOT	0.19	0.15	0.16	J	0.05	0.08	0.14	U	0.09	0.09	0.1	U	0.19	*	0.36
PZ-112-AS EPA TOT	######	0.103	0.294	U	0.000	0.0222	0.160	U	0.0208	0.100	0.256	U	ND		ND
PZ-113-AD DIS	0.56	0.36	0.3	J+	0.35	0.33	0.38	UJ	0.2	0.24	0.35	U	0.56	*	1.22
PZ-113-AD FD DIS	0.33	0.29	0.28	J	-0.04	0.15	0.38	UJ	0.33	0.29	0.28	J	0.66	*	1.16
PZ-113-AD MDNR DIS															
PZ-113-AD TOT	1.92	1.49	1.02	R	0.15	0.62	1.59	R	0.16	0.5	1.17	U	1.92	*	3.56
PZ-113-AD FD TOT	0.31	0.3	0.32	UJ	0.07	0.16	0.34	UJ	0.05	0.13	0.28	UJ	ND		ND
PZ-113-AD EPA TOT	-0.0140	0.393	0.455	U	-0.0104	0.0418	0.237	U	-0.00838	0.0335	0.190	U	ND		ND
PZ-113-AD MDNR TOT															
PZ-113-AS DIS	0.56	0.25	0.17		0.18	0.15	0.16	J	0.22	0.17	0.21	J	0.96		0.74
PZ-113-AS EPA DIS															
PZ-113-AS TOT	0.69	0.26	0.13	J	0.14	0.13	0.14	J	0.62	0.25	0.13	J	1.45		1.91
PZ-113-SS DIS	1.49	0.32	0.07	J	0.12	0.09	0.08	J	0.83	0.23	0.11	J	2.44		2.53
PZ-113-SS TOT	1.72	0.39	0.09		0.19	0.12	0.07	J	0.99	0.27	0.09		2.90		3.04
PZ-114-AS DIS	0.29	0.16	0.13	J	0.14	0.12	0.13	J+	0.16	0.12	0.08	J	0.59		0.54
PZ-114-AS TOT	0.3	0.21	0.17	J	0.01	0.09	0.24	UJ+	0.14	0.16	0.21	UJ	0.30	*	0.74
PZ-115-SS DIS	3.41	0.7	0.11		0.33	0.17	0.09	J+	2.19	0.5	0.09		5.93		6.68
PZ-115-SS TOT	3.67	0.76	0.11	J	0.32	0.18	0.13	J+	2.53	0.58	0.13	J	6.52		7.69
PZ-116-SS DIS	5.24	0.83	0.06	J	0.33	0.15	0.08	J	1.74	0.36	0.06	J	7.31		5.34
PZ-116-SS TOT	5.64	0.96	0.09		0.37	0.18	0.11	J+	1.68	0.39	0.09		7.69		5.18
PZ-200-SS DIS	0.49	0.18	0.09	J+	0.06	0.08	0.13	UJ	0.41	0.16	0.06	J	0.90	*	1.28

October 2013 / February 2014

Sample ID	Oct 2013 Uranium-234				Uranium-235				Uranium-238				TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)	Feb 2014 Uranium-234				Uranium-235				Uranium-238				TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q				Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q			
D-87 FD TOT	0.63	0.27	0.12		0	0.09	0.2	U	0.25	0.18	0.17	J	0.88	*	0.84															
D-93 DIS	0.49	0.26	0.18	J	0.17	0.18	0.22	U	0.3	0.2	0.18	J	0.79	*	1.00															
D-93 MDNR DIS	0.16	0.18	0.24	U	0.03	0.12	0.30	U	0.11	0.16	0.24	U	ND		ND															
D-93 TOT	0.55	0.25	0.16		0.04	0.09	0.18	U	0.31	0.19	0.16	J	0.86	*	1.01															
D-93 EPA TOT																														
D-93 MDNR TOT	0.47	0.26	0.20		0.03	0.08	0.17	U	0.19	0.16	0.16	J	0.66	*	0.64															
LR-100 DIS	0.17	0.15	0.17	J	0.02	0.07	0.17	U	0.14	0.13	0.12	J	0.31	*	0.50															
LR-100 FD DIS	0.33	0.24	0.17	J	0	0.14	0.31	UJ	0	0.11	0.25	UJ	0.33	*	0.89															
LR-100 TOT	0	0.12	0.27	UJ	0.06	0.15	0.33	UJ	-0.01	0.09	0.19	UJ	ND		ND															
LR-100 FD TOT	0.13	0.17	0.26	UJ	-0.01	0.11	0.22	UJ	0.12	0.15	0.18	UJ	ND		ND															
LR-103 DIS	0.23	0.18	0.16	J	0.07	0.12	0.2	U	0.1	0.12	0.14	U	0.23	*	0.51															
LR-103 TOT	0.15	0.15	0.18	UJ	0.11	0.13	0.16	U	0.15	0.15	0.18	U	ND		ND															
LR-104 DIS	2.98	1.3	0.57	J	0.27	0.46	0.8	UJ	2.14	1.06	0.45	J	5.12	*	6.75															
LR-104 FD DIS																														
LR-104 TOT	2.93	0.66	0.12	J	0.19	0.17	0.19	J	1.94	0.51	0.16	J	5.06		5.87															
LR-104 FD TOT																														
LR-105 DIS																														
LR-105 TOT																														
MW-102 DIS	5.9	1.13	0.18		0.28	0.2	0.15	J	5.04	1	0.14		11.22		15.15															
MW-102 EPA DIS																														
MW-102 TOT	6.14	1.22	0.13		0.55	0.31	0.24	J	5.2	1.08	0.19		11.89		15.75															
MW-103 DIS	1.2	0.43	0.21		0.2	0.19	0.24	U	1.55	0.49	0.14		2.75	*	4.73															
MW-103 TOT	2.32	0.64	0.2		0.12	0.16	0.25	U	2.04	0.58	0.14		4.36	*	6.19															
MW-104 DIS	2.31	0.6	0.22		0.4	0.25	0.2	J	1.37	0.44	0.24		4.08		4.27															
MW-104 TOT	3.49	0.76	0.17		0.25	0.19	0.17	J	2.99	0.68	0.15		6.73		9.02															
MW-1204 DIS	0.05	0.09	0.17	UJ	0.06	0.11	0.19	U	0.03	0.06	0.13	UJ	ND		ND															
MW-1204 FD DIS																														
MW-1204 TOT	0.17	0.14	0.12	J	0.07	0.1	0.15	U	0.09	0.12	0.18	UJ	0.17	*	0.61															
MW-1204 FD TOT																														
PZ-100-KS DIS	0.19	0.14	0.1	J+	0.11	0.12	0.12	UJ	0.1	0.11	0.14	UJ	0.19	*	0.47															
PZ-100-KS TOT	0.1	0.18	0.33	UJ+	0	0.14	0.41	UJ	0.19	0.21	0.25	UJ	ND		ND															
PZ-100-SD DIS	0.29	0.17	0.14	J	0.06	0.1	0.17	UJ	0.11	0.1	0.1	J	0.40	*	0.41															
PZ-100-SD TOT	0.47	0.22	0.13	J	0.17	0.14	0.12	J	0.14	0.13	0.14	J	0.78		0.50															
PZ-100-SS DIS	4.04	0.92	0.14		0.16	0.17	0.17	U	1.33	0.46	0.16		5.37	*	4.04															
PZ-100-SS TOT	4.98	1.1	0.26		0.27	0.24	0.28	U	1.92	0.59	0.25		6.90	*	5.85															
PZ-101-SS DIS	0.71	0.45	0.32	J	-0.01	0.16	0.34	UJ	0.31	0.3	0.32	UJ	0.71	*	1.11															
PZ-101-SS EPA DIS																														
PZ-101-SS TOT	0.28	0.26	0.28	J	0.22	0.29	0.44	UJ	0.24	0.26	0.35	UJ	0.28	*	1.25															
PZ-101-SS EPA TOT																														
PZ-102R-SS DIS	4.4	0.89	0.17	J	0.65	0.31	0.19	J	2.26	0.57	0.13	J	7.31		7.03															
PZ-102R-SS TOT	4.31	0.93	0.16		0.19	0.19	0.23	U	2.59	0.66	0.15		6.90	*	7.82															
PZ-102-SS DIS	4.07	0.78	0.12	J	0.54	0.25	0.13	J	2.23	0.52	0.13	J	6.84		6.89															
PZ-102-SS TOT	5.25	0.96	0.11	J	0.34	0.2	0.14	J	5.09	0.94	0.11	J	10.68		15.32															
PZ-102-SS EPA TOT																														
PZ-103-SS DIS	0.29	0.19	0.14	J	0.06	0.1	0.17	U	0.13	0.13	0.15	U	0.29	*	0.53															
PZ-103-SS TOT	0.73	0.28	0.16	J	0.01	0.06	0.17	UJ	0.42	0.21	0.14	J	1.15	*	1.33															
PZ-104-KS DIS	0.28	0.19	0.17	J	0.17	0.16	0.15	J	0.14	0.13	0.12	J	0.59		0.50															
PZ-104-KS TOT	0.22	0.17	0.16	J	0.08	0.12	0.19	U	0.13	0.12	0.13	J	0.35	*	0.48															
PZ-104-SD DIS	0.32	0.45	0.68	UJ	0.26	0.45	0.76	UJ	-0.01	0.39	1	UJ	ND		ND															
PZ-104-SD MDNR DIS	0.33	0.29	0.33	J	0.07	0.19	0.41	U	0.10	0.16	0.23	U	0.33	*	0.88															
PZ-104-SD TOT	0.44	0.3	0.21	J	0.06	0.17	0.37	UJ	0.1	0.17	0.3	UJ	0.44	*	1.07															
PZ-104-SD EPA TOT																														
PZ-104-SD MDNR TOT	0.05	0.14	0.33	U	0.08	0.23	0.51	U	0.27	0.30	0.41	U	ND		ND															
PZ-104-SS DIS	0.25	0.15	0.1	J	0.03	0.08	0.17	UJ	0.07	0.08	0.1	UJ	0.25	*	0.38															
PZ-104-SS FD DIS																														
PZ-104-SS TOT	0.47	0.25	0.19	J	0.07	0.11	0.16	U	0.11	0.12	0.15	UJ	0.47	*	0.52															
PZ-104-SS FD TOT																														
PZ-105-SS DIS	2.12	0.52	0.11	J	0.08	0.1	0.12	UJ	1.59	0.43	0.11	J	3.71	*	4.79															
PZ-105-SS TOT	2.24	0.58	0.14	J	0.21	0.19	0.21	J	1.49	0.46	0.17	J	3.94		4.54															
PZ-106-KS DIS	1.62	0.44	0.14	J+	0.1	0.12	0.17	UJ	0.67	0.27	0.14	J	2.29	*	2.07															
PZ-106-KS FD DIS	1.65	0.44	0.12	J+	0.25	0.18	0.14	J	0.63	0.25	0.11	J	2.53		1.99															
PZ-106-KS MDNR DIS																														
PZ-106-KS TOT	1.98	0.48	0.13	J+	0.15	0.13	0.15	J	0.57	0.24	0.13	J	2.70		1.77															
PZ-106-KS FD TOT	1.8	0.46	0.13	J+	0.08	0.1	0.12	UJ	0.32	0.18	0.11	J	2.12	*	1.01															
PZ-106-KS MDNR TOT																														
PZ-106-SD DIS	0.21	0.17	0.13	J	0.07	0.11	0.16	UJ	0.21	0.16	0.15	J	0.42	*	0.70															
PZ-106-SD TOT	0.5	0.23	0.17	J	0.09	0.12	0.18	UJ	0.24	0.16	0.16	J	0.74	*	0.80															
PZ-106-SS DIS	0.85	0.31	0.15	J	0.19	0.17	0.19	J	0.17	0.13	0.11	J	1.21		0.59															
PZ-106-SS TOT	0.93	0.35	0.12	J	0.11	0.14	0.22	J	0.41	0.23	0.17	J	1.45		1.27															
PZ-107-SS DIS	1.54	0.59	0.28	J	0.05	0.11	0.24	UJ	1.43	0.56	0.22	J	2.97	*	4.37															
PZ-107-SS FD DIS																														
PZ-107-SS TOT	0.59	0.26	0.11		0.22	0.18	0.17	J	1.09	0.37	0.13		1.90		3.35															
PZ-107-SS FD TOT																														
PZ-109-SS DIS	0.94	0.31	0.11	J	0.06	0.1	0.17	UJ	0.58	0.24	0.14	J	1.52	*	1.81															
PZ-109-SS TOT	1.51	0.47	0.19	J	0.11	0.13	0.16	UJ	0.16	0.18	0.28	UJ	1.51	*	0.91															
PZ-110-SS DIS	0.13	0.12	0.11	J	0.13	0.13	0.14	U	0.05	0.09	0.16	U	0.13	*	0.54															
PZ-110-SS TOT	0.23	0.19	0.19	J	0.09	0.15	0.26	U	0.14	0.16	0.21	U	0.23	*	0.75															
PZ-111-KS DIS	6.55	1.14	0.15	J	0.4	0.22	0.16	J	2.3	0.55	0.13	J	9.25		7.04															
PZ-111-KS TOT	7.15	1.48	0.23	J	0.23	0.21	0.2	J	2.2	0.66	0.19	J	9.58		6.66															
PZ-111-SD DIS	0.35	0.21	0.17	J	0.04	0.1	0.21	U	0.26	0.17	0.12	J	0.61	*	0.87															
PZ-111-SD TOT	0.48	0.22	0.13		0.1	0.12	0.17	U	0.16	0.13	0.12	J	0.64	*	0.56															
PZ-112-AS DIS	3.53	0.91	0.17	J	0.3	0.26	0.3	J	0.24	0.2	0.17	J	4.07		0.85															
PZ-112-AS EPA DIS																														
PZ-112-AS TOT	0.09	0.11	0.13	UJ	-0.02	0.08	0.21	U	0.11	0.13	0.17	U	ND		ND															
PZ-112-AS EPA TOT																														
PZ-113-AD DIS	0.06	0.16	0.34	UJ	0.14	0.24	0.42	UJ	0.1	0.16	0.23	UJ	ND		ND															
PZ-113-AD FD DIS	0.14	0.17	0.26	U	0.05	0.13	0.28	U	-0.03	0.08	0.21	U	ND		ND															
PZ-113-AD MDNR DIS	0.28	0.20	0.15	J	0.04	0.12	0.26	U	0.19	0.17	0.19	J	0.47	*	0.70															
PZ-113-AD TOT	0.17	0.2	0.26	UJ	0.14	0.21	0.35	UJ	0.08	0.14	0.24	UJ	ND		ND															
PZ-113-AD FD TOT	0.26	0.22	0.23	J	0.02	0.1	0.29	UJ	0.03	0.08	0.17	UJ	0.26	*	0.64															
PZ-113-AD EPA TOT																														
PZ-113-AD MDNR TOT	0.20	0.17	0.17	J	0.11	0.15	0.21	U	0.06	0.10	0.14	U	0.20	*	0.53															
PZ-113-AS DIS	0.58	0.24	0.1	J	0.12	0.13	0.17	UJ	0.49	0.22	0.14	J	1.07	*	1.54															
PZ-113-AS EPA DIS																														
PZ-113-AS TOT	0.75	0.33	0.18	J	0.16	0.17	0.24	UJ	0.35	0.22	0.19	J	1.10	*	1.15															
PZ-113-SS DIS	1.2	0.36	0.15	J	0.14	0.14	0.17	UJ	0.48	0.22	0.15	J	1.68	*	1.51															
PZ-113-SS TOT	1.19	0.36	0.19	J	0.07	0.11	0.19	UJ	0.97	0.32	0.15	J	2.16	*	2.98															
PZ-114-AS DIS	-0.01	0.06	0.13	U	0	0.11	0.24	U	-0.01	0.06	0.13	U	ND		ND															
PZ-114-AS TOT	0.13	0.15	0.2	U	0.12	0.14	0.17	U	0.15	0.15	0.16	U	ND		ND															
PZ-115-SS DIS	4.18	0.91	0.13		0.19	0.17	0.16	J	2.01	0.56	0.13		6.38		6.08															
PZ-115-SS TOT	4.05	0.96	0.25		0.34	0.25	0.23	J	2.15	0.64	0.3		6.54		6.56															
PZ-116-SS DIS	5.77	1.13	0.18	J	0.24	0.19	0.17	J	1.58	0.48	0.14	J	7.59		4.82															
PZ-116-SS TOT	5.83	1.19	0.2	J	0.2	0.2	0.24	U	1.7	0.52	0.2	J	7.53	*	5.18															
PZ-200-SS DIS	0.14	0.15	0.21	UJ	-0.02	0.07	0.19	U	0.34	0.2	0.17	J	0.34	*	1.10															

Table 7-24: Summary of Uranium Isotope Results: 2012 - 2013 Groundwater Sampling Events

DRAFT

August 2012

Sample ID	Uranium-234				Uranium-235				Uranium-238				TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q			
PZ-200-SS FD DIS	0.69	0.33	0.20		0.12	0.15	0.18	U	0.22	0.19	0.21	J	0.91	*	0.74
PZ-200-SS TOT	0.54	0.27	0.18	J	0.04	0.10	0.22	UJ	0.59	0.27	0.13	J	1.14	*	1.87
PZ-200-SS FD TOT	0.32	0.20	0.18	J	0.07	0.12	0.20	UJ	0.34	0.20	0.14	J	0.66	*	1.09
PZ-201A-SS DIS	1.96	0.49	0.10	J	0.01	0.06	0.15	UJ+	1.16	0.35	0.11	J	3.12	*	3.52
PZ-201A-SS FD DIS	2.05	0.53	0.14	J	0.09	0.11	0.13	UJ+	1.65	0.46	0.12	J	3.70	*	4.99
PZ-201A-SS TOT	2.09	0.51	0.10	J	0.08	0.10	0.14	UJ+	1.56	0.42	0.13	J	3.66	*	4.72
PZ-201A-SS FD TOT	1.64	0.70	0.31	J	0.08	0.22	0.47	UJ+	1.58	0.70	0.42	J	3.23	*	4.93
PZ-202-SS DIS	1.15	0.38	0.21		0.16	0.15	0.14	J	0.57	0.26	0.15	J	1.88		1.77
PZ-202-SS TOT	1.18	0.73	0.64	J	0.08	0.23	0.55	UJ	0.88	0.61	0.49	J	2.06	*	2.88
PZ-203-SS DIS	3.37	0.69	0.14	J	0.15	0.14	0.15	J+	0.66	0.26	0.13	J	4.19		2.05
PZ-203-SS TOT	4.11	0.77	0.16	J	0.02	0.05	0.11	UJ+	0.55	0.22	0.12	J	4.67	*	1.70
PZ-204A-SS DIS	1.98	0.60	0.15		0.21	0.20	0.21	U	1.66	0.54	0.20		3.64	*	5.05
PZ-204A-SS TOT	1.71	0.56	0.22	J	0.16	0.18	0.24	UJ	1.27	0.47	0.21	J	2.98	*	3.89
PZ-204-SS DIS	3.88	0.78	0.10	J	0.39	0.23	0.18	J	2.95	0.65	0.15	J	7.22		8.96
PZ-204-SS TOT	3.81	0.84	0.18		0.26	0.21	0.22	J	2.28	0.60	0.14		6.34		6.90
PZ-205-AS DIS	0.68	0.37	0.27	J	0.17	0.22	0.33	UJ	0.11	0.16	0.24	UJ	0.68	*	0.86
PZ-205-AS TOT	0.17	0.15	0.16	J	0.03	0.07	0.16	U	0.12	0.12	0.13	U	0.17	*	0.45
PZ-205-SS DIS	0.35	0.20	0.15	J	-0.02	0.07	0.18	UJ	0.31	0.19	0.17	J	0.66	*	1.01
PZ-205-SS TOT	0.44	0.27	0.22	J	-0.02	0.09	0.24	U	0.34	0.23	0.19	J	0.79	*	1.14
PZ-206-SS DIS	0.27	0.19	0.17	J	0.04	0.10	0.22	UJ	0.04	0.08	0.15	UJ	0.27	*	0.56
PZ-206-SS EPA DIS	0.34				0.023			U	0.105				0.45	*	need MDAs
PZ-206-SS MDNR DIS															
PZ-206-SS TOT	0.25	0.18	0.19	J	0.04	0.10	0.21	UJ	0.21	0.17	0.20	J	0.47	*	0.74
PZ-206-SS MDNR TOT															
PZ-207-AS DIS	0.06	0.14	0.27	UJ	0.04	0.10	0.21	UJ	0.08	0.13	0.23	UJ	ND		ND
PZ-207-AS EPA DIS	-0.005			U	-0.006			U	0.016			U	ND		need MDAs
PZ-207-AS MDNR DIS															
PZ-206-SS MDNR FD DIS															
PZ-207-AS TOT	0.16	0.30	0.55	UJ	0.07	0.27	0.67	UJ	0.16	0.30	0.54	UJ	ND		ND
PZ-207-AS MDNR TOT															
PZ-208-SS DIS	1.88	0.55	0.20		0.15	0.16	0.19	UJ+	0.82	0.37	0.34		2.70	*	2.52
PZ-208-SS TOT	2.04	0.62	0.18		0.37	0.28	0.28	J+	1.64	0.54	0.22		4.04		5.04
PZ-209-SD DIS															
PZ-209-SD TOT															
PZ-209-SS DIS															
PZ-209-SS TOT															
PZ-210-SD DIS															
PZ-210-SD FD DIS															
PZ-210-SD TOT															
PZ-210-SD FD TOT															
PZ-210-SS DIS															
PZ-210-SS TOT															
PZ-211-SD DIS															
PZ-211-SD FD DIS															
PZ-211-SD TOT															
PZ-211-SD FD TOT															
PZ-211-SS DIS															
PZ-211-SS TOT															
PZ-212-SD DIS															
PZ-212-SD TOT															
PZ-212-SS DIS															
PZ-212-SS TOT															
PZ-302-AI DIS	5.50	1.25	0.18	J	0.09	0.14	0.23	UJ	4.01	1.00	0.18	J	9.51	*	12.04
PZ-302-AI TOT	5.02	1.01	0.13		0.32	0.23	0.24	J	3.57	0.80	0.13		8.91		10.80
PZ-302-AS DIS															
PZ-302-AS TOT															
PZ-303-AS DIS	-0.01	0.18	0.53	UJ	0.10	0.27	0.59	UJ	-0.16	0.21	0.72	UJ	ND		ND
PZ-303-AS TOT	0.48	0.38	0.32	J	-0.06	0.18	0.50	UJ	0.12	0.20	0.31	UJ	0.48	*	1.17
PZ-304-AI DIS	1.27	0.56	0.36	J	0.00	0.18	0.39	UJ	0.58	0.41	0.48	J	1.85	*	1.91
PZ-304-AI FD DIS															
PZ-304-AI TOT	2.71	1.40	0.65	J	0.41	0.63	1.03	UJ	1.55	1.01	0.64	J	4.25	*	5.08
PZ-304-AI FD TOT															
PZ-304-AS DIS	0.07	0.35	0.83	UJ	-0.14	0.31	0.90	UJ	0.03	0.25	0.67	UJ	ND		ND
PZ-304-AS TOT	0.03	0.19	0.51	UJ	0.19	0.31	0.49	UJ	-0.02	0.18	0.39	UJ	ND		ND
PZ-305-AI DIS	0.07	0.11	0.19	U	0.20	0.22	0.30	U	-0.01	0.09	0.26	U	ND		ND
PZ-305-AI FD DIS															
PZ-305-AI EPA DIS	0.09			U	0.06			U	0.14				0.14	*	need MDAs
PZ-305-AI TOT	0.88	0.41	0.24	J	0.07	0.15	0.30	UJ	0.81	0.40	0.28	J	1.69	*	2.55
PZ-305-AI FD TOT															

April 2013

Sample ID	Uranium-234				Uranium-235				Uranium-238				TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q			
PZ-200-SS FD DIS															
PZ-200-SS TOT	0.54	0.18	0.08		0.06	0.07	0.07	U	0.52	0.18	0.06		1.06	*	1.58
PZ-200-SS FD TOT															
PZ-201A-SS DIS	2.22	0.44	0.08	J	0.15	0.10	0.07	J	1.58	0.34	0.07	J	3.95		4.78
PZ-201A-SS FD DIS															
PZ-201A-SS TOT	2.48	0.50	0.08		0.13	0.10	0.08	J	1.33	0.33	0.07		3.94		4.02
PZ-201A-SS FD TOT															
PZ-202-SS DIS	1.62	0.34	0.05	J	0.05	0.06	0.06	UJ	0.63	0.18	0.05	J	2.25	*	1.90
PZ-202-SS TOT	1.69	0.36	0.07	J	0.13	0.09	0.09	J	0.78	0.22	0.08	J	2.60		2.38
PZ-203-SS DIS	3.16	0.57	0.08		0.13	0.10	0.11	J	0.43	0.16	0.11		3.72		1.34
PZ-203-SS TOT	3.29	0.55	0.07	J	0.13	0.09	0.06	J	0.47	0.15	0.07	J	3.89		1.46
PZ-204A-SS DIS	3.10	0.57	0.08		0.08	0.07	0.07	J	2.46	0.48	0.08		5.64		7.37
PZ-204A-SS TOT	3.44	0.61	0.08		0.32	0.15	0.09		2.91	0.54	0.06		6.67		8.82
PZ-204-SS DIS	3.50	0.57	0.06	J	0.13	0.08	0.05	J	1.76	0.34	0.05	J	5.39		5.30
PZ-204-SS TOT	3.20	0.56	0.06	J	0.14	0.09	0.06	J	2.47	0.46	0.05	J	5.81		7.42
PZ-205-AS DIS	0.18	0.11	0.08	J	0.08	0.08	0.09	U	0.15	0.10	0.07	J	0.33	*	0.49
PZ-205-AS TOT	0.30	0.14	0.07	J	0.05	0.07	0.10	U	0.06	0.07	0.08	U	0.30	*	0.28
PZ-205-SS DIS	0.44	0.14	0.04		0.05	0.05	0.05	J	0.40	0.14	0.04	J	0.89		1.21
PZ-205-SS TOT	0.70	0.20	0.06		0.16	0.10	0.09	J	0.48	0.16	0.05	J	1.34		1.50
PZ-206-SS DIS	0.20	0.11	0.08	J	0.04	0.06	0.09	U	0.08	0.07	0.07	J	0.28	*	0.28
PZ-206-SS EPA DIS															
PZ-206-SS MDNR DIS															
PZ-206-SS TOT	0.20	0.11	0.08	J	0.02	0.04	0.08	U	0.05	0.07	0.12	U	0.20	*	0.39
PZ-206-SS MDNR TOT															
PZ-207-AS DIS	0.32	0.24	0.24	J	0.20	0.22	0.30	UJ	0.15	0.16	0.17	UJ	0.32	*	0.65
PZ-207-AS EPA DIS															
PZ-207-AS MDNR DIS															
PZ-206-SS MDNR FD DIS															
PZ-207-AS TOT	0.18	0.15	0.18	J	0.07	0.12	0.22	UJ	0.07	0.10	0.16	UJ	0.18	*	0.58
PZ-207-AS MDNR TOT															
PZ-208-SS DIS	1.69	0.40	0.09		0.09	0.09	0.09	J	1.23	0.32	0.07		3.01		3.71
PZ-208-SS TOT	1.94	0.40	0.07	J	0.11	0.08	0.07	J	1.36	0.31	0.06	J	3.41		4.10
PZ-209-SD DIS															
PZ-209-SD TOT															
PZ-209-SS DIS															
PZ-209-SS TOT															
PZ-210-SD DIS															
PZ-210-SD FD DIS															
PZ-210-SD TOT															
PZ-210-SD FD TOT															
PZ-210-SS DIS															
PZ-210-SS TOT															
PZ-211-SD DIS															
PZ-211-SD FD DIS															
PZ-211-SD TOT															
PZ-211-SD FD TOT															
PZ-211-SS DIS															
PZ-211-SS TOT															
PZ-212-SD DIS															
PZ-212-SD TOT															
PZ-212-SS DIS															
PZ-212-SS TOT															
PZ-302-AI DIS	4.02	0.70	0.08	J	0.11	0.09	0.07	J	2.69	0.52	0.08		6.82		8.07
PZ-302-AI TOT	4.18	0.70	0.05		0.35	0.15	0.09	J	3.21	0.57	0.08		7.74		9.73
PZ-302-AS DIS															
PZ-302-AS TOT															
PZ-303-AS DIS	0.38	0.17	0.10		0.06	0.08	0.12	U	0.20	0.12	0.09	J	0.58	*	0.65
PZ-303-AS TOT	0.91	0.25	0.06		0.05	0.06	0.07	U	0.80	0.23	0.07		1.71	*	2.42
PZ-304-AI DIS	0.50	0.27	0.24	J	0.16	0.17	0.21	UJ	0.42	0.24	0.18	J	0.92	*	1.35
PZ-304-AI FD DIS															
PZ-304-AI TOT	0.21	0.21	0.28	UJ	-0.05	0.10	0.29	UJ	0.29	0.22	0.21	J	0.29	*	1.00
PZ-304-AI FD TOT															
PZ-304-AS DIS	0.08	0.33	0.84	UJ	0.40	0.68	1.19	UJ	-0.05	0.32	0.76	UJ	ND		ND
PZ-304-AS TOT	0.85	0.68	0.61	J	0.16	0.44	0.94	UJ	-0.04	0.26	0.61	UJ	0.85	*	2.25
PZ-305-AI DIS	0.44	0.19	0.11		0.15	0.11	0.09	J	0.59	0.22	0.09		1.18		1.83
PZ-305-AI FD DIS	0.31	0.14	0.09		0.08	0.08	0.09	U	0.32	0.14	0.07		0.63	*	1.00
PZ-305-AI EPA DIS															
PZ-305-AI TOT	0.69	0.27	0.14		0.09	0.11	0.16	U	0.79	0.29	0.09		1.48	*	2.43
PZ-305-AI FD TOT	0.28	0.16	0.12	J	0.11	0.12	0.15	UJ	0.36	0.19	0.13	J	0.64	*	1.14

July 2013

Sample ID	Uranium-234				Uranium-235				Uranium-238				TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q			
PZ-200-SS FD DIS															
PZ-200-SS TOT	0.96	0.27	0.09	J+	0.17	0.12	0.11	J	0.8	0.24	0.08		1.93		2.46
PZ-200-SS FD TOT															
PZ-201A-SS DIS	2.85	0.85	0.22	J+	1.03	0.51	0.24	J	1.36	0.55	0.29		5.24		4.53
PZ-201A-SS FD DIS															
PZ-201A-SS TOT	3.12	0.93	0.3	J+	0.64	0.42	0.35	J	1.91	0.71	0.48		5.67		5.99
PZ-201A-SS FD TOT															
PZ-202-SS DIS	1.51	0.44	0.11	J	0.18	0.15	0.15	J	0.82	0.3	0.11	J	2.51		2.53
PZ-202-SS TOT	2.41	0.52	0.08	J+	0.18	0.12	0.09	J+	1.12	0.31	0.07		3.71		3.42
PZ-203-SS DIS	3.03	0.56	0.08	J+	0.31	0.15	0.1		0.88	0.24	0.06	J	4.22		2.77
PZ-203-SS TOT	2.86	0.56	0.06	J+	0.22	0.13	0.09	J	0.4	0.16	0.07	J	3.48		1.29
PZ-204A-SS DIS	2.41	0.64	0.11	J+	0.4	0.25	0.2	J+	1.86	0.54	0.11	J+	4.67		5.73
PZ-204A-SS TOT	1.98	0.67	0.21	J+	0.38	0.28	0.2	J+	1.27	0.5	0.19	J+	3.63		3.96
PZ-204-SS DIS	2.42	0.5	0.09	J+	0.28	0.15	0.11	J	1.5	0.36	0.09		4.20		4.60
PZ-204-SS TOT	2.85	0.58	0.08	J+	0.44	0.2	0.12	J	1.73	0.41	0.1		5.02		5.36
PZ-205-AS DIS	0.99	0.47	0.2	J+	0.46	0.34	0.24	J	1.08	0.5	0.2	J	2.53		3.43
PZ-205-AS TOT	0.79	0.34	0.18	J+	0.11	0.15	0.23	UJ	0.88	0.36	0.18	J	1.67	*	2.73
PZ-205-SS DIS	0.47	0.17	0.06		0.11	0.09	0.1	J	0.42	0.16	0.06		1.00		1.30
PZ-205-SS TOT	0.54	0.18	0.07	J	0.16	0.1	0.09	J	0.45	0.16	0.06	J	1.15		1.41
PZ-206-SS DIS	0.28	0.13	0.07	J+	0.07	0.07	0.07	J	0.1	0.08	0.08	J	0.45		0.33
PZ-206-SS EPA DIS															
PZ-206-SS MDNR DIS	0.53	0.28	0.19		0.26	0.23	0.25	J	0.05	0.12	0.24	U	0.53	*	0.85
PZ-206-SS TOT	0.53	0.18	0.07	J+	0.23	0.12	0.07	J	0.49	0.17	0.07	J	1.25		1.57
PZ-206-SS MDNR TOT	0.48	0.29	0.18	J	0.38	0.31	0.33	J	0.21	0.19	0.18	J	1.07		0.81
PZ-207-AS DIS	0.21	0.18	0.18	J+	0.28	0.25	0.28	J	0.11	0.15	0.23	UJ	0.21	*	0.82
PZ-207-AS EPA DIS															
PZ-207-AS MDNR DIS	0.57	0.51	0.60	J	0.29	0.41	0.61	U	0.27	0.33	0.39	U	0.57	*	1.46
PZ-206-SS MDNR FD DIS	0.88	0.65	0.47	J	0.53	0.56	0.58	U	0.20	0.31	0.47	U	0.88	*	1.65
PZ-207-AS TOT	0.1	0.22	0.43	UJ+	0.1	0.22	0.43	UJ	-0.03	0.14	0.44	UJ	ND		ND
PZ-207-AS MDNR TOT	0.81	0.61	0.50	J	0.04	0.27	0.73	U	0.31	0.42	0.63	U	0.81	*	2.21
PZ-208-SS DIS	1.58	0.39	0.1	J+	0.48	0.21	0.13	J+	0.98	0.29	0.08	J+	3.04		3.14
PZ-208-SS TOT	1.81	0.43	0.11	J+	0.32	0.17	0.13	J+	1.43	0.37	0.09	J+	3.56		4.41
PZ-209-SD DIS															
PZ-209-SD TOT															
PZ-209-SS DIS															
PZ-209-SS TOT															
PZ-210-SD DIS															
PZ-210-SD FD DIS															
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PZ-211-SD FD TOT															
PZ-211-SS DIS															
PZ-211-SS TOT															
PZ-212-SD DIS															
PZ-212-SD TOT															
PZ-212-SS DIS															
PZ-212-SS TOT															
PZ-302-AI DIS	5.18	1.31	0.23	J+	0.84	0.43	0.28	J+	4.06	1.08	0.16	J+	10.08		12.49
PZ-302-AI TOT	3.6	0.65	0.07	J+	0.73	0.24	0.08	J+	3.1	0.58	0.07	J+	7.43		9.57
PZ-302-AS DIS	2.45	0.56	0.09	J+	0.46	0.22	0.15	J	1.39	0.39	0.12		4.30		4.35
PZ-302-AS TOT	2.35	0.61	0.12	J+	0.62	0.29	0.13	J	1.44	0.44	0.15	J	4.41		4.58
PZ-303-AS DIS	1.05	0.36	0.13	J	0.37	0.22	0.13	J+	1.02	0.36	0.13	J	2.44		3.21
PZ-303-AS TOT	0.84	0.35	0.18	J	0.37	0.25	0.22	J+	0.53	0.27	0.12	J	1.74		1.75
PZ-304-AI DIS	0.63	0.35	0.18	J+	0.16	0.21	0.32	UJ+	0.33	0.25	0.18	J+	0.96	*	1.13
PZ-304-AI FD DIS															
PZ-304-AI TOT	0.72	0.37	0.17	J+	0.49	0.33	0.21	J+	0.8	0.39	0.17	J+	2.01		2.61
PZ-304-AI FD TOT															
PZ-304-AS DIS	1.27	0.91	0.89	J+	0.35	0.6	1.05	UJ	0.54	0.56	0.59	UJ	1.27	*	2.24
PZ-304-AS TOT	0.46	0.69	1.11	UJ+	0.72	0.98	1.53	UJ	0.45	0.68	1.1	UJ	ND		ND
PZ-305-AI DIS	0.13	0.1	0.11	J	0.04	0.08	0.13	U	0	0.04	0.08	U	0.13	*	0.30
PZ-305-AI FD DIS															
PZ-305-AI EPA DIS															
PZ-305-AI TOT	0.09	0.09	0.11	U	0.02	0.07	0.16	U	0.05	0.07	0.11	U	ND		ND
PZ-305-AI FD TOT															

October 2013

Sample ID	Uranium-234				Uranium-235				Uranium-238				TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q			
PZ-200-SS FD DIS															
PZ-200-SS TOT	0.45	0.22	0.13	J	0.05	0.08	0.14	UJ	0.52	0.23	0.14	J	0.97	*	1.61
PZ-200-SS FD TOT															
PZ-201A-SS DIS	2.42	0.6	0.11	J	0.1	0.13	0.2	U	1.58	0.46	0.16	J	4.00	*	4.80
PZ-201A-SS FD DIS															
PZ-201A-SS TOT	2.11	0.53	0.11	J	0.41	0.24	0.19	J	1.49	0.43	0.12	J	4.01		4.63
PZ-201A-SS FD TOT															
PZ-202-SS DIS	1.64	0.55	0.16	J+	0.09	0.14	0.2	U	0.84	0.38	0.19		2.48	*	2.60
PZ-202-SS TOT	1.58	0.49	0.23	J+	0.04	0.11	0.24	U	0.76	0.33	0.22		2.34	*	2.38
PZ-203-SS DIS	3.07	0.74	0.18	J	-0.02	0.08	0.2	U	0.58	0.28	0.16		3.65	*	1.82
PZ-203-SS TOT	3.12	0.66	0.14	J	0.08	0.1	0.12	UJ	0.34	0.18	0.13	J	3.46	*	1.07
PZ-204A-SS DIS	1.36	0.5	0.22	J	0.11	0.17	0.27	UJ	1.09	0.44	0.22	J	2.45	*	3.37
PZ-204A-SS TOT	1.21	0.79	0.66	J	-0.09	0.28	0.76	UJ	0.98	0.71	0.66	J	2.19	*	3.27
PZ-204-SS DIS	2.97	0.71	0.14		0.07	0.12	0.22	U	1.18	0.4	0.18		4.15	*	3.62
PZ-204-SS TOT	3.04	0.77	0.23		0.2	0.19	0.2	J	1.53	0.52	0.34		4.77		4.65
PZ-205-AS DIS	0.41	0.22	0.12	J+	0.15	0.16	0.22	U	0.14	0.13	0.14	J	0.55	*	0.52
PZ-205-AS TOT	0.71	0.3	0.12	J+	0.07	0.13	0.22	U	0.47	0.24	0.12	J	1.18	*	1.50
PZ-205-SS DIS	0.48	0.22	0.13	J	0.15	0.14	0.16	UJ	0.41	0.2	0.13	J	0.89	*	1.30
PZ-205-SS TOT	0.44	0.22	0.15	J	0.16	0.15	0.17	U	0.24	0.16	0.15	J	0.68	*	0.79
PZ-206-SS DIS	0.26	0.18	0.18	J	0.07	0.11	0.2	U	0.14	0.13	0.15	U	0.26	*	0.54
PZ-206-SS EPA DIS															
PZ-206-SS MDNR DIS															
PZ-206-SS TOT	0.12	0.15	0.21	U	0.01	0.1	0.26	U	0.18	0.17	0.16	J	0.18	*	0.66
PZ-206-SS MDNR TOT															
PZ-207-AS DIS	0.26	0.18	0.12	J	0.1	0.12	0.15	U	0.09	0.12	0.17	U	0.26	*	0.58
PZ-207-AS EPA DIS															
PZ-207-AS MDNR DIS															
PZ-206-SS MDNR FD DIS															
PZ-207-AS TOT	-0.02	0.07	0.2	U	-0.02	0.09	0.23	U	0.03	0.1	0.23	U	ND		ND
PZ-207-AS MDNR TOT															
PZ-208-SS DIS	1.26	0.4	0.17	J	0.15	0.14	0.17	UJ	0.67	0.28	0.18	J	1.93	*	2.07
PZ-208-SS TOT	1.52	0.44	0.13	J	0.13	0.15	0.2	UJ	1.13	0.37	0.15	J	2.65	*	3.46
PZ-209-SD DIS	6.43	1.1	0.13	J	0.33	0.2	0.18	J	3.67	0.73	0.14	J	10.43		11.09
PZ-209-SD TOT	8.49	1.43	0.14	J	0.18	0.15	0.13	J	4.36	0.87	0.11	J	13.03		13.07
PZ-209-SS DIS	3.5	0.83	0.27	J	0.12	0.16	0.24	UJ	1.77	0.55	0.32	J	5.27	*	5.38
PZ-209-SS TOT	4.34	0.86	0.1		0.27	0.19	0.13	J	1.65	0.45	0.1		6.26		5.04
PZ-210-SD DIS	5.34	1.03	0.22		0.04	0.1	0.2	U	1.84	0.51	0.18		7.18	*	5.57
PZ-210-SD FD DIS	4.97	1.07	0.24		0.25	0.22	0.25	J	2.49	0.67	0.22		7.71		7.53
PZ-210-SD TOT	6.2	1.26	0.21		0.24	0.21	0.2	J	2.79	0.72	0.2		9.23		8.42
PZ-210-SD FD TOT	5.79	1.92	0.47	J	0.3	0.42	0.64	UJ	3.08	1.27	0.55	J	8.87	*	9.47
PZ-210-SS DIS	1.76	0.47	0.16	J+	0	0.06	0.19	UJ	0.81	0.3	0.15	J	2.57	*	2.50
PZ-210-SS TOT	1.97	0.55	0.13	J+	0.04	0.1	0.23	U	0.55	0.27	0.18		2.52	*	1.75
PZ-211-SD DIS	14.08	2.13	0.13	J	0.36	0.22	0.18	J	4.56	0.87	0.14	J	19.00		13.75
PZ-211-SD FD DIS															
PZ-211-SD TOT	26.42	5.11	0.28	J	1.99	0.82	0.43	J	23.27	4.56	0.24	J	51.68		70.25
PZ-211-SD FD TOT															
PZ-211-SS DIS	2.77	0.61	0.1	J+	0.06	0.1	0.17	UJ	0.92	0.31	0.14	J	3.69	*	2.82
PZ-211-SS TOT	3.17	0.69	0.15	J+	0.16	0.15	0.19	UJ	1.27	0.39	0.11	J	4.44	*	3.87
PZ-212-SD DIS	10.76	1.73	0.11	J+	0.34	0.21	0.13	J	3.62	0.75	0.11		14.72		10.94
PZ-212-SD TOT	11.25	1.87	0.12	J+	0.35	0.23	0.21	J	3.73	0.81	0.12		15.33		11.28
PZ-212-SS DIS	2.43	0.54	0.12	J	0.14	0.13	0.16	UJ	1.31	0.37	0.13	J	3.74	*	3.98
PZ-212-SS TOT	2.63	0.61	0.15	J	0.08	0.11	0.15	UJ	1.74	0.47	0.15	J	4.37	*	5.25
PZ-302-AI DIS	4.6	0.93	0.12		0.32	0.22	0.18	J	3.44	0.76	0.13		8.36		10.40
PZ-302-AI TOT	4.47	0.82	0.14	J	0.42	0.22	0.17	J	3.38	0.67	0.15	J	8.27		10.27
PZ-302-AS DIS	0.97	0.35	0.16	J	0.14	0.15	0.21	UJ	0.36	0.2	0.12	J	1.33	*	1.17
PZ-302-AS TOT	6.22	1.37	0.17		0.2	0.23	0.31	U	4.59	1.1	0.25		10.81	*	13.82
PZ-303-AS DIS	0.51	0.29	0.18	J	0.12	0.16	0.22	UJ	0.48	0.27	0.16	J	0.99	*	1.53
PZ-303-AS TOT	0.87	0.41	0.26	J	0.05	0.15	0.34	UJ	0.89	0.41	0.21	J	1.76	*	2.81
PZ-304-AI DIS	0.35	0.28	0.25	J	0.06	0.18	0.38	UJ	0.1	0.18	0.31	UJ	0.35	*	1.10
PZ-304-AI FD DIS	0.18	0.18	0.21	U	0	0.13	0.29	U	0.35	0.24	0.16	J	0.35	*	1.18
PZ-304-AI TOT	0.26	0.24	0.28	U	0.05	0.12	0.26	U	-0.04	0.18	0.47	U	ND		ND
PZ-304-AI FD TOT	0.15	0.25	0.42	UJ	-0.04	0.22	0.52	UJ	0.16	0.24	0.36	UJ	ND		ND
PZ-304-AS DIS	0.53	0.47	0.53	J	0.09	0.22	0.45	UJ	0	0.24	0.52	UJ	0.53	*	1.76
PZ-304-AS TOT	-0.04	0.17	0.43	UJ	0.1	0.28	0.6	UJ	0.15	0.23	0.34	UJ	ND		ND
PZ-305-AI DIS	0.45	0.26	0.19	J	0.12	0.14	0.17	UJ	0.04	0.16	0.32	UJ	0.45	*	1.03
PZ-305-AI FD DIS															
PZ-305-AI EPA DIS															
PZ-305-AI TOT	0.05	0.08	0.12	UJ	0.17	0.15	0.14	J	0.09	0.11	0.16	U	0.09	*	0.56
PZ-305-AI FD TOT															

February 2014

Sample ID	Uranium-234				Uranium-235				Uranium-238				TOTAL U-234 + U-235 + U-238		Total Uranium (µg/L)
	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q	Result	CSU	MDA	FINAL Q			
PZ-200-SS FD DIS															
PZ-200-SS TOT															
PZ-200-SS FD TOT															
PZ-201A-SS DIS															
PZ-201A-SS FD DIS															
PZ-201A-SS TOT															
PZ-201A-SS FD TOT															
PZ-202-SS DIS															
PZ-202-SS TOT															
PZ-203-SS DIS															
PZ-203-SS TOT															
PZ-204A-SS DIS															
PZ-204A-SS TOT															
PZ-204-SS DIS															
PZ-204-SS TOT															
PZ-205-AS DIS															
PZ-205-AS TOT															
PZ-205-SS DIS															
PZ-205-SS TOT															
PZ-206-SS DIS															
PZ-206-SS EPA DIS															
PZ-206-SS MDNR DIS															
PZ-206-SS TOT															
PZ-206-SS MDNR TOT															
PZ-207-AS DIS															
PZ-207-AS EPA DIS															
PZ-207-AS MDNR DIS															
PZ-206-SS MDNR FD DIS															
PZ-207-AS TOT															
PZ-207-AS MDNR TOT															
PZ-208-SS DIS															
PZ-208-SS TOT															
PZ-209-SD DIS	4.20	0.80	0.13	J	0.24	0.17	0.13	J	2.27	0.53	0.14	J	6.71		6.87
PZ-209-SD TOT	5.78	1.33	0.23	J	0.37	0.29	0.22	J	2.03	0.66	0.18	J	8.18		6.22
PZ-209-SS DIS	2.16	0.54	0.18	J	0.09	0.12	0.19	UJ	0.65	0.27	0.18	J	2.81	*	2.02
PZ-209-SS TOT	2.26	0.55	0.16	J	0.10	0.12	0.17	UJ	0.88	0.31	0.15	J	3.14	*	2.70
PZ-210-SD DIS	4.15	0.94	0.20		0.05	0.12	0.23	U	1.61	0.52	0.29		5.76	*	4.90
PZ-210-SD FD DIS															
PZ-210-SD TOT	3.82	1.23	0.33	J	0.42	0.39	0.36	J	1.10	0.58	0.29	J	5.34		3.47
PZ-210-SD FD TOT															
PZ-210-SS DIS	1.08	0.36	0.13		0.26	0.19	0.14	J	0.81	0.31	0.15		2.15		2.53
PZ-210-SS TOT	1.59	0.49	0.13		0.10	0.13	0.18	U	0.68	0.30	0.15		2.27	*	2.11
PZ-211-SD DIS	8.09	1.42	0.18	J	0.43	0.25	0.16	J	2.46	0.61	0.13	J	10.98		7.53
PZ-211-SD FD DIS	7.47	1.44	0.17		0.10	0.14	0.22	U	2.15	0.61	0.14		9.62	*	6.51
PZ-211-SD TOT	7.67	1.42	0.15		0.33	0.23	0.16	J	2.25	0.60	0.13	J	10.25		6.86
PZ-211-SD FD TOT	7.37	1.36	0.17		0.32	0.22	0.15	J	1.68	0.49	0.12	J	9.37		5.15
PZ-211-SS DIS	2.74	0.67	0.19		0.03	0.10	0.22	U	0.71	0.30	0.18		3.45	*	2.22
PZ-211-SS TOT	2.71	0.66	0.18		0.47	0.27	0.20	J	1.30	0.42	0.16	J	4.48		4.09
PZ-212-SD DIS	13.62	2.23	0.18		0.44	0.26	0.22	J	5.14	1.03	0.14		19.20		15.52
PZ-212-SD TOT	16.74	3.98	0.42	J	0.56	0.49	0.48	J	4.69	1.52	0.45	J	21.99		14.23
PZ-212-SS DIS	2.21	0.59	0.19		0.04	0.11	0.22	U	1.40	0.45	0.17		3.61	*	4.27
PZ-212-SS TOT	2.50	0.61	0.13	J	0.15	0.15	0.17	UJ	1.69	0.47	0.11	J	4.19	*	5.11
PZ-302-AI DIS															
PZ-302-AI TOT															
PZ-302-AS DIS															
PZ-302-AS TOT															
PZ-303-AS DIS															
PZ-303-AS TOT															
PZ-304-AI DIS															
PZ-304-AI FD DIS															
PZ-304-AI TOT															
PZ-304-AI FD TOT															
PZ-304-AS DIS															
PZ-304-AS TOT															
PZ-305-AI DIS															
PZ-305-AI FD DIS															
PZ-305-AI EPA DIS															
PZ-305-AI TOT															
PZ-305-AI FD TOT															

Notes:

All values are in units of picoCuries per liter (pCi/L), unless otherwise noted. EPA and MDNR data were not validated.

DIS = dissolved (filtered) sample; TOT = total (unfiltered) sample

CSU = Combined Standard Uncertainty (2-sigma); MDA = Minimum Detectable Activity [yellow box] Indicates that CSUs and MDAs were not available for the EPA split sample results.

Data Validation Qualifiers (Final Q) include: U = Non-detect at the reported value, UJ = Non-Detect at the estimated reported value,

UJ+ = Non-Detect at the estimated reported value which may be biased high;

UJ- = Non-Detect at the estimated reported value which may be biased low;

J = estimated result; J+ = estimated result which may be biased high; R = rejected, data not usable; G = the sample MDA is greater than the requested reporting limit

Total Uranium-234 plus Uranium-235 plus Uranium-238 = the sum of the U-234, U-235, and U-238 results unless one or more of the results was non-detect, in which case only the detected result(s) is/are shown and the value is flagged with a *. [green box] Indicates that the calculated total Uranium mass concentration exceeded the EPA Maximum Contaminant Level (MCL) of 30 micrograms per liter (µ/L).

Non-Detect (ND) indicates that none of the Uranium isotopes were detected in the sample.

FD - Field duplicate sample

Table 7-25: Summary of Thorium-230 Decay and Radium-226 In-Growth Over Time - Area 1

Time (years)	Thorium-230 pCi/g	Radium -226		
		From Initial Ra_{226} (pCi/g)	Ingrowth from Th_{230} (pCi/g)	Total (pCi/g)
0	882	210	0	210
30	881	207	11	219
100	881	201	37	238
200	880	193	73	266
500	878	169	171	340
1,000	874	136	308	444
2,000	866	88	505	594
3,000	858	57	630	688
5,000	842	24	757	781
7,000	827	10	801	811
8,000	819	7	809	815
9,000	812	4	811	815
10,000	804	3	810	813
15,000	768	0	783	784
20,000	734	0	749	749
30,000	669	0	684	684
40,000	610	0	624	624
50,000	557	0	569	569
80,000	423	0	432	432

Constants	half life (y)	lambda (1/y)	Specific Mass to Activity (µg/pCi)
Th_{230} Half-Life	75,400	9.193E-06	4.95E-05
Ra_{226} Half-Life	1,602	4.327E-04	1.01E-06

Initial Values (from ProUCL runs for updated BRA)

Thorium 230	882	pCi/g	95% UCL for Area 1
Radium-226	210.0	pCi/g	95% UCL for Area 1

Th-230(pCi/g) = Initial_Th230(pCi/g)*EXP[-Lambda_Th(1/y)*Time(y)]

Ra-226(pCi/g) = {Initial_Ra226(pCi/g) x EXP[-Lambda_Ra(1/y) x Time(y)]} + {[Lambda_Ra(1/y) x Initial_Th230(pCi/g)] / [Lambda_Ra(1/y) - Lambda_Th(1/y)]} x {EXP[-Lambda_Th(1/y) x Time(y)] - EXP[-Lambda_Ra(1/y) x Time(y)])}

Table 7-26: Summary of Thorium-230 Decay and Radium-226 In-Growth Over Time - Area 2

Time (years)	Thorium-230 pCi/g	Radium -226		
		From Initial Ra_{226} (pCi/g)	Ingrowth from Th_{230} (pCi/g)	Total (pCi/g)
0	2,138	161	0	161
30	2,137	159	28	187
100	2,136	154	90	245
200	2,134	148	177	325
500	2,128	130	415	545
1,000	2,118	105	747	852
2,000	2,099	68	1,225	1,293
3,000	2,080	44	1,528	1,572
5,000	2,042	19	1,835	1,854
7,000	2,005	8	1,943	1,950
8,000	1,986	5	1,961	1,966
9,000	1,968	3	1,966	1,970
10,000	1,950	2	1,964	1,966
15,000	1,863	0	1,900	1,900
20,000	1,779	0	1,817	1,817
30,000	1,623	0	1,658	1,658
40,000	1,480	0	1,512	1,512
50,000	1,350	0	1,379	1,379
80,000	1,025	0	1,047	1,047

Constants	half life (y)	lambda (1/y)	Specific Mass to Activity (µg/pCi)
Th_{230} Half-Life	75,400	9.193E-06	4.95E-05
Ra_{226} Half-Life	1,602	4.327E-04	1.01E-06

Initial Values (from ProUCL runs for updated BRA)

Thorium 230	2,138	pCi/g	95% UCL for Area 2
Radium-226	161	pCi/g	95% UCL for Area 2

Th-230(pCi/g) = Initial_Th230(pCi/g)*EXP[-Lambda_Th(1/y)*Time(y)]

Ra-226(pCi/g) = {Initial_Ra226(pCi/g) x EXP[-Lambda_Ra(1/y) x Time(y)]} + {[Lambda_Ra(1/y) x Initial_Th230(pCi/g)] / [Lambda_Ra(1/y) - Lambda_Th(1/y)]} x {EXP[-Lambda_Th(1/y) x Time(y)] - EXP[-Lambda_Ra(1/y) x Time(y)])}

Table 8-1: Summary Comparison of Area 1 and 2 Soil Sample Results to RCRA Toxicity Characteristic Regulatory Levels

EPA HW No.	Contaminant	TC Level (mg/L)	x DAF of 20	Maximum Concentration in Soil (mg/kg) [1]	No. of Samples	No. of Detects	Detect Freq. (%)	Location and Depth (ft)
D004	Arsenic	5.0	100	**610**	190	166	87.4%	AC-16 @ 19-20
D005	Barium	100.0	2,000	**322,000**	156	156	100%	AC-1 PYR @ 10-11
D006	Cadmium	1.0	20	**62**	189	155	82.0%	AC-20 @ 47-49
D007	Chromium	5.0	100	**890**	376	364	96.8%	WL-208 @ 20 *
D008	Lead	5.0	100	**30,000**	188	185	98.4%	1C-6-CT @ 25-27
D009	Mercury	0.2	4	**12**	182	135	74.2%	1D-15 @77-80
D010	Selenium	1.0	20	**250**	188	126	67.0%	WL-114 @ 0 & AC-16 @ 19-20
D011	Silver	5.0	100	18	186	83	44.6%	AC-24 @ 14-15
D012	Endrin	0.02	0	0.18	36	4	11.1%	WL-218 @ 25
D013	Lindane (gamma BHC)	0.4	8	ND	35	0	0%	
D014	Methoxychlor	10.0	200	0.0057	33	1	3.0%	WL-227 @ 40
D015	Toxaphene	0.5	10	ND	33	0	0%	
D016	2,4-D	10.0	200	NA	NA	NA	NA	
D017	2,4,5-TP (Silvex)	1.0	20	NA	NA	NA	NA	
D018	Benzene	0.5	10	**120 J**	36	2	5.6%	Wl-208 @ 20 *
D019	Carbon tetrachloride	0.5	10	ND	36	0	0%	ND
D020	Chlordane	0.03	0.6	0.015	33	1	3.0%	WL-104 @ 25
D021	Chlorobenzene	100.0	2,000	180	36	8	22.2%	WL-230 @ 16
D022	Chloroform	6.0	120	**890**	36	0	0%	Wl-208 @ 20 *
D023	o-Cresol (2-Methylphenol)	200.0	4,000	0.17 J	32	2	6.3%	WL-213 @ 25
D024	m-Cresol (3-Methylphenol)	200.0	4,000	NA	NA	NA	NA	NA
D025	p-Cresol (4-Methylphenol)	200.0	4,000	0.98	34	4	11.8%	WL-213 @ 25
D026	Cresol	200.0	4,000	NA	NA	NA	NA	NA
D027	1,4-Dichlorobenzene	7.5	150	**530 Y ****	38	13	34.2%	WL-230 @ 16
D028	1,2-Dichloroethane	0.5	10	ND	36	0	0%	ND
D029	1,1-Dichloroethylene	0.7	14	ND	36	0	0%	ND
D030	2,4-Dinitrotoluene	0.13	3	ND	34	0	0%	
D031	Heptachlor (and its epoxide)	0.008	0	ND	70	0	0%	
D032	Hexachlorobenzene	0.13	3	ND	34	0	0%	
D033	Hexachlorobutadiene	0.5	10	ND	34	0	0%	
D034	Hexachloroethane	3.0	60	ND	34	0	0%	
D035	Methyl ethyl ketone (2-butanone)	200.0	4,000	52	64	10	15.6%	WL-208 @ 15
D036	Nitrobenzene	2.0	40	ND	34	0	0%	
D037	Pentachlorophenol	100.0	2,000	0.085 J	34	1	2.9%	WL-208 @ 28
D038	Pyridine	5.0	100	NA	NA	NA	NA	
D039	Tetrachloroethylene	0.7	14	ND	36	0	0%	
D040	Trichloroethylene	0.5	10	ND	36	0	0%	
D041	2,4,5-Trichlorophenol	400.0	8,000	ND	32	0	0%	
D042	2,4,6-Trichlorophenol	2.0	40	ND	34	0	0%	
D043	Vinyl chloride	0.2	4	ND	36	0	0%	

Notes: [1]Bolded maximum concentrations indicate that the measured contaminant concentration is greater than the Regulatory Level times a Dilution-Attenuation Factor (DAF) of 20.

J - Estimated value, as result was below laboratory reporting limit.

Y - Estimated value, as all surrogate compounds were diluted beyond detection limits.

* Result is from a sample obtained from a crushed 5-gallon bucket.

** Result is from EPA Method 8270. A result of 2,100 Y was obtained from the EPA Method 8260 analysis of this sample.

Table 7-12 - Stormwater Monitoring Results - Physical and Chemical Parameters

Sample Number	Date	Total Suspended Solids			Solids, Settleable			pH			Biochemical Oxygen Demand			Chemical Oxygen Demand		
		Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL
NCC-001	3/10/16	127		27	0.1		0.1				125		5	367		50
NCC-001	4/6/16	303		20	0.3		0.1	7.54		1	49		5	205		50
NCC-001	5/10/16	329		22	0.2		0.1	7.48		1	92		5	371		50
NCC-001	7/6/16	34		6	ND	U	0.1	7.51		1	18	J	5	97		50
NCC-001	8/15/16	10		6	0.1		0.1	7.78		1	ND	U	5	ND	U	50
NCC-001	9/9/16	143		6	0.2		0.1	7.73		1	11		5	115		50
NCC-001	11/3/16	5	J	6	0.1		0.1	8.00		1	ND	U	5	51		50
OU-1-001	1/20/17	ND	U	6	ND	U	0.1	7.78		1	27		5	95		50
OU-1-001	2/21/17	22		6	ND	U	0.1	7.65		1	399		5	692		50
OU-1-001	3/1/17	18		6	ND	U	0.1	8.14		1	21		5	90		50
OU-1-001	4/5/17	8		6	ND	U	0.1	7.94		1	ND	U	5	34		50
NCC-002	3/30/16	72		6	0.3		0.1	6.7		1	8		5	105		50
NCC-002	4/11/16	7		6	0.1		0.1	7.06		1	14		5	57		50
NCC-002	5/11/16	ND	U	6	ND	U	0.1	7.6		1	5	UJ-	5	ND	U	50
NCC-002	7/6/16	5	J	6	ND	U	0.1	7.67		1	8		5	51		50
NCC-002	8/15/16	ND	U	6	ND	U	0.1	7.39		1	ND	U	5	ND	U	50
NCC-002	9/9/16	16		6	ND	U	0.1	7.8		1	ND	U	5	ND	U	50
NCC-002	11/3/16	50		6	0.1		0.1	7.57		1	5		5	36	J	50
OU-1-002	1/20/17	9		6	0.1		0.1	8.46		1	ND	U	5	ND	U	50
NCC-003	3/30/16	140		6	0.1		0.1	6.35		1	ND	U	5	68		50
NCC-003	4/6/16	124		13	0.1		0.1	7.54		1	ND	U	5	ND	U	50
NCC-003	5/11/16	548		194	4.5		0.1	7.26		1	5	UJ-	5	60		50
NCC-003	7/6/16	1760		286	21		0.1	7.34		1	19		5	259		50
NCC-003	8/15/16	10		6	ND	U	0.1	7.94		1	ND	U	5	ND	U	50
NCC-003	9/9/16	309		17	0.1		0.1	8.08		1	ND	U	5	58		50
NCC-003a	9/16/16	35		6	0.1		0.1	8.12		1	ND	U	5	ND	U	50
NCC-003a	11/3/16	14		6	0.1		0.1	8.09		1	ND	U	5	46	J	50
OU-1-003A	1/20/17	29		6	0.1		0.1	7.58		1	ND	U	5	ND	U	50
NCC-004	5/12/16	520		60	0.3		0.1	7.29		1	7	J-	5	126		50

Table 7-12 - Stormwater Monitoring Results - Physical and Chemical Parameters

Sample Number	Date	Total Suspended Solids			Solids, Settleable			pH			Biochemical Oxygen Demand			Chemical Oxygen Demand		
		Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL
NCC-007	11/3/16	40		6	ND	U	0.1	7.44		1	117		5	246		50
OU-1-007	1/20/17	105		6	ND	U	0.1	7.99		1	66		5	148		50
OU-1-007	2/21/17	37		6	0.3		0.1	7.15		1	1160		50	1560		100
BUFFER ZONE	4/26/16	142		6	0.1		0.1				5	UJ	5	ND	U	50

Table 7-12 - Stormwater Monitoring Results - Physical and Chemical Parameters

Sample Number	Date	Chloride, Total			Nitrogen, Ammonia, Total			Sulfate, Total			Hardness, as (CaCO3)			Aluminum, Total		
		Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL
NCC-001	3/10/16	928		250	0.13		0.1	204		100	523		1	3.71	J+	0.025
NCC-001	4/6/16	197		50	0.17		0.1	121	J-	100	371		1	5.26		0.025
NCC-001	5/10/16	160		50	0.14	J-	0.1	136		50	423		1	6.25		0.025
NCC-001	7/6/16	88		50	0.32	J-	0.2	508	J-	500	608		1	0.586		0.025
NCC-001	8/15/16	20	J	5	0.14		0.1	305		100	474		1	0.537		0.025
NCC-001	9/9/16	23		5	ND	UJ-	0.1	198		100	338		1	1.06		0.025
NCC-001	11/3/16	83		50	0.05	J-	0.1	343		100	504		1	ND	U	0.025
OU-1-001	1/20/17	713		250	ND	UJ-	0.1	474		100	778		1	0.0300		0.025
OU-1-001	2/21/17	845		100	0.56		0.2	454		200	867		1	0.313		0.025
OU-1-001	3/1/17	666		250	0.08		0.1	379		200	566		1	0.0610		0.025
OU-1-001	4/5/17	31		5	0.04		0.1	171		100	365		1	0.260		0.025
NCC-002	3/30/16	8		5	0.2		0.1	ND	UJ-	10	90.2		1	1.09		0.025
NCC-002	4/11/16	31		10	0.1	J-	0.1	1190		1000	1580		1	0.0648		0.025
NCC-002	5/11/16	11		5	0.29	J-	0.2	1010		1000	1020		1	0.046		0.025
NCC-002	7/6/16	13		5	0.77		0.1	1130		500	1300		1	0.0315		0.025
NCC-002	8/15/16	10	J	5	0.93	J-	0.2	580		500	917		1	ND	U	0.025
NCC-002	9/9/16	ND	U	5	ND	U	0.1	428		200	533		1	0.0935		0.025
NCC-002	11/3/16	12		5	0.34		0.2	705		200	1010		1	ND	U	0.025
OU-1-002	1/20/17	78		50	ND	U	0.1	818		200	1060		1	0.154		0.025
NCC-003	3/30/16	31		5	0.25		0.1	515		500	677		1	1.12		0.025
NCC-003	4/6/16	31		10	0.21		0.1	629		200	849		1	1.36		0.025
NCC-003	5/11/16	12		5	0.12		0.1	166		50	359		1	32.1		0.025
NCC-003	7/6/16	18		5	0.22		0.1	294		200	1190		1	53.8		0.025
NCC-003	8/15/16	8	J	5	0.1		0.1	89		20	235		1	0.82		0.025
NCC-003	9/9/16	5		5	ND	U	0.1	126		100	254		1	7.93		0.025
NCC-003a	9/16/16	19		5	ND	UJ-	0.1	419		200	476		1	0.531		0.025
NCC-003a	11/3/16	30		5	0.05	J	0.1	264		200	390		1	0.134		0.025
OU-1-003A	1/20/17	55		50	ND	U	0.2	815		500	1020		1	0.0688		0.025
NCC-004	5/12/16	ND	U	5	ND	U	0.1	22	J-	10	153		1	4.96		0.025

Table 7-12 - Stormwater Monitoring Results - Physical and Chemical Parameters

Sample Number	Date	Chloride, Total			Nitrogen, Ammonia, Total			Sulfate, Total			Hardness, as (CaCO3)			Aluminum, Total		
		Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL
NCC-007	11/3/16	26		5	0.13		0.1	185		100	383		1	0.461		0.025
OU-1-007	1/20/17	151		50	0.20		0.1	170		100	412		1	1.92		0.025
OU-1-007	2/21/17	330		50	1.57		1	268		100	520		1	0.715		0.025
BUFFER ZONE	4/26/16	ND	U	5	0.35		0.1	304	J-	200	528		1	0.991		0.025

Table 7-12 - Stormwater Monitoring Results - Physical and Chemical Parameters

Sample Number	Date	Antimony, Total			Arsenic, Total			Beryllium, Total			Cadmium, Total			Cobalt, Total		
		Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL
NCC-001	3/10/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	0.0055		0.005
NCC-001	4/6/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-001	5/10/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	0.0055		0.005
NCC-001	7/6/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-001	8/15/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-001	9/9/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-001	11/3/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
OU-1-001	1/20/17	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
OU-1-001	2/21/17	ND	U	0.05	ND	U	0.025	ND	U	0.0005	0.0006	J	0.002	0.0072		0.005
OU-1-001	3/1/17	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
OU-1-001	4/5/17	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-002	3/30/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-002	4/11/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	0.0243		0.005
NCC-002	5/11/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-002	7/6/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	0.0022	J	0.005
NCC-002	8/15/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-002	9/9/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-002	11/3/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
OU-1-002	1/20/17	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-003	3/30/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-003	4/6/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-003	5/11/16	ND	U	0.05	ND	U	0.025	0.001		0.0005	ND	U	0.002	0.0179		0.005
NCC-003	7/6/16	ND	U	0.05	0.0401		0.025	0.003		0.0005	0.0022		0.002	0.0371		0.005
NCC-003	8/15/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-003	9/9/16	ND	U	0.05	ND	U	0.025	0.000		0.0005	ND	U	0.002	0.0052		0.005
NCC-003a	9/16/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-003a	11/3/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
OU-1-003A	1/20/17	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
NCC-004	5/12/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005

Table 7-12 - Stormwater Monitoring Results - Physical and Chemical Parameters

Sample Number	Date	Antimony, Total			Arsenic, Total			Beryllium, Total			Cadmium, Total			Cobalt, Total		
		Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL
NCC-007	11/3/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
OU-1-007	1/20/17	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005
OU-1-007	2/21/17	ND	U	0.05	ND	U	0.025	ND	U	0.0005	0.0005	J	0.002	0.0067		0.005
BUFFER ZONE	4/26/16	ND	U	0.05	ND	U	0.025	ND	U	0.0005	ND	U	0.002	ND	U	0.005

Table 7-12 - Stormwater Monitoring Results - Physical and Chemical Parameters

Sample Number	Date	Trivalent Chromium			Chromium, Hexavalent			Chromium, Total			Copper, Total			Iron, Total		
		Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL
NCC-001	3/10/16	ND	U	0.05	ND	U	0.025				0.0546		0.005	4.54		0.02
NCC-001	4/6/16	ND	U	0.05	ND	U	0.025				0.0486		0.005	7.47		0.02
NCC-001	5/10/16	ND	U	0.1	ND	U	0.05				0.101		0.005	10.4		0.02
NCC-001	7/6/16	ND	U	0.005	ND	U	0.005				0.0327		0.005	0.729		0.02
NCC-001	8/15/16	ND	U	0.005	ND	U	0.005				0.0066		0.005	0.47		0.02
NCC-001	9/9/16	ND	U	0.005	ND	U	0.005				0.022		0.005	1.6		0.02
NCC-001	11/3/16	ND	U	0.005	ND	U	0.005	ND	U	0.005	0.0172		0.005	0.0339		0.02
OU-1-001	1/20/17	ND	U	0.005	ND	U	0.005	ND	U	0.005	0.0108		0.005	0.580		0.02
OU-1-001	2/21/17	ND	U	0.01	ND	U	0.01				0.0887		0.005	0.397		0.02
OU-1-001	3/1/17	ND	U	0.005	ND	U	0.005				0.0319		0.005	0.0924		0.02
OU-1-001	4/5/17	ND	U	0.005	0.005		0.005				0.0061		0.005	0.356		0.02
NCC-002	3/30/16	ND	U	0.01	ND	U	0.005				0.0242		0.005	1.36		0.02
NCC-002	4/11/16	ND	U	0.01	ND	U	0.005				0.0096		0.005	0.132		0.02
NCC-002	5/11/16	ND	U	0.005	ND	U	0.005				ND	U	0.005	0.095		0.02
NCC-002	7/6/16	ND	U	0.005	ND	U	0.005				0.0051		0.005	0.249		0.02
NCC-002	8/15/16	ND	U	0.005	ND	U	0.005				ND	U	0.005	0.266		0.02
NCC-002	9/9/16	ND	U	0.005	ND	U	0.005				ND	U	0.005	0.13		0.02
NCC-002	11/3/16	ND	U	0.005	ND	U	0.005	ND	U	0.005	0.0046	J	0.005	0.183		0.02
OU-1-002	1/20/17	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	0.005	0.186		0.02
NCC-003	3/30/16	ND	U	0.01	ND	U	0.005				0.0065		0.005	1.69		0.02
NCC-003	4/6/16	ND	U	0.05	ND	U	0.025				0.0061		0.005	1.98		0.02
NCC-003	5/11/16	0.054		0.025	ND	U	0.025				0.0498		0.005	42.6		0.02
NCC-003	7/6/16	0.103		0.05	ND	U	0.05				0.156		0.005	78.4		0.02
NCC-003	8/15/16	0.005	UJ-	0.005	0.005	UJ-	0.005				0.0051		0.005	0.737		0.02
NCC-003	9/9/16	ND	U	0.005	ND	U	0.125				0.0157		0.005	10.4		0.02
NCC-003a	9/16/16	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	0.005	0.486		0.02
NCC-003a	11/3/16	ND	U	0.005	0.004	J	0.005	0.0043	J	0.005	0.0046	J	0.005	0.131		0.02
OU-1-003A	1/20/17	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	0.005	0.121		0.02
NCC-004	5/12/16	ND	U	0.01	ND	U	0.01				0.0205		0.005	7		0.02

Table 7-12 - Stormwater Monitoring Results - Physical and Chemical Parameters

Sample Number	Date	Trivalent Chromium			Chromium, Hexavalent			Chromium, Total			Copper, Total			Iron, Total		
		Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL
NCC-007	11/3/16	ND	U	0.025	ND	U	0.025	0.0048	J	0.005	0.0132		0.005	0.696		0.02
OU-1-007	1/20/17	ND	U	0.025	ND	U	0.025	0.0072		0.005	0.0140		0.005	2.54		0.02
OU-1-007	2/21/17	ND	U	0.01	0.008	J-	0.01				0.0714		0.005	2.34		0.02
BUFFER ZONE	4/26/16	ND	U	0.05	ND	U	0.025	ND	U	0.005	ND	U	0.005	1.42		0.02

Table 7-12 - Stormwater Monitoring Results - Physical and Chemical Parameters

Sample Number	Date	Lead, Total			Mercury, Total			Nickel, Total			Selenium, Total			Silver, Total		
		Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL
NCC-001	3/10/16	0.019		0.015	0.00033		0.0002	0.0244		0.005	ND	U	0.04	ND	U	0.005
NCC-001	4/6/16	0.0288		0.015	0.00031		0.0002	0.0195		0.005	ND	U	0.04	ND	U	0.005
NCC-001	5/10/16	0.0923		0.015	0.00041		0.0002	0.0267		0.005	ND	U	0.04	ND	U	0.005
NCC-001	7/6/16	ND	U	0.015	ND	U	0.0002	0.0143		0.005	ND	U	0.04	ND	U	0.005
NCC-001	8/15/16	ND	U	0.015	ND	U	0.0002	0.0085		0.005	ND	U	0.04	ND	U	0.005
NCC-001	9/9/16	ND	U	0.015	ND	U	0.0002	0.0062		0.005	ND	U	0.04	ND	U	0.005
NCC-001	11/3/16	ND	U	0.015	ND	U	0.0002	0.0063		0.005	ND	U	0.04	ND	U	0.005
OU-1-001	1/20/17	ND	U	0.015	ND	U	0.0002	0.0095		0.005	ND	U	0.04	ND	U	0.005
OU-1-001	2/21/17	ND	U	0.015	0.00006	J	0.0002	0.0321		0.005	ND	U	0.04	ND	U	0.005
OU-1-001	3/1/17	ND	U	0.015	ND	U	0.0002	0.0091		0.005	ND	U	0.04	ND	U	0.005
OU-1-001	4/5/17	ND	U	0.015	ND	U	0.0002	0.0087		0.005	ND	U	0.04	ND	U	0.005
NCC-002	3/30/16	ND	U	0.015	ND	U	0.0002	ND	U	0.005	ND	U	0.04	ND	U	0.005
NCC-002	4/11/16	ND	U	0.015	ND	U	0.0002	0.0536		0.005	ND	U	0.04	ND	U	0.005
NCC-002	5/11/16	ND	U	0.015	ND	U	0.0002	0.0226		0.005	ND	U	0.04	ND	U	0.005
NCC-002	7/6/16	ND	U	0.015	ND	U	0.0002	0.0538		0.005	0.133		0.04	ND	U	0.005
NCC-002	8/15/16	ND	U	0.015	ND	U	0.0002	0.0262		0.005	ND	U	0.04	ND	U	0.005
NCC-002	9/9/16	ND	U	0.015	ND	U	0.0002	0.0116		0.005	ND	U	0.04	ND	U	0.005
NCC-002	11/3/16	ND	U	0.015	ND	U	0.0002	0.0189		0.005	ND	U	0.04	ND	U	0.005
OU-1-002	1/20/17	ND	U	0.015	ND	U	0.0002	0.0148		0.005	ND	U	0.04	ND	U	0.005
NCC-003	3/30/16	ND	U	0.015	0.00117		0.0002	0.0082		0.005	ND	U	0.04	ND	U	0.005
NCC-003	4/6/16	ND	U	0.015	0.00027		0.0002	0.0096		0.005	ND	U	0.04	ND	U	0.005
NCC-003	5/11/16	0.0373		0.015	0.00035		0.0002	0.0727		0.005	ND	U	0.04	ND	U	0.005
NCC-003	7/6/16	0.112		0.015	0.00312		0.0002	0.14		0.005	ND	U	0.04	ND	U	0.005
NCC-003	8/15/16	ND	U	0.015	ND	U	0.0002	ND	U	0.005	ND	U	0.04	ND	U	0.005
NCC-003	9/9/16	ND	U	0.015	0.00025		0.0002	0.0196		0.005	ND	U	0.04	ND	U	0.005
NCC-003a	9/16/16	ND	U	0.015	ND	U	0.0002	0.0070		0.005	ND	U	0.04	ND	U	0.005
NCC-003a	11/3/16	ND	U	0.015	ND	U	0.0002	0.0051		0.005	ND	U	0.04	ND	U	0.005
OU-1-003A	1/20/17	ND	U	0.015	ND	U	0.0002	0.0170		0.005	ND	U	0.04	ND	U	0.005
NCC-004	5/12/16	ND	U	0.015	ND	U	0.0002	0.0115		0.005	ND	U	0.04	ND	U	0.005

Table 7-12 - Stormwater Monitoring Results - Physical and Chemical Parameters

Sample Number	Date	Lead, Total			Mercury, Total			Nickel, Total			Selenium, Total			Silver, Total		
		Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL
NCC-007	11/3/16	0.0097	J	0.015	0.00009	J	0.0002	0.0068		0.005	ND	U	0.04	ND	U	0.005
OU-1-007	1/20/17	ND	U	0.015	ND	U	0.0002	0.0069		0.005	ND	U	0.04	ND	U	0.005
OU-1-007	2/21/17	0.013	J	0.015	ND	U	0.0002	0.0270		0.005	ND	U	0.04	ND	U	0.005
BUFFER ZONE	4/26/16	ND	U	0.015	ND	U	0.0002	0.013		0.005	ND	U	0.04	ND	U	0.005

Table 7-12 - Stormwater Monitoring Results - Physical and Chemical Parameters

Sample Number	Date	Thallium, Total			Zinc, Total		
		Result	Final Q	RL	Result	Final Q	RL
NCC-001	3/10/16	ND	U	0.05	0.152		0.01
NCC-001	4/6/16	ND	U	0.05	0.167		0.01
NCC-001	5/10/16	ND	U	0.05	0.328		0.01
NCC-001	7/6/16	ND	U	0.05	0.0465		0.01
NCC-001	8/15/16	ND	U	0.05	0.0349		0.01
NCC-001	9/9/16	ND	U	0.05	0.0752		0.01
NCC-001	11/3/16	ND	U	0.05	0.0203		0.01
OU-1-001	1/20/17	ND	U	0.05	0.0909		0.01
OU-1-001	2/21/17	ND	U	0.05	0.188		0.01
OU-1-001	3/1/17	ND	U	0.05	0.0413		0.01
OU-1-001	4/5/17	ND	U	0.05	0.0358		0.01
NCC-002	3/30/16	ND	U	0.05	0.0679		0.01
NCC-002	4/11/16	ND	U	0.05	0.0398		0.01
NCC-002	5/11/16	ND	U	0.05	ND	U	0.01
NCC-002	7/6/16	ND	U	0.05	0.0119		0.01
NCC-002	8/15/16	ND	U	0.05	0.0108		0.01
NCC-002	9/9/16	ND	U	0.05	ND	U	0.01
NCC-002	11/3/16	ND	U	0.05	0.0110		0.01
OU-1-002	1/20/17	ND	U	0.05	0.0129		0.01
NCC-003	3/30/16	ND	U	0.05	0.0271		0.01
NCC-003	4/6/16	ND	U	0.05	0.0278		0.01
NCC-003	5/11/16	ND	U	0.05	0.181		0.01
NCC-003	7/6/16	ND	U	0.05	0.647		0.01
NCC-003	8/15/16	ND	U	0.05	0.0146		0.01
NCC-003	9/9/16	ND	U	0.05	0.0589		0.01
NCC-003a	9/16/16	ND	U	0.05	0.109		0.01
NCC-003a	11/3/16	ND	U	0.05	0.0121		0.01
OU-1-003A	1/20/17	ND	U	0.05	0.621		0.01
NCC-004	5/12/16	ND	U	0.05	0.0803		0.01

Table 7-12 - Stormwater Monitoring Results - Physical and Chemical Parameters

Sample Number	Date	Thallium, Total			Zinc, Total		
		Result	Final Q	RL	Result	Final Q	RL
NCC-007	11/3/16	ND	U	0.05	0.0850		0.01
OU-1-007	1/20/17	ND	U	0.05	0.108		0.01
OU-1-007	2/21/17	ND	U	0.05	0.863		0.01
BUFFER ZONE	4/26/16	ND	U	0.05	0.0308		0.01

Table 7-12 - Stormwater Monitoring Results - Physical and Chemical Parameters

Sample Number	Date	Hexane Extractable Material			Benzene			ETHYLBENZENE			TOLUENE			XYLENES, TOTAL		
		Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL
NCC-001	3/10/16	15		5	ND	U	2	ND	U	5	ND	U	5	ND	U	5
NCC-001	4/6/16	5		5	ND	U	2	ND	U	5	ND	U	5	ND	U	5
NCC-001	5/10/16	13		5	ND	U	2	ND	U	5						
NCC-001	7/6/16	7		5	ND	U	2	ND	U	5						
NCC-001	8/15/16	ND	U	5	ND	U	2	ND	U	5						
NCC-001	9/9/16	ND	U	5	ND	U	2	ND	U	5						
NCC-001	11/3/16	ND	U	6	ND	U	2	ND	U	5						
OU-1-001	1/20/17	ND	U	5	ND	U	2	ND	U	5						
OU-1-001	2/21/17	6		6	ND	U	2	ND	U	5						
OU-1-001	3/1/17	4		5	ND	U	2	ND	U	5						
OU-1-001	4/5/17	4		5	ND	U	2	ND	U	5						
NCC-002	3/30/16	ND	U	5	ND	U	2	ND	U	5	ND	U	5	ND	U	5
NCC-002	4/11/16	ND	U	5	ND	U	2	ND	U	5	ND	U	5	ND	U	5
NCC-002	5/11/16	ND	U	5	ND	U	2	ND	U	5						
NCC-002	7/6/16	6		5	ND	U	2	ND	U	5						
NCC-002	8/15/16	ND	U	5	ND	U	2	ND	U	5						
NCC-002	9/9/16	10		6	ND	U	2	ND	U	5						
NCC-002	11/3/16	3	J	6	ND	U	2	ND	U	5						
OU-1-002	1/20/17	ND	U	5	ND	U	2	ND	U	5						
NCC-003	3/30/16	ND	U	5	ND	U	2	ND	U	5	ND	U	5	ND	U	5
NCC-003	4/6/16	ND	U	5	ND	U	2	ND	U	5	ND	U	5	ND	U	5
NCC-003	5/11/16	ND	U	5	ND	U	2	ND	U	5						
NCC-003	7/6/16	6		6	2	Uj	2	5	Uj	5						
NCC-003	8/15/16	ND	U	6	ND	U	2	ND	U	5						
NCC-003	9/9/16	ND	U	6	ND	U	2	ND	U	5						
NCC-003a	9/16/16	7		5	ND	U	2	ND	U	5						
NCC-003a	11/3/16	3	J	5	ND	U	2	ND	U	5						
OU-1-003A	1/20/17	ND	U	5	ND	U	2	ND	U	5						
NCC-004	5/12/16	6		6	ND	U	2	ND	U	5						

Table 7-12 - Stormwater Monitoring Results - Physical and Chemical Parameters

Sample Number	Date	Hexane Extractable Material			Benzene			ETHYLBENZENE			TOLUENE			XYLENES, TOTAL		
		Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL	Result	Final Q	RL
NCC-007	11/3/16	2	J	6	ND	U	2	ND	U	5						
OU-1-007	1/20/17	ND	U	6	ND	U	2	ND	U	5						
OU-1-007	2/21/17	9		5	ND	U	2	ND	U	5						
BUFFER ZONE	4/26/16	6		5	ND	U	2	ND	U	5						

Table 8-3: Summary of Benzene Results in Groundwater - August 2012 through February 2014

Sample ID	Benzene August 2012	Benzene April 2013	Benzene July 2013	Benzene October 2013	Benzene February 2014
S-5	3.8 J	4.7 J	3.9 J	3.9	
S-5 EPA		4.9 J			
S-5 MDNR	3.85 J			4.23	
S-8	5 U	5 U	5.0 U	5.0 U	
S-10	3.2 J	2.4 J	4.0 J	3.4	
S-53		5 U	5.0 U	0.67	
S-61	5.0 UJ	5 U	5.0 U	5.0 U	
S-61 EPA			1.0 U		
S-82	0.31 J	5 U	5.0 U	5.0 U	
S-82 EPA		0.25 U			
S-82 MDNR				0.300 U	
S-84	1.6 J	3.5 J	2.6 J	2.8	
S-84 FD				3.5	
I-4	1.7 J	4.8 J	5.2	5.6	
I-4 FD			5.2		
I-4 MDNR	1.55 J				
I-9	0.68 J	5 U	5.0 U	5.0 U	
I-9 FD	0.63 J	5 U		5.0 U	
I-9 EPA		0.25 U			
I-9 MDNR	5.00 U			0.300 U	
I-11	5 U	5 U	5.0 U	5.0 U	
I-11 EPA			1.0 U		
I-62	5 U	5 U	5.0 U	5.0 U	
I-62 FD		5 U	5.0 U		
I-65	5 U	5 U	5.0 U	5.0 U	
I-65 FD		5 U	5.0 U		
I-66	5 U	5 U	5.0 U	5.0 U	
I-67	5 U	5 U	5.0 U	5.0 U	
I-67 FD		5 U		5.0 U	
I-68	5 U	5 U	5.0 U	5.0 U	
I-73	2.7 J	12	57	130	
D-3	0.50 J	0.29 U	0.33 J	5.0 U	
D-3 DUP	0.53 J				
D-3 EPA		0.57 J	1.0 U		
D-3 MDNR				0.410 J	
D-6	5.0 UJ	5 U	5.0 U	5.0 U	
D-6 DUP	5.0 UJ				
D-6 EPA		0.25 U	1.0 U		
D-6 MDNR				0.300 U	
D-12	5 U	5 U	4.6 J	5.0 U	
D-12 FD		5 U	4.3 J		

Table 8-3: Summary of Benzene Results in Groundwater - August 2012 through February 2014

Sample ID	Benzene August 2012	Benzene April 2013	Benzene July 2013	Benzene October 2013	Benzene February 2014
D-12 EPA			1.0 U		
D-13	5 U	5 U	5.0 U	5.0 U	
D-13 FD	5 U				
D-14		13	8.6	15	
D-81	5 U	5 U	5.0 U	5.0 U	
D-81 FD			5.0 U		
D-83	5 U	5 U	5.0 U	5.0 U	
D-83 FD			5.0 U		
D-83 EPA		0.25 U			
D-83 MDNR				0.300 U	
D-85	0.35 J	0.73 J	0.35 J	0.45	
D-85 EPA		0.42 J			
D-85 MDNR				0.410 J	
D-87	0.57 J	5 U	5.0 U	5.0 U	
D-87 FD				5.0 U	
D-93	5 U	1.6 J	1.9 J	2.7	
D-93 EPA		1.5 J			
D-93 MDNR	5.00 U			2.51	
LR-100	6.7	7.7	7.2 J	6.9	
LR-100 FD				7.7	
LR-103	5 U	5 U	5.0 U	5.0 U	
LR-104	5 U	5 U	5.0 U	5.0 U	
LR-104 DUP	5 U				
LR-105	8.1	8.2			
MW-102	5.0 UJ		5.0 U	5.0 U	
MW-102 EPA			1.0 U		
MW-103	5 U	5 U	5.0 U	5.0 U	
MW-104	0.27 J	0.75 J	5.0 UJ	5.0 U	
MW-1204	5.0 U	5 U	1.1 J	53	
MW-1204 FD		5 U			
PZ-100-KS	5 U	5 U	5.0 U	5.0 U	
PZ-100-SD	5.0 U	5 U	5.0 U	5.0 U	
PZ-100-SS	5.0 U	5 U	5.0 U		
PZ-101-SS	1.6 J-	0.81 J	0.92 J	0.74	
PZ-101-SS EPA		1.3 J	2.0		
PZ-101-SS MDNR				0.710 J	
PZ-102R-SS	5 U	5 U	5.0 U	5.0 U	
PZ-102-SS	5 U	5 U	5.0 U	5.0 U	
PZ-102-SS EPA		0.25 U			
PZ-102-SS MDNR				0.300 U	
PZ-103-SS	5.0 UJ	4.1 J	140	77	

Table 8-3: Summary of Benzene Results in Groundwater - August 2012 through February 2014

Sample ID	Benzene August 2012	Benzene April 2013	Benzene July 2013	Benzene October 2013	Benzene February 2014
PZ-104-KS	5 U	5 U	5.0 U	5.0 U	
PZ-104-KS MDNR	5.00 U				

Table 8-3: Summary of Benzene Results in Groundwater - August 2012 through February 2014

Sample ID	Benzene August 2012	Benzene April 2013	Benzene July 2013	Benzene October 2013	Benzene February 2014
PZ-104-SD	120	820	800	640	
PZ-104-SD EPA		840			
PZ-104-SD MDNR				664	
PZ-104-SS	470	1,900	1,800	2,000	
PZ-104-SS FD		2,000			
PZ-105-SS	5.0 U	5 U	5.0 U	5.0 U	
PZ-106-KS	5 U	5 U	5.0 U	5.0 U	
PZ-106-KS FD				5.0 U	
PZ-106-SD	5.0 U	5 U	5.0 U	5.0 U	
PZ-106-SS	5.0 U	5 U	5.0 U	5.0 U	
PZ-107-SS	5.0 U	5 U	0.95 J	4.1	
PZ-107-SS FD			5.0 U		
PZ-109-SS	5.0 U	5 U	5.0 U	5.0 U	
PZ-110-SS	5.0 U	5 U	5.0 U	5.0 U	
PZ-111-KS	5 U	5 U	5.0 U	5.0 U	
PZ-111-SD	5.0 U	5 U	5.0 U	5.0 U	
PZ-112-AS	58	34	32	38	
PZ-112-AS EPA			51		
PZ-113-AD	5.0 U	3.1 J	5.0 U	5.0 U	
PZ-113-AD FD	6.0		5.0 U	5.0 U	
PZ-113-AD EPA		1.2 J			
PZ-113-AD MDNR				0.300 U	
PZ-113-AS	0.33 J	5 U	5.0 U	5.0 U	
PZ-113-AS EPA			1.0 U		
PZ-113-SS	5.0 U	5 U	5.0 U	5.0 U	
PZ-114-AS	3.5 J	7.4	4.4 J	3.4	
PZ-115-SS	5.0 U	5 U	5.0 U	5.0 U	
PZ-116-SS	5.0 U	5 U	5.0 U	5.0 U	
PZ-200-SS	5.0 U	5 U	5.0 U	0.85	
PZ-200-SS DUP	5.0 U				
PZ-201A-SS	5.0 U	0.92 J	0.38 J	2.7	
PZ-201A-SS DUP	5.0 U				
PZ-202-SS	5.0 U	4.4 J	34	20	
PZ-203-SS	5.0 U	5 U	5.0 U	5.0 U	
PZ-204A-SS	5.0 U	5 U	7.3	20	
PZ-204-SS	5.0 U	5 U	5.0 U	5.0 U	
PZ-205-AS	5.6	200	1,300 J	1500	
PZ-205-SS	5.0 U	5 U	5.0 U	5.0 U	
PZ-206-SS	5.0 UJ	5 U	5.0 U	5.0 U	
PZ-206-SS EPA			1.0 U		
PZ-206-SS MDNR			0.300 U		

Table 8-3: Summary of Benzene Results in Groundwater - August 2012 through February 2014

Sample ID	Benzene August 2012	Benzene April 2013	Benzene July 2013	Benzene October 2013	Benzene February 2014
PZ-207-AS	1.6 J	2.3 J	1.8 J	1.5	
PZ-207-AS EPA			1.5		
PZ-207-AS MDNR			1.80		
PZ-208-SS	5.0 U	5 U	5.0 U	5.0 U	
PZ-209-SD				5.0 U	5.0 U
PZ-209-SS				5.0 U	5.0 U
PZ-210-SD				38	9.9
PZ-210-SD FD				38	
PZ-210-SS				0.54	0.98 J
PZ-211-SD				5.0 U	5.0 U
PZ-211-SD FD					5.0 U
PZ-211-SS				2.0	5.0 U
PZ-212-SD				5.0 U	5.0 U
PZ-212-SS				5.0 U	5.0 U
PZ-302-AI	5 U	5 U	5.0 U	5.0 U	
PZ-302-AS			10	80	
PZ-303-AS	48	68	50	40	
PZ-304-AI	3.9 J	0.95 J	1.6 J	1.7	
PZ-304-AI FD				1.7	
PZ-304-AS	8.2	10	7.1	9.7	
PZ-305-AI	1.4 J	1.2 J	1.5 J	1.1	
PZ-305-AI FD		1.2 J			
PZ-305-AI EPA			1.7		

Notes: All values are in units of micrograms per liter (µg/L). EPA and MDNR data were not validated.
FD = Field duplicate sample.
Data Validation Qualifiers (Final Q) include:
U = non-detect at the reported value
J = estimated result J- = estimated result which may be biased low
UJ = non-detect at the estimated reported value

Table 8-4: Summary of Arsenic Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Arsenic August 2012	Arsenic April 2013	Arsenic July 2013	Arsenic October 2013	Arsenic February 2014
S-5	DIS	50 U	10 U	10 J+	50 U	
S-5 MDNR	DIS	16.4			15.1 B	
S-5	TOT	14 J	12 J	16	20	
S-5 EPA	TOT		20 U			
S-5 MDNR	TOT	24.1			22.3 B	
S-8	DIS	15 U	13 U	10 U	50 U	
S-8	TOT	15 U	50 U	3.4 J	50 U	
S-10	DIS	36 U	63	46	26	
S-10	TOT	36	54	46	28	
S-53	DIS		42 U	10 U	50 U	
S-53	TOT		50 U	31	50 U	
S-61	DIS	50 U	10 U	10 U	50 U	
S-61 EPA	DIS	1.2 U				
S-61	TOT	10 U	50 U	9.4 U	50 U	
S-82	DIS	200	220	210	230	
S-82 MDNR	DIS				219	
S-82	TOT	230	230	200	230	
S-82 EPA	TOT		220			
S-82 MDNR	TOT				218	
S-84	DIS	110	130	140	150	
S-84 FD	DIS				140	
S-84	TOT	120	140	130	170	
S-84 FD	TOT				170	
I-4	DIS	50 U	50 U	14	50 U	
I-4 FD	DIS			13		
I-4 MDNR	DIS	3.66 J				
I-4	TOT	50 U	12 U	13	14	
I-4 FD	TOT			14		
I-4 MDNR	TOT	17.3				
I-9	DIS	50 U	30 J	24	24	
I-9 FD	DIS	50 U	32 J		21	
I-9 MDNR	DIS	10.0 U			22.3 B	
I-9	TOT	50 U	26 U	26	26	
I-9 FD	TOT	50 U	24 U		21	
I-9 EPA	TOT		34 J			
I-9 MDNR	TOT	10.0 U			20.0 B	
I-11	DIS	15 U	21 U	16	15	
I-11 EPA	DIS	16.2				
I-11	TOT	15	14 U	17	29	
I-62	DIS	50 U	14 U	11	50 U	
I-62 FD	DIS		16 U	11		
I-62	TOT	30 U	15 U	12	12	
I-62 FD	TOT		13 U	13		
I-65	DIS	50 U	10 U	10 U	50 U	
I-65 FD	DIS		10 U	10 U		
I-65	TOT	10 U	10 U	10 U	50 U	
I-65 FD	TOT		3 U	10 U		
I-66	DIS	50 U	4.8 U	4.6 J	50 U	
I-66	TOT	50 U	50 U	7.3 J	50 U	
I-67	DIS	50 U	10 U	4.9 J	50 U	
I-67 FD	DIS		2.7 U		50 U	
I-67	TOT	50 U	50 U	4.6 U	50 U	
I-67 FD	TOT		50 U		50 U	
I-68	DIS	11 U	50 U	2.2 J	50 U	
I-68	TOT	11	19 U	10 J+	50 U	
I-73	DIS	45	63 J+	130 J	200	
I-73	TOT	58	67	110 J	210	
D-3	DIS	13 U	50 U	3.3 U	50 U	
D-3 DUP	DIS	50 U				
D-3 EPA	DIS	84				

Table 8-4: Summary of Arsenic Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Arsenic August 2012	Arsenic April 2013	Arsenic July 2013	Arsenic October 2013	Arsenic February 2014
D-3 MDNR	DIS				5.00 U	
D-3	TOT	10 U	50 U	3.8 U	50 U	
D-3 DUP	TOT	10 U				
D-3 EPA	TOT		20 U			
D-3 MDNR	TOT				5.94 B	
D-6	DIS	50 U	50 U	10 U	50 U	
D-6 DUP	DIS	50 U				
D-6 EPA	DIS	1.2 U				
D-6 MDNR	DIS				5.00 U	
D-6	TOT	10 U	50 U	2.5 U	50 U	
D-6 DUP	TOT	10 U				
D-6 EPA	TOT		9.9 U			
D-6 MDNR	TOT				5.00 U	
D-12	DIS	50 U	50	10 U	50 U	
D-12 FD	DIS		50 U	10 U		
D-12 EPA	DIS	4.0				
D-12	TOT	10 U	50 U	10 U	50 U	
D-12 FD	TOT		50 U	10 U		
D-13	DIS	50 U	50 U	10 U	50 U	
D-13 DUP	DIS	50 U				
D-13	TOT	50 U	50 U	10 U	50 U	
D-13 DUP	TOT	50 U				
D-14	DIS		50 U	7.0 J	50 U	
D-14	TOT		15 U	10	50 U	
D-81	DIS	50 U	11 U	9.4 J	50 U	
D-81 FD	DIS			7.9 J		
D-81	TOT	10 U	50 U	8.6 J	50 U	
D-81 FD	TOT			8.3 J		
D-83	DIS	50 U	50 U	10 U	50 U	
D-83 FD	DIS			2.2 J		
D-83 MDNR	DIS				5.00 U	
D-83	TOT	50 U	50 U	2.8 J	50 U	
D-83 FD	TOT			3.2 J		
D-83 EPA	TOT		9.9 U			
D-83 MDNR	TOT				5.00 U	
D-85	DIS	32 U	40 U	43	43	
D-85 MDNR	DIS				40.5	
D-85	TOT	82	71	49	51	
D-85 EPA	TOT		72 J			
D-85 MDNR	TOT				41.2	
D-87	DIS	10 U	50 U	2.3 J	50 U	
D-87 FD	DIS				50 U	
D-87	TOT	10 U	50 U	10 U	50 U	
D-87 FD	TOT				50 U	
D-93	DIS	50 U	50 U	2.8 J	50 U	
D-93 MDNR	DIS	6.26			5.00 U	
D-93	TOT	50 U	50 U	2.3 J	50 U	
D-93 EPA	TOT		9.9 U			
D-93 MDNR	TOT	25.9			5.00 U	
LR-100	DIS	50 U	50 U	10 U	50 U	
LR-100 FD	DIS				50 U	
LR-100	TOT	50 U	50 U	10 U	50 U	
LR-100 FD	TOT				50 U	
LR-103	DIS	64	53	52	74	
LR-103	TOT	78	46 J	52	75	
LR-104	DIS	50 U	50 U	6.2 J	50 U	
LR-104 DUP	DIS	50 U				
LR-104	TOT	50 U	50 U	5.0 J	50 U	
LR-104 DUP	TOT	50 U				
LR-105	DIS	4.9 J	50 U			

Table 8-4: Summary of Arsenic Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Arsenic August 2012	Arsenic April 2013	Arsenic July 2013	Arsenic October 2013	Arsenic February 2014
LR-105	TOT	4.8 J	50 U			
MW-102	DIS	21 U		21	44	
MW-102 EPA	DIS	6.6				
MW-102	TOT	10		18	130	
MW-103	DIS	50 U	2.9 U	10 U	50 U	
MW-103	TOT	30 J	50 U	3.7 J	50 U	
MW-104	DIS	68 J+	17	17	30	
MW-104	TOT	75 J+	30 J	39	55	
MW-1204	DIS	10 U	50 U	4.6 J	100 UJ	
MW-1204 FD	DIS		50 U			
MW-1204	TOT	10 U	50 U	5.9 J	100 UJ	
MW-1204 FD	TOT		50 U			
PZ-100-KS	DIS	50 U	10 U	10 U	50 U	
PZ-100-KS	TOT	50 U	10 U	10 U	50 U	
PZ-100-SD	DIS	2.4 U	2.3 U	2.3 J	50 U	
PZ-100-SD	TOT	2.9 U	50 U	10 U	50 U	
PZ-100-SS	DIS	10 U	10 U	10 U	50 U	
PZ-100-SS	TOT	10 U	50 U	10 U	50 U	
PZ-101-SS	DIS	20 U	50 U	3.2 J	50 U	
PZ-101-SS MDNR	DIS				8.37 B	
PZ-101-SS EPA	DIS	9.1				
PZ-101-SS	TOT	6.5 J	22 U	3.4 U	50 U	
PZ-101-SS EPA	TOT		20 J		6.45 B	
PZ-101-SS MDNR	TOT				5.00 U	
PZ-102R-SS	DIS	50 U	50 U	10 U	50 U	
PZ-102R-SS	TOT	50 U	50 U	10 U	50 U	
PZ-102-SS	DIS	50 U	11 U	4.0 J	50 U	
PZ-102-SS MDNR	DIS				5.00 U	
PZ-102-SS	TOT	50 U	19 U	14	50 U	
PZ-102-SS EPA	TOT		21 J			
PZ-102-SS MDNR	TOT				5.00 U	
PZ-103-SS	DIS	50 U	50 U	2.1 J	50 U	
PZ-103-SS	TOT	25	13 U	12	50 U	
PZ-104-KS	DIS	50 U	50 U	10 U	50 U	
PZ-104-KS	TOT	50 U	50 U	10 U	50 U	
PZ-104-SD	DIS	12 J+	50 U	14	12	
PZ-104-SD MDNR	DIS				10.6 B	
PZ-104-SD	TOT	7.2 J	20 U	12 J+	50 U	
PZ-104-SD EPA	TOT		20 U		9.79 B	
PZ-104-SD MDNR	TOT				9.43 B	
PZ-104-SS	DIS	10 U	50 U	2.2 J	50 U	
PZ-104-SS FD	DIS		50 U			
PZ-104-SS	TOT	2.5 J	50 U	2.6 U	50 U	
PZ-104-SS FD	TOT		50 U			
PZ-105-SS	DIS	10 U	50 U	10 U	50 U	
PZ-105-SS	TOT	10 U	50 U	10 U	50 U	
PZ-106-KS	DIS	50 U	2 U	10 U	50 U	
PZ-106-KS FD	DIS				50 R	
PZ-106-KS MDNR	DIS	10.0 U				
PZ-106-KS	TOT	50 U	2.1 U	10 U	50 U	
PZ-106-KS FD	TOT				50 U	
PZ-106-KS MDNR	TOT	2.27 J				
PZ-106-SD	DIS	10 U	50 U	10 U	50 U	
PZ-106-SD	TOT	3.4 U	50 U	2.8 J	50 U	
PZ-106-SS	DIS	10 U	50 U	2.0 J	50 U	
PZ-106-SS	TOT	10 U	12 U	2.2 J	50 U	

Table 8-4: Summary of Arsenic Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Arsenic August 2012	Arsenic April 2013	Arsenic July 2013	Arsenic October 2013	Arsenic February 2014
PZ-107-SS	DIS	3.6 U	50 U	3.2 J	50 U	
PZ-107-SS FD	DIS			2.6 J		
PZ-107-SS	TOT	4.9 U	25 U	6.5 J	50 U	
PZ-107-SS FD	TOT			6.2 J		
PZ-109-SS	DIS	10 U	50 U	10 U	50 U	
PZ-109-SS	TOT	10 U	50 U	10 U	50 U	
PZ-110-SS	DIS	10 U	50 U	10 U	50 U	
PZ-110-SS	TOT	10 U	50 U	10 U	50 U	
PZ-111-KS	DIS	50 U	50 U	3.2 J	50 U	
PZ-111-KS	TOT	50 U	13 U	10 U	50 U	
PZ-111-SD	DIS	10 U	50 U	10 U	50 U	
PZ-111-SD	TOT	10 U	50 U	10 U	50 U	
PZ-112-AS	DIS	170	190	190	180	
PZ-112-AS EPA	DIS	180				
PZ-112-AS	TOT	190	180	190	190	
PZ-113-AD	DIS	10 U	50 U	4.9 J	50 U	
PZ-113-AD FD	DIS	13 J+		4.4 J	50 U	
PZ-113-AD MDNR	DIS				5.00 U	
PZ-113-AD	TOT	10 U	50 U	4.7 J	50 U	
PZ-113-AD FD	TOT	18		4.9 J	50 U	
PZ-113-AD EPA	TOT		20 U			
PZ-113-AD MDNR	TOT				5.35 B	
PZ-113-AS	DIS	50 U	10 J	10	16	
PZ-113-AS EPA	DIS	12.0				
PZ-113-AS	TOT	12	14 J	11	17	
PZ-113-SS	DIS	10 U	50 U	10 U	50 U	
PZ-113-SS	TOT	4.8 U	50 U	7.2 U	50 U	
PZ-114-AS	DIS	220	430	270	240	
PZ-114-AS	TOT	220	420	260	250	
PZ-115-SS	DIS	2.9 U	4 U	5.1 J	50 U	
PZ-115-SS	TOT	3.4 U	50 U	6.0 J	50 U	
PZ-116-SS	DIS	10 U	50 U	10 U	50 U	
PZ-116-SS	TOT	10 U	50 U	10 U	50 U	
PZ-200-SS	DIS	10 U	10 U	3.8 J	50 U	
PZ-200-SS DUP	DIS	10 U				
PZ-200-SS	TOT	12 J+	50 U	27	50 U	
PZ-200-SS DUP	TOT	3.5 U				
PZ-201A-SS	DIS	10 U	50 U	10 U	50 U	
PZ-201A-SS DUP	DIS	10 U				
PZ-201A-SS	TOT	10 U	11 U	10 U	10	
PZ-201A-SS DUP	TOT	10 U				
PZ-202-SS	DIS	10 U	50 U	6.8 J	50 U	
PZ-202-SS	TOT	17	50 U	7.4 J	50 U	
PZ-203-SS	DIS	10 U	10 U	10 U	50 U	
PZ-203-SS	TOT	10 U	50 U	10 U	50 U	
PZ-204A-SS	DIS	15 J+	50 U	15	17	
PZ-204A-SS	TOT	21	23 U	15	17	
PZ-204-SS	DIS	10 U	50 U	2.5 J	50 U	
PZ-204-SS	TOT	10 U	50 U	10 U	50 U	
PZ-205-AS	DIS	14 J+	25 J	39	19	
PZ-205-AS	TOT	20	32 U	95 J	30	
PZ-205-SS	DIS	10 U	50 U	10 U	50 U	
PZ-205-SS	TOT	10 U	50 U	10 U	50 U	
PZ-206-SS	DIS	50 U	50 U	10 U	50 U	
PZ-206-SS EPA	DIS	1.0 U				
PZ-206-SS MDNR	DIS			5.00 U		

Table 8-4: Summary of Arsenic Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Arsenic August 2012	Arsenic April 2013	Arsenic July 2013	Arsenic October 2013	Arsenic February 2014
PZ-206-SS	TOT	10 U	50 U	10 U	50 U	
PZ-206-SS MDNR	TOT			5.00 U		
PZ-206-SS MDNR DUP	TOT			5.00 U		
PZ-207-AS	DIS	12 U	35 U	22	50 U	
PZ-207-AS EPA	DIS	7.8				
PZ-207-AS MDNR	DIS			19.4 B		
PZ-207-AS	TOT	5.4 J	29 J	21	50 U	
PZ-207-AS MDNR	TOT			21.0 B		
PZ-208-SS	DIS	10 U	50 U	10 U	50 U	
PZ-208-SS	TOT	10 U	50 U	10 U	50 U	
PZ-209-SD	DIS				50 U	9.9 U
PZ-209-SD	TOT				50 U	9.9 U
PZ-209-SS	DIS				50 U	9.9 U
PZ-209-SS	TOT				50 U	9.9 U
PZ-210-SD	DIS				50 U	9.9 U
PZ-210-SD FD	DIS				50 U	
PZ-210-SD	TOT				21	9.9 U
PZ-210-SD FD	TOT				14	
PZ-210-SS	DIS				50 U	9.9 U
PZ-210-SS	TOT				50 U	9.9 U
PZ-211-SD	DIS				16	9.9 U
PZ-211-SD FD	DIS					9.9 U
PZ-211-SD	TOT				59	9.9 U
PZ-211-SD FD	TOT					9.9 U
PZ-211-SS	DIS				50 U	9.9 U
PZ-211-SS	TOT				50 U	9.9 U
PZ-212-SD	DIS				50 U	9.9 U
PZ-212-SD	TOT				50 U	9.9 U
PZ-212-SS	DIS				50 U	9.9 U
PZ-212-SS	TOT				50 U	9.9 U
PZ-302-AI	DIS	50 U	11 U	2.2 J	50 U	
PZ-302-AI	TOT	13 U	50 U	2.8 J	50 U	
PZ-302-AS	DIS			330	140	
PZ-302-AS	TOT			390	200	
PZ-303-AS	DIS	90	110	150	190	
PZ-303-AS	TOT	88	110	150	200	
PZ-304-AI	DIS	15 U	11 U	10 U	50 U	
PZ-304-AI FD	DIS				50 U	
PZ-304-AI	TOT	50 U	50 U	10 U	50 U	
PZ-304-AI FD	TOT				50 U	
PZ-304-AS	DIS	230	230	210	210	
PZ-304-AS	TOT	210	230	220	210	
PZ-305-AI	DIS	36 U	14 J+	25	50 U	
PZ-305-AI FD	DIS		16			
PZ-305-AI EPA	DIS	28.1				
PZ-305-AI	TOT	26	11 J	24	25	
PZ-305-AI FD	TOT		17 J			

Notes: All values are in units of micrograms per liter (µg/L). EPA and MDNR data were not validated.
Sample Fractions: DIS = Dissolved (filtered sample); TOT = Total (unfiltered sample)
FD - Field duplicate sample
Data Validation Qualifiers (Final Q) include:
U = non-detect at the reported value UJ = non-detect at the estimated reported value
UJ- = non-detect at the estimated reported value which may be biased low
J = estimated result J+ = estimated result which may be biased high
J- = estimated result which may be biased low

Table 8-5: Summary of Iron Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Iron August 2012	Iron April 2013	Iron July 2013	Iron October 2013	Iron February 2014
S-5	DIS	11,000	18,000	18,000	9,900	
S-5 MDNR	DIS	478			15,300	
S-5	TOT	13,000	19,000	22,000	19,000	
S-5 EPA	TOT		20,000			
S-5 MDNR	TOT	13,000			18,000	
S-8	DIS	920	480 J	220	250 U	
S-8	TOT	3,000	1,600	750	630	
S-10	DIS	61,000	130,000	64,000	130,000	
S-10	TOT	65,000	130,000	62,000	150,000	
S-53	DIS		1,500	100 U	500 U	
S-53	TOT		100,000	82,000	17,000	
S-61	DIS	500 U	430	44 J	500 U	
S-61	TOT	6,400	1,500	19,000	11,000	
S-82	DIS	32,000	41,000	37,000	38,000	
S-82 MDNR	DIS				35,200	
S-82	TOT	45,000	59,000	36,000	38,000 J	
S-82 EPA	TOT		71,000			
S-82 MDNR	TOT				36,900	
S-84	DIS	48,000	62,000	66,000	72,000	
S-84 FD	DIS				70,000	
S-84	TOT	69,000	73,000	120,000	95,000	
S-84 FD	TOT				97,000	
I-4	DIS	31,000	25,000	30,000	14,000	
I-4 FD	DIS			29,000		
I-4 MDNR	DIS	84.2				
I-4	TOT	41,000	26,000	32,000	19,000	
I-4 FD	TOT			32,000		
I-4 MDNR	TOT	37,700				
I-9	DIS	18,000	36,000	34,000	37,000	
I-9 FD	DIS	19,000	37,000		38,000	
I-9 MDNR	DIS	68.1			33,200	
I-9	TOT	20,000	34,000	36,000	34,000 J	
I-9 FD	TOT	21,000	34,000		34,000 J	
I-9 EPA	TOT		34,000			
I-9 MDNR	TOT	20,100			33,400	
I-11	DIS	22,000	34,000	30,000	36,000	
I-11	TOT	25,000	36,000	30,000	43,000	
I-62	DIS	3,800	6,500	6,700	7,600	
I-62 FD	DIS		6,500	6,500		
I-62	TOT	13,000	8,900	7,400	8,300	
I-62 FD	TOT		7,900	7,400		
I-65	DIS	500 U	100 U	100 U	500 U	
I-65 FD	DIS		100 U	100 U		
I-65	TOT	2,100	2,500	620	870	
I-65 FD	TOT		3,100	710		
I-66	DIS	1,900	2,100	950	1,400	
I-66	TOT	4,000	4,100	3,200	2,200	
I-67	DIS	5,900	4,400	8,700	7,900	
I-67 FD	DIS		4,800		7,800	
I-67	TOT	7,300	5,100	8,900	10,000	

Table 8-5: Summary of Iron Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Iron August 2012	Iron April 2013	Iron July 2013	Iron October 2013	Iron February 2014
I-67 FD	TOT		5,100		11,000	
I-68	DIS	400 J	460 J	130	490	
I-68	TOT	31,000	35,000	13,000	8,000	

Table 8-5: Summary of Iron Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Iron August 2012	Iron April 2013	Iron July 2013	Iron October 2013	Iron February 2014
I-73	DIS	32,000	47,000	140,000	140,000	
I-73	TOT	61,000	57,000	150,000	160,000	
D-3	DIS	27,000	30,000	38,000	34,000	
D-3 DUP	DIS	31,000				
D-3 MDNR	DIS				34,700	
D-3	TOT	31,000	31,000	38,000	35,000	
D-3 DUP	TOT	31,000				
D-3 EPA	TOT		32,000			
D-3 MDNR	TOT				31,100	
D-6	DIS	14,000	18,000	18,000	19,000	
D-6 DUP	DIS	16,000				
D-6 MDNR	DIS				17,600	
D-6	TOT	15,000	18,000	19,000	18,000 J	
D-6 DUP	TOT	15,000				
D-6 EPA	TOT		17,000			
D-6 MDNR	TOT				17,500	
D-12	DIS	11,000	11,000	8,600	9,200	
D-12 FD	DIS		11,000	8,900		
D-12	TOT	15,000	19,000	9,700	9,400	
D-12 FD	TOT		15,000	9,600		
D-13	DIS	11,000	14,000	14,000	14,000	
D-13 DUP	DIS	11,000				
D-13	TOT	16,000	31,000	14,000	15,000	
D-13 DUP	TOT	21,000				
D-14	DIS		11,000	1,100	6,800	
D-14	TOT		18,000	11,000	17,000	
D-81	DIS	18,000	18,000	14,000	16,000	
D-81 FD	DIS			14,000		
D-81	TOT	18,000	19,000	15,000	15,000	
D-81 FD	TOT			15,000		
D-83	DIS	11,000	17,000	16,000	18,000	
D-83 FD	DIS			16,000		
D-83 MDNR	DIS				16,300	
D-83	TOT	9,400	15,000		16,000 J	
D-83 FD	TOT			17,000		
D-83 EPA	TOT		15,000	16,000		
D-83 MDNR	TOT				16,400	
D-85	DIS	50,000	57,000	55,000	55,000	
D-85 MDNR	DIS				53,300	
D-85	TOT	340,000	180,000	120,000	97,000	
D-85 EPA	TOT		290,000			
D-85 MDNR	TOT				72,100	
D-87	DIS	30,000	36,000	32,000	34,000	
D-87 FD	DIS				35,000	
D-87	TOT	29,000	33,000	35,000	36,000	
D-87 FD	TOT				37,000	
D-93	DIS	32,000	22,000	20,000	22,000	
D-93 MDNR	DIS	71.8			21,100	
D-93	TOT	39,000	21,000	21,000	23,000 J	
D-93 EPA	TOT		21,000			

Table 8-5: Summary of Iron Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Iron August 2012	Iron April 2013	Iron July 2013	Iron October 2013	Iron February 2014
D-93 MDNR	TOT	37,700			21,500	

Table 8-5: Summary of Iron Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Iron August 2012	Iron April 2013	Iron July 2013	Iron October 2013	Iron February 2014
LR-100	DIS	21,000	20,000	21,000	23,000	
LR-100 FD	DIS				22,000	
LR-100	TOT	23,000	19,000	22,000	23,000	
LR-100 FD	TOT				23,000	
LR-103	DIS	37,000	40,000	34,000	38,000	
LR-103	TOT	39,000	40,000	36,000	40,000	
LR-104	DIS	17,000	14,000	13,000	14,000	
LR-104 DUP	DIS	16,000				
LR-104	TOT	17,000	14,000	13,000	14,000	
LR-104 DUP	TOT	16,000				
LR-105	DIS	15,000	13,000			
LR-105	TOT	15,000	14,000			
MW-102	DIS	5,700		5,000	500 U	
MW-102	TOT	10,000		11,000	45,000	
MW-103	DIS	500 U	210	100 U	1,400	
MW-103	TOT	98,000	11,000	13,000	14,000	
MW-104	DIS	50,000	16,000	16,000	30,000	
MW-104	TOT	63,000	26,000	58,000	110,000	
MW-1204	DIS	5,100	4,800	12,000	130,000 J	
MW-1204 FD	DIS		5,000			
MW-1204	TOT	5,700 J	4,800	13,000	140,000 J	
MW-1204 FD	TOT		4,700			
PZ-100-KS	DIS	500 U	32 J	50 J	500 U	
PZ-100-KS	TOT	200 J	220	240	520	
PZ-100-SD	DIS	1,400	1,100	820	820	
PZ-100-SD	TOT	1,500	1,600	850	640 J	
PZ-100-SS	DIS	100 U	100 U	500 U	500 U	
PZ-100-SS	TOT	54 U	500 U	500 U	500 U	
PZ-101-SS	DIS	890	3,000	500 U	1,100	
PZ-101-SS MDNR	DIS				1,100	
PZ-101-SS	TOT	1,500	15,000	580 J	1,900 J	
PZ-101-SS EPA	TOT		13,000		1,800	
PZ-101-SS MDNR	TOT				1,740	
PZ-102R-SS	DIS	1,100	220 J	100 UJ	500 U	
PZ-102R-SS	TOT	2,100	6,700	1,800 J	230 J	
PZ-102-SS	DIS	2,900	3,500	1,700 J	870	
PZ-102-SS MDNR	DIS				880	
PZ-102-SS	TOT	8,700	34,000	30,000	4,100 J	
PZ-102-SS EPA	TOT		46,000			
PZ-102-SS MDNR	TOT				2,840	
PZ-103-SS	DIS	18,000	19,000	11,000	14,000	
PZ-103-SS	TOT	42,000	26,000	39,000	18,000	
PZ-104-KS	DIS	560	810	430	440	
PZ-104-KS	TOT	1,100	1,300	590	560	
PZ-104-SD	DIS	28,000	7,900	14,000	8,700	
PZ-104-SD MDNR	DIS				7,920	
PZ-104-SD	TOT	13,000	22,000	9,000	6,500	
PZ-104-SD EPA	TOT		22,000		8,300	
PZ-104-SD MDNR	TOT				8,300	
PZ-104-SS	DIS	2,400	2,100	1,800	1,400	

Table 8-5: Summary of Iron Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Iron August 2012	Iron April 2013	Iron July 2013	Iron October 2013	Iron February 2014
PZ-104-SS FD	DIS		2,100			
PZ-104-SS	TOT	2,300	2,100	1,800	1,500	
PZ-104-SS FD	TOT		2,100			

Table 8-5: Summary of Iron Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Iron August 2012	Iron April 2013	Iron July 2013	Iron October 2013	Iron February 2014
PZ-105-SS	DIS	140	210 J	210	500 U	
PZ-105-SS	TOT	540	520	270	280	
PZ-106-KS	DIS	330 J	380	220 J	240	
PZ-106-KS FD	DIS				12,000 R	
PZ-106-KS MDNR	DIS	50.0 U				
PZ-106-KS	TOT	590	540	250 J	270	
PZ-106-KS FD	TOT				260	
PZ-106-KS MDNR	TOT	715				
PZ-106-SD	DIS	620	1,100	430	570	
PZ-106-SD	TOT	4,300	5,000	2,200	1,900 J	
PZ-106-SS	DIS	510	870	610	590	
PZ-106-SS	TOT	460	1,000	570	520	
PZ-107-SS	DIS	2,400	2,200	1,500	540	
PZ-107-SS FD	DIS			1,500		
PZ-107-SS	TOT	5,900	37,000	11,000	4,100	
PZ-107-SS FD	TOT			11,000		
PZ-109-SS	DIS	100 U	500 U	500 U	500 U	
PZ-109-SS	TOT	43 J	500 U	1,000 U	500 U	
PZ-110-SS	DIS	6,500	6,800	7,000	7,200	
PZ-110-SS	TOT	7,100 J	7,600	7,200	6,500 J	
PZ-111-KS	DIS	140 J	180 J	160	500 U	
PZ-111-KS	TOT	200 J	700	170	150	
PZ-111-SD	DIS	100 U	500 U	500 U	500 U	
PZ-111-SD	TOT	230	500 U	500 U	500 U	
PZ-112-AS	DIS	37,000	31,000	38,000	39,000	
PZ-112-AS	TOT	44,000	33,000	38,000	40,000	
PZ-113-AD	DIS	30,000	35,000	34,000	36,000	
PZ-113-AD FD	DIS	30,000		36,000	36,000	
PZ-113-AD MDNR	DIS				35,900	
PZ-113-AD	TOT	31,000	34,000	35,000	36,000	
PZ-113-AD FD	TOT	33,000		35,000	37,000	
PZ-113-AD EPA	TOT		35,000			
PZ-113-AD MDNR	TOT				36,500	
PZ-113-AS	DIS	6,700	4,200	5,500	11,000	
PZ-113-AS	TOT	7,500	7,200	5,900	13,000	
PZ-113-SS	DIS	92	500 U	54 J	500 U	
PZ-113-SS	TOT	4,500	7,800	7,600	5,300	
PZ-114-AS	DIS	80,000	97,000	72,000	74,000	
PZ-114-AS	TOT	81,000	99,000	73,000	72,000 J	
PZ-115-SS	DIS	1,500	1,200	1,600	1,300	
PZ-115-SS	TOT	1,900	1,700	1,500	1,200 J	
PZ-116-SS	DIS	100 U	500 U	100 U	500 U	
PZ-116-SS	TOT	69 J	500 U	100 U	500 U	
PZ-200-SS	DIS	7,800	6,000	7,300	9,500	
PZ-200-SS DUP	DIS	7,400				
PZ-200-SS	TOT	17,000 J	9,100	32,000	12,000	
PZ-200-SS DUP	TOT	9,200 J				
PZ-201A-SS	DIS	220	500 U	100 U	500 U	
PZ-201A-SS DUP	DIS	170				
PZ-201A-SS	TOT	190	520	53 J	500 U	

Table 8-5: Summary of Iron Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Iron August 2012	Iron April 2013	Iron July 2013	Iron October 2013	Iron February 2014
PZ-201A-SS DUP	TOT	180				

Table 8-5: Summary of Iron Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Iron August 2012	Iron April 2013	Iron July 2013	Iron October 2013	Iron February 2014
PZ-202-SS	DIS	1,700	1,800	4,900	11,000	
PZ-202-SS	TOT	21,000 J	2,800	5,000	12,000	
PZ-203-SS	DIS	130	210	140	270	
PZ-203-SS	TOT	320	250 J	280	350	
PZ-204A-SS	DIS	2,500	4,000	7,000	8,600	
PZ-204A-SS	TOT	5,500 J	10,000	9,900	9,800 J	
PZ-204-SS	DIS	550	740	2,500	340	
PZ-204-SS	TOT	2,000	4,700	1,900	810 J	
PZ-205-AS	DIS	30,000	33,000	50,000	45,000	
PZ-205-AS	TOT	34,000	36,000	150,000	70,000	
PZ-205-SS	DIS	77 U	500 U	500 U	500 U	
PZ-205-SS	TOT	120	300 J	1,000 U	500 U	
PZ-206-SS	DIS	200 J	220 J	1,000 U	500 U	
PZ-206-SS MDNR	DIS			142		
PZ-206-SS	TOT	5,700	2,400	2,200	3,100	
PZ-206-SS MDNR	TOT			1,240		
PZ-206-SS MDNR DUP	TOT			1,420		
PZ-207-AS	DIS	19,000	20,000	20,000	22,000	
PZ-207-AS MDNR	DIS			20,000		
PZ-207-AS	TOT	22,000	21,000	16,000	22,000	
PZ-207-AS MDNR	TOT			20,200		
PZ-208-SS	DIS	65 J	500 U	720	500 U	
PZ-208-SS	TOT	4,200 J	1,000	1,000	2,300 J	
PZ-209-SD	DIS				500 U	140 U
PZ-209-SD	TOT				500 U	140 U
PZ-209-SS	DIS				500 U	140 U
PZ-209-SS	TOT				500 U	150 J
PZ-210-SD	DIS				2,100 J+	610
PZ-210-SD FD	DIS				5,800 J+	
PZ-210-SD	TOT				20,000	680
PZ-210-SD FD	TOT				16,000	
PZ-210-SS	DIS				500 U	140 U
PZ-210-SS	TOT				240	1400
PZ-211-SD	DIS				11,000 J+	500 U
PZ-211-SD FD	DIS					140 U
PZ-211-SD	TOT				42,000	140 J
PZ-211-SD FD	TOT					140 U
PZ-211-SS	DIS				500 U	290 J
PZ-211-SS	TOT				500 U	140 J
PZ-212-SD	DIS				500 U	140 U
PZ-212-SD	TOT				500 U	140 U
PZ-212-SS	DIS				500 U	140 U
PZ-212-SS	TOT				700	900
PZ-302-AI	DIS	1,700	2,700	1,500	1,700	
PZ-302-AI	TOT	4,900	1,800	2,000	1,800	
PZ-302-AS	DIS			130,000	77,000	
PZ-302-AS	TOT			150,000	83,000 J	
PZ-303-AS	DIS	66,000	66,000	120,000	88,000	
PZ-303-AS	TOT	78,000	76,000	120,000	92,000	
PZ-304-AI	DIS	17,000	16,000	15,000	19,000	

Table 8-5: Summary of Iron Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Iron August 2012	Iron April 2013	Iron July 2013	Iron October 2013	Iron February 2014
PZ-304-AI FD	DIS				19,000	
PZ-304-AI	TOT	22,000	16,000	16,000	19,000	
PZ-304-AI FD	TOT				19,000	

Table 8-5: Summary of Iron Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Iron August 2012	Iron April 2013	Iron July 2013	Iron October 2013	Iron February 2014
PZ-304-AS	DIS	24,000	28,000	25,000	31,000	
PZ-304-AS	TOT	26,000	29,000	27,000	30,000	
PZ-305-AI	DIS	38,000	34,000	46,000	40,000	
PZ-305-AI FD	DIS		34,000			
PZ-305-AI	TOT	44,000	42,000	46,000	45,000	
PZ-305-AI FD	TOT		45,000			

Notes:
All values are in units of micrograms per liter (µg/L). EPA and MDNR data were not validated.
Sample Fractions: DIS = Dissolved (filtered sample); TOT = Total (unfiltered sample)
FD = Field duplicate sample
Data Validation Qualifiers (Final Q) include:
U = non-detect at the reported value UJ = non-detect at the estimated reported value
UJ- = non-detect at the estimated reported value which may be biased low
J = estimated result J+ = estimated result which may be biased high
J- = estimated result which may be biased low

Table 8-6: Summary of Manganese Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Manganese August 2012	Manganese April 2013	Manganese July 2013	Manganese October 2013	Manganese February 2014
S-5	DIS	110	240	160	90	
S-5 MDNR	DIS	86.2			130	
S-5	TOT	130	240	190	160	
S-5 EPA	TOT		260			
S-5 MDNR	TOT	131			149	
S-8	DIS	880	1,200	330	550	
S-8	TOT	1,000	1,200	320	560	
S-10	DIS	2,800	7,800	2,300	7,900	
S-10	TOT	3,100	7,300	2,400	9,500	
S-53	DIS		6,200	2,300	2,000	
S-53	TOT		8,900	4,100 J-	2,400	
S-61	DIS	580	670	680	570	
S-61 EPA	DIS	651				
S-61	TOT	720	670	960	770	
S-82	DIS	1,800	1,800	2,100	1,600	
S-82 MDNR	DIS				1,460	
S-82	TOT	2,000	2,600	2,200	1,600 J	
S-82 EPA	TOT		2,700			
S-82 MDNR	TOT				1,490	
S-84	DIS	1,900	2,000	1,900	1,900	
S-84 FD	DIS				1,900	
S-84	TOT	2,300	2,300	3,600	2,800	
S-84 FD	TOT				2,700	
I-4	DIS	880	570	480	250	
I-4 FD	DIS			470		
I-4 MDNR	DIS	821				
I-4	TOT	980	590	490	360	
I-4 FD	TOT			480		
I-4 MDNR	TOT	902				
I-9	DIS	360	1,200	1,200	1,200	
I-9 FD	DIS	370	1,300		1,200	
I-9 MDNR	DIS	379			1,070	
I-9	TOT	390	1,200	1,300	1,100 J	
I-9 FD	TOT	410	1,100		1,100 J	
I-9 EPA	TOT		1,100			
I-9 MDNR	TOT	406			1,040	
I-11	DIS	1,200	2,200	1,800	2,200	
I-11 EPA	DIS	1,190				
I-11	TOT	1,300	2,100	1,800	2,300	
I-62	DIS	400	520	490	550	
I-62 FD	DIS		520	470		
I-62	TOT	620	540	500	580	
I-62 FD	TOT		520	500		
I-65	DIS	83	14 J	34 J+	100	
I-65 FD	DIS		13 J	35 J+		
I-65	TOT	640	750	250 J-	270	
I-65 FD	TOT		850	270 J-		
I-66	DIS	3,200	4,700	4,200	4,400	
I-66	TOT	3,600	5,000	4,500	4,900	
I-67	DIS	1,100	1,200	1,400	1,500	
I-67 FD	DIS		1,200		1,400	
I-67	TOT	1,200	1,200	1,300	1,400	
I-67 FD	TOT		1,200		1,400	
I-68	DIS	1,400	1,800	1,500	2,000	
I-68	TOT	1,600	2,200	1,600	2,100	
I-73	DIS	1,100	1,700	3,800 J+	1,700	
I-73	TOT	1,500	1,800	3,800 J-	1,800	
D-3	DIS	410	500	600	550	

Table 8-6: Summary of Manganese Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Manganese August 2012	Manganese April 2013	Manganese July 2013	Manganese October 2013	Manganese February 2014
D-3 DUP	DIS	460				
D-3 EPA	DIS	426				
D-3 MDNR	DIS				558	
D-3	TOT	470	500	600	570	
D-3 DUP	TOT	470				
D-3 EPA	TOT		510			
D-3 MDNR	TOT				518	
D-6	DIS	420	600	460	560	
D-6 DUP	DIS	500				
D-6 EPA	DIS	481				
D-6 MDNR	DIS				500	
D-6	TOT	490	610	480	530 J	
D-6 DUP	TOT	480				
D-6 EPA	TOT		570			
D-6 MDNR	TOT				502	
D-12	DIS	1,100	1,200	990	1,100	
D-12 FD	DIS		1,200	980		
D-12 EPA	DIS	1,070				
D-12	TOT	1,100	1,200	1,000	1,100	
D-12 FD	TOT		1,200	980		
D-13	DIS	310	430	390	400	
D-13 DUP	DIS	310				
D-13	TOT	340	620	400 J-	430	
D-13 DUP	TOT	390				
D-14	DIS		1,600	1,200	950	
D-14	TOT		1,600	1,400 J-	1,200	
D-81	DIS	1,100	1,100	810	860	
D-81 FD	DIS			810		
D-81	TOT	1,100	1,100	850	830	
D-81 FD	TOT			860		
D-83	DIS	260	390	390	440	
D-83 FD	DIS			380		
D-83 MDNR	DIS				404	
D-83	TOT	240	350	410	430 J	
D-83 FD	TOT			400		
D-83 EPA	TOT		340			
D-83 MDNR	TOT				423	
D-85	DIS	950	1,100	1,000	1,000	
D-85 MDNR	DIS				965	
D-85	TOT	9,200	5,200	2,600	2,200	
D-85 EPA	TOT		8,800			
D-85 MDNR	TOT				1,790	
D-87	DIS	530	670	570	640	
D-87 FD	DIS				630	
D-87	TOT	520	620	620	670	
D-87 FD	TOT				670	
D-93	DIS	900	440	400	480	
D-93 MDNR	DIS	814			437	
D-93	TOT	900	450	420	580 J	
D-93 EPA	TOT		430			
D-93 MDNR	TOT	890			485	
LR-100	DIS	190	160	170	190	
LR-100 FD	DIS				180	
LR-100	TOT	220	140	170	190	
LR-100 FD	TOT				190	
LR-103	DIS	1,000	1,200	980	920	
LR-103	TOT	1,100	1,100	1,000	950	
LR-104	DIS	1,200	1,200	1,200	1,200	

Table 8-6: Summary of Manganese Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Manganese August 2012	Manganese April 2013	Manganese July 2013	Manganese October 2013	Manganese February 2014
LR-104 DUP	DIS	1,200				
LR-104	TOT	1,200	1,100	1,100 J-	1,200	
LR-104 DUP	TOT	1,200				
LR-105	DIS	52	52 J			
LR-105	TOT	70	64 J			
MW-102	DIS	1,600		2,600	1,400	
MW-102 EPA	DIS	1,780				
MW-102	TOT	2,000		2,800	2,500	
MW-103	DIS	730	510	880	1,100	
MW-103	TOT	2,700	620	1,000	1,200	
MW-104	DIS	4,400	3,700	2,400	3,400	
MW-104	TOT	4,500	3,900	3,000	5,300	
MW-1204	DIS	100	100	110	6,400 J	
MW-1204 FD	DIS		98			
MW-1204	TOT	120 J+	100	120	7,400 J	
MW-1204 FD	TOT		100			
PZ-100-KS	DIS	18 J	21	17	17	
PZ-100-KS	TOT	21 J	17	17	28	
PZ-100-SD	DIS	73	72	66	73	
PZ-100-SD	TOT	74	70 J	67	63 J	
PZ-100-SS	DIS	15 U	15 U	15 U	75 U	
PZ-100-SS	TOT	4.7 J	75 U	15 U	75 U	
PZ-101-SS	DIS	62 J	57 J	68	85	
PZ-101-SS EPA	DIS	83				
PZ-101-SS MDNR	DIS				69.0	
PZ-101-SS	TOT	81	130	48	89 J	
PZ-101-SS EPA	TOT		120		81	
PZ-101-SS MDNR	TOT				81	
PZ-102R-SS	DIS	35 J	75 U	23 J+	75 U	
PZ-102R-SS	TOT	37 J	36 J	39 J-	75 U	
PZ-102-SS	DIS	290	260	190 J	230	
PZ-102-SS MDNR	DIS				210	
PZ-102-SS	TOT	360	1,000	1,200 J-	260 J	
PZ-102-SS EPA	TOT		1,200			
PZ-102-SS MDNR	TOT				250	
PZ-103-SS	DIS	120	370	270 J	330	
PZ-103-SS	TOT	250	430	470 J-	350	
PZ-104-KS	DIS	75 U	19 J	11 U	75 U	
PZ-104-KS	TOT	21 J	25 J	14 J-	75 U	
PZ-104-SD	DIS	190	160	160	170	
PZ-104-SD MDNR	DIS				152	
PZ-104-SD	TOT	140	180	160	130	
PZ-104-SD EPA	TOT		160		168	
PZ-104-SD MDNR	TOT				169	
PZ-104-SS	DIS	65	51 J	39	40	
PZ-104-SS FD	DIS		48 J			
PZ-104-SS	TOT	61	49 J	40	41	
PZ-104-SS FD	TOT		48 J			
PZ-105-SS	DIS	6.1 U	75 U	6.1 J	75 U	
PZ-105-SS	TOT	14 J	75 U	7.6 J	75 U	
PZ-106-KS	DIS	75 U	10 J	4.1 UJ	75 U	
PZ-106-KS FD	DIS				1,100 R	
PZ-106-KS MDNR	DIS	6				
PZ-106-KS	TOT	75 U	6.1 J	5.0 J-	75 U	
PZ-106-KS FD	TOT				75 U	
PZ-106-KS MDNR	TOT	7				
PZ-106-SD	DIS	69	130	67	70	
PZ-106-SD	TOT	160	170	78	63 J	

Table 8-6: Summary of Manganese Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Manganese August 2012	Manganese April 2013	Manganese July 2013	Manganese October 2013	Manganese February 2014
PZ-106-SS	DIS	14 U	32 J	26	20	
PZ-106-SS	TOT	33	32 J	24	75 U	
PZ-107-SS	DIS	120	170	170 J	380	
PZ-107-SS FD	DIS			170 J		
PZ-107-SS	TOT	100	420	240 J-	400	
PZ-107-SS FD	TOT			240 J-		
PZ-109-SS	DIS	15 U	75 U	15 U	75 U	
PZ-109-SS	TOT	15 U	75 U	15 U	75 U	
PZ-110-SS	DIS	210	210	190	210	
PZ-110-SS	TOT	200 J+	190	200	190 J	
PZ-111-KS	DIS	75 U	75 U	3.3 J	75 U	
PZ-111-KS	TOT	75 U	75 U	15 U	75 U	
PZ-111-SD	DIS	15 U	75 U	15 U	75 U	
PZ-111-SD	TOT	15 U	75 U	15 U	75 U	
PZ-112-AS	DIS	220	170	200	220	
PZ-112-AS EPA	DIS	236				
PZ-112-AS	TOT	280	170	200	230	
PZ-113-AD	DIS	570	650	610	660	
PZ-113-AD FD	DIS	560		630	650	
PZ-113-AD MDNR	DIS				627	
PZ-113-AD	TOT	630	650	640	670	
PZ-113-AD FD	TOT	610		640	680	
PZ-113-AD EPA	TOT		680			
PZ-113-AD MDNR	TOT				648	
PZ-113-AS	DIS	6,400	5,500	5,400	6,300	
PZ-113-AS EPA	DIS	6,390				
PZ-113-AS	TOT	6,400	5,500	5,500	6,400	
PZ-113-SS	DIS	32	37 J	26	35	
PZ-113-SS	TOT	83	120	100	94	
PZ-114-AS	DIS	4,100	3,500	2,000	1,900	
PZ-114-AS	TOT	4,200	3,400	1,900	1,800 J	
PZ-115-SS	DIS	45	63	51	51	
PZ-115-SS	TOT	55	44 J	52	48 J	
PZ-116-SS	DIS	15 U	75 U	15 U	75 U	
PZ-116-SS	TOT	16	75 U	3.8 J	75 U	
PZ-200-SS	DIS	3,200	6,500	6,800 J	5,800	
PZ-200-SS DUP	DIS	2,600				
PZ-200-SS	TOT	2,900 J+	6,200	7,300 J-	5,900	
PZ-200-SS DUP	TOT	2,600 J+				
PZ-201A-SS	DIS	38	75 U	4.5 J	75 U	
PZ-201A-SS DUP	DIS	38				
PZ-201A-SS	TOT	41	87	18	75 U	
PZ-201A-SS DUP	TOT	42				
PZ-202-SS	DIS	590	610	870	1,100	
PZ-202-SS	TOT	1,200 J+	620	940	1,200	
PZ-203-SS	DIS	20 J+	25	18	22	
PZ-203-SS	TOT	21	24 J	21	23	
PZ-204A-SS	DIS	1,000	2,100	2,100	2,000	
PZ-204A-SS	TOT	1,000 J+	2,500	2,300	2,100 J	
PZ-204-SS	DIS	90	110	100	110	
PZ-204-SS	TOT	100	120	110	100 J	
PZ-205-AS	DIS	580	640	1,600	740	
PZ-205-AS	TOT	630	650	2,500 J-	1,000	
PZ-205-SS	DIS	15 U	75 U	15 U	75 U	
PZ-205-SS	TOT	15 U	75 U	15 U	75 U	
PZ-206-SS	DIS	51 J	37 J	19 J+	22	
PZ-206-SS EPA	DIS	43				
PZ-206-SS MDNR	DIS			16		

Table 8-6: Summary of Manganese Results in Groundwater - August 2012 through February 2014

Sample ID	Sample Fraction	Manganese August 2012	Manganese April 2013	Manganese July 2013	Manganese October 2013	Manganese February 2014
PZ-206-SS	TOT	110	60 J	45 J-	65	
PZ-206-SS MDNR	TOT			32		
PZ-206-SS MDNR DUP	TOT			34		
PZ-207-AS	DIS	66 J	100	66	69	
PZ-207-AS EPA	DIS	64				
PZ-207-AS MDNR	DIS			60		
PZ-207-AS	TOT	71	93	65 J-	66	
PZ-207-AS MDNR	TOT			61		
PZ-208-SS	DIS	28	29 J	20	28	
PZ-208-SS	TOT	40 J+	33 J	26	93 J	
PZ-209-SD	DIS				39	17 U
PZ-209-SD	TOT				46	17 U
PZ-209-SS	DIS				180	82
PZ-209-SS	TOT				160	80
PZ-210-SD	DIS				51	79
PZ-210-SD FD	DIS				63	
PZ-210-SD	TOT				130	79
PZ-210-SD FD	TOT				110	
PZ-210-SS	DIS				83	77
PZ-210-SS	TOT				90	80
PZ-211-SD	DIS				59	19 J
PZ-211-SD FD	DIS					19 J
PZ-211-SD	TOT				240	21 J
PZ-211-SD FD	TOT					20 J
PZ-211-SS	DIS				21	23 J
PZ-211-SS	TOT				22	22 J
PZ-212-SD	DIS				280	330
PZ-212-SD	TOT				280	320
PZ-212-SS	DIS				28	24 J
PZ-212-SS	TOT				78	58 J
PZ-302-AI	DIS	210	280	210	250	
PZ-302-AI	TOT	210	260	230	250	
PZ-302-AS	DIS			13,000	4,800	
PZ-302-AS	TOT			14,000	4,900 J	
PZ-303-AS	DIS	1,700	1,100	2,400	3,800	
PZ-303-AS	TOT	1,800	1,100	2,500	3,600	
PZ-304-AI	DIS	1,300	1,300	990	1,000	
PZ-304-AI FD	DIS				1,000	
PZ-304-AI	TOT	1,500	1,200	1,000	1,000	
PZ-304-AI FD	TOT				1,000	
PZ-304-AS	DIS	92	120	110	130 J+	
PZ-304-AS	TOT	94	110	130	120	
PZ-305-AI	DIS	4,000	3,100	3,500	3,300	
PZ-305-AI FD	DIS		3,100			
PZ-305-AI EPA	DIS	3,510				
PZ-305-AI	TOT	4,100	3,200	3,400 J-	3,500	
PZ-305-AI FD	TOT		3,300			

Notes: All values are in units of micrograms per liter (µg/L) FD = Field duplicate sample
EPA and MDNR data were not validated.
Sample Fractions: DIS = Dissolved (filtered sample); TOT = Total (unfiltered sample)
Data Validation Qualifiers (Final Q) include: R = rejected U = non-detect at the reported value
UJ = non-detect at the estimated reported value
UJ+ = non-detect at the estimated reported value which may be biased high
UJ- = non-detect at the estimated reported value which may be biased low
J = estimated result J+ = estimated result which may be biased high
J- = estimated result which may be biased low

Table 8-7: Summary of Barium Results in Groundwater - Aug. 2012 through Feb. 2014

Sample ID	Sample Fraction	Barium Aug 2012	Barium Apr 2013	Barium Jul 2013	Barium Oct 2013	Barium Feb 2014
S-5	DIS	420	470	540	390	
S-5	TOT	420	450	550	620	
S-8	DIS	260	380	290	330	
S-8	TOT	300	400	290	340	
S-10	DIS	100 J	200 J	650	110 U	
S-10	TOT	110	180 J	650	85	
S-53	DIS		370	410	290	
S-53	TOT		1,400	1,200 J-	500	
S-61	DIS	190 J	200	240	220	
S-61	TOT	250	220 J	540	390	
S-82	DIS	900	790	790	910	
S-82	TOT	1,300	1,300	790	930	
S-84	DIS	840	730	850	880	
S-84 FD	DIS				840	
S-84	TOT	1,100	900	1,700	1,200	
S-84 FD	TOT				1,300	
I-4	DIS	1,200	400	630	220	
I-4 FD	DIS			620		
I-4	TOT	1,400	410	600	300	
I-4 FD	TOT			600		
I-9	DIS	1,100	1,400	1,500	1,700	
I-9 FD	DIS	1,100	1,500		1,700	
I-9	TOT	1,100	1,400	1,500	1,500	
I-9 FD	TOT	1,200	1,400		1,600	
I-11	DIS	760	850	830	650	
I-11	TOT	860	890	820	670	
I-62	DIS	270	360	380	420	
I-62 FD	DIS		350	370		
I-62	TOT	380	390	380	440	
I-62 FD	TOT		370	380		
I-65	DIS	200 J	190	180	180	
I-65 FD	DIS		190	190		
I-65	TOT	250	280	190 J-	210	
I-65 FD	TOT		270	200 J-		
I-66	DIS	100 J	140	120	130	
I-66	TOT	120 J	170 J	140	150	
I-67	DIS	210 J	250	290	300	
I-67 FD	DIS		250		290	
I-67	TOT	230 J	250	280	290	
I-67 FD	TOT		260		300	
I-68	DIS	540	570	390	450	
I-68	TOT	730	1,000	510	530	
I-73	DIS	680	1,100	3,200	4,700	
I-73	TOT	820	1,200	3,100 J-	4,900	
D-3	DIS	1,800	2,300	2,600	2,500	
D-3 FD	DIS	2,000				
D-3	TOT	2,100	2,300	2,600	2,500	
D-3 FD	TOT	2,100				
D-6	DIS	950	1,300	1,300	1,500	
D-6 FD	DIS	1,100				

Table 8-7: Summary of Barium Results in Groundwater - Aug. 2012 through Feb. 2014

Sample ID	Sample Fraction	Barium Aug 2012	Barium Apr 2013	Barium Jul 2013	Barium Oct 2013	Barium Feb 2014
D-6	TOT	1,100	1,300	1,300	1,400	
D-6 FD	TOT	1,100				
D-12	DIS	470	440	450	450	
D-12 FD	DIS		450	460		
D-12	TOT	490	500	440	380	
D-12 FD	TOT		470	440		
D-13	DIS	530	680	660	650	
D-13 FD	DIS	510				
D-13	TOT	550	800	650 J-	670	
D-13 FD	TOT	600				
D-14	DIS		530	600	560	
D-14	TOT		600	760 J-	700	
D-81	DIS	390	390	350	350	
D-81 FD	DIS			350		
D-81	TOT	400	410	350	350	
D-81 FD	TOT			350		
D-83	DIS	1,100	1,900	1,700	1,900	
D-83 FD	DIS			1,700		
D-83	TOT	960	1,800	1,800	1,800	
D-83 FD	TOT			1,700		
D-85	DIS	1,800	1,900	1,900	1,900	
D-85	TOT	6,100	4,100	2,600	2,600	
D-87	DIS	1,200	1,300	1,500	1,500	
D-87 FD	DIS				1,500	
D-87	TOT	1,100	1,400	1,500	1,500	
D-87 FD	TOT				1,500	
D-93	DIS	1,400	1,400	1,300	1,300	
D-93	TOT	1,400	1,400	1,400	1,100	
LR-100	DIS	450	430	450	470	
LR-100 FD	DIS				460	
LR-100	TOT	440	430	430	460	
LR-100 FD	TOT				460	
LR-103	DIS	960	1,200	1,100	1,100	
LR-103	TOT	1,000	1,200	1,100	1,100	
LR-104	DIS	450	390	420	400	
LR-104 FD	DIS	430				
LR-104	TOT	450	400	410 J-	390	
LR-104 FD	TOT	430				
LR-105	DIS	750	820			
LR-105	TOT	720	820			
MW-102	DIS	390		98	110	
MW-102	TOT	490		170	550	
MW-103	DIS	230 J	200	160	180	
MW-103	TOT	1,100	320	290	300	
MW-104	DIS	550	370	410	520	
MW-104	TOT	850	480	810	1,600	
MW-1204	DIS	290	340	1,100	4,100 J	
MW-1204 FD	DIS		350			
MW-1204	TOT	290	300	1,300	3,900 J	
MW-1204 FD	TOT		300			

Table 8-7: Summary of Barium Results in Groundwater - Aug. 2012 through Feb. 2014

Sample ID	Sample Fraction	Barium Aug 2012	Barium Apr 2013	Barium Jul 2013	Barium Oct 2013	Barium Feb 2014
PZ-100-SS	DIS	65	65	66	69	
PZ-100-SS	TOT	69	70 J	67	68	
PZ-100-SD	DIS	310	320	330	350	
PZ-100-SD	TOT	320	320	330	320	
PZ-100-KS	DIS	250 U	4.4 J	4.4 J	250 U	
PZ-100-KS	TOT	250 U	4.2 J	4.7 J	250 U	
PZ-101-SS	DIS	370	520	480	620	
PZ-101-SS	TOT	500	480	530	580	
PZ-102-SS	DIS	500	430	360 J	350	
PZ-102-SS	TOT	570	690	790 J-	340	
PZ-102R-SS	DIS	86 J	82 J	73 J	79	
PZ-102R-SS	TOT	88 J	110 J	76 J-	72	
PZ-103-SS	DIS	660	560	400 J	390	
PZ-103-SS	TOT	1,100	620	610 J-	400	
PZ-104-SS	DIS	100	96 J	100	100	
PZ-104-SS FD	DIS		97 J			
PZ-104-SS	TOT	98	99 J	100	110	
PZ-104-SS FD	TOT		98 J			
PZ-104-SD	DIS	1,200	660	1,000	670	
PZ-104-SD	TOT	520	1,600	800	480	
PZ-104-KS	DIS	57 J	61 J	50	51	
PZ-104-KS	TOT	58 J	63 J	50 J-	51	
PZ-105-SS	DIS	170	170 J	170	160	
PZ-105-SS	TOT	170	180 J	170	160	
PZ-106-SS	DIS	140	150 J	150	150	
PZ-106-SS	TOT	140	150 J	150	150	
PZ-106-SD	DIS	93	94 J	95	100	
PZ-106-SD	TOT	130	140 J	130	120	
PZ-106-KS	DIS	45 J	45 J	44 J	46	
PZ-106-KS FD	DIS				620 R	
PZ-106-KS	TOT	46 J	46 J	46 J-	45	
PZ-106-KS FD	TOT				45	
PZ-107-SS	DIS	590	620	620 J	720	
PZ-107-SS FD	DIS			640 J		
PZ-107-SS	TOT	620	1,100	720 J-	740	
PZ-107-SS FD	TOT			730 J-		
PZ-109-SS	DIS	63	68 J	66	69	
PZ-109-SS	TOT	58	67 J	67	63	
PZ-110-SS	DIS	330	320	310	320	
PZ-110-SS	TOT	320	330	320	300	
PZ-111-SD	DIS	120	120 J	110	110	
PZ-111-SD	TOT	110	120 J	110	110	
PZ-111-KS	DIS	250 U	250 U	6.2 J	250 U	
PZ-111-KS	TOT	250 U	250 U	6.1 J	250 U	
PZ-112-AS	DIS	1,800	2,200	2,300	2,100	
PZ-112-AS	TOT	2,200	2,200	2,400	2,100	
PZ-113-AS	DIS	740	670	690	800	
PZ-113-AS	TOT	740	700	700	840	
PZ-113-AD	DIS	2,000 J	2,200	2,300	2,300	
PZ-113-AD FD	DIS	1,300 J		2,400	2,300	

Table 8-7: Summary of Barium Results in Groundwater - Aug. 2012 through Feb. 2014

Sample ID	Sample Fraction	Barium Aug 2012	Barium Apr 2013	Barium Jul 2013	Barium Oct 2013	Barium Feb 2014
PZ-113-AD	TOT	2,000 J	2,200	2,300	2,300	
PZ-113-AD FD	TOT	1,300 J		2,300	2,300	
PZ-113-SS	DIS	170	190 J	180	190	
PZ-113-SS	TOT	200	210 J	220	220	
PZ-114-AS	DIS	710	510	460	460	
PZ-114-AS	TOT	720	650	470	450	
PZ-115-SS	DIS	200	260	320	340	
PZ-115-SS	TOT	210	290	330	330	
PZ-116-SS	DIS	59	65 J	69	70	
PZ-116-SS	TOT	63	66 J	73	76	
PZ-200-SS	DIS	740	950	850 J	790	
PZ-200-SS FD	DIS	690				
PZ-200-SS	TOT	660	980	880 J-	800	
PZ-200-SS FD	TOT	630				
PZ-201A-SS	DIS	120	130 J	130	140	
PZ-201A-SS FD	DIS	120				
PZ-201A-SS	TOT	120	130 J	130	140	
PZ-201A-SS FD	TOT	120				
PZ-202-SS	DIS	410	400	550	620	
PZ-202-SS	TOT	660	390	580	630	
PZ-203-SS	DIS	90	90	89	88	
PZ-203-SS	TOT	89	94 J	91	89	
PZ-204-SS	DIS	180	160 J	180	170	
PZ-204A-SS	DIS	140	390	350	300	
PZ-204-SS	TOT	200	200 J	180	140	
PZ-204A-SS	TOT	340	510	440	450	
PZ-205-AS	DIS	1,300	1,200	1,300	1,600	
PZ-205-AS	TOT	1,400	1,300	1,800 J-	1,900	
PZ-205-SS	DIS	130	140 J	150	140	
PZ-205-SS	TOT	140	140 J	150	150	
PZ-206-SS	DIS	76 J	60 J	55	57	
PZ-206-SS	TOT	110	82 J	73 J-	92	
PZ-207-AS	DIS	660	820	780	700	
PZ-207-AS	TOT	700	860	770 J-	690	
PZ-208-SS	DIS	160	150 J	150	170	
PZ-208-SS	TOT	180	150 J	150	220	
PZ-209-SS	DIS				160	10 U
PZ-209-SS	TOT				160	99 J
PZ-209-SD	DIS				32	50 U
PZ-209-SD	TOT				38	44 J
PZ-210-SS	DIS				97	50 U
PZ-210-SS	TOT				63	95 J
PZ-210-SD	DIS				140	50 U
PZ-210-SD FD	DIS				220	
PZ-210-SD	TOT				630	110 J
PZ-210-SD FD	TOT				500	
PZ-211-SS	DIS				63	50 U
PZ-211-SS	TOT				64	50 J
PZ-211-SD	DIS				110	140
PZ-211-SD FD	DIS					150

Table 8-7: Summary of Barium Results in Groundwater - Aug. 2012 through Feb. 2014

Sample ID	Sample Fraction	Barium Aug 2012	Barium Apr 2013	Barium Jul 2013	Barium Oct 2013	Barium Feb 2014
PZ-211-SD	TOT				480	35 J
PZ-211-SD FD	TOT					35 J
PZ-212-SS	DIS				140	3 J
PZ-212-SS	TOT				150	110 J
PZ-212-SD	DIS				140	50 U
PZ-212-SD	TOT				140	130 J
PS-302-AS	DIS			390		
PS-302-AS	TOT			550		
PZ-302-AS	DIS				620	
PZ-302-AS	TOT				800	
PS-302-AI	DIS			350		
PS-302-AI	TOT			350		
PZ-302-AI	DIS	310	380		360	
PZ-302-AI	TOT	310	360		350	
PZ-303-AS	DIS	650	670	690	810	
PZ-303-AS	TOT	770	790	830	940	
PZ-304-AS	DIS	1,500	1,800	2,000	2,400	
PZ-304-AS	TOT	1,600	1,900	2,000	2,300	
PZ-304-AI	DIS	1,600	1,200	1,300	1,600	
PZ-304-AI FD	DIS				1,600	
PZ-304-AI	TOT	1,700	1,200	1,300	1,600	
PZ-304-AI FD	TOT				1,600	
PZ-305-AI	DIS	610	700	630	710	
PZ-305-AI FD	DIS		690			
PZ-305-AI	TOT	670	820	630 J-	640	
PZ-305-AI FD	TOT		930			
USGS-A5	DIS				130	
USGS-A5	TOT				130	
USGS-B3	DIS				570	
USGS-B3	TOT				620	
USGS-B4-S	DIS			360	390	
USGS-B4-S	TOT			380	410	
USGS-B4-D	DIS			670		
USGS-B4-D	TOT			670		
USGS-D1	DIS				230	
USGS-D1	TOT				230	
USGS-E1	DIS				250 U	
USGS-E1	TOT				250 U	

Notes: All values are in units of micrograms per liter (µg/L) FD = Field duplicate sample
Sample Fractions: DIS = Dissolved (filtered sample); TOT = Total (unfiltered sample)
Data Validation Qualifiers (Final Q) include: R = rejected U = non-detect at the reported value
UJ = non-detect at the estimated reported value
UJ+ = non-detect at the estimated reported value which may be biased high
UJ- = non-detect at the estimated reported value which may be biased low
J = estimated result J+ = estimated result which may be biased high
J- = estimated result which may be biased low

Table 8-8: Summary of Boron and Strontium Results in Groundwater - Aug. 2012 - Feb. 2014

Sample ID	Collection Date	Boron		Strontium	
S-5	10/7/2013	2300		220	
S-5	10/7/2013	3300		330	
S-8	10/1/2013	91	U	520	
S-8	10/1/2013	77		510	
S-10	10/1/2013	1300		1300	
S-10	10/1/2013	1200		1400	
S-53	10/15/2013	260	J+	370	
S-53	10/15/2013	230	U	420	
S-61	10/3/2013	ND	U	410	
S-61	10/3/2013	ND	U	450	
S-82	10/8/2013	2700		1300	
S-82	10/8/2013	2600		1300	J
S-84	10/9/2013	370	J+	570	
S-84	10/9/2013	410	J+	680	
S-84 FD	10/9/2013	400	J+	540	
S-84 FD	10/9/2013	340	J+	690	
I-4	10/7/2013	2700		260	
I-4	10/7/2013	2000		360	
I-9	10/8/2013	1400		1000	J
I-9	10/8/2013	1600		1100	
I-9 FD	10/8/2013	1400		1000	J
I-9 FD	10/8/2013	1600		1200	
I-11	10/1/2013	950		1400	
I-11	10/1/2013	990		1400	
I-62	10/1/2013	130		510	
I-62	10/1/2013	130		520	
I-65	10/15/2013	190	U	280	
I-65	10/15/2013	180	U	250	
I-66	10/9/2013	450		900	
I-66	10/9/2013	400	J+	1000	
I-67	10/3/2013	240		1300	
I-67	10/3/2013	250		1300	
I-67 FD	10/3/2013	250		1300	
I-67 FD	10/3/2013	250		1300	
I-68	10/4/2013	150		560	
I-68	10/4/2013	140		590	
I-73	10/3/2013	10000		3500	
I-73	10/3/2013	11000		3600	
D-3	10/7/2013	1600		970	
D-3	10/7/2013	1600		960	
D-6	10/8/2013	850		820	
D-6	10/8/2013	920		770	J
D-12	10/1/2013	1000		1300	

Table 8-8: Summary of Boron and Strontium Results in Groundwater - Aug. 2012 - Feb. 2014

Sample ID	Collection Date	Boron		Strontium	
D-12	10/1/2013	1000		1300	
D-13	10/7/2013	210	U	350	
D-13	10/7/2013	210		340	
D-14	10/15/2013	1800		730	
D-14	10/15/2013	1800		800	
D-81	10/3/2013	190		540	
D-81	10/3/2013	210		550	
D-83	10/8/2013	770		740	J
D-83	10/8/2013	700		780	
D-85	10/9/2013	270	J+	680	
D-85	10/9/2013	310	J+	780	
D-87	10/2/2013	1500		750	
D-87	10/2/2013	1500		750	
D-87 FD	10/2/2013	1500		750	
D-87 FD	10/2/2013	1500		740	
D-93	10/8/2013	1000		1100	J
D-93	10/8/2013	1000		1100	
LR-100	10/4/2013	2200		520	
LR-100	10/4/2013	2200		500	
LR-100 FD	10/4/2013	2100		500	
LR-100 FD	10/4/2013	2200		500	
LR-103	10/2/2013	230		730	
LR-103	10/2/2013	240		720	
LR-104	10/2/2013	75		710	
LR-104	10/2/2013	86		730	
MW-102	10/3/2013	130		800	
MW-102	10/3/2013	110		860	
MW-103	10/4/2013	110		550	
MW-103	10/4/2013	100		560	
MW-104	10/3/2013	92		1200	
MW-104	10/3/2013	150		1500	
MW-1204	10/11/2013	4100	J	14000	J
MW-1204	10/11/2013	4100	J	13000	J
PZ-100-KS	10/15/2013	620		3000	
PZ-100-KS	10/15/2013	630		3100	
PZ-100-SD	10/8/2013	ND	U	420	
PZ-100-SD	10/8/2013	ND	U	380	J
PZ-100-SS	10/8/2013	120	U	1600	
PZ-100-SS	10/8/2013	120		1600	J
PZ-101-SS	10/8/2013	820		2600	
PZ-101-SS	10/8/2013	870		2400	J
PZ-102R-SS	10/8/2013	180		1700	
PZ-102R-SS	10/8/2013	150	U	1500	J

Table 8-8: Summary of Boron and Strontium Results in Groundwater - Aug. 2012 - Feb. 2014

Sample ID	Collection Date	Boron		Strontium	
PZ-102-SS	10/8/2013	120		880	
PZ-102-SS	10/8/2013	100	U	820	J
PZ-103-SS	10/4/2013	340		6300	
PZ-103-SS	10/4/2013	330		6200	
PZ-104-KS	10/4/2013	100		2600	
PZ-104-KS	10/4/2013	110		2700	
PZ-104-SD	10/7/2013	700		670	
PZ-104-SD	10/7/2013	510		900	
PZ-104-SS	10/9/2013	140	U	1100	
PZ-104-SS	10/9/2013	140	U	1100	
PZ-105-SS	10/9/2013	58	U	770	
PZ-105-SS	10/9/2013	ND	U	760	
PZ-106-KS	10/11/2013	180	U	5400	
PZ-106-KS	10/11/2013	200	U	5300	
PZ-106-KS FD	10/11/2013	170		420	R
PZ-106-KS FD	10/11/2013	ND	R	5300	
PZ-106-SD	10/8/2013	69	U	1600	
PZ-106-SD	10/8/2013	78		1500	J
PZ-106-SS	10/7/2013	ND	U	750	
PZ-106-SS	10/7/2013	ND	U	730	
PZ-107-SS	10/3/2013	530		1500	
PZ-107-SS	10/3/2013	500		1500	
PZ-109-SS	10/9/2013	270	J+	3900	
PZ-109-SS	10/9/2013	250	J+	3600	
PZ-110-SS	10/8/2013	230	U	1200	
PZ-110-SS	10/8/2013	260		1100	J
PZ-111-KS	10/3/2013	1200		1700	
PZ-111-KS	10/3/2013	1200		1800	
PZ-111-SD	10/7/2013	58	U	1300	
PZ-111-SD	10/7/2013	59		1300	
PZ-112-AS	10/2/2013	920		1100	
PZ-112-AS	10/2/2013	930		1200	
PZ-113-AD	10/7/2013	1400		940	
PZ-113-AD	10/7/2013	1400		940	
PZ-113-AD FD	10/7/2013	1400		940	
PZ-113-AD FD	10/7/2013	1400		950	
PZ-113-AS	10/2/2013	300		650	
PZ-113-AS	10/2/2013	320		670	
PZ-113-SS	10/3/2013	ND	U	670	
PZ-113-SS	10/3/2013	ND	U	610	
PZ-114-AS	10/8/2013	170	U	570	
PZ-114-AS	10/8/2013	160		550	J
PZ-115-SS	10/8/2013	180	U	1800	

Table 8-8: Summary of Boron and Strontium Results in Groundwater - Aug. 2012 - Feb. 2014

Sample ID	Collection Date	Boron		Strontium	
PZ-115-SS	10/8/2013	210		1700	J
PZ-116-SS	10/11/2013	350	U	3500	
PZ-116-SS	10/11/2013	380		3700	
PZ-200-SS	10/2/2013	ND	U	610	
PZ-200-SS	10/2/2013	ND	U	590	
PZ-201A-SS	10/9/2013	ND	U	530	
PZ-201A-SS	10/9/2013	63	U	520	
PZ-202-SS	10/11/2013	ND	U	430	
PZ-202-SS	10/11/2013	ND	U	420	
PZ-203-SS	10/2/2013	87		660	
PZ-203-SS	10/2/2013	110		650	
PZ-204A-SS	10/8/2013	300	J+	1100	J
PZ-204A-SS	10/8/2013	340		1200	
PZ-204-SS	10/8/2013	77		1600	
PZ-204-SS	10/8/2013	60	U	1500	J
PZ-205-AS	10/15/2013	670		1700	
PZ-205-AS	10/15/2013	630		1600	
PZ-205-SS	10/9/2013	79	U	490	
PZ-205-SS	10/9/2013	66	U	510	
PZ-206-SS	10/7/2013	130		3900	
PZ-206-SS	10/7/2013	120	U	4100	
PZ-207-AS	10/4/2013	1500		680	
PZ-207-AS	10/4/2013	1500		710	
PZ-208-SS	10/8/2013	ND	U	480	
PZ-208-SS	10/8/2013	ND	U	670	J
PZ-209-SD	11/7/2013	160	U	1000	
PZ-209-SD	11/7/2013	140		1200	
PZ-209-SS	11/7/2013	190	U	2700	
PZ-209-SS	11/7/2013	170		2900	
PZ-210-SD	11/6/2013	460		1700	
PZ-210-SD	11/6/2013	590		2400	
PZ-210-SD FD	11/6/2013	550		1800	
PZ-210-SD FD	11/6/2013	490		2200	
PZ-210-SS	11/7/2013	120		1200	
PZ-210-SS	11/7/2013	120	U	1200	
PZ-211-SD	11/6/2013	170		1000	
PZ-211-SD	11/6/2013	270		2400	
PZ-211-SS	11/7/2013	380		3600	
PZ-211-SS	11/7/2013	390		3700	
PZ-212-SD	11/7/2013	93		440	
PZ-212-SD	11/7/2013	84	U	440	
PZ-212-SS	11/7/2013	120	U	3200	
PZ-212-SS	11/7/2013	130		3200	

Table 8-8: Summary of Boron and Strontium Results in Groundwater - Aug. 2012 - Feb. 2014

Sample ID	Collection Date	Boron		Strontium	
PZ-302-AI	10/3/2013	430		720	
PZ-302-AI	10/3/2013	440		700	
PZ-302-AS	10/8/2013	390		1400	J
PZ-302-AS	10/8/2013	380		1400	
PZ-303-AS	10/4/2013	290		990	
PZ-303-AS	10/4/2013	290		990	
PZ-304-AI	10/1/2013	740		1200	
PZ-304-AI	10/1/2013	740		1200	
PZ-304-AI FD	10/1/2013	750		1200	
PZ-304-AI FD	10/1/2013	750		1200	
PZ-304-AS	10/1/2013	1900		1600	
PZ-304-AS	10/1/2013	1900		1700	
PZ-305-AI	10/2/2013	64		970	
PZ-305-AI	10/2/2013	69		1000	
Note: All values are in units of ug/L.					