RECORD OF DECISION AMENDMENT

WEST LAKE LANDFILL SITE
BRIDGETON, MISSOURI
OPERABLE UNIT 1

September 2018

Prepared by:

U.S. Environmental Protection Agency
Region 7
Lenexa, Kansas

RECORD OF DECISION AMENDMENT
WEST LAKE LANDFILL SITE, OPERABLE UNIT 1
BRIDGETON, MISSOURI

TABLE OF CONTENTS

PART III: RESPONSIVENESS SUMMARY (Under Separate Cover)

FIGURES

TABLES

APPENDICES

ABBREVIATIONS & ACRONYMS

The following is a list of the abbreviations and acronyms used in this document:

General

AEA	Atomic Energy Act
AEC	U.S. Atomic Energy Commission
AMSL	Above mean sea level
AOC	Administrative Order on Consent
AR	Administrative Record
ARAR	Applicable or Relevant and Appropriate Requirement
ATSDR	Agency for Toxic Substances and Disease Registry
BMAC	Bridgeton Municipal Athletic Complex
BMP	Best management practice
BRA	Baseline Risk Assessment
BTV	background threshold values
CAG	West Lake Landfill Community Advisory Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIP	Community Involvement Plan
C.F.R.	Code of Federal Regulations
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
CSM	Conceptual Site Model
C.S.R.	Code of State Regulations
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
EVOH	Ethylene Vinyl Alcohol
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Administration
FFS	Final Feasibility Study
FS	Feasibility Study
FUSRAP	Formerly Utilized Sites Remedial Action Program
GCPT	Gamma Cone Penetration Testing
GRA	General response actions
HI	Hazard Index
HQ	Hazard Quotient
IMP	Incident Management Plan
LSBR	Leached Barium Sulfate Residues
MCL	Maximum Contaminant Level

MDHSS	Missouri Department of Health and Senior Services
MDNR	Missouri Department of Natural Resources
MSD	St. Louis Municipal Sewer District
MECA	Missouri Environmental Covenants Act
MSD	St. Louis Metropolitan Sewer District
NCC	Non-combustible cover
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
NORM	Naturally Occurring Radioactive Material
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NRRB	National Remedy Review Board
O&M	Operation and Maintenance
OM&M	Operation, Monitoring and Maintenance
OU	Operable Unit
pH	Potential of hydrogen
PRPs	Potentially Responsible Parties
PRG	Preliminary Remediation Goal
PTW	Principal Threat Waste
RA	Remedial Action
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RECA	Radiation Exposure Compensation Act
RfD	Reference Dose
RI	Remedial Investigation
RIA	Remedial Investigation Addendum
RIM	Radiologically Impacted Material
RME	Reasonable Maximally Exposed
ROD	Record of Decision
RWMM	Radioactive Waste Management Manual
SARA	Superfund Amendments and Reauthorization Act
SBLT	Sequential Batch Leaching Test
SFS	Supplemental Feasibility Study
Site	West Lake Landfill Superfund Site
SLERA	Screening Level Ecological Risk Assessment
SSE	Subsurface smoldering event
SVOC	Semi-volatile organic compound
TAL	Target Analyte List
TCAG	Technical Committee of the West Lake Landfill Community Advisory Group
TCLP	Toxicity characteristic leaching procedure

UCL	Upper confidence limit
UMTRCA	Uranium Mill Tailings Radiation Control Act
USACE	U.S. Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UU/UE	Unlimited Use and Unrestricted Exposure
VOC	Volatile organic compound

Chemicals

CO_2	Carbon dioxide
PCBs	Polychlorinated biphenyls
Ra-226	Radium-226
Ra-228	Radium-228
Rn-222	Radon-222
Th-232	Thorium-232
Th-230	Thorium-230
U-238	Uranium-238
U-235	Uranium-235
U-234	Uranium-234

Units of Measure

bcy	Bank Cubic Yards
bgs	Below Ground Surface
cm	Centimeter
ft\amsl	Feet Above Mean Sea Level
m^2	Square Meter
pCi/g	Picocuries per gram
pCi/L	Picocuries per Liter
ppm	Parts per Million
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
mrem	Millirem
sec	Second
µg/L	Micrograms per Liter
yd^3	Cubic Yards

PART I. DECLARATION

1.0 Site Name and Location

West Lake Landfill Site
Operable Unit 1
Bridgeton, Missouri
EPA Superfund Site Identification Number: MOD079900932

2.0 Statement of Basis and Purpose

This decision document presents the Amended Remedy for Operable Unit 1 (OU-1) of the West Lake Landfill Site (Site) in Bridgeton, Missouri, which was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), 42 U.S.C. § § 9601 et seq., and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. Part 300. Figures 1 through 4 depict the approximate boundaries of the Site. This decision is based on the Administrative Record (AR) for OU-1 of the Site. This Amendment fundamentally alters the remedy selected in the 2008 Record of Decision for OU-1 (2008 ROD) with respect to scope, performance and cost.

3.0 Rationale for Change in Remedy

As a result of stakeholder and community concerns following the 2008 ROD, the U.S. Environmental Protection Agency determined that further evaluation of remedial alternatives was warranted and required the Potentially Responsible Parties (PRPs) to conduct additional investigations and feasibility studies and update the baseline risk assessment (BRA). Based on the results of those investigations and evaluations, as well as consideration of the comments received on the February 2018 Proposed ROD Amendment (Proposed Plan), the EPA has determined that a fundamental change to the 2008 ROD is appropriate. The basis for this decision is detailed in Part II of this ROD Amendment. In summary, the Amended Remedy is based upon the following:

- A better understanding of the volume, concentration and location of radiologically impacted material (RIM)[1] at the Site that may present an unacceptable risk;
- New information regarding the potential for RIM to leach under certain circumstances;
- Concern that, should a subsurface heating event occur in OU-1, the heat could dry and desiccate a cap, providing a conduit for increased release of radon from the subsurface and potentially for the leaching of RIM; and
- A determination that implementation of the 2008 ROD could not be accomplished without disturbance of both putrescible waste and RIM.

[1] As discussed further in Section 5.5 of Part II, definitions of RIM were developed for radium, thorium and uranium isotopes which are the primary radionuclides of concern at the Site. The EPA has defined RIM as any waste material containing combined radium (Ra-226 plus Ra-228) or combined thorium (Th-230 plus Th-232) at levels greater than 5 pCi/g above background (i.e., 7.9 pCi/g combined thorium for the Site), or total uranium (U-238 plus U-235 plus U-234) at levels greater than 50 pCi/g above background (i.e., 52.9 pCi/g combined uranium for the Site).

This Amended Remedy and all documents that form the basis for the decision to modify the 2008 ROD will be added to the AR file for the Site as required by 40 C.F.R. § 300.825(a)(2). The AR has been developed in accordance with Section 113(k) of CERCLA and the NCP, and is available for public review at the EPA's regional office at 11201 Renner Boulevard in Lenexa, Kansas, and online at the following URL:

https://www.epa.gov/superfund/westlakelandfill

The Missouri Department of Natural Resources (MDNR), acting on behalf of the state of Missouri, concurs with the Amended Remedy. The state's concurrence letter is attached as Appendix A.

4.0 Assessment of the Site

Currently, there are no unacceptable risks from exposure to site-related contaminants for on-site workers or the community, partially due to access restrictions and fences currently in place that restrict the use and access of Area 1 and Area 2. The response actions set forth in this ROD Amendment are necessary to protect the public health or welfare or the environment from future actual or threatened releases of hazardous substances into the environment.

5.0 Description of the ROD, as Amended

The Site is composed of three OUs. OU-1, which is the subject of this Amended Remedy, contains the radiologically contaminated areas and is comprised of the following sub-areas: Radiological Area 1 (Area 1), Radiological Area 2 (Area 2), Buffer Zone and Lot 2A2 of the Crossroads Property (See Figure 2). In 2008, the EPA selected a capping remedy for OU-1, but implementation of that remedy has been postponed since 2008. Other actions have been taken in OU-1 since 2008, including the installation of a non-combustible cover (NCC) over portions of Area 1 and Area 2, development and implementation of an Incident Management Plan (IMP), installation of engineering controls and other active measures in the North Quarry of the Bridgeton Landfill due to the presence of the subsurface heating event, and on-site and perimeter air monitoring at the Site. OU-2 contains non-radiologically contaminated areas and is comprised of the following landfills: Closed Demolition Landfill, Former Active Sanitary Landfill, and Inactive Sanitary Landfill. In 2008, the EPA selected a remedy for OU-2 that included a deferral of the oversight of the Closed Demolition Landfill and the Former Active Sanitary Landfill (Bridgeton Landfill) to the MDNR. The EPA is the lead regulatory agency for oversight of the implementation of the 2008 ROD Selected Remedy at the Inactive Sanitary Landfill which has been postponed since 2008. OU-3 covers sitewide groundwater. A remedial investigation (RI), and if appropriate a feasibility study (FS), are currently in the planning stages for OU-3.

This Amended Remedy fundamentally changes the 2008 ROD Selected Remedy for OU-1, and addresses the portions of the West Lake Landfill that are contaminated with radiologically impacted soils and landfilled waste through a combination of excavation and placement of an engineered cover. In the Proposed Plan, the EPA requested public comment on all of the proposed alternatives, and specifically solicited comment on the depth and concentration criteria and disposal options. As discussed in the Decision Summary, the EPA received comments on all alternatives, including numerous comments on the Proposed Plan Preferred Remedy, Alternative 4, as well as on the specific criteria and disposal options. In response to this new information, the EPA's Amended Remedy is a modification of the Alternative 4 presented in the Proposed Plan. The Amended Remedy includes:

- Excavation and stockpiling of overburden in OU-1 Radiological Areas 1 and 2 to access the RIM;

- Excavation of RIM from the Areas 1 and 2 of OU-1 that contains combined radium or combined thorium activities greater than 52.9 pCi/g that is located generally within 12 feet of the 2005 topographic surface. Optimization of RIM removal above and below the 12-foot target depth (excavation as deep as 20 feet or as shallow as 8 feet) will be performed during the remedial design (RD) based on criteria set forth in Section 12.0;

- Excavation of radiologically impacted soil from the Buffer Zone and/or Lot 2A2 sufficient to reduce concentrations of radionuclides to background in order to allow for unlimited use and unrestricted exposure (UU/UE);

- Loading and transport of the RIM and radiologically impacted soil for disposal at an off-site permitted disposal facility;

- Regrading of the remaining solid waste materials within Areas 1 and 2 to meet the minimum (5%) and maximum (25%) slope criteria;

- Installation of a landfill cover over Areas 1 and 2 designed to meet the Resource Conservation and Recovery Act (RCRA) hazardous waste design criteria, municipal waste landfill regulations, and Uranium Mill Tailings Radiation Control Act (UMTRCA) performance and longevity standards;

- Design, installation, and maintenance of surface water runoff controls;

- Groundwater monitoring;

- Landfill gas and radon monitoring and control, in accordance with applicable or relevant and appropriate requirements (ARARs);

- Institutional controls (ICs) to prevent land uses that are inconsistent with a closed landfill containing radiological materials; and

- Long-term surveillance and maintenance of the landfill cover in Areas 1 and 2 and other remedial components.

6.0 Statutory Determinations

The Amended Remedy is protective of human health and the environment, complies with federal and state ARARs, is cost effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

The Amended Remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. Treatment is not practicable because of the large volume of contaminated media (309,700 bank cubic yards (bcy) of RIM and 1,821,000 bcy of non-RIM wastes), the heterogeneous nature of the landfill, and the limited effective treatment technologies available for radionuclides.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on portions of the Site above levels that allow for UU/UE, a statutory review will be conducted within five years after the initiation of the remedial action (RA) to ensure the remedy is, or will be, protective of human health and the environment. These five-year reviews will be conducted no less than every five years until the Site is considered appropriate for UU/UE.

7.0 ROD Amendment Data Certification Checklist

The following information and relevant updates are included in this ROD Amendment. Additional documents that form the basis for the decision to modify the 2008 ROD can be found in the AR for OU-1 of the Site.

- Contaminants of concern (COCs) and their respective concentrations, p. 32;
- Baseline risks represented by the COCs, Tables 19 through 22;
- Cleanup levels established for COCs, and the basis for these levels, p. 39;
- How source materials constituting principal threats are addressed, p. 80;
- Current and reasonably anticipated future land use assumptions used in the BRA and ROD Amendment, p. 29;
- Potential land and groundwater use that will be available at the Site after implementation of the Amended Remedy, p. 73;
- Estimated capital, annual operation, monitoring and maintenance (OM&M), and total present net worth costs, discount rate, and the number of years over which the remedy costs are projected, p. 73; and
- Key factors that led to amending the 2008 ROD (i.e., how the Amended Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision, etc.), p. 62.

8.0 Authorizing Signatures

This Amended Remedy will amend the remedy selected in the 2008 ROD for OU-1 at the West Lake Landfill Site in Bridgeton, Missouri. This Amended Remedy was selected by the EPA with concurrence from the MDNR.

Andrew R. Wheeler
Acting Administrator

9-27-18
Date

PART II. DECISION SUMMARY

1.0 Introduction to the Site and Statement of Purpose

1.1 Site Name, Location, and Description

The Site is a 200-acre, inactive solid waste disposal facility with a physical address of 13570 St. Charles Rock Road in Bridgeton, Missouri. The Site previously received radiologically contaminated materials from the processing of uranium ore for the Manhattan Engineering District and the U.S. Atomic Energy Commission (AEC), in addition to receiving municipal and demolition waste. The Site lies 18 miles northwest of downtown St. Louis in northwestern St. Louis County, approximately one mile north of the intersection of Interstate-70 and Interstate-270, and approximately one and three quarters (1.75) miles west-northwest of the St. Louis Lambert International Airport (Figure 1). The present channel of the Missouri River is located approximately one and a half (1.5) miles to the west of the Site, which is situated on the eastern boundary of the river's alluvial floodplain. Industrial properties exist both on and adjacent to the Site, and commercial and residential properties are located around and near its perimeter.

The EPA is the lead agency for the Site and the MDNR is the support agency. The Site is composed of three OUs (Figure 2). OU-1, which is the subject of this ROD Amendment, is comprised of the following sub-areas (Figure 3):

- Radiological Area 1 (Area 1) – This area was associated with landfill operations conducted at the Site prior to the commencement of state regulations in 1974. Radionuclides are contained within and on soils and waste materials that have become interspersed with the overall landfill matrix. The southwestern portion of Area 1 is overlain by the "muffin top" or "mound," which includes 40 to 45 feet of newer, non-RIM containing, waste materials, which were placed above-grade between 2002 and 2004 as part of the North Quarry portion of the Bridgeton Landfill (Figure 3). Some areas contaminated with RIM are as deep as 85 feet in this area due to the disposal of this newer waste material.

- Radiological Area 2 (Area 2) – This area, located in the northern portion of the Site, was also associated with unregulated landfill operations conducted prior to commencement of state regulations in 1974. Radionuclides are contained within and on soils and other materials that have become interspersed with the overall landfill matrix.

- Buffer Zone – This relatively small triangle-shaped property is located near the northwestern corner of the Site. This property was acquired by the landfill operators in 2001 after it was discovered that radiologically contaminated soils had eroded and migrated from the Area 2 landfill berm.

- Lot 2A2 – This property is located immediately north-northeast of the Buffer Zone. This privately owned commercial property is also impacted by radiologically contaminated soils that eroded and migrated from the Area 2 landfill berm.

A ROD for OU-2 was signed by the EPA on July 25, 2008. OU-2 is comprised of the following sub-areas (Figure 3):

- Closed Demolition Landfill – This former landfill is located between Areas 1 and 2, bordered on the northwest by Area 2 and on the southwest by Area 1. This landfill reportedly received municipal solid waste during the unregulated landfill operations and was subsequently permitted by the MDNR to receive demolition debris and other items. This landfill cell stopped accepting new waste materials in 1995.

- Inactive Sanitary Landfill – This former landfill is located on the west side of the Site, south of the western end of Area 2, and was part of the unregulated landfill operations conducted prior to the commencement of state regulations in 1974. This landfill is reported to have received sanitary wastes and a variety of other solid/liquid wastes and demolition debris.

- Former Active Sanitary Landfill – This former municipal solid waste landfill, also known as the Bridgeton Landfill, is located on the southern and eastern portions of the landfill complex. It was operated under various state permits. This landfill includes the Bridgeton North and South Quarries, which ceased accepting waste in 2004. As stated above, municipal solid waste was placed above-grade over a portion of OU-1, in the North Quarry, and now covers the southwestern portion of Area 1. A subsurface smoldering event in the South Quarry portion of Bridgeton Landfill, first discovered in late 2010, is ongoing.

Consistent with agency policy, the EPA deferred oversight of the Closed Demolition Landfill and the Former Active Sanitary Landfill (Bridgeton Landfill) to the MDNR. As stated in the 2008 OU-2 ROD, "[s]uccessful completion of [Missouri's closure and post-closure care] requirements would eliminate the need for further CERCLA action at these units." The EPA is the lead regulatory agency for oversight of the implementation of the OU-2 Remedy at the Inactive Sanitary Landfill that has been postponed since 2008.

Sitewide groundwater is being investigated under a separate operable unit, designated as OU-3. In 2008, the EPA considered source-control measures adequately protective of groundwater, stating that the OU-1 and OU-2 RODs "complete the CERCLA decision-making for the Site." This ROD Amendment, however, recognizes that an RI is needed to determine the nature and extent of site-related groundwater contamination. The EPA expects the RI and, as necessary, an FS, for OU-3 will be performed pursuant to an Administrative Settlement Agreement and Order on Consent executed by the EPA, Bridgeton Landfill, LLC, Cotter Corporation (N.S.L.), and the U.S. Department of Energy (DOE).

1.2 Basis for the ROD Amendment

As a result of stakeholder and community concern following the 2008 ROD, the EPA determined that further evaluation of remedial alternatives was warranted, and so required the PRPs to conduct additional investigations and feasibility studies and update the BRA. Based on the results of those investigations and studies, as well as consideration of the comments received on the February 2018 Proposed Plan to amend the OU-1 Remedy, the EPA has determined that a fundamental change to the 2008 ROD is appropriate. The basis for this decision is described below.

1.2.1 2008 ROD Waste Disturbance

In 2010, the EPA required the PRPs to prepare a Supplemental Feasibility Study (SFS) to further evaluate off-site, as well as, on-site disposal of all RIM. The SFS was completed in December 2011. The SFS evaluated three remedial alternatives: (1) the remedy selected in the 2008 ROD; (2) "complete rad removal" with on-site disposal; and (3) "complete rad removal" with off-site disposal. The SFS concluded that each alternative was implementable and would meet the EPA's criteria for long-term protection of human health, welfare, and the environment, provided the design and implementation of the 2008 ROD cap was altered.

The modification to the 2008 cap design generally would have required changing the angle of the outer slopes of the landfill berms to accommodate the installation of the cap within the property boundary since the property surrounding the Site is heavily developed with commercial businesses and major roadways, effectively preventing expansion of Site boundaries to accommodate the 2008 ROD cap. These slope changes would have required significant excavation and disturbance of landfill waste (112,000 bcy), including RIM (15,000 bcy). The required excavation of RIM and non-RIM wastes for the Modified 2008 ROD Alternative significantly alters the nine criteria, especially consideration of short-term effectiveness. Therefore, subsequent to the selection of the 2008 ROD Selected Remedy, it was determined that the remedy would have many of the negative short-term impacts associated with excavation without achieving the long-term permanence benefits of source removal. This Modified 2008 ROD Selected Remedy (Alternative 2) was fully evaluated in the Final Feasibility Study (FFS), completed in 2018. While Alternative 2 is still the least expensive and takes the shortest amount of time to implement, with the exception of the No Action Alternative, the balance between short-term effectiveness and long-term effectiveness is improved by a partial excavation remedy.

1.2.2 RIM Characterization

Since the SFS, additional data has been collected to further characterize the nature and extent of RIM at the Site. In February 2012, the EPA Region 7 consulted with the National Remedy Review Board (NRRB) regarding the updated remedial alternatives in the SFS. The NRRB was established to help control remedy costs and to promote consistent and cost-effective remedy decisions. Based upon comments generated during that consultation, the EPA determined additional studies were necessary, including additional characterization of the volume and location of RIM, as well as consideration of full and partial excavation scenarios.

The EPA directed the PRPs to perform a series of field investigations between 2013 and 2015 to further characterize the location of RIM in OU-1. These investigations were undertaken in further response to the NRRB recommendations, and the results were also used to evaluate possible locations and other considerations associated with the construction of engineering controls between the North Quarry of Bridgeton Landfill and Area 1 of OU-1 to address the heating event in the South Quarry. During these investigations, RIM was identified under a portion of the North Quarry "muffin top" or "mound," which is an area southwest of previously identified RIM locations in the RI, but within an area with elevated radioactivity previously identified based on early aerial gamma survey. Additional solid wastes were placed in this area as a part of the closure activities in the North Quarry. At the EPA's direction, the investigation scope was expanded to define the extent of RIM in southern portions of Area 1. The Phase 1A, 1B, 1C, and 1D investigations included a total of 104 new boring and gamma cone penetration testing (GCPT) locations.

The 2008 ROD stated that partial excavation of RIM rests on more assumptions and greater uncertainties than the capping only alternatives. In particular, the 2008 ROD noted it was not certain that discrete portions of waste material consisting of a disproportionately greater share of the radionuclide content could be located and recovered. Since 2008, the EPA performed additional RIM characterization and developed a geostatistical model of RIM. The EPA has concluded, based on all the data collected at the Site, that partial excavation of elevated concentrations of radioactive waste is practicable in certain areas and would result in a significant reduction in the long-term threat posed by the Site.

Typical municipal landfills do not contain wastes that will greatly increase in toxicity over a significant time period, like will occur at this Site where thorium will decay to radium over the next 9,000 years. Therefore, based upon the additional information collected and studies performed since 2008, the EPA has determined that the West Lake Landfill is not a typical municipal landfill and no longer considers the presumptive remedy of containment alone to be appropriate for the Site due to the toxicity of the RIM, the potential of the RIM to leach, and the increasing risks due to radioactive decay.

1.2.3 Groundwater Monitoring and Leaching Evaluation

Also in response to the NRRB consultation, the EPA directed the PRPs to perform additional groundwater sampling at the Site to supplement data previously collected and presented in the original RI and FS for OU-1. Over 300 groundwater samples from approximately 80 monitoring wells were collected and analyzed between 2012 and 2014, including samples from 8 new monitoring wells installed in 2013. The groundwater samples were analyzed for multiple contaminants, including thorium, uranium, and radium isotopes; trace metals; and volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs).

In addition to requiring further groundwater sampling, the EPA also obtained technical support from the U.S. Geological Survey (USGS) for hydrogeologic evaluations. Between 2012 and 2014, the USGS supported groundwater evaluations by the EPA, including identification of water supply wells, sample collection, data reviews, scientific studies, and data interpolations. The results of this work are documented in a report issued by the USGS on December 17, 2014, as updated on June 10, 2015.[2] The study documented leachate effects in 47 of 83 on-site wells. In 13 wells, the average dissolved combined radium was above the maximum contaminant level (MCL) with average concentrations ranging between 5.1 to 26.7 pCi/L. These concentrations are higher than previously reported in the 2008 ROD. The USGS report hypothesizes four sources of above-MCL radium at the Site, namely: (1) leaching of RIM; (2) radium within the range of natural background; (3) leaching from non-RIM wastes; and (4) mobilization of naturally occurring radionuclides due to landfill leachate. Based in part upon these findings, the EPA is initiating an additional investigation of sitewide groundwater under OU-3.

In 2015, the PRPs performed Toxicity Characteristic Leachate Procedure (TCLP) tests, sequential extraction tests, and sequential batch leaching tests (SBLT), all of which indicated that RIM from site-specific samples can leach under laboratory conditions intended to simulate landfills. The sequential extraction tests were designed to determine what specific mineral phases in RIM contained the radionuclides, and the SBLT were designed to determine if chemical constituents, namely site-related radionuclides, could leach from RIM under conditions similar to those found in a mature landfill. While these tests on RIM samples were originally performed as part of a fate and transport study that was not finalized, the leaching tests were completed. The analytical results are valid and show that radionuclides did leach from RIM samples from the Site and continued to leach in appreciable amounts through the final leaching steps in a number of the individual RIM sample tests. j

The 2008 ROD also concluded that there was no evidence of leaching; hever, the subsequent leaching tests do provide evidence of the potential for RIM to leach. Thorium-230 (Th-230) in RIM will continue to decay to Radium-226 (Ra-226), which is more readily leachable than thorium. The associated energy released during this process (emission of an alpha particle) can damage the mineral structure, which can

[2] *Background Groundwater Quality, Review of 2012–14 Groundwater Data, and Potential Origin of Radium at the West Lake Landfill Site, St. Louis County, Missouri*.

also increase the leachability of radionuclides such as Ra-226 in the future. As a result, the agency has concluded that there is evidence of leachability of RIM under conditions simulating those in a mature landfill, the increased detections of radium in groundwater since 2008, and the expected 9,000-year ingrowth of Ra-226.[3]

1.2.4 Subsurface Heating Event in Bridgeton Landfill

Near the end of the life of the Bridgeton Landfill, wastes in the North Quarry landfill cell were placed above grade, which expanded the cell over portions of Area 1 of OU-1. Subsequent to the issuance of the 2008 ROD, in December 2010, Bridgeton Landfill detected changes in the gas extraction system that indicated the presence of an exothermic (heat-generating) subsurface heating event[4] in the South Quarry portion of the Bridgeton Landfill (Figure 4). This landfill was operated under various state permits, and includes areas referred to as the Bridgeton North and South Quarries which ceased accepting waste in 2004. This ongoing event has produced elevated temperatures and excess carbon monoxide within the Bridgeton Landfill and offensive odors in the vicinity of the landfill.

Since 2010, the EPA and the MDNR have implemented a series of actions to better understand and address these Site conditions. In an effort to prevent the subsurface heating event from impacting RIM in OU-1, the EPA reached an agreement with Bridgeton Landfill, LLC to install a system of engineering controls at the Site in the North Quarry portion of Bridgeton Landfill. These measures have been designed to both monitor and control the subsurface reaction, thus reducing the unlikely chance of the subsurface heating event moving from the South Quarry of the Bridgeton Landfill, through the North Quarry, into OU-1 of the West Lake Landfill. Measures taken include a heat extraction system, lines of temperature monitoring probes, and an ethylene vinyl alcohol (EVOH) cover.

In addition, several evaluations were conducted from 2014 to 2018 on the potential impacts of a hypothetical heating event in OU-1. These evaluations considered the potential for a heating event to cause impacts such as surface desiccation and cracks, the potential for particulate releases, increased settlement and associated damage to a cap, an increase in radon gas production, and an increase in leachate production. Based on these evaluations, it was determined that it is unlikely that a new reaction could occur within or extend into either Areas 1 or Area 2 of OU-1, in part due to the age and the degree of decomposition of the waste materials, the relatively thin nature of the OU-1 waste cells, and the existing physical setting/conditions in Areas 1 and 2. However, it was also determined that if a subsurface heating event were to occur in an area with radioactive material, this could cause an increase in the release of radon. The EPA evaluated the potential exposures to this radon, and determined the risks are not anticipated to exceed the acceptable risk range (Appendix E of the FFS, January 26, 2018). A subsurface heating event could cause subsidence and cracking of the cover and an increase in leachate formation (Black and Veatch, February 2, 2018), both of which could eventually cause impacts to groundwater if not routinely maintained/repaired and controlled, respectively.

Based upon the various evaluations, the EPA has concluded that due to the age and the degree of decomposition of the waste materials, the relatively thin nature of the OU-1 waste cells, and the existing physical setting/conditions in Areas 1 and 2, the potential for a subsurface hearing event to occur within,

[3] The maximum level of radium detected in groundwater during the post 2008 investigations was 77.05 pCi/L, compared to the drinking water MCL value of 5 pCi/L.
[4] The exothermic reaction, which was detected in the South Quarry portion of the Bridgeton Landfill in 2010, has been previously referred to as a subsurface reaction (SSR), a subsurface smoldering event (SSE), and a subsurface event. Throughout this document the reaction will be referred to as the subsurface heating event.

or extend into, either Areas 1 or 2 is considered low. However, in the unlikely event that a subsurface heating event did move into or occur in OU-1, it could result in increased levels of radon flux, cracks, fissures, or other damage to the cap based on subsidence, or increased leachate production. The EPA has concluded that removal of some RIM from the landfill would help mitigate negative impacts of a subsurface heating event. Removing RIM from immediately below the cap would limit exposures from radon, gamma, and direct contact if the cap was damaged by the heat and subsidence. If a subsurface heating event were to create additional leachate, removing a majority of the radioactive source material would reduce the amount of source material available to leach to the groundwater in the future.

1.2.5 Conclusion

The 2008 ROD stated that partial excavation of RIM rests on more assumptions and greater uncertainties than the capping only alternatives. In particular, the 2008 ROD noted it was not certain that discrete portions of waste material consisting of a disproportionately greater share of the radionuclide content could be located and recovered. Since 2008, the EPA performed additional RIM characterization and developed a geostatistical model of RIM. The EPA has concluded, based on all the data collected at the Site, that excavation of areas with elevated concentrations of radioactive waste is practicable and would result in a significant reduction in the long-term threat posed by the Site.

Based on the foregoing considerations, the EPA has determined that existing conditions warrant a partial removal of RIM from the Site. The information obtained from the additional investigation and studies is contained in the Remedial Investigation Addendum (RIA) and FFS reports. These reports, along with other documents that form the basis of the EPA's decision, are part of the AR for the Site.

2.0 Site History and Enforcement Activities

Because this is an amendment to the 2008 ROD, Site history prior to 2008 is only briefly summarized in this section and the timeline below. Detailed historical information can be found in the January 2018 RIA, the February 2018 Proposed Plan and the AR.

Areas of the Site were radiologically contaminated in 1973 when soil mixed with leached barium sulfate residues (LBSR) was used as cover for landfilling operations at the West Lake Landfill. The soil, mixed with LBSR, was relocated to the West Lake Landfill from a storage and processing facility located on Latty Avenue in Hazelwood, Missouri, which was operated under license from the AEC. The U.S. Nuclear Regulatory Commission (NRC), as successor to the AEC, conducted investigations at the Site in June and August of 1976. The NRC concluded that approximately 43,000 tons of waste and soil were disposed under about 3 feet of other soil at the West Lake Landfill. The NRC subsequently commissioned a radiological study of the West Lake Landfill that confirmed the presence of two distinct radiological areas at the Site. The EPA added the Site to the National Priorities List (NPL) in 1990.

On March 3, 1993, the EPA entered into an Administrative Order on Consent (AOC) with four PRPs for performance of an RI/FS for OU-1. Those PRPs are Laidlaw Waste Systems (Bridgeton), Inc.; Rock Road Industries, Inc.; Cotter Corporation (N.S.L.); and the DOE. Between 1994 and 2006, the PRPs performed multiple investigations at the Site, including the collection and analysis of waste and soil samples and the monitoring of surface water, sediments, groundwater, and air quality.

The results of these evaluations were summarized in an RI, BRA, and FS. Based on these reports, the EPA issued a Proposed Plan for OU-1 and OU-2 in June 2006, and in May 2008 selected a remedial action for OU-1 in a ROD. The major components of the 2008 ROD included the installation of a landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills, including enhancements such as an armoring layer and radon barrier consistent with achieving the standards for uranium mill tailing sites. As part of the remedy, radiologically contaminated surface soils from the Buffer Zone and Lot 2A2 of the Crossroads Industrial Park were to be consolidated into the containment area. In addition, a program for monitoring and control of groundwater, surface water runoff, radon and decomposition gases would have been implemented. ICs and long-term surveillance were also included in the 2008 ROD to ensure appropriate future land use and ongoing maintenance.

While the PRPs and the EPA initiated RD/RA negotiations through the summer and fall of 2008, elected representatives, community groups, and concerned citizens began directing correspondence to the Office of the Administrator voicing objections to the 2008 ROD Selected Remedy. In a memorandum dated May 21, 2009, the EPA's Office of Superfund Remediation and Technology Innovation communicated to Region 7 several recommendations for consideration during RD to enhance the protectiveness of the Amended Remedy.

The PRPs and Region 7 met on January 8, 2010, after which the EPA transmitted a letter to the PRPs on January 11, 2010, requesting the preparation of a SFS consisting of an engineering and cost analysis of remedial alternatives that would remove all radioactive waste from the radiologically contaminated areas. The PRPs submitted an SFS Work Plan to the EPA on January 28, 2010, which was approved by the agency on May 21, 2010, after comment from both the EPA and the MDNR. The EPA received the final revised SFS Work Plan in June 2010 and a draft SFS Report in July. The EPA received and subsequently approved a final version of the SFS Report in September 2011 with requested change pages submitted in December 2011. After the PRPs completed the SFS in December 2011, due to the cost of the alternatives evaluated in the SFS, Region 7 consulted with the EPA's NRRB.

The NRRB's review and subsequent comments (see Appendix B) included recommendations that Region 7 perform additional groundwater evaluation; accurately characterize location and volume of RIM including options to address it; recalculate volume of RIM to be removed using a future industrial/commercial use assumptions; address consistency with CERCLA and NCP for principal threat waste at the Site; develop a sorting and removal alternative using performance standards for the excavation; reconsider treatment alternatives; re-evaluate short-term effectiveness to include mitigative measures during implementation but exclude consideration of constrained funding; reevaluate long-term effectiveness to include environmental justice and alternative engineered cover designs; consider several comments on; and recalculate cost of the containment alternative to include perpetual operation and maintenance.

In December 2017, Region 7 submitted materials to the NRRB in preparation for the January 9, 2018 NRRB meeting. As part of the package sent to the NRRB, Region 7 included a summary of actions taken to respond to the 2012 NRRB consultation. After the meeting, the NRRB provided Region 7 with further comments and recommendations on January 26, 2018 (see Appendix C). Region 7 responded on February 5, 2018, noting where certain recommendations were addressed or documented, agreeing to address other certain recommendations in RD, responding as to whether identified regulations were ARARs, and noting that the Proposed Plan requested comments on the selection of different depths and concentrations between Areas 1 and 2 (see Appendix C). On February 6, 2018, the EPA issued its Proposed Plan for OU-1 setting forth its proposal to amend the 2008 ROD.

A brush fire occurred on a portion of OU-2 on October 24, 2015. Following this surface fire, on December 10, 2015, the EPA issued a Unilateral Administrative Order (UAO) directing the private PRPs to develop and implement surface fire prevention measures at OU-1. This action resulted in the placement of a rock layer and geo-textile materials over surface RIM as an interim engineering control until a final remedy is implemented. In addition to construction of this NCC, the UAO required the PRPs to coordinate with local first responders to develop and fully implement a site-specific IMP for OU-1. The UAO further addresses the potential for the development and implementation of a vegetation sampling plan.

West Lake Landfill Timeline

Quarrying and crushing operation begins	1939
Landfilling begins at WLL	Early 1950s
Leached barium sulfate residues illegally placed at WLL	1973
State regulation and permitting of solid waste landfills begins	1974
Bridgeton Landfill in North Quarry begins accepting waste	1979
NRC Reports are issued	1976/1988
Bridgeton Landfill expands into South Quarry	1985
West Lake Landfill Superfund Site is Listed on NPL	1990
OU-1 RI/FS AOC signed by PRPs	1993
Deferral of Regulatory Oversight of WLL to the EPA from NRC	1995
Remedial Investigation	2000
Above grade landfilling over portions of Area 1 in North Quarry	2002-2004
Feasibility Study	2006
Record of Decision	2008
Discovery of Subsurface Smoldering Event in South Quarry	2010
Supplemental Feasibility Study	2011
NRRB Consultation	2012-2013
USGS Groundwater Study	2012-2014
ASPECT Fly-over survey	2013
Phase I & Additional Characterization Investigations	2013-2016
Pre-Construction Agreement and associated on-site air monitoring	2014-present
EPA off-site air monitoring	2015-2016
EVOH Cover South Quarry - Bridgeton Landfill	2015
Non-Combustible Cover installed over RIM at Surface in OU-1	2016
System of Engineering Controls added to North Quarry	2016
EVOH cover North Quarry - Bridgeton Landfill	2017
Remedial Investigation Addendum and Final Feasibility Study	2018
OU-1 Proposed Plan and ROD Amendment	2018

3.0 Community Participation

Consistent with the NCP, public participation activities conducted during the 2008 remedy selection process, and for the process in 2018, were carried out pursuant to 40 C.F.R. § 300.430(f)(2). The AR for OU-1 has been available to the public at the Bridgeton Trails Branch of the public library and was made available online on February 6, 2018, at *https://www.epa.gov/mo/west-lake-landfill*. The Public Notice for the 2008 Remedy and for the 2018 Amended Remedy were both posted in the *Bridgeton/Hazelwood Journal* of the *St. Louis Post Dispatch*. The specific community participation activities post 2008 are summarized below.

In 2013, while additional Site investigations were ongoing, the EPA assisted the community in establishing the West Lake Landfill Community Advisory Group (CAG) and began attending technical CAG meetings. Also in 2013, the EPA assigned a Technical Assistance Services for Communities

(TASC) contractor to assist the community. The agency conducted community interviews in 2014 and 2016 to assess community knowledge of and interest in the Site and started publishing the West Lake Update newsletter to provide consistent updates on Site progress to the community. The EPA continued to engage regularly with community members, including the CAG; and in 2016, the EPA opened a local site office at Bridgeton City Hall where the public could meet with agency representatives in their community. Also in 2016, the EPA held meetings as part of a Community Dialogue Framework, bringing together representatives from federal and state partner agencies, local governments, the CAG, and other community groups to engage in a dialogue regarding the Site. In 2017, in response to several community requests, the EPA shared preliminary draft versions of the RIA and FFS with the community to support transparency and continued to staff the local site office. The EPA also partnered with local community groups to host a Community Listening Session where the public had the opportunity to address senior agency leaders with their questions and concerns regarding the Site.

On February 6, 2018, following the completion of supplemental Site investigations and the FFS, the EPA published a Proposed Plan, pursuant to 40 C.F.R. § 300.435(c)(2)(ii). Notice of the Proposed Plan and public meeting was published in the *Bridgeton/Hazelwood Journal* of the *St. Louis Post Dispatch.* The AR file, which contains the RIA, FFS, and other supporting documents, was made available to the public online and at the EPA Region 7 office in Lenexa, Kansas. The comment period was opened on February 6, 2018. A public meeting for the Proposed Plan was held on March 6, 2018, at the District 9 Machinist Hall in Bridgeton, Missouri. At the meeting, the EPA provided an overview of the Site, explained the remedy selection process, and described the Preferred Alternative for OU-1. Following the presentation, the EPA received oral comments from the public. A transcript of oral comments received at the public meeting was prepared and included in the AR file. Additionally, at the request of the CAG Technical Committee (TCAG) and the PRPs, the EPA convened meetings with each group to discuss elements of the Proposed ROD Amendment on February 22 and February 27, 2018, respectively.

In response to a request from the Missouri Coalition for the Environment, the EPA extended the initial 45-day public comment period an additional 30 days, pursuant to 40 C.F.R. § 300.435(c)(2)(ii)(C). The comment period on the Proposed Plan closed on April 23, 2018. Responses to significant oral and written comments received during the public comment period are provided in the Responsiveness Summary, which is Part III of this ROD Amendment.

4.0 Scope and Role of the Response Action

The subject of this ROD Amendment is OU-1, which is comprised of contaminant source areas at the Site where RIM has been identified within surface and subsurface soil, sediment, and solid waste. The EPA previously selected a remedy for OU-1 in a ROD signed on May 29, 2008. After signing the 2008 ROD, the EPA determined that further evaluation of remedial alternatives at the Site was warranted. The Amended Remedy of excavation and containment of radioactive contaminants will also involve management of non-radioactive wastes. Management of other materials, such as stormwater and landfill leachate that may contain radioactive contaminants as well as non-radioactive contaminants, that need to be collected and disposed in a protective manner are also a part of OU-1.

The EPA, through various removal enforcement actions, has required OU-1 response actions at the Site, including the installation of an NCC over portions of Area 1 and Area 2, development and implementation of an IMP for OU-1, installation of engineering controls and other measures in the North Quarry of Bridgeton Landfill due to the presence of the subsurface heating event in the South Quarry, and on-site and perimeter air monitoring at the Site.

Additionally, on July 25, 2008, the EPA selected a remedy for OU-2. In the OU-2 ROD, the EPA selected a capping remedy for the Inactive Sanitary Landfill and deferred oversight of the Demolition Landfill and the Bridgeton Landfill to the MDNR. Authority for the implementation of the 2008 ROD at the Inactive Sanitary Landfill is maintained by the EPA. The EPA intends to implement the remedy for the Inactive Sanitary Landfill in OU-2 in coordination with the OU-1 remediation.

For OU-3, concerning sitewide groundwater, the EPA determined that a separate RI/FS is necessary. The EPA expects to finalize an agreement with the PRPs in the very near future for the performance of this work. This investigation will further characterize the nature and extent of groundwater contamination at the Site, and determine the range of naturally-occurring background concentrations of landfill-related contaminants, including radionuclides. Based on the results of this investigation, the EPA will assess whether remedial measures are needed to protect and restore groundwater at the unit boundary of the landfill and beyond. If sampling results during the OU-3 RI/FS indicates that action under CERCLA is required for the groundwater, it would be addressed in the future in a separate ROD.

As required by the NCP, the present selection of an Amended Remedy for OU-1 is consistent with any future remedial actions that may be necessary for the other OUs at the Site. For OU-2, this will include ensuring that the RCRA Subtitle D landfill cap selected for OU-2 and the UMTRCA cap required for OU-1 are properly designed and implemented in areas where these two capping remedies intersect. For OU-3, this includes taking into consideration the design and performance of the OU-1 landfill cover, as well as, the results of the OU-1 groundwater monitoring.

The purpose of the Amended remedy is to prevent current or future exposure to the contaminated radioactive soils and to reduce contaminant migration into groundwater. As part of the overall site cleanup strategy, the selected action for OU-1 will reduce known radioactive sources of groundwater contamination at the Site. This action is therefore expected to prevent further migration of radioactivity in soils and its leaching into groundwater. While the partial removal of RIM in the OU-1 action is expected to indirectly reduce groundwater contamination concentrations, the amount of improvement cannot be estimated quantitatively. Therefore, addressing the soil and groundwater contamination on separate schedules allows the accelerated cleanup of the soil.

5.0 Site Characteristics and Site Conceptual Model

This section presents a summary of the Site including the more recent RIA investigations and discusses specific Site conditions that have changed or been altered since the original RI and issuance of the 2008 ROD. Section 5.8 presents the Conceptual Site Model (CSM) through discussion of the actual and potential pathways for migration and/or exposure to the Site's contaminants. Illustrations of the Site conceptual model are depicted in Figures 5 and 6. Both radionuclide and non-radionuclide contaminants have been investigated and evaluated for OU-1.

5.1 Site Overview

The Site is a 200-acre, inactive solid waste disposal facility located in Bridgeton, Missouri, with a physical address of 13570 St. Charles Rock Road, St. Louis County, Missouri (Figure 1). The Site includes inactive landfill waste cells containing RIM; other inactive landfill waste cells not impacted by RIM; a solid waste transfer station, and an asphalt/concrete batch plant (Figure 4). In 2015, the Site operators began the operation of a newly constructed leachate pre-treatment plant for the Bridgeton Landfill, with a capacity to treat approximately 300,000 gallons of leachate per day. This leachate pre-treatment plant discharges treated leachate to a force main sewer in accordance with a permit issued by St. Louis Metropolitan Sewer District (MSD).

The Missouri River is located approximately 1.5 miles west of the Site (Figure 1). However, the Site is situated on the eastern boundary of the river's geomorphic floodplain. The site-area is largely comprised of commercial developments; however, residential properties are located within one mile of the Site (Figure 2). The Terrisan Reste residential mobile home park is located on the east side of St. Charles Rock Road, approximately one-half mile from the Site. The Spanish Village neighborhood, which contains single family residential units surrounded by a larger area of commercial and industrial facilities, is located to approximately 0.75 miles south of the Site.

5.2 Site Conditions Post-2008 ROD

Since issuance of the 2008 ROD, the Site's conditions have changed. Most notably, a subsurface heating event has occurred at the Bridgeton Landfill. This landfill, also known as the Former Active Sanitary Landfill, operated under various state permits and includes the Bridgeton North and South Quarries which ceased accepting waste in 2004 (Figure 4). In December 2010, changes were detected in the landfill gas extraction system that indicated the presence of an exothermic (heat-generating) subsurface event, also referred to as a subsurface heating event in a portion of the South Quarry of the Bridgeton Landfill. This on-going event has produced elevated temperatures and excess carbon monoxide within the landfill and offensive odors in the area.

The EPA, in conjunction with the MDNR, has taken actions to address the subsurface heating event located in the South Quarry of Bridgeton Landfill. In close coordination with the MDNR, the EPA reached an agreement with Bridgeton Landfill, LLC to install a system of engineering controls at the Site in the North Quarry portion of the Bridgeton Landfill that includes; a heat extraction system, lines of temperature monitoring probes, gas extraction wells, and the installation of an EVOH cover. These measures have been designed to both monitor and control the subsurface reaction, thus reducing the unlikely chance of the subsurface heating event moving from the South Quarry of the Bridgeton Landfill, through the North Quarry, into OU-1 of the West Lake Landfill and addressing potential for a separate subsurface heating event. The monitoring systems and the series of engineering controls provides for heat removal from the waste mass, early detection of changes in the subsurface conditions in the landfill, and contingency response actions.

Further, from 2014 to 2016, the potential impacts of the heating event on OU-1 were evaluated as presented in the AR. These evaluations included considerations for a heating event to potentially cause impacts due to one or more of the following items: surface desiccation and cracks, the potential for particulate releases, increased settlement, an increase in radon gas production, and/or an increase in leachate production. Based on these evaluations, there is uncertainty whether a new reaction could occur within or extend into either Areas 1 and 2 of OU-1, in part due to the age and degree of decomposition of the waste materials, the relatively thin nature of the OU-1 waste cells, and the existing physical setting/conditions in Areas 1 and 2.

Additionally, in December 2015, to address the potential for a surface fire to occur in the OU 1 portion of the Site prior to remedy implementation, the EPA ordered Bridgeton Landfill, LLC, Rock Road Industries, and Cotter Corporation (N.S.L.) to conduct a time critical removal action that included targeted clearing of trees and brush and placement of a non-combustible cover, or NCC, composed of aggregate and geotextile materials, over areas where RIM was located at or near the surface (Figure 10). Construction of the NCC was completed in 2018.

5.3 Missouri River Floodplain

Since the 2008 ROD, the EPA has revaluated the Site's proximity to the Missouri River Floodplain. Recent updates to site-specific floodplain information were reviewed, and a summary of this review is included in the AR for OU-1. Historically, flooding occurred in the vicinity of the Site, most notably in 1951; however, changes in Site topography and the construction and operation of the Earth City levee and stormwater management system, which was completed in 1972, have resulted in the majority of the Site being located outside of flood-prone areas. Most of the Site, including Radiological Areas 1 and 2, are located within the geomorphic floodplain of the Missouri River, but are located outside of the 100-year and 500-year floodplains (Figure 7).

The topography of the Site area has been significantly altered by quarry activities and by placement of landfill materials. Consequently, although portions of the Site were built over the historic (geomorphic) floodplain, landfilling and other Site activities have significantly increased the topographic elevation of much of the Site such that, with the exception of the Buffer Zone, Lot 2A2, and drainage areas located at the perimeter of the Site, the Site is located above and outside of the 500-year floodplain.

The Earth City Flood Control and Levee District operates and maintains a levee and stormwater management system to protect properties and associated developments from flood events. This levee system was completed in September 1972, and was designed to protect against floods with a recurrence interval greater than 500 years (0.2% annual chance of flooding from the Missouri River). Since 1972, four major floods have tested the flood control system, including significant regional Missouri River flood events in 1993 and 1995, and no flooding occurred at the Site. Detailed information on this levee system can be reviewed at *http://www.earthcityld.com/index.aspx.*

5.4 Remedial Investigations Post-2008

Following the issuance of the 2008 ROD, due in-part to ongoing community concerns, the EPA determined that additional work was necessary. In 2010, the EPA requested that the PRPs prepare a SFS consisting of an engineering and cost analysis of remedial alternatives that would remove all radioactive waste from the radiologically contaminated areas, Areas 1 and 2. Two "complete rad removal" alternatives were identified, namely excavation with off-site commercial disposal and excavation with on-site disposal in an engineered disposal cell. Analysis of these additional alternatives was performed based on existing information provided in the RI, BRA, FS, and ROD for OU-1, as well as supplemental information prepared by the EPA after issuance of the 2008 ROD.

Additionally, Region 7 consulted with the NRRB on February 29, 2012. In response to that consultation and subsequent written comments from the NRRB, the EPA required additional investigations and evaluations at the Site. In addition, developing Site conditions also led to the performance of further investigations and response actions. Thus, the EPA directed the PRPs to perform additional groundwater sampling at the Site to verify that groundwater quality was consistent with the findings of previous sampling activities conducted as part of the RI and FS. Over 300 groundwater samples from approximately 80 monitoring wells were collected and analyzed between 2012 and 2014, including samples from eight new monitoring wells installed in 2013. The groundwater samples were analyzed for multiple contaminants, including thorium, uranium, and radium isotopes; trace metals; and VOCs and SVOCs.

Additional field investigations were conducted from 2013 to 2016 to further characterize OU-1, and the results were also used to evaluate the construction of engineering controls between the North Quarry of the Bridgeton Landfill and Area 1 to address concerns with the subsurface heating event in the South Quarry. During these investigations, RIM was identified under a portion of the North Quarry "muffin top" or "mound," which is southwest of previously identified RIM locations. At the EPA's direction, the investigation scope was expanded to further define the extent of RIM in southern portions of Area 1. The investigation was conducted in phases, referred to as Phases 1A, 1B, 1C, and 1D, and included a total of 104 new boring and GCPT sounding locations. The additional characterization work conducted in 2015 included 26 new borings, including seven borings in Area 1 (AC-1 through AC-7) and 19 borings in Area 2 (AC-8 through AC-26). Additionally, ten direct-push soil borings were drilled during the additional characterization investigation to support various landfill studies, including leaching tests on RIM.

Considering all of the investigations conducted at the Site to date, nearly 500 investigative soil samples have been obtained and submitted for laboratory analyses for radium, thorium, and uranium isotopes. In addition to soil samples that have been analyzed during the investigations, other indirect measurements have been performed that provide indications of potential RIM occurrences, including the results of downhole gamma logging which provide vertical-spatial information that are indicative of occurrences of radium and other gamma emitters. Gamma and alpha scanning of drill-cores collected during the post 2008 ROD investigations have also been conducted, and overland gamma surveys were performed on the surfaces of the landfill. Based upon direct and indirect measurements, RIM was identified as being present in 144 of the 331 borings and GCPT locations at the Site. Specifically, 72 of the 231 borings and GCPT soundings located within or adjacent to Area 1 identified RIM, and 64 of the 87 borings located in or adjacent to Area 2 identified RIM. The post 2008 ROD investigations provided valuable information regarding the Site, including the identification of RIM in Area 1 southwest of previous estimates and under a portion of the North Quarry of the Bridgeton Landfill.

5.5 Definition of RIM

In 1973, radiological materials that were mixed with soil were brought to the West Lake Landfill from Latty Avenue and were used for cover. Since this time, the radioactive materials have impacted other wastes in the landfill including refuse, debris, fill materials, and quarry spoils located in Areas 1 and 2. Based upon the existing data set, the RIM has been identified in irregular volumes that are largely discontinuous and of various sizes. Radiologically impacted soil has also been identified on the Buffer Zone and Lot 2A2, due to historical soil erosion from the berm of Area 2.

The occurrences of RIM have been identified to consist of radionuclides in the U-238 decay series. Radionuclides from the Uranium-235 (U-235) and thorium-232 (Th-232) decay series are also present above mean background concentrations[5] (see Table 1), although at a lesser frequency and lower activity levels. Accordingly, the RIM criteria were developed for radium, thorium, and uranium isotopes, which are the primary radionuclides of concern at the Site. Specifically, the EPA has defined RIM at the Site as 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, or U-238 plus U-235 plus uranium-234 (U-234) at levels greater than 50 pCi/g above background. These values are based on criteria set forth in regulations promulgated by the EPA pursuant to the UMTRCA[6], and attainment of risk-based radiological cleanup levels

[5] A discussion of the mean background concentrations and the mean background concentrations plus two standard deviations for the four background samples were presented in the RI report (EMSI, 2000)

[6] Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, 40 C.F.R. Part 192.

specified in agency guidance.[7] Additionally, RIM has been defined based on the concentrations of uranium isotopes. No instances of RIM have been identified using the uranium criteria without also containing either radium and thorium above their criteria. The following numerical definitions of RIM inclusive of background are defined for the Site:

- Ra-226 plus Ra-228 = 7.9 pCi/g;
- Th-230 plus Th-232 = 7.9 pCi/g; and
- Combined uranium (U-234 plus U-235 plus U-238) = 54.5 pCi/g.

Review of the data indicates that the Th-230 activities are greater than the Ra-226 activities and are not in equilibrium. Consequently, the levels of Ra-226 at the Site will increase over a roughly 9,000-year time frame equal to the Th-230 concentrations that remain. However, maximum Ra-226 activity concentrations will never exceed the current maximum activity concentration of its parent, Th-230. The projected increase in Ra-226 levels over time will result in both increased gamma radiation levels and increased radon gas generation over time.

5.6 Summary of Results

Investigations conducted at the Site since 2008 have largely confirmed prior investigations. The RIM at the Site has been identified at or near the surface and in the subsurface in both Area 1 and Area 2. Earlier interpretations of the occurrences of RIM based on a limited data set suggested that much of the RIM exists in a relatively thin, continuous shallow layer within Areas 1 and 2. Including samples collected during the post-2008 investigations, a total of 454 radium and thorium analyses were used to characterize RIM. Based upon all data and evaluations performed at the Site, RIM has been identified in multiple irregular areas and volumes. Such occurrences are consistent with the use of soil materials containing radionuclides as cover material which would have been placed primarily on inclined, irregular surfaces of the working face of the disposed refuse. However, the current estimated extent and depth of RIM below the ground surface in Area 1 is now greater than was estimated based on investigations conducted prior to the 2008 ROD.

5.6.1 Radiological Constituents in Areas 1 and 2

The post 2008 ROD investigations have provided new insights regarding the radiological constituents in Areas 1 and 2. The vertical depth and thickness of RIM occurrences were further investigated since the 2008 ROD as determined through evaluation of direct and indirect measurements. RIM has now been identified in Area 1 at intervals ranging in thickness between 0.2 to 19 feet (4.3 feet on average), and in Area 2 between 1 and 25 feet (7.4 feet on average). Overall, the data indicate that 93 percent of the intervals in Area 1 are less than 9.5 feet thick, and 76 percent of intervals in Area 2 are less than 10.4 feet thick. A total of 18 locations were identified as displaying more than one discrete interval of RIM, including four locations in Area 1 (sonic borings 1D-9, AC-1, AC-2B and AC-3) and 14 locations in Area 2 (AC-24, AC-26A, PVC-4, PVC-5, PVC-6, PVC-7, PVC-10, PVC-40, NRC-21, NRC-22, WL-

---

[7] Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination, OSWER Directive No. 9200.4-18 (Aug. 22, 1997); Use of Soil Cleanup Criteria in 40 C.F.R. Part 192 as Remediation Goals for CERCLA Sites, OSWER Directive No. 9200.4-25 (Feb. 12, 1998); Remediation Goals for Radioactively Contaminated CERCLA Sites Using the Benchmark Dose Cleanup Criteria in 10 C.F.R. 40 Appendix A, I, Criterion 6(6), OSWER Directive No. 9200.4-35P (Apr. 11, 2000).

209, WL-210, WL-214, and WL-235). Examples of Borehole Summary Sheets are included in Appendix L of the RIA.

The results of the post 2008 ROD investigations largely confirm the findings presented in the earlier 1982 and 1988 NRC study and reports. Due to the more limited data set, the prior NRC investigations of the Site had estimated the extent of RIM to be generally located to a maximum depth of 20 feet below the surface. However, as a result of the post 2008 remedial Site investigations, additional areas with RIM were identified in portions of Area 1 and Area 2, both laterally and vertically.

The current estimated extent and depth of RIM below the ground surface in Area 1 is greater than that estimated in the previous investigations. Samples that identify RIM have been collected at a maximum depth of 429 feet above mean sea level (ft\amsl) in Area 1, which is about 20 feet below the maximum depths identified in the original NRC investigation. The RIM previously identified by the NRC (NUREG/CR-2722, 1982) was located at 455 ft\amsl, or about 20 feet below the ground surface at that time. Portions of Area 1 are now covered with additional solid waste that was placed in 2004, which effectively places RIM more than 90 feet below the current ground surface. However, an evaluation of the amount of radioactive source material present at various depths indicates that most of the radioactivity is present within 20 feet of the surface. This recently placed solid waste is not expected to contain RIM, nor has RIM been identified in portions of any borings that go through this waste.

The maximum estimated areal extent where RIM is present at the surface or in the subsurface in Area 1 is approximately 8.4 acres (Figure 8). The maximum estimated areal extent where RIM is present at the surface or in the subsurface in Area 2 is approximately 26.8 acres (Figure 9). The table below summarizes the estimated volumes, maximum depths and provides the highest detected activities detected for Area 1 and Area 2, respectively.

	RIM Volume Estimate	Maximum RIM Depth (bgs)	Highest Detected Thorium Activity	Highest Detected Radium Activity
Area 1	58,700 bcy	96 feet	58,800 pCi/g	4,926 pCi/g
Area 2	251,000 bcy	49.5 feet	51,800 pCi/g	3,720 pCi/g

5.6.2 Radiological Occurrences in Buffer Zone/Lot 2A2

Since the issuance of the 2008 ROD, no new data or specific changes have been identified or documented for these OU-1 areas that are located adjacent to Area 2; however, this summary is included in this ROD Amendment for completeness. During the original RI, radionuclide occurrences in surface soil were identified in an area known as the Buffer Zone and Lot 2A2, which is located immediately to the west of Area 2. Following the completion of landfilling activities in Area 2 but prior to the establishment of a vegetative cover over the landfill berm, erosion of soil from the Area 2 landfill berm resulted in the transport of radiologically-impacted soil from Area 2 onto the adjacent property.

Based on the results of sampling performed during the original RI, occurrences of radionuclides were found in surficial soil on these properties. The overall distribution and surficial nature of the occurrences of radiologically-impacted soil was determined to be consistent with erosional transport of soil from

Area 2. Subsequently, a portion of these properties were converted into parking areas for tractor-trailers in 1999. In February 2000, additional surface soil samples were collected from the area and submitted for laboratory testing. One sample, RC-02, obtained from the Buffer Zone contained radionuclides (Th-230) above the definition of RIM. The remainder of the surficial soil samples collected in 2000 contained either background levels of radionuclides or levels above background but less than the definition of RIM. A 2004 inspection indicated that additional regrading work had been performed that resulted in the removal or regarding of soil stockpiles created during previous activities. Additional soil sampling to determine current conditions with respect to radionuclide occurrences in the Buffer Zone and Lot 2A2 soil will be conducted as part of the RD and implementation of the Amended Remedy for this area.

5.6.3 Non-Radiological Constituents

Since 2008, further non-radiological sampling and analysis has been conducted for OU-1. Most notably, soil/waste samples were collected during the Phase 1D investigations conducted in 2015. These samples were analyzed for Target Analyte List (TAL) metals, including select additional metals such as scandium, niobium and tantalum; and the inorganic parameters carbonate, bicarbonate and alkalinity, fluoride, and sulfate. The non-radiological samples were obtained from seven of the Phase 1D borings, and these samples also contained radium and/or thorium at levels above the 7.9 pCi/g RIM criteria.

Based on the data collected, three of the samples contained elevated barium concentrations when compared to background concentrations in the St. Louis area, but the results do not correspond with elevated radionuclide and/or sulfate concentrations. While the elevated occurrences of barium are consistent with the presence of non-natural contributors (possibly LBSR based on Site historical records), variability in the occurrence of barium and sulfate at lower concentrations cannot definitively rule out natural or other anthropogenic contributors that could be encountered within landfill municipal waste, native materials or fill soils.

The occurrences of other trace metals and inorganic compounds did not correlate definitively with the presence of elevated radionuclide activities, which further cannot rule out variability attributed to either native materials or municipal landfill waste. The concentrations of niobium and scandium reported for the Phase 1D samples are within the naturally occurring ranges found in native soil. Tantalum was detected in only two of the samples with radionuclides above 7.9 p/Ci/g. It should be noted that the analytical results for all of the reported detections of niobium, scandium, and tantalum were relatively low, and were qualified as estimated concentrations by the analytical laboratory because the results were less than the laboratory reporting limit but greater than the method detection limit.

Additionally, during the original RI for Areas 1 and 2, petroleum hydrocarbons were detected. Gasoline concentrations varied from 240 to 2,600 parts per million (ppm); diesel constituents ranged from 51 to 310 ppm; and motor oil constituents ranged from 19 to 3,100 ppm. VOCs, other than petroleum hydrocarbon constituents, were detected at concentrations generally less than 1 ppm in both Areas 1 and 2. SVOCs, other than petroleum hydrocarbon constituents, were detected in both Areas 1 and 2 at concentrations less than 1 ppm. Pesticides were generally detected at concentrations less than 0.01 ppm. Polychlorinated biphenyls (PCBs) were detected in Area 1 at concentrations between 0.033 and 2.6 ppm. PCBs in Area 2 generally varied between 0.017 and 1.6 ppm. No specific correlation between these occurrences and the radiological material in OU-1 was identified during the investigations.

5.6.4 Impacts to Other Environmental Media

Radionuclide impacts to other environmental media have also been investigated at and near the Site since the 2008 ROD. Specifically, additional analyses of ambient air, stormwater, surface water, sediment, and groundwater have been conducted to assess the potential impacts to these media. Results of these analysis are discussed below.

5.6.4.1 Radon Gas and Fugitive Dust in Atmospheric Air

Since the 2008 ROD, the EPA has further evaluated both radon and fugitive dust. Analysis of radon flux measurements has shown that average emissions of radon from the surface of Areas 1 and 2 are within the EPA's promulgated standard of 20 pCi/m^2s for uranium mill tailings. The EPA has also performed air monitoring at five off-site stations, four of which were near the Site and one that was located in St. Charles, Missouri. Monitoring data collected from these locations between 2015 and 2016 were below on-site and off-site reference standards as compared to the EPA's off-site baseline. In addition, the values obtained from the EPA's background reference station in St. Charles are similar to those measured at the 13 on-site and perimeter air monitoring stations discussed below.

In addition, pursuant to a negotiated settlement with Bridgeton Landfill, LLC, 13 air monitoring stations were installed along the perimeter of the Site in 2015 to obtain baseline air monitoring data for the Site. Six of these monitors surround OU-1 Area 1, six others surround Area 2, and the thirteenth monitor is in the southwest corner of the Site. Monitoring at these locations is ongoing and ensures coverage around Areas 1 and 2 under all wind directions.

Migration of radionuclides through fugitive dust has also been studied. Fugitive dust monitoring was conducted in 1996 in Area 1 and Area 2 during the OU-1 RI. Additional analysis of fugitive dust has been accomplished since 2015, when air monitoring stations were installed around the perimeter of the Site. The median and maximum gross alpha levels in fugitive dust collected from the perimeter air monitoring stations were higher than those observed at the five off-site air monitoring locations. Gross beta results obtained from the on-site stations were comparable to the gross beta results obtained from the off-site monitoring locations. Additionally, all median and maximum values for isotopic uranium, isotopic thorium, and combined radium obtained from the on-site stations are lower than the median and maximum results found at the off-site stations.

Landfill related odors have been an issue of significant concern to the local community. These odors were exacerbated by the subsurface heating event, which was first detected in the Bridgeton Landfill in December 2010. Based upon the results of various sampling events and investigations, it has been determined that the compounds responsible for the odors are total reduced sulfur compounds, primarily dimethyl sulfide and mercaptans. The EPA and the MDNR have required that the Bridgeton Landfill be covered with an EVOH cover system to, among other reasons, help mitigate odor issues. The MDNR air monitoring/samples collected in the area surrounding the landfill indicated that levels of total reduced sulfur compounds decreased between 2013 and 2018, coinciding with the completion of the EVOH cover and the installation of additional landfill gas collection wells at the Bridgeton Landfill.

5.6.4.2 Contaminant Distribution in Storm/Surface Water and Sediments

Since 2008, stormwater and sediment transport mechanisms have been further investigated at the Site. As stated in the 2008 ROD, radionuclide migration onto the Buffer Zone and Lot 2A2 was documented. Sample results identified that these OU-1 areas have surficial and shallow soil impacts from transported radionuclides over an area of approximately 160,000 square feet.

In 2016 and 2017 sediment samples were collected during the RIA from other areas of the Site including areas downgradient from identified OU-1 stormwater outfalls. The results of this sediment sampling indicated that limited radionuclides were also present in a drainage ditch near the Northeast Surface Water Body and specifically at sample location SED-4 (Figure 10). At this location, the combined thorium concentrations for samples SED-4 and SED-4 EPA DUP were 16.16 pCi/g and 20.63 pCi/g, respectively, which exceeds the threshold of 7.9 pCi/g. The EPA required 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 feet (respectively) to the northwest (downstream) from SED-4. Two additional planned sampling locations, SED-9 and SED-10, were in an area of standing water and could not safely be sampled on that date. Samples were collected from these two locations on January 19, 2017. None of these samples contained radium or thorium levels above the RIM threshold of 7.9 pCi/g. The isolated nature of the occurrences suggests that current transport of radionuclides in sediment is not a significant migration pathway.

Stormwater from Areas 1 and 2 is transported to one of four surface water bodies at or near the Site. Within Area 2, two closed topographic depressions are created by a perimeter berm and receive runoff from the northern portion of Area 2. Runoff from the southwestern portion of Area 2, on the other hand, ponds at the Buffer Zone where, given sufficient quantity, it can be transported as overland flow into a culvert that conveys stormwater to the Earth City Stormwater Flood Control Channel. Runoff from remaining portions of Area 2, as well as all runoff from Area 1, ultimately flows through a perimeter drainage ditch located along the northeast side of the landfill adjacent to St. Charles Rock Road which then flows to a fourth surface water body located north of Area 2. Stormwater samples continue to be routinely collected from OU-1 following qualifying rain events, and the samples are analyzed for radionuclides and municipal solid waste landfill parameters. Additionally, Bridgeton Landfill, conducts stormwater monitoring pursuant to Missouri State Operating Permit No. MO-0112771. Specifically, Bridgeton Landfill, monitors five outfalls (003, 004, 005, 006, and 007) at the Site per the requirements of their National Pollutant Discharge Elimination System (NPDES) permit. Based on the results of the rainwater/stormwater runoff and surface water sampling performed during the field investigations, including the more recent stormwater monitoring initiated in 2016, dissolved or suspended transport in stormwater runoff does represent a potential migration pathway for transport of radionuclides from Areas 1 and 2. However, the analytical results collected to date for Th-230, Ra-226 and total uranium are all below the site-specific preliminary screening levels which the EPA calculated for exposure to surface water at the Site for a trespasser scenario (342.5 pCi/L for thorium, 10.2 pCi/L for radium and 131 ug/L for uranium) which presents an estimated risk of 10^{-6} excess cancer risk. Given the relatively low levels of radionuclides identified in the stormwater runoff and the lack of significant impacts in the surface water bodies, this pathway is not currently considered a major mechanism for transport of radionuclides from Areas 1 and 2.

5.6.4.3 Groundwater

Groundwater samples collected from monitoring wells located within both the unconsolidated Missouri River alluvial unit and the bedrock units at and near the Site, demonstrate impacts by the Site associated COCs. Since issuance of the 2008 ROD, the EPA has further evaluated groundwater conditions at the Site and concluded that a separate RI/FS is appropriate to determine the nature and extent of any groundwater contamination related to the Site, and as necessary, evaluate the need for the remediation of sitewide groundwater.

In 2013, the EPA's NRRB recommended additional groundwater sampling since site-related contamination has been identified under the landfill, including levels of radium exceeding the drinking water MCL of 5 p/Ci/L. Additionally, the EPA, in partnership with the USGS, conducted additional groundwater research and evaluations. The results of this work are documented in a report issued by the USGS in December of 2014 (updated in June 2015), titled Background Groundwater Quality, Review of 2012–2014 Groundwater Data, and Potential Origin of Radium at the West Lake Landfill Site, St. Louis County, Missouri. The USGS report hypothesizes four sources of radium exceeding the MCL at the Site, namely: (1) leaching of RIM, (2) radium within the range of natural background, (3) leaching from non-RIM wastes, and (4) mobilization of naturally occurring radionuclides due to landfill leachate.

The general direction of groundwater flow in the alluvial aquifer in the vicinity of the Site is to the northwest. In addition to the general regional groundwater flow, other factors influence localized groundwater levels and flow beneath the Site, such as the dewatering effects associated with the Bridgeton Landfill leachate pumping and collection activities and the low-permeability cover (EVOH cover) recently installed from 2014 to 2016 over much of Bridgeton Landfill. The Bridgeton Landfill designed and built a leachate pretreatment plant that started operation in 2015. This leachate treatment plant has the capacity to treat up to approximately 300,000 gallons of leachate per day. Water level measurements collected at the Site in 2012 and 2013 identified a depression in the water table that is associated with the ongoing leachate extraction from the Bridgeton Landfill. The leachate collection system is of hydrogeologic importance as it affects 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.

In 2013, the EPA and the USGS conducted an effort to provide information on groundwater quality near the Site and to determine groundwater use near the Site. Off-site wells were inventoried, and groundwater samples were collected from private wells located within 5 miles of the Site. Eight of the wells were completed in the Missouri River alluvial aquifer and two wells were completed in Mississippian-age bedrock units. Ra-226 results detected in the collected samples ranged from 0.197 pCi/L to 2.92 pCi/L. Ra-228 results ranged from non-detect at 0.072 pCi/L up to 2.69 pCi/L. The combined Ra-226 plus Ra-228 results from the 2013 off-site well sampling were all below the radium MCL and were considered consistent with "background" for radium values reported in the St. Louis area. Six of the off-site alluvial aquifer wells were about 1-mile north and in a generally downgradient direction from the Site. None of the results in groundwater from these off-site wells appeared to have radiological impacts associated with the Site.

In 2014, on-site data reviewed identified landfill leachate effects in 47 of the 83 monitoring wells and 13 monitoring wells that had average dissolved combined radium above the MCL of 5 pCi/L. A strong positive relation was noted between the occurrences of average combined radium above the MCL and effects from landfill leachate in wells at the Site. Currently, the ability to conclusively designate the radium origin in groundwater at the Site is limited by the following factors: (1) the amount of background radionuclide data in groundwater; (2) the absence of data on the distribution of radium isotopes in aquifer solids, in "typical" non-RIM wastes and in "typical" landfill leachate; and (3) the potential for landfill leachate to mobilize naturally occurring radium from aquifer solids. The USGS report states that the mobilization of naturally occurring radium contained in aquifer materials by chemical interaction with landfill leachate is probably an important mechanism resulting in the occurrence and persistence of radium above the MCL in groundwater at the Site. Mobilization of naturally occurring radioactive materials, due to the geochemical conditions found in the landfill, generally do not constitute background and would be attributable to the landfill. Additional investigations of groundwater for the Site will be performed as part of the OU-3 RI/FS.

5.7 Off-Site Investigations

Since 2008, the EPA undertook evaluations of potential off-site impacts at the Bridgeton Municipal Athletic Complex (BMAC) starting in May 2014. The EPA and its environmental contractors collected 112 soil samples from the BMAC and two background reference areas, Koch and Blanchette parks. BMAC is located approximately one-mile northeast of the West Lake Landfill (Figure 2). Koch park is located approximately 5 miles to the northeast of the West Lake Landfill, and Blanchette park is located approximately 2.75 miles to the northwest of the West Lake Landfill. The soil samples were sent to an analytical laboratory for radionuclide analyses of U-238, Th-230, Ra-226, and lead-210. The results were compared to background threshold values (BTVs) calculated specifically for BMAC. Soil sampling results from BMAC that exceeded the BTVs were compared to the EPA's preliminary remediation goals (PRGs) for residential soil to determine if further data review or investigation was warranted. The EPA evaluated potential receptors (park visitors and on-site workers) for contact with radiological materials via surface water, soil exposure, and air migration. The EPA concluded that a release to any of these pathways was unlikely because levels did not appear to warrant action under CERCLA since the risk to the reasonably exposed individual is estimated to be within the risk range. On July 31, 2014, the EPA announced that based on the results of this evaluation, the facility is suitable for public use and requires no further environmental response[8].

Additionally, an off-site investigation was conducted in response to public concerns in December 2016. The EPA staff and associated contractors screened areas within and around two residences located in the Spanish Village subdivision, located approximately 1.5 miles southwest of the Site (Figure 2). This off-site investigation included the use of various detectors including alpha, beta, and gamma screening instruments to support field screening and sample collection of exterior soils and interior surfaces as well as bulk dust samples. More than 140 samples were collected from these two homes and analyzed to determine the concentrations of various radionuclides, including testing to assess for the presence of radionuclides. Soil sampling results were within normal background ranges for the analyzed radionuclides, and the results of interior wipe sampling were below the EPA's residential screening levels. The sampling results also did not identify contamination, or other materials, which would indicate the presence of RIM or other materials associated with West Lake Landfill.

5.8 Conceptual Site Model

The CSM is developed to help identify potential exposure pathways by which current or future receptors could come into contact with COCs. Data collected from the post 2008 ROD Site investigations and from the previous Site investigations have been used to refine the CSM for the West Lake Landfill. This data was used to identify the sources of contamination, types of contamination, affected media, known and potential routes of migration, and known and potential receptors. The CSM is summarized on Figures 5 and 6 which depict the sources of contamination, the potential release mechanisms, migration pathways, routes of exposure, exposure mechanisms, and potential current or future receptors.

During the RIA, historical aerial photographs of the Site area were further assessed by the EPA. This information provided an updated understanding of the sequence of historical activities, including quarrying and waste disposal at the various landfill cells, and the changes of the various surface water bodies, and drainage patterns at the Site over time. Additionally, as presented in the RIA, historical aerial photographs were used to prepare summary figures that depicted the estimated topographic

---

[8] Final Pre-CERCLIS Screening Report, Bridgeton Municipal Athletic Complex, Bridgeton, Missouri. July 30, 2014.

surfaces for 1971, 1975, 1977, and 1979. These topographical surfaces were used to evaluate the relationship between the ongoing rock quarrying occurring within portions of the North Quarry relative to waste placement and management in Area 1. These surfaces were also used to identify changes in ground surface elevations between 1971 and 1975, which is the period of interest relative to the disposal of leached barium sulfate residues and associated soil. The historical aerial photography was also compared to the existing (2016) topography to identify significant changes in surface elevations.

Based upon the results of the more recent investigations and evaluations, such as the Phase 1 and Additional Characterization efforts, RIM has now been identified beneath approximately 8.4 acres in Area 1 and approximately 26.8 acres in Area 2 (Figures 8 and 9). Further, the additional data collected at the Site has identified RIM occurrences at significantly greater depths. RIM has now been identified in Boring 1D-07_2 (Area 1) at a maximum depth of approximately 96 feet bgs (422 ft\amsl). This data combined with additional considerations have resulted in the refinement of the CSM regarding the locations and depths of RIM at the Site and the variation in the thicknesses of RIM occurrences.

The NRC's 1982 report stated that, "in general, the subsurface contamination appears to be a continuous single layer, ranging from two to fifteen feet thick, located between elevations of 455 feet and 480 feet and covering 16 acres total area." Additionally, the NRC report stated that "two areas of contamination covering more than 15 acres and located at depths of up to 20 feet below the present surface, have been identified." The present surface described in the NRC report would have been the ground surface from 1982. The findings and assumptions presented in the NRC reports related to the surface were based on overland gamma surveys and the collection of 61 surface soil samples for which an on-site gamma analysis was performed, 12 of which were sent for off-site laboratory analysis for other radionuclides including thorium and uranium. The subsurface findings and assumptions presented in the NRC reports were based on 43 holes drilled and subsequent gamma logging, 19 of which were logged again to obtain in-situ estimates of gamma emitting radionuclides. No borings were extracted from the subsurface, and no subsurface samples were collected or analyzed associated with these NRC investigations.

Subsequent investigations support the finding of the previous studies, provide a more comprehensive data set that reduces uncertainties related to the potential ingrowth of Ra-226, and refines the understanding of extent and distribution of RIM at the Site. The data and evaluations presented in the RIA identify RIM in multiple irregular volumes, some of which are partially at or near the surface while others are in the deeper portions of Area 1 and Area 2. The current distribution of RIM within the landfilled areas has been impacted by both natural and anthropogenic processes after the initial placement of the radiological materials by more than 40 years of decomposition, consolidation, and differential settlement of the waste. As a result, these irregular volumes of RIM consist of soils, putrescible wastes, and demolition wastes which are often visually indistinguishable from the surrounding materials in the landfill.

Besides updating the nature and extent of radiological contaminants, the CSM, as presented in the 2018 RIA, largely confirms the Site's overall CSM. However, the EPA has further considered the potential for Site contaminants to be transported to other areas of the Site or to off-site locations in the more recent investigations. Migration pathways for Site contaminants have been further evaluated and are discussed in Section 5.8.1 and associated sub-sections.

5.8.1 Migration Pathways

Various media located at the Site, that may have become impacted by radionuclides or other materials, can potentially be transported in the air, stormwater, sediments or groundwater. The following migration pathways have been further evaluated since the issuance of the 2008 ROD. The results of these evaluations are presented in the updated BRA and elsewhere in the OU-1 AR. Specifically, the following pathways have been further evaluated by the EPA:

- Airborne transport;
- Stormwater transport;
- Sediment transport; and
- Leaching to groundwater.

The following subsections provide a summary of the migration pathway investigations and related information.

5.8.1.1 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). Radon is an inert, naturally-occurring noble gas that is generated by the decay of radium. Because it is a gas, radon produced in a soil matrix can potentially migrate from the soil into overlying indoor or ambient air. In addition, small amounts of radon can be released from radium-containing airborne particulates. Radon emission is a common process that occurs in all soils because all soils naturally contain some radium. Radon emissions have been evaluated as radon flux from the surface in 1997 and were further evaluated in 2016 after placement of the NCC. The results of these evaluations indicate that average radon flux from Areas 1 and 2 is below the standard of 20 pCi/m^2/sec established for uranium mill tailing piles under the UMTRCA.

Since the 2008 ROD, perimeter monitoring of radon levels in the ambient air has been performed at 13 air monitoring stations around the perimeters of Areas 1 and 2 (Figure 11). Results indicate that current radon levels at the Site perimeter are less than the UMTRCA standard of 0.5 pCi/L above background concentrations. Potential future (1,000 year) radon levels were also developed for the Site based on projected ingrowth of Ra-226 from Th-230 decay. Modeling of transport of future (1,000 year) radon emissions to areas adjacent to the landfill indicated that the projected future (1,000 year) radon level on Lot 2A2 would be 330 pCi/m^2 (equivalent to 0.33 pCi/L), which is less than the UMTRCA standard of 0.5 pCi/L above background. Projected future radon concentrations for the off-site receptors were also evaluated and found to be even lower. Airborne VOCs were also evaluated (43 samples from 28 borings were analyzed for VOCs). Only ambient levels of VOCs were detected; therefore, it was concluded that there is no complete pathway for VOC emissions, and this pathway was eliminated from consideration. Results of perimeter monitoring conducted between 2015-2017 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 the EPA at its five off-site monitoring stations. The NCC now covers areas where RIM was identified at the surface in OU-1 further reducing the potential for entrainment of particulates containing radionuclides.

5.8.1.2 Stormwater Transport

Stormwater transport was revaluated during the RIA, and based on the results of the stormwater and surface water sampling performed, dissolved or suspended transport in stormwater does represent a migration pathway for the transport of radionuclides. Stormwater samples have been, and continue to be collected from OU-1 outfalls. The samples are analyzed for landfill parameters and radionuclides. Bridgeton Landfill, LLC also conducts stormwater monitoring and sampling 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 per the requirements of their NPDES permit (Figure 10).

Stormwater at the Site is currently managed by engineering controls and the runoff is directed into drainage channels that route much of the surface water into one of three identified surface water bodies at the Site. The three currently identified surface water bodies present on or in the direct vicinity of the Superfund Site are; the North Surface Water Body, the flood control channel associated with the Earth City Industrial Park, and a stormwater detention pond associated with the Bridgeton Landfill which is hydraulically isolated from Area 1 and Area 2. The North Surface Water Body is a drainage ditch located between a portion of the Crossroads Industrial Park, the Site, and St. Charles Rock Road, immediately to the north and northeast of Area 2. As a part of the RIA, historical aerial photographs were reevaluated, and the review indicated that the North Surface Water Body did not exist in 1941 but does appear on the 1953 aerial photograph. The North Surface Water Body receives surface water run-off from the Northeast Perimeter Drainage Ditch, which separates St. Charles Rock Road from the Area 2 portion of the Site. This water body is generally not perennial, tends to hold water in the spring and summer months, and slowly dries out in the fall and winter months. This water body also receives runoff from the paved and gravel surfaces associated with the adjacent St. Charles Rock Road. Over the years, since the original RI, the North Surface Water Body has become overgrown with dense vegetation such that a smaller pool of water currently exists then existed during and before the original RI. Review of the historical aerial photographs indicates that a portion of the pond adjacent to Area 2 had become largely overgrown by dense vegetation starting in approximately 2003.

The Earth City flood control channel was constructed in the early 1990s and is part of an extensive series of interconnected channels that are used to manage stormwater runoff within the Earth City Industrial Park. The water level in the flood control channel can vary 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. The Bridgeton Landfill stormwater detention pond is used to manage stormwater in the Bridgeton Landfill portion of the Site, and is located south of OU-1, east of the Bridgeton Landfill, and appears to be hydraulically isolated from Area 1 and Area 2 due to Site topography and engineering controls in place at the Site.

Stormwater monitoring performed in 2016-2017 did not detect radium or uranium concentrations above drinking water standards in stormwater on-site or where stormwater discharges from Areas 1 and 2. There are no standards or other criteria for evaluation of thorium levels in water. Most of the thorium levels reported for OU-1 outfalls located along the perimeter of the Site were approximately 1 pCi/L or less. The only exceptions were the May 12, 2016, result of 3.9 pCi/L from outfall NCC-004 (later renamed OU-1-004), and the February 21, 2017, result of 3.2 pCi/L for outfall OU-1-007. Stormwater samples have exceeded MCLs for gross alpha; however, subsequent isotopic sampling of the stormwater did not find MCL exceedances for radium. Therefore, although dissolved or suspended sediment transport in rainwater runoff is a potential pathway for radionuclide migration from Areas 1 and 2, construction of the NCC reduces the potential for stormwater transport of radionuclides from Area 1 and 2. Given the relatively low levels of radionuclides present in the rainwater/stormwater runoff, this pathway is not currently considered a major mechanism for transport of radionuclides from Areas 1 and 2. Further evaluation of stormwater drainage ways will be performed during the RD.

5.8.1.3 Sediment Transport

In 2016, sediment samples were collected from some on-site and perimeter locations which contained levels of radionuclides above the definition of RIM or above typical soil background levels (Figure 10). 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. The 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 feet (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 that date. Samples were collected from these two locations subsequently, on January 19, 2017. None of these samples contained radium or thorium levels above the established limit of 7.9 pCi/g. The isolated nature of sediment occurrences at the Site suggest that current transport of radionuclides in sediment, while it could occur, is not a significant migration pathway. Further evaluation of sediment transportation and deposition will be performed during the RD.

5.8.1.4 Leaching to Groundwater

In 2017, the EPA required an evaluation of the potential for RIM to become mobile due to leaching. 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. The degree to which a radionuclide dissolves in water or remains adsorbed to a soil matrix can be described by the distribution coefficient, or K_d. Generally, the higher the numerical value of the K_d, the less soluble the compound. Literature studies reported that the primary COCs from OU-1 (Th-230 and Ra-226) have distribution coefficients in sand, loam, and clay ranging from 500 liters per kilogram (L/kg) to 36,000 L/kg. These values indicate a tendency for adsorption/absorption of these radionuclides by a soil matrix. However, as documented in the RIA, laboratory testing on RIM conducted in 2017 as part of the OU-1 RI indicated a potential for Site-related radionuclides to leach from RIM under certain conditions.

As demonstrated by TCLP tests, sequential extraction tests and SBLT conducted in 2015, RIM from site-specific samples can leach under laboratory conditions intended to simulate landfills. These tests were designed to determine the specific mineral phases within the RIM samples, and the SBLT were designed to determine if chemical constituents, namely site-related radionuclides, could leach from RIM under conditions similar to those found in a mature landfill. While these tests on RIM samples were originally done as part of a fate and transport study that was not finalized, the leaching tests were completed, and the analytical results are valid. The results demonstrated that radionuclides leached from RIM samples. Furthermore, based on the data, RIM continued to leach to pore water through the final leaching steps in a number of the individual RIM sample tests. Actual groundwater may differ from lab leachate analysis and leachate can be influenced by other factors, such as contaminants in the leachate such as petroleum and other organics, and contaminants may be carried in the leachate and groundwater through facilitated transport (e.g., colloidal transport). Because the MCL for radium in groundwater is 5 pCi/L, the leaching of even a small fraction of radium from the RIM could result in increases of radium levels in pore water above the drinking water standard.

5.8.2 Fate and Transport

Recent evaluations, as documented in the OU-1 AR, have been conducted to provide a further understanding of potential fate and transport processes that may occur at the Site. Fate and transport processes affect the concentrations of the various radionuclides that may remain at the Site over time. Of interest for this Site 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 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, because of the decay of Th-230, the levels of Ra-226 are expected to increase over time. Accounting for the in-growth of Ra-226 due to the decay of Th-230 results in an estimated Ra-226 activity level of 1,323 pCi/g in Area 1 and 1,476 pCi/g in Area 2 in 1,000 years. 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 Figures 12 and 13. Peak radium levels are expected to occur in approximately 9,000 years at which time Ra-226 activities are estimated to be 1,979 pCi/g in Area 1 and 2,253 pCi/g in Area 2.

Radionuclides can be transported into the atmosphere as a gas in the form of the various radon isotopes, and radon is discharged to the atmosphere as a result of the decay of radium. Starting in 2015, direct measurement of the radon levels in atmospheric air have been conducted at the 13 on-site air monitoring stations. 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. In 2016, Radon flux emissions were measured from the surfaces of Areas 1 and 2 after the completion of the construction of the NCC. The arithmetic mean value of the radon flux results was 0.061 pCi/m^{2}s, which is below the UMTRCA standard of 20 pCi/m^{2}s. The maximum reported values were 0.198 pCi/m^2/s for Area 1 and 1.5 pCi/m^2/s for Area 2. Radon flux measured at point 2-19 (the closest point to WL-209) was 0.098 pCi/m^2/s, and the flux measured at point 2-65 which is located near WL-223 was non-detect (<0.023 pCi/m^2/s). Further, radon that is emitted from the surface of Areas 1 and 2 is subject to natural dilution and dispersion processes active in the atmosphere.

In addition to radioactive decay, the processes of leaching can also affect the fate and transport of radioactive materials. As previously discussed, the potential leaching of site-related radionuclides was further evaluated in the RIA. During the additional characterization investigation conducted in 2015 sub-surface samples containing RIM were collected to support fate and transport evaluations and studies. Four new borings were drilled in impacted areas near AC-1, AC-3, 1D-3, and WL-114 in Area 1, and six borings were drilled in Area 2 adjacent to impacted borings AC-16, AC-18, AC-19, AC-21, AC-24 and WL-209 (Figures 14 and 15). These samples were subjected to various mineralogical specification and other analysis, and as previously discussed, to TCLP tests, sequential extraction tests and SBLT. These fate and transport studies were not completed; however, many of the associated analysis were finalized, the leaching test completed and deemed valid by the EPA, and the results are included in the OU-1 AR. Further evaluations of fate and transport processes is envisioned as part of the OU-3 RI.

6.0 Current and Future Land and Resource Uses

This section describes the current and reasonably anticipated land uses and current and potential groundwater uses at the Site. This assessment forms the basis for the reasonable exposure assumptions used in the risk assessment process.

6.1 Current Land Use

Land use at and in the vicinity of the Site remains largely unchanged since the 2008 ROD. The Site consists of an approximately 200-acre parcel of land that includes six identified waste disposal areas or units. In addition to the former landfill disposal areas, included within the boundaries of the property are a solid waste transfer station, a leachate pre-treatment plant, and an asphalt batch plant (Figure 4).

Adjacent properties that, although not used for waste disposal, are known to contain radionuclides include the Buffer Zone and Lot 2A2 of the Crossroads Industrial Park. Per CERCLA § 101(9)(B), a facility includes any Site or area where a hazardous substance has been deposited, stored, disposed of, placed, or otherwise come to be located. Accordingly, these adjacent properties are included as part of the Site. A six-foot-high chain-link fence with a three-strand barbed wire canopy encloses the entire former landfill property. The main access gate is located on St. Charles Rock Road near the northeastern perimeter of the Site.

Land use in the area surrounding the landfill remains generally commercial, industrial, with some residential. 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 and commercial facilities, including the Republic Services, Inc. hauling company facility, 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 levee system associated with the Missouri River (Figure 2). As previously discussed, Earth City and other nearby areas are separated from the river by an engineered levee system owned and maintained by the Earth City Flood Control District.

The nearest residential area to the Site is the Terrisan Reste mobile home park, which is located southeast of the Site, approximately 0.5 mile from Area 1, and the Spanish Village residential subdivision which is located to the south of the Site near the intersection of St. Charles Rock Road and I-270, approximately one mile from Area 1(Figure 2).

On the west side of Area 2 is the property referred to in the OU-1 RI 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. 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 (Figure 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.

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 are known to be present in the soil as a result of the transport of radionuclides by surficial processes from the landfill property. 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 the outdoor storage of tractor-truck trailers. OU-2 consists of all other portions of the landfill property. These areas are shown on Figure 4.

6.1.1 Land Use Restrictions

The land use restrictions from the 2008 ROD have not changed. The landfill property is subject to several controls on land use (Figure 14). An IC 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 the construction of buildings and underground utilities and pipes within Areas 1 and 2. On October 31, 2016, the prior ICs 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 ICs; 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 ICs cannot be terminated without the written approval of the current property owners, the MDNR, and the 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 the depositing or dumping of new or additional putrescible waste on the entirety of the Bridgeton Landfill after August 1, 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 St. Louis Lambert International Airport.

6.2 Future Land Use

Future land use assumptions remain unchanged from the 2008 ROD. Areas 1 and 2 are expected to remain landfills and on-site commercial uses will need to be compatible with this end use. There are buildings currently located adjacent to Areas 1 and 2 which include associated parking. In the past, portions of Area 1 were paved and used for parking and storage near the landfill entrance building. Therefore, while currently prohibited, it is reasonable to assume that OU-1 may potentially be used for parking or open storage in the future.

Development within the Earth City Levee District, which includes all the property to the north, west, and southwest of the Site, is commercial and industrial by design and the entire 1,891 acres is 97 percent developed. Surrounding land use to the south and east is also expected to remain largely commercial/industrial. Zoning in that area is consistent with this observation. There are a few residential areas near the Site to the south and southeast. In addition, since the surrounding area is already mostly developed, no significant changes in land use are anticipated. However, there is some uncertainty regarding future land use considering the 9,000-year time frame during which ingrowth will occur. If land use should change, the remedy will be examined to ensure it remains protective.

6.3 Groundwater Use

Since 2008, site-related groundwater information, including groundwater use information, has been further evaluated by the EPA. Groundwater is present in both the unconsolidated materials (alluvium) and in the bedrock underlying and adjacent to the Site. Groundwater within both the unconsolidated alluvial and bedrock units at the Site are impacted by Site associated chemicals of concern.

The Site is located at the edge of the Missouri River alluvial valley. 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 flood plain. The major bedrock aquifers favorable for groundwater development lie at great depth. The St. Peter Sandstone aquifer lies at a depth of approximately 1,450 feet below ground surface (bgs). While of regional importance, the major bedrock aquifers are not significant to the study of the Site due to their great depths and intervening shale units. The bedrock units immediately underlying and adjacent to the Site (including the Warsaw, Salem, and St. Louis Formation) are not very favorable for groundwater development. Groundwater use and the aquifers located beneath and near the Site will be further evaluated in the OU-3 RI/FS in accordance with the "Guidelines for Ground-Water Classification Under EPA Ground-Water Protection Strategy" (1986).

The nearest identified registered private water supply well, per the MDNR database, is located about one-mile northeast of the Site and other alluvial domestic water supply wells have been identified approximately 1 mile north of the Site. A public water supply surface water intake has been identified approximately seven miles downstream of the Site along the Missouri River. Additionally, the alluvial aquifer in the general vicinity of the Site is considered as a source of drinking water. Alluvial groundwater wells completed in the Missouri River flood plain are capable of very high yields, and are currently used to supply drinking water to various communities in North County of the Metro Saint Louis area. In 2013 ten off-site private wells located within 5-miles of the Site were identified and sampled by the EPA. The results indicated no site-related impacts in these wells; thus, currently no completed exposure pathway for groundwater has been identified for the Site. However, additional investigations of groundwater, including refinement of groundwater usage in the vicinity of the Site, will be performed as part of the groundwater (OU-3) RI/FS.

7.0 Summary of Site Risks

A BRA was conducted as part of the original RI/FS process to examine the current and potential future effects of the contaminants on human health and the environment. The human health assessment was updated as part of the RIA and FFS. Like the original human health risk assessment, the updated assessment indicates the Site does not present risks above levels of health concern under current conditions, but potential future uses of the Site could result in risks that exceed these levels. The updated risk assessment provides several risk estimates for future scenarios at the Site that are roughly a factor of 100 greater than estimates in the original risk assessment. Therefore, remedial action is necessary to protect public health or welfare from actual or threatened releases of hazardous substances into the environment.

7.1 Human Health Risks

The updated human health risk assessment was conducted site-specifically using standard EPA methods and guidance. Superfund risk assessments evaluate a range of current and potential future exposures to determine the risks a hazardous waste site poses to human health and the environment if no action were taken to prevent or limit exposure at the Site. It provides a basis for taking a response action and identifies exposure pathways that need to be addressed by the response action.

7.1.1 Identification of Contaminants of Concern

The 2008 ROD identified eight radionuclides (U-238, U-235, Th-232 and their associated daughter products, U-234, Th-230, Ra-226, lead-210, and protactinium-231) as COCs, based on their long half-lives. Because U-238, U-235, Th-232, and many of the daughter products were detected at levels above the site-specific background, all of the radionuclides in the uranium series (U-238 and decay products), actinium series (U-235 and decay products), and thorium series (Th-232 and decay products) have now been identified as COCs. Potassium-40 was also detected above the site-specific background, but not outside the range of what can be found in natural materials. Because potassium-40 is not a radionuclide associated with any of the decay series listed above and because the average concentration is consistent with the site-specific background, this radionuclide was not identified as a COC. Table 1 lists the radionuclide COCs.

As stated above, as in the original BRA the updated risk assessment identified Th-230 and Ra-226, including their respective decay products, as the primary COCs. These isotopes and their associated decay products accounted for more than 95% of the total risk to the target receptors.

The 2008 ROD identified four non-radiological COCs including three trace metals; arsenic, lead, and uranium as a metal; and one PCB, Aroclor 1254. The updated human health risk assessment, utilizing all the Site data to date, identified a total of 24 non-radiological contaminants as COCs, including the four previously identified. The additional COCs include the trace metals antimony, barium, beryllium, chromium, cobalt, mercury, nickel, thallium, vanadium, and zirconium; pesticides/PCBs Aldrin, Aroclor 1242, Aroclor 1248, and Dieldrin; SVOCs naphthalene and pentachlorophenol; and VOCs 1,1-dichloroethane, 1,4-dichlorobenzene, benzene, chlorobenzene, and ethyl benzene. Table 2 lists the non-radiological COCs.

The radionuclides in the waste material came from processed ore residues. The ratio of Th-230 to Ra-226 is greater than one, indicating these radionuclides are not in equilibrium. Ra-226 decays from Th-230 and has greater radiotoxicity. "In cases where decay products have greater radiotoxicity than the original radionuclide, the potential radiation dose and health risk may increase over time; in such cases, the exposure assessment should consider the change in concentrations of all decay products over time to determine the time of maximum potential impact."[9] In addition, standards in the UMTRCA Subpart A were also determined to be relevant and appropriate for the design of the Area 1 and Area 2 containment systems. These standards state that the containment system must "be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years." Therefore, the updated BRA includes an assessment of future risks at the Site that has been conservatively adjusted for ingrowth of Ra-226 and its eight daughters from decay of Th-230 over a 1,000-year study period, as well, as at approximately 9,000 years, when Ra-226 concentrations will reach a maximum.

An exposure point concentration (EPC) is the concentration of a contaminant of potential concern (COPC) in an environmental medium that may reach the potential receptor. The exposure concentration is typically defined as the average concentration contacted by the receptor at the exposure point. A conservative estimate of this average concentration is the 95th percent upper confidence limit (UCL) of the arithmetic mean. A conservative 95th percent UCL concentration was determined for each COC according to the descriptive statistics determined from the analytical data associated with each COC.

Since 2008, a number of additional investigations have resulted in collection of additional samples from within or on the surface of Area 1 and Area 2. The data from these samples have been included in the updated BRA and considered in the calculation of EPCs. In general, this has resulted in minor reductions to the EPCs from Area 2 compared to those used in the original BRA, and minor increases to the EPCs in Area 1. The EPCs of Area 2 are still generally higher than those in Area 1, as was concluded in the 2008 ROD. The updated risk assessment also incorporates the use of an additional air model not utilized in the original risk assessment, AERMOD, to estimate the migration of radon and fugitive dust. Therefore, updated EPCs for the air pathway have also been included. Tables 3 through 8 present a summary of the updated current and future EPCs.

---

[9] Radiation Risk Assessment at CERCLA Sites: Q&A, 2014, p. 16.

7.1.2 Exposure Assessment

The purpose of the exposure assessment is to estimate the nature and magnitude of the potential receptors' exposure to COCs that are present at or migrating from the Site, considering both current and reasonably anticipated future land or resource use. Components of the CSM, e.g., exposure pathways and media, were used to perform the exposure assessment. A diagram depicting the completed exposure pathways can be seen in Figure 6.

Consistent with the original BRA, the updated BRA considers current access controls such as fencing and limited entry that prevent the public from entering Areas 1 and 2, as well as other areas of the Site, and work practices that prohibit Site workers from entering Areas 1 and 2, when assessing current risk. The updated BRA also considers the recently completed installation of the temporary NCC over areas where RIM is at the surface. This cover prevents exposure pathways such as inhalation and ingestion of fugitive dusts. The temporary cover also reduces, but does not eliminate, the migration of radon. Updates to the current on-site exposure scenarios were made based on site-specific information. Current off-site residential receptors were evaluated to determine the risks to residents near the Site. A commercial building user scenario was also evaluated for Lot 2A2 and the Buffer Zone. Figure 6 contains the updated parameters that describe the current exposure scenarios.

Consistent with the original BRA, in the updated BRA it was assumed that potential future human receptors could be engaged in activities that result in ongoing occupancy of Areas 1 and 2. The updated BRA includes the same future land uses and adds future exposure scenarios for an off-site farmer and a commercial building user scenario for Lot 2A2 and the Buffer Zone. Residential use was not evaluated for Area 1 and Area 2 because it is not consistent with reasonably anticipated land use. The future exposure pathways in the updated BRA include exposure to external radiation, inhalation of radon gas or contaminated dust, submersion in air of contaminated dust, dermal contact with impacted materials, or incidental ingestion of contaminated soil. A variety of updates to the exposure scenarios evaluated in the original BRA were included in the updated BRA. The most significant of these updates relate to the future landfill storage yard worker, which includes increasing the outdoor exposure duration from one hour per day to four hours per day; increasing the total years of exposure from the central tendency value of 6.6 years to the reasonable maximum value of 25 years; and eliminating the assumption of a six to ten inch graveled or paved surface to provide all-weather access as a parking or storage facility. This improved surface was previously estimated to reduce exposures from gamma radiation by 80%. The changes to the storage yard worker scenario were selected to be consistent with the EPA's default reasonable maximum exposure assumptions or to otherwise ensure that this scenario would be representative of a reasonable maximum exposure. The updated assessment used site-specific exposure assumptions and intake parameters, when available. When site-specific values were not available, values from the EPA's Exposure Factors Handbook were used.[10] Table 10 contains the updated parameters used for the future exposure scenarios.

While the updated BRA did not evaluate residential land use for Lot 2A2 or the Buffer Zone, the EPA further considered the potential for this land use on this part when determining whether the remedy would achieve the remedial action objective to allow for unlimited use and unrestricted exposure, or UU/UE, of these properties.

[10] U.S. EPA. Exposure Factors Handbook 2011 Edition (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-09/052F, 2011.

Exposure pathways related to groundwater were not included in the BRA but will be evaluated, as appropriate, as part of the RI work for OU-3. While there are currently no known completed exposure pathways for groundwater exposure, current and potential future exposure scenarios involving groundwater, including the vapor intrusion pathway, will be incorporated into the OU-3 BRA, as appropriate.

7.1.3 Toxicity Assessment

This is the process of selecting appropriate toxicity values for use in estimating the potential health risks associated with exposure to the COCs. Cancer slope factors and toxicity values were updated for both radiological and non-radiological COCs that have been identified. For the majority of the COCs, this resulted in only very minor changes to the risks or hazard quotients compared to the original BRA. One significant updated toxicity value is the non-cancer uranium toxicity value.[11] In addition, OLEM Directive 9200.2-167 "Updated Scientific Considerations for Lead in Soil Cleanups was released since the original BRA was conducted. Consistent with EPA guidance, the assessment of radiological health risks is limited to carcinogenic effects, except for uranium. Carcinogenicity is assumed to be the limiting deleterious effect from low radiation doses. For the non-radiological contaminants, both carcinogenic and noncarcinogenic effects are evaluated.

Updated cancer slope factors and inhalation unit risks for radionuclides are presented in Table 11. Updated cancer slope factors for non-radiological COCs are presented in Table 12 and updated inhalation unit risks are in Table 13. For the noncarcinogenic effects of the non-radiological COCs, health effects are assessed by comparing exposure intake to a reference dose, or RfD. The updated RfDs for the COCs are presented in Tables 14 and 15. Note that many values in these tables are expressed in the alternate "E notation," e.g., 1×10^{-4} is expressed as 1 E-4.

7.1.4 Risk Characterization

The risk characterization combines the intakes estimated in the exposure assessment with the appropriate toxicity values identified in the toxicity assessment so that cancer risks and chemical health hazards may be estimated for each of the exposure scenarios evaluated.

For carcinogens, risks are expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. These risks are generally expressed in scientific notation, e.g., 1×10^{-6}. An excess lifetime cancer risk of 1×10^{-6} indicates a 1 in 1,000,000 chance of developing cancer from the exposure. This is referred to as "excess lifetime cancer risk" because it would be in addition to the cancer risks individuals face from other causes.

For known or suspected carcinogens, the NCP at 40 C.F.R. § 300.430(e)(2) establishes acceptable exposure levels that correlates to an excess lifetime cancer risk to an individual of between 1 in 10,000 (1×10^{-4}) and 1 in 1,000,000 (1×10^{-6}). This is known as the acceptable risk range. The calculated risks for certain potential future uses at Radiological Areas 1 and 2, as represented by the groundskeeper and a worker involved in outdoor storage, exceed the acceptable risk range. Under CERCLA, this provides a sufficient basis for taking action.

The risks associated with the noncarcinogenic toxic effects of hazardous chemicals are evaluated by comparing an exposure level or intake level to the RfD. The ratio of the intake to the RfD is called the

[11] *https://semspub.epa.gov/work/HQ/196808.pdf*

hazard quotient (HQ). An HQ less than one indicates that a receptor's dose of a single contaminant is less than the RfD and that noncarcinogenic toxic effects are unlikely. The hazard index (HI) is generated by adding the HQs for all COCs. If the HI exceeds one, then an HI is calculated by adding the HQs for all COCs that affect the same organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed.

Due to the changes affecting COCs, exposure assessment and toxicity assessment incorporated into the updated BRA, corresponding changes have occurred to the estimated risks. The risks for all of the current receptors remain within or below the acceptable risk range, with the highest current exposure being for an on-property commercial building user adjacent to Area 2. The excess lifetime cancer risk for this receptor was estimated at 1.9×10^{-5}, which is within the target cancer risk range. All of the off-property scenarios, including the residential scenarios, were below the target cancer risk range. Tables 16 through 18 present a summary of the lifetime cancer risks.

There were significant changes in the risk estimates associated with the future exposure receptors. This is most notable for the future maximally-exposed individual, which is a landfill storage yard worker on Area 2. Similar to the original BRA, the risks are primarily due to external radiation exposure from continued ingrowth of Ra-226 and its decay products. The excess cancer risk for this receptor was previously estimated at 4×10^{-4}, accounting for 1,000 years of ingrowth. The updated BRA estimates the excess lifetime cancer risk for a landfill storage yard worker at 1.9×10^{-2}, at 1,000 years of ingrowth and increases by a factor of about 2.3 at the time of maximum ingrowth, estimated at 9,000 years. Risks to future groundskeeper receptors on Area 1 and Area 2 were also estimated at about 2×10^{-3}. Nearly all the calculated cancer risks for future scenarios exceed the target cancer risk range. The majority of the risks for the future off-property scenarios are due to exposure to radon, for which there is uncertainty that is discussed more in following sections. The updated BRA also indicates that cancer risks from non-radiological contaminants are within or below the target cancer risk range. Tables 19 and 20 present a summary of the future lifetime cancer risks.

Non-radiological COC HIs exceed the EPA's acceptable threshold of one for some future on-site receptors on OU-1 in the future, indicating a potential for non-carcinogenic health effects. Zirconium in Areas 1 and 2, and to a lesser extent, cobalt in Area 2, are the primary contributors to HIs greater than 1. Uncertainty in the RfD and background levels for zirconium likely results in overestimated HQs, and is discussed in more detail in the updated BRA. Tables 21 and 22 present a summary of the HIs for the exposure scenarios.

It is important to note that some exposure pathways that have been determined to be incomplete for the current and future receptors evaluated in the updated BRA are complete during remedy construction. This was taken into consideration when evaluating short-term risks for each alternative. This primarily consists of exposures to chemical that are assumed to degrade over time and thus are not considered for future receptors. Potential exposures to these COCs would occur for all the remedies evaluated in the final feasibility study.

7.1.4.1 Uncertainties

The uncertainty analysis provides decision makers with a summary of those factors that significantly influence risk results and discusses the underlying assumptions that most significantly influence risk. This section discusses the assumptions that may contribute to over or under estimates of risk in the updated BRA. Table 23 presents a summary of the uncertainties associated with estimated risks.

7.1.4.1.1 Analytical Data Uncertainties

Uncertainty is introduced when site investigations include sampling other than random sampling. Sampling bias has been incorporated into several of the OU-1 investigations including the more recent investigation performed since the 2008 ROD. For example, the workplan for the additional characterization investigation required sampling from each boring at the location of the highest radiological screening response. This bias will tend to result in EPC calculations that overestimate actual site conditions. Another example would be that the workplace for the installation of the non-combustible cover requires confirmation sampling at 100-foot intervals along the perimeter of the cover to demonstrate that RIM is not present at the surface. This bias will tend to result in more samples that are close to background which will result in EPC that underestimate risks. While sampling bias can result in both overestimates and underestimates of risk, this source of uncertainty is generally expected to result in increased protectiveness when considering all the investigations performed on OU-1.

Another source of uncertainty for contaminants which are naturally occurring arises from the inclusion of background contribution of those contaminants when estimating risk. This uncertainty will tend to overestimate site conditions. In general, this source of uncertainty is expected to result in extremely small increases (less than 1%) of the overall risks to all receptors except current off-site residents and commercial building users, as well as, future off-site farmers and commercial building users. The cumulative excess risks for current residents and commercial building users are significantly below the target cancer risk range (10^{-7} to 10^{-8} excess cancer risk). Some of the cumulative risks to the future off-Site receptors exceed 1 x 10^{-4}. However, the cumulative risks for the on-site future receptors are a factor of 10 to 100 greater than the future off-site receptors. Therefore, this uncertainty is considered low to moderate and results in increased protectiveness but would not change the conclusions.

7.1.4.1.2 Modeling Uncertainties

The updated BRA included risk estimates that partially rely on modeling. Specifically, RAECOM, a computer program designed to estimate radon flux, and the EPA’s AERMOD were used to model the air transport of the COCs to specific receptor locations. The uncertainty introduced by the use of these models could result in either overestimation or underestimation of risk; however, the overall impact is considered to be low to moderate.

7.1.4.1.3 Land Use Assumption Uncertainties

The current land use at the Site and surrounding the Site is known. However, there is some uncertainty in the future land use of the Site, and in particular when considering the long timeframes over which the risks posed by the Site will increase. Consistent with the original BRA, use of OU-1 as a storage yard was considered reasonable, and therefore, was evaluated in the updated BRA. In addition, the updated BRA includes off-site farming in order to ensure the updated risk assessment is conservative.

7.1.4.1.4 Representative Receptor Uncertainties

Current receptors were based on a combination of site-specific information and default exposure parameters. Consistent with the EPA risk assessment guidance, current receptors were evaluated to determine the reasonable maximum exposure. The uncertainty in the representativeness of current receptors evaluated in the updated BRA is considered low.

Future receptors must be predicted based on reasonably anticipated future land uses and to ensure the estimates of risk result in a reasonable maximum exposure. Therefore, receptors were evaluated for future land uses that represent high-end but reasonable estimates of risk. In most cases, this uncertainty overestimates the most probable realistic exposures, and therefore, may overestimate risk. This is appropriate when performing risk assessments of this type so that risk managers can be reasonably assured that the public risks may not be under estimated, and so risk assessments for different locations and scenarios can be compared.

7.2 Ecological Risks

The updated BRA for OU-1 included a review of the prior screening-level ecological risk assessment (SLERA) for the Site, that was performed to ensure ecological risk was appropriately evaluated, consistent with EPA guidance. No significant changes to site-related ecological risk were identified during the review. The purpose of the screening-level risk assessment is to determine if a potential for adverse impacts to ecological receptors from exposure to COCs exists at the Site and to determine which chemicals and exposure pathways are driving the potential risk or present the greatest potential risk. There is a significant amount of uncertainty associated with the actual potential for ecological impacts. A screening-level risk assessment deals with the uncertainty by using highly conservative assumptions when estimating potential risks. In this way, sites for which there is no potential for ecological risk may be screened out from further assessment. On the other hand, if the screening-level risk assessment indicates that potential risks exist, this does not necessarily mean that site-related chemicals are impacting ecological receptors. See Table 26 for the summary of the exposure pathways for ecological receptors.

The results of the screening-level risk assessment indicate that ecological receptors are potentially at risk from exposure to COCs, especially metals, in both Areas 1 and 2. The metals could adversely affect plants and soil invertebrates. Small burrowing animals may be at risk from exposure to radioactive materials in Area 2. It should be noted that both Areas 1 and 2 currently support vegetative and animal communities. There is no observable impact to the health of the plant communities.

Uptake of metals and bioaccumulation in the food chain may affect higher organisms. Based on the models used in this risk assessment, risk to ecological receptors may result from the bioaccumulation of metals in plants and earthworms. Exposure via food sources was the predominant exposure pathway for primary consumers. Exposure of predators was directly related to the concentrations of chemicals in plants and/or earthworms and the proportion of these contaminated food sources in the diet.

For the red-tailed hawk, selenium was the only COC identified in the updated BRA. Exposure to all other contaminants present at the Site is not likely to have an adverse effect on this animal. Exposure to selenium was primarily the result of bioaccumulation in the food. Food accounts for over 99 percent of the exposure to the red-tailed hawk and the relative contributions from the various prey animals are proportional to the amount of vegetation in the prey animal’s diet. The uptake of selenium in plants is likely over estimated because the bioaccumulation factor used was more representative of selenium bioaccumulating plants which are not found at the Site. The use of maximum bioaccumulation factors for prey animals is likely to have resulted in even greater over estimation of predator exposure.

Similarly, selenium was the predominant risk driver for the white-footed mouse, cottontail rabbit, and the American robin. It was also one of the predominant risk drivers for the red fox and the American woodcock. The primary exposure pathway was bioaccumulation of the contaminant within the food chain, especially uptake by plants. As was previously described, the uptake of selenium in plants and bioaccumulation in prey animals is likely over estimated. See Table 27 for a summary of the risk findings.

It should be noted that the OU-1 areas are located within a landfill operation. Some of the ecosystems present in these areas are the result of access controls and the fact that field succession has been allowed to occur. Remediation of OU-1 may significantly alter or destroy the habitats that currently exist, forcing wildlife present to migrate to other areas. The increasing commercial/industrial development of the land surrounding the Site has removed significant amounts of wildlife habitat. This process may result in a reduction in the number of larger species in the area and the reduction of the overall ability of the area to support some types of wildlife.

8.0 Remedial Action Objectives

Remedial action objectives (RAOs) are specific goals that the remedial alternatives must accomplish to protect human health and the environment from risks posed by the Site and identified in the BRA and SLERA. These objectives are based on available information and standards, such as ARARs, to-be-considered guidance, and site-specific risk-based levels. RAOs also serve as the design basis for the remedial alternatives discussed in the following section.

In the 2008 ROD, the EPA selected RAOs based on the Presumptive Remedy for CERCLA Municipal Landfill Sites. The RAOs in the 2008 ROD for Areas 1 and 2 were:

- Prevent direct contact with landfill contents including exposure to external radiation;
- Minimize infiltration and any resulting contaminant leaching to groundwater;
- Control surface water runoff and erosion; and
- Control and treat landfill gas emissions including radon.

The RAO in the 2008 ROD for the Buffer Zone and Lot 2A2 of the Crossroads Industrial Park was:

- Prevent direct contact with contaminated surface soils or to ensure contaminant levels are low enough to allow for unlimited use and unrestricted exposure.

8.1 Updated RAOs for Areas 1 and 2

Like other areas of the Site, Areas 1 and 2 were used for solid-waste landfill disposal; however, these areas of the Site also contain substantial quantities of long-lived radionuclides mixed with the municipal solid waste, and thus, present conditions that are not typical of landfill sites. Based upon the additional information collected and studies performed since 2008 and due to the toxicity of the RIM, the potential of the waste to leach, and the increasing risks due to radioactive decay, the EPA has determined that the West Lake Landfill is not a typical municipal landfill. The EPA no longer considers the presumptive remedy of containment alone to be appropriate for the Site. Because of this, the EPA has modified the RAOs for OU-1 as follows:

- Prevent direct contact to contaminated media (including waste material, fill, stormwater, sediments, leachate and groundwater) located on or emanating from OU-1.

- Limit inhalation and external radiation exposure from contaminated media (including waste material, fill, leachate, and gas emissions) located on or emanating from OU-1 to within the acceptable risk range (10^{-4} to 10^{-6} cancer risk or a HI of less than 1 for non-carcinogenic risk).

- Minimize water infiltration to prevent contaminants from leaching to groundwater above levels protective for the reasonably anticipated use of the groundwater and surface water.[12]

- Control and manage leachate that emanates from OU-1 in accordance with standards identified in the ARARs.

- Control and treat landfill gas from OU-1 including radon in accordance with standards identified in the ARARs.

- Control surface water runoff, and minimize erosion associated with OU-1 in accordance with standards identified in the ARARs.

The EPA has performed a site-specific evaluation of risk to determine that a concentration of 52.9 pCi/g for all the radioactive COCs corresponds to a risk of about 1×10^{-3} for the future maximally exposed individual described in the updated BRA. The Amended Remedy requires excavation of some RIM greater than 52.9 pCi/g. Excavation of some RIM in combination with the installation of the engineered cover will meet these RAOs.

8.2 Updated RAOs for Lot 2A2 and the Buffer Zone portions of OU-1

Historic erosion of the landfill berm along the north side of Area 2 resulted in deposition of radiologically impacted soil on the surface of the Buffer Zone and Lot 2A2 of the Crossroads Industrial Park (also known as the Ford Property). The RAO for this property is:

- Remediate soils to the extent necessary to allow for unrestricted land use.

The EPA evaluated the requirements and cleanup standards in the UMTRCA for clean-up of radioactive soils (40 C.F.R. § 192.12) when considering remediation goals for Lot 2A2 and any portions of the Buffer Zone not utilized to construct the Area 2 engineered cover. These standards were determined not to be protective for UU/UE considering the multiple contaminants and multiple exposure pathways present at the Site. Therefore, the EPA performed a site-specific evaluation of risk and determined the radiologically impacted soils on Lot 2A2 and portions of the Buffer Zone should be remediated to background levels. Additional background characterization will be performed as a post-ROD activity to determine statistically valid background concentrations for the Buffer Zone and Lot 2A2.

9.0 Description of Remedial Alternatives

An FFS was conducted to develop and evaluate remedial alternatives for the Site. Remedial alternatives were identified and compared to the nine criteria required by the NCP. In addition to the remedial alternatives, the NCP requires that a no action alternative be considered. The no action alternative serves primarily as a point of comparison for the other alternatives. Eight alternatives, including the no action

[12] If necessary based on the findings of the OU-3 RI/FS, OU-3 will address restoration of site-wide groundwater to levels protective for the reasonably anticipated use of the groundwater in a separate ROD and remedial action.

alternative, were considered and are summarized below. Based on consideration of comments received during the public comment period, the EPA developed a modification to Alternative 4 which is included as Modified Alternative 4 in the discussions below:

Summary of Alternatives	
1	No Action - Required by NCP as a baseline for comparison
2	Engineered Cover (Cap) - Modified 2008-ROD Selected Remedy
3	Engineered Cover (Cap) - UMTRCA Engineered Cover
4	Excavation of RIM Greater Than 52.9 pCi/g Down 16 Feet Plus Engineered Cover
4 *	Modified Alternative 4 - Excavation of RIM Greater Than 52.9 pCi/g Generally to 12 Feet with Optimization Plus Engineered Cover
5	Excavation of RIM Greater Than 1,000 pCi/g Plus Engineered Cover
6	Risk Based Excavation of RIM Plus Engineered Cover
7	Excavation of RIM Greater Than 7.9 pCi/g with Off-Site Disposal in Engineered Cell
8	Excavation of RIM Greater than 7.9 pCi/g with Disposal in an On-Site Engineered Cell

9.1 Common Elements of Remedial Alternatives

The following remedy components are common to all remedial alternatives except the No Action and Full Excavation Alternatives:

- Excavation and/or regrading;
- Use of daily cover for excavation areas and stockpiles of excavated waste material;
- Construction of an engineered landfill cover;
- Construction of controls for surface water runoff;
- Monitoring for radon and landfill gas and implementation of a control system, if necessary;
- Groundwater monitoring;
- Implementation of ICs;
- Development and implementation of an Operation and Maintenance Plan;
- Development and implementation of a Bird Hazard Mitigation Plan; and
- Conduct Five-Year Reviews.

The specific requirements that all remedy components must meet are established based on an analysis of ARARs.

All remedial alternatives will address the presence of radiologically-impacted soil in the Buffer Zone and Lot 2A2 of the Crossroads Industrial Park. Radioactive materials present in these areas will either be placed on-site (Areas 1, 2 or on-site cell) and managed under an engineered cover (designed to comply to UMTRCA regulatory requirements, RCRA municipal landfill regulations, and RCRA hazardous waste design guidance) or excavated and sent to a permitted off-site disposal facility, depending on the alternative.

9.2 Description of Remedial Alternatives

Alternative 1: No Action – The No Action Alternative is included as required by the NCP to serve as a baseline for comparison of the other alternatives. Under this alternative, no engineering measures will be implemented to reduce potential exposures or control potential migration from Areas 1 and 2. Similarly, no additional ICs and no additional fencing will be implemented to control land use, access, or potential future exposures to radioactive materials. No monitoring will be conducted to identify or evaluate any potential changes that may occur to conditions at Areas 1 and 2 or to contaminant levels or occurrences. The EPA has determined that this alternative does not meet the threshold criteria, and is not protective of human health and the environment.

Estimate of waste to be excavated:	0
Estimate of RIM to be removed from Area 1 and managed in an on-site or off-site cell:	0
Estimate of RIM to be removed from Area 1 and managed in an on-site or off-site cell:	0
Estimated time to construct:	N/A
Estimated time to reach RAOs[13]:	Will not achieve RAOs
Estimated capital cost:	$0
Estimated annual OM&M cost:	$0
Estimated present worth at 7% discount rate:	$0
Expected outcome:	All contaminant mass would remain on-site; No ICs in place to control unacceptable exposures; No engineered cover so no limitations on infiltration or potential leaching to groundwater; Would not meet RAOs.
Key ARARs:	N/A

[13] Time to reach RAOs includes time for the RD and time for construction.

Alternative 2: Engineered Cover (Cap), Modified 2008 ROD-Selected Remedy – Areas 1 and 2 would be brought up to grade using inert fill and regrading of existing material. Final grades will achieve a minimum slope of two percent. Final grades would be achieved through placement of additional material, regrading of existing waste materials or a combination of the two. The specific procedures to be used would be determined as part of RD based on Site constraints, minimization of the amount of material to be moved or placed, other design requirements, health and safety considerations, cost, and other factors as appropriate. Approximately 750 yards of the material to be relocated in Area 1 and approximately 15,000 yards of the material to be relocated in Area 2 in connection with regrading of the Site is anticipated to contain RIM. This material would be relocated to areas requiring additional fill material in order to achieve final grades. In contrast to the 2008 ROD Selected Remedy, this alternative would use a regrading plan that does not extend the toe of the landfill out an estimated 100 lateral feet. Under this approach, an approximately ten-foot-high “starter berm” would be constructed along portions of the outer boundaries of Areas 1 and 2. Construction of the starter berm would require excavation of waste materials present at the toe of the landfill in these areas. These materials would be replaced by earthen material that would provide the base for a perimeter access road and perimeter drainage features, incorporate rock armoring for flood control to the extent required, and through the use of steeper side slopes for the soil/rock material (in contrast to those allowed for waste materials), would result in greatly reducing the amount of waste material that would need to be regraded under the Modified ROD Selected Remedy.

Any radiologically-contaminated soil on the Buffer Zone and Lot 2A2 of the Crossroads Industrial Park would be consolidated in the area of containment prior to the installation of a landfill cover. An engineered landfill cover would be constructed over Area 1 and Area 2 to address the presence of RIM and other wastes. The design of this cover would meet standards specified in the EPA’s UMTRCA regulations which include limits on radon releases, groundwater protection standards, and longevity requirements (200 to 1,000 years). The cover would also be designed to meet the Missouri Subtitle D closure and post-closure care requirements for sanitary landfills to address municipal solid wastes present in Area 1 and Area 2. The conceptual landfill cover includes a compacted clay layer to minimize stormwater infiltration and radon releases, a rubble/rock layer to minimize bio-intrusion, and a vegetated layer to minimize erosion potential and to increase the longevity of the cover. The need for and nature of gas control measures would be evaluated and defined as part of the RD phase.

Surface water drainage diversions, controls, and structures would also be designed and constructed as necessary. Groundwater monitoring and protection standards consistent with requirements for uranium mill tailing sites and sanitary landfills would be applied. The landfill cover would be routinely inspected and maintained to ensure the long-term integrity of the cover. ICs must be implemented to limit future uses and to ensure future uses do not impact the effectiveness or integrity of the remedial actions. The time to achieve the RAOs for this alternative is estimated to take 2.8 years. Because radionuclides above the unrestricted use criteria would remain at the Site, ICs, long-term surveillance and maintenance, five-year review evaluations, groundwater monitoring for radionuclides, and radon gas monitoring would be required.

Estimate of waste to be excavated[14]:	112,000 yd^3
Estimate of RIM to be removed from Area 1 and managed in an on-site or off-site cell:	0 (750 yd^3 will be relocated and placed under the engineered cover)
Estimate of RIM to be removed from Area 1 and managed in an on-site or off-site cell:	0 (15,000 yd^3 will be relocated and placed under the engineered cover)
Estimated time to construct:	1.8 years
Estimated time to reach RAOs:	2.8 years
Estimated capital cost:	$75,000,000
Estimated annual OM&M cost:	$176,000 to $340,000
Estimated present worth at 7% discount rate:	$71,000,000
Expected outcome:	All contaminant mass would remain on-site; Land use would be restricted; Engineered cover would prevent direct exposure; Engineered cover would minimize infiltration of precipitation limiting leaching to groundwater; Achieves RAOs.
Key ARARs:	UMTRCA Subpart A; RCRA Subtitle D.

Alternative 3: Engineered Cover (Cap) – UMTRCA Engineered Cover – This alternative is similar to Alternative 2 which requires a cover that is compliant with the UMTRCA performance based standards. The standards, as described in 40 C.F.R. § 192.02, include:

> (d) Be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years; and
>
> (e) Provide reasonable assurance that releases of Rn-222 from residual radioactive material to the atmosphere will not:
>
>> (1) Exceed an average 38 release rate of 20 picocuries per square meter per second, or
>>
>> (2) 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 design of the cover for Alternative 3 also incorporates recommendations included in the EPA's guidance for final covers on RCRA Subtitle C hazardous waste landfills, and would meet the RCRA Subtitle D municipal landfill cover regulations. A key difference between Alternative 2 and

[14] Estimate of waste to be excavated includes RIM and non-RIM (i.e., setback and overburden).

Alternative 3 is the permeability requirement for the cover system that addresses the rate of water infiltration through the landfill. The cover for Alternative 3 includes a low permeability layer that lowers the allowed permeability from 10^{-5} cm/sec associated with the ROD Selected Remedy down to a maximum of 10^{-7} cm/sec, which is the standard for hazardous waste landfills and would further limit water infiltration. Any radiologically-contaminated soil on the Buffer Zone and Crossroad Lot 2A2 property would be consolidated in the area of containment (Areas 1 or 2) prior to the installation of the landfill cover. Other aspects described in Alternative 2 would also be implemented as a part of Alternative 3. Other remedial components, including ICs, long-term surveillance and maintenance, groundwater monitoring for radionuclides, and radon gas monitoring would be required. Because radionuclides above the unrestricted use criteria would remain at the Site, five-year review evaluations would be required.

Estimate of waste to be excavated:	112,000 yd^3
Estimate of RIM to be removed from Area 1 and managed in an on-site or off-site cell:	0 (750 yd^3 will be relocated and placed under the engineered cover)
Estimate of RIM to be removed from Area 2 and managed in an on-site or off-site cell:	0 (15,000 yd^3 will be relocated and placed under the engineered cover)
Estimated time to construct:	1.8 years
Estimated time to reach RAOs:	2.8 years
Estimated capital cost:	$96,000,000
Estimated annual OM&M cost:	$176,000 to $340,000
Estimated present worth at 7% discount rate:	$90,000,000
Expected outcome:	All contaminant mass would remain on-site; Land use would be restricted; Engineered cover would prevent direct exposure; Engineered cover would minimize infiltration of precipitation limiting leaching to groundwater; Achieves RAOs.
Key ARARs and TBCs:	UMTRCA Subpart A; RCRA Subtitle D; RCRA Subtitle C cover design guidance.

Alternative 4: Excavation of RIM Greater Than 52.9 pCi/g Down 16 feet Plus Engineered Cover – Excavate RIM with radioactivity levels greater than 52.9 pCi/g for combined radium and combined thorium that is located within 16 feet of the 2005 topographic surface of Areas 1 and 2.

The 16-foot depth for Alternative 4 was developed before the additional investigation work was completed at the Site. At that time, it appeared that most of the activity was present within the top 16 feet for many of the areas except those where newer waste was disposed (i.e., muffin top area). Since that time, the location and distribution of RIM has been refined in Area 1 and Area 2 based on the results of the additional characterization investigation performed between 2013 and 2016.

RIM located at depths greater than 16 feet, regardless of concentration, would be left in place. Any radiologically-contaminated soil on the Buffer Zone and Lot 2A2 Crossroads Industrial Park in excess of unrestricted use criteria would be excavated and sent off-site for disposal if above 52.9 pCi/g or placed on-site beneath the engineered cover if less than 52.9 pCi/g. A full-scale pilot study to evaluate the ability to effectively separate RIM from landfill wastes and to segregate RIM by concentration to reduce the volume of material shipped off-site would be implemented for this option. Where possible, any excavated overburden with RIM at concentrations below 52.9 pCi/g would be placed towards the bottom of the excavation to reduce the future risks at the Site. After excavation is complete, an engineered cover meeting UMTRCA standards (as described in Alternative 3) would be placed over Areas 1 and 2. The design of the cover for Alternative 4 also incorporates recommendations included in the EPA's guidance for final covers on RCRA Subtitle C hazardous waste landfills and would meet the RCRA Subtitle D municipal landfill cover regulations. Other remedial components, including ICs, long-term surveillance and maintenance, groundwater monitoring for radionuclides, and radon gas monitoring would be required. Because radionuclides above the unrestricted use criteria would remain at the Site, five-year review evaluations would be required.

Estimate of all waste to be excavated:	273,900 yd^3
Estimate of RIM to be removed from Area 1 and managed in an on-site or off-site cell:	10,200 yd^3
Estimate of RIM to be removed from Area 2 and managed in an on-site or off-site cell:	73,700 yd^3
Estimated time to construct:	3.7 years
Estimated time to reach RAOs:	5 years
Estimated capital cost:	$274,000,000
Estimated annual OM&M cost:	$176,000 to $340,000
Estimated present worth at 7% discount rate:	$236,000,000
Expected outcome:	Majority of radioactivity removed leading to more long-term permanence; Land use would be restricted; Engineered cover would prevent direct exposure; Engineered cover would minimize infiltration of precipitation limiting leaching to groundwater; Achieves RAOs.
Key ARARs and TBCs:	UMTRCA Subpart A; RCRA Subtitle D; RCRA Subtitle C cover design guidance.

Modified Alternative 4: Excavation of RIM Greater than 52.9 pCi/g Generally to 12 Feet with Optimization Plus Engineered Cover – Excavation of RIM with radioactivity levels greater than

52.9 pCi/g for combined radium and combined thorium that is generally located within 12 feet of the 2005 topographic surface of Areas 1 and 2. During the RD, the depth of excavation of RIM concentrations greater than 52.9 pCi/g will be optimized to achieve an equivalent degree of activity removal to Alternative 4 above. This optimization will be designed to target removal of RIM deeper than 12 feet up to 20 feet where excavation can be performed with little to no increase in setback and overburden, and to leave isolated pockets of relatively small volumes of RIM greater than 52.9 pCi/g in place between 8 and 12 feet where excavation would require a disproportional disturbance of non-RIM impacted waste to access it. During the optimization to achieve removal of radioactive activity between 12 and 16 feet, preference should be given to targeting those areas that exceed concentrations of 1,000 pCi/g. Nearly all RIM above 52.9 pCi/g down to a depth of 12 feet (as measured from the 2005 topographic surface) will be excavated and all RIM below a depth of 20 feet (as measured from the 2005 topographic surface) will be left in place. Nearly all RIM above 52.9 pCi/g down to a depth of 12 feet (as measured from the 2005 topographic surface) will be excavated, except for select areas specifically identified and approved by the EPA as relatively low concentration isolated pockets that require significant removal of non-RIM overburden and set-back to reach. All RIM below a depth of 20 feet (as measured from the 2005 topographic surface) will be left in place.

Any radiologically-contaminated soil on the Buffer Zone and Lot 2A2 Crossroads Industrial Park in excess of unrestricted use criteria would be excavated and sent off-site for disposal if above 52.9 pCi/g or placed on-site beneath the engineered cover if less than 52.9 pCi/g. Where possible, any excavated overburden with RIM at concentrations below 52.9 pCi/g would be placed towards the bottom of the excavation to reduce the future risks at the Site. After excavation is complete, an engineered cover meeting UMTRCA standards (as described in Alternative 3) would be placed over Areas 1 and 2. The design of the cover for Modified Alternative 4 also incorporates recommendations included in the EPA's guidance for final covers on RCRA Subtitle C hazardous waste landfills and would meet the RCRA Subtitle D municipal landfill cover regulations. Other remedial components, including ICs, long-term surveillance and maintenance, groundwater monitoring for radionuclides, and radon gas monitoring would be required. Because radionuclides above the unrestricted use criteria would remain at the Site, five-year review evaluations would be required.

Estimate of waste to be excavated:	218,100 yd^3
Estimate of RIM to be removed from Area 1 and managed in an on-site or off-site cell:	8,200 yd^3
Estimate of RIM to be removed from Area 2 and managed in an on-site or off-site cell:	67,300 yd^3
Estimated time to reach RAOs:	4.1 years
Estimated time to construct:	2.8 years
Estimated capital cost:	$229,000,000
Estimated annual OM&M cost:	$176,000 to $340,000
Estimated present worth at 7% discount rate:	$205,000,000

Expected outcome:	Majority of radioactivity removed leading to more long-term permanence; Land use would be restricted; Engineered cover would prevent direct exposure; Engineered cover would minimize infiltration of precipitation limiting leaching to groundwater; Achieves RAOs.
Key ARARs and TBCs:	UMTRCA Subpart A; RCRA Subtitle D; RCRA Subtitle C cover design guidance.

Alternative 5: Excavation of RIM Greater Than 1,000 pCi/g Plus Engineered Cover – Excavate RIM with radioactivity levels greater than 1,000 pCi/g at all depths. The 1,000 pCi/g criterion was selected to identify the higher concentration RIM at the Site for focused excavation. UMTRCA specifically addresses activity levels of 1,000 pCi/g and greater, and these levels are generally managed in secure disposal facilities in remote locations. This alternative would eliminate radioactivity in excess of what is typical for uranium mill tailings. This alternative requires deep excavation (up to 96 feet below the land surface) of the newer Bridgeton Landfill wastes in Area 1. Any radiologically-contaminated soil on the Buffer Zone and Lot 2A2 Crossroads Industrial Park in excess of unrestricted use standards would be excavated and sent off-site for disposal if above 1,000 pCi/g, or placed on-site beneath the engineered cover in Area 1 or 2 if less than 1,000 pCi/g. A full-scale pilot study to evaluate the ability to effectively separate RIM from landfill wastes and to segregate RIM by concentration to reduce the volume of material shipped off-site would be implemented for this option. Where possible, any excavated overburden that may contain RIM at concentrations below 1,000 pCi/g would be placed towards the bottom of the excavation to further reduce future risks at the Site. After excavation is complete, an engineered cover meeting UMTRCA standards (as described in Alternative 3) would be placed over Areas 1 and 2. The design of the cover for Alternative 5 also incorporates recommendations included in the EPA's guidance for final covers on RCRA Subtitle C hazardous waste landfills and would meet the RCRA Subtitle D municipal landfill cover regulations. Other remedial components, including ICs, long-term surveillance and maintenance, groundwater monitoring for radionuclides, and radon gas monitoring would be required. Because radionuclides above the unrestricted use criteria would remain at the Site, five-year review evaluations would be required.

Estimate of waste to be excavated:	683,700 yd^3
Estimate of RIM to be removed from Area 1 and managed in an on-site or off-site cell:	7,700 yd^3
Estimate of RIM to be removed from Area 2 and managed in an on-site or off-site cell:	31,000 yd^3
Estimated time to construct:	7 years
Estimated time to reach RAOs:	8.3 years
Estimated capital cost:	$379,000,000
Estimated annual OM&M cost:	$176,000 to $340,000

Expected outcomes:	Majority of radioactivity removed leading to more long-term permanence; Land use would be restricted; Engineered cover would prevent direct exposure; Engineered cover would minimize infiltration of precipitation limiting leaching to groundwater; Achieves RAOs.
Key ARARs and TBCs:	UMTRCA Subpart A; RCRA Subtitle D; RCRA Subtitle C cover design guidance.

Alternative 6: Risk Based Excavation of RIM Plus Engineered Cover - Excavate all RIM to a depth that would be protective of anticipated future land uses. Risk estimates were developed for exposures for a future on-site storage yard worker to the remaining RIM after backfilling the excavation with non-RIM materials, but prior to the installation of the cover system. To achieve these goals, RIM located within 2.2 feet of the regraded surface of Area 1 and Area 2 must be excavated and backfilled with non-RIM material. As a result, this alternative ensures at least 7.2 feet of shielding between the ground surface and RIM after the placement of the engineered cover.

Any radiologically-contaminated soil above unrestricted use on the Buffer Zone and Lot 2A2 Crossroads Industrial Park will be removed and disposed of off-site. After excavation is complete, an engineered cover meeting UMTRCA standards (as described in Alternative 3) would be placed over Areas 1 and 2. The design of the cover for Alternative 6 also incorporates recommendations included in the EPA's guidance for final covers on RCRA Subtitle C hazardous waste landfills and would meet the RCRA Subtitle D municipal landfill cover regulations. Other remedial components, including ICs, long-term surveillance and maintenance, groundwater monitoring for radionuclides, and radon gas monitoring would be required. Because radionuclides above the unrestricted use criteria would remain at the Site, five-year review evaluations would be required.

Estimate of waste to be excavated:	103,600 yd^3
Estimate of RIM to be removed from Area 1 to be managed in an on-site or off-site cell:	2,200 yd^3
Estimate of RIM to be removed from Area 2 to be managed in an on-site or off-site cell:	13,400 yd^3
Estimated time to construct:	2.6 years
Estimated time to reach RAOs:	4.1 years
Estimated capital cost:	$187,000,000
Estimated annual OM&M cost:	$176,000 to $340,000
Estimated present worth at 7% discount rate:	$165,000,000

Expected Outcome:	Some radioactivity removed leading to small increase in long-term permanence; Land use would be restricted; Engineered cover would prevent direct exposure; Engineered cover would minimize infiltration of precipitation limiting leaching to groundwater; Achieves RAOs
Key ARARs and TBCs:	UMTRCA Subpart A; RCRA Subtitle D; RCRA Subtitle C cover design guidance.

Alternative 7: Excavation of RIM Greater Than 7.9 pCi/g with Off-Site Disposal in Engineered Cell – Excavation of all RIM in Areas 1 and 2, including deep excavation (up to 96 feet below the land surface) of the newer Bridgeton Landfill wastes overlying portions of Area 1. Removal of RIM greater than 7.9 pCi/g is expected to leave Areas 1 and 2 in a condition that would not require additional engineering and Ics due to their radiological content even though some residual radioactive material may remain on-site. This level is based on attainment of risk-based radiological cleanup levels specified in OSWER Directives 9200.4-25 and 9200.4-18.

Any radiologically-contaminated soil on the Buffer Zone and Lot 2A2 Crossroads Industrial Park above levels allowing unrestricted use would be excavated and disposed of off-site. RIM would be sorted, loaded, and transported for disposal at an off-site facility. A full-scale pilot study to evaluate the ability to effectively separate RIM from landfill wastes and to segregate RIM by concentration to reduce the volume of material shipped off-site would be implemented for this option. The remaining solid waste materials would then be regraded to meet the minimum (5%) and maximum (25%) slope criteria. A landfill cover, meeting the Missouri closure and post-closure care requirements for sanitary landfills, would then be installed over Areas 1 and 2. Surface water runoff controls, groundwater monitoring, and landfill gas monitoring and control would then be designed, installed and maintained as necessary.

Estimate of waste to be excavated:	1,820,700 yd^3
Estimate of RIM to be removed from Area 1 and managed in an off-site cell:	58,700 yd^3
Estimate of RIM to be removed from Area 2 and managed in an off-site cell:	251,000 yd^3
Estimated time to construct:	13.3 years
Estimated time to reach RAOs:	14.6 years
Estimated capital cost:	$695,000,000
Estimated annual OM&M cost:	$176,000 to $340,000
Estimated present worth at 7% discount rate:	$455,000,000

Expected Outcomes:	All radioactivity removed leading to maximum long term-permanence; For purposes of RCRA Subtitle D, land use would be restricted, landfill cover would prevent direct exposure, landfill cover would minimize infiltration of precipitation limiting leaching to groundwater; Achieves RAOs.
Key ARARs:	UMTRCA Subpart B; RCRA Subtitle D.

Alternative 8: Excavation of RIM Greater Than 7.9 pCi/g with Disposal in an On-Site Engineered Cell – Excavation of all RIM in Areas 1 and 2, including deep excavation (up to 85 feet below the land surface) of the newer Bridgeton Landfill wastes overlying Area 1. Excavated RIM would be disposed in a new engineered on-site disposal cell. Removal of RIM greater than 7.9 pCi/g is expected to leave Areas 1 and 2 in a condition that would not require additional engineering and Ics due to their radiological content, even though some residual radioactive material may remain on-site. Any radiologically-contaminated soil on the Buffer Zone and Lot 2A2 Crossroads Industrial Park in excess of unrestricted use would be excavated and placed in the on-site cell. The on-site cell would be constructed to meet the UMTRCA standards, and would include a liner, an engineered cover meeting as described in Alternative 3 (the design of the cover for Alternative 8 also incorporates recommendations included in the EPA's guidance for final covers on RCRA Subtitle C hazardous waste landfills and would meet the RCRA Subtitle D municipal landfill cover regulations), and a leachate collection system. The current Bridgeton Landfill soil stockpile area, which is outside of the geomorphic flood plane was evaluated as the location of the on-site disposal cell for purposes of the FFS; however, other locations within the landfill complex may be considered for the on-site disposal cell, if necessary. The final location of the on-site cell would be determined as part of the RD. A landfill cover, meeting the Missouri closure and post-closure care requirements for sanitary landfills, would then be installed over Areas 1 and 2. Surface water runoff controls, groundwater monitoring, and landfill gas monitoring and control would then be designed, installed and maintained as necessary.

Estimate of waste to be excavated:	1,820,700 yd^3
Estimate of RIM to be removed from Area 1 and managed in an on-site cell:	58,700 yd^3
Estimate of RIM to be removed from Area 2 and managed in an on-site cell:	251,000 yd^3
Estimated time to construct:	13.5 years
Estimated time to reach RAOs:	14.8 years
Estimated capital cost:	$591,000,000
Estimated annual OM&M cost:	$182,100 to $444,100
Estimated present worth at 7% discount rate:	$391,000,000

Expected outcome:	All radioactivity relocated to lined, on-site engineered cell leading to improved long-term permanence; Land use would be restricted; Engineered cover would prevent direct exposure; Engineered cover would minimize infiltration of precipitation limiting leaching to groundwater; Achieves RAOs.
Key ARARs and TBCs:	UMTRCA Subparts A and B; RCRA Subtitle D; RCRA Subtitle C cover design guidance.

10.0 Summary of Comparative Analysis of Alternatives

As set forth in the NCP at 40 C.F.R. § 300.430(e)(9)(iii), nine criteria are used to evaluate each remedial alternative individually and to perform a relative comparative analysis of the alternatives against each other to select a remedy. The nine evaluation criteria are (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, or volume of contaminants through treatment; (5) short-term effectiveness; (6) implementability; (7) cost; (8) state/support agency acceptance; and (9) community acceptance. The nine evaluation criteria fall into three categories: threshold criteria, primary balancing criteria, and modifying criteria. Overall protection of human health and the environment and compliance with ARARs are the threshold criteria. An alternative must meet the threshold criteria. The next five criteria are the primary balancing criteria. These criteria are used to assess the relative advantages and disadvantages of each alternative. The last two are the modifying criteria. These allow for consideration of state and community issues and concerns. This section summarizes the relative performance of each alternative against the nine criteria, noting how it compares to the other options under consideration.

10.1 Overall Protection of Human Health and the Environment

This criterion addresses whether the alternative provides adequate protection of human health and the environment, and how well the risks posed through each exposure pathway are eliminated, reduced or controlled through treatment, engineering controls and/or ICs.

Except for the No Action Alternative, all of the other alternatives in the Proposed Plan (Alternatives 2 through 8) are protective of human health and the environment, and would achieve the site-specific RAOs through the use of engineered containment, alone or in conjunction with excavation, and placement of RIM in an on- or off-site engineered cell combined with long-term monitoring, maintenance, and ICs. The Amended Remedy, which is a modification of Alternative 4, is also fully protective of human health and the environment, and will achieve the site-specific RAOs.

10.2 Compliance with ARARs

Section 121(d) of CERCLA, 42 U.S.C. § 692l(d), requires that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations which are collectively referred to as ARARs, unless such ARARs are waived under CERCLA § 121(d)(4).

Alternatives 2 through 8 and the Modified Alternative 4 could all meet chemical, location, and action-specific ARARs, but additional data would need to be collected as a part of the RD to confirm that all required landfill siting criteria could be met for Alternative 8 for an on-site disposal cell. The design of the engineered cover system required for Alternatives 3 through 6 and the Modified Alternative 4 will meet the standards for control of residual radioactive materials required in UMTRCA Subpart A, as well as portions of RCRA Subtitle D and design criteria typically associated with hazardous waste landfills.

Under Alternative 7, all RIM would be removed from Area 1 and Area 2 in accordance with the cleanup standards in UMTRCA Subpart B and managed in an off-site engineered cell. Therefore, the on-site engineered cover system for Areas 1 and 2 only needs to comply with the solid waste closure requirements in RCRA Subtitle D. All off-site shipments of radioactive or hazardous wastes, if encountered, will be performed in accordance with requirements that address the proper transportation and disposal of waste at an off-site disposal facility.

Under Alternative 8, all RIM would be removed from Area 1 and Area 2 and managed in an on-site engineered cell. Therefore, the on-site engineered cover system for Areas 1 and 2 only needs to comply with the solid waste closure requirements in RCRA Subtitle D, but the on-site cell requires both an engineered cover and liner that must comply with UMTRCA Subpart A, as well as portions of RCRA Subtitle D and design criteria typically associated with hazardous waste landfills. Area 1 and 2 would need to meet the requirements of UMTRCA Subpart B. The new on-site engineered cell must meet the standards for control of residual radioactive materials required in UMTRCA Subpart A, as well as portions of RCRA Subtitle D and design criteria typically associated with hazardous waste landfills. The on-site engineered cover system for Areas 1 and 2 only needs to comply with the solid waste closure requirements in RCRA Subtitle D.

Other regulations that are key ARARs for all the remedy alternatives including Modified Alternative 4 include: the National Emissions Standards for Hazardous Air pollutants (NESHAP) 40 C.F.R. § 61.222, standards in the Clean Water Act, Missouri Water Quality Standards, and Missouri Stormwater regulations.

10.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain on-site following remediation and the adequacy and reliability of controls. The NCP states that balancing of the nine criteria shall emphasize long-term effectiveness and permanence (40 C.F.R. § 300.430(f)(1)(ii)(E)). The EPA considered this emphasis when selecting the Amended Remedy. “Long-term effectiveness includes a consideration of the residual risk remaining at a site after the remedial action is complete...The potential for this risk may be measured by numerical standards such as cancer risk levels or the volume or concentration of contaminants in waste, media, or treatment residuals remaining on site” (55 FR 8720). The EPA has considered potential residual risks through both numerical standards and with respect to radioactivity that will remain on-site. Radioactivity is the product of the concentration, volume and density of RIM. The EPA has concluded that the long-term permanence of each remedy can be compared using numerical estimates of risk and the radioactivity removed since this is directly related to the volume and concentrations of RIM removed. In addition, removal of radioactive source material permanently reduces the threat posed by the Site. Removal of radioactive material closer to the surface or reducing the maximum concentrations of radionuclides near the surface, reduces the long-term risks and decreases the exposure potential if a subsurface heating event were to occur or if the cover becomes damaged.

All the remedial alternatives, including Modified Alternative 4, reduce the lifetime cancer risk levels to on-site workers and the general public to the lower end, or below, the target cancer risk range of 10^{-4} to 10^{-6}. All alternatives require a landfill cover to prevent direct contact with contaminants, mitigate exposures to gamma radiation and radon, and prevent infiltration of precipitation into the landfill and subsequent leaching of RIM, or other landfill wastes, to the groundwater.

Alternatives 4, 5, 6, and Modified Alternative 4 include partial removal of RIM with off-site disposal; while Alternative 7 requires removal of all RIM with off-site disposal. Each of these alternatives (4,5,6, 7 and modified 4) permanently reduces the amount of radioactivity and volume of RIM that would remain at the Site.

Alternative 6 focuses on removal of RIM that has the potential to cause an unacceptable risk to a future worker on Area 1 and 2 if there were no engineered cover. This alternative results in removal of all RIM to a shallow depth of about two feet below the expected regraded landfill surface. It results in the removal of a small volume of RIM and a very small amount of radioactivity, and therefore, leaves a majority of the RIM and radioactivity. The engineered cover is needed to minimize infiltration of precipitation and surface water into Area 1 and 2, which could result in increased leaching of contaminants to groundwater. Alternative 6 also reducing the lifetime cancer risk levels to below the target cancer risk range of 10^{-4} to 10^{-6}.

Alternatives 4, 5, and Modified Alternative 4 focus on removing RIM at specific concentrations and depths. Each of these alternatives result in the removal of a majority of the radioactivity. Of these, Alternative 5 results in the removal of the least volume of RIM, but reduces the concentrations of RIM that remain at the Site to no more than 1,000 pCi/g. Alternative 4 and Modified Alternative 4 result in removal of about twice the volume of RIM and slightly more radioactivity than Alternative 5. For Alternative 4, concentrations of RIM are limited to no more than 52.9 pCi/g down to a depth of 16 feet below the 2005 topographical surface. For Modified Alternative 4, concentrations of RIM are limited to no more than 52.9 pCi/g generally down to 12 feet below the 2005 topographical surface, but in all cases at least 8 feet below the 2005 topographical surface. Modified Alternative 4 also includes removal of some RIM at concentrations above 52.9 between 12 and 20 feet below the 2005 topographical surface. The EPA expects these deeper excavations to target higher concentrations of RIM (e.g. greater than 1,000 pCi/g). Modified Alternative 4 will result in the removal of the same amount of radioactivity as Alternative 4; however, Modified Alternative 4 may be a more reliable remedy in the long term if the excavation optimization results in on-site management of less higher concentration radioactive material.

Alternative 8 includes excavation of all RIM with disposal in an on-site cell that includes both a liner and engineered cover. This alternative leaves all the RIM on-site, but reduces potential leachability of the contaminants, unlike Alternative 2 and 3, which contain all the RIM in Areas 1 and 2 without a liner.

The proposed landfill covers for each alternative will be designed to prevent direct contact with contaminants, mitigate exposures to gamma radiation and radon, and prevent infiltration of precipitation into the landfill and subsequent leaching of RIM or other landfill wastes to the groundwater. The UMTRCA engineered cover for Alternatives 3 through 8 would have a lower permeability (1×10^{-7} vs 1×10^{-5} cm/sec) than the cover in Alternative 2, allowing less infiltration of precipitation into the landfill, and thereby reducing the potential for leaching of contaminants. In addition, the bio-intrusion layer in the UMTRCA engineered cover for Alternatives 3 through 8 is placed on top of the low permeability layer, increasing the longevity of the cover system.

Potential impacts from severe weather and natural disasters, such as a tornado or flooding, were evaluated for each alternative and are not expected to result in unacceptable exposures. Flooding is not expected to impact the long-term performance of the alternatives because the Site is located more than 1.3 miles from the Missouri River and the OU-1 landfill areas are above the 500-year flood level, except for a narrow area along the eastern toes of Areas 1 and 2. If the 500-year Earth City levee system fails or ceases to exist, a 500-year flood event is not expected to include high-energy water flows due to the landfill's distance of over one-mile from the river, and is anticipated to cause approximately two feet of flood waters to contact the toes of Areas 1 and 2. Due to the length of time this remedy must remain protective, geologic and anthropogenic uncertainties will be considered during design of the required rock armoring along the toes of the landfill. The vertical height of this flood protection feature would be subject to design phase evaluations, but is expected to include a margin of safety greater than the 500-year flood level. Although the Buffer Zone and Lot 2A2 are located within the 500-year floodplain, all the alternatives include removal or relocation of radioactively contaminated soil, which would allow for unrestricted use in these locations.

10.4 Reduction of Toxicity, Mobility, or Volume of Contaminants Through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy. The EPA further considered treatment of RIM by evaluating additional technologies in the FFS. This included additional stabilization and segregation technologies. Some of the evaluated treatment technologies have been effectively used to treat radionuclides in soil, but there are no known practicable applications of the technologies for treatment of radionuclides in solid wastes. Treatment was determined not to be practicable primarily due to the heterogenous nature of the landfills and the limited treatment technologies effective for radionuclides. As a result, none of the remedial alternatives will reduce the toxicity, mobility, or volume of the contaminants through treatment.

None of the alternatives will reduce toxicity, mobility, or volatility through treatment for Lot 2A2 or the potions of the Buffer Zone not utilized to construct the Area 2 engineered cover.

10.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup goals are achieved.

The short-term risks to the general public and surrounding community expected from implementation of any of the alternatives evaluated are all within or below the CERCLA acceptable risk range. These exposure scenarios were developed using reasonable maximum exposure parameters, and the risk estimates do not include consideration of engineering controls or best management practices. Therefore, these risks are considered high-end and are anticipated to decrease with the appropriate use of engineering controls and best management practices.

The short-term effectiveness of Alternatives 2 and 3 is considered high because they can be implemented in 2.8 years and require excavation and regrading of only 112,000 bank cubic yards of landfill wastes. Some of this waste is expected to be RIM. It is anticipated that there will be odors associated with these alternatives and a wildlife mitigation plan will still be necessary. Alternatives 2 and 3 would result in the lowest short-term impacts and increased truck traffic would be limited to transporting the engineered cover materials to the Site.

Because Alternatives 7 and 8 take approximately 14 years to complete and require excavation and handling approximately 1.8 million cubic yards of landfill wastes, the short-term effectiveness of these alternatives is considered to present greater risk throughout the duration of implementing the remedy. As stated above, excavation and handling of putrescible wastes creates odors and attracts wildlife, including birds. These alternatives would also require excavation of several hundred thousand cubic yards of newer wastes located in the North Quarry portion of the Bridgeton Landfill. The potential to generate odors and attract wildlife is greater for these wastes. In addition, excavation in this portion of the landfill could allow oxygen intrusion into the wastes, which could negatively impact the operation of the Bridgeton Landfill and potentially cause a subsurface heating event. Alternative 7 would likely increase truck traffic in the area by potentially requiring transport of RIM to a nearby rail spur. Alternative 8 (excavation and on-site disposal of all radioactive contamination above 7.9 pCi/g) would not include this increased truck traffic. However, Alternative 8 results in the greatest potential off-site risk to the public due to the duration of implementation and the potential location of the engineered cell near residences. The short-term risk from Alternative 8 is still within the CERCLA acceptable risk range.

All of the remedial alternatives potentially pose increased cancer risks to remediation workers. The risks to workers associated with the excavation alternatives (Alternatives 4, modified 4, 5, 6, 7, and 8) are higher than those associated with the two containment/cover only alternatives (Alternatives 2 and 3). In general, deeper excavations, handling larger volumes or higher concentrations of RIM, and RIM staging and loading activities increase the potential for worker exposure. Therefore, risks to workers are considered highest among the excavation alternatives for Alternatives 5, 7 and 8, and lowest for Alternative 6. The worker risks estimated for Alternative 4 and Modified Alternative 4 fall in between the other excavation alternatives, but the construction schedule for Modified Alternative 4 is less than Alternative 4, so the worker risks are also less.

For all of the alternatives, worker exposures would be closely monitored, and engineering and best management practices would be implemented to reduce exposures to within acceptable levels. Risks to workers from exposure to gamma radiation will be mitigated by developing work practices that minimize the time spent in proximity to RIM to that which is necessary to perform radiation surveys and collect samples. If necessary, these exposures can be further reduced by alternating radiation technicians between jobs that result in little or no exposure to gamma radiation with jobs that could potentially result in higher exposures to gamma radiation. All remediation workers will be trained for working around and handling radioactive materials.

Stormwater management would be required during implementation of all alternatives. Alternatives that require larger and deeper excavations over longer periods of time, such as Alternatives 5,7 and 8, would require more stormwater and leachate management than Alternatives 2, 3, 4, Modified 4, and 6. Alternative 8 will require stormwater management during both the excavation of RIM and construction of the new disposal cell. The longer an alternative takes to implement, the greater the potential for impacts from severe weather.

During construction of the remedy, concerns regarding oxygen intrusion or other actions causing or aggravating a subsurface heating event, or starting a landfill fire, are greater. Compared to the Bridgeton Landfill, the potential for an occurrence of a subsurface heating event in OU-1 (Areas 1 and 2) is reduced due to the greater age (approximately 30+ years) and higher degree of decomposition of waste materials. The newer waste in the northern portion of the North Quarry of Bridgeton Landfill overlying the southwestern portion of Area 1 is more susceptible to a subsurface heating event due to oxygen intrusion. Therefore, additional care must be taken if that waste is disturbed. Alternatives 5, 7 and 8 all require excavation in this newer waste, which could increase the potential for a subsurface heating event. After completion of the remedy, Alternatives 7 and 8 would eliminate the potential future exposures which could result from a subsurface heating event coming into contact with RIM in Area 1 or Area 2. The proposed location of the on-site disposal cell for Alternative 8 is separated from any of the other landfill cells currently at the Site so a subsurface heating event cannot move from an adjacent landfill into the new disposal cell.

The time frame to achieve the RAOs varies from 2.8 years to 14.8 years. The engineered cover remedies (Alternatives 2 and 3) are estimated to take the shortest time to achieve RAOs and the full excavation of RIM greater than 7.9 pCi/g with off-site or on-site disposal in an engineered cell (Alternatives 7 and 8) are projected to take the longest. The time frame to achieve RAOs is largely driven by the depth and volume of material excavated, the degree of handling that must occur, and the level of toxicity of the materials being handled. The number of years to achieve the RAOs for each alternative is presented below. These time frames include the time to design and construct the remedy.

	Alt. 2	Alt. 3	Alt. 4	Modified Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt 8
Time to Achieve RAOs (years)	2.8	2.8	5.0	4.1	8.3	4.1	14.6	14.8

10.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Installation of engineered landfill covers, excavation and off-site disposal of waste materials, and implementation of ICs are all technically feasible and have been implemented at other similar CERCLA sites. Monitoring of landfill cover surfaces, landfill gas, radon, groundwater, and surface water are also implementable. While construction of an on-site disposal cell is readily implementable at some CERCLA sites, there is some uncertainty in whether an on-site disposal cell can comply with all ARARs. Nevertheless, the EPA anticipates that the on-site disposal cell required for Alternative 8 could be implemented, but additional geotechnical testing/evaluation would be required during the RD.

Excavation of wastes is required for all the alternatives and implementation of each remedy will require engineering controls or best management practices to mitigate the following impacts:

- Management of exposure to construction workers during remedy implementation;
- Management of fugitive dust and potential odors;
- Management and treatment of stormwater, particularly stormwater exposed to RIM or other waste during excavation;
- Mitigation of bird hazards; and

- Identification, segregation, and off-site disposal of any hazardous wastes or regulated asbestos or PCB-containing materials that may be encountered during RIM excavation.

The degree of difficulty necessary to mitigate or manage these impacts varies between the alternatives, and in general, increases with the volume of material and depth of excavation; the number of times materials have to be handled; and the duration of the project. Potential impacts to existing Site infrastructure, as well as excavating in newer municipal solid waste, such as that disposed of in the North Quarry of Bridgeton Landfill adjacent to and overlying Area 1, exacerbates many of the existing implementability concerns. In particular, the 1,000 pCi/g Excavation (Alternative 5), and the two alternatives that excavate all RIM (Alternatives 7 and 8) would require deep excavation in Area 1 and significant excavation of the newer wastes in the North Quarry. These deeper excavations to access RIM, and the controls required to mitigate impacts described above, create additional challenges for implementation. In comparison, alternatives which do not require excavating North Quarry wastes (Alternatives 2, 3, 4, modified 4, and 6) offer implementability advantages in terms of reduced odors, bird risks, likelihood of an exothermic reaction or landfill fire, and implementation duration. Alternatives 2 and 3 require excavation of the least amount of landfill waste, and are therefore, the most implementable.

All the remedy alternatives require ICs, but there are no anticipated issues with establishing these controls.

All of the action alternatives require excavation of radiologically impacted soils sufficient to allow for UU/UE for the Lot 2A2 and the portions of the Buffer Zone not utilized to construct the Area 2 engineered cover. The EPA has determined that this will require returning the concentrations of the radiological contaminants for the Site to within background. This remedy is implementable.

10.7 Cost

Cost includes estimated capital and operation and maintenance costs as well as present worth costs. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.

Capital (construction), annual OM&M, and total present worth estimates were developed for each alternative. The standard discount rate of 7% was applied, but in recognition of the extended project duration for some alternatives, and variability of the value of money over very long periods of time, discount rates of 0.7% and non-discounted costs were also calculated and compared. Costs were calculated with project durations of 30, 200 and 1,000 years for those alternatives that could potentially need OM&M to continue for thousands of years, consistent with EPA guidance, and are presented in the table below.

Annual OM&M costs include environmental sampling and reporting expenses, inspection and maintenance costs for landfill covers, monitoring wells, leachate systems or any other required component of the remedy. The costs are listed as a range because required actions may vary from year to year.

The highest capital costs are associated with Alternatives 7 and 8, while the lowest capital costs are associated with Alternatives 2 and 3. The capital costs of the partial excavation alternatives fall squarely in the middle, ranging from about two to four times the cost of Alternatives 2 and 3 and about one third to one half of Alternatives 7 and 8. A similar cost comparison is seen for the present worth cost estimates regardless of discount rate or project duration. A distinguishing feature of these comparisons is the range of the present worth cost estimates. Consistent with EPA guidance on developing cost estimates for Feasibility Studies, the EPA has also considered non-discounted costs for comparison purposes only. For each alternative that results in containment of RIM on-site, project durations were set at 30-year, 200-year, and 1,000-year periods in accordance with EPA guidance and the UMTRCA regulations. Comparing Alternative 7 to Modified Alternative 4, the 1,000 non-discounted costs for Alternative 7 are still nearly twice as much as Modified Alternative 4.

Cost	Alt. 2	Alt. 3	Alt. 4	Modified Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt 8
Present worth at 7% (millions)	$71	$90	$236	$205	$287	$165	$455	$391
Present worth at 0.7% (millions)	$79	$100	$275	$231	$372	$189	$667	$568
Capital construction (millions)	$75	$96	$274	$229	$379	$187	$695	$591
Non-discounted total costs (30 years) (millions)	$80	$102	$280	$235	$384	$192	$699	$596
Non-discounted total costs (1,000 years) (millions)	$265	$287	$464	$412	$569	$377	$699	$788
Operations, Monitoring & Maintenance (per year)	$176 ,000 to 340,000	$176 ,000 to 340,000	$176 ,000 to 340,000	$176 ,000 to 340,000	$176 ,000 to 340,000	$176 ,000 to 340,000	$176 ,000 to 340,000	$182 ,100 to 444,100

10.8 State Acceptance

The MDNR assists the EPA in its oversight role and provides review and comments on Site documents. The state of Missouri concurred with EPA's Amended Remedy in a September 25, 2018 letter:

> "The Missouri Department of Natural Resources has reviewed the Record of Decision (ROD) Amendment for Operable Unit 1 (OU-1) of West Lake Landfill. The Department concurs with EPA's selected amended remedy as presented in this ROD Amendment.
>
> As the site progresses toward remedial design, the Department will continue to support EPA's efforts during implementation of the remedial components. Since Radiologically Impacted Material will remain at this site, the Department recognizes the need for perpetual care and monitoring and will work with EPA to develop durable long-term stewardship and monitoring plans. The ROD Amendment indicates that EPA will negotiate financial assurance with the responsible parties. The Department requests that these negotiations establish durable financial

> instruments to protect state and local jurisdictions from bearing the cost of long-term stewardship."

The Amended Remedy also reflects input received during the comment period supporting the excavation of RIM, but recognizing the challenges associated with this unique large-scale excavation.

10.9 Community Acceptance

During the public comment period, the EPA received letters and emails from more than 4,000 different commenters, as well as comments received during the public meeting held on March 6, 2018. Comments were received from community activists, local officials, business owners, PRPs and many citizens consisting of both local residents and citizens from outside the St. Louis metropolitan area.

Of the public comments received, some expressed a preference for full excavation of the RIM and off-site disposal at a licensed disposal facility. Many of those in support of full excavation expressed concern about the Site being in a floodplain, protection of the water supply, concerns about natural disasters such as earthquakes and tornadoes and a preference to avoid long-term management of waste left on-site. Conversely, some of the commenters were opposed to moving the waste off-site, with a significant number of those in support of capping the waste in place. Those in support of leaving the waste on-site expressed concern about exposures for remediation workers, spreading contaminated dust during excavation, truck and rail accidents during off-site transportation of excavated waste and damage to Missouri roads and bridges. A large number of commenters requested relocation of residents near the Site, some supporting offers of permanent relocation, while others supported temporary relocation during remediation activities. Commenters identified as PRPs did not support the EPA's Preferred Alternative identified in the Proposed Plan, Alternative 4, and instead preferred one of the capping alternatives. The PRP commenters proposed an alternative excavation depth of 12 feet and action level of 100 pCi/g, if the EPA did not select a capping alternative and instead selected an excavation remedy.

The public comments and the EPA's responses are found in Part III, the Responsiveness Summary.

11.0 Principal Threat Wastes

The NCP at 40 C.F.R. § 300.430(a)(l)(iii)(A) establishes an expectation that the EPA will use treatment to address the principal threats posed by a site wherever practicable. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur.

After issuing the 2008 ROD, the EPA has determined that some RIM located at the Site exhibits toxicity and mobility characteristics that may represent principal threat waste. The updated BRA demonstrates that RIM at the Site has the potential to cause future risk to the reasonably maximally exposed (RME) individual that exceeds 1×10^{-2} excess cancer should exposure occur. These risks are two orders of magnitude greater than what was estimated in the original OU-1 BRA. Therefore, some of the RIM at the Site presents a significant risk to human health should exposure occur.

RIM is also labile due to the decay of Th-230, one of the primary COCs, to Ra-226 and eventually into radon, which is a gas, and is correspondingly more mobile and more toxic.

Finally, sequential extraction tests and SBLT conducted in 2015 indicated that RIM from site-specific samples can leach under laboratory conditions intended to simulate a mature landfill environment.

Therefore, the combination of toxicity, lability, and mobility of the radioactive materials indicates that some RIM may represent principal threat waste.

12.0 Selected Amended Remedy

Areas 1 and 2:

The Amended Remedy for OU-1 is to excavate RIM at concentrations greater than 52.9 pCi/g (Ra-226 + Ra-228 or Th-230 + Th-232) generally down to a depth of 12 feet below the 2005 ground surface. Excavated RIM greater than 52.9 pCi/g will be disposed of off-site in a permitted facility.

During the RD, an excavation plan will be developed that will achieve the same long-term effectiveness and permanence associated with the EPA's Preferred Remedy identified in the Proposed Plan, Alternative 4, while minimizing the short-term impacts on the community and on-site workers. The plan will identify a limited number of targeted deeper excavations between 12 and 20 feet, focusing on the priority to remove RIM greater than 1,000 pCi/g where practicable without greatly increasing the excavation of non-RIM, and a limited number of isolated pockets of RIM (see Figures 17 and 18) to be left in place between 8 and 12 feet, again with a focus on limiting the excavation of non-RIM.

Following the excavation of the RIM, the Site will be regraded to accommodate and support the construction over Areas 1 and 2 of a low permeability engineered cover meeting stringent cover design criteria found in RCRA Subtitle C guidance, UMTRCA standards, and the MDNR RCRA Subtitle D landfill requirements. The engineered cover will be designed to limit radon releases, minimize infiltration of rainwater and potential subsequent leaching of residual radioactive materials to groundwater, and be effective for at least 200 and up to 1,000 years. The engineered cover will be designed to achieve the lower permeability coefficient consistent with the recommendations in the EPA's guidance for final covers on hazardous waste landfills to ensure the performance standards in the UMTRCA can be met. The implemented remedy will require inspections, monitoring and maintenance at an estimated OM&M cost of $176,000 to $340,000 per year, depending on the activities being conducted in each year.

Minimizing infiltration and potential leaching of radionuclides to groundwater using an engineered cover is consistent with any remedial actions that may be warranted under CERCLA at OU-3. The nature and extent of groundwater contamination will be characterized during the OU-3 investigation, and if warranted, a decision under CERCLA will be made regarding groundwater based on the OU-3 investigation results.

The Amended Remedy also includes engineering and ICs to restrict future uses of the Site and ensure the integrity of the engineered cover; long-term surveillance and maintenance; groundwater monitoring; storm water controls; gas monitoring and controls, as needed; and leachate management and control as needed. These controls are especially important because radioactive materials at the Site are such that risks posed by the radionuclides will increase over approximately the next 9,000 years and then start to decrease, due to the radioactive decay process. Excavation of a majority of the radioactivity, in combination with the installation and maintenance of an engineered cover and land use controls, will prevent exposure and unacceptable risks in the future. The EPA will also conduct statutory reviews of the remedy at a minimum of every 5 years to ensure the remedy remains protective.

Buffer Zone and Lot 2A2:

On the adjacent Lot 2A2 and the Buffer Zone, radioactive contaminated soils will be excavated where concentrations exceed background to allow for UU/UE of those areas. Additional background characterization will be performed as a post-ROD activity to determine statistically valid background concentrations for the Buffer Zone and Lot 2A2.

12.1 Summary of the Rationale for the Amended Remedy

The Amended Remedy is protective of human health and the environment, complies with ARARs, and provides the best balance of tradeoffs among the balancing criteria. The calculated long-term residual risk to the RME for the Amended Remedy is 5.4×10^{-6}. The Amended Remedy will achieve long-term effectiveness and permanence by partially excavating RIM and moving it off-site for proper handling at a permitted facility. The Amended Remedy is cost effective and is responsive to public comments received on the Proposed Plan.

The EPA carefully evaluated all nine criteria for each alternative in accordance with the NCP. All remedial alternatives described in this Amendment to the ROD, except No Action, are protective of human health and the environment, and all the alternatives would comply with ARARs. Upon consideration of additional information received during the public comment period, the EPA has selected a remedy that is a modified version of EPA's Preferred Remedy identified in the Proposed Plan, Alternative 4. The EPA has determined that this modified excavation remedy improves the balance of the nine criteria.

The Amended Remedy reduces some of the implementability challenges (e.g., eliminating relocation of existing infrastructure) and short-term impacts associated with excavation (e.g., reducing odors and the potential for the attraction of birds). The excavation depth of 12 feet was determined to be appropriate through further review of the RIM analytical data collected in Area 1 and 2, which show there are very few occurrences of RIM greater than 52.9 pCi/g between 12 and 16 feet in depth. Generally reducing the depth of excavation, and the related management of setback and overburden, simplifies implementation of the remedy. The other excavation alternatives either require deeper excavation, involve the handling of more overburden and setback, or do not include a significant permanent reduction of radioactivity in the landfill. The Amended Remedy is not expected to require relocation of the Transfer Stations and a buyout of the Asphalt Plant. Therefore, the Amended Remedy is a more implementable excavation remedy, and still maintains a high degree of permanence.

Short-term effectiveness at this Site is directly influenced by the amount of wastes excavated, whether RIM or non-RIM. Excavation affects the time to construct the remedy, risks to workers and residents, fugitive dust, and odors. The Amended Remedy does not require excavation of the newer Bridgeton Landfill waste above portions of Area 1, thereby limiting the potential for oxygen intrusion and reducing the possibility of a subsequent subsurface heating event or landfill fire in the North Quarry of the Bridgeton Landfill. Since part of the Site is located within 10,000 feet of the St. Louis Lambert International Airport, attracting wildlife, especially birds, is also a concern with the excavation of waste and will require a wildlife hazard management plan. The selected Amended Remedy includes excavation, but takes these concerns into consideration and seeks to reduce the total volume of waste that must be excavated and the size of excavations that would be open. The RD will seek to minimize the total volume of landfill waste to be excavated, while maintaining long-term protectiveness and permanence. During the RD, an evaluation will be performed to identify isolated pockets of RIM to be left at depths between 8 and 12 feet that, if excavated, would require excavation of large volumes of non-RIM waste as overburden and setback. Any isolated pocket of RIM that is not excavated will be offset by the removal of an equivalent amount of activity elsewhere in Areas 1 and 2 between 12 and 20 feet in order to achieve the same long-term effectiveness and permanence as the Preferred Alternative in the Proposed Plan, Alternative 4. By reducing the total amount of overburden and setback waste excavated in this fashion, the negative short-term impacts to the community and workers can be reduced.

Short-term risks to nearby community members during the construction of the Amended Remedy have been conservatively estimated to be below the target cancer risk range of 10^{-4} to 10^{-6} (i.e., 7.7×10^{-7}). Typical engineering controls associated with excavation will be implemented during the RA to further reduce these risks.

Short-term risks to workers have been conservatively estimated to exceed the target cancer risk range (2.0×10^{-3}) without consideration of any engineering controls or health and safety practices to mitigate these risks. These risks are directly related to the duration of excavation activities which in turn is determined by the total volume of waste being excavated. The Amended Remedy is expected to take 2.8 years to construct which is nearly a year shorter than Alternative 4, thereby reducing the potential short-term risks. In addition, short-term risks to remediation workers will be mitigated through a combination of engineering controls, personal protective equipment, and monitoring. Remediation worker exposures will not exceed federal and state worker protection standards, including occupational safety and health standards established 29 C.F.R. § 1910 and radiation protection standards established in 10 C.F.R. 20.

The NCP states at 40 C.F.R. § 300.430(f)(1)(ii)(E) that balancing of the nine criteria shall emphasize long-term effectiveness and permanence. The EPA considered this emphasis when selecting the Amended Remedy. "Long-term effectiveness includes a consideration of the residual risk remaining at a site after the remedial action is complete. . . . The potential for this risk may be measured by numerical standards such as cancer risk levels or the volume or concentration of contaminants in waste, media, or `treatment residuals remaining on site." (55 FR 8720). The EPA has considered potential residual risks through both cancer risk levels and with respect to radioactivity that will remain on-site. The EPA has determined that radioactivity is a good way of measuring potential residual risks considering that radioactivity is calculated using the concentration, volume and density of RIM. The EPA has concluded that the long-term permanence of this remedy can be evaluated by measuring the radioactivity removed because this measure is directly related to the volume and concentrations of RIM removed.

The EPA's Preferred Alternative identified in the Proposed Plan, Alternative 4, resulted in the removal of a majority of the source material by excavating RIM at 52.9 pCi/g to16 feet below the 2005 topographic surface. The EPA determined that the Preferred Alternative identified in the Proposed Plan, Alternative 4, achieves the best balance of the balancing criteria out of the remedy alternatives described in the Proposed Plan, considering the emphasis placed on the long-term effectiveness and permanence criteria by the regulation cited above. Modified Alternative 4 will result in the removal of the same amount of radioactivity as Alternative 4; however, Modified Alternative 4 may be a more reliable remedy in the long term because the excavation optimization focuses on removal of higher concentration radioactive material (e.g. greater than 1,000 pCi/g) in some instances. Therefore, the EPA has selected Modified Alternative 4 as the Amended Remedy that will achieve a high degree of long-term effectiveness and permanence, and improves the balance of the remaining criteria compared to Alternative 4.

The Amended Remedy requires excavation of RIM greater than 52.9 pCi/g generally down to 12 feet below the 2005 topographic surface. This is shallower than the 16 feet depth described in Alternative 4;

however, as stated previously, there are few occurrences RIM greater than 52.9 pCi/g between 12 feet and 16 feet. To achieve the same long-term effectiveness and permanence as Alternative 4, the Amended Remedy includes strategic excavation of additional RIM source material below 12 feet to a maximum depth of 20 feet. The EPA expects the deeper excavations to focus on removing higher concentrations of RIM that don't also require excavation of significant volumes of non-RIM waste. When selecting areas for excavation deeper than 12 feet, the EPA specifically prefers removal of RIM at concentrations greater than 1,000 pCi/g. In addition, any isolated pockets of RIM that are not excavated between 8 feet and 12 feet will be offset by removing additional radioactivity between 12 feet and 20 feet elsewhere in Areas 1 and 2.

Excavation of a majority of the radioactivity, in combination with the installation and maintenance of an engineered cover, will prevent direct contact with the wastes and reduce gamma radiation and radon emissions. The Amended Remedy will therefore prevent unacceptable risks in the future.

After development of the Proposed Plan, a cost estimate was developed by the EPA for the Amended Remedy and a summary of the costs is presented in Table 28. The capital costs for this alternative are estimated to be $229,000,000 and the present worth costs (7% discount for 30 year) are estimated to be $205,000,000.

Therefore, the Amended Remedy is expected to result in a capital cost savings of $45,000,000 and a present worth cost savings of $31,000,000. This is approximately 19% and 13%, respectively, less than Alternative 4. Operation and maintenance costs are estimated to range from $176,000 to $340,000 annually, depending on what actions are performed that year, which are the same as those projected for Alternative 4.

In summary, the EPA has determined that the Amended Remedy represents the best balance of long-term effectiveness, short-term effectiveness, implementability, and cost in comparison to the other alternatives. This balance emphasizes long-term effectiveness and permanence in accordance with the NCP. The Amended Remedy achieves this long-term permanence through the removal of radioactive source materials and the installation of an engineered cap cover and seeks to reduce short-term impacts by minimizing the excavation of non-RIM waste. The Amended Remedy does not require excavation in the Bridgeton Landfill. Also, the Amended Remedy is more implementable, minimizes the short-term impacts to the community and workers, takes less time to construct, and is more cost-effective to implement.

12.2 Description of the Amended Remedy

The major components of the Amended Remedy for OU-1 are described in more detail below:

12.2.1 Design and Implementation Considerations for Excavation

The design for the Amended Remedy will include the development of a targeted excavation plan. This plan will identify locations for deviation from the general excavation depth of 12 feet below the 2005 surface. The final excavation plan will result in excavation of the same amount of radioactivity as the Preferred Remedy in the Proposed Plan, Alternative 4.

Radioactivity can be estimated by multiplying the radioactivity of RIM in pCi/g by its volume and density. The EPA developed estimates of the amount of radioactivity associated with Ra-226 and Th-230 that would be removed for each alternative because these contaminants account for most of the risk to future Site users. For the purposes of the Proposed Plan, the percentage of activity removed was determined for each partial excavation alternative by comparing it to the activity removed for the full excavation alternative. This comparison of radioactivity removed was used in the February 6, 2018, Proposed Plan to evaluate long-term permanence. The EPA considered these activity estimates appropriate for use in the FFS after considering the associated uncertainty. Based on information received during the public comment period, the EPA anticipates more precise calculations being performed during the RD.

During RD, the EPA will develop a final estimate of the radioactivity that would have been removed for Alternative 4 (RIM greater than 52.9 pCi/g to a depth of 16 feet) using the same geostatistical model and formulas that will be used to develop the targeted excavation plan for the Amended Remedy. The resulting estimate of radioactivity removed for Alternative 4 must then be achieved during the implementation of the Amended Remedy to achieve the same long-term permanence as was proposed in the Proposed Plan.

The excavation plan will identify the locations where RIM greater than 52.9 pCi/g is to be removed from Area 1 and Area 2 down to 12 feet. It will also identify deeper areas where RIM may be removed to achieve the same long-term effectiveness and permanence as Alternative 4. It will also identify isolated pockets of RIM greater than 52.9 pCi/g to remain between 8 and 12 feet in certain limited instances to achieve the same or better short-term effectiveness as Alternative 4. The final boundaries of excavation will be confirmed through a combination of field screening and sampling within survey units no larger than 2,000 square meters. Confirmation sampling procedures will be specified in a site-specific sampling and analysis plan to be developed during the RD. Four permitted potential off-site disposal locations were identified and discussed in the FFS, and included locations in Utah, Idaho, Colorado, and Michigan. The location(s) for permanent disposal of the excavated RIM will be selected after further evaluation of the facilities and the associated shipping methods and routes during the RD.

12.2.2 Excavation

- During the RD, the Amended Remedy of excavating RIM concentrations greater than 52.9 pCi/g to 12 feet below the 2005 topographic surface will be optimized to target excavation in certain areas to depths greater than 12 feet. The objectives of this targeted excavation include:
    - Minimize total volume of landfill waste to be excavated to reduce short-term impacts (e.g. worker risk, odors, construction time, fugitive dust, bird and wildlife attractants, potential for impacted stormwater, potential to cause impacts to groundwater during excavation);
    - The excavation strategy will be focused on removing higher radioactivity occurrences of RIM; and
    - Maintain the same level of long-term effectiveness and permanence associated with the Proposed Plan Preferred Remedy by removal of the same total amount of radioactivity.
- Based on the objectives listed above, a targeted excavation plan that generally requires excavation to 12 feet and allows for a limited number of deviations will be created according to the following rationale:
    - If RIM greater than 52.9 pCi/g occurs between 12 and 20 feet below the surface, then evaluate and excavate where necessary to achieve long-term effectiveness and permanence objective;

- The EPA places a priority on focusing the excavation on the higher activity occurrences of RIM. Therefore, the EPA expects the areas between 12 and 16 feet will be excavated if they are greater than 1,000 pCi/g (as was presented in Alternative 5);

- The EPA also expects to focus the excavation in the areas between 16 to 20 feet on the higher activity occurrences of RIM (greater than 1,000 pCi/g) if it doesn't add significant excavation of non-RIM waste;

- Data show that isolated pockets of RIM between 8 and 12 feet only occur in a limited number of areas; and

- Not excavating isolated pockets of RIM between 8 and 12 feet will minimize the short-term impacts by reducing the volume of overburden and setback.

- The Amended Remedy is expected to include excavation and off-site disposal of approximately 75,500 bcy of RIM from Areas 1 and 2. To implement this remedy, a total of approximately 143,000 bcy of overburden and setback, which includes some radioactive contamination below 52.9 pCi/g, must be excavated. These volume estimates are based on excavation of all RIM greater than 52.9 pCi/g within 12 feet of the 2005 land surface, and may change minimally after performing the optimization described in the bullets above. It is anticipated that the optimization of the excavation plan will reduce the total excavated volume of all wastes while still achieving the same amount of long-term effectiveness and permanence.

- A combination of radiological field screening and analytical sampling techniques will be used during the RIM excavation process. Because RIM at 52.9 pCi/g may not be reliably detected using standard gamma field survey instruments due to the presence of Th-230, excavation activities are expected to rely, in part, on collection and laboratory analyses of samples. The RD will include evaluation of specialty equipment and procedures to ensure field screening is utilized to the maximum extent practicable to minimize open excavations and delays.

- To further minimize potential impacts on the excavation schedule, an on-site laboratory will be established and operated to provide quicker analyses of samples to guide excavation activities and initial confirmation that RIM above the concentration threshold has been adequately removed. A percentage of the samples analyzed by the on-site laboratory will also be sent to an off-site laboratory for verification according to an EPA approved quality assurance plan.

- Additional samples will be collected, as necessary, during the RD phase to confirm the extent of RIM near the boundaries of Area 1 and 2 to ensure that the engineered cover is properly placed over all areas where RIM will remain on Site. Samples will also be collected during the RD phase to support the basis and locations for targeted excavation specified in the optimization plan.

- Stockpiling and management of overburden and setback waste materials is anticipated on OU-1 Areas 1 and 2 (see Section 12.2.3).

- The St. Louis Airport Authority and the U.S. Department of Agriculture have identified the potential for increased bird activity in conjunction with waste excavation at the Site and the resultant increased risk of aviation bird strikes as a problem. Implementation of a Wildlife Hazard Management Plan will be required and may include measures such as daily soil cover or tarps over exposed overburden and wastes, visual and auditory frightening devices, or other approved techniques. The EPA will coordinate closely with the city of St. Louis, the FAA, and the USDA on development and implementation of the wildlife hazard management plan.

To the extent practicable, backfilling will be performed by preferentially placing waste containing RIM concentrations less than 52.9 pCi/g at the base of the excavation with non-RIM impacted waste placed above it. This practice in intended to further increase protection of future Site users against gamma radiation and radon emissions.

- All remediation workers will be trained for working around and the excavation of radioactive materials prior to working on OU-1. This training will include proper use of any personal protective equipment and personal monitoring devices necessary to perform specific job duties. Workers will be required to adhere to a site-specific health and safety plan to ensure workers are adequately protected.

- Upon consideration of information received after issuing the Proposed Plan, the Amended Remedy does not include the performance of a full-scale pilot study to evaluate the ability to effectively separate RIM from landfill wastes. The EPA has determined that the benefits of such a pilot study are uncertain, would add time and cost to the remedy, while also creating the potential for additional exposure to workers.

12.2.3 On-Site Management of Waste Materials.

- Management of exposed waste will be necessary in both the excavation areas and the stockpiles while waiting for final placement or disposition of the waste and engineered covering of the landfill. Daily soil cover, tarps, or specialized foams may be placed over open excavation areas and overburden stockpiles to minimize dust, odor, and the attraction of birds and other wildlife. Specific plans describing management of wastes will be developed during the RD. The plans will include monitoring techniques, requirements, and contingency plans.

- A stormwater management plan including a stormwater pollution prevention plan, or SWPP, will be developed during the RD. Stormwater controls will include the use of Best Management Practices (BMPs) such as the construction of temporary berms and channels to direct stormwater away from open excavations and stockpiled waste, and pumping and safely managing precipitation or other liquids that collect in depressions created by excavation activities.

- Prior to excavation, an enclosed structure equipped with dust, odor, and vapor emission control equipment will be constructed for the staging and loading of RIM for off-site disposal. The RIM staging and loading building will be used to store RIM during loading operations to minimize contact with stormwater, odor emissions, and bird attraction. Specific plans for loading and transporting RIM will be developed to comply with the permitted disposal facility's waste acceptance criteria during the RD.

- It is anticipated that a temporary road and overpass will be constructed over the existing Site access road to allow construction vehicles to move between Area 1, Area 2, and the RIM staging and loading building without disrupting operation of the transfer station and to minimize the potential for tracking RIM off-site.

- RIM will be loaded into an appropriate closed container suitable for RIM transport by truck or rail. The disposal facility and transportation method will be determined during the RD. The EPA will also further evaluate the feasibility of locating a rail spur on-site. If RIM is transported by rail from an off-site rail spur, controls will be put in place to prevent migration of contaminants during any loading operations. Monitoring will also be performed to ensure the effectiveness of any controls.

- Excavations will be backfilled with the remaining waste from Areas 1 and 2 and regraded to meet the minimum (5%) and maximum (25%) slope criteria to promote runoff without excessive erosion and to account for potential differential settlement of the waste and engineered cover. The final minimum grade will be further evaluated and refined in the RD.

- Upon completion of backfilling and regrading in each area, an engineered landfill cover will be installed over Areas 1 and 2. The engineered cover will be designed to limit precipitation infiltration and provide protection to human and ecological receptors from radioactive emissions, i.e., gamma radiation and radon, consistent with attaining the standards in UMTRCA, and recommendations in the EPA's guidance for hazardous waste landfill covers.

- Selection of the final components, the specific materials, and the configuration of the components for the landfill cover will be finalized during the RD. It is anticipated that the engineered cover may include, among others, the following general components:

    - A 2-foot thick compacted layer of low-permeability clay with a permeability coefficient of 1×10^{-7} cm/sec or less;

    - A geosynthetic clay liner (GCL) or other suitable low-permeability material such as a flexible membrane liner, installed within or on top of the low-permeability clay liner;

    - A 6-inch thick layer of drainage material such as a well-graded fine gravel/coarse sand with medium to fine-grained sand;

    - An eighteen-inch thick biointrusion/erosion protection layer consisting of well graded rock or rubble with sufficient size grading to eliminate voids, the size of which will be determined during the RD;

    - A 1-foot thick layer of soil capable of sustaining vegetative growth; and

    - Rock armoring along the base or toe of the landfill berm to provide protection from erosion due to potential flooding concerns.

- Armoring for flood protection will be included at the toe of the landfill. Specific flood protection requirements for the toe of the landfill will be further evaluated in the RD and appropriate bank protection methods will be used, e.g., rock rip rap apron. The vertical height of the flood protection feature will include a margin of safety.

- Construction of a perimeter or starter berm is anticipated to help reduce the amount of waste disturbance and regrading necessary to meet the required landfill slope specifications. After excavating waste from the toes of the landfill slopes the starter berm will be constructed in the same location using earthen material. Starter berms are expected to be located along portions of the northern and eastern edges of Area 1 and the northern and western edges of Area 2. Plans for a starter berm will be finalized in the RD, if appropriate.

- Surface water runoff controls will be designed and implemented to control and route stormwater away from the final landfill cover into water drainage systems to protect the landfill surface from erosion. These structures may include detention and sedimentation basins, diversion berms and ditches, run-off ditches, let-down structures, or other controls to effectively manage surface water runoff.

- Monitoring of radon and landfill gas and implementing controls where necessary to meet ARARs will be performed. The presence and levels of radon and landfill gas will be monitored both during and after construction of the remedy. The need for and scope of any long-term radon monitoring program will be developed during the RD. Measures to control potential accumulations and/or migration of explosive or toxic gases will be taken as needed both during and after construction. As part of the RD, specifications for a Methane Gas Emergency Monitoring and Action Plan will be prepared. A post-construction landfill gas monitoring program will be developed during the RD phase and implemented as part of the long-term monitoring program. Installation and operation of a landfill gas extraction system may be necessary if the perimeter landfill gas or radon monitoring indicate that lateral migration of either explosive gases or radon is occurring along the Site boundary.

- Implementation of groundwater monitoring for radionuclides and other COCs, consistent with requirements for landfills.

- Control and manage leachate, including treatment, that emanates from OU-1 where necessary to meet ARARs.

12.2.4 Lot 2A2 and Buffer Zone

- Investigation will be performed to identify the presence and extent of radiologically-impacted soil on Lot 2A2 and the Buffer Zone. The nature and extent of radionuclide occurrences on the Buffer Zone and Lot 2A2 Property were previously investigated. Due to subsequent grading activities conducted in these areas after the latest set of samples were obtained. The precise nature and extent of contaminated soil on these properties is currently unknown.

- Excavation and removal of radiologically-impacted soil on the Lot 2A2, and portions of the Buffer Zone not utilized to construct the Area 2 engineered cover, to allow for UU/UE on these properties.

- Excavation and off-site disposal of all radiologically impacted soil greater than 52.9 pCi/g.

- Placement of radiologically impacted soil less than 52.9 pCi/g on Area 2 beneath the engineered cover.

- Any excavation will include dust suppression and work place monitoring to ensure there is no release of fugitive dust.

- The impacted soils on Lot 2A2 and appropriate portions of the Buffer Zone will be remediated to UU/UE levels that allow unlimited use and unrestricted exposure. To meet this objective, RIM above background levels will be excavated and either put in Areas 1 and 2 or shipped off-site for proper disposal. The EPA expects this will be demonstrated through a combination of field screening and sampling within survey units no larger than 2,000 square meters. Confirmation sampling procedures will be specified in a site-specific sampling and analysis plan to be developed during the RD.

12.2.5 Long-Term Operation, Monitoring and Maintenance of the Remedy Components

The final landfill cover system will be routinely inspected and maintained to ensure the integrity of the engineered cover and the performance of the remedy over time. The inspections will focus on identifying any erosion of the landfill cover, the condition and coverage of vegetation on the landfill cover, or any other activities that could affect the integrity of the landfill cover. Periodic mowing or brush-hogging of the vegetative cover would also be performed as part of long-term OM&M.

Inspections will also be performed to assess the integrity and overall condition of the perimeter security fencing around Areas 1 and 2. Any impacts to the integrity of the fence caused by activities on adjacent properties, snow accumulation, or other factors would be repaired.

The various stormwater management structures would be inspected for damage or the presence of erosional features or excessive sediment accumulation. Repairs to these features would be made as necessary. In addition, in the event a leachate collection system or gas collection system is installed at the Site, that system will be subject to OM&M to ensure their integrity and effectiveness.

In addition to surveillance of the physical components of the remedy, the periodic Site inspections would include administrative functions such as the monitoring of ICs and coordination with key stakeholders, including the Earth City Levee District regarding management of the flood control system.

The frequency of inspections and monitoring activities will be established in the OM&M Plan. This plan will be developed and submitted for approval as part of the RD/RA process. The OM&M Plan will cover all the long-term remedy management and monitoring functions including groundwater monitoring plans, site inspection, maintenance and repair; notification and coordination; community relations; health and safety; emergency planning; activity schedules; reporting; etc. In practice, the OM&M Plan may be developed as a compilation of more focused plans.

12.2.6 Groundwater Monitoring

One of the primary objectives of the OU-1 Amended Remedy is to protect groundwater. The Amended Remedy will remove a majority of the radioactive materials from the Site and place a low-permeability engineered cover over the remaining RIM; to limit precipitation and surface water infiltration, and thus, the leaching of contaminants to underlying groundwater. A long-term groundwater monitoring program will be developed in the RD. The groundwater monitoring program will provide data to evaluate the performance of the Amended Remedy and to demonstrate that the engineered cover functions as intended and minimizes the potential for precipitation or surface water to infiltrate the waste materials. Additionally, Operable Unit 3 will further investigate groundwater conditions at the Site and determine the nature and extent of groundwater contamination, and establish appropriate groundwater remedial actions as necessary to protect groundwater resources. Data from the groundwater monitoring program will also inform the OU-3 investigation.

The groundwater monitoring program will include routine sampling and analysis of groundwater, as well as statistical evaluations of groundwater data to assess groundwater quality and identify trends. Groundwater monitoring plans requiring specific monitoring locations, sampling frequencies, parameters, and sampling and analysis procedures will be developed and included as part of the Site's long-term OM&M procedures. In the FFS, it was assumed for purposes of groundwater monitoring that 24 monitoring wells will be monitored at the Site. The specific wells to be monitored will be evaluated and determined during RD. It is anticipated that the wells to be monitored would consist of a combination of existing well clusters and new wells that will be constructed.

The long-term groundwater monitoring program may be modified with time, based on monitoring results, trend analysis, and other relevant factors. Additionally, the monitoring program may be further refined, pending the results of the OU-3 RI. The groundwater monitoring modifications may include items such as revising monitoring locations, monitoring frequency, and/or the analytes monitored to increase the effectiveness or efficiency of the monitoring program.

12.2.7 Institutional Controls

The objectives of the ICs are to prevent exposure to contaminants on both a short-term and long-term basis for all populations that could cause unacceptable risk and to maintain the integrity of the engineered components of the remedy. Land use restrictions will be implemented for OU-1 to prevent land and resource uses inconsistent with a closed landfill containing long-lived radionuclides, and to ensure future uses do not impact the effectiveness or integrity of the remedy. The ICs must be enforceable, run with the land, and be maintained indefinitely due to the presence of long-lived radionuclides in Areas 1 and 2. These restrictions do not apply to activities related to the implementation, maintenance, or repair of the remedy.

Long-term use restrictions for Areas 1 and 2 will at a minimum include the following:

- Prevent development and use for residential or recreational purposes, including housing, schools, childcare facilities, or playgrounds;
- Prevent development and use for occupied buildings, including those for industrial or commercial purposes such as manufacturing, offices, storage units and parking lots, or other facilities that are incompatible with the function or maintenance of the landfill cover;
- Prevent construction activities involving drilling, boring, digging, or other use of heavy equipment that could disturb vegetation, disrupt grading or drainage patterns, cause erosion, or otherwise compromise the integrity of the landfill cover or manage these activities such that any damage to the cover is avoided or repaired;
- Prevent the use of groundwater underlying OU-1 for all purposes except environmental monitoring; and
- Provide for access necessary for continued maintenance, monitoring, inspections, and repair.

Where appropriate, multiple mechanisms or a layered approach will be used to enhance the effectiveness of the IC strategy. Engineering controls to regulate access, such as fences, gates, and signs will also be used to support the non-engineered use restrictions.

At the Site, the affected properties (Areas 1 and 2, Buffer Zone and Lot 2A2) are privately owned, and the use restrictions must be maintained for an indefinite period of time. Therefore, recorded covenants would be used because they generally run with the land and are enforceable. The Missouri Environmental Covenants Act (MOECA), Mo. Rev. Stat.§ 260.1012, et seq., specifically authorizes property owners to establish and convey use restrictions through environmental covenants for the purpose of ensuring long-term compliance with such covenants. The Site is also listed on the State's Registry of Confirmed, Abandoned, or Uncontrolled Hazardous Waste Disposal Sites in Missouri (Uncontrolled Sites Registry) pursuant to the Missouri Hazardous Waste Management Law (Mo. Rev. Stat. § 260.440). Additional IC mechanisms that can accomplish the IC objectives may be analyzed and implemented during RD and RA.

The OM&M Plan will contain procedures for surveillance, monitoring, and maintenance of the ICs. The OM&M Plan will provide for notice to the EPA and the state of any IC violations, planned or actual land use changes, and any planned or actual transfers, sales, or leases of property subject to the use restrictions.

12.3 Estimated Remedy Costs

Estimated capital costs: $229,000,000
Estimated annual OM&M costs: $176,000 to $340,000
Estimated 30-year present worth costs: $205,000,000
Estimated 30-year non-discounted costs: $235,000,000
Estimated 1,000-year non-discounted costs: $412,000,000

A breakdown of the estimated capital costs for excavation, off-site transportation and disposal, regrading, and cover installation is provided in Table 28. The full cost documentation associated with the estimate for the Amended Remedy has been developed after finalization of the feasibility study and included in the administrative record. The costs for the Amended Remedy are based on excavation of the volume of RIM and non-RIM wastes associated with a strict depth of 12 feet below the 2005 topographical surface and concentration criteria of 52.9 pCi/g or greater combined radium and combined thorium.

As described in the previous section, the Amended Remedy allows for flexibility in the depth of excavation. Optimization of the excavation during the RD could result in changes to the total excavation volume and the schedule to complete construction from the estimates presented in this section. Any changes in costs are expected to be minor.

During implementation of the remedy, if changes to the costs result in a reduction of 30% or an increase of 50%, the EPA will modify the amended ROD in accordance with the NCP.

The variation in annual OM&M costs reflects the variation in the specific activities that occur each year (e.g., higher costs for years with additional environmental monitoring, years when landfill cover repairs may occur, and years when five-year reviews are conducted). Also, the CERCLA five-year review occurs every five years. The total present worth cost uses a discount rate of 7 percent, based on the Office of Management and Budget Circular A-94, for the duration of the 30-year evaluation period.

The 30-year evaluation period is used to allow for cost comparisons only and has nothing to do with the expected duration of the remedy. The use of a 30-year period for present worth analysis of remedy costs is not intended to imply a limit on operations, monitoring and maintenance requirements. Similarly, the EPA also considered the non-discounted costs at 1,000 years for cost comparisons consistent with the

EPA's Guidance for Developing Cost Estimates during the Feasibility Study. The OM&M activities are expected to be required for essentially as long as the remedy and waste materials remain in place. The need for and scope of continued OM&M both within and beyond 30 years will be subject to ongoing evaluation as part of the five-year review process.

12.4 Expected Outcomes of the Amended Remedy

The Amended Remedy will partially remove RIM that is greater than 52.9 pCi/g from the landfill for off-site disposal. An engineered cover will then be installed to prevent direct contact with remaining wastes, reduce gamma and radon emissions, and minimize infiltration of stormwater. Risks which fully consider the potential for ingrowth for future on-Site users and the surrounding community will be reduced to within the targeted risk range of 10^{-4} to 10^{-6}. Institutional and engineering controls and long-term monitoring and maintenance are also part of the Amended Remedy. These actions will be protective of human health and the environment. Removal of radioactively impacted soils from Lot 2A2 and portions of the Buffer Zone to allow for unlimited exposure and unrestricted use prevents the need for ICs on these properties.

OU-1, Areas 1 and 2 will remain dedicated to permanent disposal of sanitary waste mixed with radiologically contaminated soil. This use is consistent with current and reasonably anticipated future use for the Site. As such, the Site may be used in ways that are consistent with it being a closed landfill, i.e., uses that do not interfere with the function or maintenance of the landfill cover system. See section 12.2.2 for a description of the use restrictions.

13.0 Statutory Determinations

Under CERCLA § 121(b) and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with ARARs, are cost effective, and utilize permanent solutions and alternative treatment technologies to the maximum extent practicable. In addition, CERCLA includes a preference for treatment that reduces volume, toxicity, or mobility as a principal element. The EPA has determined that the Modified Alternative 4 meets these statutory requirements. As required by the NCP at 40 C.F.R. § 300.430(f)(5)(ii), the following sections discuss how the Amended Remedy meets these statutory requirements.

13.1 Protection of Human Health and the Environment

The Amended Remedy will protect human health and the environment by addressing unacceptable risks through a combination of removal and off-site disposal of the more accessible, higher concentrations of RIM and engineered containment, long-term monitoring and maintenance, and ICs on land and resource use. Exposure levels will be reduced to protective levels as set forth in the ARARs or to within the EPA's generally acceptable risk range of 10^{-4} to 10^{-6} for carcinogenic risk and below the HI of 1 for non-carcinogens.

Removal of some of the shallower occurrences of RIM that have the potential to cause risks in the future above the CERCLA Risk Range and disposal in an off-site permitted facility reduces the threat posed by the Site to human receptors and increases the reliability and permanence of the remedy given that risks will increase over time due to radioactive decay. The Modified Alternative 4 removes RIM at concentrations greater than 52.9 pCi/g generally from the top 12 feet (below the 2005 topographic surface) of Areas 1 and 2 and will reduce long-term risks to the reasonable maximally exposed individual at peak concentrations (in 9,000 years) to 5 x 10^{-6}, or 5 additional incidents of cancer in 1,000,000 people, which is within the target cancer risk range. These long-term residual risks may be further reduced through optimized replacement of the overburden prior to installation of the landfill cover. The removal of some RIM from the upper 12 feet of the landfill will also help mitigate negative impacts of a subsurface heating event. By limiting the concentrations of RIM from immediately below the engineered cover, potential exposures from radon, gamma, and direct contact if the engineered cover was damaged by the heat and subsidence are reduced. If a subsurface heating event were to create additional leachate, removing a majority of the source material would reduce the amount of source material available to leach to the groundwater in the future.

In addition, the EPA has determined that the engineered cover system as described in Section 12 above, in combination with the partial removal of RIM, will result in a remedy that is protective of human health and the environment in the long term given that RIM will remain at the Site. As described by the EPA in the 2008 ROD, the engineered containment system will reduce risks from exposure to external gamma radiation and radon and eliminate exposures from inhalation or ingestion of contaminated soils or other wastes, dermal contact with contaminated soils or other wastes, and wind dispersal of fugitive dust. The cover will prevent users of the Site from exposure to external radiation primarily through shielding and increasing the distance to the radiation source. The cover materials will be of sufficient thickness and design to meet UMTRCA requirements to provide shielding from gamma radiation. The cover materials will also be of sufficient thickness and design to retard or divert the vertical migration of radon. The landfill cover acts as a diffusion barrier allowing time for the decay of the relatively short-lived Rn-222 gas (half-life for Rn-222 is 3.8 days) during migration through the pore spaces of the cover soil. Radon is continually produced from the radium source, but needs only be detained in the cover materials for a few days before it decays to its progeny, thereby eliminating any significant radon emissions. Direct contact with waste materials is eliminated by placing the landfill cover between the waste materials and any potential receptors. Likewise, there is no potential for the generation of fugitive dust from the waste material with the landfill cover in place. The multi-layer cover will also be designed to meet more stringent permeability requirements consistent with RCRA Subtitle C design criteria to promote surface water drainage and prevent infiltration of surface water that could cause leaching of contaminants to the groundwater. Long-term maintenance of the cover and monitoring of the groundwater will ensure the Amended Remedy functions as intended. ICs will ensure that land and resource uses are consistent with permanent waste disposal and will consider the presence of radionuclides.

Implementation of the Amended Remedy will not cause unacceptable short-term risks or cross-media impacts. Because any excavation of the waste materials in Area 1 and Area 2 will decrease short-term effectiveness by increasing potential risk to remediation workers, off-site workers, and residents, generating odors, creating bird attractants, and increasing truck traffic, the Amended Remedy seeks to minimize excavation and handling of non-RIM waste while excavating a majority of the radioactivity. In order to reduce the short-term impacts described above, a limited number of the isolated pockets of RIM that would otherwise be excavated between 8’ and 12’ may be left in place. The overall schedule to complete construction is also expected to be reduced which lowers the short-term risks posed to remediation workers and the community.

13.2 Compliance with ARARs

CERCLA § 121(d) and NCP § 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations which are collectively referred to as ARARs, unless such ARARs are waived under CERCLA § 121(d)(4). ARARs for the Modified Alternative 4 are shown in Appendix D, and key ARARs are discussed below. The EPA has determined that the Amended Remedy meets the ARARs originally identified in the 2008 ROD. In addition, because the EPA's Amended Remedy now includes excavation and off-site disposal of a portion of the RIM, additional ARARs have been identified and will be met as discussed below.

13.2.1 Environmental Protection Standards for Uranium and Thorium Mill Tailings

The UMTRCA standards at 40 C.F.R. § 192.02 (b)(1) state that control of residual radioactive materials and their listed constituents shall be designed to provide reasonable assurance that release of Rn-222 from residual radioactive material to the atmosphere will not exceed an average release rate of 20 pCi/m2s. The Amended Remedy will ensure the radon emission standard promulgated under UMTRCA is met through excavation of RIM >52.9 pCi/g to a target depth of 12 feet and construction of the engineered landfill cover. The landfill cover system will be designed to provide sufficient radon attenuation to ensure that future maximum surface emissions from Areas 1 and 2 will meet the UMTRCA performance standard. The remedy will also meet the longevity standard in 40 C.F.R. § 192.02(a) in that it will be designed to be effective for up to 1,000 years, as far as reasonably achievable, but at a minimum, 200 years. In addition, even though any future groundwater remediation will be addressed pursuant to OU-3, excavating a majority of the source material from OU-1, re-grading the landfill surface to promote stormwater drainage, and installation of an engineered landfill cover with a 1×10^{-7} cm/s permeability standard will greatly reduce the potential for infiltration through and generation of leachate within the landfill mass in Areas 1 and 2. This will reduce the potential for the infiltration of precipitation to cause subsequent leaching and migration of residual radionuclides to groundwater.

The 2008 ROD required compliance with the Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings in 40 C.F.R. 192 Subparts A and B which establish concentration limits for groundwater protection. As stated in the 2008 ROD, based on the presence of radioactive materials in OU-1 and the potential for leaching to groundwater, the groundwater protection standards (40 C.F.R. 192.02(c)(3) and (4)) and monitoring requirements (40 C.F.R. 192.03) of the UMTRCA regulations were identified as relevant and appropriate requirements. Since that time, EPA has determined that a separate site-wide groundwater RI/FS will be performed pursuant to OU-3. Based on the results of this investigation, the EPA will assess whether remedial measures are needed to protect and restore groundwater at the unit boundary of the landfill and beyond. If monitoring during the OU-3 RI/FS indicates that remediation is required for the groundwater, it would be addressed in the future in a separate ROD and remedial action.

In the 2008 ROD, EPA determined that UMTRCA 40 C.F.R § 192.12 would be relevant and appropriate for the remediation of the Buffer Zone and Lot 2A2. However, EPA has further evaluated the cleanup standards in UMTRCA for those two areas and found them not to be sufficiently protective to allow for unlimited use and unrestricted exposure due to the presence of multiple contaminants and multiple exposure pathways. Similar to what was in the 2008 ROD, the EPA has determined that the cleanup standards in UMTRCA are also not relevant and appropriate for the Amended Remedy.

13.2.2 RCRA Subtitle C Hazardous Waste Requirements and Other Regulated Materials

The engineered covered described in the Modified Alternative 4 will also be designed to meet design criteria set forth in the EPA guidance that has been identified as To Be Considered. Specifically, these include the EPA's July 1989 Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments and the April 2004 (Draft) Technical Guidance for RCRA/CERCLA Final Covers. The 1989 Technical Guidance Document provides design guidance on final cover systems for hazardous waste landfills and surface impoundments. This guidance addresses multilayer cover design to provide long-term protection from infiltration of precipitation. The 2004 Draft Technical Guidance provides design information regarding cover systems for municipal solid waste and hazardous waste landfills being remediated under CERCLA, RCRA Corrective Action, and sites regulated under RCRA. This guidance includes updated information related to development of design criteria including a two-component low permeability layer with a hydraulic conductivity no greater than 1×10^{-7} cm/sec, use and types of geosynthetics such as geosynthetic clay liners, alternative materials and designs, performance monitoring, maintenance of cover systems, and other issues.

Further, if RCRA hazardous waste is generated during excavation activities it will be managed and disposed of off-Site in accordance with RCRA Subtitle C requirements relative to identification of hazardous wastes (40 C.F.R. Part 261), packaging, temporary storage, off-site transportation of hazardous wastes (40 C.F.R. Parts 262 and 263), and treatment and disposal of hazardous wastes (40 C.F.R. Part 268). These are applicable requirements in the event that hazardous wastes are generated during implementation. Similarly, the requirements of the Missouri Hazardous Waste Management Law (260.350 – 260.430 RSMo) and associated regulations (10 C.S.R. 25-7) would apply in the event that hazardous wastes are encountered. In addition, any regulated asbestos containing material encountered during the remediation will be managed and disposed of in compliance with 40 C.F.R. § 61.154(j), 10 C.S.R. 10-6.241, and St. Louis County Ordinance 612.530, all of which pertain to excavating/disturbing asbestos.

13.2.3 Missouri Solid Waste Rules for Sanitary Landfills

Similar to the 2008 ROD, the Amended Remedy will also meet various provisions of the state of Missouri's Solid Waste Rules establishing closure and post-closure requirements for sanitary landfills. Although not applicable to the closure of Areas 1 and 2, these rules are relevant and appropriate.

In addition to the RCRA Subtitle C design criteria described in the EPA guidance as discussed above, the final cover will consist of at least 2 feet of compacted clay and overlaid by at least 1 foot of soil capable of sustaining vegetative growth (10 C.S.R. 80-3.010(17)(C)(4)). Placement of soil cover addresses the requirements for minimization of fire hazards, odors, blowing litter, control of gas venting, and scavenging. Placement of clay meeting the permeability requirement in hazardous waste landfill guidance and exceeding the requirements for sanitary landfills addresses the requirement for minimizing precipitation infiltration. Placement of soil and establishment of a vegetative cover meet the requirement of providing a pleasing appearance. The final cover will prevent direct contact with the waste material.

As originally described in the 2008 ROD, the Missouri Solid Waste Rules also contain minimum and maximum side and top slope requirements. The objective of these slope requirements is to promote maximum runoff without excessive erosion and to account for potential differential settlement of the waste and engineered cover. Because landfilling of Areas 1 and 2 was completed many years ago, much of the compaction of the refuse has already taken place and differential settlement may no longer be a significant concern. Therefore, the 5% minimum sloping requirement may be greater than necessary and may not be optimal for the Amended Remedy. Sloping specifications will be designed to promote drainage and reduce infiltration of precipitation while minimizing the potential for erosion. It is anticipated that a 2% to 3% slope may be sufficient to meet drainage requirements while resulting in a lower potential for erosion. This approach could increase the life of the cover and overall longevity of the remedy compared to a steeper slope, which would be subject to increased erosion potential. The optimal minimal slope for the remedy will be further evaluated during the RD. The maximum sloping requirements would be met by the Amended Remedy.

The substantive requirements for decomposition gas monitoring and control in 10 C.S.R. 80-3.010(14) are relevant and appropriate and will be met. As necessary, the number and locations of gas monitoring points and the frequency of measurement will be established in RD submittals to be approved by the EPA and the MDNR. In the event landfill gas is detected at the Site boundaries above the regulatory thresholds, appropriate gas controls will be implemented.

The remedy will also be designed, constructed, maintained and operated to collect and remove leachate from the sanitary landfill as required by 10 C.S.R. 80-3.010(9)(A). Even though any future groundwater remediation will occur as part of OU-3, the requirements for a groundwater monitoring program in 10 C.S.R. 80-3.010(11) are relevant and appropriate. The monitoring program must be capable of monitoring any potential impact of the Site on underlying groundwater and will enable the regulatory agencies to evaluate the need for any additional requirements. The substantive MDNR landfill requirements for post-closure care and corrective action found in 10 C.S.R. 80-2.030 will be used in addition to the EPA CERCLA policy and guidance to develop robust monitoring meeting these requirements.

13.2.4 National Emissions Standards for Hazardous Air Pollutants

The Modified Alternative 4 will meet the EPA's NESHAPs, which include standards for Rn-222 emissions to ambient air from designated uranium mill tailings piles that are no longer operational. While not applicable, the Rn-222 NESHAP is relevant and appropriate. The Amended Remedy, will ensure the radon emission standard continues to be met, through excavation and off-site disposal of RIM greater than 2.9 pCI/g to a target depth of 12 feet (with a potential range of 8-20 feet), and construction of the engineered landfill cover. The landfill cover system will be designed to provide sufficient radon attenuation to ensure that the radon NESHAP standard is met under both current conditions and in the future, accounting for future radon generation resulting from increased radium levels owing to the decay of thorium over time. Performance of radon flux measurement tests, in accordance with the procedures set forth in 40 C.F.R. Part 61 Appendix B Method 115, or other procedures with prior EPA approval, will be conducted upon completion of construction of the engineered cover to demonstrate that the landfill cover achieves the radon emission standard.

The Modified Alternative 4 will also meet the EPA's National Emissions Standards for Radionuclides Other Than Radon from Department of Energy Facilities. It sets a limit on the emission of radionuclides that ensures no member of the public receives an effective dose equivalent of more than 10 mrem/year. While not applicable, these standards are relevant and appropriate because the COCs at OU-1 of the West Lake Landfill Site include radionuclides other than Rn-222.

The EPA is also including the "Dose Compliance Concentrations for Radionuclides at Superfund Sites" (DCC) calculator website as a to-be-considered for the Site to demonstrate compliance with any dose-based ARARs. For example, the specific air concentrations for radionuclides necessary to meet the NESHAP standard above will be determined using the DCC Calculator.

13.2.5 Clean Water Act, Missouri Stormwater Management Regulations, and Drinking Water Standards

The federal Clean Water Act sets standards for ambient water quality and incorporates chemical-specific standards including federal water quality criteria and state water quality standards. The Selected Remedy will ensure that the management of contaminated water that would potentially be discharged from the Site or sent to a treatment plant will meet the following ARARs and be protective. EPA will ensure that the on-site or off-site discharges to surface water meet NPDES standards specific to the contaminants including radionuclides, as appropriate.

Stormwater and surface water at the Site have been documented to flow through various stormwater outfalls that are monitored during and/or following certain storm events, and a berm on the northern portions of Area 2 help control runoff to the adjacent properties to the north. During construction of the selected remedy, stormwater management will be addressed by minimizing stormwater flow into the working areas (also referred to as run on); by minimizing the surface area of disturbed ground that is exposed to direct precipitation; and by properly detaining and treating, if necessary, runoff that has contacted the working areas. It is assumed that treated stormwater could be introduced to the MSD sanitary sewer system using the force main that is currently used to convey leachate from the Bridgeton Landfill or via tie-in to an MSD manhole in the vicinity of the West Lake Landfill. Management of stormwater during and after construction would be addressed in the Stormwater Pollution Prevention Plan that would be prepared during the RD of the selected remedy.

The Missouri regulations governing stormwater management are set forth in 10 C.S.R. 20-6.200 for construction sites and are applicable during remedial construction. The Missouri Clean Water – Chapter 6 - Storm Water Regulations at 10 C.S.R. 20-6.200(2)(B)3.B (the corresponding federal regulation is 40 C.F.R. § 122.26(b)(14)(v)) defines discharges from landfills, land application sites, and open dumps that have received industrial waste as being subject to the requirements set forth for industrial discharges throughout the state of Missouri. The substantive requirements of storm water permitting are required for all industrial discharges per 10 C.S.R. 6.200(6)(A)(1). The substantive requirements of storm water permitting are established in 10 C.S.R. 6.200(6)(B). The regulations at 10 C.S.R. 20-6.200(6)(B)) establish the substantive requirements for a site specific industrial storm water permit. Portions of this regulation are administrative in nature, (such as identification of the permit holder, reporting requirements, and a schedule of compliance) however the requirement that effluent limitations be protective of waters of the state is substantive.

A Stormwater Management Plan will be developed that clarifies how the substantive requirements of 10 C.S.R. 20-6.200(6)(A)(1), 10 C.S.R. 20-6.200(6)(B) and 10 C.S.R. 20-6.200(2)(B)(3.B will be met. BMPs will be used both during and following remedial construction activities to achieve the substantive requirements and protectiveness.

Following remedial excavation activities Site work will include, the installation and maintenance of an engineered landfill cover to prevent stormwater from contacting any remaining waste materials, and construction and maintenance of stormwater diversion and control structures as part of the final engineered landfill cover system.

In addition, any discharges of water will comply with applicable Missouri water quality standards. Missouri Water Quality Standards at 10 C.S.R. 7.031(4) provides general water quality requirements that are applicable to all waters of the state, regardless of use designations. The requirements provided in this section must be met to ensure that all proposed or existing discharges are protective. Furthermore, EPA will ensure that standards specific to the contaminants are met and that the levels are protective for the designated use of the receiving stream. All waters of the state are subject to the acute toxicity requirements listed in Tables A and B in 10 C.S.R. 7.031(5), the requirements of subsection 5(B) and other requirements of (4). The regulations at 10 C.S.R. 7.031(5) establish specific water quality standards necessary to ensure protectiveness in waters with designated uses, based on those respective uses. Specifically, water contaminants will not cause or contribute to an exceedance of standards for radiological contaminants or other primary standards and will be protective for the designated uses of the receiving waters.

As discussed above in Section 13.2.1, EPA has determined that any remediation required for groundwater would be addressed in the future in a separate ROD and remedial action for OU-3. In the 2008 ROD EPA stated that consistent with the NCP, MCLs and non-zero Maximum Contaminant Level Goals (MCLGs) were considered relevant and appropriate to all potentially usable groundwater. 40 C.F.R. Part 141 establishes primary drinking water regulations, including MCLs pursuant to Section 1412 of the Public Health Service Act, as amended by the Safe Drinking Water Act (SDWA), and related regulations applicable to public water systems. These MCLs apply to public drinking water systems. Missouri regulations (10 C.S.R. 60-4.010 et seq.) also establish MCLs for public drinking water systems. Even though any groundwater remediation will be addressed pursuant to OU-3, these substantive standards will be ARARs if the water is discharged to a surface water which constitutes a potential or future drinking water source or may be in contact with an aquifer that constitutes a potential or future drinking water source.

13.2.6 Missouri Regulations for Protection Against Ionizing Radiation

The Missouri Radiation Regulations for Protection Against Ionizing Radiation (19 C.S.R. 20-10.070 and 19 C.S.R. 090) contain standards that address storage and releases of radioactive materials. These requirements are considered relevant and appropriate during implementation of the Amended Remedy. Specifically, these regulations establish ventilation standards for rooms storing radioactive materials and limits for releases of radionuclides to the air. Other standards related to health and safety and protection of remediation workers are not ARARs but will be complied with as appropriate.

13.2.7 Missouri Well Construction Code

The Missouri Well Construction Code (10 C.S.R. 23-3.010) prohibits the placement of a well within 300 feet of a landfill. These rules are applicable and should provide protection against the placement of wells on or near the Site. The regulations on monitoring well construction (10 C.S.R. 23-4) will apply to the construction of new or replacement monitoring wells. The Amended Remedy will meet this ARAR through enforcement of the existing ICs, implementation of new ICs, and by adhering to the Well Construction Code requirements for the installation of new monitoring wells or abandonment of existing monitoring wells.

13.2.8 Transportation Regulations

Although off-Site transportation requirements are not considered ARARs, the EPA will ensure these requirements will be complied with. These include the U.S. Department of Transportation (DOT) regulations for transport of hazardous materials (49 C.F.R. Parts 100 – 178), and specific regulations related to transport of radioactive materials (49 C.F.R. Parts 171 – 180). The NRC, through a Memorandum of Understanding with DOT, also has promulgated regulations regarding transport of radioactive materials (10 C.F.R. Part 71). Requirements established by common carriers (including rail carriers) for transport of waste materials or radioactive wastes are also applicable to this alternative. Identification and evaluation of the carrier-specific requirements will be performed during the RD. The state of Missouri also has transportation related requirements at Missouri Revised Statute 260.392 and 260.380.1(5) that will be met.

13.3 Cost Effectiveness

A cost-effective remedy is one whose "costs are proportional to its overall effectiveness" (NCP § 300.430(f)(1)(ii)(D)). The Amended Remedy is considered cost effective because it provides a high degree of effectiveness and permanence at a reasonable cost. In the 2008 ROD, the EPA determined that the cost of off-site commercial disposal would not lead to appreciable increases in effectiveness and may introduce unnecessary risks. However, since 2008, the EPA has further characterized RIM distribution, re-evaluated the five balancing criteria with respect to remedial alternatives, and has determined that partial excavation is not only practicable but is important to the long-term effectiveness and permanence of the remedy. The EPA has concluded that the long-term permanence is increased as radioactivity is removed from the Site.

The EPA also recognizes that short-term effectiveness (including risks to on-Site workers and the community) at this Site is directly influenced by the amount of wastes excavated, whether RIM or non-RIM. The EPA has determined that the Amended Remedy is cost effective because it strikes the best balance between long-term effectiveness and permanence and short-term effectiveness, for the cost. Specifically, the RD will seek to minimize the total volume of landfill waste to be excavated, while maintaining long-term protectiveness and permanence without significantly altering the cost. The capping alternatives (2 and 3) are the least expensive alternatives; however, they leave all radioactive source material on-site. The risk based Alternative (6) costs nearly twice as much as the UMTRCA cover Alternative (3) but removes only a small percentage of the source material (approximately 1%). The Amended Remedy, removes a majority of the radioactive source material in approximately the same time period and at a cost of only approximately 25% more than the risk-based Alternative (6). In comparison to the full excavation with off-site disposal Alternative (7), the Amended Remedy removes more than half of the source material for less than half the cost in one third of the time. Therefore, the EPA has determined that the Amended Remedy is cost effective.

13.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

The EPA has now determined based on information in the Administrative Record that the Modified Alternative 4 is the most appropriate remedial solution for OU-1 and provides the best balance of trade-offs among the alternatives with respect to the balancing criteria set out in NCP § 300.430(f)(1)(i)(B), such that it represents the maximum extent to which permanence and treatment can be practicably utilized at this Site. The EPA's decision to select the Modified Alternative 4 also reflects input received during the comment period supporting the excavation of RIM but recognizing the challenges associated with large scale excavation, as well as the MDNR's indication of its support for the Modified Alternative 4 as the amendment to the 2008 ROD.

The EPA has determined that the Modified Alternative 4 represents the maximum extent to which permanent solutions are practicable. Treatment to reduce toxicity, mobility, or volume is not practicable because of the large volume of contaminated media (309,700 bcy of RIM and 1,821,000 bcy of non-RIM wastes), the heterogeneous nature the landfill, and the limited effective treatment technologies available for radionuclides. The heterogeneous nature of the solid waste materials and the presence of typical landfill gases such as methane also make in-situ treatment techniques difficult to safely implement and unreliable. Similarly, ex situ treatment techniques are considered impracticable. Several treatment technologies were identified for soils contaminated with radiological materials similar to what is present in OU-1, but no application of these technologies could be found for municipal solid wastes, especially solid wastes impacted by radiological material. In accordance with the NCP, potential treatment technologies were further evaluated as summarized in the FFS. Specifically, the EPA's Technology Reference Guide for Radioactively Contaminated Media (EPA 402-R-07-004) was used as guidance for potential technologies that can effectively treat environmental media at radioactively contaminated sites. This guidance document states that the special characteristics of radioactive material in a waste constrain the technologies available to address Site characterization results and satisfy RAOs. Ultimately, treatment was determined to be impracticable at the Site due to the heterogeneous nature of the waste and the limited treatment technologies available for the site-related radionuclides. As more fully discussed in the FFS, radionuclides cannot be altered or destroyed by physical, chemical, or biological processes. In-situ stabilization and solidification techniques are not considered to be effective or implementable due to the heterogeneous nature of the overall solid waste matrix at the Site.

The information in the AR indicates that the waste materials can be effectively managed over the long term using a combination of removal of higher concentrations of RIM in more accessible areas with off-site disposal and engineered containment designed for radiological materials and hazardous waste landfills. Ultimately, excavating and shipping the accessible RIM to a permitted disposal facility improves the effectiveness of the remedy over the long term.

The EPA has determined that the Modified Alternative 4 represents the best balance of long-term effectiveness and permanence, short-term effectiveness, implementability, and cost in comparison to the other alternatives. Modified Alternative 4 is protective in the long-term and removes a majority of the radioactivity of RIM at the Site in contrast to other alternatives. Compared to the deeper excavation alternatives (Alternative 5, 7, and 8), Modified Alternative 4 does not require excavation in the Bridgeton Landfill. Also, it is more implementable, minimizes the short-term impacts to the community and workers, takes less time to construct, and is more cost-effective to implement.

The EPA has also determined that the remaining RIM that will not be excavated can be effectively managed in place over the long term. The EPA recognized in the 2008 ROD that removal of some of the contamination prior to capping offered a greater measure of long-term protection over the capping only alternatives, but concluded the advantage was small compared to the potential for human exposures and increased physical hazards during the implementation phase. However, after further evaluation of the waste distribution, characteristics, and risks associated with the Site, the EPA now concludes that potential short-term impacts during the implementation of a limited partial excavation can be effectively mitigated. As recognized in the preamble to the NCP, the EPA should not immediately dismiss a remedy "that is less effective in the short term [but] also provides greater long-term effectiveness than the remedy without unacceptable adverse short-term impacts."[15] Rather, "[i]n this situation, generally the EPA would evaluate the possible measures available to mitigate the short-term impacts and thus allow the alternative to be protective during implementation." Since issuance of the 2008 ROD, the EPA has evaluated multiple means to control and mitigate the adverse short-term impacts associated with excavation of RIM. A significant portion of the worker risk can be mitigated by simply limiting the time spent near RIM to that which is necessary to conduct radiation surveys and collect samples. In addition, fugitive dust suppression, personal protective equipment (PPE) including protective clothing or respirators, and typical health and safety practices for specific jobs or functions will further mitigate the remaining risks to within the target cancer risk range. These exposures can be further reduced by alternating between radiation technicians to perform this job function during the remedy construction. The remaining fraction of worker risk can be mitigated by employing standard dust suppression measures, using personal protective equipment, using typical health and safety practices and using

[15] 55 Fed. Reg. 8666, 8725 (Mar. 8, 1990).

proper ventilation. Further, to control the risk of bird strikes, the EPA will require development and approval of a Wildlife Mitigation and Control Plan as part of the RD process prior to implementation of the remedial action for OU-1. The EPA also concluded that the limited partial excavation required by Modified Alternative 4 minimizes the potential for human exposures and increased physical hazards during the implementation phase compared to the deeper excavation alternatives.

13.5 Preference for Treatment as a Principal Element

Similar to the EPA's conclusion in the 2008 ROD, the Amended Remedy does not satisfy the preference for treatment as a principal element. For the reasons described in the previous section, no effective or practicable treatment options are available.

13.6 Five-Year Review Requirements

As recognized in the 2008 ROD, if the remedy leaves hazardous substances, pollutants, or contaminants at a Site above levels that would allow for UU/UE, pursuant to Section 121(c) of CERCLA and NCP § 300.430(f)(5)(iii)(C), the EPA shall conduct a review of such remedial action no less often than every five years after the initiation of the remedial action to assure that human health and the environment are being protected. The Site will require statutory five-year reviews.

14.0 Documentation of Significant Changes from the Proposed Plan

To fulfill CERCLA § 117(b) and NCP § 300.430(f)(5)(iii)(B) and § 300.430(f)(3)(ii)(A), the ROD Amendment must document and discuss the reasons for any significant changes made to the Amended Remedy from the time the Proposed Plan was released for public comment to the final selection of the remedy. Consistent with the EPA ROD guidance, the EPA as the lead agency, "…has the discretion to make changes to the Preferred Alternative identified in the Proposed Plan based either on new information received from the public or support agency or on information generated by the lead agency itself during the remedial process."[16]

14.1 Significant Changes from the Proposed Plan in the Amended Remedy

In the Proposed Plan, the EPA solicited comments specifically related to the depth and concentration criteria established as a baseline for Alternative 4 (i.e., the 16 feet excavation depth and the 52.9 pCi/g concentration criteria). The EPA also solicited comments related to the selection of different depths and concentration criterion between Area 1 and Area 2. The EPA received many comments regarding the depth and concentration criteria for Alternative 4.

In response to the information that the EPA received during the public comment period and additional information generated by the EPA in response, the EPA developed a Modified Alternative 4. The following bullets describe the significant modifications which have been made to Alternative 4 since the release of the Proposed Plan which the EPA has determined could have been reasonably anticipated by the public:

- The depth of the excavation of RIM greater than 52.9 pCi/g was changed from strictly 16 feet to generally 12 feet;

[16] See A Guide to Preparing Superfund Proposed Plans, Records of Decision, and other Remedy Selection Decision Documents, July 1999.

- The Amended Remedy allows for flexibility from the 12-foot depth in a limited number of places in either Area 1 and Area 2;

- The Amended Remedy will achieve the same long-term effectiveness as Alternative 4 while reducing the excavation of non-RIM waste and the schedule to construct the remedy to improve short-term effectiveness; and

- The Amended Remedy does not include a pilot study to separate radioactive materials from RIM.

14.2 Rationale for the Changes to the Proposed Plan in the Selected Remedy

As stated in section 14.1, the EPA received many comments on the depth and concentration criteria for excavation of RIM in Area 1 and Area 2. Additional data was also provided by commenters which allowed the Agency to optimize Alternative 4 using Site specific information. The bullets below provide the rationale for the significant changes described in section 14.1 above:

- As stated in the Proposed Plan, the EPA believes that Alternative 4 represents the best balance of long-term effectiveness, short-term effectiveness, implementability, and cost in comparison to the other alternatives evaluated in the FFS. After considering the comments and information received after issuing the Proposed Plan, the EPA has Modified Alternative 4 to improve the balance of long-term effectiveness, short-term effectiveness and cost.

- Alternative 4 specified an excavation depth of 16 feet below the 2005 topographic surface. The EPA's Amended Remedy generally requires excavation to 12 feet below the 2005 topographic surface as this depth is more reflective of all the Site data. Review of the RIM characterization data shows that there are very few occurrences of RIM between 12 feet and 16 feet. The Amended Remedy reduces some of the implementability challenges (e.g., eliminating relocation of the Transfer Station) and short-term impacts (e.g., reducing odors and the potential for the attraction of birds) associated with Alternative 4.

- The Amended Remedy will achieve the same long-term effectiveness and permanence as Alternative 4 by removing the same amount of radioactivity from the Site. This will be achieved by removing additional RIM above 52.9 pCi/g from as deep as 20 feet within the larger excavation areas. The EPA expects these deeper excavations to focus on higher concentrations of RIM (e.g. greater than 1,000 pCi/g) that can be accessed without requiring excavation of large volumes of non-RIM waste.

- The Amended Remedy achieves greater short-term effectiveness by reducing the volume of non-RIM wastes to be excavated by 30% (61,000 bank cubic yards) and reducing the remedy construction schedule by 25% (0.9 years) compared to Alternative 4. This reduces the potential risks to the community and remediation works during remedy construction. The short-term effectiveness may be further improved as a result of not excavating a limited number of isolated pockets of RIM between 8 feet and 12 feet. However, as stated in the bullet above, the Amended Remedy will remove the same amount of radioactivity as Alternative 4. Therefore, the radioactivity associated with any isolated pockets of RIM that are not excavated must be offset by excavating additional radioactive source material at depths below 12 feet elsewhere.

- The shorter schedule improves the short-term effectiveness of the remedy in multiple ways; the risk to workers is reduced by shortening the time of potential exposure to radioactive contaminants, the potential for odors and bird attractants resulting in potential hazards to the airport are reduced by decreasing the volumes of overburden and setback to be handled, and the shorter schedule and less overburden excavation reduces the potential for fugitive dust during the remedial action.

- The Amended Remedy is expected to result in a cost savings of $31,000,000 which is 13% less than Alternative 4. The Amended Remedy does not require buying out the asphalt plant or relocating the transfer station. The targeted excavation plan could increase or decrease the cost of the Amended Remedy but these changes are expected to be minor.

- In response to comments, the EPA has determined that a Pilot Study to mechanically separate and segregate RIM based on concentrations will not be implemented during the remedial action due to concerns about additional risks to workers, overall increases to the cost and schedule, and the uncertainty of its effectiveness. This does not impact the long-term effectiveness or permanence of the Amended Remedy.

15.0 References

Auxier & Associates, Inc., 1998. Baseline Risk Assessment, West Lake Landfill Operable Unit 1, March.

Engineering Management Support, Inc., 2000. Remedial Investigation Report, West Lake Landfill, Operable Unit 1, April.

Engineering Management Support, Inc., 2006. Feasibility Study Report, West Lake Landfill, Operable Unit 1, May.

Herst & Associates, Inc., 2005. Remedial Investigation Report, West Lake Landfill Operable Unit 2, September.

Herst & Associates, Inc., 2006. Feasibility Study Report, West Lake Landfill Operable Unit 2, June.

Auxier & Associates, Inc. (Auxier), 2018, Updated Baseline Risk Assessment, West Lake Landfill Operable Unit 1, December 22.

Engineering Management Support, Inc. (EMSI), 2018a, Remedial Investigation Addendum, West Lake Landfill Operable Unit 1, Bridgeton, Missouri, January 25.

EMSI, 2018b, Final Feasibility Study, West Lake Landfill Operable Unit 1, Bridgeton, Missouri, January 26.

Papadopulos & Associates, Inc. (SSP&A), 2017, Estimated Three-Dimensional Extent of Radiologically Impacted Material, West Lake Landfill Operable Unit-1, Bridgeton, Missouri, December 22.

U.S. EPA, 2017. Results of Bridgeton Dust Pre-CERCLA Screening Memorandum, May 11.

U.S. EPA, 2014. Final Pre-CERCLIS Screening Report Bridgeton Municipal Athletic Complex, Bridgeton, Missouri U.S. EPA Region 7 START 4, Contract No. EP-S7-13-06, Task Order No. 0002.023, July 30.

PART III: RESPONSIVENESS SUMMARY

RECORD OF DECISION AMENDMENT

WEST LAKE LANDFILL SITE
BRIDGETON, MISSOURI
OPERABLE UNIT 1

September 2018

Prepared by:

U.S. Environmental Protection Agency
Region 7
Lenexa, Kansas

TABLE OF CONTENTS

1.0 Introduction

This Responsiveness Summary provides a response to significant comments, criticisms, and new relevant information submitted to the U.S. Environmental Protection Agency regarding the agency's Proposed Record of Decision Amendment (Proposed ROD Amendment) for Operable Unit 1 (OU-1) of the West Lake Landfill Superfund Site. This response is required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).[1] All comments summarized in this document have been considered in the EPA's amended remedy selection for OU-1, referred to as the Amended Remedy.

1.1 Community Involvement

The EPA has worked closely with the state of Missouri, community members, and other stakeholders throughout the development of the Remedial Investigation Addendum (RIA), Final Feasibility Study (FFS), and Proposed ROD Amendment, referred to also as the Proposed Plan. Throughout this process, the EPA conducted many community involvement activities, such as:

- Publishing fact sheets and holding public information meetings to provide updates on activities at the Site;
- Participating in meetings and technical sessions with the West Lake Landfill Community Advisory Group (CAG);
- Providing an independent technical consultant to the community through the Technical Assistance Services for Communities contract; and
- Opening and staffing a local office where community members could regularly meet in-person with EPA personnel.

The EPA's outreach goal is to educate the community about the work being done at the Site and collaborate with stakeholders to successfully engage the public. Throughout this process, the EPA has established and maintained strong relationships with our state partners from the Missouri Department of Natural Resources (MDNR) and the Missouri Department of Health and Senior Services (MDHSS). In addition, the EPA has communicated frequently with local governments and special district governments to foster transparency and trust in agency actions. Specifically, the EPA has worked with representatives of the city of Bridgeton. the St. Louis County Department of Public Health, the Pattonville Fire District and the Pattonville School District.

The EPA made significant community outreach efforts prior to the release of the Proposed Plan to solicit community input and to prepare people to participate in the public comment period. In 2016, the EPA held a series of community dialogue meetings to promote dialogue among the various stakeholders and inform them of the remaining steps in the remedy selection process. In total, the EPA held three community dialogue meetings at the Bridgeton Recreation Center, each attracting 150-200 people. In addition, the EPA held a community listening session in October 2017 to allow stakeholders to voice concerns directly to the Regional Administrator and senior political leadership. Approximately 400 stakeholders attended the meeting, including local citizens, state and local government officials, the CAG, and various advocacy groups. The EPA also released draft versions of the RIA/FFS documents in

[1] 40 C.F.R. § 300.430(f)(3)(F); 40 C.F.R. § 300.435(c)(2)(ii)(F).

advance of the Proposed Plan to allow the public greater opportunity to review the extensive technical documents prior to the public comment period.

In compliance with the NCP, the EPA issued the Proposed Plan on February 6, 2018, and held a public comment period from February 6 through April 23, 2018.[2] Upon release of the Proposed Plan describing the proposed amendment, the EPA made the information supporting the decision available in multiple document collections online, as required by the NCP.[3] The public could access the Administrative Record file locally from the Bridgeton Trails Branch of the St. Louis County Public Library. In 2016, the EPA also installed an information kiosk in Bridgeton City Hall which provided access to the Administrative Record file on the agency's Web site.

On March 6, 2018, the EPA held a public meeting in Bridgeton to present the Proposed Plan, as required by the NCP.[4] More than 800 stakeholders attended the meeting, and the EPA provided American Sign Language interpreters at stakeholder request. In addition to verbal and written comments received at the public meeting, the EPA also collected comments via the U.S. Postal Service, Email, and the West Lake Landfill Web site.

In May 2018, the Regional Administrator met with local stakeholders, including the CAG, federal elected officials and/or staff, as well as representatives of the city of Bridgeton, Just Moms STL, and the Missouri Coalition for the Environment, to explain the steps and schedule for EPA's final decision on the OU-1 remedy.

In July 2018, the Regional Administrator and the Deputy Assistant Administrator for the Office of Land and Emergency Management held another series of meetings with Site stakeholders to provide an update on the schedule for the EPA to issue the final decision on the OU-1 remedy. These meetings included federal elected officials and/or their staff, a state representative, the Mayor of Bridgeton and City Administrator, the CAG, Just Moms STL, Republic Services and the Missouri Coalition for the Environment.

1.2 Organization of Responsiveness Summary

The EPA received more than 4,200 written and oral comments during the public comment period. All comments were reviewed in development of the Amended Remedy and included in the Administrative Record. In the Proposed Plan, the EPA requested input on all of the alternatives, the balancing criteria, the depth, the concentration, and disposal. As described in Parts I and II of the ROD Amendment, public input played a role in the development and ultimate selection of Modified Alternative 4 as the Amended Remedy. As required by the NCP, this Responsiveness Summary presents the agency's responses to each of the significant comments, criticisms, and new relevant information.[5]

The EPA has categorized and summarized comments by topic and issue under descriptive headings. The Responsiveness Summary has been organized into seven general sections. Section 2.0, Site Management, responds to comments concerning the EPA's overall administration of the Site, such as the agency's cleanup authority, use of operable units, and stakeholder engagement activities. Section 3.0, Site Conditions, focuses on comments related to physical conditions at the Site, including on-site waste characterization and off-site investigations. Section 4.0, Risk Assessment, concerns comments on the

[2] 40 C.F.R. § 300.435(c)(2)(ii)(A).
[3] 40 C.F.R. § 300.435(c)(2)(ii)(B), (C).
[4] 40 C.F.R. § 300.435(c)(2)(ii)(D).
[5] 40 C.F.R. § 300.435(c)(2)(ii)(F).

EPA's calculation of current and future risks on which the remedial action is based. Section 5.0, Analysis of Remedial Alternatives, broadly addresses numerous issues related to the EPA's analysis of the NCP's nine remedy selection criteria, including community acceptance which covers comments received on specific remedial alternatives. Section 6.0, Remedial Design, and Section 7.0, Post-Remedy Implementation, provide responses to comments concerning issues that will be addressed after remedy selection. Within each of these sections, the EPA's response to issues raised in the comments immediately follows the comment summary.

2.0 Site Management

2.1 Transfer to FUSRAP

Comment

Numerous commenters requested that regulatory oversight of cleanup activities at the Site be transferred to the Formerly Utilized Sites Remedial Action Program (FUSRAP) operated by the U.S. Army Corps of Engineers (USACE) under agreement with the Department of Energy (DOE). Among the reasons given were that the EPA does not have either the authority or sufficient experience to address nuclear wastes. One commenter expressed the belief that West Lake Landfill was excluded from the FUSRAP program so that DOE would not need to pay for remedial action. Another commenter stated that the Site qualifies as a Vicinity Property to HISS/FUTURA (Latty Avenue site) and should not have been excluded from the current FUSRAP cleanup. Further, they stated that based on the Federal Facilities Agreement for the Latty Avenue Site, it appears that any RIM found within the Bridgeton Landfill property line would become the responsibility of FUSRAP. Other comments expressed a preference that the USACE work on the Site, citing their experience and safety record. There was one request that the EPA follow the same standards that FUSRAP would follow. Alternatively, there were some commenters who did not want the Site transferred to FUSRAP, believing that doing so would further delay cleanup and cost the government additional money.

Response

West Lake Landfill is a National Priorities List site that is being remediated under the Superfund Program. As documented in the Administrative Record for OU-1, the EPA, the USACE, and the DOE agreed that the Site is best addressed under the EPA's regulatory oversight, and in 1995 the Nuclear Regulatory Commission (NRC) deferred the cleanup of OU-1 to the EPA. Since then the EPA has continued to act as the lead agency during development and oversight of response actions for OU-1. It is also important to understand that regardless of which agency is in the lead, the Site would still be subject to the cleanup requirements of the CERCLA and the remedial decision-making process outlined in the NCP. Both the EPA and the USACE follow the cleanup standards and procedures established by CERCLA and the NCP.

The U.S. Atomic Energy Commission (AEC) established FUSRAP in March 1974 under the authority of the Atomic Energy Act of 1954 to identify, investigate, and take appropriate cleanup action at sites where the Manhattan Engineer District and the AEC conducted activities associated with development of the nation's early atomic energy program. In October 1997, Congress transferred responsibility for the cleanup of FUSRAP-eligible sites to the USACE. To date, the DOE has not determined the Site to be eligible for FUSRAP, nor has it been added to the program by Congress. Additionally, the DOE and the NRC deferred regulatory oversight of FUSRAP to the EPA in the early 1990s.

While the EPA has experience as the lead agency for numerous sites with radiologically contaminated wastes across the country, the agency recognizes that the radioactive contamination at the Site is similar to contamination found at FUSRAP sites in the St. Louis area. For this reason, the agency entered into an Interagency Agreement with the USACE in August 2014 to obtain their assistance and expertise during development and review of the RIA and FFS. The USACE's comments and feedback on these documents are contained in the Administrative Record file published with the Proposed Plan. The EPA intends to continue seeking support from the USACE and other experts during the design and implementation phases of the remedial action.

2.2 Operable Unit 1

Comment

One commenter stated that the EPA has gathered no new information from the additional testing and analysis performed between 2008 and 2018 that changes the EPA's prior conclusion that capping is the appropriate remedy.

Response

The EPA has determined that a fundamental change to the 2008 ROD is appropriate, the basis of which is detailed in Part II of Amended ROD. In summary, the Amended Remedy for OU-1 is based upon the following:

- A better understanding of the volume, concentration and location of RIM at the Site that may present an unacceptable risk;
- New information regarding the potential for RIM to leach under certain circumstances;
- Concern that, should a subsurface heating event occur in OU-1, the heat could dry and desiccate a cap, providing a conduit for increased release of radon from the subsurface and potentially for the leaching of RIM; and
- A determination that implementation of the 2008 ROD could not be accomplished without disturbance of both putrescible waste and RIM.

2.3 Operable Unit 2

Comment

One commenter stated that the EPA should be responsible for the South Quarry of the Bridgeton Landfill.

Response

The Bridgeton Landfill (also known as the Former Active Sanitary Landfill), the Closed Demolition Landfill and the Inactive Sanitary Landfill are designated collectively by the EPA as Operable Unit 2 (OU-2). The Bridgeton Landfill and the Closed Demolition Landfill are operated under Resource Conservation and Recovery Act (RCRA) solid waste permits issued by the state of Missouri. Consistent with the EPA's policy on coordination between RCRA and CERCLA actions[6], the agency's 2008 ROD for OU-2 deferred oversight of these landfill units to the MDNR. For these landfill units, the terms of their respective permits dictate the appropriate closure and post-closure care requirements. Successful completion of these requirements would eliminate the need for further CERCLA action at these units. The EPA is the lead agency to oversee remediation of the Inactive Sanitary Landfill portion of OU-2.

Comment

One commenter observed that the OU-2 ROD did not take into consideration a subsurface heating event in the South Quarry and that the OU-2 ROD provides an opportunity for the EPA to buy-out those community members living closest to the Site.

Response

The OU-2 ROD was signed in 2008, before the subsurface heating event was detected in the Bridgeton Landfill during December 2010. Oversight of the Bridgeton Landfill has been deferred to the MDNR and is being addressed pursuant to state requirements. The EPA has considered the presence of the subsurface heating event and related concerns in the selection of the Amended Remedy. In cooperation with the MDNR, EPA has taken significant actions to evaluate and address these concerns at the Site, as described further in Section 3.2, below. Please also refer to Section 2.8.2 for the EPA's response to comments concerning relocation.

2.4 Operable Unit 3

Comment

Several commenters stated that the OU-1 remedy should not be finalized and implemented until the RI/FS process for sitewide groundwater has been completed. One commenter stated that the amended ROD for OU-1 should be considered an interim ROD until a decision has been made with respect to potential groundwater contamination under OU-3. One commenter questioned the EPA's legal authority to compel the OU-3 responsible parties to pay for future removal of radioactive material in OU-1 because the EPA did not appropriately consider groundwater an exposure pathway for OU-1.

Response

The EPA recognizes that groundwater protection is a concern due to the Site's proximity and interaction with the Missouri River Alluvial Aquifer. Since issuance of the 2008 ROD, the EPA has further evaluated groundwater conditions at the Site and determined that, consistent with the provisions of the NCP, the complexity of groundwater conditions warrants a separate RI/FS, under a new operable unit, designated as OU-3. The EPA has received support from the U.S. Geological Survey (USGS) and the MDNR on development to a scope of work for the groundwater investigation. Based on the results of the OU-3 RI, remedial action will be taken to address groundwater if appropriate. As required by the NCP, the present selection of an Amended Remedy for OU-1 is consistent with any future remedial actions that may be necessary for the other OUs at the Site. For OU-3, this includes taking into consideration the design and performance of the OU-1 landfill cover, as well as, the results of the OU-1 groundwater monitoring.

The EPA does not believe that implementation of the Amended Remedy for OU-1 should be delayed

[6] EPA 530-F-98-026, OSWER Memorandum (October 1998).

pending the OU-3 investigations. The use of operable units at remediation sites is a common approach in remediating Superfund sites, especially for complex sites. The NCP provides that remedial actions are to be implemented "as soon as site data and information make it possible to do so."[7] In doing so, the agency "promotes the responsiveness and efficiency of the Superfund program by encouraging action prior to or concurrent with conduct of an RI/FS as information is sufficient to support remedy selection."[8]

Regarding the responsible parties' payment of response costs related to any potential future excavation of RIM, CERCLA provides that potentially responsible parties (PRPs) may be liable for all costs incurred by the government in responding to any release or threatened release at the Site. The statute further provides that the agency may order or enter into settlements with such parties to undertake necessary response actions. If future circumstances warrant a fundamental change to the scope, performance, or cost of the remedial action for OU-1, such as removal of additional RIM, the NCP stipulates procedures to amend the selected remedy.[9] As required by the NCP, the Amended Remedy for OU-1 is consistent with and will not preclude implementation of any future remedial actions that may be necessary for OU-3. Likewise, any remedy ultimately selected for OU-3 will be consistent with and not preclude implementation of the Amended Remedy for OU-1, or any future change to that remedy.

2.5 Comparisons to Other Sites

Comment

Several commenters compared the West Lake Landfill Superfund Site to other Superfund sites or other types of sites. For example, commenters expressed the belief that actions taken at Love Canal, Times Beach, Herculaneum, and Fernald were faster or cost less, or noting that buy-outs were offered at some of those sites as well as for the runway expansion project at the St. Louis Lambert International Airport. Commenters also mentioned Weldon Spring as an example when expressing a preference for on-site or off-site disposal. A few commenters noted measures taken at Hanford, Rocky Flats, or the Waste Isolation Plant Project, or noted remedies selected or findings made at FUSRAP sites in St. Louis, Seaway, and Savannah River, as relevant to measures or findings at this Site. A few other commenters expressed caution that revisiting the remedy selection in the future could result in greater time, cost, and risk than originally proposed, citing as examples the Shallow Lands and the Denver Radium sites. One commenter identified several sites (e.g. Weldon Spring; Shpack Landfill; Shattuck; Hematite, Missouri; Fernald; BoRit Asbestos; Donna Reservoir and Canal System; Peterson/Puritan, Inc.; Hunter's Point Shipyard) where radioactive material has been safely removed in various different environments, including throughout Missouri.

Response

Remedy selections are site-specific determinations based on analyses of unique data, exposure pathways, and evaluated risks using the nine evaluation criteria set forth in the NCP.[10] As explained in the preamble to the NCP, "EPA believes that flexibility is needed in the remedy selection process precisely because each Superfund site presents a different set of circumstances." This flexibility is essential because "[a] rigid set of criteria . . . would not be well suited to such diverse site circumstances, and would be less responsive to Congress' mandate to consider a large number of factors, including

[7] 40 C.F.R. § 300.430(a)(1).
[8] *See* 55 Fed. Reg. 8666, 8703 (Mar. 8, 1990).
[9] 40 C.F.R. § 300.435(c)(2)(ii).
[10] 40 C.F.R. § 300.430(e)(9)(iii).

protectiveness, permanence and treatment, cost, effectiveness, and state and public participation." While Superfund project managers regularly review actions taken at other remediation sites to further their knowledge of relevant experiences, it cannot be concluded that an action deemed necessary at one site would be appropriate at another site where circumstances are not identical. The Amended Remedy for the Site is based on a large set of site-specific data and information. This Site poses unique challenges such as the presence of radioactive waste in a municipal landfill, a subsurface heating event in adjacent landfill, and the Site's proximity to an airport. The EPA's consideration of comments relating to these site-specific circumstances is provided in subsequent sections of this Responsiveness Summary.

Comment

One commenter stated that the EPA is treating the Site differently than FUSRAP sites in North St. Louis County where radiologically contaminated soils under roads, buildings, and other structures are being managed in place. This commenter further stated that the EPA is proposing to remove materials that in the 2008 ROD it equated to inaccessible soils at FUSRAP sites.

Response

The EPA has developed the Amended Remedy according to CERCLA, based upon consideration of site-specific data and information, and has evaluated risks specific to the Site in a manner consistent with the NCP. As described in the FFS, all alternatives, including Alternative 4, are implementable. The Amended Remedy is a partial excavation remedy which is modified from Alternative 4, and is also implementable. Although, the RIM located at the Site is generally not located under buildings, roads or other structures, some portions of RIM are harder to access than others such as RIM located close to the transfer station and RIM beneath the above-grade portion of the North Quarry portion of the Bridgeton Landfill. Consideration of this condition was included in the development of the Amended Remedy. The Amended Remedy removes a majority of radioactivity while avoiding implementability and short-term risk issues of deeper and less accessible RIM.

EPA's Modified Alternative 4 will result in some RIM that will not be excavated from the Site. This determination is based on EPA's consideration and evaluation of the NCP criteria, primarily long-term effectiveness and permanence, short-term effectiveness, implementability and cost. The EPA notes that several of the considerations in UMTRCA 40 C.F.R. 192.21 are similar to the NCP criteria evaluated by EPA in reaching the final conclusion regarding the partial excavation remedy for OU-1.

Please refer to Section 2.1 for response to further comments regarding the FUSRAP program.

2.6 Community Participation

Comment

One commenter stated that the role of the public is not to select or develop a remedy but to comment on the remedy proposed by the EPA. By asking for comments on specific elements of the remedy, the commenter argued, the EPA is asking the public to develop the remedy.

Response

Section 117 of CERCLA and several provisions in the NCP provide for meaningful community involvement in selecting the remedial action. The NCP states that "[t]he purpose of the proposed plan is to supplement the RI/FS and provide the public with a reasonable opportunity to comment on the preferred alternative for remedial action, as well as alternative plans under consideration, and to participate in the selection of remedial action at a site."[11] Additionally, the NCP requires the EPA to make proposed ROD amendments and information supporting the decision available for public comment and solicit the submission of written or oral comments.[12] In accordance with these provisions, the EPA solicited public comment on all alternatives presented in the FFS, as well as on disposal options and the depth and concentration criteria presented in the agency's preferred alternative. Decisions concerning these issues have significant potential implementation impacts on the community due to the length of construction and the long-term management of waste. The EPA believes, therefore, that it was appropriate to seek specific input from the public on those issues. As a result of the comments received on the concentration and depth criterion for partial excavation, EPA has made changes to the Amended Remedy that achieves a better balance of the NCP criteria, specifically with regard to long-term effectiveness and permanence, short-term effectiveness, implementability, and cost criteria.

Comment

One commenter stated that it believes the EPA has systematically ignored scientific facts and data that do not support its preferred remedy, and that the agency has offered explanations for its decision that run counter to the scientific evidence before it, in contravention of the EPA's *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Environmental Protection Agency*, which requires that "the disseminated information is being presented in an accurate, clear, complete, and unbiased manner, and as a matter of substance, is accurate, reliable, and unbiased."

Response

The guidance cited by the commenter was developed in response to guidelines issued by the Office of Management and Budget under Section 515(a) of the Treasury and General Government Appropriations Act for Fiscal Year 2001 (Public Law 106-554; H.R. 5658). The EPA's guidance contains the EPA's policy and procedural guidance for ensuring and maximizing the quality of information disseminated by the EPA. Various processes are outlined in this guidance to support the dissemination of quality information, including internal procedures for the development of overall quality systems, conducting peer reviews, action development processes, correctional processes, informational resources, as well as programmatic processes.

The EPA is dedicated to the collection, generation, and dissemination of high quality information. The EPA supports the use of accurate, reliable and unbiased scientific facts and data in making remedial decisions and has done so at this Site. The EPA has made substantial efforts to remain transparent during the development of the Amended Remedy. The EPA provided draft versions of decision documents, including the RIA and FFS, on its website prior to the start of the public comment period. In addition, EPA has engaged with many different stakeholders regarding the additional data and information collected at the site since 2008, including the CAG, other federal and state agencies, and PRP representatives.

Comment

A commenter suggested that free access should be granted to the public to inspect the Site during

[11] 40 C.F.R. § 300.430(f)(2).
[12] 40 C.F.R. § 300.435(c)(2)(ii).

implementation of the remedy.

Response

As stated above, the EPA supports transparency throughout the CERCLA process. However, in terms of access to Superfund sites, site-specific health and safety plans are required that specify, at a minimum, employee training and protective equipment, medical surveillance requirements, standard operating procedures, and contingency planning in conformance with 29 C.F.R. § 1910.120(*l*)(1) and (*l*)(2) for all work conducted at the Site. Access at the Site is anticipated to be generally limited to those personnel that have the required training, medical surveillance and protective equipment, and are needed to conduct activities to implement the remedy. The EPA, in conjunction with our state partners at the MDNR, will have trained personnel performing oversight of the implementation of the remedy.

Comment

Several commenters stated that the EPA needs to increase or improve its community involvement efforts at the Site. One commenter suggested better communication with the public about the risk of contaminants at the Site.

Response

The EPA and other partner agencies, such as the Agency for Toxic Substances and Disease Registry (ATSDR), will continue to provide information to the public regarding potential risks associated with the Site. Over the past few years, the EPA has increased its efforts to communicate with a variety of community members and stakeholders regarding the recent OU-1 site investigations. The EPA has encouraged and supported community involvement by publishing fact sheets, holding public information meetings, facilitating establishment of the CAG, participating in various public meetings, providing independent technical assistance to the community, and opening a local office in the community. Further, the Agency has supported additional community participation through community interviews, establishment and support of the Community Dialog Framework, routine issuance of a Site newsletter titled “West Lake Updates” to inform the public of important site actions and milestones, and responding to request for information by members of the community and the technical sub-committee of the CAG. The EPA will continue to work with the community and other stakeholders during remedial design and remedy implementation and look for additional avenues to improve community involvement efforts.

Comment

Several commenters recommended that the EPA seek the expert opinions of Todd Thalhamer.

Response

The EPA has reviewed input previously provided by Todd Thalhamer regarding the Site, as well as from other stakeholders, and these reviews are documented in the Administrative Record for OU-1. The EPA consults with and utilizes many experts for important Site concerns such as landfill regulations, the subsurface heating event, groundwater, stormwater, air monitoring, and health considerations. Specifically, the EPA has consulted with the ATSDR, the MDNR, the USACE, the USGS, the EPA Office of Research and Development, the EPA National Analytical Radiation Environmental Laboratory and others on various aspects of this Amended Remedy.

Comment

One commenter stated that the Site has not been remediated because the residents are not light-skinned.

Response

The EPA is committed to ensuring environmental protection for all people and maintains the lead agency role for compliance with Executive Order 12898, which directs federal agencies to develop environmental justice strategies to address disproportionate adverse human health and environmental effects of their programs on minority and low-income populations. Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies. The Site was evaluated for potential environmental justice concerns and consideration of vulnerable populations was taken into consideration in the development and implementation of agency actions with a particular focus on meaningful public involvement.

2.7 Participation by Potentially Responsible Parties

Comment

Several commenters expressed concern that the EPA is listening to PRPs rather than citizens.

Response

The remedial process undertaken at the Site is consistent with the requirements of Sections 104, 122(a), and 122(d)(3) of CERCLA, which permit the EPA to enter into agreements with liable parties for the performance of site investigations and response actions. The NCP also states that the EPA shall "[c]onserve [Hazardous Substance Trust Fund] monies by encouraging private party response."[13] The EPA has repeatedly affirmed its commitment to having the PRPs conduct cleanup activities, including the RI/FS.[14] PRP performance of work at NPL sites conserves Fund monies, making additional resources available to respond to contamination at Sites where viable PRPs are unavailable. Importantly, the PRPs and the public are given equal opportunity to comment on the EPA's preferred alternative at the remedy selection stage. The EPA has considered comments from interested community stakeholders, including the PRPs, in development of the Amended Remedy.

Comment

Many commenters believe that additional sampling should be performed by an independent organization and expressed distrust for any sampling performed by the PRPs.

Response

As explained in response to the previous comment, the EPA has a longstanding policy to pursue

[13] 40 C.F.R. § 300.400(c)(3).
[14] *See* "Enforcement First for Remedial Action at Superfund Sites" (Sept. 20, 2002); "Enforcement First at Superfund Sites: Negotiation and Enforcement Strategies for Remedial Investigation / Feasibility Studies (RI/FS)," OSWER Dir. No. 9355.2-21 (Aug. 9, 2005); "Promoting Enforcement First for Remedial Investigation/Feasibility Studies at Superfund Sites," OSWER Dir. No. 9200.2-109 (Mar. 20, 2012).

"Enforcement First" throughout the Superfund cleanup process. Here, as at all PRP-lead sites, the PRPs conducted work under the EPA's oversight. This is done to ensure that the PRPs and their contractors are proposing, implementing, and reporting the investigation in an appropriate manner and in accordance with EPA approved planning documents. The EPA or the EPA's contractors are present on-site during most of the field work to observe sampling and screening techniques and to collect split samples to confirm analytical results. The laboratories that analyze the PRPs' samples are independent laboratories that are required to maintain appropriate quality control procedures and retain data and associated records. The EPA reviews the analytical reports, laboratory quality control documentation, and related information and requires revisions or additional work, if necessary. The MDNR, the USGS, and the USACE have supported the EPA on this project by conducting technical reviews of the data and documentation provided by the PRPs and their contractors.

In addition, the NCP specifically sets forth requirements to ensure data quality and EPA oversight of data collection.[15] Specifically, the NCP requires that sampling and analysis plans provide a process for obtaining data of sufficient quality and quantity to satisfy data needs. Sampling and analysis plans for work performed for OU-1 has been reviewed and approved by the EPA.

Comment

Multiple commenters stated that the DOE or the U.S. Department of Defense (DOD) should pay for some or all of the remedy.

Response

Pursuant to Section 107(a) of CERCLA, responsible parties may be liable for all costs incurred by the government in responding to any release or threatened release at the Site. Such costs may include expenditures incurred as a result of investigation, planning, cleanup of the Site, enforcement, and destruction or loss of natural resources. The EPA has formally notified the DOE of its potential liability for releases or threatened releases of hazardous substances from the Site. The EPA has not, however, identified the DOD as a PRP.

2.8 Other Community Concerns

2.8.1 Community Health

Comment

Many comments were received urging the EPA to take action with respect to Coldwater Creek and expressing the belief that contamination from the West Lake Landfill Site has impacted Coldwater Creek. Comments requested further environmental testing and remedial action at Coldwater Creek as well as relocation, compensation, or other help for those living near or affected by Coldwater Creek. A few commenters noted that environmental and health concerns associated with Coldwater Creek are examples of the effects of leaving nuclear waste in place, and several commenters mentioned Coldwater Creek in expressing a preference for off-site rather than on-site disposal.

Response

This remedy decision pertains to OU-1 of the West Lake Landfill Superfund Site, which is located

---

[15] 40 C.F.R. §300.430(b)(8); 40 C.F.R. §300.435(b)(1).

approximately 7 miles from Coldwater Creek, a separate site being addressed under FUSRAP. The EPA is not aware of evidence that contamination from the Site has impacted Coldwater Creek, or vice versa.

Questions or comments regarding actions taken at Coldwater Creek should be addressed to the U.S. Army Corps of Engineers, St. Louis District FUSRAP Program, which is the lead agency for cleanup activities at Coldwater Creek. Correspondence may be communicated to the USACE via email at *STLFUSRAP@usace.army.mil*.

Comment

Many comments addressed health issues that commenters believe are attributable to the Site. Notably, comments regularly referred also to Coldwater Creek and the SLAPS and HISS FUSRAP sites, where radiological wastes were previously stored. Specifically, many individuals relate experiences of living in the area near West Lake Landfill and Coldwater Creek, or of growing up, attending school or working near these locations. The majority of such comments communicate generalized concern for public health impacts that may be related to radiological contamination at these sites. Many commenters referred specifically to health issues that they themselves, their relatives, or fellow community members, including adults and children, have experienced. These comments include descriptions of various cancers, autoimmune disorders, heart disease, respiratory issues, inflammatory diseases, fertility and birth difficulties, developmental problems, neurological conditions, and chronic migraines. Frequently, individuals that commented on general or specific health concerns also described prolonged anxiety associated with living near radioactive waste sites, as well as prospective fear that they or their friends or relatives may be affected by health issues. These comments regularly concluded with an expression of distrust or outrage directed toward governmental entities responsible for protecting human health and the environment, especially the EPA. Conversely, a few commenters stated that although there are concerns that radioactive elements are present, the immediate health risks are not as severe as some people have come to believe.

Response

The EPA has sampled off-site areas in response to public concerns. As described in more detail in Section 3.1.2 of the Responsiveness Summary, the results have consistently demonstrated no current off-site health risk in excess of the target cancer risk range associated with exposure to radiological contamination from West Lake Landfill OU-1. These data include indoor and outdoor environmental samples collected from two homes in the Spanish Village neighborhood,[16] the Bridgeton Municipal Athletic Complex (BMAC) investigation,[17] the EPA's year-long air monitoring effort,[18] the current air monitoring efforts conducted by the PRPs, off-site and perimeter soil and sediment sampling events summarizes in the RIA. In late 2015, the ATSDR also published a West Lake Landfill OU-1 Health Consultation that concluded there was no off-site health risk.[19]

Comment

One commenter expressed concern about the health effects of chemicals that may be present in

[16] Results of Bridgeton Dust Pre-CERCLA Screening (May 11, 2017).
[17] Final Pre-CERCLIS Screening Report, Bridgeton Municipal Athletic Complex, Bridgeton, Missouri (July 30, 2014)
[18] Final Data Summary of Radiological Parameters Analyzed During Baseline Off-Site Air Monitoring (Oct. 22, 2015); Final Data Summary of Baseline Off-site Air Monitoring Via Sampling for Volatile Organic Compounds and Hydrogen Sulfide by Application of Passive/Diffusive Sampling Methods (October 26, 2015).
[19] ***https://www.atsdr.cdc.gov/HAC/pha/West_Lake_Landfill/West_Lake_Landfill_HC_October2015_508.pdf.***

deodorizers that the landfill operators use to mask odors and stated their use should cease.

Response

Commercially available deodorizing technologies have been developed for sites such as landfills to either encapsulate or mask the odor-generating compounds. The deodorizers currently in use at Bridgeton Landfill are associated with the on-site waste transfer station and activities conducted at the Bridgeton Landfill, and are not located on, or otherwise associated with OU-1 of the West Lake Landfill. However, during remedial design for the Amended Remedy, engineering controls, including the use of deodorizers, will be evaluated and considered for use during remedy implementation to help control and manage odor issues at the Site. Specific questions related to the deodorizers currently in use at the Site should be directed to the MDNR Solid Waste Management Program.

Comment

Numerous commenters requested that health screenings be provided for citizens who believe they have been affected by the Site.

Response

There are currently no known off-site exposures to site-related radiologically impacted material of health concern, therefore there are no recommendations for additional health screenings outside of those normally recommended by personal physicians.

2.8.2 Relocation of Residents

Comment

Numerous commenters expressed a desire for relocation of people in the community, primarily of residents but also of businesses and animals. Some commenters included examples of other sites or situations where residents were relocated, such as Doe Run, Times Beach, and the expansion of the St. Louis Lambert International Airport. The commenters proposed various distances and certain neighborhoods for which relocation should be implemented. Commenters also varied in the type of relocation (e.g. voluntary, permanent, temporary, building of government housing, etc.) and in the reasons for relocation (e.g., risks during remedy implementation, health concerns for themselves and family members, air quality issues, odors, concerns about the SSE, radiation exposure, etc.) Several commenters requested permanent relocation based on current risks off-site while other commenters requested temporary relocation during the implementation of the remedy.

Response

The NCP includes provisions for temporary and permanent relocation for residents, businesses, and community facilities when the agency determines that it is necessary to protect human health and the environment. There are two types of relocation: permanent and temporary. The primary reasons for conducting a permanent relocation would be to address an immediate risk to human health (where an engineering solution is not readily available) or where the structures (e.g., homes or businesses) are an impediment to implementing a protective remedy. These determinations are made on a site-by-site basis.

As with any decisions or actions the EPA takes, relocation or any other remedial action can only be considered based on scientifically-sound data to guide our efforts. At this time, the scientific data available to the EPA based on the off-site investigations that have been performed does not warrant consideration of temporary or permanent relocation.

The EPA has determined that available on-site and off-site data do not warrant permanent relocation and the EPA's current evaluation of the Amended Remedy is that temporary relocation will not be needed during remedy implementation. The EPA intends to have an active monitoring program in place to ensure that air, stormwater runoff, and off-site sediments and soils do not contain unacceptable levels of contamination. Implementation of the amended remedy will further ensure the long-term protection of human health and the environment.

Comment

One commenter suggested that RECA legislation provides compensation.

Response

The Radiation Exposure Compensation Act (RECA) 42 U.S.C. § 2210 note (2012) established an administrative program for claims relating to atmospheric nuclear testing and claims relating to uranium industry employment. The Act delegated authority to the Attorney General, not EPA, to establish procedures and make determinations regarding whether claims satisfy statutory eligibility criteria.

2.8.3 Property Values & Property Assurance

Comment

Several commenters raised concerns regarding property values and requested property assurance. The comments received varied from asking for compensation for nearby property owners, assuring property values will be protected, and providing financial buyouts for residents both nearby and some distance away from the Site. Many commenters voiced concern that homeowners are unable to sell their property due to its proximity to the Site. Others suggested that sale may be possible, though at depressed value, and urged that a measure of financial assurance be made available for property owners in the area (e.g., within two or five miles) that choose either to sell or stay in their homes. One commenter expanded the scope of this request for financial assurance, stating that property value assurance should be provided to maintain the tax base in municipalities that may experience declining property values due to a perception that the area is unsafe.

Response

The EPA lacks the legal authority to address these types of claims and requests. Pursuant to CERCLA, the EPA has the legal authority to respond to releases, or substantial threats of releases, of hazardous substances into the environment. The factors that the EPA must consider for remedy selection purposes are dictated by the statute and the nine remedy selection criteria set forth in the NCP. CERCLA does not provide a means for the EPA or private parties to compel the payment of, or recover damages associated with, personal injury, diminution in property value, "stigma damages," lost profits, or lost rents.

2.8.4 Public Notification

Comment

Multiple commenters wanted some type of public warning system in the event of emergencies or releases that could potentially occur at the Site, due to the SSE, flooding or remediation activities.

Response

The EPA will keep the community informed regarding on-going remedial activities, consistent with the Site Community Involvement Plan. The EPA has many contingency plans in place to prevent and respond to releases, should they occur. These plans include: the January 26, 2017, Incident Management Plan; the August 4, 2017, Temperature Monitoring Probe Work Plan; and the December 16, 2017, draft Inert Gas Injection Work Plan for Hot Spot Remediation. The EPA will work with local first responders, including police and fire department representatives, to ensure that in the case of an on-site emergency or in the event of a release, provisions outlined in the Incident Management Plan are understood and will be implemented.

Comment

One commenter stated that regulations should be enacted that would prevent a landlord from renting a property in the vicinity of the Site without notification. One commenter expressed a need to coordinate with the real estate commission to ensure Superfund sites, and any sites containing nuclear energy, are disclosed to potential buyers so they can make educated decisions on the purchase of their home.

Response

Regulations governing rental properties are typically a matter addressed by local or state governments. Information on the location of sites listed on the National Priorities List across the nation can be found online through the EPA's website at *https://www.epa.gov/superfund/ national-priorities-list-npl-sites-state*.

3.0 Site Conditions

3.1 Site Characterization

3.1.1 On-Site Characterization

Comment

Many commenters expressed a desire for further Site characterization, specifically additional testing to further delineate the extent of RIM before making a final remedy decision. Many commenters believed that additional sampling or investigations should occur before implementation of an excavation remedy.

Multiple commenters urged that more sampling of the entire Site should occur, especially in areas that have not been previously tested for radioactive contamination. Some commenters specifically called for comprehensive testing of Bridgeton Landfill, particularly the North Quarry. Commenters suggested a need for more investigation of Bridgeton Landfill between the known boundaries of Area 1 and the SSE. One commenter sought information on the results of the additional North Quarry sampling that was announced by the agency in October 2017, and another encouraged sampling of the SSE itself for radioactive contamination.

One commenter, suggested that further sampling should occur after RIM has been excavated to determine whether radioactivity has leached into lower reaches of the landfill.

Another commenter requested specific language be added to the ROD regarding the EPA's statement in Section 3 of the Proposed Plan that "[a]s part of the remedial design process, additional characterization of RIM locations and volume may need to be performed." The same commenter listed specific areas of the Site that will likely require additional characterization during remedial design, including Lot 2A2, drainage areas into the north surface water body, and the southern boundary of Area 2.

Another commenter encouraged the EPA to more seriously consider the information provided by the public about other potentially contaminated areas at the Site, which they claim have not been tested. One of these commenters noted that members of the community had personal knowledge of or had spoken with former workers who recalled entire trucks and drums being dumped or buried in portions of the landfill.

Response

The EPA has concluded that sufficient information has been collected for OU-1 to adequately assess the risks posed to human health and the environment and to support the development, evaluation, and selection of the Amended Remedy. Characterization of the Site has included many phases of investigation, including early Site analysis performed by the NRC, the initial RI completed in 2006, and subsequent extensive efforts, including the 2018 RIA, undertaken by the EPA to further characterize the Site. The investigations and evaluations as documented in the RIA and FFS collectively address all of the investigative factors described in the NCP.

As stated in the NCP, "[t]he purpose of the remedial investigation (RI) is to collect data necessary to adequately characterize the Site for the purpose of developing and evaluating effective remedial alternatives."[20] The RI, therefore, should provide "information to assess the risks to human health and the environment and to support the development, evaluation, and selection of appropriate response alternatives."[21] To achieve that purpose, the NCP requires that field investigations conducted during the RI assess the physical characteristics of the site, general characteristics of the waste, and actual and potential exposure pathways.[22] As explained in EPA guidance, "the objective of the RI/FS process is not the unobtainable goal of removing all uncertainty, but rather to gather information sufficient to support an informed risk management decision regarding which remedy appears to be most appropriate for a given site."[23]

The RI and RIA investigative field work were conducted in multiple phases based on a variety of factors including historical information about how the property was used over time, data results from previous investigations, and screening information regarding the presence of radioactive materials. For example, based on historical documentation, radioactive material from Latty Avenue was brought to the West Lake Landfill between July and October 1973. Evaluation of aerial photographs and depth contours based on the photos demonstrate that active quarrying (removal of limestone rock) was still underway in

[20] 40 C.F.R. § 300.430(d)(1).
[21] *Id.*
[22] 40 C.F.R. § 300.430(d)(2).
[23] "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA," OSWER Dir. No. 9355.3-01, pp. 1-3 (Oct. 1988).

the North Quarry of Bridgeton landfill until 1979, at which time the MDNR issued a permit for solid waste disposal in this area. It is, therefore, reasonable to conclude that waste from the Latty Avenue site was not actively placed in the North Quarry of Bridgeton Landfill. The Phase 1 Comprehensive Report contains the data from sampling in the area where the North Quarry of the Bridgeton Landfill and the southern boundary of Area 1 intersect.

No information from the Site data collected to date, or from a review of other available information, has identified or confirmed the specific presence of buried trucks or drums such as those mentioned in the comments. Per CERCLA, the EPA is required to make remedial decisions based upon science, facts, and site-specific data. Thus, unconfirmed potential conditions cannot be the basis for response actions or remedial decisions. The EPA will continue to evaluate Site conditions and information presented to the agency and respond appropriately. In the Amended Remedy, the EPA notes that additional sampling will be performed during remedial design to support both design and construction efforts, including areas necessary to define the boundaries of Areas 1 and 2.

With respect to waste characterization beyond the landfill units, a number of off-site and perimeter soil and sediment sampling events were conducted during the RIA. These investigations included results with radionuclide concentrations slightly above background levels and a few detections above the Site definition of RIM. Additional sampling that was conducted in these areas did not identify RIM (except on the Buffer Zone and Lot 2A2). The conclusions drawn in the RIA are that contaminant migration could occur via wind, rainwater runoff, or erosion but that the isolated nature of these occurrences suggest that the transport of radionuclides via these routes is not currently a significant migration pathway and does not support the need for additional off-site remedial investigation at this time.

Additionally, the EPA expects that sampling of the Buffer Zone and Lot 2A2, the north surface water body, and potentially other areas will aid the remedial design to refine RIM volume estimates. The Buffer Zone and Lot 2A2 is an area where sampling during the RI identified radionuclides that had migrated via erosion from Area 2 onto these areas. These two sub-areas were added to OU-1 of the Site, and the Buffer Zone was purchased by the landfill owners. Additionally, remedial design work will be required for both the Buffer Zone and Lot 2A2 to refine the current understanding of radionuclide impacts, and support remedial actions, in these areas.

Sediment sampling was performed to a depth of six inches in perimeter drainage channels during the RIA. The agency recognizes that the greatest potential for transport of radionuclides in sediment would have likely occurred historically, after the material from Latty Avenue was brought to the Site and spread as cover, but this was done prior to the establishment of vegetation and the placement of the non-combustible cover. Based on this time line the EPA will conduct additional sampling during remedial design at locations along the perimeter drainage channels around the Site and areas such as north surface water body and areas leading from historical staging and deposition areas within the landfill to refine the extent of areas that need to be addressed by the Amended Remedy.

Comment

One commenter stated that the conceptual site model (CSM) would have more credibility had it included historic context and extreme events, including fires and flooding. The commenter also stated that the CSM did not adequately characterize groundwater.

Response

The CSM is a tool developed to help explain the physical, chemical and biological processes that control the transport, migration and actual/potential impacts of contamination in soil, air, groundwater, surface water and/or sediments, to human and/or ecological receptors. As a tool, the CSM is one of many ways to summarize and communicate contaminant processes and pathways at a Site, and is not intended to replace the supportive information used to develop the CSM. An updated CSM for the Site was developed to incorporate new information gathered since the 2008 ROD. The CSM is presented in the RIA and it provides both a written summary and an illustrative representation of site-specific contaminant processes and pathway information. The CSM is shown in Figure 5 and Figure 6 in the ROD Amendment.

Historical erosion associated with contaminant transport onto the Buffer Zone and Lot 2A2 is discussed in the CSM. A reported fire in the North Quarry of Bridgeton Landfill that occurred in OU-2 has not demonstrated impacts to RIM in OU-1, and as such is not specifically discussed in the CSM for OU-1 in the RIA. A time-critical removal action was taken to address the possibility of any future surface fires occurring in OU-1. Historical flooding in the vicinity of the Site is discussed in the RIA, however no documented transport of contaminates has been identified associated with the historic (pre-1973) flooding, thus this information is not specifically included in the CSM. The CSM at a Site is updated when new information is discovered that changes the understanding of the contaminate processes and pathways, and as such, should new information arise, the CSM will be further evaluated and updated as appropriate.

EPA will address investigation of site-wide groundwater as OU-3. The upcoming OU-3 remedial investigation will provide information useful for the CSM. Specifically, the OU-3 remedial investigation will build upon, as needed, current site information and provide an understanding and summary of the potential and known sources of groundwater contamination, potential release mechanisms, potential routes of migration (including any known or suspected preferential pathways), groundwater flow (vertical and horizontal), Missouri River and groundwater interaction, factors that control contaminant distribution, and potential human and environmental receptors.

Comment

Several commenters indicated that the EPA inappropriately assumed that all RIM in the landfill is leached barium sulfate residues (LBSR). The commenters expressed concern that other contaminants might have been found but were not considered.

Response

The Amended Remedy is appropriately based upon risk estimates developed from site-specific data sets, consistent with the NCP. Radiological scanning and analytical testing conducted at the Site covered many suspected contaminant types, including heavy metals, volatile organic compounds (VOCs) semi-volatile organic compounds, total petroleum hydrocarbons, pesticides, polychlorinated biphenyls, and a suite of radionuclides. As discussed in the RIA and FFS, the EPA acknowledges that there is limited uncertainty regarding the presence of other radiological contaminants at the Site. There is, however, considerable certainty based upon substantial historical information that the material brought from Latty Avenue to the West Lake Landfill consisted of LBSR mixed with soil, and that this mixture was applied as cover over waste disposal areas. The Updated BRA has identified and evaluated site-specific risks based upon data associated with all radionuclides detected and other contaminants identified at the Site.

Data from over 500 samples has clearly indicated that Manhattan Project-related byproducts (i.e., radium and thorium) are the primary radiological contaminants at the Site. Rare earth elements potentially associated with other contaminants, other radiological compounds, or other processes were not identified in any appreciable amounts in samples collected from OU-1 during remedial investigations, as documented in the Administrative Record. Based on these findings, the nature of LBSR was of critical importance because thorium-230 activities are greater than the radium-226 activities, therefore the radioactivity at the Site is expected to increase over the next 9,000 years. This disequilibrium indicates that the radiological isotopes of thorium and radium are not found in proportions that are naturally occurring. Taking this into account was important in understanding the Site, including specific properties of the primary radiological contaminants and other identified contaminants have been appropriately addressed, as well.

The EPA also considered the potential for other radioactive contaminants to have been present in the soil that was mixed with the leached barium sulfate residues at the Latty Avenue Site before being brought to the West Lake Landfill. Radionuclides sampled for at West Lake include the same contaminants of concern (e.g., Ra-226 and -228, Th-230, -228 and -232, and U-234, -235 and -238 and associated daughter products such as Pb-210, Pa-231, and Ac-227 and trace metals) identified in the 2005 ROD for Latty Avenue and SLAPS (see Table 2-2, North St. Louis County Sites ROD, Final, September 2005). Therefore, the sampling performed for the Site discussed in the paragraph above would have identified all the potential radiological contaminants of concern.

3.1.2 Other Investigations

3.1.2.1 General

Comment

Some commenters expressed the belief that contamination from the Site has migrated off-site. Several commenters recommended further off-site investigations, including perimeter sampling and sampling of water bodies, parks, and commercial and residential properties near the Site.

Response

Based upon the information and data summaries contained within the Administrative Record, the EPA has conducted off-site investigations, including off-site air monitoring, soil sampling at the BMAC, and dust sampling at two residential properties near the Site. Comments and associated responses relating to these off-site investigations are discussed in separate sections of the Responsiveness Summary. Based upon conclusions stated in the RIA and FFS, the EPA does not believe that further off-site investigation is necessary to support remedy selection.

During remedial investigation activities for OU-1, characterization of on-site conditions and identification of completed transport pathways were performed to determine any off-site media that may be impacted to focus any off-site investigations. These remedial investigation activities were incorporated into the updated Baseline Risk Assessment. The Remedial Investigation Addendum reaffirmed conclusions reached in the original Remedial Investigation that wind, rainwater runoff, and erosional transport represent potential pathways for contaminant migration from OU-1. As a result, post 2008 investigations included the collection of samples from a variety of media, including sediment, stormwater, and surface water samples from locations both on-site and at site boundaries; and in the surrounding community.

The results of these evaluations demonstrate that significant migration of contaminants has not occurred except in the Buffer Zone and Lot 2A2. Soil and sediment samples collected around the boundaries of Area 1 and Area 2 were generally consistent with background/ambient levels. One sample location collected from the drainage ditch between St. Charles Rock Road and Area 2 was above the EPA's definition of RIM (7.9 pico Curies per gram, or pCi/g, combined radium or combined thorium); however, subsequent sampling from the same location and several additional nearby locations did not identify RIM, although some detections were identified as being above background levels. In summary, while the remedial investigation work for OU-1 has identified multiple transport pathways for contaminant migration, the EPA's evaluation of these pathways does not indicate significant or widespread contamination or current exposures health-base levels, as suggested by the commenters.

As noted above, migration of contaminants into the Buffer Zone and Lot 2A2 are the only locations where the EPA has identified significant migration of contaminants from the Site. The Buffer Zone and Lot 2A2 became contaminated by the migration of radionuclides via erosion from Area 2. While this portion of the Site has been previously investigated and is part of OU-1, the current presence and extent of contamination in these locations is not fully defined due to the property owners' addition of a parking lot over impacted portions of the property.

Comment

Commenters expressed the belief that other studies have concluded that contamination from the Site has migrated off-site, including the 1982 NRC report about off-site pathways; 1988 NRC report of groundwater contamination; 2013 MDNR study; 2014 USGS study of groundwater; and 2015 Attorney General report on impacted trees and groundwater.

Response

The 1982 NRC report concludes that "There is no indication that significant quantities of contaminants are moving off-site at this time." The 1988 NRC report's conclusions include that "Although these radiological conditions indicate that remedial action is needed, it is unlikely that anyone has received significant radiation exposures from the existing situation." Neither NRC report ruled out the potential for off-site contamination but both reports conclude that significant migration or exposures were unlikely, and both reports indicated the need for further investigation.

The MDNR "West Lake Landfill Radiological Survey" Report from May 16, 2013 concluded that, for all tested media, results were consistent with background values.

The USGS study documented leachate effects in 47 of 83 on-site wells and 13 wells with an average dissolved combined radium above the MCL. Further discussion regarding the 2014 USGS study is included in the groundwater response in Section 3.4. OU-3 will further evaluate contamination in groundwater and address uncertainties identified in the USGS report.

Additionally, groundwater has been sampled from several off-site private water supply wells located within nearby alluvial and bedrock units. In 2013, nearby, private off-site wells were inventoried, and groundwater samples were collected from 10 private wells located within approximately five miles of the Site. Eight of these wells were completed in the Missouri River Alluvial Aquifer and two wells were completed in Mississippian-age bedrock units. The combined radium-226 plus radium-228 results from the off-site wells sampled were below the radium drinking water MCLs and were generally consistent with radium values reported in the St. Louis area. Six of the off-site alluvial aquifer wells were located approximately two miles north and downgradient from the Site. None of the groundwater results from these off-site wells appear to have radiological or other impacts associated with the Site.

The 2015 Attorney General reports are addressed under Section 3.1.2.6.

The EPA has previously reviewed and considered these reports in deciding to amend the 2008 ROD.

3.1.2.2 Air

Comment

Numerous commenters expressed concern about fugitive dust and releases into the air during remedy construction due to the presence of radiological contamination at the Site and requested that air monitoring equipment be positioned both on- and off-site to determine if contaminants are migrating through the air. Further, several commenters expressed concerns that the SSE is either currently causing, or will in the future cause radioactive particles to be released to the air. These commenters also suggested that the radiological material should be removed to avoid potential on-going or future contaminant migration through the air. Another commenter noted, to the contrary, that historical on- and off-site air monitoring demonstrates that there have been no airborne releases of radionuclides from the Site.

Response

Extensive air monitoring for radionuclides and other contaminants has been conducted at the Site. Specifically, air monitoring has been conducted at 13 on-site stations, and at five off-site stations located in the surrounding community. The on-site monitoring was initiated in 2014 and continues to sample the air, on and at the perimeter of the Site. The off-site monitoring was conducted from 2015 to 2016 while the subsurface heating event in Bridgeton Landfill was occurring. Both the on-site and off-site air monitoring results for particulates and site-related radionuclides were generally consistent with urban background levels. Additionally, the results for gross alpha, beta, and VOCs were also consistent with urban background levels. The EPA will continue to evaluate future air monitoring data to ensure effective air monitoring during remedy implementation.

Further, site-specific air monitoring programs will be developed during the remedial design to ensure the protection of Site workers and the community during remedy implementation. The Amended Remedy, was modified from the Preferred Remedy based on comments to balance the removal of radioactive material with reducing short-term implementation impacts. Comments regarding potential generation of fugitive dust and odors during remedy implementation were taken into consideration in the selection of the Amended Remedy. See Section 5.2.2.2.2 of the Responsiveness Summary for further information on air monitoring anticipated during remedy implementation. For further information related to the subsurface heating event, see Section 3.2. of the Responsiveness Summary.

Comment

One commenter discussed peer-reviewed research articles written by Marco Kaltofen. One of these articles describes the volatilizing of radionuclides carried by small radioactive particles from this site, thereby creating an exposure pathway for local residents. A few commenters stated that the EPA has not considered the information in these articles and excluded this research from the Feasibility Study.

Another commenter observed that radon gas in the gas collection system of the Bridgeton Landfill can continuously degrade, condensing and creating dangerous mixes with other chemicals and then flaring these mixes to the community, carrying radioactivity as radon gas or as particulate matter for long distances, as concluded by the Kaltofen study. The commenter argues that the study refutes the EPA conclusion that airborne transport of radioactive material is not occurring. According to the study, the commenter states, fugitive radioactive dust and/or radon has either been wind-blown or propelled by flaring to travel long distances and has been found sequestered in homes.

Response

The EPA has reviewed and considered the two Marco Kaltofen articles mentioned in the comment, and the results of EPA's review and comments on these articles are included in the Administrative Record for OU-1. The EPA's comments on both articles generally identify concerns with characterization of background and other data quality controls. More specifically, comparisons made between data collected in the St. Louis area to background studies performed at other Sites located several states away seems inappropriate. Additionally, the potential for natural processes, such as the fate and transport of naturally occurring radon and decay products, to contribute to results are either not accounted for or not fully accounted for in the data evaluation, leading to unsupported conclusions. The articles do not contain information regarding data or sample collection methods, analytical testing methods, supporting calculations, and other key information. Therefore, EPA has determined that the conclusions reached in the articles are not well supported. Further, based upon the results of off-site radiological samples collected from two homes located in the residential subdivision of Spanish Village Further. Based upon the results of radiological samples collected from within and outside of these homes, the levels of the radon daughter products and other radionuclides were identified within normal ranges for urban environments. Further, the results did not demonstrate evidence of radiological contamination from the Site.

Additionally, the EPA included an evaluation of the impacts of an SSE on OU-1 in the FFS. This evaluation included an analysis of the potential risk posed by the release of radon caused by an SSE occurring in Area 1 or Area 2. This included analysis of exposures from additional radon that could potentially be released from the Bridgeton Landfill gas collection system. The estimate of risks from all sources of excess radon, including the gas collection system, was within or below the target risk range of 10^{-4} to 10^{-6} for all receptors including off-site residents. The Amended Remedy includes control of landfill gases and radon, as necessary.

Comment

One commenter stated that it needed to be clarified which contaminants of concern could have an additional effect on volatilization and mobilization of RIM through soil, water and air.

Response

The EPA assumes that the comment is specifically intended to address the potential for radon migration. Dispersion of radon from radium is a natural process. Radon can move through the air, soil pore spaces, and water. Radium found at the Site includes radium from RIM and from other sources such as native soil, rocks, and other materials. Any source of radium will contribute to the overall amount of radon present.

The radionuclide contaminants of concern at the Site are in the uranium decay series and as such can contribute to radon generation. The Amended Remedy has been specifically developed to address radon concerns by partial removal of source materials and the use of an UMTRCA cover over areas containing RIM, Additionally, during remedial design consideration of site conditions including the migration of radon will be conducted and appropriate measures will be implemented, as needed, to ensure the protectiveness of the remedy. Further evaluations of groundwater conditions will be conducted in OU-3.

Comment

Many local residents commented that odors in the area have caused physical and mental impacts leading to a reduced quality of life. Commenters described unacceptable exposures to odors and that this condition is expected to continue until the SSE in Bridgeton Landfill is no longer active. Some residents in the area commented on how they avoid being outdoors and opening windows due to the odors. A couple of businesses in the area mentioned that the odors affect their business and customers. A few commenters requested that additional site-actions be taken to stop the odor.

Response

The EPA understands that odors are a significant concern for the surrounding community and has worked to address odor issues associated with the subsurface heating event in the Bridgeton Landfill. Specifically, the EPA and the MDNR have taken actions to control landfill gas emissions from the Site and reduce odors in the community. In August 2013, under the direction of the MDNR, Bridgeton Landfill placed an EVOH cover over the South Quarry of the Bridgeton Landfill to direct landfill gases toward landfill gas extraction wells. In 2016, the cover was extended to substantial portions of the North Quarry under an administrative order with the EPA, that required a number of engineering measures to monitor and manage Site conditions associated with the SSE.

In December 2016, the EPA also took enforcement actions for noncompliance identified at the Champ Landfill, which is located about two miles south of the Site. The agency compelled Champ Landfill to complete numerous measures designed to minimize odors and landfill gas air emissions, including installation of 33 additional gas extraction wells. The result of these improvements resulted in significantly lower landfill gas emissions and odors in the surrounding community.
Landfill gas sampling at Bridgeton Landfill indicates that the gases given off by the landfill are generally mercaptans and sulfur-containing compounds. Mercaptans are a class of sulfur-containing compounds that have an extremely offensive, garlicky odor. Seventy-eight percent of the measured landfill gas at Bridgeton is dimethyl sulfide, 14.5% is methyl mercaptan, and only 1.4% is hydrogen sulfide. Other sulfides and mercaptans make up the balance of the gas mix. Reduced sulfur-containing compounds have a very low odor threshold, meaning that they are offensive-smelling at very low (parts per billion) levels. These reduced sulfur compounds can cause respiratory irritation. The MDHSS routinely instructs sensitive residents to avoid exposure to these respiratory irritants during days when they are downwind from the landfill.

The recent engineering controls placed on the Bridgeton Landfill have drastically reduced, but not eliminated, all of the reduced sulfur compounds in ambient air. Although the reduced sulfur compounds producing the odors are respiratory irritants, recent air sampling conducted both on-site and off-site in 2016 and 2017 did not detect odor causing sulfur compounds at levels greater than area background.

3.1.2.3 Bridgeton Municipal Athletic Complex

Comment

Several commenters expressed concern over the validity of investigations performed at the BMAC. Specifically, several commenters did not feel that testing the uppermost two inches of soil was appropriate, and that deeper testing should have been, or should be, performed to a depth such as six inches.

Response

In May 2014, the EPA undertook evaluation of potential off-site impacts at the BMAC in response to public concerns. This effort involved surface screening for gross gamma radiation detection, which analyzed data collected from more than 58,000 surface points, as well as collection and analysis of more than 100 surface soil samples. Soil samples were collected from infield areas, outfield areas, grassy areas outside of playing fields, and drainage areas. The depth of the sample was based on several considerations. First, contaminant migration from the Site, if any, would have occurred through air or surface water, therefore contamination would be expected at or very near the surface. Collection of samples from the uppermost two inches, rather than a deeper interval, therefore represents an undiluted sample of the highest potentially impacted soils. In addition, surface soil sampling was selected as a conservative measure because this study area is a baseball field, where people are most likely to be exposed to the top two inches of soil. The EPA worked closely with the community to specifically collect data in areas that had triggered the concern of citizen scientists. The EPA sampled two nearby parks to provide data from similar properties that would not have been potentially affected by the Site for comparison. The EPA assumed the BMAC visitors and on-site workers would be potential receptors for contact with radiological materials via surface water, soil exposure, and air migration. Following completion of this effort, on July 31, 2014, the EPA announced that the facility is suitable for public use and requires no further environmental response.

3.1.2.4 Residential Dust

Comment

Many commenters expressing the belief that contamination from West Lake Landfill has moved off-site, including to homes surrounding the landfill. Most of these comments cite to a 2013 Missouri Department of Natural Resources study, summarized by the commenters as concluding that radioactivity has migrated to nearby areas in easily detectable amounts. Several comments urged the EPA to test homes surrounding the landfill. Referring to the EPA’s sampling in Spanish Village, one commenter stated that testing only two homes does not prove that radioactivity is absent from surrounding homes. One commenter suggested that the EPA should provide air purification or other types of filtering devices to homes.

Response

The EPA conducted residential sampling in 2016 after learning that a private lawsuit had been filed claiming contaminants from the Site were found in and around two homes in the Spanish Village neighborhood. The EPA was not granted access to the property that is the subject of the lawsuit, but the agency obtained permission to access and sample two nearby residential properties. On May 11, 2017, the EPA released an investigation report that includes laboratory analysis of more than 140 samples of exterior soil, interior surface, and bulk dust obtained from the Spanish Village homes. The results showed no evidence of radiological contamination associated with the Site either outside or inside the homes at the two sampled properties. Additionally, soil, surface dust, and air samples were collected by the EPA and the MDNR from nearby Spanish Village Park and the results did not detect radiological contamination associated with the Site. Based on this information, the EPA determined that additional residential sampling is not warranted.

The EPA assumes that the commenters are referencing the MDNR "West Lake Landfill Radiological Survey" Report from May 16, 2013. This report concluded that, for all tested media, the results were consistent with background values.

3.1.2.5 Leachate Pipeline

Comment

Commenters expressed concerns about potential off-site migration of contaminants through a leachate pipeline that leaves the Site and runs past schools, homes, and through several municipalities. City council members of Charlack specifically requested that the leachate pipeline (force main) associated with Bridgeton Landfill be investigated under CERCLA from its origin to the discharge point located near their municipality. Several commenters expressed concern about potential contamination at the Chain of Rocks Water Treatment Plant, where pre-treated leachate from the Bridgeton Landfill is sometimes sent and further treated.

Response

The pipeline discussed in these comments is associated with the Bridgeton Landfill located in OU-2 of the Site, which does not contain radiological contamination and is not connected to or otherwise associated with OU-1. The permeate (landfill leachate that has been pre-treated) that is discharged from Bridgeton Landfill through this pipeline (force main) is regulated under a pre-treatment permit issued by the St. Louis Metropolitan Sewer District (MSD). The MSD requires periodic sampling and analysis of the permeate per the facility's permit requirements, before it is sent to other facilities for further treatment, such as the Chain of Rocks Water Treatment Plant. For questions related to the pipeline (force main sewer), or other related concerns, please contact the St. Louis Metropolitan Sewer District.

3.1.2.6 Vegetation Sampling

Comment

Several commenters discussed concerns regarding a report associated with tree core samples that were collected both on- and off-site by representatives of the Missouri Attorney General's office that included vegetative samples analyzed for a variety of contaminants, including radionuclides.[24]

Response

The EPA has reviewed and identified a number of significant issues with the approach and conclusions

---

[24] Joel G. Burken, et. al, "Westlake Landfill Tree Core Analysis Report" (Sept. 2, 2015), *available at* https://dnr.mo.gov/env/swmp/facilities/docs/wll_tree_core_analysis_report.pdf; Shoaib Usman, "Report on Westlake Landfill Phytoforensic Assessment using Gamma Spectroscopy" (Sept. 2, 2015), *available at* https://dnr.mo.gov/env/swmp/facilities/docs/opinionreport_wll_usman.pdf; Joel G. Burken, "Westlake Landfill Organic Pollutant Phytoforensic Assessment" (Sept. 2, 2015), *available at* https://dnr.mo.gov/env/swmp/facilities/docs/burkenexpertopinionreport.pdf.

presented in the Attorney General's reports. First, the Usman report states that "[t]his study is for screening purposes only, therefore no quantitative data on radioactive material per unit tree core mass is available at this time." The EPA also notes, as recognized in the report, that "no efficiency calibration was possible due to the complex detector sample geometry and consequently no quantitative radioactivity contents in the samples are obtained." The screening level analysis for radionuclides only provided results in relative units (i.e., counts) and did not provide information to determine the actual activity of any radionuclide or a basis to compare the results to regulatory limits or risk-based screening levels. The EPA is not aware of any follow-up reports that provide quantitative data.

Second, the usefulness of the data is limited because multiple samples were batched to complete a single analysis, including a mixture of both on- and off-site tree cores. This approach prevents the identification of differences between samples collected from trees on-site and those collected off-site.

Third, the report did not consider the potential presence of naturally occurring radioactive materials in the collected tree core samples, which would include the same radionuclides that are present at the Site. Because the uranium-238, uranium-235, and thorium-232 decay series are Naturally Occurring Radioactive Material (NORM) and present as background in water, soils, and rock across the world, the contribution of NORM in any batched set of tree cores must be considered along with several other factors before definitive conclusions regarding site-related contamination may be drawn from the data. In this study, the comparison of counts measured from batches of tree core samples were made to background as measured in the "low background room lined with sheets on the walls and the floor." The determination that a batched sample is radioactive compared to the background in a lead-lined counting room is not be unexpected given that uptake of NORM into plants has been well established in scientific literature.

In conclusion, the EPA does not agree with the report's finding that "there were no…Naturally Occurring Radioactive Material (NORM) observed in the samples analyzed." The agency does not believe that sufficient information was provided, or appropriate analysis performed, that would "indicate off site migration of RIM, either in groundwater or in aerial transport of particulate matter," as asserted in the report.

3.2 Subsurface Heating Event

Comment

Many commenters provided input regarding the sub-surface heating event (known also as the "sub-surface smoldering event," or SSE) occurring in the South Quarry of the Bridgeton Landfill. Many commenters stated that the SSE is causing distress for property owners and persons living or working near the Site. The EPA also received comments stating that the engineering measures taken at the Site to monitor and control the SSE have not adequately addressed all public concerns. Others expressed a desire to have ongoing monitoring and management of the SSE.

Commenters also expressed specific concerns regarding the distance between the RIM located in Area 1 and the SSE in Bridgeton Landfill. Some remarked that there is uncertainty about this distance and the possibility of the SSE meeting, impacting, and/or reacting with the radioactive waste. Overall, observations on this issue varied widely, including concerns such as a collapse of the landfill surface, a landfill fire occurring at the surface, a Chernobyl-like reaction, a catastrophic chain-reaction, the spread of radioactive particles in smoke, or an explosion impacting populated areas with radioactive fallout. Many commenters stated that contact between the SSE and RIM may adversely impact the nearby community, while others stated that there would be broader impacts to the St. Louis metropolitan area, bordering states, and even other countries. Finally, some of the commenters suggested that the SSE should be extinguished immediately, or that a barrier wall should be built to prevent the SSE from migrating into OU-1.

Response

The EPA, in conjunction with the MDNR, has taken significant actions to address the subsurface heating event located in the South Quarry of Bridgeton Landfill. In April of 2016, in close coordination with the MDNR, the EPA reached an agreement with Bridgeton Landfill, LLC to install several engineering controls in the North Quarry portion of Bridgeton Landfill, including heat extraction wells, temperature monitoring probes, gas extraction wells, and the installation of an ethylene vinyl alcohol (EVOH) cover. These measures are designed to both control and monitor the subsurface heating event by providing early detection of changes in subsurface conditions in the landfill, removing heat from the waste mass to control the SSE, and require contingency response actions such as inert gas injection, should conditions requiring response actions. If elevated temperatures, or other indications of an SSE, were to occur in the North Quarry, timely response actions will be taken to control and mitigate any effects of such occurrences. Response actions could include, but are not necessarily limited to, repair of the landfill cover or other engineered systems affected by a reaction; installation of additional landfill cover materials, such as EVOH; implementation of additional heat extraction systems and/or physical barriers; implementation or expansion of landfill gas extraction systems; implementation or expansion of leachate collection systems; or other measures as appropriate. These systems reduce the unlikely chance of the subsurface heating event moving from the South Quarry through the North Quarry of the Bridgeton Landfill into OU-1 of the West Lake Landfill. The EPA and the MDNR will continue to closely monitor the SSE, its effects, and the effectiveness of the installed engineering controls and related measures.

Based on evaluations summarized in the Administrative Record, there is uncertainty whether a new reaction could occur within, or extend into, either Areas 1 and 2 of OU-1, due in part to the age and degree of decomposition of the waste materials, the relatively thin nature of the OU-1 waste cells, and the existing physical setting and conditions in Areas 1 and 2. Additionally, the EPA disagrees with comments stating that RIM will become explosive or otherwise result in significant off-site impacts if an subsurface heating event contacts radiological waste materials in OU-1. As described in the FFS, the presence of heat or fire will not result in a catastrophic chain-reaction or nuclear explosion. Technical evaluations have, however, identified other potential impacts that a subsurface heating event could have on OU-1 before, during, or after remedy implementation. Analysis of these considerations is provided in the February 5, 2018 acceptance with modifications letter for FFS.

In addition to undertaking measures to control and monitor the subsurface heating event, the EPA studied potential effects of a subsurface heating event on OU-1 during development of the FFS. These studies evaluated the potential impact of a subsurface heating event resulting from surface desiccation and cracks, increased settlement, potential for particulate releases, an increase in radon gas production, and/or an increase in leachate production. With respect to potential physical impacts related to a subsurface heating event, the evaluations concluded that cracks can form in the landfill mass due to desiccation if liquids entrained in the material volatized, resulting in increased void space in the landfill mass. Such cracking would increase the porosity of the mass, allowing for higher permeability and more rapid movement of generated landfill gas to a point of release. The increased porosity of the landfill materials and potential development of a crack to the surface would provide a direct pathway for release of generated landfill gas and a potential pathway for increased particulate escape from the landfill.

Increased temperatures associated with the SSE are below a temperature that would impact radionuclides other than radon in RIM located in Areas 1 and 2. Concentrations of radon-222 gas and its progeny were simulated in air at the closest occupied structure, the closest boundary fence, and at the two closest communities as discussed in the FFS. The combined radon concentration at the fence line from all sources and both study areas was projected to be 0.162 pico Curies per liter (pCi/L) which is less than the 0.5 pCi/L alternative radon concentration published at 40 C.F.R. § 61.192.02(b)(2). The theoretical risks to receptors were then evaluated at each location of interest (i.e., indoor workers at the closest occupied structure, outdoor workers at the closest boundary fence, and residential receptors at the two closest communities). The highest risk identified in this study, which was 2.2 x 10^{-5} for an outdoor worker at the property boundary. This is within the target cancer risk range. This was the total risk from all sources resulting from a subsurface heating event in both Area 1 and Area 2. Risks to the closest communities were at or below 10^{-6} which does not exceed the target risk range of 10^{-4} to 10^{-6}.

The potential for increased leachate production due to a subsurface heating event occurring in OU-1 was also evaluated in the FFS. A potential subsurface heating event, and the heat front developed surrounding a subsurface heating event, would volatize the moisture in the organic material. This steam would re-condense in cooler zones of the landfill, thus increasing liquid generation in the landfill and the quantity of leachate exiting the landfill. A subsurface heating event would also change the characteristics of the leachate generated from the waste due to the thermal decomposition of the waste in the SSE. A subsurface heating event would likely result in higher levels of biological oxygen demand, chemical oxygen demand, volatile organic compounds, and dissolved metals in leachate. If a subsurface heating event were to occur in OU-1, the waste mass permeability would likely initially increase because of the reduction in mass volume due to thermal decomposition of the primarily organic portion of the waste, and moisture reduction and desiccation of areas of organic waste or soils outside of the subsurface heating event. Consolidation of the waste, and subsidence, would then reduce the mass permeability over time. Initially, increased permeability would increase the rate at which infiltration, or internally generated water, would move through the landfill mass. However, the changes due to increased mass permeability from infiltration would not significantly impact total leachate quantity.

3.3 Surface Fires

Comment

Some commenters provided input regarding concerns of surface fires occurring at the Site.

Response

Surface fires have occurred at the Site, both during and after the cessation of active waste placement. Based upon available information, it appears that the more recent surface fires have been related to damaged or failed electrical equipment, mowing activities, or maintenance operations. To address such surface fire risks prior to OU-1 remedy implementation, the EPA ordered Bridgeton Landfill, LLC, Rock Road Industries, Inc. and Cotter Corporation (N.S.L.) to place a non-combustible cover composed of a rock layer and geotextile materials over areas where RIM is located at or near the surface.

Additionally, the EPA has required the site-operators to develop and implement an Incident Management Plan (IMP), which is available in the Administrative Record. The IMP provides detailed instructions and plans for both on-site personnel and first responders responding to potential incidents at the Site, including surface fires. The IMP includes specific information related to on-site response equipment, chemical storage areas, fire hydrant locations, spill prevention and response items, emergency contact information, points of egress, and other important safety information to support responses to any potential site-related incident. Due to the implementation of the IMP, and the installation of the non-combustible cover, the risks associated with a surface fire occurring at the Site are considered manageable.

Finally, the Amended Remedy will further limit the ability of a surface fire to impact RIM. The Amended Remedy involves partially excavating waste, re-grading the Site per applicable landfill regulations, and then placing appropriate capping materials over the entirety of the Site. After implementation, all waste materials remaining on-site will be contained under a multi-layered cap that will be routinely inspected and maintained.

3.4 Groundwater

Comment

One commenter argued that it is inappropriate to characterize the potential for leaching as a new finding because the 2008 ROD stated that "radionuclide and non-radionuclide contamination is present in the landfill units; the potential for leaching to groundwater and off-site migration is a pathway that should be addressed as part of the remedy for the Site."

Response

The 2008 ROD did appropriately mention and consider leaching to groundwater as a potential migration pathway. However, due in part to the results of leaching tests performed since 2008 as well as new information regarding radium detections in groundwater above the drinking water MCL at the Site, the EPA is amending the 2008 ROD to further support the protection of groundwater in relation to OU-1, and is also specifically requiring a RI/FS for groundwater under OU-3.

Comment

A commenter stated that the EPA has delayed "agreed upon, court-mandated groundwater related testing which was supposed to have been done in 2008."

Response

The EPA acknowledges that the Site requires additional assessment of groundwater, but no court has mandated groundwater-related testing for the Site. The EPA's National Remedy Review Board (NRRB) recommended additional groundwater sampling in 2013, which is perhaps what this commenter is referring to. From 2012 to 2014, the EPA conducted additional groundwater sampling, research, and evaluations in partnership with the USGS. This work included additional sample collection, comprehensive data reviews, the identification of off-site water supply wells, scientific studies, and data interpolations. The results of this work are largely documented in a report issued by USGS in December of 2014 as updated in June 2015.[25] Groundwater sampling has identified radium contaminations under the landfill with concentrations above the drinking water MCL of 5 pCi/L. Additional investigation of groundwater will be conducted as part of OU-3, as described further in Section 2.3.

---

[25] Background *Groundwater* Quality, Review of 2012–14 *Groundwater* Data, and Potential Origin of Radium at the *West Lake Landfill* Site, St. Louis County, Missouri.

Comment

Several commenters were concerned regarding potential impacts to groundwater beneath and near the Site. The commenters generally indicated a desire to excavate and remove as much RIM as possible to prevent the potential migration of radionuclides into or through groundwater. Several commenters mentioned the proximity of the Site to the Missouri River and expressed concerns regarding impacts to groundwater in the Missouri River Alluvial Aquifer, which is used as a source of potable water in the St. Louis area. Other commenters mentioned that the current data set for this Site includes radium detections exceeding the drinking water MCL of 5 pCi/L and that the waste cells located at the Site are unlined and may currently interact with groundwater units located near and beneath the Site. One commenter stated that the groundwater beneath the Site is currently in contact with the RIM materials.

Response

The EPA recognizes that groundwater protection is a critical concern due to the Site's proximity and interaction with the Missouri River Alluvial Aquifer. Since issuance of the 2008 ROD, the EPA has further evaluated groundwater conditions at the Site and concluded that a separate RI/FS is appropriate to determine the nature and extent of any groundwater contamination related to the Site, as described further in Section 2.3. The EPA agrees that any removal of RIM improves the long-term protectiveness and permanence of the remedy by reducing the potential for migration of RIM, including to groundwater. Therefore, in addition to partial excavation of RIM, the Amended Remedy incorporates installation of a low-permeability landfill cover, which will minimize rainwater infiltration.

The EPA understands and shares the community's desire to assure the safety of their drinking water. Most residents living near the Site receive their drinking water from Missouri American Water Works Company, which is required under the Safe Drinking Water Act of 1974 to sample and analyze the water for radionuclides and other contaminants prior to distribution. Area residents can obtain water quality reports directly from the Missouri American Water. The closest identified public drinking water supply intake station to the Site is the Howard Bend Water Treatment Plant located along the Missouri River approximately seven miles downstream of the Site.

In addition, groundwater has been sampled from several off-site private water supply wells located within nearby alluvial and bedrock units. In 2013, nearby, private off-site wells were inventoried, and groundwater samples were collected from 10 private wells located within approximately five miles of the Site. Eight of these wells were completed in the Missouri River Alluvial Aquifer and two wells were completed in Mississippian-age bedrock units. The combined radium-226 plus radium-228 results from the off-site wells sampled were below the radium drinking water MCLs and were generally consistent with radium values reported in the St. Louis area. Six of the off-site alluvial aquifer wells were located approximately two miles north and downgradient from the Site. None of the groundwater results from these off-site wells appear to have impacts associated with the Site.

As noted by some commenters, the EPA recognizes that investigations have found levels of radium above drinking water MCLs in the Site's monitoring well network. As a part of the OU-1 remedial investigations, over 300 groundwater samples from approximately 80 monitoring wells were collected and analyzed between 2012 and 2014. The groundwater samples were analyzed for multiple contaminants, including thorium, uranium, and radium isotopes; trace metals; and volatile organic compounds and semi-volatile organic compounds. The USGS reported that the mobilization of naturally occurring radium contained in aquifer materials by chemical interaction with landfill leachate is an important mechanism potentially resulting in the occurrence and persistence of radium above the MCL.

Further, the EPA acknowledges that uncertainties remain regarding groundwater elevations beneath the Site, specifically in relation to deeper occurrences of RIM in Areas 1 and 2. To reduce or eliminate these uncertainties, the OU-3 groundwater investigation will include a focus on groundwater elevations and hydraulic gradients beneath and near the Site and assess how site-related activities, such as leachate pumping in Bridgeton Landfill affect groundwater conditions. As discussed in Section 2.3, the EPA believes that these investigations may proceed subsequent to the selection and implementation of the OU-1 remedy.

Comment

One commenter stated that historic testing of the materials at the Latty Avenue site demonstrated that the leachability of that material was significantly less than five percent and generally at or below one percent. This commenter referenced the September 1981 solubility testing of the Latty Avenue debris pile by Oak Ridge Associated Universities as found in the Radiological Evaluation of Decontamination Debris Located at the Futura Chemical Company Facility, 9200 Latty Avenue, Hazelwood, Missouri, dated September 9, 1981.

Response

The EPA has reviewed the referenced 1981 report, and based on this review, the agency notes that the leaching tests at the Latty Avenue site were performed on a pile of contaminated soil/building materials that remained after the source material piles were transported off-site. The presence or amount of LSBR in the sampled pile of contaminated soil/debris at the Latty Avenue site is unknown. Therefore, it is not possible to draw conclusions regarding the potential for RIM to leach at OU-1 based on the leaching test results of the Latty Avenue materials.

Comment

One commenter stated that the radiological material located at the Site was previously “aggressively” processed and leached in multiple stages via strong acids and bases to remove uranium. As such, this commenter states, the materials that remained were stable and of low toxicity, referencing a Harrington & Ruehle document from 1959. Further, this commenter stated that the leaching test performed on RIM confirmed that RIM is solid and immobile. Specifically, the commenter also stated that the leachability test resulted in less than five percent of the material leaching. The commenter stated that for the RIM to leach the following steps would need to occur; all of the sulfate in the landfill would need to be consumed, the landfill would have to flood, and the leachate collection system in the Bridgeton Landfill would have to fail.

One commenter stated that the EPA placed too much emphasis on an incomplete fate and transport data analysis. One other commenter stated that the RIA, nor the “Draft Fate and Transport Evaluation for Radiologically Impacted Material” does not support EPA’s statements that there is a potential for radioactive materials to leach. Specifically, the commenter points to specific topics discussed in the Draft Fate and Transport Report, such as: (1) the majority of radium was found to be present in association with barite, (2) uranium and thorium were found to be present predominantly in highly stable forms (residual fraction, barite or iron mineral phases); (3) the Sequential Batch Leaching Test (SBLT) was unduly conservative because solid to solution ratio is higher than typical for the represented environments and used aggressive methods that are more acidic than typical landfill conditions and are not indicative of what might be generated in groundwater conditions; and, (4) the fate and transport samples analyzed were more concentrated for radionuclides than approximately 82.5% of available site data.

Response

Both the RIA and the draft Fate and Transport report conclude that there is potential for radionuclides to leach from RIM. The commenter's statement that RIM was previously "aggressively" processed and leached to a material that remains stable and of low toxicity is misleading. Per the referenced Harrington and Ruehle document, the Leached Barium Sulfate Residues (LBSR) are a by-product of uranium leaching processes used to extract uranium from ore. The ore material was processed and leached with strong acids and base alkaline solutions to remove uranium, and then further processed to remove remaining uranium not extracted by prior processing steps. Left behind were barium sulfates residues, containing radioactive radium and thorium byproducts.

By contrast, RIM is the heterogeneous mixture of radiological contamination, soil and landfill materials located within the OU-1 waste cells of the West Lake Landfill. Thus, the RIM was not subjected to leaching processes. Further, the observation of RIM being "stable" does not account for the continued decay of thorium-230 resulting in ingrowth of radium-226, nor the crystal lattice damage to the mineral complexes from on-going alpha decay.

Additionally, in 2016, it was demonstrated by SBLT on samples containing RIM, that the site-related radionuclides of uranium, radium, and thorium leached to pore water under certain laboratory conditions, designed to simulate a mature landfill. While RIM is a solid, and thus not readily mobile, the leaching tests identified amounts of uranium, thorium, and radium that became solubilized from mineral bound forms. The SBLT used a synthetic landfill leachate designed to simulate conditions in a mature landfill and the leaching tests were only conducted for a limited timeframe. Additionally, the radionuclides continued to leach at the final stages of the SBLT, even though the solution conditions used in the SBLT included several steps at a neutral pH level, and other steps initially at pH of 5.0[26i]. In comparison to these pH values, the pH of rainwater in the U.S. ranges from approximately 4.8 to 5.0 (Galloway, 1982*)*.

Further, the SBLT samples were purposefully selected from field borings with large field gamma counts to ensure actual RIM would be present and evaluated in the test. Failure to do such would result in inaccurate and unrepresentative data. The draft Fate and Transport report identified that much of the uranium and thorium were predominantly found in stable barite or iron mineral phases, and some of the radium was also found to be associated with microcrystalline barite, but a portion of the mineral complexes were also identified as either poorly crystalline or amorphous. Overall the radium results indicated that between 8% to12% of the radium mass contained in the initial solid phase leached to pore water. This result indicated that not all the radium is being held within an insoluble barium sulfate phase, and supports that some radionuclides in RIM are associated with poorly crystalline or amorphous mineral complexes. Leaching of small percentages of radium from RIM could result in increases of radium levels in pore water, above the drinking water MCL of 5 pCi/L.

Comment

One commenter noted that according to a report by Dr. Robert E. Criss of Washington University, "Diagrams in McLaren-Hart (1996b; Fig. 3-29) clearly show groundwater in contact with landfill radwaste. Data in EMSI (2012) document that large-scale radionuclide migration in groundwater has

[26] *SBLT generally had 6 steps, steps 1-3 were repetitive leaching at neutral pH (initial solution pH of 7.3 and 50 mg/L HA) steps 4-6 had initial solution pH of 5.0 and 0 mg/L HA.*

occurred."

Response

The EPA has reviewed the report prepared by Dr. Robert E. Criss of Washington University and the results of this review are documented in the Administrative Record for OU-1. A response to this report, prepared by the USGS, is also included in the Administrative Record. The EPA has also reviewed the diagrams in the 1996 McLaren-Hart report, and the referenced 2012 groundwater document. These results of these reviews are documented in the Administrative Record for OU-1.

The EPA is requiring a RI/FS for groundwater at the Site, and the EPA does not agree that the 2012 report referenced by the commenter demonstrates that “large-scale radionuclide migration in groundwater has occurred.” The EPA does acknowledge that some uncertainty remains regarding groundwater conditions at the Site, including groundwater elevations near and beneath the Site, specifically in relation to deeper occurrences of RIM in Areas 1 and 2. To reduce or eliminate these uncertainties, the OU-3 groundwater investigation will include a focus on groundwater elevations and hydraulic gradients beneath and near the Site and assess how site-related activities, such as leachate pumping in Bridgeton Landfill, affect groundwater conditions.

3.5 Stormwater

Comment

Several commenters provided input regarding stormwater and the potential for site contaminants, namely radionuclides, to migrate in stormwater following rain events.

Response

The EPA recognizes the potential for radionuclides in Areas 1 and 2 to be transported to other portions of the Site or to off-site areas via precipitation runoff. Due to the risk of such impacts, multiple sampling efforts and best management practices have been implemented at the Site over the past several years.

The OU-1 stormwater outfalls are regularly monitored after rain events that result in more than 1/10 inches of rain. Since 2016, more than 100 stormwater samples have been collected and analyzed for site-related radionuclides and other landfill contaminants. Analytical results for thorium-230, radium-226 and total uranium are all below the site-specific preliminary screening levels (342.5 pCi/L for thorium, 10.2 pCi/L for radium, and 131 micrograms per liter for uranium) that the EPA calculated for exposure to surface water at the Site for a trespasser scenario. The agency has also worked closely with the MDNR to review stormwater data and address stormwater related issues for both OU-1 and Bridgeton Landfill.

Further, the ROD Amendment specifically addresses potential stormwater impacts by identifying the following two remedial action objectives, or RAOs, for OU-1:

- Prevent direct contact to contaminated media (including waste material, fill, stormwater, sediments, leachate and groundwater) located on or emanating from OU-1; and

- Control surface water runoff, and minimize erosion associated with OU-1 in accordance with standards identified in the ARARs.

The stormwater monitoring requirements at the Site will need to be modified to account for new outfalls and drainage patterns created both during and following remedy construction. Appendix M of the FFS includes conceptual designs for both excavation and regrading activities that have been developed to support related cost and schedule estimates. These designs will be further developed and evaluated during remedial design. The EPA and the MDNR will continue to work closely on the development of future stormwater management documents and related plans for both the remedial construction and post-remedy timeframes for all areas of the Site.

Comment

One commenter stated that they were concerned that flooding runoff during the airport expansion was contaminated with waste from West Lake Landfill.

Response

The EPA has reviewed information regarding the St. Louis Lambert International Airport expansion project that started in approximately 1998 and was completed in 2006. Based upon the review, the nearest point of the airport expansion project was located several miles to the east of the West Lake Landfill Site. Due to regional topography, the direction, and overall distance from the airport expansion project, the West Lake Landfill Site is not anticipated to have impacted the airport expansion project.

4.0 Risk Assessment

Comment

One commenter stated that the EPA's conclusions in the Proposed Plan regarding potential risks from the Site directly contradict numerous prior statements made by the agency that there are no risks to the surrounding community and no off-site releases occurring from the Site.

Response

The commenter correctly observes that the Proposed Plan states that current risks to on-site and off-site human receptors do not exceed the CERCLA cancer risk range of 10^{-4} to 10^{-6} and that non-cancer hazards are below a hazard index of one, considering the current Site use restrictions. That conclusion is consistent with the findings of off-site investigations that have also not found unacceptable levels of exposure at off-site locations. However, as also stated in the Proposed Plan, "[t]he BRA concludes that risks to a future reasonable maximally exposed individual results in a $2x10^{-2}$ cancer risk when considering 1,000 years of radium-226 ingrowth. The maximum reasonably exposed individual will exceed $5x10^{-2}$ when considering 9,000 years of radium-226 ingrowth (maximum ingrowth)." Although, as previously described, investigations have not found evidence of off-site releases from the Site resulting in current unacceptable exposure to off-site receptors, future risks are expected to exceed the target cancer risk range for off-site receptors. Therefore, action is warranted under CERCLA.

Comment

Commenters expressed concerns regarding the credibility of sources other than the EPA that were making statements about risks due to contaminants at West Lake Landfill.

Response

The agency's assessment of risks due to the radiological contamination at the Site is contained within the updated Baseline Risk Assessment. The EPA and other partner agencies, such as the ATSDR, will continue to provide information to the public regarding health effects risks, or perceived risks, associated with the Site. The EPA will continue to work closely with various project stakeholders, including community members on various aspect of the Site, including health effects and risks.

Comment

One commenter asked for the EPA to clearly define acceptable risks and to share the definition with the community.

Response

The NCP requires that remedies achieve remediation goals that "establish acceptable exposure levels that are protective of human health and the environment…" In addition to applicable or relevant and appropriate requirements under state and federal law, the NCP provides that remediation goals shall be developed by considering the following:

- For systemic toxicants, acceptable exposure levels shall represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating a margin of safety; and

- For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} to 10^{-6} using information on the relationship between dose and response. The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple exposure pathways.[27]

The EPA has developed a set of guidance documents, collectively referred to as the "Risk Assessment Guidance for Superfund," that describe the processes used to determine whether contamination at a Superfund site exceeds the acceptable exposure levels defined in the NCP. The results of the evaluation process are usually documented in a report called a Baseline Risk Assessment.

For contaminants that may cause cancer, referred to as "carcinogens," risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. For CERCLA sites the range of 10^{-4} to 10^{-6} for lifetime cancer risk means that an individual has a 1 in 10,000 to 1 to 1,000,000 *additional* likelihood of developing cancer due to exposure to contamination from the site. A risk greater than 1 in 10,000 due to exposure to site contamination is considered a level requiring action. This very small likelihood of developing cancer due to exposures to contamination at a site would be in addition to all other reasons people may develop cancer—such as heredity, occupational exposures, lifestyle choices.

In the NCP, contaminants that are not cancer-causing are referred to as "systemic toxicants." The potential for noncarcinogenic effects due to exposure at a Superfund site is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose derived for a similar exposure period. This ratio of exposure to toxicity is called a hazard quotient. The noncancer hazard quotient assumes that there is a level of exposure below which it is unlikely for even sensitive populations to experience adverse health effects. Sensitive populations include children, elderly people

---

[27] 40 C.F.R. § 300.430(e)(2)(i)(A)(1)-(2).

and those with other health problems that may make them more susceptible to harm from exposure to contaminants. Generally, it is assumed that there may be an unacceptable level of exposure if the level of a contaminant is greater than the “reference dose.”

Comment

Several commenters argued that risks calculated in the updated Baseline Risk Assessment (Updated BRA) are overstated, even though one of the commenters acknowledged that the EPA followed the appropriate guidance documents. The reasons cited include:

> **Issue 1:** A 25-year exposure time for future workers was used even though the EPA’s Exposure Factors Handbook estimates an average employment stay time of 6.6 worker.
>
> **Issue 2:** The focus of the investigations was on the characterization of RIM, including locating areas and depth intervals with the highest levels of radioactivity, such that there was a bias in the overall data toward higher radionuclide levels. The use of these data to calculate a 95% upper confidence limit on the mean (UCL) to be used as the exposure point concentration resulted in overstatement of the average exposure and risk.
>
> **Issue 3:** The administrative record clearly documents that the modeled exposures reflect an overstated risk, as demonstrated by the air modeling results. Risk estimates for exposures to contaminants by the air pathway were calculated based on modeled values as opposed to measured data.
>
> **Issue 4:** Background was included in the risk estimates and led to overestimation of radon risks.
>
> **Issue 5:** Radiological risks were calculated using a risk-based (i.e., PRG Calculator) rather than dose-based (i.e., RESRAD code) approach.[28]
>
> **Issue 6:** The presence of the temporary non-combustible cover was ignored, and it was assumed that an engineered cover—required by law for all closed landfills in the state of Missouri—would not be present in the future.
>
> **Issue 7:** Receptors and land uses considered were inconsistent with the current institutional controls established by the PRPs and present day surrounding land uses.
>
> **Issue 8:** The maximum risks were to a future landfill storage yard worker present at the site in 1,000 years, identified as the “Reasonably Maximally Exposed,” or RME, receptor. This is not reasonable given site-specific conditions.
>
> **Issue 9:** For all reasonably anticipated future conditions, exposure will be minimized such that risks are within the CERCLA risk range.
>
> **Issue 10:** Use of a 9,000-year long-term risk assessment in selecting the preferred remedy in the Proposal is arbitrary and inconsistent with Superfund risk assessment practices. Neither the EPA’s own guidance or risk assessment practices contemplate or require the use of a 9,000-year

---

[28] *RESRAD for Radiological Risk Assessment: Comparison with EPA CERCLA Tools – PRG and DCC Calculators.* Environmental Science Division, Argonne National Laboratory. ANL/EVS/TM-15/1, pp. 2, 7, 8, and 114.

long-term risk assessment period.

Response

Superfund risk assessments determine the risks that a site poses to human health and the environment if no action is taken to address contaminants at the Site. Superfund human health risk assessments use a Reasonable Maximum Exposure (RME) scenario when making risk estimates to ensure that everyone at the Site is protected. The NCP requires the lead agency to conduct a site-specific baseline risk assessment, as appropriate, as part of the remedial investigation. The primary purpose of the baseline risk assessment is to provide risk managers with an understanding of the current and potential future risks to human health and the environment posed by a site and any uncertainties associated with the assessment. As previously noted, the EPA developed a set of guidance documents known as the "Risk Assessment Guidance for Superfund," or RAGS, that describe the processes for preparation of a baseline risk assessment. RAGS provides specific guidance and information for conducting each of the four steps in the baseline risk assessment process: (1) data collection and analysis; (2) exposure assessment; (3) toxicity assessment; and (4) risk characterization.

The processes in these guidance documents were used in preparation and review of the Updated BRA for the Site. Below are responses to the individual issues identified in the issues described above:

Issue 1: Consistent with agency guidance, the EPA used the standard default exposure factor of 25 years for the worker exposure duration because it is an upper bound value that represents an RME.[29] The commenters' suggested that 6.6 years is an estimate of an average employment stay time. However, an average employment stay time is a central tendency value rather than an upper bound value. Therefore, 6.6 years does not represent an RME.

Issue 2: The objective of data collection during remedial investigation is to determine the nature and extent of threats to human health and the environment posed by the Site. RIM was identified as contaminated material at the Site, and as such, was the proper focus of Site characterization activities and the risk assessment process. RAGS Part A discusses the need for large numbers of soil (or other solid material) samples due to their heterogeneous nature.[30] The guidance also encourages sampling plans that characterize hot spots due to their potential impact on the risk assessment. These factors were taken into consideration during the characterization activities that took place at the Site.

Exposure is defined as the contact of an organism with a chemical or physical agent. To determine how much of the chemical or physical agent the organism will be exposed to, it is necessary to calculate exposure point concentrations (EPCs) which is an estimate of the arithmetic average of the concentration that is contacted over the exposure period. Because of the uncertainty associated with any estimate of exposure concentration, the upper confidence limit (i.e., the 95% upper confidence limit, or 95% UCL) on the arithmetic average will be used for this variable in the baseline risk assessment.[31] This is the process that was used at the Site. Use of 95% UCL is not intended to represent the "average" concentration for the Site. The 95% UCL is a probability statement. It represents a value that there is 95% confidence that the true

[29] "Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors," OSWER Dir. No. 9200.1-120 (Feb. 6, 2014).
[30] RAGS Part A §4.5.2, p.4-11
[31] RAGS Part A §6.4.1, p. 6-19

distribution of the sampling data has a population mean less than or equal to the calculated UCL.

Issue 3: The EPA agrees that estimating risks based on measured data prevents the introduction of additional uncertainty inherent to any model. However, constraints related to conditions at a site or the nature of a specific contaminant may lead to circumstances where modeling is necessary and reasonable. At the West Lake Landfill site, concentrations of radium-226 will increase over time, which will lead to increases in the amount of radon produced from the RIM. Therefore, it is not possible to estimate future concentrations of radon for risk assessment purposes without the help of a model. The EPA guidance states, "to the extent possible, measurement data should be used to evaluate current exposures. When measurements at the exposure locations cannot be made, or when potential concentrations and exposures will be predicted at future times, modeling may be needed to estimate past or future movement of radionuclides."[32]

While the impact of the uncertainty of the radon modeling has been determined to be low to moderate, the impact on the uncertainty due to radon toxicology has been determined to be very high. It should be noted that in the Updated BRA it was concluded that radon risks account for as much as 100% of the risks for certain receptors other than the RME. However, the current risk estimates for *all* receptors are below or within the target cancer risk range of 10^{-4} to 10^{-6}. In fact, for all the current receptors for which radon accounts for a majority of risk, the total risk is 10^{-7} or lower. While several of the future receptors exceed the target cancer risk range, and radon exposures accounted for between 90% to 98% of the risk, the estimated total risk for all of these receptors are at least a factor of 100 less than the RME. Radon exposure accounts for only about 2% of the total risk to the RME, and so this uncertainty has very little impact on the overall conclusion of the baseline risk assessment with respect to the need for action under CERCLA or on risk management decisions.

Issue 4: The inclusion of background in the risk assessment followed by an evaluation of the effect of background is consistent with EPA guidance, including RAGS A[33] which "…recommend[s] a baseline risk assessment approach that retains all constituents that exceed risk-based screening concentrations. This approach involves addressing site-specific background issues at the end of the risk assessment, in the risk characterization. Specifically, the COPCs with high background concentrations should be discussed in the risk characterization. […] and if data are available, the contribution of background to site concentrations should be distinguished. COPCs that have both release-related and background-related sources should be included in the risk assessment. When concentrations of naturally occurring elements at a site exceed risk-based screening levels, that information should be discussed qualitatively in the risk characterization."

Issue 5: The EPA radiation preliminary remediation goal (PRG) calculator is the appropriate method for use in a Superfund baseline risk assessment. As stated in OSWER 9285.6-20, Q10, "EPA has made the policy decision that risks from radionuclide exposures at remedial sites should be estimated in the same manner as chemical contaminants, which is consistent with EPA's remedial program implementing guidance.[34] Consequently, approaches that do not follow

---

[32] OSWER 9200.4-40 - Rad Q&A, 2014
[33] Role of Background in the CERCLA Cleanup Program, OSWER 9285.6-07P, April 26, 2002
[34] Memorandum from Robert Perciasepe, Office of Air and Radiation and Timothy Fields, Jr. Office of Solid Waste and Emergency Response, Washington, DC. to Charles M. Hardin, Conference of Radiation Control Program Directors. 7/7/2000.

the remedial program's policies and guidance should not be used at CERCLA remedial sites." Furthermore, the directive states that "The PRG calculators,[35] which are used to develop risk-based PRGs for radionuclides, are recommended by EPA for Superfund remedial radiation risk assessments."[36]

<u>Issue 6</u>: A risk assessment cannot consider risk reductions that would occur in the future, even if the action would be taken to comply with some or all of the applicable or relevant and appropriate requirements established for a site.

<u>Issue 7</u>: In OSWER Directive 9355.0-30[37], it states that the cumulative site baseline risk should include all media that the reasonable maximum exposure scenario indicates are appropriate to combine and should not assume that institutional controls or fences will account for risk reduction. Likewise, a risk assessment cannot consider risk reductions that would occur in the future because of actions taken to comply with some or all of the ARARs established for a site. Consistent with the EPA statutes and guidance for developing risk assessments, the Updated BRA for West Lake Landfill does not consider current institutional controls or access restrictions, such as fences, in the evaluation of potential future risks.

OSWER 9355.0-30 also states that both current and reasonably likely future risks need to be considered in a risk assessment. An adequate consideration of future risk may necessitate the assessment of risks assuming a land use different from that which currently exists at the Site. The current land use and the potential land use associated with the highest level of exposure and risk that can reasonably be expected to occur should be addressed in the baseline risk assessment. The Updated BRA for the Site states that the land use assumptions were based on the clear predominance of commercial/industrial land use around the Site and that certain land uses are inconsistent on an inactive landfill. Land use surrounding the Site in the past included farming and therefore farming scenarios were evaluated in off-site locations for the future risk estimates. While currently not being used as such, use of OU-1 as a storage yard was determined to represent the highest level of exposure and risk that can reasonably be expected to occur. This is consistent with the Directive.

<u>Issue 8</u>: Per the EPA guidance entitled Radiation Risk Assessment at CERCLA Sites: Q&A, Question 18, regarding the time period that should be considered for possible future exposures: "The PRG calculators include assumptions for the appropriate time period for generic land use exposure scenarios. Furthermore, in some cases, federal or state ARARs my include specific time-frame requirements for a given purpose, which is often a thousand years for dose-based standards. Several of the isotopes are listed with a "+E" designation. This designation indicates that the dose conversion factor includes the contribution from ingrowth of daughter isotopes out to 1,000 years."[38] The radionuclides for the Site are of the type with the +E designation. Also, UMTRCA is an ARAR for the remedial alternatives considered for this site and includes specific time frames. As a result, the dose compliance calculator calculates specific time frame requirements of 1,000 years. Therefore, 1,000 years is an appropriate time frame for use in the calculation dose assessment that determine risks for the RME at this Site.

<u>Issue 9</u>: A baseline risk assessment estimates future risk if no actions were taken. Current and

[35] U.S. EPA 2009a. Preliminary Remediation Goals for Radionuclides in Outdoor Surfaces (SPRG) electronic calculator.
[36] OSWER 9285.6-20, Q16.
[37] The Role of Risk Assessment in Superfund Remedy in Selection Decisions.
[38] Radiation Risk Assessment at CERCLA Sites: Q& OSWER 9285.6-20 A, June 13, 2014.

future risks posed by the Site then determine whether further action will be taken and the actions necessary to address the risk. The risk assessment process does not include assumptions about what "reasonably anticipated future conditions" may exist, so may not presume whether risks at the Site will be within the acceptable range at some time in the future.

Issue 10: As stated in the Updated BRA, dated January 22, 2018, (pg. 208, Section 6.4.6), "the BRA presents estimated risks that potentially could occur 1,000 years in the future." However, because "peak radium occurrences are expected to occur in approximately 9,000 years" (pg. 208, Section 6.4.6), a discussion of the risks at 9,000 years is also presented in the BRA. This evaluation is consistent with OSWER 9285.6-20 (Q13) that states the following: "In cases where decay products have greater radiotoxicity than the original radionuclide, the potential radiation dose and health risk may increase over time; in such cases, the exposure assessment should consider the change in concentrations of all decay products over time to determine the time of maximum potential impact."

Comment

One commenter asked why the EPA did not consider health risks posed by radionuclides including mutagenesis and teratogenesis.

Response

Biological effects associated with exposure to ionizing radiation in the environment may include carcinogenicity (induction of cancer), mutagenicity (induction of mutations in somatic or reproductive cells, including genetic effects), and teratogenicity (effects on the growth and development of an embryo or fetus). Agency guidance indicates that the radiogenic cancer risk is normally assumed to be limiting for risk assessments at Superfund remedial sites, and evaluation of teratogenic and genetic effects is not required.[39]

Comment

One commenter stated that the EPA did not adequately consider risks to future off-site residential farmers from ingestion of crops.

Response

Future risks to off-site residential farmers due to ingestion of crops was not calculated in the risk assessment because it was determined that the contribution from this pathway (ingestion of crops) to total risk for an off-site farmer would be so low, and the uncertainties so great, that to do so would not change the total calculated risks in a meaningful manner. Since the crops would be grown off-site, the most likely opportunity for them to be affected by Site contaminants would be through wind-blown contaminated dust, not groundwater, since the roots of most food crops are relatively shallow (with the possible exception of tree crops) and unlikely to result in uptake of groundwater contaminants. Any contribution to the food chain would have to be modelled with a very high degree of uncertainty and hence not be meaningful.

[39] Risk Assessment Guidance for Superfund Volume I, Section 10.6.1, pp. 10-30 (1989); Estimating Radiogenic Cancer Risks, EPA 402-R-93-076 (1994); OSWER 9285.6-20, Q26.

Comment

A few commenters expressed concern that the EPA focused on radiological contaminants, and as a result, did not adequately consider other chemical contaminants in the baseline risk assessment. One commenter specifically stated that barium and lead were not considered in the risk assessment.

Response

The Updated BRA and Appendix H of the FFS for OU-1 of the West Lake Landfill Site include consideration of exposures to both radiological and chemical contaminants, and consider both carcinogenic and non-carcinogenic, or toxic, effects. Barium and lead, as well as several other heavy metals and organic chemicals were evaluated (Section 5.1.1, 5.1.2 and 5.1.3 of the Updated BRA dated January 22, 2018). Non-radiological contaminants account for 5% or less of the total carcinogenic risk. Hazard index estimates for future risk scenarios range from 0.0007 (Off-Property South Farmer) to 32.0 (Landfill Outdoor Storage Yard Worker in Area 2) depending on the receptor location and exposure scenario. These results are discussed in detail in Sections 5.3.1 and 5.4.2 of the Updated BRA.

Comment

Many commenters expressed concern for future risks because concentrations of radium-226 at the Site will increase in the future. One commenter stated that conclusions regarding uranium-235 presented in the risk assessment were erroneous.

Response

The EPA's Proposed Plan and numerous other documents in the AR, including the Updated BRA, acknowledge the impacts of future ingrowth of radium-226 from thorium-230. Because the half-life of thorium-230 is known, radiological decay and associated daughter ingrowth over time will change the concentrations of the radionuclides in a predictable manner. Ultimately, this leads to the conclusion that concentrations of radium-226 and decay daughters will reach a maximum in approximately 9,000 years.

The EPA guidance for remedial sites impacted by radiological contaminants states that in cases where decay products have greater radiotoxicity than the original radionuclide, the potential radiation dose and health risk may increase over time; in such cases, the exposure assessment should consider the change in concentrations of all decay products over time to determine the time of maximum potential impact[40]. Consistent with this approach, the EPA included risk estimates for exposure scenarios potentially present at 1,000 years and 9,000 years in the future. Estimates of risk incorporating 1,000 years of ingrowth were included to support evaluations in the FFS of various remedial alternatives' compliance with the UMTRCA, (40 CFR 192) which has been established as an ARAR for the Amended Remedy. Estimates of risk incorporating 9,000 years of ingrowth were included to account for the maximum concentrations of radium-226 at the time of maximum potential impact. Further discussions of time frames used to calculate risks associated with the Site are discussed elsewhere in this section of the Responsiveness Summary.

The EPA notes that the Updated BRA used estimated values for some constituents including uranium-235. The estimated values were derived from the naturally occurring ratios of uranium-235 isotopes when compared to more prevalent uranium isotopes. However, the EPA believes site-risk have been appropriately estimated and are supported based upon the results of analytical testing of RIM during the

[40] (OSWER 9200.4-40 - Rad Q&A, 2014)

pyrolysis study, which confirmed that the uranium-235 isotopes identified at the Site are consistent with naturally occurring ratios. The results of this analytical testing for the pyrolysis study are discussed in the Radon Emanation Study dated November 10, 2016, as found in the Administrative Record. Further, refer to Section 2.4.2 of the Updated BRA for a discussion on uranium-235.

Comment

One commenter expressed concern that wildlife had not been adequately addressed through ecological risk assessment.

Response

A Screening Level Ecological Risk Assessment (SLERA) was conducted for OU-1 as part of the RI/FS in 2000 and then revised in the 2018 Updated BRA, Attachment B. The SLERA indicated that OU-1 chemicals of potential concern, primarily metals, potentially pose a risk to plants, invertebrates, and wildlife receptors at OU-1 under current conditions. However, because it is anticipated that the surface of the Site will be regraded and covered with an engineered cover which must be properly maintained as required by federal and state regulations, the Site will not provide suitable habitat for ecological receptors under future conditions. No measurable long-term impacts to plants or animals in surrounding ecosystems are expected from implementation of the remedial alternatives. No wetlands are located within the construction footprint of OU-1 and no endangered species were identified.

Comment

A commenter expressed concern for risks to current on-property workers including the trash haulers and transfer station workers.

Response

There were two current worker exposure scenarios evaluated in the baseline risk assessment: a current on-property grounds keeper and a commercial building user. Other current receptors were not evaluated because access to OU-1 is controlled and restricted. Trash haulers and transfer station workers would not be expected to have direct contact with soil or airborne soil particulates due to the presence of the non-combustible cover over Areas 1 and 2. These access controls and restrictions on Areas 1 and 2 will continue during and after remedy implementation.

5.0 Analysis of Remedial Alternatives

5.1 Remedial Components

5.1.1 Excavation

5.1.1.1 Principal Threat Waste

Comment

Two commenters stated that the RIM is not principal threat waste, or PTW. They claim that the EPA's change from the 2008 ROD regarding PTW is not supported in the record. The commenters also contrasted the EPA's finding in the Proposed Plan that PTW may be present at the Site to the lack of such a finding at the St. Louis FUSRAP sites.

One of these commenters included arguments that the EPA's concentration criteria associated with the preferred alternative (52.9 pCi/g) is not appropriate to associate with PTW because the referenced UMTRCA cleanup guideline envisions residential use of property impacted by mill tailings, not a landfill setting which will require a cap that will provide shielding and reduced exposures. Further, the commenter stated, even if the concentration criteria were an appropriate threshold, the EPA estimates of risk presented in the Updated Baseline Risk Assessment are overstated.

The commenters stated that even if the RIM were a PTW, containment would still be the appropriate remedy because of difficulties treating the wastes.

The commenters also claim that the RIM is not mobile, and that the EPA overstates the results of the 2016 leachability evaluation. Commenters go on to state that there is no confirmed evidence of leaching. The commenters argued that the RIM is not highly toxic and state that the average concentrations are "comparatively low."

Response

In the 2008 ROD, the EPA determined that the waste materials at the Site did not include PTW. However, since 2008, based upon site-specific data from leachability tests conducted in 2016, and further based upon evaluations presented in the 2018 Updated BRA, the EPA concluded in the Proposed Plan and the Amended ROD that the RIM located at the Site exhibits toxicity and mobility characteristics that may represent PTW.

The determination that PTW may be present at the Site is consistent with the NCP and agency guidance. The NCP sets forth the expectation that the EPA use treatment to address the principal threats posed by a site, wherever practicable, and use engineering controls (e.g., containment) for waste that poses a relatively low long-term threat or where treatment is impracticable. Agency guidance also recognizes that the determination of whether PTW is present at a site, and the application of the NCP expectations serve as general guidelines and do not dictate the selection of a particular remedial alternative.[41]

According to the PTW guidance, the evaluation of PTW is to be applied on a site-specific basis when characterizing source material. PTWs are generally source materials considered to be highly toxic or highly mobile and cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur. This determination should be based on the inherent toxicity as well as the physical state of the material, the potential mobility of the wastes in the site-specific environmental setting, and the lability and degradation products of the material.

As discussed in a separate section of the Responsiveness Summary, the BRA was updated in 2018 in accordance with current EPA guidance and consistent with the NCP. The Updated BRA demonstrates that RIM at the Site has the potential to cause future risk to the RME individual that exceeds 1×10^{-2} excess lifetime cancer risk should exposure occur. These risks are two orders of magnitude greater than what was estimated in the original Baseline Risk Assessment and OU-1. Therefore, some of the RIM at the Site presents a significant risk to human health should exposure occur.

The PTW guidance further states that determination as to whether a source material is a principal or low-level threat waste should be based on the inherent toxicity as well as a consideration of the physical state of the materials (e.g., liquid), the potential mobility of the wastes in the particular environmental settings, and the lability and degradation products of the materials. The EPA notes that RIM in particular

[41] "A Guide to Principal Threat and Low Level Threat Wastes" OSWER Dir. No. 9380.3-06FS (Nov. 1991).

is labile when considering that the Thorium-230 present at the Site will decay to Radium-226 and eventually into radon, which is a gas, and is correspondingly more mobile and more toxic. The EPA also further considered the potential mobility of the RIM with respect to its presence in a landfill. As stated above, the radiological isotopes that are associated with RIM will become mobile via the migration of radon gas which decays from radium. Further, as demonstrated by Toxicity Characteristic Leaching Procedure and Sequential Batch Leachate Tests performed on samples containing RIM in 2016, the site-related radionuclides were shown to leach under certain conditions While the RIM is a solid, and thus not readily mobile, the leaching tests were designed to determine if chemical constituents, namely site-related radionuclides, could leach from RIM. The test results indicated that radionuclides did leach from the site-specific RIM samples and continued to leach in appreciable amounts through final batch leaching steps in a number of the individual leaching tests. Because the MCL for radium in groundwater is 5 pCi/L, the leaching of even a small fraction of radium from RIM can result in increased radium concentrations in pore water above the drinking water standard, demonstrating contaminant mobility.

In accordance with the NCP, potential treatment technologies were further evaluated as summarized in Section 4 of the FFS. Specifically, the EPA's Technology Reference Guide for Radioactively Contaminated Media (EPA 402-R-07-004) was used as guidance for potential technologies that can effectively treat environmental media at radioactively contaminated sites. This guidance document states that the special characteristics of radioactive material in a waste constrain the technologies available to address site characterization results and satisfy RAOs. Ultimately, treatment was determined to be impracticable at the Site due to the heterogeneous nature of the waste and the limited treatment technologies available for the site-related radionuclides.

As indicated by the commenter, there is no NCP preference for excavation of PTW. The EPA's rationale for selecting the Amended Remedy is presented in the ROD Amendment and does not rely upon the determination that PTW is present at the Site. As previously stated, since the 2008 ROD, the EPA has further evaluated the toxicity and mobility of the RIM and the significant risk to human health should exposure to RIM occur. In the 2011 Supplemental Feasibility Study, the agency conservatively assumed that PTWs may be present within OU-1. In 2013, the NRRB observed that based on the Site data it appears there is discrete, accessible highly toxic PTW at the Site and recommended that the Region explain how its approach to treatment is consistent with the NCP and CERCLA's statutory preference for treatment to the maximum extent practicable. In the Proposed Plan, the EPA determined that PTW may be present at the Site; however, treatment of the RIM is impracticable.

Comment

One commenter stated that the ROD for the North St. Louis County Site concludes that no PTWs are present at the North St. Louis County sites. The commenter also states that RIM at the Site is a processed residue waste from the North St. Louis County sites, making the PTW determination at the Site inconsistent with previous EPA decisions.

Response

According to the PTW guidance, the evaluation of PTW is to be applied on a site-specific basis when characterizing source material. This determination should be based on the inherent toxicity as well as the physical state of the material, the potential mobility of the wastes in the site-specific environmental setting, and the lability and degradation products of the material. The physical conditions, concentrations, and potential mobility of RIM at the Site differs considerably from those at the North St. Louis County FUSRAP sites. In the 2008 ROD, the EPA determined that the waste materials at the Site did not include PTW. However, based upon site-specific data from leachability tests and upon evaluations presented in the Updated BRA, the EPA has concluded that RIM located at the Site exhibits toxicity and mobility characteristics that may represent PTW.

Comment

One commenter stated that none of the investigations since 2008 have revealed new information on the activity levels, the exposure pathways, or the inherent toxicity of RIM.

Response

The EPA has collected significant new data, reconsidered exposure pathways, and developed updated risk estimates for the Site since 2008, as discussed in other responses included in this Responsiveness Summary. The basis for the Amended Remedy is detailed in Part II of this ROD Amendment. In part, the Amended Remedy is based upon the following:

- A better understanding of the volume, concentration, and location of RIM at the Site;
- Unacceptable future risk, as presented in the Updated BRA; and
- New laboratory data regarding the potential for RIM to leach under certain circumstances.

From 2012 to 2014, the EPA also conducted additional groundwater sampling, research, and evaluations in partnership with the USGS. This groundwater sampling identified radium contaminations under the landfill with concentrations above the drinking water MCL of 5 pCi/L. Operable Unit 3 will further investigate groundwater conditions at the Site and determine the nature and extent of groundwater contamination, and establish appropriate groundwater remedial actions if necessary.

5.1.1.2 Presumptive Remedy for CERCLA Municipal Landfill Sites

Comment

One commenter disagreed with the EPA's determination that the Site is not a typical municipal landfill due simply to the presence of radionuclides. The commenter states that the acceptance of equivalent radiological contaminants at landfills in other states contradicts the EPA's assertion that the presence of RIM at the Site renders it something other than a typical municipal waste landfill, citing examples of regulations in Michigan and Illinois that permit disposal of radionuclides below 50 pCi/g and as high as 200 pCi/g, respectively.

Response

The EPA has made the determination that the Site is not a typical municipal landfill based upon consideration of site-specific considerations and information, consistent with the NCP. The preamble to the NCP explains that the "remedy selection process . . . promotes national consistency while allowing consideration that "EPA is developing guidance on expected remedies for specific types of sites (e.g., municipal landfills) and specific types of waste (e.g., PCBs) that will assist in streamlining decision-making and promoting greater consistency"

Further, the EPA asserts that making direct comparisons of the Superfund Site where nuclear weapons by-products were placed and used as cover material, to permitted facilities for the disposal of comparatively low-level radionuclides is not appropriate. The EPA notes that some of the radionuclide concentrations identified at the West Lake Landfill Site are orders of magnitude higher than the state regulations referenced in the comment.

Comment

Commenters stated that the RIM can be reliably contained and note that each of the alternatives presents a containment approach. Commenters also note that containment is the appropriate remedy under the Presumptive Remedy for CERCLA Municipal Landfill Sites, and that hot spots do not exist to warrant treatment.

Response

Since 2008, the EPA performed additional RIM characterization and developed a geostatistical model of RIM. The EPA has concluded, based on all the data collected at the Site, that partial excavation of elevated concentrations of radioactive waste is practicable in certain areas and would result in a significant reduction in the long-term threat posed by the Site.

Typical municipal landfills do not contain wastes that will greatly increase in toxicity over a significant time period, like will occur at this Site where thorium will decay to radium over the next 9,000 years. Therefore, based upon the additional information collected and studies performed since 2008, the EPA has determined that the West Lake Landfill is not a typical municipal landfill and no longer considers the presumptive remedy of containment alone to be appropriate for the Site due to the toxicity of the RIM, the potential of the RIM to leach, and the increasing risks due to radioactive decay.

5.1.1.3 Volume & Activity of Excavated RIM

Comment

Some commenters expressed concern that the EPA was not considering the percentage of the volume of RIM that would be removed in selection of its Proposed Plan Preferred Alternative. Commenters also noted that the EPA’s Proposed Plan Preferred Alternative does not remove a majority of the estimated volume of RIM. Commenters asked how the EPA determined the percentage of radioactivity that would be removed under the EPA’s preferred alternative, and many expressed a preference for this percentage to be increased (75% and 99%). Some commenters suggested that estimating activity at today’s concentrations will lead to an overestimate of the activity removed due to the potential for ingrowth of Radium-226. Several commenters stated that the use of percentage of radioactivity calculations to justify the remedy selection is not supported by the Administrative Record and does not provide a basis to change from a capping-only remedy to an excavation remedy.

Response

Evaluations presented in the FFS, SFS, and the original Feasibility Study demonstrate that removal of RIM impacts several of the NCP’s remedy selection criteria, particularly short-term effectiveness, long-term effectiveness and permanence, implementability, and cost. In order to consider these impacts, a variety of metrics were used in the EPA’s evaluation of remedial alternatives, including volume of RIM removed, volume of non-RIM waste excavated, and the concentration and total radioactivity of radium and thorium removed. Volume metrics were fully considered in the remedy selection evaluation to estimate the time required to complete excavation, the cost for transportation and disposal of RIM, and the potential for excavation to generate short-term impacts.

The cancer risk level is directly related to the concentration of RIM. Therefore, for two equivalent volumes of RIM, exposure to the one that contains higher concentrations would cause greater risk. As such, the removal of higher concentrations of RIM has a larger impact on the long-term effectiveness of a remedy than removal of an equivalent volume of RIM at lower concentrations. The Amended Remedy includes an optimized excavation that emphasizes removal of higher concentrations of RIM at depth in a limited number of locations.

"Long-term effectiveness and permanence includes a consideration of the residual risk remaining at a site after the remedial action is complete...The potential for this risk may be measured by numerical standards such as cancer risk levels or the volume or concentration of contaminants in waste, media, or treatment residuals remaining on site" (55 Fed. Reg. 8720 (Mar. 8, 1990)). The EPA has considered potential residual risks through both cancer risk levels and with respect to radioactivity that will remain on-site. Therefore, the EPA also considered the volume of RIM removed with respect to evaluating long-term effectiveness and permanence. The EPA also estimated the radioactivity removed for each alternative. Radioactivity can be estimated by multiplying the concentration of RIM by its volume and density. These radioactivity estimates are also useful for evaluating long-term effectiveness and permanence because radioactivity is representative of both volume and concentration.

The NCP states that balancing of the nine criteria shall emphasize long-term effectiveness and permanence… (40 C.F.R. § 300.430(f)(1)(ii)(E)). Some commenters requested a higher percentage of radioactivity be removed. The EPA's goal is to select a remedy that provides the best balance of the nine criteria. The deeper an excavation, the greater the short-term impacts and the greater the implementability challenges. The EPA determined that the Amended Remedy achieves a high degree of long-term effectiveness and permanence while improving the short term effectiveness, implementability and cost criteria.

An estimation of the activity removed based on current concentrations would be less than the removal of the same activity 9,000 years in the future, fully accounting for ingrowth. Similarly, estimates of the activity that will remain based on current concentrations would be less than the activity that would remain 9,000 years in the future. Because ingrowth will occur for the activity that is removed and the activity that remains, the percentage of activity removed will be the same based on current concentrations as in 9,000 years. The EPA has evaluated the long-term residual cancer risk levels caused by the RIM that will remain at the Site after the remedy is implemented based on concentrations that would be present 9,000 years in the future. The Amended Remedy long-term excess cancer risk for future site users and the surrounding community are within or below the target risk range of 10^{-4} to 10^{-6}.

Comment

One commenter stated that the concept of percent radioactivity was introduced too late to be meaningfully evaluated and has been improperly used as a substitute for evaluation of the actual short- and long-term risks for the Site.

Response

At MDNR's recommendation, the EPA included estimates of the percentage of radioactivity that would be removed under each of the excavation alternatives in the Proposed Plan. The state suggested, and the EPA agreed at that time, that these estimates would provide a helpful measure to compare the expected outcomes of different excavation scenarios presented in the Proposed Plan. The agency used the percentage of activity removed for comparison of the relative long-term effectiveness and permanence for the remedial alternatives, not as a substitute for evaluation of the actual short- and long-term risks for the Site. As described above, the EPA has concluded that the amount of radioactivity that remains on-site itself is an objective metric that appropriately informs the long-term effectiveness and permanence achieved for the Amended Remedy.

Comment

The commenter disagreed with the way that activity levels were derived. The commenter disagrees with the EPA's use of UCLs and mean values that were calculated from data sets that are skewed, rather than normally distributed. The commenter further disagreed with the summing of average activities, arguing that the total activity should have been divided by the total mass.

Response

The EPA developed activity estimates and included the associated calculations along with an explanation of these calculations and how the resulting activities would be considered with respect to the nine criteria established in the NCP in the February 5, 2018 approval letter for the January 26, 2018 Final Feasibility Study. As discussed in this letter, EPA relied upon the same data and information utilized to estimate the 3D extent of RIM report and otherwise characterize the RIM occurrences at the Site. The same UCLs and means were calculated and used as appropriate to estimate the exposure point concentrations for purposes of calculating baseline risk for OU-1. While there is uncertainty when utilizing these UCLs and mean values in the Remedial Investigation Addendum and Final Feasibility Study, this uncertainty was determined acceptable and appropriate for the intended use. For these reasons, EPA determined that these UCLs and mean values would be appropriate for estimating activity.

In addition to this, the EPA included an estimate of the total activity of Radium-226 present in the leached barium sulfate residues which were brought to the Site in 1973. The EPA compared the total estimated Ra-226 activity associated with the Full Excavation of RIM with Off-site Disposal remedy (77 Ci) to the estimated activity in the table above (26 Ci - 31 Ci) and determined the geostatistical based estimates to be reasonable. Therefore, the EPA concluded the estimates of Ra-226 and Th-230 activity associated with the various remedial alternatives as presented in the table below to be preliminary but sufficient for use in a feasibility study.
Finally, the same commenters provided estimates of activity in their comment letters and concluded the following, "Although completed from a different standpoint and using a different methodology, the U.S. EPA found similar proportions when comparing between the two Areas as communicated February 5th, 2018 (in its approval of the Final Feasibility Study, with modifications)…" EPA fully considered the activity estimates provided by the commenters and concluded that these estimates further support EPA's remedy evaluation because similar proportions of activity were estimated for EPA's Preferred Alternative in the Proposed Plan (Alternative 4).

5.1.1.4 Depth

Comment

Many commenters raised concerns related to the depth of the excavation specified in the Proposed Plan, preferences ranging from no excavation to a depth of 600 feet. Numerous commenters stated that all or as much RIM as possible should be removed from the Site. Many commenters stated that RIM should be removed deeper than 16 feet without specifying an alternative depth, and one stated that RIM should be excavated to a depth of 20 to 26 feet. Other commenters suggested the use of differential depths for Areas 1 and 2, excavating all or most RIM in Area 2, and excavating to 16 feet, or as much as possible, in Area 1, for example.

Some commenters stated, though, that the 16-foot excavation depth specified for the Preferred Alternative in the Proposed Plan was arbitrary and not supported by the Administrative Record. These commenters stated the excavation depth should be flexible to maximize removal of RIM, and some suggested that the excavation should continue if RIM was present and accessible at 16 feet. Specifically, two commenters stated that no excavation was necessary but, if excavation was selected, an alternative depth and concentration of 12 feet should be used rather than the 16-foot criteria specified in the Proposed Plan. Some commenters also noted that there were very few occurrences of RIM between 12 and 16 feet. Commenters further suggested that the depth of excavation could be flexible, excavating deeper in some areas and shallower in others. One of the commenters described two ways to optimize the proposed 12-foot excavation: (1) excavate a small distance deeper than 12 feet in limited areas where excavation is already identified as necessary in order to retrieve additional RIM with minimal additional excavation and handling of non-RIM waste; and (2) exclude excavation of isolated areas of RIM with very little radioactivity that require substantial excavation of overburden and setback in order to access the RIM.

Response

In response to these and other comments related to short- and long-term effectiveness considerations associated with excavation of RIM from the Site, the EPA has modified Alternative 4 to implement an optimized excavation of RIM greater than 52.9 pCi/g to a general depth of 12 feet below the 2005 ground surface. This optimization allows flexibility to excavate higher concentrations of RIM as deep as 20 feet and to not excavate isolated RIM between 8 and 12 feet in select areas.

An optimization plan will be developed during remedial design that will achieve the same long-term effectiveness and permanence, as measured by activity, that was associated with Alternative 4 as presented in the Proposed Plan. The optimized excavation will, however, minimize negative short-term impacts on the community and on-site workers. To accomplish this optimization, the plan will identify a limited number of targeted deeper excavations between 12 and 20 feet, prioritizing RIM greater than 1,000 pCi/g that can be excavated with minimal increase in the excavation of non-RIM waste. The plan will also identify a limited number of isolated pockets of RIM to be left in place between 8 and 12 feet, again with a focus on limiting the excavation of non-RIM waste.

The 16-foot depth parameter proposed in Alternative 4 was selected prior to the completion of all additional investigations of RIM since issuance of the 2008 ROD. A depth of 16 feet was selected because, based on information known at the time, this depth was thought to result in excavation of a majority of the volume of RIM in Areas 1 and 2, consistent with statements made in the previous NRC investigations.

The EPA's understanding of the distribution of both volume and activity of RIM, however, have been refined by more recent investigations of RIM, subsequent geostatistical modeling of RIM occurrences, and additional information provided in response to the public comment period. The EPA reviewed the boring logs and analytical data provided in the RIA and calculated estimates of activity represented by RIM greater than 52.9 pCi/g to depths of 4 feet, 8 feet, 12 feet, 16 feet, and 20 feet based on information received from commenters after release of the Proposed Plan. These evaluations confirmed, as noted by some commenters, that there were very few occurrences of RIM between 12 and 16 feet. The data also indicates that some of the occurrences of RIM between 12 and 20 feet include relatively high concentrations (e.g., greater than 1,000 pCi/g). For example, results from samples collected from boring AC-21 at about 12.5 feet below the 2005 topographic surface include a combined thorium concentration 6,817 pCi/g. For these reasons, the EPA has determined that 20 feet is an appropriate maximal depth for excavation of RIM from the Site.

The EPA also considered the impact of excavation of isolated occurrences of RIM on the long-term effectiveness and permanence, short-term effectiveness, and implementability of the remedy. The EPA determined that these criteria are negatively impacted as the depth increases, and the volume of setback and overburden that must be excavated to access this waste increases. Excavation depths of 5 feet generally would not require setback. Excavation beyond that depth, however, requires excavation of additional non-RIM material or setback at three to one slope. As a result, the volume of setback increases rapidly with depth. The EPA has determined that excavating certain isolated pockets of RIM between 8 and 12 feet below the 2005 surface could have significant short-term impacts to workers and the community if it is associated with excavation of relatively large volumes of setback and overburden. The Amended Remedy, therefore, allows for selection of a limited number of isolated pockets between 8 feet and 12 feet to be identified during remedial design that would not be excavated in order to reduce short-term impacts associated with excavation. These impacts include odor, fugitive dust, stormwater management, wildlife attractants, and increased worker risk. Although these isolated pockets of RIM are expected to represent relatively small amounts of radioactivity, any occurrence of RIM not excavated between 8 and 12 feet will be offset by excavation of deeper RIM elsewhere in OU-1.

Comment

Commenters asked for justification of the 2005 surface as the baseline for excavation. One commenter suggested a depth of excavation from the current surface.

Response

Additional inert fill materials were placed in Areas 1 and 2 after the 2005 topographic survey, pursuant to the Materials Management Plan, which has been included in the AR. The Plan states that “placement and stockpiling of suitable fill material can be conducted in a manner that will be consistent with whichever remedial alternative that may be ultimately selected for the Site.” Since that time, the EPA has considered partial excavation of RIM based on depth. The EPA has consistently required the depth criteria be measured from the 2005 topographic surface to ensure that these remedy alternatives and the Amended Remedy are not impacted by the placement of this inert fill.

The 2005 topographic surface was also addressed in the October 31, 2014, draft Estimated Volumes for Partial Excavation Options Identified by the EPA available in the Administrative Record. As discussed in this document, the 2005 topographic surface was the same topographic surface used for the evaluations in the December 16, 2011, Supplemental Feasibility Study. This concept was later incorporated into the EPA’s December 9, 2015, Statement of Work for the RIA and FFS, also included in the Administrative Record. Therefore, potential changes to surface elevations subsequent to 2005, including such conditions as settlement, placement of additional fill material, or placement of the NCC, still do not been influence the EPA’s determination that the 2005 topographic surface is an appropriate baseline.

5.1.1.5 Concentration

Comment

One commenter stated that identification of an activity threshold that would permit use of field instruments to measure radioactivity and identify RIM for potential excavation would greatly increase the efficiency of the field work and reduce potential impacts associated with such activities. The commenter suggested the use of a 100 pCi/g threshold in place of the 52.9 pCi/g value would remove essentially the same footprint and activity of RIM but with about 30% less overburden and setback removal and disturbance compared to the preferred remedy set forth in the EPA's Proposed Plan. Another commenter added that excavation to a depth of 12 feet and an activity level of 100 pCi/g would result in:

- smaller open areas at any given time which would reduce worker exposure, reduce fugitive dust, air emissions, odors, wind-blown litter, bird attraction and contact storm water and leachate generation;

- reduced implementation period (estimated to be approximately one year shorter) which would reduce the duration of fugitive dust, air emissions, odors, wind-blown litter, bird attraction and contact storm water and leachate generation;"

- less overburden material which would need to be managed (estimated to be approximately 30% less), further reducing the implementation period and potential for fugitive dust, air emissions, odors, wind-blown litter, and bird attraction.

Another commenter stated that the "EPA's claim in the [Proposed Plan] that 52.9 pCi/g is an appropriate cleanup level for radionuclides, simply because it is the sum of background plus 10 times the UMTRCA surface soil cleanup standard of 5 *pCi/g* under 40 C.F.R. 192, is arbitrary and contradicts sound science." They also state that "identification of an activity threshold that would permit use of field instruments to measure radioactivity and identify RIM in conjunction with potential excavation would greatly increase the efficiency of the field work and reduces the potential impacts associated with such activities."

Another commenter states that a risk-based cleanup level should be derived from a scientifically defensible calculation of the required source term activity that would result in the level of risk sought to be avoided.

Numerous commenters stated a preference for an excavation concentration level of 7.9 pCi/g. One commenter stated that Alternative 4 would leave behind RIM at concentrations that are not protective of human health according to UMTRCA standards and EPA guidance (OSWER Dir. 9272.0-15P). A few commenters also referred to a preference for the "Federal level of 7.5 pCi/g." (The latter appears to be a typographical error that intended to reflect 7.9 rather than 7.5 pCi/g.)

Response

The EPA evaluated the UMTRCA cleanup standards specified in 40 C.F.R. § 192.12 in the ARARs analysis provided in the FFS. After further consideration of comments and subsequent evaluation of ARARs for the Amended Remedy, the EPA has concluded that unless an engineered containment system is installed that is compliant with standards in UMTRCA Subpart A, the cleanup standards in 40 C.F.R. § 192.12 are relevant and appropriate for Area 1 and Area 2. Therefore, the full excavation alternatives (Alternatives 7 and 8) required removal of RIM sufficient to leave Areas 1 and 2 in a condition that would not require additional engineering and institutional controls due to their radiological content (i.e., removal of RIM that exceed the standard in 40 C.F.R. § 192.12). The engineered containment system for Alternatives 7 and 8 would only be required to meet Missouri's solid waste disposal regulations. Because all other alternatives—including the EPA's preferred alternative in the Proposed Plan and the Amended Remedy in the ROD Amendment—require a containment system compliant with UMTRCA standards, the cleanup standard in 40 C.F.R. § 192.12 is not relevant or appropriate for Area 1 and Area 2.

The EPA initially proposed a concentration threshold of 52.9 pCi/g for the preferred alternative in the Proposed Plan because it was a factor of 10 greater than the UMTRCA cleanup standard (5 pCi/g over background) and was thought to correspond to a risk significantly above the target risk range for future site users. In the Proposed Plan, the EPA specifically solicited comment on the concentration criteria associated with the Preferred Alternative. After careful consideration of the comments received, the EPA has determined that the 52.9 pCi/g concentration criteria should be retained because (1) the EPA determined this concentration criteria would correspond to a risk of approximately 1 x 10^{-3} and is therefore representative of RIM that has the potential to cause significant risk, and (2) the degree to which field screening using standard radiation detection equipment can be relied upon does not significantly affect implementation of the remedy. These points are discussed in more detail below.

In response to comments received regarding the rationale for establishing these concentration criteria, the EPA has included an evaluation of the risk posed to the RME identified in the Updated BRA from a concentration threshold of 52.9 pCi/g in the administrative record. This site-specific evaluation of risk confirms that a concentration threshold of 52.9 pCi/g corresponds to an excess cancer risk of approximately 1 x 10^{-3} which is consistent with EPA's previous statements in the Administrative Record.

The EPA has also considered that the concentration criteria selected for the remedy has an impact on the ability to rely on field screening to guide excavation. Section 7.2.4 of the FFS discusses use of radiological screening during excavation to distinguish RIM to be excavated and disposed of from other waste materials. The FFS concludes that the full excavation alternatives, Risk-Based Partial Excavation alternative, and potentially the Partial Excavation of RIM to 52.9 pCi/g alternative, would pose additional difficulties and uncertainties during construction compared to the 1,000 pCi/g due to a reduced ability to rely on radiological field screening.

In response to comments received, the EPA has considered alternative concentration criteria, specifically 100 pCi/g combined radium and combined thorium, along with the claim that use of a 100 pCi/g concentration criterium would allow for use of field screening techniques to identify RIM that could be excavated. EPA also consider the comment that the 100 pCi/g criteria is based on the overall distribution of radium and thorium activities within Areas 1 and 2. The EPA further considered claims that use of field screening instruments to measure radioactivity and identify RIM would allow for more continuous and uninterrupted excavation thereby greatly increasing the efficiency of the field work and reducing the potential impacts associated with such activities.

The EPA has concluded that the use of field screening techniques during excavation would result in greater efficiency of the field work. The EPA has also determined that claims provided by commenters about to the excavation procedure that would be required for a partial excavation remedy with a 52.9 pCi/g concentration threshold and the impact attributed to whether field screening can be fully relied upon during excavation are inconsistent with the FFS, overly restrictive, and exaggerated.

EPA has determined that further reliance on field screening would not eliminate the need to collect and analyze any samples other than verification samples at the bottom of an excavation. All the analytical data collected at the Site demonstrate that RIM is present in OU-1 over a range of concentrations both above and below 52.9 pCi/g and 100 pCi/g. It is reasonable to expect that field screening can reliably be used to direct portions of the excavation associated with Alternatives 4, 5, 6, 7, 8, and the Amended Remedy. This is further supported by the extent to which gamma screening was used to characterize the

RIM in OU-1 and incorporated into the geostatistical 3-D model of RIM. Therefore, an assumption that implementation of a remedy that directs the excavation entirely by collection and analysis of five samples from every 10-meter by 10-meter by 6-inch block of waste in Area 1 and Area 2 is not reasonable. In addition, even if excavation could be directed entirely by field screening, excavation pauses or stops would still be required to conduct appropriate radiological surveys using field screening equipment in order to demonstrate whether waste material is above or below the established concentration criteria. However, the EPA recognizes that the time required to complete a radiation survey would be shorter than the time to collect and analyze samples in an on-site laboratory.

The EPA agrees that the ability to rely upon field screening techniques during excavation will increase efficiency to an extent. For instance, use of field screening equipment would reduce the potential for delays during excavation. The EPA notes the occurrences of RIM greater than 52.9 pCi/g down to 16 feet generally include a few larger multi-acre portions of Area 1 and 2 surrounded by a small number of less than an acre sized islands. For example, RIM greater than 52.9 pCi/g down to 16 feet below the 2005 topographic surface has been identified in three larger locations in the norther portion of Area 1 and three very small locations grouped close together near the transfer station. Similarly, RIM greater than 52.9 pCi/g down to 16 feet below the 2005 topographic surface has been identified in one very large location throughout most of Area 2 surrounded by eight smaller locations. Therefore, the size and surface area of the open excavation at any given point during construction of Alternative 4 and the Amended Remedy would generally be large regardless of the extent to which field screening can be used to direct the excavation. Information provided by the commenters on an estimated extent of RIM greater than 100 pCi/g down to 12 feet below the 2005 topographic surface generally depicts the same features as Alternative 4.

Commenters also provided information to support that common gamma field screening equipment will be unable to reliably screen RIM at OU-1 at a concentration of 52.9 pCi/g, whereas, this same equipment can be utilized to reliably screen at 100 pCi/g. The EPA concluded in the FFS, as discussed above, that there are potential additional challenges and uncertainties with respect to RIM characterization during excavation for Alternative 4. After consideration of all the comments received related to alternative concentration criteria, the Amended Remedy uses a concentration criterion of RIM greater 52.9 pCi/g as one of the partial excavation criteria because this concentration corresponds to a risk of approximately 1×10^{-3} which is an order of magnitude above the target risk range of 10^{-4} to 10^{-6} range. Therefore, in general the same challenges associated with RIM characterization during remedy construction for Alternative 4 are expected for the Amended Remedy. During remedial design, the EPA expects to address these challenges and reduce the uncertainties associated with RIM characterization during remedy construction. Excavation procedures will be developed that incorporate field screening using conventional equipment to the maximum extent possible given RIM greater than 52.9 pCi/g is expected to be encountered for portions of the excavation.

In addition, during remedial design an evaluation of specialized radiological measurement techniques and equipment to improve the effectiveness of field screening will be performed. As an example, devices such as Field Instrument for Detection of Low Energy Radiation detectors are specifically designed to detect low energy gamma radiation such as what is emitted from Thorium-230. These detectors have been used for environmental cleanups at other sites, including by the DOE at the Lawrence Livermore National Laboratory Site, for detection of depleted uranium in surface soil which similar to one of the primary contaminants of concern at the Site (Thorium-230).

5.1.1.6 Sorting

Comment

Commenters stated that the EPA needs to provide more information about the pilot program to separate RIM from non-RIM and at least one commenter opposes separation due to potential exposures. Some commenters stated, however, that the material should be removed without sorting if detecting alpha radiation is too complicated or proves unreliable in the field, and that attempting to separate RIM from non-RIM waste is a bad idea.

Response

The EPA evaluated sorting and segregation technologies in the FFS. However, based upon consideration of public comment received after issuance of the Proposed Plan, the Amended Remedy does not include performance of a full-scale pilot study to evaluate the ability to effectively separate RIM from landfill wastes. The EPA has determined that the benefits of such a pilot study are uncertain and would add time and cost to the remedy while also creating the potential for additional exposure to workers.

5.1.1.7 Other

Comment

One commenter questioned why the EPA would place excavated waste that was less than 52.9 pCi/g at the bottom of the excavation before construction of the cover rather than disposing of it since it had already been dug up.

Response

In the FFS, Alternative 4 was designed to provide for removal of higher concentration occurrences of contamination. The rationale for selecting a level of 52.9 pCi/g is outlined in Section 5.1.1.5 of this Responsiveness Summary. Because RIM less than 52.9 pCi/g will be excavated and handled under the Amended Remedy, in order to maintain the best balance of the modifying criteria the EPA believes that the long-term effectiveness of the remedy will be enhanced by placing such wastes as far below the surface as possible before construction of the landfill cover. The evaluation of risks described in the updated Baseline Risk Assessment demonstrates that the majority of the risk posed by RIM is caused by exposure to gamma radiation and to a lesser extent radon. Exposure to gamma radiation and radon from RIM is decreased as the depth to RIM is increased. Therefore, Alternative 4 included a preference that backfilling and regrading of wastes materials that are below the concentration threshold would be placed closer to the bottom of any excavation in order to reduce the potential for future exposure to gamma radiation and radon.

Comment

One commenter asked which state and federal agencies will be involved with excavation at the Site.

Response

The EPA has been working closely throughout the remedial process with its state counterpart, the MDNR, and will continue to do so. The EPA has also enlisted the expertise and support of several federal agencies in the process including the USACE, the USGS. These federal agencies, and additional agencies as needed, will continue to be involved as necessary. The EPA will be the lead agency and will conduct oversight of site cleanup with the MDNR as the support agency.

Comment

Commenters suggested that the EPA come back after the SSE extinguishes itself to excavate RIM from areas that cannot safely be accessed at this time.

Response

The EPA notes that the existing subsurface heating event is located in the South Quarry of the Bridgton Landfill and is not located in proximity to the areas targeted for excavation by the Amended Remedy. To move into closer proximity of the RIM, the subsurface heating event would have to first move through the "neck" area, then through the North Quarry of Bridgeton Landfill, before finally reaching the boundary of OU-1 Area 1, which EPA notes is unlikely. Further, the EPA in close coordination with MDNR has taken efforts to both monitor and manage the existing subsurface heating event and should site conditions change, or should the subsurface heating event begin to move towards OU-1 appropriate response actions will be initiated at the Site. Based upon this information and related items as detailed in the Administrative Record, the EPA believes that the Amended Remedy can be safely implemented.

The EPA also considered the potential impacts to the North Quarry portion of the Bridgeton Landfill that could occur if excavation of RIM required disturbance of North Quarry wastes. Excavation of these materials introduces oxygen to the waste which could cause a new SSE or surface fire. Therefore, remedies which required excavation of RIM that lies underneath portions of the Bridgeton Landfill would include additional implementation challenges and short-term impacts compared to other alternatives. EPA also considered the potential for this deeper RIM to present a risk of exposure to future site users. Because the depth of this RIM is significant, there is no potential for this RIM to cause exposure from direct contact, gamma radiation, or radon after installation of the engineered containment system. The Amended Remedy requires installation of an engineered containment system and so there would be no basis to go back after installation of the engineered containment to excavate this deeper RIM in the future.

5.1.2 Disposal

Comment

Many commenters supported leaving the waste in place, similar to the 2008 ROD Remedy. Other commenters supported excavation and disposal in an on-site lined cell. One commenter stated that "Use of an on-site cell could expedite excavation and handling of the RIM reducing the overall time that the waste material would be exposed and handled."

Many other commenters supported off-site disposal of RIM, and many specified that the disposal of radiological materials and waste should occur at an out-of-state, licensed, nuclear storage facility. Reasons cited by the commenters in support of off-site disposal included that disposal in an on-site cell: would allow for continued ingrowth and radon emanation at the Site; would allow for leaching of contaminants into groundwater; would allow for contaminated stormwater runoff; would be subject to flood issues due to proximity to the river; would be subject to seismic and/or future significant climatic events; and does not provide for a more permanent solution to the maximum extent possible. One commenter is concerned that transportation accident rates were not taken into account in the EPA's assessment of short-term effectiveness.

This commenter also argued that on-site disposal offers several advantages including: elimination of sorting and segregation of RIM reducing potential impacts to workers, reduction in time required to excavate and relocate RIM and non-RIM, improved implementability, and reduction of potential impacts to community and delays to construction caused by off-site transportation. In addition, the commenter argued that on-site disposal could reduce total duration of waste handling activities by one year, reducing impacts from odor, air emissions, bird attraction, and potential stormwater contact and leachate generation.

Response

The EPA developed costs and schedule estimates for the Amended Remedy which includes off-site disposal and a similar remedy that includes disposal of the partially excavated RIM on-site. These estimates were developed using schedules and spreadsheets provided in the FFS that were modified based on the adjusted volumes of waste to be excavated for the Amended Remedy. Cost and schedule estimates were compared for both on-site and off-site disposal for the Amended Remedy as presented in the Administrative Record. The cost for off-site disposal was estimated to be $205,000,000.00 versus $199,000,000.00 for the on-site disposal. The estimated schedule for off-site disposal was 2.8 years to implement, compared to 2.5 years to implement for on-site disposal. These differences are insignificant when considering the typical uncertainty associated with typical RI/FS cost and schedule estimates. The EPA notes that the complexity of the schedules, as well as, overlapping and parallel completion of activities creates uncertainty when attempting to identify specific schedule differences between the partial excavation greater than 52.9 pCi/g with off-site disposal versus disposal in an on-site cell. The primary differences in schedule were due to the construction and subsequent demolition of the RIM staging and loading building necessary for off-site disposal and constructing the on-site cell required for on-site disposal and the primary differences in cost were due primarily to the off-site disposal costs.

The EPA evaluated an engineered on-site disposal alternative (Alternative 8) in the Final Feasibility Study and identified several potential implementation issues including:

- Uncertainty regarding the ability to meet certain MDNR siting requirements
- Uncertainty regarding the geologic and geotechnical conditions of the potential site;
- Requirements related to the proximity of the Site to the St. Louis Lambert International Airport, including increased potential for aviation-bird strikes due to moving landfill waste into the new disposal cell within the airport flight paths; and
- Issues from construction traffic occurring on or near existing on-site infrastructure and the actively used on-site areas (i.e., solid waste transfer station and concrete and asphalt batch plant).

While the total volume of RIM that would be excavated and disposed outside of Area 1 and Area 2 for EPA's Amended Remedy (74,000 cubic yards) is less than the full excavation alternative (320,000 cubic yards) these challenges would still need to be addressed if the Amended Remedy included on-site disposal.

In addition to implementation challenges, on-site disposal is less advantageous for the Amended Remedy than it is for the full excavation alternative. Because the Amended Remedy entails partial excavation, on-site disposal would result in three radiological disposal areas following remedy implementation (i.e., Area 1, Area 2, and the new engineered disposal cell) that would require long-term monitoring and specific engineering measures for safe management. The on-site cell, as evaluated in the

FFS, is also located closer to residential properties and has the highest short-term risks for the community, although the risks are still within the target cancer risk range.

The EPA evaluated off-site disposal for the Amended Remedy and determined there are potential benefits to the off-site disposal of RIM and subsequent reduction in the overall amount of RIM remaining on-site, including:

- Greater long-term effectiveness and permanence due to less source material remaining on site; and
- Fewer issues from on-site construction traffic during remedy construction.

The EPA evaluated off-site disposal as presented in the Administrative Record for OU-1. Four disposal facilities were identified that could potentially receive and dispose of the RIM from the Site. The four facilities as identified in the FFS are:

- U.S. Ecology's facility in Grandview, Idaho,
- U.S. Ecology's facility in Wayne, Michigan,
- Energy*Solutions* facility in Clive, Utah, and
- Clean Harbors' Deer Trail facility in Last Chance, Colorado.

5.1.3 Landfill Cover

Comment

Many commenters supported capping in place without excavation, indicating that the capping alternatives met all the remedial action objectives established for the Site, therefore excavation is unnecessary. Other reasons for preferring a capping only remedy included such topics as reduction in cost, reduction in time to complete remediation, reduction in potential for bird strike hazards, elimination of sorting and segregation of waste materials, a reduction in the possibility for traffic accidents or for spreading contamination along transportation routes, and a reduction in wear and associated maintenance on roadways. Specifically, most supported capping in place without excavation, for reasons such as reduction in cost, reduction in time to complete remediation, reduction in potential for bird strike hazards, elimination of sorting and segregation of waste materials, a reduction in the possibility for traffic accidents or for spreading contamination along transportation routes, and a reduction in wear and associated maintenance on roadways.

Response

The EPA recognizes that the capping-only alternatives do attain RAOs, but the EPA has concluded that Alternatives 2 and 3 do not represent the best balance of NCP criteria. Neither of these alternatives result in removal of RIM from the Site, which the agency has determined will result in improved long-term effectiveness and permanence of the remedy.

Many of the comments also indicated misperceptions about both of the capping alternatives. Many commenters appeared to assume that there would be no odor concerns or attraction of birds for a capping remedy. To the contrary, implementation of the capping-only alternatives is not feasible without relocation of a significant volume of waste material. As much as 115,000 cubic yards of waste and RIM in Areas 1 and 2 would be cut, moved, and regraded to reduce existing landfill slopes for the 2008 capping remedy. Disturbance of this amount of waste would generate odors, present a potential attraction for birds, and potentially increase risks to workers in comparison to a capping remedy without disturbance of waste, which is not feasible at this site. These topics are discussed in the FFS and were considered by the EPA in selecting the Amended Remedy.

Comment

Many commenters expressed concern related to risks for remediation workers and their families and implied that capping only remedies would eliminate these risks.

Response

A capping-only remedy could potentially reduce the risks to workers but would not eliminate them. As indicated in other responses in this section, capping would still require relocation of a significant volume of waste. For all of the alternatives, worker exposures would be closely monitored, and engineering and best management practices would be implemented to reduce exposures to within acceptable levels. Risks to workers from exposure to gamma radiation will be mitigated by developing work practices that minimize the time spent in proximity to RIM to that is necessary to perform radiation surveys and collect samples. If necessary, these exposures can be further reduced by alternating radiation technicians between jobs that result in little or no exposure to gamma radiation with jobs that could potentially result in higher exposures to gamma radiation. All remediation workers will be trained for working around and handling radioactive materials. More information regarding worker risks can be found in Section 5.2.2.2.2. Risk to workers were considered in the selection of the Amended Remedy, as discussed in Section 14.2 of Part II of the ROD Amendment.

Comment

Many commenters stated that excavation is unnecessary because capping would meet all the remedial action objectives.

Response

It is true that all the remedial alternatives, except the no action alternative, meet all the RAOs. A remedy is selected based on the best balance of the NCP's nine criteria. The EPA carefully evaluated all nine criteria for each alternative in accordance with the NCP. All remedial alternatives described in this Amendment to the ROD, except No Action, are protective of human health and the environment, and all the alternatives would comply with ARARs. Upon consideration of additional information received during the public comment period, the EPA has selected a remedy that is a modified version of EPA's preferred remedy identified in the Proposed Plan, Alternative 4. The EPA has determined that this modified excavation remedy improves the balance of the nine criteria. The rationale for the selection of the Amended Remedy is summarized in Section 12.1 of Part II of the ROD Amendment.

Comment

Many commenters stated that excavation would make the situation worse, and went on to state that previous studies, including those by the ATSDR, the MDHSS, and the EPA, showed the materials were safely contained in the quarry so that a capping-only remedy is sufficient.

Response

The updated baseline risk assessment determined that although there are no current unacceptable levels of exposures, there is a potential for unacceptable levels of exposure in the future if no remedial actions are taken. It is true that excavation and stockpiling of soils will require careful management to reduce the potential for short-term impacts such as windblown debris or contamination, precipitation infiltration, stormwater run-off, and odors. However, capping also involves excavation and relocation of wastes, requiring the need to manage the similar short-term impacts.

Comment

Some commenters opposed capping due to their concerns that it is not possible to stabilize the landfill cap and radioactive waste beneath it for the length of time it will remain hazardous, nor do they believe a cap will prevent leaching to groundwater. One commenter stated that assuming there are no complications or severe damages to the cover before 1,000 years, when the longevity requirement has surpassed this time frame, the UMTRCA cap will need to be replaced.

Response

As explained in Section 9 of the Proposed Plan, the design of this cover would meet standards specified in the UMTRCA regulations which include longevity requirements (200 to 1,000 years). Further, the landfill cover will be routinely inspected and maintained to ensure the integrity of the cover. Institutional controls will be implemented to limit future uses and to ensure future uses do not impact the effectiveness or integrity of the remedial actions. Since the Amended Remedy will leave hazardous substances, pollutants, or contaminants remaining at the Site above levels that would allow for unlimited use and unrestricted exposure, pursuant to Section 121(c) of CERCLA and N.C.P. §300.430(f)(5)(iii)(C), the EPA must conduct a review of the remedy no less often than every five years after the initiation of the remedial action to assure that human health and the environment are being protected. The public is notified that the five-year review has begun and is invited to provide information to the EPA regarding the Site. During the five-year review process, issues needing action are identified, recommendations to address the issues are developed and a schedule for implementation of the recommendations is determined. The five-year review is summarized in a report that is made available to the public.

Comment

One commenter wanted to know whether the cap would have a “water tight seal.”

Response

The cap over Areas 1 and 2 will consider appropriate design guidance, such that it consists of a multi-layered, cover system, engineered to include a maximum permeability of 10^{-7} that will significantly minimize the infiltration of surface water or precipitation and reduce the potential for RIM to leach. This design criteria minimizes infiltration to the extent practicable. Additionally, the inclusion of a bio-intrusion layer above the low permeability layer, will provide a protective buffer to deter the creation of potential conduits into the cap that could otherwise be created by biological receptors.

5.1.4 Buffer Zone and Lot 2A2

Comment

A few commenters noted that institutional controls have failed at the Site before, pointing to the transport of RIM to the Buffer Zone as an example.

Response

As documented in the Administrative Record, the transport of RIM to Buffer Zone and Lot 2A2 of the Crossroads Industrial Property was the result of erosional transport and not due to a failure of institutional controls. The use and long-term monitoring of institutional controls by the EPA at the Site is consistent with the NCP. The EPA will appropriately monitor the institutional controls for the Site during five-year reviews. Should monitoring identify issues with the protectiveness of the Amended Remedy, including institutional controls, additional actions will be evaluated and response measures implemented to ensure continued protectiveness.

Comment

Two commenters stated that there are no documents or studies in the record supporting the EPA's establishment of a cleanup level at background for the Buffer Zone and Lot 2A2, and that this level was selected after the RIA and FFS indicated that 7.9 pCi/g was the appropriate level for cleanup of these areas.

Response

The EPA included in the January 2018 NRRB report a site-specific evaluation of risk and corresponding PRGs for soils on Lot2A2 and any portions of the Buffer Zone that will not be utilized to construct the Area 2 cap. This report, which is included in the Administrative Record, also includes the rationale for proposal of these background-based cleanup levels. These were the cleanup levels specified for the Buffer Zone and Lot 2A2 in the Proposed Plan.

The agency has established guidance explaining that "EPA's policy of generally establishing PRGs based on ARARs, in the absence of multiple pathways or contaminants, is based on the assumption that individual ARARs will be protective. For example, the NCP expressly authorizes consideration of the cumulative risk range in setting PRGs where attainment of ARARs would result in a cumulative risk in excess of 10^{-4} due to multiple contaminants or pathways. (40 C.F.R. 300.430(e)(2)(I)(D).)"[42]

The EPA identified UMTRCA Subpart B as an ARAR for cleanup of the Buffer Zone and Lot 2A2. The cleanup standard in UMTRCA Subpart B requires that "[t]he 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."[43]

Radium-226 is one of the primary contaminants of concern for OU-1 of the Site. However, many of the radionuclides in the uranium-238, uranium-235, and Thorium-232 decay series have also been identified as contaminants of concern at the Site, notably Thorium-230, Thorium-232, Tadium-228, Uranium-238, Uranium-234, Uranium-235, andProtactinium-231. An evaluation of cumulative risk from all the contaminants of concern, including radionuclides, is necessary in order to determine whether the cleanup standard in UMTRCA Subpart B is protective.

The EPA performed a site-specific risk evaluation to estimate the cumulative excess cancer risk to a commercial building user that would result from selecting remediation cleanup levels consistent with the

[42] "Clarification of the Role of Applicable, or Relevant and Appropriate Requirements in Establishing Preliminary Remediation Goals under CERCLA," OSWER Dir. No. 9200.4-23 (Aug. 22, 1977).
[43] 40 C.F.R. § 192.12(a).

EPA's definition of RIM, which is based on the cleanup standard for Radium-226 found in UMTRCA Subpart B. The definition of RIM in the RIA is defined as combined radium (Radium-226 and Radium-228) greater than 7.9 pCi/g; combined thorium (Thorium-230 and Thorium-232) greater than 7.9 pCi/g; or total uranium (Uranium-234, Uranium-235, and Uranium-238) greater than 54.5 pCi/g.

Using Radium-226 as surrogate for combined radium, Thorium-230 as a surrogate for combined thorium, and Uranium-238 as surrogate for total uranium, the risk to a commercial building user is 1.07 x 10^{-4}. Therefore, implementation of the UMTRCA standards that are consistent with the definition of RIM for OU-1 and EPA's UMTRCA guidance[44] would be protective if the cleanup levels were being set based on a commercial building user scenario working on OU-1. However, in the Proposed Plan the EPA established a RAO for Lot 2A2 and portions of the Buffer Zone property not utilized for construction of the Area 2 cap that requires remediation to the extent necessary to allow for unrestricted use and unlimited exposure. To ensure that the RAO is met, less restrictive land uses, such as residential use, must be considered for development of cleanup levels.

The EPA performed the same evaluation to estimate the cumulative excess cancer risk to a residential receptor from impacted soils at levels consistent with the definition of RIM. The cumulative risk calculated for the residential receptor is 6 x 10^{-4} without consideration of the consumption of produce pathway. Inclusion of exposures due to consumption of produce from a residential garden grown in soils at these levels would increase this risk. Based on these calculations, the EPA has reaffirmed that the definition of RIM, and by extension the cleanup standards in UMTRCA Subpart B, are not sufficiently protective (i.e., less than 1 x 10^{-4}) to allow for unlimited use and unrestricted exposure for Lot 2A2, portions of the Buffer Zone, or any impacted soil outside the footprint of the Area 1 and Area 2 engineered containment.

As a part of the package submitted to the NRRB, the EPA developed PRGs for a commercial building user that corresponded to a risk of 1 x 10^{-5} excess cancer for the primary radionuclides of concern. Because some of the calculated PRGs for the commercial building user were less than background, the EPA proposed cleanup levels in the Proposed Plan as equivalent to the site-specific background to allow for unrestricted land use for the Buffer Zone/Lot 2A2. While residential land use is not anticipated for this portion of the Site, an evaluation of land uses that would result in greater exposure to site-related contaminants must be performed before cleanup levels are established. The EPA developed PRGs for the residential receptor that correspond to a 10^{-4} risk, and they are all at or below the site-specific background. Therefore, the EPA is selecting background as the cleanup level for the radionuclides of concern, including Radium-226, Thorium-230, and Uranium-238. All of the documentation supporting these determinations is found in the Administrative Record. The Proposed Plan also stated that background has been estimated previously for the Site but is expected to be further evaluated as a part of the remedial action. The EPA expects additional background characterization to be conducted as part of the remedial design sufficient to statistically estimate background for each radionuclide.

Comment

One commenter stated that the EPA's proposed cleanup levels were unreasonable in comparison to nearby sites, including the Coldwater Creek Site which is being performed by the USACE. The commenter also stated that these cleanup activities have been conducted for years in accordance with the UMTRCA standard to allow for unlimited use and unrestricted exposure at public, commercial, and

[44] "Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites," OSWER Dir. No. 9200.4-25 (Feb. 12, 1998).

residential properties along Coldwater Creek.

Response

The 2003 feasibility study developed by the USACE for the North St. Louis County Site, which includes contaminated properties along Cold Water Creek, provides a site-specific risk-based evaluation to select remediation goals. These goals were developed according to several regulations which were determined to be ARARs. This includes portions of UMTRCA and NRC regulations found in Appendix A of 10 C.F.R. Part 40. Ultimately, risk evaluations included in the feasibility study for the North County Site demonstrate that the site-specific remediation goals are sufficiently protective for residential use. The corresponding risks estimates were on the higher end of the acceptable risk range. The North County feasibility study also states that implementation of these cleanup levels for time-critical removal actions performed at the North County Site have resulted in remediation of soils such that "*residual concentrations do not produce risks significantly above background.*"

The EPA also performed a site-specific risk-based evaluation to determine cleanup levels for the West Lake Landfill consistent with EPA guidance and the NCP, as described in detail above. This evaluation demonstrates the need for background-based remediation cleanup levels for remediation of Lot 2A2 and portions of Buffer Zone not utilized to construct the Area 2 engineered cover.

Comment

Two commenters state that the cleanup level is impracticable or difficult to implement, with one commenter identifying specific concerns with implementability such as variations on what is background at different locations and limitations in documenting the absence of any incremental amount over background.

Response

The EPA asserts that remediation of radiologically impacted soils on Lot 2A2 and portions of the Buffer Zone to background levels is practicable as discussed in the nine-criteria evaluation presented in the ROD Amendment. The EPA expects further characterization of background to be conducted. It is standard practice at CERCLA sites to characterize background for site contaminants that are also naturally occurring. The EPA acknowledges that that there is variation in background concentrations of radionuclides by location and soil types which will be incorporated into individual background threshold values. The EPA expects the identification and excavation of impacted soils to occur utilizing a combination of field screening and soil sampling using both standard and specialty radiation equipment. The EPA asserts that this portion of the Amended Remedy is implementable and necessary to be protective of human health and the environment.

Comment

One commenter stated that waste from the "lot" (Lot 2A2) and buffer zone should not be relocated to Areas 1 and 2 but should be stored (disposed) off-site.

Response

The EPA has evaluated disposal options for the Buffer Zone and Lot 2A2. As described in the FFS, any radiologically contaminated soil with activity levels above those that would allow for unrestricted use will be removed from these areas as necessary to meet the standards established by 40 C.F.R. 192

Subpart B. This contaminated soil, if below 52.9 p/Ci/g, will be consolidated in the area of containment (Areas 1 or 2) prior to placement of fill material or construction of the cover over that portion of the Site. By contrast, any contaminated soil in these areas, above 52.9 p/Ci/g will be removed and disposed of off-site.

Prior sampling of the Buffer Zone and Lot 2A2 only detected low levels of radionuclides, below the 95% UCL levels used for development of the conceptual design of the engineered cover system. This will be verified during remedial design based on the results of the remedial design radiation survey and sampling of the Buffer Zone and Lot 2A2. The evaluation of the landfill cover thickness and design and the evaluation of the long-term protectiveness of this alternative were based upon the 95% UCL for all materials. Therefore, relocation of any material that is regraded is not expected to affect the long-term protectiveness of this alternative since the cover system was designed to be protective of higher values than this regraded material would contain. If appropriate, the potential for off-site disposal of this material can be further evaluated during the remedial design phase.

5.1.5 Other Remedial Measures

5.1.5.1 Treatment Alternatives

Comment

Several commenters recommended treatment methods and remedial options that they thought should be considered to address the Site. Recommendations include:

- Freezing the waste in place
- Treating the waste using mushrooms, sunflowers, plants and trees (also known as phytoremediation)
- Stabilization technologies
- Bio-stimulation as a follow-on to excavation
- In situ vitrification
- Installation of a base liner
- Place a dome over waste
- Construct a permanent building to store the waste
- Send the waste into deep space
- Store the waste in tunnels (beneath the Kremlin)

Response

The EPA believes that the most practicable technologies were thoroughly evaluated as a part of the FFS, following the Guidance for Conduction Remedial Investigations and Feasibility Studies Under CERCLA, OSWER Directive 9355.3-01, October 1988. The technology screening process in a feasibility study involves identifying general response actions, or GRAs, that may be applicable for development of remedial alternatives based on the site characterization results and the RAOs established for the Site or the operable unit. Expectations are set out in the NCP at 40 C.F.R. §300.430(a)(iii). Potential remedial action technologies associated with each GRA that may be applicable to addressing the site characterization results and satisfying the RAOs are first identified and screened based on technical implementability. The resultant technologies are then evaluated based on anticipated effectiveness, implementability, and relative cost to identify the most applicable technologies. Due to the presence of radionuclides at this Site, the Technology Reference Guide for Radioactively Contaminated

Media was used as a reference. The detailed analysis of practicable technologies is included in Section 4 of the FFS.

Comment

A commenter asked whether radiation can be filtered out of water.

Response

The EPA is unaware of filtering technologies that can remove "radiation" from water, however filtering of stormwater and other liquids can remove colloidal particles that may include particles that contain radioactive isotopes. Filtering technology was considered in the FFS evaluations and will be further evaluated during remedial design.

5.1.5.2 Liner

Comment

One commenter stated that if any wastes were left on-site, a barrier should be placed below the waste.

Response

The EPA is unaware of reliable or cost-effective technologies or engineered systems that would allow for a barrier or liner system to be installed below the waste currently in-place in the West Lake Landfill Site. While some overlapping bentonite injection approaches might provide a limited barrier at the injection depth, it would not be possible to verify that this approach would provide a complete protective barrier under the waste, as it would not be possible to effectively inspect the barrier. Also, based on the heterogeneous wastes and demolition debris disposed of in the West Lake Landfill, it is likely that refusal of the injection equipment would be a common problem. Full excavation with on-site disposal in a lined on-site cell was evaluated as one of the alternatives but the Modified Alternative 4 achieved a better balance of the nine criteria evaluated to select a remedy. The low permeability cover will be designed to minimize infiltration and leaching of RIM to groundwater.

5.1.5.3 Leachate System

Comment

One commenter expressed concern that the preferred remedy did not currently include a leachate collection system for OU-1. Numerous commenters expressed concern that the Site's existing leachate pumping and treatment system in the Bridgeton Landfill could fail or cease to operate.

Response

The EPA agrees that the management of leachate at the Site is an important consideration and evaluated leachate management for the Amended Remedy. Environmental monitoring and management activities will be designed and implemented to address any subsurface liquids encountered in OU-1. It is not currently anticipated that groundwater will be encountered during excavation of RIM in the implementation of the Amended Remedy; however, based on the potential extent and depths of excavations associated with the Amended Remedy, pockets of perched leachate present in the waste mass may be encountered during implementation. To address this matter, the ROD Amendment includes an RAO to “control and manage leachate that emanates from OU-1 in accordance with standards identified in the ARARs.”

During remedial design for OU-1, evaluations will be conducted, and appropriate plans will be developed to specifically address the handling, sampling, treatment, and disposal of any leachate or liquids encountered in the excavation areas. Based upon evaluations included in the FFS, the leachate encountered during remedy implementation will be pumped into temporary holding tanks and tested to determine treatment options and disposal requirements. It should be noted that the Amended Remedy for OU-1 does not include the use of the existing Bridgeton Landfill leachate collection and pre-treatment systems. As explained in Section 2.2, the MDNR is responsible for oversight of the operation of the Bridgeton Landfill.

5.2 Remedy Selection Criteria

5.2.1 Threshold Criteria

5.2.1.1 Protectiveness

Comment

A commenter stated that since it is more likely the United States government will exist in the near and distant future than a corporate PRP, the most protective long-term remedy should be implemented, which they believed to be Alternative 7.

Response

The West Lake Site is like many other Superfund and disposal sites where waste will be permanently managed for many years into the future. The reality is that all potential remedies are ultimately reliant on the durability and adaptability of human systems, and Superfund provides the current human construct under which we must work. The criteria for selection of the remedy are established in the NCP at 40 C.F.R. 300.430(e)(9). EPA determined that all of the alternatives evaluated in the FFS, excluding No Action, would meet the threshold criteria of protectiveness. EPA has also fully evaluated each alternative against the NCP balancing criteria. In consideration of that analysis, along with the modifying criteria of state and community acceptance, EPA has determined that a modification of Alternative 4 represents the best balance of the NCP criteria. Additional discussion of EPA’s comparative analysis can be found in Section 10.0.

5.2.1.2 Compliance with ARARs

Comment

One commenter argued that Alternative 4 is less safe than Alternative 7 because, despite the alternative’s compliance with certain ARARs, the risks that the requirements are intended to address are still present at the Site. Specifically, this commenter stated that compliance with various Missouri solid waste management regulations is only achieved because the landfill stopped receiving wastes before the effective date of the regulations. In addition, the commenter stated that Alternative 4 “avoids compliance” with UMTRCA only because “the origin of the RIM . . . differs from the radiological material covered by the statute, not because the RIM is materially different in type, composition, or risk.”

Response

The NCP's requirement of compliance with ARARs is not intended to weigh the relative protectiveness of remedial alternatives. As stated in EPA guidance, "CERCLA and the NCP establish separate requirements to be protective and meet ARARs…CERCLA requires that remedial actions attain ARARs 'at a minimum . . .'"[45] With the exception of the No Action Alternative, the EPA has concluded that all of the remedial alternatives provide adequate protection of human health and the environment. While one component of the protectiveness evaluation is an alternative's ability to attain ARARs,[46] compliance with ARARs as a distinct threshold criterion is concerned with the applicability of a promulgated federal or state requirement or the relevance or appropriateness of that requirement to the remedial activities under consideration.[47] Importantly, to the commenter's concern, this threshold criterion ensures that legally inapplicable state and federal requirements are nevertheless treated as "relevant and appropriate" where they "address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site."[48] To that end, the NCP enumerates a number of factors that the agency examines to determine whether a requirement addresses problems or situations sufficiently similar to the circumstances of the remedial action under consideration.[49]

Here, the potential ARARs identified in the FFS and final ARARs identified in Appendix D of the ROD Amendment accurately identify the specific state and federal requirements that the commenter questions. With respect to the commenter's observations relating to the Missouri solid waste management regulations, the agency reiterates the findings in the FFS and ROD Amendment that these requirements are not legally applicable to Alternative 4 (as to the other alternatives) because the landfill units comprising OU-1closed after October 9, 1991 and prior to October 3, 1993, when sanitary landfills in Missouri became subject to the requirements of the solid waste management regulations. Further, the regulations that the commenter specifically raised are also appropriately identified as neither relevant nor appropriate for Alternative 4.

As for the ARAR status of federal UMTRCA regulations, the EPA would like to correct the commenter's misstatement that alternative 4 "avoids compliance" with UMTRCA due to the historical origin of the radioactive materials at the Site. Although the FFS and ROD Amendment properly determines that the EPA's UMTRCA regulations are, for various reasons, not legally applicable to the Site, the agency has nevertheless concluded that these regulations are relevant and appropriate to various aspects of the remedial action. Accordingly, Section 6.2.6 of the FFS properly evaluates, and Section 7.1.2.1 of the FFS and the ROD Amendment accurately determines, that Alternative 4 (and the Modified Alternative 4 selected by EPA) will attain compliance with substantive portions of relevant and appropriate UMTRCA requirements.

Comment

A commenter stated that the EPA determined that the standards in UMTRCA are relevant and appropriate for cleanup of any radiologically contaminated soils on the Buffer Zone and Lot 2A2 in the

---

[45] "Clarification of the Role of ARARs and Establishing PRGs Under CERCLA," OSWER Dir. No. 9200.4-23 (Aug. 22, 1997).
[46] 55 Fed. Reg. 8666, 8720 (Mar. 8, 1990) (noting that "the protectiveness determination in the detailed analysis draws upon the assessments conducted under other evaluation criteria," including compliance with ARARs).
[47] *See* 40 C.F.R. § 300.400(g)(1)-(2).
[48] 55 Fed. Reg. 8666, 8742-43 (Mar. 8, 1990) ("[J]urisdictional prerequisites, while key in the applicability determination, are not the basis for relevance and appropriateness. Rather, the evaluation focuses on the purpose of the requirement, the physical characteristics of the site and the waste, and other environmentally- or technically-related factors.").
[49] 40 C.F.R. § 300.400(g)(2)(i)-(viii).

2008 ROD and that 5 pCi/g was also identified as an appropriate standard in the more recent FFS.

Response

Section 13.2 of the 2008 ROD, Compliance with ARARs, states "the soil standards found in the Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 C.F.R. 192 Subpart B) are relevant and appropriate requirements for the cleanup of any radiologically impacted soil that may be present on the Buffer Zone/Crossroad Property." The 2008 ROD also includes a reference to OSWER directive 9200.4-25, *Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites*, in the same section. Further, the 2008 ROD refers throughout the document to "remediation goals that support unlimited use and unrestricted exposure" but does not specify the remediation goals.

Similarly, the FFS in section 3.1.1.1.2 – Standards for Cleanup of Contaminated Land – 40 C.F.R. § 192.12(a), it is stated "the EPA has concluded that the cleanup standards in 40 C.F.R. § 192.12 are relevant and appropriate for all of OU-1, except for the areas covered by an engineered cap compliant with standards in UMTRCA Subpart A." The FFS then states, "In accordance with OSWER Directive 9200.4-25, areas not covered by such an engineered cap require a site-specific determination of risk demonstrating protectiveness under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)."

Finally, the EPA asserted in the February 2018 letter approving the FFS with modification, that evaluations performed in the RIA, the Updated BRA, and the FFS do not provide information sufficient to conclude that a cleanup level equal to the definition of RIM (i.e., combined radium and combined thorium equal to or greater that 7.9 pCi/g) would allow for unrestricted (i.e., residential) use of the Site relative to radionuclide occurrences. As explained in response to a comment in Section 5.1.4, the EPA included such an evaluation in the January 2018 NRRB Report.

Comment

One commenter states that a particular provision of the Atomic Energy Act (AEA) of 1954 obligates the federal government to excavate radiological materials at the Site. The commenter quotes Section 81(a) of the AEA, 42 U.S.C. § 2111(a), which provides that the Atomic Energy Commission

> shall not permit the distribution of any byproduct material to any licensee, and shall recall or order the recall of any distributed material from any licensee, who is not equipped to observe or who fails to observe such safety standards to protect health as may be established by the Commission or who uses such material in violation of law or regulation of the Commission or in a manner other than as disclosed in the application therefor or approved by the Commission.

The commenter further states that Cotter Corporation's unlawful disposal of leached barium sulfate, a by-product material, at the West Lake Landfill in 1973 constitutes sufficient grounds to order the removal of RIM from the Site.

Response

The EPA interprets the commenter's analysis of the Atomic Energy Act, or AEA, to contain two observations relevant to the agency's consideration. First, the commenter suggests that the AEA offers an independent legal basis for the EPA to require excavation of RIM from the Site. Second, the comment may be further read to imply that this provision of the AEA is a federal requirement with which remedial action at the Site must comply.

With regard to the first suggestion, the EPA defers to the Nuclear Regulatory Commission, the regulatory successor to the Atomic Energy Commission, as the entity with the authority to recall by-product material pursuant to 42 U.S.C. § 2111(a). As previously explained, the NRC deferred oversight of the cleanup of radioactive materials at West Lake Landfill to the EPA in 1995. The EPA evaluated several remedial alternatives, include full excavation with off-Site or on-Site disposal. This remedy selection proceeds pursuant to the EPA's authority under CERCLA, which requires that remedial actions attain ARARs among other requirements. To the extent that the commenter implies that this statutory provision is an applicable or relevant and appropriate federal requirement, the agency disagrees. Section 121(d)(2) of CERCLA, 42 U.S.C. § 9621(d)(2), provides that remedial actions must require "a level or standard of control" that attains federal and state ARARs. The agency does not interpret 42 U.S.C. § 2111(a)—defining an administrative obligation of another federal agency—as establishing "a level or standard of control" for remedial actions under CERCLA.

Comment

The radioactivity dumped at the West Lake Landfill was referenced by the NRC (now the DOE) as being licensed material in a 1995 letter to the EPA. Therefore, the Radioactive Waste Management Manual, or RWMM, should be applicable at the West Lake Landfill. The RWMM states, "The requirements of this Manual apply to all new and existing DOE radioactive waste management facilities, operations, and activities." The DOE manual clearly states that low-level radioactive waste should not be located in a floodplain, tectonically active area, or in the zone of water table fluctuation.

Response

In 1995, the NRC deferred the cleanup of OU-1 to the EPA. The Site is now being managed under CERCLA, and as such, the process for identifying appropriate regulations and guidance was followed. Per the NCP at 40 C.F.R. 300.430(b)(9), as part of the RI/FS process the FFS initiated the identification of ARARs and as appropriate TBCs. The EPA did not identify the RWMM as an ARAR or TBC requirement.

Comment

One commenter stated that the ROD Amendment should clearly state that financial assurance requirements are not considered as ARARs, and that such requirements will be negotiated with the PRPs in consent decree after issuance of the ROD Amendment.

Response

ARARs are promulgated environmental requirements and, as such, financial assurance does not constitute an ARAR. EPA will address financial assurance requirements during upcoming negotiations with the PRPs.

5.2.2 Primary Balancing Criteria

5.2.2.1 Long-Term Effectiveness & Permanence

5.2.2.1.1 General

Comment

One commenter stated that the Administrative Record and the EPA's statements in the Proposed Plan are contrary to the agency's conclusion that removal of near-surface RIM "reduces the long-term risks and decreases the exposure potential if the cover would be damaged, or if a subsurface heating event were to occur." Specifically, the commenter alleged that the EPA lacks analysis to support its conclusion that "unspecified and hypothetical damage to the landfill cover would result in additional long-term risks or exposure potential" if RIM is not removed to 16 feet. Second, the commenter argued that future maintenance and inspections under the EPA and the MDNR would provide for the repair of any damage that does occur. Third, it was noted that the EPA's Proposed Plan does not expect that severe weather and natural disasters would result in unacceptable exposures." Finally, the commenter also pointed to several of the agency's conclusions related to the potential impacts of an SSE, namely (1) that an SSE is unlikely to occur in OU-1; (2) that, even in the event of an SSE, particulate releases are also unlikely because SSE temperatures are below the melting point of RIM; (3) that increased risk attributable to SSE-induced cracks in the landfill cover are more dependent on maintenance of the surface than the depth of RIM; and (4) that the likelihood of particulates reaching the surface with SSE-generated landfill gas is remote.

Response

The NCP instructs the EPA to assess remedial alternatives "for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful."[50] Among the factors that the agency shall consider are the "[m]agnitude of residual risk remaining from untreated waste" and the "[a]dequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste."[51] The NCP clarifies that the latter factor "addresses in particular the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative, such as a cap . . . ; and the potential exposure pathways and risks posed should the remedial action need replacement."[52] Importantly, the preamble to the NCP explains that "[t]he potential for this risk may be measured . . . by the volume or concentration of contaminants in waste, media, or treatment residuals remaining on site."[53]

In light of the NCP's recognition of uncertainty, the agency believes that it is appropriate to consider "unspecified and hypothetical damage to the landfill cover" in its evaluation of the long-term effectiveness and permanence criterion. The NCP explicitly directs the EPA to consider such uncertainty in its analysis, as well as the potential risk of exposure to residual contamination as a result of damage induced by a subsurface heating event or natural disaster. The commenter correctly observes that routine inspections and proper maintenance would repair any damage that may occur but disregards potential exposure to the inspectors who identify and construction workers who repair such damage, if RIM, and

[50] 40 C.F.R. § 300.430(e)(9)(iii)(C).
[51] 40 C.F.R. § 300.430(e)(9)(iii)(C)(1)-(2).
[52] 40 C.F.R. § 300.430(e)(9)(iii)(C)(2).
[53] 55 Fed. Reg. 8666, 8720 (Mar. 8, 1990).

particularly high activity RIM, were left closer to cap (i.e. the surface of the landfill). And although the EPA has concluded, as noted by the commenter, that impacts related to a subsurface heating event or natural disaster are unlikely, it is important to recall that this criterion deals with "the degree of certainty that the alternative will prove successful." Any potential for such impacts, however minor, weighs against alternatives that leave more rather than less RIM at the Site and nearer to the surface. Based on this analysis, the EPA has concluded that any level of excavation of RIM from the Site will enhance the long-term effectiveness and permanence of the remedy.

Comment

One commenter observed that the EPA's *Guide to Selecting Superfund Remedial Actions* states that the long-term effectiveness factor "will often be decisive where alternatives vary significantly in the types of residuals that will remain on-site and/or their respective long-term management controls."

Response

The commenter correctly cites EPA's guidance on this issue. The agency agrees with the commenter's suggestion that the remedial alternatives evaluated differ significantly with respect to the residual contamination that would remain at the Site and, consequently, the long-term management controls that would be required. In developing the Proposed Plan and, subsequently, the Amended Remedy, the agency placed appropriate weight on the long-term effectiveness and permanence criterion, as instructed by the NCP, which states that "special emphasis is to be afforded alternatives that offer advantages in long-term effectiveness and permanence."[54]

Comment

Comments were received stating that Alternative 7 would be the most protective in terms of long-term effectiveness and permanence, because the magnitude of residual risks pose the least risk to the "maximally exposed individual" across all levels of long-term evaluation (one year, 1,000 years, and 9,000 years)

Response

The commenter is correct that Alternative 7 would achieve the highest level of protectiveness and long-term effectiveness and permanence because it would result in the least amount of residual contamination remaining at the Site after implementation of the remedy. Nevertheless, this criterion is one of five primary balancing criteria and two modifying criteria that the agency must evaluate to select an appropriate remedy for the Site. The EPA has concluded that the Amended Remedy provides the best balance of trade-offs associated with all remedy selection criteria while emphasizing the importance of the long-term effectiveness and permanence of the remedy, as instructed by the NCP.

5.2.2.1.2 Residual Contamination

Comment

Commenters expressed concerns that the RIM that would remain at the Site under the EPA's preferred alternative would not be protective of future generations and would not guarantee the safety of the surrounding community. Another commenter suggested it would be safer to remove the radioactive

[54] 55 Fed. Reg. 8666, 8725 (Mar. 8, 1990).

materials deeper than 16 feet, given the evidence that some of the gamma radiation exceeds a million counts per minute at depths of up to 90 feet below the surface.

Response

The EPA agrees that remedial action is required at the Site due to potential future risks, which are evaluated in the Updated BRA for all reasonable pathways and receptors. Risks have been conservatively calculated, and account for the fact that levels of radioactivity will continue to increase due to the ingrowth of radium from thorium over time. The Amended Remedy, once implemented, provides for adequate long-term protection by considerably reducing the levels of radioactivity caused by RIM at the landfill. The Amended Remedy includes removal of contamination located closer to the surface, and construction of a landfill cover. This remedy is protective and it reduces the potential for human exposures to the RIM. The deeper occurrences (e.g., deeper than 16 feet) of RIM at the Site, some of which may include high concentrations (e.g., greater than 1,000 pCi/g), are less likely to result in any exposures due to their distance from the surface. RIM at depths of 90 feet is not capable of causing exposures at the surface, especially after installation of the engineered containment system associated with the Amended Remedy.

It is expected that the cap will be maintained according to an Operation and Maintenance Plan, and statutory reviews of the remedy will occur to ensure its continued protectiveness, as required by the NCP.[55] These reviews will determine whether the Amended Remedy is protective of human health and the environment, evaluate any changes in conditions around and on the Site, and identify any issues that may adversely affect protectiveness of the remedy. The EPA will oversee remedial activities occurring at the Site throughout the duration of the remedy.

Comment

One commenter stated that a risk probability assessment should be included in the remedy to address possible failures of each remedy.

Response

As explained in response to previous comment in this section, the NCP specifically requires the EPA to evaluate uncertainties associated with remedial alternatives under the long-term effectiveness and permanence criterion. Under this criterion, the NCP instructs the agency to assess “the degree of certainty that the alternative will prove successful,”[56] considering such factors as the “[m]agnitude of residual risk remaining from untreated waste” and the “[a]dequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste.”[57] The latter of these factors, in particular, addresses the “uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative, such as a cap . . . ; and the potential exposure pathways and risks posed should the remedial action need replacement.”[58] The EPA has performed this analysis per the NCP and concluded that the Amended Remedy utilizes technologies that are proven in the long-term. The Amended Remedy provides extra assurance of long-term protectiveness because it removes RIM in the shallow subsurface. An assessment of possible failures due to a subsurface heating event was

[55] 40 C.F.R. § 300.430(f)(4)(ii).
[56] 40 C.F.R. § 300.430(e)(9)(iii)(C).
[57] 40 C.F.R. § 300.430(e)(9)(iii)(C)(1)-(2).
[58] 40 C.F.R. § 300.430(e)(9)(iii)(C)(2).

included in the FFS and is addressed in Section 3.2 of this Responsiveness Summary. Comments and responses related to possible failures due to natural disasters are covered in Section 5.2.2.1.3 of this Responsiveness Summary.

5.2.2.1.3 Natural Disasters

Comment

The EPA received many comments regarding concerns related to natural disasters. These comments largely mentioned or identified three specific types of natural disasters; (1) seismic events or earthquakes, (2) tornados, or (3) flood events to occur at or otherwise impact the Site. Many of the comments expressed concerns over the potential for flooding to mobilize contaminants including RIM, during and following remedy implementation. One commenter stated that the EPA failed to include the impact of climate change on the remedy in the Proposed Plan, i.e., increased potential for flooding from climate change effects.

Response

Relevant and predictable climatic or geologic events that could be reasonably anticipated, including climate change, were considered in the evaluation of the long-term effectiveness of the remedial alternatives. This evaluation also considered potential system vulnerabilities to climate impacts in accordance with related technical guidance documents and fact sheets. These assessments evaluated the likelihood for climate related impacts or hazards to reduce the effectiveness of remedial or landfill systems. This generally includes an evaluation of potential damage to the overall Site, potential damage to on-site infrastructure, and/or damage to the materials considered in the conceptual designs for the various alternatives. Specific consideration was addressed for damage to cover systems, potential washout of contaminated contents, as well as unexpected and additional costs for repairing or replacing components of remedial systems. Further, potential relevant items or events that may affect remedial designs, remedy implementation, and the long-term performance of the Amended Remedy will be further considered and evaluated during the remedial design phase.

It should be noted that the EPA and many other federal and state agencies have successfully conducted remedial actions at many remedial sites located across the country including sites located in or near seismic zones, in areas of tornadic activity, and near floodplains. Over the decades, issues associated with natural disasters such as flooding have been encountered that have impacted the remedial actions; however, the EPA believes that with careful planning, routine inspections, proper maintenance, and robust design features remedial actions are appropriate and effective in these settings.

Identified potential impacts from climate change and extreme weather events are discussed in the Administrative Record and such impacts are not expected to result in unacceptable exposures. Furthermore, potential impacts to the Selected Remedy associated with climate change and extreme weather, if encountered, would be identified by routine inspections that would assess the Site for signs of surface damage such as stress to or loss of surface vegetation on the cover, visible erosion or other damage to the cap surface. Such impacts would be repaired with conventional construction practices and in accordance with site-specific O&M plans. The EPA fully intends to have routine inspections and assessments of the Site, and any identified issues will be properly addressed to ensure the protectiveness of the Amended Remedy. While Alternative 7 would eliminate the potential for weather related impacts to the RIM at the Site, the landfill would remain, containing other waste materials, and would still need to be routinely inspected and potentially repaired following extreme weather events. The Selected

Remedy does remove a majority of the RIM from the Site, which will limit the potential for impacts from climate change and extreme weather and further supports long term protectiveness over capping only remedies.

Comment

The EPA received many comments regarding the Site's location near the Missouri River and related flooding and floodplain concerns. Additionally, commenters noted that under some alternatives the radioactive material will remain on-site for thousands of years, and conditions associated with the river course and floodplain could change, resulting in uncertainties as to future conditions relative to the floodplain and the Site. One commenter stated the commenter was unsure how floodplain extent was determined. One commenter specifically pointed to anthropogenic changes to the river and increased urban development that are and will continue to increase flooding frequency and intensity. One commenter expressed concern that flooding will make the Site vulnerable to landslides.

One commenter stated that the paper presented by Maggie Wen, Washington University, contradicts information the EPA used to determine effects of flooding on the Site. Multiple commenters were concerned that floodwaters in the River Des Peres could be affected by the Site.

Response

The EPA acknowledges that potions of the Site are located within the Missouri River geomorphic floodplain, and that flooding associated with both the Missouri River and Cowmire Creek could occur in the general vicinity of the Site. The EPA has reviewed Federal Emergency Management Agency, or FEMA, flood insurance maps and other flood related information for the Site area during the remedial investigations conducted at the Site, and based upon the review determined that the majority of the Site is not located within the 100- or 500-year floodplain, as designated by the flood insurance maps. As discussed in the OU-1 decision documents, historically, there have been occurrences of documented flooding in the St. Louis Area, including near the Site. However, changes in both the Site topography and construction and operation of the Earth City Levee and the regional stormwater management system have resulted in the majority of the Site being located outside of flood-prone areas. Specifically**,** the Earth City Flood Control and Levee District operates and maintains a levee and stormwater management system to protect properties and associated developments from flood events. This levee system was designed to protect against floods with a recurrence interval greater than 500 years (0.2% annual chance of flooding). In 1993 and in 1995 during significant regional Missouri River flood events the levee system operated as intended and no flooding conditions were documented at the Site.

As previously mentioned, most of the Site including, Areas 1 and 2, are located within the geomorphic floodplain of the Missouri River, but are located outside of the 100-year and 500-year floodplain**s.** The topography of the site-area has been significantly altered and raised by the placement of landfill materials. Consequently, although portions of the Site were built over the historic and geomorphic floodplains, Site activities have significantly increased the topographic elevation. With the exception of the Buffer Zone, Lot 2A2**,** and drainage areas located along the perimeter of the Site, the majority of the Site is now outside of the 500-year floodplain. The highest topographic level in Area 2 is about 500 feet above mean sea level, or ft\amsl, on the southwest side of Area 2, sloping to approximately 470 ft\amsl near the top of the landfill berm. The upper surface of the berm along the western edge of Area 2 is located from approximately 20 to 30 feet above the adjacent Buffer Zone/Lot 2A2 area and approximately 30 to 40 feet higher than the water surface in the flood control channel located to the southwest of Area 2.

Because the disposal areas of the Site are located outside of the 0.2-percent annual chance (500-year) floodplain, no specific flood mitigative actions are required by statute unless the remedial action (1) impacts the base floodplain, (2) indirectly supports floodplain development, or (3) is a critical action. Remedial actions for OU-1 are not expected to impact the base floodplain or indirectly support floodplain development. In the event of a failure of the Earth City Levee System (which provides protection from flood events with a recurrence interval greater than 500 years), floodwaters could inundate the Buffer Zone and Lot 2A2. Due to the current distance from the river, such floodwaters would not be expected to be "high energy", but instead are estimated to low velocity or mostly stagnant and without the energy capable of resulting in significant damage or erosion. It is expected that any radiologically-impacted soil that may remain on the Buffer Zone or Lot 2A2 properties would be removed as part of the implementation of the Amended Remedy. However, since the northwestern most portion of Area 2 could be contacted by flood waters should the levee system fail. Remedial assumptions provided in the FFS include the installation of rock armoring for flood protection along the toe of the northern portions of Area 2. This will be further evaluated in remedial design and appropriate bank protection methods will be used, such as a rock rip rap apron. The vertical height of the flood protection feature will be designed to include a margin of safety over the 500-year flood level. This flood protection feature will specifically protect the landfill berm against future erosion, slope failures, or landslide type events.

The EPA is aware that the radioactive materials will be radioactive for millennia. Managing the West Lake Superfund Site over the long-term poses the same sort of challenges faced at numerous remedial sites where long-lived contaminants such as radionuclides, heavy metals, and other stable toxic materials will remain, including near floodplains. The EPA believes that with careful planning, routine inspections, proper maintenance, and robust design features, remedial actions are appropriate and effective in these settings. Should longer-term physical conditions associated with the Missouri River's course, the Site, or the floodplain determinations change in the future, the protectiveness of the remedy will be reassessed and as appropriate be modified in response.

Additionally, the EPA reviewed the floodplain "paper" as provided by a community member (Maggie Wen). The submitted paper contains technical information summarizing four evaluations of flooding and potential flood events at the Site, however, the paper included significant non-trivial uncertainties related to the evaluations and associated conclusions. The paper, while well written and presented, did not provide definitive insights or new technical information, and as such has not changed the agency's determinations regarding flooding evaluations at the Site.

The River Des Peres watershed is located approximately three miles southeast of the West Lake Landfill. Due to the regional topography of the site-area, and the distance to the headwaters of this river, the Site is not anticipated to impact or otherwise interact with this watershed, including the underground storm sewer system associated with the River Des Peres.

Comment

Many comments were received expressing concern regarding the Site's location in the Midwest as being in "tornado alley," which is interpreted as being located in a part of the country that is prone to tornadic activity.

Response

An evaluation of the potential impacts of a tornado was included as part of the evaluation of the long-term effectiveness of each of the alternatives in Section 6 of the FFS. This evaluation concluded that none of the alternatives, once fully implemented, were expected to incur significant impacts to the subsurface areas of the Site due to a tornado. Based on published assessments and photographic documentation, it was shown that historically, grassy areas such as those anticipated at the surface of the Site following remedy implementation, did not display substantial or significant damage in areas impacted by tornadoes. Based upon the evaluations summarized in the FFS, if a tornado were to damage the vegetation associated with a cap, such an impact is not considered to be significant because it would be identified and, due to the design and thickness of the engineered cover system, would not result in unacceptable exposures to site-related contaminants. A tornado could damage or destroy above-ground infrastructure such as signage, fencing, or environmental monitoring equipment. However, such impacts are not considered to be significant because they would be readily identified and repaired or replaced under site-specific operations and maintenance work. Therefore, the Amended Remedy is not considered vulnerable to impacts from a tornado in terms of the long-term effectiveness.

Comment

Specific comments were also received that expressed concerns related to the Site's proximity to seismic zones such as the New Madrid fault zone, the potential for liquification of soil and other materials located under/at the Site, and other potential effects of a seismic event or earthquake.

Response

The EPA agrees that the Site is located in an area of potential seismic activity. The St. Louis metropolitan area faces earthquake hazards from the more distant New Madrid and Wabash Valley seismic zones, as well as from the more proximal St. Genevieve seismic zone. The alluvial materials under portions of the landfill are not as vulnerable to earthquake liquefaction as some other soil types; however, liquefaction can occur in loose, fine-grained materials that are saturated with water. The Site is situated over a combination of bedrock, sands, and gravels and these materials tend to possess greater frictional strength than more fine-grained sedimentary materials. However, should a significant seismic event of 5.8 or higher on the Richter scale occur in the area, portions of the general site-area that exist over alluvial materials have been estimated to have a risk of liquefaction according to the *St. Louis Area Earthquake Hazards Mapping Project: Seismic and Liquefaction Hazard Maps* (USGS 2017).

Observational data on the performance of solid waste landfills during earthquakes indicate that, in general, this type of infrastructure is not particularly susceptible to earthquake-induced damage. However, in the event the Site is subjected to an earthquake, the potential for damage exists. In the event the cover or other remedial systems are damaged, the damage would be assessed, and repairs would be made, as needed, consistent with the site-specific Operation and Maintenance plans developed during remedial design, and potentially from other engineering evaluations.

Comment

One commenter pointed to potential effects of climate change on cover systems, as analyzed in Table 7-1 of the FFS as reason to not cap the RIM waste in-place. Another commenter stated that selection of Alternative 7 would make the effects of climate change on the Site a non-issue because the largest amount of RIM would have been removed.

Response

As stated in the FFS, "Removal of all of the RIM under the full excavation of RIM alternative would provide the most permanent method to prevent impacts from climate change, flooding, tornadoes, or other severe weather conditions. Removal of portions of the RIM under the various partial excavation alternatives would reduce the amount of source material and therefore would reduce the potential for impacts of these types of events. The Amended Remedy does remove a majority of the RIM from the Site, which will limit the potential for impacts from climate change and extreme weather and further supports long-term protectiveness over capping-only remedies. Furthermore, potential impacts to the Amended Remedy associated with climate change and extreme weather, if encountered, would be identified by routine inspections, and any impacts would be repaired with conventional construction practices and in accordance with site-specific O&M plans.

5.2.2.2 Short-Term Effectiveness

5.2.2.2.1 Construction Time

Comments

Many commenters expressed concern about the length of the construction time frame, frequently requesting that remediation be expedited. A few commenters suggested specific time frame limits for cleanup while others expressed distrust in the estimates presented for the alternatives, believing that the timeframes were skewed to dissuade the public from more extensive and long-term alternatives. Several commenters offered suggestions to expedite remediation including working multiple shifts, working on multiple areas within the Site simultaneously, eliminating sorting of waste, and offering incentives for timely completion of work. A few commenters expressed the opposite sentiment, stating that a quick fix was not a long-term fix, and generally advocating for full excavation. One commenter observed that the difference in time to complete is even more pronounced for the preferred alternative than the remedy selected in the 2008 ROD.

Response

The EPA recognizes that the length of remedy implementation is an important consideration for this Site. Appendix J of the FFS, titled "Estimated Project Schedules for the Remedial Alternatives," contains summaries as well as detailed breakdowns for how each of the estimates were determined. Contrary to the suggestion of certain commenters, the estimated time frames for construction were not skewed to favor one alternative over another. Numerous assumptions had to be made to generate these estimates, which are described in Appendix J, but they were reviewed in depth for accuracy and appropriateness by the EPA as well as external experts. The EPA believes, therefore, that they are appropriate estimates for comparison of remedial alternatives.

The agency further acknowledges that preferred alternative presented in the Proposed Plan would require more time to implement than the 2008 ROD. Reducing the construction time frame, and associated short-term risks, is a priority for the EPA, and such considerations played an important role in the agency's final remedy selection. The Amended Remedy reduces the construction time period to approximately 2.8 years from 3.7 years as presented in the Proposed Plan.

The plan for execution of the work to remediate the Site will be the subject of the remedial design, which will be reviewed and approved by the EPA. Details related to how the excavation will proceed as well as waste handling methods will be addressed in the remedial design. Contractual issues, such as payment of incentives for timely completion of work, would be a matter for the PRPs to consider when determining the optimal manner to achieve the approved schedule for completion of work at the Site

Comment

One commenter recommended that the EPA resolve the discrepancy between the EPA's and PRPs' estimate of the expansion of volume of materials when removed from ground, noting that the PRPs use 200% while EPA used 150%. If 150% is accurate, the commenter stated, this will reduce time and cost.

Response

The EPA is unaware of the discrepancy regarding the volume expansion estimates mentioned in the comment. The value for the volume expansion estimate used in the FFS was 150%, which was necessary to develop reasonable estimates for both cost and schedule for the evaluated alternatives. The volume estimates relied upon standard industry practices and are appropriate for FS-level summary estimates. Although there is some uncertainty regarding the actual amount of volume expansion that may occur during remedy implementation, the volume expansion estimates were used consistently for all of the excavation alternatives.

Comment

Many commenters expressed a desire to leave materials on-site, either in an on-site disposal cell or beneath a cap, because this would expedite remediation. Some of these commenters believed that excavation and off-site transportation would take 30 to 40 years.

Response

Disposal of materials on-site would involve the construction of an engineered cell that meets regulatory criteria. The 30- to 40-year time frame is a significant overestimation. The full excavation scenario is only projected to take 14.6 to 14.8 years, depending on whether there is off-site or on-site disposal. The partial excavation remedy presented in the Proposed Plan was projected to take 5 years to implement. The Amended Remedy, by comparison, is projected to take approximately 2.8 year to construct, which will include excavation and transportation of waste to an off-site disposal cell. The Amended Remedy will take approximately 4.1 years to implement, when including design time.

5.2.2.2.2 Risks of Implementation

Comment

Commenters expressed concern that the excavation and removal process will release radioactive particles into the air and wanted assurance that monitoring will be in place. Several commenters stated that exposure to airborne radiological contamination would be minimized by not excavating the Site.

Response

The commenters accurately observe that excavation presents the potential for airborne releases of contaminated fugitive dust. Issues related to air monitoring, specifically airborne migration of fugitive dust, will be addressed during remedial design and during implementation of the Amended Remedy. The EPA will require best management practices such as dust suppression, personal and area air monitoring, limiting active excavation on excessively dry and/or windy days, and other engineering controls, as needed, to ensure that contaminated dust is not migrating off-site or affecting on-site workers. The details of dust prevention, mitigation measures, and air monitoring requirements will be developed during the RD based on the site-specific information, including existing air and metrological data and applicable or relevant and appropriate requirements, including federal standards for radon and other radionuclides. Ultimately, action levels will be established that are protective of site-workers and the surrounding community.

Comment

Commenters expressed concern that excavation or movement of contaminants during remediation could result in migration of contaminants beyond the Site boundary through stormwater or sediments.

Response

The EPA acknowledges that excavation presents the potential for migration of contaminants via stormwater and sediments. To prevent such migration, the surface area of disturbed ground exposed to direct precipitation will be minimized during implementation of the Amended Remedy, which will reduce the amount of stormwater falling or flowing into excavation areas. In addition, various engineering controls will be used at the Site, as discussed in the Administrative Record for OU-1. The use of best management practices, or BMPs, to control and manage stormwater will be further evaluated and refined during remedial design, and stormwater monitoring requirements at the Site will be modified to account for new outfalls and drainage patterns created both during and following remedial construction. Radionuclides captured by the BMPs will be treated, disposed of, and otherwise addressed by the application of various procedures determined during remedial design. The EPA and the MDNR will continue to coordinate closely on the development of future stormwater management documents and related plans for both the remedial construction and post-remedy time frames for all areas of the Site.

Comment

Many commenters expressed concern that excavation workers and truck drivers would be at greater risk of radiation exposure if RIM is excavated. Commenters regularly noted, too, that greater risk would accompany the use of heavy machinery during excavation. One commenter observed that the risks caused during construction are more pronounced for the Proposed Plan Preferred Alternative than for the 2008 ROD Selected Remedy. One commenter stated that risk to workers posed by Alternative 4 exceeds the EPA's acceptable risk range and that the Proposed Plan does not describe the "engineering measures" and "best management practices" that could reduce the cancer risks to on-site workers. For these reasons, the commenters either stated a preference for remedial alternatives that would contain the waste in-place or, more frequently, on-site disposal of excavated materials. Another commenter stated that the EPA should calculate and state clearly on the record how much additional worker exposure to radiation after these mitigation measures it deems acceptable under these circumstances. Another commenter states that EPA's evaluation of short-term risks fails to consider cost associated with engineering measures and best management practices for worker protection.

Response

The EPA recognizes that the use of heavy machinery on-site can potentially result in the generation of fugitive dust, including from the disturbance of RIM located at the surface of the Site, as well as during subsurface excavation activities. The agency assessed the potential for short-term impacts to workers and the community with respect to each remedial alternative presented in the FFS. This assessment included quantitative risk estimates for construction workers, remediation technicians, and nearby receptors such as off-site workers and residents. These risk estimates were developed under the same guidelines and fundamental principles as the estimates developed in the Baseline Risk Assessment. As stated in Appendix H of the FFS, the purpose of the remedial risk assessment is in part to calculate a conservative assessment of the potential short-term risks to the reasonable maximally-exposed receptor and residents during remedy implementation. It also conservatively states that "this risk assessment does not take into consideration radiation safety and health and safety precautions implemented in the field." Risks due to use of heavy machinery and transportation-related accidents are addressed in response to comments in Section 5.2.2.2.3.

All remedial alternatives except the No Action Alternative involve excavation of both RIM and non-RIM materials. Therefore, fugitive dust generation, radon releases, and gamma radiation present potential risks to workers for all remedial alternatives, except the No Action Alternative, including the capping-only remedies. Since additional excavation of RIM increases handling of radioactive materials and the overall time frame to complete the remedy, Alternatives 4 through 8 do result in greater potential risks to remediation workers than the capping-only remedies, presented as Alternatives 2 and 3, which require excavation of less radioactive material and take less time to implement.

Between these two categories, the primary difference relating to estimated worker risk is attributable to remediation technicians working in the RIM staging and sorting building that would be constructed for the excavation alternatives. The FFS states that use of a temporary rigid frame fabric structure erected in a fixed location where excavated RIM would be staged prior to off-site transportation was retained as a remedial technology/process option for fugitive dust and odor control. Risk evaluations show that there is roughly a two order of magnitude increase in potential risk to workers for alternatives that involve excavation and handling of RIM over alternatives that leave the RIM in place. Risks to the reasonably maximally-exposed remediation technician for Alternatives 2, 3, and 6 range from 2.8×10^{-5}, or 28 instances of cancer per 1,000,000 people, to 5.0×10^{-5}, or 50 instances of cancer per 1,000,000 people. By comparison, for Alternatives 4, 5, 7, and 8, which involve excavation and handling of RIM, risks to a remediation technician range from 2.2×10^{-3}, or 22 instances of cancer per 10,000 people, to 1.1×10^{-2}, or 110 instances of cancer per 10,000 people. This significant differential exists even though the time to complete the excavation for Alternative 6 is 2.6 years compared to 3.7 years for Alternative 4. A further example is that the risk to a remediation worker for full excavation are 3.7×10^{-3} compared to 2.2×10^{-3} for Alternative 4, again in contrast to a construction time of 13.3 years for the full excavation with off-site disposal compared to 3.7 years for Alternative 4. While a number of variables contribute to differences in risk estimates for each alternative, these examples demonstrate that inclusion of remediation technicians working in a RIM staging and loading building account for the largest negative impact to the short-term risk estimates.

This risk to remediation workers working inside the staging and loading building was, therefore, a significant consideration for the EPA when evaluating short-term risks. The majority of remediation workers, including radiation survey/radiation control technicians working outside the RIM staging and loading building (heavy equipment operators, truck drivers, laborers, and engineers or other construction management personnel), will either never be working inside this building, or their activities inside a staging and loading building will result in significantly less exposure than those whose entire job involves working in a building. For example, truck drivers will primarily be sitting inside their truck while it is being loaded. This will provide some level of shielding from the RIM and they will be further from the RIM as compared to the remediation technician, who was evaluated as the reasonably maximally-exposed worker. The EPA can therefore conclude that the potential short-term risks during remedy implementation for nearly all other workers will be significantly less than the reasonable maximally-exposed worker in the RIM staging and loading building.

For all remediation workers, exposures can be significantly reduced by limiting the time spent near RIM, employing standard dust control measures, requiring proper use of protective clothing to reduce or eliminate inhalation and ingestion of contaminated fugitive dust, and ensuring proper ventilation through an air control system in the staging and loading building. This is critically important for the radiation technicians working in the RIM staging and loading building. The risks for these workers are estimated by assuming the entire work day will be spent standing directly on top of the RIM in the staging and loading building for the duration of the remedy construction. Therefore, these exposures can be significantly reduced by simply limiting the time spent near RIM to that which is necessary to conduct radiation surveys and collect samples. These exposures can be further reduced if necessary by alternating radiation technicians to perform this job function during the remedy construction. The EPA expects that the various mitigation strategies discussed in this response will prevent work exposure from exceeding federal and state worker protection standards including 29 C.F.R. § 1910 and 10 C.F.R. Part 20. Developing and implementing work practices that minimize the time spent near RIM as discussed above will not require any additional cost not accounted for in the FFS. In addition, engineering controls including the RIM Staging and Loading building and controls for fugitive dust were already included in the estimated remedy costs.

The EPA recognizes, as noted by some commenters, that the risks associated with excavation are greater than those that would be present for the capping alternative identified in the 2008 ROD. Nevertheless, the agency has concluded that increased risk presented during implementation of the Amended Remedy can be adequately managed. The Proposed Plan states that, "[f]or all of the alternatives, worker exposures will be closely monitored, and engineering measures and best management practices will be taken to reduce exposures to within acceptable levels. However, risks to workers from exposure to gamma radiation can only be controlled by limiting exposure durations."

Comment

Several commenters recommended the use of a temporary structure(s) over excavation areas and other work areas, generally as a means of addressing health and safety concerns by isolating remedial activities and thus preventing the potential migration of radionuclides off-site.

Response

The EPA agrees that the use of temporary structures should be considered at the Site as a technology to support remedial activities. The use of temporary structures was evaluated in the FFS and will be further evaluated during remedial design. Based upon the FFS evaluations, the use of temporary structures may be appropriate for the RIM staging and loading operations to better manage and control potential air emissions and prevent contact with precipitation. Use of a temporary structure may also be considered if materials are encountered during excavation that pose difficulty for control of air emissions, such as friable asbestos-containing material, drums, or other vessels containing volatile or highly toxic materials or high levels of radionuclides. Such structures may also be appropriate if standard procedures such as direct wetting, misting, foam applications or other engineered techniques are deemed to be ineffective or unsafe.

It should be noted that the EPA identified several engineering challenges in the FFS with the use of temporary structures at the Site. Due to the geotechnical properties of the buried refuse found in Areas 1 and 2, construction of stable and cost-effective foundation systems for the any temporary structure within or over waste cells may not be feasible. Additionally, the use of a temporary structure over the refuse is further complicated by other factors, such as size limits of commercially available temporary structures, inability to accommodate steeply graded side slopes, and the need to move the structure many times, resulting in an increase in both cost and schedule. Additionally, a temporary structure would need potential enhancements such as increased ventilation, explosion-proof electrical equipment and enhanced monitoring to help mitigate risk to workers, which may be higher in an enclosed space than in the open.

Comment

Some commenters expressed concerns that on-site excavation activities, if conducted in proximity to the SSE, could exacerbate the existing reaction, start a new reaction or landfill fire, and cause additional risks to workers and the community. Some of the commenters suggested the EPA begin and finish all excavation work as quickly as possible to remove the radioactive waste before a reaction or landfill fire could reach it.

Response

The Amended Remedy does not involve excavating or otherwise targeting the removal of any non-radioactive waste materials located near the existing SSE, which is occurring in the South Quarry of Bridgton Landfill (OU-2). The EPA agrees that excavating into or disturbing solid waste in a landfill environment can result in oxygen intrusion and may increase the threat of a reaction or landfill fire. The Amended Remedy minimizes short-term impacts in OU-1 by reducing the amount of waste disturbed, thus reducing the chance of causing a reaction or landfill fire. During remedial design, work plans and health and safety plans will be developed to provide guidance for the safe execution of the excavation and related intrusive activities, including provisions to minimize the potential for starting a reaction or a landfill fire.

5.2.2.2.3 Transportation Concerns

Comment

Several commenters expressed concern that during off-site transportation of contaminated materials via truck or rail there would be an increased risk of radiation exposure to local and rural communities, landfill workers, truck operators, and first responders along haul routes due to dust emissions. The commenters also stated concern about increased potential for traffic collisions, specifically expressing concern that radioactive waste could be spread across the state of Missouri along highways and railroads. Several commenters expressed the need for transportation of waste materials to be done safely and that plans and training that would be needed to prepare first responders for potential accidents.

Response

The EPA recognizes that there will be an increased risk of truck traffic accidents and exposure to radionuclides from dust emissions resulting from the excavation and loading of RIM for transport and off-site disposal. The EPA will require air monitoring while loading and handling work is being conducted, as well as the use of BMPs and engineering controls to ensure that contaminated dust does not migrate off-site during excavation or transportation. The details of the actions necessary to protect on-site workers and the surrounding community will be fully developed during the remedial design. These plans will include air monitoring during excavation activities, shipment of waste in enclosed Department of Transportation-approved containers, and specified haul routes for truck traffic that consider local traffic patterns and congestion to select the safest routes and times of days for operation.

Although these materials pose a risk to human health and the environment, they are not unlike hazardous materials that are regularly shipped by truck or rail. All hazardous materials shipped by truck or rail must include placards identifying the materials being transported. Trucks and rail cars transporting RIM waste will have placards identifying the material to alert first responders in the event of an accident. First responders are familiar with the use of these placards and how to respond appropriately. In the event of an accident, this information ensures that those responding to the accident would have the information necessary to ensure their own safety and the safety of the public. Appendix H of the FFS may be referred to for more detailed information related to transportation of wastes for the Site.

Comment

One commenters stated that the EPA sought to exclude consideration of increased traffic risks and industrial accidents, contrary to the NCP's short-term effectiveness criterion.

Response

Per the NCP, the EPA considered transportation and industrial accident incidence in the short-term effectiveness criterion analysis, as it relates to impacts to workers and the community from the possible exposure to releases of contaminants resulting from such accidents. Injuries or fatalities resulting from truck or other industrial accidents are not, however, generally considered environmental risks that should be evaluated under the short-term effectiveness criterion, especially for common earthmoving/hauling alternatives such as those evaluated in the FFS. Such risks should therefore not be used to unduly imbalance an alternative. While an unusually high incidence rate may be of concern, potential worker accidents are typically addressed through project health and safety plans. The health and safety plan and other planning documents for implementation of the Amended Remedy will address this concern.

Comment

The EPA received many comments that expressed concern over the impact that the additional traffic would have on the roads of Missouri. A few commenters specified a preference for a certain method of transportation to ship the waste off-site. Several commenters were concerned that the burden of paying for road repairs would fall on taxpayers. One commenter expressed concern that neighboring states could oppose and stop the transportation of these wastes.

Response

Shipping methods of excavated RIM will be determined during the remedial design phase. The FFS considered using trucks to ship to a nearby rail spur for transport to an off-site disposal facility. The remedial design will consider implementability factors such as safety of all communities and workers, cost, transportation regulations, waste acceptance criteria. These considerations will be weighed in order to identify the best method of transportation. All regulations promulgated by the Department of Transportation and the Occupational Safety and Health Administration will also be followed during transport to ensure safety and allow for safe shipment across state lines.

5.2.2.2.4 Airport Proximity

Comments

Many commenters expressed concerns regarding open excavations and exposed waste due, in part, to concerns over attracting nuisance wildlife, primarily birds, and increasing bird populations and/or bird strikes, thus causing a hazard to the nearby airport. These commenters expressed a desire to limit open excavations and often suggested that a capping remedy should be selected for the Site. One commenter expressed concern that while the excavation was open birds could pick up materials contaminated with RIM and potentially carry them off-site. In addition, comments were received stating that the EPA did not adequately address these concerns, or underestimated short-term risks, related to bird strikes. One commenter stated that the EPA ignores the risks that the negative easement and the Federal Aviation Administration Record of Decision were intended to safeguard against.

One commenter expressed a desire for a more detailed outline of wildlife mitigation measures be included in the ROD Amendment, also recommending a wildlife hazard benchmark assessment be used in developing site-specific wildlife mitigation efforts, with proof testing prior to starting any excavation activities. Further the commenter stated that the timeframes and amounts of putrescible waste that will be exposed are important considerations and should be minimized, due to wildlife attraction issues. This commenter went on to state that detailed steps must be taken to ensure a robust wildlife hazard assessment, as well as an identification, monitoring, mitigation and elimination plan that can identify and act on potential bird hazards, before bird activity is established, because once a bird hazard to aircraft develops, it is more difficult to control and eliminate.

Some commenters proposed specific modifications to the Selected Remedy that they assert would help to minimize the excavation footprint and associated excavation durations, thus reducing the amount and timeframes of excavated material to be managed, hence reducing overall bird attraction to the Site. One commenter provided an example of a successful bird mitigation program at the Forward Landfill in San Joaquin County, California, an active landfill located about 2,000 feet closer to the Stockton Metropolitan Airport than West Lake Landfill is from the St. Louis Lambert International Airport.

Response

Larger-scale excavation alternatives, such as Alternative 7 or 8, that include excavation of more waste including some of the newer waste located at the Site, likely pose a greater potential for bird or other wildlife hazards. By contrast the Amended Remedy is a partial excavation remedy that does not require extensive excavation of, or into, the relatively younger waste, and specifically the waste located above the North Quarry portion of the Bridgeton Landfill. During remedial design the Amended Remedy will be further evaluated to minimize open excavation timeframes, and to reduce the overall disturbance of waste materials, thus limiting attractiveness to wildlife, and as indicated in the FFS, actions such as covering exposed waste with soil at the end of each work shift will also be used to help minimize bird attraction.

Further, the EPA has considered the use of wildlife mitigation efforts, and specifically bird mitigation for the Site due to its proximity to runways and flight paths associated with the St. Louis Lambert International Airport. Specifically, in the FFS, concerns regarding the potential for bird strikes that may occur during remedial actions, were evaluated. This evaluation determined that mitigation of bird hazards would need to be addressed for any of the evaluated remedial alternatives, (except no action) including the capping alternatives, because all require disturbance of some amount of potentially putrescible wastes. Therefore, as part of the remedial design process, prior to implementation of remedial actions such as excavation, a Wildlife Mitigation and Control Plan will be developed for the Site. Key elements of this plan will include details for items such as, but not limited to; training of bird control personnel and the frightening of birds using properly-applied procedures, based on standard pyrotechnics and other approved methods, as well as specific assessment, reporting and notification procedures. Also, the need for a wildlife hazard benchmark assessment will be evaluated during the remedial design, and used to support a site-specific wildlife hazard management plan.

Any necessary permits or permissions associated with wildlife or bird mitigation efforts will be identified during remedial design. The EPA intends to closely coordinate with the airport and other appropriate entities, such as the FAA, the Missouri Department of Conservation, and the U.S. Department of Agriculture during the remedial design and remedial action phases to develop and implement appropriate and effective wildlife mitigation actions. Additionally, the EPA notes that successful bird mitigation plans have been implemented at active landfills in close proximity to airports (R.P. DeFusco, 2007; Rolph A. Davis, 2013), including a plan with bird species generally common in the St. Louis area. The EPA is aware that bird mitigation efforts can become less effective over time; however, the two reports cited indicate bird control was successful for at least two years, which is estimated to be longer than the excavation timeframes associated with the Amended Remedy.

5.2.2.2.5 Other

Comment

Numerous commenters stated that odors have been and still are impacting the community. Many of the commenters were concerned that odors may be worse during remedy implementation.

Response

The EPA acknowledges that managing odors is a significant concern for the Site and the surrounding community. The EPA has considered stakeholder input regarding the potential for short-term impacts, including odors, in developing the Amended Remedy. The Amended Remedy will be designed and implemented to minimize the disturbance of putrescible waste. This will include limiting the size of open excavations at any one time, thus reducing the amount of exposed waste and associated odors that are produced during remedy implementation. During the remedial design, the EPA will continue to develop and refine methods and best management practices to address multiple implementation issues, including odors. One method that will be further evaluated in the remedial design is use of daily cover materials, such as tarps, clean soil, or other inert materials, to cover exposed waste during excavation.

Comment

One commenter stated that a non-excavation remedy would avoid extensive carbon emissions.

Response

In general, wastes contained within landfills are known to be large producers of carbon dioxide, or $CO_{2,}$ emissions. Bridgeton Landfill provides information about its emissions to the MDNR, and such data are routinely posted to the MDNR's Web site. Based on this information, approximately 35% of Bridgeton Landfill's total gas emissions from flares are CO_2. The open excavation area necessary to implement the Amended Remedy is not expected to contribute significantly to the overall carbon emissions from the landfill, so it is not the case that a non-excavation remedy would avoid landfill related carbon emissions. Detailed analysis of the quantity of carbon dioxide equivalent greenhouse gas emissions predicted for each remedial Alternatives discussed in the FFS have been developed (Appendix I). Although these analyses are relevant, the selection of the Amended Remedy is based in the balancing of the nine criteria.

In general, wastes contained within landfills are known to be large producers of carbon dioxide, or CO_2, emissions. Bridgeton Landfill provides information about its emissions to the MDNR, and such data are routinely posted to the MDNR's web site. Based on this information, approximately 35% of Bridgeton Landfill's total gas emissions from flares are CO_2. The open excavation area necessary to implement the Amended Remedy is not expected to contribute significantly to the overall carbon emissions from the landfill, so it is not the case that a non-excavation remedy would avoid landfill related carbon emissions.

With respect to carbon emissions from heavy machinery, it is reasonable to conclude that the volume of carbon emissions from trucks and other equipment would be less for non-excavation remedial alternatives than for excavation alternatives, especially those including off-site disposal. These considerations have not been evaluated, though, nor does the EPA believe it is appropriate to do so under the NCP's remedy selection criteria. Detailed analysis of the quantity of carbon dioxide equivalent greenhouse gas emissions predicted for each remedial Alternatives discussed in the FFS have been developed (Appendix I). Although these analyses are relevant, the selection of the Amended Remedy is based in the balancing of the nine criteria.

In general, wastes contained within landfills are known to be large producers of carbon dioxide, or CO_2, emissions. Bridgeton Landfill provides information about its emissions to the MDNR, and such data are routinely posted to the MDNR's web site. Based on this information, approximately 35% of Bridgeton Landfill's total gas emissions from flares are CO_2. The open excavation area necessary to implement the Amended Remedy is not expected to contribute significantly to the overall carbon emissions from the landfill, so it is not the case that a non-excavation remedy would avoid landfill related carbon emissions.

In general, wastes contained within landfills are known to be large producers of carbon dioxide, or CO_2, emissions. Bridgeton Landfill provides information about its emissions to the MDNR, and such data are routinely posted to the MDNR's web site. Based on this information, approximately 35% of Bridgeton Landfill's total gas emissions from flares are CO_2. The open excavation area necessary to implement the Amended Remedy is not expected to contribute significantly to the overall carbon emissions from the landfill, so it is not the case that a non-excavation remedy would avoid landfill related carbon emissions.

Comment

Missouri Asphalt Products, LLC objects to any remedy that disrupts their operations.

Response

The Amended Remedy will not displace or require closure of Missouri Asphalt Products, LLC.

5.2.2.3 Cost

Comment

One commenter stated that Alternative 4 fails to consider the long-term operation and maintenance costs at the Site and that the agency inappropriately calculated present worth cost only to 1,000 years despite acknowledgement that O&M will be required for greater than 9,000 years.

Response

The abbreviated presentation of alternative costs presented in a table in the Proposed Plan listed a present worth, based on a 7% discount rate, capital costs and annual operation and maintenance, or

O&M, costs for each alternative. However, in the FFS, and in greater detail in Appendix K of that report, costs for each alternative were presented as capital costs, annual O&M costs and present worth at discount rates of 7%, 0.7% and 0% (undiscounted) for a time frames of 30, 200, and 1,000 years.

The relevant guidance document is "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study."[59] There has been no change in policy or guidance published by the EPA that contradicts or supersedes this guidance for preparation of Superfund cost estimates. The policy on use of the discount rates for RI/FS cost analyses is stated in the preamble to the NCP (55 FR 8722) and in OSWER Directive 9355.3-20.[60] The cost estimating guidance states that the discount rate remains at 7%, (p. 4-5); however, it recommends that a "no discounting" scenario be considered for long-term projects. (p. 4-2) This was done in the FFS for each alternative considered. The cost estimating guidance also recommends that "sensitivity analysis should be considered for those factors that have a relatively high degree of uncertainty and that, with only a small change in their value, could significantly affect the overall cost of the alternative." (p. 5-15 to 5-16) A discount rate of 0.7% was used in the FFS to calculate present value for each alternative to reflect a more conservative estimate than a 7% discount rate. The approach used is also consistent with *Guidelines for Preparing Economic Analyses*, section 6.3,[61] which notes that projects with long-term environmental problems, such as radioactive waste disposal sites, should use discount rates lower than those found in the marketplace for cost estimating purposes.

The cost estimating guidance states that although "past USEPA guidance recommended the general use of a 30-year period of analysis for estimating present value costs," this approach is no longer recommended. It is recommended that "site-specific justification should be provided for the period of analysis selected, especially when the project duration exceeds the selected period of analysis." In the cost estimating guidance, this quotation is footnoted to provide an example for a radioactive waste facility which has a 10,000-year project duration but the period of analysis for the cost estimate is bounded at 1,000 years. This is consistent with what was done for each alternative in the FFS that has an extended project duration. Specifically, present values at 7%, 0.7% and 0% were calculated for 30, 200 and 1,000 years.

In summary, the cost estimates presented in the FFS were prepared consistent with the EPA guidance for each of the alternatives and are fully discussed in the ROD Amendment. The standard discount rate of 7% was applied but in recognition of the extended project duration for some alternatives, and variability of the value of money over very long periods of time, discount rates of 0.7% and non-discounted costs were also calculated and compared. Costs, including O&M costs, were calculated with project durations of 30, 200 and 1,000 years for those alternatives that could potentially continue for thousands of years, consistent with the example provided in the guidance.

Comment

One commenter stated that annual expenditure by the PRPs is the same for each remedy. The commenter was concerned that this was due to a limit on the amount of expense the PRPs are expected to bear per year.

[59] U.S. Environmental Protection Agency, EPA 540-R-00-002, OSWER 9355.0-75 (July 2000).
[60] Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis, (USEPA 1993).
[61] National Center for Environmental Economics, Office of Policy, U.S. Environmental Protection Agency, (December 17, 2010, updated May 2014).

Response

All alternatives presented in the ROD Amendment, except for the no action alternative, include a cap and monitoring. O&M costs for the alternatives are driven by specific activities that occur each year (*e.g.*, environmental monitoring, routine cap maintenance), with higher costs for years with additional environmental monitoring or more extensive landfill cover repairs may occur, and years when five-year reviews are conducted. Since the activities predicted to occur in response to cap maintenance, monitoring, and reporting are similar for all of the alternatives, so are the costs. Note that the O&M costs for alternative 8 are higher because of the additional management needed for the on-site disposal cell. There is no limit to the amount of expense that the PRPs are expected to bear per year.

Comment

Several commenters stated that cost should not be a consideration when selecting a remedy because the Site is affecting residents' health. One commenter critiqued that the EPA weighted cost too heavily.

Response

The NCP at 40 C.F.R. § 300.430(e)(9) sets forth nine criteria that must be evaluated to select a remedial action. All remedial alternatives must be protective of human health and the environment, and cost is one of five balancing criteria that the EPA must evaluate in selecting the most appropriate remedial action at a site. As such, the EPA may not disregard cost in its remedy selection for the Site, as suggested by the commenter, nor has it inappropriately weighted cost in its analysis.

Comment

Several commenters questioned the cost effectiveness of the preferred alternative, pointing out that a capping alternative would be less expensive than excavation and place less burden on taxpayers. One commenter said that in the Cost Effectiveness section of the 2008 ROD, the EPA had written "Cost and implementability considerations also work against [excavation alternatives]." They further stated that the EPA had failed to correctly consider cost-effective in the Proposed Plan in determining that the preferred alternative was cost-effective, and that the Proposal's inclusion of cost on an equally-weighted basis of all of the balancing factors inappropriately reduces the importance of cost in the evaluation, contrary to the NCP.

Another commenter stated the EPA has not taken the necessary step of evaluating the relationship of costs to effectiveness within and across alternatives (55 Fed. Reg. 8728 (Mar. 8, 1990)) and the EPA has not examined incremental cost differences in relationship to incremental differences in effectiveness.

Response

In the 2008 ROD, the EPA stated "The Selected Remedy is considered cost effective because it provides a high degree of effectiveness and permanence at a reasonable cost. Based on evaluations performed as part of the RI/FS, the more expensive option of off-site commercial disposal would not lead to appreciable increases in effectiveness and, in fact, may introduce unnecessary risks." The conclusion stated was that the Selected Remedy was cost-effective.

A cost-effective remedy in the Superfund program is one whose "costs are proportional to its overall effectiveness."[62] It is possible for more than one alternative to be cost effective, and the Superfund program does not mandate the selection of the most cost effective cleanup alternative. In addition, the most cost-effective remedy is not necessarily the remedy that provides the best balance of tradeoffs with respect to the remedy selection criteria, nor is it necessarily the least-costly alternative that is both protective of human health and the environment and ARAR-compliant. Rather, cost effectiveness is concerned with reasonableness of the relationship between the effectiveness afforded by each alternative and its costs compared to other available options.[63]

One of the five principal requirements for the selection of remedies under CERCLA is that a remedy must be cost effective. The NCP defines a cost-effective remedy is one whose "costs are proportional to its overall effectiveness" (40 C.F.R. § 300.430(f)(1)(ii)(D)), which indicates cost effectiveness should be assessed using the criteria of long-term effectiveness and permanence, short-term effectiveness, toxicity mobility or volume or volume reduction. Overall effectiveness is then compared to cost to ensure that the remedy is cost-effective. The Amended Remedy is considered cost effective because it provides a high degree of effectiveness and permanence at a reasonable cost. In the 2008 ROD, the EPA determined that the cost of off-site commercial disposal would not lead to appreciable increases in effectiveness and may introduce unnecessary risks. However, since 2008, the EPA has further characterized RIM distribution, re-evaluated the five balancing criteria with respect to remedial alternatives, and has determined that partial excavation is not only practicable but is important to the long-term effectiveness and permanence of the remedy. The EPA has concluded that the long-term permanence is increased as radioactivity is removed from the Site.

The EPA also recognizes that short-term effectiveness (including risks to on-Site workers and the community) at this Site is directly influenced by the amount of wastes excavated, whether RIM or non-RIM. The EPA has determined that the Amended Remedy is cost effective because it strikes the best balance between long-term effectiveness and permanence and short-term effectiveness, for the cost. Specifically, the RD will seek to minimize the total volume of landfill waste to be excavated, while maintaining long-term protectiveness and permanence without significantly altering the cost.

The capping alternatives (2 and 3) are the least expensive alternatives; however, they leave all radioactive source material on-site. The risk based Alternative (6) costs nearly twice as much as the UMTRCA cover Alternative (3) but removes only a small percentage of the source material (approximately 1%). The Amended Remedy, removes a majority of the radioactive source material in approximately the same time period and at a cost of only approximately 25% more than the risk-based Alternative (6). In comparison to the full excavation with off-site disposal Alternative (7), the Amended Remedy removes more than half of the source material for less than half the cost in one third of the time. In addition, the Modified Alternative 4 is $31,000,000 less costly than Alternative 4 as presented in the proposed plan while maintaining long-term effectiveness and improving short term effectiveness. Therefore, by evaluating these incremental cost differences in relationship to the incremental differences in overall effectiveness, the EPA has determined that the Amended Remedy is cost effective.

---

[62] 40 C.F.R. § 300.430(f)(1)(ii)(D).
[63] A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents, EPA 540-R-98-031, OSWER Dir. No. 9200.1-23P, PB98-963241 (July 1999).

5.2.3 Modifying Criteria

5.2.3.1 Community Acceptance

Comment

Many comments stated support for or against specific alternatives presented in the Proposed Plan. These commenters typically offered reasons for their support or opposition, citing one or a combination of advantages and disadvantages of RIM excavation, transportation, and disposal. When reasoning supportive of excavation was provided by a commenter, the comment generally emphasized current or future risks relating to radioactive exposure and the potential migration of contamination to groundwater and surface water bodies. By contrast, comments that advocated containment of RIM at the Site typically highlighted risks associated with excavation and transportation of RIM from the Site, as well as the increased time and cost of excavation. Some of these commenters further emphasized the protectiveness of containment-only remedies.

Response

The EPA considered all comments expressing support for or concern regarding a particular remedial alternative or alternatives presented in the Proposed Plan. The NCP states that the EPA "shall consider . . . community comments regarding the lead agency's evaluation of alternatives with respect to the other criteria. These comments may prompt the lead agency to modify aspects of the preferred alternative or decide that another alternative provides a more appropriate balance."[64] As noted above, community acceptance of the preferred alternative was typically determined by commenters' individual perspectives on the relative advantages and/or disadvantages of excavation and/or capping. The EPA's evaluation of and response to such positions is presented in the Sections 5.2.1 and 5.2.2 of this Responsiveness Summary, which address comments relating to the EPA's evaluation of the NCP's threshold and primary balancing criteria. Those responses inform the EPA's balancing of the NCP's remedy selection criteria, which is the basis of the Amended Remedy presented in Part II of the ROD Amendment.

The following subsections summarize comments received on each of the remedial alternatives evaluated in the FFS and Proposed Plan. To the extent that these comments raise issues related to other remedy selection criteria, the response provides specific cross-references to the sections of this Responsiveness Summary in which the agency provides responses to those issues. Responses are also provided below to unique comments relating to individual remedial alternatives that have not otherwise been addressed in this Responsiveness Summary.

Comment

One commenter stated that community acceptance is a modifying factor that cannot override remedial action effectiveness, lower short-term risks, easier and faster implementation, greater predictability, and cost-effectiveness of a containment remedy.

Response

The EPA agrees with the commenter that community acceptance is properly treated as a modifying criterion, and that this criterion should not "override" other remedy selection criteria, such as long- and short-term effectiveness, implementability, and cost. Nevertheless, the NCP clearly states that comments

[64] 40 C.F.R. § 300.430(f)(4)(i).

received from the community during the public comment period "may prompt the lead agency to modify aspects of the preferred alternative or decide that another alternative provides a more appropriate balance."[65] Importantly, the community acceptance criterion "is broadly defined to include all interested parties, including PRPs."[66] The EPA has, therefore, received and considered comments from interested community stakeholders, including the PRPs, in developing the Amended Remedy.

5.2.3.1.1 Alternative 2: Modified 2008 ROD-Selected Remedy

Comment

Several commenters supported the capping remedy selected in the 2008 ROD because removing RIM presents exposure risks to workers and the surrounding community, potential for stormwater contamination during excavation, transportation risks during relocation to the off-site disposal, a longer implementation time frame, and higher costs. A large number of commenters expressed support for capping the Site but did not specify between Alternatives 2 and 3. Many commenters noted that the EPA stated in the Proposed Plan that both capping remedies are protective. A portion of these commenters also noted that several other agencies and departments, including the Centers for Disease Control and the MDHSS, have determined that the Site is safe in its current condition.

Response

Please refer to comments and responses in Sections 4.0, 5.1.3, 5.2.1., 5.2.2.2.1 through 5.2.2.2.3 and 5.2.2.4.

Comment

One commenter expressed support for either Alternative 2 or 3 as the best balance of the NCP criteria because they meet the target cancer risk range for long-term and short-term risk, are readily implementable, have the shortest time to reach RAOs, and are least costly. The commenter stated that any incremental reduction of cancer risk for periods of time in excess of 1,000 years are not enough to outweigh the primary balancing criteria. The commenter also stated that only Alternatives 2 and 3 limit exposures by not excavating RIM and that they have fewer injuries or deaths from industrial accidents and fatal transportation accidents.

Response

The EPA has concluded, as noted by these commenters, that all remedial alternatives other than the No Action Alternative, including Alternatives 2 and 3, are protective of human health and the environment and achieve RAOs. Please refer to comments and responses in Sections 2.8, 3.1.2, 4.0, 5.2.2.1, 5.2.2.2, and 5.2.3.1.

5.2.3.1.2 Alternative 3: UMTRCA Engineered Cover

Comment

One commenter expressed a preference for Alternative 3 with institutional controls to address

---

[65] 40 C.F.R. § 300.430(f)(4)(i).
[66] 55 Fed. Reg. 8666, 8723 (Mar. 8, 1990).

groundwater contamination.

Response

Please refer to the comments and responses in Section 2.3.

5.2.3.1.3 Alternative 4: Excavation of RIM Greater Than 52.9 pCi/g Down 16 feet Plus Engineered Cover

Comment

One commenter stated that there appears to be no benefit to Alternative 4 over Alternatives 2 and 3 because it will not be protective of groundwater and there will be risks to on-site workers and the community during excavation. Numerous commenters stated that the "partial removal plan" (interpreted as Alternative 4 as presented in the Proposed Plan) was unacceptable and more removal of RIM was necessary. One commenter stated that the risk of fire could impact PTW that the EPA would leave behind in implementing Alternative 4. One commenter stated that "EPA also improperly discounts, or overlooks altogether, the serious short-term risks to the remediation workers and the community that will result from an excavation of any amount, including the partial excavation in EPA's selected Alternative 4. These include increased risks of exposure to dusts, increased greenhouse gas (carbon) emissions, risks of traffic accidents (including associated deaths and injuries, as well as spills of excavated materials), and most significantly increased risks of bird strikes to aircraft at the nearby Lambert-St. Louis Airport due to excavation of the landfill and associated exposure of wastes."

Response

Please refer to comments and responses in Sections 5.1.1.3, 5.2.2.1.3, 5.2.2.2.2 through 5.2.2.2.5.

5.2.3.1.4 Alternative 5: Excavation of RIM Greater Than 1,000 pCi/g Plus Engineered Cover

Comment

Several comments expressed a preference for Alternative 5 combined with off-site storage.

Response

Please refer to comments and responses in Sections 5.1.1.3 and 5.1.2.

5.2.3.1.5 Alternative 6: Risk Based Excavation of RIM Plus Engineered Cover

Comment

One commenter stated that the EPA ignored Alternative 6 and did not sufficiently conduct a comparative evaluation of alternatives. The commenter further stated that the EPA did not compare the implementability of alternatives except to note that difficulty increases with volume and depth of excavation. The commenter stated that if any excavation is performed, Alternative 6 is more appropriate than Alternative 4 because it has the lowest long-term residual cancer risk, minimizes short-term risk by reaching RAOs one year sooner than Alternative 4, and is more cost effective.

Another commenter argued that Alternative 6 is more protective and the better option because it is more cost-effective, and its risk-based approach is protective. Specifically, the commenter prefers Alternative 6 because it is more protective of future on-site workers. In addition, because the commenter's business is in close proximity to OU-1 it will result in less disruption to their business due to construction time tables.

Response

Alternative 6 focuses on removal of RIM that has the potential to cause an unacceptable risk to a future worker on Area 1 and 2 if there were no engineered cover. This alternative results in removal of all RIM to a shallow depth of about two feet below the expected regraded landfill surface. It results in the removal of a small volume of RIM and a very small amount of radioactivity, and therefore, leaves a majority of the RIM and radioactivity. The Amended Remedy, by comparison, results in removal of a majority of radioactivity while minimizing negative short-term impacts associated with excavation. Both Alternative 6 and the Amended Remedy reduce the lifetime cancer risk levels to below the target cancer risk range of 10^{-4} to 10^{-6}. The Amended Remedy and Alternative 6 achieve RAOs in the same amount of time, 4.1 years. The construction of the Amended Remedy is 2.8 years, only slightly longer than the 2.6 years needed for construction of Alternative 6. The Amended Remedy also will not require closure or relocation of the asphalt plant. Based on these considerations and others described in the ROD Amendment and Section 5.0 of this Responsiveness Summary, the EPA has concluded that the Amended Remedy represents a better balance of the NCP's remedy selection criteria than Alternative 6.

5.2.3.1.6 Alternative 7: Excavation of RIM Greater Than 7.9 pCi/g with Off-Site Disposal in Engineered Cell

Comment

Many commenters expressed specific support for Alternative 7, with several citing concerns about leaving any radioactive material in place including health impacts, risks to the community, location in a flood plain and/or highly populated area, and natural disasters. Of those expressing support for Alternative 7, many commenters stated a belief that Alternative 7 would result in the removal of all radioactive material or waste. Many commenters also noted that Alternative 7 would result in greater protection and has greater long-term effectiveness than Alternative 4. Several commenters also expressed the belief that Alternative 4 was selected as the preferred alternative because of cost considerations.

A few commenters expressed qualified support for Alternative 7 or recommended modifications to this alternative. For example, one commenter recommended adding more sampling and an increased frequency of five-year reviews. Several commenters expressed support for Alternative 7 but questioned the pilot program. Some commenters expressed a preference for greater removal than proposed under Alternative 7. Some commenters recommended tailored excavation, such as implementing Alternative 7 in certain areas, particularly Area 2, if not all areas.

A few commenters noted their disapproval of Alternative 7. One commenter stated that Alternatives 7 or 8 are not necessary because there are no known users of groundwater in the immediate area and the groundwater is unusable due to previous unlined landfilling. Similarly, another commenter identified three issues with Alternative 7 including delay, relocating waste means polluting elsewhere, and concerns for workers.

Response

Please refer to comments and responses in Sections 2.3, 3.4, 5.1.1.6, 5.2.2.1, 5.2.2.4, 6.0.

5.2.3.1.7 Alternative 8: Excavation of RIM Greater Than 7.9 pCi/g with Disposal in an On-Site Engineered Cell Comment

Several commenters that favor Alternative 7 wrote that they do not want on-site disposal and specifically reject Alternative 8.

Response

Please refer to comments and responses in Sections 5.2.2 and 5.1.2

6.0 Remedial Design

Comment

One commenter stated that scoping of the excavation design would be better addressed as part of the remedial design process, rather than establishing arbitrary criteria unrelated to RAOs, site conditions, or NCP factors.

Response

The EPA agrees that many details regarding the approach and designs for excavation activities should be further developed, evaluated, and finalized during remedial design. Specific planning documents, work plans, excavation plans, and other supporting design-related information will be generated using site-specific data and reviewed by the EPA to appropriately support field work in accordance with the objectives of the Amended Remedy.

Comment

Several commenters stated that local authorities (i.e. emergency responders) and other community representatives should be included in remedy design and planning.

Response

The NCP requires that EPA review the Community Involvement Plan (CIP) prior to initiating the remedial design “to determine whether it should be revised to describe further public involvement activities during Remedial Design/Remedial Action that are not already addressed or provided for” in the CIP. The West Lake CIP will be updated in the near future and the EPA will continue to coordinate with the CAG and TCAG during the next phase of work at the Site. It is the EPA’s intent to keep the community informed and involved throughout the remedial design and remedial action process.

The roles and responsibilities of first responders with respect to remedial sites are established as part of the required health and safety plans developed during the remedial design/remedial action, or RD/RA, portion of the Superfund process. The EPA guidance (Health and Safety Roles and Responsibilities at Remedial Sites) that discusses the coordination with local responders including fire departments, hospitals, police departments will be followed.

The EPA, MDNR, and the Bridgeton Landfill are working in coordination with local authorities and first responders on continuing updates to and implementation of the January 26, 2017, Incident Management Plan that has been updated several times. This plan provides site-specific information to support responses from the landfill operators, local responders, the MDNR, and the EPA to a variety of incidents should they occur at the Bridgeton or West Lake Landfills.

Comment

One commenter stated that all fill material should be tested.

Response

Plans for the testing of any materials used in remediation of the Site will be considered in the remedial design.

Comment

One commenter stated that he wanted sampling processes defined in such a manner that whether the EPA did the work, or an individual property owner did the work, the results would be the same and no one would ever re-test and get a different result.

Response

The EPA generally requires that environmental sampling conducted at the Site follow approved sampling plans and quality assurance project plans. Additionally, the laboratories analyzing the samples are normally required to adhere to both quality control and quality assurance procedures that ensure reliable data. Even with such measures it is relatively common to see some variability in environmental sample results due to a variety of factors. For the West Lake Landfill Site, the soil and waste samples collected from the landfill are expected to be slightly to very heterogeneous, thus, samples analyzed from the same general area of soil or solid waste may have detectable variations in chemical composition. Therefore, during remedial design proper procedures for collecting, handling and analyzing samples, to eliminate as many sources of variation and obtain reliable data, will be established. However, it is not possible to eliminate all variations in environmental sample results.

7.0 Post-Remedy Implementation

Comment

One commenter stated the Site should be turned into a park after a full removal of contamination. Another commenter stated that increased disturbance of the surface would make it more difficult to reuse the Site in an appropriate manner.

Response

The West Lake Site has been a landfill since the early 1950s and will remain a dedicated landfill into the future due to the historical disposal of solid wastes at the Site. Therefore, reuse opportunities for the Site will be very limited. Land use at the Site is currently restricted through covenants recorded by the property owners. These covenants cannot be terminated without the written approval of both the MDNR and the EPA. In addition, more comprehensive land-use restrictions are required as part of the Amended Remedy.

Comment

Several commenters stated that 5-year reviews should occur more frequently than every 5 years.

Response

The NCP at 40 C.F.R. §300.430(f)(4)(ii), requires a five-year review if the remedial action results in hazardous substances, pollutants or contaminants remaining at the Site above levels that allow for unlimited use and unrestricted exposure. This review evaluates whether the remedy is protective of human health and the environment and is required *no less often* than every five years after the date of such remedy.[67] The EPA will oversee remedial activities occurring at the Site throughout the duration of the remedy. When issues arise at the Site that need to be addressed, it is not necessary to wait until a five-year review of the remedy is conducted to address those issues. Inspections and monitoring are not limited to five-year reviews and the frequency of routine OM&M activities will be established in the OM&M plan developed in the RD.

Comment

One commenter requested that a comprehensive groundwater review be conducted every second year. One commenter requested a system that provides information on at least a quarterly basis, combined with a “genuine and sincere conversation” that aims to respond to the community concern. Another commenter requested a major public meeting every five years.

Response

The frequency of groundwater monitoring will be set forth in a future monitoring plan to be approved by EPA that will described the frequency and type of monitoring to be performed. For the purposes of cost estimates in the FFS, groundwater monitoring was planned to take place semi-annually for the first five years, and annually thereafter. The monitoring discussed in the FFS is for evaluation of the effectiveness of the cap. Additional groundwater investigation and monitoring will be conducted in OU-3. Data collected for OU-3 may inform potential modifications to the monitoring network and schedule. Specific details of groundwater monitoring will be determined in the RD and OU-3, and can be modified as needed over time.

EPA has a history of active community engagement at the West Lake Landfill and will continue to keep the community informed and engaged throughout the investigation and cleanup process. The specific details of community involvement will be described in the Community Involvement Plan. The Community Involvement Plan is a living document that is updated throughout the Superfund process. An EPA community engagement specialist and a remedial project manager are normally assigned to each Superfund site and are made generally available to address specific concerns from the community.

[67] “Guide to Preparing Superfund Proposed Plans, Records of Decision and Other Remedy Selection Decision Documents,” EPA 540-R-98 (July 1999), pp. 6-4.

Comment

One commenter brought up a need to notify future cultures of the hazard buried at the Site.

Response

Land use at the Site is currently restricted through covenants recorded on the deeds by the property owners. In addition, more comprehensive land-use restrictions are required as part of the Amended Remedy. These legal notices are the enforceable means of notification to land owners and others now and in the future who seek information about the property hazards and limitations that exist. The Site will remain subject to five-year reviews of the remedy indefinitely, including review of the land-use restrictions.

Comment

One commenter expressed that a modification to EPA's preferred remedy to change the concentration to 100 piC/g, depth to excavation to 12 feet, and on-site disposal would result in a remedial outcome that is better aligned with the EPA's Superfund Task Force Recommendations released in July 2017.

Response

EPA established the Superfund Task Force on May 22, 2017, to provide recommendations for improving and expediting site cleanups and promoting redevelopment. The EPA acknowledges that the Modified Alternative 4 selected as the remedial option for OU-1 is aligned with certain goals of the Superfund Task Force and will result in improved short-term effectiveness, implementability, and cost considerations. It also incorporates optimization elements without reducing long-term effectiveness or permanence.

Comment

A commenter stated that the total effective dose equivalent for Alternative 4 is nearly four times the exposure dose of Alternative 7, and exceeds the 5,000 millirem per year limit established by the OSHA and the NRC. For these reasons, Alternative 7 has lower short-term risks than Alternative 4.

Response

EPA included conservative estimates of short-term cumulative risk for the reasonably maximally-exposed remediation technician during construction for each remedy including alternative 4 and alternative 7. These risk estimates do not account for any engineering controls, health and safety practices, or proper use of personnel protective equipment. The risk estimates also consider potential exposures throughout the duration of construction, which for alternative 4 is about 3.7 years and for alternative 7 is 13.3 years. The estimated cumulative short-term risks to the maximally-exposed worker for Alternative 7 is 3.7×10^{-3} compared to 2.2×10^{-3} for Alternative 4. The short-term cumulative risks for the Amended Remedy is 2.0×10^{-3}. Therefore, the short-term risks for remediation workers are lower for Alternative 4 and the Amended Remedy than Alternative 7.

The EPA also included an estimate of the annual dose in millirem per year for the same remediation worker for each remedial alternative evaluated in the Final Feasibility Study. The annual dose for Alternative 7 (1820 mrem/y) is lower than the annual dose for Alternative 4 (6940 mrem/y). This is because the concentration criteria (7.9 pCi/g) and the associated average concentration of RIM that the remediation technician is estimated to be exposed to for Alternative 7 is less than the concentration criteria (52.9 pCi/g) for Alternative 4. The potential cumulative dose received by the maximally-exposed remediation technician can be determined using information contained in Appendix H that accounts for the total number of hours of exposure over the total number of years of construction. The total dose for Alternative 4 (7.10×10^3 mrem) is less than the total dose for Alternative 7 (1.09×10^4 mrem). This conclusion is consistent with the estimates of risk discussed above given that more 90% of the total risk is caused by exposure to gamma.

Comment

One commenter pointed out that the Proposed Plan states that UMTRCA standards require that a cover be constructed to be effective for at least 200 to 1,000 years, and stated that the maximum concentrations of Radium-226 will occur in 9,000 years. The commenter expressed concern that a cover that is protective for up to 1,000 years cannot provide long-term effectiveness and permanence when increases in radium will occur for approximately 9,000 years. Choosing an alternative that does not consider costs and risks over the full 9,000-year period fails to meet the long-term effectiveness and permanence criteria of the NCP.

Response

EPA evaluated the long-term residual cancer risk levels that would be present after 9,000 years of ingrowth (representative of the maximum Radium-226 conditions at the Site) to future site users and the community after implementing each remedy. This was done to ensure the design of the remedy would be protective of human health and the environment fully considering the effects of ingrowth and increasing risks from Radium-226.

EPA also determined that the standards for control of radioactive material in UMTRCA Subpart A (40 C.F.R. § 192.02), including that control of residual radioactive materials and their listed constituents shall be designed be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years, would be relevant and appropriate for the Amended Remedy. This standard does not limit the time frame over which the remedy will be protective to either 200 years or 1,000 years. This standard leads to the use of materials to construct the engineered containment that are natural and therefore don't inherently breakdown over time. Thus, EPA can conclude that as long as the containment system is in place, the remedy will prevent direct contact with RIM and limit gamma radiation and radon emissions to protective levels.

In addition, these standards result in the design of a containment system that minimizes the need for on-going maintenance to the extent practicable. In this way, long-term monitoring and maintenance is expected to require minimal maintenance and focus more monitoring and inspections of the containment system. Nevertheless, monitoring and maintenance of the containment system will be required for several thousand years in the future. The EPA will ensure the protectiveness of the remedy through implementation of a long-term OM&M plan and performance of five- year reviews over this same time period.

With respect to cost, the EPA evaluated both discounted and non-discounted costs consistent with EPA guidance on developing cost estimates for feasibility studies. This is further discussed in Section 5.2.2.4.

TABLES

Table 1 Radiological Contaminants of Concern				
Analyte	**Frequency (Detections/Analyses)**	**Range of Detections**	**Arithmetic Mean**	**Background**
		(pCi/g)	(pCi/g)	(pCi/g)
Uranium Series				
Uranium-238	440 / 443	0.040 - 1,823	16	1.33
Thorium-234	232 / 354	0.50 - 1,166	19	1.18
Protactinium-234	2.0 / 12.0	23.0 - 42.6	6	NA
Uranium-234	445 / 450	0.064 - 1,711	18	1.47
Thorium-230	453 / 454	0.13 - 58,800	1,357	1.51
Radium-226	379 / 454	0.26 - 4,926	92	1.06
Lead-214	433 / 450	0.24 - 4,578	80	1.01
Bismuth-214	388 / 450	0.21 - 3,690	87	0.72
Lead-210	303 / 451	0.62 - 2,700	54	2.08
Actinium Series				
Uranium-235	441 / 441	0.003 - 88.3	0.83	0.326
Thorium-231	6 / 12	4.88 - 324	76	NA
Protactinium-231	77 / 449	0.81 - 2,030	29	2.19
Actinium-227	312 / 464	0.007 - 1,320	18	0.454
Thorium-227	15 / 18	1.30 - 691	88	ND
Radium-223	27 / 139	0.070 - 5,270	109	9.51
Lead-211	7.0 / 12.0	2.72 - 603	124	NA
Bismuth-211	10 / 12.0	0.70 - 3,980	625	NA
Thorium Series				
Thorium-232	442 / 454	0.010 - 515	7.4	0.895
Radium-228	325 / 454	0.081 - 45.0	1.6	1.12
Actinium-228	285 / 311	0.051 - 31.8	1.4	NA
Thorium-228	336 / 350	0.089 - 106.0	3.2	0.683
Radium-224	52 / 121	0.47 - 6,580	178	1.93
Lead-212	398 / 431	0.11 - 800	5.2	1.29
Bismuth-212	27 / 152	0.39 - 10.8	3.6	0.905
Thallium-208	372 / 434	0.080 - 23.5	0.83	0.435

Table 2 Chemical Contaminants of Concern

Chemical Contaminants of Concern

Analyte	CAS Number	Detection Frequency	Maximum Screening Concentration (mg/kg)[a]	Nutrient Screening Level (mg/kg)	Nutrient Screening Level > Maximum Concentration?	Ingestion Sceening Level (mg/kg)	Dermal Screening Level (mg/kg)	Inhalation Screening Level (mg/kg)	Target Screening Level (mg/kg)	Toxicity Comparison	Screen Results
Inorganic Chemicals											
Antimony	7440-36-0	88 / 162	54		No	47			47	No	Pass
Arsenic	7440-38-2	141 / 164	610		No	4	17	3,900	3	No	Pass
Barium	7440-39-3	132 / 132	322,000		No	23,000		300,000	22,000	No	Pass
Beryllium	7440-41-7	108 / 164	250		No	230		6,900	230	No	Pass
Chromium[b,*]	7440-47-3	158 / 164	369	261	No	7		200	6	No	Pass
Cobalt[*]	7440-48-4	130 / 132	2,800	8	No	35		1,900	35	No	Pass
Lead	7439-92-1	162 / 164	30,000		No				800	No	Pass
Mercury	7439-97-6	120 / 163	12		No			5	5	No	Pass
Nickel	7440-02-0	164 / 164	3,600		No	2,300		54,000	2,200	No	Pass
Thallium	7440-28-0	16 / 162	33		No	1.2			1.2	No	Pass
Uranium Total	E715565[c]	12 / 12	614		No	23		24,000	23	No	Pass
Vanadium	7440-62-2	107 / 132	1,800		No	590		60,000	580	No	Pass
Zirconium	7440-67-7	6 / 6	2,700		No	9			9	No	Pass
Pesticides/PCBs											
Aldrin	309-00-2	9 / 36	0.47		No	0.19		4	0.18	No	Pass
Aroclor 1242	53469-21-9	5 / 37	2.6		No	1.6	2.8	13	0.95	No	Pass
Aroclor 1248	12672-29-6	2 / 37	18		No	1.6	2.8	13	0.95	No	Pass
Aroclor 1254	11097-69-1	4 / 37	1.7		No	1.6	2.8	18	0.97	No	Pass
Dieldrin	60-57-1	5 / 36	0.33		No	0.2	0.48	3,600	0.14	No	Pass
Semivolatile Organic Compounds											
Naphthalene	91-20-3	9 / 36	67		No	2,300	4,200	17	17	No	Pass
Pentachlorophenol	87-86-5	1 / 34	1,700		No	8.2	7.7	3,300,000	4	No	Pass
Volatile Organic Compounds											
1,1-Dichloroethane	75-34-3	1 / 36	100		No	570		16	16	No	Pass
1,4-Dichlorobenzene	106-46-7	13 / 38	530		No	610		12	11	No	Pass
Benzene	71-43-2	2 / 36	100		No	59		5.6	5.1	No	Pass
Chlorobenzene	108-90-7	8 / 36	180		No	2,300		140	130	No	Pass
Ethyl benzene	100-41-4	7 / 36	100		No	300		28	25	No	Pass

[*] indicates the analyte is an essential nutrient.

[a] Maximum screening concentrations in this table come from the maximum concentrations in the data set, whether the concentrations are detected or are detection limits.

[b] The ingestion, dermal, inhalation, and target screening levels presented are for chromium +6.

[c] Uranium was listed as "Uranium Total" in the data set and no CAS number was provided. Given that uranium is of importance at this site, the CAS number in the EPA RSL generic table was included in this table.

Table 3 Current Exposure Point Concentrations in Area 1 Soil

Analyte	95% UCL on the Arithmetic Mean		Units
	Surface Soil[a]	All Depths	
Uranium Series			
Uranium-238	25	12	pCi/g
Uranium-234	27	15	pCi/g
Thorium-230	1,707	2,028	pCi/g
Radium-226	120	210	pCi/g
Lead-210	204 (179[b])	72	pCi/g
Actinium Series			
Uranium-235[c]	1.31	0.68	pCi/g
Protactinium-231	87	46	pCi/g
Actinium-227	44	16	pCi/g
Thorium Series			
Thorium-232	6.08	15	pCi/g

[a] The surface soil information in this table comes from Table 8 of the BRA. The surface soil values, along with ProUCL (EPA 2016a) output, are used in calculating human health risks presented in Tables 33 and 34 of the BRA. The radium-226 information for surface soil is also used in determining current radon concentrations presented in Table 26 of the BRA. The all depth soil information in this table comes from Table 9 of the BRA. Both surface soil values and all depths values are used to determine future exposure point concentrations presented in Table 22 of the BRA.

[b] Time-weighted average considering the decay of radium-226 into lead-210 over the 25-year exposure duration. A time-weighted average is not provided for all depths because the all depths concentrations are not quantitatively used under current conditions.

[c] Calculated using the uranium-238 and uranium-234 results and the expected isotopic abundance in natural uranium. A discussion is provided in Section 2.4.2 of the BRA.

Table 4 Current Exposure Point Concentrations in Area 2 Soil

	95% UCL on the Arithmetic Mean		
Analyte	**Surface Soil[a]**	**All Depths**	**Units**
Uranium Series			
Uranium-238	17	46	pCi/g
Uranium-234	32	47	pCi/g
Thorium-230	3,257	2,418	pCi/g
Radium-226	267	173	pCi/g
Lead-210	71 (130[b])	79	pCi/g
Actinium Series			
Uranium-235[b]	1.24	2.33	pCi/g
Protactinium-231	122	66	pCi/g
Actinium-227	77	42	pCi/g
Thorium Series			
Thorium-232	10	10	pCi/g

[a] The surface soil information in this table comes from Table 10 of the BRA. The surface soil values, along with ProUCL (EPA 2016a) output, are used in calculating human health risks presented in Tables 33 and 35 of the BRA. The radium-226 information for surface soil is also used in determining current radon concentrations presented in Table 26. The all soil depths information in this table comes from Table 11 of the BRA. All depths values are used to determine future exposure point concentrations presented in Table 23 of the BRA.

[b] Time-weighted average considering the decay of radium-226 into lead-210 over the 25-year exposure duration. A time-weighted average is not provided for all depths because the all depths concentrations are not quantitatively used under current conditions.

[c] Calculated using the uranium-238 and uranium-234 results and the expected isotopic abundance in natural uranium. A discussion is provided in Section 2.4.2 of the BRA.

Table 5 Current Exposure Point Concentrations for Buffer Zone Soil

Analyte	95% UCL on the Arithmetic Mean		Units
	Surface Soil[a]	All Depths	
Uranium Series			
Uranium-238	3.85	1.58	pCi/g
Uranium-234	3.72	1.69	pCi/g
Thorium-230	280	279	pCi/g
Radium-226	17	7	pCi/g
Lead-210	50 (40[b])	21	pCi/g
Actinium Series			
Uranium-235[b]	0.19	0.08	pCi/g
Protactinium-231	7.93	7.93	pCi/g
Actinium-227	6.15	6.15	pCi/g
Thorium Series			
Thorium-232	2.62	1.49	pCi/g

[a] The surface soil information in this table comes from Table 12 of the BRA. The radium-226 information for surface soil is also used in determining current radon concentrations presented in Table 26 of the BRA. The all soil depths information in this table comes from Table 13 of the BRA. All depths values are used to determine future exposure point concentrations presented in Table 24 of the BRA.

[b] Time-weighted average considering the decay of radium-226 into lead-210 over the 25-year exposure duration. A time-weighted average is not provided for all depths because the all depths concentrations are not quantitatively used under current conditions.

[c] Calculated using the uranium-238 and uranium-234 results and the expected isotopic abundance in natural uranium. A discussion is provided in Section 2.4.2 of the BRA.

Table 6 Future (1,000 years) Exposure Point Concentrations for Area 1 Soil

Analyte[b]	95% UCL on the Arithmetic Mean		Units
	Surface Soil[a]	All Depths	
Uranium Series			
Uranium-238	25	12	pCi/g
Uranium-234	27	15	pCi/g
Thorium-230	1,692	2,010	pCi/g
Radium-226	675	845	pCi/g
Actinium Series			
Uranium-235[c]	1.31	0.68	pCi/g
Protactinium-231	87	46	pCi/g
Thorium Series			
Thorium-232	6.08	15	pCi/g
Inorganic Chemicals			
Antimony	-	7.69	mg/kg
Arsenic	-	22	mg/kg
Barium	-	33,914	mg/kg
Beryllium	-	0.6	mg/kg
Chromium	-	38	mg/kg
Cobalt	-	106	mg/kg
Lead	-	2,302	mg/kg
Mercury	-	0.92	mg/kg
Nickel	-	309	mg/kg
Thallium	-	0.40	mg/kg
Uranium[d]	-	36	mg/kg
Vanadium	-	32	mg/kg
Zirconium	-	241	mg/kg

[a] Radiological information in this table comes from aging thorium-230 and radium-226 concentrations of the like designation (surface soil or all soil depths) in Table 19 to 1,000 years. Inorganic chemical information in this table comes from Table 9 of the BRA. Radiological and chemical information from this table, along with ProUCL (EPA 2016a) output, is used to calculate future human health risks as presented in Tables 38 and 41, as well as particulate concentrations in air as presented in Table 25 of the BRA. Radium-226 information is used to project future radon concentrations in air (Table 26).

[b] A 1,000-year period was selected as relevant and appropriate based on design requirements set forth in 10 CFR Part 61 and 40 CFR Part 192.

[c] Calculated using the uranium-238 and uranium-234 results and the expected isotopic abundance in natural uranium (Section 2.4.2 of the BRA).

[d] Of the isotopes of natural uranium, uranium-238 accounts for more than 99 percent of the mass of uranium. The mass concentration of uranium was calculated by dividing the uranium-238 result in (pCi/g) by the specific activity of 0.336 pCi/µg, resulting in a mass concentration of mg uranium per kg soil (mg/kg).

Table 7 Future (1,000 years) Exposure Point Concentrations for Area 2 Soil

	95% UCL on the Arithmetic Mean		
Analyte[a,b]	**Surface Soil**	**All Depths**	**Units**
Uranium Series			
Uranium-238	17	46	pCi/g
Uranium-234	32	47	pCi/g
Thorium-230	3,228	2,396	pCi/g
Radium-226	1,312	957	pCi/g
Actinium Series			
Uranium-235[c]	1.24	2.33	pCi/g
Protactinium-231	122	66	pCi/g
Thorium Series			
Thorium-232	10	10	pCi/g
Inorganic Chemicals			
Antimony	-	5.54	mg/kg
Arsenic	-	65	mg/kg
Barium	-	19,619	mg/kg
Beryllium	-	0.88	mg/kg
Chromium	-	35	mg/kg
Cobalt	-	695	mg/kg
Lead	-	1,388	mg/kg
Mercury	-	0.24	mg/kg
Nickel	-	720	mg/kg
Thallium	-	1.04	mg/kg
Uranium[d]	-	137	mg/kg
Vanadium	-	283	mg/kg
Zirconium	-	2,700	mg/kg

[a] Radiological information in this table comes from aging thorium-230 and radium-226 of the like designation (surface soil or all soil depths) in Table 20 to 1,000 years. Inorganic chemical information in this table comes from Table 11 of the BRA. Radiological and chemical information from this table, along with ProUCL (EPA 2016a) output, is used to calculate future human health risks as presented in Tables 39 and 42 of the BRA, as well as future particulate concentrations in air as presented in Table 25 of the BRA. Radium-226 information is used to calculate radon future concentrations in air.

[b] A 1,000-year period was selected as relevant and appropriate based on design requirements set forth in10 CFR Part 61 and 40 CFR Part 192.

[c] Calculated using the uranium-238 and uranium-234 results and the expected isotopic abundance in natural uranium (Section 2.4.2 of the BRA).

[d] Of the isotopes of natural uranium, uranium-238 accounts for more than 99 percent of the mass of uranium. The mass concentration of uranium was calculated by dividing the uranium-238 result in pCi/g by the specific activity of 0.336 pCi/µg, resulting in a mass concentration of mg uranium per kg soil (mg/kg).

Table 8 Future (1,000 years) Exposure Point Concentrations for Buffer Zone Soil

Analyte[a,b]	95% UCL on the Arithmetic Mean		Units
	Surface Soil	**All Depths**	
Uranium Series			
Uranium-238	3.85	1.58	pCi/g
Uranium-234	3.72	1.69	pCi/g
Thorium-230	277	277	pCi/g
Radium-226	109	102	pCi/g
Actinium Series			
Uranium-235[c]	0.19	0.08	pCi/g
Protactinium-231	7.93	7.93	pCi/g
Thorium Series			
Thorium-232	2.62	1.49	pCi/g
Inorganic Chemicals			
Antimony	-	ND	mg/kg
Arsenic	-	2.90	mg/kg
Barium	-	NA	mg/kg
Beryllium	-	2.20	mg/kg
Chromium	-	49	mg/kg
Cobalt	-	NA	mg/kg
Lead	-	400	mg/kg
Mercury	-	ND	mg/kg
Nickel	-	33	mg/kg
Thallium	-	ND	mg/kg
Uranium[d]	-	4.69	mg/kg
Vanadium	-	NA	mg/kg
Zirconium	-	NA	mg/kg

[a] Radiological information in this table comes from aging thorium-230 and radium-226 concentrations of the like designation (surface soil or all soil depths) to 1,000 years. Inorganic chemical information in this table comes from Table 13 of the BRA. Radiological and chemical information from this table, along with ProUCL (EPA 2016a) output, is used to calculate future human health risks, as well as future particulate concentrations in air. Radium-226 information is used to calculate radon future concentrations in air.

[b] A 1,000-year period was selected as relevant and appropriate based on design requirements set forth in10 CFR Part 61 and 40 CFR Part 192.

[c] Calculated using the uranium-238 and uranium-234 results and the expected isotopic abundance in natural uranium (Section 2.4.2 of BRA).

[d] Of the isotopes of natural uranium, uranium-238 accounts for more than 99 percent of the mass of uranium. The mass concentration of uranium was calculated by dividing the uranium-238 result in pCi/g by the specific activity of 0.336 pCi/µg, resulting in a mass concentration of mg uranium per kg soil (mg/kg).

NA Samples were not analyzed for this constituent.

ND Not detected.

Table 9 Parameters Used to Estimate Potential Current Exposure

	On-Property Receptors								Off-Property Receptors			
Source Term:	Area 1, Area 2, and Buffer Zone								Area 1, Area 2, and Buffer Zone			
Receptor:	*Commercial Building User*				*Grounds Keeper*				*Resident*		*Commercial Building User*	
	Air		Soil		Air		Soil		Air		Air	
Pathway Parameter (units)												
Scenario-specific parameters												
Exposure Time (ET) indoors (h/d)	6	a	0	a	0	b	0	b	NA	c	6	a
ET outdoors (h/d)	2	a	0.1	d	10	b	1.46	e	NA	c	2	a
ET total (h/d)	8	a	0.1	d	10	b	1.46	e	24	c,f	8	a
Exposure Frequency (EF) (d/y)	250	c,f	250	c,f	12	b	4	b	350	c,f	250	c,f
Exposure Duration (ED) (y)	25	g	25	g	25	g	25	g	26	c,f	25	g
Body Weight (BW) (kg)	80	h	80	h	80	h	80	h	NR		NR	
Life (y)	70	c,f	70	f	70	f	70	f	70	c,f	70	c,f
AT-Cancer (d)	25,550	i	25,550	i	25,550	i	25,550	i	25,550	i	25,550	i
Inhalation of dusts and radon												
Inhalation Rate (IRA) (m^3/d)	60	j	NA	k	60	j	NA	k	20/10	l	60	j
Incidental ingestion of soil/sediment												
Ingestion Rate (IR_s) (kg/d)	NA	k	NA	k	NA	k	NA	k	NA	k	NA	k
Fraction of Ingestion (FI) (unitless)	NA	k	NA	k	NA	k	NA	k	NA	k	NA	k
Dermal contact with soil/sediment												
Surface Area (SA) (cm^2)	NA	k	NA	k	NA	k	NA	k	NA	k	NA	k
Adherence Factor (AF) (mg/cm^2)	NA	k	NA	k	NA	k	NA	k	NA	k	NA	k
Absorption Fraction (ABS) (unitless)	NA	k	NA	k	NA	k	NA	k	NA	k	NA	k

NR Not relevant.

NA Value not available.

[a] Assumes an office worker would be in a building 6 hours per day (exposure time indoors) and would spend 2 hours of the day outside (exposure time outdoors), on-property. This estimate is based on Table 16-1 from EPA's Exposure Factors Handbook (EPA 2011) that states that the total time outdoors expected for an adult is 281 minutes/day. That is an average of 20% of 24 hours; 20% of an 8-hour work day was rounded up to 2 hours/day.

[b] Per Bridgeton Landfill, details are discussed in Section 3.1.5 of the BRA.

[c] Default values for the resident and default adult indoor value for the commercial building user in the EPA PRG Calculator (https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search) as of May 30, 2017. Although the default value for an indoor worker is 250 and the default value for an outdoor worker is 225, a value of 250 days per year is conservatively applied to both indoor and outdoor exposure frequencies. The resident exposure duration of 20 years represents 6 years as a child and 20 years as an adult.

[d] Per Bridgeton Landfill, commercial building users come near the Area 2 fence approximately 0.5 hours per 5-day work week, or 0.1 hours each day, and do not go near the Area 1 fence. The exposure time near the Area 2 fence is conservatively applied to the Area 1 fence also.

[e] This value represent the time the receptor would be on property adjacent to the fence along Area 1+Area 2/Buffer Zone (direct exposure from soil). Details are discussed in Section 3.1.5 of the BRA.

Table 10 Parameters Used to Estimate Potential Future (1,000 years) Exposure

	Landfill Receptors								Off-Property Receptors			
Source Term:	Area 1, Area 2, and Buffer Zone								Area 1, Area 2, and Buffer Zone			
Receptor:	*Storage Yard Worker*				*Grounds Keeper*				*Farmer*		*Commercial Building User*	
Pathway Parameter (units)	Soil		Air		Soil		Air		Air		Air	
Scenario-specific parameters												
Exposure Time (ET) indoors (h/d)	0	a	4	a	0	b	0	b	NA	c	6	d
ET outdoors (h/d)	4	a	4	a	10	b	10	b	NA	c	2	d
ET total (h/d)	4	a	8	a	10	b	10	b	24	c,g	8	d
Exposure Frequency (EF) (d/y)	250	c	250	c	12	b	12	b	350	c,g	250	c
Exposure Duration (ED) (y)	25	e	25	e	25	e	25	e	40	c	25	e
Body Weight (BW) (kg)	80	f	80	f	80	f	80	f	NR	f	NR	f
Life (y)	70	g	70	g	70	g	70	g	70	g	70	g
Averaging Time (AT)-Noncancer (d)	9,125	h	9,125	h	9,125	h	9,125	h	14,600	h	9,125	h
AT-Cancer (d)	25,550	h	25,550	h	25,550	h	25,550	h	25,550	h	25,550	h
Inhalation of dusts and radon												
Inhalation Rate (IRA) (m^3/d)	NA	i	60	j	NA	i	60	i	20/10	k	60	j
Incidental ingestion of soil/sediment												
Ingestion Rate (IR_s) (kg/d)	0.0001	l	NA	i	0.0001	l	NA	i	NA	m	NA	m
Fraction of Ingestion (FI) (unitless)	1.00	n	NA	i	1.00	n	NA	i	NA	m	NA	m
Dermal contact with soil/sediment												
Surface Area (SA) (cm^2)	3,527	l	NA	i	3,527	l	NA	i	NA	m	NA	m
Adherence Factor (AF) (mg/cm^2)	0.12	l	NA	i	0.12	l	NA	i	NA	m	NA	m
Absorption Fraction (ABS) (unitless)	csv	o	NA	i	csv	o	NA	i	NA	m	NA	m

NR = Not relevant.

NA = Not applicable.

[a] It is assumed that a storage yard worker spends 4 hours per day working outside on Area 1 or Area 2 and 4 hours indoors in a building adjacent to OU-1. This results in 8 hours of exposure time for air. For soil, the receptor would be on Area 1/Area 2, assuming a total outdoor exposure time of 4 hours/day. Details are discussed in Section 3.1.5 of the BRA.

[b] Per Bridgeton Landfill, details are discussed in Section 3.1.5 of the BRA.

[c] Default values for the resident and default adult indoor value for the commercial building user in the EPA PRG Calculator (https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search) as of May 30, 2017. Although the default value for an indoor worker is 250 and the default value for an outdoor worker is 225, a value of 250 days per year is conservatively applied to both indoor and outdoor exposure frequencies.

[d] Assumes an office worker would be in a building 6 hours per day (exposure time indoors) and would spend 2 hours of the day outside (exposure time outdoors). This estimate is based on Table 16-1 from EPA's Exposure Factors Handbook (EPA 2011) that states that the total time outdoors expected for an adult is 281 minutes/day. That is an average of 20% of 24 hours; 20% of an 8-hour work day was rounded up to 2 hours/day.

Table 11 Radiological Carcinogenic Slope Factors

Isotope	Inhalation Slope Factor (risk/pCi)	Adult Soil Ingestion Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Submersion External Exposure Slope Factor (risk/yr per pCi/m3)	Lambda (1/yr)	Half-life (yr)	ICRP Lung Absorption Type
Uranium 238 Series							
U-238	2.36E-08	4.66E-11	1.24E-10	2.62E-13	1.55E-10	4.47E+09	S
Th-234	3.08E-11	9.51E-12	1.77E-08	2.85E-11	1.05E+01	6.60E-02	S
Pa-234m	0.00E+00	0.00E+00	9.06E-08	8.89E-11	3.11E+05	2.23E-06	-
U-234	2.78E-08	5.11E-11	2.53E-10	5.13E-13	2.82E-06	2.46E+05	S
Pa-234	1.20E-12	9.66E-13	6.62E-06	6.26E-09	9.06E+02	7.65E-04	S
Th-230	3.41E-08	7.73E-11	8.45E-10	1.34E-12	9.19E-06	7.54E+04	F
Ra-226	2.82E-08	2.95E-10	2.50E-08	2.85E-11	4.33E-04	1.60E+03	S
Rn-222	2.28E-12	0.00E+00	1.69E-09	1.62E-12	6.62E+01	1.05E-02	-
Po-218	1.39E-11	0.00E+00	6.84E-15	3.95E-17	1.17E+05	5.90E-06	-
Pb-214	7.77E-11	2.21E-13	9.94E-07	1.02E-09	1.36E+04	5.10E-05	S
At-218	0.00E+00	0.00E+00	2.74E-11	3.08E-14	1.46E+07	4.76E-08	-
Bi-214	6.18E-11	1.47E-13	7.34E-06	6.69E-09	1.83E+04	3.79E-05	S
Rn-218	0.00E+00	0.00E+00	3.39E-09	3.19E-12	6.24E+08	1.11E-09	-
Po-214	0.00E+00	0.00E+00	3.85E-10	3.57E-13	1.33E+11	5.21E-12	-
Tl-210	0.00E+00	0.00E+00	1.34E-05	1.24E-08	2.80E+05	2.47E-06	-
Pb-210	1.59E-08	5.99E-10	1.48E-09	3.93E-12	3.12E-02	2.22E+01	S
Bi-210	4.55E-10	3.74E-12	2.77E-09	5.29E-12	5.05E+01	1.37E-02	S
Hg-206	0.00E+00	0.00E+00	4.83E-07	4.96E-10	4.47E+04	1.55E-05	-
Po-210	1.45E-08	1.44E-09	4.51E-11	4.18E-14	1.83E+00	3.79E-01	S
Tl-206	0.00E+00	0.00E+00	6.11E-09	9.40E-12	8.67E+04	7.99E-06	-
Uranium 235 Series							
U-235	2.50E-08	4.92E-11	5.51E-07	6.32E-10	9.84E-10	7.04E+08	S
Th-231	1.50E-12	9.07E-13	2.49E-08	3.97E-11	2.38E+02	2.91E-03	S
Pa-231	7.62E-08	1.54E-10	1.27E-07	1.34E-10	2.12E-05	3.28E+04	F
Ac-227	1.49E-07	2.01E-10	1.98E-10	3.15E-13	3.18E-02	2.18E+01	S
Th-227	3.50E-08	2.06E-11	4.45E-07	4.81E-10	1.35E+01	5.12E-02	S
Fr-223	4.07E-11	4.88E-12	1.35E-07	1.77E-10	1.66E+04	4.19E-05	S
Ra-223	2.92E-08	1.23E-10	4.55E-07	5.25E-10	2.21E+01	3.13E-02	S
At-219	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.90E+05	1.78E-06	-
Rn-219	0.00E+00	0.00E+00	2.35E-07	2.38E-10	5.52E+06	1.26E-07	-
Bi-215	0.00E+00	0.00E+00	1.08E-06	1.07E-09	4.79E+04	1.45E-05	-
Po-215	0.00E+00	0.00E+00	7.48E-10	7.29E-13	1.23E+10	5.65E-11	-
Pb-211	4.03E-11	2.63E-13	2.91E-07	2.79E-10	1.01E+04	6.87E-05	S
Bi-211	0.00E+00	0.00E+00	1.90E-07	1.91E-10	1.70E+05	4.07E-06	-
Tl-207	0.00E+00	0.00E+00	1.59E-08	1.81E-11	7.64E+04	9.08E-06	-
Po-211	0.00E+00	0.00E+00	3.76E-08	3.50E-11	4.24E+07	1.64E-08	-
Thorium 232 Series							
Th-232	4.33E-08	8.47E-11	3.58E-10	6.81E-13	4.93E-11	1.41E+10	S
Ra-228	4.37E-08	6.70E-10	3.43E-11	2.15E-13	1.21E-01	5.75E+00	S
Ac-228	4.92E-11	8.58E-13	4.04E-06	3.76E-09	9.87E+02	7.02E-04	S
Th-228	1.32E-07	6.40E-11	5.64E-09	7.45E-12	3.63E-01	1.91E+00	S
Ra-224	1.13E-08	8.47E-11	3.91E-08	4.17E-11	6.91E+01	1.00E-02	S

Table 11 Radiological Carcinogenic Slope Factors Continued

Isotope	Inhalation Slope Factor (risk/pCi)	Adult Soil Ingestion Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Submersion External Exposure Slope Factor (risk/yr per pCi/m3)	Lambda (1/yr)	Half-life (yr)	ICRP Lung Absorption Type
Rn-220	1.15E-12	0.00E+00	2.77E-09	2.63E-12	3.93E+05	1.76E-06	-
Po-216	0.00E+00	0.00E+00	7.10E-11	6.59E-14	1.51E+08	4.60E-09	-
Pb-212	6.29E-10	1.31E-11	4.96E-07	5.57E-10	5.71E+02	1.21E-03	S
Bi-212	1.13E-10	4.44E-13	4.96E-07	4.61E-10	6.02E+03	1.15E-04	S
Po-212	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.31E+13	9.48E-15	-
Tl-208	0.00E+00	0.00E+00	1.75E-05	1.59E-08	1.19E+05	5.81E-06	-

Table 12 Chemical Oral Slope Factor Toxicity Values

Chemical	CASNUM	Mutagen?	Volatile?	GIABS	ABS	Oral Slope Factor (mg/kg-day)$^{-1}$	Source	EPA Cancer Class	Tumor Type	Target Organ	Species	Method	Reference
Antimony (metallic)	7440-36-0	No	No	0.15	-			Not assessed under the IRIS Program.					
Arsenic, Inorganic	7440-38-2	No	No	1	0.03	1.50E+00	IRIS	A	Skin cancer	Skin	Human	Time- and dose-related formulation of the multistage model	Tseng 1977; Tseng et al. 1968, EPA 1988
Barium	7440-39-3	No	No	0.07	-			Carcinogenic potential cannot be determined (Inhalation route) Not likely to be carcinogenic to humans (Oral route)					
Benzene	71-43-2	No	Yes	1	-	5.50E-02	IRIS	Known/likely human carcinogen	Leukemia	Blood	Human	Linear extrapolation of human occupational data	Rinsky et al. 1981, Rinsky et al. 1987, Paustenbach et al. 1993, Crump 1994, EPA 1998, EPA 1999
Beryllium and compounds	7440-41-7	No	No	0.007	-			Carcinogenic potential cannot be determined (Oral route) Known/likely human carcinogen (Inhalation route)					
Chromium^{3+} Insoluble Salts	16065-83-1	No	No	0.013	-			Carcinogenic potential cannot be determined					
Chromium^{6+}	18540-29-9	Yes	No	0.025	-	5.00E-01	Cal EPA	Known/likely (inhalation) cannot	NA	NA	NA	NA	NA

Chemical	CASNUM	Mutagen?	Volatile?	GIABS	ABS	Oral Slope Factor (mg/kg-day)$^{-1}$	Source	EPA Cancer Class	Tumor Type	Target Organ	Species	Method	Reference
								determine (oral)					
Cobalt	7440-48-4	No	No	1	-			LI					
Mercury (elemental)	7439-97-6	No	Yes	1	-			D					
Nickel Soluble Salts	7440-02-0	No	No	0.04	-			NA					
Thallium (Soluble Salts)	7440-28-0	No	No	1	-			IN					
Uranium (Soluble Salts)	E715565	No	No	1	-			NA					
Vanadium and Compounds	7440-62-2	No	No	0.026	-			IN					
Zirconium	7440-67-7	No	No	1	-			IN					

NA signifies that no data were available.
"—" signifies value not applicable.

Table 13 Chemical Inhalation Unit Risk Toxicity Values

Chemical	CASNUM	Mutagen?	Volatile?	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Source	EPA Cancer Class	Tumor Type	Target Organ	Species	Method	Reference
Antimony (metallic)	7440-36-0	No	No			Not assessed under the IRIS Program.					
Arsenic, Inorganic	7440-38-2	No	No	4.30E-03	IRIS	A	Cancer	Lung	Human	Absolute-risk linear model	Brown and Chu 1983a,b,c, Lee-Feldstein 1983, Higgins 1982, Enterline and Marsh 1982
Barium	7440-39-3	No	No			Carcinogenic potential cannot be determined (Inhalation route) Not likely to be carcinogenic to humans (Oral route)					
Beryllium and compounds	7440-41-7	No	No	2.40E-03	IRIS	Carcinogenic potential cannot be determined (Oral route) Known/likely human carcinogen (Inhalation route)	Lung cancer	Lung	Human	Relative risk	Wagoner et al. 1980
$Chromium^{+3}$, Insoluble Salts	16065-83-1	No	No			Carcinogenic potential cannot be determined					
$Chromium^{+6}$	18540-29-9	Yes	No	8.40E-02	IRIS	Known/likely (inhalation) cannot determine (oral)	Lung cancer	Lung	Human	Multistage, extra risk	Mancuso 1975
Cobalt	7440-48-4	No	No	9.00E-03	PPRTV	LI	Adenoma and carcinoma	Alveolar/bronchiolar	Rat/Mouse	NA	NTP 1998, Bucher et al. 1999
Mercury (elemental)	7439-97-6	No	Yes			D					
Nickel Soluble Salts	7440-02-0	No	No	2.60E-04	Cal EPA	NA	NA	NA	NA	NA	NA
Thallium (Soluble Salts)	7440-28-0	No	No			IN					
Uranium (Soluble Salts)	E715565	No	No			NA					
Vanadium and Compounds	7440-62-2	No	No			IN					
Zirconium	7440-67-7	No	No			IN					

NA signifies that no data were available.
"—" signifies value not applicable.

Table 14 Chemical Oral Reference Dose Toxicity Values

Chemical	CASNUM	Volatile?	GIABS	ABS	Chronic Oral Reference Dose (mg/kg-day)	Source	Basis	Confidence Level	Critical Effect	Target Organ	MF	UF	Species	Route	Study Duration	Reference
Antimony (metallic)	7440-36-0	No	0.15	-	4.00E-04	IRIS	LOAEL: 0.35 mg/kg-day	Low	Longevity, blood glucose, and cholesterol	Whole body	1	1000	Rat	NA	NA	Schroeder et al.1970
Arsenic, Inorganic	7440-38-2	No	1	0.03	3.00E-04	IRIS	NOAEL: 0.0008 mg/kg-day	Medium	Hyperpigmentation, keratosis and possible vascular complications	Skin and blood	1	3	Human	NA	NA	Tseng 1977; Tseng et al.1968
Barium	7440-39-3	No	0.07	-	2.00E-01	IRIS	BMDL 05: 63 mg/kg-day	Medium	Nephropathy	Neurological	1	300	Mouse	NA	NA	NTP 1994
Beryllium and compounds	7440-41-7	No	0.007	-	2.00E-03	IRIS	BMD 10: 0.46 mg/kg-day	Low-Medium	Small intestine lesions	Gastrointestinal	1	300	Dog	NA	NA	Morgareidge et al. 1976
Chromium^{+3} Insoluble Salts	16065-83-1	No	0.013	-	1.50E+00	IRIS	NOAEL (ADJ): 1468 mg/kg-day	Low	No effects observed	None	10	100	Rat	NA	NA	Ivankovic and Preussmann 1975
Chromium^{+6}	18540-29-9	No	0.025	-	3.00E-03	IRIS	NOAEL (ADJ): 2.5 mg/kg-day	Low	None reported	None	3	300	Rat	NA	NA	MacKensie et al. 1958
Cobalt	7440-48-4	No	1	-	3.00E-04	PPRTV	LOAEL: 1 mg/kg-day	Low	Decreased iodine uptake	Thyroid	NA	3000	Human	Oral	2 weeks	Roche and Layrisse 1956
Mercury (elemental)	7439-97-6	Yes	1	-												
Nickel Soluble Salts	7440-02-0	No	0.04	-	2.00E-02	IRIS	NOAEL: 5 mg/kg-day	Medium	Decreased body and organ weights	Body weight	1	300	Rat	NA	NA	Ambrose et al. 1976
Thallium (Soluble Salts)	7440-28-0	No	1	-	1.00E-05	PPRTV SCREEN	NOAEL-est: .04 mg/kg-day	NA	Histopathology	Skin	NA	3000	Rat	Oral: gavage	90 days	MRI 1988
Uranium (Soluble Salts)	E715565	No	1	-	2.00E-04	ATSDR	LOAEL: 0.06 mg/kg-day	NA	Nuclear vesiculation, cytoplasmic vacuolation, tubular dilation, interstitial lymphoid cuffing	Renal	NA	300	Rat	Renal	91 days	Gilman et al. 1998
Vanadium and Compounds	7440-62-2	No	0.026	-	5.04E-03	SURR	:	NA	NA	NA		NA	NA	NA	NA	NA
Zirconium	7440-67-7	No	1	-	8.00E-05	PPRTV SCREEN	LOAEL: .79 mg/kg-day	NA	Glycosuria; Increased glucose and cholesterol levels	Urine; Blood	NA	10000	Rat	Oral: drinking water and diet	weaning to death	Schroeder et al. 1970

NA signifies that no data were available.
"—" signifies value not applicable.

Table 15 Chemical Inhalation Reference Concentration Toxicity Values

Chemical	CASNUM	Volatile?	Chronic Inhalation Reference Concentration (mg/m^3)	Source	Basis	Confidence Level	Critical Effect	Target Organ	MF	UF	Species	Route	Duration	Reference
Antimony (metallic)	7440-36-0	No												
Arsenic, Inorganic	7440-38-2	No	1.50E-05	Cal EPA	NA	NA	NA	Development: cardiovascular system, nervous system, lung, skin	NA	NA	NA	NA	NA	NA
Barium	7440-39-3	No	5.00E-04	HEAST	NOEL: 0.8 mg/cu m	NA	Fetotoxicity	Fetus	NA	1000	Rat	Inhalation: intermittent	4 months	NA
Beryllium and compounds	7440-41-7	No	2.00E-05	IRIS	LOAEL (HEC): 0.0002 mg/m3	Medium	Beryllium sensitization and progression to CBD	Immune, respiratory	1	10	Human	NA	NA	Kreiss et al. 1996
Chromium(III), Insoluble Salts	16065-83-1	No												
Chromium+6	18540-29-9	No	1.00E-04	IRIS	BMC 10 (ADJ): 0.034 mg/m3	Medium	Lactate dehydrogenase in bronchioalveolar lavage fluid	Lungs	1	300	Rat	NA	NA	Glaser et al. 1990, Malsch et al. 1994
Cobalt	7440-48-4	No	6.00E-06	PPRTV	NOAEL: 1.9 ug/m3	Medium to low	Irritation; Decreased function	Respiratory Tract; Lung	NA	300	Human	Inhalation	NA	Nemery et al. 1992
Mercury (elemental)	7439-97-6	Yes	3.00E-04	IRIS	LOAEL (ADJ): 0.009 mg/m3	Medium	Hand tremor; increases in memory disturbances; slight subjective and objective evidence of autonomic dysfunction	Neurological	1	30	Human	NA	NA	Fawer et al. 1983, Piikivi and Tolonen 1989, Piikivi and Hanninen 1989, Piikivi 1989, Ngim et al. 1992, Liang et al. 1993
Nickel Soluble Salts	7440-02-0	No	9.00E-05	ATSDR	NOAEL: 0.03 mg/m3	NA	Atrophy of olfactory epithelium	Respiratory	NA	30	Rat	Resp.	2 years	NTP 1996
Thallium (Soluble Salts)	7440-28-0	No												
Uranium (Soluble Salts)	E715565	No	4.00E-05	ATSDR	NOAEL: 0.05 mg/m3	NA	Slight tubular atrophy	Renal	NA	30	Dog	Renal	1 year	Stokinger et al. 1953
Vanadium and Compounds	7440-62-2	No	1.00E-04	ATSDR	LOAEL: 0.28 mg/m3	NA	hyperplasia of alveolar and bronchiolar epithelium, degeneration and hyperplasia of epiglottis epithelium, and goblet cell hyperplasia in nasal	Resp.	NA	30	Rat	Resp.	2 years (6 hr/d, 5 d/wk)	NTP 2002

Chemical	CASNUM	Volatile?	Chronic Inhalation Reference Concentration (mg/m^3)	Source	Basis	Confidence Level	Critical Effect	Target Organ	MF	UF	Species	Route	Duration	Reference
							respiratory epithelium							
Zirconium	7440-67-7	No	-											

NA signifies that no data were available.

"—" signifies value not applicable.

Table 16 Calculated Current LCRs, On-Property Grounds Keeper Scenario -Area 1 and Area 2

COPC	Inhalation of Radon[a]	Direct Radiation from Soil	Direct Radiation Submersion in Air	All Routes
Uranium Series				
Uranium-238 + 2 dtrs	NA	1.60E-10	NE	1.60E-10
Uranium-234	NA	3.79E-14	NE	3.79E-14
Thorium-230	NA	6.48E-11	NE	6.48E-11
Radium-226 + 8 dtrs	NA	1.44E-06	NE	1.44E-06
Actinium Series				
Uranium-235 + 1 dtr	NA	8.92E-11	NE	8.92E-11
Protactinium-231 + 10 dtrs	NA	3.22E-08	NE	3.22E-08
Thorium Series				
Thorium-232 + 10 dtrs	NA	1.23E-07	NE	1.23E-07
Radon-222 Series in Air[b]				
Rn-222	4.98E-08	NA	1.62E-12	4.98E-08
Po-218	3.94E-08	NA	5.10E-18	3.94E-08
Pb-214	2.20E-09	NA	1.32E-12	2.20E-09
Bi-214 + 1 dtr	1.68E-11	NA	8.34E-14	1.69E-11
			Total	**1.69E-06**

NA Not applicable

NE indicates no exposure due to presence of non-combustible cover.

[a] Direct radiation risks from soil are from the EPA PRG Calculator (https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search) and surface soil concentrations. Risks from inhalation of radon and direct radiation risks from submersion are from the EPA PRG Calculator (https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search) and projected current concentrations.

[b] Radon source term includes emissions from all OU-1 areas.

Table 17 Calculated Current LCRs, Off-Property Resident Scenario - Off-Property Southeast and South

COPC	Exposure Route: Inhalation of Radon[a]	Exposure Route: Direct Radiation, Submersion in Air	All Routes
Off-Property Southeast Radon-222 Series in Air[b]			
Rn-222	8.57E-09	9.44E-13	8.57E-09
Po-218	3.28E-08	1.44E-17	3.28E-08
Pb-214	1.17E-08	2.38E-11	1.17E-08
Bi-214 + 1 dtr	4.97E-10	8.37E-12	5.06E-10
		Total	**5.36E-08**
Off-Property South Radon-222 Series in Air[b]			
Rn-222	2.73E-09	3.00E-13	2.73E-09
Po-218	1.25E-08	5.48E-18	1.25E-08
Pb-214	6.55E-09	1.33E-11	6.56E-09
Bi-214 + 1 dtr	4.00E-10	6.73E-12	4.06E-10
		Total	**2.22E-08**

[a] Risks from inhalation of radon and direct radiation risks from submersion are from the EPA PRG Calculator (https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search) and projected current concentrations.

[b] Includes contributions to emissions from all OU-1 areas.

Table 18 Calculated Current LCRs, Commercial Building User Scenario, Adjacent Property, Lot 2A2

Adjacent Property, Lot 2A2			
Radon-222 Series in Air[b]			
Rn-222	3.15E-07	1.02E-11	3.15E-07
Po-218	8.41E-08	1.09E-17	8.41E-08
Pb-214	1.22E-09	7.32E-13	1.22E-09
Bi-214 + 1 dtr	2.26E-12	1.12E-14	2.27E-12
		Total	**4.01E-07**

[a] Risks from inhalation of radon and direct radiation risks from submersion are from the EPA PRG Calculator (https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search) and projected current concentrations.

[b] Includes indoor and outdoor contributions from all OU-1 areas.

Table 19 Calculated Future (1,000 years) LCRs, Commercial Building User Scenario – Adjacent Property, Lot 2A2

COPC	Exposure Route: Inhalation of Dust	Inhalation of Radon[a]	Direct Radiation, Submersion in Air	All Routes
Uranium Series				
Uranium-238 + 2 dtrs	8.46E-08	NA	1.03E-12	8.46E-08
Uranium-234	1.01E-07	NA	8.51E-17	1.01E-07
Thorium-230	6.62E-06	NA	1.19E-14	6.62E-06
Radium-226 + 8 dtrs	4.58E-06	NA	2.74E-11	4.58E-06
Actinium Series				
Uranium-235 + 1 dtr	4.51E-09	NA	5.52E-15	4.51E-09
Protactinium-231 + 10 dtrs	1.54E-06	NA	4.57E-13	1.54E-06
Thorium Series				
Thorium-232 + 10 dtrs	2.01E-07	NA	8.22E-13	2.01E-07
Radon-222 Series in Air[b]				
Rn-222	NA	9.21E-05	2.99E-09	9.21E-05
Po-218	NA	2.46E-05	3.18E-15	2.46E-05
Pb-214	NA	3.58E-07	2.14E-10	3.58E-07
Bi-214 + 1 dtr	NA	6.60E-10	3.27E-12	6.63E-10
Inorganic Chemicals				
Antimony (metallic)	-	NA	NA	0.00E+00
Arsenic, Inorganic	1.43E-08	NA	NA	1.43E-08
Barium	-	NA	NA	0.00E+00
Beryllium and compounds	1.96E-10	NA	NA	1.96E-10
Chromium^{+6}	2.20E-07	NA	NA	2.20E-07
Cobalt	3.10E-07	NA	NA	3.10E-07
Lead and Compounds	-	NA	NA	0.00E+00
Mercury (elemental)	-	NA	NA	0.00E+00
Nickel Soluble Salts	9.54E-09	NA	NA	9.54E-09
Thallium (Soluble Salts)	-	NA	NA	0.00E+00
Uranium (Soluble Salts)	-	NA	NA	0.00E+00
Vanadium and compounds	-	NA	NA	0.00E+00
Zirconium	-	NA	NA	0.00E+00
			Total	**1.31E-04**

NA Not applicable

[a] Radiological risks from inhalation of radon and dust and direct radiation risks from submersion are from the EPA PRG Calculator (https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search) and projected future radon and particulate concentrations. Chemical risks from dust inhalation are from the EPA RSL Calculator (https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) and particulate concentrations.

[b] Includes indoor and outdoor contributions from all OU-1 areas.

Table 20 Calculated Future (1,000 years) LCRs,
Landfill Storage Yard Worker Scenario - Area 2

COPC	Exposure Route: Inhalation of Dust	Inhalation of Radon[a]	Direct Radiation from Soil	Direct Radiation, Submersion in Air	Incidental Soil Ingestion	Dermal	All Routes
Uranium Series							
Uranium-238 + 2 dtrs	2.41E-07	NA	3.09E-06	2.92E-12	1.62E-06	NA	4.95E-06
Uranium-234	2.89E-07	NA	3.40E-08	2.43E-16	1.50E-06	NA	1.82E-06
Thorium-230	1.82E-05	NA	5.56E-06	3.28E-14	1.16E-04	NA	1.40E-04
Radium-226 + 8 dtrs	1.27E-05	NA	1.94E-02	7.57E-11	1.40E-03	NA	2.08E-02
Actinium Series							
Uranium-235 + 1 dtr	1.28E-08	NA	2.79E-06	1.57E-14	7.29E-08	NA	2.88E-06
Protactinium-231 + 10 dtrs	4.24E-06	NA	2.39E-04	1.26E-12	2.05E-05	NA	2.64E-04
Thorium Series							
Thorium-232 + 10 dtrs	5.45E-07	NA	2.95E-04	2.22E-12	5.97E-06	NA	3.01E-04
Radon-222 Series in Air[b]							
Rn-222	NA	1.64E-04	NA	5.32E-09	NA	NA	1.64E-04
Po-218	NA	2.57E-04	NA	3.33E-14	NA	NA	2.57E-04
Pb-214	NA	2.90E-05	NA	1.74E-08	NA	NA	2.90E-05
Bi-214 + 1 dtr	NA	4.43E-07	NA	2.19E-09	NA	NA	4.45E-07
Inorganic Chemicals							
Antimony (metallic)	-	NA	NA	NA	-	-	0.00E+00
Arsenic, Inorganic	4.23E-08	NA	NA	NA	1.80E-05	3.80E-06	2.18E-05
Barium	-	NA	NA	NA	-	-	0.00E+00
Beryllium and compounds	3.33E-10	NA	NA	NA	-	-	3.33E-10
$Chromium^{+6}$	4.59E-07	NA	NA	NA	5.39E-06	-	5.85E-06
Cobalt	9.37E-07	NA	NA	NA	-	-	9.37E-07
Lead and Compounds	-	NA	NA	NA	-	-	0.00E+00
Mercury (elemental)	-	NA	NA	NA	-	-	0.00E+00
Nickel Soluble Salts	2.82E-08	NA	NA	NA	-	-	2.82E-08
Thallium (Soluble Salts)			NA	NA	-	-	0.00E+00
Uranium (Soluble Salts)			NA	NA	-	-	0.00E+00

Table 21 Calculated Future (1,000 years) Hazard Quotients and Hazard Indices, Landfill Storage Yard Worker – Area 1 and Area 2

COPC	Exposure Route: Soil Ingestion	Exposure Route: Inhalation[a]	Exposure Route: Dermal Absorption	Total
Area 1				
Antimony (metallic)	0.0165	-	-	0.01646
Arsenic, Inorganic	0.0379	0.00065	0.00801	0.04652
Barium	0.14493	0.02468	-	0.16961
Beryllium and compounds	0.00026	0.00001	-	0.00027
Chromium^{+6}	0.0108	0.00014	-	0.01095
Cobalt	0.304	0.0097	-	0.31345
Lead and Compounds	-	-	-	0.00
Mercury (elemental)	-	0.00000109	-	0.00000109
Nickel Soluble Salts	0.0132	0.0014	-	0.01465
Thallium (Soluble Salts)	0.03419	-	-	0.03419
Uranium (Soluble Salts)	0.1543	0.00042	-	0.15470
Vanadium and compounds	0.00549	0.00020	-	0.00569
Zirconium	2.58	-	-	2.58
Total Hazard Index for Landfill Outdoor Worker – Area 1				**3.35**
Area 2				
Antimony (metallic)	0.0119	-	-	0.0119
Arsenic, Inorganic	0.112	0.001840	0.02367	0.137
Barium	0.08384	0.016850	-	0.10069
Beryllium and compounds	0.00038	0.000019	-	0.00040
Chromium^{+6}	0.0101	0.000153	-	0.01023
Cobalt	1.98600	0.04861	-	2.035
Lead and Compounds	-	-	-	0.00
Mercury (elemental)	-	0.0000004	-	0.0000004
Nickel Soluble Salts	0.0308	0.00338	-	0.03416
Thallium (Soluble Salts)	0.08915	-	-	0.08915
Uranium (Soluble Salts)	0.58735	0.001447	-	0.58880
Vanadium and compounds	0.0481	0.001189	-	0.0493
Zirconium	28.9	-	-	28.9
Total Hazard Index for Landfill Outdoor Worker – Area 2				**32.0**

[a] Chemical hazard quotients from dust inhalation are from the EPA RSL Calculator (https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) and projected future particulate concentrations.

Table 22 Calculated Future (1,000 years) Hazard Quotients and Hazard Indices, Off-Property Commercial Building User

COPC	Exposure Route Inhalation HQ[a]
Total HI at Off-Property West	
Adjacent Lot, 2A2	
Antimony (metallic)	-
Arsenic, Inorganic	0.00062
Barium	0.00578
Beryllium and compounds	0.0000114
Chromium^{+6}	0.000074
Cobalt	0.01613
Lead and Compounds	-
Mercury (elemental)	0.000000128
Nickel Soluble Salts	0.00114
Thallium (Soluble Salts)	-
Uranium (Soluble Salts)	0.00048
Vanadium and compounds	0.00039
Zirconium	-
Total HI at Adjacent Lot, 2A2	**0.025**

[a] Chemical hazard quotient from dust inhalation are from the EPA RSL Calculator (https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) and projected future particulate concentrations.

Table 23 Uncertainties Associated with Estimated Risks for OU-1

Source of Uncertainty	Section of Discussion	Magnitude of Potential Impact on Estimated Risks	Direction of Bias on Estimated Risks
Heterogeneity of waste form	6.4.1	High	Increases protectiveness
Positive bias in sampling	6.1.1	High	Increases protectiveness
Not subtracting natural background from exposure point concentrations	6.1.2	Low to Moderate	Increases protectiveness
Calculation of 95% UCL	6.4.4/6.4.5	Moderate	Increases protectiveness
Current on-property land use/receptors	6.3.1-6.3.3	None	None
Future on-property land use/receptors	6.3.1-6.3.3	Low	Increases Protectiveness
Current off-property land use/receptors	6.3.1-6.3.3	None	None
Future off-property land use/receptors	6.3.1-6.3.3	Low	Increases protectiveness
Source definition (representativeness)	6.4.5	Moderate	Indeterminate
Age of future source	6.4.6	Moderate	Indeterminate
Approximating exposure with simplified expressions	6.3.3	Moderate to high	Increases protectiveness
Individual parameter values	6.3.3	Low to moderate	Generally increases protectiveness
Composite effect of combining uncertain parameter values	6.3.3	Moderate to high	Generally increases protectiveness
CSFs and RfDs (Non-radon)	6.5.1	Moderate to high	Increases protectiveness
Radon toxicology	6.2.1.4/6.2.1.5	Very high	Increases protectiveness
Default (100%) bioavailability	6.5.3	Moderate	Increases protectiveness
Representative constituent concentrations	6.2.1.2/6.2.1.3/ 6.2.1.6/ 6.4.1/6.4.4/6.4.5	Moderate	Increases protectiveness
Radon emission rate	6.2.1.1	Moderate	Indeterminate

Table 24 Summary of Future (1,000 years) Particulate Air Concentrations at Exposure Locations

Analyte[a]	Off-Property, North (721800 E 4294970 N)	Off-Property, South (721948 E 4292823 N)	Off-Property, Southeast (722898 E 4293620 N)	Off-Property, West (721410 E 4294668 N)	On-site, Area 1 (722130 E 4294400 N)	On-site, Area 2 (721720 E 4294785 N)	On-site, Buffer Zone (721580 E 4294600 N)	Adjacent Property, Lot 2A2 (721525 E 4294645 N)	On-property, next to Area 1 (722076 E 4294421 N)	On-property, next to Area 2 (721800 E 4294880 N)
Uranium Series (pCi/m^3)										
Uranium-238 + D	3.10E-05	1.66E-07	6.88E-07	1.34E-05	2.47E-05	8.51E-05	6.39E-05	2.86E-05	1.95E-05	7.79E-05
Uranium-234	3.16E-05	1.73E-07	7.21E-07	1.36E-05	2.93E-05	8.66E-05	6.52E-05	2.91E-05	2.24E-05	7.93E-05
Thorium-230	1.67E-03	1.07E-05	4.67E-05	7.28E-04	3.37E-03	4.46E-03	3.71E-03	1.55E-03	2.29E-03	4.11E-03
Radium-226 + D	6.68E-04	4.34E-06	1.90E-05	2.91E-04	1.41E-03	1.78E-03	1.47E-03	6.20E-04	9.55E-04	1.64E-03
Actinium Series (pCi/m^3)										
Uranium-235 + 1 D	1.57E-06	8.48E-09	3.52E-08	6.75E-07	1.35E-06	4.29E-06	3.23E-06	1.44E-06	1.05E-06	3.93E-06
Protactinium-231 + D	4.54E-05	2.80E-07	1.21E-06	1.98E-05	7.84E-05	1.22E-04	1.02E-04	4.24E-05	5.43E-05	1.12E-04
Thorium-232 Series (pCi/m^3)										
Thorium-232 + 10 D	7.48E-06	5.53E-08	2.49E-07	3.29E-06	2.34E-05	1.95E-05	1.68E-05	6.95E-06	1.53E-05	1.81E-05
Inorganic Chemicals (µg/m^3)										
Antimony	3.96E-06	2.92E-08	1.31E-07	1.71E-06	1.24E-05	1.04E-05	7.50E-06	3.53E-06	8.11E-06	9.62E-06
Arsenic	4.41E-05	2.43E-07	1.01E-06	1.90E-05	4.24E-05	1.21E-04	9.18E-05	4.07E-05	3.22E-05	1.10E-04
Barium	1.43E-02	1.14E-04	5.17E-04	6.20E-03	5.41E-02	3.69E-02	2.68E-02	1.27E-02	3.49E-02	3.44E-02
Beryllium	6.53E-07	4.04E-09	1.77E-08	3.50E-07	1.04E-06	1.70E-06	5.14E-06	9.99E-07	7.31E-07	1.55E-06
Chromium (as IV)	2.58E-05	1.76E-07	7.86E-07	1.27E-05	6.24E-05	6.71E-05	1.36E-04	3.22E-05	4.17E-05	6.17E-05
Cobalt	4.63E-04	2.38E-06	9.74E-06	1.99E-04	2.56E-04	1.28E-03	9.18E-04	4.23E-04	2.23E-04	1.17E-03
Lead	1.02E-03	7.95E-06	3.61E-05	4.53E-04	3.68E-03	2.62E-03	2.61E-03	9.75E-04	2.38E-03	2.43E-03
Mercury	1.96E-07	2.16E-09	1.03E-08	8.62E-08	1.43E-06	4.69E-07	3.44E-07	1.68E-07	8.99E-07	4.46E-07
Nickel	4.89E-04	2.77E-06	1.17E-05	2.11E-04	5.67E-04	1.33E-03	1.02E-03	4.50E-04	4.16E-04	1.22E-03
Thallium	7.05E-07	3.94E-09	1.65E-08	3.03E-07	7.48E-07	1.92E-06	1.38E-06	6.41E-07	5.57E-07	1.77E-06
Uranium	9.23E-05	4.94E-07	2.05E-06	3.98E-05	7.35E-05	2.53E-04	1.90E-04	8.50E-05	5.81E-05	2.32E-04
Vanadium	1.88E-04	9.55E-07	3.88E-06	8.08E-05	8.77E-05	5.21E-04	3.74E-04	1.72E-04	8.08E-05	4.76E-04
Zirconium	1.79E-03	9.00E-06	3.65E-05	7.69E-04	7.34E-04	4.96E-03	3.56E-03	1.64E-03	7.07E-04	4.53E-03

[a] Information in this table comes from Tables 22 through 24 and AERMOD results from Appendix A. Information in this table, along with ProUCL (EPA 2016a) output, is used to calculate human health risks as presented in Tables 38 through 53.

Table 25 Projected Radon Concentrations at Selected Locations from all Source Groups

Analyte[a]	Off-Property, North (721800 E 4294970 N)	Off-Property, South (721948 E 4292823 N)	Off-Property, Southeast (722898 E 4293620 N)	Off-property, West (721410 E 4294668 N)	On-site, Area 1 (722130 E 4294400 N)	On-site, Area 2 (721720 E 4294785 N)	On-site, Buffer Zone (721580 E 4294600 N)	Adjacent Property, Lot 2A2 (721525 E 4294645 N)	On-Property, next to Area 1 (722076 E 4294421 N)	On-Property, next to Area 2 (721800 E 4294880 N)
Flight distance(m)	300	1570	1090	180	250	440	50	60	70	220
Flight time (min)[b]	1.2	6.4	4.4	0.73	1.0	1.8	0.20	0.24	0.28	0.89
Current[c]										
Rn-222 (pCi/m^3)	8.5 E-1	7.4 E-3	2.3 E-2	6.3 E-1	1.4 E+0	2.2 E+0	2.2 E+0	1.1 E+0	1.1 E+0	1.8 E+0
Po-218 (pCi/m^3)	2.0 E-1	5.6 E-3	1.5 E-2	9.1 E-2	2.7 E-1	7.1 E-1	9.8 E-2	4.8 E-2	5.8 E-2	3.2 E-1
Pb-214 (pCi/m^3)	3.3 E-3	5.2 E-4	9.3 E-4	8.4 E-4	3.6 E-3	1.7 E-2	2.6 E-4	1.3 E-4	1.9 E-4	3.6 E-3
Bi-214+D[d] (pCi/m^3)	4.7 E-5	4.0 E-5	5.0 E-5	6.9 E-6	4.3 E-5	3.6 E-4	6.0 E-7	2.9 E-7	5.5 E-7	3.6 E-5
Future[e]										
Rn-222 (pCi/m^3)	2.4 E+2	2.3 E+0	7.3 E+0	1.8 E+2	5.0 E+2	6.2 E+2	6.8 E+2	3.2 E+2	3.8 E+2	5.3 E+2
Po-218 (pCi/m^3)	5.8 E+1	1.7 E+0	4.6 E+0	2.7 E+1	1.0 E+2	2.0 E+2	3.0 E+1	1.4 E+1	2.1 E+1	9.2 E+1
Pb-214 (pCi/m^3)	9.4 E-1	1.6 E-1	2.9 E-1	2.5 E-1	1.3 E+0	4.9 E+0	7.7 E-2	3.7 E-2	6.7 E-2	1.0 E+0
Bi-214+D[d] (pCi/m^3)	1.3 E-2	1.2 E-2	1.6 E-2	2.0 E-3	1.6 E-2	1.0 E-1	1.8 E-4	8.6 E-5	2.0 E-4	1.0 E-2

[a] Information in this table comes from Tables 22 through 24 and AERMOD results from Appendix A. Information in this table, along with ProUCL (EPA 2016a) output, is used to calculate human health risks as presented in Tables 38 through 53.
[b] Average flight time to a location estimated as quotient of the location's distance from the center of the domain and 4.1 m/s, the average annual wind speed (Dist(m)/Speed(m/s/60s/min).
[c] Post-non-combustible cover placement
[d] Concentrations listed on the Bi-214+D line apply to both Bi-214 and its short-lived daughter, Po-214.
[e] Assumes no cover.

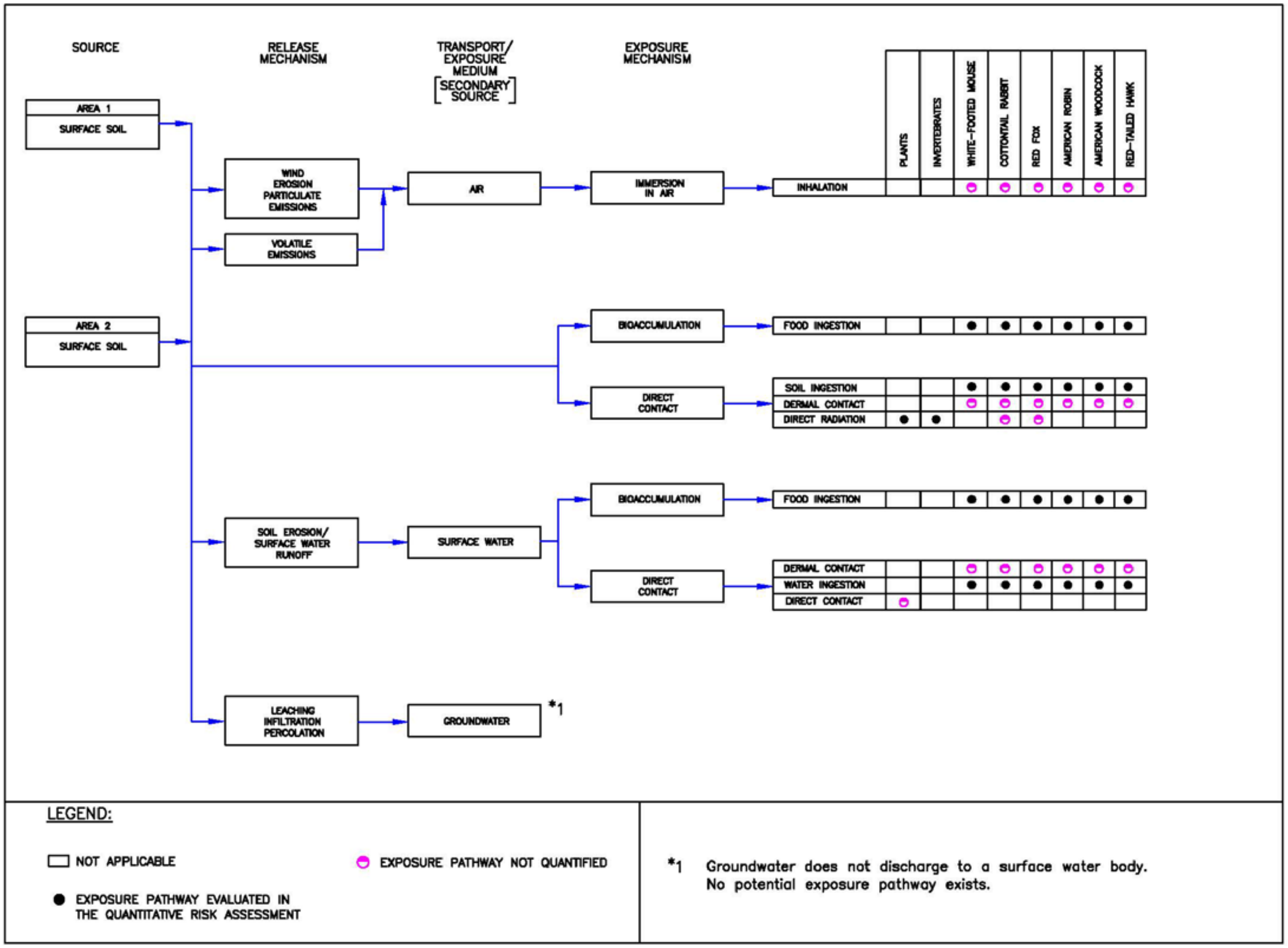


Table 26 Conceptual Model Used in SLERA

Table 27 Chemical- and Species-specific Hazard Quotients and Hazard Indices

Home Range	Receptor Types			
COPC	Plants	Invertebrates	Mammalian	Avian
Area 1				
Arsenic	12 (22)	ND (3.7)	4.8 (610)	5.1 (9.1)
Cadmium	0.25 (2.6)	0.056 (0.40)	22 (44)	10 (49)
Chromium, as Cr III	ND (31)	ND (78)	10.85 (0.001)	14.2 (12)
Copper	33 (23)	29 (46)	47 (202)	82 (60)
Lead	250.0 (6.4)	17.65 (0.64)	535.7 (4.7)	2727.3 (32)
Nickel	95 (120)	13 (18)	28 (1.6)	17 (1.2)
Radium-226 + D [a]	0.469 (0.086)	0.469 (0.086)	3.28 (0.60)	3.28 (0.60)
Selenium	481 (250)	6.1 (3.6)	397 (4885)	208 (15866)
Uranium	256 (88)	ND (ND)	393 (2.9)	80 (0.065)
HI	1127 (547)	66 (152)	1441 (5753)	3148 (16030)
Area 2				
Arsenic	33.9 (3.5)	ND (0.58)	13.26 (176)	14.2 (8.2)
Cadmium	0.11 (2.1)	0.024 (0.32)	9.44 (63)	4.42 (220)
Chromium, as Cr III	ND (49)	ND (123)	5.0 (0.0003)	6.54 (107)
Copper	5.1 (3.6)	4.5 (7.2)	7.3 (57)	12.9 (53)
Lead	108 (44)	7.6 (4.4)	232 (50)	1182 (1238)
Nickel	92 (23)	12.5 (3.4)	26.9 (0.56)	16.7 (1.3)
Radium-226 + D	0.35 (0.35)	0.35 (0.35)	2.5 (2.5)	2.5 (2.5)
Selenium	73 (38)	0.93 (0.54)	60 (1346)	32 (13672)
Uranium	1103 (175)	ND (ND)	1691 (10)	345 (0.26)
HI	1416 (347)	26 (144)	2048 (1698)	1615 (15337)
Both Areas				
Arsenic			13.3 (22)	14.2 (0.000091)
Cadmium			22 (70)	10 (ND)
Chromium, as Cr III			10.9 (0.00076)	14.2 (0.22)
Copper			47 (2.8)	82.1 (0.0037)
Lead			536 (6.8)	2727 (0.046)
Nickel			28 (0.59)	17.1 (NA)
Radium-226 + D			3.3 (2.5)	3.3 (2.5)
Selenium			397 (47)	208 (0.00044)
Uranium			1691 (0.11)	345 (0.00058)
HI			2748 (154)	3422 (12)

Notes: 2000 SLERA values are reproduced in parentheses for convenience.

ND – Not determined.

NE – Receptor groups do not roam far enough to be exposed to both areas. Not evaluated

[a] Radium-226 signifies the aggregate radiation effects from radium-226 and its decay products were considered when deriving these benchmark values.

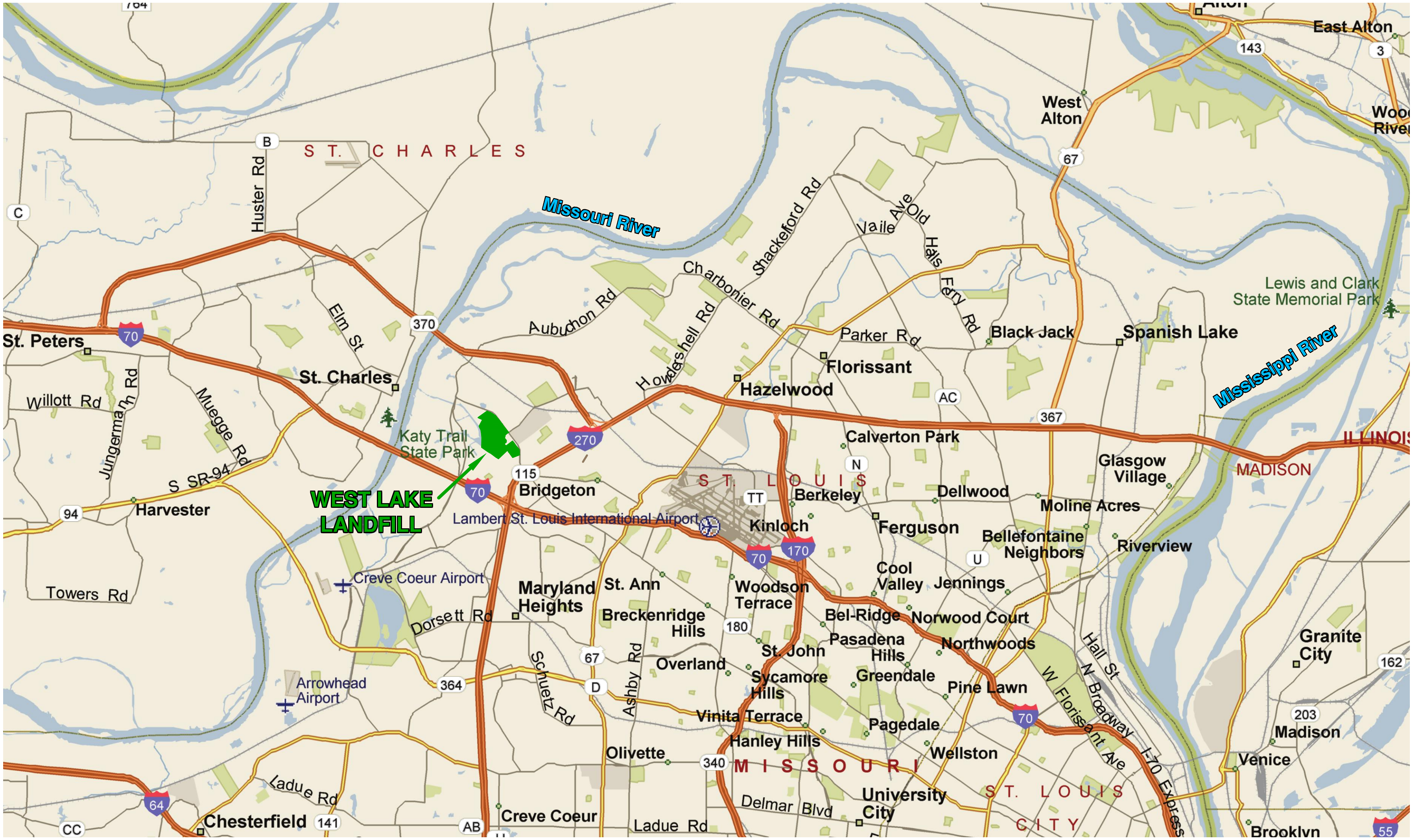
Table 28 Preliminary Estimated Capital Costs for the Amended Remedy

Partial Excavation >52.9 pCi/g to 12 feet Off-site Disposal Alternative

Cost Item			Estimated Capital Costs
Construction Costs		$	78,300,000
Radiological Survey/H&S Support Costs		$	10,359,000
On-site Rad Laboratory		$	635,000
Long-Term Monitoring Facilities		$	218,000
Post Construction Radon Flux Monitoring		$	27,000
Stormwater Monitoring during Construction		$	148,800
Air Monitoring during Construction		$	559,200
Institutional Controls		$	52,000
Subtotal		$	90,299,000
Project Management	5%	$	4,515,000
Engineering Design	6%	$	5,418,000
Construction Management	6%	$	5,418,000
Subtotal - Construction On-Site		$	105,650,000
Off-site Transportation and Disposal		$	32,700,000
Subtotal - Transport/Disposal Off-site		$	32,700,000
Contingencies:			
Scope (construction onsite)	55%	$	58,108,000
Scope (transport/disposal offsite)	15%	$	4,905,000
Bid (all activities)	20%	$	27,670,000
Subtotal - Contingency		$	90,680,000
Other Requirements:			
Buy-out Asphalt Plant Lease		$	-
Permitting for Relocation of Transfer Station		$	-
Relocate Transfer Station (not required)		$	-
Subtotal - Other Requirements		$	-
Partial Excavation >52.9 pCi/g to 12 feet Off-site Disposal Alternative		$	229,000,000

Estimated Length Construction	3/4/19	start
	12/15/21	end
	1,017	no. Days
	2.78	no. Years
	12	no. Quarters

FIGURES



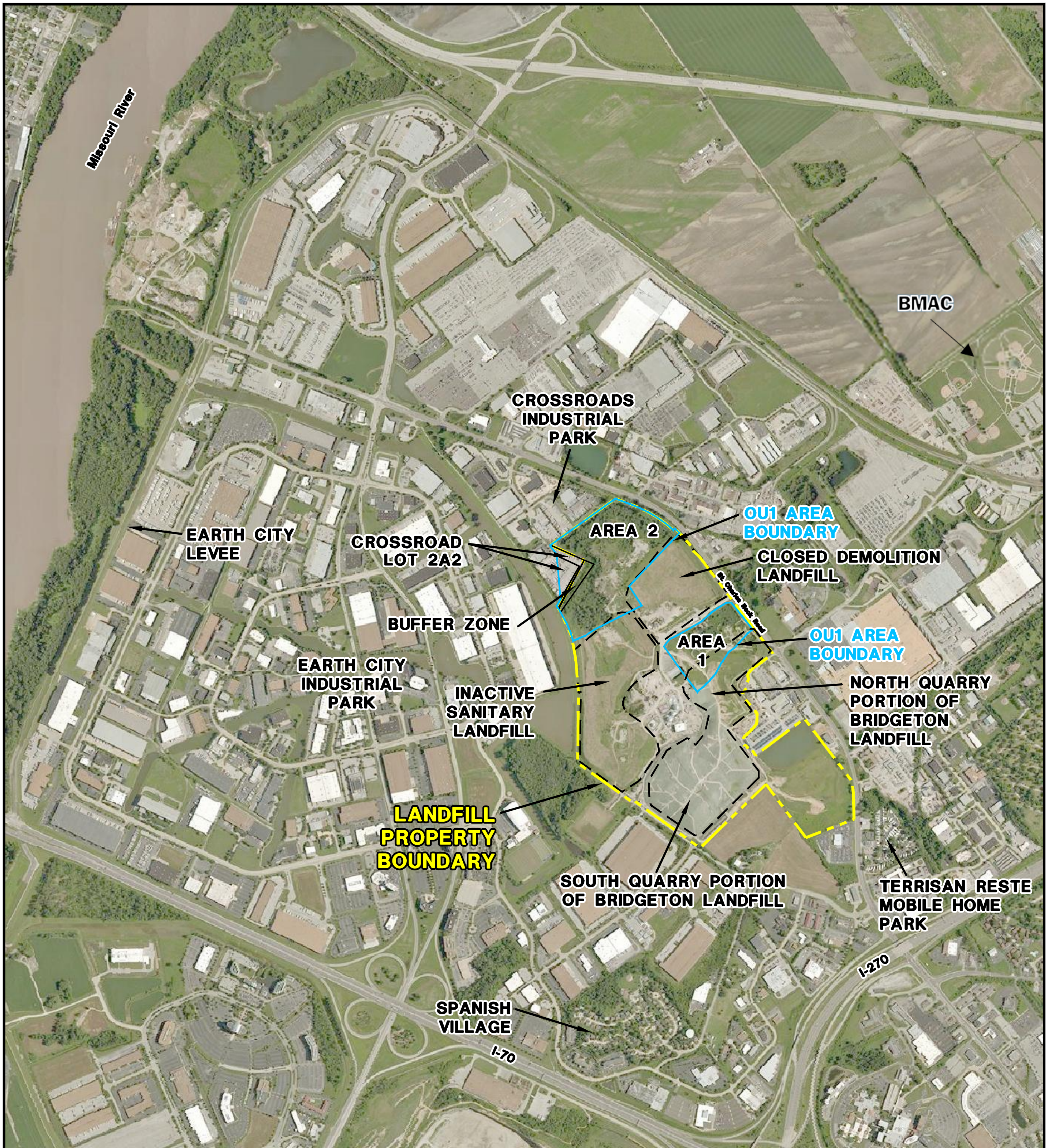
0 3
SCALE IN MILES

N

Site Vicinity Map

West Lake Landfill

Figure 1



Source: USGS Aerial Photography

N

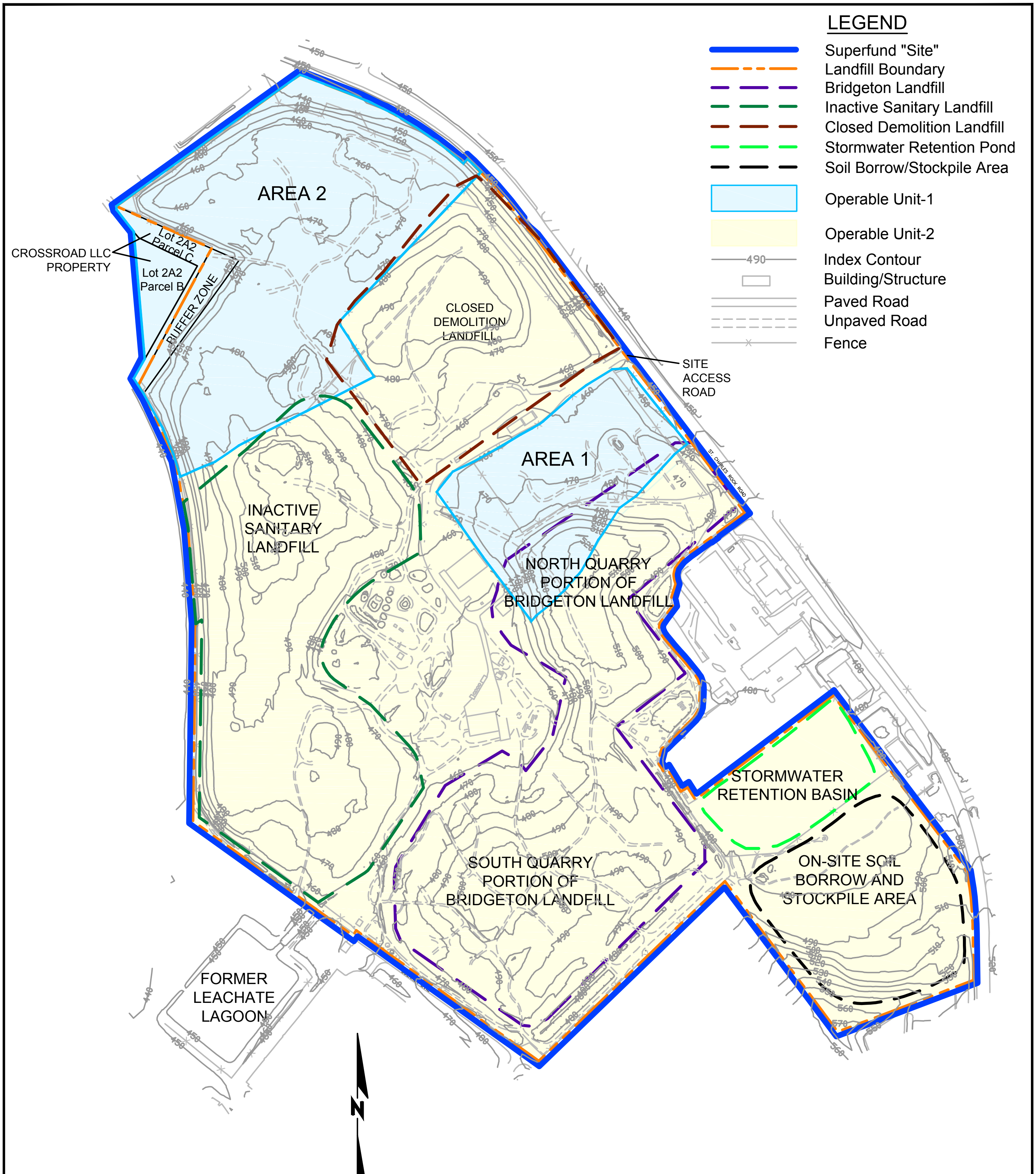
0 2000

SCALE IN FEET

Site Location Map

West Lake Landfill

Figure 2



0 350 700

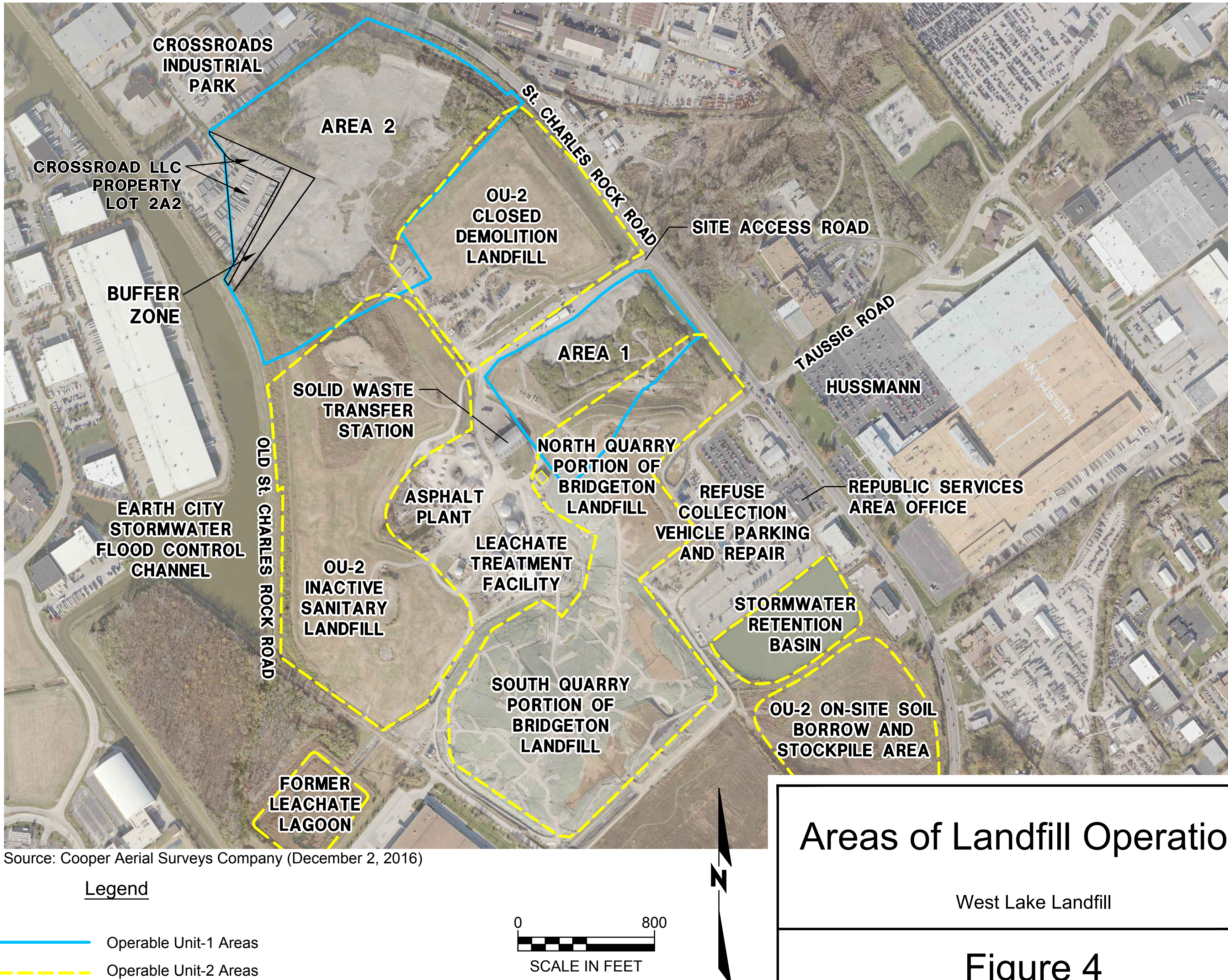
SCALE IN FEET

Notes:
- Aerial Topography Provided By Cooper Aerial Surveys Co. and is Dated December 2, 2016
- All Elevations Are Above Mean Sea Level (amsl)

Site Areas

West Lake Landfill

Figure 3



Source: Cooper Aerial Surveys Company (December 2, 2016)

Legend

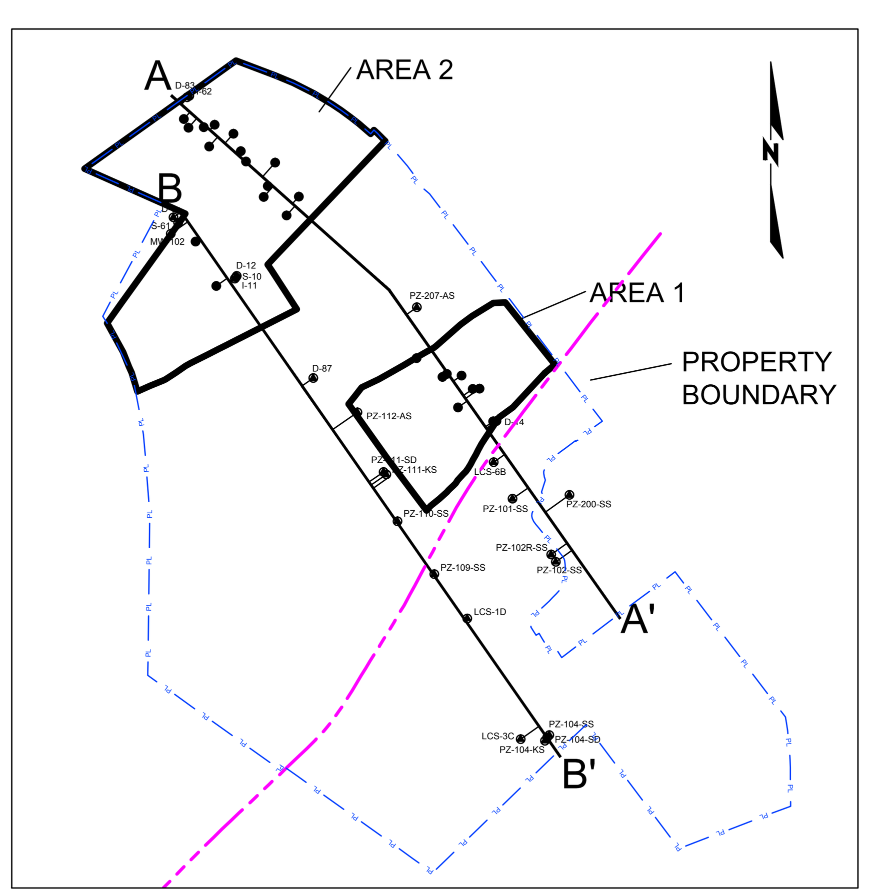
Operable Unit-1 Areas

Operable Unit-2 Areas

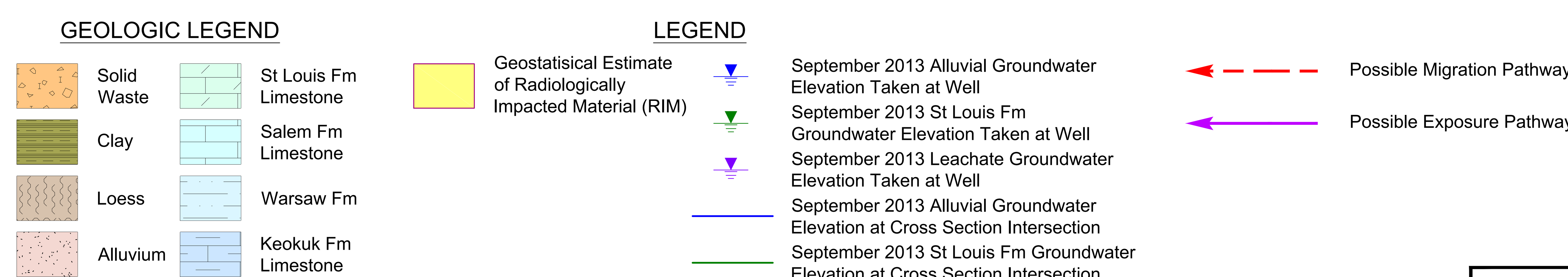
Areas of Landfill Operations

West Lake Landfill

Figure 4



Cross Section Index



Notes: These cross-sections were developed to display groundwater conditions beneath the site, and only reflect the RIM occurrences along these sections.
Please see the cross-sections in Appendix M for more detailed portrayals of the RIM occurrences in Areas 1 and 2.
Ground surface from Aerial Topography provided by Cooper Aerial Surveys Co. and is dated December 2, 2016

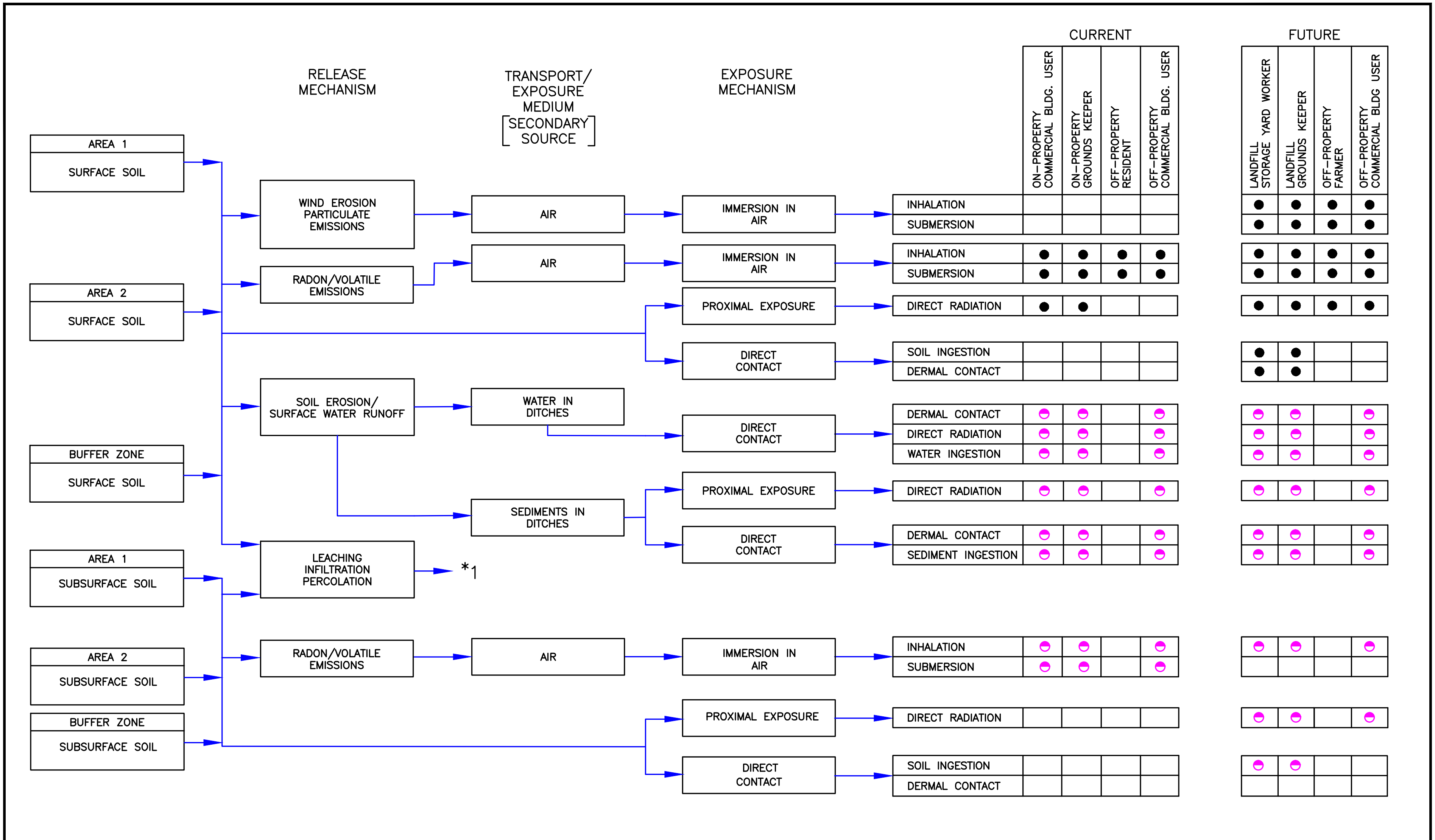
0 75 150

HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 5X

Potential Contaminant Migration and Exposure Pathways

West Lake Landfill

Figure 5



LEGEND

NOT APPLICABLE

● EXPOSURE PATHWAY EVALUATED IN THE QUANTITATIVE RISK ASSESSMENT

A PRELIMINARY SCREENING (OR INFORMATION PROVIDED BY THE U.S. ENVIRONMENTAL PROTECTION AGENCY [RAGS, PART B]) HAS DEMONSTRATED THAT THE CONTRIBUTION TO EXPOSURE FROM THIS EXPOSURE PATHWAY IS NEGLIGIBLE.

*1The groundwater pathway will be addressed by the OU-3 RI/FS.

Site Conceptual Model

West Lake Landfill

Figure 6

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAS)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
- CBRS and OPA boundary
- International, State, or County boundary
- Corporate, Extraterritorial Jurisdiction, or Urban Growth boundary
- Area Not Included boundary
- Military Reservation, Native American Lands boundary
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

- A — A: Cross section line
- 23 — 23: Transect line
- 87°07'45", 32°22'30": Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- $^{42}76^{000m}$E: 1000-meter Universal Transverse Mercator grid values, zone 15
- 600000 FT: 5000-foot grid ticks: Missouri State Plane coordinate system, east zone (FIPSZONE 2401), Transverse Mercator projection
- DX5510 ×: Bench mark (see explanation in Notes to Users section of this FIRM panel)
- ● M1.5: River Mile
- Aqueduct, Culvert, Flume, Penstock, or Storm Sewer
- Road or Railroad Bridge

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
AUGUST 2, 1995

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

February 4, 2015 – to update corporate limits, to change Base Flood Elevations, to add Special Flood Hazard Areas, to change Special Flood Hazard Areas, to change zone designations, to add roads and road names, to incorporate previously issued Letters of Map Revision, to reflect updated topographic information.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0039K

FIRM
FLOOD INSURANCE RATE MAP

ST. LOUIS COUNTY, MISSOURI
AND INCORPORATED AREAS

PANEL 39 OF 445
(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

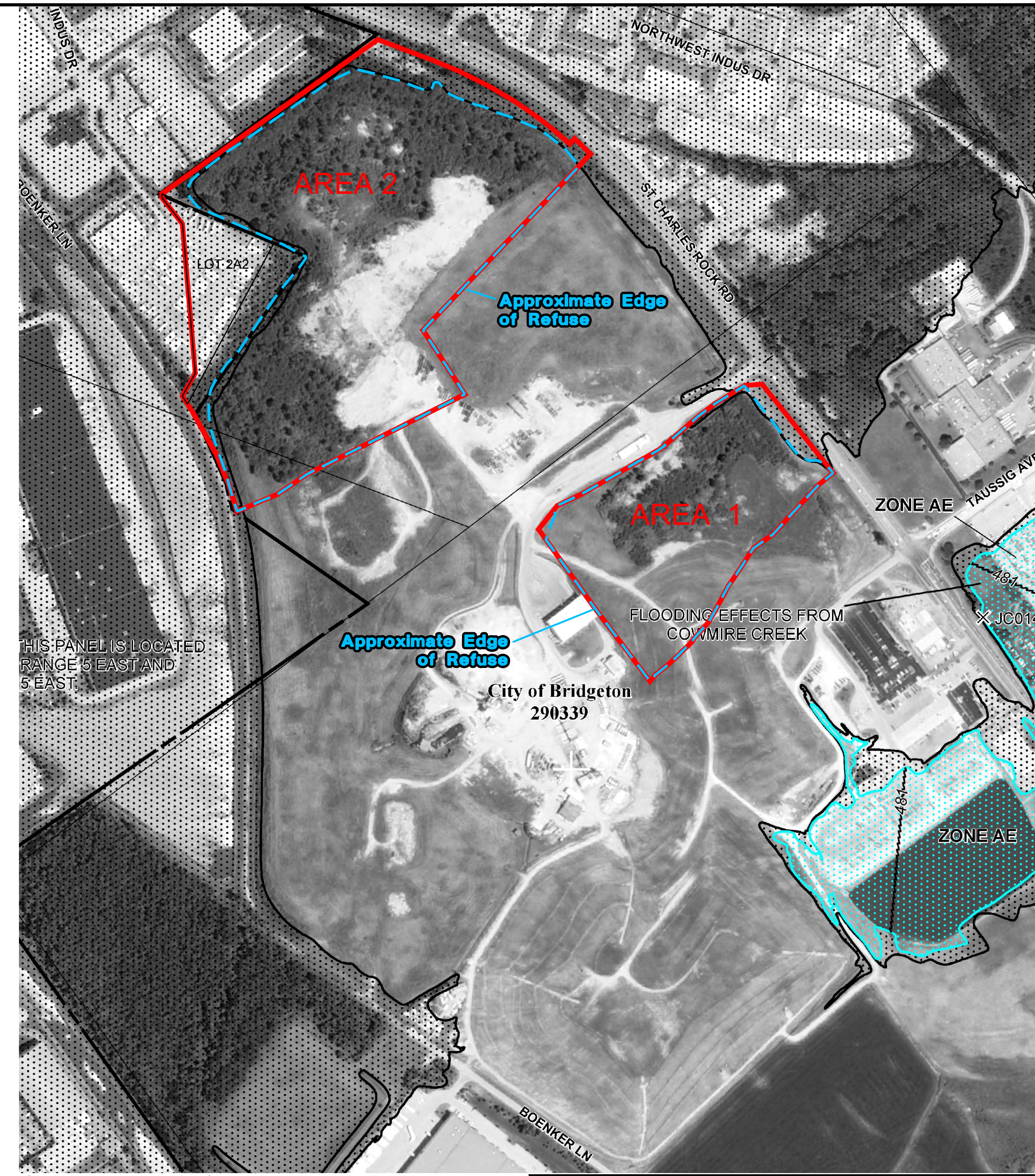
COMMUNITY	NUMBER	PANEL	SUFFIX
BRIDGETON, CITY OF	290339	0039	K
CHAMP, VILLAGE OF	290909	0039	K
MARYLAND HEIGHTS, CITY OF	290889	0039	K
ST. LOUIS COUNTY	290327	0039	K

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
29189C0039K

MAP REVISED
FEBRUARY 4, 2015

Federal Emergency Management Agency



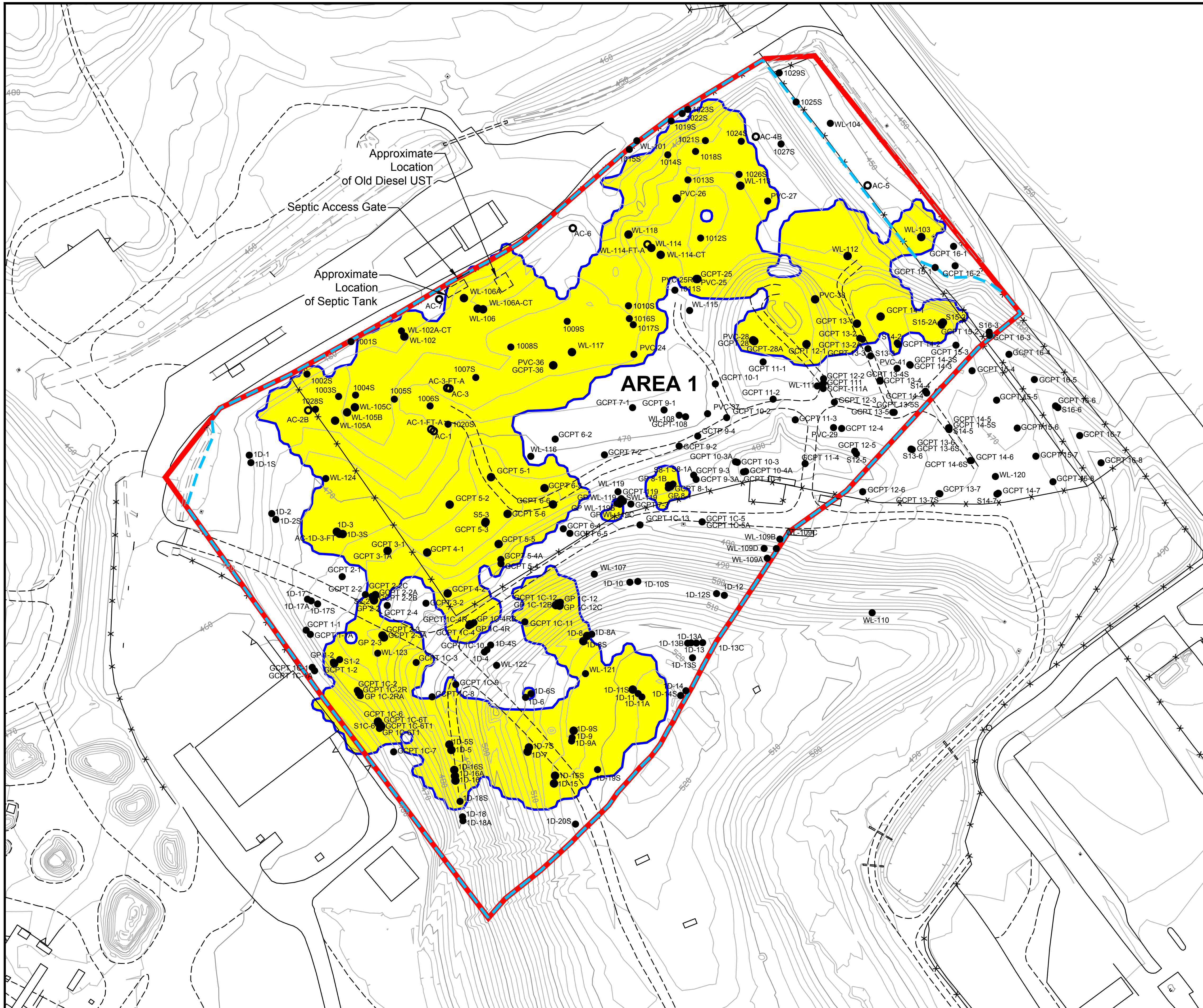
Source: FIRM Map 29189C0039K

N

0 600
SCALE IN FEET

FEMA FIRM Map
City of Bridgeton Area
West Lake Landfill

Figure 7



LEGEND

- OU-1 Area Boundary
- Approximate Edge of Refuse
- and Soil Boring or Surface Soil Sample
- Geostatistical-Based Estimate of RIM Extent
- 490 Index Contour
- Intermediate Contour
- Depression Contour
- Building/Structure
- Paved Road
- Unpaved Road
- Fence
- Retaining Wall

Notes:

- The Areal Extent of RIM Shown on this Figure does not Represent a Contiguous Layer, but Rather Portrays the Composite Occurrence of RIM at all Depths/Elevations
- Aerial Topography Provided By Cooper Aerial Surveys Co. and is Dated December 2, 2016
- All Elevations Are Above Mean Sea Level (amsl)

N

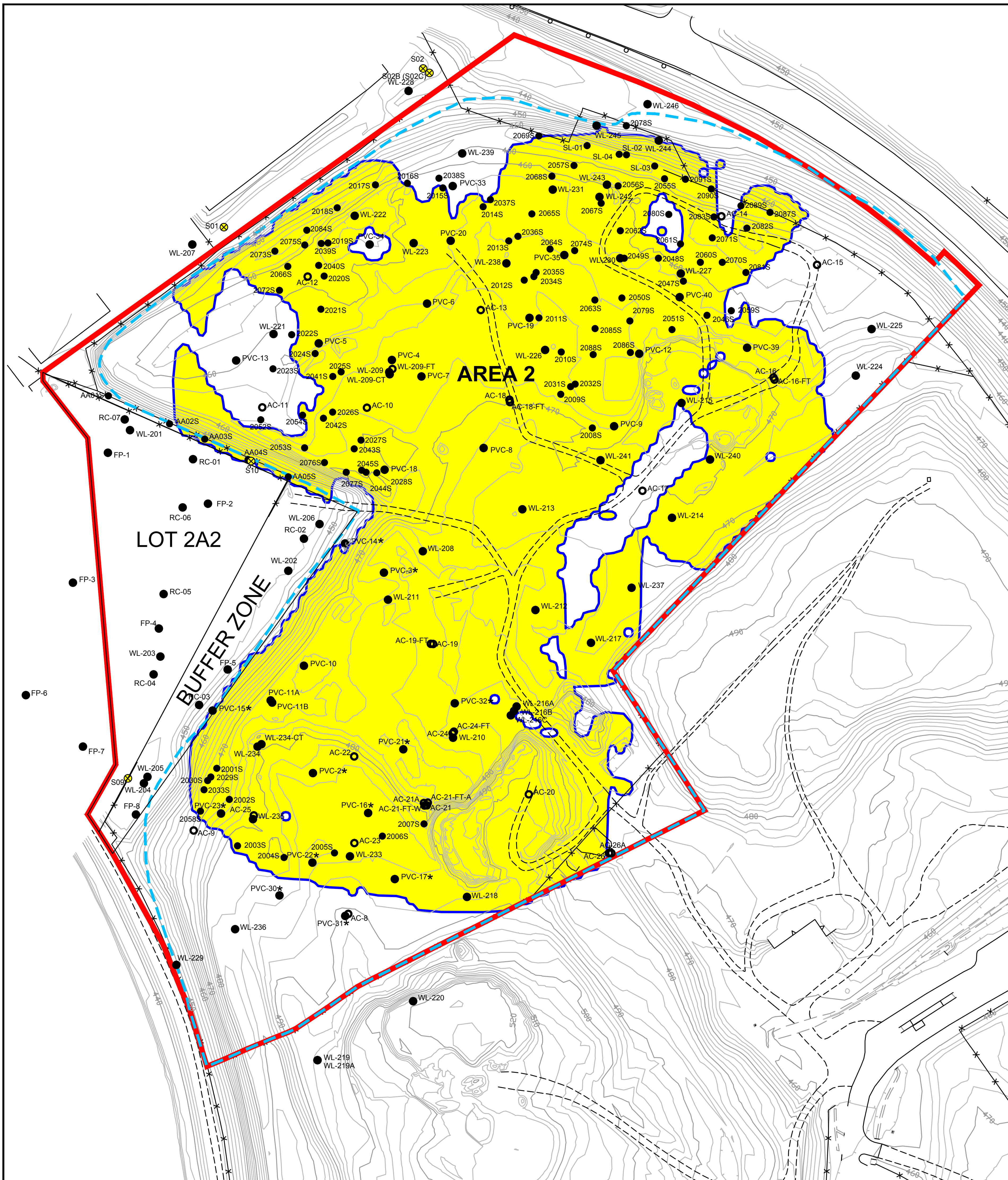
150 0 150

SCALE IN FEET

Approximate Extent of RIM Area 1

West Lake Landfill

Figure 8



LEGEND

(red line)	OU-1 Area Boundary
(blue dashed line)	Approximate Edge of Refuse
●, ○ and ⊗	Soil Boring or Surface Soil Sample
*	Location Approximate-No Survey Data Available
(yellow box)	Geostatistical-Based Estimate of RIM Extent
490	Index Contour
	Intermediate Contour
	Depression Contour
	Building/Structure
	Paved Road
	Unpaved Road
	Fence
	Retaining Wall

N

200 0 200

SCALE IN FEET

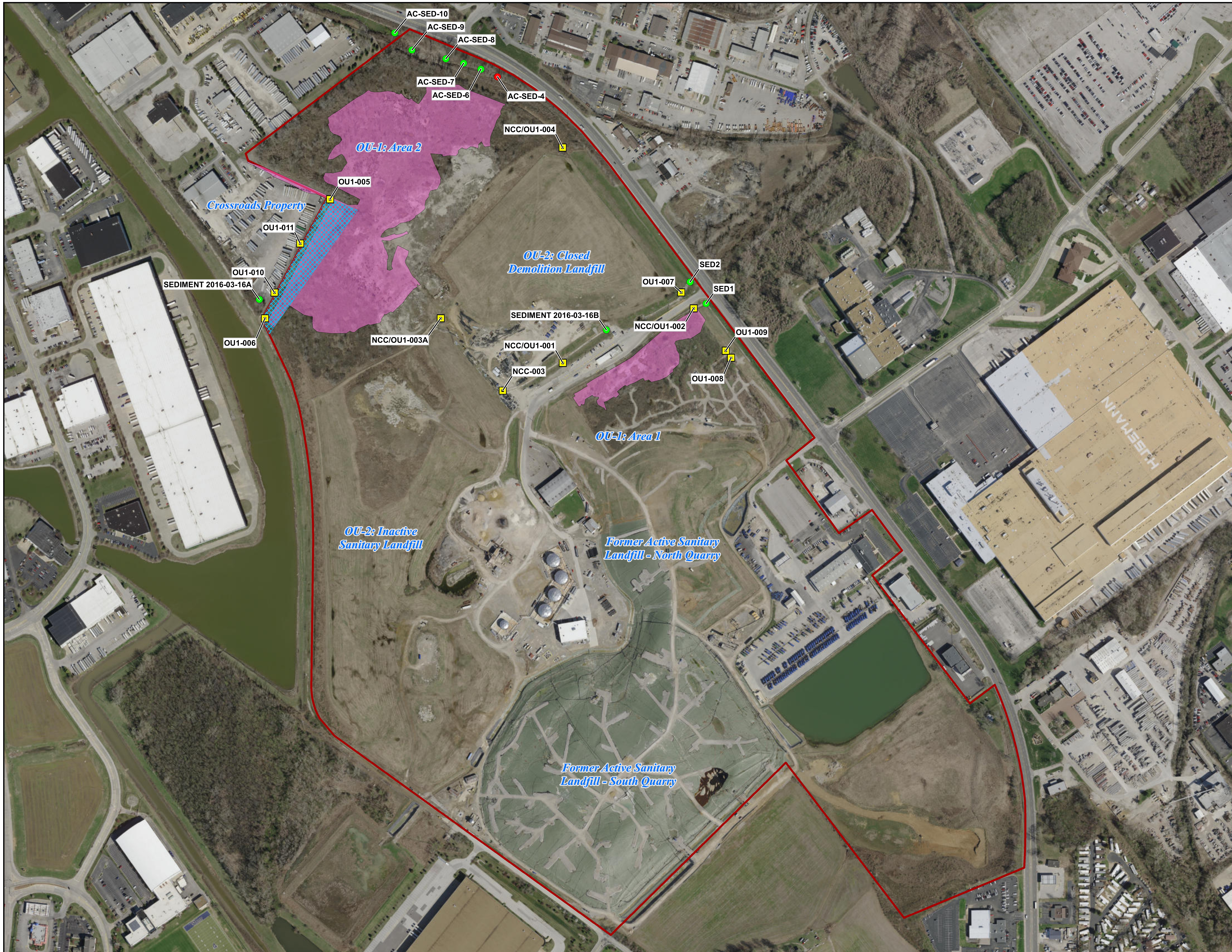
Notes:

- The Areal Extent of RIM Shown on this Figure does not Represent a Contiguous Layer, but Rather Portrays the Composite Occurrence of RIM at all Depths/Elevations
- Aerial Topography Provided By Cooper Aerial Surveys Co. and is Dated December 2, 2016
- All Elevations Are Above Mean Sea Level (amsl)

Approximate Extent of RIM Area 2

West Lake Landfill

Figure 9



Legend

EPA/PRP Sediment Sampling Locations 2015-2017

- Below RIM definition
- Meets RIM definition[1]

Stormwater Outfall Locations

- Stormwater Outfall Location
- Buffer Zone
- Extent of NCC Cover[3]
- West Lake Landfill Site Boundary

EPA Environmental Protection Agency

MDNR Missouri Department of Natural Resources

NCC Non-combustible Cover

OU Operable Unit

PRP Potentially Responsible Party

RIM Radiologically-Impacted Material[2]

Notes:

[1] Initial samples collected at location AC-SED-4 contained combined thorium meeting the definition of RIM (combined thorium above 7.9 picoCuries per gram [pCi/g]). Follow-up samples from the location did not meet the definition of RIM.

[2] RIM is defined as material containing combined radium activity exceeding 7.9 pCi/g, combined thorium activity exceeding 7.9 pCi/g, or total uranium activity exceeding 54.5 pCi/g.

[3] This map depicts the extent of the NCC prior to the completion of the last phase of installation which included the steep sloped areas.

N

330 0 330

Feet

Note: The Environmental Protection Agency does not guarantee the accuracy, completeness, or timeliness of the information shown, and shall not be liable for any injury or loss resulting from the reliance upon the information shown.

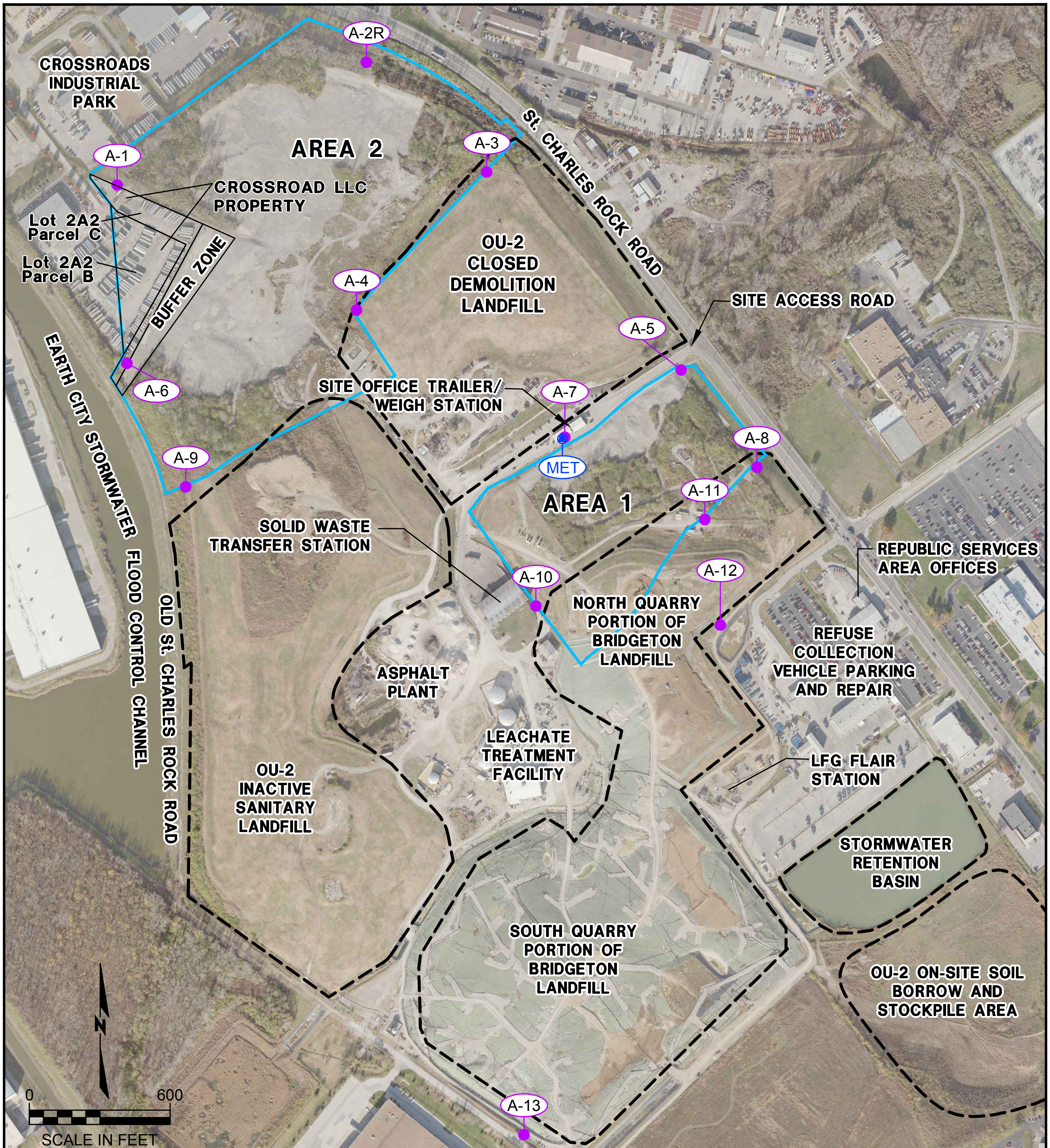
Source: ESRI, Digital Globe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Environmental Protection Agency Region 7 Responsible Parties

Stormwater and Sediment Sample Locations

West Lake Landfill

Figure 10

Date: 8/28/2017 Drawn By: Nick Wiederholt Project No: 103X0251610134000



Source: Cooper Aerial Surveys Company (December 2, 2016)

Legend

OU-1 Area Boundary

A-1 Environmental Monitoring Station

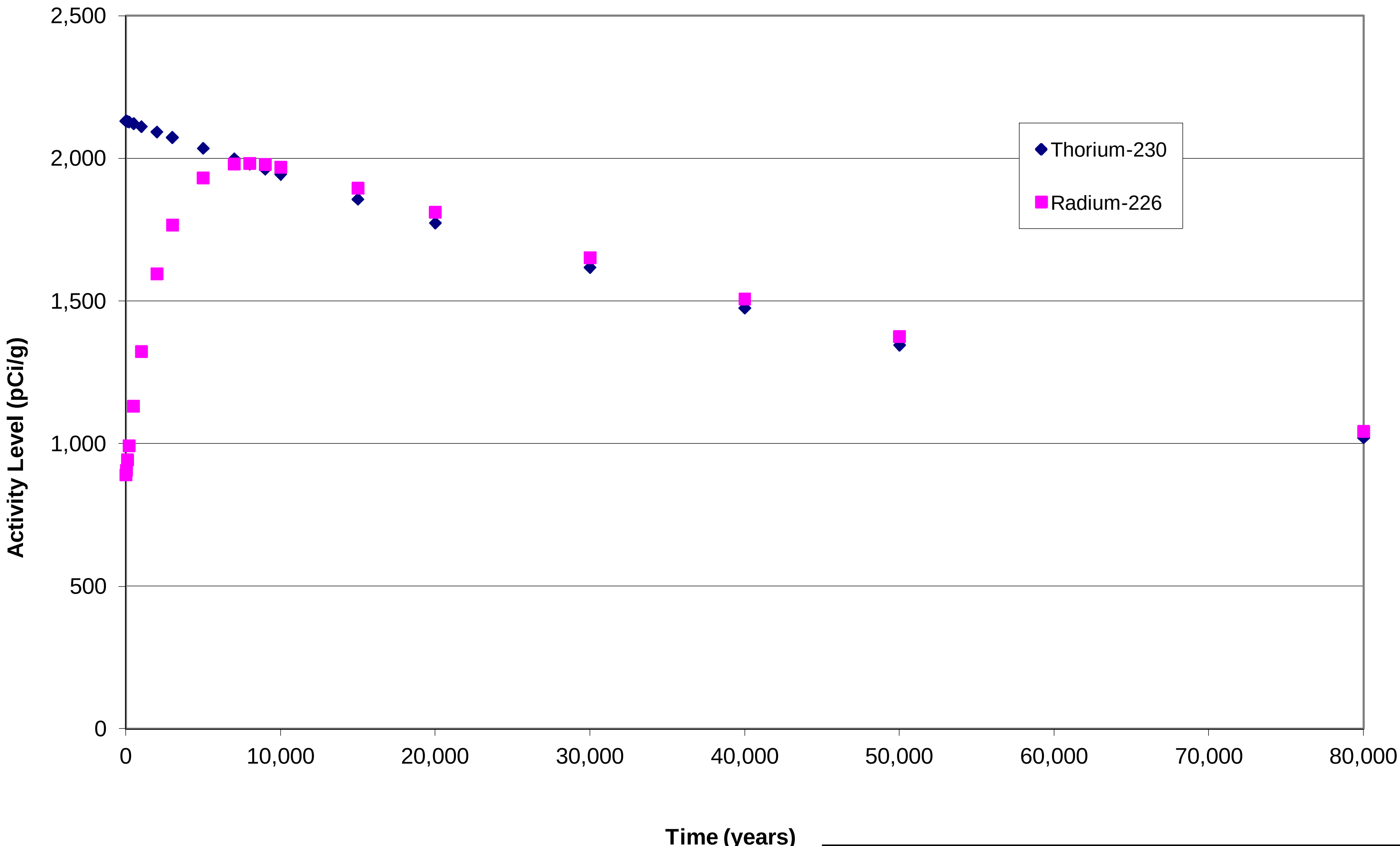
Meteorological Station MET

Air Quality Monitoring Stations

for Post ROD Baseline Monitoring

West Lake Landfill

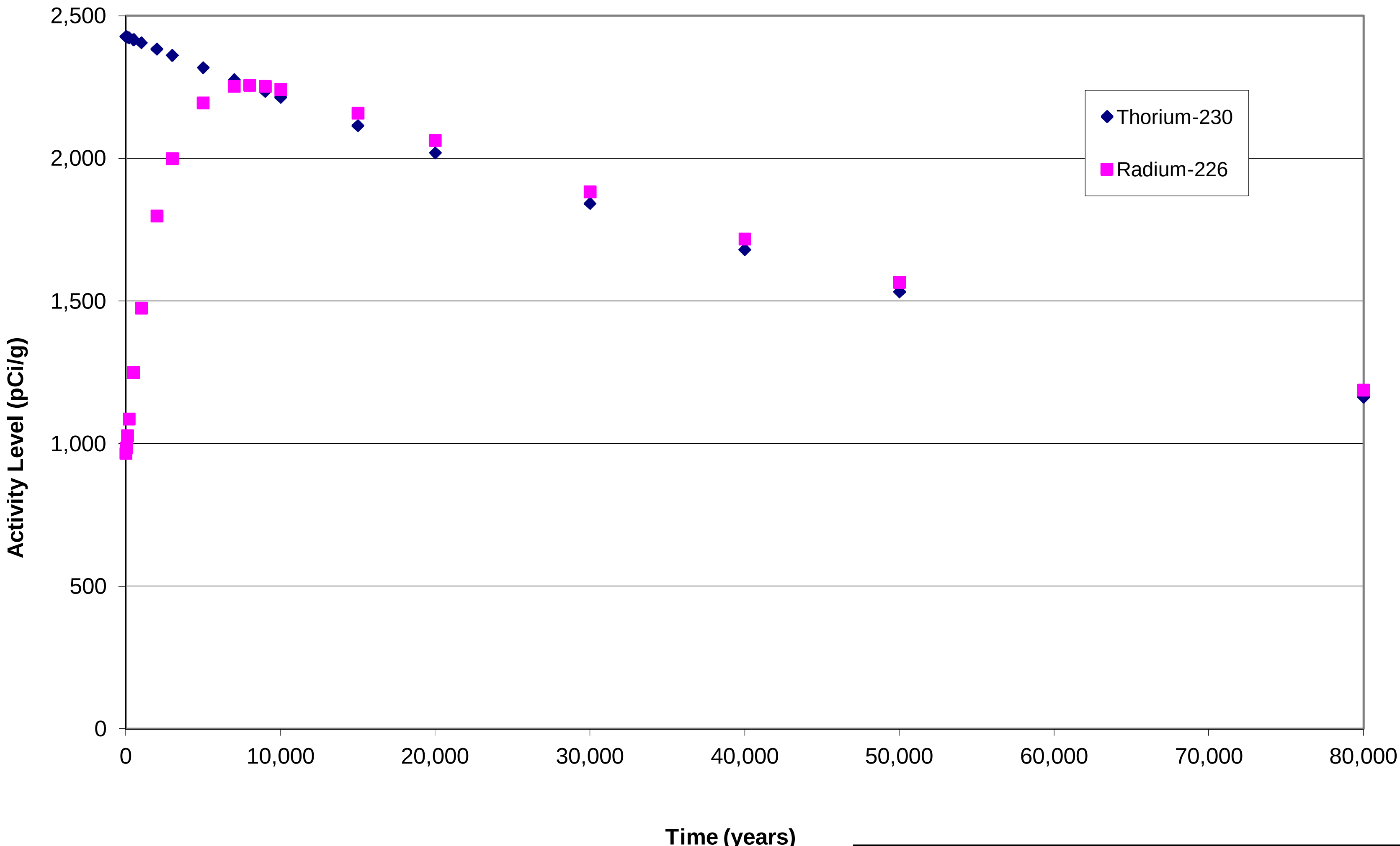
Figure 11



Thorium-230 Decay and Radium-226 Ingrowth Over Time Area 1

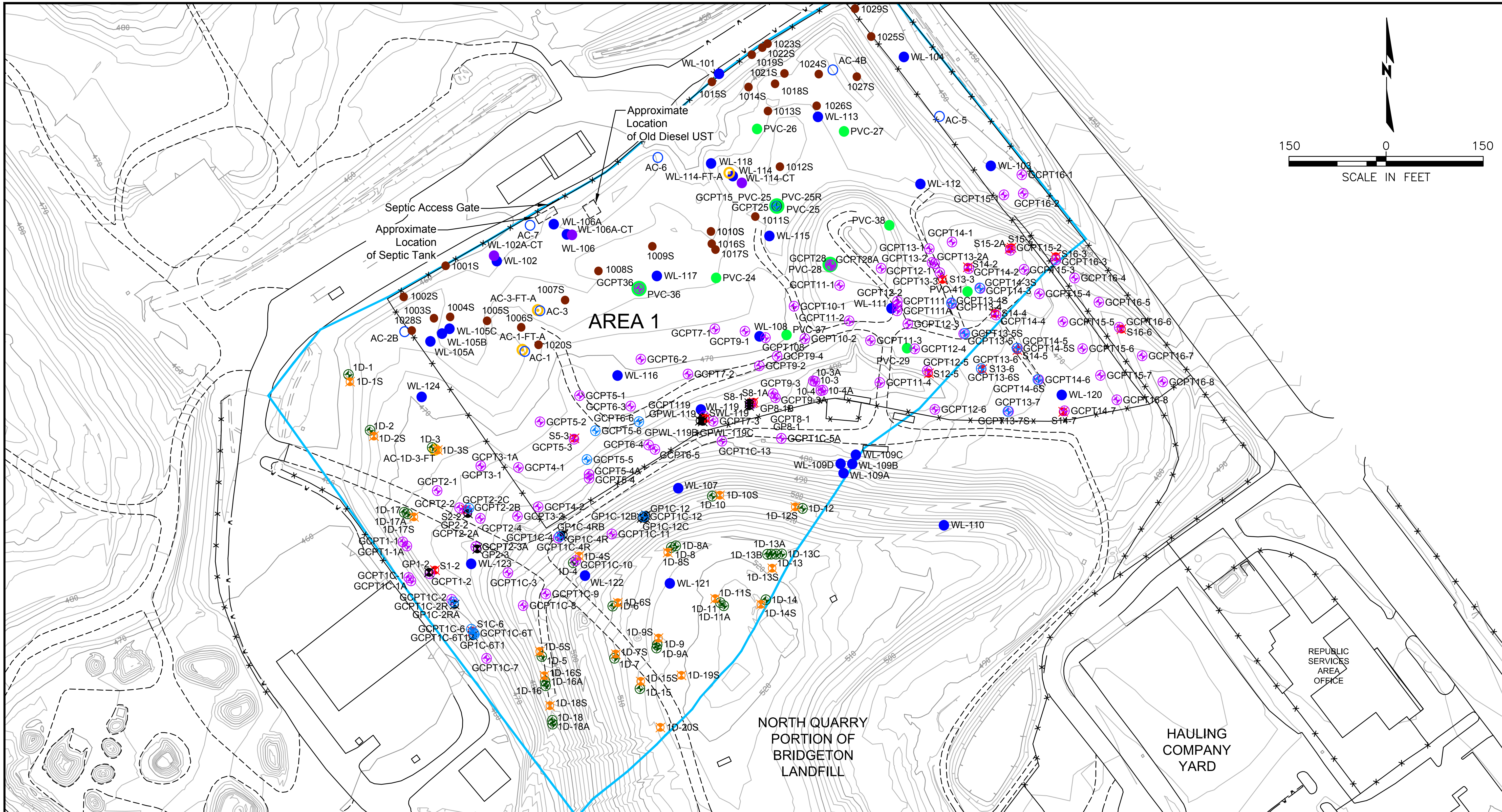
West Lake Landfill

Figure 12



Thorium-230 Decay and
Radium-226 Ingrowth Over Time
Area 2
West Lake Landfill

Figure 13



Legend

- PVC series – NRC borings
- WL series – RI borings (1995 RI borings done by McLaren Hart)
- Phase 1A GCPT Soundings
- Phase 1B GCPT Soundings
- Phase 1C Sonic Borings
- Phase 1C Percussion Geoprobe Borings
- Phase 1D GCPT Soundings
- Phase 1D Sonic Borings
- Cotter Soil Borings
- Additional Characterization Borings
- Additional Characterization Fate and Transport Borings
- NCC Surface Sample
- OU-1 Area Boundary
- Index Contour
- Intermediate Contour
- Building/Structure
- Paved Road
- Unpaved Road
- Fence

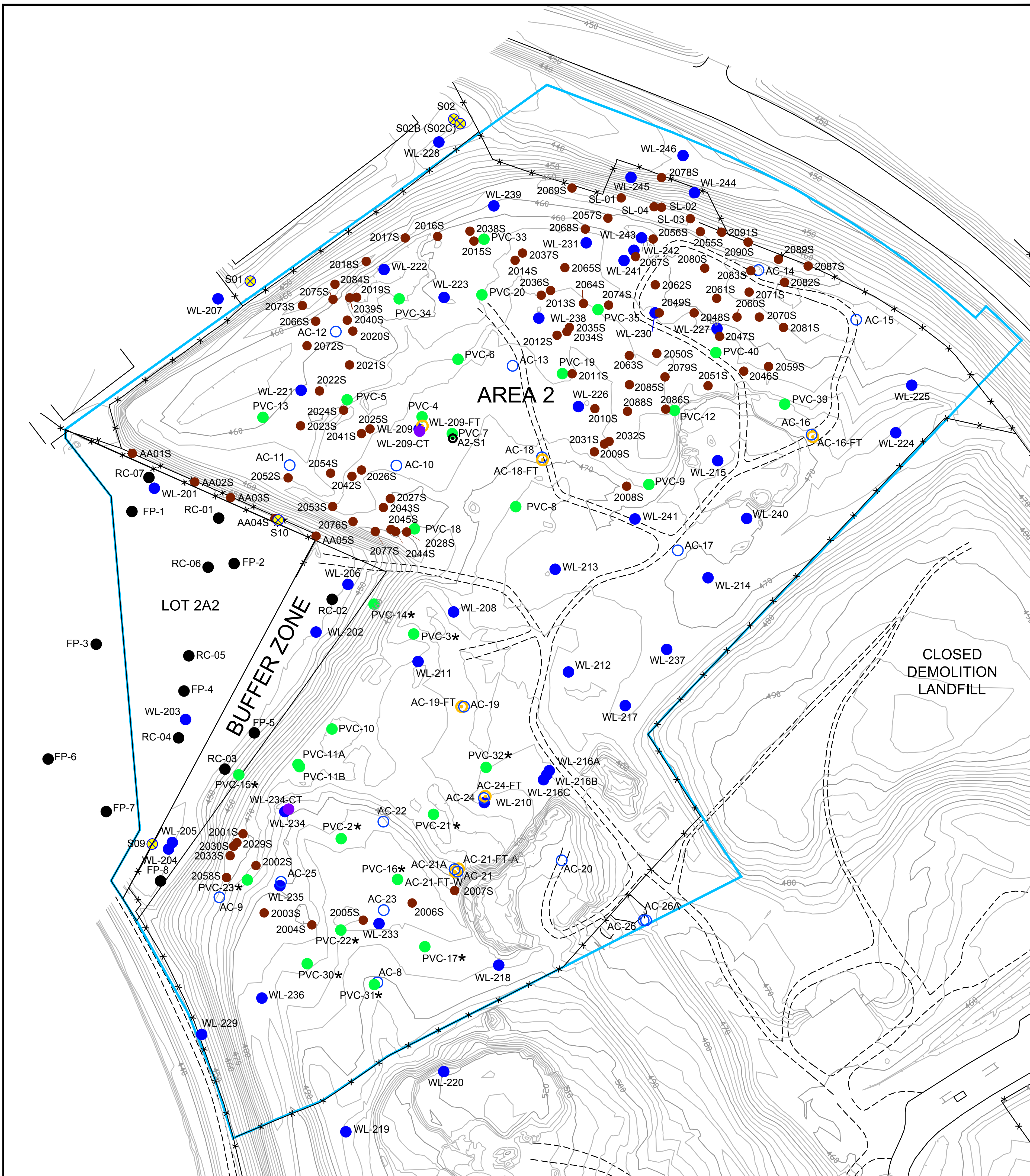
Notes:

- PVC 25, 28, and 36 were Logged Multiple Times Resulting in Multiple Boring Symbols at Each Location, Making the Individual Symbols Difficult to Differentiate
- Aerial Topography Provided by Cooper Aerial Surveys Co. and is Dated December 2, 2016
- All Elevations are Above Mean Sea Level (amsl)

Soil/Waste Sample Locations Area 1

West Lake Landfill

Figure 14



- PVC series – NRC borings
- ★ PVC series – NRC borings (location Approximate - no survey data available)
- WL series – RI borings (1995 RI borings done by McLaren Hart)
- Shallow Samples (EMSI - 1997&2000)
- Cotter Soil Borings
- Additional Characterization Borings
- Additional Characterization Fate and Transport Borings
- MDNR Soil Sample
- NCC Surface Sample
- EPA Surface Soil Sample

OU-1 Area 2 Boundary
490 Index Contour
Intermediate Contour
Building/Structure
Paved Road
Unpaved Road
Fence

Notes:
- Aerial Topography Provided By Cooper Aerial Surveys Co. and is Dated December 2, 2016
- All Elevations are Above Mean Sea Level (amsl)

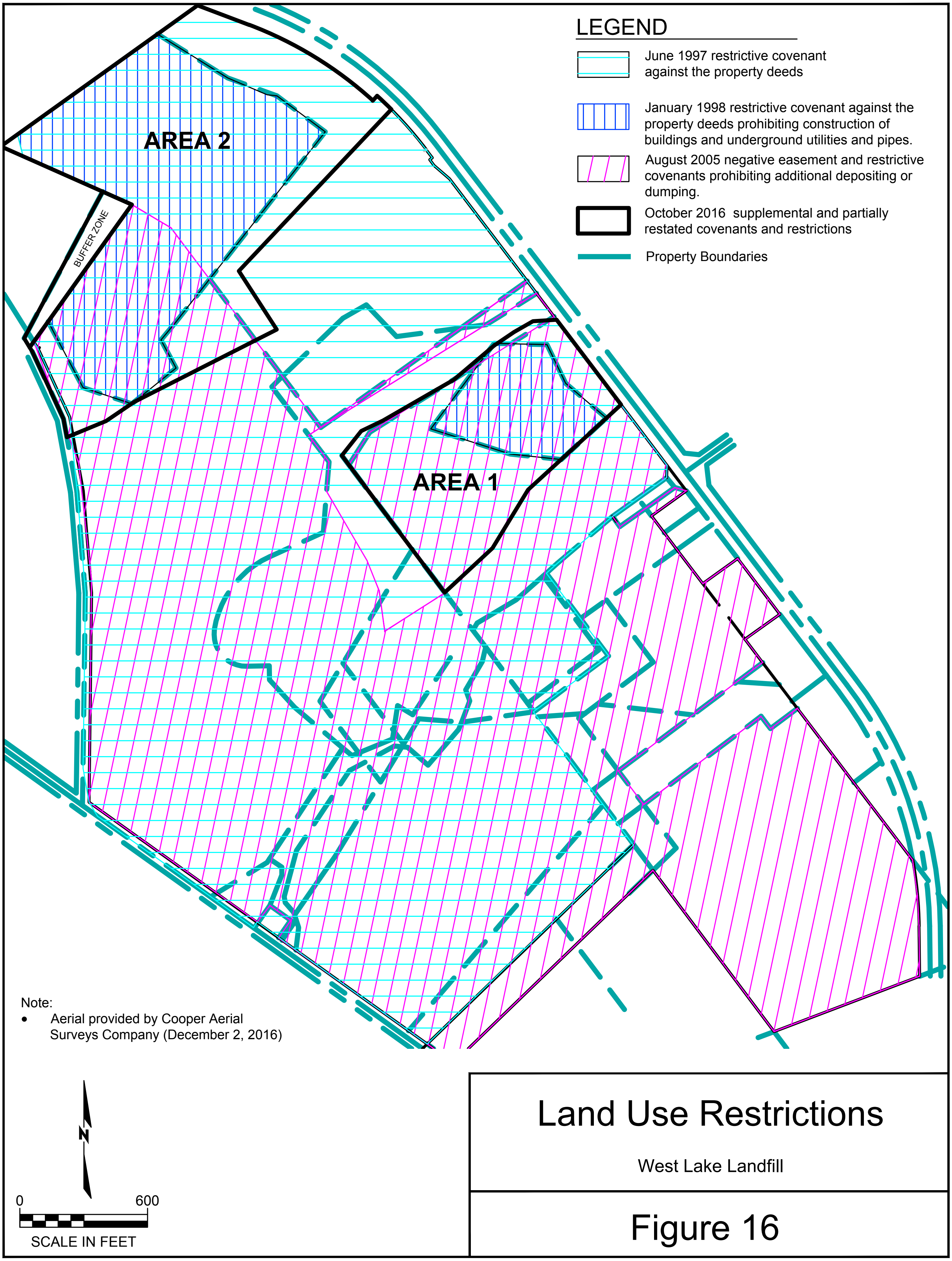
N

200 0 200
SCALE IN FEET

Soil/Waste Sample Locations Area 2

West Lake Landfill

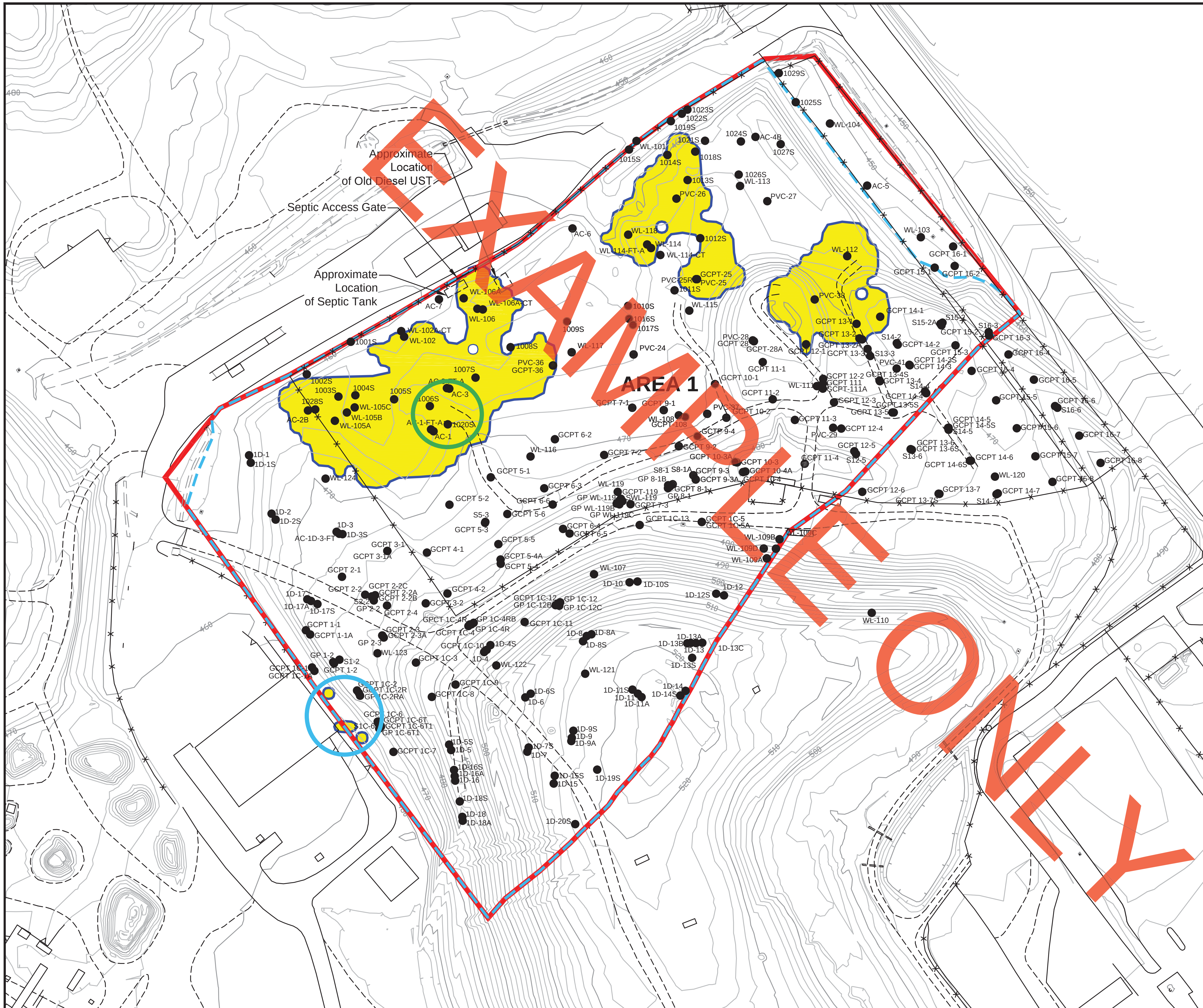
Figure 15



Land Use Restrictions

West Lake Landfill

Figure 16



LEGEND

- Potential isolated pockets[1]
- Potential areas of deeper excavation[1]
- OU-1 Area Boundary
- Approximate Edge of Refuse
- Soil Boring or Surface Soil Sample
- Geostatistical-Based Estimate of RIM Extent (>52.9 pCi/g <16' Below 2005 Topographic Surface)
- Index Contour
- Intermediate Contour
- Depression Contour
- Building/Structure
- Paved Road
- Unpaved Road
- Fence
- Retaining Wall

Notes:

- The Areal Extent of RIM Shown on this Figure does not Represent a Contiguous Layer, but Rather Portrays the Composite Occurrence of RIM at all Depths/Elevations
- Aerial Topography Provided By Cooper Aerial Surveys Co. and is Dated December 2, 2016
- All Elevations Are Above Mean Sea Level (amsl)

[1] These areas were selected to serve only as examples. Final determinations will be made during Remedial Design.

150 0 150

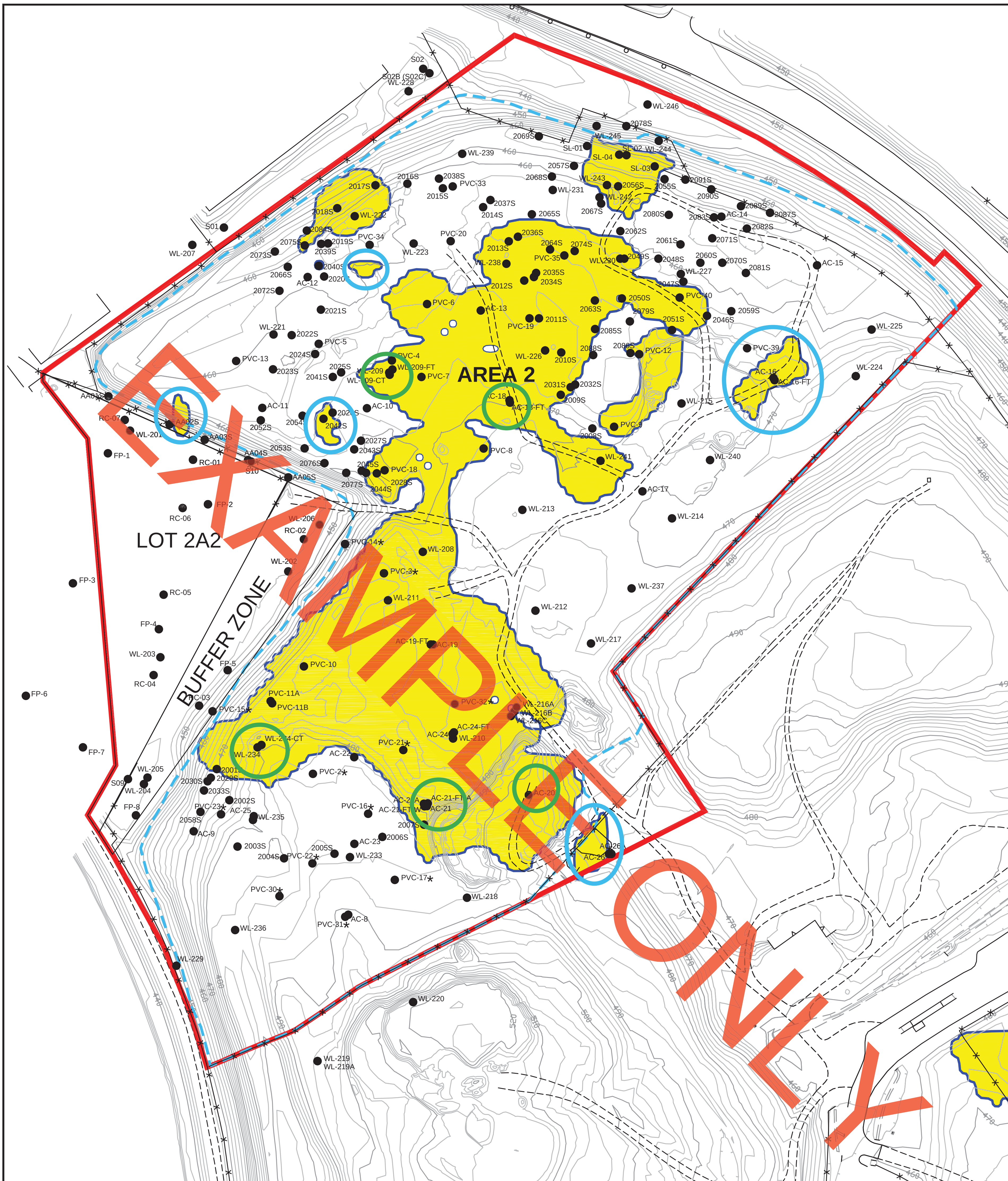
SCALE IN FEET

Approximate Extent of RIM-Area 1 (>52.9 pCi/g & <16' Deep)

Modification Examples

West Lake Landfill

Figure 17



LEGEND

- Potential isolated pockets[1]
- Potential areas of deeper excavation[1]
- OU-1 Area Boundary
- Approximate Edge of Refuse
- Soil Boring or Surface Soil Sample
- Location Approximate-No Survey Data Available
- Geostatistical-Based Estimate of RIM Extent (>52.9 pCi/g & <16' Below 2005 Topographic Surface)
- Index Contour
- Intermediate Contour
- Depression Contour
- Building/Structure
- Paved Road
- Unpaved Road
- Fence
- Retaining Wall

200 0 200

SCALE IN FEET

Notes:

- The Areal Extent of RIM Shown on this Figure does not Represent a Contiguous Layer, but Rather Portrays the Composite Occurrence of RIM at all Depths/Elevations
- Aerial Topography Provided By Cooper Aerial Surveys Co. and is Dated December 2, 2016
- All Elevations Are Above Mean Sea Level (amsl)

1 These areas were selected to serve only as examples. Final determinations will be made during Remedial Design.

Approximate Extent of RIM-Area 2 (>52.9 pCi/g & <16' Deep)

Modification Examples

West Lake Landfill

Figure 18

APPENDIX A
State Acceptance Letter

September 25, 2018

Mr. Jim Gulliford
Region 7 Administrator
U.S. Environmental Protection Agency
11201 Renner Boulevard
Lenexa, KS 66219

RE: U.S. Environmental Protection Agency's (EPA) Record of Decision (ROD) Amendment, West Lake Landfill Superfund Site, Operable Unit 1

Dear Mr. Gulliford:

The Missouri Department of Natural Resources appreciates the opportunity to review the EPA's selected amended remedy for Operable Unit 1 of the West Lake Landfill, located in Bridgeton, Missouri.

The Department's final position on the selected remedy is as follows:

> "The Missouri Department of Natural Resources has reviewed the Record of Decision (ROD) Amendment for Operable Unit 1 (OU-1) of West Lake Landfill. The Department concurs with EPA's selected amended remedy as presented in this ROD Amendment.
>
> As the site progresses toward remedial design, the Department will continue to support EPA's efforts during implementation of the remedial components. Since Radiologically Impacted Material will remain at this site, the Department recognizes the need for perpetual care and monitoring and will work with EPA to develop durable long-term stewardship and monitoring plans. The ROD Amendment indicates that EPA will negotiate financial assurance with the responsible parties. The Department requests that these negotiations establish durable financial instruments to protect state and local jurisdictions from bearing the cost of long-term stewardship."

We understand that EPA will finalize the ROD Amendment and start the remedial design and remedial action phase. We look forward to reviewing and providing feedback on associated planning and action documents. If you have any questions, please contact Carey Bridges of my staff at (573) 751-0763 or by email at carey.bridges@dnr.mo.gov. Thank you.

Sincerely,

Carol S. Comer
Director

c: Ms. Lynn Juett, Branch Chief, U.S. EPA R7
Ms. Christine Jump, Remedial Project Manager, U.S. EPA R7

APPENDIX B
Comments from the 2012 NRRB Consultation

National Remedy Review Board Discussions Regarding the Remedy at the West Lake Landfill Superfund Site

Purpose

The Board conducted this consultation on February 29, 2012. The review of the West Lake Landfill operable unit 1 (OU l) potential remedial action was planned to be a full review culminating in a recommendations memo. After the presentation to the Board and based on feedback from Board members, the Region concluded that additional work was appropriate and requested an optional early consultation. Under NRRB guidelines, Regions may request an optional NRRB consultation on remedial alternatives at any time prior to the draft proposed plan. The discussion captured in this document reflects basic ideas and general suggestions based on the Board's professional experience and knowledge of regional practices.

Site Summary

The West Lake Landfill Site (the Site) is on a parcel of approximately 200 acres located in the northwestern portion of the St. Louis metropolitan area. The Site consists of the 1) Bridgeton Sanitary Landfill (Former Active Sanitary Landfill), 2) Radiological Area 1, 3) Radiological Area 2, 4) Buffer Zone/Crossroad Property, and 5) Closed Demolition Landfill. The Site was used agriculturally until a limestone quarrying and crushing operation began in 1939. The quarrying operation continued until 1988 and resulted in two quarry pits. Beginning in the early 1950s, portions of the quarried areas and adjacent areas were used for landfilling municipal solid waste (MSW), industrial solid wastes, and construction/demolition debris. These operations were not subject to state permitting because they occurred prior to the formation of the Missouri Department of Natural Resources (MDNR) in 1974. Two landfill areas were radiologically contaminated in 1973 when they received soil mixed with leached barium sulfate residues.

The barium sulfate residues, containing traces of uranium, thorium, and their long-lived daughter products, were some of the uranium ore processing residues initially 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), which is part of the St. Louis Formerly Utilized Sites Remedial Action Program managed by the U.S. Army Corps of Engineers.

In 1966 and 1967, the remaining residues from SLAPS were purchased by a private company for mineral recovery and placed in storage at a nearby facility on Latty Avenue under an AEC license. Most of the residues were shipped to Canon City, Colorado, for reprocessing except for the leached barium sulfate residues, which were the least valuable in terms of mineral content, i.e., most of the uranium and radium was removed in previous precipitation steps. Reportedly, 8,700 tons of leached barium sulfate residues were mixed with approximately 39,000 tons of soil and then transported to the Site. According to the landfill operator, the soil was used as cover for municipal refuse in routine landfill operations.

The Site has been divided into two OUs. OU 1 consists of Radiological Area 1 and Radiological Area 2 (Areas 1 and 2) and the Buffer Zone/Crossroad Property. OU 2 consists of the other landfill areas that are not impacted by radionuclides, i.e., the Closed Demolition Landfill, the Inactive Sanitary Landfill, and the Former Active Sanitary Landfill. OU 1 is the subject of this review.

Comments

Site Characterization

Based on the information presented to the Board, it appeared that there were some samples of site groundwater that exceed standards considered to be applicable and relevant or appropriate requirements (ARARs). Also, the package provided to the Board states that the OU1 and OU2 RODs provide the final remedial actions for both source control and groundwater and complete the CERCLA decision-making for the Site. In addition, the Region stated that since no discernible plume was identified at this site, the Region's preferred approach was to take no remedial action at the present time but to continue monitoring groundwater. The Board notes that under existing Agency guidance, action "may be warranted if a chemical specific standard that defines acceptable risk is violated" (Office of Solid Waste and Emergency Response (OSWER) Directive No. 9355.0-30, April 1991, *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*). OSWER Directive No. 9283.1-33, June 2009, *Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration* also discusses whether CERCLA remedial action is warranted under these types of conditions. Since the NCP's expectation in §300.430(a)(1) (iii)(F) states that wherever practicable "EPA expects to return usable ground waters to their beneficial uses", the Board suggests that the Region consider adding wells at the site to better delineate the vertical and lateral extent of potential site-related contamination previously indentified from limited sampling in Areas 1 and 2. These additional wells would be instrumental in clarifying the presence of isolated groundwater contamination versus a groundwater plume in the complex subsurface geologic setting, and would help inform a decision about whether CERCLA response authority is warranted to address any additional contamination.

The package provided to the Board at page 22 states that "Only four wells exhibited a total radium concentration above 5 picoCuries per liter (pCi/l). These exceedances ranged from 5.74 pCi/l to 6.33 pCi/l. The slight exceedances are isolated spatially. Two of the four wells with total radium exceedances are located in areas that are not downgradient of either Radiological Area 1 or Radiological Area 2." The chart on page 21of the package, however, indicates that there were two wells with exceedances and that the maximum detected concentration was 8 pCi/l. The Board suggests that the Region reconcile these discrepancies.

Waste Characterization

Location of Radiologically Impacted Material - The site review package and power point presentation provided to the Board characterized radiologically impacted material (RIM) at the site to be: 1) intermixed throughout the landfill matrix, 2) consisting of municipal refuse in Area 1, and mostly construction and demolition debris in Area 2, 3) dispersed both laterally and vertically at depths up to 15 feet in Area 1 and 12 feet in Area 2 with some localized occurrences that are deeper , and 4) representing an amount of hazardous fill equal to 500,000 cubic yards (cy). The Board notes that the remedial investigation (RI), the 1982 Nuclear Regulatory Commission (NRC) Radiological Survey and the 1988 NRC report describe the RIM to be in an identifiable and relatively localized area (e.g., a thin layer in the upper part of the landfill) which is consistent with the short time period that RIM was brought to the landfill relative to its long operating life. The Board also notes that some of the RI boring data indicating deeper contamination was footnoted as not credible or representative (i.e., RIM knocked into the boring holes during drilling or logging activities). The Board is concerned that inconsistencies in the waste characterization may have led to significant uncertainties in determining the location and volume of RIM in the landfill.

Volume of RIM - The site review package and power point presentation provided to the Board indicated an amount of hazardous material to move equal to 500,000 cubic yards (cy). Though using different reference levels, the Board notes that the RI report estimated the volume of RIM to be about 143,000 cy, which is similar to the amount (approximately 150,000 cy) identified in the 1982 and 1988 NRC reports. The large uncertainty related to the location and volume of RIM could negatively impact the alternatives evaluation process (including how the cost and feasibility of various implementation options have been evaluated) and lead to a preferred alternative that may not be protective or cost effective. Thus, a smaller volume of RIM would make consideration of other alternatives (i.e., an on-site disposal cell or off-site disposal at a commercial facility) more feasible and realistic.

The Board suggests that the Region carefully examine the data and information contained in the RI and NRC reports to ensure that the location and volume of RIM is accurately characterized and if necessary consider conducting further investigations possibly using test trenches. Furthermore, the range of alternatives should include options for addressing the likely volume and location (including hot spots) of RIM at the Site.

Future Land Use

The supplemental feasibility study (SFS, page 62) indicates that "the cleanup standards to be used for the development and evaluation of the 'complete rad removal' are background-based standards." The SFS also appears to have used unrestricted land use in estimating the volume of RIM that would have to be removed under a "complete rad removal" scenario. The Region indicated that the West Lake Landfill property is zoned industrial/commercial and will stay that way. The Board believes that using background-based standards and unrestricted use may have led to overstating the volume of RIM that would have to be excavated and possibly treated under a "complete rad removal" alternative. The Board suggests that the Region use a more reasonable future use assumption of industrial/commercial and based on this land use, recalculate the volume of RIM to be removed.

Principal Threat Waste

Based on the documents provided to the Board, it appears that there are potentially significant amounts of RIM that are highly toxic (e.g., based on NRC estimates in the 1982 and 1988 reports, radium up to

22,000 picoCuries per gram (pCi/g), bismuth-214 up to 19,000 pCi/g, and average thorium-230 concentrations of 9,000 pCi/gr; the package at page 44 notes that the RI report discussed thorium-230 at levels as high as 57,300 pCi/gr and that the highest gamma peak intensity readings are at shallow depths). The FS states (page 84) that most of Area 2 contains RIM at levels above 100 pCi/gr. The NRC reports also discuss how the toxicity of this RIM will continue to increase over time: "Ra-226 activity will increase in time (for example, over the next 200 years, Ra-226 activity will increase nine-fold over the present level). This increase in Ra-226 must be considered in evaluating the long-term hazard posed by this radioactive material." (1988 NRC report, page 14). The SFS also acknowledges this fact. Thus, based on the data, it appears there is discrete, accessible highly toxic principal threat waste at this site. OSWER Directive No. 9380.3-06FS, November 1991, *A Guide to Principal Threat and Low Level Threat Wastes*, provides guidance on several related issues, including the NCP's expectations for treatment of principal threats posed by the site, wherever practicable. The Board suggests that the Region carefully consider the range of alternatives developed for this site and explain in its decision documents how the preferred alternative, when selected, will be consistent with CERCLA and NCP, or publish an explanation as to why not. In particular, the Region should more fully explain how its approach to treatment is consistent with the statute and the NCP, including specifically CERCLA § 121(b)(1)'s preference for treatment "to the maximum extent practicable;" CERCLA § 121(d)(1)'s requirements regarding protectiveness and applicable or relevant and appropriate requirements; 40 CFR § 300.430(a)(1)(iii)(A)'s expectation that "treatment [be used] to address the principal threats posed by a site, wherever practicable"; and 40 CFR § 300.430(f)(1)(ii)(E)'s preference for treatment "to the maximum extent practicable" while protecting human health and the environment, attaining ARARs identified in the ROD, and balancing the five primary criteria listed in the NCP.

Remedy Performance

Removal/excavation - In light of the waste characterization (above) and treatment (below) comments, and data indicating that much of the RIM may be located relatively near the surface; it appears feasible to remove more highly contaminated material and significantly reduce long-term risk at the site. The Board is aware of ongoing cleanups in other Regions where the reduction of radiologically-impacted source material is being safely and efficiently undertaken in a manner that is protective both to the workers and the community. If the RIM is located near the surface in a discreet layer, it can be sorted out in the field with instruments that provide instantaneous measurements to ensure that only contaminated material is retrieved which, in turn, minimizes disposal costs. The Board suggests that the Region consider developing an alternative that includes sorting and removing the RIM in a precise manner using performance standards for the excavation process and includes treatment to the maximum extent practicable. The Board also suggests that cleanup levels reflect the fact that the site is zoned industrial/commercial and is most likely to stay that way given the reasonably anticipated future land use.

Treatment - The Board notes that several treatment technologies were evaluated and screened out during the FS process. The Region did evaluate a "complete rad removal" approach and indicated "that none of the 13 treatment technologies were able to deal with the extremely heterogeneous mixture of the radiologically contaminated soil and MSW. Thus, none of the remedies evaluated in the SFS meet the preference for treatment." (package, page 34). The Board notes that "treatment" can include measures taken to reduce volume. So, regardless of whether the RIM resides in a heterogeneous or a homogeneous distribution, volume separation techniques (volume reduction) and off-site disposal in a dedicated and regulated radioactive disposal unit may result in a more permanent remedy if short-term risks are minimized by engineering controls, personal protection equipment, or administrative controls, as well as if the radioactive waste is able to be physically sorted from the other waste in the landfill. If some, most or all of the RIM can be detected, distinguished by emission signals, and resides in distinct homogeneous layers, field screening techniques or an on-site laboratory can be used for isolation followed by removal. If the waste resides in a more heterogeneous distribution, commercial sorting technologies, using multiple scanning spectroscopic techniques (that have been used on federal facility sites) and/or an on-site laboratory, should be considered and evaluated. This is especially true for the RIM in Area 2, since it appears that "construction fill" (as opposed to "sanitary" fill) was added to cover the contamination on this portion of the site, and Area 2 contains the majority of the RIM and overburden. A reduction in volume may make off-site disposal a more cost-effective alternative. These radioactive signal sorting processes could also be considered if a portion of the surface radioactive waste is planned to be consolidated under a final cover. The Board suggests that the Region reconsider treatment alternatives or provide more explanation for ruling out an in-situ or ex-situ solidification/stabilization process that is specifically designed for both the high sulfate content and saturated conditions found at this site.

Short-term Effectiveness - The package provided to the Board includes a comparison of the short-term effectiveness of the three action alternatives. The comparison is presented as risk estimates that are presumed to potentially occur to nearby residents during remedy implementation. The lowest carcinogenic risk presented is for the capping alternative, while the risks to residents during remedy implementation estimated for the two alternatives that include removal of radiation-related material is an order of magnitude higher. However, all of the short-term risks were within the risk range of 10^{-4} to 10^{-6}.

The Board notes reduction of rad-impacted source material currently is being undertaken at other sites in a manner that is protective and without unacceptable short-term impacts, where it has been determined that eliminating the source is an important objective of the cleanup. Therefore, based on the fact that the Agency has safely cleaned up numerous hazardous waste sites with radiological contamination across the country, including many in residential areas, the cleanup work can be done safely without unacceptable risk in accordance with approved health and safety plans and appropriate engineering controls as necessary to ensure that any risks to the community are minimized and mitigated. The Board suggests that the Region re-evaluate the alternatives against the nine criteria, including those listed on page 32 of the package, pursuant to 40 CFR § 300.430(e)(9)(iii).

The short-term effectiveness comparison also includes effects from transportation accidents. Truck and other industrial injuries/fatalities are not generally environmental risks that should be considered in a short-term effectiveness analysis, especially for common earthmoving/hauling alternatives such as these. While an unusually high incidence of accidents may be of concern, potential worker accidents are typically addressed through project health and safety plans. Consistent with the NCP (§300.430(e)(9)(iii), the Board suggests that the comparison be re-evaluated focusing on the extent to which accidents expose workers or the community to possible releases resulting from such accidents, and considering "mitigative measures during implementation."

The short-term effectiveness section described impacts to the community during implementation. The presentation also included a discussion of potential environmental justice (EJ) issues that may be encountered if waste is transported off-site. The Board notes that impacts to the community or EJ issues were not included in the section describing the long-term effects of leaving the waste in place. Consistent with NCP §300.430(e)(9)(iii), the Board suggests that an analysis of both short-term and long-term effects on the community (including any sensitive or potentially high-exposure subpopulations) be included in the detailed analysis in future decision documents.

Also, in the presentation to the Board, one of the Region's points for not carrying forward the excavation and off-site disposal alternative is the possibility of constrained funding ($10M/year if cleanup is done as a Fund-lead). The presentation states that it could take from 22-28 years to complete the work if funded at $10M/year. The Board notes that the short-term effectiveness provision in the NCP (§300.430(e)(9)(iii)(E)) does not include funding as a consideration.

<u>Long-term Effectiveness</u> - The package presented to Board described an alternative as a hybrid cap/cover design incorporating both Resource Conservation and Recovery Act (RCRA) Subtitle D and Uranium Mill Tailings Radiation Control Act (UMTRCA) cover design features applied to an existing unlined landfill. However, the package lacked sufficient information on the long-term protectiveness of this alternative. Specifically, how the cap/cover remains protective given the increasing daughter ingrowth concentrations of radium 226/228, radon 222, and the increase in toxicity over time (1,000 years).

Both of these cover designs (RCRA Subtitle D and UMTRCA) have shortcomings for RIM waste itself, especially in a humid region. A comparison of various landfill capping designs addressing both humid region conditions and long-term protection from RIM (1,000 years) would be an important concept for the preferred remedy. However, the package did not appear to include alternative cap designs, i.e., EPA landfill cap guidance design, existing cap designs for similar RIM at Weldon Springs, or evapotranspiration cover cap system designs (OSWER Fact Sheets: EPA 542-F11-001, February 2011, *Fact Sheet on Evapotranspiration Cover Systems for Waste Containment*). For example, a RCRA Subtitle C/UMTRCA hybrid may be suitable for both long-term infiltration management and radiation shielding protection. The Board suggests that the Region include in its remedy selection process evaluations of cap designs similar to, but not limited to, the above conditions and guidances. The package also does not address several aspects of the potential for future migration of contamination to groundwater. The fact that the Region believes there is no discernible plume above MCL levels may not be a sufficient basis to determine there is little or no potential for groundwater contamination that should be addressed consistent with the NCP's expectations. Particularly in light of the long-lived toxic nature of the radioactive contaminants as well as chemical and physical changes over time at the landfill, the Board suggests that a more rigorous evaluation of potential migration to groundwater be undertaken. The evaluation should not assume that pumping at the former active sanitary landfill will continue, unless that is part of this remedy. For these reasons, the Board suggests that the Region consider examining additional information on alternative cap designs plus fate and transport of groundwater that supports long-term protectiveness.

Applicable or Relevant and Appropriate Requirements

UMTRCA - In the package provided to the Board, the ARARs discussion (page 45) states that UMTRCA is an ARAR for waste that eroded off Area 2, yet only a to-be-considered (TBC) criteria for the design of the cap over Areas 1 and 2; the reason provided by the Region being that the eroded waste resembles a mine tailings pile while the MSW landfill areas do not.

The Board suggests that the Region further clarify why UMTRCA is considered an ARAR for purposes of cleaning up RIM that has eroded from Area 2 onto adjoining land (which does not in fact resemble a staging pile), but not for purposes of cleaning up RIM that appears to be located in Area 2 at and just below the surface. Since the RIM on the adjacent property apparently comes from RIM in Area 2 and is the same material, and the contamination is similarly situated in both Area 2 and the adjacent property (i.e., at or near the surface), and neither location serves or was intended to serve as a waste pile, the basis for the distinction being made for ARARs purposes between Area 2 and the adjacent property is not clear.

The Board agrees that the UMTRCA standards most likely was not written for a situation where contamination such as the RIM here would be disposed of in an unlined (i.e., no sides and no liner on the bottom) solid waste disposal unit; however, to the extent UMTRCA is designed to address contamination somewhat like the RIM at this site (even though those standards appear to be designed for similar contaminants but at concentrations of only up to 1000 pCi/gr), it provides a useful regulatory benchmark on how to handle, dispose of, and cap this kind of material. Nonetheless, the UMTRCA standards would appear potentially relevant and appropriate for ARAR purposes when evaluating factors like the longevity/integrity of a unit serving as a repository for centuries.

The Board notes that even if UMTRCA standards are considered as an ARAR, meeting those standards may not ensure protectiveness over the long-term for several reasons, including RIM at levels currently measured at up to 57,300 pCi/gr of thorium, as well as the increasing daughter ingrowth concentrations of radium 226/228, radon 222, and the increase in toxicity projected to peak at about 700,000 pCi/gr. over time (1,000 years). While the package states that "consistent with UMTRCA, the cap design will include a rubble layer and the final caps on Areas 1 and 2 will meet the radon emission standards provided for in UMTRCA" it does not state that the cap design will meet the UMTRCA standards. The Board suggests that the Region evaluate whether the alternatives under consideration for Area 2 will meet the UMTRCA standards as ARARs, as well as any NRC standards (and guidance that might serve as TBCs) that exist for licensed facilities storing or disposing of radiological waste.

RCRA - The package indicates that RCRA subtitle D regulations "represent the primary standards for design and implementation of a containment remedy." The Board notes that OSWER Directive No. EPA/540/P-91/001, February 1991, *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* does state that RCRA Subtitle D closure requirements are generally applicable. However, it is not clear to the Board how a municipal solid waste regulation (e.g., provisions governing an MSW landfill) could be considered as a controlling ARAR for disposal of non-MSW material, especially material as hazardous as the RIM at this site (e.g., RIM at levels currently measured at up to 57,300 pCi/gr, with increase in toxicity projected to peak at about 700,000 pCi/gr). The Board notes that Areas 1 and 2 were not permitted as subtitle D landfills or licensed as an NRC facility, and is not aware of other sites where RCRA Subtitle D standards have been considered as the correct benchmark for management of waste like the RIM at this site. The Board suggests that the Region carefully consider the appropriateness of using RCRA Subtitle D regulations for RIM, where radium-226 activity will increase by a factor of thirty-five 1,000 years from now, as an ARAR for this site.

Deleted: ,

Federal Aviation Administration Guidance - With regard to the Federal Aviation Administration (FAA) Guidance, the Board agrees with the Region that this guidance is not an ARAR, and acknowledges the importance of ensuring flight safety in the vicinity of the site. The Board notes that all of Area 2 of the site is more than 10,000 feet from the runway, that it appears that about half of Area 1 is also more than 10,000 feet from the runway, and that for the relatively small portion of Area 1 that is inside the 10,000 foot perimeter, it should be feasible to use netting or other devices (e.g., movable tent or building) for the short amount of time that would be needed to excavate or treat (e.g., solidification) the RIM material found at or near the surface of Area 1, if an alternative reflecting that approach were to be selected. Thus, the FFA guidance may inform, but does not inhibit, actions involving the processing of materials if an alternative including excavation and hauling is chosen. During the presentation, the Region mentioned an agreement between the landowner and the FAA addressing property that may be partially addressed by the FAA guidance. The Board also notes that while important to acknowledge, the agreement is not an ARAR and does not otherwise limit EPA's broad response authority under CERCLA.

Executive Orders - Furthermore, the review package indicates in the section discussing ARARs (page 45) that Executive Order 11988 and Missouri Governor's Order 82-19 are "regulations [that] are remedy drivers." The Board notes that while executive orders like these are important considerations, neither of these orders represent the kind of promulgated, enforceable, generally applicable (or waiveable) regulations or standards that qualify as ARARs. However, to the extent they are considered as remedy drivers, the Region should evaluate and explain in its future decision documents how these orders provide for a protective remedy.

List of ARARs - Finally, the Board also notes that some of the citations included in the ARARs tables provided in the SFS may not be described in enough detail pursuant to EPA/540/G-89/006, August 1988, *CERCLA Compliance With Other Laws Manual.* The Region should work closely with their Office of Regional Council to clarify the list of ARARs.

Cost

According to the information presented to the Board, the discount rate used for the net present worth cost calculations in the SFS was 2.3 percent. However, the Board notes that in accordance with current EPA guidance, OSWER Directive No. 9355.0-75, July 2000, *A Guide to Developing and Documenting*

Cost Estimates During the Feasibility Study, a discount rate of 7 percent should generally be used for all non-Federal facility FS present value analyses and, if a different discount rate is selected, a specific explanation should be provided and/or a sensitivity analysis performed to evaluate the discount rate impacts. The Region should either: (1) use a discount rate of 7 percent for all present worth calculations (as was done for the 2008 ROD), or (2) provide an explanation and sensitivity analysis in accordance with the above-noted 2000 EPA guidance. The Board also suggests that if the 2.3 percent rate is carried forward that both the 7 and 2.3 percent rates be provided, with appropriate explanation, for comparison purposes.

In addition, a containment alternative that will require perpetual operation and maintenance to remain protective was presented to the Board. Based on the information provided in the SFS, the cost estimate for this alternative does not appear to include all costs that would be necessary to effectively maintain the remedy in perpetuity and because of this, there may not be an accurate evaluation of costs. The costs identified only include mowing grass and filling holes that develop over time. The Board suggests that the Region recalculate (and explain in its decision documents) the cost of this alternative to include all of the components of the cap, what perpetual operation and maintenance is required for each of these components (which likely includes repair and replacement), and the costs associated with that work.

APPENDIX C
Comments from the 2018 NRRB Consultation and EPA Region 7 Response to Comments

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND
EMERGENCY RESPONSE

NOW THE
OFFICE OF LAND AND
EMERGENCY MANAGEMENT

January 26, 2018

MEMORANDUM

SUBJECT: National Remedy Review Board Recommendations for the West Lake Landfill Superfund Site

FROM: Douglas Ammon, Chair Douglas C. Ammon
National Remedy Review Board

TO: Mary Peterson, Director
Superfund Division
U.S. Environmental Protection Agency Region 7

Purpose

The National Remedy Review Board (the Board) has completed its review of the proposed cleanup action for the West Lake Landfill Superfund site, in Bridgeton, Missouri. This memorandum documents the Board's advisory recommendations.

Context for Board Review

The U.S. Environmental Protection Agency (EPA) Administrator established the Board as one of the October 1995 Superfund Administrative Reforms to help control response costs and promote consistent and cost-effective remedy decisions. The Board furthers these goals by providing a cross-regional, management-level, "real time" review of high cost proposed response actions prior to their being issued for public comment. The Board reviews proposed cleanup actions that exceed its cost-based review criteria.

The Board review is intended to help control remedy costs and to promote both consistent and cost-effective decisions. Consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), in addition to being protective, all remedies are to be cost-effective. The Board considers the nature of the site; risks posed by the site; regional, state, tribal, Community Advisory Group (CAG) and potentially responsible parties (PRPs) opinions on proposed actions; the quality and reasonableness of

30324591

the cost estimates; and any other relevant factors or program guidance in making our advisory recommendations. The overall goal of the review is to ensure sound decision making consistent with current law, regulations, and guidance.

Generally, the Board makes the advisory recommendations to the appropriate regional division director. Then, the region will include these recommendations in the administrative record for the site, typically before the proposed cleanup plan for public comment is issued. While the Board's recommendations are expected to carry substantial weight, other important factors, such as subsequent public comment or technical analyses of response options, may influence the Agency's final remedy decision.

The Board expects the regional division director to respond in writing to its recommendations within a reasonable period of time, noting in particular how the recommendations influenced the proposed cleanup decision, including any effect on the estimated cost of the action. Although the Board's recommendations are to be given substantial weight, the Board does not change the Agency's current delegations or alter the public's role in site decisions.

Overview of the Proposed Action

The West Lake Landfill Superfund site is a 200-acre, inactive solid waste disposal facility located in Bridgeton, Missouri. Areas of the West Lake Landfill were radiologically contaminated in 1973 when soil mixed with leached barium sulfate was used as cover for landfilling operations at West Lake Landfill.

The site is composed of three operable units (OUs). OU-1 consists of areas at the site where radiologically impacted material (RIM) has been identified within surface soil and subsurface solid waste. The remaining surface area of the site is designated as OU-2, which consists of several inactive fill areas that contain sanitary waste or demolition debris. The EPA has specifically designated OU-3 to address potential groundwater contamination at the site. This Board review is focused on the remedial alternatives under consideration for the radiologically impacted areas that constitute OU-1.

In May 2008, the EPA issued a Record of Decision (ROD) for OU-1 of the site. The major components of the ROD-selected remedy included installation of a landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills, including enhancements such as an armoring layer and radon barrier consistent with standards for uranium mill tailing sites, consolidation within the landfill, institutional controls (ICs), and groundwater monitoring. In 2010, the EPA determined that further evaluation of remedial alternatives was warranted. After completion of a Supplemental Feasibility Study in 2011, Region 7 consulted with the Board in February 2012. In response to the Board's consultation memo dated February 28, 2013, Region 7 conducted additional investigation activities. The Board would like to acknowledge the thoroughness of these activities and related findings that address the items and suggestions from the Board's consultation.

RIM is located in two landfill disposal areas known as Radiological Areas 1 and 2, as well as in two adjacent parcels of industrial property referred to as the Buffer Zone and Lot 2A2 of the Crossroads Industrial Park. The RIM within Areas 1 and 2 consist of soils containing radium and thorium isotopes within municipal solid waste, industrial waste, and construction and demolition debris, which may contain other non-radionuclide constituents such as trace metals and volatile organic compounds.
The areal extent of RIM in Area 1 is approximately 8.4 acres immediately to the southeast of the main access road to the site. The areal extent of RIM in Area 2 is approximately 26.8 acres along the northern

boundary of the site. The RIM in Areas 1 and 2 does not consist of a continuous layer but rather several discontinuous lenses consisting of varying volumes at depths ranging from 0 to 89.4 feet below ground surface in Area 1 and from 0 to 42.5 feet below ground surface in Area 2. The estimate of the volumes of RIM within Areas 1 and 2 are 58,700 and 251,000 cubic yards, respectively.

Although a preferred alternative was not provided to the Board, the Region presented the range of remedial alternatives under consideration for OU-1. The remedial alternatives include cap in place (with either a modified 2008 ROD selected engineered cover or an Uranium Mill Tailings Radiation Control Act (UMTRCA) engineered cover), full excavation (with either onsite or offsite disposal), and three partial excavation options based on different criteria. The Board reviewed all alternatives.

National Remedy Review Board Advisory Recommendations

The Board reviewed the informational package describing the remedial alternatives and discussed related issues with Region 7 management and staff on January 9, 2018. The Board notes that the range of alternatives has been developed considering the Board's prior consultation. In typical circumstances, the Board is presented with a preferred alternative. In this case, the site was included on the December 8, 2017, Administrator's List of Superfund Sites Targeted for Immediate, Intense Action and a preferred alternative had yet to be identified. As a result, the applicability of a recommendation may depend upon which alternative is proposed. Based on the aforementioned review and discussion the Board offers the following comments:

Waste Characterization

The Board notes that there remains some uncertainty with the presence and volume of RIM especially in the deeper locations such as in the vicinity of borings WL-210 and WL-235, for example. The Board recommends that the Region describe the impact of this uncertainty on the comparison of alternatives in its decision documents and provide a detailed clarification in the Administrative Record. While the Board agrees with the Region that RIM at the site has been sufficiently characterized to make a remedy decision, the Board recommends that if the proposed remedy includes excavation that the Region include additional characterization of RIM location as a part of pre-design investigation.

The Board notes the use of different units (e.g., counts per minute (cpm) and picocuries per gram (pCi/g)) for different types of measurements in the information presented. The Board recommends that the decision documents clearly explain the different roles associated with each type of measurement used, including when they are used for gamma readings (downhole and core) and the analytical results (radium/uranium/thorium levels).

Human Health Risk

Based on the information provided to the Board, human health risks are presented for several time frames significantly in the future (1,000 and 9,000 years). The Board recommends that the Region include a nearer-term future time frame consistent with Superfund risk assessment practices in the baseline human health risk assessment. The Board recommends that the Region clarify the current and future risks that support the basis for action at the site. In particular, the Board recommends that the Region clarify that the risks evaluated in the baseline human health risk assessment are those posed prior to any remedial action, without existing fences and ICs, in accordance with the NCP Preamble (55 FR 8711, March 8, 1990). Additionally, the Region should clearly define in site documents the other risks, and the time frames these risks represent. For example, risks estimated for the UMTRCA time frame of

1,000 years and risks representing exposures at 9,000 years which is when the peak activity from the RIM will occur, should be clearly described.

Based on the information presented to the Board, the long-term exposure potentials, presented as post-remedy implementation cancer risks based on exposures in 1,000 years, for all of the alternatives are protective and are, in some cases, well below the risk range. The Board recommends that in the decision documents, the Region better explain the basis for the near and long-term risks and long-term effectiveness provided for each alternative.

Applicable or Relevant and Appropriate Requirements (ARARs)

Based on the information provided to the Board, some of the potential alternatives being evaluated would involve leaving RIM at the site. The Board notes that the RIM contains significant quantities of radium, thorium, and uranium which are not in secular equilibrium, and that in-growth over hundreds/thousands of years makes it very important to ensure that the radioactive waste disposal (either in-situ management and/or onsite disposal) remain protective of human health and the environment in the long-term. The Board also notes that EPA has promulgated regulations in 40 CFR Part 192, subpart B (Uranium Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites). In the preamble to the final rule (48 FR 590, January 5, 1983), it discusses the fact that uranium mill tailing sites typically involve materials at between 300 and 1000 pCi/g. The Region acknowledged that concentrations of RIM in portions of Area 1 and Area 2 exceed the upper end of what is considered typical for uranium mill tailing sites (300-1,000 pCi/g) and as such has expanded the evaluation of ARARs to account for RIM which exceeds 1,000 pCi/g. The Region stated that it was evaluating Nuclear Regulatory Commission (NRC) low level waste regulations contained in 10 CFR Part 61. The Board recommends that the Region specifically evaluate 10 CFR 61.41, 61.42, and 61.50 in its analysis.

The Region indicated it may consider a Resource Conservation and Recovery Act (RCRA) Subtitle C technical guidance as a requirement "to be considered" (TBC). As stated in EPA's September 18, 2000, letter to the Honorable Clint Stennett (Idaho State Senate), included in the official record for the July 25, 2000 hearing of the U.S. Senate Environment and Public Works Committee, "EPA has some general principles that apply to the disposal of hazardous waste, which it has incorporated into the Subtitle C standards. These principles and standard may provide protection from some of the risks from the materials that NRC has decided not to regulate, but this material can also carry risks that are not addressed by the RCRA standards." The Board recommends that the Region consider whether the underlying regulation which is being interpreted by the RCRA Subtitle C technical guidance should be considered as a potential ARAR for the onsite disposal cell and engineered cover. The Board notes that these principles should be considered for offsite disposal of lower activity waste.

Remedy Performance

Based on data collected since the previous Board consultation, RIM is present at depths deeper than previously identified in Area 1. The package presented to the Board included three partial excavation alternatives and two full excavation scenarios. Given the new data, and the practicability of implementing full excavation of RIM, the Board is recommending that the uncertainties of accomplishing deeper excavation should be acknowledged in its decision documents. The Board also recommends the decision documents should explain that excavation alternatives may still leave radionuclide residues in the landfill to be managed in perpetuity.

The Board also suggests that the Region's decision documents contain a more in-depth analysis of the five balancing criteria than was presented to the Board to highlight the differences among alternatives.

Based on the information provided to the Board, the Region was careful to note what contamination issues would be addressed in this operable unit (OU-1) and what would be investigated/addressed as part of other OUs. Specifically, the Region indicated that this remedy would address areas that contain RIM, and that OU-3 has been designated to address groundwater. The Board notes that the remedy for this OU needs to be complimentary to any remedy for OU-3 (water levels, groundwater sources that may be within the landfill, etc.). The Board recommends that the Region address in its analysis of the remedial alternatives the potential for RIM to act as an ongoing source of groundwater contamination. The Board also suggests that as the groundwater study moves forward, the information gathered during that study be used wherever possible to support the design of OU-1.

The 2008 ROD referenced the Presumptive Remedies Guidance for CERCLA Municipal Landfills Sites. It is important to note that the West Lake Landfill is not a typical municipal landfill because it contains highly radioactive waste from Atomic Energy Commission/Manhattan project that is increasing in activity up to 9,000 years into the future. The Board recommends the Region clarify in its decision documents the unique nature of the RIM within a municipal landfill and how guidance on capping and "hot spot" removal is addressed depending on the alternative selected.

Each of the remedial alternatives, as presented to the Board, address both Areas 1 and 2. The Board notes that portions of Areas 1 and 2 have somewhat different characteristics in some respects, including location and volume of RIM. The Board recommends the Region consider the option of selecting tailored remedial alternatives for Area 1 and Area 2 from the range of alternatives presented.

Also, based on information provided to the Board, several remedial alternatives involve excavation of the RIM. The Board recommends that the Region consider any recent advances in Thorium-230 field measures and "optimization" techniques during design and implementation including best management practices.

The Community Advisory Group expressed concerns in documents provided to the Board regarding earthquakes, flooding, and uncontrolled fires. The Board recognizes that natural disasters can impact the St. Louis area. However, the Board notes that several public works projects in the U.S., built to protect the public health and the environment, are located in areas with natural disaster threat possibilities. The Board recommends that the decision documents address the consideration of the impacts from natural disasters.

In the information provided to the Board, the Federal Aviation Administration restriction (10,000 feet from end of the runway) was mentioned. The Board notes that all of Area 2 is outside the 10,000 feet restricted space and that much of Area 1 where RIM is located is also at or outside the 10,000 feet restricted space. The Board agrees with the Region that there are a number of onsite mitigation measures that can be taken to address odor and bird issues related to excavation of municipal waste. In addition, the Board recommends that the Region work with the Airport Authority and Federal Aviation Administration to identify other potential mitigation measures.

Conclusion

We commend the Region's collaborative efforts in working with the Board and stakeholder groups at this site. We request that a draft response to these recommendations be included with the draft proposed plan when it is forwarded to the Office of Superfund Remediation and Technology Innovation's Site Assessment and Remedy Decisions (SARD) branch for review. The SARD branch will work with both your staff and the Board to resolve any remaining issues prior to the release of the record of decision. This memo will be posted to the Board's website (https://www.epa.gov/superfund/national-remedy-review-board-nrrb) 30 calendar days of my signature. Once your response is final and made part of the site's administrative record your response will also be posted on the Board's website.

Thank you for your support and the support of your managers and staff in preparing for this review. Please call me at (703) 347-8925 should you have any questions.

cc: J. Woolford (OSRTI)
D. Stalcup (OSRTI)
C. Mackey (OSRE)
P. Leonard (FFRRO)
E. Adams (OSRTI)
J. Hovis (OSRTI)
NRRB members

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 7
11201 Renner Boulevard
Lenexa, Kansas 66219

FEB 05 2018

MEMORANDUM

SUBJECT: National Remedy Review Board Recommendations for the West Lake Landfill Superfund Site

FROM: Mary Peterson, Director
Superfund Division
Mary P. Peterson

TO: Douglas C. Ammon, Chair
National Remedy Review Board

The U.S. Environmental Protection Agency, Region 7 would like to thank the members of the National Remedy Review Board for their time and efforts in reviewing the material presented on the West Lake Landfill Superfund Site. Region 7 will use the comments and recommendations offered by the Board in moving forward with the remedy process and establishing a final remedy for the Site that is protective of human health and the environment. Below you will find a summary of the information provided to the Board regarding the Site followed by the Region's responses to the January 26, 2018, Board recommendations.

Overview of the Proposed Action

The West Lake Landfill Superfund Site is a 200-acre, inactive solid waste disposal facility located in Bridgeton, Missouri. Areas of the West Lake Landfill were radiologically contaminated in 1973 when soil mixed with leached barium sulfate was used as cover for landfilling operations at West Lake Landfill.

The site is composed of three operable units, or OUs. OU-1 consists of areas at the site where radiologically impacted material, or RIM, has been identified within surface soil and subsurface solid waste. The remaining surface area of the site is designated as OU-2, which consists of several inactive fill areas that contain sanitary waste or demolition debris. The EPA has specifically designated OU-3 to address potential groundwater contamination at the site. This Board review is focused on the remedial alternatives under consideration for the radiologically impacted areas that constitute OU-1.

In May 2008, the EPA issued a Record of Decision, or ROD, for OU-1 of the Site. The major components of the ROD-selected remedy included the installation of a landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills, including enhancements such as an armoring layer and radon barrier consistent with standards for uranium mill tailing sites, consolidation within the landfill, institutional controls (ICs), and groundwater monitoring. In 2010, the EPA determined that further evaluation of remedial alternatives was warranted. After completion of a Supplemental Feasibility Study in 2011, Region 7 consulted with the Board in February 2012. In response to the Board's consultation memo dated February 28, 2013, Region 7 conducted additional investigation activities. The Board would like to acknowledge the thoroughness of these activities and related findings that address the items and suggestions from the Board's consultation. RIM is located in two landfill disposal areas known as Radiological Areas 1 and 2, as well as in two adjacent parcels of industrial property referred to as the Buffer Zone and Lot 2A2 of the Crossroads Industrial Park. The RIM within Areas 1 and 2 consist of soils containing radium and thorium isotopes within municipal solid waste, industrial waste, and construction and demolition debris, which may contain other non-radionuclide constituents such as trace metals and volatile organic compounds. The areal extent of RIM in Area 1 is approximately 8.4 acres immediately to the southeast of the main access road to the Site. The areal extent of RIM in Area 2 is approximately 26.8 acres along the northern boundary of the Site. The RIM in Areas 1 and 2 does not consist of a continuous layer but rather several discontinuous lenses consisting of varying volumes at depths ranging from 0 to 89.4 feet below ground surface in Area 1 and from 0 to 42.5 feet below ground surface in Area 2. The estimate of the volumes of RIM within Areas 1 and 2 are 58,700 and 251,000 cubic yards, respectively.

The Board noted that in response to the Board's consultation memo dated February 28 2013, the Region had conducted additional investigation activities. The Board acknowledged the thoroughness of those activities and related findings that addressed the items and suggestions from the Board's consultation.

Information provided to the Board by the Region for the January 9, 2018 review included the following:

- NRRB Consultation Considerations
- West Lake Landfill Extent & Distribution of RIM PowerPoint
- Site Background Summary
- NRRB Report
- NRRB PowerPoint

Although a preferred alternative was not provided to the Board, the Region presented the range of remedial alternatives under consideration for OU-1. The remedial alternatives include cap in place (with either a modified 2008 ROD selected engineered cover or an Uranium Mill Tailings Radiation Control Act (UMTRCA) engineered cover), full excavation (with either on-site or off-site disposal), and three partial excavation options based on different criteria. The Board reviewed all alternatives.

The Board reviewed the informational package describing the remedial alternatives and discussed related issues with Region 7 management and staff on January 9, 2018. The Board noted that the range of alternatives had been developed considering the Board's prior consultation. In typical circumstances, the Board is presented with a preferred alternative. In this case, the Site was included on the December 8, 2017, Administrator's List of Superfund Sites Targeted for Immediate, Intense Action and a preferred alternative had yet to be identified. As a result, the applicability of a recommendation may depend upon which alternative is proposed.

Waste Characterization

1. *The Board noted that there remains some uncertainty with the presence and volume of RIM especially in the deeper locations. The Board recommended that the Region describe the impact of this uncertainty on the comparison of alternatives in its decision documents and provide a detailed clarification in the Administrative Record.*

   Region 7 Response: The Region recognizes there remains some uncertainty with the limited set of soil borings that indicate deeper occurrences of Radiologically Impacted Material (RIM), particularly in Area 2. To better understand the potential impact of these deep borings on the cost estimates provided in the FFS, the Region completed an exercise to approximate the costs associated with these deeper occurrences of RIM for these two borings (WL-210 and WL-234) and two other nearby borings (AC-24 and AC-25) in Area 2 and to determine the proportion of those costs compared to the cost of Full Excavation of RIM from Areas 1 and 2.

The EPA utilized volume estimates provided by the Respondents for the RIM, overburden, and setbacks necessary to access this deep RIM and costs presented in Appendix K of the FFS to generate these estimates. The results of these calculations indicate that approximately 5% of the total estimated costs related to the Full Excavation of RIM with off-site disposal is associated with the deep RIM in borings WL-210 and WL-235. The details for these calculations are provided in the EPA's letter approving the FFS with comments, which will be placed in the final Administrative Record.

The Region determined that sufficient information exists from the multiple investigations implemented at the Site (over 500 soil samples and over 100 borings) such that the presence and volume of the RIM is known sufficiently to select the appropriate remedy for the Site. As in any remedial investigation, some uncertainty remains regarding the final delineation of all contamination. This uncertainty can be further reduced as a part of the remedial design of the final selected remedy.

This uncertainty regarding the deeper occurrences of RIM in Area 2 has been documented in the final RIA Report and the comment letter approving with modifications the January 26, 2018 Final FFS Report and is discussed in the Proposed Plan.

2. *The Board recommends that if the proposed remedy includes excavation that the Region include additional characterization of RIM location as a part of pre-design investigation.*

   Region 7 Response:
   The Region has added a discussion to the Proposed Plan indicating that additional characterization of RIM is anticipated for excavation remedies that may include deep RIM. Additional post-ROD delineation efforts are common for excavation remedies in the Superfund program and are envisioned during a Pre-Design Investigation or during the initial phase of the Remedial Design for the West Lake Superfund Site.

3. *The Board recommends that the decision documents clearly explain the different roles associated with each type of measurement used, including when they are used for gamma readings (downhole and core) and the analytical results (radium/uranium/thorium levels).*

   Region 7 Response:
   Two primary types of data have been used during investigation of the West Lake Site; field screening data such as gamma and alpha scanning, and analytical data from samples analyzed at an off-site laboratory. Field screening data is reported in relative terms related to the instrument response to a specific type of radioactivity, such as gamma radiation, and is often expressed in counts per minutes or counts per second. The type of equipment utilized during the various remedial investigations performed at the Site provide measurement for gross gamma or gross alpha radiation. Analytical data provides concentrations of specific radionuclides at a level of precision specified in a quality assurance project plan or sampling and analysis plan. Analytical data associated with the Site along with field screening data was used to develop the extent of RIM presented in the Remedial Investigation Addendum (RIA) and the volume estimates of RIM presented for each of the remedy

alternatives presented in the Final Feasibility Study (FFS). These estimates are developed and described in the final Estimated Three-Dimensional Extent of Radiologically Impacted Material (December 22, 2017, S.S. Papadopulos). All the risk evaluations presented in the updated Baseline Risk Assessment (BRA) and the FFS utilized analytical data only.

Additional information related to this recommendation is provided in the Administrative Record and summarized in relevant portions of the RIA, the FFS, and the Estimated Three-Dimensional Extent of Radiologically Impacted Material Report.

Human Health Risk

4. *The Board recommended that the Region include a nearer-term future time frame consistent with Superfund risk assessment practices in the baseline human health risk assessment. The Board recommended that the Region clarify the current and future risks that support the basis for action at the site. In particular, the Board recommended that the Region clarify that the risks evaluated in the Baseline Human Health Risk Assessment are those posed prior to any remedial action, without existing fences and ICs, in accordance with the NCP Preamble (55 FR 8711, March 8, 1990). Additionally, the Board recommended the Region clearly define in site documents the other risks, and the time frames these risks represent.*

   Region 7 Response:
   The Baseline Risk Assessment (BRA) adhered to existing and appropriate the EPA guidance in the calculation of risk for current and potential future receptors. In response to the previous Board consultation comments, the EPA ensured that ingrowth of radium from the parent thorium was fully considered in the BRA and that the risks were calculated based on 1000 years of in-growth as is the practice for UMTRCA sites. Risks were also calculated after 9000 years of in-growth to evaluate the maximum concentrations possible. As a result, the presentation to the Board focused on this aspect of the BRA. A risk calculation based on the current concentration and ratio of radionuclides at the Site using the future scenario exposure assumptions (i.e. a storage yard worker) would result in risks that exceed the CERCLA risk range of (1x10-4 to 1x10-6); however, current risks based on the present activities and uses at the Site calculated in accordance with RAGs, do not exceed the CERCLA risk range.

   The Region added additional clarification and explanation regarding timeframes associated with risk evaluations for near time and future risks in its February 2, 2018 letter approving the Updated Baseline Risk Assessment. Site risks and associated timeframes are clearly defined and presented in the Proposed Plan, Updated Baseline Risk Assessment, and FFS.

Applicable or Relevant and Appropriate Requirements (ARARs)

5. *The Board recommended that the Region specifically evaluate 10 CFR 61.41, 61.42, and 61.50 in its analysis.*

   Region 7 Response:
   The region required the Respondents to specifically evaluate in the FFS whether the requirements set forth in 10 CFR Part 61, including 10 CFR 61.41, 61.42, and 61.50, are ARARs for the OU-1 remedial action. Region 7 has concluded that 10 CFR 61.50(7) and 61.52(2) are potentially relevant and appropriate for the on-site disposal cell alternative. Region 7 has concluded that 10 CFR 61.41 is not relevant or appropriate because the dose based requirements in these regulations are greater than

the ARAR protectiveness criteria evaluation recommendation of 15 mrem/yr provided in OSWER Directive 9200.4-40 (May, 2014). Region 7 has also concluded that 10 CFR 61.42 is not relevant and appropriate because the requirements in 10 CFR 61.50(7) provide a more appropriate standard related to intruder barriers. In addition, all alternatives where RIM will remain in place will include institutional controls over the lifetime of the remedial action.

6. *The Board recommended that the Region consider whether the underlying regulation which is being interpreted by the RCRA Subtitle C technical guidance should be considered as a potential ARAR for the onsite disposal cell and engineered cover.*

   Region 7 Response:
   The region considered whether the underlying regulation for the RCRA Subtitle C technical guidance should be an ARAR for the on-site disposal cell and engineered cover. While Region 7 has determined that the UMTRCA regulations are the primary ARAR for the on-site disposal cell, to ensure the UMTRCA performance standards are met RCRA Subtitle C Subpart N (40 CFR 264.301 is considered relevant and appropriate for the on-site disposal cell liner and leachate collection system. The evaluations of the remedial alternatives presented in the FFS are predicated on the presumption that any hazardous or mixed waste that may be encountered would be transported off-site for treatment and/or disposal. Therefore, the hazardous waste regulations related to design, operation, closure or post-closure of a hazardous waste landfill are not expected to be applicable for the on-site disposal cell. Similarly, the EPA has also carefully reviewed the underlying RCRA Subtitle C regulations at 40 CFR 264.310 for the engineered cover system. While these closure regulations would not be both relevant and appropriate to remedial actions for Areas 1 and 2, Region 7 has determined that in light of the West Lake Landfill contaminant's toxicity, longevity, potential to leach, and location (in certain instances) at depth near the water table, a cap meeting the more specific standards described in the Subtitle C guidance would achieve the groundwater protectiveness standard of the UMTRCA regulations (40 C.F.R. 192.02(c)(3)). The RCRA Subtitle C technical guidance RCRA/CERCLA Final covers, 1989 and Final Covers on Hazardous Waste Landfills and Surface Impoundments, 2004 are TBCs for the UMTRCA cover proposed for all alternatives leaving RIM on-site. RCRA Subtitle C landfill covers are less permeable than Subtitle D covers (10^{-7} cm/sec and 10^{-5} cm/sec, respectively). These guidance documents provide the technical design basis and evaluation techniques needed in order to meet the UMTRCA requirements for covers over radioactive materials that prevent infiltration of precipitation and thereby provide the protection of groundwater.

<u>Remedy Performance</u>

7. *The Board recommended that the uncertainties of accomplishing deeper excavation be acknowledged in its decision documents. The Board also recommended the decision documents explain that excavation alternatives may still leave radionuclide residues in the landfill to be managed in perpetuity.*

   Region 7 Response:
   A discussion regarding the implementation issues associated with deeper excavation of RIM is included in the FFS as well as in the Proposed Plan. Region 7's letter approving the January 26, 2018 FFS as well as the Proposed Plan include explicit language stating that after removal of RIM (above 7.9 pCi/g of combined radium or combined thorium) some residual radioactive material will remain at the Site.

8. *The Board also suggested that the Region's decision documents contain a more in-depth analysis of the five balancing criteria than was presented to the Board to highlight the differences among alternatives.*

   Region 7 Response:
   It should be noted that the Board Report provided a more in-depth analysis of the five balancing criteria. Due to the time constraints of presenting the very technical information about the Site and the eight alternatives considered by Region 7, and the technical questions and responses from the Board, the presentation of the five balancing criteria was not as fully discussed during the Board Review. The FFS and the Proposed Plan contain an in-depth analysis of the five balancing criteria.

9. *The Board recommended that the Region address in its analysis of the remedial alternatives the potential for RIM to act as an ongoing source of groundwater contamination. The Board also suggested that as the groundwater study moves forward, the information gathered during that study be used wherever possible to support the design of OU-1.*

   Response: Testing of RIM for leaching was performed as a part of the additional investigations and studies at the Site since the last Board consultation. Recent data has demonstrated that RIM does have the potential to leach under certain conditions; however, the remedial alternatives that leave RIM on-site include an engineered cover that relies upon UMTRCA standards and RCRA guidance, discussed above in the response to comment 6, for limiting infiltration and protection of groundwater.

   The region will use information gathered by the investigation of groundwater in OU-3 to inform the design of the remedy for OU-1, as appropriate. Engineered covers over all alternatives except full excavation with off-site disposal are designed to prevent infiltration and thus reduce potential leaching regardless of the depth of the RIM.

10. *The Board recommended the Region clarify in its decision documents the unique nature of the RIM within a municipal landfill and how guidance on capping and "hot spot" removal is addressed depending on the alternative selected.*

    Region 7 Response:
    Based upon the additional data collected since the 2008 ROD, the region determined that the West Lake Landfill is not a typical municipal landfill due to the presence of PTW, the toxicity of the RIM and the increasing risks due to radioactive decay. Some of the RIM identified within OU-1 is located in discrete and accessible portions of the Site. The volume of the RIM that could be potentially excavated for some of the alternatives is significant and its remediation will reduce Site risks. Therefore, the region no longer considers the presumptive remedy of containment alone to be appropriate for the Site. These facts and determinations are described in the Proposed Plan.

11. *The Board recommended the Region consider the option of selecting tailored remedial alternatives for Area 1 and Area 2 from the range of alternatives presented.*

    Response:
    RIM is currently estimated to be present at approximately 50 feet below the ground surface in Area 2 and approximately 90 feet below the ground surface in Area 1. Excavation of all RIM within Area 1, including deep RIM, would impact the existing infrastructure in the North Quarry of the Bridgeton Landfill. This deeper excavation creates concerns with causing a new or exacerbating an existing

subsurface heating event, making removal of deeper RIM in Area 1 more challenging than in Area 2. In the Proposed Plan, the region acknowledged that while the general nature of the radiological contamination is comparable between Areas 1 and 2, the spatial and volumetric distribution of RIM in these areas is distinct. Also in the Proposed Plan, the region is seeking input from the public regarding the selection of different depths and concentrations between Areas 1 and 2.

12. *The Board recommended that the Region consider any recent advances in Thorium-230 field measures and "optimization" techniques during design and implementation including best management practices.*

    Region 7 Response:
    During the remedial design and remedial action phases of the project, the region will ensure that up to date field measurement and techniques are used. The FFS includes a cost estimate for an on-site analytical laboratory to ensure timely and accurate measurements of Thorium-230 in confirmation samples that will be collected during remedial action. Some confirmation samples will be sent to an off-site laboratory in accordance with a quality assurance project plan (QAPP) to validate data determined from the on-site laboratory.

13. *The Board recommended that the decision documents address the consideration of the impacts from natural disasters.*

    Region 7 Response:
    As noted in the presentation to the Board and in the full Board Report, evaluation of possible impacts from natural disasters, such as tornados or flooding were conducted for the alternatives in the FFS. Flooding is not expected to impact the long-term performance of the alternatives because the Site is currently located more than 1.3 miles from the Missouri River. Even if the 500-year levee ceases to exist, a 500-year flood event is not expected to include high-energy water flows due to the landfill's distance to from the river and is only anticipated to cause approximately two feet of flood waters to contact the toes of the landfill. Due to the length of time this remedy must remain protective, geologic and anthropogenic uncertainties will be considered during design of any necessary armoring of the toes of the landfill. The vertical height of any flood protection features such as armoring are subject to design phase evaluations but are expected to include a margin of safety over the 500-year floodplain.

14. *The Board recommended that the Region work with the Airport Authority and Federal Aviation Administration to identify other potential mitigation measures.*

    Region 7 Response:
    Once a remedy has been selected, Region 7 will work with the PRPs, the City of St. Louis and airport officials to identify potential mitigation measures and ensure they are implemented correctly in the Remedial Action phase of the process. In addition, Region 7 will continue to coordinate with the FAA, as appropriate.

cc: J. Woolford, OSRTI
D. Stalcup, OSRTI
C. Mackey, OSRE
P. Leonard, FFRRO
E. Adams, OSRTI
J. Hovis, OSRTI
NRRB Members

APPENDIX D
ARARs for Modified Alternative 4

Appendix D-1: Chemical Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Chemical/Medium	Requirement	Determination
40 C.F.R. § 192, Subpart A Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, Standards for the Control of Residual Radioactive Material from Inactive Uranium Processing Sites 40 C.F.R. § 192.02(a), (b)	Radon-222 in air	The annual average release rate of radon-222 to the atmosphere applied over the entire surface of a disposal site should not exceed 20 pCi/m2-s, and the annual average concentration of radon-222 in air at or above any location outside the disposal site should not be increased by more than 0.5 pCi/L. 40 C.F.R. 192.02(b). Protection standards also include the requirement that the control of the radioactive materials be designed to be effective for up to 1,000 years, as far as reasonably achievable, but at a minimum, 200 years. 40 C.F.R. 192.02(a).	Relevant and appropriate. The West Lake Landfill OU-1 Site is not a designated Title I uranium mill tailings site; therefore, this requirement would not be applicable. As these regulations address radon emissions, which is a concern for OU-1, they are considered relevant and appropriate.
40 C.F.R. Part 61, Subpart H National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities 40 C.F.R. § 61.90-97 40 C.F.R. § 61.90-92	Radionuclides other than radon-222 and radon-220 in air	Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent to 10 mrem/yr. 40 C.F.R. § 61.92. Applies to any DOE facility that emits any radionuclide other than radon- 222 and radon-220 into the air, except any disposal facility subject to 40 C.F.R. Part 191, Subpart B or 40 C.F.R. Part 192.	Relevant and appropriate for portions of the Site that are "facilities" and not subject to 40 C.F.R. Part 192. Because the West Lake Landfill OU-1 Site is not a Department of Energy owned or operated facility, these standards are not applicable. As these regulations address standards for airborne effluents containing radionuclides, they are relevant and appropriate to any buildings, structures or operations on OU-1 if 40 C.F.R. Part 192 does not otherwise apply.
40 C.F.R. Part 61, Subpart T National Emissions Standards for Hazardous Air Pollutants, National Emissions Standards for Radon Emissions from disposal of Uranium Mill Tailings 40 C.F.R. § 61.222(a)	Radon-222 in air	Radon-222 emissions to ambient air from uranium mill tailings piles that are no longer operational should not exceed 20 pCi/(m2-sec) (1.9 pCi/(ft2-sec)) of radon- 222. 40 C.F.R. § 61.222(a).	Relevant and appropriate. The West Lake Landfill OU-1 Site is not a designated uranium mill tailings site, so this requirement would not be applicable; however it is considered relevant and appropriate because a portion of the waste materials at the Site do emit radon. 40 C.F.R. § 61.222(a)'s limit of 20 pCi/(m2-sec) (1.9 pCi/(ft2-sec)) of radon-222 is relevant and appropriate.
Missouri Water Quality Standards, 10 C.S.R. § 20-7.031(5)	Water	Water contaminants shall not cause or contribute to an exceedance of standards for radiological contaminants or other primary standards	These standards are applicable to discharges of waters of the state.

Appendix D-1: Chemical Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Chemical/Medium	Requirement	Determination
RSMo Sections 260.500-550; 10 C.S.R. 24-2.010; 10 C.S.R. 24-3.010 (1) The Department of Natural Resources is authorized under sections 260.500-260.550, RSMo to administer the state's Hazardous Substance Emergency Response Office 10 C.S.R. 24-2.010 Definitions10 C.S.R. 24-3.010 Notification Procedures for Hazardous Substance Emergencies and for Emergency Notification of Releases of Hazardous Substances and Extremely Hazardous Substances	All chemicals, compound s or substances listed under CERCLA.	CERCLA reporting requirements are incorporated by reference in MO state law and regulations. Any release in the excess of the RQ must be reported and cleaned up in accordance with state law and Regulations.	This notification requirement is not an ARAR but we expect to comply with this requirement.
RSMo Sections 260.500-550; 10 C.S.R. 24-2.010; 10 C.S.R. 24-3.010	Petroleum	MO state law and regulations require that any release of petroleum in excess of the RQ must be reported and cleaned up in accordance with state law and Regulations.	This notification requirement is not an ARAR but we expect to comply with this requirement.
10 C.S.R. 20-7.031(5)(B)(1) The specific criteria shall apply to waters contained in Tables G and H of this rule and the Missouri Use Designation Dataset. (B) Toxic Substances. 1. Water contaminants shall not cause the criteria in Tables A and B to be exceeded. Concentrations of these substances in bottom sediments or waters shall not harm benthic organisms and shall not accumulate through the food chain in harmful concentrations, nor shall state and federal maximum fish tissue levels for fish consumption be exceeded. More stringent criteria may be imposed if there is evidence of additive or synergistic effects.	Water	Water contaminants shall not cause an exceedance of criteria in Tables A and B; Concentrations of these substances in bottom sediments or waters shall not harm benthic organism and shall not accumulate through the food chain in harmful concentrations, nor shall state and federal maximum fish tissue levels for fish consumption be exceeded.	These standards are applicable to discharges to waters of the state.

Appendix D-1: Chemical Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Chemical/Medium	Requirement	Determination
10 C.S.R. 20-7.031(5)(B)(2) (5) Specific Criteria. (B) Toxic Substances. 2. For compliance with this rule, metals shall be analyzed by the following methods: A. Aquatic life protection and human health protection—fish consumption. (I) Mercury—total recoverable metals. (II) All other metals—dissolved metals; B. Drinking water supply—total recoverable metals; and C all other beneficial uses – total recoverable metals.	Water	Analysis methods for metals are specified.	These standards are applicable to discharges to waters of the state.
10 C.S.R. 20-7.031(5)(B)(3) Other toxic substances for which sufficient toxicity data are not available may not be released to waters of the state until safe levels are demonstrated through adequate bioassay studies.	Water	Other toxic substances for which sufficient toxicity data are not available may not be released to waters of the state until safe levels are demonstrated through studies.	Applicable if contaminated media treatment generated free liquids that are free liquids that are discharged to a surface water body.
10 C.S.R. 20-7.031(5)(E) Water contaminants shall not cause pH to be outside of the range of 6.5 to 9.0 standard pH units.	Water	Shall not cause pH to be outside the range of 6.5 - 9.0 standard units.	If contaminated media treatment generated free liquids that are discharged to a surface water body, these standards are applicable.
10 C.S.R. 20-7.031(5)(F) Taste- and Odor-Producing Substances Taste- and odor-producing substances shall be limited to concentrations in the streams or lakes that will not interfere with beneficial uses of the water. For those streams and lakes designated for drinking water supply use, the taste- and odor-producing substances shall be limited to concentrations that will not interfere with the production of potable water by reasonable water treatment processes.	Water	Shall not interfere with beneficial uses.	These standards are applicable to discharges to waters of the state.

Appendix D-1: Chemical Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Chemical/Medium	Requirement	Determination
10 C.S.R. 20-7.031(5)(H) Solids. Water contaminants shall not cause or contribute to solids in excess of a level that will interfere with beneficial uses. The stream or lake bottom shall be free of materials which will adversely alter the composition of the benthos, interfere with the spawning of fish or development of their eggs, or adversely change the physical or chemical nature of the bottom.	Water	Shall not cause or contribute to excess of a level that will interfere with beneficial uses.	If elevated TSS is present in any potential discharge, these standards are applicable.
10 C.S.R. 20-7.031(5)(I); cross-reference 10 C.S.R. 60-4.060 Radioactive Materials. All streams and lakes shall conform to state and federal limits for radionuclides established for drinking water supply.	Water	Shall conform to state and federal limits for drinking water supply.	As these standards establish specific water quality standards necessary to ensure protectiveness in waters with designated uses, these standards are applicable.
10 C.S.R. 2-7.031(5)(J) Dissolved Oxygen. Water contaminants shall not cause the dissolved oxygen to be lower than the levels described in Table A or Table K—Site- Specific Criteria.	Water	Shall not cause levels lower than described in Table A or Table K.	If DO is not within the acceptable range in any potential discharge, these standards are applicable.
10 C.S.R. 20-7.031(5)(K) Total Dissolved Gases. Operation of impoundments shall not cause the total dissolved gas concentrations to exceed one hundred ten percent (110%) of the saturation value for gases at the existing atmospheric and hydrostatic pressures.	Water	Operation of impoundments shall not to exceed 110% of the saturation value for gases at the existing atmospheric and hydrostatic pressures.	If dissolved gases are present in any potential discharge, these standards are applicable.
10 C.S.R. 20-7.031(5)(L), 10 C.S.R. 20-7.031 Table A (2009) Sulfate and Chloride Limit for Protection of Aquatic Life. Water contaminants shall not cause sulfate or chloride criteria to exceed the levels described in Table A.	Water	Shall not cause or contribute to levels in excess of Table A from 2009 version of the Missouri Water Quality Standards.	If sulfides and chlorides are elevated in any potential discharge, these standards are applicable.

Appendix D-1: Chemical Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Chemical/Medium	Requirement	Determination
10 C.S.R. 20-7.031(5)(M) Carcinogenic Substances. Carcinogenic substances shall not exceed concentration in water which correspond to the 10-6 cancer risk rate. This risk rate equates to one (1) additional cancer case in a population of one (1) million with lifetime exposure. Derivation of this concentration assumes average water and fish consumption amounts. Assumptions are two (2) liters of water and six and one-half (6.5) grams of fish consumed per day. Federally established final maximum contaminant levels for drinking water supply shall supersede drinking water supply criteria developed in this manner.	Water	Shall not exceed concentrations in water which correspond to the 10-6 cancer risk rate, at average fish and water consumption amounts. Federal limits for drinking water supply shall supersede criteria developed in this manner.	If carcinogenic substances are elevated in any potential discharge, these standards are applicable.
10 C.S.R. 20-7.031(5)(Q) WET Chronic Tests. Chronic WET tests performed at the percent effluent at the edge of the mixing zone shall not be toxic to the more sensitive of at least two (2) representative, diverse species.	Water	Chronic WET tests performed at the percent effluent at the edge of the mixing zone shall not be toxic to the more sensitive of at least two representative, diverse species. Pollutant attenuation will be considered.	If WET is elevated in any potential discharge, these standards are applicable.

Appendix D-1: Chemical Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Chemical/Medium	Requirement	Determination
10 C.S.R. 20-7.031 (5)(R) Biocriteria. The biological integrity of waters, as measured by lists or numeric indices of benthic invertebrates, fish, algae, or other appropriate biological indicators, shall not be significantly different from reference waters. Waters targeted for numeric biological criteria assessment must be contained within the Missouri Use Designation Dataset and shall be compared to reference waters of similar size, scale within the stream network, habitat type, and aquatic ecoregion type. Reference water locations for some aquatic habitat types are listed in Table I.	Water	Receiving waters shall not be significantly different than reference waters.	In the event discharges are significant enough to reach a classified water and biological impacts occur, then this requirement is applicable for those discharges.
10 C.S.R. 80-3.010(11)B.4 10 C.S.R. 80-3.010 Appendix 1 10 C.S.R. 80-3.010 Appendix 2 Groundwater Monitoring. (A) Requirements. The owner/operator of a sanitary landfill shall implement a groundwater monitoring program capable of determining the sanitary landfill's impact on the quality of groundwater underlying the sanitary landfill. (B) Satisfactory Compliance-Design	Water	Appendix 1 Appendix 2	Relevant and appropriate.
TMDL for Missouri Load Missouri's Water Quality Standards, 10 C.S.R. 20- 7.031, Table A, under Persistent, Bioaccumulative, Man-made Toxics.Satisfactory Compliance-Design	Water	TMDLs	Relevant and appropriate as the Missouri River has TMDLs for PCBs and chlordane.
10 C.S.R. 10-6.165 Restriction of Emission of Odors	Air	May not cause, permit, or allow the emission of odor greater than 7:1 for two separate trials not less than 15 minutes apart within the period of one hour outside of property boundary.	Relevant and appropriate if odor is present in the air when waste is excavated.

Appendix D-1: Chemical Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Chemical/Medium	Requirement	Determination
10 C.S.R. 10-6.170 Restriction of Particulate Matter to the Ambient Air Beyond the Premises of Origin	Air	Particulate matter (dust) seen leaving the property or observed on surfaces beyond the property of origin are a violation of Missouri regulations.	Relevant and appropriate if PM is present in the air when waste is excavated or dust is generated during cover construction of soil layers.
10 C.S.R. 10-6.241 Registration, Notification and Performance Requirements	Air	Registration, Abatement, Notification, Inspection, Demolition and performance requirements	Performance standards and notification requirements are relevant and appropriate if friable asbestos is encountered.
640.100-640.140 RSMo 10 C.S.R. 60-4.010 (Maximum Contaminant Limits)	Water	Safe Drinking Water Law and specified regulatory contaminant limits.	Substantive standards will be ARARs if the water is discharged to a surface water which constitutes a potential or future drinking water source or may be in contact with an aquifer that constitutes a potential or future drinking water source.

Appendix D-2: Location Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Location Subject to Requirement	Citation	Requirement	Determination
Landfills, land application sites, open dumps that have received hazardous or industrial wastes.	10 C.S.R 20-6.200 Storm Water Regulations 10 C.S.R. 20-6.200(2)(B)3.B (and the corresponding federal regulation is 40 C.F.R. 122.26(b)(14)(v)) define discharges from landfills, land application sites, and open dumps that have received industrial waste as being subject to the requirements set forth for industrial discharges throughout the state of Missouri. The substantive requirements of storm water permitting are required for all industrial discharges per 10 C.S.R. 6.200(6)(A)(1). The substantive requirements of storm water permitting are established in 10 CSR 6.200(6)(B). The regulations at 10 C.S.R. 20-6.200(6)(B)) establish the substantive requirements for a site specific industrial storm water permit.	Establishes regulatory basis and substantive requirements for storm water discharges.	Substantive requirements are applicable for control of storm water runoff during and after remedy construction.
Fee Fee Creek Watershed	10 C.S.R 20-7.015(5) (A) Discharge to metropolitan no-discharge streams is prohibited, except as specifically permitted under the Water Quality Standards 10 C.S.R 20-7.031 and noncontaminated storm water flows.	Effluent Limitations for Metropolitan No-Discharge Streams. Discharge is prohibited except as specifically permitted under the Water Quality Standards 10 C.S.R 20-7031(7).	These standards are applicable if water pollutants are present in any water discharge.
Waters of the State of Missouri	10 C.S.R 20-7.031(2)(A)-(C) (2) Designation of Uses. (A) Rebuttable presumption. (B) Presumed Uses. All waters described in subsection (2)(A) shall also be assigned Livestock and wildlife protection and Irrigation designated uses, as defined in this rule. (C) Other Uses.	Protection of designated uses.	These standards are applicable if water pollutants are present in any water discharge.
Waters of the State of Missouri	10 C.S.R 20-7.031(3) The antidegradation policy shall provide three (3) levels of protection.	Waters of the state are subject to applicable Anti-Degradation Tiers 1 & 2.	These standards are applicable if water pollutants are present in any water discharge.
Waters of the State of Missouri	10 C.S.R 20-7.031(4) The following water quality criteria shall be applicable to all waters of the state at all times including mixing zones.	General criteria are applicable to all waters of the state at all times, including mixing zones.	These standards are applicable if water pollutants are present in any water discharge.

Appendix D-2: Location Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Location Subject to Requirement	Citation	Requirement	Determination
Mixing Zones	10 C.S.R 20-7.031(5)(A) Specific Criteria. The specific criteria shall apply to waters contained in Tables G and H of this rule and the Missouri Use Designation Dataset. Protection of drinking water supply is limited to surface waters designated for raw drinking water supply and aquifers. Protection of whole body contact recreation is limited to waters designated for that use. (A) The maximum chronic toxicity criteria in Tables A and B shall apply to waters designated for the indicated uses given in the Missouri Use Designation Dataset and Tables G and H.	Where mixing zones are applicable, they will be based on 7Q10 low flow.	These standards are applicable if water pollutants are present in any water discharge. The immediate receiving stream is not classified for mixing zone to apply.
Surface of Landfills	10 C.S.R 80-3.010(8)(B)(1)(F) and (8)(C) Design and Operation (8) Water Quality. (B) Satisfactory Compliance-Design. F. Provisions for surface water runoff control to minimize infiltration and erosion of cover.	Runoff control to minimize infiltration and erosion.	These requirements are not applicable as they only apply to landfills in operation after 10-9-91. Substantive portions of 10 C.S.R 80-3.010(8)(B)(1)(F) and 10 C.S.R 80-3.010(8)(C) are relevant and appropriate under Action Specific. Runoff control to minimize infiltration and erosion is standard practice. Regarding (8)(C), while not operations, minimization of surface water contact with waste and surface water diversion from open waste if waste is exposed during remedy implementation should be performed.
Landfill	10 C.S.R 80-3.010(15) Vectors. (A) Requirements. Conditions shall be maintained that are unfavorable for the harboring, feeding and breeding of vectors.	Vector control for exposed waste.	These requirements would be relevant and appropriate to regrading of Areas 1 and 2 after removal of radiologically-impacted material.

Appendix D-2: Location Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Location Subject to Requirement	Citation	Requirement	Determination
All work areas	10 C.S.R 80-3.010(4)(B) 1.A and 1.B., 10 C.S.R 80-3.010(19) (4)(B)(1)(A) Requires new or existing municipal solid waste landfills or lateral expansions that are located within 10,000 feet of any airport runway end used by turbojet aircraft to demonstrate that the units are designed and operated so that the municipal solid waste landfill unit does not pose a bird hazard to aircraft. (4)(B)(1)(B) Owners/operators proposing to site new sanitary landfills and horizontal expansions of existing sanitary landfills within a five (5)-mile radius of any airport runway end used by turbojet aircraft or piston-type aircraft shall notify the affected airport and the Federal Aviation Administration (FAA). (19) Safety. (A) Requirement. The sanitary landfill shall be designed, constructed and operated in a manner so as to protect the health and safety of personnel and others associated with and affected by the operation. The design, construction and operation of the sanitary landfill shall minimize environmental hazards and shall conform to applicable ambient air quality and source control regulations.	Airport safety and protect health and safety of personnel.	While these safety related requirements are not relevant and appropriate to regrading of Areas 1 and 2 after removal of radiologically-impacted material, they are considered TBC.
Landfill	10 C.S.R 80-3.010(13) The design, construction and operation of the sanitary landfill shall minimize environmental hazards and shall conform to applicable ambient air quality and source control regulations.	Air Quality	These requirements would be relevant and appropriate to excavation and grading activities in Areas 1 and 2.

Appendix D-2: Location Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Location Subject to Requirement	Citation	Requirement	Determination
Side slope of landfill and disturbed areas	10 C.S.R 80-3.010(6)(A) Requirement. The construction, operation and closure of the sanitary landfill shall include quality assurance and quality control measures to ensure compliance with approved plans and all applicable federal, state and local requirements. The permittee shall be responsible for ensuring that the quality assurance/quality control supervision is conducted by a qualified professional. (B) Satisfactory Compliance - Design	QA/QC for landfill cover.	These requirements are not applicable as they only apply to landfills in operation after 10-9-91; however, substantive portions as related to closure/final cover and to ensure compliance with ARARs are Relevant and Appropriate under Action Specific. The design and associated QA/QC requirements will be detailed in CERCLA documents and approved as part of the CERCLA process.
Landfill	10 C.S.R 80-3.010(17)(A): Requirement. Cover shall be applied to minimize fire hazards, infiltration of precipitation, odors and blowing litter; control gas venting and vectors; discourage scavenging; (B) Satisfactory Compliance Design. The owner/operator shall prepare a written closure plan that describes the steps necessary to close all sanitary landfill phases at any point during the active life of the sanitary landfill in accordance with the requirements of 10 C.S.R 80-2.030(4)(A). In addition, includes specifications for the final cover requirements.	Cover requirements to minimize fire hazard, infiltration, odors, blowing litter, gas venting, vectors, discourage scavenging, appearance.	Substantive elements of these chapters are relevant and appropriate.
Landfill	10 C.S.R 80-3.010(18)(A) Requirement. In order to conserve sanitary landfill site capacity, thereby preserving land resources and to minimize moisture infiltration and settlement, solid waste and cover shall be compacted to the smallest practicable volume. (B) Satisfactory Compliance Design. (C) Satisfactory Compliance Operations.	Compaction if existing cap is disturbed.	Substantive elements of these chapters are relevant and appropriate.

Appendix D-2: Location Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Location Subject to Requirement	Citation	Requirement	Determination
Landfill	10 C.S.R 80-3.010(4)(A) In order to conserve sanitary landfill site capacity, thereby preserving land resources and to minimize moisture infiltration and settlement, solid waste and cover shall be compacted to the smallest practicable volume.	Site selection – geologic, hydrologic and soil conditions.	Substantive elements of these chapters are relevant and appropriate.
Land	Archeological and Historic Preservation Act (54 USC 312508; PL 113-287; 128 Stat. 3256)	Data recovery and preservation activities should be conducted if prehistoric, historical, and archaeological data might be destroyed as a result of a federal, federally assisted, or federally licensed activity or program.	No destruction of such data is expected to result from remedial action. The Site has been considerably disturbed by past human activities and is therefore not expected to contain any such data. However, if these data were affected, *e.g.*, at any potential off-site borrow area, the requirement would be applicable.
Any	Endangered Species Act, as amended (16 USC 1531-1544; 50 C.F.R. Part 17)	Federal agencies should ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify any critical habitat.	No critical habitat has been identified in the affected area, and no adverse impacts to threatened or endangered species are expected to result from any remedial action. However, if such species were affected, the requirement would be applicable. An assessment of the potential for occurrences of threatened or endangered species was performed during the RI. No federal listed or proposed threatened and endangered species or their habitats were identified at or in the vicinity of the Site.

Appendix D-2: Location Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Location Subject to Requirement	Citation	Requirement	Determination
Any	Missouri Wildlife Code (1989) (RSMo. 252.240; 3 CSR 10-4.111), Endangered Species	Endangered species, i.e., those designated by the U.S. Department of the Interior and the Missouri Department of Conservation as threatened or endangered (see1978 Code, RSMo. 252.040), should not be pursued, taken, possessed, or killed.	No critical habitat has been identified in the affected area, and no adverse impacts to threatened or endangered species are expected to result from any remedial action. However, if such species were affected, the requirement would be applicable.
Farmland (prime, unique, or of state and local importance)	Farmland Protection Policy Act (7 USC 4201 et seq.) Farmland Protection [7 C.F.R. 658; 40 C.F.R. 6.302(c)]	Federal agencies should take steps to ensure that federal actions do not cause U.S. farmland to be irreversibly converted to nonagricultural uses in cases in which other national interests do not override the importance of the protection of farmland or otherwise outweigh the benefits of maintaining farmland resources. Criteria developed by the U.S. Soil Conservation Service are to be used to identify and take into account the adverse effects of federal programs on farmland preservation. Federal agencies should consider alternative actions that could lessen adverse effects and should ensure that programs are compatible with state and local government and private programs and policies to protect farmland.	This requirement would be applicable for any potential soil borrow area off-site. Mitigative measures and restoration activities would also be conducted at any off-site borrow area, as appropriate, to minimize any adverse impacts to farmland.

Appendix D-3: Action-Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Action	Requirement	Remarks
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 C.F.R. 192), Subpart A, Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites 40 C.F.R. 192.02	Radioactive waste disposal	Control of residual radioactive materials at designated uranium processing or depository sites should be designed to be effective for at least 200 years and up to 1,000 years, to the extent reasonably achievable. In addition, the control should be designed such that releases of radon-222 from the residual radioactive material would not exceed an average rate of 20 pCi/m2-s or increase the annual average concentration in air outside the disposal site by more than 0.5 pCi/L. Because this standard applies to design, monitoring after disposal is not required to demonstrate compliance	The West Lake Landfill OU-1 Site is not a designated Title I uranium mill tailings site. Therefore, this requirement would not be applicable. These regulations are applicable to uncontrolled areas whereas the current and future uses of Areas 1 and 2 are restricted. As OU-1 does contain radiologically impacted materials, these requirements are relevant. The wastes contain radium. and thorium, therefore the longevity standard is relevant and appropriate. As the radiologically impacted materials will remain on-site beyond the 30-year post-closure period for a solid waste landfill, the 200/1000 year period, this standard is relevant and appropriate.
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 C.F.R. 192), Subpart D, Standards for Management of Uranium Byproduct Materials Pursuant to Section 84 of the U.S. Atomic Energy Act of 1954, as amended. 40 C.F.R. 192.32	Radioactive waste disposal	Disposal areas for uranium and thorium by-product materials should be designed to be effective for at least 200 years and up to 1,000 years, to the extent reasonably achievable. In addition, the control should be designed so that releases of radon-222 and radon-220 from these materials (*i.e.*, excluding the cover) would not exceed an average of 20 pCi/m2-s. The standard applies to design, so monitoring for radon after installation of an appropriately designed cover is not required. (This requirement does not apply to any portion of the Site that contains residual surface and subsurface concentrations of radium-226 and radium-228 at or below those identified in Subpart B which was described under potential chemical-specific ARARs and TBCs.)	The West Lake Landfill OU-1 Site is not a designated Title I uranium mill tailings site. Therefore, this requirement would not be applicable. These regulations are applicable to uncontrolled areas whereas the current and future uses of Areas 1 and 2 are restricted. As OU-1 does contain radiologically impacted materials, these requirements are relevant. The wastes contain radium. and thorium, therefore the longevity standard is relevant and appropriate. As the radiologically impacted materials will remain on-site beyond the 30-year post-closure period for a solid waste landfill, the 200/1000 year period, this standard is relevant and appropriate.

Appendix D-3: Action-Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Action	Requirement	Remarks
Resource Conservation and Recovery Act (RCRA) Subtitle C (40 C.F.R. 240 et seq.)	Hazardous waste management	Establishes standards for identification of and treatment, storage and disposal of hazardous wastes including hazardous wastes disposed in landfills. Standards for Identification of hazardous wastes (40 C.F.R. 261) Standards for Generators of hazardous wastes (40 C.F.R. 262) Standards for Transporters of hazardous wastes (40 C.F.R. 263) Use and Management of Containers (40 C.F.R. 264 Subpart I) Land Disposal Restrictions (40 C.F.R. 264 Subpart N) Staging Piles (40 C.F.R. 264.554) Specifically, must determine if solid waste is a hazardous waste using the following method: • Should first determine if waste is excluded from regulation under 40 C.F.R. 261.4; and • Must then determine if waste is listed as a hazardous waste under subpart D 40 C.F.R. part 261 or whether the waste is (characteristic waste) identified in subpart C of 40 C.F.R. part 261 by either: (1) Testing the waste according to the methods set forth in subpart C of 40 C.F.R. part 261, or according to an equivalent method approved by the Administrator under 40 C.F.R. §260.21; or (2) Applying knowledge of the hazard characteristic of the waste in light of the materials or the processes used. A generator may accumulate hazardous waste at the facility provided that (accumulation of RCRA	The radiologically-impacted materials in Areas 1 and 2 do not meet the criteria for classification as hazardous wastes; however, other waste materials in Areas 1 or 2 may meet these criteria and as such these requirements may be applicable.

Appendix D-3: Action-Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Action	Requirement	Remarks
		hazardous waste on site as defined in 40 C.F.R. §260.10): • waste is placed in containers that comply with 40 C.F.R. 265.171–173; and • the date upon which accumulation begins is clearly marked and visible for inspection on each container; • container is marked with the words "hazardous waste"; or • container may be marked with other words that identify the contents if accumulation of 55 gal. or less of RCRA hazardous waste or one quart of acutely hazardous waste listed in §261.33(e) at or near any point of generation.	
Missouri Radiation Regulations; Protection Against Ionizing Radiation (19 C.S.R. 20-10.090), Disposal of Radioactive Wastes	Radioactive waste disposal	Radioactive waste material should not be disposed of by dumping or burial in soil, except at sites approved by and registered with the Missouri Department of Health; no releases to air or water should cause exposure of any person above the limits specified in 10-C.S.R. 20-10.040.	The substantive portions of these requirements would be applicable.

Appendix D-3: Action-Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Action	Requirement	Remarks
Missouri Radiation Regulations; Protection Against Ionizing Radiation (19 C.S.R. 20-10.070), Storage of Radioactive Materials	Radioactive waste Storage Control of radioactive contamination	Radioactive materials should be stored in a manner that will not result in the exposure of any person, during routine access to a controlled area, in excess of the limits identified in 19 C.S.R. 20-10.040 (see related discussion for contaminant-specific requirements); a facility used to store materials that may emit radioactive gases or airborne particulate matter should be vented to ensure that the concentration of such substances in air does not constitute a radiation hazard; and provisions should be made to minimize hazards to emergency workers in the event of a fire, earthquake, flood, or windstorm.	These substantive portions of these requirements would be applicable to the temporary storage of radiologically-impacted soils that might be generated during any remedial action.
Missouri Solid Waste Rules (10 C.S.R. 80), Chapter 4, Demolition Landfills, 4.010(17), Cover	Solid waste disposal	The landfill should be covered to minimize fire hazard, infiltration of precipitation, odors and blowing litter; control gas venting and vectors; discourage scavenging; and provide a pleasing appearance. Final slope of the top shall be a minimum of 5%. No slopes shall ever exceed 33 1/3 % and slopes shall not exceed 25% without a detailed slope stability analysis. The final cover should be at least 1 ft of compacted clay with a permeability of 1×10^{-5} cm/sec or less overlain by 2 ft of soil capable of supporting vegetative growth.	These requirements would be relevant and appropriate to regrading of Areas 1 and 2 after removal of radiologically-impacted material, and to the final slopes and cover design for Areas 1 and 2.

Citation	Action	Requirement	Remarks
Noise Control Act, as Amended; Noise Pollution and Abatement Act (42 USC 4901 et seq)	Construction activities	The public should be protected from noises that jeopardize human health or welfare.	These requirements would be applicable to any remedial action.
National Emissions Standards for Hazardous Air Pollutants - Asbestos 40 C.F.R. Part 61 40 C.F.R 61.150 40 C.F.R. § 61.154(j)	Asbestos management	Requirements for management of regulated asbestos containing materials (RACM). 40 C.F.R. 61.150(a) requires that there be no visible emissions to the outside air during collection, processing, packaging, or transporting of any asbestos containing waste material. 40 C.F.R. 61.150(b)(1) and (2) requires that all asbestos-containing waste material shall be deposited as soon as is practical by the waste generator at a waste disposal site operated in accordance with the provisions of § 61.154, or an EPA-approved site that converts RACM and asbestos-containing waste material into non asbestos (asbestos-free) material according to the provisions of § 61.155.	Standards for demolition and renovation are applicable in the event that RACM is encountered during remedy implementation. Notice requirements may become applicable in the event that it is determined that RACM is located within the relevant portions of the Site and that RACM is disturbed during excavation.

Appendix D-3: Action-Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Action	Requirement	Remarks
National Ambient Air Quality Standards, 40 C.F.R. 50 40 C.F.R. §§ 50.3-50.19	Radionuclides Radon and Particulates	Air quality standards	Standards for air emissions during remedy implementation. It should be noted that these primary and secondary standards reference the following: sulfur dioxide, PM10 (particulate matter), PM2.5 (particulate matter), Carbon Monoxide, Ozone, Oxides of Nitrogen, and Lead. They do not directly address radioactive materials, but may be relevant to the extent that there may be a need to control airborne particulates during the implementation of the ultimate remedy selected for the Site.
PCB Spill Cleanup Policy 40 C.F.R. 761 Subparts D, G, N, O, P, R and S	PCB cleanup and management	Requirements for cleanup of PCB wastes. In particular Subpart D regulates storage and disposal of PCB wastes and establishes requirements for handling, storage, and disposal of PCB-containing materials, including PCB remediation wastes, and sets performance standards for disposal technologies for materials/wastes with concentrations in excess of 50 milligrams per kilogram (mg/kg). Establishes decontamination standards for PCB contaminated debris. If additional testing identifies wastes at concentrations of 50 mg/kg PCBS, TSCA regulations may be applicable for managing excavated material for off-site disposal and listed here: 40 C.F.R. 761.1(b)(5), 40 C.F.R. 761.3, 40 C.F.R. 761.50(a) and (b)3, 40 C.F.R. 761.61(a)(5) and (b), 40 C.F.R. 761.65(c)(9)(i)-(iii), and 40 C.F.R. 761(c).	Applicable if PCBs are encountered during remedy implementation

Appendix D-3: Action-Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Action	Requirement	Remarks
Missouri Storm Water Regulations 10 C.S.R. 20-6.200		Requirements for control of stormwater runoff	Substantive requirements are applicable for control of storm water runoff during and after remedy construction.
De Minimis Emissions Levels 10 C.S.R. 10-6.020(3)(A)	PM-10 Non-methane organic compounds (NMOC)	Air quality standards	Standards for air emissions during remedy implementation.
Controlling Emissions During Episodes of High Air Pollution Potential 10 C.S.R. 10-6.130		Requirements for controlling emissions during air pollution events	Applicable. Could require shut down of remedy implementation construction operations during a purple or maroon air quality event.

Appendix D-3: Action-Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Action	Requirement	Remarks
Restriction of Particulate Matter to the Ambient Air Beyond the Premises of Origin 10 C.S.R.-6.170	Particulate Matter	Requirements for controlling emissions	Applicable to the control of fugitive dust emissions during remedy construction activities.
40 C.F.R. Part 122 (EPA Administered Permit Program - The National Pollutant Discharge Elimination System), Subpart C (Permit Conditions) 40 C.F.R. 122.26(b)(14)(v)	Various pollutants	The regulatory provisions contained in this part implement National Pollutant Discharge Elimination System (NPDES) Program under sections 318, 402, and 405 of the Clean Water Act (CWA) (Public Law 92-500, as amended, 33 U.S.C. 1251 *et seq.*). Stormwater permits are required for any landfill, land application sites and open dumps that receive or have received industrial waste, and said stormwaters impact waters of the United States. 40 C.F.R. 22.26(b)(14)(v). Certain conditions are applicable to permits and permit holders regulated pursuant to 40 C.F.R. 122.26, including compliance with the effluent standard under Section 307a of the Clean Water Act for toxic pollutants and with standard for sewage sludge.	Applicable if stormwaters draining from the Site impact Waters of the United States. Missouri has an approved state program/delegated water program under 40 C.F.R. Part 123.

Appendix D-3: Action-Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Action	Requirement	Remarks
40 C.F.R. Part 131 (Water Quality Standards) 40 C.F.R. § 131.36	Sets forth requirements and procedures for developing, reviewing, revising and approving water quality standards by the States as authorized by the Clean Water Act	40 C.F.R. Part 131 describes the requirements and procedures for developing, reviewing, revising, and approving water quality standards by the States as authorized by section 303(c) of the Clean Water Act. 40 C.F.R. Part 131 does not lay out specific standards to be applied, but rather serves as a framework by which States must develop water quality standards for water bodies, including uses that may be made of such bodies, and standards to promote the safety of water as used. It also provides for the process by which EPA reviews, revises and approves of water quality standards developed by States.	It does not appear that these standards are applicable to Missouri, but are relevant. It should be noted that Missouri has adopted Water Quality Standards under 10 C.S.R. 20-7.031(5), which regulate concentrations of inorganics, trace metals, organics, pesticides, man-made volatiles, PAHs, phthalates and other chemicals.
L. 1981 H.S.H.B. 1192, an Act This state law provides for protection of caves (including sinkholes) and cave life from vandalism and pollution.	Pollution and vandalism	Relates to protection of caves (including sinkholes) and cave life	Relates to protection of caves (including sinkholes) and cave life. The law may be applicable if site contains the presence of solution enlarged fractures during excavation.
Hazardous Waste Management Law 260.350-260.1039 Hazardous Waste Regulations 10 C.S.R. 25-1 through 19 10 C.S.R. 25-19.010 Electronics Scrap Management	Hazardous Waste Generation, storage, treatment, transportation and disposal	Follow all applicable state and federal hazardous waste laws and regulations	Substantive portions of Division 25 may be relevant and appropriate if hazardous waste is required to be managed under the selected remedial options.

Appendix D-3: Action-Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Action	Requirement	Remarks
10 C.S.R. 80-2.030 Solid Waste Disposal Area Closure, Post-Closure Care and Corrective Action Plans and procedures with Associated Financial Assurance Requirement	Closure and Post-closure	Care and O&M	The substantive MDNR landfill requirements for post-closure care and corrective action found in 10 C.S.R. 80-2.030 are considered relevant and appropriate.
10 C.S.R. 80-2.030(1) To prevent a solid waste disposal area from being a blight on the land, a hazard to health and safety and air pollution problem or a source of pollution to any water course, the owner/operator of any solid waste disposal area shall obtain approval of the method of closure from the department prior to closure.	Closing sides of disturbed landfill	Obtain approval	The substantive MDNR landfill requirements for post-closure care and corrective action found in 10 C.S.R. 80-2.030 are also considered relevant and appropriate.

Appendix D-3: Action-Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Action	Requirement	Remarks
10 C.S.R. 80-3.010(17)(B)3,7,(C)3 Surface grades and side slopes needed to promote maximum runoff, without excessive erosion, to minimize infiltration. Final side slopes shall not exceed twenty-five percent (25%) unless it has been demonstrated in a detailed slope stability analysis approved by the department that the slopes can be constructed and maintained throughout the entire operational life and post-closure period of the landfill. (C)3. No active, intermediate or final slope shall exceed thirty-three and one-third percent (33 1/3%).	Slope construction	Runoff without excessive erosion, stability	Substantive elements of these chapters are relevant and appropriate.
10 C.S.R. 80-3.010(8)(C)(2) The quantity of water coming in contact with solid waste shall be minimized by the daily operational practices. Water which comes in contact with solid waste shall be managed as leachate in accordance with the approved plans.	Precipitation on open side slopes	Treat as leachate	Relevant and appropriate during construction.

Appendix D-3: Action-Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Action	Requirement	Remarks
10 C.S.R. 80-3.010(6) Testing of each lift of the soil component of the final cover and landfill liner for field density and field moisture once per every ten thousand (10,000) square feet and providing relatively uniform coverage over the landfill surface.	QA/QC of cover	Thickness and testing of each lift of soil	Prevent infiltration and promote vegetative growth. Relevant and appropriate during construction.

Appendix D-3: Action-Specific ARARs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Action	Requirement	Remarks
10 C.S.R. 80-3.010(17)(C)4 As each phase of the sanitary landfill is completed, a final cover system shall be installed at portions of A. Existing sanitary landfills without composite liners. This final cover shall consist of at least two feet (2') of compacted clay with a coefficient of permeability of 1 × 10-5 cm/sec or less and overlaid by at least one foot (1') of soil capable of sustaining vegetative growth; B. Sanitary landfills with composite liners. This final cover shall consist of component layers, in order from top to bottom, as follows: (I) Two feet (2') of soil capable of sustaining vegetative growth; (II) A drainage layer; (III) A geomembrane liner at least as thick as the geomembrane liner described in subparagraph (10)(B)1.G; (IV) One foot (1') of compacted clay with a coefficient of permeability of 1 × 10-5 cm/sec or less; and C. The geomembrane liner shall be in intimate contact with the underlying compacted clay. 5. The installation of the final cover systems	Cover requirements	2 feet of clay, 1 foot vegetative soil, 1x10-5 permeability, if disturbed	Substantive elements of these chapters are relevant and appropriate.

Appendix D-4: TBCs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Chemical/Medium	Requirement	Determination
OSWER Directive 9285.6-20 (“Radiation Risk Assessment at CERCLA Sites: Q&A”)	Radon/Air	Provides guidance on conducting risk assessment on radiologically contaminated sites.	TBC for purposes of demonstrating compliance with UMTRCA where UMTRCA is identified as an ARAR for indoor air radon exposure. This guidance provides pCi/l concentration levels to show compliance with the UMTRCA working level indoor air levels.
OSWER 9200.4-18 ("Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA, 1997a))	Radioactive contamination at CERCLA sites.	Provide guidance on use of the UMTRCA standards as CERCLA cleanup levels. Cleanup of radionuclides is governed by the risk range for all carcinogens established in the NCP when ARARs are not available or are not sufficiently protective. 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 10-4 and 10-6; 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.	As this is only guidance, it is not an ARAR. EPA has defined the full excavation of RIM alternatives to mean attainment of the risk-based radiological clean levels specified in OSWER directives 9200.4-25 and 9200.4-18.
EPA’s Regional Screening Levels for Chemical Contaminants at Superfund Sites.	Various	EPA’s RSL website (https://ww.epa.gov/risk/regional-screening-levels-rsls) and associated tables and calculator is a tool to present risk based screening levels and variable risk based screening level calculation equations for chemical contaminants.	This EPA tool is a TBC when determining protective exposure levels of contaminants of concern.
EPA’s "Dose Compliance Concentrations for Radionuclides at Superfund Sites" (DCC) calculator.	Various	EPA’s DCC Calculator (https://epa-dccs.ornl.gov/) website is a tool to demonstrate compliance with any dose-based ARAR.	The EPA is including the DCC calculator website as a TBC to demonstrate compliance with any dose-based ARAR. For example, the specific air concentrations for radionuclides necessary to meet the NESHAP standard above will be determined using the DCC Calculator.

Appendix D-4: TBCs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Chemical/Medium	Requirement	Determination
EPA Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments, OSWER 530-SW- 89-047 (July 1989)	Hazardous Wastes	Provides design guidance on final cover systems for hazardous waste landfills and surface impoundments. Addresses multilayer cover design to provide long-term protection from infiltration of precipitation.	As this is only guidance, it is not an ARAR. While RCRA Subtitle C regulations are neither applicable nor relevant and appropriate to West Lake Landfill OU-1, EPA guidance on the design of landfill covers for RCRA and CERCLA sites may provide information useful for the design of a final cover system. Therefore, this guidance is a TBC.
(Draft) Technical Guidance for RCRA/CERCLA Final Covers, EPA OSWER 540-R-04-007 (April 2004)	Hazardous Wastes	Provides design information regarding cover systems for municipal solid waste (MSW) and hazardous waste (HW) landfills being remediated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Resource Conservation and Recovery Act (RCRA) Corrective Action, and sites regulated under the RCRA. Specifically, this guidance recommends and describes a multi-layer cover system that includes a two-component low permeability layer with a hydraulic conductivity no greater than 1 x 10-7 cm/sec. This guidance includes updated information related to development of design criteria, use and types of geosynthetics such as geosynthetic clay liners, alternative materials and designs, performance monitoring, maintenance of cover systems, and other issues.	While RCRA Subtitle C regulations are neither applicable nor relevant and appropriate to West Lake Landfill OU-1, EPA guidance on the design of landfill covers for RCRA and CERCLA sites provides specific information that is useful for the design of a final cover system that will result in compliance with the UMTRCA performance standards. Because proper design and construction of a final cover is key to long-term protection from infiltration of precipitation, these criteria will be incorporated into the design of the engineered landfill cover system. Therefore, this guidance is a TBC.
FAA Record of Decision (1998) FAA Memorandum of Understanding (2003)		The FAA ROD includes requirements relative to proximity of the proposed Lambert Airport new runway to the existing Bridgeton Sanitary Landfill. The FAA MOU, entered into between the FAA, EPA and other agencies, addresses aircraft-wildlife strikes.	The FAA ROD and FAA MOU are not legally binding and are not ARARs. They do, however, represent TBC criteria.

Appendix D-4: TBCs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Chemical/Medium	Requirement	Determination
FAA Advisory Circular AC 150/5200-33B (2007)		FAA Advisory Circular AC 150/5200-33B, "Hazardous Wildlife Attractants On or Near Airports," provides guidance on certain land uses that have the potential to attract hazardous wildlife on or near public-use airports. This circular recommends against locating a MSWLF within certain separation distances: 1. Airports serving piston-powered aircraft – 5,000 feet, 2. Airports serving turbine-powered (jet) aircraft – 10,000 feet, 3. Protection of approach, departure and circling airspace – 5 statute miles	This requirement is a TBC relative to excavation at the Site.
Executive Order 11988 - 40 CFR 6.302(b) and App. A		Federal agencies should avoid, to the maximum extent possible, any adverse impacts associated with direct and indirect development of a floodplain. 40 C.F.R. Part 6 describes EPA's policy on implementing Executive Orders 11988 (Floodplain Management). The procedures substantively require that EPA conduct its activities to avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupation or modification of floodplains.	This requirement is a TBC for any remedial action for the Buffer Zone/Crossroad Property. Mitigative measures would be taken to minimize any adverse impacts.
Governor's Executive Order 82-19		Potential effects of actions taken in a floodplain should be evaluated to avoid adverse impacts.	This requirement is a TBC for any remedial action for the Buffer Zone/Crossroad Property. Mitigative measures would be taken to minimize any adverse impacts.

Appendix D-4: TBCs for Remedial Action at the West Lake Landfill Superfund Site, OU-1 ROD Amendment

Citation	Chemical/Medium	Requirement	Determination
Closure and Post- Closure Plan Laidlaw Waste Systems (Bridgeton), Inc. Sanitary Landfill, December 1996, Revised September 1997, Revised April 1998, Revised April 2016		Sets out closure and post-closure procedures for any portion of the OU-1 remedy that impact the Bridgeton Landfill permitted area, in particular, the final cover, grading and vegetation plan.	Sets out the procedures to be used at the Landfill to comply with the MDNR Solid Waste Regulations. This document should be considered in the design and construction of any cover system or drainage improvements that may be constructed for Areas 1 and 2 or if additional waste materials are placed in these areas as part of a remedial action that impact the Bridgeton Landfill permitted area. This document will also need to be considered if any regrading and/or landfill cover improvements are implemented for Areas 1 or 2.