

Tronox Navajo Abandoned Uranium Mines Eastern Abandoned Uranium Mine Region

Final Section 32 and 33 Mines Engineering Evaluation/Cost Analysis



August 31, 2023



**Tronox Navajo Abandoned Uranium Mines
Eastern Abandoned Uranium Mine Region**

**Section 32 and 33 Mines
Engineering Evaluation/Cost Analysis**

**Response, Assessment, and Evaluation Services 2
Contract No. 68HE0923D0002
Task Order 003**

August 31, 2023

**Submitted to
U.S. Environmental Protection Agency**

**Submitted by
Tetra Tech, Inc.
1999 Harrison Street, Suite 500
Oakland, CA 94612**





TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
ACRONYMS AND ABBREVIATIONS	v
1.0 EXECUTIVE SUMMARY	1
1.1 PURPOSE OF THE ENGINEERING EVALUATION/COST ALTERNATIVES ANALYSIS	1
1.2 SITE CHARACTERIZATION.....	1
1.3 REMOVAL ACTION OBJECTIVES	2
1.4 IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES	3
1.5 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES.....	3
2.0 SITE CHARACTERIZATION.....	5
2.1 SITE DESCRIPTION AND BACKGROUND	5
2.1.1 Site Location.....	5
2.1.2 Type of Mine and Operational Status.....	5
2.1.3 Regulatory History	6
2.1.4 Site Features and Landscape	6
2.1.5 Geology and Hydrology	7
2.1.6 Land Use and Populations	8
2.1.7 Sensitive Ecosystems and Habitat.....	8
2.1.8 Meteorology and Climate.....	12
2.2 PREVIOUS RECLAMATION AND REMOVAL ACTIONS	12
2.3 PREVIOUS SITE INVESTIGATIONS	12
2.4 SOURCE, NATURE, AND EXTENT OF CONTAMINATION	13
2.4.1 Background Threshold Values	13
2.4.2 Constituents of Interest.....	14
2.4.3 Source and Nature of Contamination	14
2.4.4 Extent of Contamination	16
2.5 RISK ASSESSMENT.....	16
2.5.1 Human Health Risk Assessment	17
2.5.2 Ecological Risk Assessment.....	19
2.5.3 Risk Assessment Results Summary	20
2.6 BACKGROUND COMPARISON	21
2.7 REMOVAL ACTION GOALS AND REMOVAL ACTION EXTENT	22
2.7.1 Removal Action Goals	22
2.7.2 Radium-226 Removal Action Extent	23
2.7.3 Other Removal Action Extent Considerations	24



3.0	IDENTIFICATION OF REMOVAL ACTION OBJECTIVES	25
3.1	REMOVAL ACTION OBJECTIVES	25
3.2	STATUTORY LIMITS ON REMOVAL ACTIONS.....	25
3.3	REMOVAL SCOPE	25
3.4	REMOVAL SCHEDULE.....	26
4.0	IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES ..	27
4.1	DEVELOPMENT AND SCREENING OF ALTERNATIVES.....	27
4.1.1	Summary of Technology Identification and Screening.....	27
4.1.2	Summary of Alternative Development.....	33
4.1.3	Applicable or Relevant and Appropriate Requirements.....	35
4.2	DESCRIPTION OF ALTERNATIVES	36
4.2.1	Common Elements	36
4.2.2	Description of Removal Action Alternatives	42
4.3	DETAILED ANALYSIS OF ALTERNATIVES.....	46
4.3.1	Effectiveness Criterion	47
4.3.2	Implementability Criterion	48
4.3.3	Cost Criterion	48
4.3.4	Cost Estimating Process	48
4.3.5	Alternative 1: No Action	49
4.3.6	Alternative 2: Consolidate and Cap All Waste at Onsite Repository.....	51
4.3.7	Alternative 3: Dispose of All Mine Waste Off Site at Red Rock Disposal Facility.....	55
4.3.8	Alternative 4: Dispose of All Mine Waste Off Site at a Resource Conservation and Recovery Act C or Low-Level Radioactive Waste Facility.....	59
5.0	COMPARATIVE ANALYSIS OF ALTERNATIVES.....	64
5.1	COMPARATIVE ANALYSIS APPROACH	64
5.2	SUMMARY OF ANALYSIS	64
5.2.1	Effectiveness	64
5.2.2	Implementability	68
5.2.3	Projected Costs	71
6.0	RECOMMENDED ALTERNATIVE	72
7.0	REFERENCES	74



EXHIBITS

Exhibit 1. Summary of Alternative Ratings..... 4

Exhibit 2. Federal and Navajo Nation-Listed Endangered or Threatened Species Having
Potential to Occur at the Section 32 and 33 Mine Area..... 10

Exhibit 3. Provisional Background Threshold Values..... 13

Exhibit 4. Exposure Units and Receptor Descriptions..... 18

Exhibit 5. Cancer Risks and Noncancer Hazards 18

Exhibit 6. Candidate COCs Identified Based on Cancer Risks and Noncancer Hazards 19

Exhibit 7. Candidate COECs 20

Exhibit 8. Candidate COCs or COEC for Soil..... 21

Exhibit 9. Selected Soil RAG for Each COC and COEC 23

Exhibit 10. Potential Community Impacts from Trucking 42

Exhibit 11. Alternative 2 Cost Breakdown 54

Exhibit 12. Red Rock Transportation and Tipping Costs 55

Exhibit 13. Alternative 3 Cost Breakdown 59

Exhibit 14. Deer Trail Transportation and Tipping Costs 60

Exhibit 15. Alternative 4 Cost Breakdown 63

Exhibit 16. Comparative Rating of Alternatives..... 64

Exhibit 17. Potential Community Impacts from Trucking 66

Exhibit 18. Environmental Impacts of Alternatives 67

Exhibit 19. Construction Completion Time for Alternatives..... 67

Exhibit 20. Alternative Costs and Ratings..... 71



FIGURES

- Figure 1. Regional Location
- Figure 2. Section 32 and 33 Mines Access
- Figure 3. Section 32 and 33 Mines Site Features
- Figure 4. Section 32 and 33 Mines Geology
- Figure 5. Regional Aquifers and Wells
- Figure 6. Section 32 and 33 Mines Proposed Future Land Use
- Figure 7. Thoreau, New Mexico, Average Monthly Precipitation, Snowfall, and Temperature
- Figure 8. Thoreau, New Mexico, Wind Rose Diagram
- Figure 9. Section 32 and 33 Mines Conceptual Site Model Wire Diagram
- Figure 10. Section 32 and 33 Mines Gamma Radiation Survey
- Figure 11. Section 32 and 33 Mines Estimated Radium-226 Surface Soil Concentrations
- Figure 12. Section 32 and 33 Mines Proposed Removal Action Extent
- Figure 13. Proposed Construction Activities
- Figure 14. Proposed Surficial Restoration Activities
- Figure 15. Alternative 2 - Onsite Repository Location and Features
- Figure 16. Alternative 3 - Off-Navajo Nation Disposal at Red Rock Disposal Facility Haul Route
- Figure 17. Alternative 4 - Off-Navajo Nation Disposal at Clean Harbors RCRA C Hazardous Waste Disposal Facility Haul Route

TABLES

- Table 1. Mine Features and Dimensions at the Section 32 and 33 Mines
- Table 2. Comparison of Sections 32 and 33 Mines Site Surface Soil Concentrations to Background Concentrations
- Table 3. General Response Actions, Technologies, and Process Options
- Table 4. Applicable or Relevant and Appropriate Requirements and To Be Considered Requirements for the Section 32 and 33 Mines

APPENDICES

- Appendix A Site Images
- Appendix B Site Delineation
- Appendix C Risk Assessment
- Appendix D Cost Analysis



ACRONYMS AND ABBREVIATIONS

§	Section
°F	Degrees Fahrenheit
ARAR	Applicable or relevant and appropriate requirement
AUM	Abandoned uranium mine
bgs	Below ground surface
BSA	Background study area
BTV	Background threshold value
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	<i>Code of Federal Regulations</i>
CO _{2e}	carbon dioxide equivalent
COC	Contaminant of concern
COEC	Contaminant of ecological concern
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
CSM	Conceptual site model
E&E	Ecology and Environment, Inc.
Eco-SSL	Ecological soil screening level
EE/CA	Engineering evaluation/cost analysis
EPC	Exposure point concentration
ERA	Ecological risk assessment
ESL	Environmental screening level
ET	Evapotranspiration
EU	Exposure unit
g/cm ³	Gram per cubic centimeter
HELP	Hydrologic Evaluation of Landfill Performance
HHRA	Human health risk assessment
HI	Hazard index
HQ	Hazard quotient
IC	Institutional control
Kerr-McGee	Kerr-McGee Corporation
LANL	Los Alamos National Laboratory
LLRW	Low-level radioactive waste

ACRONYMS AND ABBREVIATIONS (CONTINUED)

MARSSIM	<i>Multi-Agency Radiation Survey and Site Investigation Manual</i>
mg/day	Milligram per day
mg/kg-day	Milligram per kilogram per day
N3B	Newport News Nuclear BWXT-Los Alamos
NAMLRD	Navajo Nation Abandoned Mine Lands Reclamation Department
NAUM	Navajo abandoned uranium mine
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NECR	Northeast Church Rock
NNDFW	Navajo Nation Department of Fish and Wildlife
NNEPA	Navajo Nation Environmental Protection Agency
NOAEL	No observed adverse effect level
NOEC	No observed effect concentration
NORM	Naturally occurring radioactive material
NRC	U.S. Nuclear Regulatory Commission
NTUA	Navajo Tribal Utility Authority
OSHA	Occupational Safety and Health Administration
pCi/g	Picocurie per gram
PRG	Preliminary remediation goal
psf	Pound per square foot
Ra-226	Radium-226
RAG	Removal action goal
RAO	Removal action objective
RBSL	Risk-based screening level
RCRA	Resource Conservation and Recovery Act
RfC	Reference concentration
RfD	Reference dose
RME	Reasonable maximum exposure
RSE	Removal site evaluation
RSL	Regional screening level
SE	Secular equilibrium
SF	Slope factor
SLERA	Screening-level risk assessment
SPLP	Synthetic precipitation leaching procedure
SWPPP	Stormwater pollution prevention plan
TBC	To be considered
TCLP	Toxicity characteristic leaching procedure
TCR	Target cancer risk
TENORM	Technologically enhanced naturally occurring radioactive material



ACRONYMS AND ABBREVIATIONS (CONTINUED)

Tetra Tech	Tetra Tech, Inc.
THQ	Target hazard quotient
TRV	Toxicity reference value
UCL95	95 percent upper confidence level
UMTRCA	Uranium Mill Tailings Radiation Control Act
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UTL95-95	95 percent upper tolerance limit with 95 percent coverage
WCS	Waste Control Specialists
Weston	Weston Solutions, Inc.
WRS	Wilcoxon Rank Sum



1.0 EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (USEPA) prepared this engineering evaluation/cost analysis (EE/CA) report regarding the Section 32 and 33 Mines near Gallup, New Mexico, in the Navajo Nation.

1.1 PURPOSE OF THE ENGINEERING EVALUATION/COST ALTERNATIVES ANALYSIS

The EE/CA **develops and evaluates alternatives for addressing the risks to human health and the environment** associated with mine waste and contaminated soils remaining at the Section 32 and 33 Mines. These alternatives are developed and evaluated in the context of the Fundamental Laws of the Diné and in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

1.2 SITE CHARACTERIZATION

The **Section 32 and 33 Mines** are located in northwestern New Mexico, within the Casamero Lake Chapter of the Navajo Nation and adjacent private land, approximately 9 miles north of Prewitt, New Mexico ([Figure 1](#)). The Section 32 and 33 Mines are former underground uranium mines with an associated transfer station in the Grants Mining District. The Section 32 Mine is administered by the Casamero Lake Chapter of the Navajo Nation, and the Section 33 Mine is privately owned. The Section 32 Mine produced 20,117 tons of ore between 1960 and 1969, and the Section 33 Mine produced 4,243 tons of ore between 1960 and 1964. In 2012, USEPA Region 9 closed three mine shafts and excavated and consolidated waste rock from the Section 32 Mine and Section 32/33 Transfer Station in a temporary stockpile as part of a CERCLA Superfund cleanup action. The features at the Section 32 and 33 Mines include **three closed mine shafts, five unreclaimed waste piles, one reclaimed transfer station, and one temporary stockpile** (Weston Solutions, Inc. [Weston] 2019). No mine waste has been removed from the Section 32 and 33 Mines.

The Section 32 and 33 Mines are near several rural residences and 1.2 miles southeast of the Casamero Lake Chapter House. The Section 32 and 33 Mines area is currently used for grazing and recreation. The likely future land use at the Section 32 and 33 Mines is:

- **Kee'da'whíí tééh (full-time Navajo residential):** Areas that are easily accessible and relatively flat.

The nature and extent of contamination at the Section 32 and 33 Mines were assessed with various technologies during a removal site evaluation (RSE) conducted in June 2019 (Weston 2019). **Most of the waste at the site is within the temporary stockpile and unreclaimed waste piles.**

As part of this EE/CA, risk assessments at the site were conducted to evaluate the potential risk posed to human and ecological health by mine-related contamination. **The results of the human health risk assessment (HHRA) and ecological risk assessment (ERA) indicate that risks are present at the Section 32 and 33 Mines for human and ecological receptors. At the Section 32 Mine, radium-226 (Ra-226), iron, and uranium are contaminants of concern (COC) for human health. At the Section 33 Mine, uranium is a COC for**



human health and selenium is a contaminant of ecological concern (COEC). A removal action is recommended for contamination associated with COCs and COECs at the Section 32 and 33 Mines.

Human health and ecological removal action goals (RAG) were derived for COCs and COECs. The RAG is the lesser of the human health and the ecological risk-based screening levels (RBSL). When one or both RBSLs are less than the provisional background threshold value (BTV), the RAG becomes the BTV. For purposes of the EE/CA, the provisional BTV is used to represent background for delineating contaminated areas. Protecting human health and the environment is the purpose of this work.

Multiple lines of evidence were used to develop the removal action extent at the Section 32 and 33 Mines, including the extent of Ra-226 in surface soil, extent of contamination of other COCs and COECs not co-located with Ra-226, surface waste areas, transport pathways, and risk management considerations. The removal action extent covers 24 acres at the Section 32 and 33 Mines. **An estimated 70,000 cubic yards of mine waste and contaminated soil will be addressed by removal action.**

1.3 REMOVAL ACTION OBJECTIVES

The first step in developing removal alternatives is to establish RAOs. Taking current and potential future land use and Navajo cultural considerations into account, the RAOs are to:

- Prevent exposure to soil with contaminants at levels above background concentrations and above concentrations that would pose an unacceptable risk to human health with residential use and traditional Diné Lifeways outside of any potential capped area
- Prevent exposure to soil with contaminants that would pose an unacceptable risk to human health with traditional Diné Lifeways on any potential capped area, which may include exposures that occur during activities such as livestock grazing, hunting, and plant gathering and use
- Prevent exposure to soil with contaminants that would pose an unacceptable risk to plants, animals, and other ecological receptors
- Prevent migration of contaminants to surface water or groundwater that pose an unacceptable risk to human health
- Prevent offsite migration of contaminants above background concentrations and at concentrations that could pose a risk to human health or the environment

The scope of the removal action will be to address all solid media contamination at the Section 32 and 33 Mines and to be the final action for solid media at the site. These RAOs have been developed to be considerate of Diné Lifeways.



1.4 IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES

The following removal action alternatives were developed and evaluated as part of this EE/CA. Each alternative was evaluated against the criteria of effectiveness, implementability, and cost.

- **Alternative 1: No Action (this must always be evaluated)** – No treatment or removal action would occur at the site. In this case, all threats would remain unchanged. Mine waste and contaminated soils would continue to threaten human and ecological receptors. Gamma radiation and physical hazards would still be present.
- **Alternative 2: Consolidate and Cap All Waste at Onsite Repository** – Addresses RAOs by excavating residual waste rock and contaminated soils; consolidating the waste in a repository including the existing stockpile; and capping the repository. An evapotranspiration (ET) cap would be used that is protective and would limit contaminant migration. The repository would be inspected and maintained in perpetuity.
- **Alternative 3: Dispose of All Mine Waste Off Site at Red Rock Disposal Facility** – Addresses RAOs by excavating the stockpile contents, residual waste rock, and contaminated soils and hauling the waste to and disposing of the waste off site at the Red Rock disposal facility near Thoreau, New Mexico. Off-Navajo Nation disposal is protective and would not require long-term maintenance.
- **Alternative 4: Dispose of All Mine Waste Off Site at a Resource Conservation and Recovery Act (RCRA) C or Low-Level Radioactive Waste (LLRW)** – Addresses RAOs by excavating the stockpile contents, residual waste rock, and contaminated soils; and hauling and disposing of the waste at an offsite RCRA facility, such as the Clean Harbors Deer Trail facility in Deer Trail, Colorado, or an LLRW facility licensed by the U.S. Nuclear Regulatory Commission (NRC), such as the Waste Control Specialists (WCS) in Andrews, Texas. Off-Navajo Nation disposal is protective and would not require long-term maintenance.

For the applicable removal action alternatives, plant life that matches the natural landscape will be planted on the installed covers of excavated material. All temporary roads built for construction will also be removed, and the site will be restored. The surface of the site will be recontoured and revegetated to match the natural landscape.

1.5 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The removal action alternatives were evaluated individually and in relation to each other using three broad criteria: effectiveness, implementability, and cost. [Exhibit 1](#) presents an overview of the comparative analysis results.

The recommended alternative for the Section 32 and 33 Mines is Alternative 3 (disposal of all mine waste off site at Red Rock disposal facility). While the alternative is four times the cost of Alternative 2 (consolidate and cap all waste at onsite repository), it removes the waste from the Casamero Lake community and consolidates the waste at a dedicated facility capable of long-term management of the waste.



Exhibit 1. Summary of Alternative Ratings

Removal Action Alternative		Attainment of Threshold Criteria ^a	Effectiveness	Implementability	Cost Rating (Million) ^b
1	No Action	Fail	Short-Term: Average Long-Term: Very Poor	Tech: Very Good Admin: Very Good	Very Good \$0
2	Consolidate and Cap All Waste at Onsite Repository	Pass	Short-Term: Good Long-Term: Good	Tech: Good Admin: Good	Very Good (\$2.5)
3	Dispose of All Mine Waste Off Site at Red Rock Disposal Facility	Pass	Short-Term: Poor Long-Term: Very Good	Tech: Very Good Admin: Average	Average (\$9.8)
4	Dispose of All Mine Waste Off Site at a RCRA C or LLRW Facility	Pass	Short-Term: Very Poor Long-Term: Very Good	Tech: Very Good Admin: Good	Very Poor (\$37.5)

Notes:

Bold indicates the highest rating in the category.

^a Threshold criteria are (a) overall protectiveness and (b) compliance with applicable or relevant and appropriate requirements.

^b Estimated costs are net present value.

Admin Administrative feasibility

LLRW Low-level radioactive waste

RCRA Resource Conservation and Recovery Act

Tech Technical feasibility

Though USEPA has identified a recommended alternative, USEPA will solicit input from Navajo Nation officials, regulators, chapter representatives, other stakeholders, and the community on the final EE/CA and recommended alternative during a public comment period. USEPA and the Navajo Nation Environmental Protection Agency (NNEPA) will hold a public meeting during the comment period to listen to input. While all input will be considered, ultimately, the final decision will be based on the effectiveness, implementability, and cost criteria and documented in an action memorandum. USEPA will consider the Navajo Nation Fundamental Law and Diné Lifeways in its restoration approach.

2.0 SITE CHARACTERIZATION

This section presents the site description and background; previous reclamation and removal actions; previous site investigations; source, nature, and extent of contamination; and risk assessment of the Section 32 and 33 Mines.

2.1 SITE DESCRIPTION AND BACKGROUND

The Section 32 and 33 Mines site covers 56 acres and contains waste rock and other mine debris placed on relatively flat valley floor around closed mining shafts and a transfer station approximately 1,000 feet south of the Section 32 Mine area.

The following subsections describe the site location, type of mines and operational status, regulatory history, features and landscape, geology and hydrology, land use and populations, sensitive ecosystems and habitat, and meteorology and climate. [Appendix A](#) contains site images that show the current condition of the complex.

2.1.1 Site Location

The Section 32 and 33 Mines site is within the Casamero Lake Chapter community of the Navajo Nation in the Eastern Abandoned Uranium Mine (AUM) Region. The site is 9 miles north of the Prewitt, New Mexico, exit on Interstate 40 at 35.490 degrees latitude and -108.017 degrees longitude in McKinley County, New Mexico. The elevation is approximately 7,000 feet above mean sea level.

The site is accessed from Prewitt, New Mexico, by traveling north on paved County Road 19 and then east on an unpaved access road. The unpaved access road passes by multiple residences and ends along the south boundary of the Section 32 temporary stockpile. A fence borders the private property on Section 33 along the west boundary of the Section 33 Mine ([Figure 2](#)) (Tetra Tech, Inc. [Tetra Tech] 2022a).

2.1.2 Type of Mine and Operational Status

The Section 32 and 33 Mines were deep, dry underground mines that were accessed through near-vertical mine shafts. The mines were likely developed using underground room-and-pillar mining techniques to extract lenticular ore bodies containing uranium and vanadium (New Mexico Energy and Minerals Department 1979). Whether the pillars were salvaged and the rooms blasted closed is unknown. The Section 32/33 Transfer Station south of the main mining area was used for both mines.

Much of the waste produced is overburden that was piled near the mine shafts. Overburden is low-grade native material that miners had to get through to access the ore. No surface features such as subsidence, fissures, or cracks that may indicate mine collapse were observed during the Weston RSE investigation (Weston 2019).

The Section 32 and 33 Mines were developed in the early 1960s by the Kerr-McGee Corporation (Kerr-McGee), a predecessor of Tronox. The Section 32 Mine was operated by Kerr-McGee from 1960 to 1969 and produced 20,117 tons of uranium ore (McLemore and Chenoweth 1991).



The Section 33 Mine was operated by Kerr-McGee from 1960 to 1964 and produced 4,242 tons of uranium ore (McLemore and Chenoweth 1991). Both mines are reported to be last operated by the Cobb Nuclear Company.

Site features, haul and exploratory roads, exploratory boreholes, and reclamation features are shown on [Figure 3](#).

2.1.3 Regulatory History

The Section 32 and 33 Mines are part of the 2015 Kerr-McGee/Tronox Settlement Agreement (*In re: Tronox Incorporated, No. 09-10156* [Bankruptcy Court for the Southern District of New York, November 23, 2010]). The Section 32 Mine is within Navajo Allotment Land, and the Section 33 Mine is privately owned. The Section 32 and 33 Mines site remediation is being completed under CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

2.1.4 Site Features and Landscape

The Section 32 and 33 Mines site is on gently to moderately sloping terrain. The vegetation communities on the site include plains-mesa grassland, great basin desert shrub, juniper woodland, and arroyo riparian. The site has 37 percent vegetation cover with large areas disturbed from human activity (NV5, Inc. 2019a). [Appendix A](#) contains photographs of the site vegetation.

Mine features at the Section 32 and 33 Mines include mine shafts and unmapped underground workings, waste piles, mine debris, a transfer station, and a haul road ([Figure 3](#)). Reclamation of some of these mine features occurred during the 2012 removal action described in [Section 2.2](#).

Mine waste at the Section 32 Mine and Section 32/33 Transfer Station was consolidated in a temporary stockpile at the Section 32 Mine immediately west of the Section 33 Mine. Mine waste at the Section 33 Mine is stockpiled in five piles on flat terrain above a 1- to 3-foot slope. Surface water flow on the Section 33 Mine converges into a small ephemeral drainage that flows west toward the waste stockpiles and is head-cutting into the Section 33 Mine area. The relatively flat terrain slopes 3 degrees to the west, starting at the base of a ridge 0.64 mile east of the Section 32 and 33 Mines site.

[Table 1](#) presents the reclamation status, reclamation description, and dimensions for each mine feature at the Section 32 and 33 Mines; reclamation activities are discussed in [Section 2.2](#). The mine features are:

- Mine Shaft S32-01 is in the southeast corner of the Section 32 Mine.
- Mine Shaft S32-02 is in the southeast corner of the Section 32 Mine and adjacent to Mine Shaft S32-01.
- Mine Shaft S32-03 is in the southwest corner of the reclaimed Section 32/33 Transfer Station.
- Waste Pile S33-01, Waste Pile S33-02, Waste Pile S33-03, Waste Pile S33-04, and Waste Pile S33-05 are within the Section 33 Mine and numbered from north to south.



- Section 32/33 Transfer Station is approximately 1,000 feet south of the Section 32 Mine on a 2- to 4-degree north-dipping slope and has a sealed vent hole.

Mine feature locations and extents were mapped during the 2012 removal action (Ecology and Environment, Inc. [E&E] 2014), with an additional waste pile (Waste Pile S32-02) mapped during the Tetra Tech 2022 field reconnaissance (Tetra Tech 2022a).

A cultural resource inventory survey of the Section 32 Mine and the western half of the Section 33 Mine (NV5, Inc. 2019b) was completed as part of the 2019 Weston RSE (Weston 2019). The survey found various resources, some of which are in the project area, and recommended for avoidance.

2.1.5 Geology and Hydrology

The following subsections describe the geology, hydrogeology, and hydrology of the Section 32 and 33 Mines.

2.1.5.1 Geology

The Section 32 and 33 Mines are within the Smith Lake subdistrict of the Grants Mining District. The Grants Mining District is a belt of sandstone-hosted uranium deposits that stretches from the Pueblo of Laguna to the area of Gallup, New Mexico. Most uranium deposits in the Grants Mining District are found in sandstone members of the Jurassic-age (199 to 145 million years ago) Morrison Formation. In the Section 32 and 33 Mines area, the Morrison Formation is covered by younger Cretaceous-age (145 to 65 million years ago) sandstones and mudstones. Quaternary-age (1.8 million years ago to present) sand, sediment, and soil deposits fill small stream valleys and cover floodplains. [Figure 4](#) presents the geology at the site and in the surrounding areas. The important geological units in and near the Section 32 and 33 Mines are listed in stratigraphic order (oldest to youngest) and described below:

- Morrison Formation
 - Recapture Member consists of sandstone and claystone.
 - Westwater Canyon Member consists of sandstone and is the main host of uranium deposits in the portion of the Grants Mining District where the Section 32 and 33 Mines are located (Santos 1970). The Westwater Canyon Member interfingers with both the Recapture and Brushy Basin Members. One of the larger fingers of the Westwater Canyon Member in the overlying Brushy Basin Member is the Poison Canyon Sandstone, which includes the ore horizon mined through the Section 32 and 33 Mines. The Poison Canyon Sandstone varies in thickness, and ore is known to be where the sandstone is 30 to 90 feet thick (Santos 1970).
 - Brushy Basin Member consists of green/gray mudstones and a minor amount of sandstone.
- Dakota Sandstone consists of sandstone with a minor amount of mudstone, coal, and conglomerate, and interfingers with the overlying Mancos Shale. The mesa to the south of the Section 32 and 33 Mines is primarily Dakota Sandstone.



- Mancos Shale consists of mudstone, claystone, and siltstone. A small amount of Mancos Shale outcrops at the surface within the Section 32 and 33 Mines area. The mesa to the east is primarily Mancos Shale.
- Alluvium is the silt, sand, and gravel in small stream valleys and floodplains. Most of the surface geology at the Section 32 and 33 Mines is alluvium.

Though a discussion of the geology, soils, and aquifers in the Lukachukai Mountains Navajo area uranium mines characterization conceptual site model (CSM) is under development, no corresponding version for the Eastern AUM Region that would include the Section 32 and 33 Mines is currently planned.

2.1.5.2 Hydrogeology

A series of arroyos, formed from surface water flow from the surrounding mesas, are the main drainage pathways in the area. These arroyos are dry most of the year and flood during monsoon season. The closest arroyo is a shallow southwest-flowing arroyo approximately 200 feet north of the Section 32 and 33 Mines. [Figure 2](#) shows the topography and hydrology at the site and surrounding areas, and [Figure 5](#) shows the regional aquifers and wells.

Groundwater depth and information on nearby water wells used for drinking water were not available during the 2019 Weston RSE (Weston 2019). No drinking water wells were identified within 4 miles of the site during the 2009 Weston site screening investigation (Weston 2009).

2.1.6 Land Use and Populations

Several residences are near the Section 32 and 33 Mines with the closest residence 0.5 mile to the west. The closest population center is the community surrounding the Casamero Lake Chapter House, which is 9 miles northwest of the site.

The area containing the Section 32 and 33 Mines is fenced off from active cattle grazing on the Section 33 private property. Resident use of the Section 32/33 Transfer Station area is evidenced by recently used access roads and a trash dump site.

- **Kee'da'whíí tééh (full-time Navajo residential)**, defined as areas that are easily accessible and relatively flat, is the potential future land use identified at the Section 32 and 33 Mines ([Figure 6](#)).

The flat terrain of the Section 32 and 33 Mines provides more potential locations for the siting of houses, hogans, corrals, or stock loading ramps. Future land uses could include agricultural activities, commercial activities, and/or residential areas.

2.1.7 Sensitive Ecosystems and Habitat

The Section 32 and 33 Mines are within an Area 3 wildlife sensitive area as identified by the Navajo Nation Department of Fish and Wildlife (NNDFW) and classified as a less sensitive area containing a low and fragmented concentration of endangered and rare plant, animal, and game species on the Navajo Nation (NNDFW 2008). Therefore, development can proceed as recommended by NNDFW with few exceptions.

Most of the habitat at the Section 32 and 33 Mines is terrestrial/upland, and the primary impacted environmental medium is soil. Several small arroyos pass through the Section 32 and 33 Mines but do not support wetlands or a riparian corridor and appear to convey insufficient flows to justify augmentation (NV5, Inc. 2019a) ([Figure 7](#)). Stock ponds are also near the site but are not surrounded by vegetation. Riparian and wetland habitats are particularly important for ecological health in arid ecosystems, such as that at the Section 32 and 33 Mines area.

A natural resources survey was performed in November 2018 to identify protected species and general wildlife habitat and general vegetation and vegetative community types for the Section 32 and 33 Mines area (NV5, Inc. 2019a). The survey found that shrub and grassland communities dominate the area around the Section 32 and 33 Mines and most closely resemble the plains-mesa grassland community. The shrubby areas consist of Great Basin desert shrub saltbush communities. Arroyo riparian vegetation is confined to the bottom of the ephemeral waterways that cross through the study area but constitute less than 2 percent of the overall area.

Documented vegetative communities around the mines were Great Basin desert scrub (saltbush/blue grama/galleta/western wheat grass), Great Basin desert scrub (saltbush/kochia/gumweed/various weeds), and arroyo riparian (rabbitbrush/saltbush/galleta). All are lowland communities that occur on mostly flat open ground. Most of the area has been heavily disturbed in the past and is still impacted by cattle grazing. As a result, the overall vegetative cover and species diversity across much of this area is low (NV5, Inc. 2019a). Vegetated areas at the site are expected to provide better habitat for terrestrial receptors because plants serve as a food source and provide areas of refuge.

In general, wildlife was not common across the site with fewer than 20 vertebrate species documented during the survey. Overall, birds were scarce in species diversity and numbers. Signs to indicate presence of large mammals were found only in the wooded areas around the periphery of the site. Small mammals were also uncommon. Some of this lack of diversity and abundance is likely because of the time of year the survey was conducted (winter). However, many of the lowland Great Basin desert scrub communities were in poor condition with stunted shrub growth and little herbaceous ground cover. Additionally, a substantial portion of the north half of the Section 32 Mine is impacted by human activities and domestic predators, such as dogs. All of these factors can reduce the quality of habitat for vertebrate species. Based on a regional biological survey, federal, state, and Navajo Nation-listed endangered or threatened species having the potential to occur at the Section 32 and 33 Mines area are listed in [Exhibit 2](#); however, many are located outside of the reclamation area.

Tetra Tech (2022b) conducted a habitat assessment during the data gap investigation on November 18 and 20, 2022, to assess the potential for the project to affect Endangered Species Act-listed species or critical habitats, migratory birds protected by the Migratory Bird Treaty Act, and NNDFW sensitive species potentially occurring within 0.5 mile of the facility disturbance footprint of the project. The field survey was conducted by Sean Kite (a Tetra Tech biologist). The assessment found no rare plant species, plant species of management interest, habitats in which rare plant species occur, or federally listed or sensitive species in the project area. All suitable nesting areas were surveyed, and no active raptor species nests were documented. Some suitable habitat was observed for mountain plover. Several areas of barren ground xeric habitat were observed across the site. No prairie dog colony habitat that could be



used by burrowing owls was observed during the site assessment. Other avian and wildlife species observed included common raven (*Corvus corax*), house finch (*Haemorphous mexicanus*), rock wren (*Salpinctes obsoletus*), and American kestrel (*Falco sparverius*).

Exhibit 2. Federal and Navajo Nation-Listed Endangered or Threatened Species Having Potential to Occur at the Section 32 and 33 Mine Area

Name	Status	Suitable Habitat and Potential Presence within the Site
Plants		
Zuni fleabane (<i>Erigeron rhizomatus</i>)	USFWS E EMNRD E	Not present within 3 miles of the site.
Acoma fleabane (<i>Erigeron acomanus</i>),	NESL G3	No suitable geologic substrate present.
Sivinski's fleabane (<i>Erigeron sivinskii</i>)	NESL G4	No suitable geologic substrate present.
Navajo bladderpod (<i>Physaria navajoensis</i>)	NESL G3	No suitable geologic substrate present.
Goodding's onion (<i>Allium gooddingii</i>)	EMNRD E	No suitable forested habitat present.
Parish's alkali grass (<i>Puccinellia parishii</i>)	EMNRD E	No alkali seeps or wetlands present.
Heil's milk-vetch (<i>Astragalus heilii</i>),	NESL G4	No formations of the Mesa Verde Group within 3 miles of the site.
Fishes		
Zuni blue-head sucker (<i>Catostomus discobolus yarrowi</i>)	USFWS E NMDGF E	No perennial waterways present.
Amphibians		
Northern leopard frog (<i>Lithobates pipiens</i>)	NESL G2	No permanent water sources within 3 miles of the site.
Insects		
Monarch butterfly (<i>Danaus plexippus</i>)	USFWS C	Not present within 3 miles of the site.
Mammals		
Black-footed ferret (<i>Mustela nigripes</i>)	NESL G1 FE	Considered extirpated from the Navajo Nation. Closest habitat was reintroduced on tribal ranch lands at Big Boquillas in Coconino, Arizona.
Birds		
Southwestern willow flycatcher (<i>Empidonax traillii extimus</i>)	USFWS E NMDGF E	Not present within 3 miles of the site.
Mexican spotted owl (<i>Strix occidentalis lucida</i>)	USFWS T	The nearest designated critical habitat is approximately 24 miles southeast of the site within the Cibola National Forest.
Yellow-billed cuckoo (<i>Coccyzus americanus</i> subsp. <i>Occidentalis</i>)	USFWS T NMDGF S	Not present within 3 miles of the site.
Bald eagle (<i>Haliaeetus leucocephalus</i>)	BGEPA NMDGF T	No large lakes, rivers, or riparian habitats present.



Exhibit 2. Federal and Navajo Nation-Listed Endangered or Threatened Species Having Potential to Occur at the Section 32 and 33 Mine Area

Name	Status	Suitable Habitat and Potential Presence within the Site
Least tern (<i>Sternula antillarum</i>)	NMDGF E	No large lakes, rivers, or playas present.
Costa's hummingbird (<i>Calypte costae</i>)	NMDGF T	No suitable wooded canyons present.
Golden eagle (<i>Aquila chrysaetos</i>)	BGEPA NESL G4	Potential nesting habitat on cliff faces nearby but none within 1 mile of the site.
Burrowing owl (<i>Athene cunicularia</i>)	NESL G4	Potential habitats present in prairie dog holes, banner-tailed kangaroo rat mounds, and mammal burrows in sidewalls of drainages.
Grey vireo (<i>Vireo vicinior</i>)	NESL G4 NMDGF T	Suitable nesting habitat in coniferous woodland (pinyon/juniper woodlands) in the southern half of the Section 32 Mine and eastern edge of the Section 33 Mine.
Peregrine falcon (<i>Falco peregrinus anatum/tundrius</i>)	NESL G4 NMDGF T	Potential nesting habitat on cliff faces nearby but not within 1 mile of the site.
Mountain plover (<i>Charadrius montanus</i>)	NESL G4	Potential habitat in plains-mesa grassland habitat in the center of the Section 32 Mine and south of the houses.
Spotted bat (<i>Euderma maculatum</i>)	NMDGF T	Suitable nesting habitat in coniferous woodland (pinyon/juniper woodlands) in the southern half of the Section 32 Mine and eastern edge of the Section 33 Mine.
American dipper (<i>Cinclus mexicanus</i>)	NESL G3	No permanent water sources within 3 miles of the site.
Pinyon jay (<i>Gymnorhinus cyanocephalus</i>)	BGEPA	No habitat within 3 miles of the site.

Notes:

Information from USFWS (2022) and NNDFW (2022).

BGEPA Bald and Golden Eagle Protection Act

C Candidate

E Endangered

EMNRD New Mexico Energy, Minerals and Natural Resources Department

FE Federally Endangered

G1 Group 1: A species or subspecies that no longer occurs on the Navajo Nation.

G2 Group 2: Endangered: A species or subspecies whose prospects of survival or recruitment are in jeopardy.

G3 Group 3 Endangered: A species or subspecies whose prospects of survival or recruitment are likely to be in jeopardy in the foreseeable future.

G4 Group 4: A species or subspecies with insufficient information for listing as endangered but has reason to be considered for listing.

NESL Navajo Endangered Species List

NMDGF New Mexico Department of Game and Fish

NNDFW Navajo Nation Department of Fish and Wildlife

S Susceptible

T Threatened

USFWS U.S. Fish and Wildlife Service



2.1.8 Meteorology and Climate

The climate in the Section 32 and 33 Mines area and surrounding mesas is semiarid with low precipitation, high temperatures, and strong winds. Daily temperature and precipitation data from Western Regional Climate Center station in nearby Thoreau, New Mexico, was examined for years 1976 to 2016 (Western Regional Climate Center 2018). Data from 2016 to the present from this station and other stations near the Section 32 and 33 Mines were not available. The station data indicate the following weather trends:

- Average annual precipitation (recorded) is 10.71 inches.
- Average monthly maximum temperatures range from 43.2 degrees Fahrenheit (°F) in January to 85.5 °F in July.
- Average minimum monthly temperatures range from 18.6 °F in January to 55.8 °F in July with freezing being common from November through April.
- In the summer, seasonal monsoon rains can occur from July until October, limiting access to use of access roads.

Figure 7 shows the Thoreau, New Mexico, average monthly precipitation, snowfall, and temperature. Figure 8 shows that the wind in Thoreau, New Mexico, typically originates from the southwest.

2.2 PREVIOUS RECLAMATION AND REMOVAL ACTIONS

USEPA Region 6 began a removal action and conducted reclamation work at the Section 32 and 33 Mines in 2012. Three mine shafts were closed, and waste rock from the Section 32 Mine and Section 32/33 Transfer Station was placed in a temporary onsite stockpile (E&E 2012). USEPA Region 9 was not granted access to conduct remediation at the Section 33 Mine by the landowner in 2012 (Weston 2019). Table 1 presents descriptions and dimensions for each mine and reclamation feature, and Figure 3 presents the reclamation features.

2.3 PREVIOUS SITE INVESTIGATIONS

Previous environmental investigations for the Section 32 and 33 Mines include:

- Preliminary assessment in 2009 to verify the location and type of waste present at each mine site (Weston 2009).
- Removal assessment in 2012 to determine contamination extent and removal area. Activities included gamma scan surveys of soil and waste piles, sampling of soil and waste piles, and assessment of homesites near the site (E&E 2012). A cultural resource inventory survey was completed as part of the removal assessment, which included field surveys and review of records at the Navajo Nation Heritage and Historic Preservation Department (CSWTA, Inc. 2012).
- RSE field investigations in 2019 that included gamma radiation surveys and collection and analysis of surface soil samples. The gamma investigation included the mine sites, haul road, and surrounding mesas (Weston 2019). A cultural resource inventory survey

(NV5, Inc. 2019b) was completed on the Section 32 Mine and the western half of the Section 33 Mine and included with the RSE. The survey found various resources, some of which are in the project area, and recommended for avoidance.

- Data gaps field investigation in 2022 that included gamma radiation surveys, collection and analysis of surface soil samples, establishment of background study areas, and a biological survey. The investigation covered the mine sites, haul road, and former transfer station (Tetra Tech 2023).

2.4 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

The source, nature, and extent of waste materials at the Section 32 and 33 Mines were characterized during the 2019 Weston RSE investigation (Weston 2019) and the 2022 Tetra Tech data gaps investigation (Tetra Tech 2023). The following subsections present the calculation of BTVs, results of the investigations and identification of constituents of interest (COI), sources and nature of contamination, extent of contamination, and identification of exposure units (EU).

2.4.1 Background Threshold Values

The 2019 Weston RSE established a background study area (BSA) in the Quaternary alluvium, the geologic unit present at the surface of the Section 32 and 33 Mines (Weston 2019). However, only gamma data were collected at the 2019 BSA and site-specific assessment of the geology found the BSA was in proximity to the geologic contact between Quaternary alluvium and Mancos Shale Lower Body (Tetra Tech 2023).

Consequently, as part of the data gap investigation in November 2022, a desktop study identified a new site-specific Quaternary alluvium BSA (Figure 3) located away from mining impacts with geology similar to the Section 32 and 33 Mines. The desktop study evaluated the geology, soils, and hydrology of the Section 32 and 33 Mines and AUM-related areas and identified an appropriate strategy for establishing background and siting locations of potential BSAs.

Background samples were analyzed for total metals (including thorium and uranium) via USEPA SW-846 Method 6020 and Ra-226, radium-228, and potassium-40 via USEPA Method 901.1. Ten percent of the background samples were analyzed for isotopic thorium and uranium via ASTM International Method D3972 and lead-210 via Eichrom Method.

Provisional BTVs for were calculated (Exhibit 3) based on the 95 percent upper tolerance limit with 95 percent coverage (UTL95-95). The limit represents a 95 percent probability (or confidence) that 95 percent of samples from background are below that value.

Exhibit 3. Provisional Background Threshold Values

Analyte	Units	Provisional BTV
Radium-226	pCi/g	1.9
Gamma	cpm	16,061
Aluminum	mg/kg	28,800
Antimony	mg/kg	0.34
Arsenic	mg/kg	8.1



Exhibit 3. Provisional Background Threshold Values

Analyte	Units	Provisional BTV
Barium	mg/kg	104
Beryllium	mg/kg	1.1
Cadmium	mg/kg	0.23
Chromium	mg/kg	21
Cobalt	mg/kg	9.5
Copper	mg/kg	18
Iron	mg/kg	28,700
Lead	mg/kg	19
Manganese	mg/kg	279
Molybdenum	mg/kg	1.4
Nickel	mg/kg	19
Selenium	mg/kg	2.5
Silver	mg/kg	0.34
Thallium	mg/kg	0.47
Uranium	mg/kg	1.5
Vanadium	mg/kg	40
Zinc	mg/kg	73

Notes:

cpm counts per minute

pCi/g Picocurie per gram

mg/kg Milligram per kilogram

2.4.2 Constituents of Interest

The COIs are radionuclides and metals geochemically related to the uranium deposition and uranium decay chain radionuclides. Identified COIs for the Section 32 and 33 Mines are Ra-226, aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, uranium, vanadium, and zinc.

2.4.3 Source and Nature of Contamination

The main source of contamination at the Section 32 and 33 Mines is waste rock derived from the Poison Canyon Sandstone and overburden (overlying rock) that was dumped at the mine. The waste rock was produced from driving shafts through sandstone and mudstone to reach and extract the ore bodies. During the 2012 removal action, some of the waste rock was placed into a stockpile. The waste rock is characterized as clayey silty sand with larger-sized rock (greater than 6 inches in diameter) originating from the mine workings. Geotechnical analysis of soils at the site indicated that the soil types include clayey sand, clayey silty sand, and silty sand. Such soil types are more susceptible to erosion, especially during precipitation and snow melt events.

The main contaminant transport pathway at the site is erosion of waste or contaminated soil by surface water and redeposition downstream. Wind erosion of waste may also move contamination from the surface of the mine waste to adjacent areas. Fluvial and aeolian waste

deposits may be remobilized and transported off site. Radon gas emanation and the leaching and dissolution of metals and radionuclides from waste may also occur. The CSM wire diagram presented in [Figure 9](#) shows the sources of contamination, release mechanisms, and exposure media, as well as potential human health and ecological receptors and exposure pathways (see [Section 2.5](#)).

2.4.3.1 Waste Characteristics

Metals leachability data pertaining to the Section 32 and 33 Mines were collected during the 2022 data gap investigation (Tetra Tech 2023) for metals leachability analysis via both the toxicity characteristic leaching procedure (TCLP) and the synthetic precipitation leaching procedure (SPLP). All TCLP results were below detection limits and regulatory criteria, indicating that the waste does not exhibit a RCRA toxicity characteristic for hazardous waste if sent for disposal off site.

SPLP metals and radionuclide results were compared to USEPA and Navajo surface water quality criteria. Ra-226, aluminum, barium, lead, selenium, and uranium in leachate from waste exceeded surface water quality criteria, indicating that leachate generated could impact surface water quality at the Section 32 and 33 Mines. Groundwater is not present in waste rock or alluvium at the Section 32 and 33 Mines.

2.4.3.2 Geotechnical Characteristics

Geotechnical data pertaining to the Section 32 and 33 Mines were collected during the 2022 data gap investigation (Tetra Tech 2023) and will be used during the design phase.

Geotechnical samples were analyzed for dry and wet bulk density, porosity, constant and falling head conductivity, particle size distribution, Atterberg limits, standard Proctor compaction, direct shear, and swell or collapse. The borrow soil samples were also analyzed for agronomic viability. The purpose of the geotechnical testing was to understand the physical characteristics of the waste and borrow soil to support radon and hydraulic modeling, suitability of the borrow soil for use as cover material, waste and borrow soil compaction requirements, plasticity of the waste and borrow soil, and loading limits before failure.

Results for the mine waste were:

- Bulk densities: 1.82 to 1.88 grams per cubic centimeter (g/cm^3)
- Porosities: 38.3 to 42.3 percent
- Saturated hydraulic conductivities: 6.4×10^{-5} to 6.1×10^{-6} indicative of fine sand to loams
- Particle size distributions: silty sands to a sandy lean clay
- Atterberg testing: liquid limit of 41 to 43, plastic limit of 19 to 23, and plasticity index of 18 to 24
- Proctor compaction: optimum moisture contents of 16.8 to 21.4 percent with maximum dry bulk densities of 1.60 to $1.72 \text{ g}/\text{cm}^3$



- Direct shear friction: angles from 31 degrees (111 pounds per square foot [psf] cohesion) to 33 degrees (144 psf cohesion) under loads ranging from 200 to 6,000 psf
- Soils classified as sandy lean clay and lean clay that exhibited a moderate amount of cohesiveness with no concern for swelling or collapse

2.4.4 Extent of Contamination

Data characterizing the extent of contamination (radiation intensity through gamma scan surveys and metals during the 2019 Weston RSE investigation and 2022 Tetra Tech data gaps investigation) is used to identify contamination migration pathways and support the risk assessment and removal decisions.

Uranium is a naturally occurring radioactive material (NORM) and effects of mining can lead to technologically enhanced naturally occurring radioactive material (TENORM). Examples of TENORM at the Section 32 and 33 Mines include all waste rock, soil disturbed around the mine shafts, waste in the stockpile, and waste that has migrated into surrounding soils and the haul road.

Areas undisturbed by mining activity are considered NORM and may include bedrock outcrops outside the area of mining activity, as well as areas impacted by transport of material from undisturbed areas. At the Section 32 and 33 Mines, bedrock outcrops of Mancos Shale may be NORM; downwind transport or erosion from these NORM areas may contribute to elevated gamma levels and Ra-226 and metals concentrations downslope of these outcrops. [Figure 10](#) presents the extent of NORM and TENORM at the Section 32 and 33 Mines, and [Appendix B](#) presents the lines of evidence for determining the TENORM boundary.

At the Section 32 and 33 Mines, the areas that consistently have the highest Ra-226 and metals concentrations above the BTV are waste piles, soil surrounding the stockpile, intermittent areas along the haul road, and small areas in the reclaimed transfer station footprint ([Figure 11](#)).

2.5 RISK ASSESSMENT

The purpose of the risk assessment is to estimate current and future human health risk under appropriate RME scenarios and ecological risk focused on the known ecosystems for the region. This risk assessment was performed using “Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA” (USEPA 1993a) and, thus, does not include or require all elements of a baseline risk assessment (USEPA 1989a, 1993a, 2001). EE/CA guidance is flexible regarding the extent and structure of the risk assessments. Risk assessments identify the potential risk to human health and ecological receptors if no action is taken at a site. Risk assessments also determine COCs and COECs, estimate the extent to which human and ecological receptors might be exposed to these contaminants, and assess the potential adverse effects associated with these contaminants.

The HHRA identifies human health candidate COCs, and the ERA identifies candidate COECs recommended for further evaluation in this EE/CA. In addition, the results of the risk assessments serve as lines of evidence in determining the extent of soil removal necessary at the site to meet cleanup goals. The complete risk assessment is included as [Appendix C](#). The results



of the risk assessment help USEPA decide whether to conduct a removal action at a site, identify which exposures need to be addressed by the action, and develop appropriate cleanup levels (USEPA 1993a).

2.5.1 Human Health Risk Assessment

This subsection describes the key elements of the HHRA methodology. An HHRA is the process for evaluating how people are impacted by exposure to one or more environmental stressors, such as metals or radiation. Exposure is how a contaminant can enter a body (for example, by eating produce that absorbed contaminants, breathing contaminated dust, touching contaminated materials, or radiation emanating from soil). This risk assessment uses Navajo-specific exposure scenarios, as explained below, to assess how a person can be exposed to contamination at AUMs on the Navajo Nation. For the Section 33 Mine private property, a default resident (non-Navajo) receptor was used in the risk assessment. This HHRA focuses on soil contamination only. The HHRA does not include ingestion of surface water or groundwater by people or animals. Safe drinking water is supplied to residents on the Navajo Nation. No known wells are in the Section 32 and 33 Mine area.

The HHRA evaluates whether site-related contaminants of potential concern (COPC) detected in soil pose unacceptable risks to potential current and future people at a site under conditions at the time of the EE/CA (unremediated conditions) (USEPA 1989a, 1993a). The HHRA includes the following components: data evaluation and selection of COPCs, exposure assessment, toxicity assessment, and risk characterization.

In [Appendix C](#), Figure C-2 and Figure C-3 present the locations of the soil samples used in the risk assessment for the Section 32 Mine and Section 33 Mine, respectively. [Appendix C](#), Table C-1, provides a summary of the sample results for the Section 32 and 33 Mines. Any contaminant with a maximum detected value exceeding its COPC screening level is retained as a COPC for the HHRA risk calculations. Based on the screening, the following contaminants were identified as COPCs and are included in the risk estimates in the HHRA: Ra-226, aluminum, antimony, arsenic, barium, cadmium, cobalt, copper, iron, manganese, molybdenum, nickel, selenium, thallium, uranium, and vanadium.

The exposure assessment is the process of measuring or estimating intensity, frequency, and duration of human exposure to a contaminant in the environment. The CSM describes the exposure setting and identifies potentially complete exposure pathways by which receptors (both people and ecological) could contact site-related contaminants. The CSM is provided on [Figure 9](#).

An EU is a geographic area within which an exposed person may reasonably be assumed to move at random and where exposure to contamination is equally likely at all areas within the EU. EUs used in the risk assessment and future removal actions within the TENORM area were developed by identifying areas with a common land use to match areas with distinct cleanup goals. The EUs identified at the Section 32 and 33 Mines are:

- **Section 32 Mine** – The Section 32 Mine is allotment land of the Navajo Nation. Most of the active mining took place at the Section 33 Mine; however, a small portion of the mine footprint extends into the far-eastern section of the Section 32 Mine. The Section 32



Mine contains a waste stockpile and transfer area with a mine shaft. Several residences are located on the Section 32 Mine with the nearest residence approximately 2,000 feet from the former mine site. Therefore, Kee'da'whíí tééh (full-time Navajo resident) was selected as the RME receptor for the HHRA.

- **Section 33 Mine** – The Section 33 Mine is privately owned land used for livestock grazing. Most of the active mining took place at the Section 33 Mine; waste piles are present on site. The Section 33 Mine land could be used for a residence in the future; therefore, the default resident was selected as the RME receptor for the HHRA.

Exhibit 4 presents a brief description of each receptor along with the associated geographic distribution. The specific exposure pathways and inputs for these receptors evaluated in the HHRA are provided in Appendix C, Table C-3.

Exhibit 4. Exposure Units and Receptor Descriptions

Exposure Unit	Receptor Name	Receptor Description
Section 32 Mine	Kee'da'whíí tééh (Full-time Navajo resident)	Members of the Navajo Nation that live full time at a site. Includes external exposure to radiation, incidental ingestion of soil, dermal exposure to soil (metals only), inhalation of soil (or dust), ingestion of homegrown produce and gathered wild plants, and consumption of animal products from raised animals (meat, milk, eggs) and hunted animals (meat), as well as plant exposures (ingestion, dermal, and inhalation) from Diné Lifeways practices, including medicinal and ceremonial exposures.
Section 33 Mine	Default Resident	Non-Navajo people that live full time at a site. Exposure pathways evaluated include external exposure to radiation, incidental ingestion of soil, dermal exposure to soil (metals only), and inhalation of soil (or dust).

The toxicity assessment identifies the toxicity parameters needed for the risk assessment. The toxicity values used in the streamlined HHRA are all standard values provided by USEPA. Risk characterization proceeds by combining the results of the exposure and toxicity assessments. For the Navajo Abandoned Uranium Mines (NAUM) program HHRAs, the risk characterization process described in Appendix C was used.

The cancer risk for the age-adjusted adult and child and noncancer hazard for the child receptor for each EU and soil interval are provided in Appendix C, Table C-7, and summarized in Exhibit 5.

Exhibit 5. Cancer Risks and Noncancer Hazards

Exposure Unit	Soil Interval	Cancer Risk	Adult Noncancer Hazard Index	Child Noncancer Hazard Index
Section 32 Mine	Surface Soil	1×10⁻²	10	20
	Subsurface Soil	1×10⁻²	10	20
Section 33 Mine	Surface Soil	2×10⁻³	0.4	4
	Subsurface Soil	3×10⁻³	0.4	5

Notes:

Bolded values exceed the target cancer risk or target hazard.



Exhibit 6 presents the COCs identified based on cancer risk for the age-adjusted adult and child receptor and noncancer hazard for both the adult receptor and child receptor for the Kee'da'whíí tééh (full-time Navajo resident) receptor on the Section 32 Mine and the age-adjusted adult and child receptor and noncancer hazard for both the adult receptor and child receptor for the default resident on the Section 33 Mine for each soil interval.

Exhibit 6. Candidate COCs Identified Based on Cancer Risks and Noncancer Hazards

Exposure Unit	Soil Interval	Cancer Risk	Noncancer Hazard
Section 32 Mine	Surface Soil	Radium-226 Arsenic	Cobalt Iron Manganese Thallium Uranium
	Subsurface Soil	Radium-226 Arsenic	Cobalt Iron Manganese Thallium Uranium
Section 33 Mine	Surface Soil	Radium-226	Uranium
	Subsurface Soil	Radium-226	Uranium

Note:
COC Contaminant of concern

2.5.2 Ecological Risk Assessment

The objective of the ERA is to evaluate whether ecological receptors may be adversely affected by exposure to site-related contaminants. The ERA is intended to support risk management decision-making at each site while maintaining a conservative approach protective of ecological populations and communities.

The ERA approach is based on the USEPA (1997, 1998) eight-step process outlined in the “ERA Guidance for Superfund.” Per USEPA (1997) guidance, the ERA process at a site comprises a screening-level ERA (SLERA) and, if necessary, a baseline ERA; therefore, it may include some or all of the eight steps (see [Appendix C](#) for details). However, as described in EE/CA guidance (USEPA 1993a), a risk assessment should be used to help justify a removal action, identify what current or potential exposures should be prevented, and focus on the specific problem that the removal action is intended to address. Therefore, for this EE/CA, the ERA includes a Tier I SLERA (USEPA Steps 1 and 2) and a Tier II Refined SLERA (USEPA Step 3a), which includes refined exposure estimates and ecological effects concentrations and comparisons of site and background concentrations.

The ERA describes the ecological CSM and evaluates the potential risk to plants, invertebrates, birds, and mammals. The Tier I SLERA in [Appendix C](#), Table C-8, identifies contaminants of potential ecological concern (COPEC) that warrant further assessment through calculation of hazard quotients (HQ) using the maximum site concentration and no observed effect concentration; contaminants with HQs greater than or equal to 1 are advanced to the Tier II Refined SLERA. In the Tier II Refined SLERA, the exposure point concentrations (EPC) for



contaminants for which HQs exceeded 1 in the Tier I SLERA are calculated for each EU and depth interval. Tier II SLERA risk estimates were calculated by dividing EPCs by minimum Tier II RBSLs for each COPEC. COECs identified in Tier II are listed in [Appendix C](#), Table C-10, and summarized in [Exhibit 7](#).

Exhibit 7. Candidate COECs

Exposure Unit	Soil Interval	Contaminant ¹		
		Radium-226	Selenium	Vanadium
Section 32 Mine	Surface Soil	--	X	X
	Subsurface Soil	--	X	X
Section 33 Mine	Surface Soil	X	X	X
	Subsurface Soil	X	X	X

Notes:

¹ [Appendix C](#), Table C-11, shows a comparison of individual soil sample results to the lowest observed effect concentrations for the plant and invertebrate communities. Risk managers should consult this table for the locations of exceedances.

-- Not a candidate COEC.

X Candidate COEC; the exposure point concentration exceeds the Tier II screening level.

COEC Contaminant of ecological concern

Based on the results of the Tier II Refined SLERA, Ra-226, selenium, and vanadium were identified as COECs. Ra-226 was identified as a COEC in surface and subsurface soil at the Section 33 Mine. Ra-226 poses potential risk to soil invertebrates but not to plants, birds, or mammals based on receptor-specific HQs (the ratio of the EPC to the receptor-specific lowest observed effect concentration screening level). Selenium and vanadium were identified as COECs in surface and subsurface soil at Section 32 and 33 mines. Selenium poses potential risk to plants, birds, and mammals based on receptor-specific HQs. Vanadium poses potential risk to birds only based on receptor-specific HQs. Tier II HQs greater than 1 indicate potential ecological risk because the Tier II screening value is based on an observed adverse effect concentration. Tier II HQs less than 1 indicate little potential ecological risk to the overall population for a given COPEC and receptor combination.

2.5.3 Risk Assessment Results Summary

Candidate COCs and COECs were identified based on available laboratory and toxicological data for the Section 32 and Section 33 Mines. The HHRA and ERA results indicate that risk is above a level of concern for the contaminants listed in [Exhibit 8](#).

As shown on [Exhibit 8](#), primary candidate COCs and COECs in soil for both EUs are Ra-226, selenium, uranium, and vanadium. Arsenic, cobalt, iron, and thallium are also candidate COCs at the Section 32 Mine.



Exhibit 8. Candidate COCs or COEC for Soil

Exposure Unit	Contaminant ¹								
	Radium-226	Arsenic	Cobalt	Iron	Manganese	Selenium	Thallium	Uranium	Vanadium
Section 32 Mine	X	X	X	X	X	X	X	X	X
Section 33 Mine	X	--	--	--	--	X	--	X	X

Notes:

¹ Appendix C, Table C-11, shows a comparison of individual soil sample results to lowest observed effect concentrations for the plant and invertebrate communities. Risk managers should consult Table C-11 for the locations of exceedances for radium-226, barium, selenium, thallium, uranium, and vanadium.

-- Not a candidate COC or COEC. Not recommended for further evaluation in the EE/CA.

X Candidate COC and/or COEC. Recommended for further evaluation in the EE/CA.

COC Contaminant of concern

COEC Contaminant of ecological concern

EE/CA Engineering evaluation/cost analysis

2.6 BACKGROUND COMPARISON

The background datasets from BSA 1 was used to perform two-population statistical tests to compare candidate COCs and COECs concentrations in soil at Sections 32 and 33 Mines with background soil concentrations. All methods followed USEPA (2002, 2010, 2022d) statistical guidance for evaluating background concentrations of chemicals in soil. The background comparison is presented in Table 2. Candidate COCs and COECs within the range of background concentrations were eliminated as a COC or COEC for the geologic unit of interest.

A tiered approach employing one or more statistical methods was used to conduct two-population tests. The first tier in this approach compares the median concentrations between the site and background populations using the Wilcoxon-Mann-Whitney test for datasets without nondetects or with nondetects all having the same detection limit. For datasets with nondetect results and variable detection limits, Gehan's modification to the Wilcoxon Rank Sum (WRS) test (Gehan test) and Tarone-Ware test were used. These two-population tests are available in ProUCL 5.2 (USEPA 2022d). If the first tier tests indicated that the site concentrations are greater than background concentrations, no further testing was conducted. If the first tier tests indicated that the site concentrations are less than or equivalent to background concentrations, a second tier test to compare the righthand tails or upper quantiles of the site and background populations using the Quantile test was performed. One-sided statistical tests are used in all cases and employ a Type I error rate of 0.05 (5 percent).

The following H_0 and H_A hypotheses were tested:

H_0 : the median metal concentration for the site is less than or equal to the median concentration in the background population

H_A : the median metal concentration for the site is greater than the median concentration in the background population



The Quantile test (Johnson and others 1987; USEPA 1994, 2002, 2010) was conducted for all metals where the Gehan, Tarone-Ware, and Wilcoxon-Mann-Whitney tests did not reject H_0 ; that is, when it was concluded that the median site and background concentrations were not significantly different.

The Quantile test is a nonparametric two-population test developed for comparing the righthand tails or upper quantiles of two distributions. The Quantile test can be used when some proportion of high-value measurements (rather than the entire distribution) of one population has shifted relative to a second population. The Quantile test is not as powerful as the WRS test when the distribution of site concentrations is shifted in its entirety to the right of the background distribution. However, the Quantile test is more powerful than the WRS test for detecting cases where only a small number of high-value measurements are present in the upper quantile of the site distribution. For this reason, USEPA (1994, 2002, 2010) guidance recommends the Quantile test be used in conjunction with the WRS test. When applied together, these tests have more power to detect true differences between two population distributions.

The background comparison found that arsenic, cobalt, iron, thallium, vanadium, and zinc site concentrations were within the range of background concentrations for the Quaternary alluvium geological unit. Therefore, arsenic, cobalt, iron, thallium, vanadium, and zinc were eliminated as COCs or COECs at the Section 32 and 33 Mines and cleanup associated with these metals is not recommended.

2.7 REMOVAL ACTION GOALS AND REMOVAL ACTION EXTENT

Removal actions at NAUM sites are focused on removing soil as the source of contamination; removal of contaminated soil should remove the source of contamination to surface water. RAGs were derived by comparison of human health RBSLs calculated using the NAUM Risk Calculator (USEPA 2023), ecological RBSLs, and BTVs (see [Section 2.4.1](#)). Development of the removal action extent and other considerations, including additional waste areas, waste mobility, disturbed mineralized areas, waste accessibility, and risk management, are also discussed in the following subsections.

2.7.1 Removal Action Goals

Human health and ecological RAGs were derived for each applicable receptor, EU, and COC or COEC recommended for removal action. The RAG is the lesser of the human health and the ecological RBSL unless either of the RBSLs is less than the BTV. If the BTV is higher than either of the RBSLs, then the RAG is to address material that is distinguishable from background. For purposes of this EE/CA, the BTV (presented in [Exhibit 3](#)) is used to represent background for delineating contaminated areas. [Exhibit 9](#) provides the selected numerical RAG for each COC and COEC recommended for removal at each EU.



Exhibit 9. Selected Soil RAG for Each COC and COEC

COC / COEC	Units	Human Health RBSL ¹	Ecological RBSL ²	BTV ³	Removal Action Goal ⁴
Section 32 Mine - Kee'da'whíí tééh (Full-time Navajo resident)					
Radium-226 ⁵	pCi/g	0.053	15	1.9	1.9
Manganese	mg/kg	32	--	279	279
Selenium	mg/kg	--	1.0	2.5	2.5
Uranium	mg/kg	2.8	--	1.5	2.8
Section 33 Mine - Default Resident (Non-Navajo)					
Radium-226 ⁵	pCi/g	1.3	15	1.9	1.9
Selenium	mg/kg	--	1.0	2.5	2.5
Uranium	mg/kg	16	--	1.5	16

Notes:

- ¹ The human health RBSL is based on the receptor assumed at each exposure unit. For metals with both carcinogenic and noncarcinogenic effects, the human health RBSL is the lesser (more conservative) of the carcinogenic- and noncarcinogenic-based screening levels.
- ² The ecological RBSL is based on the minimum lowest observed effect concentration for all feeding guilds evaluated for the depth interval as presented in [Appendix C](#), Table C-10.
- ³ The BTVs are the 95 percent upper tolerance limit with 95 percent coverage from site-specific background data (Tetra Tech, 2023).
- ⁴ The RAG is the lesser of the human health and the ecological RBSL unless either of the RBSLs is less than the BTV. If the BTV is higher than either of the RBSLs, then the RAG is to address material that is distinguishable from background. For purposes of this EE/CA, the BTV is used to represent background for delineating contaminated areas.
- ⁵ Secular equilibrium is assumed for radium-226 for calculation of risk.
- Not a COC or COEC
- bgs Below ground surface
- BTV Background threshold value
- COC Contaminant of concern
- COEC Contaminant of ecological concern
- EE/CA Engineering evaluation/cost analysis
- mg/kg Milligram per kilogram
- pCi/g Picocurie per gram
- RAG Removal action goal
- RBSL Risk-based screening level

2.7.2 Radium-226 Removal Action Extent

Because of greater coverage and density, gamma scan data are used as a surrogate to evaluate the extent of Ra-226 contamination in all EUs regardless of whether Ra-226 was identified as a COC or COEC. The gamma survey data collected during the RSE investigation and data gap investigations in November 2022 at the Section 32 and 33 Mines were evaluated and converted to estimated Ra-226 concentrations to determine the Ra-226 removal action extent. A *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (USEPA 2020)-based approach using area averaging was employed that evaluated estimated Ra-226 concentrations against the EU-specific Ra-226 RAG within 2,000-square-meter survey units. An evaluation of areas with elevated concentrations was also conducted to identify 100-square-meter areas with average concentrations that exceed twice the RAG; these areas were added to the preliminary removal action footprint. Contiguous 100-square-meter areas with average concentrations below the RAG were removed from the survey unit designated for removal action.



Once this evaluation was conducted for each EU, the resulting Ra-226 removal action extents were combined to estimate the preliminary removal action extent for Ra-226 at the Section 32 and 33 Mines.

The RAG for the EUs is the same given the same geological unit and land use:

- 15.95 microrentgen per hour based on the provisional BTV for Quaternary alluvium

2.7.3 Other Removal Action Extent Considerations

The preliminary removal action extent was modified based on the evaluation of additional lines of evidence as follows:

- **Extent of contamination of other COCs and COECs not co-located with Ra-226:** Areas outside the Ra-226 removal action extent with elevated concentrations of other COCs and COECs were added to the preliminary removal action extent.
- **Surface and subsurface waste areas:** Waste rock piles and subsurface reclamation mine features (such as stockpiles) were added to the preliminary removal action extent.
- **Transport pathways:** No additional mine features and areas with potential for future transport of waste material downgradient to other geologic units with lower RAGs were identified.
- **Risk management considerations:** Areas where disturbance may result in destabilization of slopes (by removing vegetation), excessive erosion, and sedimentation.

Figure 12 presents the proposed removal action extent at the Section 32 and 33 Mines. The total calculated surface area is 24 acres, and the total estimated volume is approximately 70,000 cubic yards (round up from the totals listed below) within the proposed removal action. The extent broken down by the stockpile and other contaminated surface areas is as follows:

- Section 33 Mine Waste Piles: 0.64 acre; estimated 3,000 cubic yards
- Section 33 Mine Other Areas: 4.02 acres; estimated 11,000 cubic yards
- Section 32 Mine Stockpile: 2.39 acres; estimated 41,000 cubic yards
- Section 32 Mine Other Areas (including haul road and transfer station): 16.31 acres; estimated 13,000 cubic yards

A description of the excavation area, including excavation depths, is included in [Section 4.2.1.1](#).



3.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

This section presents the RAOs, statutory limits on removal actions, removal scope, and removal schedule.

3.1 REMOVAL ACTION OBJECTIVES

An early step in developing removal action alternatives is to establish RAOs. CERCLA does not allow removal action alternatives to require remediation of NORM or soil to concentrations below background levels. Taking current and potential future land use (residential) and Navajo cultural considerations into account, the RAOs for the soil removal action are to:

- Prevent exposure to soil with contaminants from mining activities that would pose an unacceptable risk to human health with the reasonably anticipated future land use and traditional Diné Lifeways.
- Prevent exposure to soil with contaminants from mining activities that would pose an unacceptable risk to plants, animals, and other ecological receptors.
- Prevent offsite migration of contaminants from mining activities to surface water, groundwater, or air that pose an unacceptable risk to human health.

USEPA developed the “Navajo Nation Abandoned Uranium Mines Technology Evaluation and Alternative Development Technical Memorandum” (Tetra Tech, Forthcoming[b]) to describe the general response actions that will satisfy the RAOs listed above. A summary of the technology screening and alternative development process addressed in the technology technical memorandum is provided in [Section 4.1](#). [Section 4.2](#) describes the retained removal action alternatives for the Section 32 and 33 Mines, and [Section 4.3](#) presents a detailed analysis of the removal action alternatives with respect to NCP effectiveness, implementability, and cost criteria. [Section 5.0](#) presents a comparative analysis of the removal action alternatives.

3.2 STATUTORY LIMITS ON REMOVAL ACTIONS

Pursuant to CERCLA Section (§) 104(c)(1), the normal statutory limits for CERCLA removal actions of \$2 million and 12 months do not apply since the selected action will be funded by a responsible party and not by Superfund.

3.3 REMOVAL SCOPE

The scope of the removal action will be to address all solid media contamination at the Section 32 and 33 Mines and to be the final action for solid media at the site. The removal action will also protect against potential future impacts to groundwater and surface water. Post-removal site controls will be part of the analysis for a removal action alternative that does not include the complete removal of contaminants to an offsite location.



3.4 REMOVAL SCHEDULE

NCP requires a minimum public comment period of 30 days following release of the proposed final EE/CA by USEPA. USEPA, NNEPA, and State of New Mexico will work together to respond to comments received during the public comment period and publish an action memorandum following the response to comments. USEPA will provide public notification of the removal action schedule upon issuance of the action memorandum.

During the implementation of the selected removal action alternative(s), several factors may affect the removal action schedule, including removal action planning and design, cultural and biological clearances and mitigation, seasonal weather-related restrictions, and access for construction equipment. Depending on the removal action alternative(s) selected in the final EE/CA, design and implementation of the construction activities will likely require between 1 and 9 months potentially over more than one construction season, which is limited to March through October, depending on schedule-limiting factors such as truck availability, monsoon rains, and snowfall. Inspections and maintenance of graded and revegetated site surfaces will be required at the site for at least the first 30 years after restoration. Inspections and maintenance of onsite cap, if selected, will be conducted as specified in a site-specific long-term surveillance plan (10 *Code of Federal Regulations* [CFR] § 40.28) with inspection frequencies adjusted based on cover or cap stability and inspection findings. A 100-year maintenance period is used for the onsite capping alternative cost estimate and for comparison purposes.



4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section identifies and analyzes the removal action alternatives for the Section 32 and 33 Mines. [Section 4.1](#) summarizes the process of screening potential technologies and identifies the removal action alternatives that may be effective and implementable at the site, [Section 4.2](#) describes in detail the retained removal action alternatives, and [Section 4.3](#) provides a detailed analysis of the removal action alternatives based on the NCP evaluation criteria of effectiveness, implementability, and cost.

4.1 DEVELOPMENT AND SCREENING OF ALTERNATIVES

This subsection identifies general response actions, identifies and screens technologies, develops and describes potential removal action alternatives, and identifies the applicable or relevant and appropriate requirements (ARAR).

4.1.1 Summary of Technology Identification and Screening

The removal action alternative development process involves identifying general response actions, technology types, and process options that may satisfy RAOs. [Table 3](#) presents the general response actions that were considered for the AUMs and includes institutional controls (IC), engineering controls, disposal, and ex situ and in situ treatment. The initial screening below eliminates infeasible technologies and process options and retains potentially feasible technologies and process options.

A technology or process option can be eliminated from further consideration if it does not meet the effectiveness threshold criteria (protectiveness and compliance with ARARs) or substantive implementability criteria (technical, administrative, availability, and local acceptance), details of which are conveyed in [Section 4.3](#). In addition, a technology or process option can be eliminated if its cost is substantially higher than other technologies or process options and at least one other technology or process option is retained that offers equal protectiveness.

Institutional Controls. ICs include the implementation of access restrictions to control current and future land use, including traditional Diné Lifeways. ICs would not reduce waste migration from a site but could be used to protect human health and the environment by administratively restricting access to affected areas. In addition, these restrictions may be used in conjunction with other technologies to protect an implemented action. While the ICs are not effective as stand-alone remedies, they are retained as components of alternatives that include capping waste on Navajo lands. Potentially applicable ICs consist of land use and access restrictions that are described below.

- **Chapter Land Use Plans** – Land use plans are used on Navajo lands similar to zoning on private lands to control current and future land uses.
- **Deed Restrictions** – Deed restrictions do not exist on Navajo lands.
- **Navajo Land Department Homesite Lease Approvals** – Building a home on Navajo lands requires a homesite lease from the Navajo Land Department. The Navajo Land



Department may restrict homesite leases on or near areas with hazardous conditions from mining activities.

- **Environmental Control Easements** – Environmental control easements are intended for use at sites that contain or may contain hazardous wastes or substances that may threaten public health, safety, or welfare, or the environment if certain land uses are permitted or if certain activities are performed on these sites. Environmental control easements are primarily used to address residual contamination.

Engineering Controls. Engineering controls are used primarily to reduce exposure to contaminants. These goals are accomplished by creating a barrier that prevents direct exposure to or transport of waste from the contaminated sources to the surrounding lands. Engineering controls include surface controls, physical barriers, soil sorting, containment, consolidation, capping, onsite backfilling of pits and highwalls, and backfilling of underground voids.

- **Surface controls** – Surface control measures are used primarily to reduce contaminant transport, direct exposure, and the overall exposure area. Surface controls could be appropriate in more remote areas where direct human contact is not a primary concern or as a component of a containment alternative. Surface control process options include consolidation, grading, revegetation, and erosion controls. These measures are retained at the Section 32 and 33 Mines for use in conjunction with other technologies.
- **Physical barriers** – Physical barriers may include portal closure or site access controls such as fencing and signage. These process options are usually integrated with other technologies to various degrees based on site characteristics and are not effective as a stand-alone technology. The vertical shafts at the Section 32 and 33 Mines were closed during reclamation but will be closed again if disturbed during remedy implementation.
- **Sorting** – Soil and waste sorting is a standard process applied as an intermediate step between soil or waste excavation and onsite or off-Navajo Nation treatment or disposal methods. The process goal is to segregate highly contaminated material from less contaminated material, allowing for different treatment or disposal options. Sorting reduces the waste volume requiring treatment or disposal, increases the volume of material that can remain on site with limited or no treatment or containment, and allows classification of waste to reduce the volume requiring more costly treatment or disposal options. A full-scale study is planned as part of a time-critical removal action at the Cove Chapter. The goal of the study is to segregate material at or below cleanup goals from waste requiring offsite disposal. Sorting is retained and may be considered in conjunction with onsite consolidation and containment at the Section 32 and 33 Mines to remove higher concentration waste for offsite disposal.
- **Onsite consolidation and containment** – Mine waste can be consolidated and capped to prevent exposure. Waste from all areas of the site is gathered together, or consolidated, and then capped. Typically, the cap is an ET cover designed to minimize water infiltration and leaching of contaminants, control erosion, control radon emissions, and limit exposure to contaminants. The containment may be directly on site or waste from multiple mines can be consolidated and capped at one mine site as a combined action under CERCLA § 104(d)(4). Combined actions are considered “on site” and, thus, retain



the CERCLA permit exemption for onsite actions. Consolidation and containment are retained at the Section 32 and 33 Mines.

- **Backfilling of cuts, benches, and pits** – Backfilling of aboveground mine workings with mine waste occurs when mine waste is excavated and consolidated in cuts, benches, and pits in isolated areas. The mine waste can be either treated to stabilize or solidify as needed. Placement of mine waste would need to consider surrounding slope steepness and minimize slope with engineered rock walls to strengthen the slope. Placing a soil cover over the waste (containment) would be required to reduce erosion and promote vegetative growth. These mine features do not exist at the Section 32 and 33 Mines; therefore, backfilling is not retained.
- **Backfilling of underground voids** – Backfilling of underground mine workings with mine waste occurs when mine waste is pushed or pumped down vertical mine workings (shafts, stopes, and vents) or injection wells, or transported or pumped into and placed within horizontal workings (adits, drifts, and stopes) and underground vertical workings (shafts, chutes, raises, winzes, and declines). Mine waste can be placed dry or wet, depending on access to and whether the mine workings are flooded. Dry placement requires reopening and rehabilitating adits and shafts for entry and providing a means for material movement (conveyor). Dry placement at the Section 32 and 33 Mines is not retained because all waste requiring disposal would likely not fit into accessible mine workings.

Wet placement requires creating a slurry that can flow or be pumped into the underground mine workings. Approximately 4,000 gallons of water per cubic yard of waste is typically required to create a 5 percent solids slurry. Forming a paste mixture with less water (about 670 gallons of water per cubic yard of waste) is possible, but directional placement would be required. Locating mine voids and drilling of multiple large diameter boreholes would also be required to inject slurry. Once injected, the slurry could partially separate back into solid and water, and this contaminated water could migrate to surface water or groundwater. Cement or another solidifying agent could be added to the slurry to reduce separation but would increase the volume of imported materials and decrease the amount of waste that could be disposed of in the workings. Wet placement is retained at the Section 32 and 33 Mines; however, the mine shafts are already backfilled, requiring drilling of multiple deep injection wells to reach workings.

Disposal. Mine waste can be excavated and disposed of on or off site as a potential remedy. Onsite disposal may be applicable at mines where waste is consolidated or for locations where a separate onsite repository would be constructed. Offsite disposal may be applicable if the disposal site is accessible to a large volume of truck traffic and the waste can be hauled to an on- or off-Navajo Nation regional repository or a RCRA C or LLRW facility licensed to receive radiological waste. Pretreatment of waste using solidification or stabilization to address potential leachability may be considered where repository design does not address the potential for leachate generation. On- or offsite disposal and on- or off-Navajo Nation disposal are retained for the Section 32 and 33 Mines.

Treatment. CERCLA and NCP prefer treatment of waste that significantly and permanently reduces the volume, toxicity, or mobility of contaminants in selecting remedial actions. CERCLA § 121(b), 40 CFR § 300.430(a)(1)(iii), and USEPA (1991a) guidance on principal



threat and low-level threat waste describe how to identify wastes that may be appropriate for treatment. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur.

USEPA has fully considered whether the site contained any principal threat waste, whether that waste could safely be contained using engineering controls, and whether any treatment options may be practicable for the waste at the site. As a result of its investigation and analysis, USEPA concluded that, while individual samples at the site contained higher levels of contaminants that might be considered principal threat waste, the waste at the site is extremely variable and heterogeneous. USEPA found no distinct areas of waste rock that were distinguishable as meeting the definitions of principal threat waste in USEPA (1991a) guidance. However, to be consistent with USEPA's preference for treatment, USEPA did fully evaluate a complete range of treatment options. A summary of the treatment evaluation is discussed below.

Ex Situ Treatment. Excavation and treatment involve the removal of waste from a source area and subsequent treatment using processes that chemically, physically, or thermally reduce contaminant toxicity, mobility, or volume. Treatment processes have the primary objective of either (1) concentrating chemicals for additional treatment, disposal, or recovery of valuable constituents or (2) reducing the mobility of the chemicals. A short screening summary of different ex situ treatment classes is described below.

- **Physical and Chemical Treatments** – Physical treatment processes use physical separation and the characteristics of materials to concentrate constituents into a relatively smaller volume for disposal or further treatment. Chemical treatment processes act by adding a chemical reagent that either removes contaminants from the material or fixates contaminants within the material matrix. The net result of chemical treatment processes is a reduction of toxicity and mobility of contaminants in the solid media. Different types of physical and chemical treatments screened include soil washing, acid extraction, ablation, milling, solidification, and stabilization.
 - **Soil washing** is a treatment process that involves washing the contaminated waste (with water) in a heap, vat, or agitated vessel to dissolve water-soluble contaminants. The most common forms of uranium oxides attached to sand particles in waste rock at the site have low solubility in water, rendering soil washing ineffective for removal to below cleanup goals. Dewatered precipitates and sludge must be disposed of at a mill or RCRA C or LLRW facility licensed to receive radiological waste because of the concentrating of radionuclides. Because of the low concentrations of uranium in the waste rock, varying solubilities at different pH ranges for radionuclides and metals, and limited demonstrated application for AUM wastes, soil washing likely would not meet cleanup goals and was not retained.
 - **Acid extraction** is similar to soil washing except an acidic solution instead of water is applied to the waste rock or other contaminated media in a heap, vat, or agitated vessel. Acid extraction would dissolve a portion of the mineralized uranium attached to the sand particles; however, some percentage could remain bound in the sand particles. Dissolved contaminants are subsequently precipitated for additional treatment and disposal. Based on the uranium mineralization in the waste rock and



- varying solubilities of radionuclides and metals at different pH ranges, acid extraction likely would not decrease concentrations of all contaminants below cleanup goals and was not retained.
- **Ablation** can be applied to sandstone-hosted uranium mineralization where the uranium minerals form a crust on the sand grains. The ablation process mixes water and waste rock into a slurry and impacts opposing slurry streams, causing collisions between the sandstone particles and fragments and removing the uranium minerals coating the sand grains. Uranium mass then shifts from coarse-grain to fine-grain fraction, resulting in a much smaller volume of waste requiring disposal. Pilot-scale studies at three sites on the Navajo Nation has shown that up to 95 percent removal of uranium mass from the coarse sand fraction can be achieved, that the treated materials are not RCRA hazardous, and do not generate leachable metals or radionuclides above USEPA and Navajo Nation water quality standards. Concentrates are disposed of offsite at a RCRA C or LLRW facility licensed to receive radiological waste. However, ablation has not been able to achieve low cleanup goals for unrestricted use. Instead, ablation can be used to reduce uranium mass for waste consolidated on site, reducing risk and improving acceptance by the community. Retention of ablation as a stand-alone or pretreatment step will require scaling up and additional testing at full scale to verify uranium and Ra-226 removal efficiencies and costs. USEPA will continue to monitor progress of the technology and may consider ablation at a future date.
 - **Milling** is an offsite commercial process that removes uranium by a combination of several methods, including pulverization and acid extraction. Concentrations of uranium in the waste rock at the site are low, so any processing would, therefore, yield only a minimal amount of uranium. Additionally, milling does not remove radium and the resulting mill waste is neither less toxic nor less mobile than the source material. Thus, milling was not retained for treatment of uranium mine waste. Milling may be considered as a pretreatment step for recovering uranium before disposal in a tailings disposal facility; however, an operational mill that is in compliance with the CERCLA Off-Site Rule is not located within the region and milling alone as a pretreatment step was also not retained.
 - **Solidification and Stabilization** are processes that either physically encapsulates or chemically alters mine waste to reduce contaminant leachability, mobility, or toxicity. Neither process addresses radiation concerns. Solidification involves mixing waste with a binder material such as cement, fly ash, clay, or geopolymers. Stabilization involves mixing waste with a neutralizing material such as lime/fly ash and pozzolan/cement. The binder or neutralizing material would have to be hauled to the site, and a batch plant would need to be set up to mix the material with waste. The mixing process requires a large quantity of water for binding to occur; therefore, a water source must be developed or water must be imported from off site. Once the material is solidified or stabilized, it may be placed into a repository or in aboveground mine workings as stackable blocks or gravel admixture; however, the volume of waste requiring disposal greatly increases because of the addition of binding and neutralizing agents. Furthermore, unless placed in a disposal cell or repository, the solidified or stabilized material may break apart when exposed to

freeze-thaw and precipitation, potentially increasing leachability. On- or offsite disposal options are just as protective for the original volume of waste and use fewer resources. As a result, solidification and stabilization were not retained.

- **Thermal treatment** – Thermal treatment technologies apply very high levels of heat to the excavated soil in a reactor to volatilize and oxidize contaminants and render them amenable to additional processing. Thermal treatment is typically used for organic contaminants and is not effective on radionuclides and metals in soils.

In Situ Treatment. In situ treatment involves treating the contaminated medium where it is currently located. In situ technologies reduce the mobility and toxicity of the contaminated medium and may reduce exposure to the contaminated materials; however, they allow a lesser degree of control, in general, in comparison to ex situ treatment options. A short screening summary of different in situ treatment classes is described below.

- **Physical and chemical treatments** – Potentially applicable in situ physical and chemical treatment technologies include soil stabilization and solidification. In situ stabilization and solidification are similar to conventional ex situ stabilization in that a solidifying agent (or combination of agents) induces a chemical or physical change in the mobility or toxicity of the contaminants. The in situ process uses deep-mixing techniques to allow maximum contact of the solidifying agents with the contaminated medium. The technologies were not retained because the waste pile depth would make the in situ approach problematic. In addition, exposure to external irradiation by treated materials would remain unless covered with a calculated depth of soil.
- **Thermal treatment** – In situ vitrification is a process used to melt contaminated solid media in situ to immobilize radionuclides and metals into a glass-like, inert, non-leachable solid matrix. Vitrification requires significant energy to generate sufficient current to force the solid medium to act as a continuous electrical conductor. In situ vitrification has been demonstrated only at the pilot scale, and treatment costs are extremely high compared with other treatment technologies. The technology does not address exposure from external irradiation from treated materials and is not considered a feasible option because the infrastructure necessary to deliver high-voltage electricity to a site is unavailable and portable generators cannot provide sufficient voltage, which makes the startup and treatment cost prohibitive. Therefore, in situ verification was not retained.
- **Vegetative treatment** – Vegetation treatment (also known as phytoremediation) is an innovative process that uses plants to remove, transfer, stabilize, or destroy contaminants in soil or sediment. Phytoremediation methods applicable to AUM waste are limited to phytoextraction and phytostabilization. Much of the contamination at the site is located in 30- to 60-foot-deep piles and not all of the waste would be easily accessible by plant roots. Moreover, because radionuclides and metals cannot be biodegraded, plants used in phytoremediation must be harvested and sent for disposal as a radioactive waste and prevention of human or animal consumption of the plants would be necessary. Because of the depth of waste, limited depth of root penetration, and harvested material handling requirements, phytoremediation was not retained.



If the treatments discussed above or any other treatment methods are shown to be effective and practicable before selection of a remedy, USEPA will amend this analysis and consider such treatments.

4.1.2 Summary of Alternative Development

After an initial screening of general response actions and technologies, containment, consolidation, and capping along with various disposal process options were the only technologies identified as being fully protective, effective, and implementable for the Section 32 and 33 Mines. ICs, surface controls, and access controls are feasible but not as stand-alone responses and may be combined with containment and disposal options. A list of analyzed but excluded disposal process options for the site is included below and is followed by a list of retained alternatives comprising excavation and other disposal process options.

The following site-specific disposal alternatives were removed from consideration as infeasible during development of this EE/CA for the Section 32 and 33 Mines:

- **Excavation, Onsite Ablation, Onsite Capping of Treated Material, and Offsite Disposal of Concentrates.** Ablation may not be able to attain background levels for all waste, therefore, this potential future disposal alternative would utilize ablation as pretreatment step to reduce Ra-226 and uranium concentrations posing a risk to people and ecological receptors and volume before treated material is consolidated and covered onsite. The pretreatment step is more protective than simple onsite consolidation and capping as contaminant mass remaining on site is reduced by up to 95 percent. Ablation pretreatment could be retained after additional scalability testing and where a viable offsite disposal alternative at a similar cost is not available and the community would like contaminant mass and volume reduction before onsite consolidation and capping.
- **Excavation and Disposal at Uranium Mill Tailings Radiation Control Act (UMTRCA) Sites.** Several UMTRCA sites, including the United Nuclear Corporation Mill Facility discussed below, assessed for disposal of the Section 32 and 33 Mines waste were considered infeasible because those sites were closed, had insufficient capacity to receive the waste, or had groundwater contamination issues that could prohibit disposal under the CERCLA Off-Site Rule.
- **Excavation and Disposal at Unlicensed Disposal Facilities.** Use of two currently unlicensed locations for new disposal facilities at abandoned coal mines near Grants and Fort Wingate was considered infeasible because of limitations under 10 *United States Code* 2692. Factors included the long time required to license new disposal facilities, whether the coal mines could meet licensing requirements, and contamination issues at both sites that could prohibit disposal under the CERCLA Off-Site Rule.
- **Excavation and Disposal at White Mesa Mill.** The White Mesa Mill facility was considered for extraction of uranium from waste rock and subsequent disposal in the adjacent tailings facility. However, disposal at the tailings facility was determined to be infeasible at this time because of potential contamination issues that would prohibit disposal under the CERCLA Off-Site Rule. This may be an option in the future if compliance with the CERCLA Off-Site Rule can be documented and concurrence obtained from USEPA.



- **Use of Both Upper and Lower Synthetic Liners for Repositories.** Onsite disposal was evaluated as a removal alternative. Each onsite disposal alternative involves two cover options: (1) using a store-and-release (also known as ET) cover, and (2) using an upper synthetic liner with a store-and-release cover. Use of both an upper and lower liner has been screened out as an option because this would add significant additional cost without adding any additional protection. A Hydrologic Evaluation of Landfill Performance (HELP) model was used to evaluate the difference in percolation through 3 and 4 feet deep ET cover systems. The models showed annual percolation through the cover at amounts less than the accuracy of the model (0.002453 inches for the ET cover of 3 feet and 0.001598 inches for the ET cover of 4 feet). Because precipitation measurement inputs into the model are only accurate to 0.1 or 0.01 inch, the modeled percolation value is zero. This modeling indicates that no liners are necessary to prevent infiltration into the wastes with an ET cover ranging from 3 to 4 feet in depth.
- **Evaluation of Rail Transport of Waste to Disposal Facilities.** Two off-Navajo Nation disposal facilities are set up to receive railcars containing waste rock: a RCRA C landfill in Deer Trail, Colorado, and a LLRW facility in Andrews, Texas. Rail transport was evaluated considering two options: (1) trucking to a rail spur along the Interstate 40 corridor and (2) extending a rail line from Gallup to the Section 32 and 33 Mines. The relative volume requiring transport was compared against the costs to purchase land along a right of way, bridge construction across arroyos, long permitting lead times, and a cost of construction of \$3 to \$4 million per mile. As a result, the option to extend a rail line to the Section 32 and 33 Mines was assessed to not be viable. USEPA also visited potential rail spur sites in the Gallup area (11 miles) and in the Thoreau area (48 miles) and determined that transloading facilities would need to be constructed and operated to receive the waste from trucks to transfer into railcars and would create another area requiring clean up at the end of the project. USEPA determined that trucking the waste through the communities would be no different than hauling waste to the Red Rock disposal facility. Waste transfer and scheduling would also add additional construction duration to the cleanup. Therefore, USEPA determined that trucking and rail transport would have limited benefit to the local community and was assessed to not be viable.

Retained Removal Action Alternatives. The following alternatives were retained for further evaluation in this EE/CA and have been tailored to address site-specific conditions and other local requirements.

- **Alternative 1: No Action** – No new treatment, containment, or response action would occur at the site. Maintenance of the existing soil cover and site controls would continue. Alternative 1 has been included as a requirement of NCP and to provide a basis for comparison of the remaining alternatives. Exposure to COCs by human and ecological receptors would not be reduced.
- **Alternative 2: Consolidate and Cap All Waste at Onsite Repository** – All waste rock and contaminated soils from the Section 32 and 33 Mines with concentrations above the action levels would be consolidated and capped in an onsite repository. A store-and-release cover (ET cover) will be used. The cover would be designed to meet performance criteria to achieve specified radon flux attenuation goals.



- **Alternative 3: Dispose of All Mine Waste Off Site at Red Rock Disposal Facility** – Waste rock and contaminated soils with concentrations above the action levels would be excavated and disposed of at a State of New Mexico permitted offsite disposal facility located adjacent to but managed separately from the Red Rock Municipal landfill near Thoreau, New Mexico.
- **Alternative 4: Dispose of All Mine Waste Off Site at a RCRA C or LLRW Facility** – Waste rock and contaminated soils with concentrations above the action levels would be excavated and disposed of at a RCRA C permitted and State of Colorado radiological licensed facility, such as the Clean Harbors RCRA C facility in Deer Trail, Colorado, or an NRC licensed LLRW facility, such as the WCS facility in Andrews, Texas.

Retained removal action alternatives listed above are fully described in [Section 4.2.2](#) and will be carried through a detailed analysis in [Section 4.3](#).

4.1.3 Applicable or Relevant and Appropriate Requirements

Pursuant to NCP at 40 CFR § 300.415(j), USEPA has promulgated a requirement that removal actions attain federal and state ARARs to the extent practicable considering the exigencies of the situation. The ARARs evaluation completed for the Section 32 and 33 Mines was comprehensive, and no ARARs were rejected based on the exigencies of the situation. The Section 32 and 33 Mines are located on Navajo Nation and private lands. Pursuant to NCP at 40 CFR § 300.5, the term “state” includes American Indian tribes. Therefore, for the purposes of evaluating potential ARARs, Navajo requirements will be treated the same as state requirements. The identification of ARARs is an iterative process; therefore, ARARs are referred to as potential until the final determination is made by USEPA in the action memorandum.

NCP at 40 CFR § 300.5 identifies ARARs and other “To Be Considered” (TBC) criteria as follows:

- **Applicable requirements** are defined as “those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance found at a CERCLA site.”
- **Relevant and appropriate requirements** are defined as “those cleanup standards, standards of control, and other substantive requirements, criteria, or limitation promulgated under federal or state environmental facility siting laws that, while not ‘applicable’ address problems or situations sufficiently similar to those encountered at the CERCLA site and that is well suited to the particular site.”
- **TBC criteria** consist of advisories, criteria, or guidance that were developed by USEPA, other federal agencies, or states that may be useful in developing CERCLA remedies and include non-promulgated guidance or advisories that are not legally binding and that do not have the status of potential ARARs. TBCs generally fall within three categories: health effects information with a high degree of credibility, technical information on how to perform or evaluate site investigations or response actions, and policy.



ARARs apply to onsite actions completed as part of a removal action. The onsite actions evaluated in this EE/CA will occur on Navajo Nation as well as on private lands. Navajo Nation statutory and regulatory requirements will be evaluated as potential ARARs for Navajo Nation lands (USEPA 1991b). State of New Mexico has regulatory jurisdiction on private lands but not on Navajo Nation lands. State of New Mexico statutory and regulatory requirements will be evaluated as potential ARARs for private lands in the next version of this EE/CA after compilation and approval by USEPA. Compliance with ARARs requires compliance only with the substantive requirements contained within the statute or regulation and, pursuant to CERCLA § 121(e)(1), does not require compliance with procedural requirements, such as permitting or recordkeeping. ARARs do not apply to offsite response actions. Instead, offsite response actions must comply with independently applicable requirements (not relevant and appropriate) and must comply with both substantive and procedural components of the requirements.

USEPA, as the lead agency, is responsible for identifying potential federal ARARs and evaluating potential State of New Mexico ARARs and Navajo Nation ARARs. For a State of New Mexico or Navajo Nation requirement to be identified as a potential ARAR, the requirement must be more stringent than the corresponding federal ARARs.

USEPA has divided ARARs into three categories: chemical specific, location specific, and action specific. The three categories are described below:

- **Chemical-Specific ARARs** are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.
- **Location-Specific ARARs** apply to the geographical or physical location of a site. These requirements limit where and how the response action can be implemented.
- **Action-Specific ARARs** include performance, design, or other controls on the specific activities to be performed as part of the response action for a site.

The potential ARARs for this response action are presented and analyzed in [Table 4](#) by ARAR category and address requirements specific to the alternatives for the Section 32 and 33 Mines.

4.2 DESCRIPTION OF ALTERNATIVES

[Section 4.2.1](#) provides a summary of common site construction and restoration elements applicable to all alternatives. A detailed description of removal action alternatives and associated costs, which focuses on the different waste disposal options, is presented in [Section 4.2.2](#).

4.2.1 Common Elements

To reduce repetitive discussion in the detailed alternative analyses, common removal action elements for Alternatives 2 through 4 are provided in the following subsections.



4.2.1.1 Common Elements for Construction and Restoration

Common removal action elements at the Section 32 and 33 Mines for construction and restoration for Alternatives 2 through 4 are described below.

Site Preparation. Laydown areas would be established after biological and cultural resource clearances near the onsite repository location near the Section 32 and 33 Mines site, depending on the alternative chosen. Laydown areas may include port-a-potties, wash water, refuse pickup, decontamination station, temporary offices, temporary Wi-Fi and radio, and potentially a construction water well and tank stand. The laydown areas would also include security personnel and temporary fencing and signage for access controls. Laydown areas would remain until completion of the remedy.

No power is available at the Section 32 and 33 Mines; therefore, power for the project would be provided by diesel generators for the temporary work site (laydown) and well site location (if constructed). The diesel generators would require bulk fuel storage at the laydown area, as well as daily storage on the project site. A secondary containment area would be constructed around generators, storage tanks, and fueling area. The generators would provide power for various types of construction equipment, lighting systems, and pumps.

A sufficient water supply is not available for construction near the Section 32 and 33 Mines. Purchase of water from the Navajo Tribal Utility Authority (NTUA) or construction of a new construction supply well near the onsite repository would be needed to provide water for the project. Utility water could be obtained from NTUA hydrants depending upon existing infrastructure and the volume of water available. Well depths would likely range from 500 to 700 feet bgs if utility water is not available. Generators for site power would be used to run the well pump. A water storage tank for the water trucks would also be required. If a well is constructed, it could be left for use by the Navajo community for irrigation or livestock.

Cultural and Biological Exclusion and Timing. Cultural resource investigations were completed within the Section 32 and 33 Mines boundary in 2019 by NV5, Inc. as a subcontractor for Weston (NV5, Inc. 2019b; Weston 2019). The presence of cultural resources could impose limitations on removal actions. The cultural resources survey of the Section 32 Mine and the western half of the Section 33 Mine was completed (NV5, Inc. 2019b) and included with the RSE. The survey found various resources, some of which are in the project area, and recommended for avoidance.

The Section 32 and 33 Mines are within an Area 3 wildlife sensitive area, which is classified as a less sensitive area containing a low and fragmented concentration of endangered and rare plant, animal, and game species on the Navajo Nation (see [Section 2.1.7](#)). Most of the habitat at the Section 32 and 33 Mines is terrestrial/upland and has been highly disturbed by mining activity. Additional biological surveys would be conducted before any intrusive field work.

Site Access. The Section 32 and 33 Mines are located on gently to moderately sloping terrain. The site waste piles and stockpile are accessible from an existing but dilapidated and partially obliterated dirt road and residential access dirt road in poor condition. Both roads are close to residences; therefore, a temporary haul road would be constructed away from residences. Road placement would be determined after community and applicable agency input. [Figure 13](#) shows a



proposed haul road north of the site and residences. Access road construction and maintenance, including grading of uneven surfaces and installation of culverts, would be necessary. Temporary fencing would be required during removal activities, and access to the work area would be marked and signed. Traffic controls may be required for ingress and egress on haul roads, depending on residential traffic.

Air Monitoring. A sampling and analysis plan would be prepared that describes the methods and procedures for collecting, analyzing, and evaluating air samples within and at the perimeter of work zones. A minimum of three air monitoring stations would be positioned and operated to monitor dust and airborne contaminant concentrations during grubbing, excavation, stockpiling, loading of trucks, and site restoration. Air monitoring results would be used to document that onsite and offsite migration of contaminants at unacceptable concentrations does not occur. Workers nearby dirt moving and loading activities would also wear real-time dust monitoring equipment to identify the need for respiratory protection upgrades.

Dust Control. Off-road haul routes and site excavation and restoration areas would be wetted so that dust generation is minimized. Frequent water spraying would be used during soil moving activities at all work zones for dust suppression. Rock fields and grating would also be used to reduce the track out of dirt onto paved surfaces. Water used for dust control and to clean paved surfaces would be imported or pumped from a new construction well as described above. Dust control would be used to maintain compliant air quality conditions and a safe working environment and would also protect the health of nearby residents, workers, the general public, and the environment. Use of binding agents such as magnesium chloride and polymers would be considered to reduce water use for dust suppression.

Stormwater Control. Excavated areas would be graded to pre-mining contours when possible and oriented to reduce scouring with low-energy flow rates and patterns. The drainage system would be integrated with the topography and existing drainage patterns to the extent possible. Activities at the site must be evaluated for potential impacts on federally listed species and critical habitat and for certification to meet the substantive requirements of the National Pollutant Discharge Elimination System Multi-Sector General Permit. Once the site has been stabilized, post-removal action site controls would be initiated.

Excavation Approach. Waste rock within the stockpile, unreclaimed waste rock, and contaminated soils at the reclaimed transfer station and haul road above RAGs are the removal areas of concern at the site (Figure 13). The estimated 70,000 cubic yards of waste is easily accessible. Waste excavation methods considered for the Section 32 and 33 Mines include standard- to large-size excavators and loaders. Waste rock and contaminated soils would be temporarily stockpiled for load out. Borrow material, if needed, would first be obtained from on site; additional imported borrow material may be needed.

Waste Handling and Transfer. For cost estimating purposes, 25-ton-covered on-highway dump trucks were assumed for on- and, if applicable, offsite transport. For Alternative 2, waste will be consolidated and capped in place. For Alternatives 3 and 4, waste will be loaded and hauled to an offsite disposal facility. No transfer station would be required because the Section 32 and 33 Mines can be accessed with multiple types of trucks. Dry brushing of all truck bed and wheels

would occur before each truck leaves the site. Traffic control planning and implementation would be required for Alternatives 3 and 4.

Surficial Restoration Activities. Disturbed areas along the mine access road were identified as needing surficial restoration because of a lack of vegetation. USEPA developed a matrix in the “Navajo Nation Abandoned Uranium Mines Surficial Restoration Approaches Technical Memorandum” (Tetra Tech, Forthcoming[c]) to identify different features and areas of mine sites requiring restoration and the corresponding typical restoration approaches. [Table 1](#) identifies the mine features and areas present at the Section 32 and 33 Mines along with general restoration approaches. Further details regarding each feature and area requiring restoration are described below:

- **Existing haul road.** A 0.8-mile dilapidated dirt road exists from the main access road to the Section 32 stockpile ([Figure 2](#)). The road would be contour graded to match surrounding grade and seeded using local grasses and forbs. A soil berm would be used to block vehicular access. Any construction-related damage to the existing paved road would be repaired.
- **Temporary access road.** A temporary road would be constructed to facilitate construction access and removal of waste from the Section 32 and 33 Mines. Following construction, the temporary access road would be obliterated. This road would be restored by contour grading to match surrounding grade, covered with biodegradable matting and coir logs, and seeded using local grasses and forbs. Drainage swales would be covered with rock to reduce erosion. A soil berm would be used to block vehicular access to the temporary access road.

Site Restoration Activities. USEPA has developed a matrix to identify the different features and areas of mine sites requiring restoration and the typical restoration approaches for each feature and area. [Table 1](#) identifies the mine features at the Section 32 and 33 Mines along with general restoration approaches. Further details regarding each feature and area requiring restoration are described below:

- **Mine shafts.** The mine shafts have been closed by USEPA ([Figure 3](#)). The mine shafts would be inspected and repaired as necessary.
- **Boreholes and vent shafts.** No boreholes or vent shafts were identified during a review of historical documents and during the RSE. If identified during construction, boreholes would be closed by placing an inflatable bladder at a depth of 6 feet below grade and grouting to ground surface.
- **Stockpile.** USEPA constructed a temporary stockpile at the Section 32 Mine ([Figure 3](#)). Under Alternative 2, the existing stockpile would be included in a new onsite repository. Under Alternatives 3 and 4, the existing stockpile would be excavated and restored.
- **Waste excavation areas.** Excavated areas would be contour graded to match adjacent topography ([Figure 14](#)). The areas within the drainages leading from the mine sites would be graded to flow along the topographically lowest path. The drainage pathways would be excavated to form a channel and lined with rock. Fencing and signage would be



erected around the restored area (site and borrow area) to protect revegetation efforts from grazing over a period of up to 30 years.

- **Fencing.** Domestic livestock would not be allowed to enter the site until it is fully restored. Once vegetation is restored and the site has stabilized, perimeter fencing at the Section 32 and 33 Mines may be removed except where a repository is present. Repository perimeter fencing and signage would remain indefinitely. Restoration activities may take 30 years or more before adequate vegetation is in place and final stabilization is achieved.
- **Livestock controls.** In addition to fencing, berms or barricades would be constructed on temporary access roads and benches to reduce ease of access for livestock over the short term and to allow for successful revegetation.
- **Drainage channel restoration.** Disturbance of drainage channels would be required. Restoration of the channels would require restoring a natural energy grade line and planting of shrubs and forbs within the riparian zone.
- **Runoff from above the site.** Sheet flow runoff from upslope of the site would be intercepted and diverted to the restored drainage pathways using rock and soil berms (Figure 14).

4.2.1.2 Common Elements for Maintenance

Common removal action elements at the Section 32 and 33 Mines for maintenance for Alternatives 2 through 4 are described below.

Maintenance during Site Restoration. Maintenance would be performed for up to 30 years for restored areas of the site including excavation areas, removed roads, and borrow areas. Annual maintenance would include:

- Vegetation survey in late spring
- Erosion control inspection and maintenance survey after the monsoon season
- Vegetation maintenance, including reseeding and removing weeds
- Maintenance of the access road until vegetation and restored areas have stabilized
- Repairs to erosional features and water control berms

CERCLA Off-Site Rule. Alternatives that involve transportation off site for disposal would require compliance with the CERCLA Off-Site Rule. In general, the Off-Site Rule requires that facilities that accept contaminated or hazardous wastes from a CERCLA site must follow all applicable regulations and laws (that is, they must be approved to take those wastes and be in compliance with the applicable federal, state, and local requirements to do so). The permitted disposal facilities considered for any alternatives involving offsite disposal would be required to have existing approval under the CERCLA Off-Site Rule.



4.2.1.3 *Potential Unavoidable Impacts*

Except for Alternative 1 (no action), each of the removal action alternatives would result in an overall improvement to the local environment. However, for Alternatives 2 through 4, unavoidable impacts are expected and include:

- Moderate existing vegetation coverage in the Section 32 and 33 Mines area is terrestrial/upland and depending on the degree of mining disturbance, includes scrub brush and grasses. Construction activities would generally be limited to areas of mining disturbance within the Section 32 and 33 Mines boundaries, reclaimed Section 32/33 Transfer Station, and contaminated soils surrounding site features and portions of the haul road. Disturbed areas would be reclaimed, but reestablishing the existing grasses and forbs vegetation would take up to 30 years.
- A new temporary access road would need to be constructed to provide access for construction equipment and to haul out waste. The road would be removed, and disturbed slopes would be restored to the extent possible.
- Local populations using County Road 19 would be inconvenienced by heavy equipment activity for the 1- to 9-month active construction period and by increased truck traffic on Interstate 40 and County Road 19. Generation of dust on access roads would be minimized through spraying with water during construction and hauling activities. Noise would be limited to normal work hours to avoid disturbing local residents.
- Disruption of sensitive species and habitat during construction activities may occur at the Section 32 and 33 Mines. If sensitive species are identified during a biological survey, the timing of construction activities would be adjusted to limit disturbance and biological monitoring would be conducted during construction activities.
- Cultural resources have previously been identified at the Section 32 and 33 Mines. A cultural resource specialist would be consulted during the removal design to avoid sensitive areas during proposed construction activities. Cultural resource monitors would be on site during construction activities to oversee any work areas beyond those already cleared.
- Disruption of wildlife and livestock access to the restored site is estimated for 30 years after completion of site work to establish and stabilize vegetation. Livestock access to the onsite cover would be restricted with range fencing, depending on the cap design, to limit damage to the cap.
- Increased risk of traffic accidents and fatalities and greenhouse gas emissions is anticipated because of the trucking of fill, cover material, and waste. As the haul distance increases, the potential risks also increase ([Exhibit 10](#)).



Exhibit 10. Potential Community Impacts from Trucking

Alternative	Transport Miles	Greenhouse Gases (metric tons CO _{2e})	Accident Injury Risk	Fatality Risk
Alternative 1: No Action	0	0	0	0
Alternative 2: Consolidate and Cap All Waste at Onsite Repository	16,000	<1	0.52 in 100	0.2 in 1,000
Alternative 3: Disposal of All Mine Waste Off Site at Red Rock Disposal Facility	116,000	200	3.8 in 100	1.8 in 1,000
Alternative 4: Disposal of All Mine Waste Off Site at a RCRA C or LLRW Facility	3,803,000	7,000	1.23 accidents	1 fatality

Notes:

CO_{2e} Carbon dioxide equivalent

LLRW Low-level radioactive waste

RCRA Resource Conservation and Recovery Act

4.2.2 Description of Removal Action Alternatives

The following subsections present descriptions of the four removal action alternatives identified in [Section 4.1](#). If any treatment technologies as identified in [Section 4.1.1](#) are shown to be viable alternatives, these technologies will be incorporated into the removal action alternatives.

4.2.2.1 Alternative 1: No Action

Under Alternative 1, radionuclide and metal COCs and COECs in the stockpile, waste pile, and surrounding soils would not be addressed. No land use controls, signage, range fencing, or barriers would be used to limit access to a site. Existing fencing around the Section 32 stockpile would remain. No removal or site stabilization activities would occur.

4.2.2.2 Alternative 2: Consolidate and Cap All Waste at Onsite Repository

Under Alternative 2, the RAOs would be accomplished through excavation of residual waste and contaminated soils and containment of waste with an existing stockpile in a new onsite repository in a new location on Section 33 ([Figure 15](#)). The estimated 37,430 cubic yards of waste from the Section 32 and 33 Mines would be excavated and consolidated with the current stockpile (29,635 cubic yards) and capped.

The new onsite repository would be protected from erosion through upslope surface water diversion berms and ditches. Other components of the alternative would include land use and access controls to protect the repository cover and site restoration process ([Figure 15](#)). Site excavation and restoration elements common to alternatives are described in [Section 4.2.1.1](#).

Site restoration activities include grading of waste excavation areas, erosion controls, and revegetation. Permanent fencing and signage would be installed around the repository to prevent damage to the cap. Site restoration activities are described further in [Section 4.2.1.1](#). A risk assessment of the Section 32 and 33 Mines is included in [Appendix C](#).



Removal Action Components

Additional information regarding individual components is provided in [Section 4.2.1.1](#). Components of the removal action include:

- Construction of the access road for haul trucks
- Excavation of waste from the Section 33 Mine
- Excavation of contaminated soils from the Section 32/33 Transfer Station and area around the Section 32 stockpile
- Consolidation of waste and contaminated soils in a new location on Section 33
- Construction of the ET cap over the compacted waste
- Site restoration with short-term erosion and stormwater controls, grading, and revegetation
- Long-term cover maintenance of the onsite repository

Cost Estimate

The total estimated cost for consolidation and capping of estimated 70,000 cubic yards onsite is **\$2.5 million**. This includes a capital cost of \$1.73 million and total maintenance costs for 100 years of \$488,800 ([Appendix D](#), Table D-1).

4.2.2.3 Alternative 3: Dispose of All Mine Waste Off Site at Red Rock Disposal Facility

Alternative 3 requires the disposal of waste off site at the Red Rock disposal facility in McKinley County, New Mexico. Under Alternative 3, the RAOs would be accomplished through excavation, transport, and off-Navajo Nation disposal of mine waste and contaminated soil. The site would be reclaimed through implementation of restoration measures followed by maintenance of restored features and use of access controls to protect the site restoration process. Site excavation and restoration elements common to alternatives are described in [Section 4.2.1.1](#).

The estimated 70,000 cubic yards of waste from the Section 32 and 33 Mines would be hauled off the Navajo Nation and disposed of at a specially designed and managed disposal area at the Red Rock disposal facility. The hauling of waste would comply with applicable state permitting requirements for the transport of radioactive materials. TCLP metals results would be collected and analyzed to verify that no toxicity characteristic levels are exceeded and that the waste does not exhibit RCRA hazardous waste characteristics.

The waste also falls under the Beville Amendment exclusion and would not be regulated as a RCRA waste in this scenario. In general, the CERCLA Off-Site Rule requires that facilities that accept contaminated or hazardous wastes from a CERCLA site must follow all applicable regulations and laws (that is, they must be approved to take those wastes and be in compliance with the applicable federal, state, and local requirements to do so). The waste disposal facility would be located on a property adjacent to the Red Rock Landfill but operated under a State of New Mexico Groundwater Discharge Permit and not a state RCRA landfill permit.



Alternative 3 can only be chosen and implemented if disposal at the Red Rock disposal facility is also the chosen alternative for the Quivira Tronox Mine Site removal action.

Sufficient waste volume to be disposed of is required to license the Red Rock disposal facility to receive mine waste, and this can only be achieved for the Section 32 and 33 Mines if combined with the significantly larger waste quantity from the Quivira Tronox Mine Site (estimated at 1,041,000 cubic yards).

Site restoration activities include backfilling and grading of waste excavation areas, erosion controls, and revegetation. Site restoration activities are described further in [Section 4.2.1.1](#). A risk assessment of the Section 32 and 33 Mines is included in [Appendix C](#). The Red Rock disposal facility is 15.4 miles from the site and does not currently contain a license for radioactive waste disposal. A Stennett analysis was prepared by the U.S. Army Corps of Engineers (USACE) to evaluate the safety for site workers at the proposed Red Rock disposal facility during waste tipping, consolidation, and capping. The Stennett analysis indicated that facility workers would be safe under the exposure scenario used to develop the analysis. Considerations of the analysis included the characteristics of the waste including contaminant concentrations, as well as construction equipment, methods, and durations of worker exposure (USACE 2022).

The haul route to the Red Rock disposal facility is depicted on [Figure 16](#).

Removal Action Components

Additional information regarding individual components is provided in [Section 4.2.1.1](#). Components of the removal action include:

- Construction of access roads
- Excavation of waste and contaminated soils exceeding RAGs using both a standard excavator and loader ([Figure 13](#))
- Hauling and disposal of waste to the Red Rock disposal facility
- Restoration of temporary construction access roads
- Placement of biodegradable matting and coir logs where applicable and revegetation of soil covered areas
- Construction of run-on and runoff controls above and below excavation areas using soil and rock berms and drainage ditches, armoring the drainage swales passing through excavation areas, and construction of detention basins to intercept eroding soils
- Maintenance of surficial restoration areas

Cost Estimate

The total cost for Alternative 3 is estimated to be **\$9.83 million**. This includes capital costs of \$9.65 million and total site restoration maintenance costs for 30 years of \$179,000 ([Appendix D](#), Table D-2).



4.2.2.4 Alternative 4: Dispose of All Mine Waste Off Site at a Resource Conservation and Recovery Act C or Low-Level Radioactive Waste Facility

Alternative 4 requires the disposal of waste off site at a RCRA C and State of Colorado radiological licensed facility, such as Clean Harbors facility in Deer Trail, Colorado, or an NRC licensed LLRW facility, such as the WCS facility in Andrews, Texas, depending on waste concentration and acceptance limits. Under Alternative 4, RAOs would be accomplished through excavation, transport, and off-Navajo Nation disposal of mine waste and contaminated soil at a hazardous waste or LLRW facility. The Section 32 and 33 Mines would be reclaimed through implementation of site restoration measures followed by short-term maintenance of restored features and use of access controls to protect the site restoration process. Site excavation and restoration elements common to alternatives are described in [Section 4.2.1.1](#).

The estimated 70,000 cubic yards of waste from the Section 32 and 33 Mines would be hauled off the Navajo Nation and disposed of at the Clean Harbors facility in Colorado or the WCS facility in Texas. The hauling of waste would comply with applicable state permitting requirements for the transport of radioactive materials.

Site restoration activities include road closure, grading of waste excavation areas, and controlling runoff from above the site ([Figure 14](#)). Roads required for maintenance activities would be reclaimed once the site has stabilized (30 years). Site restoration activities are described further in [Section 4.2.1.1](#). A risk assessment of the Section 32 and 33 Mines is included in [Appendix C](#).

The Clean Harbors facility, permitted to receive RCRA Class C hazardous waste and licensed by the state of Colorado to receive radioactive material, and the WCS facility, licensed by NRC to receive LLRW, are both in compliance with the CERCLA Off-Site Rule. In general, the CERCLA Off-Site Rule requires that facilities that accept contaminated or hazardous wastes from a CERCLA site must follow all applicable regulations and laws (that is, they must be approved to take those wastes and be in compliance with the applicable federal, state, and local requirements to do so). The disposal facilities considered for any alternatives involving offsite disposal would be required to have existing approval under the CERCLA Off-Site Rule.

Disposal at a permitted or licensed facility is a standard disposal method involving transport to and disposal at the applicable waste disposal facility. Licensed or permitted facilities are generally constructed to prevent the release of hazardous or radioactive materials and include engineered cells and liners that exceed requirements for municipal or commercial solid waste disposal facilities.

TCLP metals concentrations would be assessed before selection of an alternative to profile the waste for disposal at a RCRA-permitted disposal facility. No pretreatment of the waste would be required before disposal.

[Figure 13](#) and [Figure 14](#) show the proposed waste excavation and restoration areas at the Section 32 and 33 Mines. For Alternative 4, waste would be transported to and disposed of at the Clean Harbors RCRA C hazardous waste disposal facility in Deer Trail, Colorado, or the WCS facility licensed by NRC to receive LLRW in Andrews, Texas. The selected disposal facility could be changed in the action memorandum if necessary. [Figure 17](#) shows the proposed haul routes from the site to the Clean Harbors facility in Colorado and the WCS facility in Texas.



Removal Action Components

Additional information regarding individual components is provided in [Section 4.2.1.1](#).

Components of the removal action include:

- Construction of access roads
- Excavation of waste and contaminated soils exceeding RAGs using both a standard excavator and loader ([Figure 13](#))
- Load out and hauling of waste to the Clean Harbors RCRA C hazardous waste disposal facility or the WCS LLRW facility
- Off-Navajo Nation disposal of waste at the Clean Harbors RCRA C hazardous waste disposal facility near Deer Trail, Colorado, or the WCS facility in Andrews, Texas
- Restoration of temporary construction access roads
- Placement of biodegradable matting and coir logs where applicable and revegetation of soil covered areas
- Construction of run-on and runoff controls above and below excavation areas using soil and rock berms and drainage ditches, armoring the drainage swales passing through excavation areas, and construction of detention basins to intercept eroding soils
- Maintenance of surficial restoration areas

Cost Estimate

The total estimated cost for transportation and off-Navajo Nation disposal of estimated 70,000 cubic yards of waste at the Clean Harbors RCRA C hazardous waste disposal facility in Deer Trail, Colorado, is **\$37.54 million** ([Appendix D](#), Table D-3). This includes a capital cost of \$37.36 million and total site restoration maintenance costs for 30 years of \$179,000.

Alternative 4 overall has the highest costs of all the alternatives based on costs related to hauling distance.

4.3 DETAILED ANALYSIS OF ALTERNATIVES

As required by NCP and described in the “Guidance on Conducting Non-Time Critical Removal Actions under CERCLA” (USEPA 1993a), retained removal action alternatives are evaluated individually against three broad criteria: effectiveness, implementability, and cost. The individual alternative analysis ranks the three criteria of each alternative qualitatively as very poor, poor, average, good, or very good.

In addition, based on USEPA (2016) guidance, five key elements in environmental metrics activities should be considered throughout the remedy selection process:

- Minimize total energy use and maximize renewable energy use
- Minimize air pollutants and carbon dioxide equivalent (CO₂e) emissions
- Minimize water use and negative impacts to water resources



- Improve materials management and waste reduction efforts by reducing, reusing, or recycling whenever feasible
- Protect ecosystem services

The evaluation criteria and qualitative rating ranges are described below.

4.3.1 Effectiveness Criterion

This criterion evaluates protectiveness, compliance with ARARs, short-term effectiveness, long-term effectiveness and permanence, and reduction in toxicity, mobility, or volume of waste.

- **Overall Protection of Human Health and the Environment** – This threshold criterion evaluates whether each alternative provides adequate protection of human health and the environment. The assessment of overall protection focuses on whether a specific alternative achieves adequate protection and how site risks posed through each pathway addressed by the EE/CA are eliminated, reduced, or controlled through treatment, engineering, or land use controls. Based on effectiveness and ARAR compliance, alternatives are either considered protective or not protective.
- **Compliance with ARARs** – This threshold criterion evaluates whether each alternative would meet the identified ARARs. Alternatives are either in compliance with ARARs or not in compliance.
- **Short-Term Effectiveness (during Removal Action)** – This criterion evaluates the effects that the alternative would have on human health and the environment under current conditions prior to the action and during its construction and implementation phase. The evaluation includes both radiation risks from exposure to the contaminated soils and risks to the workers and communities under current conditions and from construction work, fuel consumption, greenhouse gas emissions, water use, waste and materials management, ecosystem protection, and traffic accident and fatality risk during implementation, and also takes into account the time necessary to complete the action. An environmental metrics analysis was completed for each alternative to evaluate energy requirements, emissions, water resources, materials management, land management, and ecosystem protection. Short-term effectiveness was rated from very poor to very good.
- **Long-Term Effectiveness and Permanence (after Removal Action)** – This criterion evaluates the results of the removal action in terms of the risk remaining at the site after response objectives have been met. The primary focus of this evaluation is on the extent and effectiveness of the controls used to manage the risk posed by wastes remaining at the site. Long-term effectiveness and permanence was rated from very poor to very good.
- **Reduction of Toxicity, Mobility, or Volume through Treatment** – This criterion addresses the statutory preference for remedies that employ treatment as a principal element by assessing the relative performances of treatment technologies for reducing toxicity, mobility, or volume of the contaminated media. Specifically, the analysis should examine the magnitude, significance, and irreversibility of each estimated reduction. Reduction of toxicity, mobility, or volume through treatment was rated from very poor to very good.



4.3.2 Implementability Criterion

This criterion evaluates the technical and administrative feasibility of implementing an alternative and the availability of required services and materials.

- **Technical Feasibility** – This criterion takes into account construction considerations, demonstrated performance, adaptability to environmental conditions, and timing. Technical feasibility was rated from very poor to very good.
- **Availability of Required Services and Materials** – This criterion evaluates whether staff, equipment services, disposal locations, and any other required services and materials are available in the necessary time frames for construction and maintenance activities. This criterion was combined with technical feasibility for this EE/CA.
- **Administrative Feasibility** – This criterion considers regulatory approval and scheduling constraints. Administrative feasibility was rated from very poor to very good.
- **Tribal, Supporting Agency, and Community Acceptance** – These criteria are initially addressed in this final EE/CA after initial input from Navajo Nation and supporting agencies. However, community acceptance will be addressed in a responsiveness summary of the action memorandum after the public review and comment period on the final EE/CA.

4.3.3 Cost Criterion

The types of costs assessed include the following:

- Capital costs, including both direct and indirect costs
- Annual post-removal site control costs (termed maintenance within this EE/CA for brevity)
- Net present value of capital and maintenance costs

In accordance with USEPA (1993a, 2000b) guidance, engineering costs are estimates within plus 50 to minus 30 percent of the actual project cost (based on year 2023 dollars).

4.3.4 Cost Estimating Process

Cost estimates were prepared in accordance with USEPA (2000b) guidelines using engineer's estimates, unit costs (cubic yard, linear feet, and square foot quantities) from RSMeans 2023 cost estimating software (Gordian 2023), and vendor quotes. Gallup, New Mexico, was used as the reference city in the RSMeans software to ensure unit costs for labor, equipment, and supplies where applicable to work in the region. Unit costs were validated and adjusted where necessary by verifying that the crew size, equipment, and time allotted for an activity (production rate) were applicable to earthwork at a large mining construction site in the region.

In accordance with USEPA (1993a, 2000c) guidance, the engineering costs are estimates that are expected to be within plus 50 to minus 30 percent of the actual project cost (based on year 2023 dollars). Only the rolled up construction and capital costs, maintenance costs for site restoration,



long-term maintenance costs for repositories, and net present values are presented for each alternative. Cost details and assumptions are presented in [Appendix D](#).

Other construction-related costs were identified and included in the cost approach, including mobilization and demobilization, contractor site overhead, travel and lodging, third-party oversight, Navajo Nation tax for on-Navajo Nation activities, and a 20 percent contingency. Non-construction-related costs required before and during construction activities were also identified and included in the cost approach, including design, planning, resource surveys, confirmation sampling, and reporting.

Contingency costs for construction are based on the extra time, equipment, and personnel required to safely work with radioactive materials; remote location of the site; differences in labor pool costs between RSM means estimating software reference cities and the project area; and potential for changes in material and transportation costs. Changes in the cost elements are likely as commodity prices change and new information and data are collected during the engineering design and construction pre-bid and walk-through meetings.

The needs for maintenance costs were identified, including the need for site restoration for a period of 30 years to address any erosion and revegetation efforts and the need for cap and cover maintenance for a period of 100 years for onsite consolidation and capping. Project duration (30 years versus 100 years) varies depending on the alternative being evaluated and will be addressed in the cost discussion for each alternative.

Common capital and maintenance costs for each removal action alternative include access road construction, access road reclamation, site restoration, and annual maintenance of site restoration efforts over 30 years. Annual inspection and maintenance of repository cap (erosion repairs and vegetation replanting) would be intensive for the first 30 years because of revegetation efforts but would decrease after vegetation is established. Maintenance of site restoration and cap restoration efforts is addressed in [Section 4.2.1.2](#) in more detail. The net present value of each removal action alternative provides the basis for the cost comparison. The net present value represents the amount of money that, if invested in the initial year of the removal action at a given interest rate, would provide the funds required to make future payments to cover all maintenance costs associated with the removal action over its planned life.

To assess the required funds to be set aside for implementing maintenance activities in the future, this EE/CA uses a 3.5 percent discount rate, which is the 30-year rolling average of the annual discount rates for varying streams of payments as provided by the Office of Management and Budget (2022). The 3.5 percent discount rate would require more money to be set aside for future maintenance costs than the historical average of 7 percent referenced in USEPA (1993a) guidance.

4.3.5 Alternative 1: No Action

Under Alternative 1, no actions would be performed at the Section 32 and 33 Mines. The conditions that are currently found at the site would remain unchanged. No action does not meet the threshold criteria of protectiveness and will not be evaluated further.



4.3.5.1 Effectiveness

Overall Protection of Public Health and the Environment – Alternative 1 is not protective and would not achieve RAOs. This alternative would not minimize potential exposure to or transport of COCs or COECs from the site or control radiation and physical hazards at the site. This alternative would not reduce risk to human health or the environment. Therefore, protection of human health and the environment would not be achieved under Alternative 1.

Compliance with ARARs – Under Alternative 1, no ARARs would exist with which to comply per CERCLA § 121(d). ARARs are triggered by an action and are, therefore, not pertinent if no cleanup occurs.

Short-Term Effectiveness – Alternative 1 has no action, so no short-term risks would exist for the community or workers from construction activities. However, threats to human and ecological receptors would persist in the short term. Because no construction activities would occur, no additional energy use, greenhouse gas emissions, water use, waste and materials management, and ecosystem protection requirements would be triggered. No additional traffic volume or potential accidents and fatalities associated with construction would occur.

Long-Term Effectiveness and Permanence – No controls or long-term measures would be implemented to control COCs or COECs at the site under Alternative 1. Under this alternative, waste would continue to be accessible by humans and animals and subject to potential migration to uncontaminated or less contaminated areas. Risks at the site are currently unacceptable and would continue to be unacceptable under Alternative 1. Over time, the site risks may increase or decrease or remain the same as exposure to and migration of waste would not be controlled.

Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 1 employs no treatment, so no reductions in toxicity, mobility, or volume through active treatment would occur.

4.3.5.2 Implementability

Technical Feasibility and Availability of Services and Materials – Alternative 1 is readily implementable because no construction is involved. This alternative would not impact the ability to conduct removal or remedial actions in the future. No services or materials would be needed to implement Alternative 1.

Administrative Feasibility – Alternative 1 is administratively feasible as taking no action is always feasible.

4.3.5.3 Costs

No removal action costs would be incurred for Alternative 1 as it involves no removal activities and no legal or administrative activities.



4.3.6 Alternative 2: Consolidate and Cap All Waste at Onsite Repository

Alternative 2 involves the excavation of mine waste and contaminated soil and the placement of waste into an onsite repository.

4.3.6.1 Effectiveness

Overall Protection of Public Health and the Environment – Alternative 2 is protective of human health and the environment as the soil and mine waste that contain radionuclide and metal COCs and COECs would be capped within an onsite repository.

The capped area would be covered with a soil ET cap. The engineered cap is a physical barrier that offers protection from water infiltration and percolation into the contaminated soils, protects groundwater resources, and provides adequate shielding from ionizing radiation to protect human health and the environment. The cover would prevent direct contact between the wastes and the public or the environment. Proper construction and design of the cover includes the establishment of vegetation, which reduces erosion. Proper stormwater controls and maintenance of the cover would prevent release of the contaminated soils back into the environment. A 100-year maintenance period is used for onsite capping alternative cost estimating and comparison purposes. Additional maintenance costs beyond 100 years will depend on inspection results and updates to the long-term surveillance plan.

Compliance with ARARs – Federal and Navajo ARARs identified in [Table 4](#) would be met for the Section 32 and 33 Mines under Alternative 2.

Short-Term Effectiveness – The short-term impacts to the community, workers, and environment under Alternative 2 are described below.

- **Protection of the Community during Removal Action** – Under Alternative 2, increased truck traffic to the site would have a short-term impact on traffic safety and air quality on dirt access and haul roads.

Truck traffic would be coordinated under a transportation plan for routes, times of operation, and onsite traffic rules. Emergency spill containment and cleanup contingencies would also be included in the transportation plan. Over the short term, Alternative 2 would involve 16,155 transport miles and is estimated to result in 0.005 traffic accidents and 0.0002 traffic fatalities and create less than 1 metric tons of CO_{2e}. Risks remain low because waste hauling between the Section 32 and 33 Mines and the onsite repository is only on onsite unpaved haul roads rather than on the highway.

- **Protection of Workers** – Short-term risks of physical injury exist for site workers. All workers would require standard 40-hour Occupational Safety and Health Administration (OSHA) hazardous materials and radiation awareness training and would be adequately protected by using appropriate personal protective equipment and following safe work practices and standards. Radiation exposure monitoring would be required. Short-term impacts to air quality in the surrounding environment may occur during excavation and loading of waste for offsite transport. Dust suppression and monitoring would be required to ensure that workers are not exposed to radionuclides in particulates. Decontamination of workers and equipment would be required before exiting the site.



Under Alternative 2, heavy equipment would be used to clear and grub, excavate, transfer, load, and transport waste to a facility, as well as reclaim the site by grading the footprints of the removal areas, applying growth media, and applying native seed and soil amendments for local vegetation establishment. Potential exposure and protection procedures for workers engaged in these activities would be addressed in detail under a site health and safety plan. During excavation and material handling activities, measures would be taken to reduce fugitive dust emissions and associated impacts to workers. Water would be imported for dust control, and workers in the controlled area would don the appropriate safety equipment and implement safety practices, such as air monitoring. Work areas would be secured (for example, marked or fenced) to limit access to authorized personnel only.

- **Environmental Impacts** – Even with control measures, short-term environmental impacts could occur from excavation and placement of waste in an onsite repository. These environmental impacts may include sedimentation of local drainages, residual track-in and track-out effects of soil and mud, noise, disturbed vegetation, and dust generation. Other environmental impacts include fuel burning and releasing of emissions that would lead to climate impacts. However, the threat to the environment is moderate because the waste rock would be consolidated and capped within 1 to 2 months. In addition, revegetation would expedite the return of native flora once cleanup actions are complete. However, revegetation may not occur immediately. The short-term threat posed by exposure to uranium and radionuclides would be minimal. Impacts from hauling waste and importing materials are discussed in [Section 4.3.6.2](#).
- **Environmental Metrics Analysis** – A qualitative evaluation of all environmental metrics was conducted for this version of the EE/CA. The results are presented in [Appendix C](#). The analysis estimates that Alternative 2 would involve 16,000 transport miles, consume 2,800 gallons of diesel, and create less than 1 metric ton of CO_{2e}. Alternative 2 was assessed as having a **small** environmental footprint.
- **Time until Removal Action Objectives Are Achieved** – The construction time required to achieve preliminary RAOs for Alternative 2 would be 1 to 2 months following 1 year of design, planning, and permitting. Construction may be extended depending on schedule-limiting factors such as monsoon rains and snowfall.

Long-Term Effectiveness and Permanence – Alternative 2 would safely and reliably contain all waste in an onsite repository with an ET cap, and RAOs would be achieved at all areas at the Section 32 and 33 Mines. Landfills and mines in the southwestern U.S. are routinely closed on site with ET covers and a maintenance plan. The Navajo Nation Abandoned Mine Lands Reclamation Department (NAMLRD) has a demonstration repository in the Tse Tah area, and Tetra Tech (2021) has prepared a white paper that provides additional support for the use of ET covers. Cover maintenance is a well-established practice. Since contaminated soils would remain on the site, potential exposure reductions to those accessing the site would be dependent on the maintenance of the cover. Drainage features and stormwater controls would be included in the design so that surface water would be diverted from the capped areas and aid in prolonging the integrity of the cover. Alternative 2 is expected to effectively mitigate the long-term effects on potential human and ecological receptors for as long as the cover and permanent fencing and signage are maintained. An engineered ET cover would meet the RAOs and ARARs and be protective of human health and the environment for at least 200 years.



Land use controls would be necessary to limit access to and disturbance of the site and onsite repository during restoration. For the areas at the site where all waste has been removed, short-term monitoring and repair of revegetation and erosion controls would also be required for up to 30 years.

Force majeure events, such as earthquakes, climate change, or large floods, could impact the remedy or waste left in place, but design criteria for the removal action would take these into account to the extent practicable.

Finally, the uncertainties of disposing of waste in an onsite repository under Alternative 2 are considered low because of the stable nature of the waste, design of the repository and ET cap, use of conventional materials and methods, and long track record of repositories as an accepted remedy.

Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 2 employs no treatment, so no reductions in toxicity, mobility, or volume through active treatment would occur.

4.3.6.2 Implementability

Technical Feasibility and Availability of Services and Materials – Alternative 2 involves earthwork and material hauling that is technically feasible and would use conventional techniques, materials, and labor for the excavation and associated activities.

Construction and environmental monitoring equipment and services are all readily available. Labor would be available both on the Navajo Nation and in the regional market. A sufficient volume of water for dust suppression may be obtained through construction of an onsite water well or imported water.

Local sources of borrow material are enough to meet the needs for fill, topsoil, and gravel for capping options under all potential cap designs and for restoration after excavation. Riprap would need to be imported from Durango, Colorado, to meet engineering specifications for armoring drainage channels.

Alternative 2 would be completed as a single phase, and no future removal actions are anticipated. Maintenance of the repository cap would be required for up to a 100-year period and reevaluated thereafter. The expertise and equipment needed for long-term monitoring and maintenance of the onsite repository cap, erosional features and controls, and revegetation are available. Run-on water control berms and drainage ditches at the repository would be repaired as necessary. Permanent range fencing and warning signs around the repository would also be checked and repaired or replaced as necessary.

Administrative Feasibility – Coordination between USEPA, NNEPA, NAMLRD, and the State of New Mexico to address federal, state and Navajo ARARs would be easily implemented. Federal, state, tribal, and local permits for onsite actions under CERCLA at the site and the proposed onsite repository are not required because this is an onsite location in a mining-disturbed area (drilled and explored extensively) and within a mine lease boundary. Transportation permits would not be necessary. Environmental reviews may be required from the



Navajo Nation and would be easily implemented. Finally, negotiations with the Navajo Nation or other landowners with potential offsite soil borrow sources and repository areas would need to be conducted and agreements crafted.

The entity responsible for the long-term surveillance plan would maintain various plans and conduct periodic inspections and reviews, including:

- A stormwater pollution prevention plan (SWPPP) overseen by NNEPA (to verify that restoration is protective of surface water quality)
- A long-term surveillance plan implemented after repository cap construction and overseen by NNEPA and USEPA

Land use controls for waste placed in the repository would require coordination with NNEPA, the Navajo Land Department, and the Cove Chapter because deed restrictions are not possible on the Navajo Nation.

4.3.6.3 Costs

Overall, Alternative 2 has the lowest costs of the alternatives because of onsite hauling and disposal at the onsite repository even after both short-term (30-year) site restoration maintenance costs and long-term (100-year) onsite repository maintenance costs are considered. USEPA would be responsible for long-term maintenance of the repository. Alternative 2 would also require less earthwork as the stockpile would not be excavated and instead included in the onsite repository footprint.

A breakdown of the major cost categories associated with implementing Alternative 2 is presented in [Exhibit 11](#). Detailed cost estimates are provided in [Appendix D](#), Table D-1.

Exhibit 11. Alternative 2 Cost Breakdown

Cost Component	Section 32 and 33 Mines
Excavated Surface Area (acres)	18
Excavated Volume (cubic yards)	70,000
Capital Costs	
Field Overhead and Oversight	\$120,000
General Site Work	\$185,300
Earthwork	\$939,000
Transportation and Disposal	\$0
Subtotal Direct Capital Costs	\$1,244,000
Indirect Capital Costs	\$261,000
Contingency Allowance (15%)	\$225,750
Total Capital Costs	\$1,731,000
Maintenance Costs	
Present Worth of 100 Years Maintenance at a Discount Rate of 3.5%	\$588,000
Contingency Allowance (25%)	\$147,000
Total Maintenance Costs	\$735,000
Total Costs	\$2,466,000

4.3.7 Alternative 3: Dispose of All Mine Waste Off Site at Red Rock Disposal Facility

Alternative 3 assumes that contaminated soils with concentrations above the action levels would be excavated and disposed of at the Red Rock state-permitted disposal facility in McKinley County, New Mexico. Exhibit 12 presents the processing and transportation costs for the Red Rock disposal facility.

The Red Rock disposal facility is currently a RCRA D landfill and is not licensed to accept LLRW. However, the facility has additional adjacent land where a State of New Mexico permit for a new facility that can accept LLRW for permanent disposal is planned. The State of New Mexico is not opposed to the facility development and has provided guidance on how such a facility would be permitted. USACE (2022) evaluated the operations of the facility in a Stennett analysis and determined that, under the operating conditions assumed, the facility would be safe for workers.

Exhibit 12. Red Rock Transportation and Tipping Costs

Receiving Facility	Processing and Transportation Costs
Red Rock Disposal Facility	\$68 per ton*

Note:

* Exact costs have not been obtained for the Red Rock disposal facility yet. This placeholder cost is for the Red Rock Landfill and will be updated with information from the facility when available.

The Red Rock disposal facility is currently evaluating the costs of permit and facility modification to accept this type and volume of waste. The cost for the landfill currently is a placeholder and will be updated when the facility provides a quote.

Alternative 3 can only be chosen and implemented if disposal at the Red Rock disposal facility is also the chosen alternative for the Quivira Tronox Mine Site removal action. Sufficient waste volume to be disposed of is required to license the Red Rock disposal facility to receive mine waste, and this can only be achieved for the Section 32 and 33 Mines if combined with the significantly larger waste quantity from the Quivira Tronox Mine Site (estimated at 1,041,000 cubic yards).

4.3.7.1 Effectiveness

Overall Protection of Public Health and the Environment – Alternative 3 would protect human health and the environment as the contaminated soils exceeding the action level at the Section 32 and 33 Mines would be removed for offsite transportation and disposal at a permitted facility designed to manage radioactive waste. This alternative would significantly minimize potential long-term exposure to contaminated soils from the Section 32 and 33 Mines. Potential short-term exposures during excavation, transport, and at the final disposal site would be managed through engineering controls.

From a COPC exposure perspective, the Alternative 3 actions are protective of human health and the environment. However, highway fatality calculations indicate shipping soils to the Red Rock disposal facility for disposal have a significant risk of a highway traffic fatality. Chemically,



disposal at the Red Rock disposal facility is protective, but, physically, this may not be the case. This is discussed further in the evaluation of short-term effectiveness.

Compliance with ARARs – Alternative 3 would meet federal, state, and Navajo Nation ARARs for the Section 32 and 33 Mines. Common ARARs across Alternatives 2 through 4 are found in [Table 4](#).

Short-Term Effectiveness – Alternative 3 involves excavation of all waste for offsite disposal at the Red Rock disposal facility. The short-term impacts to the community, workers, and environment under Alternative 3 are as described below.

- **Protection of the Community during Removal Action** – Under Alternative 3, increased truck traffic to the site would have a short-term impact on traffic safety and air quality on dirt access and haul roads.

For Alternative 3, bulk carriers hauling the containerized wastes off site would be covered, secured, and weighed to document compliance with total and axle load limits. Truck traffic would be coordinated under a transportation plan for routes, times of operation, and onsite traffic rules. Emergency spill containment and cleanup contingencies would also be included in the transportation plan. A new access and haul road would be constructed to avoid nearby residents and extend from the site north for approximately 0.2 mile and then west for 0.65 mile to connect with County Road 19.

Alternative 3 would involve 116,000 transport miles and is estimated to result in 0.04 traffic accidents and 0.0018 traffic fatalities and create 200 metric tons of CO₂e. This alternative also leaves the waste in place for the 3 to 5 years of state permitting, design, and facility construction.

- **Protection of Workers during Removal Action** – Short-term risks of physical injury exist for site workers. All workers would require standard 40-hour OSHA hazardous materials and radiation awareness training and would be adequately protected by using appropriate personal protective equipment and following safe work practices and standards. Radiation exposure monitoring would be required. Short-term impacts to air quality in the surrounding environment may occur during excavation and loading of waste for offsite transport. Dust suppression and monitoring would be required to ensure that workers are not exposed to or inhale radionuclides in particulates. Decontamination of workers and equipment would be required before exiting the site.

Under Alternative 3, heavy equipment would be used to clear and grub, excavate, transfer, load, and transport waste to a facility, as well as reclaim the site by grading the footprints of the removal areas, applying growth media, and applying native seed and soil amendments for local vegetation establishment. Potential exposure and protection procedures for workers engaged in these activities would be addressed in detail under a site health and safety plan. During excavation and material handling activities, measures would be taken to reduce fugitive dust emissions and associated impacts to workers. Water would be imported for dust control, and workers in the controlled area would don the appropriate safety equipment and implement safety practices, such as air monitoring. Work areas would be secured (for example, marked or fenced) to limit access to authorized personnel only.



- **Environmental Impacts** – Even with control measures, short-term environmental impacts could occur. These environmental impacts may include residual track-in and track-out effects of soil and mud, noise, disturbed vegetation, and dust generation. Other environmental impacts include fuel burning and releasing of emissions that would lead to climate impacts. However, the threat to the environment is moderate because the mine waste could be consolidated and capped within 4 to 5 months. In addition, revegetation would expedite the return of native flora once cleanup actions are complete. The short-term threat posed by exposure to uranium and radionuclides would be minimal. Impacts from hauling waste and importing materials are discussed in [Section 4.3.7.2](#).
- **Environmental Metrics Analysis** – A qualitative evaluation of all environmental metrics was conducted for this version of the EE/CA. The results are presented in [Appendix C](#). The preliminary analysis estimates Alternative 3 would involve 116,000 transport miles, consume 20,000 gallons of diesel, and create 200 metric ton of CO_{2e}.
- **Time until Removal Action Objectives Are Achieved** – Excavation, hauling off the Navajo Nation, and disposal of waste at the Red Rock disposal facility would meet preliminary RAOs in the short term. The construction time required to achieve RAOs for Alternative 3 would be approximately 4 to 5 months. Construction may be extended depending on schedule-limiting factors such as truck availability, monsoon rains, and snowfall.

Long-Term Effectiveness and Permanence – Since all contaminated soils would be excavated and removed from the site, potential exposure reductions to receptors accessing the site would be permanent. Long-term maintenance is lowest under this alternative because it focuses on native vegetation reestablishment only and does not require repository maintenance. Alternative 3 is expected to mitigate the long-term effects on potential onsite human and ecological receptors.

Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 3 employs no treatment, so no reductions in toxicity, mobility, or volume through active treatment would occur.

Managing waste at landfills reduces the overall mobility of bulk waste but does not treat the waste. Alternative 3 does not reduce COC or COPC toxicity, mobility, or volume through treatment. Under Alternative 3, waste would be disposed of at the Red Rock disposal facility near Gallup, New Mexico, which is or would be permitted for LLRW disposal.

4.3.7.2 Implementability

Technical Feasibility and Availability of Services and Materials – Alternative 3 is technically feasible and would use conventional techniques, materials, and labor for the excavation and associated activities. The Section 32 and 33 Mines are readily accessible. Excavation would be scheduled and performed to maximize direct loading and ensure worker and public safety. Engineering controls for fugitive dust and site monitoring would be used to control potential exposures to sensitive receptors. Profiling and manifesting of the material would be done in coordination with the transporters and the offsite disposal facility.

Alternative 3 consists mainly of simple earthwork and material hauling. Alternative 3 requires a contractor experienced in the excavation of mine waste, drainage channel reconstruction,



biodegradable erosion control matting and wattles, and stormwater diversion berms and ditches, hazardous substances, and traffic, dust, and stormwater management. The equipment required for the work is readily available and consists of scrapers, loaders, dozers, crushing and screening plant for borrow materials, and on-highway haul trucks. The disposal of waste at the Red Rock disposal facility has a haul distance of 15.4 miles.

Construction and environmental monitoring equipment and services are all readily available. Labor would be available both on the Navajo Nation and in the regional market. Access to a sufficient volume of water for dust suppression is necessary, which would be obtained through construction of an onsite water well or trucked in from the Gallup municipal supply.

Sources of borrow material are adequate to meet the needs for fill and topsoil for restoration after excavation.

Alternative 3 would be completed as a single phase, and no future removal actions are anticipated. Long-term monitoring and maintenance would not be required; however, short-term maintenance of erosional controls and revegetation efforts would be required. Run-on water control berms, drainage ditches, and sediment detention basins would be repaired as necessary. Temporary range fencing would also be checked and repaired as necessary.

The Red Rock disposal facility is currently in compliance with its operating permits and with the CERCLA Off-Site Rule. Because all waste would be disposed of off site, reliance on the disposal capacity of the Red Rock disposal facility brings uncertainty to the availability of services at the time of the removal action. A change to the disposal facility could be selected in the action memorandum if necessary.

Administrative Feasibility – Implementation of Alternative 3 would require coordination between USEPA, NNEPA, NAMLRD, and the State of New Mexico to address federal, State, and tribal ARARs, but federal permits for onsite actions under CERCLA are not required. The Red Rock disposal facility would be required to undergo a Stennett analysis and obtain a Groundwater Discharge Permit from the State of New Mexico. General construction permits and environmental reviews may be required from the Navajo Nation. Finally, negotiations with the Navajo Nation or other landowners with potential offsite soil borrow sources would need to be conducted and agreements crafted.

Alternative 3 can only be chosen and implemented if disposal at the Red Rock disposal facility is also the chosen removal action alternative for the Quivira Tronox Mine Site and the waste from the Section 32 and 33 Mines is combined with the significantly larger waste quantity from the Quivira Tronox Mine Site (estimated at 1,041,000 cubic yards).

Alternative 3 is rated average for administrative feasibility since it would require a Stennett analysis and state permitting. All contaminated soil is anticipated to be accepted by permitted facilities. However, Alternative 3 is currently rated average for administrative feasibility because the Red Rock disposal facility is not currently permitted for radioactive waste disposal. The permitting options are being identified by the facility, but the permit would take time to obtain through permitting and due diligence evaluation, including local input. The overall time frame for this process has not been clarified but would be included in this EE/CA when available.



The entity responsible for the short-term surveillance of site restoration features would maintain various plans and conduct periodic inspections and reviews, including a SWPPP overseen by NNEPA (to verify that restoration is protective of surface water quality).

4.3.7.3 Costs

Alternative 3 overall has the second highest costs of the alternatives because of facility disposal fees. Costs assume that all material above screening levels would be removed from the site and disposed of at the Red Rock disposal facility. The facility would be responsible for long-term operation and maintenance of the wastes it receives. Operation and maintenance at the Section 32 and 33 Mines would only consist of revegetation and 30 years of monitoring and maintenance for revegetation.

A breakdown of the major cost categories associated with implementing Alternative 3 is presented in [Exhibit 13](#). Detailed cost estimates are provided in [Appendix D](#), Table D-2.

Exhibit 13. Alternative 3 Cost Breakdown

Cost Component	Section 32 and 33 Mines
Excavated Surface Area (acres)	22
Excavated Volume (cubic yards)	70,000
Capital Costs	
Field Overhead and Oversight	\$240,000
General Site Work	\$284,200
Earthwork	\$729,000
Transportation and Disposal	\$6,626,700
Subtotal Direct Capital Costs	\$7,880,000
Indirect Capital Costs	\$511,000
Contingency Allowance (15%)	\$1,258,650
Total Capital Costs	\$9,650,000
Maintenance Costs	
Present Worth of 30 Years Maintenance at a Discount Rate of 3.5%	\$143,000
Contingency Allowance (25%)	\$35,800
Total Maintenance Costs	\$179,000
Total Costs	\$9,829,000

4.3.8 Alternative 4: Dispose of All Mine Waste Off Site at a Resource Conservation and Recovery Act C or Low-Level Radioactive Waste Facility

Alternative 4 involves the excavation of mine waste and contaminated soil, loading into highway legal trucks, and transport and disposal of waste at the Deer Trail RCRA-permitted and State of Colorado radiological licensed facility in Deer Trail, Colorado. [Exhibit 14](#) presents the processing and transportation costs for the Deer Trail facility. The Deer Trail facility currently has the appropriate permitting, licensing, bonding, and CERCLA Off-Site Rule approvals. A change to the disposal facility could be selected in the action memorandum if necessary.



Exhibit 14. Deer Trail Transportation and Tipping Costs

Receiving Facility	Processing and Transportation Costs
Deer Trail Landfill	\$190 per ton

4.3.8.1 Effectiveness

Overall Protection of Public Health and the Environment – Alternative 4 is protective of human health and the environment as the soil and mine waste that contain radionuclide and metal COCs and COECs would be disposed of at an off-Navajo Nation hazardous waste disposal facility. This alternative would significantly minimize potential long-term exposure to contaminated soils from the Section 32 and 33 Mines. Potential short-term exposures during excavation, transport, and at the final disposal site would be managed through engineering controls.

From a contaminant exposure perspective, Alternative 4 is protective of human health and the environment. However, highway fatality calculations indicate shipping soils to Deer Trail for disposal would result in a large increase in highway traffic accidents and fatalities. This is discussed further in the evaluation of short-term effectiveness.

Compliance with ARARs – Alternative 4 will meet federal, state, and tribal ARARs identified in Table 4. ARARs do not apply to offsite actions, but offsite actions must comply with independently applicable requirements (not relevant and appropriate). Independently applicable requirements cannot be waived, and all components, both substantive and procedural, must be complied with at all times.

Short-Term Effectiveness – Alternative 4 involves excavation of all waste for offsite disposal at a RCRA-permitted facility. The short-term impacts to the community, workers, and environment under Alternative 4 are described below.

- **Protection of the Community**– Dust generation is unavoidable, but dust mitigation measures should prevent most unacceptable exposures to the community. Air monitors would be placed around the construction zone at the mine sites and the transfer station to measure potential risks to the community and to trigger additional dust control if necessary.

Increased truck traffic would have a short-term impact on traffic safety within the area around the site and air quality on dirt access roads. Hauling waste from the site to the off-Navajo Nation Clean Harbors RCRA C hazardous waste disposal facility near Deer Trail, Colorado, would lead to increased traffic on County Road 19 and other state highways along the route to the disposal facility for 8 to 9 months.

Over the short term, Alternative 4 would involve 3,802,860 transport miles and is estimated to result in 1.23 traffic accidents and 0.0574 traffic fatalities and create 7,000 metric tons CO₂e. The estimates are greater than those for Alternative 3 because of the 567-mile haul distance between the Section 32 and 33 Mines and the Clean Harbors RCRA C hazardous waste disposal facility.



- **Protection of Workers** – Short-term impacts to air quality in the surrounding environment may occur. Dust suppression and monitoring would keep worker exposure to dust within acceptable levels. Decontamination of workers and equipment would be required before exiting the site.

Short-term risks of physical injury would exist for site workers. All workers would be required to wear personal dosimeters to monitor that exposure does not exceed OSHA limits. The risk to truck drivers would be greater than that for Alternatives 2 and 3 because of the increase in time and miles required for transport.

- **Environmental Impacts** – Even with control measures, short-term environmental impacts could occur. These environmental impacts may include sedimentation of the local drainages, residual track-in and track-out effects of soil and mud, noise, disturbed vegetation, and dust generation. However, the threat to the environment is very high because the mine waste would be cleaned up within 8 to 9 months. In addition, revegetation would expedite the return of native flora. The short-term threat posed by exposure to uranium and radionuclides would be minimal.
- **Environmental Metrics Analysis** – A qualitative evaluation of all environmental metrics was conducted for this version of the EE/CA. The results are presented in [Appendix C](#). The analysis estimates Alternative 3 would involve 3,803,000 transport miles, consume 660,000 gallons of diesel, and create 7,000 metric ton of CO_{2e}.
- **Time until Removal Action Objectives Are Achieved** – Excavation, hauling off Navajo Nation, and disposal of waste at the Clean Harbors disposal facility would meet preliminary RAOs in the short term. The construction time required to achieve preliminary RAOs for Alternative 4 would be 8 to 9 months at the Section 32 and 33 Mines because of the 3-day truck cycle time. Construction may be extended depending on schedule-limiting factors such as truck availability, monsoon rains, and snowfall.

Long-Term Effectiveness and Permanence – Alternative 4 would relocate and safely dispose of all waste in a hazardous waste disposal facility, and RAOs would be achieved at the site. No sources of mining-related residual risk would remain at the Section 32 and 33 Mines.

No long-term maintenance is required for Alternatives 4 because no waste would remain on site. Therefore, Alternative 4 has a substantial advantage over on-Navajo Nation actions of Alternative 2, which would require up to 100 years of onsite repository cap inspections and maintenance.

Land use controls would be necessary to limit access to and disturbance of the site during restoration. For the areas at the site where all waste has been removed, short-term monitoring of revegetation efforts and erosion controls would also be required.

Finally, the uncertainties of disposing of waste off site under Alternative 4 are considered low because of the use of conventional materials and methods and the long track record of hazardous waste disposal facilities as an accepted remedy.

Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 4 employs no treatment, so no reductions in toxicity, mobility, or volume through active treatment would occur.



Managing waste at landfills reduces the overall mobility of bulk waste but does not treat the waste. Alternative 4 does not reduce COC or COPC toxicity, mobility, or volume through treatment. Under Alternative 4, waste would be disposed of at permitted RCRA facility in Deer Trail, Colorado, which is permitted and licensed for uranium mine waste disposal.

4.3.8.2 Implementability

Technical Feasibility and Availability of Services and Materials – Alternative 4 consists mainly of earthwork and material hauling. The equipment required for the work is readily available and consists of conventional excavators, scrapers, loaders, dozers, crushing and screening plant for borrow materials, and on-highway haul trucks.

Construction and environmental monitoring equipment and services are all readily available. Labor would be available both on the Navajo Nation and in the regional market. Availability of on-highway haul trucks may be a limiting factor and increase project duration. Access to a sufficient volume of water for dust suppression is necessary, which would be obtained through construction of an onsite water well or imported.

Local sources of borrow material are enough to meet the needs for fill and topsoil for restoration after excavation. Riprap would need to be imported from Durango, Colorado, to meet engineering specifications for armoring drainage channels.

No future removal actions are anticipated. Long-term monitoring and maintenance would not be required; however, short-term maintenance of erosional controls and revegetation efforts would be required.

The Clean Harbors hazardous waste disposal facility is currently in compliance with its operating permit and with the CERCLA Off-Site Rule. Because all waste would be disposed of off site, reliance on the disposal capacity of the Clean Harbors facility brings uncertainty to the availability of services at the time of the removal action. A change to the disposal facility or additional disposal facilities could be selected in the action memorandum if necessary.

Administrative Feasibility – Coordination between USEPA, NNEPA, NAMLRD, and the State of New Mexico to address federal, state, and Navajo ARARs would be easily implemented. Federal, state, tribal, and local permits for onsite actions under CERCLA are not required. Environmental reviews may be required from the Navajo Nation and would be easily implemented. Finally, negotiations with the Navajo Nation or other landowners with potential offsite soil borrow sources would need to be conducted and agreements crafted.

Offsite disposal of materials from a CERCLA site must comply with the CERCLA Off-Site Rule. The Clean Harbors hazardous waste disposal facility currently has approval under the Off-Site Rule and would need to maintain such approval.

The entity responsible for the short-term surveillance of site restoration features would maintain various plans and conduct periodic inspections and reviews, including a SWPPP overseen by NNEPA (to verify that restoration is protective of surface water quality).



4.3.8.3 Costs

Overall, Alternative 4 has the highest costs of all the alternatives because of trucking costs and facility disposal fees. Costs assume that all material above screening levels would be removed from the site and disposed of at a RCRA-permitted facility. The facility would be responsible for long-term operation and maintenance of the wastes it receives.

A breakdown of the major cost categories associated with implementing Alternative 4 for the Section 32 and 33 Mines is presented in [Exhibit 15](#). Detailed cost estimates are provided in [Appendix D](#), Table D-3.

Exhibit 15. Alternative 4 Cost Breakdown

Cost Component	Section 32 and 33 Mines
Excavated Surface Area (acres)	22
Excavated Volume (cubic yards)	70,000
Capital Costs	
Field Overhead and Oversight	\$555,000
General Site Work	\$73,000
Earthwork	\$745,000
Transportation and Disposal	\$27,304,000
Subtotal Direct Capital Costs	\$28,678,000
Indirect Capital Costs	\$3,807,000
Contingency Allowance (15%)	\$4,872,000
Total Capital Costs	\$37,357,000
Maintenance Costs	
Present Worth of 30 Years Maintenance at a Discount Rate of 3.5%	\$143,000
Contingency Allowance (25%)	\$35,800
Total Maintenance Costs	\$179,000
Total Costs	\$37,536,000

5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents the approach for the comparative analysis of alternatives and a summary of the analysis. The comparative analysis includes evaluation of the relative effectiveness, implementability, and cost between alternatives.

5.1 COMPARATIVE ANALYSIS APPROACH

The final step of the draft EE/CA is to conduct a comparative analysis of the removal action alternatives. This analysis will discuss each alternative's strengths and weaknesses relative to the other alternatives in achieving RAOs. An explanation of the evaluation and ranking criteria is presented in [Section 4.3](#). Navajo Nation, supporting agency, and public acceptance will be evaluated after stakeholder comments have been received on the draft EE/CA.

5.2 SUMMARY OF ANALYSIS

All alternatives except Alternative 1 meet the threshold criterion of protectiveness of public health and the environment. [Exhibit 16](#) presents a comparative rating of alternatives.

Exhibit 16. Comparative Rating of Alternatives

Alternative	Attainment of Threshold Criteria ^a	Effectiveness	Implementability	Cost Rating (Million) ^b
Alternative 1: No Action	Fail	Short-Term: Average Long-Term: Very Poor	Tech: Very Good Admin: Very Good	Very Good (\$0)
Alternative 2: Consolidate and Cap All Waste at Onsite Repository	Pass	Short-Term: Good Long-Term: Good	Tech: Good Admin: Good	Very Good (\$2.5)
Alternative 3: Disposal of All Mine Waste Off Site at Red Rock Disposal Facility	Pass	Short-Term: Poor Long-Term: Very Good	Tech: Very Good Admin: Average	Average (\$9.8)
Alternative 4: Disposal of All Mine Waste Off Site at a RCRA C or LLRW Facility	Pass	Short-Term: Very Poor Long-Term: Very Good	Tech: Very Good Admin: Good	Very Poor (\$37.5)

Notes:

Bold indicates the highest rating in the category.

^a Threshold criteria are (a) overall protectiveness and (b) compliance with applicable or relevant and appropriate requirements.

^b Estimated costs are net present value

Admin Administrative feasibility

LLRW Low-level radioactive waste

RCRA Resource Conservation and Recovery Act

Tech Technical feasibility

5.2.1 Effectiveness

Effectiveness comprises two threshold criteria (protectiveness and compliance with ARARs) and includes short-term effectiveness (during removal action) and long-term effectiveness and permanence (after removal action).



5.2.1.1 Overall Protectiveness of Human Health and the Environment

All alternatives except Alternative 1 are protective of public health and the environment.

5.2.1.2 Compliance with ARARs

All alternatives would be performed in compliance with the federal, state, and Navajo Nation ARARs identified in [Table 4](#).

5.2.1.3 Short-Term Effectiveness (during Removal Action)

Short-term effectiveness comprises four criteria (discussed below): protection of the community, protection of workers, environmental impacts, and time to meet RAOs. Overall short-term effectiveness is rated, **Good** for Alternative 2, **Poor** for Alternative 3, and **Very Poor** for Alternative 4.

Protection of the Community

Alternative 2 is rated **Good**. This alternative creates the least traffic and dust impacts to the community as truck traffic would only be increased on the main access road to transport equipment and construction materials for excavation and repository construction. No excavated waste would be hauled through the community. Dust impacts would be limited to the dirt haul road to the onsite repository with no impacts to the community. Fewer haul miles through the community would also result in less traffic accidents.

Alternative 3 (haul route to Red Rock disposal facility in McKinley, New Mexico) is rated **Average**. Excavated waste from the Section 32 and 33 Mines will be hauled on County Road 19 and Interstate 40 and pass through local communities. This alternative would potentially lead to more traffic impacts to the communities than Alternative 2 because excavated waste would be hauled a longer distance (15.4 miles) through the communities to the Red Rock disposal facility.

Alternative 4 (haul route to RCRA-permitted facility in Deer Trail, Colorado) has the highest impact on traffic, largest increase in truck emissions, and largest increase in potential traffic accidents and fatalities. Dust impacts would occur along dirt haul roads. Excavated waste from the Section 32 and 33 Mines will be hauled on County Road 19, Interstate 40, and on state highways to an off-Navajo Nation disposal facility located 567 miles away. Alternative 4 is rated **Very Poor** because of the longer roundtrip distances to the disposal facilities and the greater potential impacts to communities.

Protection of Workers

Worker protection primarily involves radiation exposure, dust inhalation hazards, physical injury, and traffic accidents. All action alternatives involve the same degree of excavation work; therefore, all action alternatives have equal amounts of potential radiation exposure, potential dust inhalation hazards, and potential for injury to workers. However, Alternative 2 involves construction of a repository, which introduces an additional level of threat to workers because of additional handling activities and duration of exposure during consolidation and capping.



However, the risk associated with repository construction are greatly exceeded by risk associated with hauling waste off site.

The rate of traffic accidents and fatalities is proportional to the amount of hauling for that alternative. For the action alternatives, the total haul distance on all roadways for Alternative 2 is approximately 0.5 mile, Alternative 3 is 15.4 miles (disposal at the Red Rock disposal facility), and Alternative 4 is 567 miles (disposal at the Clean Harbors hazardous waste facility). Risks associated with each alternative are addressed in [Exhibit 17](#).

Exhibit 17. Potential Community Impacts from Trucking

Alternative	Transport Miles	Project Duration	Accident Injury Risk	Fatality Risk
Alternative 1: No Action	0	0	0	0
Alternative 2: Consolidate and Cap All Waste at Onsite Repository	16,000	1 to 2 months	Very Low (0.52 in 100)	Low (0.2 in 1,000)
Alternative 3: Disposal of All Mine Waste Off Site at Red Rock Disposal Facility	116,000	4 to 5 months	Low (3.8 in 100)	Average (1.8 in 1,000)
Alternative 4: Disposal of All Mine Waste Off Site at a RCRA C or LLRW Facility	3,803,000	8 to 9 months	Very High (1.23 accidents)	Very High (1 fatality)

Notes:

LLRW Low-level radioactive waste

RCRA Resource Conservation and Recovery Act

Environmental Impacts

Shorter haul distances and construction durations minimize the potential for construction-related environmental impacts to occur both on public roads and off road and in the construction areas that would require mitigation. These impacts may include residual track-out effects of soil and mud, noise, nuisance soil spills during waste hauling, sedimentation of local drainages, and harmful emissions. In addition, construction of a repository increases the amount of construction activities and, therefore, increases environmental impacts while offsite disposal increases fuel consumption and greenhouse gas emissions. Site inspections and maintenance activities are expected to have an impact on alternative environmental footprints. [Exhibit 18](#) presents the environmental impacts of each alternative.

Environmental Metrics Analysis. For this draft EE/CA, a preliminary analysis of the environmental impacts was conducted to estimate the magnitude of each alternative and are summarized in [Appendix C](#). A complete evaluation will be conducted using USEPA's recommended methodology and documented in subsequent EE/CA versions. The preliminary analysis estimates Alternative 2 would involve 16,000 transport miles, consume 2,800 gallons of diesel, and create less than 1 metric ton of CO_{2e}. Alternative 2 was assessed as having a **small** environmental footprint.



Exhibit 18. Environmental Impacts of Alternatives

Alternative	Estimated Diesel Use (million gallon)	Miles Traveled	Greenhouse Gas Emissions (metric ton CO ₂ e)	Greenness Score ^a
Alternative 1: No Action	Low (0)	Low (0)	Low (0)	Low (6/48)
Alternative 2: Consolidate and Cap All Waste at Onsite Repository	Moderate (2,000)	Moderate (16,000)	Low (<1)	Moderate (26/48)
Alternative 3: Disposal of All Mine Waste Off Site at Red Rock Disposal Facility	High (20,000)	High (116,000)	Moderate (200)	High (33/48)
Alternative 4: Disposal of All Mine Waste Off Site at a RCRA C or LLRW Facility	Very High (660,000)	Very High (3.80 million)	Very High (7,000)	Very High (43/48)

Notes:

^a The lower the greenness score, the less impact the alternative has on the environment. See [Appendix D, Table D-1](#).

CO₂e Carbon dioxide equivalent

LLRW Low-level radioactive waste

RCRA Resource Conservation and Recovery Act

Alternative 2 is rated **Good** because of the least amount of water used, least amount of species disturbance because of the shortest project durations, shorter haul distances that require less energy, and smaller greenhouse gas footprint than offsite hauling under Alternatives 3 and 4. However, Alternative 2 could limit future land uses because of the need to protect repository caps. Alternatives 3 and 4 are rated **Poor** and **Very Poor** because of the increased water use for dust control and species disturbance over moderate to very long project durations and moderate and to very large energy requirements and greenhouse gases produced by the truckloads of waste hauled off site to local and regional disposal facilities. Alternative 1 is rated **Very Good** as no removal action would be performed.

Time until Removal Action Objectives Are Achieved

A summary of the construction completion time for each alternative is presented in [Exhibit 19](#). All action alternatives could be completed between 1 to 9 months. Alternatives 3 to 4 is limited by the number of trucks and the turnaround time for the haul trucks.

Exhibit 19. Construction Completion Time for Alternatives

Alternative	Construction Completion Time
Alternative 1: No Action	0 month
Alternative 2: Consolidate and Cap All Waste at Onsite Repository	1 to 2 months
Alternative 3: Disposal of All Mine Waste Off Site at Red Rock Disposal Facility	4 to 5 months
Alternative 4: Disposal of All Mine Waste Off Site at a RCRA C or LLRW Facility	8 to 9 months

Notes:

LLRW Low-level radioactive waste

RCRA Resource Conservation and Recovery Act



5.2.1.4 Long-Term Effectiveness and Permanence (after Removal Action)

For all action alternatives, waste removal or containment from source areas would reduce the magnitude of residual risk to background levels for radionuclides. Noncancer hazards would be removed, and risk to ecological receptors would be reduced to levels below known effects concentrations and background levels. None of the alternatives reduce the toxicity, mobility, or volume through treatment.

Alternatives 3 and 4 are rated **Very Good** as sources of risk at the site would be removed and disposed of off the Navajo Nation. The cap and liner at the disposal facility would limit exposure pathways. Alternatives 3 and 4 would also allow for unrestricted future use of the site. Removing waste from the Navajo Nation eliminates the long-term surveillance requirements and long-term environmental footprints associated with the repositories under Alternative 2. Alternatives 3 and 4 would not require long-term site inspections or repairs but have increased possibility of traffic accidents in comparison to Alternative 2.

Alternatives 2 would consolidate all waste in a repository. Permanence of risk reduction would rely on the repository design standards to minimize long-term maintenance, but long-term surveillance of the repositories would still be required. Alternative 2 is rated **Good** and because the repository with the waste contained above ground will reduce potential infiltration from the sides.

Although the Alternative 2 repository is expected to be fully protective in both the short and long term, the ET cap will require a long-term maintenance and monitoring commitment. Replacement of repository components would not be required because their lifespan is indefinite, especially under a monitoring and maintenance regime. Over the long term, additional accidents and fatalities could also result from site inspections and repairs during long-term maintenance of the onsite repository cap. Alternative 2 would have an additional small energy and greenhouse gas footprint associated with annual maintenance inspections and maintenance over the 100-year maintenance duration.

Alternative 1 is rated **Very Poor** because no removal action would be performed. Human health risk may be partially reduced through increased awareness of risks, but no reduction in risk to the ecosystem would occur. Uncontrolled and untreated waste would remain and continue to be accessible by humans and animals and subject to potential migration to uncontaminated or less contaminated areas.

5.2.2 Implementability

Implementability comprises two criteria: (1) technical feasibility and availability of services and materials, and (2) administrative feasibility.

5.2.2.1 Technical Feasibility and Availability of Services and Materials

Action alternatives consist mainly of earthwork and material hauling. The alternatives are technically feasible with labor available through the local and regional markets and equipment and materials.



The action alternatives would be completed as a single phase, and no future remedial actions are anticipated. Short-term monitoring of site restoration features will occur under all action alternatives while long-term monitoring and maintenance, particularly the inspection and repair of erosional features and controls and revegetation, would be required for the repository. Experienced contractors, construction equipment, and materials are available within the region.

Alternatives 3 and 4 are both technically feasible to implement as all waste is removed from the Section 32 and 33 Mines. Therefore, Alternatives 3 and 4 are rated **Very Good**.

Alternative 2 is technically feasible to implement as waste is consolidated in an onsite repository. Design methods, construction practices, and engineering requirements are well documented and understood. However, more resources would be required than for Alternatives 3 and 4; therefore, Alternative 2 is rated **Good**.

Alternative 1 is rated **Very Good** as it is readily implementable and no construction is involved. Alternative 1 would not impact the ability to conduct removal or remedial actions in the future. No services or materials would be needed because no removal action would be performed.

5.2.2.2 Administrative Feasibility

Administratively, Alternative 4 is rated **Good** as the least amount of design, permitting, and approvals from and coordination with agencies is required because no on-Navajo Nation disposal would be involved. Post-remedy inspections, reviews, and land use controls would be limited in comparison with alternatives that involve constructed repositories. However, limitations and delays on waste acceptance at off-Navajo Nation facilities are possible because of the volume of waste or disposal facility permit limitations.

Alternative 3 is rated **Average** because of additional permitting requirement for the Red Rock disposal facility.

Alternative 2 is rated **Very Good** as less design, permitting, and approvals from and coordination with agencies is required for onsite repository cap construction in comparison to Alternatives 3 and 4.

Alternative 1 is rated **Very Good** as taking no action is feasible.

5.2.2.3 Tribal, Supporting Agency Acceptance, and Community Acceptance

USEPA and NNEPA believe that Alternative 3 (dispose of all mine waste off site at Red Rock disposal facility) has the highest likelihood of acceptance by the Navajo Nation, State of New Mexico, and Casamero Lake community. Community acceptance may be reduced by a 3- to 5-year delay for permitting, design, and facility construction and a 4- to 5-month waste hauling period with increased community disruption, noise, and haul truck traffic volume on local highways.

USEPA and NNEPA believe that Alternative 2 (consolidate and cap all waste in onsite repository) may not receive acceptance from the Navajo Nation and the local communities because it does not require removal of all wastes from the communities. Alternative 2 is more



easily implementable (1 to 2 years of design and 1 to 2 months of hauling) and will have significantly lower community disruption, noise, and truck traffic impacts because of limited hauling of waste through the community than Alternative 3.

USEPA and NNEPA believe that Alternative 4 (dispose of all mine waste off site at a RCRA C or LLRW facility) might be acceptable to the Navajo Nation and the community because all waste would be removed from the community and approximately double the construction period and the associated community disruption, noise, and haul truck traffic because of the 3-day turnaround time and long roundtrip distance (up to 612 miles) to the RCRA C or LLRW disposal facility. Navajo Nation, State of New Mexico, and community acceptance will be further addressed through the public comment process.

Alternatives 2 and 3 would provide potential job opportunities during construction and short-term monitoring and maintenance. Alternative 2 would provide additional opportunities during the required long-term inspection and maintenance of the ET cap. Alternatives 3 and 4 would provide additional job opportunities for truck drivers hauling waste to the offsite disposal facilities. No long-term maintenance would occur under Alternatives 3 and 4.

Community input received during informal community meetings and workshops have identified concerns related to moving radioactive materials through the community, traffic, and safety of leaving the waste on site or placing the waste in the Red Rock disposal facility. The following potential mitigations could address community concerns:

- Dust will be controlled using water during loading and on haul roads. Air monitoring will evaluate dust leaving the site to identify changes required, including applying more water or stopping work on a windy day.
- Before leaving the site, each truck will be inspected to ensure loads are covered and loose material has been cleaned and removed to avoid tracking material off site. Each truck will be scanned for radioactivity to safely pass through communities.
- Strict limits will be set for truck load volume and weight leaving the site to reduce damage to road surfaces.
- Protection will be achieved through a combination of time and distance. For example, the exposure from a truck passing by on a road or highway is lower as exposure time decreases with the truck's speed. Distance also minimizes exposure, where low levels of gamma activity from waste rock decrease rapidly when measuring from even several feet away.
- A traffic control plan will be prepared to control haul routes, haul times, and days and to identify and avoid locations of schools or other sensitive populations.
- An accident contingency plan will be prepared to plan for responding to a haul truck accident. Typically, an accidental spill of waste rock presents a smaller danger compared to an accident involving gasoline, propane, or other chemical. A waste rock spill can be quickly contained and cleaned up with a front-end loader and a gamma detector.
- Waste material will be transferred from trucks only at a controlled area at the Red Rock disposal facility designed for material handling and with dust control and spill response materials. Waste rock will not be mixed with other municipal waste. Dust will be



controlled using water. Air monitoring will evaluate dust leaving the site to identify any changes required, including applying more water or stopping work on a windy day.

- Long-term risk to the community around the Red Rock disposal facility is low because the disposal cell is isolated from the community, waste rock will be covered daily during operation, wastes will be closed with an engineered cap, and monitoring wells in shallow groundwater will detect any potential releases.

This EE/CA will be available to the public for a 30-day public comment period to give community members an opportunity to review and comment on the documents, especially the recommended alternative proposed in the EE/CA. During the public comment period, a public open house will be scheduled to present information contained in the EE/CA and to solicit questions and comments from the community. USEPA will coordinate scheduling and provide formal announcement of the public comment period and open house. This process offers the community and other stakeholders the opportunity to provide input and comment for the USEPA to take into consideration when making decisions about the site cleanup.

5.2.3 Projected Costs

[Exhibit 20](#) presents a summary of the cost for each alternative. Alternative costs are assigned a rating by comparing each alternative to the others based on 2022 price evaluations.

Present values, including maintenance costs were calculated for each alternative using a baseline 10-year project duration for site restoration and 100-year cap project duration for onsite and regional repositories (required under UMTRCA 40 CFR § 192[d] Part A) (Alternatives 2 and 3, respectively) at a 3.5 percent discount rate (30-year rolling average) (Office of Management and Budget 2020).

Exhibit 20. Alternative Costs and Ratings

Alternative	Capital Cost	Onsite Maintenance (Present Value at 3.5% Discount Rate)	Cost Rating	Total Estimated Cost (2022 Million Dollars)
1	\$0	\$0	\$0	Very Good
2	\$1.7 MM	\$735,000 (100 years)	Very Good	\$2.5 MM
3	\$9.7 MM	\$179,000 (30 years)	Average	\$9.8 MM
4	\$37.3 MM	\$179,000 (30 years)	Very Poor	\$37.5 MM

Notes:

Higher cost alternatives rate lower in cost ratings, which is consistent with the rating scheme where high = less desirable.

Alternative 1 is the least expensive because no construction and maintenance costs are incurred and is rated **Very Good**. Alternative 2 costs are based on the overall costs for construction and 100-year maintenance of the onsite repository. Alternative 3 has a greater cost because of a hauling waste off site a distance at 15.4 miles and facility fees. Alternative 4 has the highest cost of \$37.5 million because of the longest hauling distance at 567 miles. Overall, Alternative 2 is rated **Very Good**, Alternative 3 is rated **Average**, and Alternative 4 is rated **Very Poor**.



6.0 RECOMMENDED ALTERNATIVE

As required by NCP and described in USEPA (1993a) guidance, alternatives were evaluated individually against the following three broad criteria: effectiveness, implementability, and cost (see [Section 4.3](#)). [Section 5.0](#) includes a comparative analysis evaluating the strengths and weaknesses of each alternative relative to the other alternatives with respect to the three criteria and in achieving RAOs.

For the Section 32 and 33 Mines, USEPA recommends Alternative 3 (dispose of all mine wastes at Red Rock disposal facility). The primary elements of the recommended alternative are:

- Excavation of uranium mine waste from the Section 32 and 33 Mines to the cleanup goals
- Completion of permitting, design, and construction of the Red Rock disposal facility, which is expected to take 3 to 5 years
- Transportation of the waste in covered trucks to the Red Rock disposal facility over 4 to 5 months for disposal in a separate facility and disposal cell from the municipal landfill
- Site restoration by regrading, implementing erosion and stormwater controls, and amending and revegetating the area
- Preparation of a short-term monitoring and maintenance plan after the remedy is identified in the action memorandum
- Short-term monitoring and maintenance of the site restoration areas for 30 years
- Long-term monitoring and maintenance of the Red Rock disposal facility, which would be the responsibility of the Northwest New Mexico Regional Solid Waste Authority supported by financial assurance bonding

If the Red Rock disposal facility cannot be permitted or constructed because of administrative or technical issues, Alternative 2 (consolidate and cap all waste at onsite repository) would be considered. Site restoration would remain the same by regrading, implementing erosion and stormwater controls, and revegetating the area. Long-term monitoring and maintenance of an onsite cap for 100 years would be the responsibility of USEPA.

The largest capital costs for Alternative 3 are excavation, transportation, and disposal of the mine wastes at the Red Rock disposal facility. A Stennett analysis showed this alternative to be safe for disposal facility workers receiving waste under the parameters of the analysis (USACE 2022). RAOs and cleanup levels for surface soil, air, and radiation would be achieved at the completion of the remedy construction. A 10-to-30-year period of recovery would be needed to achieve site vegetative restoration, depending on precipitation patterns.

The total cost for Alternative 3 is estimated to be \$9.8 million, which is four times as much as Alternative 2 (consolidate and cap all waste at onsite repository) and about one-third the cost of Alternative 4 (dispose of all mine waste at a RCRA C or LLRW facility).

Alternative 3 is equally protective as Alternative 4 and more protective to the Casamero Lake community than Alternatives 1 and 2. Alternative 3 transports the waste 15.4 miles for disposal



compared to 567 miles in Alternative 4. The shorter distance would produce significantly lower diesel exhaust emissions from long-haul transportation and also significantly reduce community disruption from noise and potential traffic accidents and fatalities.

USEPA and NNEPA expect that Alternative 3 will be more acceptable to the Navajo Nation and the local communities than Alternatives 1 and 2 because all waste would be removed from the site, resulting in unrestricted land use once vegetation is reestablished. All alternatives would provide job opportunities to the community during construction, waste hauling, and short-term maintenance while Alternative 2 and 3 would provide long-term inspection and maintenance job opportunities at on- and offsite repositories. Training programs would be used to develop job skills to allow the local community to participate in both short- and long-term construction and maintenance opportunities. Because the EE/CA is open to public comment, the recommended alternative may change between the final EE/CA and the final alternative selected in the action memorandum.



7.0 REFERENCES

- Beyer, W.N., E.E. Connor, and S. Gerould. 1994. "Estimates of Soil Ingestion by Wildlife." *Journal of Wildlife Management*. Volume 58, Number 2. Pages 375 through 382.
- CSWTA, Inc. 2012. "A Cultural Resources Inventory Survey for Environmental Quality Management, Inc. Uranium Contaminant Clean Up Project in Casamero Lake, McKinley County, New Mexico." September 20.
- Dunning, J.B. 1993. *CRC Handbook of Avian Body Masses*. CRC Press. Boca Raton, Florida.
- Ecology and Environment, Inc. (E&E). 2012. "Removal Assessment Report, Tronox AUM Sections 32 and 33 Eastern Agency, Prewitt, McKinley County, New Mexico. September.
- E&E. 2014. "Removal Action Report, Tronox AUM Sections 32, Eastern Agency, Prewitt, McKinley County, New Mexico. February.
- Gordian. 2023. RSMMeans Data. Version 2022.
- Johnson, R.A., S. Verrill, and D.H. Moore II. 1987. "Two-Sample Rank Tests for Detecting Changes that Occur in a Small Proportion of the Treated Population." *Biometrics*. Volume 43. Pages 641-655.
- Los Alamos National Laboratory (LANL). 2015. "Screening-Level Ecological Risk Assessment Methods, Revision 4 (EP2015-0174)." October 29.
- McLemore, V.T. and Chenoweth, W.L. 1991. "Uranium Mines and Deposits in the Grants District, Cibola and McKinley Counties, New Mexico." New Mexico Bureau of Mines and Mineral Resources, Open File Report 353.
- Montgomery Watson Harza. 2018. "Northeast Church Rock 95% Design Report, United Nuclear Corporation." July.
- Navajo Nation Department of Fish and Wildlife (NNDFW). 2008. "Biological Resource Land Use Clearance Policies and Procedures (RCP), RCS-44-08." <https://nndfw.org/clup.htm>.
- NNDFW. 2022. Navajo Natural Heritage Program Data Release, Reference Number 22tett104. March 29.
- Newport News Nuclear BWXT-Los Alamos, LLC (N3B). 2020. "ECORISK Database." Release 4.2. November.
- New Mexico Energy and Minerals Department. 1979. "An Overview of the New Mexico Uranium Industry." January.
- NV5, Inc. 2019a. "Natural Resources Evaluation Tronox NAUM, Sections 32 and 33, McKinley County, New Mexico." June.



- NV5, Inc. 2019b. “A Cultural Resource Survey for the Tronox NAUM, Sections 32 and 33, McKinley County, New Mexico.” September.
- Office of Management and Budget. 2022. “2022 Discount Rates for OMB Circular No. A-94.” December 21.
- Santos. 1970. “Stratigraphy of the Morrison Formation and Structure of the Ambrosia Lake District, New Mexico.” Contributions to Economic Geology: Geological Survey Bulletin 1272-E.
- Shacklette, H.T., and J.G. Boerngen. 1984. “Element Concentration in Soils and Other Surficial Materials of the Conterminous United States.” U.S. Geological Survey Professional Paper, Volume 1270. Government Printing Office.
- TerraSpectra Geomatics. 2007. “Abandoned Uranium Mines and the Navajo Nation, Navajo Nation AUM Screening Assessment Report and Atlas with Geospatial Data.” August.
- Tetra Tech, Inc. (Tetra Tech). 2021. “Application of Evapotranspiration Cover in the Southwest.” February.
- Tetra Tech. 2022a. “Section 32 and 33 Mines Field Report, June Reconnaissance Visit.” Response, Assessment, and Evaluation Services. Contract No. EP-S9-17-03. Task Order 0031. July.
- Tetra Tech. 2022b. “Wildlife Habitat Assessments at the Section 32 and 33 Mines Technical Memorandum.” Response, Assessment, and Evaluation Services. Contract No. EP-S9-17-03. November 21.
- Tetra Tech. 2023. “Section 32 and 33 Mines Eastern Abandoned Uranium Mine Region Data Gap Investigation Report.” Response, Assessment, and Evaluation Services 2. Contract No. 68HE0923D0002. Task Order 0003. August.
- Tetra Tech. Forthcoming(a). “Navajo Area Uranium Mines Risk Assessment Conceptual Site Model and Methodology.” Response, Assessment, and Evaluation Services. Contract No. EP-S9-17-02.
- Tetra Tech. Forthcoming(b). “Navajo Nation Area Uranium Mines Technology Evaluation and Alternative Development Technical Memorandum.” Response, Assessment, and Evaluation Services. Contract No. EP-S9-17-02.
- Tetra Tech. Forthcoming(c). “Navajo Nation Area Uranium Mines Surficial Restoration Approaches Technical Memorandum.” Response, Assessment, Evaluation Services. Contract No. EP-S9-17-02.
- U.S. Army Corps of Engineers (USACE). 2022. “Technical Memorandum; Disposal of Uranium Mine Spoils Stennett Evaluation.” Draft. December.

- U.S. Environmental Protection Agency (USEPA). 1989a. *Risk Assessment Guidance for Superfund. Volume I, Human Health Evaluation Manual (Part A)*. Interim Final. EPA/540/1-89/002. Office of Emergency and Remedial Response. December. https://www.epa.gov/sites/production/files/2015-09/documents/rags_a.pdf.
- USEPA. 1989b. "Guidance on Indian Involvement in the Superfund Program." Revised Interim Final. Office of Solid Waste and Emergency Response Directive 9375.5-02A. November.
- USEPA. 1991. "A Guide to Principal Threat and Low Level Threat Waste." Office of Solid Waste and Emergency Response. Directive 9380.3-06FS. November.
- USEPA. 1992. "Framework for Ecological Risk Assessment." Risk Assessment Forum. EPA/630/R- 92/001. February.
- USEPA. 1993a. "Guidance on Conducting Non-Time Critical Removal Actions under CERCLA." Office of Solid Waste and Emergency Response. EPA540-R-93-057. August. <https://semspub.epa.gov/work/HQ/122068.pdf>.
- USEPA. 1993b. External Exposure to Radionuclides in Air, Water, and Soil. Federal Guidance Report No. 12. Office of Radiation and Indoor Air, Washington, DC. EPA 402-R-93-081. <https://www.epa.gov/radiation/federal-guidance-radiation-protection>.
- USEPA. 1994. "Statistical Methods for Evaluating the Attainment of Cleanup Standards, Volume 3: Reference-Based Standards for Soils and Solid Media." USEPA 230-R-94-004. Office of Policy, Planning and Evaluation. June.
- USEPA. 1997. "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments." Environmental Response Team, Office of Solid Waste and Emergency Response. Directive 9285.7-25. EPA-540-R-97-006. June.
- USEPA. 1998. "Guidelines for Ecological Assessment." Risk Assessment Forum. EPA/630/R-5/002FA. April.
- USEPA. 2000a. "Amended Guidance on Ecological Risk Assessment at Military Bases: Process Considerations, Timing of Activities, and Inclusion of Stakeholders." Memorandum, Region 4. June.
- USEPA. 2000b. "A Guide to Developing and Documenting Cost Estimates during the Feasibility Study." EPA 540-R-00-002. July.
- USEPA. 2001. "The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments." Office of Solid Waste and Emergency Response. Directive No. 9345.0-14. EPA/540/F-01/014. June.
- USEPA. 2002. "Calculating Exposure Point Concentrations at Hazardous Waste Sites." OSWER Directive 9285.6-10. December.



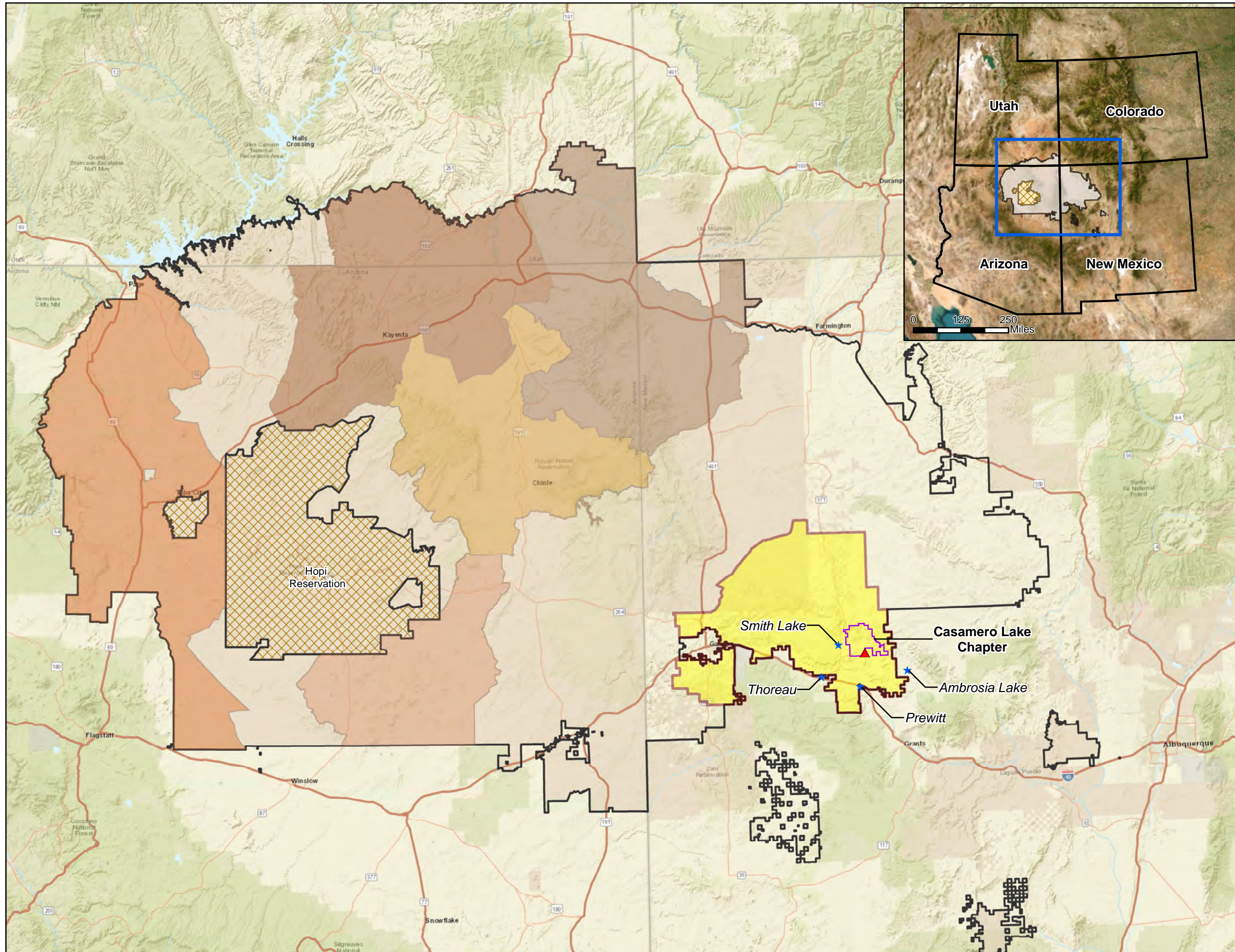
- USEPA. 2005. “Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.” Office of Solid Waste, Washington, DC.
<https://archive.epa.gov/epawaste/hazard/tsd/td/web/html/risk.html>.
- USEPA. 2010. “ProUCL Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations, Version 4.1.01. May.
- USEPA. 2011. “Action Memorandum: Request for a Non-Time-Critical Removal Action at the Northeast Church Rock Mine Site, McKinley County, New Mexico, Pinedale Chapter of the Navajo Nation.” September 29.
- USEPA. 2016. “Memorandum Regarding Consideration of Greener Cleanups Activities in the Superfund Cleanup Process. From James E. Woolford, Director, Office of Superfund Remediation and Technology, Office of Land and Emergency Management; Charlotte Bertrand, Director, Federal Facilities Restoration and Reuse Office, Office of Land and Emergency Management; Cyndy L. Mackey, Director, Office of Site Restoration Enforcement, Office of Enforcement and Compliance Assurance; and Richard Albores, Acting Director, Federal Facilities Enforcement Office, Office of Enforcement and Compliance Assurance. To Regional Superfund National Program Managers, Regions 1-10, and Regional Counsels, Regions 1-10. August 2.
<https://semspub.epa.gov/work/HQ/100000160.pdf>.
- USEPA. 2020. *Multi-Agency Radiation Survey and Site Investigation Manual*. Revision 1. EPA 402-R-91-016, Rev.1. August.
- USEPA. 2022a. “Preliminary Remediation Goals for Radionuclide Contaminants at Superfund Sites (PRG) User’s Guide.” Accessed June. https://epa-prgs.ornl.gov/radionuclides/users_guide.html.
- USEPA. 2022b. “Regional Screening Levels (RSLs) – User’s Guide.” May.
<https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide>.
- USEPA. 2022c. “EPA EcoBox (A Toolbox for Ecological Risk Assessors).” Accessed May.
<https://www.epa.gov/ecobox>.
- USEPA. 2022d. “ProUCL Version 5.2.0 Technical Guide.” Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. June 14.
- USEPA. 2023. “Navajo Abandoned Uranium Mine Risk Calculator.” Version 1.02. August.
- U.S. Fish and Wildlife Service (USFWS). 2022. “List of Threatened and Endangered Species That May Occur in Your Proposed Action Location or May Be Affected by Your Proposed Action.” Project Code: 2022-0024895. New Mexico Ecological Services Field Office, Albuquerque, New Mexico. March 28.
- Western Regional Climate Summaries. 2018. Period of Record Monthly Climate Summary 10/1/1929 to 11/30/1992. <https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?nm8830>



Weston Solutions, Inc. (Weston). 2009. “Navajo Abandoned Uranium Mine Site Screen Report – Section 32 AUM Site.” Prepared for USEPA under Contract No. W91238-06-F-0083. May.

Weston. 2019. “Removal Site Evaluation Report for Tronox Navajo Area Uranium Mines Sections 32 and 33 Mines, McKinley County, New Mexico. Prepared for USEPA.” September.

FIGURES



- ★ Populated Place
 - ▲ Section 32 / 33 Site Location
 - Affected Chapter Boundary
 - ▭ Navajo Nation Boundary
 - ▨ Hopi Reservation
- Navajo Nation Abandoned Uranium Mine Regions**
- Eastern Region
 - Central Region
 - Northern Region
 - North Central Region
 - Southern Region
 - Western Region

1 inch = 25 miles
 1:1,584,000

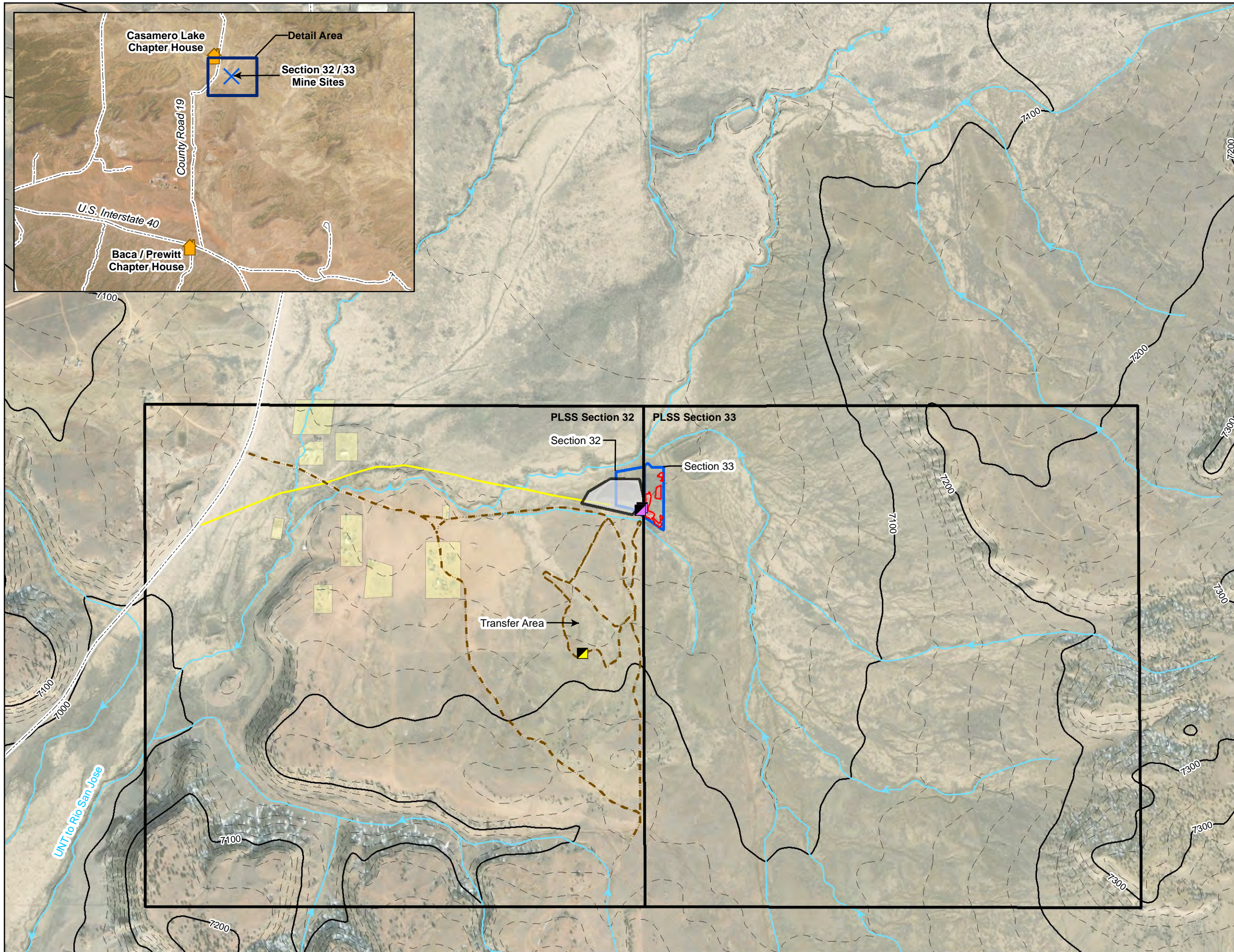
REGIONAL LOCATION

Prepared For: U.S. EPA Region 9

Prepared By:

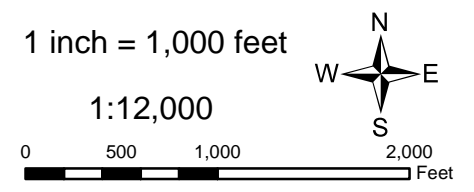
TETRA TECH
 1999 Harrison Street, Suite 500
 Oakland, CA 94612

Task Order No.: 0031	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 5/25/2023
Coordinate System: NAD 1983 UTM Zone 12N Transverse Mercator	Figure No.: 1



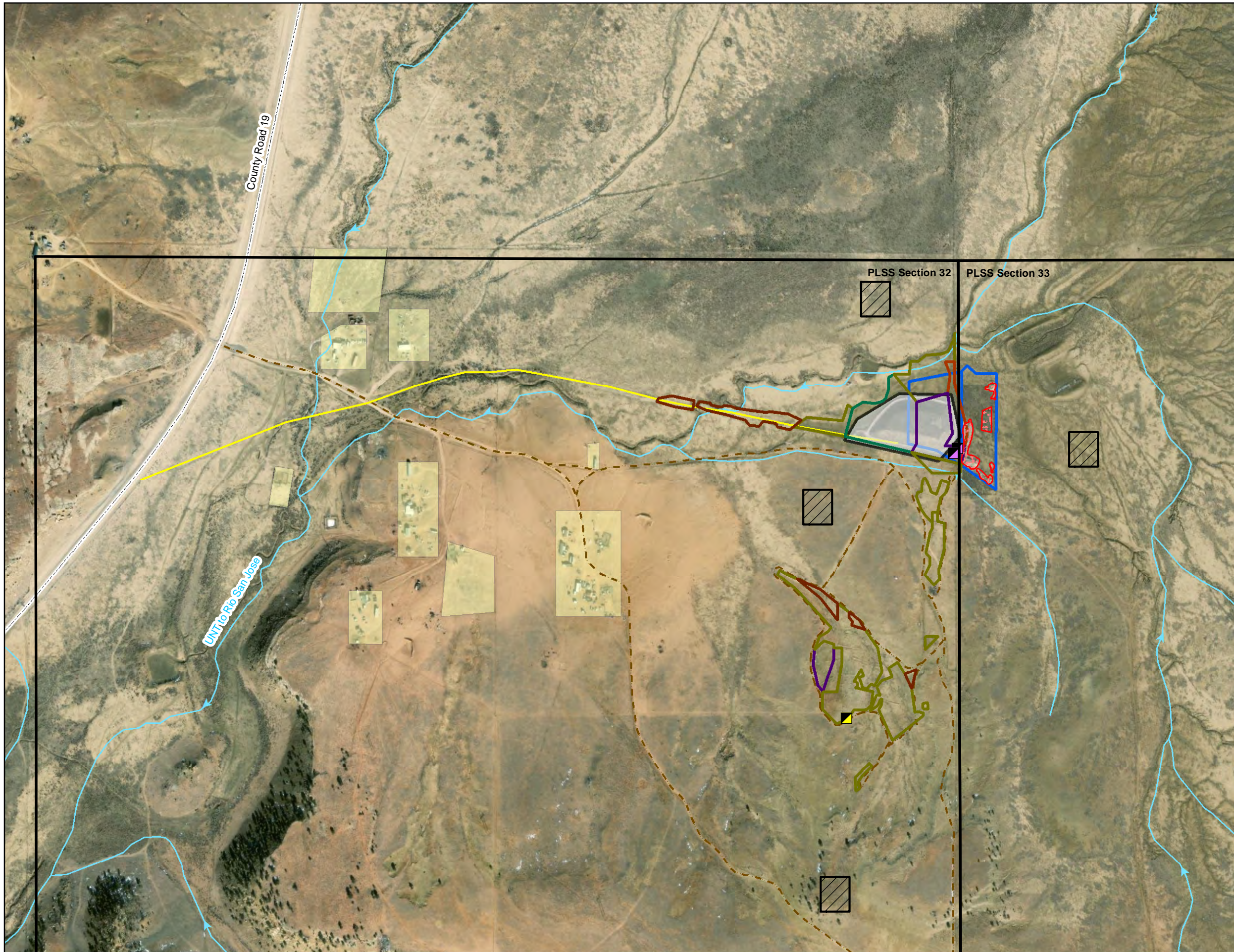
- 100-Foot Contour
- - - 20-Foot Contour
- Drainage
- ▭ Tronox AUM Site¹
- ▭ PLSS Section Boundary / RSE Survey Area
- Site Features**
- ▣ Closed Mine Shaft
- ▴ Closed Mine Vent
- Historic Haul Road
- ▭ Residential Feature
- ▭ Waste Stockpile Footprint
- ▭ Waste Pile
- - - County Road
- - - Local Road

Notes:
¹ Boudary is from TSG (2007).
 AUM Abandoned uranium mine
 PLSS Public Land Survey System
 RSE Removal site evaluation
 TSG TerraSpectra Geomatics
 UNT Unnamed tributary



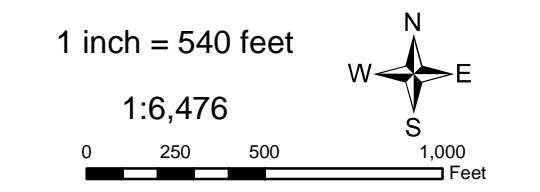
SECTION 32 AND 33 MINES ACCESS

Prepared For: U.S. EPA Region 9 	Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0031	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 6/7/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: 2



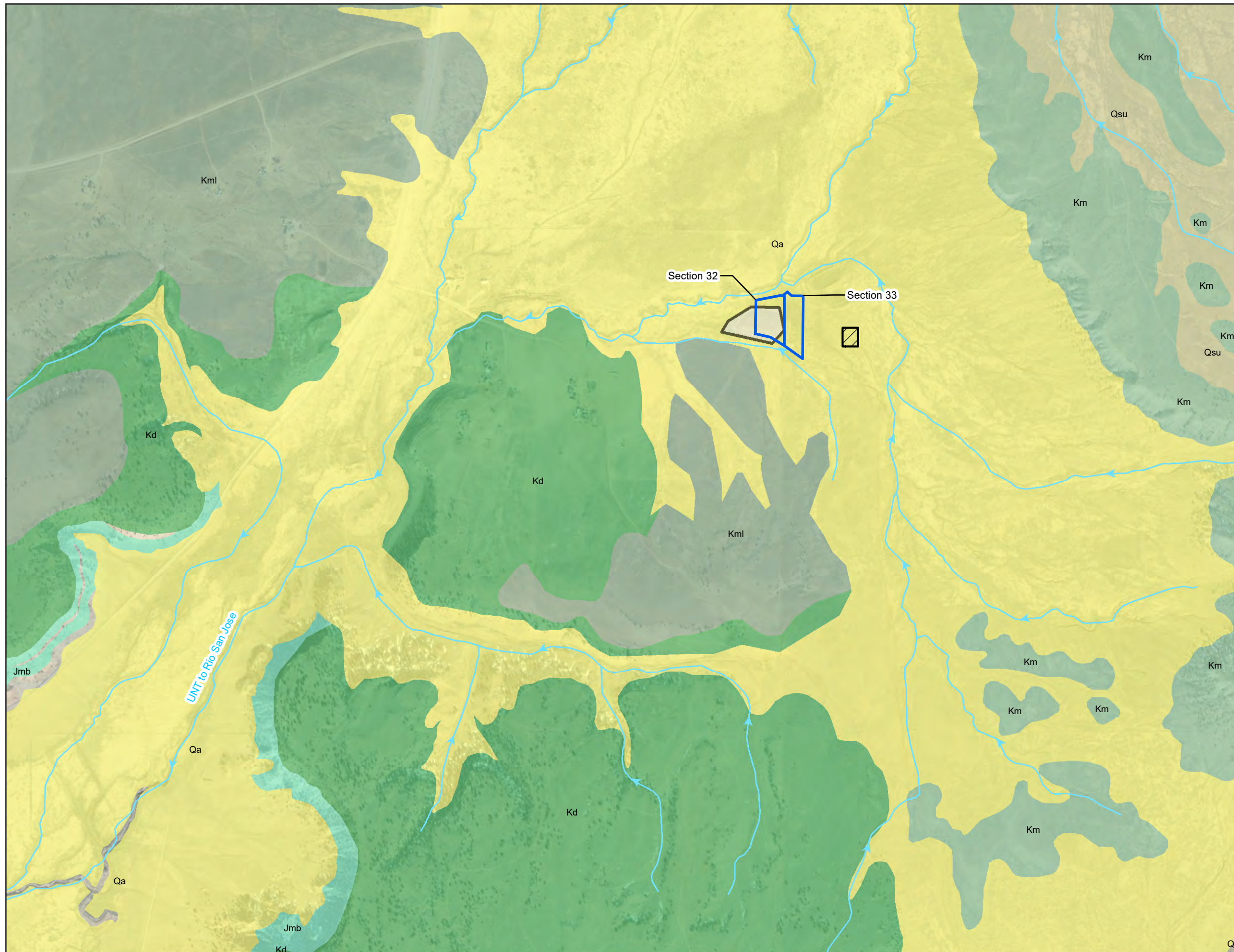
- Site Features**
- Closed Mine Shaft
 - Closed Mine Vent
 - Historic Haul Road
 - Residential Feature
 - Waste Stockpile Footprint
 - Waste Pile
- 2012 Removal Action Areas**
Excavation Depth (ft)
- 0.5 ft bgs
 - 1 ft bgs
 - 2 ft bgs
 - 3 ft bgs
 - 4 ft bgs
 - Tronox AUM Site¹
 - Background Study Area
 - PLSS Section Boundary / RSE Survey Area
 - County Road
 - Local Road
 - Drainage

Notes:
¹ Boudary is from TSG (2007).
 AUM Abandoned uranium mine
 bgs Below ground surface
 ft Foot
 PLSS Public Land Survey System
 RSE Removal site evaluation
 TSG TerraSpectra Geomatics
 UNT Unnamed tributary



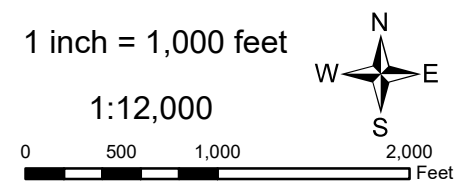
SECTION 32 AND 33 MINES
SITE FEATURES

Prepared For: U.S. EPA Region 9 	Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0031	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 6/7/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: 3



- Geologic Units**
- Surficial Deposits*
- Qa—Quaternary Alluvium
 - Qsu—Upland Deposits
- Cretaceous*
- Km—Main body of Mancos Shale
 - Kml—Lower part of Mancos Shale
 - Kd—Dakota Sandstone
- Jurassic*
- Jmb—Brushy Basin Member of Morrison Formation
- Tronox AUM Site¹
 - Waste Stockpile Footprint
 - Background Study Area
 - Drainage

Notes:
¹ Boudary is from TSG (2007).
 AUM Abandoned uranium mine
 TSG TerraSpectra Geomatics
 UNT Unnamed tributary



SECTION 32 AND 33 MINES
 GEOLOGY



Task Order No.: 0031

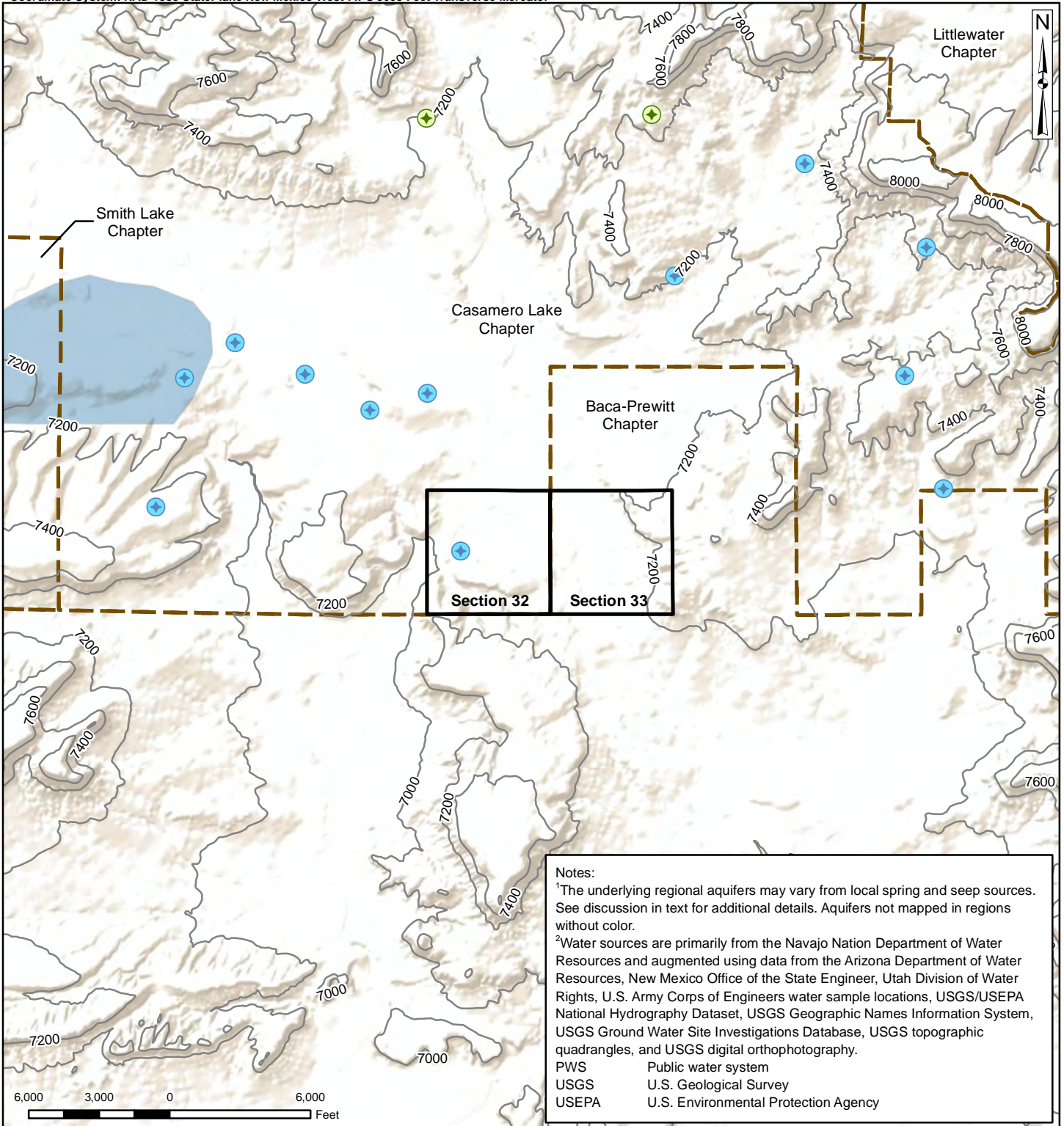
Contract No.: EP-S9-17-03

Location: NAVAJO NATION

Date: 6/7/2023

Coordinate System:
 NAD 1983 State Plane New Mexico
 West FIPS 3003 Feet Transverse

Figure No.: 4



Notes:
¹The underlying regional aquifers may vary from local spring and seep sources. See discussion in text for additional details. Aquifers not mapped in regions without color.
²Water sources are primarily from the Navajo Nation Department of Water Resources and augmented using data from the Arizona Department of Water Resources, New Mexico Office of the State Engineer, Utah Division of Water Rights, U.S. Army Corps of Engineers water sample locations, USGS/USEPA National Hydrography Dataset, USGS Geographic Names Information System, USGS Ground Water Site Investigations Database, USGS topographic quadrangles, and USGS digital orthophotography.
 PWS Public water system
 USGS U.S. Geological Survey
 USEPA U.S. Environmental Protection Agency

	D Aquifer ¹
	PWS Well Location ²
	Non-PWS Well Location ²
	PLSS Section Boundary / RSE Survey Area
	Navajo Nation Chapter Boundary
	200 ft Contour Surface

Prepared for: U.S. EPA Region 9



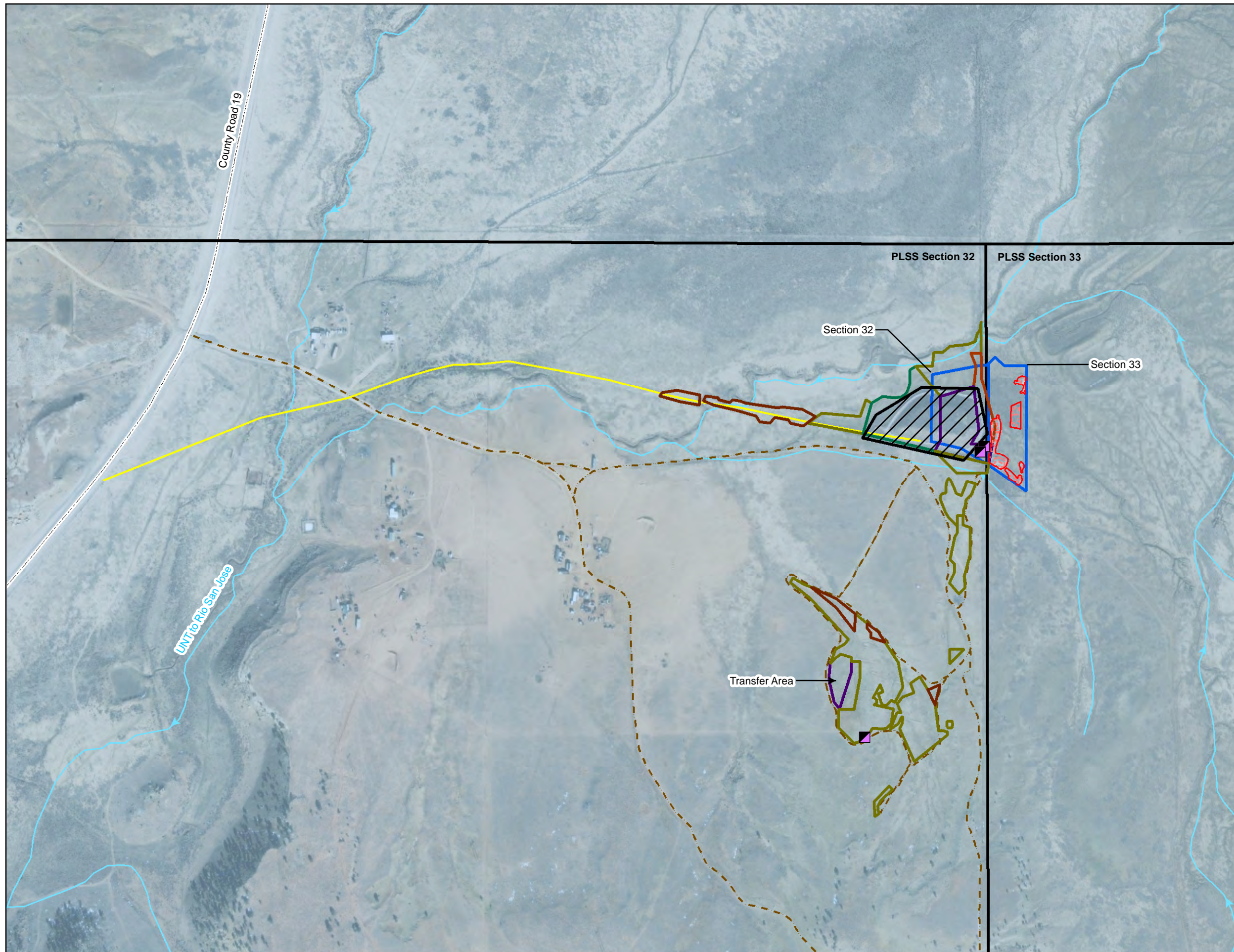
Prepared By:



TETRA TECH
 1999 Harrison Street, Suite 500
 Oakland, CA 94612

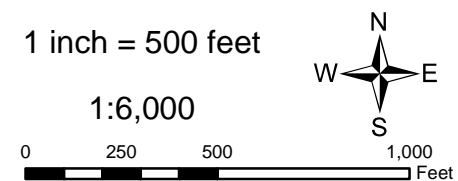
REGIONAL AQUIFERS AND WELLS

Task Order No.:	Contract No.:	Figure No.:
0031	EP-S9-17-03	
Location:	Date:	5
NAVAJO NATION	7/6/2022	



- Land Use Type - Full-Time Residential
- Tronox AUM Site¹
- PLSS Section Boundary / RSE Survey Area
- County Road
- Local Road
- Drainage
- Site Features**
- Closed Mine Shaft
- Historic Haul Road
- Waste Stockpile Footprint
- Waste Pile
- 2012 Removal Action Areas**
- Excavation Depth (ft)*
- 0.5 ft bgs
- 1 ft bgs
- 2 ft bgs
- 3 ft bgs
- 4 ft bgs

Notes:
¹ Boundary is from TSG (2007).
 AUM Abandoned uranium mine
 bgs Below ground surface
 ft Foot
 PLSS Public Land Survey System
 RSE Removal site evaluation
 TSG TerraSpectra Geomatics
 UNT Unnamed tributary



SECTION 32 AND 33 MINES
 PROPOSED FUTURE LAND USE

Prepared For: U.S. EPA Region 9

Prepared By:



Task Order No.:
0016

Contract No.:
EP-S9-17-03

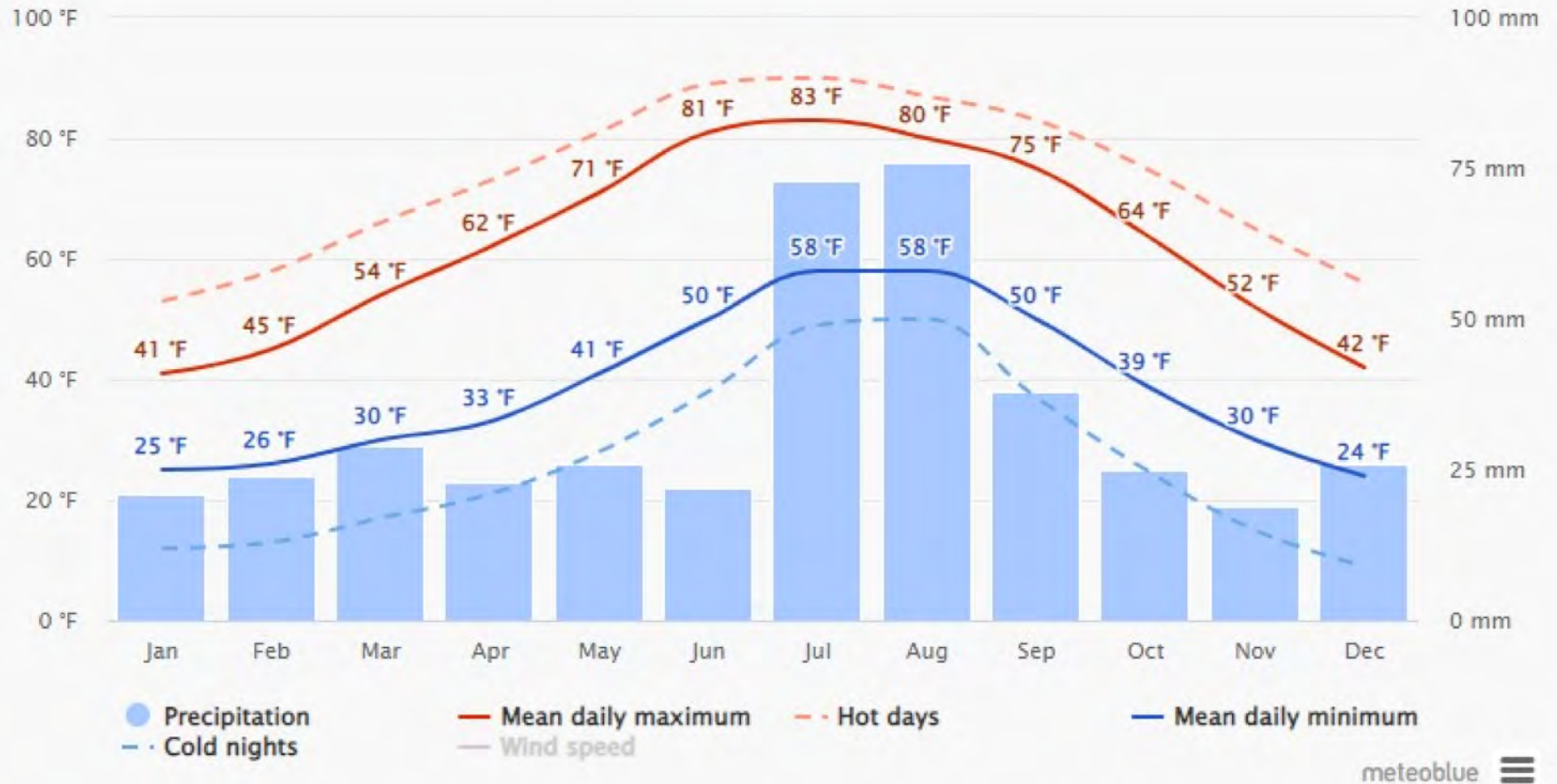
Location:
NAVAJO NATION

Date:
6/7/2023

Coordinate System:
 NAD 1983 State Plane New Mexico
 West FIPS 3003 Feet Transverse

Figure No.:
6

Average temperatures and precipitation



meteoblue

Unofficial values based on averages/sums of smoothed daily data. Information is computed from available daily data during the 1973-2016 period. Smoothing, missing data, and observation-time changes may cause these 1973-2016 values to differ from official National Climatic Data Center (NCDC) values. This table is presented for use at locations that don't have official NCDC data. No adjustments were made for missing data or time of observation.

Data taken from https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/thoreau_united-states_5494395

Prepared for: U.S. EPA Region 9



THOREAU, NEW MEXICO AVERAGE MONTHLY PRECIPITATION, SNOWFALL, AND TEMPERATURE

Prepared By:



Task Order No.:

TO0003

Contract No.:

68HE0923D0002

Location:

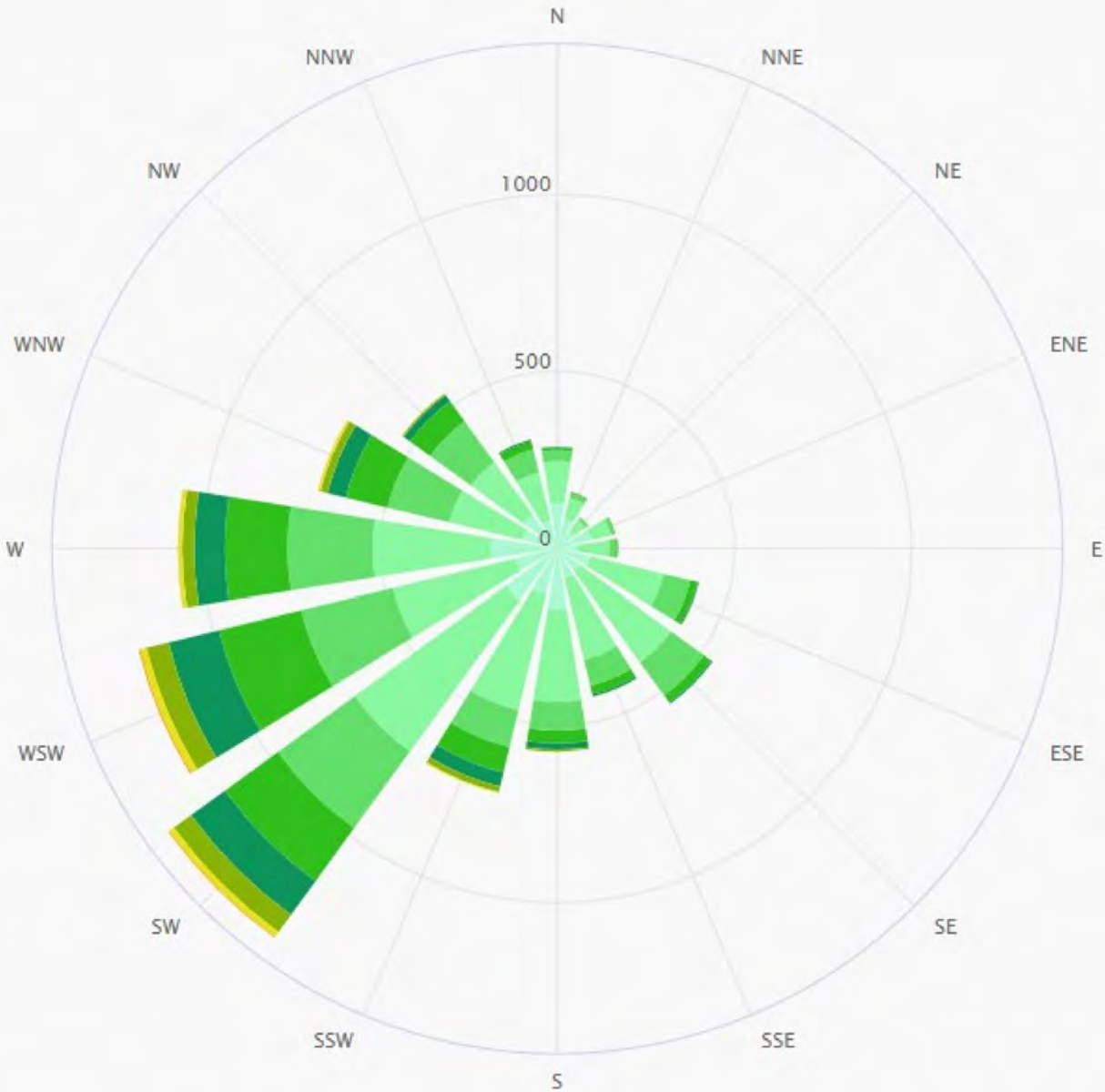
NAVAJO NATION

Date:

7/22/2020

Figure No.:

7



meteoblue

Source: https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/thoreau_united-states_5494395

Prepared for: U.S. EPA Region 9



THOREAU, NEW MEXICO WIND ROSE DIAGRAM

Prepared By:



Task Order No.:

TO0003

Contract No.:

68HE0923D0002

Figure No.:

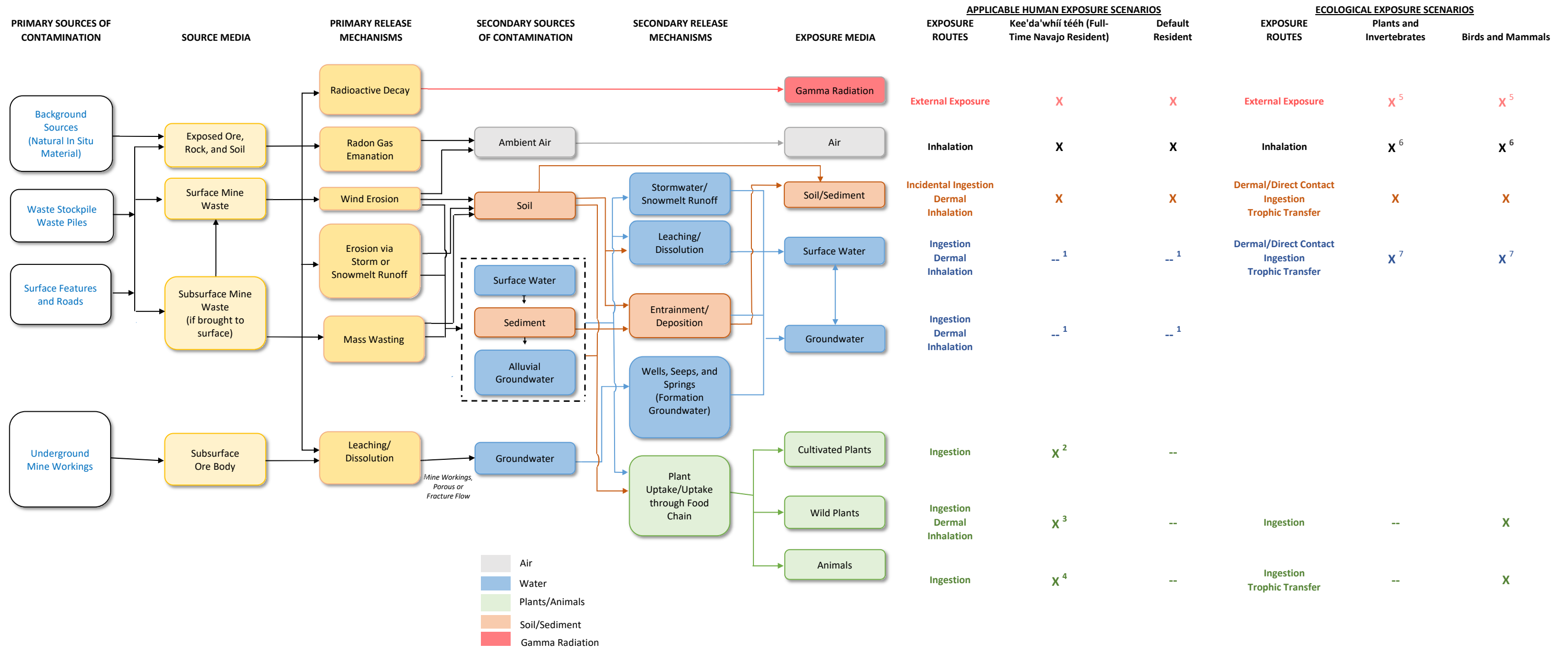
8

Location:

NAVAJO NATION

Date:

10/21/2022



Notes:

This conceptual site model wire diagram was adapted from Neptune and Company, Inc. and TerraSpectra Geomatics. 2018. "Cove Chapter Abandoned Uranium Mines Conceptual Site Model Development." Prepared for U.S. Army Corps of Engineers in Support of U.S. Environmental Protection Agency Region 9. July.

¹ The human health risk evaluation does not include ingestion of surface water or groundwater by humans or animals.

² The human health risk evaluation includes ingestion of select cultivated plants (crops) by this receptor. Scenario inputs provided by the Navajo Nation Environmental Protection Agency (2021).

³ The human health risk evaluation includes ingestion, dermal (metals only), and inhalation of select wild herbs and medicinal plants by this receptor. Scenario inputs provided by the Navajo Nation Environmental Protection Agency (2021).

⁴ The human health risk evaluation includes ingestion of home-raised animals (meat, milk, and eggs) and hunted animals (meat only) for this receptor. Scenario inputs provided by the Navajo Nation Environmental Protection Agency (2021).

⁵ The ecological risk evaluation does not include evaluation of external exposure to gamma radiation.

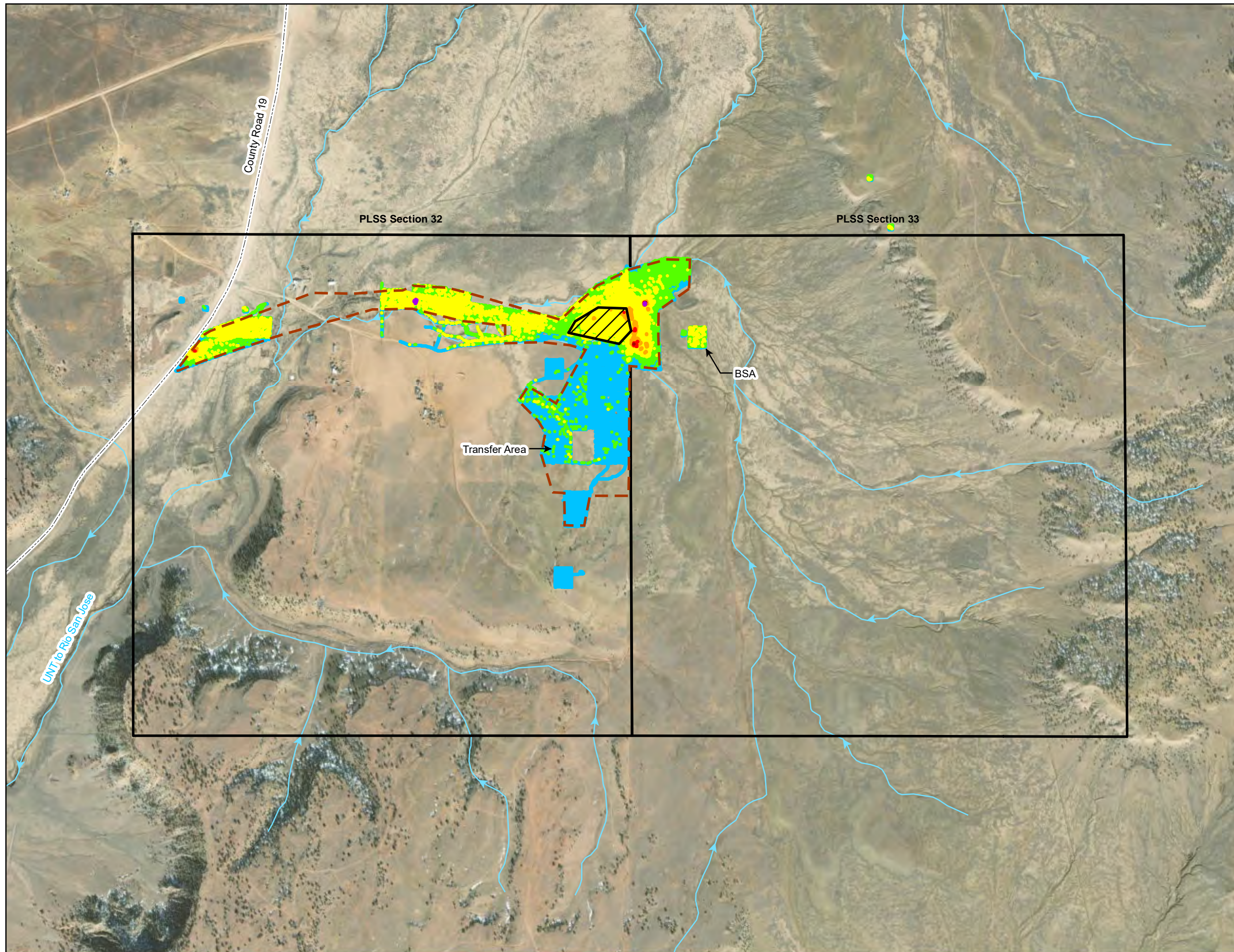
⁶ Potential exposures include inhalation of ambient air and air in burrows and underground mines. The ecological risk evaluation does not include evaluation of the inhalation pathway.

⁷ The ecological risk evaluation does not include evaluation of direct contact with or ingestion of surface water.

X Indicates the exposure pathway is potentially complete and is evaluated in the risk assessment except as noted.

-- Indicates the exposure pathway is not complete or *de minimus* and is not evaluated in the risk assessment

Figure 9. Section 32 and 33 Mines Conceptual Site Model Wire Diagram



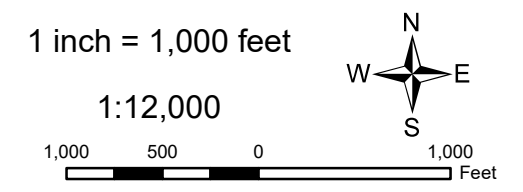
Gamma Exposure Rate ($\mu\text{R/hr}$)¹

● ≤ 17.8	$\leq \text{UCL}$
● 17.8 - 18.8	$\text{UCL} - \text{BTV}^2$
● 18.8 - 35.6	$\text{BTV} - 2 \times \text{UCL}$
● 35.6 - 53.4	$2 \times \text{UCL} - 3 \times \text{UCL}$
● 53.4 - 71.2	$3 \times \text{UCL} - 4 \times \text{UCL}$
● 71.2 - 89.0	$4 \times \text{UCL} - 5 \times \text{UCL}$
● > 89.0	$> 5 \times \text{UCL}$

TENORM Boundary
 Waste Stockpile Footprint
 PLSS Section Boundary / RSE Survey Area

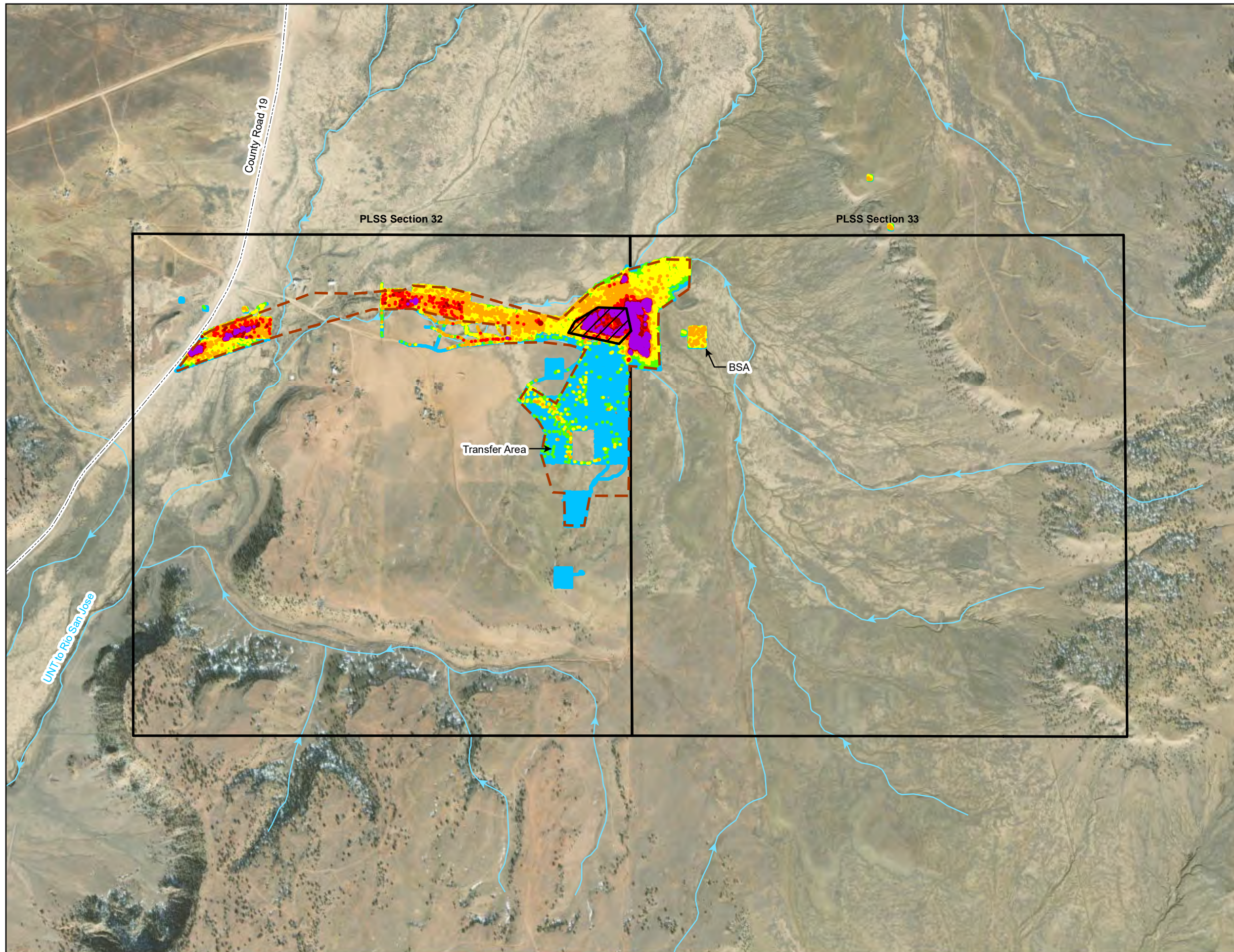
Note:
¹Gamma survey data was collected by Weston Solutions, Inc. between June 26 and August 18, 2018.
²BTV is based on the 95 percent upper tolerance limit with 95 percent coverage of the background dataset.

$\mu\text{R/hr}$ Microrentgen per hour
 BTV Background threshold value
 PLSS Public Land Survey System
 RSE Removal site evaluation
 TENORM Technologically enhanced naturally occurring radioactive material
 UCL 95 percent upper confidence limit on the mean of the background dataset
 UNT Unnamed tributary



**SECTION 32 AND 33 MINES
 GAMMA RADIATION SURVEY**

Prepared For: U.S. EPA Region 9 	Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0016	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 8/25/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: 10



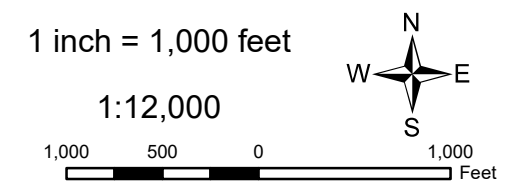
Estimated Radium-226 (pCi/g)¹

● ≤ 1.66	≤ UCL
● 1.66 - 1.92	UCL - BTV (RAG) ^{2,3}
● 1.92 - 3.32	BTV - 2 x UCL
● 3.32 - 4.98	2 x UCL - 3 x UCL
● 4.98 - 6.64	3 x UCL - 4 x UCL
● 6.64 - 8.30	4 x UCL - 5 x UCL
● > 8.30	> 5 x UCL

TENORM Boundary
 Waste Stockpile Footprint
 PLSS Section Boundary / RSE Survey Area

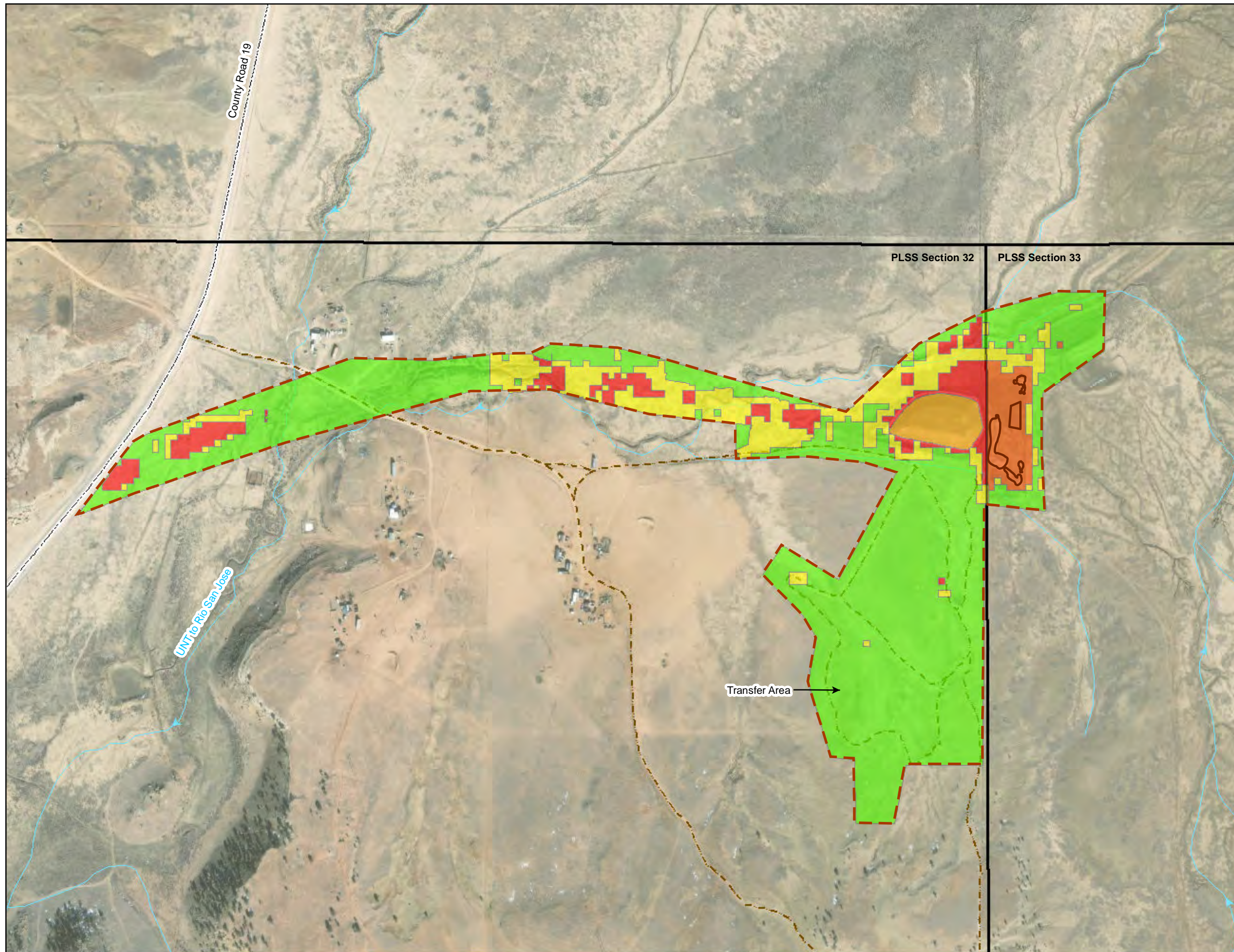
Notes:
¹Gamma survey data was collected by Weston Solutions, Inc. between June 26 and August 18, 2018.
²BTV is based on the 95 percent upper tolerance limit with 95 percent coverage of the background dataset.
³The RAG is equal to the BTV because the BTV is greater than the HH and Eco RBSLs.

BTV Background threshold value
 Eco Ecological
 HH Human health
 pCi/g Picocurie per gram
 PLSS Public land survey system
 RAG Removal action goal
 RBSL Risk-based screening level
 RSE Removal site evaluation
 TENORM Technologically enhanced naturally occurring radioactive material
 UCL 95 percent upper confidence limit on the mean of the background dataset
 UNT Unnamed tributary



SECTION 32 AND 33 MINES
 ESTIMATED RADIUM-226
 SURFACE SOIL CONCENTRATIONS

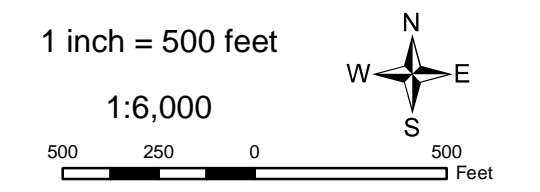
Prepared For: U.S. EPA Region 9 	Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0016	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 8/25/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: 11



- Proposed Removal Action Extent**
- Excavation - Section 32
 - Excavation - Section 33
 - Excavation - Waste Stockpile
 - Assumed 20%
 - No Cleanup
 - TENORM Boundary
 - PLSS Section Boundary / RSE Survey Area
 - Waste Stockpile
 - Waste Pile
 - County Road
 - - - Local Road
 - Drainage

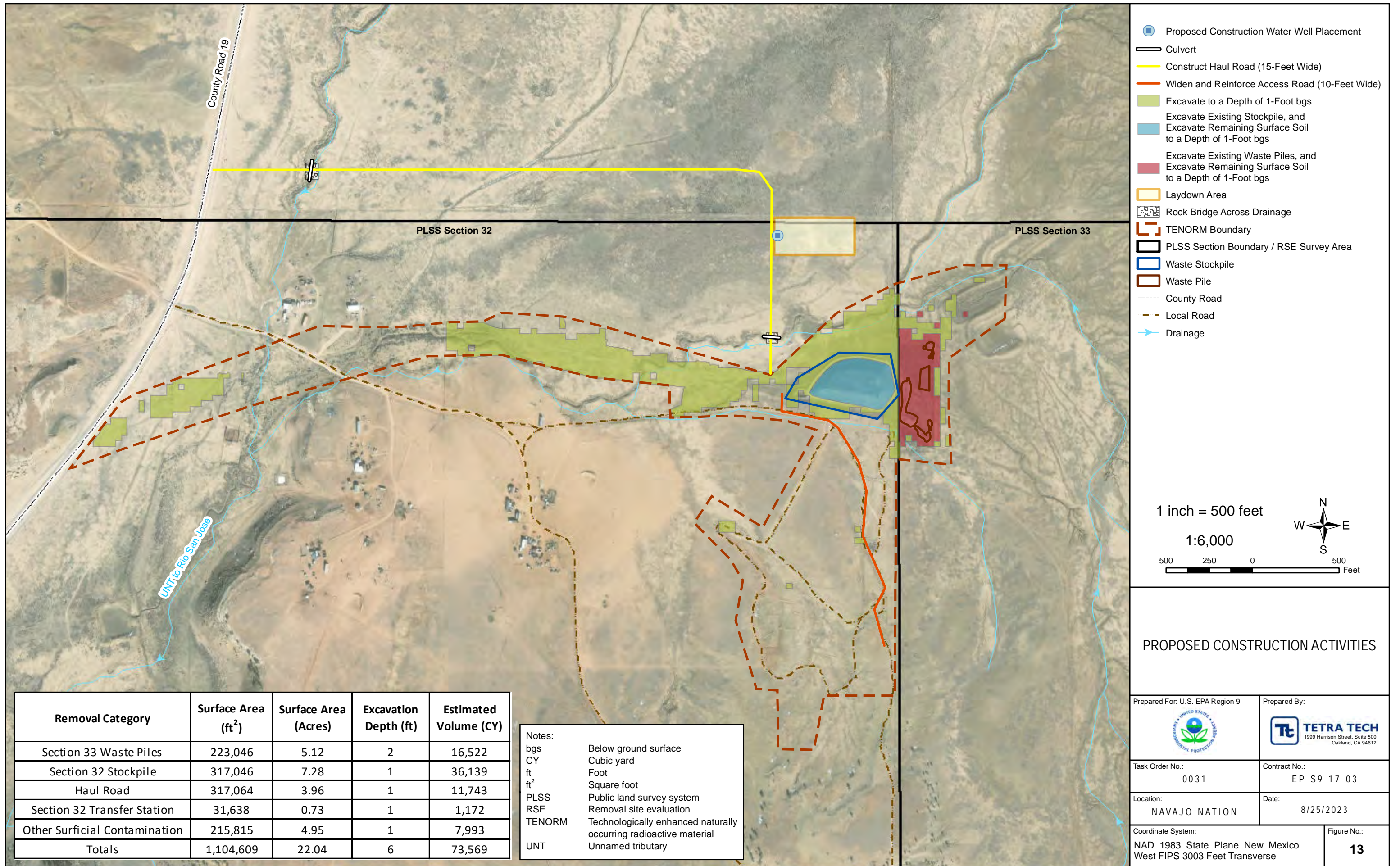
Notes:

PLSS Public land survey system
RSE Removal site evaluation
TENORM Technologically enhanced naturally occurring radioactive material
UNT Unnamed tributary

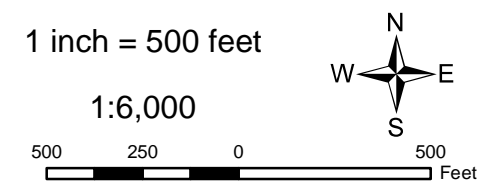


**SECTION 32 AND 33 MINES
PROPOSED REMOVAL ACTION EXTENT**

Prepared For: U.S. EPA Region 9 	Prepared By: TETRA TECH <small>1999 Harrison Street, Suite 500 Oakland, CA 94612</small>
Task Order No.: <p style="text-align: center;">0016</p>	Contract No.: <p style="text-align: center;">EP-S9-17-03</p>
Location: <p style="text-align: center;">NAVAJO NATION</p>	Date: <p style="text-align: center;">8/25/2023</p>
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: <p style="text-align: center;">12</p>



- Proposed Construction Water Well Placement
- Culvert
- Construct Haul Road (15-Foot Wide)
- Widen and Reinforce Access Road (10-Foot Wide)
- Excavate to a Depth of 1-Foot bgs
- Excavate Existing Stockpile, and Excavate Remaining Surface Soil to a Depth of 1-Foot bgs
- Excavate Existing Waste Piles, and Excavate Remaining Surface Soil to a Depth of 1-Foot bgs
- Laydown Area
- Rock Bridge Across Drainage
- TENORM Boundary
- PLSS Section Boundary / RSE Survey Area
- Waste Stockpile
- Waste Pile
- County Road
- Local Road
- Drainage

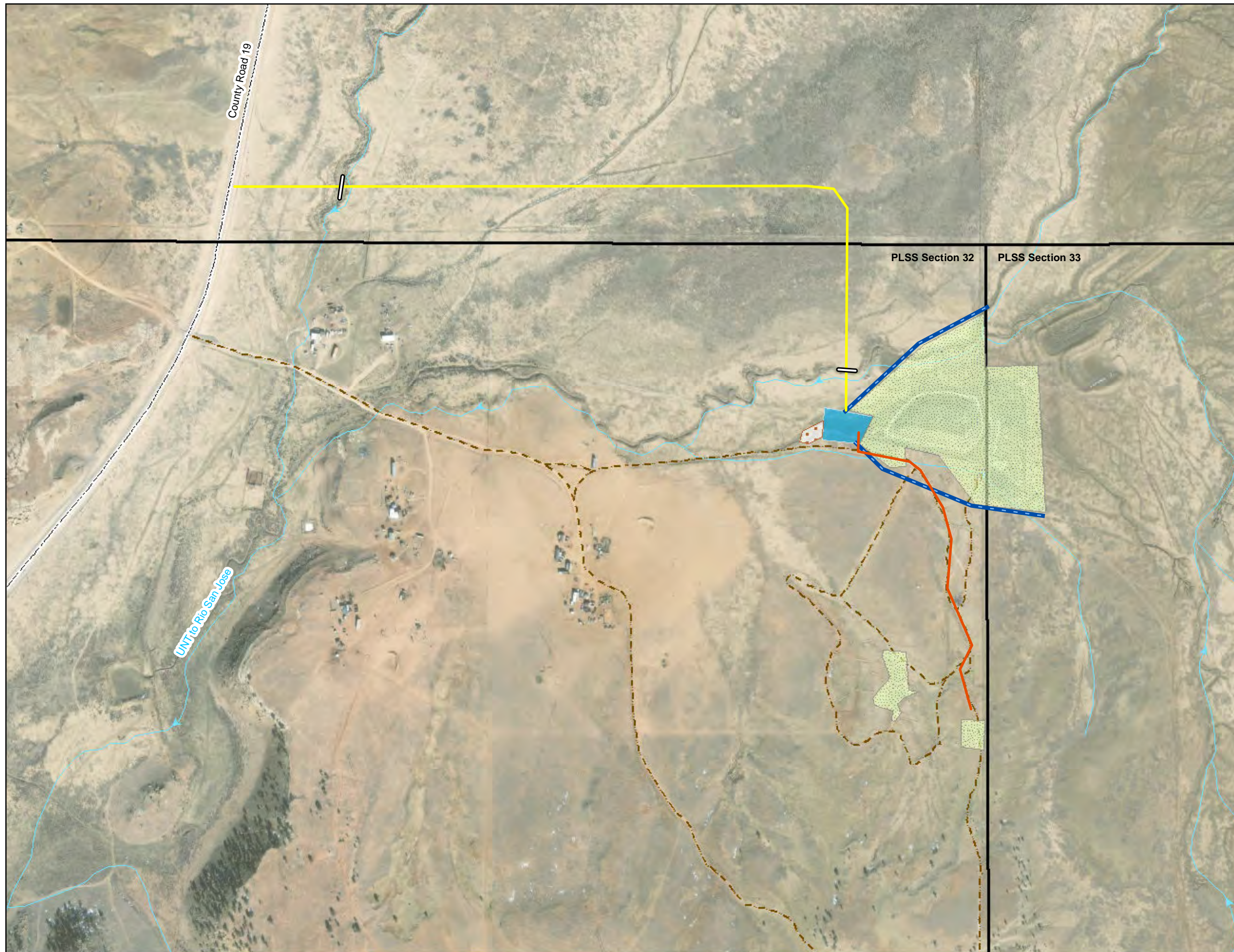


PROPOSED CONSTRUCTION ACTIVITIES

Removal Category	Surface Area (ft ²)	Surface Area (Acres)	Excavation Depth (ft)	Estimated Volume (CY)
Section 33 Waste Piles	223,046	5.12	2	16,522
Section 32 Stockpile	317,046	7.28	1	36,139
Haul Road	317,064	3.96	1	11,743
Section 32 Transfer Station	31,638	0.73	1	1,172
Other Surficial Contamination	215,815	4.95	1	7,993
Totals	1,104,609	22.04	6	73,569

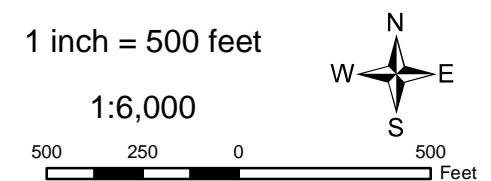
Notes:
 bgs Below ground surface
 CY Cubic yard
 ft Foot
 ft² Square foot
 PLSS Public land survey system
 RSE Removal site evaluation
 TENORM Technologically enhanced naturally occurring radioactive material
 UNNT Unnamed tributary

Prepared For: U.S. EPA Region 9 	Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0031	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 8/25/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: 13



- Obliterate Access Road After 10 Years
(Pull Up Material, Grade, and Revegetate)
- Obliterate Haul Road After 10 Years
(Pull Up Material, Grade, and Revegetate)
- Remove Culvert
- Rock-Lined Drainage Channel
- Grade with Positive Drainage and Hydroseed
- Rock Outfall
- Sediment / Water Detention Basin
- PLSS Section Boundary / RSE Survey Area
- County Road
- Local Road
- Drainage

Notes:
 PLSS Public land survey system
 RSE Removal site evaluation
 UNT Unnamed tributary



PROPOSED SURFICIAL RESTORATION ACTIVITIES

Prepared For: U.S. EPA Region 9

Prepared By:

TETRA TECH
 1999 Harrison Street, Suite 500
 Oakland, CA 94612

Task Order No.:
0016

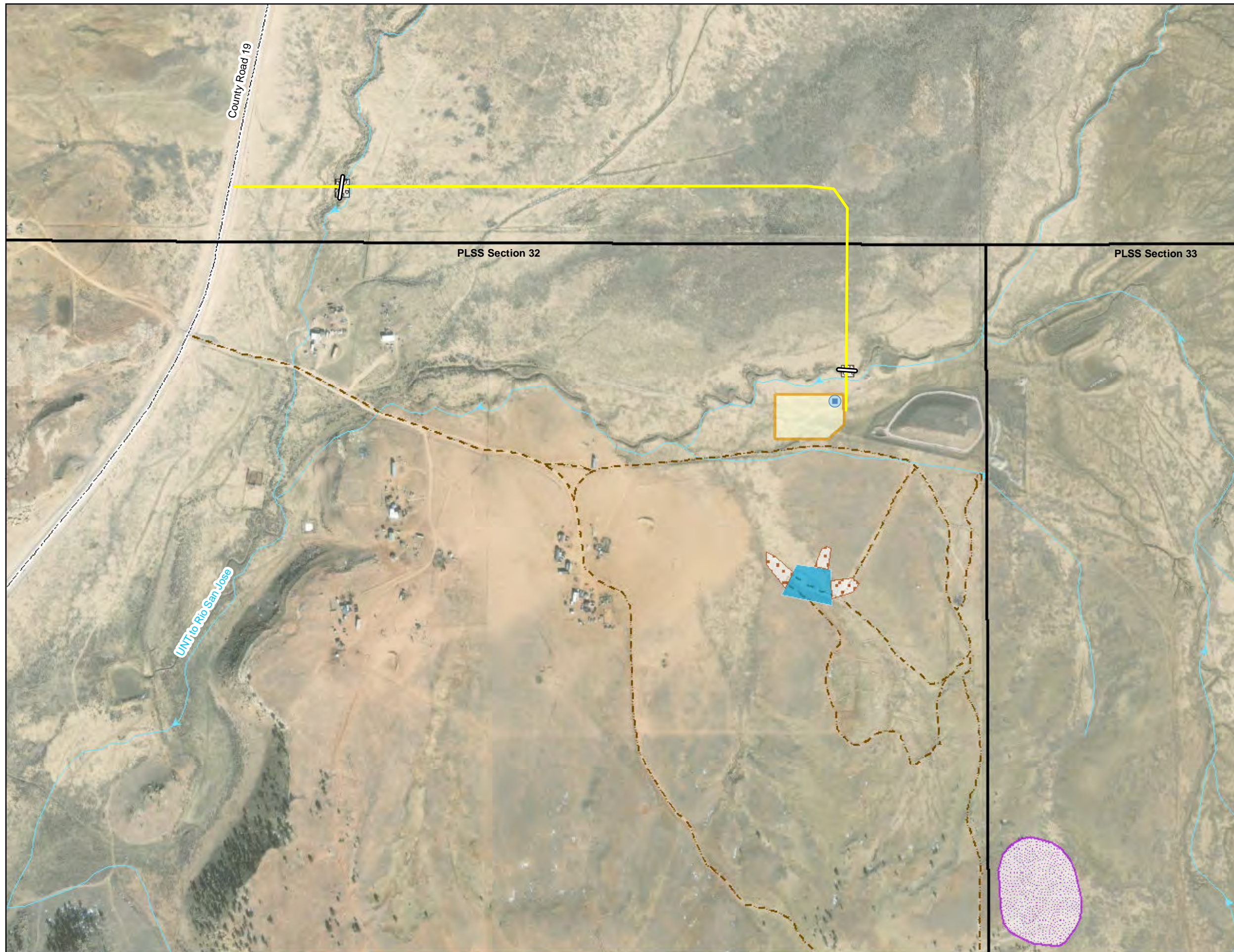
Contract No.:
EP-S9-17-03













Location:
NAVAJO NATION

Date:
8/25/2023

Coordinate System:
 NAD 1983 State Plane New Mexico
 West FIPS 3003 Feet Transverse

Figure No.:
14

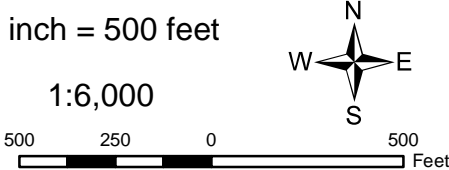


-  Proposed Construction Water Well Placement
-  Culvert
-  Construct Haul Road (15-Foot Wide)
-  Proposed Laydown Area
-  Proposed Sediment / Water Detention Basin
-  Proposed Onsite Repository
-  Proposed Rock Outfall
-  Rock Bridge Across Drainage
-  PLSS Section Boundary / RSE Survey Area
-  County Road
-  Local Road
-  Drainage



Notes:

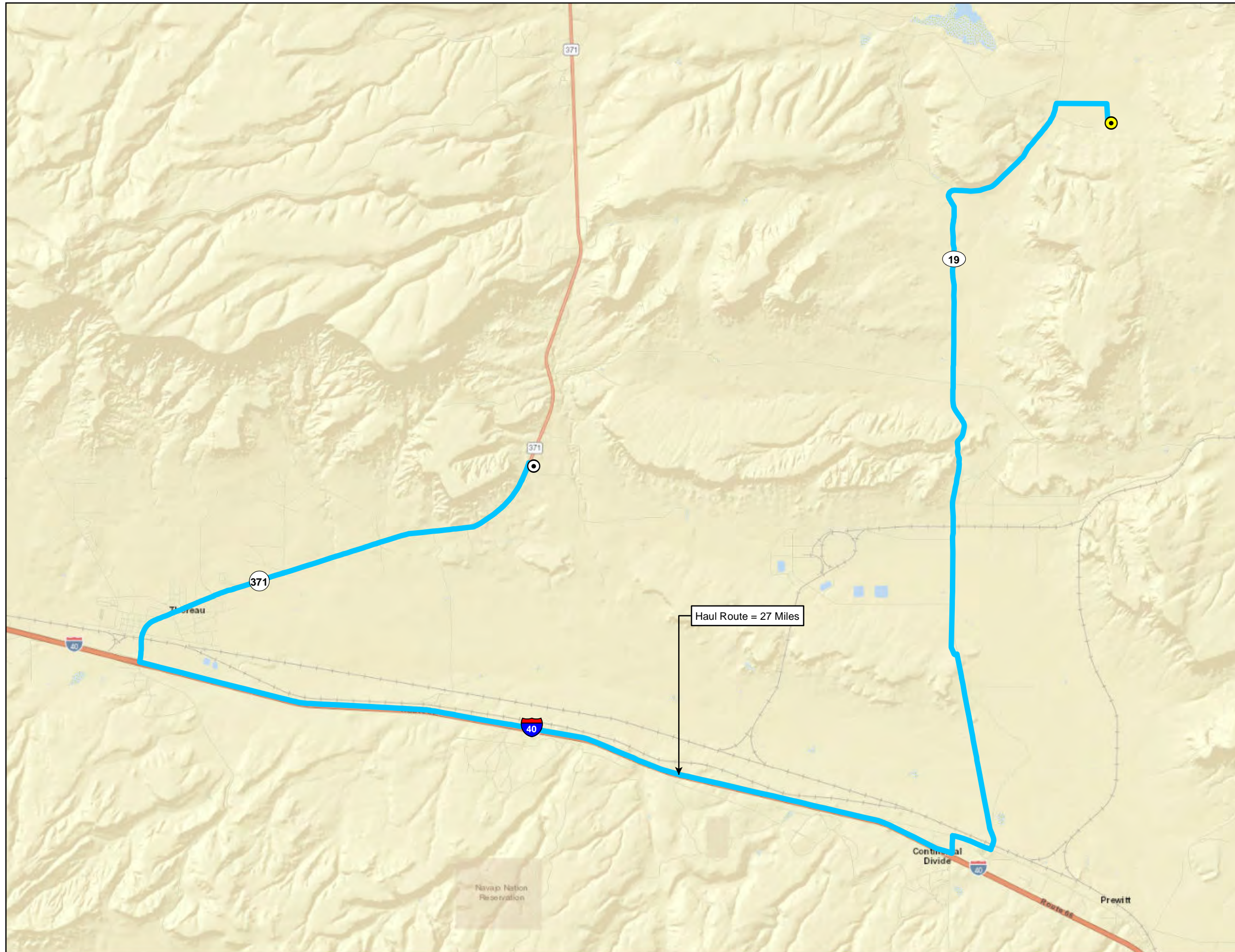
PLSS Public land survey system
RSE Removal site evaluation
UNT Unnamed tributary

1 inch = 500 feet
1:6,000

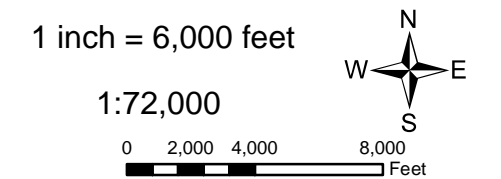


**ALTERNATIVE 2 - ON-SITE REPOSITORY
LOCATION AND FEATURES**

Prepared For: U.S. EPA Region 9 	Prepared By: 
Task Order No.: 0016	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 8/25/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: 15



- Section 32 / 33 Project Site
- Red Rock Disposal Facility
- Proposed Haul Route



**ALTERNATIVE 3 — OFF-NAVAJO
 NATION DISPOSAL AT
 RED ROCK DISPOSAL FACILITY**

Prepared For: U.S. EPA Region 9



Prepared By:



Task Order No.:
0031

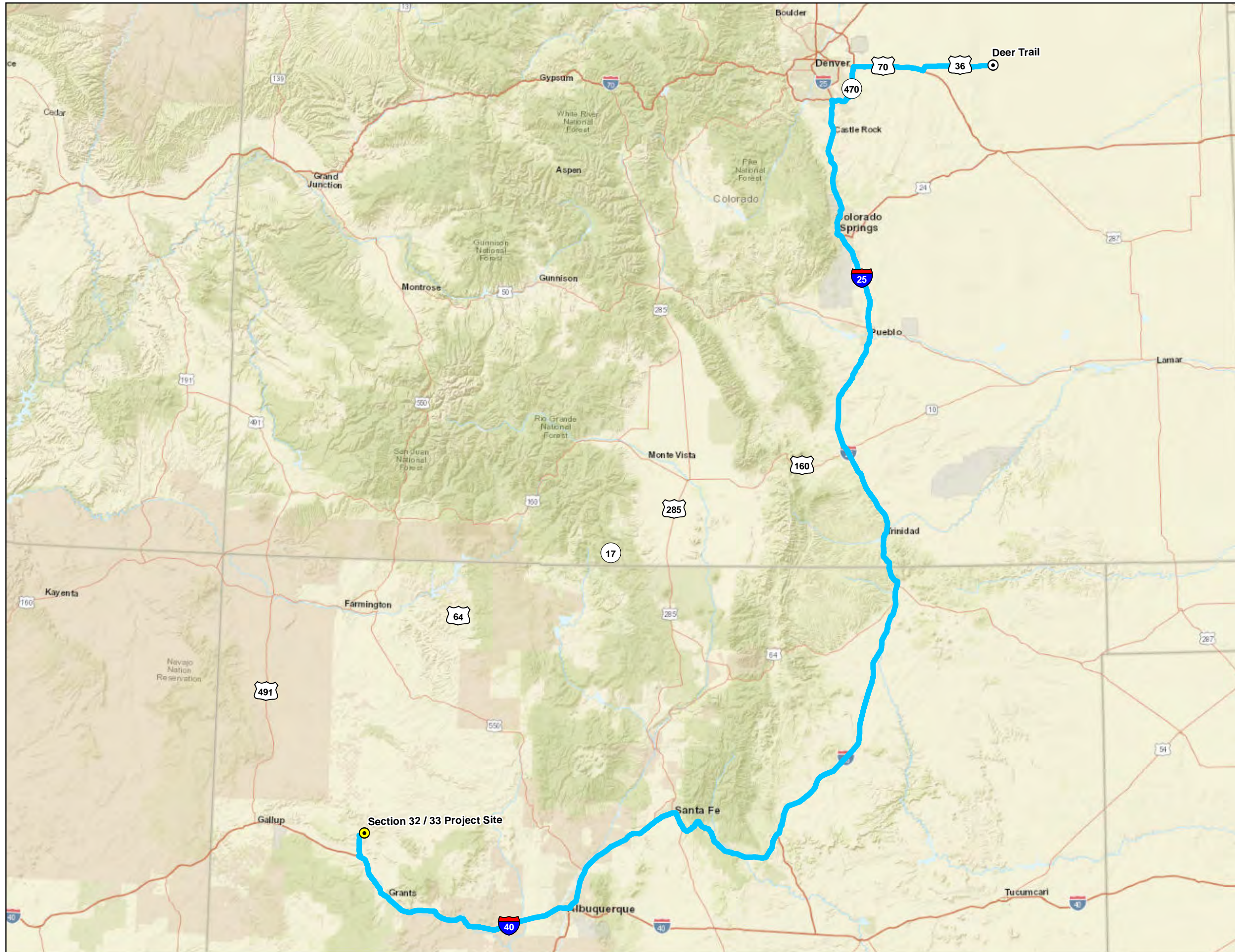
Contract No.:
EP-S9-17-03

Location:
NAVAJO NATION

Date:
8/25/2023

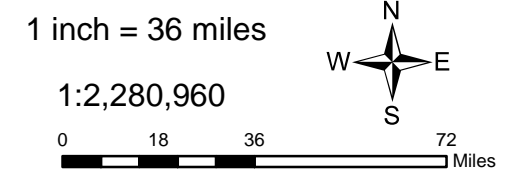
Coordinate System:
NAD 1983 State Plane New Mexico
West FIPS 3003 Feet Transverse

Figure No.:
16



- Section 32 / 33 Project Site
- Populated Place
- Proposed Haul Route

Note:
RCRA Resource Conservation and Recovery Act



**ALTERNATIVE 4 — OFF-NAVAJO
NATION DISPOSAL AT
CLEAN HARBORS RCRA SUBTITLE C
HAZARDOUS WASTE DISPOSAL FACILITY
HAUL ROUTE**

Prepared For: U.S. EPA Region 9 	Prepared By: TETRA TECH <small>1999 Harrison Street, Suite 500 Oakland, CA 94612</small>
Task Order No.: 0031	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 8/25/2023
Coordinate System: NAD 1983 UTM Zone 13 N Transverse Mercator	Figure No.: 17

TABLES

Table 1. Mine Features and Dimensions at the Section 32 and 33 Mines

Feature	Reclamation Status	Reclamation Description	Dimensions
Section 32 Mine			
Mine Shaft S32-01	Reclaimed	Excavated to 12 feet bgs and backfilled	Undocumented
Mine Shaft S32-02	Reclaimed	Excavated to 12 feet bgs and backfilled	Undocumented
Mine Shaft S32-03	Reclaimed	Excavated to 4 feet bgs and backfilled	5 feet by 5 feet
Section 32/33 Transfer Station	Reclaimed	Excavated and waste placed in stockpile. Transfer station serviced both the Section 32 Mine and Section 33 Mine.	267,432 square feet
Section 32 Stockpile	Reclamation Feature	Received waste from transfer station, over excavated mine shafts, and waste formerly at stockpile site. Includes a rock-lined drainage around stockpile and a rock-lined detention basin at the southwest corner.	317,064 square feet
Old Haul Road	Unreclaimed	None	0.84 mile
Vent Shaft	Unreclaimed	Identified during 2022 data gap investigation.	18 inches in diameter
Section 33 Mine			
Waste Pile S33-01	Unreclaimed	None	223,046 square feet
Waste Pile S33-02	Unreclaimed	None, mapped during Tetra Tech field reconnaissance.	
Waste Pile S33-03	Unreclaimed	None	
Waste Pile S33-04	Unreclaimed	None	
Waste Pile S33-05	Unreclaimed	None	

Note:
bgs Below ground surface

Table 2. Comparison of Sections 32 and 33 Mines Site Surface Soil Concentrations to Background Concentrations

COC/COEC	Sections 32 and 33 Mines Qa Soil (0-6 inch bgs)			Sections 32 and 33 Mines BSA-1 Qa Soil (0-6 inch bgs)			Two-Population Statistical Tests				Final Conclusion for Background Screen
	Sample Size		Detection Frequency (Percent)	Sample Size		Detection Frequency (Percent)	Gehan Test ^a	Tarone-Ware ^a	Wilcoxon-Mann-Whitney ^b	Quantile Test ^c	
	Detected	Total		Detected	Total		Site > Background?	Site > Background?	Site > Background?	Site > Background?	Site > Background?
Radium-226	61	61	100%	30	30	100%	--	--	No	Yes	Yes
Arsenic	65	65	100%	30	30	100%	--	--	No	No	No
Cobalt	65	65	100%	30	30	100%	--	--	No	No	No
Iron	65	65	100%	30	30	100%	--	--	No	No	No
Manganese	65	65	100%	30	30	100%	--	--	No	Yes	Yes
Selenium	61	61	100%	30	30	100%	--	--	No	Yes	Yes
Thallium	58	61	95%	30	30	100%	No	No	--	No	No
Uranium	62	62	100%	30	30	100%	--	--	Yes	Yes	Yes
Vanadium	65	65	100%	30	30	100%	--	--	No	No	No
Zinc	65	65	100%	30	30	100%	--	--	No	No	No

- Notes:
- ^a The Gehan and Tarone-Ware tests are tests of central tendency and are only used when multiple nondetect results are present in the dataset (USEPA 2022).
 - ^b The Wilcoxon-Mann-Whitney tests are tests of central tendency and can only be used when all the data are detected or there is a single detection limit for the nondetected results.
 - ^c Quantile tests were performed to confirm the conclusion that the upper tails of site concentrations are less than those for background. Quantile tests were not performed in cases where the two-population tests for central tendency indicated the site concentrations are greater than background. Quantile tests were performed using ProUCL Version 4.1.01 (USEPA 2010).
 - Not applicable
 - bgs Below ground surface
 - COC Contaminant of concern
 - COEC Contaminant of ecological concern
 - Qa Quaternary alluvium
 - USEPA U.S. Environmental Protection Agency

References:

U.S. Environmental Protection Agency (USEPA). 2010. "ProUCL Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations." Version 4.1.01. May.

USEPA. 2022. "ProUCL Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations." Version 5.2. June.

Table 3. General Response Actions, Technologies, and Process Options

General Response Actions	Response Action Technology	Process Options
No Action	None	Not applicable
Institutional Controls	Land Use Controls	Chapter Land Use Plans
		Homesite Lease Approval
	Access Restrictions	Deed Restrictions
		Environmental Control Easements
Engineering Controls	Physical Barriers	Fencing/Barrier
	Surface Controls	Consolidation, Grading, Revegetation, and Erosion Protection
		Soil Binder
	Segregation	Soil Sorting
	Backfilling of Mine Workings	Backfilling of Cuts, Benches, and Pits
		Backfilling of Underground Voids
	Containment	Earthen Cover
		Earthen Cover with Upper HDPE or Geosynthetic Clay Liner
Regional Disposal	On-Navajo Nation Regional Repository	
	Off-Navajo Nation Regional Repository	
Off-Navajo Nation Disposal	Non-RCRA, Class A LLRW, or RCRA C Hazardous Waste Disposal Facility with State License to Receive Radioactive Material	
Excavation and Treatment	Physical/ Chemical Treatment	Soil washing
		Acid Extraction
		Ablation
		Milling
		Solidification
		Stabilization
	Thermal Treatment	Vitrification
In-Place Treatment	Physical/ Chemical Treatment	Solidification
		Stabilization
	Thermal Treatment	Vitrification
	Vegetative Treatment	Phytoextraction/ Phytostabilization

Notes:

HDPE High-density polyethylene

LLRW Low-level radioactive waste

RCRA Resource Conservation and Recovery Act

Table 4. Applicable or Relevant and Appropriate Requirements and To Be Considered Requirements for the Section 32 and 33 Mines

Table 4a and Table 4b list the federal and Navajo Nation location- and action-specific applicable or relevant and appropriate requirements (ARAR) and “To Be Considered” (TBC) requirements, respectively, that have been identified for all the alternative response actions described in the engineering evaluation/cost analysis (EE/CA) for the Section 32 and 33 Mines. The U.S. Environmental Protection Agency (USEPA) did not identify chemical-specific ARARs or TBCs because potential federal, State of New Mexico, and Navajo Nation chemical-specific ARARs were not as conservative as the risk-based cleanup standards developed for this action. Chemical-related requirements tied to an action such as cap design were included in the action-specific table (Table 4b). Identification and evaluation of ARARs is an iterative process that continues throughout the response process. As site conditions, contaminants, and response alternatives at the Section 32 and 33 Mines are better understood, the ARARs and TBCs and their relevance to the removal action may change. ARARs and TBCs are finalized in the action memorandum for the selected response action.

Cleanup standards were derived through the USEPA risk assessment process in accordance with the following USEPA guidance.

- “Clarification of the Role of Applicable, or Relevant and Appropriate Requirements in Establishing Preliminary Remediation Goals under CERCLA” (USEPA 1997a)
- “Establishment of Cleanup Levels for CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] Sites with Radioactive Contamination” (USEPA 1997b)
- “Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites” (USEPA 1998)
- “Radiation Risk Assessment at CERCLA Sites: Q&A” (USEPA 2014)

The following Navajo Nation laws, regulations, and guidance are not considered ARARs or TBCs for the response actions anticipated by this EE/CA; however, they are listed here because situations may arise during implementation of the alternatives discussed in the EE/CA or during future actions at the Section 32 and 33 Mines where these requirements may be applicable.

- Navajo Nation CERCLA, 4 Navajo Nation Code (N.N.C.) Sections (§§) 2101-2805 – The Navajo Nation CERCLA requirements must be complied with during implementation of the response action if petroleum contamination is discovered at the Section 32 and 33 Mines because Navajo Nation CERCLA Section (§) 2104.Q includes petroleum in the definition of hazardous substance. Based on site investigations thus far, petroleum contamination is not anticipated.
- Navajo Nation Underground and Aboveground Storage Tank Act of 2012 (NNSTA), 4 N.N.C. §§ 1501-1577 – If any permanent storage tanks are found at a site, including both underground and aboveground storage tanks and tanks holding not only petroleum but any hazardous substances, NNSTA § 1542(C)(1) requires removal of the tanks. (The guidance for temporary/mobile storage tanks brought on site is included in Table 4b as a TBC because that situation is anticipated to arise.)

Table 4. Applicable or Relevant and Appropriate Requirements and To Be Considered Requirements for the Section 32 and 33 Mines

- Navajo Nation Business Opportunity Act, 5 N.N.C. §§ 201-214, and the Navajo Preference in Employment Act, 15 N.N.C. §§ 601-619 – While these are not environmental regulations and, therefore, are not ARARs, these regulations give preference to Navajo Nation businesses and individuals when hiring employees and contractors to perform the response actions anticipated by this EE/CA.
- Navajo Nation Diné Radioactive Materials Transportation Act (RMTA), 18 N.N.C. §§ 1304-1307 – RMTA is not applicable to onsite activities; however, its requirements may be applicable to transportation on public roads on the Navajo Nation between sites that are subject to a combined action pursuant to CERCLA § 104(d)(4), as well as for shipment of radioactive materials through the Navajo Nation generally. RMTA § 1307 includes specific requirements that are not found in federal law, including advance notice of the transportation of radioactive and related substances, equipment, vehicles, persons, and materials over and across the Navajo Nation, as well as license fees, bonding requirements, route restrictions, and curfews.

The EE/CAs for which the ARARs tables below were prepared do not address groundwater and, therefore, ARARs for groundwater are not included. If any groundwater contamination is found at the Section 32 and 33 Mines, the related ARARs will be addressed at that time.

References:

- U.S. Environmental Protection Agency (USEPA). 1997a. “Clarification of the Role of Applicable, or Relevant and Appropriate Requirements in Establishing Preliminary Remediation Goals under CERCLA.” Office of Solid Waste and Emergency Response (OSWER) Directive No. 9200.4-23. August.
- USEPA. 1997b. “Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination.” OSWER Directive No. 9200.4-18. August.
- USEPA. 1998. “Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites.” OSWER Directive No. 9200.4-25. February.
- USEPA. 2014. “Radiation Risk Assessment at CERCLA Sites: Q&A.” OSWER Directive No. 9200.4-40. May.

Table 4a. Location-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
Cultural Resources	<p>FEDERAL</p> <p>The Native American Graves Protection and Repatriation Act</p> <p>25 U.S.C. §§ 3002(c) and (d)</p> <p>43 CFR §§ 10.3(b)-(c) and 10.4(b)-(e)</p>	<p>Protects Native American cultural items from unpermitted removal and excavation and requires the protection of such items in the event of inadvertent discovery. Excavation or removal of cultural items must be done under procedures required by this act and the Archaeological Resources Protection Act (Section 3 (c)(1)).</p>	<p>Applicable</p> <p>Substantive requirements are applicable if cultural items (meaning human remains and associated or unassociated funerary objects, sacred objects, or cultural patrimony) are inadvertently discovered or intentionally excavated or removed within the area to be disturbed. If cultural items are discovered, ongoing activity in the area of discovery must stop, the relevant Indian tribe official must be notified immediately, and reasonable effort must be made to protect such cultural items.</p>
Cultural Resources	<p>FEDERAL</p> <p>National Historic Preservation Act</p> <p>54 U.S.C. §§ 306101(a), 306102, 306107, and 306108</p> <p>36 CFR §§ 800.3(a) and (c); 800.4(a)-(c); 800.5(a)-(b); 800.6(a)-(b); 800.10(a); 800.13(b)-(d)</p>	<p>Federal agencies are required to consider the effects of federally funded (in whole or in part) activity on any historic property or objects and minimize harm to any National Historic Landmark. Federal agencies may be required to identify historic properties or objects, determine whether proposed activity will have an adverse effect on historic properties or objects, and develop alternatives or modifications to the proposed action that could avoid, minimize, or mitigate adverse effects through the National Historic Preservation Act's Section 106 process.</p>	<p>Applicable</p> <p>Substantive requirements are applicable if a federally funded activity could adversely affect historic property (meaning a prehistoric or historic district, site, building, structure, or object) included on, or eligible for inclusion on, the National Register of Historic Places.</p>
Cultural Resources	<p>FEDERAL</p> <p>Preservation of Historical and Archaeological Data</p> <p>54 U.S.C. §§ 312502(a) and 312503</p>	<p>Protects significant scientific, prehistorical, historical, and archaeological data. When a federal agency action may cause irreparable loss or destruction of significant data, the agency must notify DOI and either recover, protect, and preserve the data itself or request DOI to do so.</p>	<p>Applicable</p> <p>Substantive requirements are applicable if a federal agency action may cause irreparable loss or destruction to significant scientific, prehistorical, historical, or archaeological data.</p>

Table 4a. Location-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
Cultural Resources	FEDERAL Archaeological Resources Protection Act of 1979 16 U.S.C. §§ 470cc(a)-(c) and 470ee(a) 43 CFR §§ 7.4(a), 7.5(a), 7.7, 7.8(a), 7.9(c), and 7.35	Prohibits the excavation, removal, damage, or alteration or defacement of archaeological resources on public or Indian lands unless by permit or exception.	Applicable Substantive requirements are applicable if eligible archaeological resources are within the area to be disturbed.
Cultural Resources	FEDERAL American Indian Religious Freedom Act 42 U.S.C. § 1996	Policy of the United States to protect access to and the use of religious, ceremonial, and burial sites and sacred objects by Native American groups.	TBC Policy should be followed if Native American sacred sites are identified within the area to be disturbed.
Biological Resources	FEDERAL Migratory Bird Treaty Act 16 U.S.C. § 703(a) 50 CFR §§ 10.13 and 21.10	Prohibits the killing, capturing, taking, and incidental taking of protected migratory bird species, their parts, nests, and eggs without DOI's prior approval. Protected migratory birds species are listed at 50 CFR § 10.13.	Applicable Substantive requirements are applicable if migratory birds or their nests are present at or near the site.
Biological Resources	FEDERAL Bald and Golden Eagle Protection Act 16 U.S.C. §§ 668(a) 50 CFR §§ 22.10; 22.80(a), (c)-(f); 22.85(a)-(b) and (d)-(e) 50 CFR § 13.21(b)	Prohibits the unpermitted taking, including the killing, disturbing, or incidental taking, of bald and golden eagles, their parts, nests, and eggs.	Applicable Substantive requirements are applicable if bald or golden eagles or their nests are identified at or near the site.

Table 4a. Location-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
Biological Resources	<p>FEDERAL</p> <p>Endangered Species Act</p> <p>16 U.S.C. §§ 1531(c); 1536(a)(2), (c)-(d), (g)-(h), and (l); 1538(a) and (g); 1539(a)</p> <p>50 CFR §§ 17.21(a)-(c); 17.22(b); 17.31(a) and (c); 17.32(b); 17.82; and 17.94(a)</p> <p>50 CFR §§ 402.09; 402.12 (a)-(b) and (i); 402.14(a); 402.15(a)</p>	<p>Federal agencies must ensure that any activities funded, carried out, or authorized by them do not jeopardize the continued existence of any threatened or endangered species or result in the destruction or alteration of such species' habitats. Endangered and threatened species are listed at 50 CFR Part 17, Subpart B.</p>	<p>Applicable</p> <p>Substantive requirements are applicable if endangered or threatened species are identified at the site.</p>
Cultural Resources	<p>NAVAJO NATION</p> <p>Navajo Nation Cultural Resources Protection Act</p> <p>11 N.N.C. §§ 1003(S); 1021; and 1031</p>	<p>Prohibits alteration, damage, excavation, defacement, destruction, or removal of cultural properties.</p>	<p>Applicable</p> <p>Substantive requirements are applicable to activities at the AUM sites where cultural resources may be encountered.</p>
Cultural Resources	<p>NAVAJO NATION</p> <p>Navajo Nation Policy for the Disposition of Cultural Resources Collections</p> <p>Sections 2 and 6.1 (These sections would trigger other provisions in the policy)</p>	<p>Establishes procedures and guidelines to be followed for excavation (as a last resort) and disposition of cultural resources recovered on the Navajo Nation, including the handling of inadvertent discovery.</p>	<p>TBC</p> <p>TBC for activities on AUM sites where cultural resources may be encountered.</p>

Table 4a. Location-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
Cultural Resources	<p>NAVAJO NATION Navajo Nation Guidelines for the Treatment of Discovery Situations</p>	<p>Establish procedures and guidelines to be followed in any situation involving the discovery of cultural or historic property, including historical and prehistoric archaeological sites and traditional cultural properties and human remains whether or not previously identified.</p>	<p>TBC NNHHPD performs these functions pursuant to a contract with BIA under which NNHHPD serves as the BIA's agent.</p>
Cultural Resources	<p>NAVAJO NATION Navajo Nation Policy for the Protection of Jishchaá: Gravesites, Human Remains, and Funerary Items</p>	<p>Establishes principles for locating and handling of gravesites, human remains, and associated artifacts and soil in the area to be disturbed by AUM removal activities. See in particular Section IV (Traditional Concerns), which contains requirements if the AUM activity comes into contact with gravesites, human remains, or funerary items. It imposes specific requirements for how to navigate around, prepare for, and respond to burial grounds and uncovered remains. See also Section V (Encountering Gravesites, Human Remains, and Funerary Items), which specifies the procedures when an inadvertent discovery is made. Sections VI and VII contain additional requirements in that event.</p>	<p>TBC</p>
Biological Resources	<p>NAVAJO NATION Navajo Nation Endangered Species Act 17 N.N.C. §§ 500-508 Navajo Nation Endangered Species List – Resource Committee Resolution RCAU-103-05</p>	<p>NNESA § 507 makes it unlawful for any person to “take, possess, transport, export, process, sell or offer for sale or ship any species or subspecies of wildlife” listed as endangered or threatened on federal or Navajo Nation lists, which also protect those species’ critical habitat. NNESA §§ 500-504 and 506-508 also protect, to various extents, game fish, game birds, songbirds, game animals, fur-bearing animals (all defined under § 500), and hawks, vultures, and owls from being taken.</p> <p>The Navajo Nation Endangered Species List includes species that are not on the federal list. It also provides broader criteria for when species would be listed based on their prospects of survival or recruitment within the Navajo Nation (see categories “G2” and “G3”). Category G4 provides a means for the Navajo Nation Department of Fish and Wildlife to include additional species (or exclude species), making it possible for the list to change during the course of work.</p>	<p>Applicable Substantive requirements applicable if protected species or habitat are identified within the area to be disturbed on AUM sites.</p>

Table 4a. Location-Specific ARARs and TBC Information

Notes:

§	Section
§§	Sections
ARAR	Applicable or relevant and appropriate requirement
AUM	Abandoned uranium mine
BIA	Bureau of Indian Affairs
CFR	<i>Code of Federal Regulations</i>
DOI	U.S. Department of the Interior
N.N.C.	<i>Navajo Nation Code</i>
NNESA	Navajo Nation Endangered Species Act
NNHHPD	Navajo Nation Heritage and Historic Preservation Department
TBC	To be considered
U.S.C.	<i>United States Code</i>

Table 4b. Action-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
Air	FEDERAL Clean Air Act 42 U.S.C. §§ 7401, et seq. 40 CFR § 61.92	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 of 10 millirems per year.	Relevant and Appropriate This standard is applicable to a DOE facility. The site is not a DOE facility; therefore, this standard is not applicable. However, this standard has been determined to be relevant and appropriate during removal action activities because of potential emissions of radionuclides during excavation of the waste and movement of the waste.
Air	FEDERAL Clean Air Act 42 U.S.C. §§ 7401, et seq. 40 CFR §§ 61.222(a)	Radon-222 emissions to the ambient air from a uranium mill tailings pile that is no longer operational shall not exceed 20 picocuries per square meter per second.	Relevant and Appropriate These requirements are applicable to nonoperational uranium mill tailings piles. The site's waste to be disposed of is not uranium mill tailings. These requirements have been determined to be relevant and appropriate to the design of the engineered cover to be constructed in Alternative 2, which consists of onsite containment of the contaminated soil and uranium waste rock.
Water	FEDERAL Clean Water Act 33 U.S.C. § 1342(p)(3)(A) NPDES – Stormwater Discharges 40 CFR §§ 450.21	Requires BMPs to abate discharges of pollutants from stormwater discharges, including erosion and sediment control BMPs. All treatment and control systems and facilities will be properly operated and maintained.	Applicable If there are discharges to WOTUS. Relevant and Appropriate If there are discharges to Navajo Nation surface waters (as defined in Table 206.1 of Navajo Nation Surface Water Quality Standards 2015).

Table 4b. Action-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
Water	<p>FEDERAL Clean Water Act 33 U.S.C. § 1342(p) NPDES 2022 Construction General Permit for Stormwater Discharges from Construction Activities Part 2. Technology-Based Effluent Limitations. Section 2.2. Erosion and Sediment Control Requirements, Subsection 2.2.1.</p>	<p>Requires implementation of erosion and sediment controls to minimize the discharge of pollutants in stormwater from construction activities. Natural buffers or equivalent erosion and sediment controls must be provided and maintained for discharges to receiving waters within 50 feet of the site's earth disturbances. For any discharges to receiving waters within 50 feet of the site's earth disturbances, one of the following alternatives must be complied with:</p> <ul style="list-style-type: none"> i. Provide and maintain a 50-foot undisturbed natural buffer ii. Provide and maintain an undisturbed natural buffer that is less than 50 feet and is supplemented by erosion and sediment controls that achieve, in combination, the sediment load reduction equivalent to a 50-foot undisturbed natural buffer iii. If infeasible to provide and maintain an undisturbed natural buffer of any size, implement erosion and sediment controls to achieve the sediment load reduction equivalent to a 50-foot undisturbed natural buffer. 	<p>Applicable</p> <p>For operators of construction activities if weather events necessitating stormwater runoff controls occur during onsite excavation, waste consolidation, and repository construction.</p>
Repository	<p>FEDERAL Uranium Mill Tailings Radiation Control Act 42 U.S.C. §§ 7918 and 2022 40 CFR §§192.02(a) and (d)</p>	<p>Requires design of uranium mill tailings disposal sites to provide for control of residual radioactive materials for up to 1,000 years to the extent reasonably achievable and, in any case, for at least 200 years. The uranium mill tailings disposal site must also be designed and stabilized in a manner that minimizes the need for future maintenance.</p>	<p>Relevant and Appropriate</p> <p>These standards are applicable to UMTRCA Title I sites. The site is not a Title I site; therefore, these requirements are not applicable. These requirements have been determined to be relevant and appropriate to the design of the engineered cover to be constructed under Alternative 2, which consists of onsite containment of the contaminated soil and uranium waste rock.</p>

Table 4b. Action-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
Repository	<p>FEDERAL Uranium Mill Tailings Radiation Control Act 42 U.S.C. §§ 7918 and 2022 10 CFR Part 40, Appendix A. Criteria 1, 4, 6(1), 6(3), 6(5) and 6(7)</p>	<p>In selecting and designing uranium mill tailings disposal sites, certain criteria must be considered, including remoteness, hydrologic and topographic features, potential for erosion, and vegetation. Disposal sites must be covered by an earthen cap, or approved alternative, that meets certain control requirements, including limiting the release of radon-222 to the atmosphere. When the final radon barrier is placed in phases, verification of the radon-222 release rate must be completed for each portion of the final radon barrier as it is emplaced. Waste or rock with elevated levels of radium must not be placed near the surface of disposal sites. Disposal sites must be closed in a manner that, to the extent necessary, controls, minimizes, or eliminates post-closure escape of non-radiological hazardous constituents, leachate, contaminated rainwater, or waste decomposition products to the ground or surface waters or atmosphere.</p>	<p>Relevant and Appropriate These standards are applicable to UMTRCA Title I sites. The site is not a Title I site; therefore, these requirements are not applicable. These requirements have been determined to be relevant and appropriate to the design of the engineered cover to be constructed in Alternative 2, which consists of onsite containment for the contaminated soil and uranium waste rock.</p>
Repository	<p>FEDERAL NRC Regulations Protection of the General Population from Releases of Radioactivity 10 CFR § 61.41</p>	<p>Concentrations of radioactive material that may be released to the general environment in groundwater, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable.</p>	<p>Relevant and Appropriate This standard is applicable to NRC sites. The site is not a NRC site; therefore, this requirement is not applicable. This standard was found to be relevant and appropriate to the design of the engineered cover to be constructed in Alternative 2, which consists of onsite containment of contaminated soil and uranium waste rock.</p>
All	<p>NEW MEXICO NMAC § 20.3.13.1317</p>	<p>Requires the protection of the general population from the release of radioactivity.</p>	<p>Relevant and Appropriate This regulation is the same as 40 CFR § 192. This requirement is not applicable to the site but is relevant and appropriate.</p>

Table 4b. Action-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
All	NEW MEXICO NMAC § 20.3.4	Establishes standards for protection against radiation.	Relevant and Appropriate This regulation is the same as 10 CFR § 20. This requirement is not applicable to the site but is relevant and appropriate.
Soil	NEW MEXICO NMAC §§ 19.10.5.507 and 19.10.5.508	Establishes performance and reclamation standards and requirements for noncoal mining operations.	Relevant and Appropriate This regulation provides revegetation requirements for existing noncoal mining operations, as well as other reclamation requirements.
Soil and Water	NEW MEXICO New Mexico Soil and Water Conservation District Act New Mexico Statutes Annotated 73-20-25	Establishes state authority to control and prevent soil erosion, prevent floodwater and sediment damage to soil, and conserve natural resources.	TBC This regulation will be a TBC to the extent that it does not conflict with CERCLA, the National Contingency Plan, 40 CFR Part 300, or other federal requirements.
Soil	NEW MEXICO Joint Guidance for the Cleanup and Reclamation of Existing Uranium Mining Operations in New Mexico (March 2016)	This guidance is used to assist mine site responsible parties in addressing soil radiation at existing uranium mines as part of reclamation activities.	TBC This guidance will be a TBC to the extent that it does not conflict with CERCLA, the National Contingency Plan, 40 CFR Part 300, or other federal requirements.
Soil	NEW MEXICO Guidance for Soil Suitability, Revegetation and Self Sustaining Ecosystem (1996)	Used to implement and evaluate vegetation success and soil cover material properties and reclamation.	TBC This guidance will be a TBC for restoration of excavated or covered waste.

Table 4b. Action-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
All	<p>NAVAJO NATION</p> <p>Navajo Nation Fundamental Law 1 N.N.C. §§ 201-206</p> <p>Navajo Nation Guidance on the Uniform Application of Fundamental Law to AUM Cleanup Activities (2022)</p>	<p>The Navajo people have an obligation under the Navajo Nation Fundamental Law to listen to elders and medicine people and respect, preserve, and protect Mother Earth as stewards and guardians for the benefit of future generations.</p> <p>The 2020 guidance explains the principles of the Navajo Nation Fundamental Law and how the principles would be applied at the various stages of AUM cleanup.</p>	<p>TBC</p> <p>Navajo Nation Fundamental Law and the 2022 guidance will be TBCs to the extent that they do not conflict with CERCLA, the National Contingency Plan, 40 CFR Part 300, or other federal requirements.</p>
Soil and Water	<p>NAVAJO NATION</p> <p>Navajo Nation Underground and Aboveground Storage Tank Act of 2012 – 4 N.N.C. §§ 1501-1577, as amended</p> <p>NNEPA Storage Tank Program Guidance No. 3 (ASTs at Construction Sites) – Section III (Operating Guidelines)</p>	<p>Regulates storage of petroleum and other regulated substances in underground tanks and ASTs. This guidance clarifies that the NNSTA applies to ASTs that are temporarily placed at construction sites within the Navajo Nation. It requires such ASTs to file tank information forms with NNEPA, locate the tank within a secondary containment area, secure the tank to prevent movement on the containment surface or mount it on metal skids (not on an elevated stilt rack), and contact the Navajo Nation Storage Tank Program for an inspection of the AST to check for evidence of soil contamination both before the first deposit of a regulated substance and when the AST is removed from the site.</p>	<p>TBC</p> <p>Guidance should be followed for AUM response activities requiring ASTs to be brought to sites (for example, for fuel needed for equipment and vehicles).</p>

Notes:

§	Section	NMAC	<i>New Mexico Administrative Code</i>
§§	Sections	N.N.C.	<i>Navajo Nation Code</i>
ARAR	Applicable or relevant and appropriate requirement	NNCWA	Navajo Nation Clean Water Act
AST	Aboveground storage tank	NNEPA	Navajo Nation Environmental Protection Agency
AUM	Abandoned uranium mine	NNSTA	Navajo Nation Underground and Aboveground Storage Tank Act
BMP	Best management practice	NPDES	National Pollutant Discharge Elimination System
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	NRC	U.S. Nuclear Regulatory Commission
CFR	<i>Code of Federal Regulations</i>	TBC	To be considered
CWA	Clean Water Act	UMTRCA	Uranium Mill Tailings Radiation Control Act
DOE	U.S. Department of Energy	U.S.C.	<i>United States Code</i>
		WOTUS	Waters of the U.S.

APPENDIX A

SITE IMAGES

The following photos were taken during the Weston Solutions, Inc. removal site evaluation (RSE) field investigation of the Section 32 and 33 Mines.



PHOTOGRAPH 1

Date: 7/19/17

Location: Section 32 and 33 Mines

Description: Section 32 and Section 33 fenceline with Section 33 mine waste just beyond fence



PHOTOGRAPH 2

Date: 7/19/17

Location: Section 32 and 33 Mines

Description: Section 32 waste repository



PHOTOGRAPH 3

Date: 7/19/17

Location: Section 32 and 33 Mines

Description: Section 33 mine waste debris



PHOTOGRAPH 4

Date: 7/19/17

Location: Section 32 and 33 Mines

Description: Ludlum 2x2 reading at Section 32 and Section 33 fence line



PHOTOGRAPH 5

Date: 7/19/17

Location: Section 32 and 33 Mines

Description: Erosion control between Section 33 (left) and Section 32 (right)



PHOTOGRAPH 6

Date: 7/19/17

Location: Section 32 and 33 Mines

Description: Section 32 repository (left) and Section 33 mine waste (right)



PHOTOGRAPH 7

Date: 6/17/17

Location: Section 32 and 33 Mines

Description: Mancos shale outcrop in Section 33

The following photos were taken during the Tetra Tech, Inc. field reconnaissance of the Section 32 and Section 33 Mines.



PHOTOGRAPH 8

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Locked gate to Section 32 waste stockpile facing northeast



PHOTOGRAPH 9

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Minor erosion of the southeast corner of Section 32 waste stockpile cap facing northwest



PHOTOGRAPH 10

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Surface water pathway flowing west from Section 33 Mine towards the Section 32 waste stockpile, flows west



PHOTOGRAPH 11

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Section 32 waste stockpile facing northeast



PHOTOGRAPH 12

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Quaternary alluvium material down to 6 inches in location approximately 300 feet south of Section 32 waste stockpile



PHOTOGRAPH 13

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Facing north, sparse vegetation in area around the Section 32/33 Mines at northern boundary of Section 32 waste stockpile



PHOTOGRAPH 14

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Mancos Shale outcrop exposed by erosion from surface water pathway flowing south at location approximately 1,200 feet south of Section 32 waste stockpile and east of transfer station



PHOTOGRAPH 15

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Mancos Shale outcrop in context (see photo 14) facing south



PHOTOGRAPH 16

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Section 33 Mine facing northeast



PHOTOGRAPH 17

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Facing north, surface water pathway from Section 33 Mine (right) and Section 32 Stockpile (left) headcutting into slope between the sites



PHOTOGRAPH 18

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Facing east, wood debris from demolished mining structures in Waste Pile S33-01



PHOTOGRAPH 19

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Facing west, distinct color difference (dry) between light grey waste piles (bottom) and red-brown Quaternary alluvium (top left)



PHOTOGRAPH 20

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Facing southeast, Waste Pile S33-02 mapped during Tetra Tech 2022 field event and severe mudcracks suggesting ponding during rain events (mudcracks are present throughout Section 33 Mine)

APPENDIX B

SITE DELINEATION

**Tronox Navajo Abandoned Uranium Mines
Eastern Abandoned Uranium Mine Region**

**Final
Appendix B
Section 32 and 33 Mines
Site Delineation**

Response, Assessment, and Evaluation Services 2

Contract No. 68HE0923D0002

Task Order 003

August 31, 2023

Submitted to

U.S. Environmental Protection Agency

Submitted by

Tetra Tech, Inc.

1999 Harrison Street, Suite 500

Oakland, CA 94612





TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
ACRONYMS AND ABBREVIATIONS	B-ii
1.0 INTRODUCTION	B-1
2.0 LINES OF EVIDENCE AND SITE DELINEATION METHODS	B-3
3.0 SITE DELINEATION RESULTS	B-4
4.0 REFERENCES	B-5

FIGURES

- Figure B-1. Section 32 and 33 Mines Site Features
- Figure B-2. Section 32 and 33 Mines Estimated Radium-226 Surface Soil Concentrations
- Figure B-3. Section 32 and 33 Mines Distribution of Selenium in Surface Soils
- Figure B-4. Section 32 and 33 Mines Distribution of Uranium Surface Soil Distribution
- Figure B-5. Section 32 and 33 Mines Local Geology
- Figure B-6. Section 33 Mine Unreclaimed Waste Piles Facing Northeast
- Figure B-7. Section 32 and 33 Mines Unreclaimed Waste Pile S33-01 Facing East
- Figure B-8. Section 32 and 33 Mines Unreclaimed Waste Pile S33-02 Facing Southeast
- Figure B-9. Section 32 Stockpile Facing East
- Figure B-10. Reclaimed Section 32/33 Transfer Station Facing North with Disturbed Soil and No Vegetation



ACRONYMS AND ABBREVIATIONS

AUM	Abandoned uranium mine
MARSSIM	<i>Multi-Agency Radiation Survey and Site Investigation Manual</i>
NORM	Naturally occurring radioactive material
Ra-226	Radium-226
TENORM	Technologically enhanced naturally occurring radioactive material
Tetra Tech	Tetra Tech, Inc.
USEPA	U.S. Environmental Protection Agency
Weston	Weston Solutions, Inc.



1.0 INTRODUCTION

The purpose of this appendix is to describe the methods and observations used to identify and delineate naturally occurring radioactive material (NORM) and technologically enhanced naturally occurring radioactive material (TENORM) at the Section 32 and 33 Mines.

NORM and TENORM boundaries are defined based on site reconnaissance observations and evaluation of data from the Weston Solutions, Inc. (Weston) (2019) removal site evaluation and a November 2022 data gaps investigation (Tetra Tech, Inc. [Tetra Tech] 2023) in accordance with the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (U.S. Environmental Protection Agency [USEPA] 2000), “Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining” (USEPA 2008), “NORM-TENORM Determinations and Delineation” (USEPA 2021a), and “Mining Forensics and Physical Disturbance Guidance” (USEPA 2021b) at abandoned uranium mines (AUM). NORM and TENORM boundaries do not necessarily correspond to impacted and non-impacted areas at a site. Definitions for impacted and non-impacted areas and for NORM and TENORM in the above guidance documents are provided below.

MARSSIM (USEPA 2000) does not provide guidance on NORM and TENORM delineation but does provide guidance on categorizing site areas as follows:

Categorization is the act or result of separating an area or survey unit into one of two categories: impacted or non-impacted. Areas that have no reasonable potential for residual radioactive material are categorized as non-impacted areas. These areas have no radiological impact from site operations and are typically identified early in the cleanup process. Areas with some reasonable potential for residual radioactive material are categorized as impacted areas.

USEPA (2008) defines TENORM as follows:

Naturally occurring radioactive materials that have been concentrated or exposed to the accessible environment as a result of human activities such as manufacturing, mineral extraction, or water processing.” Technologically enhanced means that “the radiological, physical, and chemical properties of the radioactive material have been concentrated or further altered by having been processed, or beneficiated, or disturbed in a way that increases the potential for human and/or environmental exposures.

USEPA (2008) defines NORM as follows:

Materials which may contain any of the primordial radionuclides or radioactive elements as they occur in nature, such as radium, uranium, thorium, potassium, and their radioactive decay products, such as radium and radon, that are undisturbed as a result of human activities.

According to USEPA (2021a), a feature is defined as TENORM at an AUM if it (1) has been processed, beneficiated, or otherwise disturbed (hereinafter referred to as disturbed) by mining activities; and (2) increases or could increase exposure to human health and the environment.



Based on the above definitions, an area that was physically disturbed can be classified as TENORM and non-impacted. Not all TENORM areas contain levels of radium-226 (Ra-226) or other contaminants of potential concern that require cleanup.

Disturbance at AUMs is divided into mechanical processes and transport processes (USEPA 2021b) as follows:

- Mechanical or geochemical disturbance of rock or soil and mechanical transport of those materials by direct mining activities. For example, dewatering ponds; excavating pits, adits, or shafts; pushing waste piles off cliffs; and ore spilling from haul trucks.
- Natural geologic or geomorphic disturbance of rock or soil and mechanical transport of those materials by gravity, wind, and water. For example, erosion triggered by mechanical disturbance that exposes contaminants not present at the surface before mining.



2.0 LINES OF EVIDENCE AND SITE DELINEATION METHODS

During the NORM-TENORM delineation at the Section 32 and 33 Mines, the following lines of evidence were examined using the processes described below:

- ***Mapped Mine Features:*** Mine features such as waste piles, mine shafts, and site-related transfer stations are defined as TENORM.
- ***Site History and Known Reclamation Activities:*** Reclamation features such as mine waste stockpiles are defined as TENORM.
- ***Transport Features:*** A downgradient assessment of transport from mine features toward surface water pathways where transport would be likely to occur.
- ***Gamma Radiation Data, Estimated Ra-226 Data, and Metals Data:*** Gamma radiation and estimated Ra-226 data were used to evaluate areas impacted by mining and where exposure to humans or the environment has increased. The distribution of concentrations of contaminants of concern and contaminants of ecological concern identified in the Section 32 and 33 Mines risk assessment was used to evaluate areas potentially impacted by mining and where potential exposure to humans or the environment has increased.
- ***Geologic Mapping:*** Undisturbed areas within the Poison Canyon Sandstone ore host rock unit are classified as NORM; no Poison Canyon Sandstone is exposed at the surface in the Section 32 and 33 Mines area.

3.0 SITE DELINEATION RESULTS

This section presents the results of the TENORM delineation. [Figure B-1](#) through [Figure B-10](#) show the lines of evidence, including supporting Section 32 and 33 Mines data and photographs, used to conduct the TENORM delineation.

At the Section 32 and 33 Mines, mapped site features and the raw Ra-226 concentrations (as converted from Section 32 and 33 Mines gamma survey data [Tetra Tech 2023]) were used as the primary lines of evidence for delineating TENORM. [Figure B-1](#) presents the site features (including mine features, reclamation features, and transport features). [Figure B-2](#) presents the estimated Ra-226 soil concentrations, and [Figure B-3](#) and [Figure B-4](#) present the selenium and uranium soil concentrations. All mine and reclamation features, including the haul road leading into the site, closed mine shafts, and the stockpile are mapped as TENORM.

The Section 32 and 33 Mines site lies within Quaternary alluvium, which consists of loose sediment and soil deposits on valley floor, with outcrops of the underlying Mancos Shale to the south. Underlying the Mancos Shale is the Morrison Formation and the Poison Canyon Sandstone within the middle Morrison Formation, which is considered the host rock unit for uranium. No Poison Canyon Sandstone is exposed at the surface in the Section 32 and 33 Mines area. [Figure B-5](#) shows the different geologic units at the surface of the site.

No evidence of transport of mine waste contamination was found in surface water pathways downgradient of the site (Tetra Tech 2022, 2023; Weston 2019).

[Figure B-6](#) through [Figure B-8](#) show photographs of unreclaimed waste piles at the Section 33 Mine. The Section 32 stockpile is displayed in [Figure B-9](#). Disturbed ground at the reclaimed Section 32/33 Transfer Station is shown in [Figure B-10](#). All these site features are mining related and considered TENORM.

In summary, the following features and areas are considered TENORM at the Section 32 and 33 Mines:

- Unreclaimed waste piles
- The Section 32 stockpile
- Reclaimed mine shafts (included in the footprint of other site features)
- Contaminated surface soils surrounding site features resulting from transport of mine waste
- Haul road leading to the site

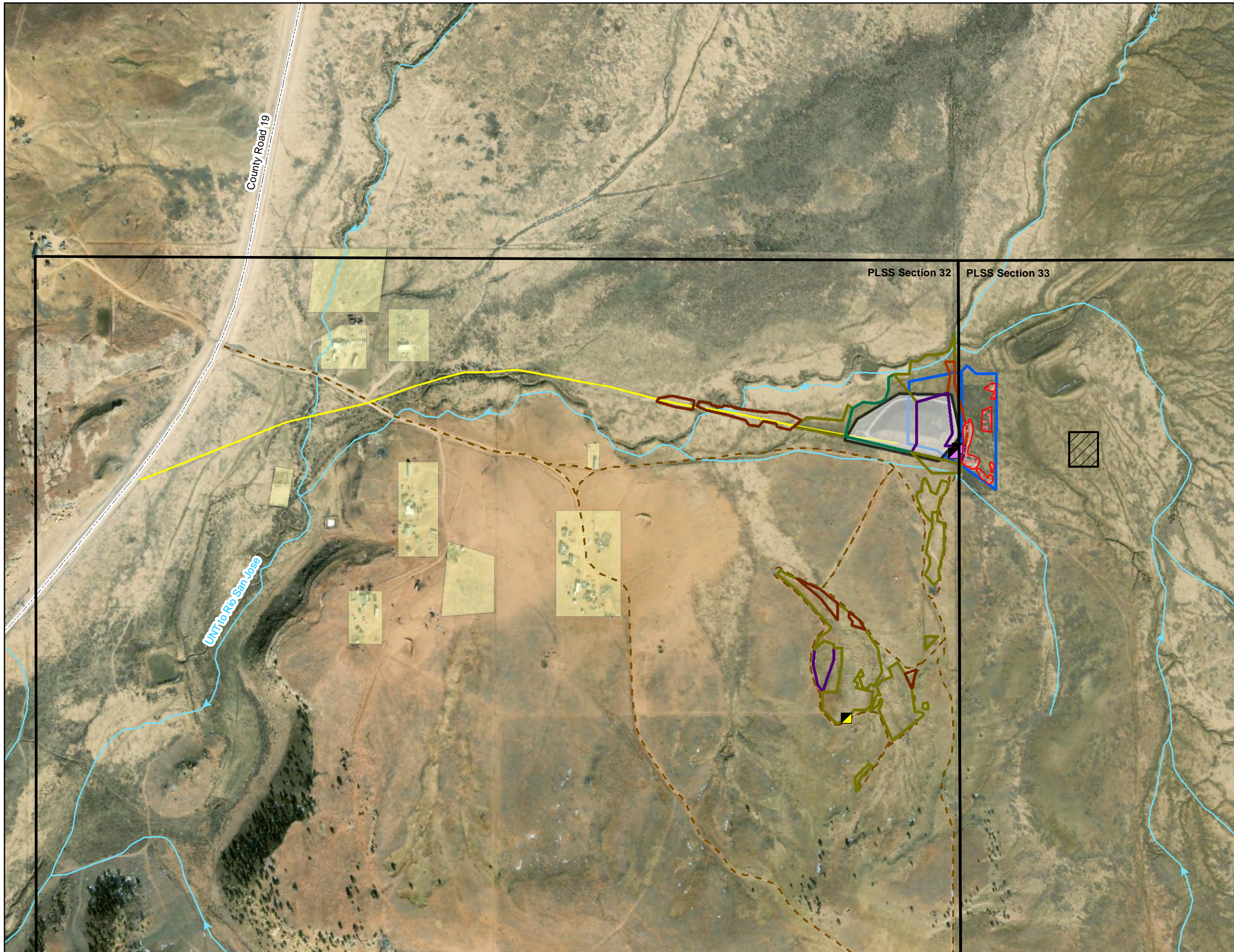
Not all TENORM features contain measured concentrations of Ra-226 above the background threshold value, which is the removal action goal at the Section 32 and 33 Mines. Only TENORM areas with Ra-226 concentrations above the background threshold value or that are considered sources of contamination are recommended for cleanup.



4.0 REFERENCES

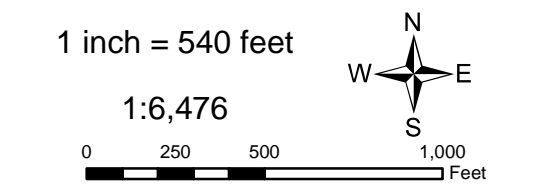
- TerraSpectra Geomatics. 2007. “Abandoned Uranium Mines and the Navajo Nation, Navajo Nation AUM Screening Assessment Report and Atlas with Geospatial Data.” August.
- Tetra Tech, Inc. (Tetra Tech). 2022. “Section 32 and 33 Mines Field Report, June Reconnaissance Visit.” Response, Assessment, and Evaluation Services. Contract No. EP-S9-17-02. Task Order 0031. July.
- Tetra Tech. 2023. “Section 32 and 33 Mines Data Gaps Investigation Transmittal Memorandum.” Response, Assessment, and Evaluation Services. Contract No. EP-S9-17-03.
- U.S. Environmental Protection Agency (USEPA). 2000. *Multi-Agency Radiation Survey and Site Investigation Manual*. August.
- USEPA. 2008. “Technologically Enhanced Naturally Occurring Radioactive Material From Uranium Mining. Volume 1: Mining and Reclamation Background.” EPA 402-R-08-005. April.
- USEPA. 2021a. “NORM-TENORM Determinations and Delineation.” Draft. June 14.
- USEPA. 2021b. “Mining Forensics and Physical Disturbance Guidance.” Draft. June 14.
- Weston Solutions, Inc. (Weston). 2019. “Removal Site Evaluation Report for Tronox Navajo Area Uranium Mines Sections 32 and 33 Mines, McKinley County, New Mexico. Prepared for USEPA.” September.

FIGURES



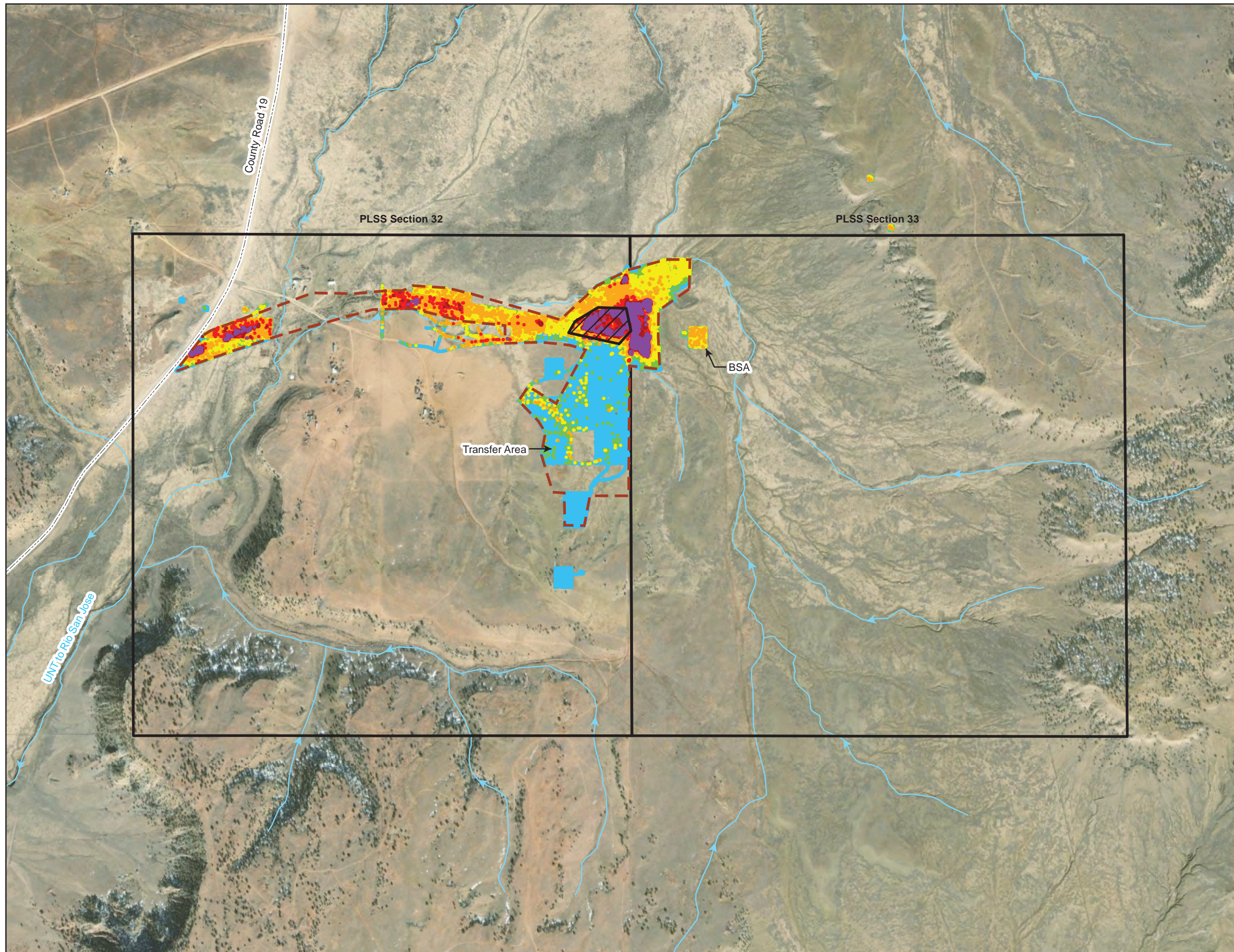
- Site Features**
- Closed Mine Shaft
 - Closed Mine Vent
 - Historic Haul Road
 - Residential Feature
 - Waste Stockpile Footprint
 - Waste Pile
- 2012 Removal Action Areas**
Excavation Depth (ft)
- 0.5 ft bgs
 - 1 ft bgs
 - 2 ft bgs
 - 3 ft bgs
 - 4 ft bgs
 - Tronox AUM Site¹
 - Background Study Area
 - PLSS Section Boundary / RSE Survey Area
 - County Road
 - Local Road
 - Drainage

Notes:
¹ Boudary is from TSG (2007).
 AUM Abandoned uranium mine
 bgs Below ground surface
 ft Foot
 PLSS Public Land Survey System
 RSE Removal site evaluation
 TSG TerraSpectra Geomatics
 UNT Unnamed tributary



SECTION 32 AND 33 MINES
 SITE FEATURES

Prepared For: U.S. EPA Region 9 	Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0031	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 6/7/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: B-1



Estimated Radium-226 (pCi/g)¹

● ≤ 1.66	≤ UCL
● 1.66 - 1.92	UCL - BTV (RAG) ^{2, 3}
● 1.92 - 3.32	BTV - 2 x UCL
● 3.32 - 4.98	2 x UCL - 3 x UCL
● 4.98 - 6.64	3 x UCL - 4 x UCL
● 6.64 - 8.30	4 x UCL - 5 x UCL
● > 8.30	> 5 x UCL

TENORM Boundary
 Waste Stockpile Footprint
 PLSS Section Boundary / RSE Survey Area

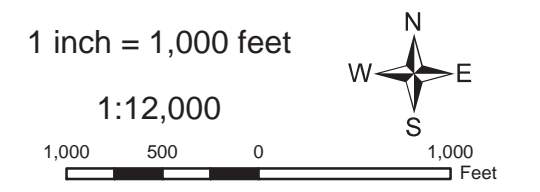
Notes:

¹Gamma survey data was collected by Weston Solutions, Inc. between June 26 and August 18, 2018.

²BTV is based on the 95 percent upper tolerance limit with 95 percent coverage of the background dataset.

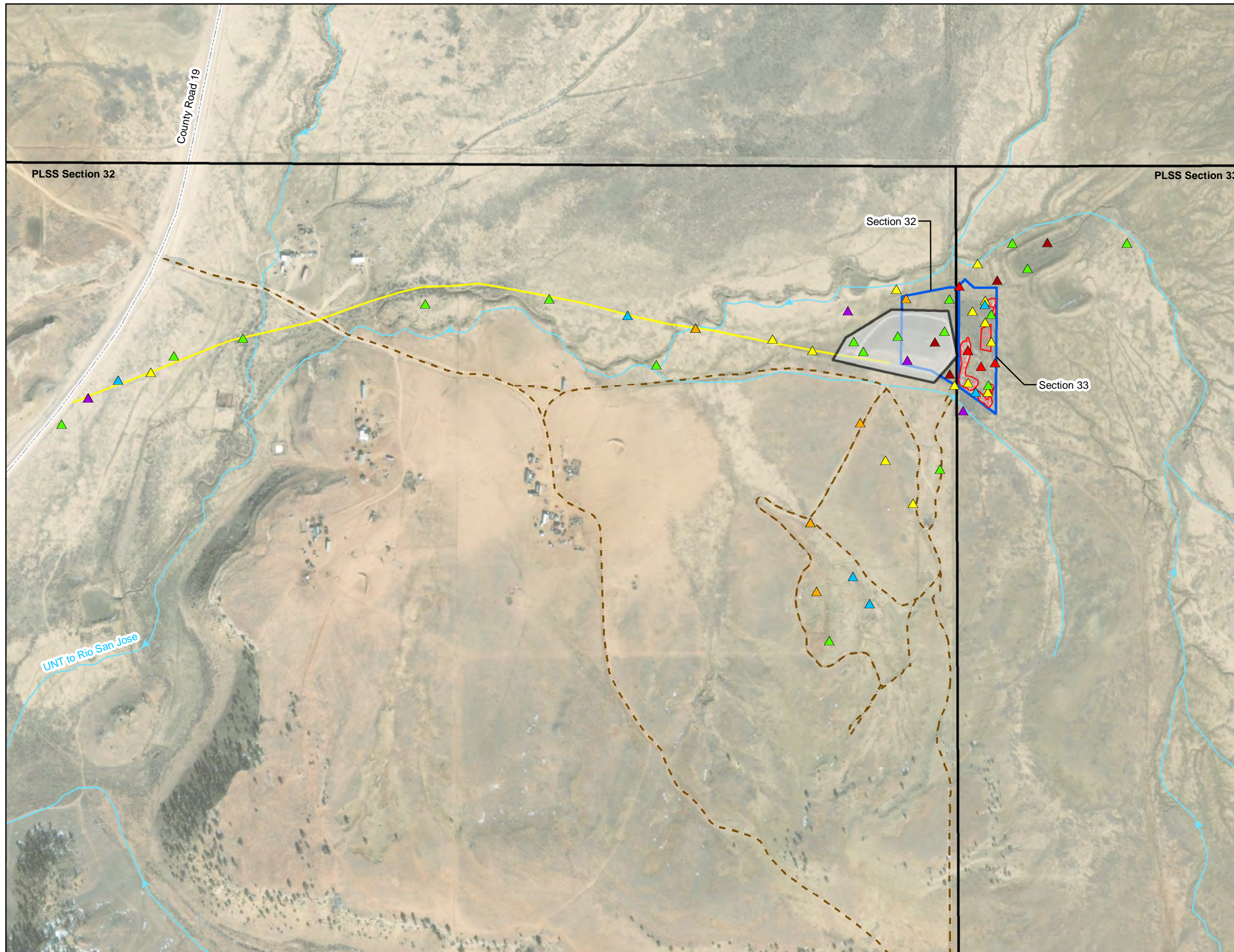
³The RAG is equal to the BTV because the BTV is greater than the HH and Eco RBSLs.

BTV Background threshold value
 Eco Ecological
 HH Human health
 pCi/g Picocurie per gram
 PLSS Public land survey system
 RAG Removal action goal
 RBSL Risk-based screening level
 RSE Removal site evaluation
 TENORM Technologically enhanced naturally occurring radioactive material
 UCL 95 percent upper confidence limit on the mean of the background dataset
 UNT Unnamed tributary



SECTION 32 AND 33 MINES
ESTIMATED RADIUM-226
SURFACE SOIL CONCENTRATIONS

Prepared For: U.S. EPA Region 9 	Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0016	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 6/7/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: B-2

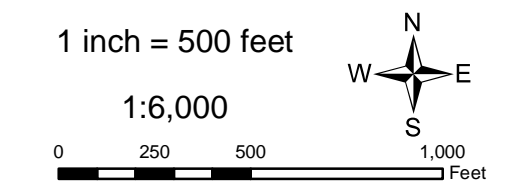


Selenium Surface Soil Concentration (mg/kg)

- ▲ 0.467000 - 1.050000
- ▲ 1.050001 - 1.670000
- ▲ 1.670001 - 2.260000
- ▲ 2.260001 - 3.420000
- ▲ 3.420001 - 4.750000
- ▲ 4.750001 - 10.500000
- ▲ 10.500001 - 16.800000

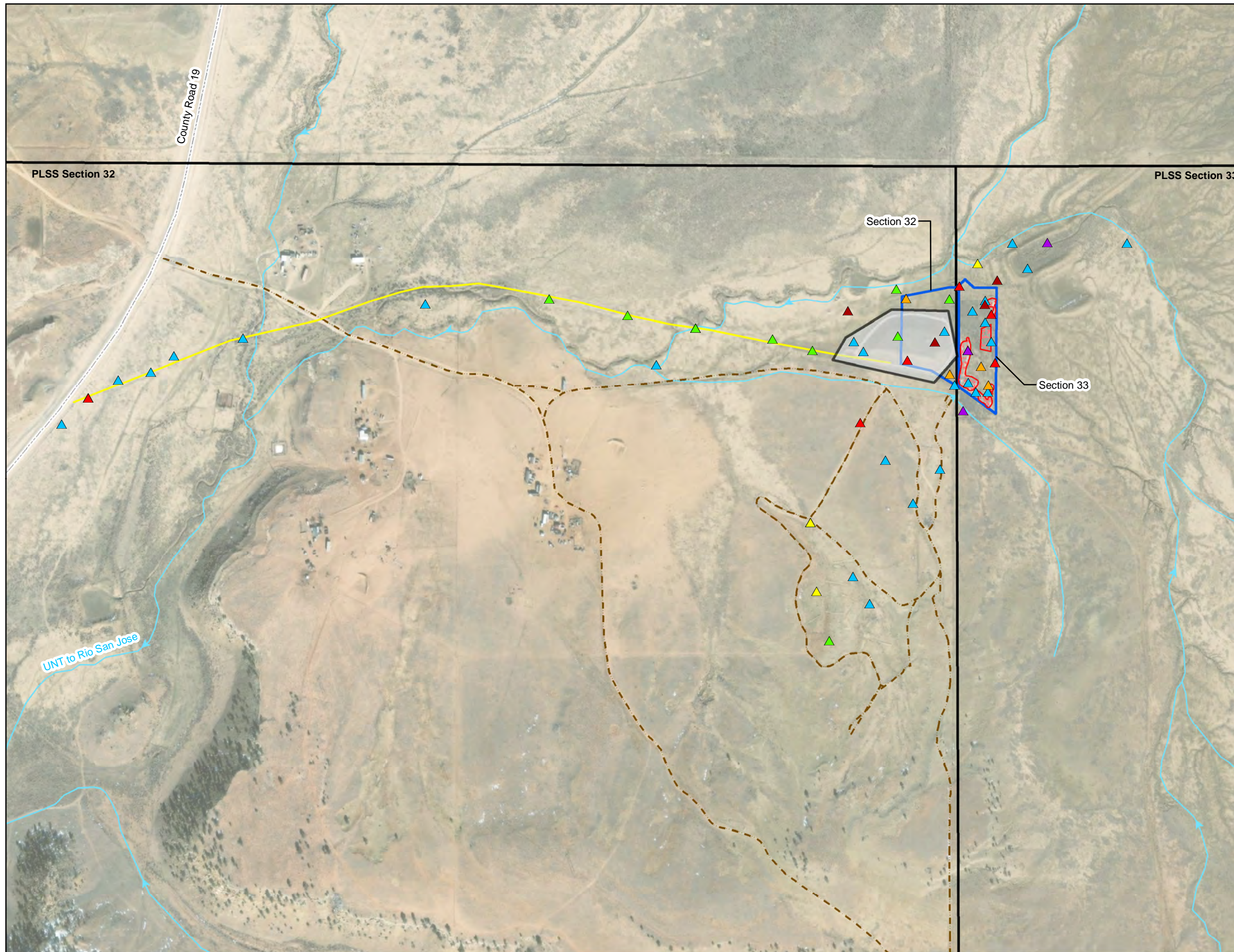
- ▭ Waste Stockpile Footprint
- ▭ Waste Pile
- ▭ Tronox AUM Site¹
- ▭ PLSS Section Boundary / RSE Survey Area
- Historic Haul Road
- County Road
- Local Road
- Drainage

¹ Boundary is from TSG (2007).
 AUM Abandoned uranium mine
 mg/kg Milligram per kilogram
 PLSS Public Land Survey System
 RSE Removal site evaluation
 TSG TerraSpectra Geomatics
 UNT Unnamed tributary



**SECTION 32 AND 33 MINES
 SELENIUM SURFACE SOIL
 DISTRIBUTION**

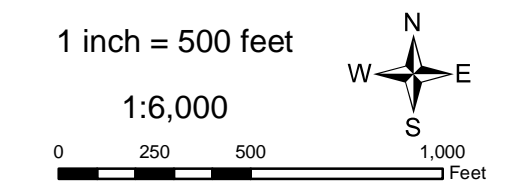
Prepared For: U.S. EPA Region 9 	Prepared By:
Task Order No.: 0031	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 1/25/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: B-3



- Uranium Surface Soil Concentration (mg/kg)**
- ▲ 0.606000 - 1.610000
 - ▲ 1.610001 - 2.740000
 - ▲ 2.740001 - 4.760000
 - ▲ 4.760001 - 9.410000
 - ▲ 9.410001 - 18.800000
 - ▲ 18.800001 - 32.400000
 - ▲ 32.400001 - 78.000000

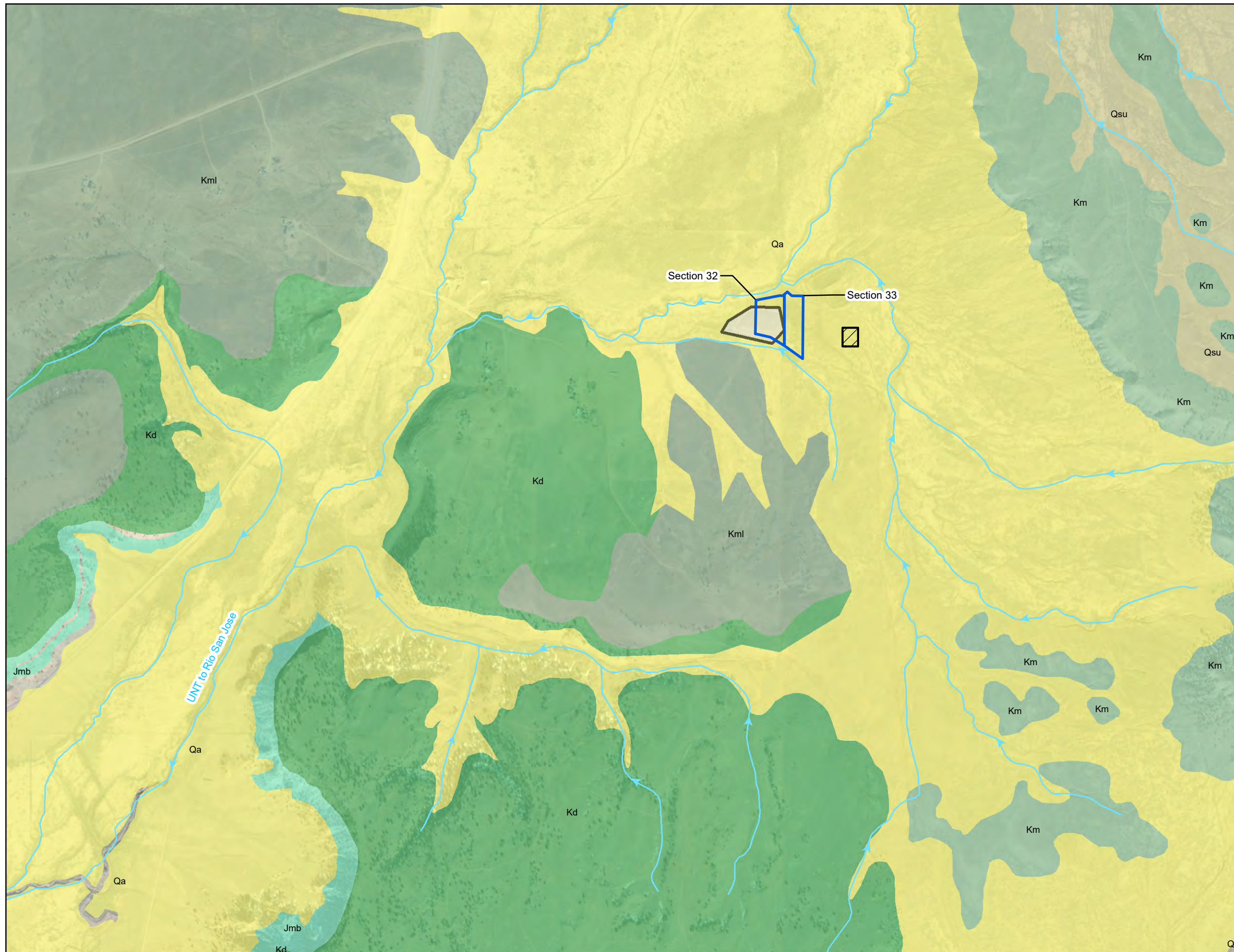
- ▭ Waste Stockpile Footprint
- ▭ Waste Pile
- ▭ Tronox AUM Site¹
- ▭ PLSS Section Boundary / RSE Survey Area
- Historic Haul Road
- County Road
- Local Road
- Drainage

¹ Boundary is from TSG (2007).
 AUM Abandoned uranium mine
 mg/kg Milligram per kilogram
 PLSS Public Land Survey System
 RSE Removal site evaluation
 TSG TerraSpectra Geomatics
 UNT Unnamed tributary



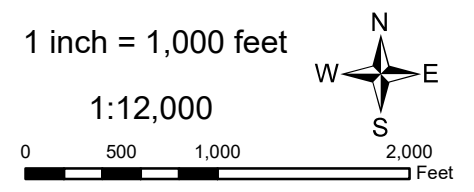
**SECTION 32 AND 33 MINES
 URANIUM SURFACE SOIL
 DISTRIBUTION**

Prepared For: U.S. EPA Region 9 	Prepared By:  TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0031	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 1/25/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: B-4



- Geologic Units**
- Surficial Deposits*
- Qa—Quaternary Alluvium
 - Qsu—Upland Deposits
- Cretaceous*
- Km—Main body of Mancos Shale
 - Kml—Lower part of Mancos Shale
 - Kd—Dakota Sandstone
- Jurassic*
- Jmb—Brushy Basin Member of Morrison Formation
- Tronox AUM Site¹
 - Waste Stockpile Footprint
 - Background Study Area
 - Drainage

Notes:
¹ Boudary is from TSG (2007).
 AUM Abandoned uranium mine
 TSG TerraSpectra Geomatics
 UNT Unnamed tributary



SECTION 32 AND 33 MINES
 LOCAL GEOLOGY



Task Order No.:
0031

Contract No.:
EP-S9-17-03

Location:
NAVAJO NATION

Date:
6/7/2023

Coordinate System:
 NAD 1983 State Plane New Mexico
 West FIPS 3003 Feet Transverse

Figure No.:
B-5



Figure B-6. Section 33 Mine Unreclaimed Waste Piles Facing Northeast



Figure B-7. Section 32 and 33 Mines Unreclaimed Waste Pile S33-01 Facing East



Figure B-8. Section 32 and 33 Mines Unreclaimed Waste Pile S33-02 Facing Southeast



Figure B-9. Section 32 Stockpile Facing East



Figure B-10. Reclaimed Section 32/33 Transfer Station Facing North with Disturbed Soil and No Vegetation

APPENDIX C

RISK ASSESSMENT

**Tronox Navajo Abandoned Uranium Mines
Eastern Abandoned Uranium Mine Region**

**Final
Appendix C
Section 32 and 33 Mines
Risk Assessment**

Response, Assessment, and Evaluation Services 2

Contract No. 68HE0923D0002

Task Order 003

August 31, 2023

**Submitted to
U.S. Environmental Protection Agency**

**Submitted by
Tetra Tech, Inc.
1999 Harrison Street, Suite 500
Oakland, CA 94612**





TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
ACRONYMS AND ABBREVIATIONS	C-iv
1.0 BACKGROUND AND ENVIRONMENTAL SETTING	C-1
1.1 MINE HISTORY AND LOCATION.....	C-1
1.2 GEOLOGY, HYDROGEOLOGY, AND HYDROLOGY.....	C-2
1.2.1 Geology.....	C-2
1.2.2 Hydrogeology	C-3
1.3 LAND USE.....	C-3
1.4 ECOLOGICAL SETTING	C-4
1.4.1 Climate.....	C-4
1.4.2 Vegetation.....	C-4
1.4.3 Wildlife	C-5
1.4.4 Special Status Species.....	C-5
2.0 DATA USED IN THE RISK ASSESSMENT	C-7
2.1 AVAILABLE DATA.....	C-7
2.2 DATA REDUCTION METHODS.....	C-8
2.3 EXPOSURE UNITS	C-8
3.0 HUMAN HEALTH RISK ASSESSMENT.....	C-9
3.1 DATA EVALUATION AND IDENTIFICATION OF CONTAMINANTS OF POTENTIAL CONCERN	C-9
3.2 EXPOSURE ASSESSMENT	C-9
3.2.1 Conceptual Site Model.....	C-10
3.2.2 Human Health Receptors, Exposure Pathways, and Exposure Parameters.....	C-10
3.2.3 Exposure Parameters.....	C-12
3.2.4 Exposure Point Concentrations.....	C-12
3.3 TOXICITY ASSESSMENT	C-13
3.3.1 Carcinogenic Effects.....	C-13
3.3.2 Noncarcinogenic Effects.....	C-13
3.3.3 Sources of Toxicity Values and Other Contaminant-Specific Parameters.....	C-13
3.4 RISK CHARACTERIZATION	C-14
3.4.1 Estimates of Cancer Risk and Noncancer Hazard	C-14
3.4.2 Uncertainty Associated with the Human Health Risk Assessment	C-15
4.0 ECOLOGICAL RISK ASSESSMENT	C-18
4.1 PROBLEM FORMULATION	C-18
4.1.1 Ecological Habitat and Biological Resources.....	C-19



4.1.2	Stressors and Constituents of Interest Selection	C-19
4.1.3	Potentially Complete Exposure Pathways	C-19
4.1.4	Assessment Endpoints	C-19
4.1.5	Measurement Endpoints.....	C-20
4.1.6	Conceptual Site Model.....	C-21
4.2	ANALYSIS OF EXPOSURE AND EFFECTS.....	C-21
4.2.1	Exposure Estimates.....	C-21
4.2.2	Ecological Effects	C-22
4.3	RISK CHARACTERIZATION	C-22
4.3.1	Tier I Screening for Contaminants of Potential Ecological Concern	C-23
4.3.2	Tier II Screening for Contaminants of Ecological Concern	C-23
4.3.3	Uncertainty Associated with the Ecological Risk Assessment.....	C-24
4.3.4	Exposure Estimates.....	C-24
4.3.5	Nondetected Contaminants of Potential Ecological Concern.....	C-25
4.3.6	Combined Exposures Across Media and Exposure Units	C-25
4.3.7	Tier II Hazard Quotients Based on No and Low Effect Levels	C-26
4.3.8	Risk to Plant and Invertebrate Communities	C-26
5.0	RISK ASSESSMENT RESULTS SUMMARY	C-27
6.0	REFERENCES	C-28

EXHIBITS

Exhibit C-1.	Federal and Navajo Nation-Listed Endangered or Threatened Species Having Potential to Occur at the Section 32 and 33 Mine Area.....	C-5
Exhibit C-2.	Receptor Evaluated at Each Exposure Unit	C-11
Exhibit C-3.	Cancer Risks and Noncancer Hazards	C-15
Exhibit C-4.	Candidate COCs Identified Based on Cancer Risks and Noncancer Hazards	C-15
Exhibit C-5.	Tier II Refined SLERA Candidate COECs.....	C-23
Exhibit C-6.	Candidate COCs or COECs for Soil	C-27



FIGURES

- Figure C-1. Section 32 and 33 Mines Location
- Figure C-2. Section 32 Mine Exposure Unit and Sample Locations
- Figure C-3. Section 33 Mine Exposure Unit and Sample Locations
- Figure C-4. Section 32 and 33 Mines Risk Assessment Conceptual Site Model

TABLES

- Table C-1. Soil Results Data Summary and Contaminant of Potential Concern Screening
- Table C-2. Exposure Unit Summary of Land Use, Geologic Formation, Type, Area, and Available Samples
- Table C-3. Human Health Exposure Parameters
- Table C-4. Exposure Point Concentrations for Human Health Risk Assessment
- Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine
- Table C-5.2. Human Health Risk and Hazard Calculations - Section 32 Mine
- Table C-6. Human Health Risk and Hazard Summary by Exposure Pathway
- Table C-7. Human Health Risk and Hazard Summary and Identification of Candidate Contaminants of Concern
- Table C-8. Ecological Risk Assessment Tier I Screening for Soil
- Table C-9. Exposure Point Concentrations for Ecological Risk Assessment
- Table C-10. Tier II Ecological Risk Hazard Quotients and Identification of Candidate Contaminants of Ecological Concern
- Table C-11. Comparison of Individual Sample Results to Plant and Invertebrate Lowest Observed Effect Concentrations

ATTACHMENT

- Attachment C-1. Data Used in the Risk Assessment



ACRONYMS AND ABBREVIATIONS

AUM	Abandoned uranium mine
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Contaminant of concern
COEC	Contaminant of ecological concern
COI	Constituent of interest
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
CSM	Conceptual site model
Eco-SSL	Ecological soil screening level
EE/CA	Engineering evaluation/cost analysis
EPC	Exposure point concentration
ERA	Ecological risk assessment
ESL	Ecological screening level
EU	Exposure unit
HHRA	Human health risk assessment
HQ	Hazard quotient
IUR	Inhalation unit risk
Kerr-McGee	Kerr-McGee Corporation
LANL	Los Alamos National Laboratory
LOEC	Lowest observed effect concentration
N3B	Newport News Nuclear BWXT-Los Alamos, LLC
NAUM	Navajo abandoned uranium mine
NNDFW	Navajo Nation Department of Fish and Wildlife
NNEPA	Navajo Nation Environmental Protection Agency
NOEC	No observed effect concentration
NORM	Naturally occurring radioactive material
ORNL	Oak Ridge National Laboratory
OSWER	Office of Solid Waste and Emergency Response
PRG	Preliminary remediation goal
Ra-226	Radium-226
RfC	Reference concentration
RfD	Reference dose

**ACRONYMS AND ABBREVIATIONS (CONTINUED)**

RME	Reasonable maximum exposure
RSE	Removal site evaluation
RSL	Regional screening level
SF	Slope factor
SLERA	Screening-level ecological risk assessment
TCR	Target cancer risk
TENORM	Technologically enhanced naturally occurring radioactive material
Tetra Tech	Tetra Tech, Inc.
THQ	Target hazard quotient
UCL95	95 percent upper confidence limit
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
Weston	Weston Solutions, Inc.



1.0 BACKGROUND AND ENVIRONMENTAL SETTING

The purpose of this Navajo Abandoned Uranium Mines (NAUM) program site-specific risk assessment is to estimate current and future human health risk under appropriate reasonable maximum exposure (RME) scenarios and ecological risk focused on the known ecosystems for the region. The results of the risk assessment are used to assist in removal action decisions at the Section 32 and 33 Mines. This NAUM risk assessment was performed using “Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act]” (U.S. Environmental Protection Agency [USEPA] 1993) and, thus, does not include or require all elements of a baseline risk assessment (USEPA 1989, 2001).

The human health risk assessment (HHRA) identifies candidate human health contaminants of concern (COC) for each exposure unit (EU) while the ecological risk assessment (ERA) identifies candidate contaminants of ecological concern (COEC) for each EU. The results of the risk assessments serve as lines of evidence in determining the extent of soil removal necessary at the Section 32 and 33 Mines to meet the removal action goals. See the “Navajo Abandoned Uranium Mines Risk Assessment Methodology” (USEPA 2023c) for additional information for conducting risk assessments at NAUM sites.

The Navajo Nation contains areas of naturally high levels of uranium. Starting in the 1940s, large amounts of uranium were mined on the Navajo Nation. Mining has brought more uranium to the surface of the earth, making exposure to people, plants, and animals more likely. Uranium is a naturally occurring radioactive material (NORM), and the effects of mining can lead to the presence of technologically enhanced naturally occurring radioactive material (TENORM).

Examples of TENORM at the Section 32 and 33 Mines include mine shafts and unmapped underground workings, waste piles, mine debris, a transfer station, and a haul road. Reclamation of some of these mine features occurred during the 2012 removal action and are described in Section 2.2 of the main engineering evaluation/cost analysis (EE/CA) report.

1.1 MINE HISTORY AND LOCATION

The Section 32 and 33 Mines are located within the Casamero Lake Chapter of the Navajo Nation in the Eastern Abandoned Uranium Mine (AUM) Region. The site is 9 miles north of the Prewitt, New Mexico, exit on Interstate 40 at 35.490 degrees latitude and -108.017 degrees longitude in McKinley County, New Mexico. The elevation is approximately 7,000 feet above mean sea level. The Section 32 Mine is within Navajo Allotment Land, and the Section 33 Mine is privately owned. [Figure C-1](#) shows the site location.

The Section 32 and 33 Mines were deep, dry underground mines. Both mines were accessed through near-vertical mine shafts and likely developed using underground room-and-pillar mining techniques to extract lenticular ore bodies containing uranium and vanadium (New Mexico Energy and Minerals Department 1979). Whether the pillars were salvaged and the rooms blasted closed is unknown. The Section 32/33 Transfer Station south of the main mining area was used for both mines.



Much of the waste produced at the Section 32 and 33 Mines is overburden that was piled near the mine shafts. Overburden is low-grade, native material that miners had to get through to access the ore. No surface features like subsidence, fissures, or cracks that may indicate mine collapse were observed during the removal site evaluation (RSE) investigation (Weston Solutions, Inc. [Weston] 2019).

The Section 32 and 33 Mines were developed in the early 1960s by the Kerr-McGee Corporation (Kerr-McGee), a predecessor of Tronox. The Section 32 Mine was operated by Kerr-McGee from 1960 to 1969 and produced 20,117 tons of uranium ore (McLemore and Chenoweth 1991). The Section 33 Mine was operated by Kerr-McGee from 1960 to 1964 and produced 4,242 tons of uranium ore (McLemore and Chenoweth 1991). Both mines are reported to be last operated by the Cobb Nuclear Company. Section 32 and 33 Mines features, haul and exploratory roads, exploratory boreholes, and reclamation features are shown on Figure 3 of the main EE/CA report.

The Section 32 and 33 Mines are accessed from Prewitt, New Mexico, by traveling north on paved County Road 19 and then east on an unpaved access road. The unpaved access road passes by multiple residences and ends along the south boundary of the Section 32 Mine temporary stockpile. A fence borders the private property on the Section 33 Mine along the west boundary of the Section 33 Mine.

1.2 GEOLOGY, HYDROGEOLOGY, AND HYDROLOGY

The following subsections describe the geology, hydrogeology, and hydrology of the Section 32 and 33 Mines. For more information, see Section 2.1.5 of the main EE/CA report.

1.2.1 Geology

The Section 32 and 33 Mines are within the Smith Lake subdistrict of the Grants Mining District. The Grants Mining District is a belt of sandstone-hosted uranium deposits that stretches from the Pueblo of Laguna to the area of Gallup, New Mexico. Most uranium deposits in the Grants Mining District are found in sandstone members of the Jurassic-age Morrison Formation. In the Section 32 and 33 Mines area, the Morrison Formation is covered by younger Cretaceous-age sandstones and mudstones. Quaternary-aged sand, sediment, and soil deposits fill small stream valleys and cover floodplains. Figure 5 of the main EE/CA report presents the geology at the site and in the surrounding areas. The important geological units in and near the Section 32 and 33 Mines are listed in stratigraphic order (oldest to youngest) and described below:

- Morrison Formation:
 - The Recapture member is made of sandstone and claystone.
 - The Westwater Canyon member is made of sandstone and is the main host of uranium deposits in the portion of the Grants Mining District where the Section 32 and 33 Mines are located (Santos 1970). The Westwater Canyon member interfingers with both the Recapture and Brushy Basin members. One of the larger fingers of the Westwater Canyon member in the overlying Brushy Basin member is the Poison Canyon Sandstone, which includes the ore horizon mined through the Section 32 and



33 Mines. The Poison Canyon Sandstone varies in thickness, and ore is known to be where the sandstone is 30 to 90 feet thick (Santos 1970).

- The Brushy Basin member is made of green/gray mudstones and a minor amount of sandstone.
- Dakota Sandstone is made of sandstone with a minor amount of mudstone, coal, and conglomerate, and interfingers with the overlying Mancos Shale. The mesa to the south of the Section 32 and 33 Mines is primarily Dakota Sandstone.
- Mancos Shale is made of mudstone, claystone, and siltstone. A small amount of Mancos Shale outcrops at the surface within the Section 32 and 33 Mines area. The mesa to the east the Section 32 and 33 Mines is primarily Mancos Shale.
- Alluvium is the silt, sand, and gravel in small stream valleys and floodplains. Most of the surface geology at the Section 32 and 33 Mines is alluvium.

1.2.2 Hydrogeology

A series of drainages, formed from surface water flow from the surrounding mesas, are the main drainage pathways in the Section 32 and 33 Mines area. These drainages are dry most of the year and flood during monsoon season. The closest drainage to the Section 32 and 33 Mines is approximately 200 feet to the north and is shallow and southwest flowing.

Groundwater depth and information on nearby water wells used for drinking water were not available during the 2019 Weston RSE (Weston 2019). No drinking water wells were identified within 4 miles of the mine sites during the 2009 Weston site screening investigation (Weston 2009). Additional research into existing wells and groundwater depth will be part of the construction design at Section 32 and 33 Mines.

1.3 LAND USE

Several residences are located nearby the Section 32 and 33 Mines, and the closest residence is 2,000 feet to the west. The closest population center is the community surrounding the Casamero Lake Chapter House, which is approximately 9 miles northwest of the Section 32 and 33 Mines.

The area containing the Section 32 and 33 Mines is fenced off from active cattle grazing on the Section 33 private property. Resident use of the area near the Section 32/33 Transfer Station is evidenced by recently used access roads and a trash dump site. The flat terrain of the Section 32 and 33 Mines provides more potential locations for the siting of houses, hogans, corrals, or stock-loading ramps. Future land uses could include agricultural activities, commercial activities, and residential areas; however, for the HHRA, only the RME scenario is evaluated at each EU (USEPA 2023c). The following potential RME land uses are identified for the Section 32 and 33 Mines:

- **Kee'da'whíí tééh (full-time Navajo resident)** is defined as areas that are easily accessible and relatively flat and is the land use identified at the Section 32 Mine.



- **Residential** is the potential current and future land use identified for the private property at the Section 33 Mine.

See [Section 2.3](#) for information on the EUs and receptors evaluated for each area of the Section 32 and 33 Mines.

1.4 ECOLOGICAL SETTING

The Section 32 and 33 Mines are in a remote area with a revegetated, previously disturbed mine area potentially providing habitat for ecological receptors. Wildlife inhabiting the site may directly ingest radionuclides and metals, which may then be transported to the organs within the wildlife receptors or other sites.

A natural resources survey was performed in November 2018 to identify protected species and general wildlife habitat and general vegetation and vegetative community types for the Section 32 and 33 Mine area (NV5, Inc. 2019). The survey found that shrub and grassland communities dominate the area around the Section 32 and 33 Mines and most closely resemble the Plains-Mesa Grassland community. The shrubby areas consisted of Great Basin Desert Shrub Saltbush communities. Arroyo Riparian vegetation is confined to the bottom of the intermittent waterways that cross through the study area, but waterways constitute less than 2 percent of the overall area.

The Section 32 and 33 Mines are within an Area 3 wildlife sensitive area, as identified by the Navajo Nation Department of Fish and Wildlife (NNDFW). Area 3 wildlife sensitive areas are classified as a less sensitive area containing a low and fragmented concentration of endangered and rare plant, animal, and game species on the Navajo Nation (NNDFW 2008). Therefore, development can proceed as recommended by NNDFW with few exceptions.

1.4.1 Climate

The Navajo Nation lies in a semi-arid climate with a high annual net pan evaporation rate of 54 inches per year. The nearby City of Gallup receives an average annual rainfall of 11 inches. Wind for 11 months of the year typically originates from the southwest, and in the month of August originates predominantly from the south. The winter average temperature is 29 degrees Fahrenheit with an average temperature in summer of 68 degrees Fahrenheit. Extreme heat in the summer (100 degrees Fahrenheit) and cold in the winter (-34 degrees Fahrenheit) can occur. Additional information on the climate at the Section 32 and 33 Mines is provided in Section 2.1.8 of the main EE/CA report.

1.4.2 Vegetation

Documented vegetative communities around the Section 32 and 33 Mines are Great Basin Desert Scrub (Saltbush, Blue Grama, Galleta, Western Wheat Grass), Great Basin Desert Scrub (Saltbush, Kochia, Gumweed, Various Weeds), and Arroyo Riparian (Rabbitbrush, Saltbush, Galleta). All of these are lowland communities that occur on mostly flat open ground. Most of the area has been heavily disturbed by mining activities in the past and is still impacted by cattle grazing. As a result, the overall vegetative cover and species diversity across much of this area is



low (NV5, Inc. 2019). Vegetated areas at the site are expected to provide better habitat for terrestrial receptors because plants serve as a food source and provide areas of refuge.

1.4.3 Wildlife

Most of the habitat at the Section 32 and 33 Mines is terrestrial/upland, and the primary impacted environmental medium is soil. Several small drainages pass through the Section 32 and 33 Mines, but these do not support wetlands or a riparian corridor and appear to convey insufficient flows to justify augmentation (NV5, Inc. 2019). Stock ponds are also located near the site but are not surrounded by vegetation. Riparian and wetland habitats are particularly important for ecological health in arid ecosystems, such as that at the Section 32 and 33 Mines area.

In general, wildlife is not common across the Section 32 and 33 Mines. Fewer than 20 vertebrate species were documented at the site during the natural resources survey (NV5, Inc. 2019). Overall, birds were scarce in species diversity and numbers. Signs of large mammals were found only in the wooded areas around the periphery of the Section 32 and 33 Mines. Small mammals were also uncommon. Some of this lack of diversity and abundance is likely because of the time of year the survey was conducted (winter). However, many of the lowland Great Basin Desert Scrub communities were in poor condition with stunted shrub growth and very little herbaceous ground cover. Additionally, a substantial portion of the northern half of the Section 32 Mine is impacted by human activities and domestic predators, such as dogs. All these factors can reduce the quality of habitat for vertebrate species.

1.4.4 Special Status Species

Based on a regional biological survey, federal and Navajo Nation-listed endangered or threatened species having the potential to occur at the Section 32 and 33 Mine area are in [Exhibit C-1](#); however, many are located outside of the reclamation area.

Exhibit C-1. Federal and Navajo Nation-Listed Endangered or Threatened Species Having Potential to Occur at the Section 32 and 33 Mine Area

Name	Status	Suitable Habitat and Potential Presence within the Section 32 and 33 Mines
Birds		
Golden eagle (<i>Aquila chrysaetos</i>)	BGEPA NESL G4	Potential nesting habitat on cliff faces nearby but none within 1 mile of the site.
Burrowing owl (<i>Athene cunicularia</i>)	NESL G4	Potential habitats present in prairie dog holes, banner-tailed kangaroo rat mounds, and mammals burrows in sidewalls of drainages.
Grey vireo (<i>Vireo vicinior</i>)	NESL G4 NMDGF T	Suitable nesting habitat in Coniferous Woodland (Pinyon/Juniper woodlands) in southern half of the Section 32 Mine and eastern edge of the Section 33 Mine.
Peregrine falcons (<i>Falco peregrinus anatum/tundrius</i>)	NESL G4 NMDGF T	Potential nesting habitat on cliff faces nearby but not within 1 mile of the site.
Mountain plover (<i>Charadrius montanus</i>)	NESL G4	Potential habitat in Plains Mesa Grassland habitat in the center of the Section 32 Mine south of the houses.



Name	Status	Suitable Habitat and Potential Presence within the Section 32 and 33 Mines
Mammals		
Spotted bat (<i>Euderma maculatum</i>)	NMDGF T	Suitable nesting habitat in Coniferous Woodland (Pinyon/Juniper woodlands) in southern half of the Section 32 Mine and eastern edge of the Section 33 Mine.

Notes:

Sources are USFWS (2022) and NNDFW (2022).

- BGEPA Bald and Golden Eagle Protection Act
- G4 Group 4: Insufficient for listing as “endangered” but has reason to consider them.
- NESL Navajo Endangered Species List
- NMDGF New Mexico Department of Game and Fish
- NNDFW Navajo Nation Department of Fish and Wildlife
- T Threatened
- USFWS U.S. Fish and Wildlife Service



2.0 DATA USED IN THE RISK ASSESSMENT

Data compilation and management tasks conducted at the Section 32 and 33 Mines risk assessment included the selection of useable data and evaluation of sample depth intervals and selection of depth intervals to be evaluated. At this time, gamma data are not considered definitive data and, therefore, were not used in the risk assessment. However, gamma data were used to help delineate TENORM boundaries and will be used to define the risk-based footprint for removal decisions.

The compiled investigation data for the constituents of interest (COI) were reviewed to confirm that the appropriate data were used for the evaluation of each EU. Essential nutrients such as calcium, magnesium, potassium, and sodium are not retained as COIs. The data were separated by the depth intervals to be evaluated before calculating the exposure point concentrations (EPC) and other statistical values. [Figure C-2](#) presents the locations of the available soil samples used in the risk assessment for the Section 32 Mine. [Figure C-3](#) presents the locations of the available soil samples used in the risk assessment for the Section 33 Mine.

2.1 AVAILABLE DATA

Evaluation of potential human and ecological exposure at the Section 32 and 33 Mines is limited to radionuclides and metals in soil. [Table C-1](#) provides the summary of all sample results available for the risk assessment for the Section 32 and 33 Mines. [Table C-2](#) provides the summary of the number of samples available for each EU at the Section 32 and 33 Mines. [Attachment C-1](#) presents the results of all available soil samples for the Section 32 and 33 Mines.

A data useability assessment is conducted to confirm that the useability of the laboratory data is consistent with USEPA guidance (1992a). Data validation of all results used in the risk assessment was performed per the guidelines for data review (USEPA 2004, 2020). Data validation reports were reviewed, and the following key data validation flags should be considered in the data reduction process:

- Estimated values (flagged with “J” qualifiers) are treated as detected concentrations.
- Rejected data (flagged with “R” qualifiers) are not included in the risk assessment datasets because of deficiencies in meeting quality control criteria. No data in the datasets were rejected.
- Results with final validation qualifiers containing a “U” or “UJ” are nondetect values included as part of the risk assessment datasets. The method reporting limit was used as the value for nondetect results. There are four selenium and five uranium results in the RSE results (Weston 2019) that are reported as nondetect, but the method reporting limit was not provided with the data. These four selenium and five uranium results were not included in the exposure evaluation of the risk assessment.



2.2 DATA REDUCTION METHODS

The metals and radiological data were queried to select the best result for each unique combination of sample media, location ID, sample date, and sample depth for which duplicate data exist. These procedures conservatively select one result for original and field duplicate pairs. For duplicate samples, the maximum detected concentration of the original and field duplicate result was selected as the result for use in the risk assessment. If both the original and field duplicate result are nondetect, the result associated with the lower reporting limit was used.

2.3 EXPOSURE UNITS

An EU is a geographic area with a particular land use within which an exposed receptor (a person or animal) may reasonably be assumed to move at random and where contact across the EU is equally likely over the course of an exposure duration. In addition, plants, which do not move, and soil invertebrates, which move over smaller areas, are evaluated for each EU in the ERA. The Section 32 and 33 Mines EUs were developed by identifying areas of contiguous TENORM contamination and anticipated future land use. The risk assessment boundary (the entirety of all areas evaluated within EUs) was established via soil sampling and augmented through examination of gamma survey data. See Section 2.3 of the main EE/CA report for descriptions of previous investigations and Section 2.4 of the main EE/CA report for the extent of contamination at the Section 32 and 33 Mines.

Based on the site evaluation and summarized in [Table C-2](#), the following EUs were identified at the Section 32 and 33 Mines:

- **Section 32 Mine** – The Section 32 Mine is allotment land of the Navajo Nation. Several residences are located on the Section 32 Mine with the nearest residence located approximately 2,000 feet from the former mine site. Therefore, Kee'da'whíí tééh (full-time Navajo resident) was selected as the RME receptor for the HHRA.
- **Section 33 Mine** – The Section 33 Mine is privately-owned land that is currently used for livestock grazing. Most of the active mining took place at the Section 33 Mine, and waste piles are present on site. The property could be used for a residence in the future; therefore, the default resident (non-Navajo) was selected as the RME receptor for the HHRA.

The existing or anticipated future land use for an area is key in determining the potential receptors evaluated in the HHRA conducted for a site. Local chapters establish how areas within their jurisdiction can and cannot be used, and some lands have been designated as wildlife areas, which may restrict the type of future land use that is permitted. Section 32 and 33 Mines is classified as an Area 3 wildlife area; thus, development can proceed as recommended by NNDFW with few exceptions.

The RME receptor for each EU was selected based on the criteria provided in the NAUM risk assessment methodology (USEPA 2023c) and site knowledge. [Figure C-2](#) and [Figure C-3](#) provide the locations of samples used in the risk assessment for each EU.



3.0 HUMAN HEALTH RISK ASSESSMENT

The HHRA evaluates whether site-related contaminants detected in soil pose unacceptable risks to potential current and future people at a site under conditions at the time of the EE/CA (unremediated conditions) (USEPA 1989). The HHRA results will serve, along with other factors (such as the ERA and the three National Oil and Hazardous Substances Pollution Contingency Plan and EE/CA criteria of feasibility, implementability, and cost), as a basis for risk management decisions. The HHRA is intended to provide input for risk management decision-making for a site while maintaining a conservative approach protective of people at a site. The methodology for the HHRA is based on the NAUM risk assessment methodology (USEPA 2023c). [Table C-1](#) through [Table C-7](#) present data and analysis associated with the HHRA.

3.1 DATA EVALUATION AND IDENTIFICATION OF CONTAMINANTS OF POTENTIAL CONCERN

All samples collected between 0 and 72 inches below ground surface (bgs) and analyzed by a certified laboratory were used to screen for contaminants of potential concern (COPC) for the HHRA. Samples at Section 32 and 33 Mines were analyzed for metals and radium-226 (Ra-226). The maximum detected concentrations of contaminants were screened using the Kee'da'whíí tééh (full-time Navajo resident) soil screening levels using a target cancer risk (TCR) of one in one million (1×10^{-6}) and a noncancer target hazard quotient (THQ) of 0.1. These conservative screening levels were used to identify and include all contaminants that could contribute to cumulative risk in the cancer risk calculations, and to ensure that the contaminants affecting the same target organ are accounted for in the noncancer hazard calculations. The NAUM Risk Calculator (USEPA 2023d) was used to calculate the COPC screening levels. For contaminants with both cancer and noncancer health effects, the lower of the two screening levels was used for screening.

Any contaminant with a maximum detected concentration exceeding its COPC screening level is retained as a COPC for the HHRA risk calculations. [Table C-1](#) provides the COPC screening for the available Section 32 and 33 Mines data. Based on the screening, the following contaminants were identified as COPCs and are included in the risk estimates in the HHRA: Ra-226, aluminum, antimony, arsenic, barium, cadmium, cobalt, copper, iron, manganese, molybdenum, nickel, selenium, thallium, uranium, and vanadium.

3.2 EXPOSURE ASSESSMENT

The exposure assessment is the process of measuring or estimating intensity, frequency, and duration of human exposure to a contaminant in the environment. The exposure assessment considers land use assumptions, discusses the mechanisms by which people might contact COPCs in environmental media, and characterizes exposure factors (for example, time on site). The intake assumptions are combined with the estimated concentration for each COPC at each EU, called the EPC, to quantitatively estimate the contaminant exposure for the receptors at a



given EU. In accordance with USEPA (1989) guidance, an exposure assessment consists of three steps:

1. Characterization of the exposure setting (physical environment and potential receptors)
2. Identification of exposure pathways (constituent sources, exposure points, and exposure routes)
3. Quantification of pathway-specific exposures (receptor intake calculations using the EPC and exposure assumptions)

3.2.1 Conceptual Site Model

The risk assessment conceptual site model (CSM) describes the exposure setting and identifies potentially complete exposure pathways by which receptors (people, plants, and animals) could contact site-related contamination. The CSM is used throughout the site investigation and removal processes to (1) provide a framework for addressing potential risks, (2) evaluate the need for additional data acquisition activities, and (3) evaluate health risks and the need for corrective measures. As defined in Volume 1, Part A, of the “Risk Assessment Guidance for Superfund” (USEPA 1989), the following four elements are necessary to form a complete exposure pathway:

- A source or release from a source
- A mechanism of release and transport
- A point of contact for potential receptors
- An exposure route.

If any one of the four elements are missing, the exposure pathway is incomplete. In general, only potentially complete exposure pathways are evaluated in the HHRA.

The removal actions at NAUM sites are focused on removing soil as the source of contamination. Removal of contaminated soil should remove the source of contamination to surface water and groundwater.

For the HHRA, exposure to surface water or groundwater is assumed to be minimal as water used for domestic purposes is supplied on the Navajo Nation. Water used in homes and for cattle is tested for contamination.

See Section 1.4 of the main EE/CA report for further discussion on the sources and extent of contamination. The site-specific CSM for the Section 32 and 33 Mines is presented on [Figure C-4](#).

3.2.2 Human Health Receptors, Exposure Pathways, and Exposure Parameters

The current and future potential human receptors based on land use were identified at the Section 32 and 33 Mines as follows:

- Kee'da'whíí tééh (full-time Navajo resident) at the Section 32 Mine on the Navajo Nation.



- Default resident (non-Navajo) at the Section 33 Mine on private property.

Consistent with Superfund methodology, the risks and hazards related to removal activities at the site are anticipated to be managed within acceptable levels using engineering controls and personal protective equipment. Therefore, potential exposures to contaminants by removal action workers are not evaluated in the risk assessment, but worker protections should be included for removal actions at the site.

The CSM describes the exposure setting and identifies potentially complete exposure pathways by which people could contact site-related contamination.

Consistent with the NAUM risk assessment methodology (USEPA 2023c), the HHRA only evaluates the RME individual at an EU. [Exhibit C-2](#) presents the RME receptor selected at each EU and a description of the exposure scenario.

Exhibit C-2. Receptor Evaluated at Each Exposure Unit

Exposure Unit	Receptor Name	Receptor Description
Section 32 Mine	Kee'da'whíí tééh (Full-Time Navajo resident)	A member (adult and child) of the Navajo Nation that lives full time at a site. Includes external exposure to radiation, incidental ingestion of soil, dermal exposure to soil (metals only), inhalation of soil or dust, ingestion of homegrown produce and gathered wild plants, and consumption of animal products from raised animals (meat, milk, eggs) and hunted animals (meat), as well as plant exposures (ingestion, dermal, and inhalation) from Other Diné Lifeways practices, including medicinal and ceremonial exposures.
Section 33 Mine	Default Resident (Non-Navajo)	Non-Navajo people that live full time at a site. Exposure pathways evaluated include external exposure to radiation, incidental ingestion of soil, dermal exposure to soil (metals only), and inhalation of soil or dust.

The following list provides the RME scenarios evaluated at the Section 32 and 33 Mines and the potentially complete human exposure pathways that apply to all land use types and receptors:

- Potential exposure to gamma radiation via external exposure
- Potential exposure to site-related contaminants in soil through the incidental ingestion, dermal contact, and inhalation

In addition, the RME receptor, Kee'da'whíí tééh (full-time Navajo resident), at the Section 32 Mine was evaluated for the following exposure pathways:

- Potential exposure to site-related contaminants in homegrown produce through ingestion
- Potential exposure to site-related contaminants in gathered plants via ingestion or inhalation or both. Potential exposure to metals in gathered plants via dermal contact. The plant exposure pathway includes Other Diné Lifeways, such as medicinal and ceremonial uses of plants.



- Potential exposure to site-related contaminants in animal products (raised and hunted) via ingestion

3.2.3 Exposure Parameters

Exposure inputs for the Navajo receptors are based on the Navajo Nation Environmental Protection Agency (NNEPA) inputs for receptors evaluated at the NAUM sites. The Navajo receptor exposure parameters are provided in [Table C-3](#), and the rationale for the exposure inputs provided by NNEPA are included as Attachment 1 of the NAUM risk assessment methodology (USEPA 2023c). Appendix B of the NAUM risk assessment methodology (USEPA 2023c) provides discussion of the non-standard exposure pathways evaluated in the Navajo-specific exposure scenarios, including selection of input parameters for plant and animal consumption pathways.

The exposure parameters used for the default resident (non-Navajo) at Section 33 Mine are also provided on [Table C-3](#). The default resident exposure inputs are from the USEPA online PRG Calculator (USEPA 2023a) or RSL Calculator (USEPA 2023b).

3.2.4 Exposure Point Concentrations

To calculate concentrations in environmental media (for example, surface soil) to which people might be exposed, representative statistics are calculated from the data sets for each EU.

The available soil data for the site were divided by the EUs identified in [Section 2.0](#). Soil samples are further divided by sample depth to correspond to the surface and subsurface soil intervals evaluated in the risk assessment. Surface soil samples are those collected from 0 to 6 inches bgs while subsurface soil samples are those collected from 0 up to 72 inches bgs. As described in the NAUM risk assessment methodology (USEPA 2023c), these soil depths were selected to incorporate the use of more of the available data from the NAUM sites. A depth of 72 inches was selected for potential human health exposures because deeper soil could become exposed in the future by erosion. In addition, plants in desert settings commonly have roots to 72 inches bgs. Thus, uptake to plants from contamination at depth is a complete exposure pathway for both the HHRA and ERA. Furthermore, burrowing animals are evaluated in the ERA; 72 inches bgs is an appropriate exposure depth for evaluating these ecological receptors.

The methods described in Appendix D of the NAUM risk assessment methodology (USEPA 2023c) were used to calculate the EPC for each COPC in each EU. The approach and calculations for EPCs follow USEPA (1989, 1992b, 2000a, 2002) guidance. The EPC calculations for this risk assessment were performed using ProUCL 5.2 (USEPA 2022b). A minimum of 10 samples and four detected results are required to calculate the 95 percent upper confidence limit (UCL95) of the arithmetic mean used as the EPC for a given contaminant. If the dataset was smaller than 10 samples or the number of detections was less than four, the maximum detected concentration was used as the EPC. If a nonradioactive COPC was not detected in a sample when entering data into ProUCL, the sample reporting limit was used as the numerical value for EPC calculations. The EPCs used in the HHRA for each COPC for each EU and grouped by soil depth interval are presented in [Table C-4](#).



3.3 TOXICITY ASSESSMENT

The toxicity assessment describes the relationship between a dose of a contaminant and the potential likelihood of an adverse health effect. The purpose of the toxicity assessment is to quantitatively estimate the inherent toxicity of COPCs for use in risk characterization. Potential effects of contaminants are separated into two categories: cancer and noncancer effects. Some contaminants can cause cancer while others can cause noncancer health effects such as neurological problems, kidney disease, and thyroid disease. Some contaminants, such as arsenic, have both cancer and noncancer health effects. Potential health risks for radionuclide COPCs are evaluated only for cancer risks while metals COPCs are evaluated for both cancer risks and noncancer hazards as appropriate.

3.3.1 Carcinogenic Effects

For carcinogens, such as radionuclides, USEPA assumes that no dose is low enough to not cause an adverse health effect and that the risk increases as the dose increases.

Potential carcinogenic effects resulting from human exposure to contaminants are estimated quantitatively using cancer slope factors (SF), which represent the theoretical increased risk per milligram of constituent intake per kilogram body weight per day (inverse of milligram per kilogram per day). Oral SFs are toxicity values for evaluating the probability of an individual developing cancer from oral exposure to contaminant levels over a lifetime. The oral SF is also used in the dermal exposure pathway with an absorption factor applied for the nonradioactive contaminants.

The inhalation unit risk (IUR) factor is defined as the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to a contaminant at a concentration of 1 microgram per cubic meter in air. SFs or IUR factors are used to estimate a theoretical upper-bound lifetime probability of an individual developing cancer from exposure to a potential carcinogen.

3.3.2 Noncarcinogenic Effects

Potential noncarcinogenic effects resulting from human exposure to contaminants are generally estimated quantitatively using chronic reference doses (RfD) and chronic reference concentrations (RfC). The RfD, expressed in units of daily dose (in milligrams per kilogram per day), is an estimate of the daily maximum level of exposure to human populations (including sensitive sub-populations) that is likely to be without an appreciable risk of deleterious effects (USEPA 1989). The oral RfD is also used in the dermal exposure pathway with an absorption factor applied. USEPA has derived RfCs for inhalation exposures for some contaminants. An inhalation RfC is similar to an RfD. If the concentration of a contaminant in air to which a human is exposed is lower than the RfC, no appreciable risk for noncancer health effects results from that exposure.

3.3.3 Sources of Toxicity Values and Other Contaminant-Specific Parameters

The USEPA (2003) established a hierarchy of human health toxicity values for Superfund; this hierarchy should be followed for selecting the toxicity values used in the HHRA. This HHRA used the toxicity values used in the NAUM Risk Calculator (USEPA 2023d), which are provided



in Table 4 and Table 5 of the NAUM risk assessment methodology (USEPA 2023c) for radionuclides and metals, respectively. Toxicity values are from the preliminary remediation goals (PRG) for radionuclides (USEPA 2023a) and regional screening levels (RSL) (USEPA 2023b) websites.

3.4 RISK CHARACTERIZATION

In general, risk characterization proceeds by combining the results of the exposure and toxicity assessments. In standard Superfund HHRA, exposures are calculated by use of medium-specific EPCs and a series of pathway-specific exposure parameters. These exposures are then multiplied or divided by analyte-specific toxicity factors (for example, SFs, unit risk factors, RfDs, and RfCs) to generate receptor- and exposure pathway-specific risks and hazards.

3.4.1 Estimates of Cancer Risk and Noncancer Hazard

Human health exposure factors were calculated for each applicable receptor and COPCs for all the potentially complete soil-related exposure pathways. For metal COPCs with both carcinogenic and noncarcinogenic toxicity, intake factors were calculated for both cancer and noncancer for each relevant exposure pathway. The methods, assumptions, and inputs for the calculation of the intake factors for the Navajo-specific scenario is provided in the NAUM risk assessment methodology (USEPA 2023c). [Table C-5.1](#) and [Table C-5.2](#) present the calculated cumulative cancer risk and noncancer hazard for each COPC for each EU by soil depth interval. That is, the risk is summed for all the exposure pathways relevant to each receptor. [Table C-6](#) provides a summary of the cumulative risk by exposure pathway for each EU.

The intake factors used in the HHRA were calculated using the NAUM Risk Calculator (USEPA 2023d). The USEPA (2023b) RSL Calculator considers only direct soil exposures (for example, soil ingestion, dermal contact, and inhalation of fugitive dust). The NAUM Risk Calculator generates exposure pathway-specific cancer risks and noncancer hazards, including animal product and produce consumption pathways, and exposure pathways specific to the Navajo, as well as external exposure to radiation and direct exposure to radiation in soil through incidental ingestion and inhalation. The complete set of equations and inputs for calculating the exposure inputs for Navajo receptors is provided in the NAUM risk assessment methodology (USEPA 2023c).

The cumulative cancer risk for the age-adjusted adult and child receptors and noncancer hazards for the adult and child receptors for each EU and soil depth interval are provided in [Table C-7](#) and summarized in [Exhibit C-3](#).



Exhibit C-3. Cancer Risks and Noncancer Hazards

Exposure Unit	Soil Interval	Cancer Risk	Adult Noncancer Hazard	Child Noncancer Hazard
Section 32 Mine	Surface Soil	1×10^{-2}	10	20
	Subsurface Soil	1×10^{-2}	10	20
Section 33 Mine	Surface Soil	2×10^{-3}	0.4	4
	Subsurface Soil	3×10^{-3}	0.4	5

Note:

Bolded values exceed the target cancer risk or target hazard.

Candidate COCs are identified based on the cancer risk exceeding the TCR of 1×10^{-4} or a noncancer hazard of 1 for the RME receptor at the EU. COPCs with a cancer risk within the USEPA risk range of greater than 1×10^{-6} to 1×10^{-4} are indicated on [Table C-7](#). Target organ analyses were not performed for any scenario-media combination because no instances arose where the target organ hazard index exceeded 1 and no individual COPC had a hazard exceeding 1. [Exhibit C-4](#) presents the candidate COCs for each EU as identified in [Table C-7](#).

Exhibit C-4. Candidate COCs Identified Based on Cancer Risks and Noncancer Hazards

Exposure Unit	Soil Interval	Cancer Risk	Noncancer Hazard
Section 32 Mine	Surface and Subsurface Soil	Radium-226 Arsenic	Cobalt Iron Manganese Thallium Uranium
Section 33 Mine	Surface and Subsurface Soil	Radium-226	Uranium

Notes:

COC Contaminant of concern

3.4.2 Uncertainty Associated with the Human Health Risk Assessment

Uncertainties are inherent in the process of quantitative risk assessments based on the use of environmental sampling results, assumptions regarding exposure, and the quantitative representation of contaminant toxicity. Analysis of the critical areas of uncertainty in a risk assessment provides a better understanding of the quantitative results through the identification of the uncertainties that most significantly affect the results.

USEPA (1989) guidance stresses the importance of providing an in-depth analysis of uncertainties so that risk managers are better informed when evaluating risk assessment conclusions. Potentially significant sources of uncertainty for this risk assessment are discussed in the following subsections. The NAUM risk assessment methodology (USEPA 2023c) provides more general HHRA uncertainty discussions for topics applicable to all NAUM sites.



3.4.2.1 Sample Design

The sampling collection for the site was not based on a random sampling design. Instead, sampling was biased toward known areas of contamination based on the results of gamma surveys. Thus, while some areas do not have the same level of sampling coverage as others, those areas are not likely to have high levels of contamination based on the site survey techniques employed before collection of discrete samples for laboratory analysis. The uncertainty associated with the sample collection is moderate, but the samples used in the risk assessment are likely to overestimate the actual site risk because of the biased nature of the samples collected at the site.

3.4.2.2 Uncertainty in the Conceptual Site Model

The CSM for the Section 32 and 33 Mines incorporates several assumptions regarding the completeness and reasonableness of the exposure scenarios presumed at the site. The primary assumptions seem evidently valid. Examples include:

- Potential future use of areas within the Section 32 Mine for Kee'da'whíí tééh (full-time Navajo resident) — Examples of nearby full-time residences on the Navajo Nation are available.
- Potential future use of the mine areas within the Section 33 Mine for a default (non-Navajo) resident — Examples of nearby full-time residences are available, and no restrictions are in place to prevent building a residence on the site.

The NAUM Risk Calculator (USEPA 2023d) used to calculate the risk and hazards incorporates numerous Navajo-specific exposure pathways. Therefore, any potential to underestimate total exposure by a Kee'da'whíí tééh (full-time Navajo resident) receptor is expected to be small to moderate.

The risk and hazards for the default resident (non-Navajo) were calculated using standard exposure parameters that are based on average expected exposures and are backed by peer-reviewed studies. Therefore, any potential to underestimate total exposure by a default resident receptor is expected to be minimal.

3.4.2.3 Uncertainty in Exposure Parameters

Values assumed for most of the exposure parameters used in the calculation of intakes were based primarily on default parameters recommended by USEPA (2023a, 2023b) guidance. These assumptions might result in under- or overestimating the intakes calculated for specific receptors, depending on the accuracy of the assumptions relative to actual site conditions and land uses. The NAUM risk assessment methodology (USEPA 2023c) provides discussion of the uncertainties associated with the Navajo receptors evaluated.

A default residential receptor was selected for the private property at the Section 33 Mine. If this receptor is less conservative than the actual future land use (for example, the land is not used for residential), the HHRA would not be protective. Likewise, if the future land use is less intensive than the receptor selected (for example, agriculture), the HHRA would be overly protective.



At other NAUM sites, the risk and hazards to RME receptors from different EUs were added as possible and reasonable. However, at Section 32 and 33 Mines there are only two EUs and both are evaluated for residential receptors. Thus, the risk and hazards from the individual EUs are not appropriate to add together for a site-wide risk evaluation.



4.0 ECOLOGICAL RISK ASSESSMENT

An ERA is the process for evaluating how likely the environment will be impacted as a result of exposure to one or more environmental stressors, such as radionuclides or metals. The objective of the ERA is to evaluate whether ecological receptors may be adversely affected by exposure to contaminants. The ERA is intended to provide input for risk management decision-making at each site while maintaining a conservative approach protective of ecological populations and communities. This ERA follows the guidelines in the NAUM risk assessment methodology (USEPA 2023c).

Consistent with standard risk assessment practice and USEPA (1992a, 1998, 2022a) guidance, the ERA is presented in three major phases:

- Problem formulation
- Analysis of exposure and effects
- Risk characterization

The ERA approach is based on the USEPA (1997, 1998) eight-step process outlined in the “ERA Guidance for Superfund: Process for Designing and Conducting ERAs” (USEPA 1998). Per USEPA (1997) guidance, the ERA process at a site comprises a screening-level ERA (SLERA) and, if necessary, a baseline ERA; therefore, an ERA may include some or all of the eight steps. However, as described in EE/CA guidance (USEPA 1993), a risk assessment should be used to help justify a removal action, identify what current or potential exposures should be prevented, and focus on the specific problem that the removal action is intended to address. Therefore, for this risk assessment, the ERA includes a Tier I SLERA (USEPA Steps 1 and 2) and a Tier II Refined SLERA. The Tier II Refined SLERA incorporates components of USEPA Step 3 and includes refined exposure estimates and ecological effect concentrations. [Table C-1](#), [Table C-2](#), and [Table C-8](#) through [Table C-11](#) present data and analysis associated with the ERA.

4.1 PROBLEM FORMULATION

The problem formulation phase is a planning and scoping process that establishes the goals, breadth, and focus of the risk assessment. The product of the problem formation is a CSM that identifies the environmental values to be protected (assessment endpoints), data needed, and analyses to be used. The components of the problem formulation include:

- Ecological habitat and biological resources
- Stressors and COI selection
- Potentially complete exposure pathways
- Assessment endpoints
- Measurement endpoints
- Ecological CSM



The Tier I SLERA includes the screening-level problem formulation (Step 1), exposure estimation, effects evaluation, and screening-level risk calculation (Step 2) of the USEPA risk assessment process. The product of the Tier I SLERA is a list of contaminants of potential ecological concern (COPEC) in affected media that are recommended for further evaluation in a Tier II Refined SLERA.

The Tier II Refined SLERA evaluates the Tier I COPECs by refining the exposure estimates and ecological effects concentrations. At the conclusion of the Tier II Refined SLERA, the candidate COECs are identified.

4.1.1 Ecological Habitat and Biological Resources

The ecological habitat and biological resources at the Section 32 and 33 Mines are described in [Section 1.4](#).

4.1.2 Stressors and Constituents of Interest Selection

All detected metals and radionuclides in soil and surface water were considered COIs in this ERA. Essential nutrients that are not priority pollutants, such as calcium, magnesium, potassium, and sodium, were not retained as COIs. See Section 2.4 of the main EE/CA report for further discussion on the sources and extent of contamination.

Soil was sampled from each EU. Samples collected within soil (0 to 6 and 0 to 72 inches bgs) were used in the risk assessment as described in [Section 2.0](#).

4.1.3 Potentially Complete Exposure Pathways

A contaminant must be able to travel from the source to the representative receptor and must be taken up by the receptor through one or more exposure routes for an exposure pathway to be considered complete. Potential exposure pathways that may result in receptor contact with contaminants in the environment include soils, sediment, surface water, groundwater, air, and food-chain transfer. Soil and sediment are the primary exposure media of concern. Potential exposure pathways are shown in the wire diagram CSM ([Figure C-4](#)). Discussion of the exposure pathways for ecological receptors at NAUM sites is provided in the NAUM risk assessment methodology (USEPA 2023c).

Soil exposures are evaluated in the ERA for the Section 32 and 33 Mines. The removal actions at NAUM sites are focused on removing soil as the removal of contaminated soil should remove the source of contamination to surface water and groundwater. Exposure to surface water or groundwater is assumed to be minimal because the presence of surface water at the Section 32 and 33 Mines is intermittent and groundwater is too deep for ecological receptors to access.

4.1.4 Assessment Endpoints

USEPA (1997) defines assessment endpoints as explicit expressions of the actual environmental values (for example, ecological resources) that are to be protected. Assessment endpoints are environmental characteristics that, if impaired, would indicate a need for action by risk managers.

The assessment endpoints identified for evaluation in the ERA were based on the ecological habitat, stressors and COPECs, and potentially complete exposure pathways identified in [Section 4.1.3](#) and depicted on the CSM ([Figure C-4](#)). Each assessment endpoint is intended to protect the local populations of the identified resources. The assessment endpoints used to evaluate the potential ecological risk to receptors typical of the area at the Section 32 and 33 Mines were:

- Protection of terrestrial plants
- Protection of terrestrial invertebrates
- Protection of herbivorous birds
- Protection of insectivorous birds
- Protection of carnivorous birds
- Protection of herbivorous mammals
- Protection of insectivorous mammals
- Protection of carnivorous mammals

4.1.5 Measurement Endpoints

Measurement endpoints related to the assessment endpoints were identified because assessment endpoints are usually not amenable to direct measurement. USEPA (1997) defines a measurement endpoint as a measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint and is a measure of biological effects (such as mortality, reproduction, or growth).

4.1.5.1 Tier I Screening-Level Ecological Risk Assessment

For the Tier I SLERA, Tetra Tech, Inc. (Tetra Tech) used USEPA's (2023e) ecological soil screening levels (Eco-SSL) as the primary source for no observed effect concentrations (NOEC) screening levels. Eco-SSLs are available for the protection of plants, invertebrates, birds, and mammals from the three primary feeding groups (herbivores, insectivores, and carnivores). Discussion of the Tier I SLERA is provided in the NAUM risk assessment methodology (USEPA 2023c).

Where a USEPA Eco-SSL is not available for a COPEC and receptor, a no observed adverse effect level-based toxicity value from the Los Alamos National Laboratory (LANL) EcoRisk database (Newport News Nuclear BWXT-Los Alamos, LLC [N3B] 2022) is selected as the Tier I screening level. The LANL EcoRisk database includes ecological screening levels (ESL) for plant, invertebrate, avian, and mammalian receptors. The ESLs for soil-dwelling invertebrates and terrestrial plants are based on direct contact with soil by plants and soil-dwelling organisms living in impacted soil. Soil invertebrate and plant screening levels were also taken from the Oak Ridge National Laboratory (ORNL) (Efroymson, Will, and Suter II 1997; Efroymson, Will, Suter II, and Wooten 1997) if a screening level was not available as an Eco-SSL or from the LANL EcoRisk database.



The Tier I screening levels selected from Eco-SSLs (USEPA 2023e), the LANL ESLs (N3B 2022), and ORNL (Efroymson, Will, and Suter II 1997; Efroymson, Will, Suter II, and Wooten 1997) for use in the Tier I SLERA screening were the lowest NOECs for all receptor groups (the lowest of the plant-, invertebrate-, bird- [herbivorous, insectivorous, and carnivorous], and mammal-based [herbivorous, insectivorous, and carnivorous] NOECs) for each COPEC. The Tier I screening levels are provided in [Table C-8](#) and Table 8 of the NAUM risk assessment methodology (USEPA 2023c).

4.1.5.2 Tier II Refined Screening-Level Ecological Risk Assessment

The Tier II Refined SLERA screening levels are lowest observed effect concentrations (LOEC). The LOECs for birds and mammals are based on a lowest observed adverse effect level-based toxicity reference value that is generally considered to be protective of wildlife populations (N3B 2022). USEPA (2023e) Eco-SSL guidance does not select and recommend LOECs; therefore, for the Tier II Refined SLERA, the LANL LOECs (N3B 2022) were used as the primary source. The Tier II screening levels selected for use in the Tier II Refined SLERA are the LANL LOECs (N3B 2022) for plants, invertebrates, birds (herbivores, insectivores, and carnivores), and mammals (herbivores, insectivores, and carnivores). The Tier II Refined SLERA screening levels are provided in [Table C-10](#) and Table 10 of the NAUM risk assessment methodology (USEPA 2023c).

4.1.6 Conceptual Site Model

The CSM illustrates exposure pathways to be evaluated in the ERA and provides other key information such as contaminant sources, release and transport mechanisms, and the relative importance of exposure pathways to specific receptor groups. The CSM incorporates all components of the problem formulation as discussed above and illustrated on [Figure C-4](#).

4.2 ANALYSIS OF EXPOSURE AND EFFECTS

In the analysis phase, exposure to stressors (metals and radionuclides) and their relationship to ecological effects are evaluated. A determination is made of (1) the degree to which ecological receptors are exposed and (2) whether that level of exposure is likely to cause harmful ecological effects.

4.2.1 Exposure Estimates

For the Tier I SLERA, a single sitewide exposure area that included all data collected within the Section 32 and 33 Mines was used for the evaluation of potential risk to ecological receptors. Exposure estimates for the Tier I SLERA for soil are the maximum detected concentrations for COIs in soil compared to the minimum Tier I screening levels for all receptors (plants, invertebrates, birds [herbivorous, insectivorous, and carnivorous], and mammals [herbivorous, insectivorous, and carnivorous]). For each detected analyte, the maximum detected concentrations used in the Tier I SLERA for each COPEC are presented in [Table C-8](#).

For the Tier II Refined SLERA, the Section 32 and 33 Mines investigation area was divided into two EUs as described in [Section 2.3](#). Surface and subsurface soils were evaluated in each EU with depth intervals of 0 to 6 inches bgs for surface soil and 0 to the maximum depth available



but not to exceed 72 inches bgs for subsurface soil. Soil and sediment data from 0 to 72 inches bgs were used to evaluate potential risks to ecological receptors. Drainages at the site are dry for most of the year, and, therefore, sediment results were evaluated as soil.

The EPCs were calculated as described in [Section 3.2.4](#) and are presented on [Table C-9](#). The EPCs used in the ERA for each COPEC and grouped by EU for soil (by soil depth interval) and water are presented in [Table C-10](#).

4.2.2 Ecological Effects

Ecological effects of potential concern are those that can impact populations by causing adverse effects on development, reproduction, and survival (USEPA 1997). Literature-based effects concentrations (NOECs and LOECs) as described in [Section 4.1.5](#) were used in the ERA to characterize potential effects from direct contact and uptake through the food web to terrestrial ecological receptors, including vegetation, soil invertebrates, birds, and mammals.

For the Tier I SLERA, a hazard quotient (HQ) was calculated as the ratio of the contaminant concentration to the Tier I screening level (NOEC) by COPEC and receptor. Tier I HQs equal to or greater than 1.0 indicate potential unacceptable risk to plants, invertebrates, birds, and mammals based on a conservative comparison of the maximum detected concentration to the minimum NOEC-based screening level for all receptors. Tier I HQs less than 1.0 indicate little to no potential ecological risk for a given COPEC, and the COPEC may be excluded from further consideration (that is, the COPEC was not evaluated in the Tier II Refined SLERA). The Tier I SLERA HQ was calculated as follows:

$$\text{Tier I HQ} = \frac{\text{Maximum Detected Concentration}}{\text{Tier I Screening Level (NOEC)}}$$

For the Tier II Refined SLERA, risk estimates were calculated by dividing EPCs by Tier II screening levels (NOEC and LOEC). Tier II HQs greater than or equal to 1.0 indicate potential risk to plants, invertebrates, birds, and mammals based on the estimated sitewide average (based on the lesser of the UCL95 and maximum detected concentration). Tier II HQs less than 1.0 based on the NOEC indicate little potential ecological risk to the overall population for a given COPEC and receptor combination. Tier II HQs greater than or equal to 1.0 based on the LOEC indicates potential risk since LOEC is based on observed effect concentration. The Tier II Refined SLERA HQ was calculated as follows:

$$\text{Tier II HQ} = \frac{\text{EPC}}{\text{Tier II Screening Level (NOEC and LOEC)}}$$

4.3 RISK CHARACTERIZATION

In the risk characterization phase, potential risk is estimated through integration of exposure and effects, potential risks are considered in the context of uncertainties associated with the SLERA, and risk descriptions are provided.



4.3.1 Tier I Screening for Contaminants of Potential Ecological Concern

Tier I HQs, which represent the ratio of the maximum detected concentration in the environmental medium to the Tier I screening levels, are presented in [Table C-8](#). All contaminants in soil have an HQ greater than or equal to 1.0 (Ra-226, antimony, arsenic, barium, chromium, lead, manganese, nickel, selenium, thallium, uranium, vanadium, and zinc).

An HQ less than 1.0 indicates that the contaminant alone is unlikely to cause adverse effects (USEPA 1997). For HQs equal to or greater than 1.0, the potential for ecological risk cannot be excluded and further evaluation or removal action may be warranted. COPECs and receptor combinations with Tier I SLERA HQs equal to or greater than 1.0 were further evaluated in the Tier II Refined SLERA.

4.3.2 Tier II Screening for Contaminants of Ecological Concern

The Tier II Refined SLERA includes initial components of Step 3 of USEPA's eight-step ERA process and serves to refine the risk estimates from the Tier I SLERA (USEPA 2000b). Specifically, the Tier II Refined SLERA involves the refinement of the conservative screening-level assumptions used in the Tier I SLERA and the refinement of exposure estimates and ecological effects concentrations.

The USEPA ProUCL Version 5.2 statistical software was used to identify the distributional assumptions and calculate the UCL95 for contaminants identified as Tier II COPECs (USEPA 2022b). [Table C-9](#) summarizes the frequency of detection, range of sample quantitation limits, range of detected concentrations, and EPCs for each contaminant in soil for which the Tier I HQ was equal to or exceeded 1.0 for each EU at the Section 32 and 33 Mines.

Tier II Refined SLERA risk estimates were calculated by dividing EPCs by the minimum of the Tier II screening levels (NOEC and LOEC) for each COPEC. Tier II HQs less than 1.0 based on the NOEC indicate little potential ecological risk to the overall population for a given COPEC and receptor combination. Tier II HQs greater than or equal to 1.0 based on the LOEC indicate potential risk since the LOEC is based on an observed effect concentration. Risk management decisions are made on the outcome of the EPC compared to the Tier II LOEC screening level. Candidate COECs identified in the Tier II Refined SLERA, including the Tier II screening levels, EPCs, and HQs, are listed in [Table C-10](#). Candidate COECs are summarized in [Exhibit C-5](#).

Exhibit C-5. Tier II Refined SLERA Candidate COECs

Exposure Unit	Soil Depth Interval	Contaminant		
		Radium-226	Selenium	Vanadium
Section 32 Mine	Surface Soil	--	X	X
	Subsurface Soil	--	X	X
Section 33 Mine	Surface Soil	X	X	X
	Subsurface Soil	X	X	X

Notes:

- Not a Tier II Refined SLERA COPEC
- X Tier II Refined SLERA Candidate COEC
- COEC Contaminant of ecological concern
- SLERA Screening-level ecological risk assessment

Table C-11 presents an analysis of the nonmobile receptors (that is, the plant and invertebrate communities) using a comparison of data from each sample to the LOECs protective of plant and invertebrate communities. Ra-226 concentrations exceeded the invertebrate screening level in 3 of 40 samples at the Section 32 Mine and in 6 of 20 samples at the Section 33 Mine. Barium concentrations exceeded the plant screening level in 8 of 44 samples at the Section 33 Mine. Selenium concentrations exceeded the plant screening level in 6 of 44 locations at the Section 32 Mine and in 12 of 22 locations at the Section 33 Mine. The invertebrate screening level for selenium was also exceeded at two locations at the Section 33 Mine. Plant screening levels for thallium (three locations), uranium (one location), and vanadium (one location) were also exceeded at the Section 33 Mine. Risk managers should consult **Table C-11** for the locations of exceedances for these analytes.

4.3.3 Uncertainty Associated with the Ecological Risk Assessment

Uncertainty plays an important role in risk-based decision-making and is, therefore, incorporated explicitly into the risk characterization process. Identifying known sources of uncertainty is a critical component of an ERA because conservative default assumptions incorporated into the ERA protocol are associated with substantial uncertainty. The ERA process is based on assumptions and extrapolations to evaluate potential risk to ecological receptors. These assumptions are intentionally conservative and may result in overestimates of site-specific risk to ensure that no COPECs that pose actual risk are eliminated from the ERA. The primary components of uncertainties include those associated with site data and exposure, the development and use of toxicity values, and interpretation of HQs to estimate potential risk to representative receptors. The NAUM risk assessment methodology (USEPA 2023c) provides more general ERA uncertainty discussions for topics applicable to all NAUM sites.

4.3.4 Exposure Estimates

Because Tetra Tech evaluated the Section 32 and 33 Mines using limited collected data, all concentrations measured are, therefore, only estimates of concentrations that may occur throughout the site (with associated error). Tetra Tech assumed in the Tier I SLERA that the maximum detected concentration detected in surface and subsurface soils at the Section 32 and 33 Mines represented the entire site to ensure protectiveness. However, this method creates bias in the data toward the more disturbed or affected environments at the site and is likely to overestimate Tier I COPEC exposure concentrations.

Similarly, in the Tier II Refined SLERA, an EPC for each COPEC for each area of the site was used to estimate EU-wide exposures and ensure protectiveness. The use of the UCL95 concentration may under- or overestimate COPEC concentrations used to characterize conditions throughout the site, depending on their actual sitewide distribution. In addition, portions of the site are bare ground and do not provide habitat or foraging area for some ecological receptors. Bare ground areas are included in the evaluation; however, the nature of the bare ground areas (toxicity, lack of soil, etc.) is unknown.

Site-specific bulk chemistry concentrations were compared with toxicity benchmarks values such as Eco-SSLs and LANL ESLs as an indicator of the potential for adverse effects. Bulk chemistry results for onsite samples likely overestimate the bioavailable fraction of each COPEC as the



results do not consider whether the contaminant is bound to soil particles or other compounds that could prevent uptake by plants and invertebrates, or absorption upon direct contact or ingestion by higher trophic-level receptors.

The ERA assumes that all receptors live and forage solely within a single EU; however, this assumption is not necessarily true for the avian and larger mammalian receptors, which can forage over larger areas and are not likely to be consistently exposed to COPECs in soil at the estimated site concentrations. Mobile ecological receptors could be exposed to more than one EU depending on the foraging and home range of the particular species. The use of media-based screening levels does not account for the sizes of the EUs or the foraging area or for exposure in more than one EU. Nonmobile receptors, such as the plant and soil invertebrate communities, are assessed for each EU by sample, and small ranging receptors, such as small mammals, would likely remain within the boundaries of an EU if sufficient food and shelter were available. However, free-ranging wildlife, such as raptors, large herbivores, and top-level predators, would travel across EUs. Furthermore, use of a site can vary seasonally. Therefore, the actual amount of soil or prey ingested from the site would likely be less than the values used in the risk calculations, resulting in an overestimate of risk. The impact of this uncertainty is species dependent but likely small given that those receptors that would travel across multiple EUs have large home ranges.

As with any site investigation, uncertainty will be associated with the representativeness of the samples both spatially and temporally. Soil samples were collected from two events: in 2019 for the RSE and in 2022 to address data gaps. [Figure C-2](#) and [Figure C-3](#) show the sample locations for each EU. Spatial variability is limited because soil samples used in the risk assessment were all collected within the disturbed area of the mine site. Temporal variability is limited because soil sampling methods were consistent among sampling events and because of the known environmental fate of the COPECs (lack of degradation).

4.3.5 Nondetected Contaminants of Potential Ecological Concern

Little uncertainty is involved with the analytical analysis for soil at the Section 32 and 33 Mines as all COPECs were detected in soil above their respective detection limits.

4.3.6 Combined Exposures Across Media and Exposure Units

The design of the ecological screening process and use of media-based screening levels assumes isolation of exposure (for example, risk from exposure to soil is not added to the risk from exposure to surface water because data is not available to assess surface water). Because surface water is present irregularly on site, an aquatic community would be unlikely to become established; however, birds, mammals, and reptiles could ingest the water when it is available.

Depending on the home range of an upper-trophic-level receptor, exposure could occur across EUs. While the risk analysis does not account for combined exposures across EUs, the uncertainty is minimized by the assessment of each EU independently and use of conservative EPCs. Uncertainty is associated with the use of the UCL95 as a representative concentration for all free-ranging ecological species in each EU, but the magnitude of this uncertainty is unknown.



4.3.7 Tier II Hazard Quotients Based on No and Low Effect Levels

The screening process involves two major steps:

1. Comparison of the maximum detected concentration to the Tier I screening levels (NOEC)
2. Comparison of the EPC for each EU compared to the Tier II screening levels (NOEC and LOEC)

Candidate COECs will be identified on the outcome of the Tier II EPC (UCL95) compared to the Tier II LOEC screening level. [Table C-10](#) identifies, through shading, instances of the EPC exceeding the LOEC screening level by receptor group.

HQs less than 1.0 resulting from a comparison of the EPC to a NOEC provide further confidence in the removal of those COPECs from further consideration as candidate COECs. An analysis using the NOEC is presented in [Table C-10](#) by EU using the lowest NOEC. For example, at the Section 32 Mine, antimony, barium, chromium, lead, manganese, nickel, thallium, and zinc have soil NOEC-based HQs equal to or greater than 1.0 but are below 1.0 when the LOEC is used. The magnitude of this uncertainty is minimal because of the use of the lowest NOECs and LOECs from all receptor groups and the use of a conservative UCL95 as the EPC.

4.3.8 Risk to Plant and Invertebrate Communities

To address the potential risk to plant and invertebrate communities, concentration data from each sample across EUs are compared to the Tier II community-specific screening values (LOEC). [Table C-11](#) presents this analysis so that risk managers can evaluate the potential risk to these communities by sample location.

Chromium and molybdenum do not have Tier II screening values for either community. The magnitude of the impacts of chromium and molybdenum on nonmobile communities is unknown. One candidate COEC (vanadium) at the Section 32 and 33 Mines does not have a soil invertebrate screening value. The magnitude of the impacts of vanadium on the soil invertebrate community is unknown.



5.0 RISK ASSESSMENT RESULTS SUMMARY

Candidate COCs and COECs were identified based on available laboratory and toxicological data for the Section 32 and 33 Mines. The HHRA and ERA results indicate that risk is above a level of concern for the contaminants listed in [Exhibit C-6](#).

Exhibit C-6. Candidate COCs or COECs for Soil

Exposure Unit	Contaminant ¹								
	Radium-226	Arsenic	Cobalt	Iron	Manganese	Selenium	Thallium	Uranium	Vanadium
Section 32 Mine	X	X	X	X	X	X	X	X	X
Section 33 Mine	X	--	--	--	--	X	--	X	X

Notes:

¹ [Table C-11](#) shows a comparison of individual soil sample results to LOECs for the plant and invertebrate communities. Risk managers should consult [Table C-11](#) for the locations of exceedances of LOECs for radium-226, barium, selenium, thallium, uranium, and vanadium.

-- Not a candidate COC or COEC. Not recommended for further evaluation in the EE/CA.

X Candidate COC and/or COEC. Recommended for further evaluation in the EE/CA.

COC Contaminant of concern

COEC Contaminant of ecological concern

EE/CA Engineering evaluation/cost analysis

LOEC Lowest observed effect concentration

6.0 REFERENCES

- Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997. “Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process.” ES/ER/TM-126/R2. Oak Ridge National Laboratories, Oak Ridge, TN.
- Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997. “Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants.” ES/ER/TM-85/R3. Oak Ridge National Laboratories, Oak Ridge, TN.
- Los Alamos National Laboratory. 2015. “Screening-Level Ecological Risk Assessment Methods.” Revision 4. EP2015-0174. October 29.
- McLemore, V.T. and Chenoweth, W.L. 1991. “Uranium Mines and Deposits in the Grants District, Cibola and McKinley Counties, New Mexico.” New Mexico Bureau of Mines and Mineral Resources, Open File Report 353.
- Navajo Nation Department of Fish and Wildlife (NNDFW). 2008. “Biological Resource Land Use Clearance Policies and Procedures (RCP), RCS-44-08.” <https://nndfw.org/clup.htm>.
- NNDFW. 2022. “Navajo Natural Heritage Program Data Release.” Reference Number 22tett104. March 29.
- Navajo Nation Environmental Protection Agency (NNEPA). 2021. “Navajo Tribe Provisional Reasonable Maximum Exposures for the Navajo Risk Assessments.” Draft. September 15.
- New Mexico Energy and Minerals Department. 1979. “An Overview of the New Mexico Uranium Industry.” January.
- Newport News Nuclear BWXT-Los Alamos, LLC (N3B). 2022. “ECORISK Database.” Release 4.3. 701067. Document EM2020-0575. September.
- NV5, Inc. 2019. “Natural Resources Evaluation Tronox NAUM, Sections 32 and 33, McKinley County, New Mexico.” June.
- Santos. 1970. “Stratigraphy of the Morrison Formation and Structure of the Ambrosia Lake District, New Mexico.” Contributions to Economic Geology: Geological Survey Bulletin 1272-E.
- TerraSpectra Geomatics. 2007. “Abandoned Uranium Mines and the Navajo Nation, Navajo Nation AUM Screening Assessment Report and Atlas with Geospatial Data.” August.
- Tetra Tech, Inc. 2023. “Section 32 and 33 Mines Eastern Abandoned Uranium Mine Region Data Gap Investigation Report.” Response, Assessment, and Evaluation Services. Contract No. 68HE0923D0002. Task Order 0003. August.

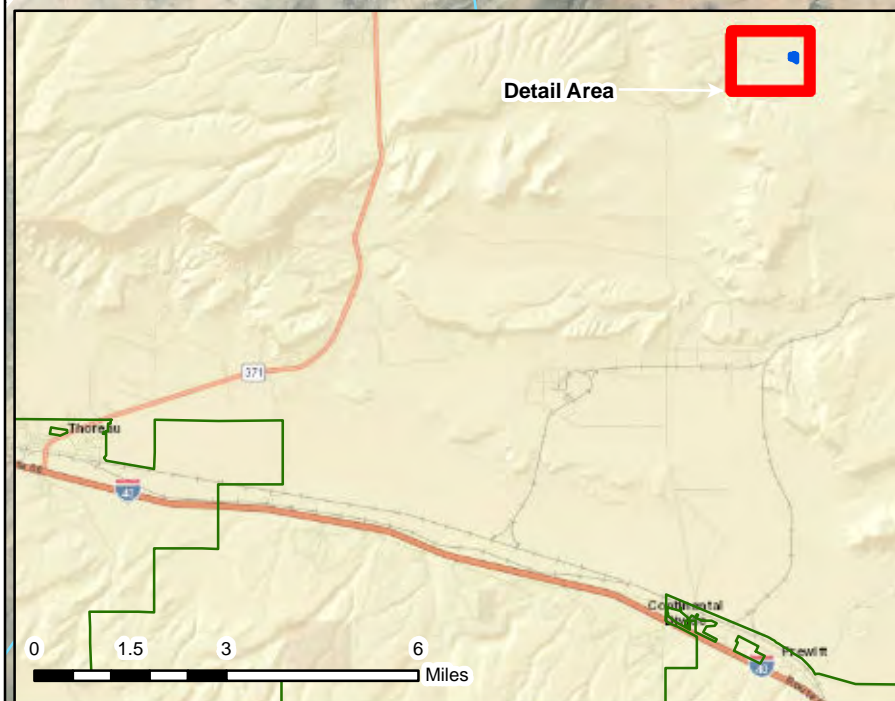
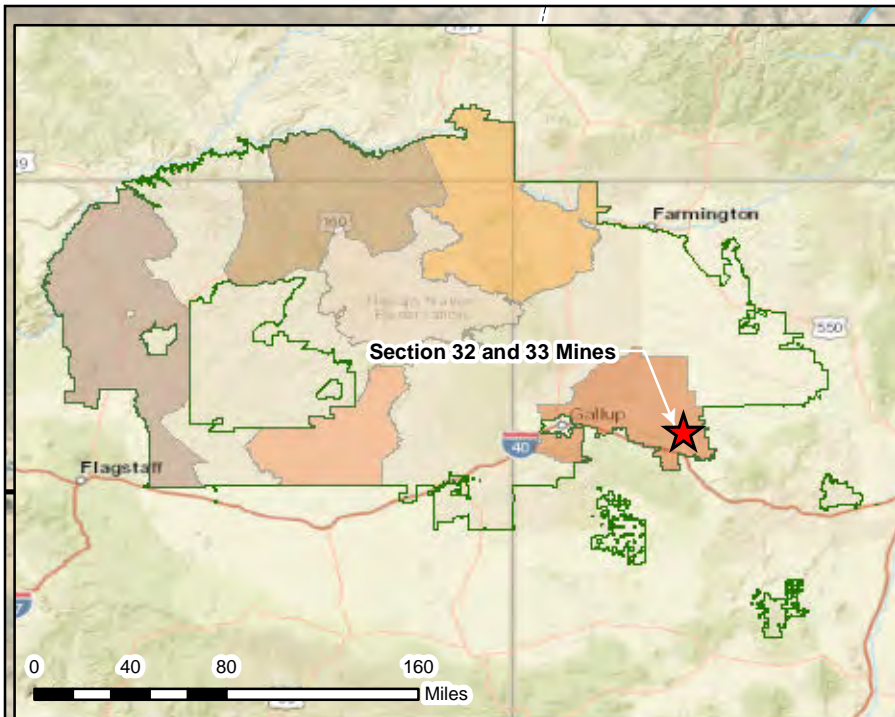


- U.S. Environmental Protection Agency (USEPA). 1989. "Risk Assessment Guidance for Superfund Volume I – Human Health Evaluation Manual, Part A (RAGS)." EPA/540/1-89/002.
- USEPA. 1992a. "Guidance for Data Useability in Risk Assessment (Part A)." Office of Solid Waste and Emergency Response (OSWER). Publication 9285.7-09A. April.
- USEPA. 1992b. "Supplemental Guidance to [Risk Assessment Guidance for Superfund] RAGS: Calculating the Concentration Term." Intermittent Bulletin. Volume 1. Number 1. Publication 9285.7-081.
- USEPA. 1993. "Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA." OSWER 9360.0-32. August.
- USEPA. 1997. "ERA Guidance for Superfund: Process for Designing and Conducting ERAs." Interim Final. Washington, DC. EPA/540/R-97/006. June.
- USEPA. 1998. "Guidelines for Ecological Assessment." Office of Research and Development. EPA/630/R-5/002FA. April.
- USEPA. 2000a. "Guidance for Data Quality Assessment: Practical Methods for Data Analysis: USEPA QA/G-9, QA97 Version." USEPA/600/R-96/084. Office of Research and Development. July.
- USEPA. 2000b. Memorandum Regarding Amended Guidance on Ecological Risk Assessment at Military Bases: Process Considerations, Timing of Activities, and Inclusion of Stakeholders." From Ted W. Simon, Ph.D., Office of Technical Services. To Jon D. Johnston, Chief, Earl Bozeman, Chief, U.S. Department of Defense Section, and Remedial Project Managers. June 23.
- USEPA. 2001. "The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments." EPA 540/F-01/014. OSWER. June.
- USEPA. 2002. "Calculating Exposure Point Concentrations at Hazardous Waste Sites." OSWER Directive 9285.6-10. December.
- USEPA. 2003. "Human Health Toxicity Values in Superfund Risk Assessments." OSWER Directive 9285.7-53. December 5.
- USEPA. 2004. *Multi-Agency Radiological Laboratory Analytical Protocols Manual*. NUREG-1576/EPA 402-B-04-001A/NTIS PB2004-105421. July.
- USEPA. 2020. "National Functional Guidelines for Inorganic Superfund Methods Data Review." OLEM 9240.0-66/EPA 540-R-20-006. November.
- USEPA. 2022a. "EPA EcoBox (A Toolbox for Ecological Risk Assessors)." Accessed May. <https://www.epa.gov/ecobox>.



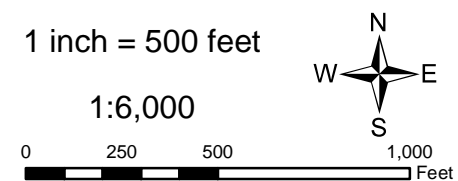
- USEPA. 2022b. “ProUCL 5.2.0 Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations.” June 14.
- USEPA. 2023a. “Preliminary Remediation Goals for Radionuclides at Superfund Sites.” February. https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search.
- USEPA. 2023b. “Regional Screening Levels (RSLs).” May 4. https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search.
- USEPA. 2023c. “Navajo Abandoned Uranium Mines Risk Assessment Methodology.” Draft Final. Response, Assessment, and Evaluation Services. Contract No. EP-S9-17-02. August.
- USEPA. 2023d. “Navajo Abandoned Uranium Mine Risk Calculator.” Version 1.02. August.
- USEPA. 2023e. “Interim Ecological Soil Screening Level Documents.” Accessed July 20. <https://www.epa.gov/chemical-research/interim-ecological-soil-screening-level-documents>.
- U.S. Fish and Wildlife Service (USFWS). 2022. “List of Threatened and Endangered Species That May Occur in Your Proposed Action Location or May Be Affected by Your Proposed Action.” Project Code: 2022-0024895. New Mexico Ecological Services Field Office, Albuquerque, New Mexico. March 28.
- Weston Solutions, Inc. (Weston). 2009. “Navajo Abandoned Uranium Mine Site Screen Report – Section 32 AUM Site.” Prepared for USEPA under Contract No. W91238-06-F-0083. May.
- Weston. 2019. “Removal Site Evaluation Report for Tronox Navajo Area Uranium Mines Sections 32 and 33 Mines, McKinley County, New Mexico.” Prepared for USEPA. September.

FIGURES



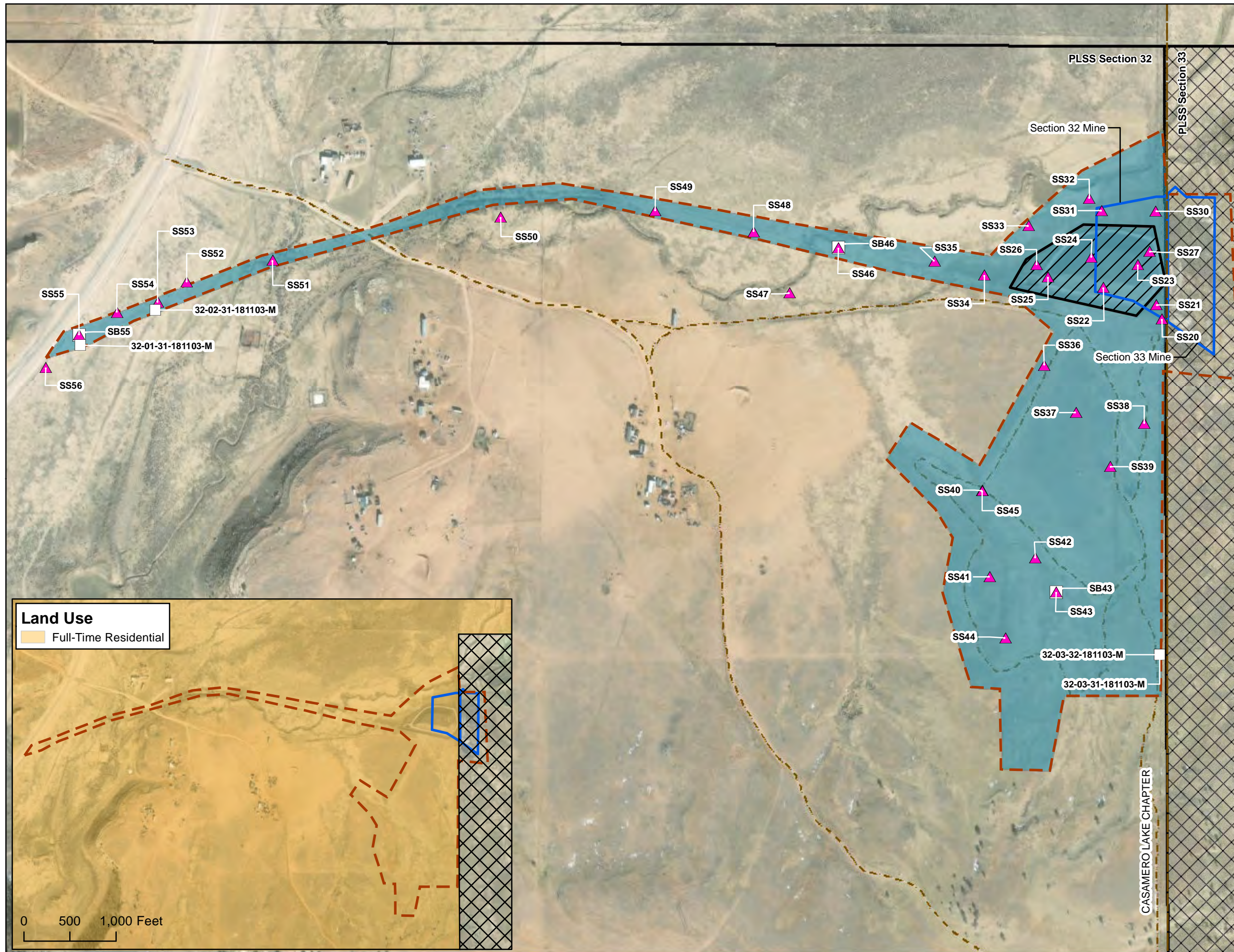
- Tronox AUM Site¹
 - PLSS Section Boundary / RSE Survey Area
 - Historic Haul Road
 - County Road
 - Local Road
 - Drainage
- Navajo Nation Regions**
- Central Region
 - Eastern Region
 - North Central Region
 - Northern Region
 - Southern Region
 - Western Region

Notes:
¹ Boudary is from TSG (2007).
 AUM Abandoned uranium mine
 PLSS Public Land Survey System
 RSE Removal site evaluation
 TSG TerraSpectra Geomatics
 UNT Unnamed tributary



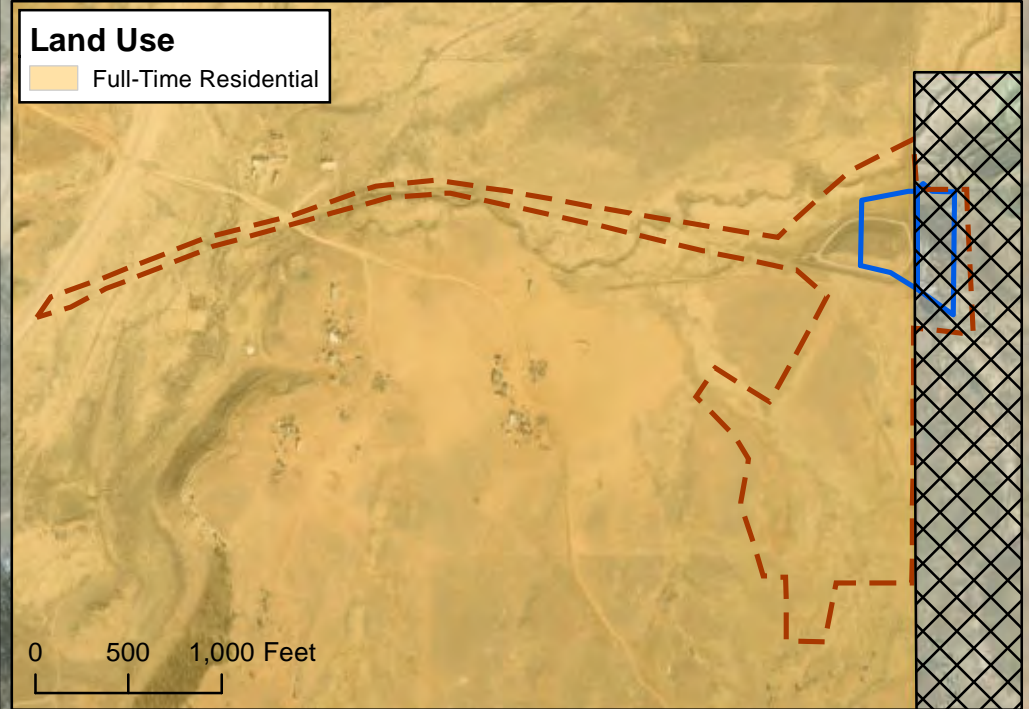
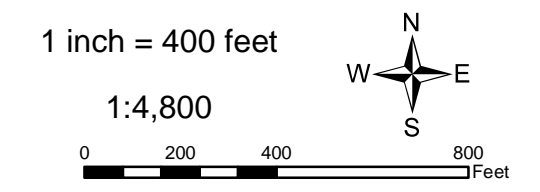
SECTION 32 AND 33
 MINES LOCATION

Prepared For: U.S. EPA Region 9 	Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0031	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 8/25/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: C-1



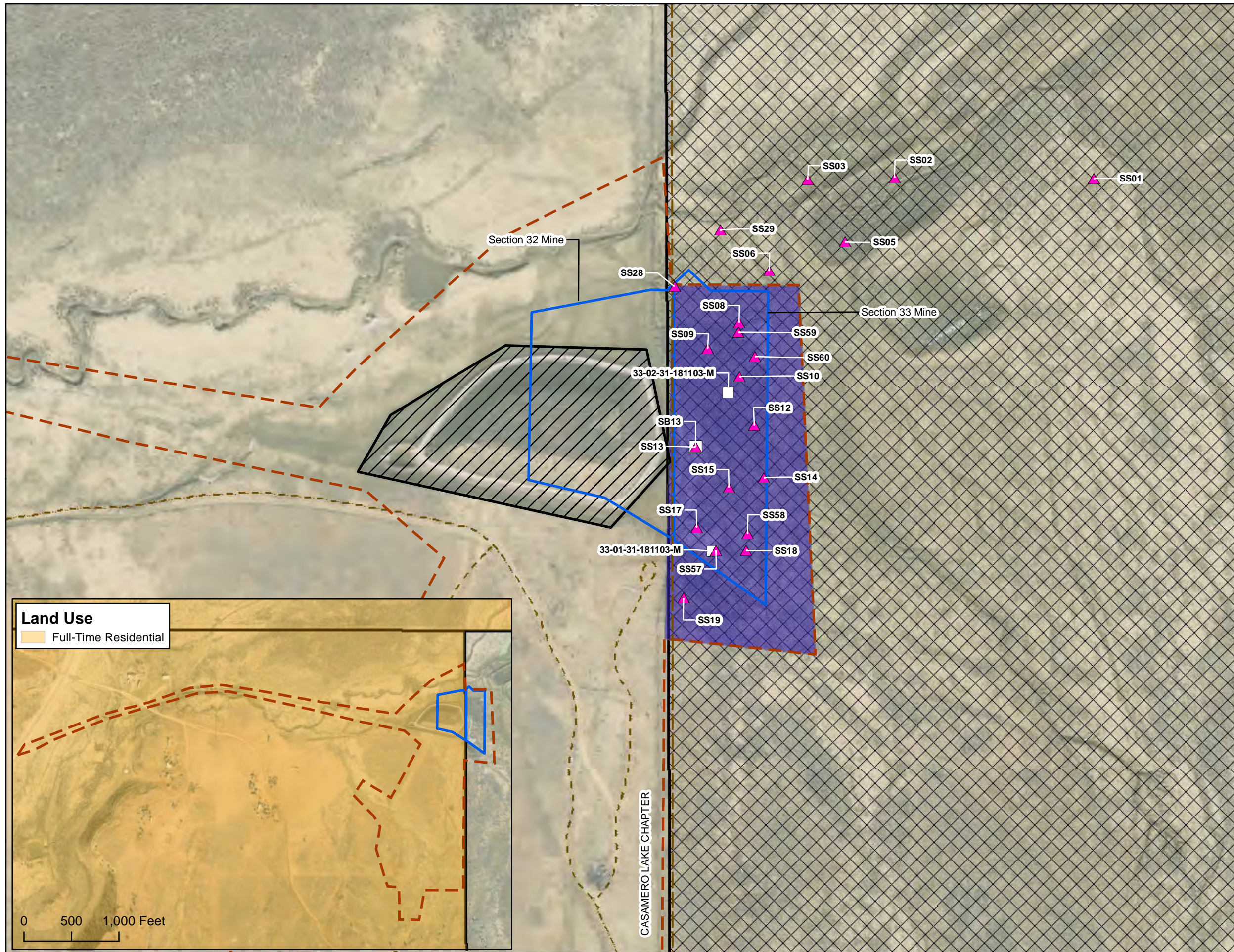
- TENORM Boundary
- PLSS Section Boundary / RSE Survey Area
- Private Property
- Tronox AUM Site¹
- Section 32 Waste Stockpile - Subsurface Only
- Local Road
- Soil Sample Locations**
 - Surface Soil Sample Location
 - Subsurface Soil Sample Location
- Exposure Units**
 - Section 32 Mine

Notes:
¹Boundary is from TSG (2007).
 PLSS Public land survey system
 RSE Removal site evaluation
 TENORM Technologically enhanced naturally occurring radioactive material
 TSG TerraSpectra Geomatics



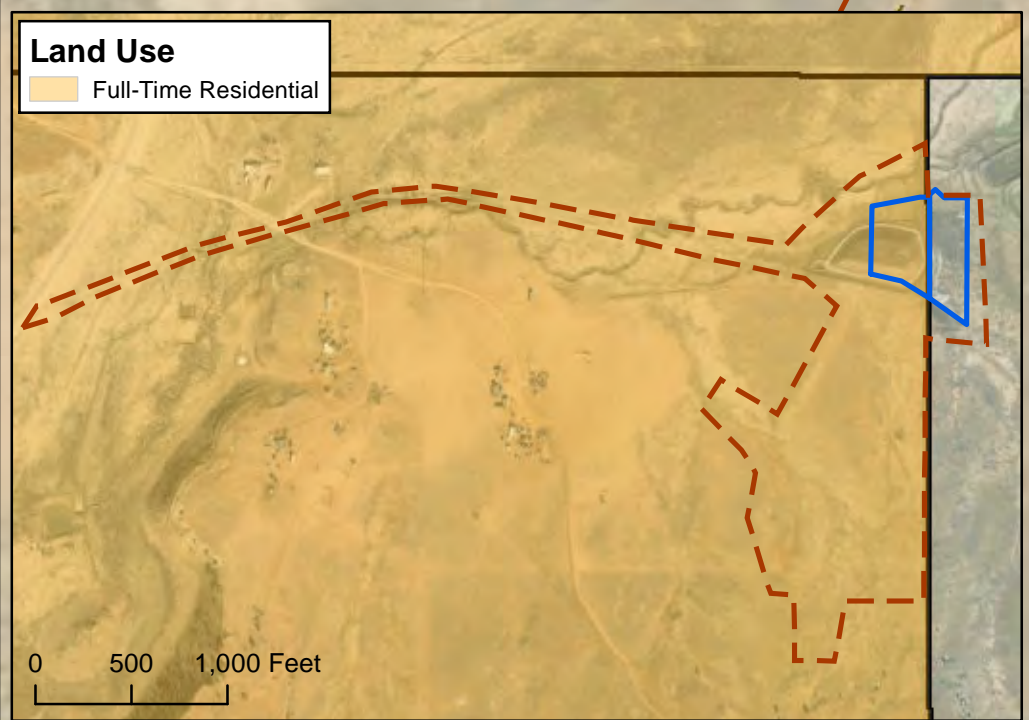
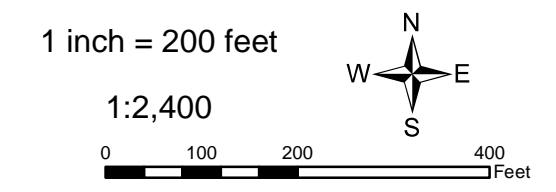
SECTION 32
 EXPOSURE UNIT AND
 SAMPLE LOCATIONS

Prepared For: U.S. EPA Region 9 	Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0031	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 8/31/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: C-2



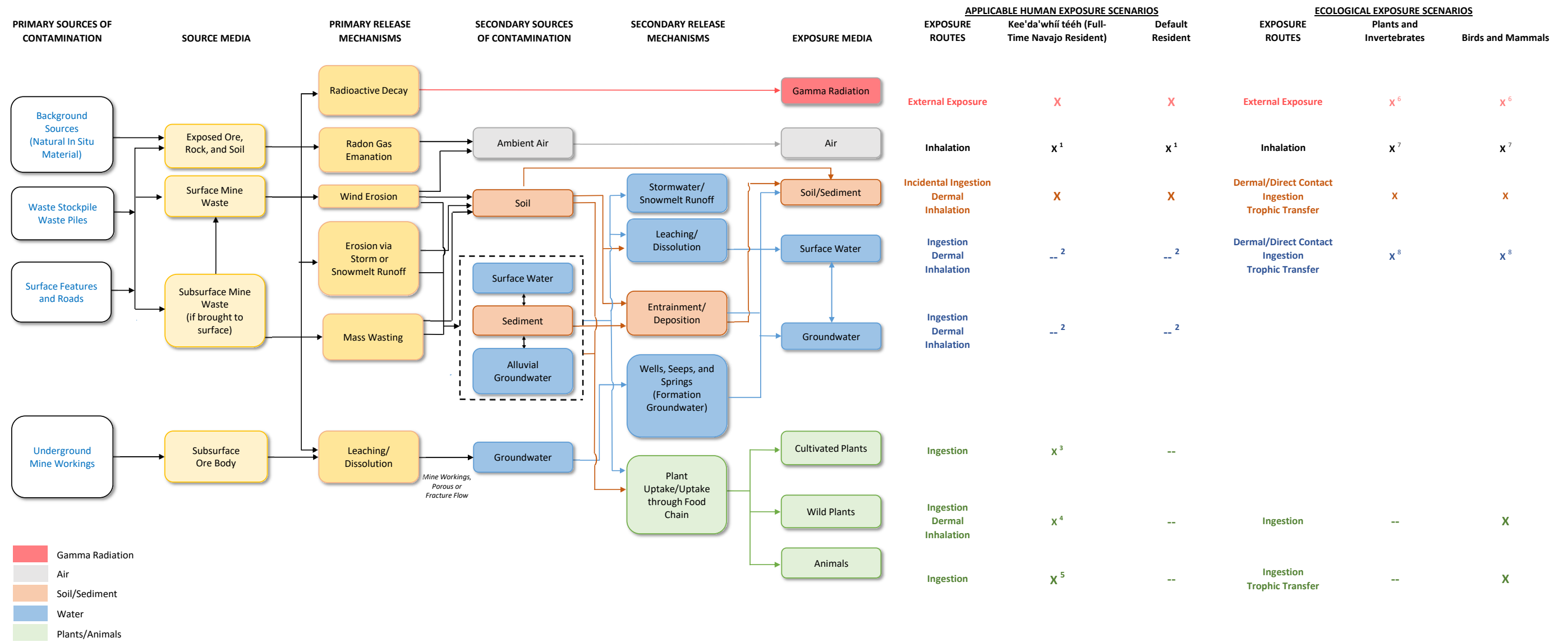
- TENORM Boundary
- PLSS Section Boundary / RSE Survey Area
- Private Property
- Tronox AUM Site¹
- Section 32 Waste Stockpile - Subsurface Only
- Local Road
- Soil Sample Locations**
- Surface Soil Sample Location
- Subsurface Soil Sample Location
- Exposure Units**
- Section 33 Mine

Notes:
¹Boundary is from TSG (2007).
 PLSS Public land survey system
 RSE Removal site evaluation
 TENORM Technologically enhanced naturally occurring radioactive material
 TSG TerraSpectra Geomatics



**SECTION 33
 EXPOSURE UNIT AND
 SAMPLE LOCATIONS**

Prepared For: U.S. EPA Region 9 	Prepared By: TETRA TECH <small>1999 Harrison Street, Suite 500 Oakland, CA 94612</small>
Task Order No.: 0031	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 8/31/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: C-3



Notes:

- X Indicates the exposure pathway is potentially complete and is evaluated in the risk assessment except as noted.
- Indicates the exposure pathway is not complete or *de minimis* and is not evaluated in the risk assessment

¹ The human health risk evaluation does not include inhalation of radon by humans or animals. Because radon is a gas and readily disperses in outdoor air, the risk in outdoor air is minimal. Radon in indoor air is a potential risk for future residential receptors; however, radon exposure is building-specific and the buildings are not currently present and, thus, cannot be evaluated. Furthermore, because radon is a known risk in the area, any future buildings would likely be constructed to mitigate this known risk.

² The human health risk evaluation does not include ingestion of surface water or groundwater by humans or animals. Safe drinking water is supplied to residents in the area. Wells used for livestock have been tested and are upgradient of the known groundwater contamination in the area.

³ The human health risk evaluation includes ingestion of select cultivated plants (crops) by this receptor. Scenario inputs were provided by the Navajo Nation Environmental Protection Agency (NNEPA) (2021).

⁴ The human health risk evaluation includes ingestion, dermal (metals only), and inhalation of select wild herbs and medicinal plants by this receptor. Scenario inputs were provided by NNEPA (2021).

⁵ The human health risk evaluation includes ingestion of home-raised animals (meat, milk, and eggs) and hunted animals (meat only) for this receptor. Scenario inputs were provided by NNEPA (2021).

⁶ The ecological risk evaluation includes evaluation of external radiation based on exposure to gamma-emitting radionuclides from contaminated soil and evaluation of internal radiation through plant uptake, incidental soil ingestion, and food web uptake (Los Alamos National Laboratory [LANL] 2015).

⁷ Potential exposures include inhalation of ambient air and air in burrows and underground mines. The ecological risk evaluation does not include evaluation of the inhalation pathway.

⁸ The ecological risk evaluation does not include evaluation of direct contact with or ingestion of surface water.

References:

Los Alamos National Laboratory (LANL). 2015. "Screening-Level Ecological Risk Assessment Methods." Revision 4. EP2015-0174. October 29.

Navajo Nation Environmental Protection Agency (NNEPA). 2021. "Navajo Tribe Provisional Reasonable Maximum Exposures RME for the Navajo Risk Assessments." Draft. September 15.

Figure C-4. Section 32 and 33 Mines Risk Assessment Conceptual Site Model

TABLES

Table C-1. Soil Results Data Summary and Contaminant of Potential Concern Screening

Constituent of Interest ^a	Detection Frequency ^b	Units	Minimum Detected Concentration (qualifier) ^b	Maximum Detected Concentration (qualifier) ^b	Location of Maximum Concentration ^b	Depth of Maximum Concentration (inches bgs) ^b	COPC Screening Level ^c	Include Constituent as a COPC? ^d
Radionuclides								
Radium-226	63 / 63	pCi/g	1.08	161	S3233-SS59-01-111822	0-6	0.00053	Yes
Metals								
Aluminum	69 / 69	mg/kg	4,650	27,000	S3233-SS03-01-111522	0-6	1,250	Yes
Antimony	6 / 63	mg/kg	0.343 J	0.638 J	S3233-SS14-01-111522	0-6	0.39	Yes
Arsenic	69 / 69	mg/kg	1.29	13.8	S3233-SS60-01-111822	0-6	0.025	Yes
Barium	69 / 69	mg/kg	26.8	307	S3233-SS23-01-111522	0-6	124	Yes
Beryllium	69 / 69	mg/kg	0.257	1.19	S3233-SS03-01-111522	0-6	2.9	No
Cadmium	60 / 63	mg/kg	0.0207 J	0.333	S3233-SS03-01-111522	0-6	0.042	Yes
Chromium	69 / 69	mg/kg	1.25 J	21.7 J	S3233-SS03-01-111522	0-6	2,080	No
Cobalt	69 / 69	mg/kg	1.23	10.4	S3233-SS03-01-111522	0-6	0.26	Yes
Copper	69 / 69	mg/kg	2.7	20	S3233-SS03-01-111522	0-6	6.5	Yes
Iron	69 / 69	mg/kg	4,570	31,500	S3233-SS03-01-111522	0-6	796	Yes
Lead	69 / 69	mg/kg	5.67	22.2	S3233-SS03-01-111522	0-6	400	No
Manganese	69 / 69	mg/kg	73.2	419	S3233-SS20-01-111522	0-6	3.2	Yes
Molybdenum	61 / 63	mg/kg	0.205 J	1.86 J	S3233-SS03-01-111522	0-6	1.24	Yes
Nickel	69 / 69	mg/kg	2.43	22.8	S3233-SS03-01-111522	0-6	20	Yes
Selenium^e	65 / 69	mg/kg	0.467 J	102	S3233-SS58-01-111822	0-6	1.7	Yes
Silver	30 / 63	mg/kg	0.123 J	0.663	S3233-SB43-0612-111822	6-12	2.0	No
Thallium	59 / 63	mg/kg	0.142 J	0.645	S3233-SS03-01-111522	0-6	0.0092	Yes
Uranium^e	64 / 69	mg/kg	0.606 J	251	S3233-SS59-01-111822	0-6	0.28	Yes
Vanadium	69 / 69	mg/kg	8 J	92	S3233-SS59-01-111822	0-6	6.9	Yes
Zinc	69 / 69	mg/kg	9.87	95.6	S3233-SS08-01-111522	0-6	147	No

Notes:

^a **Bolded contaminants** are selected as human health COPCs because the maximum detected concentration exceeds the COPC screening level.

^b Includes all soil samples with analytical results from the Section 32 and 33 Mines, including field duplicate results, collected for the removal site evaluation (Weston 2019) and 2022 sampling (Tetra Tech 2023).

^c The COPC screening levels are calculated using the USEPA (2023d) NAUM Risk Calculator for the Kee'da'whíí tééh (full-time Navajo resident) using a target risk of 1E-06 and target hazard quotient of 0.1 except for lead. The lead screening value is based on the regional screening level for residential soil (USEPA 2023b).

^d A contaminant is included as a COPC for the human health risk assessment if the maximum detected concentration exceeds the COPC screening level.

^e Four selenium and five uranium results in the removal site evaluation results were reported as nondetect, but the method reporting limit was not provided with the data (Weston 2019). These four selenium and five uranium results were not included in the exposure evaluation of the risk assessment.

Table C-1. Soil Results Data Summary and Contaminant of Potential Concern Screening

Notes (continued):

bgs	Below ground surface
COPC	Contaminant of potential concern
J	Estimated concentration
mg/kg	Milligram per kilogram
NAUM	Navajo abandoned uranium mine
pCi/g	Picocurie per gram
Tetra Tech	Tetra Tech, Inc.
USEPA	U.S. Environmental Protection Agency
Weston	Weston Solutions, Inc.

References:

- Tetra Tech, Inc. (Tetra Tech). 2023. "Section 32 and 33 Mines Eastern Abandoned Uranium Mine Region Data Gap Investigation Report." Response, Assessment, and Evaluation Services. Contract No. 68HE0923D0002. Task Order 0003. August.
- U.S. Environmental Protection Agency (USEPA). 2023b. "Regional Screening Levels (RSLs)." May 4. <https://www.epa.gov/risk/regional-screening-levels-rsls>.
- USEPA. 2023d. "Navajo Abandoned Uranium Mine Risk Calculator." Version 1.02. August.
- Weston Solutions, Inc. (Weston). 2019. "Removal Site Evaluation Report for Tronox Navajo Area Uranium Mines Sections 32 and 33 Mines, McKinley County, New Mexico." Prepared for USEPA. September.

Table C-2. Exposure Unit Summary of Land Use, Geologic Formation, Type, Area, and Available Samples

Exposure Unit	Land Use / Receptor	Geologic Formation	Type	Area (acre)	Number of Surface Soil (or Sediment) Samples (0-6 inches bgs) ^a	Number of Subsurface Soil Samples (0-72 inches bgs) ^a
Section 32 Mine	Kee'da'whíí tééh (Full-Time Navajo Resident)	Quaternary alluvium	TENORM	485	37 - Radiological 37 - Metals	40 - Radiological 44 - Metals except as noted ^b 40 - Antimony, Cadmium, Molybdenum, Silver, Thallium
Section 33 Mine	Default Resident (Non-Navajo)	Quaternary alluvium	TENORM	4.9	22 - Radiological 22 - Metals	23 - Radiological 25 - Metals except as noted ^b 23 - Antimony, Cadmium, Molybdenum, Silver, Thallium

Notes:

^a Includes all soil samples with analytical results from the Section 32 and 33 Mines, including field duplicate results, collected for the removal site evaluation (Weston 2019) and 2022 data gaps sampling (Tetra Tech, 2023). Soil depths were not provided in the Weston (2019) data tables, but the text indicates that samples were collected from 0 to 18 inches bgs.

^b Four selenium and five uranium results in the removal site evaluation results were reported as nondetect, but the method reporting limit was not provided with the data (Weston 2019). These four selenium and five uranium results were not included in the exposure evaluation of the risk assessment.

bgs Below ground surface
 TENORM Technologically enhanced naturally occurring radioactive material
 Tetra Tech Tetra Tech, Inc.
 Weston Weston Solutions, Inc.

References:

Tetra Tech, Inc. (Tetra Tech). 2023. "Section 32 and 33 Mines Eastern Abandoned Uranium Mine Region Data Gap Investigation Report." Response, Assessment, and Evaluation Services. Contract No. 68HE0923D0002. Task Order 0003. August.
 Weston Solutions, Inc. (Weston). 2019. "Removal Site Evaluation Report for Tronox Navajo Area Uranium Mines Sections 32 and 33 Mines, McKinley County, New Mexico." Prepared for the U.S. Environmental Protection Agency. September.

Table C-3. Human Health Exposure Parameters

Input Parameter	Symbol	Units	Receptor	
			Kee'da'whíí tééh (Full-Time Navajo Resident) ^a	Default Resident ^b
Common Parameters				
Exposure Duration - Adult	ED	years	69	20
Exposure Duration - Child	EDc	years	6	6
Exposure Duration - Lifetime Total	EDa	years	75	26
Exposure Time - Lifetime Total	t	years	75	26
Averaging Time - Cancer	ATc	days	27,375	25,550
Averaging Time - Noncancer - Adult	ATnc	days	25,185	7,300
Averaging Time - Noncancer - Child	ATnc	days	2,190	2,190
Exposure Frequency - Adult	EFa	days/year	350	350
Exposure Frequency - Child	EFc	days/year	350	350
Consumption Exposure Frequency for Animal and Plant Products- Adult	CEFa	days/year	350	0
Consumption Exposure Frequency for Animal and Plant Products- Child	CEFc	days/year	350	0
Body Weight - Adult	BWa	kg	80	80
Body Weight - Child	BWc	kg	15	15
Conversion Factor 1	CF1	g/mg	1/1,000	1/1,000
Conversion Factor 2	CF2	kg/mg	1/1,000,000	1/1,000,000
Conversion Factor 3	CF3	day/hours	1/24	1/24
Conversion Factor 4	CF4	g/kg	1,000	1,000
Conversion Factor 5	CF5	year/days	1/365	1/365
Conversion Factor 6	CF6	kg/g	1/1,000	1/1,000
Conversion Factor 7	CF7	pCi/Bq	27.027027	27.027027
Decay Constant	λ	1/year	Radionuclide-specific from the USEPA PRG Calculator	
Soil Ingestion Parameters				
Onsite Soil Ingestion Rate - Adult	IRSa	mg/day	360	100
Onsite Soil Ingestion Rate - Child	IRSc	mg/day	400	200
Dust Inhalation Parameters				
Inhalation Rate when Exposed - Adult	IRAres-a	m ³ /day	25	20
Inhalation Rate when Exposed - Child	IRAres-c	m ³ /day	10	10
Exposure Time - Adult	ETa	hours/day	22	24
Exposure Time - Child	ETc	hours/day	22	24
City/Climatic Zone	-	-	Albuquerque, NM	Albuquerque, NM
Mean Annual Wind Speed	Um	m/s	4.02	4.02
Areal extent of site surface soil contamination	As	acres	0.5	0.5
Fraction of Vegetative Cover	V	-	0.5	0.5
Particulate Emission Factor	PEF	m ³ /kg	6,609,630,250	6,609,630,250
Radiation External Exposure Parameters				
Gamma Shielding Factor - Outdoor	GSF _o	-	1	1
Gamma Shielding Factor - Indoor	GSF _i		0.7	0.4
Exposure Time on Site Outdoors - Adult	ET _{a-o}	hours/day	12	1.752
Exposure Time on Site Indoors - Adult	ET _{a-i}		10	16.416
Exposure Time on Site Outdoors - Child	ET _{c-o}	hours/day	12	1.752
Exposure Time on Site Indoors - Child	ET _{c-i}		10	16.416
Metals Dermal Exposure Parameters				
Surface Area - Adult	SAa	cm ² /day	6,032	6,032
Surface Area - Child	SAc	cm ² /day	2,373	2,373
Adherence Factor - Adult	AFa	mg/cm ²	0.12	0.07
Adherence Factor - Child	AFc	mg/cm ²	0.2	0.2

Table C-3. Human Health Exposure Parameters

Input Parameter	Symbol	Units	Receptor		
			Kee'da'whíí tééh (Full-Time Navajo Resident) ^a	Default Resident ^b	
Plant Consumption Parameters					
Total Plant Ingestion Rate - Adult	IRa	g/day	834	0	
Total Plant Ingestion Rate - Child	IRc	g/day	417	0	
Produce Contaminated Fraction	Annual Average	CFplant	-	0.55	
	Fall	-	-	0.75	
	Winter	-	-	0.5	
	Spring	-	-	0.3	
	Summer	-	-	0.65	
	Herbs/medicinal	CFmedicinal	-	1	-
Diet Fraction	Corn - White	DF	-	0.1	-
	Corn - Blue		-	0.1	-
	Corn - Yellow		-	0.05	-
	Corn - Red Speckled		-	0.03	-
	Corn - Sweet Corn		-	0.02	-
	Squash - Pumpkin		-	0.02	-
	Squash - Other Squash		-	0.08	-
	Melons - Watermelon		-	0.05	-
	Melons - Cantaloupe		-	0.05	-
	Tree Fruit - Apples		-	0.05	-
	Tree Fruit - Apricots		-	0.05	-
	Tree Fruit - Peaches		-	0.05	-
	Other Vegetables - Beans		-	0.1	-
	Other Vegetables - Brussels sprouts		-	0.02	-
	Other Vegetables - Cucumbers		-	0.02	-
	Other Vegetables - Tomatoes		-	0.02	-
	Other Vegetables - Chili		-	0.05	-
	Other Vegetables - Onions		-	0.02	-
Other Vegetables - Potatoes	-	0.02	-		
Herbs and Medicinal	-	-	0.1	-	
Plant-Soil Transfer Factor	Bvwet	pCi/g-fresh plant per pCi/g-dry soil	Plant-specific based on plant type as indicated by the USEPA PRG Calculator	-	
Mass Loading Factor	MLF	g-dry soil per g-fresh plant	Plant-specific based on plant type as indicated by the USEPA PRG Calculator	-	
Bioconcentration Factor for Aboveground Plants	Brag	mg/kg-dry plant per mg/kg-dry soil	Metal-specific as selected from USEPA (2005) or Baes and others (1984)	-	
Bioconcentration Factor for Belowground Plants	Brroot	mg/kg-dry plant per mg/kg-dry soil	Metal-specific as selected from USEPA (2005) or Baes and others (1984)	-	

Table C-3. Human Health Exposure Parameters

Input Parameter	Symbol	Units	Receptor	
			Kee'da'whíí tééh (Full-Time Navajo Resident) ^a	Default Resident ^b
Animal Consumption Parameters				
Total Animal Ingestion Rate - Adult	IRa	g/day	983	0
Total Animal Ingestion Rate - Child	IRc	g/day	491.5	0
Contaminated Fraction	Chicken	CF	-	0.05
	Chicken Eggs	CF	-	0.75
	Beef	CF	-	0.25
	Milk - Cow	CF	-	0.01
	Pig	CF	-	0.05
	Goat	CF	-	1
	Milk - Goat	CF	-	1
	Sheep	CF	-	0.9
	Milk - Sheep	CF	-	0.9
	Horse	CF	-	1
	Domesticated Turkey	CF	-	0.05
	Wild Turkey	CF	-	0.02
	Deer	CF	-	0.02
	Elk	CF	-	0.02
	Rabbit	CF	-	1
Prairie Dog	CF	-	1	
Badger	CF	-	1	
Diet Fraction	Chicken	DF	-	0.2
	Chicken Eggs	DF	-	0.07
	Beef	DF	-	0.25
	Milk - Cow	DF	-	0.06
	Pig	DF	-	0.07
	Goat	DF	-	0.05
	Milk - Goat	DF	-	0.01
	Sheep	DF	-	0.2
	Milk - Sheep	DF	-	0
	Horse	DF	-	0.005
	Domesticated Turkey	DF	-	0.003
	Wild Turkey	DF	-	0.002
	Deer	DF	-	0.03
	Elk	DF	-	0.03
	Rabbit	DF	-	0.005
Prairie Dog	DF	-	0.01	
Badger	DF	-	0.005	
Animal Consumption Parameters (continued)				
Mass-Loading Factor for Pasture	MLF _{pasture}	g-dry soil per g-dry plant	0.25	-
Density of Milk	ρ _m	kg/L	1.03	-
Soil Intake Rate	Q _s	kg/day	Animal-specific from the USEPA PRG Calculator	-
Fodder Intake Rate	Q _p	kg/day	Animal-specific from the USEPA PRG Calculator	-
Bioavailability in Soil	B _s	-	Metal-specific	-
Metabolism Factor	MF	-	Metal-specific	-
Bioaccumulation Factor for Metals	B _a	days/kg	Animal- and metal-specific from USEPA (2005) or Baes and others (1984)	-
Dry Soil-to-Plant Transfer Factor	B _v _{dry}	pCi/g-dry plant per pCi/g-dry soil	Metal-specific	-
Radionuclide Transfer Factor	TF _m	pCi/day per pCi/kg	Animal- and metal-specific from USEPA (2005) or Baes and others (1984)	-

Table C-3. Human Health Exposure Parameters

Input Parameter	Symbol	Units	Receptor		
			Kee'da'whíí tééh (Full-Time Navajo Resident) ^a	Default Resident ^b	
Other Diné Lifeways					
Age-adjusted ingestion rate of medicinal plants	Navajo Tea	IFadj	g/day	1.0	-
	Sumac (skunkbush and other)	IFadj	g/day	6.4	-
	Soaptree Yucca	IFadj	g/day	6.4	-
	Sagebrush	IFadj	g/day	12.9	-
	Corn Pollen and Other Corn	IFadj	g/day	19.3	-
	Other Plant Types	IFadj	g/day	6.4	-
Adult dermal rate of medicinal plants	Navajo Tea	DCRa	g/day	2.1	-
	Sumac (skunkbush and other)	DCRa	g/day	38.6	-
	Soaptree Yucca	DCRa	g/day	38.6	-
	Sagebrush	DCRa	g/day	12.9	-
	Corn Pollen and Other Corn	DCRa	g/day	38.6	-
	Other Plant Types	DCRa	g/day	6.4	-
Mass of plant available for inhalation	Sagebrush	IMa	g/day	25.7	-
	Corn Pollen and Other Corn	IMa	g/day	12.9	-
	Other Plant Types	IMa	g/day	6.4	-
Inhalation fraction	Sagebrush	IF	-	0.1	-
	Corn Pollen and Other Corn	IF	-	0.1	-
	Other Plant Types	IF	-	0.1	-

Notes:

^a Exposure inputs for the Navajo receptor provided by NNEPA (2021).

^b Default values for resident receptor from the PRG Calculator (USEPA 2023a) and RSL Calculator (USEPA 2023b). Plant ingestion is included in the USEPA PRG Calculator but not in the RSL Calculator and was set to zero for the default resident.

-	Not applicable	m ³ /kg	Cubic meter per kilogram
cm ² /day	Square centimeter per day	mg/cm ²	Milligram per square centimeter
days/kg	Days per kilogram	mg/day	Milligram per day
g	Gram	mg/kg	Milligram per kilogram
g/day	Gram per day	NM	New Mexico
g/kg	Gram per kilogram	NNEPA	Navajo Nation Environmental Protection Agency
g/mg	Gram per milligram	pCi/Bq	Picocurie per becquerel
kg	Kilogram	pCi/day	Picocurie per day
kg/day	Kilogram per day	pCi/g	Picocurie per gram
kg/g	Kilogram per gram	pCi/kg	Picocurie per kilogram
kg/L	Kilogram per liter	PRG	Preliminary remediation goal
kg/mg	Kilogram per milligram	RME	Reasonably maximum exposed
m/s	Meter per second	RSL	Regional screening level
m ³ /day	Cubic meter per day	USEPA	U.S. Environmental Protection Agency

References:

Navajo Nation Environmental Protection Agency (NNEPA). 2021b. "Navajo Tribe Provisional Reasonable Maximum Exposures RME for the Navajo Risk Assessments." Draft. September 15.

USEPA. 2023a. "Preliminary Remediation Goals for Radionuclides (PRG)." May. https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search.

USEPA. 2023b. "Regional Screening Levels (RSLs)." May. https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search.

USEPA. 2023c. "Navajo Abandoned Uranium Mines Risk Assessment Methodology." Draft Final. Response, Assessment, and Evaluation Services. Contract No. EP-S9-17-02. August.

Table C-4. Exposure Point Concentrations for Human Health Risk Assessment

Section 32 Mine											
COPC ^a	Units	Detection Frequency	Number of High Nondetect Results ^b	Maximum Concentration (qualifier)	Location of Maximum Concentration	Arithmetic Mean ^c	UCL95 / Distribution ^d		Exposure Point Concentration		
									Value ^e	Statistic ^e	Method ^f
Surface Soil (0-6 inches bgs)											
Radium-226	pCi/g	21 / 21	0	27.3	S3233-SS27-01-111522	16.38	30.35	NP	5.4	UCL	(14)
Aluminum	mg/kg	21 / 21	0	23,800	S3233-SS26-01-111522	15,979	18,297	N	17,800	UCL	(2)
Antimony	mg/kg	5 / 19	13	0.343	S3233-SS46-01-111822	0.37	0.420	n/a	0.34	Maximum	(1)
Arsenic	mg/kg	21 / 21	0	8.3	S3233-SS41-01-111822	6.348	7.374	N	6.5	UCL	(2)
Barium	mg/kg	21 / 21	0	307	S3233-SS23-01-111522	83.78	95.33	N	197	UCL	(2)
Cadmium	mg/kg	18 / 21	0	0.24	S3233-SS30-01-111722	0.161	0.197	N	0.15	UCL	(2)
Cobalt	mg/kg	21 / 21	0	8.72	S3233-SS30-01-111722	6.601	7.625	N	7.1	UCL	(2)
Copper	mg/kg	21 / 21	0	17.1	S3233-SS30-01-111722	12.70	14.64	N	12	UCL	(2)
Iron	mg/kg	21 / 21	0	26,300	S3233-SS26-01-111522	19,369	22,285	N	20,300	UCL	(2)
Manganese	mg/kg	21 / 21	0	419	S3233-SS20-01-111522	209	230.50	N	284	UCL	(2)
Molybdenum	mg/kg	19 / 21	0	1	S3233-SS30-01-111722	0.871	1.065	N	0.69	UCL	(2)
Nickel	mg/kg	21 / 21	0	19	S3233-SS30-01-111722	12.78	15.14	N	13	UCL	(2)
Selenium	mg/kg	21 / 21	0	13.3	S3233-SS27-01-111522	12.22	21.65	NP	2.6	UCL	(14)
Thallium	mg/kg	19 / 21	0	0.471	S3233-SS30-01-111722	0.352	0.408	N	0.29	UCL	(15)
Uranium	mg/kg	21 / 21	0	32.4	S3233-SS27-01-111522	22.7	44.71	NP	7	UCL	(14)
Vanadium	mg/kg	21 / 21	0	38.7	S3233-SS53-01-111822	33.58	40.05	N	28	UCL	(2)

Table C-4. Exposure Point Concentrations for Human Health Risk Assessment

Section 32 Mine											
COPC ^a	Units	Detection Frequency	Number of High Nondetect Results ^b	Maximum Concentration (qualifier)	Location of Maximum Concentration	Arithmetic Mean ^c	UCL95 / Distribution ^d		Exposure Point Concentration		
									Value ^e	Statistic ^e	Method ^f
Subsurface Soil (0-18 inches bgs)											
Radium-226	pCi/g	38 / 38	0	32.7	S3233-SB55-0612-111822	16.38	30.35	NP	6.5	UCL	(14)
Aluminum	mg/kg	41 / 41	0	25,000	32-02-31-181103-M	15,979	18,297	N	17,400	UCL	(2)
Antimony	mg/kg	26 / 26	14	0.343 J	S3233-SS46-01-111822	0.37	0.420	n/a	0.34	Maximum	(1)
Arsenic	mg/kg	41 / 41	0	8	S3233-SS41-01-111822	6.348	7.374	N	6.3	UCL	(2)
Barium	mg/kg	41 / 41	0	307	S3233-SS23-01-111522	83.78	95.33	G	194	UCL	(6)
Cadmium	mg/kg	38 / 38	0	0.24	S3233-SS30-01-111722	0.161	0.197	N	0.15	UCL	(2)
Cobalt	mg/kg	41 / 41	0	8.72	S3233-SS30-01-111722	6.601	7.625	N	6.8	UCL	(2)
Copper	mg/kg	41 / 41	0	17.1 J	S3233-SS30-01-111722	12.70	14.64	N	12	UCL	(2)
Iron	mg/kg	41 / 41	0	26300	S3233-SS26-01-111522	19,369	22,285	N	19,800	UCL	(2)
Manganese	mg/kg	41 / 41	0	419	S3233-SS20-01-111522	209	230.50	N	274	UCL	(2)
Molybdenum	mg/kg	38 / 38	0	1.18 J	S3233-SS30-01-111722	0.871	1.065	N	0.68	UCL	(2)
Nickel	mg/kg	41 / 41	0	19 J	S3233-SS30-01-111722	12.78	15.14	N	12	UCL	(2)
Selenium	mg/kg	40 / 40	0	13.3	S3233-SS27-01-111522	12.22	21.65	NP	2.6	UCL	(15)
Thallium	mg/kg	38 / 38	0	0.471	S3233-SS30-01-111722	0.352	0.408	N	0.29	UCL	(3)
Uranium	mg/kg	41 / 41	0	77	32-03-31-181103-M	22.7	44.71	NP	11	UCL	(15)
Vanadium	mg/kg	41 / 41	0	38.7	S3233-SS53-01-111822	33.58	40.05	N	39	Maximum	(2)

Table C-4. Exposure Point Concentrations for Human Health Risk Assessment

Section 33 Mine											
COPC ^a	Units	Detection Frequency	Number of High Nondetect Results ^b	Maximum Concentration (qualifier)	Location of Maximum Concentration	Arithmetic Mean ^c	UCL95 / Distribution ^d		Exposure Point Concentration		
									Value ^e	Statistic ^e	Method ^f
Surface Soil (0-6 inches bgs)											
Radium-226	pCi/g	21 / 21	0	161	S3233-SS59-01-111822	16.38	30.35	NP	30	UCL	(14)
Aluminum	mg/kg	21 / 21	0	27,000	S3233-SS03-01-111522	15,979	18,297	N	18,300	UCL	(2)
Antimony	mg/kg	5 / 19	0	1 J	S3233-SS14-01-111522	0.37	0.420	N	0.42	UCL	(3)
Arsenic	mg/kg	21 / 21	0	13.8	S3233-SS60-01-111822	6.348	7.374	N	7.4	UCL	(2)
Barium	mg/kg	21 / 21	0	131	S3233-SS19-01-111522	83.78	95.33	NP	95	UCL	(14)
Cadmium	mg/kg	18 / 21	0	0	S3233-SS03-01-111522	0.161	0.197	N	0.20	UCL	(3)
Cobalt	mg/kg	21 / 21	0	10	S3233-SS03-01-111522	6.601	7.625	NP	7.6	UCL	(14)
Copper	mg/kg	21 / 21	0	20	S3233-SS03-01-111522	12.70	14.64	NP	15	UCL	(14)
Iron	mg/kg	21 / 21	0	31,500	S3233-SS03-01-111522	19,369	22,285	NP	22,300	UCL	(14)
Manganese	mg/kg	21 / 21	0	301	S3233-SS03-01-111522	209	230.50	NP	231	UCL	(14)
Molybdenum	mg/kg	19 / 21	0	2 J	S3233-SS03-01-111522	0.871	1.065	N	1.1	UCL	(3)
Nickel	mg/kg	21 / 21	0	23	S3233-SS03-01-111522	12.78	15.14	NP	15	UCL	(14)
Selenium	mg/kg	21 / 21	0	102	S3233-SS58-01-111822	12.22	21.65	NP	22	UCL	(14)
Thallium	mg/kg	19 / 21	0	1	S3233-SS03-01-111522	0.352	0.408	N	0.41	UCL	(3)
Uranium	mg/kg	21 / 21	0	251	S3233-SS59-01-111822	22.7	44.71	NP	45	UCL	(14)
Vanadium	mg/kg	21 / 21	0	92	S3233-SS59-01-111822	33.58	40.05	NP	40	UCL	(14)

Table C-4. Exposure Point Concentrations for Human Health Risk Assessment

Section 33 Mine											
COPC ^a	Units	Detection Frequency	Number of High Nondetect Results ^b	Maximum Concentration (qualifier)	Location of Maximum Concentration	Arithmetic Mean ^c	UCL95 / Distribution ^d		Exposure Point Concentration		
									Value ^e	Statistic ^e	Method ^f
Subsurface Soil (0-18 inches bgs)											
Radium-226	pCi/g	22 / 22	0	161	S3233-SS59-01-111822	16.42	30.00	NP	30	UCL	(14)
Aluminum	mg/kg	24 / 24	0	27,000	S3233-SS03-01-111522	15,470	17,729	N	17,700	UCL	(2)
Antimony	mg/kg	5 / 20	0	1 J	S3233-SS14-01-111522	0.37	0.414	N	0.41	UCL	(3)
Arsenic	mg/kg	24 / 24	0	14	S3233-SS60-01-111822	5.98	6.953	N	7.0	UCL	(2)
Barium	mg/kg	24 / 24	0	131	S3233-SS19-01-111522	79.5	91.84	N	92	UCL	(2)
Cadmium	mg/kg	19 / 22	0	0	S3233-SS03-01-111522	0.154	0.191	N	0.19	UCL	(3)
Cobalt	mg/kg	24 / 24	0	10	S3233-SS03-01-111522	6.179	7.187	NP	7.2	UCL	(14)
Copper	mg/kg	24 / 24	0	20	S3233-SS03-01-111522	11.85	13.74	NP	14	UCL	(14)
Iron	mg/kg	24 / 24	0	31,500	S3233-SS03-01-111522	18,526	21,386	NP	21,400	UCL	(14)
Manganese	mg/kg	24 / 24	0	301	S3233-SS03-01-111522	196	219	NP	219	UCL	(14)
Molybdenum	mg/kg	20 / 22	0	2 J	S3233-SS03-01-111522	0.857	1.043	N	1.0	UCL	(3)
Nickel	mg/kg	24 / 24	0	23	S3233-SS03-01-111522	11.9	14.24	NP	14	UCL	(14)
Selenium	mg/kg	24 / 24	0	102	S3233-SS58-01-111822	11.64	19.88	NP	20	UCL	(14)
Thallium	mg/kg	19 / 22	0	1	S3233-SS03-01-111522	0.342	0.398	N	0.40	UCL	(3)
Uranium	mg/kg	22 / 22	0	251	S3233-SS59-01-111822	21.82	40.8	NP	41	UCL	(15)
Vanadium	mg/kg	24 / 24	0	92	S3233-SS59-01-111822	32.58	38.15	NP	38	UCL	(14)

Notes:

^a EPCs calculated if "Yes" for "Include Constituent as a COPC?" on Table C-1.

^b Number of nondetect results that exceeded the maximum detected concentration. These results were not included in the statistical calculations.

^c The arithmetic mean for datasets with nondetected results is calculated using the KM method.

^d Tested using the Shapiro-Wilk W or Lilliefors test for normal and lognormal distributions and the Anderson-Darling and Kolmogorov-Smirnov tests for gamma distributions. A 5 percent level of significance was used in all tests. Distribution tests were conducted only for samples with at least four detected results. Distributions not confirmed as N, LN, or G were treated as NP in all statistical calculations.

^e The EPC is the lesser of the UCL95 and the maximum detected concentration. The maximum detected concentration is the default when there are fewer than 10 samples or fewer than four detected results. All methods follow USEPA (2002, 2022b).

^f The statistical methods for selecting the exposure point concentration are as follows (not all are used):

- | | | |
|------------------------------------|----------------------------------|--------------------------------------|
| (1) Maximum detected concentration | (6) 95% Approximate Gamma UCL | (11) 95% KM Bootstrap-t UCL |
| (2) 95% Student's t UCL | (7) 95% Gamma Approximate KM-UCL | (12) 95% BCA UCL |
| (3) 95% KM (t) UCL | (8) 95% H-UCL | (13) 95% KM BCA UCL |
| (4) 95% Adjusted Gamma UCL | (9) 95% H-UCL (KM log) | (14) 95% Percentile Bootstrap UCL |
| (5) 95% Gamma Adjusted KM-UCL | (10) 95% Bootstrap-t UCL | (15) 95% KM Percentile Bootstrap UCL |

Table C-4. Exposure Point Concentrations for Human Health Risk Assessment

Notes (continued):

--	Not applicable
BCA	Bias-corrected accelerated bootstrap method
bgs	Below ground surface
COPC	Contaminant of potential concern
EPC	Exposure point concentration
G (distribution)	Gamma distribution
H-UCL	UCL based upon Land's H-statistic
J	Estimated concentration
KM	Kaplan-Meier
LN	Lognormal distribution
mg/kg	Milligram per kilogram
N	Normal distribution
n/a	Not applicable
NP	Nonparametric distribution
pCi/g	Picocurie per gram
UCL	Upper confidence limit
UCL95	One-sided 95 percent upper confidence limit of the mean
USEPA	U.S. Environmental Protection Agency

References:

- U.S. Environmental Protection Agency (USEPA). 2002. "Calculating Exposure Point Concentrations at Hazardous Waste Sites." Office of Solid Waste and Emergency Response. Directive 9285.6-10. December.
- USEPA. 2022b. "ProUCL Version 5.2.0 Technical Guide." Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. June 14.

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																			
COPC ^a	EPC ^b	Units	Cancer Intake ^c	Units	Slope Factor/ Unit Risk ^d	Units	Cancer Risk ^e	Adult Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f		Child Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f	
												Adult						Child	
Exposure Medium: Surface Soil (0-6 inches bgs)																			
Exposure Route: Incidental Soil Ingestion																			
Radium-226	5.4E+00	pCi/g	5.1E+04	pCi/g	5.7E-09	Risk/pCi/g	2.9E-04	--	--	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							3E-04	Radionuclide Noncancer Total					--	Radionuclide Noncancer Total					--
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	7.7E-02	mg/kg-day	1.0E+00	mg/kg-day	0.077	4.6E-01	mg/kg-day	1.0E+00	mg/kg-day	0.46		
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.5E-06	mg/kg-day	4.0E-04	mg/kg-day	0.0037	8.7E-06	mg/kg-day	4.0E-04	mg/kg-day	0.022		
Arsenic	6.5E+00	mg/kg	2.3E-05	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	3.5E-05	1.7E-05	mg/kg-day	3.0E-04	mg/kg-day	0.056	1.0E-04	mg/kg-day	3.0E-04	mg/kg-day	0.33		
Barium	2.0E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	8.5E-04	mg/kg-day	2.0E-01	mg/kg-day	0.0043	5.0E-03	mg/kg-day	2.0E-01	mg/kg-day	0.025		
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	6.5E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0065	3.8E-06	mg/kg-day	1.0E-04	mg/kg-day	0.038		
Cobalt	7.1E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.1E-05	mg/kg-day	3.0E-04	mg/kg-day	0.10	1.8E-04	mg/kg-day	3.0E-04	mg/kg-day	0.61		
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	5.2E-05	mg/kg-day	4.0E-02	mg/kg-day	0.0013	3.1E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0077		
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	8.8E-02	mg/kg-day	7.0E-01	mg/kg-day	0.13	5.2E-01	mg/kg-day	7.0E-01	mg/kg-day	0.74		
Manganese	2.8E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.2E-03	mg/kg-day	2.4E-02	mg/kg-day	0.051	7.3E-03	mg/kg-day	2.4E-02	mg/kg-day	0.30		
Molybdenum	6.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.0E-06	mg/kg-day	5.0E-03	mg/kg-day	0.00060	1.8E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0035		
Nickel	1.3E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	5.6E-05	mg/kg-day	2.0E-02	mg/kg-day	0.0028	3.3E-04	mg/kg-day	2.0E-02	mg/kg-day	0.017		
Selenium	2.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.1E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0022	6.6E-05	mg/kg-day	5.0E-03	mg/kg-day	0.013		
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.3E-06	mg/kg-day	1.0E-05	mg/kg-day	0.13	7.4E-06	mg/kg-day	1.0E-05	mg/kg-day	0.74		
Uranium	6.9E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.0E-05	mg/kg-day	2.0E-04	mg/kg-day	0.15	1.8E-04	mg/kg-day	2.0E-04	mg/kg-day	0.88		
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.024	7.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.14		
Metals Cancer Total							4E-05	Metals Noncancer Total					0.7	Metals Noncancer Total					4
Exposure Route Cancer Total							3E-04	Exposure Route Noncancer Total					0.7	Exposure Route Noncancer Total					4
Exposure Medium: Surface Soil (0-6 inches bgs)																			
Exposure Route: External Exposure																			
Radium-226	5.4E+00	pCi/g	2.8E+02	pCi/g	8.4E-06	risk/year pCi/g	2.3E-03	--	--	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							2E-03	Radionuclide Noncancer Total					--	Radionuclide Noncancer Total					--
Exposure Route Cancer Total							2E-03	Exposure Route Noncancer Total					--	Exposure Route Noncancer Total					--
Exposure Route: Dermal Exposure																			
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	1.0E+00	mg/kg-day	--	--	mg/kg-day	1.0E+00	mg/kg-day	--		
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	4.0E-04	mg/kg-day	--	--	mg/kg-day	4.0E-04	mg/kg-day	--		
Arsenic	6.5E+00	mg/kg	1.4E-06	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	2.1E-06	9.9E-07	mg/kg-day	3.0E-04	mg/kg-day	0.0033	5.9E-06	mg/kg-day	3.0E-04	mg/kg-day	0.020		
Barium	2.0E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-01	mg/kg-day	--	--	mg/kg-day	2.0E-01	mg/kg-day	--		
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.0E-08	mg/kg-day	1.0E-04	mg/kg-day	0.00030	1.8E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0018		
Cobalt	7.1E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	mg/kg-day	3.0E-04	mg/kg-day	--		
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	4.0E-02	mg/kg-day	--	--	mg/kg-day	4.0E-02	mg/kg-day	--		
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	7.0E-01	mg/kg-day	--	--	mg/kg-day	7.0E-01	mg/kg-day	--		
Manganese	2.8E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.4E-02	mg/kg-day	--	--	mg/kg-day	2.4E-02	mg/kg-day	--		
Molybdenum	6.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--		
Nickel	1.3E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-02	mg/kg-day	--	--	mg/kg-day	2.0E-02	mg/kg-day	--		
Selenium	2.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--		
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	1.0E-05	mg/kg-day	--	--	mg/kg-day	1.0E-05	mg/kg-day	--		
Uranium	6.9E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-04	mg/kg-day	--	--	mg/kg-day	2.0E-04	mg/kg-day	--		
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--		
Metals Cancer Total							2E-06	Metals Noncancer Total					0.004	Metals Noncancer Total					0.02
Exposure Route Cancer Total							2E-06	Exposure Route Noncancer Total					0.004	Exposure Route Noncancer Total					0.02

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																	
COPC ^a	EPC ^b	Units	Cancer Intake ^c	Units	Slope Factor/ Unit Risk ^d	Units	Cancer Risk ^e	Adult Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f	Child Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f
												Adult					Child
Exposure Medium: Surface Soil (0-6 inches bgs)																	
Exposure Route: Inhalation of Particulates																	
Radium-226	5.4E+00	pCi/g	4.7E-01	pCi	5.9E-08	Risk/pCi	2.8E-08	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							3E-08	Radionuclide Noncancer Total				--	Radionuclide Noncancer Total				--
Aluminum	1.8E+04	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	2.4E-06	mg/m ³	5.0E-03	mg/m ³	0.00047	2.4E-06	mg/m ³	5.0E-03	mg/m ³	0.00047
Antimony	3.4E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	4.5E-11	mg/m ³	3.0E-04	mg/m ³	0.00000015	4.5E-11	mg/m ³	3.0E-04	mg/m ³	0.00000015
Arsenic	6.5E+00	mg/kg	8.6E-07	µg/m ³	4.3E-03	(µg/m ³) ⁻¹	3.7E-09	8.6E-10	mg/m ³	1.5E-05	mg/m ³	0.000058	8.6E-10	mg/m ³	1.5E-05	mg/m ³	0.000058
Barium	2.0E+02	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	2.6E-08	mg/m ³	5.0E-04	mg/m ³	0.000052	2.6E-08	mg/m ³	5.0E-04	mg/m ³	0.000052
Cadmium	1.5E-01	mg/kg	2.0E-08	µg/m ³	1.8E-03	(µg/m ³) ⁻¹	3.6E-11	2.0E-11	mg/m ³	1.0E-05	mg/m ³	0.0000020	2.0E-11	mg/m ³	1.0E-05	mg/m ³	0.0000020
Cobalt	7.1E+00	mg/kg	9.4E-07	µg/m ³	9.0E-03	(µg/m ³) ⁻¹	8.5E-09	9.4E-10	mg/m ³	6.0E-06	mg/m ³	0.00016	9.4E-10	mg/m ³	6.0E-06	mg/m ³	0.00016
Copper	1.2E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--
Iron	2.0E+04	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--
Manganese	2.8E+02	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	3.8E-08	mg/m ³	5.0E-05	mg/m ³	0.00076	3.8E-08	mg/m ³	5.0E-05	mg/m ³	0.00076
Molybdenum	6.9E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	9.2E-11	mg/m ³	2.0E-03	mg/m ³	0.000000046	9.2E-11	mg/m ³	2.0E-03	mg/m ³	0.000000046
Nickel	1.3E+01	mg/kg	1.7E-06	µg/m ³	2.6E-04	(µg/m ³) ⁻¹	4.5E-10	1.7E-09	mg/m ³	9.0E-05	mg/m ³	0.000019	1.7E-09	mg/m ³	9.0E-05	mg/m ³	0.000019
Selenium	2.6E+00	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	3.5E-10	mg/m ³	2.0E-02	mg/m ³	0.000000017	3.5E-10	mg/m ³	2.0E-02	mg/m ³	0.000000017
Thallium	2.9E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--
Uranium	6.9E+00	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	9.2E-10	mg/m ³	4.0E-05	mg/m ³	0.000023	9.2E-10	mg/m ³	4.0E-05	mg/m ³	0.000023
Vanadium	2.8E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	3.7E-09	mg/m ³	1.0E-04	mg/m ³	0.000037	3.7E-09	mg/m ³	1.0E-04	mg/m ³	0.000037
Metals Cancer Total							1E-08	Metals Noncancer Total				0.002	Metals Noncancer Total				0.002
Exposure Route Cancer Total							4E-08	Exposure Route Noncancer Total				0.002	Exposure Route Noncancer Total				0.002
Exposure Medium: Surface Soil (0-6 inches bgs)																	
Exposure Route: Plant Consumption																	
Radium-226	5.4E+00	pCi/g	5.9E+05	pCi/g	3.7E-09	Risk/pCi/g	2.2E-03	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							2E-03	Radionuclide Noncancer Total				--	Radionuclide Noncancer Total				--
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.1E-01	mg/kg-day	1.0E+00	mg/kg-day	0.21	5.5E-01	mg/kg-day	1.0E+00	mg/kg-day	0.55
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	7.7E-06	mg/kg-day	4.0E-04	mg/kg-day	0.019	2.1E-05	mg/kg-day	4.0E-04	mg/kg-day	0.052
Arsenic	6.5E+00	mg/kg	9.3E-05	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	1.4E-04	8.2E-05	mg/kg-day	3.0E-04	mg/kg-day	0.27	2.2E-04	mg/kg-day	3.0E-04	mg/kg-day	0.73
Barium	2.0E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	4.5E-03	mg/kg-day	2.0E-01	mg/kg-day	0.022	1.2E-02	mg/kg-day	2.0E-01	mg/kg-day	0.060
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	8.9E-06	mg/kg-day	1.0E-04	mg/kg-day	0.089	2.4E-05	mg/kg-day	1.0E-04	mg/kg-day	0.24
Cobalt	7.1E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.3E-04	mg/kg-day	3.0E-04	mg/kg-day	0.43	3.4E-04	mg/kg-day	3.0E-04	mg/kg-day	1.1
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.0E-03	mg/kg-day	4.0E-02	mg/kg-day	0.051	5.4E-03	mg/kg-day	4.0E-02	mg/kg-day	0.13
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.4E-01	mg/kg-day	7.0E-01	mg/kg-day	0.34	6.3E-01	mg/kg-day	7.0E-01	mg/kg-day	0.90
Manganese	2.8E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.1E-02	mg/kg-day	2.4E-02	mg/kg-day	1.3	8.2E-02	mg/kg-day	2.4E-02	mg/kg-day	3.4
Molybdenum	6.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	7.5E-05	mg/kg-day	5.0E-03	mg/kg-day	0.015	2.0E-04	mg/kg-day	5.0E-03	mg/kg-day	0.040
Nickel	1.3E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.8E-04	mg/kg-day	2.0E-02	mg/kg-day	0.0090	4.8E-04	mg/kg-day	2.0E-02	mg/kg-day	0.024
Selenium	2.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	4.6E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0093	1.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.025
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.0E-06	mg/kg-day	1.0E-05	mg/kg-day	0.30	8.1E-06	mg/kg-day	1.0E-05	mg/kg-day	0.81
Uranium	6.9E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	9.3E-05	mg/kg-day	2.0E-04	mg/kg-day	0.46	2.5E-04	mg/kg-day	2.0E-04	mg/kg-day	1.2
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.4E-04	mg/kg-day	5.0E-03	mg/kg-day	0.069	9.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.18
Metals Cancer Total							1E-04	Metals Noncancer Total				4	Metals Noncancer Total				10
Exposure Route Cancer Total							2E-03	Exposure Route Noncancer Total				4	Exposure Route Noncancer Total				10

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																			
COPC ^a	EPC ^b	Units	Cancer Intake ^c	Units	Slope Factor/ Unit Risk ^d	Units	Cancer Risk ^e	Adult Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f	Child Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f		
												Adult					Child		
Exposure Medium: Surface Soil (0-6 inches bgs)																			
Exposure Route: Animal Consumption																			
Radium-226	5.4E+00	pCi/g	1.1E+06	pCi/g	3.7E-09	Risk/pCi/g	4.1E-03	--	--	--	--	--	--	--	--	--	--		
Radionuclide Cancer Total							4E-03	Radionuclide Noncancer Total					--	Radionuclide Noncancer Total					--
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.2E-02	mg/kg-day	1.0E+00	mg/kg-day	0.012	3.3E-02	mg/kg-day	1.0E+00	mg/kg-day	0.033		
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.3E-07	mg/kg-day	4.0E-04	mg/kg-day	0.00057	6.1E-07	mg/kg-day	4.0E-04	mg/kg-day	0.0015		
Arsenic	6.5E+00	mg/kg	7.2E-06	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	1.1E-05	6.4E-06	mg/kg-day	3.0E-04	mg/kg-day	0.021	1.7E-05	mg/kg-day	3.0E-04	mg/kg-day	0.057		
Barium	2.0E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.6E-05	mg/kg-day	2.0E-01	mg/kg-day	0.00013	6.8E-05	mg/kg-day	2.0E-01	mg/kg-day	0.00034		
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.4E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0034	9.0E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0090		
Cobalt	7.1E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	6.8E-05	mg/kg-day	3.0E-04	mg/kg-day	0.23	1.8E-04	mg/kg-day	3.0E-04	mg/kg-day	0.61		
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.1E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0027	2.9E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0072		
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.8E-01	mg/kg-day	7.0E-01	mg/kg-day	0.26	4.9E-01	mg/kg-day	7.0E-01	mg/kg-day	0.70		
Manganese	2.8E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	9.4E-05	mg/kg-day	2.4E-02	mg/kg-day	0.0039	2.5E-04	mg/kg-day	2.4E-02	mg/kg-day	0.010		
Molybdenum	6.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.1E-06	mg/kg-day	5.0E-03	mg/kg-day	0.00062	8.3E-06	mg/kg-day	5.0E-03	mg/kg-day	0.0017		
Nickel	1.3E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.9E-05	mg/kg-day	2.0E-02	mg/kg-day	0.0019	1.0E-04	mg/kg-day	2.0E-02	mg/kg-day	0.0052		
Selenium	2.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.0E-04	mg/kg-day	5.0E-03	mg/kg-day	0.040	5.3E-04	mg/kg-day	5.0E-03	mg/kg-day	0.11		
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	5.3E-06	mg/kg-day	1.0E-05	mg/kg-day	0.53	1.4E-05	mg/kg-day	1.0E-05	mg/kg-day	1.4		
Uranium	6.9E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	9.8E-07	mg/kg-day	2.0E-04	mg/kg-day	0.0049	2.6E-06	mg/kg-day	2.0E-04	mg/kg-day	0.013		
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.2E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0064	8.5E-05	mg/kg-day	5.0E-03	mg/kg-day	0.017		
Metals Cancer Total							1E-05	Metals Noncancer Total					1	Metals Noncancer Total					3
Exposure Route Cancer Total							4E-03	Exposure Route Noncancer Total					1	Exposure Route Noncancer Total					3
Exposure Medium: Surface Soil (0-6 inches bgs)																			
Exposure Route: Other Diné Lifeways Plant Ingestion																			
Radium-226	5.4E+00	pCi/g	3.2E+05	pCi/g	3.7E-09	Risk/pCi/g	1.2E-03	--	--	--	--	--	--	--	--	--	--		
Radionuclide Cancer Total							1E-03	Radionuclide Noncancer Total					--	Radionuclide Noncancer Total					--
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.3E-01	mg/kg-day	1.0E+00	mg/kg-day	0.13	--	mg/kg-day	1.0E+00	mg/kg-day	--		
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	5.0E-06	mg/kg-day	4.0E-04	mg/kg-day	0.012	--	mg/kg-day	4.0E-04	mg/kg-day	--		
Arsenic	6.5E+00	mg/kg	4.6E-05	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	6.9E-05	5.0E-05	mg/kg-day	3.0E-04	mg/kg-day	0.17	--	mg/kg-day	3.0E-04	mg/kg-day	--		
Barium	2.0E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.9E-03	mg/kg-day	2.0E-01	mg/kg-day	0.014	--	mg/kg-day	2.0E-01	mg/kg-day	--		
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	6.0E-06	mg/kg-day	1.0E-04	mg/kg-day	0.060	--	mg/kg-day	1.0E-04	mg/kg-day	--		
Cobalt	7.1E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	8.1E-05	mg/kg-day	3.0E-04	mg/kg-day	0.27	--	mg/kg-day	3.0E-04	mg/kg-day	--		
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.4E-03	mg/kg-day	4.0E-02	mg/kg-day	0.034	--	mg/kg-day	4.0E-02	mg/kg-day	--		
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.4E-01	mg/kg-day	7.0E-01	mg/kg-day	0.21	--	mg/kg-day	7.0E-01	mg/kg-day	--		
Manganese	2.8E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.1E-02	mg/kg-day	2.4E-02	mg/kg-day	0.87	--	mg/kg-day	2.4E-02	mg/kg-day	--		
Molybdenum	6.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	5.1E-05	mg/kg-day	5.0E-03	mg/kg-day	0.010	--	mg/kg-day	5.0E-03	mg/kg-day	--		
Nickel	1.3E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.1E-04	mg/kg-day	2.0E-02	mg/kg-day	0.0056	--	mg/kg-day	2.0E-02	mg/kg-day	--		
Selenium	2.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.9E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0059	--	mg/kg-day	5.0E-03	mg/kg-day	--		
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.8E-06	mg/kg-day	1.0E-05	mg/kg-day	0.18	--	mg/kg-day	1.0E-05	mg/kg-day	--		
Uranium	6.9E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	5.7E-05	mg/kg-day	2.0E-04	mg/kg-day	0.29	--	mg/kg-day	2.0E-04	mg/kg-day	--		
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.1E-04	mg/kg-day	5.0E-03	mg/kg-day	0.042	--	mg/kg-day	5.0E-03	mg/kg-day	--		
Metals Cancer Total							7E-05	Metals Noncancer Total					2	Metals Noncancer Total					--
Exposure Route Cancer Total							1E-03	Exposure Route Noncancer Total					2	Exposure Route Noncancer Total					--

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																			
COPC ^a	EPC ^b	Units	Cancer Intake ^c	Units	Slope Factor/ Unit Risk ^d	Units	Cancer Risk ^e	Adult Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f		Child Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f	
												Adult						Child	
Exposure Medium: Surface Soil (0-6 inches bgs)																			
Exposure Route: Other Diné Lifeways Plant Dermal																			
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	1.0E+00	mg/kg-day	--	--	mg/kg-day	1.0E+00	mg/kg-day	--	--	--
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	4.0E-04	mg/kg-day	--	--	mg/kg-day	4.0E-04	mg/kg-day	--	--	--
Arsenic	6.5E+00	mg/kg	3.9E-06	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	5.8E-06	4.2E-06	mg/kg-day	3.0E-04	mg/kg-day	0.014	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	--
Barium	2.0E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-01	mg/kg-day	--	--	mg/kg-day	2.0E-01	mg/kg-day	--	--	--
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	6.6E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0066	--	mg/kg-day	1.0E-04	mg/kg-day	--	--	--
Cobalt	7.1E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	--
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	4.0E-02	mg/kg-day	--	--	mg/kg-day	4.0E-02	mg/kg-day	--	--	--
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	7.0E-01	mg/kg-day	--	--	mg/kg-day	7.0E-01	mg/kg-day	--	--	--
Manganese	2.8E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.4E-02	mg/kg-day	--	--	mg/kg-day	2.4E-02	mg/kg-day	--	--	--
Molybdenum	6.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	--
Nickel	1.3E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-02	mg/kg-day	--	--	mg/kg-day	2.0E-02	mg/kg-day	--	--	--
Selenium	2.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	--
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	1.0E-05	mg/kg-day	--	--	mg/kg-day	1.0E-05	mg/kg-day	--	--	--
Uranium	6.9E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-04	mg/kg-day	--	--	mg/kg-day	2.0E-04	mg/kg-day	--	--	--
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	--
Metals Cancer Total							6E-06	Metals Noncancer Total				0.02	Metals Noncancer Total				--		
Exposure Route Cancer Total							6E-06	Exposure Route Noncancer Total				0.02	Exposure Route Noncancer Total				--		
Exposure Medium: Surface Soil (0-6 inches bgs)																			
Exposure Route: Other Diné Lifeways Plant Inhalation																			
Radium-226	5.4E+00	pCi/g	3.4E+03	pCi	5.9E-08	risk/pCi	2.0E-04	--	--	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							2E-04	Radionuclide Noncancer Total				--	Radionuclide Noncancer Total				--		
Aluminum	1.8E+04	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	1.3E-03	mg/m ³	5.0E-03	mg/m ³	0.26	--	mg/m ³	5.0E-03	mg/m ³	--	--	--
Antimony	3.4E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	5.0E-08	mg/m ³	3.0E-04	mg/m ³	0.00017	--	mg/m ³	3.0E-04	mg/m ³	--	--	--
Arsenic	6.5E+00	mg/kg	4.7E-04	µg/m ³	4.3E-03	(µg/m ³) ⁻¹	2.0E-06	5.1E-07	mg/m ³	1.5E-05	mg/m ³	0.034	--	mg/m ³	1.5E-05	mg/m ³	--	--	--
Barium	2.0E+02	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	2.9E-05	mg/m ³	5.0E-04	mg/m ³	0.058	--	mg/m ³	5.0E-04	mg/m ³	--	--	--
Cadmium	1.5E-01	mg/kg	5.5E-05	µg/m ³	1.8E-03	(µg/m ³) ⁻¹	9.9E-08	6.0E-08	mg/m ³	1.0E-05	mg/m ³	0.0060	--	mg/m ³	1.0E-05	mg/m ³	--	--	--
Cobalt	7.1E+00	mg/kg	7.5E-04	µg/m ³	9.0E-03	(µg/m ³) ⁻¹	6.8E-06	8.2E-07	mg/m ³	6.0E-06	mg/m ³	0.14	--	mg/m ³	6.0E-06	mg/m ³	--	--	--
Copper	1.2E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--	--	--
Iron	2.0E+04	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--	--	--
Manganese	2.8E+02	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	2.1E-04	mg/m ³	5.0E-05	mg/m ³	4.2	--	mg/m ³	5.0E-05	mg/m ³	--	--	--
Molybdenum	6.9E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	5.1E-07	mg/m ³	2.0E-03	mg/m ³	0.00025	--	mg/m ³	2.0E-03	mg/m ³	--	--	--
Nickel	1.3E+01	mg/kg	1.0E-03	µg/m ³	2.6E-04	(µg/m ³) ⁻¹	2.7E-07	1.1E-06	mg/m ³	9.0E-05	mg/m ³	0.013	--	mg/m ³	9.0E-05	mg/m ³	--	--	--
Selenium	2.6E+00	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	3.0E-07	mg/m ³	2.0E-02	mg/m ³	0.000015	--	mg/m ³	2.0E-02	mg/m ³	--	--	--
Thallium	2.9E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--	--	--
Uranium	6.9E+00	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	5.8E-07	mg/m ³	4.0E-05	mg/m ³	0.015	--	mg/m ³	4.0E-05	mg/m ³	--	--	--
Vanadium	2.8E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	2.1E-06	mg/m ³	1.0E-04	mg/m ³	0.021	--	mg/m ³	1.0E-04	mg/m ³	--	--	--
Metals Cancer Total							9E-06	Metals Noncancer Total				5	Metals Noncancer Total				--		
Exposure Route Cancer Total							2E-04	Exposure Route Noncancer Total				5	Exposure Route Noncancer Total				--		
Surface Soil (0-6 inches bgs) Receptor Cancer Risk Total							1E-02	Receptor/Media Noncancer Hazard Total				10	Receptor/Media Noncancer Hazard Total				20		

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																	
COPC ^a	EPC ^b	Units	Cancer Intake ^c	Units	Slope Factor/ Unit Risk ^d	Units	Cancer Risk ^e	Adult Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f	Child Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f
												Adult					Child
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: Incidental Soil Ingestion																	
Radium-226	6.5E+00	pCi/g	6.2E+04	pCi/g	5.7E-09	Risk/pCi/g	3.5E-04	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							4E-04	Radionuclide Noncancer Total				--	Radionuclide Noncancer Total				--
Aluminum	1.7E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	7.5E-02	mg/kg-day	1.0E+00	mg/kg-day	0.075	4.4E-01	mg/kg-day	1.0E+00	mg/kg-day	0.44
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.5E-06	mg/kg-day	4.0E-04	mg/kg-day	0.0037	8.7E-06	mg/kg-day	4.0E-04	mg/kg-day	0.022
Arsenic	6.3E+00	mg/kg	2.3E-05	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	3.4E-05	1.6E-05	mg/kg-day	3.0E-04	mg/kg-day	0.054	9.7E-05	mg/kg-day	3.0E-04	mg/kg-day	0.32
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	8.4E-04	mg/kg-day	2.0E-01	mg/kg-day	0.0042	5.0E-03	mg/kg-day	2.0E-01	mg/kg-day	0.025
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	6.5E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0065	3.8E-06	mg/kg-day	1.0E-04	mg/kg-day	0.038
Cobalt	6.8E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.9E-05	mg/kg-day	3.0E-04	mg/kg-day	0.098	1.7E-04	mg/kg-day	3.0E-04	mg/kg-day	0.58
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	5.2E-05	mg/kg-day	4.0E-02	mg/kg-day	0.0013	3.1E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0077
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	8.5E-02	mg/kg-day	7.0E-01	mg/kg-day	0.12	5.1E-01	mg/kg-day	7.0E-01	mg/kg-day	0.72
Manganese	2.7E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.2E-03	mg/kg-day	2.4E-02	mg/kg-day	0.049	7.0E-03	mg/kg-day	2.4E-02	mg/kg-day	0.29
Molybdenum	6.8E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.9E-06	mg/kg-day	5.0E-03	mg/kg-day	0.00059	1.7E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0035
Nickel	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	5.2E-05	mg/kg-day	2.0E-02	mg/kg-day	0.0026	3.1E-04	mg/kg-day	2.0E-02	mg/kg-day	0.015
Selenium	2.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.1E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0022	6.6E-05	mg/kg-day	5.0E-03	mg/kg-day	0.013
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.3E-06	mg/kg-day	1.0E-05	mg/kg-day	0.13	7.4E-06	mg/kg-day	1.0E-05	mg/kg-day	0.74
Uranium	1.1E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	4.7E-05	mg/kg-day	2.0E-04	mg/kg-day	0.24	2.8E-04	mg/kg-day	2.0E-04	mg/kg-day	1.4
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.024	7.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.14
Metals Cancer Total							3E-05	Metals Noncancer Total				0.8	Metals Noncancer Total				5
Exposure Route Cancer Total							4E-04	Exposure Route Noncancer Total				0.8	Exposure Route Noncancer Total				5
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: External Exposure																	
Radium-226	6.5E+00	pCi/g	3.3E+02	pCi/g	8.4E-06	risk/year pCi/g	2.8E-03	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							3E-03	Radionuclide Noncancer Total				--	Radionuclide Noncancer Total				--
Exposure Route Cancer Total							3E-03	Exposure Route Noncancer Total				--	Exposure Route Noncancer Total				--
Exposure Route: Dermal Exposure																	
Aluminum	1.7E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	1.0E+00	mg/kg-day	--	--	mg/kg-day	1.0E+00	mg/kg-day	--
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	4.0E-04	mg/kg-day	--	--	mg/kg-day	4.0E-04	mg/kg-day	--
Arsenic	6.3E+00	mg/kg	1.3E-06	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	2.0E-06	9.6E-07	mg/kg-day	3.0E-04	mg/kg-day	0.0032	5.7E-06	mg/kg-day	3.0E-04	mg/kg-day	0.019
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-01	mg/kg-day	--	--	mg/kg-day	2.0E-01	mg/kg-day	--
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.0E-08	mg/kg-day	1.0E-04	mg/kg-day	0.00030	1.8E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0018
Cobalt	6.8E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	mg/kg-day	3.0E-04	mg/kg-day	--
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	4.0E-02	mg/kg-day	--	--	mg/kg-day	4.0E-02	mg/kg-day	--
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	7.0E-01	mg/kg-day	--	--	mg/kg-day	7.0E-01	mg/kg-day	--
Manganese	2.7E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.4E-02	mg/kg-day	--	--	mg/kg-day	2.4E-02	mg/kg-day	--
Molybdenum	6.8E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
Nickel	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-02	mg/kg-day	--	--	mg/kg-day	2.0E-02	mg/kg-day	--
Selenium	2.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	1.0E-05	mg/kg-day	--	--	mg/kg-day	1.0E-05	mg/kg-day	--
Uranium	1.1E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-04	mg/kg-day	--	--	mg/kg-day	2.0E-04	mg/kg-day	--
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
Metals Cancer Total							2E-06	Metals Noncancer Total				0.003	Metals Noncancer Total				0.02
Exposure Route Cancer Total							2E-06	Exposure Route Noncancer Total				0.003	Exposure Route Noncancer Total				0.02

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																			
COPC ^a	EPC ^b	Units	Cancer Intake ^c	Units	Slope Factor/ Unit Risk ^d	Units	Cancer Risk ^e	Adult Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f		Child Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f	
												Adult						Child	
Exposure Medium: Subsurface Soil (0-18 inches bgs)																			
Exposure Route: Inhalation of Particulates																			
Radium-226	6.5E+00	pCi/g	5.6E-01	pCi	5.9E-08	Risk/pCi	3.3E-08	--	--	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							3E-08	Radionuclide Noncancer Total					--	Radionuclide Noncancer Total					--
Aluminum	1.7E+04	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	2.3E-06	mg/m ³	5.0E-03	mg/m ³	0.00046	2.3E-06	mg/m ³	5.0E-03	mg/m ³	0.00046	0.00046	0.00046
Antimony	3.4E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	4.5E-11	mg/m ³	3.0E-04	mg/m ³	0.00000015	4.5E-11	mg/m ³	3.0E-04	mg/m ³	0.00000015	0.00000015	0.00000015
Arsenic	6.3E+00	mg/kg	8.4E-07	µg/m ³	4.3E-03	(µg/m ³) ⁻¹	3.6E-09	8.4E-10	mg/m ³	1.5E-05	mg/m ³	0.000056	8.4E-10	mg/m ³	1.5E-05	mg/m ³	0.000056	0.000056	0.000056
Barium	1.9E+02	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	2.6E-08	mg/m ³	5.0E-04	mg/m ³	0.000052	2.6E-08	mg/m ³	5.0E-04	mg/m ³	0.000052	0.000052	0.000052
Cadmium	1.5E-01	mg/kg	2.0E-08	µg/m ³	1.8E-03	(µg/m ³) ⁻¹	3.6E-11	2.0E-11	mg/m ³	1.0E-05	mg/m ³	0.0000020	2.0E-11	mg/m ³	1.0E-05	mg/m ³	0.0000020	0.0000020	0.0000020
Cobalt	6.8E+00	mg/kg	9.0E-07	µg/m ³	9.0E-03	(µg/m ³) ⁻¹	8.1E-09	9.0E-10	mg/m ³	6.0E-06	mg/m ³	0.00015	9.0E-10	mg/m ³	6.0E-06	mg/m ³	0.00015	0.00015	0.00015
Copper	1.2E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--	--	--
Iron	2.0E+04	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--	--	--
Manganese	2.7E+02	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	3.6E-08	mg/m ³	5.0E-05	mg/m ³	0.00073	3.6E-08	mg/m ³	5.0E-05	mg/m ³	0.00073	0.00073	0.00073
Molybdenum	6.8E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	9.0E-11	mg/m ³	2.0E-03	mg/m ³	0.000000045	9.0E-11	mg/m ³	2.0E-03	mg/m ³	0.000000045	0.000000045	0.000000045
Nickel	1.2E+01	mg/kg	1.6E-06	µg/m ³	2.6E-04	(µg/m ³) ⁻¹	4.1E-10	1.6E-09	mg/m ³	9.0E-05	mg/m ³	0.000018	1.6E-09	mg/m ³	9.0E-05	mg/m ³	0.000018	0.000018	0.000018
Selenium	2.6E+00	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	3.5E-10	mg/m ³	2.0E-02	mg/m ³	0.000000017	3.5E-10	mg/m ³	2.0E-02	mg/m ³	0.000000017	0.000000017	0.000000017
Thallium	2.9E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--	--	--
Uranium	1.1E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	1.5E-09	mg/m ³	4.0E-05	mg/m ³	0.000037	1.5E-09	mg/m ³	4.0E-05	mg/m ³	0.000037	0.000037	0.000037
Vanadium	2.8E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	3.7E-09	mg/m ³	1.0E-04	mg/m ³	0.000037	3.7E-09	mg/m ³	1.0E-04	mg/m ³	0.000037	0.000037	0.000037
Metals Cancer Total							1E-08	Metals Noncancer Total					0.002	Metals Noncancer Total					0.002
Exposure Route Cancer Total							5E-08	Exposure Route Noncancer Total					0.002	Exposure Route Noncancer Total					0.002
Exposure Medium: Subsurface Soil (0-18 inches bgs)																			
Exposure Route: Plant Consumption																			
Radium-226	6.5E+00	pCi/g	7.2E+05	pCi/g	3.7E-09	Risk/pCi/g	2.6E-03	--	--	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							3E-03	Radionuclide Noncancer Total					--	Radionuclide Noncancer Total					--
Aluminum	1.7E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.0E-01	mg/kg-day	1.0E+00	mg/kg-day	0.20	5.4E-01	mg/kg-day	1.0E+00	mg/kg-day	0.54	0.54	0.54
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	7.7E-06	mg/kg-day	4.0E-04	mg/kg-day	0.019	2.1E-05	mg/kg-day	4.0E-04	mg/kg-day	0.052	0.052	0.052
Arsenic	6.3E+00	mg/kg	9.0E-05	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	1.4E-04	8.0E-05	mg/kg-day	3.0E-04	mg/kg-day	0.27	2.1E-04	mg/kg-day	3.0E-04	mg/kg-day	0.71	0.71	0.71
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	4.4E-03	mg/kg-day	2.0E-01	mg/kg-day	0.022	1.2E-02	mg/kg-day	2.0E-01	mg/kg-day	0.059	0.059	0.059
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	8.9E-06	mg/kg-day	1.0E-04	mg/kg-day	0.089	2.4E-05	mg/kg-day	1.0E-04	mg/kg-day	0.24	0.24	0.24
Cobalt	6.8E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.2E-04	mg/kg-day	3.0E-04	mg/kg-day	0.41	3.3E-04	mg/kg-day	3.0E-04	mg/kg-day	1.1	1.1	1.1
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.0E-03	mg/kg-day	4.0E-02	mg/kg-day	0.051	5.4E-03	mg/kg-day	4.0E-02	mg/kg-day	0.13	0.13	0.13
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.3E-01	mg/kg-day	7.0E-01	mg/kg-day	0.33	6.2E-01	mg/kg-day	7.0E-01	mg/kg-day	0.88	0.88	0.88
Manganese	2.7E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.0E-02	mg/kg-day	2.4E-02	mg/kg-day	1.2	7.9E-02	mg/kg-day	2.4E-02	mg/kg-day	3.3	3.3	3.3
Molybdenum	6.8E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	7.4E-05	mg/kg-day	5.0E-03	mg/kg-day	0.015	2.0E-04	mg/kg-day	5.0E-03	mg/kg-day	0.039	0.039	0.039
Nickel	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.7E-04	mg/kg-day	2.0E-02	mg/kg-day	0.0083	4.4E-04	mg/kg-day	2.0E-02	mg/kg-day	0.022	0.022	0.022
Selenium	2.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	4.6E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0093	1.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.025	0.025	0.025
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.0E-06	mg/kg-day	1.0E-05	mg/kg-day	0.30	8.1E-06	mg/kg-day	1.0E-05	mg/kg-day	0.81	0.81	0.81
Uranium	1.1E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.5E-04	mg/kg-day	2.0E-04	mg/kg-day	0.74	3.9E-04	mg/kg-day	2.0E-04	mg/kg-day	2.0	2.0	2.0
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.4E-04	mg/kg-day	5.0E-03	mg/kg-day	0.069	9.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.18	0.18	0.18
Metals Cancer Total							1E-04	Metals Noncancer Total					4	Metals Noncancer Total					10
Exposure Route Cancer Total							3E-03	Exposure Route Noncancer Total					4	Exposure Route Noncancer Total					10

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																	
COPC ^a	EPC ^b	Units	Cancer Intake ^c	Units	Slope Factor/ Unit Risk ^d	Units	Cancer Risk ^e	Adult Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f	Child Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f
												Adult					Child
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: Animal Consumption																	
Radium-226	6.5E+00	pCi/g	1.3E+06	pCi/g	3.7E-09	Risk/pCi/g	4.9E-03	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							5E-03	Radionuclide Noncancer Total				--	Radionuclide Noncancer Total				--
Aluminum	1.7E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.2E-02	mg/kg-day	1.0E+00	mg/kg-day	0.012	3.2E-02	mg/kg-day	1.0E+00	mg/kg-day	0.032
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.3E-07	mg/kg-day	4.0E-04	mg/kg-day	0.00057	6.1E-07	mg/kg-day	4.0E-04	mg/kg-day	0.0015
Arsenic	6.3E+00	mg/kg	7.0E-06	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	1.1E-05	6.2E-06	mg/kg-day	3.0E-04	mg/kg-day	0.021	1.6E-05	mg/kg-day	3.0E-04	mg/kg-day	0.055
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.5E-05	mg/kg-day	2.0E-01	mg/kg-day	0.00013	6.7E-05	mg/kg-day	2.0E-01	mg/kg-day	0.00034
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.4E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0034	9.0E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0090
Cobalt	6.8E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	6.5E-05	mg/kg-day	3.0E-04	mg/kg-day	0.22	1.7E-04	mg/kg-day	3.0E-04	mg/kg-day	0.58
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.1E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0027	2.9E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0072
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.8E-01	mg/kg-day	7.0E-01	mg/kg-day	0.26	4.8E-01	mg/kg-day	7.0E-01	mg/kg-day	0.69
Manganese	2.7E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	9.1E-05	mg/kg-day	2.4E-02	mg/kg-day	0.0038	2.4E-04	mg/kg-day	2.4E-02	mg/kg-day	0.010
Molybdenum	6.8E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.1E-06	mg/kg-day	5.0E-03	mg/kg-day	0.00061	8.2E-06	mg/kg-day	5.0E-03	mg/kg-day	0.0016
Nickel	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.6E-05	mg/kg-day	2.0E-02	mg/kg-day	0.0018	9.6E-05	mg/kg-day	2.0E-02	mg/kg-day	0.0048
Selenium	2.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.0E-04	mg/kg-day	5.0E-03	mg/kg-day	0.040	5.3E-04	mg/kg-day	5.0E-03	mg/kg-day	0.11
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	5.3E-06	mg/kg-day	1.0E-05	mg/kg-day	0.53	1.4E-05	mg/kg-day	1.0E-05	mg/kg-day	1.4
Uranium	1.1E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.6E-06	mg/kg-day	2.0E-04	mg/kg-day	0.0078	4.2E-06	mg/kg-day	2.0E-04	mg/kg-day	0.021
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.2E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0064	8.5E-05	mg/kg-day	5.0E-03	mg/kg-day	0.017
Metals Cancer Total							1E-05	Metals Noncancer Total				1	Metals Noncancer Total				3
Exposure Route Cancer Total							5E-03	Exposure Route Noncancer Total				1	Exposure Route Noncancer Total				3
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: Other Diné Lifeways Plant Ingestion																	
Radium-226	6.5E+00	pCi/g	3.9E+05	pCi/g	3.7E-09	Risk/pCi/g	1.4E-03	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							1E-03	Radionuclide Noncancer Total				--	Radionuclide Noncancer Total				--
Aluminum	1.7E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.2E-01	mg/kg-day	1.0E+00	mg/kg-day	0.12	--	mg/kg-day	1.0E+00	mg/kg-day	--
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	5.0E-06	mg/kg-day	4.0E-04	mg/kg-day	0.012	--	mg/kg-day	4.0E-04	mg/kg-day	--
Arsenic	6.3E+00	mg/kg	4.5E-05	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	6.7E-05	4.9E-05	mg/kg-day	3.0E-04	mg/kg-day	0.16	--	mg/kg-day	3.0E-04	mg/kg-day	--
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.9E-03	mg/kg-day	2.0E-01	mg/kg-day	0.014	--	mg/kg-day	2.0E-01	mg/kg-day	--
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	6.0E-06	mg/kg-day	1.0E-04	mg/kg-day	0.060	--	mg/kg-day	1.0E-04	mg/kg-day	--
Cobalt	6.8E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	7.8E-05	mg/kg-day	3.0E-04	mg/kg-day	0.26	--	mg/kg-day	3.0E-04	mg/kg-day	--
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.4E-03	mg/kg-day	4.0E-02	mg/kg-day	0.034	--	mg/kg-day	4.0E-02	mg/kg-day	--
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.4E-01	mg/kg-day	7.0E-01	mg/kg-day	0.20	--	mg/kg-day	7.0E-01	mg/kg-day	--
Manganese	2.7E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.0E-02	mg/kg-day	2.4E-02	mg/kg-day	0.84	--	mg/kg-day	2.4E-02	mg/kg-day	--
Molybdenum	6.8E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	5.0E-05	mg/kg-day	5.0E-03	mg/kg-day	0.010	--	mg/kg-day	5.0E-03	mg/kg-day	--
Nickel	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.0E-04	mg/kg-day	2.0E-02	mg/kg-day	0.0051	--	mg/kg-day	2.0E-02	mg/kg-day	--
Selenium	2.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.9E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0059	--	mg/kg-day	5.0E-03	mg/kg-day	--
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.8E-06	mg/kg-day	1.0E-05	mg/kg-day	0.18	--	mg/kg-day	1.0E-05	mg/kg-day	--
Uranium	1.1E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	9.2E-05	mg/kg-day	2.0E-04	mg/kg-day	0.46	--	mg/kg-day	2.0E-04	mg/kg-day	--
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.1E-04	mg/kg-day	5.0E-03	mg/kg-day	0.042	--	mg/kg-day	5.0E-03	mg/kg-day	--
Metals Cancer Total							7E-05	Metals Noncancer Total				2	Metals Noncancer Total				--
Exposure Route Cancer Total							2E-03	Exposure Route Noncancer Total				2	Exposure Route Noncancer Total				--

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																			
COPC ^a	EPC ^b	Units	Cancer Intake ^c	Units	Slope Factor/ Unit Risk ^d	Units	Cancer Risk ^e	Adult Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f		Child Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f	
												Adult						Child	
Exposure Medium: Subsurface Soil (0-18 inches bgs)																			
Exposure Route: Other Diné Lifeways Plant Dermal																			
Aluminum	1.7E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	1.0E+00	mg/kg-day	--	--	mg/kg-day	1.0E+00	mg/kg-day	--	--	--
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	4.0E-04	mg/kg-day	--	--	mg/kg-day	4.0E-04	mg/kg-day	--	--	--
Arsenic	6.3E+00	mg/kg	3.8E-06	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	5.7E-06	4.1E-06	mg/kg-day	3.0E-04	mg/kg-day	0.014	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	--
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-01	mg/kg-day	--	--	mg/kg-day	2.0E-01	mg/kg-day	--	--	--
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	6.6E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0066	--	mg/kg-day	1.0E-04	mg/kg-day	--	--	--
Cobalt	6.8E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	--
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	4.0E-02	mg/kg-day	--	--	mg/kg-day	4.0E-02	mg/kg-day	--	--	--
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	7.0E-01	mg/kg-day	--	--	mg/kg-day	7.0E-01	mg/kg-day	--	--	--
Manganese	2.7E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.4E-02	mg/kg-day	--	--	mg/kg-day	2.4E-02	mg/kg-day	--	--	--
Molybdenum	6.8E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	--
Nickel	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-02	mg/kg-day	--	--	mg/kg-day	2.0E-02	mg/kg-day	--	--	--
Selenium	2.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	--
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	1.0E-05	mg/kg-day	--	--	mg/kg-day	1.0E-05	mg/kg-day	--	--	--
Uranium	1.1E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-04	mg/kg-day	--	--	mg/kg-day	2.0E-04	mg/kg-day	--	--	--
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	--
Metals Cancer Total							6E-06	Metals Noncancer Total				0.02	Metals Noncancer Total				--		
Exposure Route Cancer Total							6E-06	Exposure Route Noncancer Total				0.02	Exposure Route Noncancer Total				--		
Exposure Medium: Subsurface Soil (0-18 inches bgs)																			
Exposure Route: Other Diné Lifeways Plant Inhalation																			
Radium-226	6.5E+00	pCi/g	4.1E+03	pCi	5.9E-08	Risk/pCi	2.4E-04	--	--	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							2E-04	Radionuclide Noncancer Total				--	Radionuclide Noncancer Total				--		
Aluminum	1.7E+04	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	1.3E-03	mg/m ³	5.0E-03	mg/m ³	0.25	--	mg/m ³	5.0E-03	mg/m ³	--	--	--
Antimony	3.4E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	5.0E-08	mg/m ³	3.0E-04	mg/m ³	0.00017	--	mg/m ³	3.0E-04	mg/m ³	--	--	--
Arsenic	6.3E+00	mg/kg	4.6E-04	µg/m ³	4.3E-03	(µg/m ³) ⁻¹	2.0E-06	5.0E-07	mg/m ³	1.5E-05	mg/m ³	0.033	--	mg/m ³	1.5E-05	mg/m ³	--	--	--
Barium	1.9E+02	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	2.9E-05	mg/m ³	5.0E-04	mg/m ³	0.058	--	mg/m ³	5.0E-04	mg/m ³	--	--	--
Cadmium	1.5E-01	mg/kg	5.5E-05	µg/m ³	1.8E-03	(µg/m ³) ⁻¹	9.9E-08	6.0E-08	mg/m ³	1.0E-05	mg/m ³	0.0060	--	mg/m ³	1.0E-05	mg/m ³	--	--	--
Cobalt	6.8E+00	mg/kg	7.2E-04	µg/m ³	9.0E-03	(µg/m ³) ⁻¹	6.5E-06	7.9E-07	mg/m ³	6.0E-06	mg/m ³	0.13	--	mg/m ³	6.0E-06	mg/m ³	--	--	--
Copper	1.2E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--	--	--
Iron	2.0E+04	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--	--	--
Manganese	2.7E+02	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	2.0E-04	mg/m ³	5.0E-05	mg/m ³	4.0	--	mg/m ³	5.0E-05	mg/m ³	--	--	--
Molybdenum	6.8E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	5.0E-07	mg/m ³	2.0E-03	mg/m ³	0.00025	--	mg/m ³	2.0E-03	mg/m ³	--	--	--
Nickel	1.2E+01	mg/kg	9.6E-04	µg/m ³	2.6E-04	(µg/m ³) ⁻¹	2.5E-07	1.0E-06	mg/m ³	9.0E-05	mg/m ³	0.012	--	mg/m ³	9.0E-05	mg/m ³	--	--	--
Selenium	2.6E+00	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	3.0E-07	mg/m ³	2.0E-02	mg/m ³	0.000015	--	mg/m ³	2.0E-02	mg/m ³	--	--	--
Thallium	2.9E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--	--	--
Uranium	1.1E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	9.3E-07	mg/m ³	4.0E-05	mg/m ³	0.023	--	mg/m ³	4.0E-05	mg/m ³	--	--	--
Vanadium	2.8E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	2.1E-06	mg/m ³	1.0E-04	mg/m ³	0.021	--	mg/m ³	1.0E-04	mg/m ³	--	--	--
Metals Cancer Total							9E-06	Metals Noncancer Total				5	Metals Noncancer Total				--		
Exposure Route Cancer Total							2E-04	Exposure Route Noncancer Total				5	Exposure Route Noncancer Total				--		
Subsurface Soil (0-18 inches bgs) Receptor Cancer Risk Total							1E-02	Receptor/Media Noncancer Hazard Total				10	Receptor/Media Noncancer Hazard Total				20		

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Notes:

^a COPCs are the constituents of interest with a maximum detected concentration exceeding the COPC screening level (see Table C-1).

^b EPCs are provided on Table C-4.

^c The intakes are the EPC multiplied by the exposure parameters and any applicable contaminant-specific inputs (see Table C-3 for exposure inputs, Table 4 of the NAUM risk assessment methodology [USEPA 2023c] for contaminant-specific inputs, and Appendix B of the NAUM risk assessment methodology [USEPA 2023c] for equations).

^d The toxicity values are provided in Table 4 of the NAUM risk assessment methodology (USEPA 2023c).

^e The cancer risk for each contaminant for each exposure pathway is calculated by multiplying the cancer intake value with the toxicity value as follows:

For contaminant i : $Risk_i = \text{Cancer Intake}_i \times \text{Toxicity Factor}_i$

^f The noncancer hazard for each contaminant for each exposure pathway is calculated by dividing the noncancer intake value by the toxicity value as follows:

For contaminant i : $Hazard_i = \text{Noncancer Intake}_i / \text{Toxicity Factor}_i$

--	Not applicable
µg/m ³	Microgram per cubic meter
bgs	Below ground surface
COPC	Contaminant of potential concern
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
mg/m ³	Milligram per cubic meter
NAUM	Navajo abandoned uranium mine
pCi	Picocurie
pCi/g	Picocurie per gram
RfC	Reference concentration
RfD	Reference dose
USEPA	U.S. Environmental Protection Agency

Reference:

U.S. Environmental Protection Agency (USEPA). 2023c. "Navajo Abandoned Uranium Mines Risk Assessment Methodology." Draft Final. Response, Assessment, and Evaluation Services. Contract No. EP-S9-17-02. August.

Table C-5.2. Human Health Risk and Hazard Calculations - Section 33 Mine

Section 33 Mine - Default Resident (Non-Navajo)																			
COPC ^a	EPC ^b	Units	Cancer Intake ^c	Units	Slope Factor/ Unit Risk ^d	Units	Cancer Risk ^e	Adult Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f		Child Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f	
												Adult						Child	
Exposure Medium: Surface Soil (0-6 inches bgs)																			
Exposure Route: Incidental Soil Ingestion																			
Radium-226	3.0E+01	pCi/g	3.4E+04	pCi/g	5.7E-09	Risk/pCi/g	1.9E-04	--	--	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							2E-04	Radionuclide Noncancer Total					--	Radionuclide Noncancer Total					--
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.2E-02	mg/kg-day	1.0E+00	mg/kg-day	0.022	2.3E-01	mg/kg-day	1.0E+00	mg/kg-day	0.23		
Antimony	4.2E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	5.0E-07	mg/kg-day	4.0E-04	mg/kg-day	0.0013	5.4E-06	mg/kg-day	4.0E-04	mg/kg-day	0.013		
Arsenic	7.4E+00	mg/kg	6.4E-06	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	9.6E-06	5.3E-06	mg/kg-day	3.0E-04	mg/kg-day	0.018	5.7E-05	mg/kg-day	3.0E-04	mg/kg-day	0.19		
Barium	9.5E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.1E-04	mg/kg-day	2.0E-01	mg/kg-day	0.00057	1.2E-03	mg/kg-day	2.0E-01	mg/kg-day	0.0061		
Cadmium	2.0E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.4E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0024	2.6E-06	mg/kg-day	1.0E-04	mg/kg-day	0.026		
Cobalt	7.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	9.1E-06	mg/kg-day	3.0E-04	mg/kg-day	0.030	9.7E-05	mg/kg-day	3.0E-04	mg/kg-day	0.32		
Copper	1.5E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.8E-05	mg/kg-day	4.0E-02	mg/kg-day	0.00045	1.9E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0048		
Iron	2.2E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.7E-02	mg/kg-day	7.0E-01	mg/kg-day	0.038	2.9E-01	mg/kg-day	7.0E-01	mg/kg-day	0.41		
Manganese	2.3E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.8E-04	mg/kg-day	2.4E-02	mg/kg-day	0.012	3.0E-03	mg/kg-day	2.4E-02	mg/kg-day	0.12		
Molybdenum	1.1E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.3E-06	mg/kg-day	5.0E-03	mg/kg-day	0.00026	1.4E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0028		
Nickel	1.5E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.8E-05	mg/kg-day	2.0E-02	mg/kg-day	0.00090	1.9E-04	mg/kg-day	2.0E-02	mg/kg-day	0.0096		
Selenium	2.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.6E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0053	2.8E-04	mg/kg-day	5.0E-03	mg/kg-day	0.056		
Thallium	4.1E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	4.9E-07	mg/kg-day	1.0E-05	mg/kg-day	0.049	5.2E-06	mg/kg-day	1.0E-05	mg/kg-day	0.52		
Uranium	4.5E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	5.4E-05	mg/kg-day	2.0E-04	mg/kg-day	0.27	5.8E-04	mg/kg-day	2.0E-04	mg/kg-day	2.9		
Vanadium	4.0E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	4.8E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0096	5.1E-04	mg/kg-day	5.0E-03	mg/kg-day	0.10		
Metals Cancer Total							1E-05	Metals Noncancer Total					0.5	Metals Noncancer Total					5
Exposure Route Cancer Total							2E-04	Exposure Route Noncancer Total					0.5	Exposure Route Noncancer Total					5
Exposure Medium: Surface Soil (0-6 inches bgs)																			
Exposure Route: External Exposure																			
Radium-226	3.0E+01	pCi/g	2.6E+02	pCi/g	8.4E-06	risk/year pCi/g	2.2E-03	--	--	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							2E-03	Radionuclide Noncancer Total					--	Radionuclide Noncancer Total					--
Exposure Route Cancer Total							2E-03	Exposure Route Noncancer Total					--	Exposure Route Noncancer Total					--
Exposure Route: Dermal Exposure																			
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	1.0E+00	mg/kg-day	--	--	mg/kg-day	1.0E+00	mg/kg-day	--		
Antimony	4.2E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	4.0E-04	mg/kg-day	--	--	mg/kg-day	4.0E-04	mg/kg-day	--		
Arsenic	7.4E+00	mg/kg	9.0E-07	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	1.3E-06	1.1E-06	mg/kg-day	3.0E-04	mg/kg-day	0.0037	6.7E-06	mg/kg-day	3.0E-04	mg/kg-day	0.022		
Barium	9.5E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-01	mg/kg-day	--	--	mg/kg-day	2.0E-01	mg/kg-day	--		
Cadmium	2.0E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	4.0E-08	mg/kg-day	1.0E-04	mg/kg-day	0.00040	2.4E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0024		
Cobalt	7.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	mg/kg-day	3.0E-04	mg/kg-day	--		
Copper	1.5E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	4.0E-02	mg/kg-day	--	--	mg/kg-day	4.0E-02	mg/kg-day	--		
Iron	2.2E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	7.0E-01	mg/kg-day	--	--	mg/kg-day	7.0E-01	mg/kg-day	--		
Manganese	2.3E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.4E-02	mg/kg-day	--	--	mg/kg-day	2.4E-02	mg/kg-day	--		
Molybdenum	1.1E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--		
Nickel	1.5E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-02	mg/kg-day	--	--	mg/kg-day	2.0E-02	mg/kg-day	--		
Selenium	2.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--		
Thallium	4.1E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	1.0E-05	mg/kg-day	--	--	mg/kg-day	1.0E-05	mg/kg-day	--		
Uranium	4.5E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-04	mg/kg-day	--	--	mg/kg-day	2.0E-04	mg/kg-day	--		
Vanadium	4.0E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--		
Metals Cancer Total							1E-06	Metals Noncancer Total					0.004	Metals Noncancer Total					0.02
Exposure Route Cancer Total							1E-06	Exposure Route Noncancer Total					0.004	Exposure Route Noncancer Total					0.02

Table C-5.2. Human Health Risk and Hazard Calculations - Section 33 Mine

Section 33 Mine - Default Resident (Non-Navajo)																	
COPC ^a	EPC ^b	Units	Cancer Intake ^c	Units	Slope Factor/ Unit Risk ^d	Units	Cancer Risk ^e	Adult Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f	Child Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f
												Adult					Child
Exposure Medium: Surface Soil (0-6 inches bgs)																	
Exposure Route: Inhalation of Particulates																	
Radium-226	3.0E+01	pCi/g	3.6E+00	pCi	5.9E-08	Risk/pCi	2.1E-07	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							2E-07	Radionuclide Noncancer Total				--	Radionuclide Noncancer Total				--
Aluminum	1.8E+04	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	1.3E-05	mg/m ³	5.0E-03	mg/m ³	0.0026	1.3E-05	mg/m ³	5.0E-03	mg/m ³	0.0026
Antimony	4.2E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	3.0E-10	mg/m ³	3.0E-04	mg/m ³	0.00000099	3.0E-10	mg/m ³	3.0E-04	mg/m ³	0.00000099
Arsenic	7.4E+00	mg/kg	1.9E-06	µg/m ³	4.3E-03	(µg/m ³) ⁻¹	8.3E-09	5.2E-09	mg/m ³	1.5E-05	mg/m ³	0.00035	5.2E-09	mg/m ³	1.5E-05	mg/m ³	0.00035
Barium	9.5E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	6.7E-08	mg/m ³	5.0E-04	mg/m ³	0.00013	6.7E-08	mg/m ³	5.0E-04	mg/m ³	0.00013
Cadmium	2.0E-01	mg/kg	5.2E-08	µg/m ³	1.8E-03	(µg/m ³) ⁻¹	9.4E-11	1.4E-10	mg/m ³	1.0E-05	mg/m ³	0.000014	1.4E-10	mg/m ³	1.0E-05	mg/m ³	0.000014
Cobalt	7.6E+00	mg/kg	2.0E-06	µg/m ³	9.0E-03	(µg/m ³) ⁻¹	1.8E-08	5.4E-09	mg/m ³	6.0E-06	mg/m ³	0.00089	5.4E-09	mg/m ³	6.0E-06	mg/m ³	0.00089
Copper	1.5E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--
Iron	2.2E+04	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--
Manganese	2.3E+02	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	1.6E-07	mg/m ³	5.0E-05	mg/m ³	0.0033	1.6E-07	mg/m ³	5.0E-05	mg/m ³	0.0033
Molybdenum	1.1E+00	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	7.8E-10	mg/m ³	2.0E-03	mg/m ³	0.00000039	7.8E-10	mg/m ³	2.0E-03	mg/m ³	0.00000039
Nickel	1.5E+01	mg/kg	3.9E-06	µg/m ³	2.6E-04	(µg/m ³) ⁻¹	1.0E-09	1.1E-08	mg/m ³	9.0E-05	mg/m ³	0.00012	1.1E-08	mg/m ³	9.0E-05	mg/m ³	0.00012
Selenium	2.2E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	1.6E-08	mg/m ³	2.0E-02	mg/m ³	0.00000078	1.6E-08	mg/m ³	2.0E-02	mg/m ³	0.00000078
Thallium	4.1E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--
Uranium	4.5E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	3.2E-08	mg/m ³	4.0E-05	mg/m ³	0.00079	3.2E-08	mg/m ³	4.0E-05	mg/m ³	0.00079
Vanadium	4.0E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	2.8E-08	mg/m ³	1.0E-04	mg/m ³	0.00028	2.8E-08	mg/m ³	1.0E-04	mg/m ³	0.00028
Metals Cancer Total							3E-08	Metals Noncancer Total				0.008	Metals Noncancer Total				0.008
Exposure Route Cancer Total							2E-07	Exposure Route Noncancer Total				0.008	Exposure Route Noncancer Total				0.008
Surface Soil (0-6 inches bgs) Receptor Cancer Risk Total							2E-03	Receptor/Media Noncancer Hazard Total				0.5	Receptor/Media Noncancer Hazard Total				5

Table C-5.2. Human Health Risk and Hazard Calculations - Section 33 Mine

Section 33 Mine - Default Resident (Non-Navajo)																			
COPC ^a	EPC ^b	Units	Cancer Intake ^c	Units	Slope Factor/ Unit Risk ^d	Units	Cancer Risk ^e	Adult Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f		Child Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f	
												Adult						Child	
Exposure Medium: Subsurface Soil (0-18 inches bgs)																			
Exposure Route: Incidental Soil Ingestion																			
Radium-226	3.0E+01	pCi/g	3.4E+04	pCi/g	5.7E-09	Risk/pCi/g	1.9E-04	--	--	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							2E-04	Radionuclide Noncancer Total					--	Radionuclide Noncancer Total					--
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.1E-02	mg/kg-day	1.0E+00	mg/kg-day	0.021	2.3E-01	mg/kg-day	1.0E+00	mg/kg-day	0.23		
Antimony	4.1E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	4.9E-07	mg/kg-day	4.0E-04	mg/kg-day	0.0012	5.2E-06	mg/kg-day	4.0E-04	mg/kg-day	0.013		
Arsenic	7.0E+00	mg/kg	6.0E-06	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	9.1E-06	5.0E-06	mg/kg-day	3.0E-04	mg/kg-day	0.017	5.4E-05	mg/kg-day	3.0E-04	mg/kg-day	0.18		
Barium	9.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.1E-04	mg/kg-day	2.0E-01	mg/kg-day	0.00055	1.2E-03	mg/kg-day	2.0E-01	mg/kg-day	0.0059		
Cadmium	1.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.3E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0023	2.4E-06	mg/kg-day	1.0E-04	mg/kg-day	0.024		
Cobalt	7.2E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	8.6E-06	mg/kg-day	3.0E-04	mg/kg-day	0.029	9.2E-05	mg/kg-day	3.0E-04	mg/kg-day	0.31		
Copper	1.4E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.7E-05	mg/kg-day	4.0E-02	mg/kg-day	0.00042	1.8E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0045		
Iron	2.1E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.6E-02	mg/kg-day	7.0E-01	mg/kg-day	0.037	2.7E-01	mg/kg-day	7.0E-01	mg/kg-day	0.39		
Manganese	2.2E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.6E-04	mg/kg-day	2.4E-02	mg/kg-day	0.011	2.8E-03	mg/kg-day	2.4E-02	mg/kg-day	0.12		
Molybdenum	1.0E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.2E-06	mg/kg-day	5.0E-03	mg/kg-day	0.00024	1.3E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0026		
Nickel	1.4E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	1.7E-05	mg/kg-day	2.0E-02	mg/kg-day	0.00084	1.8E-04	mg/kg-day	2.0E-02	mg/kg-day	0.0089		
Selenium	2.0E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	2.4E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0048	2.6E-04	mg/kg-day	5.0E-03	mg/kg-day	0.051		
Thallium	4.0E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	4.8E-07	mg/kg-day	1.0E-05	mg/kg-day	0.048	5.1E-06	mg/kg-day	1.0E-05	mg/kg-day	0.51		
Uranium	4.1E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	4.9E-05	mg/kg-day	2.0E-04	mg/kg-day	0.25	5.2E-04	mg/kg-day	2.0E-04	mg/kg-day	2.6		
Vanadium	3.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	4.6E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0091	4.9E-04	mg/kg-day	5.0E-03	mg/kg-day	0.097		
Metals Cancer Total							9E-06	Metals Noncancer Total					0.4	Metals Noncancer Total					5
Exposure Route Cancer Total							2E-04	Exposure Route Noncancer Total					0.4	Exposure Route Noncancer Total					5
Exposure Medium: Subsurface Soil (0-18 inches bgs)																			
Exposure Route: External Exposure																			
Radium-226	3.0E+01	pCi/g	2.6E+02	pCi/g	8.4E-06	risk/year pCi/g	2.2E-03	--	--	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							2E-03	Radionuclide Noncancer Total					--	Radionuclide Noncancer Total					--
Exposure Route Cancer Total							2E-03	Exposure Route Noncancer Total					--	Exposure Route Noncancer Total					--
Exposure Route: Dermal Exposure																			
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	1.0E+00	mg/kg-day	--	--	mg/kg-day	1.0E+00	mg/kg-day	--		
Antimony	4.1E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	4.0E-04	mg/kg-day	--	--	mg/kg-day	4.0E-04	mg/kg-day	--		
Arsenic	7.0E+00	mg/kg	8.5E-07	mg/kg-day	1.5E+00	(mg/kg-day) ⁻¹	1.3E-06	1.1E-06	mg/kg-day	3.0E-04	mg/kg-day	0.0035	6.4E-06	mg/kg-day	3.0E-04	mg/kg-day	0.021		
Barium	9.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-01	mg/kg-day	--	--	mg/kg-day	2.0E-01	mg/kg-day	--		
Cadmium	1.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	3.8E-08	mg/kg-day	1.0E-04	mg/kg-day	0.00038	2.3E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0023		
Cobalt	7.2E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	mg/kg-day	3.0E-04	mg/kg-day	--		
Copper	1.4E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	4.0E-02	mg/kg-day	--	--	mg/kg-day	4.0E-02	mg/kg-day	--		
Iron	2.1E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	7.0E-01	mg/kg-day	--	--	mg/kg-day	7.0E-01	mg/kg-day	--		
Manganese	2.2E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.4E-02	mg/kg-day	--	--	mg/kg-day	2.4E-02	mg/kg-day	--		
Molybdenum	1.0E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--		
Nickel	1.4E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-02	mg/kg-day	--	--	mg/kg-day	2.0E-02	mg/kg-day	--		
Selenium	2.0E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--		
Thallium	4.0E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	1.0E-05	mg/kg-day	--	--	mg/kg-day	1.0E-05	mg/kg-day	--		
Uranium	4.1E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	2.0E-04	mg/kg-day	--	--	mg/kg-day	2.0E-04	mg/kg-day	--		
Vanadium	3.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day) ⁻¹	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--		
Metals Cancer Total							1E-06	Metals Noncancer Total					0.004	Metals Noncancer Total					0.02
Exposure Route Cancer Total							1E-06	Exposure Route Noncancer Total					0.004	Exposure Route Noncancer Total					0.02

Table C-5.2. Human Health Risk and Hazard Calculations - Section 33 Mine

Section 33 Mine - Default Resident (Non-Navajo)																			
COPC ^a	EPC ^b	Units	Cancer Intake ^c	Units	Slope Factor/ Unit Risk ^d	Units	Cancer Risk ^e	Adult Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f		Child Noncancer Intake ^c	Units	RfD/ RfC ^d	Units	Noncancer Hazard ^f	
												Adult						Child	
Exposure Medium: Subsurface Soil (0-18 inches bgs)																			
Exposure Route: Inhalation of Particulates																			
Radium-226	3.0E+01	pCi/g	3.2E+03	pCi	5.9E-08	Risk/pCi	1.9E-04	--	--	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							2E-04	Radionuclide Noncancer Total				--	Radionuclide Noncancer Total				--		
Aluminum	1.8E+04	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	1.2E-05	mg/m ³	5.0E-03	mg/m ³	0.0025	1.2E-05	mg/m ³	5.0E-03	mg/m ³	0.0025	0.0025	0.0025
Antimony	4.1E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	2.9E-10	mg/m ³	3.0E-04	mg/m ³	0.00000096	2.9E-10	mg/m ³	3.0E-04	mg/m ³	0.00000096	0.00000096	0.00000096
Arsenic	7.0E+00	mg/kg	2.1E-03	µg/m ³	4.3E-03	(µg/m ³) ⁻¹	9.1E-06	4.9E-09	mg/m ³	1.5E-05	mg/m ³	0.00033	4.9E-09	mg/m ³	1.5E-05	mg/m ³	0.00033	0.00033	0.00033
Barium	9.2E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	6.5E-08	mg/m ³	5.0E-04	mg/m ³	0.00013	6.5E-08	mg/m ³	5.0E-04	mg/m ³	0.00013	0.00013	0.00013
Cadmium	1.9E-01	mg/kg	--	µg/m ³	1.8E-03	(µg/m ³) ⁻¹	--	1.3E-10	mg/m ³	1.0E-05	mg/m ³	0.000013	1.3E-10	mg/m ³	1.0E-05	mg/m ³	0.000013	0.000013	0.000013
Cobalt	7.2E+00	mg/kg	--	µg/m ³	9.0E-03	(µg/m ³) ⁻¹	--	5.1E-09	mg/m ³	6.0E-06	mg/m ³	0.00085	5.1E-09	mg/m ³	6.0E-06	mg/m ³	0.00085	0.00085	0.00085
Copper	1.4E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--	--	--
Iron	2.1E+04	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--	--	--
Manganese	2.2E+02	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	1.5E-07	mg/m ³	5.0E-05	mg/m ³	0.0031	1.5E-07	mg/m ³	5.0E-05	mg/m ³	0.0031	0.0031	0.0031
Molybdenum	1.0E+00	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	7.1E-10	mg/m ³	2.0E-03	mg/m ³	0.00000035	7.1E-10	mg/m ³	2.0E-03	mg/m ³	0.00000035	0.00000035	0.00000035
Nickel	1.4E+01	mg/kg	--	µg/m ³	2.6E-04	(µg/m ³) ⁻¹	--	9.9E-09	mg/m ³	9.0E-05	mg/m ³	0.00011	9.9E-09	mg/m ³	9.0E-05	mg/m ³	0.00011	0.00011	0.00011
Selenium	2.0E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	1.4E-08	mg/m ³	2.0E-02	mg/m ³	0.00000071	1.4E-08	mg/m ³	2.0E-02	mg/m ³	0.00000071	0.00000071	0.00000071
Thallium	4.0E-01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	--	mg/m ³	--	mg/m ³	--	--	mg/m ³	--	mg/m ³	--	--	--
Uranium	4.1E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	2.9E-08	mg/m ³	4.0E-05	mg/m ³	0.00072	2.9E-08	mg/m ³	4.0E-05	mg/m ³	0.00072	0.00072	0.00072
Vanadium	3.8E+01	mg/kg	--	µg/m ³	--	(µg/m ³) ⁻¹	--	2.7E-08	mg/m ³	1.0E-04	mg/m ³	0.00027	2.7E-08	mg/m ³	1.0E-04	mg/m ³	0.00027	0.00027	0.00027
Metals Cancer Total							9E-06	Metals Noncancer Total				0.008	Metals Noncancer Total				0.008		
Exposure Route Cancer Total							2E-04	Exposure Route Noncancer Total				0.008	Exposure Route Noncancer Total				0.008		
Subsurface Soil (0-18 inches bgs) Receptor Cancer Risk Total							3E-03	Receptor/Media Noncancer Hazard Total				0.4	Receptor/Media Noncancer Hazard Total				5		

Notes:

^a COPCs are the constituents of interest with a maximum detected concentration exceeding the COPC screening level (see Table C-1).

^b EPCs are provided on Table C-4.

^c The intakes are the EPC multiplied by the exposure parameters and any applicable contaminant-specific inputs (see Table C-3 for exposure inputs, Table 4 of the NAUM risk assessment methodology [USEPA 2023c] for contaminant-specific inputs, and Appendix B of the NAUM risk assessment methodology [USEPA 2023c] for equations).

^d The toxicity values are provided in Table 4 of the NAUM risk assessment methodology (USEPA 2023c).

^e The cancer risk for each contaminant for each exposure pathway is calculated by multiplying the cancer intake value with the toxicity value as follows:

$$\text{For contaminant } i : \text{Risk}_i = \text{Cancer Intake}_i \times \text{Toxicity Factor}_i$$

^f The noncancer hazard for each contaminant for each exposure pathway is calculated by dividing the noncancer intake value by the toxicity value as follows:

$$\text{For contaminant } i : \text{Hazard}_i = \text{Noncancer Intake}_i / \text{Toxicity Factor}_i$$

--	Not applicable	mg/m ³	Milligram per cubic meter
µg/m ³	Microgram per cubic meter	NAUM	Navajo abandoned uranium mine
bgs	Below ground surface	pCi	Picocurie
COPC	Contaminant of potential concern	pCi/g	Picocurie per gram
EPC	Exposure point concentration	RfC	Reference concentration
mg/kg	Milligram per kilogram	RfD	Reference dose
mg/kg-day	Milligram per kilogram per day	USEPA	U.S. Environmental Protection Agency

Reference:

U.S. Environmental Protection Agency (USEPA). 2023c. "Navajo Abandoned Uranium Mines Risk Assessment Methodology." Draft Final. Response, Assessment, and Evaluation Services. Contract No. EP-S9-17-02. August.

Table C-6. Human Health Risk and Hazard Summary by Exposure Pathway

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																													
COPC	EPC	Units	Incidental Soil Ingestion			External Exposure / Dermal Contact			Inhalation of Particulates			Plant Consumption			Animal Consumption			ODL Plant Ingestion			ODL Plant Dermal			ODL Plant Inhalation			Total Risk or Hazard		
			Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard
Surface Soil (0-6 inches bgs)																													
Radium-226	5.4E+00	pCi/g	2.9E-04	--	--	2.3E-03	--	--	2.8E-08	--	--	2.2E-03	--	--	4.1E-03	--	--	1.2E-03	--	--	--	--	--	2.0E-04	--	--	1E-02	--	--
Aluminum	1.8E+04	mg/kg	--	0.077	0.46	--	--	--	--	0.00047	0.00047	--	0.21	0.55	--	0.012	0.033	--	0.13	--	--	--	--	0.26	--	--	0.7	1	
Antimony	3.4E-01	mg/kg	--	0.0037	0.022	--	--	--	--	0.00000015	0.00000015	--	0.019	0.052	--	0.00057	0.0015	--	0.012	--	--	--	--	0.00017	--	--	0.04	0.07	
Arsenic	6.5E+00	mg/kg	3.5E-05	0.056	0.33	2.1E-06	0.0033	0.020	3.7E-09	0.000058	0.000058	1.4E-04	0.27	0.73	1.1E-05	0.021	0.057	6.9E-05	0.17	--	5.8E-06	0.014	--	2.0E-06	0.034	--	3E-04	0.6	1
Barium	2.0E+02	mg/kg	--	0.0043	0.025	--	--	--	--	0.000052	0.000052	--	0.022	0.060	--	0.00013	0.00034	--	0.014	--	--	--	--	0.058	--	--	0.1	0.09	
Cadmium	1.5E+01	mg/kg	--	0.0065	0.038	--	0.00030	0.0018	3.6E-11	0.0000020	0.0000020	--	0.089	0.24	--	0.0034	0.0090	--	0.060	--	--	0.0066	--	9.9E-08	0.0060	--	1E-07	0.2	0.3
Cobalt	7.1E+00	mg/kg	--	0.10	0.61	--	--	--	8.5E-09	0.00016	0.00016	--	0.43	1.1	--	0.23	0.61	--	0.27	--	--	--	--	6.8E-06	0.14	--	7E-06	1	2
Copper	1.2E+01	mg/kg	--	0.0013	0.0077	--	--	--	--	--	--	--	0.051	0.13	--	0.0027	0.0072	--	0.034	--	--	--	--	--	--	--	0.09	0.1	
Iron	2.0E+04	mg/kg	--	0.13	0.74	--	--	--	--	--	--	--	0.34	0.90	--	0.26	0.70	--	0.21	--	--	--	--	--	--	--	0.9	2	
Manganese	2.8E+02	mg/kg	--	0.051	0.30	--	--	--	--	0.00076	0.00076	--	1.3	3.4	--	0.0039	0.010	--	0.87	--	--	--	--	4.2	--	--	6	4	
Molybdenum	6.9E-01	mg/kg	--	0.00060	0.0035	--	--	--	--	0.000000046	0.000000046	--	0.015	0.040	--	0.00062	0.0017	--	0.010	--	--	--	--	0.00025	--	--	0.03	0.05	
Nickel	1.3E+01	mg/kg	--	0.0028	0.017	--	--	--	4.5E-10	0.000019	0.000019	--	0.0090	0.024	--	0.0019	0.0052	--	0.0056	--	--	--	--	2.7E-07	0.013	--	3E-07	0.03	0.05
Selenium	2.6E+00	mg/kg	--	0.0022	0.013	--	--	--	--	0.000000017	0.000000017	--	0.0093	0.025	--	0.040	0.11	--	0.0059	--	--	--	--	0.000015	--	--	0.06	0.1	
Thallium	2.9E-01	mg/kg	--	0.13	0.74	--	--	--	--	--	--	--	0.30	0.81	--	0.53	1.4	--	0.18	--	--	--	--	--	--	--	1	3	
Uranium	6.9E+00	mg/kg	--	0.15	0.88	--	--	--	--	0.000023	0.000023	--	0.46	1.2	--	0.0049	0.013	--	0.29	--	--	--	--	0.015	--	--	0.9	2	
Vanadium	2.8E+01	mg/kg	--	0.024	0.14	--	--	--	--	0.000037	0.000037	--	0.069	0.18	--	0.0064	0.017	--	0.042	--	--	--	--	0.021	--	--	0.2	0.3	
Exposure Pathway Risk/Hazard Total			3E-04	0.7	4	2E-03	0.004	0.02	4E-08	0.002	0.002	2E-03	4	10	4E-03	1	3	1E-03	2	--	6E-06	0.02	--	2E-04	5	--	1E-02	10	20
Subsurface Soil (0-18 inches bgs)																													
Radium-226	6.5E+00	pCi/g	3.5E-04	--	--	2.8E-03	--	--	3.3E-08	--	--	2.6E-03	--	--	4.9E-03	--	--	1.4E-03	--	--	--	--	--	2.4E-04	--	--	1E-02	--	--
Aluminum	1.7E+04	mg/kg	--	0.075	0.44	--	--	--	--	0.00046	0.00046	--	0.20	0.54	--	0.012	0.032	--	0.12	--	--	--	--	0.25	--	--	0.7	1	
Antimony	3.4E-01	mg/kg	--	0.0037	0.022	--	--	--	--	0.00000015	0.00000015	--	0.019	0.052	--	0.00057	0.0015	--	0.012	--	--	--	--	0.00017	--	--	0.04	0.07	
Arsenic	6.3E+00	mg/kg	3.4E-05	0.054	0.32	2.0E-06	0.0032	0.019	3.6E-09	0.000056	0.000056	1.4E-04	0.27	0.71	1.1E-05	0.021	0.055	6.7E-05	0.16	--	5.7E-06	0.014	--	2.0E-06	0.033	--	3E-04	0.6	1
Barium	1.9E+02	mg/kg	--	0.0042	0.025	--	--	--	--	0.000052	0.000052	--	0.022	0.059	--	0.00013	0.00034	--	0.014	--	--	--	--	0.058	--	--	0.1	0.08	
Cadmium	1.5E+01	mg/kg	--	0.0065	0.038	--	0.00030	0.0018	3.6E-11	0.0000020	0.0000020	--	0.089	0.24	--	0.0034	0.0090	--	0.060	--	--	0.0066	--	9.9E-08	0.0060	--	1E-07	0.2	0.3
Cobalt	6.8E+00	mg/kg	--	0.098	0.58	--	--	--	8.1E-09	0.00015	0.00015	--	0.41	1.1	--	0.22	0.58	--	0.26	--	--	--	--	6.5E-06	0.13	--	7E-06	1	2
Copper	1.2E+01	mg/kg	--	0.0013	0.0077	--	--	--	--	--	--	--	0.051	0.13	--	0.0027	0.0072	--	0.034	--	--	--	--	--	--	--	0.09	0.1	
Iron	2.0E+04	mg/kg	--	0.12	0.72	--	--	--	--	--	--	--	0.33	0.88	--	0.26	0.69	--	0.20	--	--	--	--	--	--	--	0.9	2	
Manganese	2.7E+02	mg/kg	--	0.049	0.29	--	--	--	--	0.00073	0.00073	--	1.2	3.3	--	0.0038	0.010	--	0.84	--	--	--	--	4.0	--	--	6	4	
Molybdenum	6.8E-01	mg/kg	--	0.00059	0.0035	--	--	--	--	0.000000045	0.000000045	--	0.015	0.039	--	0.00061	0.0016	--	0.010	--	--	--	--	0.00025	--	--	0.03	0.04	
Nickel	1.2E+01	mg/kg	--	0.0026	0.015	--	--	--	4.1E-10	0.000018	0.000018	--	0.0083	0.022	--	0.0018	0.0048	--	0.0051	--	--	--	--	2.5E-07	0.012	--	2E-07	0.03	0.04
Selenium	2.6E+00	mg/kg	--	0.0022	0.013	--	--	--	--	0.000000017	0.000000017	--	0.0093	0.025	--	0.040	0.11	--	0.0059	--	--	--	--	0.000015	--	--	0.06	0.1	
Thallium	2.9E-01	mg/kg	--	0.13	0.74	--	--	--	--	--	--	--	0.30	0.81	--	0.53	1.4	--	0.18	--	--	--	--	--	--	--	1	3	
Uranium	1.1E+01	mg/kg	--	0.24	1.4	--	--	--	--	0.000037	0.000037	--	0.74	2.0	--	0.0078	0.021	--	0.46	--	--	--	--	0.023	--	--	1	3	
Vanadium	2.8E+01	mg/kg	--	0.024	0.14	--	--	--	--	0.000037	0.000037	--	0.069	0.18	--	0.0064	0.017	--	0.042	--	--	--	--	0.021	--	--	0.2	0.3	
Exposure Pathway Risk/Hazard Total			4E-04	1	5	3E-03	0.003	0.02	5E-08	0.002	0.002	3E-03	4	10	5E-03	1	3	2E-03	2	--	6E-06	0.02	--	2E-04	5	--	1E-02	10	20

Table C-6. Human Health Risk and Hazard Summary by Exposure Pathway

Section 33 Mine - Default Resident (Non-Navajo)																													
COPC	EPC	Units	Incidental Soil Ingestion			External Exposure / Dermal Contact			Inhalation of Particulates			Plant Consumption			Animal Consumption			ODL Plant Ingestion			ODL Plant Dermal			ODL Plant Inhalation			Total Risk or Hazard		
			Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard
Surface Soil (0-6 inches bgs)																													
Radium-226	3.0E+01	pCi/g	1.9E-04	--	--	2.2E-03	--	--	2.1E-07	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2E-03	--	--
Aluminum	1.8E+04	mg/kg	--	0.022	0.23	--	--	--	--	0.0026	0.0026	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.2	
Antimony	4.2E-01	mg/kg	--	0.0013	0.013	--	--	--	--	0.00000099	0.00000099	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.001	0.01		
Arsenic	7.4E+00	mg/kg	9.6E-06	0.018	0.19	1.3E-06	0.0037	0.022	8.3E-09	0.00035	0.00035	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1E-05	0.02	0.20	
Barium	9.5E+01	mg/kg	--	0.00057	0.0061	--	--	--	--	0.00013	0.00013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0007	0.006		
Cadmium	2.0E+01	mg/kg	--	0.0024	0.026	--	0.00040	0.0024	9.4E-11	0.000014	0.000014	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9E-11	0.003	0.03	
Cobalt	7.6E+00	mg/kg	--	0.030	0.32	--	--	--	1.8E-08	0.00089	0.00089	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2E-08	0.03	0.3	
Copper	1.5E+01	mg/kg	--	0.00045	0.0048	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0004	0.005		
Iron	2.2E+04	mg/kg	--	0.038	0.41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	0.4		
Manganese	2.3E+02	mg/kg	--	0.012	0.12	--	--	--	--	0.0033	0.0033	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.1		
Molybdenum	1.1E+00	mg/kg	--	0.00026	0.0028	--	--	--	--	0.00000039	0.00000039	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0003	0.003		
Nickel	1.5E+01	mg/kg	--	0.00090	0.0096	--	--	--	1.0E-09	0.00012	0.00012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1E-09	0.001	0.01	
Selenium	2.2E+01	mg/kg	--	0.0053	0.056	--	--	--	--	0.00000078	0.00000078	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.005	0.06		
Thallium	4.1E-01	mg/kg	--	0.049	0.52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.5		
Uranium	4.5E+01	mg/kg	--	0.27	2.9	--	--	--	--	0.00079	0.00079	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	3		
Vanadium	4.0E+01	mg/kg	--	0.0096	0.10	--	--	--	--	0.00028	0.00028	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.1		
Exposure Pathway Risk/Hazard Total			2E-04	0.5	5	2E-03	0.004	0.02	2E-07	0.008	0.008	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2E-03	0.5	5	
Subsurface Soil (0-18 inches bgs)																													
Radium-226	3.0E+01	pCi/g	1.9E-04	--	--	2.2E-03	--	--	1.9E-04	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3E-03	--	--
Aluminum	1.8E+04	mg/kg	--	0.021	0.23	--	--	--	--	0.0025	0.0025	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.2	
Antimony	4.1E-01	mg/kg	--	0.0012	0.013	--	--	--	--	0.00000096	0.00000096	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.001	0.01	
Arsenic	7.0E+00	mg/kg	9.1E-06	0.017	0.18	1.3E-06	0.0035	0.021	9.1E-06	0.00033	0.00033	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2E-05	0.02	0.20	
Barium	9.2E+01	mg/kg	--	0.00055	0.0059	--	--	--	--	0.00013	0.00013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0007	0.006		
Cadmium	1.9E-01	mg/kg	--	0.0023	0.024	--	0.00038	0.0023	--	0.000013	0.000013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.003	0.03		
Cobalt	7.2E+00	mg/kg	--	0.029	0.31	--	--	--	--	0.00085	0.00085	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	0.3		
Copper	1.4E+01	mg/kg	--	0.00042	0.0045	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0004	0.004		
Iron	2.1E+04	mg/kg	--	0.037	0.39	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	0.4		
Manganese	2.2E+02	mg/kg	--	0.011	0.12	--	--	--	--	0.0031	0.0031	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.1		
Molybdenum	1.0E+00	mg/kg	--	0.00024	0.0026	--	--	--	--	0.00000035	0.00000035	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0002	0.003		
Nickel	1.4E+01	mg/kg	--	0.00084	0.0089	--	--	--	--	0.00011	0.00011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0009	0.009		
Selenium	2.0E+01	mg/kg	--	0.0048	0.051	--	--	--	--	0.00000071	0.00000071	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.005	0.05		
Thallium	4.0E-01	mg/kg	--	0.048	0.51	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.5		
Uranium	4.1E+01	mg/kg	--	0.25	2.6	--	--	--	--	0.00072	0.00072	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	3		
Vanadium	3.8E+01	mg/kg	--	0.0091	0.097	--	--	--	--	0.00027	0.00027	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.009	0.1		
Exposure Pathway Risk/Hazard Total			2E-04	0.4	5	2E-03	0.004	0.02	2E-04	0.008	0.008	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3E-03	0.4	5	

Notes:
 Section 32 Mine results are from Table C-5.1, and Section 33 Mine results are from Table C-5.2.
 -- Not applicable
 bgs Below ground surface
 COPC Contaminant of potential concern
 EPC Exposure point concentration
 mg/kg Milligram per kilogram
 ODL Other Diné Lifeways
 pCi/g Picocurie per gram

Table C-7. Human Health Risk and Hazard Summary and Identification of Candidate Contaminants of Concern

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)					
COPC ^a	Units	Exposure Point Concentration	Cancer Risk ^{b,c,d}	Noncancer Hazard ^{b,d,e}	
				Adult	Child
Surface Soil (0-6 inches bgs)					
Radionuclides^f					
Radium-226	pCi/g	5.4E+00	1.0E-02	--	--
Radionuclide Total			1E-02	--	--
Metals					
Aluminum	mg/kg	1.8E+04	--	0.68	1.0
Antimony	mg/kg	3.4E-01	--	0.036	0.075
Arsenic	mg/kg	6.5E+00	2.6E-04	0.57	1.1
Barium	mg/kg	2.0E+02	--	0.10	0.085
Cadmium	mg/kg	1.5E-01	9.9E-08	0.17	0.29
Cobalt	mg/kg	7.1E+00	6.8E-06	1.2	2.3
Copper	mg/kg	1.2E+01	--	0.089	0.15
Iron	mg/kg	2.0E+04	--	0.93	2.3
Manganese	mg/kg	2.8E+02	--	6.4	3.7
Molybdenum	mg/kg	6.9E-01	--	0.027	0.045
Nickel	mg/kg	1.3E+01	2.7E-07	0.032	0.046
Selenium	mg/kg	2.6E+00	--	0.057	0.14
Thallium	mg/kg	2.9E-01	--	1.1	3.0
Uranium	mg/kg	6.9E+00	--	0.92	2.1
Vanadium	mg/kg	2.8E+01	--	0.16	0.34
Metal Total			3E-04	10	20
Cumulative Risk/Hazard Total			1E-02	10	20
Subsurface Soil (0-18 inches bgs)					
Radionuclides^f					
Radium-226	pCi/g	6.5E+00	1.2E-02	--	--
Radionuclide Total			1E-02	--	--
Metals					
Aluminum	mg/kg	1.7E+04	--	0.67	1.0
Antimony	mg/kg	3.4E-01	--	0.036	0.075
Arsenic	mg/kg	6.3E+00	2.6E-04	0.55	1.1
Barium	mg/kg	1.9E+02	--	0.098	0.084
Cadmium	mg/kg	1.5E-01	9.9E-08	0.17	0.29
Cobalt	mg/kg	6.8E+00	6.5E-06	1.1	2.2
Copper	mg/kg	1.2E+01	--	0.089	0.15
Iron	mg/kg	2.0E+04	--	0.91	2.3
Manganese	mg/kg	2.7E+02	--	6.2	3.6
Molybdenum	mg/kg	6.8E-01	--	0.026	0.044
Nickel	mg/kg	1.2E+01	2.5E-07	0.029	0.042
Selenium	mg/kg	2.6E+00	--	0.057	0.14
Thallium	mg/kg	2.9E-01	--	1.1	3.0
Uranium	mg/kg	1.1E+01	--	1.5	3.4
Vanadium	mg/kg	2.8E+01	--	0.16	0.34
Metal Total			3E-04	10	20
Cumulative Risk/Hazard Total			1E-02	10	20

Table C-7. Human Health Risk and Hazard Summary and Identification of Candidate Contaminants of Concern

Section 33 Mine - Default Resident (Non-Navajo)					
COPC^a	Units	Exposure Point Concentration	Cancer Risk^{b,c,d}	Noncancer Hazard^{b,d,e}	
				Adult	Child
Surface Soil (0-6 inches bgs)					
Radionuclides^f					
Radium-226	pCi/g	3.0E+01	2.4E-03	--	--
Radionuclide Total			2E-03	--	--
Metals					
Aluminum	mg/kg	1.8E+04	--	0.022	0.23
Antimony	mg/kg	4.2E-01	--	0.0013	0.013
<i>Arsenic</i>	mg/kg	7.4E+00	<i>1.1E-05</i>	0.018	0.19
Barium	mg/kg	9.5E+01	--	0.00057	0.0061
Cadmium	mg/kg	2.0E-01	9.4E-11	0.0087	0.051
Cobalt	mg/kg	7.6E+00	1.8E-08	0.030	0.32
Copper	mg/kg	1.5E+01	--	0.0012	0.0076
Iron	mg/kg	2.2E+04	--	0.038	0.41
Manganese	mg/kg	2.3E+02	--	0.012	0.12
Molybdenum	mg/kg	1.1E+00	--	0.0012	0.0037
Nickel	mg/kg	1.5E+01	1.0E-09	0.00090	0.0096
Selenium	mg/kg	2.2E+01	--	0.0053	0.056
Thallium	mg/kg	4.1E-01	--	0.052	0.53
Uranium	mg/kg	4.5E+01	--	0.27	2.9
Vanadium	mg/kg	4.0E+01	--	0.0097	0.10
Metal Total			<i>1E-05</i>	0.4	4
Cumulative Risk/Hazard Total			2E-03	0.4	4
Subsurface Soil (0-18 inches bgs)					
Radionuclides^f					
Radium-226	pCi/g	3.0E+01	2.6E-03	--	--
Radionuclide Total			3E-03	--	--
Metals					
Aluminum	mg/kg	1.8E+04	--	0.024	0.23
Antimony	mg/kg	4.1E-01	--	0.0012	0.013
<i>Arsenic</i>	mg/kg	7.0E+00	<i>1.9E-05</i>	0.021	0.20
Barium	mg/kg	9.2E+01	--	0.00068	0.0060
Cadmium	mg/kg	1.9E-01	--	0.0027	0.027
Cobalt	mg/kg	7.2E+00	--	0.030	0.31
Copper	mg/kg	1.4E+01	--	0.00042	0.0045
Iron	mg/kg	2.1E+04	--	0.037	0.39
Manganese	mg/kg	2.2E+02	--	0.014	0.12
Molybdenum	mg/kg	1.0E+00	--	0.00024	0.0026
Nickel	mg/kg	1.4E+01	--	0.00095	0.0091
Selenium	mg/kg	2.0E+01	--	0.0048	0.051
Thallium	mg/kg	4.0E-01	--	0.048	0.51
Uranium	mg/kg	4.1E+01	--	0.25	2.6
Vanadium	mg/kg	3.8E+01	--	0.0094	0.097
Metal Total			<i>2E-05</i>	0.4	5
Cumulative Risk/Hazard Total			3E-03	0.4	5

Table C-7. Human Health Risk and Hazard Summary and Identification of Candidate Contaminants of Concern

Notes:

- ^a **Bolded COPCs** are selected as candidate COCs because cancer risk is greater than one in ten thousand (1E-04) or noncancer hazard is greater than 1. *Italicized COPCs* are contaminants within the USEPA's cancer risk range (cancer risk greater than 1 in 1 million [1E-06] and less than or equal to 1E-04).
- ^b **Bolded values** are values greater than the target cancer risk of one in ten thousand (1E-04) or noncancer target hazard of 1. *Italicized values* are within the USEPA's acceptable cancer risk range (cancer risk greater than 1E-06 and less than or equal to 1E-04). Total risks and total hazards are reported to one significant digit; thus, values are commonly rounded. In practice, values can be slightly higher than the stated cutoff but still be considered equal to the cutoff because of rounding. Target organ analyses were performed for any scenario-media combination with a noncancer hazard greater than 1. If the target organ hazard index exceeds 1 but no individual COPC has a hazard quotient exceeding 1, the COPC contributing the highest amount of hazard was identified as a candidate COC.
- ^c Cancer risks are provided on Tables C-5.1 and C-5.2.
- ^d The methodology for calculating the risks and hazards and the inputs for cancer and noncancer equations are provided in the "Navajo Abandoned Uranium Mines Risk Assessment Methodology" (USEPA 2023c).
- ^e Noncancer hazards are presented on Tables C-5.1 and C-5.2.
- ^f For radionuclides, uranium-238 is assumed to be in secular equilibrium with its decay chain; that is, all decay chain nuclides are present in equal activity concentrations. In this case, the risk from radium-226 and its decay products (that is, radium-226 in secular equilibrium) will account for most of the risk from the uranium-238 decay chain.

--	Not applicable
bgs	Below ground surface
COC	Contaminant of concern
COPC	Contaminant of potential concern
mg/kg	Milligram per kilogram
pCi/g	Picocurie per gram
USEPA	U.S. Environmental Protection Agency

Reference:

U.S. Environmental Protection Agency (USEPA). 2023c. "Navajo Abandoned Uranium Mines Risk Assessment Methodology." Draft Final. Response, Assessment, and Evaluation Services. Contract No. EP-S9-17-02. August.

Table C-8. Ecological Risk Assessment Tier I Screening for Soil

Constituent of Interest ^a	Detection Frequency ^b	Maximum Detected Concentration ^b	Plant NOEC ^{c,d}	Soil Invertebrates NOEC ^{c,d}	Avian Herbivore NOEC ^{c,d}	Avian Ground Insectivore NOEC ^{c,d}	Avian Carnivore NOEC ^{c,d}	Mammalian Herbivore NOEC ^{c,d}	Mammalian Ground Insectivore NOEC ^{c,d}	Mammalian Carnivore NOEC ^{c,d}	Minimum NOEC	HQ based on Minimum NOEC ^e	Include Contaminant as a COPEC in Tier II? ^f
Radionuclides (pCi/g)													
Radium-226	63 / 63	161	<u>54</u>	<u>1.5</u>	<u>34</u>	<u>8.2</u>	<u>79</u>	<u>160</u>	<u>510</u>	<u>370</u>	1.5	107	Yes
Metals (mg/kg)													
Aluminum	69 / 69	27,000	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	No
Antimony	6 / 63	0.64	<u>11</u>	78	NSL	NSL	NSL	10	0.27	4.9	0.27	2.4	Yes
Arsenic	69 / 69	14	18	6.8	67	43	1,100	170	46	170	6.8	2.0	Yes
Barium	69 / 69	307	<u>110</u>	330	<u>720</u>	<u>820</u>	<u>7,500</u>	3,200	200	9,100	110	2.8	Yes
Beryllium	69 / 69	1.2	<u>2.5</u>	40	NSL	NSL	NSL	21	34	90	2.5	0.48	No
Cadmium	60 / 63	0.3	32	140	28	0.77	630	73	0.36	84	0.36	0.93	No
Chromium	69 / 69	22	<u>1</u>	0.4	78	26	780	380	34	180	0.4	54	Yes
Cobalt	69 / 69	10	13	NSL	270	120	1,300	2,100	230	470	13	0.80	No
Copper	69 / 69	20	70	80	76	80	1,600	1,100	49	560	49	0.41	No
Iron	69 / 69	31,500	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	No
Lead	69 / 69	22	120	1,700	46	11	510	1,200	56	460	11	2.0	Yes
Manganese	69 / 69	419	220	450	4,300	4,300	650,000	5,300	4,000	6,200	220	1.9	Yes
Molybdenum	61 / 63	1.9	2	NSL	18	15	90	NSL	NSL	NSL	2	0.93	No
Nickel	69 / 69	23	38	280	210	<u>20</u>	2,800	340	10	130	10	2.3	Yes
Selenium	65 / 69	102	0.52	4.1	2.2	1.2	83	2.7	0.63	2.8	0.52	196	Yes
Silver	30 / 63	0.66	560	NSL	69	4.2	930	1,500	14	990	4.2	0.16	No
Thallium	59 / 63	0.65	0.050	NSL	6.9	4.5	48	1.2	0.42	5.0	0.050	13	Yes
Uranium	64 / 69	251	25	NSL	1,500	1,100	14,000	1,000	480	4,800	25	10	Yes
Vanadium	69 / 69	92	<u>60</u>	NSL	13	7.8	140	1,300	280	580	7.8	12	Yes
Zinc	69 / 69	96	160	120	950	46	30,000	6,800	79	10,000	46	2.1	Yes

Notes:

^a **Bolded constituents** are selected as COPECs for Tier II evaluation because the HQ is equal to or greater than 1.0.

^b Includes soil samples from all exposure units collected from 0 to 72 inches bgs. Includes all duplicate soil samples. See Table C-1 for the summary statistics for each contaminant.

^c NOEC based on Eco-SSL (USEPA 2023e) unless otherwise noted. Underlined text indicates an Eco-SSL not available for that receptor group and where the NOEC is based on LANL (N3B 2022) no effect level. NOECs from Efroymsen, Will, Suter II, and Wooten (1997) are used for chromium and molybdenum for plants. NOECs from Efroymsen, Will, and Suter II (1997) are used for chromium for soil invertebrates.

^d Grey highlighted cells indicate the EPC exceeds the NOEC for the receptor group.

^e HQ is calculated by dividing the maximum detected concentration by the minimum NOEC. **Bolded HQ** values indicate HQs equal to or greater than 1.0.

^f A constituent is included as a COPEC if the calculated HQ is equal to or greater than 1.0.

bgs	Below ground surface	mg/kg	Milligram per kilogram
COPEC	Contaminant of potential ecological concern	N3B	Newport News Nuclear BWXT-Los Alamos, LLC
Eco-SSL	Ecological soil screening level	NOEC	No observed effect concentration
EPC	Exposure point concentration	NSL	No screening level
HQ	Hazard quotient	pCi/g	Picocurie per gram
LANL	Los Alamos National Laboratory	USEPA	U.S. Environmental Protection Agency

Table C-8. Ecological Risk Assessment Tier I Screening for Soil

References:

Efroymsen, R.A., M.E. Will, and G.W. Suter II. 1997. "Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process."

ES/ER/TM-126/R2. Oak Ridge National Laboratories, Oak Ridge, TN.

Efroymsen, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997. "Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants."

ES/ER/TM-85/R3. Oak Ridge National Laboratories, Oak Ridge, TN.

Newport News Nuclear BWXT-Los Alamos, LLC (N3B). 2022. "ECORISK Database." Release 4.3. 701067. Document EM2020-0575. September.

U.S. Environmental Protection Agency (USEPA). 2023e. "Interim Ecological Soil Screening Level Documents." Accessed July 20. <https://www.epa.gov/chemical-research/interim-ecological-soil-screening-level-documents>.

Table C-9. Exposure Point Concentrations for Ecological Risk Assessment

Section 32 Mine												
Contaminant	Units	Detection Frequency	Number of High Nondetect Results ^a	Maximum Concentration (qualifier)	Location of Maximum Concentration	Arithmetic Mean ^b	UCL95 / Distribution ^c			Exposure Point Concentration		
										Value ^d	Statistic ^d	Method ^e
Surface Soil (0-6 inches bgs)												
Radium-226	pCi/g	37 / 37	0	27.3	S3233-SS27-01-111522	3.7	5.4	NP	5.4	UCL	(14)	
Arsenic	mg/kg	37 / 37	0	8.3	S3233-SS41-01-111822	6.1	6.5	N	6.5	UCL	(2)	
Barium	mg/kg	37 / 37	0	307	S3233-SS23-01-111522	177	197	N	197	UCL	(2)	
Chromium	mg/kg	37 / 37	0	18.2	S3233-SS34-01-111722	13	14	N	14	UCL	(2)	
Lead	mg/kg	37 / 37	0	18.9	S3233-SS30-01-111722	14	15	N	15	UCL	(2)	
Manganese	mg/kg	37 / 37	0	419	S3233-SS20-01-111522	268	284	N	284	UCL	(2)	
Nickel	mg/kg	37 / 37	0	18.7	S3233-SS30-01-111722	12	13	N	13	UCL	(2)	
Selenium	mg/kg	37 / 37	0	13.3	S3233-SS27-01-111522	2.0	2.6	NP	2.6	UCL	(14)	
Thallium	mg/kg	36 / 37	0	0.471	S3233-SS30-01-111722	0.27	0.29	N	0.29	UCL	(3)	
Uranium	mg/kg	37 / 37	0	32.4	S3233-SS27-01-111522	4.9	6.9	NP	6.9	UCL	(14)	
Vanadium	mg/kg	37 / 37	0	38.7	S3233-SS53-01-111822	26	28	N	28	UCL	(2)	
Zinc	mg/kg	37 / 37	0	74.7	S3233-SS30-01-111722	51	54	N	54	UCL	(2)	
Subsurface Soil (0-18 inches bgs)												
Radium-226	pCi/g	38 / 38	0	32.7	S3233-SB55-0612-111822	4.5	6.5	NP	6.5	UCL	(14)	
Arsenic	mg/kg	41 / 41	0	8.3	S3233-SS41-01-111822	5.9	6.3	N	6.3	UCL	(2)	
Barium	mg/kg	41 / 41	0	307	S3233-SS23-01-111522	174	194	G	194	UCL	(4)	
Chromium	mg/kg	41 / 41	0	18.2	S3233-SS34-01-111722	12	13	N	13	UCL	(2)	
Lead	mg/kg	41 / 41	0	18.9	S3233-SS30-01-111722	13	14	N	14	UCL	(2)	
Manganese	mg/kg	41 / 41	0	419	S3233-SS20-01-111522	258	275	N	274	UCL	(2)	
Nickel	mg/kg	41 / 41	0	18.7 J	S3233-SS30-01-111722	11	12	N	12	UCL	(2)	
Selenium	mg/kg	38 / 40	0	13.3	S3233-SS27-01-111522	2.0	2.6	NP	2.6	UCL	(15)	
Thallium	mg/kg	37 / 38	0	0.471	S3233-SS30-01-111722	0.26	0.29	N	0.29	UCL	(3)	
Uranium	mg/kg	39 / 41	0	77	32-03-31-181103-M	6.9	11	NP	11	UCL	(15)	
Vanadium	mg/kg	41 / 41	0	38.7	S3233-SS53-01-111822	26	28	N	28	UCL	(2)	
Zinc	mg/kg	41 / 41	0	74.7	S3233-SS30-01-111722	49	52	N	52	UCL	(2)	

Table C-9. Exposure Point Concentrations for Ecological Risk Assessment

Section 33 Mine											
Contaminant	Units	Detection Frequency	Number of High Nondetect Results ^a	Maximum Concentration (qualifier)	Location of Maximum Concentration	Arithmetic Mean ^b	UCL95 / Distribution ^c	Exposure Point Concentration			
								Value ^d	Statistic ^d	Method ^e	
Surface Soil (0-6 inches bgs)											
Radium-226	pCi/g	21 / 21	0	161	S3233-SS59-01-111822	16	30	NP	30	UCL	(14)
Antimony	mg/kg	5 / 19	0	0.638 J	S3233-SS14-01-111522	0.37	0.42	N	0.42	UCL	(3)
Arsenic	mg/kg	21 / 21	0	13.8	S3233-SS60-01-111822	6.3	7.4	N	7.4	UCL	(2)
Barium	mg/kg	21 / 21	0	131	S3233-SS19-01-111522	84	95	NP	95	UCL	(14)
Chromium	mg/kg	21 / 21	0	21.7 J	S3233-SS03-01-111522	12	14	NP	14	UCL	(14)
Lead	mg/kg	21 / 21	0	22.2	S3233-SS03-01-111522	15	17	N	17	UCL	(2)
Manganese	mg/kg	21 / 21	0	301	S3233-SS03-01-111522	209	231	NP	231	UCL	(14)
Nickel	mg/kg	21 / 21	0	22.8	S3233-SS03-01-111522	13	15	NP	15	UCL	(14)
Selenium	mg/kg	21 / 21	0	102	S3233-SS58-01-111822	12	22	NP	22	UCL	(14)
Thallium	mg/kg	19 / 21	0	0.645	S3233-SS03-01-111522	0.35	0.41	N	0.41	UCL	(3)
Uranium	mg/kg	21 / 21	0	251	S3233-SS59-01-111822	23	45	NP	45	UCL	(14)
Vanadium	mg/kg	21 / 21	0	92.3	S3233-SS59-01-111822	34	40	NP	40	UCL	(14)
Zinc	mg/kg	21 / 21	0	95.6	S3233-SS08-01-111522	52	62	NP	62	UCL	(14)
Subsurface Soil (0-18 inches bgs)											
Radium-226	pCi/g	22 / 22	0	161	S3233-SS59-01-111822	16	30	NP	30	UCL	(14)
Antimony	mg/kg	5 / 20	0	0.638 J	S3233-SS14-01-111522	0.37	0.41	N	0.41	UCL	(3)
Arsenic	mg/kg	24 / 24	0	13.8	S3233-SS60-01-111822	6.0	7.0	N	7.0	UCL	(2)
Barium	mg/kg	24 / 24	0	131	S3233-SS19-01-111522	80	92	N	92	UCL	(2)
Chromium	mg/kg	24 / 24	0	21.7 J	S3233-SS03-01-111522	11	13	NP	13	UCL	(14)
Lead	mg/kg	24 / 24	0	22.2	S3233-SS03-01-111522	14	16	N	16	UCL	(2)
Manganese	mg/kg	24 / 24	0	301	S3233-SS03-01-111522	196	219	NP	219	UCL	(14)
Nickel	mg/kg	24 / 24	0	22.8	S3233-SS03-01-111522	12	14	NP	14	UCL	(14)
Selenium	mg/kg	24 / 24	0	102	S3233-SS58-01-111822	12	20	NP	20	UCL	(14)
Thallium	mg/kg	19 / 22	0	0.645	S3233-SS03-01-111522	0.34	0.40	N	0.40	UCL	(3)
Uranium	mg/kg	22 / 22	0	251	S3233-SS59-01-111822	22	41	NP	41	UCL	(15)
Vanadium	mg/kg	24 / 24	0	92.3	S3233-SS59-01-111822	33	38	NP	38	UCL	(14)
Zinc	mg/kg	24 / 24	0	95.6	S3233-SS08-01-111522	48	58	NP	58	UCL	(14)

Table C-9. Exposure Point Concentrations for Ecological Risk Assessment

Notes:

- ^a Number of nondetect results that exceeded the maximum detected concentration. These results were not included in the statistical calculations.
- ^b The arithmetic mean for datasets with nondetected results is calculated using the KM method.
- ^c Tested using the Shapiro-Wilk W or Lilliefors test for normal and lognormal distributions and the Anderson-Darling and Kolmogorov-Smirnov tests for gamma distributions. A 5 percent level of significance was used in all tests. Distribution tests were conducted only for samples with at least four detected results. Distributions not confirmed as N, LN, or G were treated as NP in all statistical calculations.
- ^d The EPC is the lesser of the UCL95 and the maximum detected concentration. The maximum detected concentration is the default when there are fewer than 10 samples or fewer than four detected results. All methods follow USEPA (2002, 2022b).
- ^e The statistical methods for selecting the exposure point concentration are as follows (not all are used):

(1) Maximum detected concentration	(6) 95% Approximate Gamma UCL	(11) 95% KM Bootstrap-t UCL
(2) 95% Student's t UCL	(7) 95% Gamma Approximate KM-UCL	(12) 95% BCA UCL
(3) 95% KM (t) UCL	(8) 95% H-UCL	(13) 95% KM BCA UCL
(4) 95% Adjusted Gamma UCL	(9) 95% H-UCL (KM log)	(14) 95% Percentile Bootstrap UCL
(5) 95% Gamma Adjusted KM-UCL	(10) 95% Bootstrap-t UCL	(15) 95% KM Percentile Bootstrap UCL

BCA	Bias-corrected accelerated bootstrap method
bgs	Below ground surface
EPC	Exposure point concentration
G (distribution)	Gamma distribution
H-UCL	UCL based upon Land's H-statistic
J	Estimated concentration
KM	Kaplan-Meier
LN	Lognormal distribution
mg/kg	Milligram per kilogram
N	Normal distribution
NP	Nonparametric distribution
pCi/g	Picocurie per gram
UCL	Upper confidence limit
UCL95	One-sided 95 percent upper confidence limit of the mean
USEPA	U.S. Environmental Protection Agency

References:

U.S. Environmental Protection Agency (USEPA). 2002. "Calculating Exposure Point Concentrations at Hazardous Waste Sites." Office of Solid Waste and Emergency Response. Directive 9285.6-10. December.

USEPA. 2022b. "ProUCL Version 5.2.0 Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations." June 14.

Table C-10. Tier II Ecological Risk Hazard Quotients and Identification of Candidate Contaminants of Ecological Concern

Section 32 Mine															
COPEC ^a	Units	EPC ^b	Minimum NOEC ^c	HQ based on Minimum NOEC ^d	Plant LOEC ^e	Soil Invertebrates LOEC ^e	Avian Herbivore LOEC ^f	Avian Ground Insectivore LOEC ^f	Avian Carnivore LOEC ^f	Mammalian Herbivore LOEC ^f	Mammalian Ground Insectivore LOEC ^f	Mammalian Carnivore LOEC ^f	Minimum LOEC	HQ based on Minimum LOEC ^d	Include Contaminant as a Candidate COEC? ^g
Surface Soil (0-6 inches bgs)															
Radionuclides															
Radium-226	pCi/g	5.4	10	0.54	540	15	340	82	610	3,400	5,100	3,700	15	0.36	No
Metals															
Antimony	mg/kg	0.34	0.27	1.3	58	780	--	--	NSL	27	79	460	27	0.013	No
Arsenic	mg/kg	6.5	6.8	0.96	91	68	340	150	1,000	180	31	1,300	31	0.21	No
Barium	mg/kg	197	110	1.8	260	3,200	1,200	1,400	13,000	14,000	10,000	190,000	260	0.76	No
Chromium	mg/kg	14	0.40	35	--	--	160	73	560	41,000	6,300	180,000	73	0.19	No
Lead	mg/kg	15	11	1.4	570	8,400	36	23	160	600	170	7,000	23	0.65	No
Manganese	mg/kg	284	220	1.3	1,100	4,500	2,700	4,700	50,000	7,500	10,000	150,000	1,100	0.26	No
Nickel	mg/kg	13	10	1.3	270	1,300	500	81	440	540	21	2,500	21	0.62	No
Selenium	mg/kg	2.6	0.52	5.0	3.0	41	1.9	1.4	7.5	3.4	1.0	130	1.0	2.6	Yes
Thallium	mg/kg	0.29	0.050	5.8	0.50	--	69	45	480	12	4.2	50	0.50	0.58	No
Uranium	mg/kg	7	25	0.28	250	--	15,000	11,000	140,000	2,600	1,200	12,000	250	0.028	No
Vanadium	mg/kg	28	7.8	3.6	80	--	14	9.5	110	1,500	610	6,900	9.5	2.9	Yes
Zinc	mg/kg	54	46	1.2	810	930	870	120	590	18,000	980	94,000	120	0.45	No
Subsurface Soil (0-72 inches bgs)															
Radionuclides															
Radium-226	pCi/g	6.5	10	0.65	540	15	340	82	610	3,400	5,100	3,700	15	0.43	No
Metals															
Antimony	mg/kg	0.34	0.27	1.3	58	780	--	--	NSL	27	79	460	27	0.013	No
Arsenic	mg/kg	6.3	6.8	0.93	91	68	340	150	1,000	180	31	1,300	31	0.20	No
Barium	mg/kg	194	110	1.8	260	3,200	1,200	1,400	13,000	14,000	10,000	190,000	260	0.75	No
Chromium	mg/kg	13	0.40	33	--	--	160	73	560	41,000	6,300	180,000	73	0.18	No
Lead	mg/kg	14	11	1.3	570	8,400	36	23	160	600	170	7,000	23	0.61	No
Manganese	mg/kg	274	220	1.2	1,100	4,500	2,700	4,700	50,000	7,500	10,000	150,000	1,100	0.25	No
Nickel	mg/kg	12	10	1.2	270	1,300	500	81	440	540	21	2,500	21	0.57	No
Selenium	mg/kg	2.6	0.52	5	3.0	41	1.9	1.4	7.5	3.4	1.0	130	1.0	2.6	Yes
Thallium	mg/kg	0.29	0.050	5.8	0.50	--	69	45	480	12	4.2	50	0.50	0.58	No
Uranium	mg/kg	11	25	0.4	250	--	15,000	11,000	140,000	2,600	1,200	12,000	250	0.044	No
Vanadium	mg/kg	28	7.8	3.6	80	--	14	9.5	110	1,500	610	6,900	9.5	2.9	Yes
Zinc	mg/kg	52	46	1.1	810	930	870	120	590	18,000	980	94,000	120	0.43	No

Table C-10. Tier II Ecological Risk Hazard Quotients and Identification of Candidate Contaminants of Ecological Concern

Section 33 Mine															
COPEC ^a	Units	EPC ^b	Minimum NOEC ^c	HQ based on Minimum NOEC ^d	Plant LOEC ^e	Soil Invertebrates LOEC ^e	Avian Herbivore LOEC ^f	Avian Ground Insectivore LOEC ^f	Avian Carnivore LOEC ^f	Mammalian Herbivore LOEC ^f	Mammalian Ground Insectivore LOEC ^f	Mammalian Carnivore LOEC ^f	Minimum LOEC	HQ based on Minimum LOEC ^d	Include Contaminant as a Candidate COEC? ^g
Surface Soil (0-6 inches bgs)															
Radionuclides															
Radium-226	pCi/g	30	10	3.0	540	15	340	82	610	3,400	5,100	3,700	15	2.0	Yes
Metals															
Antimony	mg/kg	0.42	0.27	1.6	58	780	--	--	NSL	27	79	460	27	0.016	No
Arsenic	mg/kg	7.4	6.8	1.1	91	68	340	150	1,000	180	31	1,300	31	0.24	No
Barium	mg/kg	95	110	0.9	260	3,200	1,200	1,400	13,000	14,000	10,000	190,000	260	0.37	No
Chromium	mg/kg	14	0.40	35	--	--	160	73	560	41,000	6,300	180,000	73	0.19	No
Lead	mg/kg	17	11	1.5	570	8,400	36	23	160	600	170	7,000	23	0.74	No
Manganese	mg/kg	231	220	1.1	1,100	4,500	2,700	4,700	50,000	7,500	10,000	150,000	1,100	0.21	No
Nickel	mg/kg	15	10	1.5	270	1,300	500	81	440	540	21	2,500	21	0.71	No
Selenium	mg/kg	22	0.52	42	3.0	41	1.9	1.4	7.5	3.4	1.0	130	1.0	22	Yes
Thallium	mg/kg	0.41	0.050	8.2	0.50	--	69	45	480	12	4.2	50	0.50	0.82	No
Uranium	mg/kg	45	25	1.8	250	--	15,000	11,000	140,000	2,600	1,200	12,000	250	0.18	No
Vanadium	mg/kg	40	7.8	5.1	80	--	14	9.5	110	1,500	610	6,900	9.5	4.2	Yes
Zinc	mg/kg	62	46	1.3	810	930	870	120	590	18,000	980	94,000	120	0.52	No
Subsurface Soil (0-72 inches bgs)															
Radionuclides															
Radium-226	pCi/g	30	10	3.0	540	15	340	82	610	3,400	5,100	3,700	15	2.0	Yes
Metals															
Antimony	mg/kg	0.41	0.27	1.5	58	780	--	--	NSL	27	79	460	27	0.015	No
Arsenic	mg/kg	7.0	6.8	1.0	91	68	340	150	1,000	180	31	1,300	31	0.23	No
Barium	mg/kg	92	110	0.8	260	3,200	1,200	1,400	13,000	14,000	10,000	190,000	260	0.35	No
Chromium	mg/kg	13	0.40	33	--	--	160	73	560	41,000	6,300	180,000	73	0.18	No
Lead	mg/kg	16	11	1.5	570	8,400	36	23	160	600	170	7,000	23	0.70	No
Manganese	mg/kg	219	220	1.0	1,100	4,500	2,700	4,700	50,000	7,500	10,000	150,000	1,100	0.20	No
Nickel	mg/kg	14	10	1.4	270	1,300	500	81	440	540	21	2,500	21	0.67	No
Selenium	mg/kg	20	0.52	38	3.0	41	1.9	1.4	7.5	3.4	1.0	130	1.0	20	Yes
Thallium	mg/kg	0.40	0.050	8.0	0.50	--	69	45	480	12	4.2	50	0.50	0.80	No
Uranium	mg/kg	41	25	1.6	250	--	15,000	11,000	140,000	2,600	1,200	12,000	250	0.16	No
Vanadium	mg/kg	38	7.8	4.9	80	--	14	9.5	110	1,500	610	6,900	9.5	4.0	Yes
Zinc	mg/kg	58	46	1.3	810	930	870	120	590	18,000	980	94,000	120	0.48	No

Table C-10. Tier II Ecological Risk Hazard Quotients and Identification of Candidate Contaminants of Ecological Concern

Notes:

^a **Bolded COPECs** have a HQ greater than 1.0.

^b EPCs are provided in Table C-9.

^c NOECs are provided in Table C-8.

^d HQ is calculated by dividing the EPC by the ecological screening level. **Bolded HQ** values indicate HQs greater than 1.0.

^e Screening levels for plants and invertebrates are LOECs (N3B 2022).

^f Grey highlighted cells indicate the EPC exceeds the LOEC for the receptor group.

^g Ecological Tier II screening levels for soil are LOECs or LOAELs based on the LANL low-effect level ESLs (N3B 2022). Screening levels for birds and mammals are LOAELs for avian herbivores (American robin), avian ground insectivores (American robin), avian intermediate carnivores (American kestrel), mammalian herbivores (mountain cottontail), mammalian ground insectivores (montane shrew), and mammalian top carnivores (gray fox).

^h A contaminant is identified as a candidate COEC if the Tier II HQ (HQ based on minimum LOEC) is equal to or greater than 1.0.

--	No screening level
bgs	Below ground surface
COEC	Contaminant of ecological concern
COPEC	Contaminant of potential ecological concern
EPC	Exposure point concentration
ESL	Environmental screening level
HQ	Hazard quotient
LANL	Los Alamos National Laboratory
LOAEL	Lowest observed adverse effect level
LOEC	Lowest observed effect concentration
mg/kg	Milligram per kilogram
N3B	Newport News Nuclear BWXT-Los Alamos, LLC
pCi/g	Picocurie per gram

Reference:

Newport News Nuclear BWXT-Los Alamos, LLC (N3B). 2022. "ECORISK Database." Release 4.3. 701067. Document EM2020-0575. September.

Table C-11. Comparison of Individual Sample Results to Plant and Invertebrate Lowest Observed Effect Concentrations

Sample Identification	Sample Bottom Depth (inches bgs)	Contaminant:	Ra-226	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Molybdenum	Nickel	Selenium	Silver	Thallium	Uranium	Vanadium	Zinc	
		Units:	pCi/g	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
		Plant LOEC: ^a	540	NSL	3.0	91	260	25	160	NSL	130	NSL	NSL	NSL	570	1,100	NSL	270	3.0	NSL	0.50	250	80	810
		Soil Invertebrate LOEC: ^a	15	NSL	780	68	3,200	400	760	NSL	NSL	NSL	NSL	NSL	8,400	4,500	NSL	1,300	41	NSL	NSL	NSL	NSL	930
Section 32 Mine																								
32-01-31-181103-M	0-18		--	11,000	--	3.3	150	0.56	--	4.8	3.1	4.4	12,000	4.3	140	--	5	0 U	--	--	0 U	16	24	
32-02-31-181103-M	0-18		--	25,000	--	4.9	110	1.1	--	12	6.3	10	22,000	6	220	--	9.7	0 U	--	--	0 U	34	49	
32-03-31-181103-M	0-18		--	12,000	--	3.2	150	0.66	--	2.6	2.6	4.1	11,000	6.6	240	--	3.6	0 U	--	--	77	23	17	
32-03-32-181103-M	0-18		--	13,000	--	4.3	250	0.72	--	2.8	2.8	5.5	11,000	6.1	240	--	4	0 U	--	--	0 U	15	14	
S3233-SB43-0612-111822	6-12		1.44	16,700	0.345 U	6.89	292	0.821	0.0688	12	7.07	8.43	21,100	14	330	0.205	12	1.35	0.663	0.189	0.823	17.3	48.3	
S3233-SB46-0612-111822	6-12		1.1	10,200	0.32 U	5.03	97.1	0.654	0.144	9.19	5.69	9.95	15,100	10.3	203	0.591	9.86	1.53	0.097 U	0.223	1.32	19.4	40.2	
S3233-SB55-0612-111822	6-12		32.7	10,400	0.331 U	4.5	156	0.561	0.0916	7.52	4.24	7.59	12,100	12	176	0.392	6.26	6.91	0.35	0.156	25.3	32.2	31.4	
S3233-SS20-01-111522	0-6		--	--	--	--	--	--	--	--	7.79	--	24,200	13.5	419	0.507	--	--	--	--	--	30.6	--	
S3233-SS20-02-111522	0-6		1.78	21,300	0.36 U	5.41	201	0.9	0.118	15.3	--	11.6	--	--	--	--	13.9	1.44	0.545 U	0.292	1.42	--	53.8	
S3233-SS21-01-111522	0-6		1.33	21,700	0.327 U	6.53	195	0.955	0.155	16.5	8.68	13.6	23,500	15.9	309	0.642	15.9	1.6	0.495 U	0.351	1.05	29.8	62.9	
S3233-SS22-01-111522	0-6		4.76	18,800	0.303 U	6.94	108	0.982	0.203	14.4	8.16	15.1	23,200	17.2	277	0.872	16.1	3.74	0.459 U	0.381	18.8	29.3	63.5	
S3233-SS23-01-111522	0-6		2.33	16,700	0.312 U	8.03	307	0.87	0.0875	12.8	7.12	9.34	21,900	15.8	314	0.365	12.3	1.74	0.473 U	0.195	3.4	21.2	51.8	
S3233-SS24-01-111522	0-6		2.87	13,700	0.324 U	5.29	208	0.688	0.0895	9.89	5.32	7.49	15,500	11.4	265	0.218	9.35	1.49	0.491 U	0.157	1.78	17.4	38.6	
S3233-SS25-01-111522	0-6		7.24	18,700	0.352 U	5.78	156	0.853	0.132	13.6	6.56	11.5	20,100	13.8	267	0.543	12.6	3.19	0.533 U	0.276	9.41	26.8	51.8	
S3233-SS26-01-111522	0-6		2.15	23,800	0.356 U	7.2	114	1.09	0.209	18.1	8.69	16.5	26,300	17.9	250	1.01	17.4	1.94	0.54 U	0.434	1.69	34.2	71.4	
S3233-SS27-01-111522	0-6		27.3	14,900	0.355 U	5.84	137	0.765	0.128	10.6	5.65	10.2	16,800	13.3	219	0.665	10.5	13.3	0.537 U	0.283	32.4	34.4	42.9	
S3233-SS28-01-111722	0-6		2.56	19,200	0.377 U	6.49	104	0.893	0.175	15	7.46	15	22,500	15.9	211	0.974	15.1	2.14	0.572 U	0.378	2.74	30.2	61.5	
S3233-SS29-01-111722	0-6		2.04	18,700	0.379 U	6.97	84.6	0.909	0.231	14.9	7.85	16.1	23,500	17	209	1.17	16.2	1.87	0.574 U	0.433	1.76	29.7	65.2	
S3233-SS30-01-111722	0-6		4.76	20,700	0.357 U	7.52	96.2	1.03	0.24	17.7	8.72	17.1	25,300	18.9	234	1.18	18.7	2.57	0.124	0.471	16	33.8	74.7	
S3233-SS31-01-111722	0-6		1.68	19,300	0.329 U	7.42	90.7	0.992	0.216	16.4	8.6	16.8	24,800	18.2	237	1.07	17.7	2.03	0.0996 U	0.451	1.51	31.2	72.5	
S3233-SS32-01-111722	0-6		1.35	16,300	0.365 U	6.28	110	0.826	0.17	13.4	7.14	13.3	21,200	14.4	230	0.912	13.4	1.67	0.111 U	0.33	1.37	27.5	57.1	
S3233-SS33-01-111722	0-6		1.56	17,500	0.317 U	6.98	92.9	0.907	0.201	14.7	7.89	14.6	22,100	16	237	0.887	15.1	1.86	0.161	0.356	1.47	28.8	62.9	
S3233-SS34-01-111722	0-6		1.84	23,100	0.358 U	7.15	118	1.05	0.214	18.2	8.1	16.1	24,800	18	238	1.05	17.2	2.07	0.125	0.447	1.86	34.7	73.5	
S3233-SS35-01-111722	0-6		4.85	17,500	0.327 U	6.61	125	0.878	0.213	13.3	7.2	14.3	21,600	16.5	270	0.914	14.2	3.42	0.146	0.352	4.76	28.1	60.8	
S3233-SS36-01-111722	0-6		1.08	9,310	0.342 U	3.99	148	0.496	0.136	7.7	4.54	7.27	13,400	9.99	325	0.309	7.73	1.05	0.166	0.142	0.606	15.8	31.5	
S3233-SS37-01-111722	0-6		1.32	10,400	0.301 U	3.41	140	0.511	0.154	8.57	4.68	7.82	12,200	11.3	340	0.327	7.6	1.02	0.179	0.146	0.802	16.1	33.8	
S3233-SS38-01-111722	0-6		1.18	18,300	0.331 U	6.37	300	0.816	0.109	13.6	6.57	9.88	18,700	11.1	277	0.411	13.4	1.38	0.1 U	0.225	2.21	31	43.4	
S3233-SS39-01-111722	0-6		2.77	16,700	0.328 U	6.04	285	0.762	0.118	11.4	6.18	8.68	20,300	12.3	399	0.38	11.6	2.7	0.238	0.203	3.93	23.7	43.4	
S3233-SS40-02-111722	0-6		1.55	16,600	0.326 U	7.67	289	0.833	0.115	13.1	7.22	9.48	20,300	15.7	311	0.294	12.6	1.47	0.135	0.208	1.26	19.9	52.9	
S3233-SS41-01-111822	0-6		1.61	8,850	0.299 U	8.3	155	0.483	0.0484	7.9	3.72	4.87	15,900	8.14	140	0.569	5.6	1.03	0.175	0.147	2.26	15	25.7	
S3233-SS42-01-111822	0-6		2.1	12,000	0.304 U	8.29	139	0.815	0.0505	10.3	6.59	9.06	19,000	13.9	191	0.341	11.1	1.3	0.151	0.182	1.87	13.9	49.3	
S3233-SS43-01-111822	0-6		1.59	15,300	0.338 U	6.72	306	0.737	0.0648	11.4	6.61	7.71	19,400	13.8	313	0.264	10.9	1.44	0.231	0.194	1.36	17.7	46.2	
S3233-SS44-01-111822	0-6		1.19	19,800	0.329 U	7.21	187	0.928	0.0661	14.7	6.91	7.92	20,300	13.5	337	0.512	13	1.4	0.182	0.21	1.31	24.6	49.7	
S3233-SS45-01-111822	0-6		1.19	16,900	0.336 U	7.49	295	0.826	0.102	13.3	6.66	9	19,800	14.9	294	0.283	12.4	1.37	0.177	0.202	1.26	19.8	51.9	
S3233-SS46-01-111822	0-6		1.64	9,520	0.343	5	99	0.616	0.133	8.77	5.43	9.43	14,800	10.7	190	0.543	9.13	1.81	0.0891 U	0.208	1.53	18.6	39	
S3233-SS47-01-111822	0-6		1.48	14,800	0.326 U	4.71	112	0.683	0.144	11.6	5.61	10.8	16,000	12.8	227	0.836	10.2	0.467	0.488	0.242	1.01	24.5	43.2	
S3233-SS48-01-111822	0-6		2.99	15,600	0.326 U	4.96	272	0.777	0.156	11.7	6.21	12.3	17,100	14.3	234	0.921	10.5	1.24	0.358	0.282	2.42	28.1	48.3	
S3233-SS49-01-111822	0-6		1.87	14,800	0.34 U	4.41	192	0.762	0.16	10.9	5.56	11.6	15,800	13.2	222	0.813	9.37	1.36	0.354	0.243	1.42	25.8	46.2	
S3233-SS50-01-111822	0-6		1.68	20,400	0.347 U	5.87	115	0.933	0.201	15.8	7.42	14.6	20,600	16.1	241	1.05	13.3	0.622	0.51	0.352	1.19	34.4	59.3	
S3233-SS51-01-111822	0-6		5.75	18,100	0.366 U	5.75	118	0.923	0.152	13.7	7.6	13.4	18,800	15.2	291	0.504	10.8	1.27	0.453	0.238	7.03	32.5	55.1	
S3233-SS52-01-111822	0-6		4.27	20,100	0.347 U	5.58	134	0.943	0.158	15	7.47	13.5	18,400	15.4	266	0.748	10.6	0.742	0.54	0.236	23.2	35.8	54.2	
S3233-SS53-01-111822	0-6		4.84	23,600	0.339 U	6.15	165	1.15	0.148	16.8	8.11	14.5	20,300	16.9	299	0.618	11.2	1.27	0.542	0.396	12.4	38.7	58.6	
S3233-SS54-01-111822	0-6		3.51	15,100	0.336 U	4.9	169	0.807	0.156	11.3	5.91	11.7	16,300	13.9	237	0.648	8.91	1.24	0.354	0.209	2.78	26.4	46.8	
S3233-SS55-01-111822	0-6		24.3	8,990	0.345 U	4.15	192	0.561	0.0873	7.27	4.14	7.21	11,500	10.7	180	0.363	6.05	3.83	0.332	0.131 U	10.3	25.3	29.2	
S3233-SS56-01-111822	0-6		1.43	12,000	0.329 U	4.5	209	0.649	0.121	9.1														

Table C-11. Comparison of Individual Sample Results to Plant and Invertebrate Lowest Observed Effect Concentrations

Sample Identification	Sample Bottom Depth (inches bgs)	Contaminant:	Ra-226	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Molybdenum	Nickel	Selenium	Silver	Thallium	Uranium	Vanadium	Zinc		
		Units:	pCi/g	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
		Plant LOEC: ^a	540	NSL	3.0	91	260	25	160	NSL	130	NSL	NSL	NSL	570	1,100	NSL	270	3.0	NSL	0.50	250	80	810	
		Soil Invertebrate LOEC: ^a	15	NSL	780	68	3,200	400	760	NSL	NSL	NSL	NSL	NSL	8,400	4,500	NSL	1,300	41	NSL	NSL	NSL	NSL	930	
Section 33 Mine																									
33-01-31-181103-M	0-18		--	8,300	--	2.5	41	0.36	--	1.7	1.8	2.7	8700	3.9	76	--	2.7	12	--	--	0 U	23	11		
33-02-31-181103-M	0-18		--	22,000	--	5.5	81	0.92	--	11	6.2	11	24000	7.3	170	--	13	2.8	--	--	0 U	30	50		
S3233-SB13-0612-111522	6-12		17.20	5,440	0.326 U	2.18	26.8	0.257	0.0207	2.49	1.67	4	5190	5.67	73.2	0.56	2.43	7.86	0.0989 U	0.128 U	47	23.8	10.6		
S3233-SS01-01-111522	0-6		1.63	18,100	0.36 U	7.86	77.6	0.945	0.295	16.1	8.72	18.2	25700	18.6	232	1.79	19.2	2.09	0.545 U	0.543	1.28	33.4	72.5		
S3233-SS02-01-111522	0-6		1.61	17,500	0.364 U	7.32	76.1	0.933	0.282	15.1	8.25	15.9	23600	17.1	208	1.67	17.6	1.88	0.552 U	0.512	1.19	31.2	67.2		
S3233-SS03-01-111522	0-6		1.65	27,000	0.324 U	8.95	106	1.19	0.333	21.7	10.4	20	31500	22.2	301	1.86	22.8	2.26	0.491 U	0.645	1.61	43.6	86.3		
S3233-SS05-01-111522	0-6		2.00	17,600	0.396 U	6.87	77.5	0.867	0.191	14.5	8.15	15.1	23900	16.9	208	1.05	16	1.85	0.599 U	0.403	1.41	26.5	64.4		
S3233-SS06-01-111522	0-6		2.10	22,900	0.338 U	7.4	99.1	0.991	0.236	18.1	8.84	16.9	27000	19	263	0.962	18.2	2.11	0.512 U	0.483	2.52	33.8	71.9		
S3233-SS08-01-111522	0-6		15.60	19,800	0.359 U	6.84	96.2	0.89	0.207	15.5	7.74	16.1	23400	17.7	234	0.952	16	4.75	0.544 U	0.418	11.6	34.5	95.6		
S3233-SS09-01-111522	0-6		14.80	21,100	0.324 U	7.67	116	1.01	0.223	16.7	9.18	18	26200	19.9	259	0.849	18.1	4.52	0.49 U	0.44	8.21	35.3	73.1		
S3233-SS10-01-111522	0-6		1.69	19,500	0.361 U	7.14	101	0.895	0.181	15.8	9.23	16.5	25100	17.3	260	0.96	17.2	1.76	0.547 U	0.395	1.33	30.5	66.1		
S3233-SS12-01-111522	0-6		1.65	19,200	0.356 U	6.89	99.1	0.866	0.174	15.1	9.35	15.3	25100	16.7	267	0.861	16.7	2.08	0.539 U	0.376	1.24	28.9	64.2		
S3233-SS13-01-111522	0-6		34.3	9,010	0.636	4.58	80.7	0.498	0.061	4.83	3.36	6.77	9060	9.68	194	0.792	5.33	16.8	0.539 U	0.2	78	29.9	20.9		
S3233-SS14-01-111522	0-6		2.45	18,400	0.638	6.83	99.9	0.854	0.17	15.1	8.38	15	23500	16.6	238	0.99	16.1	2.26	0.563 U	0.388	1.57	30.1	69.9		
S3233-SS15-01-111522	0-6		6.98	16,600	0.371 U	6.33	92.3	0.807	0.183	13.1	7.64	14.4	21900	15.7	235	0.809	14.6	10.5	0.562 U	0.364	6.31	29.8	57.8		
S3233-SS17-01-111522	0-6		14.6	4,650	0.51	1.29	62.8	0.273	0.0224	1.25	1.23	2.7	4570	6.92	109	0.0711 U	1.44	14.3	0.101 U	0.124 U	12.6	16.9	9.87		
S3233-SS18-01-111522	0-6		10.9	19,200	0.378	6.83	88.7	0.873	0.179	15.6	8.01	15.2	23500	16.9	224	1.17	16.2	9.12	0.539 U	0.419	25.1	33.9	61.8		
S3233-SS19-01-111522	0-6		2.25	14,300	0.53	5.29	131	0.653	0.134	10.6	5.33	9.17	17200	12.2	259	0.398	10.5	1.42	0.467 U	0.21	1.99	24.8	40.3		
S3233-SS57-01-111822	0-6		22.6	5,030	0.309 U	1.71	6.7	0.285	0.0188 U	1.79	2.83	2.73	6450	4.24	94.2	0.0754 U	1.99	8.22	0.158	0.132 U	11.6	22.6	6.77		
S3233-SS58-01-111822	0-6		30.3	4,360	0.327 U	1.4	6.08	0.231	0.0177 U	1.6	1.32	2.27	4310	5.55	110	0.139	1.46	102	0.0991 U	0.134	30.2	59.7	5.06		
S3233-SS59-01-111822	0-6		161	--	--	--	131	--	--	--	--	--	--	--	215	0.439	--	57.8	0.458	--	251	92.3	--		
S3233-SS59-02-111822	0-6		--	9,400	0.338 U	4.84	--	0.478	0.0414	4.06	2.94	5.32	12400	13.5	--	--	4.05	--	--	0.236	--	--	15.6		
S3233-SS60-01-111822	0-6		11.3	14,000	0.353 U	13.8	22.9	1.08	0.0199 U	4.1	2.41	10.1	6350	11.3	61.4	0.311	3.61	6.95	0.152	0.171	23.4	7.54	9.15		
Section 33 Mine Frequency of Exceedance:			6/20	0/22	0/20	0/22	0/22	0/22	0/20	0/22	0/22	0/22	0/22	0/22	0/22	0/20	0/22	12/22	0/20	3/20	1/22	1/22	0/22		
Section 32 and 33 Mines Overall Frequency of Exceedance			9/60	0/66	0/60	0/66	8/66	0/66	0/60	0/66	0/66	0/66	0/66	0/66	0/66	0/60	0/66	18/66	0/60	3/60	1/66	1/66	0/60		

Notes:

^a Screening levels for plants and invertebrates are LOECs (Newport News Nuclear BWXT-Los Alamos, LLC 2022)

	Exceeds soil invertebrate LOEC
	Exceeds plant LOEC
	Exceeds both plant and soil invertebrate LOECs

--	Not analyzed
bgs	Below ground surface
LOEC	Lowest observed effect concentration
mg/kg	Milligram per kilogram
NSL	No screening level
pCi/g	Picocurie per gram
Ra-226	Radium-226
U	Not detected

Reference:

Newport News Nuclear BWXT-Los Alamos, LLC. 2022. "ECORISK Database." Release 4.3. 701067. Document EM2020-0575. September.

ATTACHMENT C-1

DATA USED IN THE RISK ASSESSMENT

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Aluminum	11,000	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Arsenic	3.3	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Barium	150	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Beryllium	0.56	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Chromium	5	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Cobalt	3	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Copper	4	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Iron	12,000	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Lead	4	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Manganese	140	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Nickel	5	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Selenium	-- U	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Uranium	-- U	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Vanadium	16	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Zinc	24	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Aluminum	25,000	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Arsenic	4.9	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Barium	110	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Beryllium	1.1	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Chromium	12	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Cobalt	6	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Copper	10	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Iron	22,000	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Lead	6	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Manganese	220	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Nickel	10	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Selenium	-- U	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Uranium	-- U	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Vanadium	34	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Zinc	49	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Aluminum	12,000	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Arsenic	3.2	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Barium	150	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Beryllium	0.66	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Chromium	3	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Cobalt	3	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Copper	4	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Iron	11,000	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Lead	7	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Manganese	240	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Nickel	4	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Selenium	-- U	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Uranium	77	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Vanadium	23	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Zinc	17	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Aluminum	13,000	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Arsenic	4.3	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Barium	250	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Beryllium	0.72	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Chromium	3	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Cobalt	3	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Copper	6	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Iron	11,000	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Lead	6	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Manganese	240	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Nickel	4	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Selenium	-- U	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Uranium	-- U	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Vanadium	15	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Zinc	14	--	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Aluminum	16,700	48.1	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Antimony	0.345 UJ	0.345	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Arsenic	6.89	0.358	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Barium	292	1.06	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Beryllium	0.821	0.0212	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Cadmium	0.0688 J	0.0212	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Chromium	12	0.212	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Cobalt	7 J	0.0635	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Copper	8 J	0.0698	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Iron	21,100	69.8	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Lead	14	0.106	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Manganese	330	2.12	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Molybdenum	0 JJ	0.0847	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Nickel	12	0.106	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	EPA 901.1M	Radium-226	1.44	0.104	pCi/g

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Selenium	1 J	0.381	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Silver	0.663	0.105	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Thallium	0.189 J	0.148	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Uranium	0.823	0.014	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Vanadium	17 J	0.317	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Zinc	48 J	0.847	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Aluminum	10,200	42.3	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Antimony	0.32 UJ	0.32	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Arsenic	5.03	0.314	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Barium	97	0.093	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Beryllium	0.654	0.0186	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Cadmium	0.144 J	0.0186	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Chromium	9	0.186	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Cobalt	6	0.0558	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Copper	10 J	0.614	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Iron	15,100	61.4	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Lead	10	0.093	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Manganese	203	1.86	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Molybdenum	1 J	0.0744	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Nickel	10	0.093	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	EPA 901.1M	Radium-226	1.1	0.135	pCi/g
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Selenium	2	0.335	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Silver	0.097 U	0.097	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Thallium	0.223 J	0.13	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Uranium	1.32 J	0.0123	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Vanadium	19	0.279	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Zinc	40	0.744	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Aluminum	10,400	41.6	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Antimony	0.331 UJ	0.331	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Arsenic	4.5	0.309	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Barium	156	0.0914	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Beryllium	0.561	0.0183	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Cadmium	0.0916 J	0.0183	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Chromium	8	0.183	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Cobalt	4	0.0548	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Copper	8 J	0.0603	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Iron	12,100	60.3	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Lead	12	0.0914	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Manganese	176	0.183	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Molybdenum	0 J	0.0731	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Nickel	6	0.0914	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	EPA 901.1M	Radium-226	32.7	0.321	pCi/g
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Selenium	7	0.329	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Silver	0.35 J	0.1	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Thallium	0.156 J	0.128	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Uranium	25.3	0.0121	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Vanadium	32	0.274	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Zinc	31	0.731	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Aluminum	19,500	44.5	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Antimony	0.336 U	0.336	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Arsenic	5.4	0.331	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Barium	187	0.0978	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Beryllium	0.832	0.0196	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Cadmium	0.114 J	0.0196	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Chromium	14 J	0.196	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Cobalt	8	0.0587	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Copper	11	0.0646	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Iron	24,200	64.6	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Lead	14	0.0978	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Manganese	419	1.96	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Molybdenum	1 J	0.0783	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Nickel	14	0.0978	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	EPA 901.1M	Radium-226	1.33	0.106	pCi/g
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Selenium	1	0.352	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Silver	0.509 UJ	0.509	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Thallium	0.29 J	0.137	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Uranium	1.22	0.0129	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Vanadium	31 J	0.293	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Zinc	51	0.783	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Aluminum	21,300	49.6	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Antimony	0.36 U	0.36	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Arsenic	5.41	0.369	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Barium	201	0.109	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Beryllium	0.9	0.0218	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Cadmium	0.118 J	0.0218	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Chromium	15 J	0.218	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Cobalt	8	0.0654	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Copper	12 J	0.072	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Iron	20,900	72	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Lead	13 J	0.109	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Manganese	345	2.18	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Molybdenum	0 J	0.0873	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Nickel	14 J	0.109	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	EPA 901.1M	Radium-226	1.78	0.135	pCi/g
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Selenium	1	0.393	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Silver	0.545 U	0.545	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Thallium	0.292 J	0.153	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Uranium	1.42	0.0144	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Vanadium	29	0.327	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Zinc	54	0.873	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Aluminum	21,700	46.3	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Antimony	0.327 U	0.327	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Arsenic	6.53	0.344	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Barium	195	0.102	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Beryllium	0.955	0.0204	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Cadmium	0.155 J	0.0204	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Chromium	17 J	0.204	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Cobalt	9	0.0611	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Copper	14	0.0672	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Iron	23,500	67.2	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Lead	16	0.102	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Manganese	309	2.04	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Molybdenum	1 J	0.0815	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Nickel	16	0.102	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	EPA 901.1M	Radium-226	1.33	0.105	pCi/g
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Selenium	2	0.367	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Silver	0.495 UJ	0.495	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Thallium	0.351 J	0.143	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Uranium	1.05	0.0134	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Vanadium	30 J	0.306	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Zinc	63	0.815	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Aluminum	18,800	43.8	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Antimony	0.303 U	0.303	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Arsenic	6.94	0.325	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Barium	108	0.0962	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Beryllium	0.982	0.0192	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Cadmium	0.203	0.0192	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Chromium	14 J	0.192	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Cobalt	8	0.0577	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Copper	15 J	0.0635	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Iron	23,200	63.5	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Lead	17 J	0.0962	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Manganese	277	1.92	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Molybdenum	1 J	0.077	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Nickel	16 J	0.0962	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	EPA 901.1M	Radium-226	4.76	0.167	pCi/g
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Selenium	4	0.346	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Silver	0.459 U	0.459	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Thallium	0.381 J	0.135	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Uranium	18.8	0.0127	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Vanadium	29	0.289	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Zinc	64	0.77	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Aluminum	16,700	46	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Antimony	0.312 U	0.312	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Arsenic	8.03	0.341	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Barium	307	1.01	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Beryllium	0.87	0.0202	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Cadmium	0.0875 J	0.0202	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Chromium	13 J	0.202	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Cobalt	7	0.0606	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Copper	9 J	0.0667	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Iron	21,900	66.7	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Lead	16 J	0.101	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Manganese	314	2.02	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Molybdenum	0 J	0.0808	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Nickel	12 J	0.101	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	EPA 901.1M	Radium-226	2.33	0.1	pCi/g
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Selenium	2	0.364	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Silver	0.473 U	0.473	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Thallium	0.195 J	0.141	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Uranium	3.4	0.0133	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Vanadium	21	0.303	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Zinc	52	0.808	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Aluminum	13,700	43.1	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Antimony	0.324 U	0.324	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Arsenic	5.29	0.32	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Barium	208	0.947	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Beryllium	0.688	0.0189	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Cadmium	0.0895 J	0.0189	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Chromium	10 J	0.189	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Cobalt	5	0.0568	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Copper	7 J	0.0625	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Iron	15,500	62.5	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Lead	11 J	0.0947	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Manganese	265	1.89	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Molybdenum	0 J	0.0757	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Nickel	9 J	0.0947	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	EPA 901.1M	Radium-226	2.87	0.102	pCi/g
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Selenium	1	0.341	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Silver	0.491 U	0.491	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Thallium	0.157 J	0.133	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Uranium	1.78	0.0125	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Vanadium	17	0.284	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Zinc	39	0.757	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Aluminum	18,700	44.6	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Antimony	0.352 U	0.352	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Arsenic	5.78	0.331	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Barium	156	0.098	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Beryllium	0.853	0.0196	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Cadmium	0.132 J	0.0196	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Chromium	14 J	0.196	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Cobalt	7	0.0588	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Copper	12 J	0.0647	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Iron	20,100	64.7	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Lead	14 J	0.098	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Manganese	267	1.96	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Molybdenum	1 J	0.0784	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Nickel	13 J	0.098	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	EPA 901.1M	Radium-226	7.24	0.149	pCi/g
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Selenium	3	0.353	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Silver	0.533 U	0.533	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Thallium	0.276 J	0.137	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Uranium	9.41	0.0129	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Vanadium	27	0.294	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Zinc	52	0.784	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Aluminum	23,800	49	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Antimony	0.356 U	0.356	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Arsenic	7.2	0.364	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Barium	114	0.108	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Beryllium	1.09	0.0215	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Cadmium	0.209 J	0.0215	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Chromium	18 J	0.215	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Cobalt	9	0.0646	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Copper	17 J	0.071	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Iron	26,300	71	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Lead	18 J	0.108	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Manganese	250	2.15	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Molybdenum	1 J	0.0861	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Nickel	17 J	0.108	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	EPA 901.1M	Radium-226	2.15	0.152	pCi/g
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Selenium	2	0.387	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Silver	0.54 U	0.54	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Thallium	0.434	0.151	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Uranium	1.69	0.0142	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Vanadium	34	0.323	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Zinc	71	0.861	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Aluminum	14,900	47.5	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Antimony	0.355 U	0.355	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Arsenic	5.84	0.353	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Barium	137	0.104	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Beryllium	0.765	0.0209	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Cadmium	0.128 J	0.0209	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Chromium	11 J	0.209	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Cobalt	6	0.0627	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Copper	10 J	0.069	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Iron	16,800	69	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Lead	13 J	0.104	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Manganese	219	2.09	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Molybdenum	1 J	0.0836	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Nickel	11 J	0.104	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	EPA 901.1M	Radium-226	27.3	0.221	pCi/g
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Selenium	13	0.376	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Silver	0.537 U	0.537	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Thallium	0.283 J	0.146	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Uranium	32.4	0.0138	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Vanadium	34	0.313	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Zinc	43	0.836	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Aluminum	20,700	51.7	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Antimony	0.357 UJ	0.357	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Arsenic	7.52	0.384	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Barium	96	0.114	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Beryllium	1.03	0.0227	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Cadmium	0.24	0.0227	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Chromium	18	0.227	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Cobalt	9	0.0681	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Copper	17 J	0.0749	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Iron	25,300	74.9	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Lead	19	0.114	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Manganese	234	2.27	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Molybdenum	1 J	0.0908	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Nickel	19	0.114	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	EPA 901.1M	Radium-226	4.76	0.16	pCi/g
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Selenium	3	0.409	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Silver	0.124 J	0.108	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Thallium	0.471	0.159	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Uranium	16 J	0.015	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Vanadium	34	0.341	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Zinc	75	0.908	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Aluminum	19,300	48.2	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Antimony	0.329 UJ	0.329	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Arsenic	7.42	0.358	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Barium	91	0.106	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Beryllium	0.992	0.0212	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Cadmium	0.216	0.0212	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Chromium	16	0.212	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Cobalt	9	0.0636	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Copper	17 J	0.0699	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Iron	24,800	69.9	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Lead	18	0.106	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Manganese	237	2.12	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Molybdenum	1 J	0.0848	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Nickel	18	0.106	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	EPA 901.1M	Radium-226	1.68	0.13	pCi/g
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Selenium	2	0.382	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Silver	0.0996 U	0.0996	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Thallium	0.451	0.148	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Uranium	1.51 J	0.014	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Vanadium	31	0.318	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Zinc	73	0.848	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Aluminum	16,300	42.9	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Antimony	0.365 UJ	0.365	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Arsenic	6.28	0.319	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Barium	110	0.0943	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Beryllium	0.826	0.0189	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Cadmium	0.17 J	0.0189	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Chromium	13	0.189	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Cobalt	7	0.0566	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Copper	13 J	0.0622	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Iron	21,200	66.2	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Lead	14	0.0943	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Manganese	230	1.89	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Molybdenum	1 J	0.0754	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Nickel	13	0.0943	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	EPA 901.1M	Radium-226	1.35	0.101	pCi/g
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Selenium	2	0.339	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Silver	0.111 U	0.111	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Thallium	0.33 J	0.132	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Uranium	1.37 J	0.0124	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Vanadium	28	0.283	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Zinc	57	0.754	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Aluminum	17,500	43.4	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Antimony	0.317 UJ	0.317	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Arsenic	6.98	0.323	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Barium	93	0.0954	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Beryllium	0.907	0.0191	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Cadmium	0.201	0.0191	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Chromium	15	0.191	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Cobalt	8	0.0573	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Copper	15 J	0.063	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Iron	22,100	63	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Lead	16	0.0954	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Manganese	237	1.91	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Molybdenum	1 J	0.0763	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Nickel	15	0.0954	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	EPA 901.1M	Radium-226	1.56	0.127	pCi/g
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Selenium	2	0.344	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Silver	0.161 J	0.0961	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Thallium	0.356 J	0.134	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Uranium	1.47 J	0.0126	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Vanadium	29	0.286	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Zinc	63	0.763	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Aluminum	23,100	50.1	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Antimony	0.358 UJ	0.358	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Arsenic	7.15	0.372	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Barium	118	0.11	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Beryllium	1.05	0.022	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Cadmium	0.214 J	0.022	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Chromium	18	0.22	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Cobalt	8	0.066	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Copper	16 J	0.0726	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Iron	24,800	72.6	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Lead	18	0.11	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Manganese	238	2.2	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Molybdenum	1 J	0.088	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Nickel	17	0.11	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	EPA 901.1M	Radium-226	1.84	0.134	pCi/g
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Selenium	2	0.396	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Silver	0.125 J	0.108	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Thallium	0.447	0.154	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Uranium	1.86 J	0.0145	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Vanadium	35	0.33	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Zinc	74	0.88	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Aluminum	17,500	43.2	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Antimony	0.327 UJ	0.327	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Arsenic	6.61	0.321	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Barium	125	0.0949	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Beryllium	0.878	0.019	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Cadmium	0.213	0.019	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Chromium	13	0.19	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Cobalt	7	0.0569	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Copper	14 J	0.0626	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Iron	21,600	62.6	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Lead	17	0.0949	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Manganese	270	1.9	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Molybdenum	1 J	0.0759	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Nickel	14	0.0949	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	EPA 901.1M	Radium-226	4.85	0.11	pCi/g
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Selenium	3	0.342	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Silver	0.146 J	0.0992	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Thallium	0.352 J	0.133	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Uranium	4.76 J	0.0125	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Vanadium	28	0.285	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Zinc	61	0.759	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Aluminum	9,310	4.47	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Antimony	0.342 UJ	0.342	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Arsenic	3.99	0.332	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Barium	148	0.0982	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Beryllium	0.496	0.0196	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Cadmium	0.136 J	0.0196	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Chromium	8	0.196	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Cobalt	5	0.0589	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Copper	7 J	0.0648	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Iron	13,400	64.8	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Lead	10	0.0982	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Manganese	325	1.96	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Molybdenum	0 J	0.0785	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Nickel	8	0.0982	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	EPA 901.1M	Radium-226	1.08	0.0871	pCi/g
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Selenium	1	0.353	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Silver	0.166 J	0.104	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Thallium	0.142 J	0.137	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Uranium	0.606 J	0.013	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Vanadium	16	0.294	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Zinc	32	0.785	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Aluminum	10,400	4.74	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Antimony	0.301 UJ	0.301	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Arsenic	3.41	0.352	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Barium	140	0.104	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Beryllium	0.511	0.0208	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Cadmium	0.154 J	0.0208	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Chromium	9	0.208	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Cobalt	5	0.0625	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Copper	8 J	0.0687	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Iron	12,200	68.7	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Lead	11	0.104	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Manganese	340	2.08	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Molybdenum	0 J	0.0833	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Nickel	8	0.104	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	EPA 901.1M	Radium-226	1.32	0.0863	pCi/g
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Selenium	1 J	0.375	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Silver	0.179 J	0.0912	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Thallium	0.146 J	0.146	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Uranium	0.802 J	0.0137	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Vanadium	16	0.312	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Zinc	34	0.833	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Aluminum	18,300	48.7	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Antimony	0.331 UJ	0.331	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Arsenic	6.37	0.361	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Barium	300	1.07	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Beryllium	0.816	0.0214	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Cadmium	0.109 J	0.0214	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Chromium	14	0.214	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Cobalt	7	0.0642	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Copper	10 J	0.0706	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Iron	18,700	70.6	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Lead	11	0.107	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Manganese	277	2.14	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Molybdenum	0 J	0.0855	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Nickel	13	0.107	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	EPA 901.1M	Radium-226	1.18	0.0897	pCi/g
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Selenium	1	0.385	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Silver	0.1 U	0.1	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Thallium	0.225 J	0.15	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Uranium	2.21 J	0.0141	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Vanadium	31	0.321	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Zinc	43	0.855	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Aluminum	16,700	45.1	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Antimony	0.328 UJ	0.328	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Arsenic	6.04	0.335	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Barium	285	0.99	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Beryllium	0.762	0.0198	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Cadmium	0.118 J	0.0198	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Chromium	11	0.198	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Cobalt	6	0.0594	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Copper	9 J	0.0654	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Iron	20,300	65.4	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Lead	12	0.099	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Manganese	399	1.98	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Molybdenum	0 J	0.0792	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Nickel	12	0.099	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	EPA 901.1M	Radium-226	2.77	0.156	pCi/g
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Selenium	3	0.356	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Silver	0.238 J	0.0994	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Thallium	0.203 J	0.139	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Uranium	3.93 J	0.0131	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Vanadium	24	0.297	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Zinc	43	0.792	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Aluminum	15,200	47.3	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Antimony	0.311 UJ	0.311	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Arsenic	6.9	0.351	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Barium	283	1.04	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Beryllium	0.772	0.0208	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Cadmium	0.101 J	0.0208	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Chromium	12	0.208	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Cobalt	6	0.0624	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Copper	8 J	0.0686	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Iron	18,200	68.6	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Lead	14	0.104	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Manganese	280	2.08	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Molybdenum	0 J	0.0832	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Nickel	11	0.104	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	EPA 901.1M	Radium-226	1.52	0.1	pCi/g
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Selenium	1	0.374	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Silver	0.123 J	0.0943	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Thallium	0.185 J	0.146	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Uranium	1.11 J	0.0137	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Vanadium	19	0.312	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Zinc	48	0.832	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Aluminum	16,600	46.5	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Antimony	0.326 UJ	0.326	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Arsenic	7.67	0.345	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Barium	289	1.02	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Beryllium	0.833	0.0204	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Cadmium	0.115 J	0.0204	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Chromium	13	0.204	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Cobalt	7	0.0613	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Copper	9 J	0.0674	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Iron	20,300	67.4	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Lead	16	0.102	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Manganese	311	2.04	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Molybdenum	0 J	0.0818	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Nickel	13	0.102	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	EPA 901.1M	Radium-226	1.55	0.112	pCi/g
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Selenium	1	0.368	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Silver	0.135 J	0.0987	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Thallium	0.208 J	0.143	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Uranium	1.26 J	0.0135	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Vanadium	20	0.307	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Zinc	53	0.818	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Aluminum	8,850	4.37	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Antimony	0.299 UJ	0.299	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Arsenic	8.3	0.325	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Barium	155	0.0961	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Beryllium	0.483	0.0192	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Cadmium	0.0484 J	0.0192	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Chromium	8	0.192	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Cobalt	4	0.0577	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Copper	5 J	0.0634	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Iron	15,900	63.4	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Lead	8	0.0961	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Manganese	140	0.192	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Molybdenum	1 J	0.0769	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Nickel	6	0.0961	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	EPA 901.1M	Radium-226	1.61	0.103	pCi/g
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Selenium	1	0.346	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Silver	0.175 J	0.0905	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Thallium	0.147 J	0.135	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Uranium	2.26 J	0.0127	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Vanadium	15	0.288	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Zinc	26	0.769	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Aluminum	12,000	48.1	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Antimony	0.304 UJ	0.304	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Arsenic	8.29	0.357	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Barium	139	0.106	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Beryllium	0.815	0.0211	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Cadmium	0.0505 J	0.0211	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Chromium	10	0.211	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Cobalt	7	0.0634	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Copper	9 J	0.0697	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Iron	19,000	69.7	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Lead	14	0.106	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Manganese	191	0.211	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Molybdenum	0 J	0.0845	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Nickel	11	0.106	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	EPA 901.1M	Radium-226	2.1	0.108	pCi/g

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Selenium	1	0.38	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Silver	0.151 J	0.0921	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Thallium	0.182 J	0.148	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Uranium	1.87 J	0.0139	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Vanadium	14	0.317	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Zinc	49	0.845	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Aluminum	15,300	48	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Antimony	0.338 UJ	0.338	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Arsenic	6.72	0.357	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Barium	306	1.06	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Beryllium	0.737	0.0211	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Cadmium	0.0648 J	0.0211	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Chromium	11	0.211	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Cobalt	7	0.0634	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Copper	8 J	0.0697	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Iron	19,400	69.7	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Lead	14	0.106	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Manganese	313	2.11	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Molybdenum	0 J	0.0845	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Nickel	11	0.106	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	EPA 901.1M	Radium-226	1.59	0.115	pCi/g
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Selenium	1	0.38	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Silver	0.231 J	0.102	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Thallium	0.194 J	0.148	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Uranium	1.36 J	0.0139	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Vanadium	18	0.317	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Zinc	46	0.845	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Aluminum	19,800	43.5	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Antimony	0.329 UJ	0.329	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Arsenic	7.21	0.323	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Barium	187	0.0956	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Beryllium	0.928	0.0191	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Cadmium	0.0661 J	0.0191	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Chromium	15	0.191	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Cobalt	7	0.0573	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Copper	8 J	0.0631	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Iron	20,300	63.1	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Lead	14	0.0956	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Manganese	337	1.91	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Molybdenum	1 J	0.0765	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Nickel	13	0.0956	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	EPA 901.1M	Radium-226	1.19	0.115	pCi/g
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Selenium	1	0.344	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Silver	0.182 J	0.0996	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Thallium	0.21 J	0.134	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Uranium	1.31 J	0.0126	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Vanadium	25	0.287	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Zinc	50	0.765	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Aluminum	16,900	47.6	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Antimony	0.336 UJ	0.336	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Arsenic	7.49	0.354	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Barium	295	1.05	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Beryllium	0.826	0.0209	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Cadmium	0.102 J	0.0209	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Chromium	13	0.209	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Cobalt	7	0.0628	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Copper	9 J	0.0691	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Iron	19,800	69.1	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Lead	15	0.105	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Manganese	294	2.09	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Molybdenum	0 J	0.0837	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Nickel	12	0.105	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	EPA 901.1M	Radium-226	1.19	0.0815	pCi/g
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Selenium	1	0.377	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Silver	0.177 J	0.102	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Thallium	0.202 J	0.146	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Uranium	1.26 J	0.0138	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Vanadium	20	0.314	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Zinc	52	0.837	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Aluminum	9,520	4.39	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Antimony	0.343 JJ	0.294	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Arsenic	5	0.326	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Barium	99	0.0965	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Beryllium	0.616	0.0193	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Cadmium	0.133 J	0.0193	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Chromium	9	0.193	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Cobalt	5	0.0579	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Copper	9 J	0.0637	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Iron	14,800	63.7	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Lead	11	0.0965	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Manganese	190	0.193	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Molybdenum	1 J	0.0772	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Nickel	9	0.0965	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	EPA 901.1M	Radium-226	1.64	0.114	pCi/g
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Selenium	2	0.348	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Silver	0.0891 U	0.0891	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Thallium	0.208 J	0.135	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Uranium	1.53 J	0.0127	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Vanadium	19	0.29	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Zinc	39	0.772	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Aluminum	14,800	42.1	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Antimony	0.326 UJ	0.326	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Arsenic	4.71	0.313	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Barium	112	0.0926	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Beryllium	0.683	0.0185	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Cadmium	0.144 J	0.0185	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Chromium	12	0.185	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Cobalt	6	0.0556	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Copper	11 J	0.0611	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Iron	16,000	61.1	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Lead	13	0.0926	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Manganese	227	1.85	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Molybdenum	1 J	0.0741	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Nickel	10	0.0926	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	EPA 901.1M	Radium-226	1.48	0.144	pCi/g
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Selenium	0.467 J	0.333	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Silver	0.488 J	0.0987	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Thallium	0.242 J	0.13	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Uranium	1.01	0.0122	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Vanadium	25	0.278	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Zinc	43	0.741	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Aluminum	15,600	44	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Antimony	0.326 UJ	0.326	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Arsenic	4.96	0.327	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Barium	272	0.967	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Beryllium	0.777	0.0193	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Cadmium	0.156 J	0.0193	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Chromium	12	0.193	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Cobalt	6	0.058	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Copper	12 J	0.0638	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Iron	17,100	63.8	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Lead	14	0.0967	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Manganese	234	1.93	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Molybdenum	1 J	0.0774	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Nickel	11	0.0967	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	EPA 901.1M	Radium-226	2.99	0.114	pCi/g
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Selenium	1	0.348	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Silver	0.358 J	0.0987	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Thallium	0.282 J	0.135	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Uranium	2.42	0.0128	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Vanadium	28	0.29	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Zinc	48	0.774	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Aluminum	14,800	45.9	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Antimony	0.34 UJ	0.34	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Arsenic	4.41	0.341	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Barium	192	1.01	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Beryllium	0.762	0.0202	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Cadmium	0.16 J	0.0202	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Chromium	11	0.202	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Cobalt	6	0.0606	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Copper	12 J	0.0666	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Iron	15,800	66.6	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Lead	13	0.101	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Manganese	222	2.02	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Molybdenum	1 J	0.0808	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Nickel	9	0.101	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	EPA 901.1M	Radium-226	1.87	0.114	pCi/g
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Selenium	1	0.363	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Silver	0.354 J	0.103	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Thallium	0.243 J	0.141	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Uranium	1.42	0.0133	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Vanadium	26	0.303	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Zinc	46	0.808	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Aluminum	20,400	47.7	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Antimony	0.347 UJ	0.347	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Arsenic	5.87	0.354	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Barium	115	0.105	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Beryllium	0.933	0.021	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Cadmium	0.201 J	0.021	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Chromium	16	0.21	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Cobalt	7	0.0629	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Copper	15 J	0.0692	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Iron	20,600	69.2	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Lead	16	0.105	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Manganese	241	2.1	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Molybdenum	1 J	0.0838	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Nickel	13	0.105	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	EPA 901.1M	Radium-226	1.68	0.145	pCi/g
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Selenium	1 J	0.377	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Silver	0.51 J	0.105	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Thallium	0.352 J	0.147	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Uranium	1.19	0.0138	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Vanadium	34	0.314	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Zinc	59	0.838	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Aluminum	18,100	50.1	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Antimony	0.366 UJ	0.366	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Arsenic	5.75	0.372	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Barium	118	0.11	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Beryllium	0.923	0.022	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Cadmium	0.152 J	0.022	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Chromium	14	0.22	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Cobalt	8	0.0661	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Copper	13 J	0.0727	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Iron	18,800	72.7	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Lead	15	0.11	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Manganese	291	2.2	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Molybdenum	1 J	0.0882	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Nickel	11	0.11	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	EPA 901.1M	Radium-226	5.75	0.177	pCi/g
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Selenium	1	0.397	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Silver	0.453 J	0.111	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Thallium	0.238 J	0.154	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Uranium	7.03	0.0145	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Vanadium	33	0.331	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Zinc	55	0.882	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Aluminum	20,100	46.9	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Antimony	0.347 UJ	0.347	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Arsenic	5.58	0.348	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Barium	134	0.103	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Beryllium	0.943	0.0206	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Cadmium	0.158 J	0.0206	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Chromium	15	0.206	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Cobalt	7	0.0619	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Copper	14 J	0.068	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Iron	18,400	68	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Lead	15	0.103	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Manganese	266	2.06	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Molybdenum	1 J	0.0825	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Nickel	11	0.103	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	EPA 901.1M	Radium-226	4.27	0.19	pCi/g
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Selenium	1 J	0.371	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Silver	0.54	0.105	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Thallium	0.236 J	0.144	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Uranium	23.2	0.0136	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Vanadium	36	0.309	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Zinc	54	0.825	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Aluminum	23,600	48.1	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Antimony	0.339 UJ	0.339	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Arsenic	6.15	0.357	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Barium	165	0.106	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Beryllium	1.15	0.0211	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Cadmium	0.148 J	0.0211	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Chromium	17	0.211	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Cobalt	8	0.0634	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Copper	15 J	0.0697	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Iron	20,300	69.7	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Lead	17	0.106	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Manganese	299	2.11	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Molybdenum	1 J	0.0845	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Nickel	11	0.106	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	EPA 901.1M	Radium-226	4.84	0.203	pCi/g
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Selenium	1	0.38	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Silver	0.542	0.103	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Thallium	0.396 J	0.148	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Uranium	12.4	0.0139	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Vanadium	39	0.317	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Zinc	59	0.845	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Aluminum	15,100	47.4	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Antimony	0.336 UJ	0.336	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Arsenic	4.9	0.352	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Barium	169	0.104	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Beryllium	0.807	0.0208	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Cadmium	0.156 J	0.0208	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Chromium	11	0.208	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Cobalt	6	0.0625	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Copper	12 J	0.0687	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Iron	16,300	68.7	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Lead	14	0.104	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Manganese	237	2.08	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Molybdenum	1 J	0.0833	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Nickel	9	0.104	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	EPA 901.1M	Radium-226	3.51	0.149	pCi/g
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Selenium	1	0.375	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Silver	0.354 J	0.102	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Thallium	0.209 J	0.146	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Uranium	2.78	0.0137	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Vanadium	26	0.312	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Zinc	47	0.833	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Aluminum	8,990	4.24	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Antimony	0.345 UJ	0.345	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Arsenic	4.15	0.315	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Barium	192	0.932	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Beryllium	0.561	0.0186	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Cadmium	0.0873 J	0.0186	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Chromium	7	0.186	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Cobalt	4	0.0559	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Copper	7 J	0.0615	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Iron	11,500	61.5	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Lead	11	0.0932	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Manganese	180	0.186	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Molybdenum	0 J	0.0746	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Nickel	6	0.0932	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	EPA 901.1M	Radium-226	24.3	0.368	pCi/g
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Selenium	4	0.336	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Silver	0.332 J	0.105	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Thallium	0.131 U	0.131	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Uranium	10.3	0.0123	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Vanadium	25	0.28	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Zinc	29	0.746	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Aluminum	12,000	45.3	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Antimony	0.329 UJ	0.329	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Arsenic	4.5	0.337	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Barium	209	0.996	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Beryllium	0.649	0.0199	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Cadmium	0.121 J	0.0199	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Chromium	9	0.199	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Cobalt	5	0.0598	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Copper	8 J	0.0657	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Iron	13,600	65.7	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Lead	11	0.0996	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Manganese	206	1.99	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Molybdenum	0 J	0.0797	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Nickel	7	0.0996	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	EPA 901.1M	Radium-226	1.43	0.108	pCi/g
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Selenium	1 J	0.359	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Silver	0.265 J	0.0996	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Thallium	0.155 J	0.139	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Uranium	0.99	0.0131	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Vanadium	21	0.299	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Zinc	35	0.797	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Aluminum	8,300	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Arsenic	2.5	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Barium	41	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Beryllium	0.36	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Chromium	2	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Cobalt	2	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Copper	3	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Iron	8,700	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Lead	4	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Manganese	76	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Nickel	3	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Selenium	12	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Uranium	-- U	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Vanadium	23	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Zinc	11	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Aluminum	22,000	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Arsenic	5.5	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Barium	81	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Beryllium	0.92	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Chromium	11	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Cobalt	6	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Copper	11	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Iron	24,000	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Lead	7	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Manganese	170	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Nickel	13	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Selenium	3	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Uranium	-- U	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Vanadium	30	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Zinc	50	--	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Aluminum	5,440	4.16	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Antimony	0.326 U	0.326	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Arsenic	2.18	0.309	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Barium	27	0.0914	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Beryllium	0.257	0.0183	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Cadmium	0.0207 J	0.0183	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Chromium	2 J	0.183	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Cobalt	2	0.0549	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Copper	4	0.0603	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Iron	5,190	6.03	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Lead	6	0.0914	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Manganese	73	0.183	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Molybdenum	1 J	0.0731	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Nickel	2	0.0914	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	EPA 901.1M	Radium-226	17.2	0.158	pCi/g
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Selenium	8	0.329	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Silver	0.0989 UJ	0.0989	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Thallium	0.128 U	0.128	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Uranium	47	0.0121	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Vanadium	24 J	0.274	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Zinc	11	0.731	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Aluminum	18,100	51	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Antimony	0.36 U	0.36	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Arsenic	7.86	0.379	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Barium	78	0.112	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Beryllium	0.945	0.0224	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Cadmium	0.295	0.0224	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Chromium	16 J	0.224	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Cobalt	9	0.0672	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Copper	18	0.0739	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Iron	25,700	73.9	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Lead	19	0.112	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Manganese	232	2.24	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Molybdenum	2 J	0.0896	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Nickel	19	0.112	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	EPA 901.1M	Radium-226	1.63	0.0969	pCi/g
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Selenium	2	0.403	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Silver	0.545 UJ	0.545	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Thallium	0.543	0.157	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Uranium	1.28	0.0148	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Vanadium	33 J	0.336	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Zinc	73	0.896	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Aluminum	17,500	45.3	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Antimony	0.364 U	0.364	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Arsenic	7.32	0.337	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Barium	76	0.0997	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Beryllium	0.933	0.0199	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Cadmium	0.282	0.0199	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Chromium	15 J	0.199	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Cobalt	8	0.0598	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Copper	16	0.0658	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Iron	23,600	65.8	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Lead	17	0.0997	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Manganese	208	1.99	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Molybdenum	2 J	0.0797	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Nickel	18	0.0997	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	EPA 901.1M	Radium-226	1.61	0.165	pCi/g
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Selenium	2	0.359	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Silver	0.552 UJ	0.552	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Thallium	0.512	0.14	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Uranium	1.19	0.0132	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Vanadium	31 J	0.299	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Zinc	67	0.797	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Aluminum	27,000	51.9	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Antimony	0.324 U	0.324	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Arsenic	8.95	0.386	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Barium	106	0.114	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Beryllium	1.19	0.0228	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Cadmium	0.333	0.0228	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Chromium	21.7 J	0.228	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Cobalt	10.4	0.0684	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Copper	20	0.0753	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Iron	31,500	75.3	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Lead	22.2	0.114	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Manganese	301	2.28	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Molybdenum	1.86 J	0.0913	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Nickel	22.8	0.114	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	EPA 901.1M	Radium-226	1.65	0.124	pCi/g
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Selenium	2	0.411	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Silver	0.491 UJ	0.491	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Thallium	0.645	0.16	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Uranium	1.61	0.0151	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Vanadium	44 J	0.342	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Zinc	86	0.913	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Aluminum	17,600	51.8	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Antimony	0.396 U	0.396	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Arsenic	6.87	0.385	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Barium	78	0.114	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Beryllium	0.867	0.0228	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Cadmium	0.191 J	0.0228	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Chromium	15 J	0.228	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Cobalt	8	0.0683	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Copper	15	0.0751	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Iron	23,900	75.1	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Lead	17	0.114	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Manganese	208	0.228	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Molybdenum	1 J	0.091	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Nickel	16	0.114	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	EPA 901.1M	Radium-226	2	0.114	pCi/g
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Selenium	2	0.41	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Silver	0.599 UJ	0.599	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Thallium	0.403 J	0.159	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Uranium	1.41	0.015	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Vanadium	27 J	0.341	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Zinc	64	0.91	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Aluminum	22,900	48.9	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Antimony	0.338 U	0.338	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Arsenic	7.4	0.363	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Barium	99	0.107	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Beryllium	0.991	0.0215	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Cadmium	0.236	0.0215	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Chromium	18 J	0.215	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Cobalt	9	0.0645	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Copper	17	0.0709	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Iron	27,000	70.9	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Lead	19	0.107	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Manganese	263	2.15	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Molybdenum	1 J	0.0859	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Nickel	18	0.107	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	EPA 901.1M	Radium-226	2.1	0.133	pCi/g

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Selenium	2	0.387	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Silver	0.512 UJ	0.512	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Thallium	0.483	0.15	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Uranium	2.52	0.0142	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Vanadium	34 J	0.322	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Zinc	72	0.859	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Aluminum	19,800	46.7	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Antimony	0.359 U	0.359	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Arsenic	6.84	0.347	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Barium	96	0.103	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Beryllium	0.89	0.0205	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Cadmium	0.207	0.0205	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Chromium	16 J	0.205	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Cobalt	8	0.0616	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Copper	16	0.0678	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Iron	23,400	67.8	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Lead	18	0.103	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Manganese	234	2.05	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Molybdenum	1 J	0.0821	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Nickel	16	0.103	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	EPA 901.1M	Radium-226	15.6	0.208	pCi/g
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Selenium	5	0.37	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Silver	0.544 UJ	0.544	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Thallium	0.418	0.144	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Uranium	11.6	0.0136	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Vanadium	35 J	0.308	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Zinc	95.6	0.821	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Aluminum	21,100	49.3	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Antimony	0.324 U	0.324	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Arsenic	7.67	0.366	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Barium	116	0.108	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Beryllium	1.01	0.0217	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Cadmium	0.223	0.0217	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Chromium	17 J	0.217	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Cobalt	9	0.065	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Copper	18	0.0715	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Iron	26,200	71.5	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Lead	20	0.108	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Manganese	259	2.17	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Molybdenum	1 J	0.0867	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Nickel	18	0.108	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	EPA 901.1M	Radium-226	14.8	0.144	pCi/g
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Selenium	5	0.39	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Silver	0.49 UJ	0.49	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Thallium	0.44	0.152	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Uranium	8.21	0.0143	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Vanadium	35 J	0.325	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Zinc	73	0.867	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Aluminum	19,500	50	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Antimony	0.361 U	0.361	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Arsenic	7.14	0.371	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Barium	101	0.11	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Beryllium	0.895	0.022	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Cadmium	0.181 J	0.022	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Chromium	16 J	0.22	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Cobalt	9	0.0659	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Copper	17	0.0725	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Iron	25,100	72.5	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Lead	17	0.11	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Manganese	260	2.2	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Molybdenum	1 J	0.0879	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Nickel	17	0.11	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	EPA 901.1M	Radium-226	1.69	0.136	pCi/g
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Selenium	2	0.396	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Silver	0.547 UJ	0.547	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Thallium	0.395 J	0.154	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Uranium	1.33	0.0145	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Vanadium	31 J	0.33	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Zinc	66	0.879	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Aluminum	19,200	50	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Antimony	0.356 U	0.356	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Arsenic	6.89	0.371	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Barium	99	0.11	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Beryllium	0.866	0.022	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Cadmium	0.174 J	0.022	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Chromium	15 J	0.22	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Cobalt	9	0.0659	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Copper	15	0.0725	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Iron	25,100	72.5	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Lead	17	0.11	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Manganese	267	2.2	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Molybdenum	1 J	0.0879	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Nickel	17	0.11	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	EPA 901.1M	Radium-226	1.65	0.101	pCi/g
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Selenium	2	0.396	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Silver	0.539 UJ	0.539	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Thallium	0.376 J	0.154	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Uranium	1.24	0.0145	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Vanadium	29 J	0.33	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Zinc	64	0.879	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Aluminum	9,010	4.39	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Antimony	0.636 J	0.356	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Arsenic	4.58	0.326	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Barium	81	0.0965	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Beryllium	0.498	0.0193	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Cadmium	0.061 J	0.0193	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Chromium	5 J	0.193	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Cobalt	3	0.0579	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Copper	7	0.0637	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Iron	9,060	6.37	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Lead	10	0.0965	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Manganese	194	1.93	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Molybdenum	1 J	0.0772	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Nickel	5	0.0965	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	EPA 901.1M	Radium-226	34.3	0.215	pCi/g
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Selenium	17	0.347	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Silver	0.539 UJ	0.539	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Thallium	0.2 J	0.135	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Uranium	78	0.0127	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Vanadium	30 J	0.289	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Zinc	21	0.772	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Aluminum	18,400	51.5	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Antimony	0.638 J	0.372	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Arsenic	6.83	0.382	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Barium	100	0.113	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Beryllium	0.854	0.0226	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Cadmium	0.17 J	0.0226	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Chromium	15 J	0.226	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Cobalt	8	0.0679	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Copper	15	0.0746	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Iron	23,500	74.6	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Lead	17	0.113	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Manganese	238	2.26	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Molybdenum	1 J	0.0905	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Nickel	16	0.113	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	EPA 901.1M	Radium-226	2.45	0.144	pCi/g
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Selenium	2	0.407	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Silver	0.563 UJ	0.563	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Thallium	0.388 J	0.158	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Uranium	1.57	0.0149	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Vanadium	30 J	0.339	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Zinc	70	0.905	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Aluminum	16,600	49.4	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Antimony	0.371 U	0.371	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Arsenic	6.33	0.367	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Barium	92	0.109	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Beryllium	0.807	0.0217	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Cadmium	0.183 J	0.0217	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Chromium	13 J	0.217	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Cobalt	8	0.0651	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Copper	14	0.0716	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Iron	21,900	71.6	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Lead	16	0.109	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Manganese	235	2.17	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Molybdenum	1 J	0.0868	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Nickel	15	0.109	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	EPA 901.1M	Radium-226	6.98	0.155	pCi/g
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Selenium	11	0.391	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Silver	0.562 UJ	0.562	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Thallium	0.364 J	0.152	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Uranium	6.31	0.0143	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Vanadium	30 J	0.326	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Zinc	58	0.868	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Aluminum	4,650	4.04	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Antimony	0.51 J	0.332	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Arsenic	1.29	0.3	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Barium	63	0.0889	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Beryllium	0.273	0.0178	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Cadmium	0.0224 J	0.0178	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Chromium	1 J	0.178	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Cobalt	1	0.0533	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Copper	3	0.0587	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Iron	4,570	5.87	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Lead	7	0.0889	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Manganese	109	0.178	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Molybdenum	0 UJ	0.0711	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Nickel	1	0.0889	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	EPA 901.1M	Radium-226	14.6	0.148	pCi/g
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Selenium	14	0.32	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Silver	0.101 UJ	0.101	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Thallium	0.124 U	0.124	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Uranium	12.6	0.0117	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Vanadium	17 J	0.267	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Zinc	10	0.711	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Aluminum	19,200	48.5	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Antimony	0.378 J	0.356	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Arsenic	6.83	0.36	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Barium	89	0.107	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Beryllium	0.873	0.0213	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Cadmium	0.179 J	0.0213	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Chromium	16 J	0.213	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Cobalt	8	0.064	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Copper	15	0.0704	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Iron	23,500	70.4	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Lead	17	0.107	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Manganese	224	2.13	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Molybdenum	1 J	0.0853	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Nickel	16	0.107	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	EPA 901.1M	Radium-226	10.9	0.165	pCi/g
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Selenium	9	0.384	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Silver	0.539 UJ	0.539	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Thallium	0.419 J	0.149	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Uranium	25.1	0.0141	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Vanadium	34 J	0.32	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Zinc	62	0.853	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Aluminum	14,300	44.3	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Antimony	0.53 J	0.308	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Arsenic	5.29	0.329	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Barium	131	0.0974	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Beryllium	0.653	0.0195	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Cadmium	0.134 J	0.0195	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Chromium	11 J	0.195	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Cobalt	5	0.0585	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Copper	9	0.0643	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Iron	17,200	64.3	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Lead	12	0.0974	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Manganese	259	1.95	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Molybdenum	0 J	0.078	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Nickel	11	0.0974	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	EPA 901.1M	Radium-226	2.25	0.0847	pCi/g
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Selenium	1	0.351	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Silver	0.467 UJ	0.467	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Thallium	0.21 J	0.136	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Uranium	1.99	0.0129	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Vanadium	25 J	0.292	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Zinc	40	0.78	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Aluminum	19,200	48.4	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Antimony	0.377 U	0.377	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Arsenic	6.49	0.359	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Barium	104	0.106	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Beryllium	0.893	0.0213	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Cadmium	0.175 J	0.0213	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Chromium	15 J	0.213	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Cobalt	7	0.0638	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Copper	15 J	0.0702	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Iron	22,500	70.2	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Lead	16 J	0.106	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Manganese	211	0.213	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Molybdenum	1 J	0.0851	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Nickel	15 J	0.106	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	EPA 901.1M	Radium-226	2.56	0.137	pCi/g
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Selenium	2	0.383	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Silver	0.572 U	0.572	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Thallium	0.378 J	0.149	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Uranium	2.74	0.014	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Vanadium	30	0.319	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Zinc	62	0.851	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Aluminum	18,700	48.3	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Antimony	0.379 U	0.379	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Arsenic	6.97	0.359	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Barium	85	0.106	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Beryllium	0.909	0.0212	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Cadmium	0.231	0.0212	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Chromium	15 J	0.212	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Cobalt	8	0.0637	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Copper	16 J	0.0701	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Iron	23,500	70.1	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Lead	17 J	0.106	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Manganese	209	0.212	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Molybdenum	1 J	0.085	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Nickel	16 J	0.106	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	EPA 901.1M	Radium-226	2.04	0.183	pCi/g
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Selenium	2	0.382	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Silver	0.574 U	0.574	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Thallium	0.433	0.149	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Uranium	1.76	0.014	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Vanadium	30	0.319	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Zinc	65	0.85	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Aluminum	5,030	4.29	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Antimony	0.309 UJ	0.309	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Arsenic	1.71	0.319	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Barium	7	0.0942	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Beryllium	0.285	0.0188	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Cadmium	0.0188 U	0.0188	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Chromium	2	0.188	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Cobalt	3	0.0565	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Copper	3 J	0.0622	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Iron	6,450	6.22	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Lead	4	0.0942	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Manganese	94	0.188	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Molybdenum	0 UJ	0.0754	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Nickel	2	0.0942	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	EPA 901.1M	Radium-226	22.6	0.262	pCi/g
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Selenium	8	0.339	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Silver	0.158 J	0.0936	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Thallium	0.132 U	0.132	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Uranium	11.6	0.0124	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Vanadium	23	0.283	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Zinc	7	0.754	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Aluminum	4,360	4.02	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Antimony	0.327 UJ	0.327	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Arsenic	1.4	0.299	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Barium	6	0.0883	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Beryllium	0.231	0.0177	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Cadmium	0.0177 U	0.0177	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Chromium	2	0.177	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Cobalt	1	0.053	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Copper	2 J	0.0583	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Iron	4,310	5.83	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Lead	6	0.0883	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Manganese	110	0.177	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Molybdenum	0 JJ	0.0707	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Nickel	1	0.0883	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	EPA 901.1M	Radium-226	30.3	0.363	pCi/g
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Selenium	102	3.18	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Silver	0.0991 U	0.0991	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Thallium	0.134 J	0.124	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Uranium	30.2	0.0117	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Vanadium	60	0.265	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Zinc	5	0.707	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Aluminum	9,130	4.54	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Antimony	0.329 UJ	0.329	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Arsenic	4.44	0.337	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Barium	131	0.0998	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Beryllium	0.463	0.02	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Cadmium	0.0301 J	0.02	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Chromium	4	0.2	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Cobalt	3	0.0599	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Copper	5 J	0.0658	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Iron	11,200	65.8	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Lead	13	0.0998	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Manganese	215	2	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Molybdenum	0 J	0.0798	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Nickel	4	0.0998	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	EPA 901.1M	Radium-226	161	0.548	pCi/g
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Selenium	58	0.359	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Silver	0.458 J	0.0998	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Thallium	0.216 J	0.14	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Uranium	251	0.0132	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Vanadium	92	0.299	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Zinc	14	0.798	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Aluminum	9,400	4.48	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Antimony	0.338 UJ	0.338	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Arsenic	4.84	0.333	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Barium	84	0.0985	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Beryllium	0.478	0.0197	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Cadmium	0.0414 J	0.0197	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Chromium	4	0.197	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Cobalt	3 J	0.0591	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Copper	5 J	0.065	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Iron	12,400	66	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Lead	14	0.0985	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Manganese	211	1.97	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Molybdenum	0 J	0.0788	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Nickel	4	0.0985	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	EPA 901.1M	Radium-226	148	0.806	pCi/g
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Selenium	57 J	0.355	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Silver	0.293 J	0.102	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Thallium	0.236 J	0.138	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Uranium	225	0.013	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Vanadium	86 J	0.296	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Zinc	16 J	0.788	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Aluminum	14,000	45.3	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Antimony	0.353 UJ	0.353	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Arsenic	13.8	0.337	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Barium	23	0.0996	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Beryllium	1.08	0.0199	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Cadmium	0.0199 U	0.0199	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Chromium	4	0.199	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Cobalt	2 J	0.0598	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Copper	10 J	0.0657	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Iron	6,350	6.57	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Lead	11	0.0996	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Manganese	61	0.199	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Molybdenum	0 J	0.0797	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Nickel	4	0.0996	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	EPA 901.1M	Radium-226	11.3	0.173	pCi/g
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Selenium	7 J	0.359	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Silver	0.152 J	0.107	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Thallium	0.171 J	0.139	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Uranium	23.4	0.0131	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Vanadium	8 J	0.299	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Zinc	9 J	0.797	mg/kg

- Notes:
 -- Not reported
 bgs Below ground surface
 J Estimated concentration
 JJ Estimated concentration
 MDC Minimum detectable concentration
 MDL Method detection limit
 mg/kg Milligram per kilogram
 pCi/g Picocurie per gram
 U Not detected
 UJ Not detected; detection limit is estimated

APPENDIX D

COST ANALYSIS

Table D-1 – Alternative 2: Consolidation of Mine Waste on Section 32

Cost Estimate Summary				
Site: Section 32/33 Mines		Description: Alternative 2: Consolidate and Cap All Waste at Onsite Repository		
Location: Navajo Nation, New Mexico				
Phase: Feasibility Study (-30% to +50%)				
Base Year: 2023				
Date: June 2023				
Direct Capital Costs				
Description	Quantity	Unit	Unit Cost	Total Cost
Field Overhead and Oversight Costs:				
Field Overhead and Oversight	1	MO	36,715	\$36,700
Mobilization/Demobilization	2	EA	29,077	\$58,200
Travel, Lodging and Per Diem	5	Ea Person per MO	4,995	\$25,000
SUBTOTAL				\$120,000
General Site Work Costs:				
Fence Construction/Repair - Equipment Storage Area	1,000	LF	\$28.24	\$28,200
Clearing and Grubbing	22	AC	\$1,332	\$29,400
Land Surveying	22	AC	\$697	\$15,400
New Access and Haul Road	1	Lump Sum	\$112,270	\$112,300
SUBTOTAL				\$185,300
Earthwork Costs:				
Excavation of Mine Waste (excavate and load onto trucks)	55,093	BCY	\$1.77	\$97,500
Excavation of Mine Waste - Dozer (Assuming 25% of total volume)	18,364	BCY	\$4.41	\$81,000
Site Restoration	22	AC	\$23,807	\$524,800
Erosion and Sediment Control	22	AC-YR	\$735	\$16,200
Dust Control	16	Day	\$5,931	\$94,100
Soil Cap	5,916	CCY	\$34.10	\$201,800
Mirafi 160N/O Orange Nonwoven Fabric	5,916	SY	\$1.81	\$10,700
SUBTOTAL				\$1,026,000
Transportation and Disposal Costs:				
Off-Site Disposal of Contaminated Soil	0	Ton	\$0.00	\$0
SUBTOTAL				\$0
Total Direct Capital Costs (Rounded to Nearest \$1,000)				\$1,331,000
Indirect Capital Costs				
Description	% of Direct Capital Costs			Total Cost
Permitting/Planning/Institutional Controls	4%			\$53,240
Professional/Techician - Project Management	5%			\$66,550
Professional/Techician - Remedial Design	6%			\$79,860
Professional/Techician - Construction Management	6%			\$79,860
Total Indirect Capital Costs (Rounded to Nearest \$1,000)				\$280,000
Total Capital Costs				
Description	% of Total Capital Costs			Total Cost
Subtotal Capital Costs				\$1,611,000
Contingency Allowance	15%			\$241,650
Total Capital Cost (Rounded to Nearest \$1,000)				\$1,853,000
Maintenance Costs				
Description				Total Cost
Annual Maintenance costs include Regrading and Revegetation				
Present Worth of 30 Years Maintenance (Rounded to the Nearest \$1,000)	3.5%			\$391,000
Contingency Allowance	25%			\$97,800
Total Present Worth Maintenance Cost (Rounded to Nearest \$1,000)				\$488,800
Total Cost (Rounded to Nearest \$1,000)				\$2,342,000

Notes:

- x1.25 Expansion Factor Used for all LCY quantities
- x0.9 Compaction Factor Used for all CCY quantities
- X1.5 Expansion Factor Used for Hauling of Building Demolition Waste

AC	Acres	LCY	Loose Cubic Yards
BCY	Bank Cubic Yards	LF	Linear Feet
CCY	Compacted Cubic Yards	MO	Month
CF	Cubic Feet	SY	Square Yards
EA	Each	YR	Year

Table D-1 - Alternative 2: Consolidate and Cap All Waste at Onsite Repository

Project Length Calculation		
Mobilization/Demobilization		
	Total Time (Days)	3.00
Clearing and Grubbing		
	Total Acres	22.04
	Daily Output	4.00
	Total Clearing Time (Days)	5.51
On-Site Excavation and Transport		
	Total On Site Transport (CY)	-
	On-site Transport Daily Output (CY/day/truck)	374
	# of Trucks	20
	Total On-site Transport Time (Days)	-
Soil Cap		
	Total Import (CY)	5,916
	Daily Output (CY/Truck)	1,000
	Total Time (Days)	5.92
Site Restoration		
	Total Area Outside Caps (Acres)	22.04
	Volume per Acre of Imported Borrow (CY/Acre)	807
	Daily Output for Importing Borrow (CY/Day/Dozer)	1,000
	# of Dozers	4.00
	Total Site Restoration Time (days)	4.45
Maintenance		
	Interest Rate (Based on 30 year Average of OMB Circular A-94 rates) (%)	3.5%
	Area of repository cap requiring regrading each year (%)	10%
	Area of repository cap requiring revegetation each year (%)	25%
	Areas not capped of requiring regrading each year (%)	10%
	Areas not capped requiring revegetation each year (%)	25%
	Equipment mobilization cost for annual maintenance (\$)	717
Total Job Duration		
	Working Days (Assume 240 days/year)	19
	Working Months	1.00
	Actual Months	1.50
	Working Years	0.08
	Actual Years	0.12
	Total Job Duration	4 mo

Table D-2 – Alternative 3: Removal, Transportation, and Disposal of Mine Waste at Red Rock Non-RCRA Disposal Facility

Cost Estimate Summary				
Site: Section 32/33 Mines		Description: Alternative 3: Dispose of All Mine Waste Off Site at Red Rock Disposal Facility		
Location: Navajo Nation, New Mexico				
Phase: Feasibility Study (-30% to +50%)				
Base Year: 2023				
Date: June 2023				
Direct Capital Costs				
Description	Quantity	Unit	Unit Cost	Total Cost
Field Overhead and Oversight Costs:				
Field Overhead and Oversight	4	MO	36,715	\$146,900
Mobilization/Demobilization	2	EA	29,077	\$58,200
Travel, Lodging and Per Diem	7	Ea Person per MO	4,995	\$35,000
SUBTOTAL				\$240,000
General Site Work Costs:				
Fence Construction/Repair - Equipment Storage Area	1,000	LF	\$28.24	\$28,200
Clearing and Grubbing	22	AC	\$1,332	\$29,400
Land Surveying	22	AC	\$697	\$15,400
New Access and Haul Road	1	Lump Sum	\$211,218	\$211,200
SUBTOTAL				\$284,200
Earthwork Costs:				
Excavation of Mine Waste (excavate and load onto trucks)	73,458	BCY	\$1.77	\$130,000
Site Restoration	22	AC	\$23,807	\$523,800
Erosion and Sediment Control	22	AC-YR	\$735	\$16,200
Dust Control	10	Day	\$5,931	\$59,000
SUBTOTAL				\$729,000
Transportation and Disposal Costs:				
Hauling to Red Rock Disposal Facility	91,822	LCY	\$10.05	\$922,800
Disposal Contaminated Soil - Red Rock Disposal Facility	91,822	LCY	\$58.00	\$5,325,700
Dust Control	64	Day	\$5,931	\$378,200
SUBTOTAL				\$6,626,700
Total Direct Capital Costs (Rounded to Nearest \$1,000)				\$7,880,000
Indirect Capital Costs				
Description	% of Direct Capital Costs			Total Cost
Permitting/Planning/Institutional Controls	4%			\$102,172
Professional/Technician - Project Management	5%			\$127,715
Professional/Technician - Remedial Design	5%			\$127,715
Professional/Technician - Construction Management.	6%			\$153,258
Total Indirect Capital Costs (Rounded to Nearest \$1,000)				\$511,000
Total Capital Costs				
Description	% of Total Capital Costs			Total Cost
Subtotal Capital Costs				\$8,391,000
Contingency Allowance	15%			\$1,258,650
Total Capital Cost (Rounded to Nearest \$1,000)				\$9,650,000
Maintenance Costs				
Description				Total Cost
Annual Maintenance costs include Regrading and Revegetation				
Present Worth of 10 Years Maintenance (Rounded to the Nearest \$1,000)	3.5%			\$143,000
Contingency Allowance	25%			\$35,800
Total Present Worth Maintenance Cost (Rounded to Nearest \$1,000)				\$179,000
Total Cost (Rounded to Nearest \$1,000)				\$9,829,000

Notes:

x1.25 Expansion Factor Used for all LCY quantities
 x0.9 Compaction Factor Used for all CCY quantities

AC	Acres	LCY	Loose Cubic Yards
BCY	Bank Cubic Yards	LF	Linear Feet
CCY	Compacted Cubic Yards	MO	Month
CF	Cubic Feet	SY	Square Yards
EA	Each	YR	Year

Table D-2 – Alternative 3: Dispose of All Mine Waste Off Site at Red Rock Disposal Facility

Project Length Calculation	
Mobilization/Demobilization	
Total Time (Days)	3.00
Clearing and Grubbing	
Total Acres	22.00
Daily Output	4.00
Total Clearing Time (Days)	5.50
Hauling	
Total Material (CY)	91,822
Daily Output (CY/trip)	15.00
Trip/Day/Truck	4.00
# of Trucks	24.00
Total Time (Days)	63.77
Site Restoration	
Total Area (Acres)	22.04
Volume per Acre of Imported Borrow (CY/Acre)	807
Daily Output for Importing Borrow (CY/Day/Dozer)	1,000
# of Dozers	4.00
Total Site Restoration Time (Days)	4.45
Maintenance	
Interest Rate (Based on 30 year Average of OMB Circular A-94 rates) (%)	7%
Area of repository cap requiring regrading each year (%)	10%
Area of repository cap requiring revegetation each year (%)	25%
Areas not capped of requiring regrading each year (%)	10%
Areas not capped requiring revegetation each year (%)	25%
Equipment mobilization cost for annual maintenance (\$)	717
Total Job Duration	
Working Days (Assume 240 days/year)	77
Working Months	4.00
Actual Months	6.00
Working Years	0.32
Actual Years	0.48
Total Job Duration	3.4 mo

Table D-3 – Alternative 4: Removal, Transportation, and Disposal of Mine Waste at Deer Trail RCRA-Licensed Facility

Cost Estimate Summary				
Site: Section 32/33 Mines		Description: Alternative 4: Dispose of All Mine Waste Off Site at a RCR) C or LLRW Facility		
Location: Navajo Nation, New Mexico				
Phase: Feasibility Study (-30% to +50%)				
Base Year: 2023				
Date: June 2023				
Direct Capital Costs				
Description	Quantity	Unit	Unit Cost	Total Cost
Field Overhead and Oversight Costs:				
Field Overhead and Oversight	11	MO	36,715	\$403,900
Mobilization/Demobilization	4	EA	29,077	\$116,300
Travel, Lodging and Per Diem	7	Ea Person per MO	4,995	\$35,000
SUBTOTAL				\$555,000
General Site Work Costs:				
Fence Construction/Repair - Equipment Storage Area	1,000	LF	\$28.24	\$28,200
Clearing and Grubbing	22	AC	\$1,332	\$29,400
Land Surveying	22	AC	\$697	\$15,400
New Access and Haul Road	1	Lump Sum	\$211,218	\$211,200
SUBTOTAL				\$73,000
Earthwork Costs:				
Excavation of Mine Waste (excavate and load onto trucks)	73,458	BCY	\$1.77	\$130,000
Site Restoration	22	AC	\$23,807	\$523,800
Erosion and Sediment Control	44	AC-YR	\$735	\$32,400
Dust Control	10	Day	\$5,931	\$59,000
SUBTOTAL				\$745,000
Transportation and Disposal Costs:				
Hauling to Deer Trail, CO	91,822	LCY	\$180	\$16,528,000
Disposal Contaminated Soil - Deer Trail, CO	91,822	LCY	\$105	\$9,641,300
Dust Control	191	Day	\$5,931	\$1,134,600
SUBTOTAL				\$27,303,900
Total Direct Capital Costs (Rounded to Nearest \$1,000)				\$28,677,000
Indirect Capital Costs				
Description	% of Direct Capital Costs			Total Cost
Permitting/Planning/Institutional Controls	4%			\$761,428
Professional/Technician - Project Management	5%			\$951,785
Professional/Technician - Remedial Design	5%			\$951,785
Professional/Technician - Construction Management	6%			\$1,142,142
Total Indirect Capital Costs (Rounded to Nearest \$1,000)				\$3,807,000
Total Capital Costs				
Description	% of Total Capital Costs			Total Cost
Subtotal Capital Costs				\$32,484,000
Contingency Allowance	15%			\$4,872,600
Total Capital Cost (Rounded to Nearest \$1,000)				\$37,357,000
Maintenance Costs				
Description				Total Cost
Annual Maintenance costs include Regrading and Revegetation				
Present Worth of 10 Years Maintenance (Rounded to the Nearest \$1,000)	3.5%			\$143,000
Contingency Allowance	25%			\$35,800
Total Present Worth Maintenance Cost (Rounded to Nearest \$1,000)				\$179,000
Total Cost (Rounded to Nearest \$1,000)				\$37,536,000

Notes:

x1.25 Expansion Factor Used for all LCY quantities
 x0.9 Compaction Factor Used for all CCY quantities

AC	Acres	LCY	Loose Cubic Yards
BCY	Bank Cubic Yards	LF	Linear Feet
CCY	Compacted Cubic Yar	MO	Month
CF	Cubic Feet	SY	Square Yards
EA	Each	YR	Year

Table D-3 – Alternative 4: Dispose of All Mine Waste Off Site at a RCRA C or LLRW Facility

Project Length Calculation		
Mobilization/Demobilization		
	Total Time (Days)	3.00
Clearing and Grubbing		
	Total Acres	22.00
	Daily Output	4.00
	Total Clearing Time (Days)	5.50
Hauling		
	Total Off Site Waste (LCY)	91,822
	Daily Output (Trucks loads/day)	20.00
	Truck Capacity (CY/Truck)	24.00
	Total Trucking Time (Days)	191.30
Site Restoration		
	Total Area (Acres)	22.04
	Volume per Acre of Imported Borrow (CY/Acre)	807
	Daily Output for Importing Borrow (CY/Day/Dozer)	1,000
	# of Dozers	4.00
	Total Site Restoration Time (Days)	4.45
Maintenance		
	Interest Rate (Based on 30 year Average of OMB Circular A-94 rates) (%)	7%
	Area of repository cap requiring regrading each year (%)	10%
	Area of repository cap requiring revegetation each year (%)	25%
	Areas not capped of requiring regrading each year (%)	10%
	Areas not capped requiring revegetation each year (%)	25%
	Equipment mobilization cost for annual maintenance (\$)	717
Total Job Duration		
	Working Days (Assume 240 days/year)	205
	Working Months	11
	Actual Months	17
	Working Years	0.85
	Actual Years	1.28
	Total Job Duration	7.9 mo

Unit Cost Breakdown

Cost Item	Cost Source	Unit Cost	Unit	Description
Support Structures				
Trailers	015213200350	\$264.86	Month	Office trailer, furnished, rent per month, 32' x 8', excl. hookups
Storage Boxes	015213201250	\$95.73	Month	Storage boxes, rent per month, 20' x 8'
Field Office Lights/HVAC	015213400160	\$177.57	Month	Field office expense, field office lights & HVAC
Telephone/internet	015213400140	\$95.23	Month	Field office expense, telephone bill; average bill/month, incl. long distance
Portable Toilets	015433406410	\$220.92	Month	Rent toilet portable chemical
Field Office Equipment	015213400100	\$248.99	Month	Field office expense, office equipment rental, average
Field Office Supplies	015213400120	\$98.70	Month	Field office expense, office supplies, average
Trash	Engineering Estimate	\$435.00	Month	No markup
Air Monitoring Equipment Rental CR-1	Vendor Quote	\$1,975.00	Month	1 @ \$1,250/month MultiRAE Pro Pumped 10.6 eV and 1 @ \$725/month SKC Particulate Monitor (Field Environmental Instruments published quote)
Air Monitoring Equipment Rental CR-1E	Vender Quote	\$1,975.00	Month	1 @ \$1,250/month MultiRAE Pro Pumped 10.6 eV and 1 @ \$725/month SKC Particulate Monitor (Field Environmental Instruments published quote)
Rental trucks 4WD	015433407200	\$1,578.00	Month	Rent truck pickup 3/4 ton 4 wheel drive
4WD truck fuel	Engineering Estimate	\$1,792.00	Month	No markup (Weeks x 4 = Months)
Rental cars	Vendor Quote	\$1,505.00	Month	Weeks x 4 = Months
Rental car fuel	Engineering Estimate	\$916.36	Month	No markup (Weeks x 4 = Months)
Submersible Pump (Month)	015433404700	\$520.74	Month	Rent pump submersible electric 2" diam., 120 GPM
Truck Scales (Month)	Engineering Estimate	\$200.00	Month	No markup
Security - Night Watchman	Engineering Estimate	\$20.00	HR	No markup. 432 hrs/ month. Looks like they assumed 6-14 hr shifts and 1-24 hr shift per week for 4 weeks.
Voluntary Alternative Housing	Per EPA direction	\$2,000,000.00	Lump Sum	
Mobilization/Demobilization				
Mobilization/Demobilization of Trailers/Storage Boxes	015436501300	\$284.87	Each	Mobilization or demobilization, delivery charge for equipment, hauled on 3 ton capacity towed trailer. 50 mi. roundtrip.
Temporary Electric Connect/Disconnect	262713102240	\$3,379.81	Each	Meter center, main circuit breaker, rainproof, 1P 3W 120/240 V, 400 A
Large Equipment Mobilization/Demobilization	015436501500	\$872.32	Each	Mobilization or demobilization, delivery charge for equipment, hauled on 40-ton capacity towed trailer. 50 mi. roundtrip.
Small Equipment	015436501400	\$717.03	Each	Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer. 50 mi roundtrip.
Travel, Lodging, and Per Diem				
Travel/Airfare	Engineering Estimate	\$350.00	Month	No markup. Is this an ok estimate? 1.5 trips per month @ \$350
Lodging and Per Diem	CONUS Rate	\$149.00	Day	CONUS rate for Gallup, NM as of 11/2020 (94+54)
Fence Construction/Repair				
Fence Construction/Repair	323113200200	\$28.24	LF	Fence, chain link industrial, galvanized steel, 3 strands barb wire, 2" posts @ 10' OC, 9 ga. wire, 6' high, schedule 40, includes excavation, & concrete
Clearing and Grubbing				
Clear and Grub	311313100300	\$1,331.54	Acre	Selective clearing, brush, light clearing, with dozer, ball and chain, excludes removal offsite
Land Surveying				
Topographical Survey, Average	22113090050	\$697.34	Acre	Topographical surveying, conventional, average
Excavation of Mine Waste				
Excavate, place in stockpile (no utilities)	312316435700	\$1.77	BCY	Excavator, hydraulic, crawler mtd., 1 C.Y. cap. = 100 C.Y./hr. Add 15% for loading into trucks. 800CY/Day
Excavating - Dozer	312316464200	\$4.41	BCY	Dozer, open site, sand and gravel, 200 HP dozer, 150' haul, assuming 25% of waste requiring dozer
General Backfill from Off-Site				
Import Borrow Soil, includes delivery	312323150020 + 312323151800	\$27.54	LCY	Material only, bank run gravel + Delivery charge, minimum 20 tons, 1 hr. round trip, add. B34B Crew. Assume 1.5 tons/cy

Unit Cost Breakdown

Cost Item	Cost Source	Unit Cost	Unit	Description
Place/compact backfill/cover material	312323170020 + 312323235600	\$3.15	LCY	Spread dumped material, no compaction by dozer + Compaction sheepsfoot or wobbly wheel roller, 6" lifts, 2 passes
General Backfill from On-Site				
Excavate, place in stockpile (no utilities)	312316465400	\$5.51	BCY	Excavating, bulk, dozer, open site, bank measure, sand and gravel, 300 HP dozer, 300' haul
Load stockpiles to trucks	312316420200	\$2.71	BCY	Excavator, hydraulic, crawler mtd., 1 C.Y. cap. = 100 C.Y./hr. Add 15% for loading into trucks. 800CY/Day
Off-road truck, 22 cy, 10 MPH, 2 mile cycle	312323205110	\$4.12	LCY	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment. Daily Output 374 LCY/Day
Place/compact backfill/cover material	312323170020 + 312323235600	\$3.15	LCY	Spread dumped material, no compaction by dozer + Compaction sheepsfoot or wobbly wheel roller, 6" lifts, 2 passes
On-Site Transportation				
Off-road truck, 22 cy, 10 MPH, 2 mile cycle	312323205110	\$4.12	LCY	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 22 C.Y. truck, cycle 2 mile, 10 MPH, excludes loading equipment. Daily Output 374 LCY/Day
Place/compact backfill/cover material	312323170020 + 312323235600	\$3.15	LCY	Spread dumped material, no compaction by dozer + Compaction sheepsfoot or wobbly wheel roller, 6" lifts, 2 passes
Site Restoration				
Import Borrow Soil, includes delivery	312323150020 + 312323151800	\$20.49	LCY	Material only, bank run gravel + Delivery charge, minimum 20 tons, 1 hr. round trip, add. B34B Crew. Assume 1.5 tons/cy. 1000 CY/Day
Place/compact vegetative layer	312323170020 + 312323235600	\$3.15	LCY	Spread dumped material, no compaction by dozer + Compaction sheepsfoot or wobbly wheel roller, 6" lifts, 2 passes
Hydroseeding	329219145400	\$56.01	MSF	Seeding athletic fields, seeding utility mix with mulch and fertilizer, 7 lb. per M.S.F., hydro or air seeding
Fine Grading	312213200280	\$0.22	SY	
Rough Grading		\$5,269.30	SF	cost per 100,000 SF
Erosion and Sediment Control				
Silt Fence, Polypropylene, 3-ft High	312514161000	\$2.75	LF	Synthetic erosion control, silt fence, install and remove, 3' high.
Straw waddles	312514160600	\$3.94	LF	Straw in polymeric netting, biodegradable log
Dust Control				
Dust Control, Heavy	312323202510	\$1,976.96	Truck/Day	Crew B59, 1 truck/trailer and 1 driver.
Import and Install Geotextile Fabric				
Mirafi 160N/O Orange Nonwoven Geotextile Fabric	Vender Quote, ACF West Geosynthetics	\$1.81	SY	Import and place Mirafi 160N/O Orange Nonwoven Geotextile Fabric
Hauling of Off-Site Licensed Facility				
Hauling to White Mesa Mill	312323204114	\$60.00	LCY	200 loaded miles x \$5/loaded mi = \$1000 per trip /25 tons per trip = \$40 per ton * 1.5 tons/ cy = \$60/LCY
Hauling to Deer Trail, CO	312323204114	\$180.00	LCY	600 loaded miles x \$5/loaded mi = \$3000 per trip /25 tons per trip = \$120 per ton * 1.5 tons/ cy = \$180/LCY
Hauling to Red Rock Disposal Facility	312323204114	\$10.05	LCY	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 20 C.Y. truck, cycle 50 miles, 50 MPH, excludes loading equipment.
Disposal of Contaminated Soil at Licenced Facility				
Disposal Contaminated Soil - White Mesa Mill	Quote for disposal at White Mesa Mill - March 2020	\$81.00	LCY	Price does not include hauling. \$54/Ton, assume 1.5 tons/CY.
Disposal Contaminated Soil - Deer Trail, CO	Quote for disposal at Deer Trail, CO - September 2020 (includes tax and fees)	\$105.00	LCY	Price does not include hauling. \$70/Ton, assume 1.5 tons/CY.
Disposal Contaminated Soil - Red Rock Disposal Facility	Using same price as Deer Trail	\$82.50	LCY	Assumed price (\$55/ton). Landfill quoted between \$53 and 58/ton.

Unit Cost Breakdown

Cost Item	Cost Source	Unit Cost	Unit	Description
Transport to and Place Material at Off-Site Location				
Hauling	312323204714	\$20.10	LCY	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 20 C.Y. truck, cycle 50 miles, 50 MPH, excludes loading equipment. Actual 100 mile cycle so multiply by 2.
Place/compact backfill/cover material	312323170020 + 312323235600	\$3.15	LCY	Spread dumped material, no compaction by dozer + Compaction sheepsfoot or wobbly wheel roller, 6" lifts, 2 passes
Soil Cap				
Import Borrow Soil, includes delivery	312323150020 + 312323151800	\$27.54	LCY	Material only, bank run gravel + Delivery charge, minimum 20 tons, 1 hr. round trip, add. B34B Crew. Assume 1.5 tons/cy. 130 Ton/Day/Truck
Place/compact borrow	312323170020 + 312323235600	\$3.15	LCY	Spread dumped material, no compaction by dozer + Compaction sheepsfoot or wobbly wheel roller, 6" lifts, 2 passes. 1000 LCY/Day/Truck
Excavation of Off-Site Repository				
Excavate, place in stockpile (no utilities)	312316465400	\$5.51	BCY	Excavating, bulk, dozer, open site, bank measure, sand and gravel, 300 HP dozer, 300' haul
Soil Cap at Off-Site Repository				
Place/compact borrow	312323170020 + 312323235600	\$3.15	LCY	Spread dumped material, no compaction by dozer + Compaction sheepsfoot or wobbly wheel roller, 6" lifts, 2 passes. 1000 LCY/Day/Truck
Fence Maintenance				
Fence Inspection	Engineers Estimate	\$110.00	HR	
Fence Repair	Engineers Estimate	\$2.42	LF	

Notes:

BCY = Bank cubic yard	HDPE = High-density polyethylene	psi = pounds per square inch
CY = Cubic Yard	HP = Horse power	SF = Square feet
ECY = Compacted Cubic Yard	LCY = Loose cubic yard	SY = Square yards
EOH = East of Highway 69	LF = Linear foot	WHO = West of Highway 69
ft = foot	min = minute	MSF = Thousand Square Feet
GCL = Geocomposite clay liner	MPH = Miles per hour	