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ALTERNATIVES ANALYSIS MEMORANDUM (AAM)

TRONOX SETTLEMENT NAVAJO AREA URANIUM MINES
SECTION 10 MINE
MCKINLEY COUNTY, NEW MEXICO

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ABBREVIATIONS AND ACRONYMS

µR/hr	microroentgens per hour
ALSD	Ambrosia Lake Sub-District
ARARs	applicable or relevant and appropriate requirements
ASPECT	Airborne Spectral Photometric Environmental Collection Technology
ASTM	American Society for Testing and Materials International
AUM	abandoned uranium mine
bgs	below ground surface
Bi-214	Bismuth-214
BLM	Bureau of Land Management (of the U.S. Department of the Interior)
BRA	background reference area
BTV	background threshold value
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CO_2e	carbon dioxide equivalent
COC	contaminant of concern
COPC	contaminant of potential concern
COPEC	contaminant of potential ecological concern
cpm	counts per minute
CY	cubic yards
DCGL	Derived Concentration Guideline Level
$DCGL_{emc}$	Derived Concentration Guideline Level – elevated measurement comparison
$DCGL_{W}$	Derived Concentration Guideline Level – wide area
DOD	Department of Defense
DOE	U.S. Department of Energy
DRS	Documented Release Sampling Report
East GSA	East Geographic Sub-Area
Eco-SSL	ecological soil screening level
EE/CA	Engineering Evaluation/Cost Analysis
NMEMNRD	New Mexico Energy, Minerals & Natural Resource Department
EMB	Emergency Management Branch
EPA	United States Environmental Protection Agency
ESL	ecological screening level
ESRI	Environmental Systems Research Institute
GMB	Grants Mineral Belt
GMD	Grants Mining District
GPS	Global Positioning System
GSA	Geographic Sub-Area
HQ	hazard quotient
LANL	Los Alamos National Laboratory

ABBREVIATIONS AND ACRONYMS (CONTINUED)

Marron	Marron and Associates
MARSSIM	Multi-Agency Radiation Site Survey and Investigation Manual
MCA	Multi-Channel Analyzer
mg/kg	milligram per kilogram
MTL	maximum tolerable limit
NA	not applicable
NaI	sodium iodide
NAPL	nonaqueous phase liquid
NAUM	Navajo Area Uranium Mines
NCP	National Contingency Plan
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMEMD	New Mexico Energy and Minerals Department
NMHED	New Mexico Health and Environment Department
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPV	net present value
NRC	Nuclear Regulatory Commission
NRCS	United States Department of Agriculture Natural Resource Conservation Service
NTCRA	Non Time-Critical Removal Action
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
OSRTI	Office of Superfund Remediation and Technology Innovation
OSWER	Office of Solid Waste and Emergency Response
PRP	Potential Responsible Party
pCi/g	picocuries per gram
pCi/l	picocuries per liter
pCi/m^2	picocuries per square meter
PRB	Prevention and Response Branch
PRG	Preliminary Remediation Goal
PUF	polyurethane foam
Ra-226	radium-226
RAML	Rio Algom Mining, LLC
RAO	Removal Action Objective
RCRA	Resource Conservation and Recovery Act
RESRAD	Residual Radiation
RSE	Removal Site Evaluation
RSL	Regional Screening Level
SEMS	Superfund Enterprise Management System

ABBREVIATIONS AND ACRONYMS (CONTINUED)

SHPO	State Historic Preservation Office
SLO	State Land Office
START-3	Superfund Technical Assessment and Response Team
TAL	Target Analyte Metals
TBC	To-Be-Considered
TCRA	Time-Critical Removal Action
TDD	Technical Direction Document
Tl-206	thallium-206
Tl-207	thallium-207
TO	Task Order
UO_2	Uraninite
U.S.	United States
$USiO_4$	Coffinite
USDA	U.S. Department of Agriculture
USGS	United States Geographic Survey
U-235	Uranium-235
U-238	Uranium-238
UTL95-95	95% upper tolerance limit with 95% coverage
UMTRCA	Uranium Mill Tailings Radiation Control Act
VSP	Visual Sampling Plan
WESTON®	Weston Solutions, Inc.
WRCC	Western Regional Climate Center

EXECUTIVE SUMMARY

Weston Solutions, Inc. (WESTON®), the Superfund Technical Assessment and Response Team (START) Contractor (EPA Team), was originally tasked by the U.S. Environmental Protection Agency (EPA) Region 6 Prevention and Response Branch (PRB) under EP-W-06-042, Task Order (TO) Number 0041 (West Geographic Sub-Area [GSA]) to conduct a Removal Site Evaluation (RSE) and an Engineering Evaluation/Cost Analysis (EE/CA) at the Tronox Settlement Navajo Area Uranium Mines (NAUM) Section 10 Mine Site (the Site) located in the Ambrosia Lake Sub-District (ALSD) of the Grants Mining District (GMD), and northwest of San Mateo in McKinley County, New Mexico. The Site was originally included within the West GSA; however, because it has a different owner currently than the West GSA Mines, the Site was later awarded a unique tasking document. The performance period for this task order ended on 22 March 2017. New Technical Direction Document (TDD) No. 0009/Weston-042-17-015 (West Geographic Sub-Area) was issued under the EPA Region 8 Contract No. EP-S8-13-01 on 23 March 2017 to continue RSE activities at the Site. The performance period for this TDD ended on 17 August 2017. New TDD No. 0001/17-044 was issued by the EPA Emergency Management Branch (EMB) under the EPA Region 6 START-4 Contract No. EP-S5-17-02 on 18 August 2017 to continue START activities specifically for the Section 10 Mine Site. The period of performance for this TDD is currently scheduled to end on 14 August 2020.

The activities conducted under the TO and TDDs are associated with abandoned uranium mines (AUMs), including surrounding properties, and are part of an ongoing program to assess and remediate Tronox -elated AUMs within the GMD, specifically those within the ALSD and outside of Navajo lands. A Site Location Map is provided as Figure 1-1. A Site Area Map, provided as Figure 1-2, presents an overview map of the different AUM GSAs in the ALSD and highlights the Section 10 Mine area of interest. The purpose of this EE/CA is to present the available data collected relative to the Site, describe the Removal Action Objectives (RAOs), describe the removal alternatives available to address contamination at the Site to meet the RAOs, and provide an analysis of the alternatives.

Background and Site Description

In November 2014, the United States (U.S.) District Court for the Southern District of New York approved a settlement agreement to resolve fraudulent conveyance claims against Kerr-McGee Corporation and related subsidiaries of Anadarko Petroleum Corporation. Among other provisions, the settlement provides EPA funding for the assessment and cleanup of over fifty (54) Tronox NAUM sites located in EPA Region 6 and EPA Region 9 jurisdictional areas. Twenty-one of the 22 eligible mines are located within the ALSD; the other mine is located in the adjacent Smith Lake Sub-District (SLSD). Of these 21 eligible mines within the ALSD, only 11 surface operational areas are associated with these mines since several of the eligible mines operate through a geographically central main shaft. All of these mining surface operational areas have undergone some form of closure actions and removal of surface features. Some of these mines were operated as "wet mines", where the underground workings were dewatered and the collected mine water was discharged to nearby surface drainage features such as creeks and arroyos. Little environmental data currently exists on the Tronox NAUM Area Mines in general, or specifically, regarding risks to the public health and/or the environment and/or any threat abatement actions that may be necessary.

The EPA Region 6 Tronox NAUM Area comprises approximately 100 square miles within the ALSD in McKinley County, New Mexico. The ALSD is located within the GMD, which is an area of uranium mineralization occurrence approximately 100 miles long and 25 miles wide, encompassing portions of McKinley, Cibola, Sandoval, and Bernalillo counties of New Mexico. The Section 10 Mine Site is located in the ALSD approximately 20 miles north of Grants, Cibola County, New Mexico, and 9 miles northwest of the intersection of New Mexico State Highways 509 and 605 (Figure 1-2).

The Section 10 Mine Site is composed of a former underground uranium mine that is located in Section 10, Township 14 North, Range 10 West of the New Mexico Principal Baseline and Meridian. The Site also includes related surface areas impacted by associated mining operations from the Mine. The Section 10 Mine does not appear to have been a wet mine. Section 10 Mine (Kermac Mine No. 10) drilling began in 1955 by Mid Continent and Dunn Bros, following claims made by Stella Dysart at the ore body's eastern extent at the Dysart #1 Mine. Drilling continued until 1956 when Kerr-McGee (Kermac) obtained control of the property in 1956 and installed a shaft (Holmquist, 1970). The mine went into production in 1957.

Kermac closed the mine in 1959 with plans for lessees Spahr and Allmon to take over operations. Subsequent operations by the lessees closed again in 1962 before control reverted back to Stella Dysart. Homestake-Sapin gained control in 1964 and shipped from protore stockpiles. By 1981, Cobb Nuclear Corporation obtained mining claims over most of the southern half of Section 10, which included the Section 10 Mine.

The Site is currently undeveloped, though livestock grazing occurs in many sections of the Ambrosia Lake Valley. There are currently no residences in the former mining area of the Section 10 Mine Site and it is highly unlikely that the property would be used for residential development due to the remoteness of the area. Cattle ranching is likely to remain the future use of the site. A rancher may be exposed to radiological contaminants through incidental ingestion of soil, external radiation from contaminants, inhalation of fugitive dusts, and consumption of meat.

Section 10 Mine Site circa 1980

<u>Nature and Extent of Contamination</u>

The nature and extent of the contamination was defined through surface gamma scans and subsurface soil sample collection. Based on the results of the risk assessment, the contaminant of concern (COC) for the Section 10 Mine Site is radium-226 (Ra-226). Ra-226 is typically selected as the radionuclide of interest at uranium mine sites for the following reasons: (a) it is found to be a significant contributor of radiological risk to human health, (b) its decay products give off strong gamma radiation that is easy and cost-effective to measure, (c) a cleanup standard is provided in the State of New Mexico's *Joint Guidance for the Cleanup and Reclamation of Existing Uranium*

Mining Operations in New Mexico (NMEMNRD et al, March 2016), and (d) Ra-226 is the radionuclide for which historical cleanup limits have been specified.

The total surface area exceeding the scanning-equivalent action level was established to be 20 acres. The total volume of soil exceeding the action level was determined to be 39,058 cubic yards (CY), consisting of a surface area of approximately 20 acres at a 1 foot depth and a waste stockpile volume of approximately 7,291 CY.

Table ES-1
Removal Volume Estimate
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

	Surface Area		Volume
Zone	**Square Feet**	**Acres**	**Cubic Yards**
1 ft. Excavation Area	857,700	20	31,767
Waste Pile (Aboveground)	NA	NA	7,291
TOTAL	**857,700**	**20**	**39,058**

Removal Action Objectives

The main objective of this removal action is to mitigate actual or potential risks to human health and/or the environment posed by excess radiological on-site contamination, and to the extent feasible, reclaim the entire Site for the projected future land use – livestock grazing. The scope of the response action will be to address excess radiological contamination in soil greater than the action level of 6.8 picocuries per gram (pCi/g) for Ra-226, which is inclusive of the Ra-226 background concentration (1.9 pCi/g), and represents an excess target cancer risk of $1.3x10^{-4}$. The response action is intended to be the final action for the surface and near-surface contaminated soils/debris at the Site and to contribute to any potential remedial actions that may be contemplated for the Site through source control.

Potential Removal Action Alternatives

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

- Alternative 1: No Further Action – included to satisfy the requirements of the National Contingency Plan and to provide a basis for comparison of the remaining alternatives.
- Alternative 2: Excavation and Off-Site Disposal of Contaminated Soils at a Licensed Low-Level Radioactive Waste Facility – assumes that contaminated soils with concentrations of Ra-226 greater than the action level would be excavated and disposed of off-site at a licensed disposal facility permitted to receive the waste. Three potential licensed facilities that are authorized to accept low-level radioactive waste and/or naturally occurring low-level radioactive soil with Ra-226 concentrations ranging from 2 pCi/g to approximately 500 pCi/g were identified within the western United States.
- Alternative 3: Excavation, Consolidation, and Long-Term Management of the Radiologically Contaminated Soils/Debris at a Non-Incised, On-Site Repository – assumes that radiologically contaminated soils/debris with concentrations of Ra-226 greater than the action level would be excavated, consolidated, and managed in perpetuity at a non-commercial, newly created repository located within the site boundary. The repository would include an engineered cover of the consolidated contaminated soils.
- Alternative 4: Capping of Contaminated Soil in Place – assumes that contaminated soils with concentrations of Ra-226 greater than the action level would be capped in place using an engineered cover.

Summary of Comparative Analysis

Alternative 1, No Further Action, does not meet removal action objectives or protectiveness standards and therefore is not effective. Alternative 2, Excavation and Off-Site Disposal of Contaminated Soils at a Licensed Low-Level Radioactive Waste Facility, provides a high level of long-term effectiveness; however, it has a medium level of short-term effectiveness since the waste material would be transported off-site and hauled for long distances, increasing the risk of exposure to the public and the environment. Alternative 3, Excavation, Consolidation and Long-Term Management of the Radiologically Contaminated Soils/Debris at a Non-Incised On-Site Repository, provides a medium level of long-term effectiveness to reduce the risk to humans and the environment, while also providing a high level of short-term effectiveness, since none of the waste material will need to be transported off-site. Administrative feasibility for Alternative 3 is high, since no permits are required for on-site action. Alternative 4, Capping of Contaminated Soil in Place, provides similar levels of short-term and long-term effectiveness as Alternative 3 but medium administrative feasibility.

Although Alternatives 3 and 4 also share medium cost-effectiveness, Alternative 3 is 18% more cost-effective than Alternative 4. Alternative 2 is estimated to have a high capital cost in comparison to Alternatives 3 and 4; therefore, although it is technically feasible, Alternative 2 has a low cost-effectiveness. Implementability of Alternative 3 is considered to be high due to the straightforward nature of the excavation plan, the repository design based on industry standards, and the use of excavated surface soils outside of the contaminated area that can be used for the evapotranspiration cover. The technical implementability of Alternative 4 is considered to be medium due to the straightforward nature of the capping plan. The evapotranspiration cover design is based on industry standards; however, the large volume of cap material would require the designation of a sizable off-site borrow area. The administrative implementability of Alternative 4 would be medium as subsurface contamination is not addressed by Multi-Agency Radiation Site Survey and Investigation Manual (MARSSIM) and would thus require a unique, site-specific compliance plan.

1.0 INTRODUCTION

Weston Solutions, Inc. (WESTON®), the Superfund Technical Assessment and Response Team (START) Contractor (EPA Team), was originally tasked by the U.S. Environmental Protection Agency (EPA) Region 6 Prevention and Response Branch (PRB) under EP-W-06-042, Task Order (TO) Number 0041 (West Geographic Sub-Area [GSA]) to conduct a Removal Site Evaluation (RSE) and an Engineering Evaluation/Cost Analysis (EE/CA) at the Tronox Settlement Navajo Area Uranium Mines (NAUM) Section 10 Mine Site (the Site) located in the Ambrosia Lake Sub-District (ALSD) of the Grants Mining District (GMD), and northwest of San Mateo in McKinley County, New Mexico (Figure 1-1). The Site was originally included within the West GSA; however, because it has a different owner currently than the West GSA Mines, the Site was later awarded a unique tasking document. The performance period for this task order ended on 22 March 2017. New Technical Direction Document (TDD) No. 0009/Weston-042-17-015 (West Geographic Sub-Area) was issued under the EPA Region 8 Contract No. EP-S8-13-01 on 23 March 2017 to continue RSE activities at the Site. The performance period for this TDD ended on 17 August 2017. New TDD No. 0001/17-044 was issued by the EPA Emergency Management Branch (EMB) under the EPA Region 6 START-4 Contract No. EP-S5-17-02 on 18 August 2017 to continue START activities specifically for the Section 10 Mine Site. The period of performance for this TDD is currently scheduled to end on 14 August 2020. The Section 10 Mine-specific TDD is provided in Appendix O. The Superfund Enterprise Management System (SEMS) Identification Number assigned to the Site is NMN000605371. This EE/CA will describe and summarize work performed in support of the RSE and EE/CA field efforts and present alternative removal actions and their evaluation to be completed as part of a Non Time-Critical Removal Action (NTCRA) at the Site.

The activities conducted under the TO and TDDs are associated with abandoned uranium mines (AUMs), including surrounding properties, and are part of an ongoing program to assess and remediate Tronox-related AUMs within the GMD, specifically those within the ALSD and outside of Navajo lands. A Site Area Map, provided as Figure 1-2, presents an overview map of the different AUM GSAs in the ALSD and highlights the Section 10 Mine area of interest.

1.1 PURPOSE AND SCOPE

The purpose of this EE/CA is to present the available data collected relative to the Site, describe the Removal Action Objectives (RAOs), describe the removal alternatives available to address contamination at the Site to meet the RAOs, and provide an analysis of the alternatives. This EE/CA was conducted following the basic methodology outlined in 40 Code of Federal Regulations (CFR) §300.415 and further discussed in the EE/CA guidance (EPA, 1993). The report is compiled in accordance with the guidance and standards established under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and guidance issued by the EPA, specifically *Guidance for Conducting Non Time- Critical Removal Actions* (EPA/540-R-93-057, 1993); and *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA Office of Solid Waste and Emergency Response [OSWER] 9355.0-75; July 2000). The report is divided into seven sections as described below.

- Section 1: Introduction – Provides background information, summarizes the findings of previous investigations and reports, summarizes the nature and extent of contamination, and presents the results of human health and ecological risk assessments.
- Section 2: Removal Action Objectives – Presents the RAOs, identifies the surface area and volumes of contaminated media, and discusses the removal action schedule.
- Section 3: Removal Action Alternatives – Lists applicable or relevant and appropriate requirements (ARARs), and identifies and describes alternatives to address the removal action goals.
- Section 4: Analysis of Alternatives – Provides an individual analysis of the alternatives using EPA evaluation criteria.
- Section 5: Comparative Analysis of Removal Action Alternatives – Comparatively analyzes the removal action alternatives.
- Section 6: Recommended Alternative – Based on comparative analysis, recommends one alternative from the listed removal action alternatives.
- Section 7: References – Lists the references used in the development of this report.

1.2 SITE DESCRIPTION AND BACKGROUND

The EPA Region 6 Tronox NAUM Area comprises approximately 100 square miles within the center of the Ambrosia Lake Sub-District (ALSD) of the Grants Mining District (GMD) in

McKinley County, New Mexico. The following sections provide overviews of the GMD and ALSD before providing a Site-specific description and background of the Section 10 Mine.

1.2.1 Grants Mining District

New Mexico has the second-largest identified uranium ore reserves of any state in the United States after Wyoming (McLemore, 2007). Almost all of its uranium is found in the GMD (formerly and occasionally still referred to by various entities as the Grants Mineral Belt [GMB]), an area of uranium mineralization occurrence approximately 100 miles long and 25 miles wide encompassing portions of McKinley, Cibola, Sandoval, and Bernalillo counties in the northwest part of New Mexico. The GMD includes the Laguna and Marquez geographic sub-districts that are wholly within EPA Region 6 jurisdiction and the ALSD that has shared EPA Region 6 and 9 jurisdiction. A Site Location Map is provided as Figure 1-1.

The GMD (hereafter to mean only those sub-districts wholly within EPA Region 6 jurisdiction or the ALSD-shared jurisdiction areas) is within the Navajo and Datil sections of the Colorado Plateau physiographic province. Characteristic land features include rugged mountains, broad flat valleys, mesas, cuestas, rock terraces, steep escarpments, canyons, lava flows, volcanic cones, buttes, and arroyos (EPA, 1975). The Continental Divide extends through the northwest corner of the GMD. Thus lying east of the Divide, streams and rivers in the GMD eventually flow into the Rio Grande, one of the principal rivers of the western United States that runs through the length of central New Mexico approximately 70 miles east of the center of the GMD. Nearly all of the streams in the GMD are intermittent and flow only during periods of heavy precipitation (same).

The uranium ores in the GMD are found in the northward dipping limestone and sandstones that were tilted as a result of the Zuni Uplift, which produced the Zuni Mountains that lie south and generally parallel to the trend of the mineralized zone (Holmquist, 1970). The majority of the uranium deposits in the GMD are in sandstone formations (McLemore, 2007). The first large sandstone uranium deposit to be discovered in the GMD was found by Anaconda Company in the early 1950’s using aerial prospecting on the Laguna Reservation about 32 miles east of Grants, New Mexico and about 8 miles north of Highway 66. This discovery, the Jackpile deposit, probably influenced other large companies to investigate the Grants area for important deposits of uranium (same).

Upon the commercial discovery of uranium in New Mexico in 1950, the GMD was henceforth the primary focus of uranium extraction and production activities in New Mexico from the 1950s until the late 1990s. Several different companies moved into the region in the 1950s, particularly oil companies. They included Anaconda Company, Phillips Petroleum Company, Rio de Oro Uranium Mines, Inc., Kermac Nuclear Fuels Corporation (a cooperative of Kerr-McGee Oil Industries, Anderson Development Corporation, and Pacific Uranium Mines, Inc.), Homestake Mining Company, Sabre-Pinion Corporation, United Western Minerals Company, J. H. Whitney and Company, White Weld & Co., San Jacinto Petroleum Corporation, Lisbon Uranium Corporation, and Superior Oil Company (McLemore, 2007; TIME, 1957). Five uranium mills, shown on Figure 1-1, operated in the GMD to process the ore into triuranium octoxide (U_3O_8), commonly referred to as “yellowcake”. Four of the mills were in the ALSD and one was located in the Laguna Sub-District.

No uranium ore has been actively mined in the GMD since 1998, although Rio Algom continued to recover uranium dissolved in water from its flooded underground mine workings in Ambrosia Lake until 2002. The Navajo Nation, whose reservation contains much of the known ore deposits, declared a moratorium on uranium mining in 2005 (McLemore, 2007).

The GMD contains 97 legacy uranium mines and five former uranium mill and tailing disposal sites that were active during the Atomic Energy Commission uranium purchase years (1940s-1970) and beyond until the 1990s. Over 52 million tons of uranium ore were extracted from these mines, constituting approximately 68% of the total uranium ore mined in the United States (EPA, 2015a). In the GMD alone, over 300 mining permits were issued by the State of New Mexico on lands consisting of public, tribal, and private property for mine exploration and mining operations. The extraction of uranium-bearing ore occurred through open pits, from underground workings that were extensively connected, and solution mining (same).

The State of New Mexico has specifically identified that the 97 legacy uranium mines require assessment and possible cleanup. The mines had reportable ore production and surface expression post mining (i.e., waste rock piles, vents/shafts, physical remnants, etc.) (same).

The EPA has identified four (4) categories with respect to entities that should be responsible for addressing the legacy mines and operational impacts within the GMD.

- Mines associated with Jackpile National Priorities List (NPL) Site (Laguna Sub-District).
- Mines covered by the Tronox settlement (ALSD).
- Mines with potential responsible parties (PRP).
- Mines without responsible parties (orphans).

Additionally, the Homestake Mining Mill NPL Site is located within the GMD near Milan, New Mexico.

The Jackpile-Paguate mines (Figure 1-1) are located in the Laguna Sub-District on the Pueblo of Laguna. The whole mine area was added to the NPL in December 2013 and will be addressed by the EPA's Remedial Program. As stated previously, the EPA Region 6 Tronox NAUM Area lies within ALSD. A description of the ALSD follows immediately below.

The progress of assessment and cleanup efforts of uranium mines, mills, residential areas, and water supply sources throughout the GMD is tracked by EPA via 5-year plans located on the EPA website at https://www.epa.gov/grants-mining-district/draft-2015-2020-grants-mining-district-five-year-plan.

1.2.2 Ambrosia Lake Sub-District

The ALSD is the largest of the sub-districts within the GMD, comprising approximately 760 square miles and stretching from Interstate Highway 40 to the south, New Mexico state highway 371 from Thoreau to Crownpoint to the west, a line 25 miles north of the Cibola County/ McKinley County border to the north, and the western portion of the Cibola National Forest and approximately 16 miles west of the McKinley County/Sandoval County border to the east (Figure 1-2). As referenced above, federal removal jurisdiction is held jointly within the ALSD by EPA Regions 6 and 9. The western one-third of the ALSD is Navajo Nation (R9) or mixed ownership and the remainder is private land under EPA Region 6 jurisdiction. The eastern half of the ALSD lies almost wholly within the San Mateo Creek Watershed Basin.

Geology and Hydrogeology

The ALSD is located in the southeast corner of the Navajo section of the Colorado Plateau physiographic province. The geology is characterized by elongated domal uplifts, monoclines, and broad structural platforms. The majority of the regional structure formed during late Cretaceous to early the Tertiary period (Hilpert, 1963) and was probably accompanied by east-west directed tension that produced north- and northwest-trending faults and joints (Santos, 1970). Uranium deposits within the ALSD occur at several stratigraphic levels within the Westwater Canyon Member of the Jurassic Morrison Formation.

The following description of the lithology and hydrology of Ambrosia Lake was taken from a 1977 report by the Los Alamos Scientific Laboratory on the geology and hydrology of Ambrosia Lake (Purtymun et al, 1977). The description follows the order of oldest to youngest formation, i.e., rocks of the Permian, Triassic, Jurassic, and Cretaceous periods. Figure 1-3 illustrates the rock formations of the ALSD. Figure 1-4 illustrates the major fault zones of the ALSD.

Rocks of Permian age are the Glorieta Sandstone and the overlying San Andres Limestone. The Glorieta Sandstone is about 16 meters thick and the San Andres Limestone is about 34 meters in thickness.

The rocks of the Triassic period are the Chinle Formation and the overlying Wingate Sandstone. The lower part of the Chinle Formation is a silty sandstone; the middle part is a hard sandstone; and the upper part is siltstone and mudstone. The Chinle Formation is about 443 meters thick. The Wingate Sandstone is a cross-bedded sandstone with a regional thickness of about 18 meters.

Rocks of the Jurassic period overlying the Wingate Sandstone are the San Rafael Group and the Morrison Formation. The San Rafael Group is composed of four members which in ascending order, are the Entrada Sandstone, the Todilto Limestone, the Summerville Formation, and the Bluff Sandstone. The Entrada Sandstone is about 30 to 40 meters thick. The Todilto Limestone thickness ranges from 9 to 13 meters. Overlying the Todilto Formation is the Summerville Formation, a fine-grained sandstone with a thickness of approximately 100 meters. The uppermost member of the San Rafael Group is the Bluff Sandstone, whose thickness ranges from 30 to about 90 meters.

The Morrison Formation, also of the Jurassic period, is composed of three members which, in ascending order, are the Recapture Member, the Westwater Canyon Member and uppermost Brushy Basin Member. The Recapture Member is a siltstone with a thickness from 29 to about 45 meters. The Westwater Canyon Member is a fine- to coarse-grained, poorly sorted sandstone. The sandstone is cross-bedded and locally contains conglomerate lenses as well as clay chert pebbles and inclusions of petrified wood fragments. The Westwater Canyon Member, whose thickness ranges from 44 to about 60 meters, contains extensive deposits of uranium and vanadium ores at several stratigraphic levels. Most of the uranium ores exist in the form of the minerals coffinite ($USiO_4$) and uraninite (UO_2) (Thomson, undated). It also contains trace amounts of molybdenum, iron, and various other metals (Kerr-McGee, undated) and is also the principal aquifer of the ALSD. The uppermost Brushy Basin Member is a mudstone with thicknesses from 29 to 52 meters.

Rocks of the Cretaceous period are, in ascending order, the Dakota Sandstone, Mancos Shale, and Crevasse Canyon Formation. The Dakota Sandstone thickness ranges from 18 to 24 meters and outcrops along the southwestern edge of Ambrosia Lake. The overlying Mancos Shale forms the floor of the Ambrosia Lake Valley and, in places, is covered by a thin veneer of alluvium. The Mancos Shale is a thick lithologic unit composed of calcareous, fissile clay of marine origin. Interbedded with the shale are three sandstone beds, the Tres Hermanos, each generally less than 9 meters thick. The upper surface of the shale is cut away by erosion, with thicknesses ranging from 52 to 158 meters. East of the San Mateo Fault (Figure 1-4), the shale is about 310 meters thick on the downthrown side of the fault. The overlying Crevasse Canyon Formation is composed of shale, claystone, siltstone, minor seams of coal, and tan sandstone. The Formation outcrops in the northeastern part of Ambrosia Lake. Quaternary alluvium occurs along the Arroyo del Puerto and in low areas and depressions in the valley. The alluvium is derived from the Crevasse Canyon Formation and the Mancos Shale and is composed of silts, sands, gravels, and a few cobbles and boulders of sandstone. The alluvium may, in part, be worked by water and, in places, consists of wind-laid sand. The thickness ranges from a veneer to as much as 30 meters.

Overall, the Ambrosia Lake Valley is underlain by sedimentary rocks to depths greater than 1000 meters. These rocks are part of the structural element known as the Chaco Slope, a part of the southern extension of the San Juan Basin. The highlands south of the Chaco Slope, the Zuni uplift, have flexed the sedimentary rocks so that the general regional dip of these units is northward and north-eastward across the Chaco Slope into the San Juan Basin. There is little, if any, structure in the southern part of the Ambrosia Lake Valley except the general dip of the sedimentary beds to the northeast at 1 to 3 degrees. The older rocks (Dakota Sandstone) outcrop on the southwestern edge of the area, while the younger rocks (Crevasse Canyon Formation) outcrop to the northeast. Two closely spaced, north-south trending normal faults in the central part of the area are downthrown to the east. The largest fault, the San Mateo Fault, occurs along the eastern edge of the area and is downthrown to the east about 150 meters.

Major drainage through the Ambrosia Lake Valley is the southeastern trending Arroyo del Puerto that is a tributary of San Mateo Creek. The flow in Arroyo del Puerto is ephemeral but became a perennial stream during the release of water pumped from the uranium mines in the area. The flow extends to San Mateo Creek where it is lost to evaporation and infiltration into the underlying rocks (Purtymun et al, 1977). The gradient on Arroyo del Puerto is low and the arroyo tends to meander; thus, large areas of marsh grasses, sedges, and cattails occur along the channel. Evapotranspiration reduces a large percentage of the flow during the summer months. Stream flow losses into the Mancos Shale are probably quite small; however, losses are greater where the channel is cut on sandstone units of the Mancos Shale or the Dakota Sandstone near the southern border of the area. Minor amounts of recharge to these sandstones occur from stream flow into the arroyo.

The principal aquifers in the GMD are the Glorieta Sandstone and San Andres Limestone of Permian age, the Westwater Canyon Member of the Morrison Formation of the late Jurassic period, the Dakota Sandstone of the Cretaceous period and alluvium and basalt of the Quaternary period (John and West, 1963). The Westwater Canyon Member furnishes most of the water supply in the ALSD. Contamination of regional private wells with uranium mining-related constituents above drinking water standards has been documented (EPA, 2015a). Shallow alluvial aquifers are also contaminated with uranium mining-related constituents (same; NMHED, 1986). Water from the Westwater Canyon Member was pumped out to access the uranium for many mines in the ALSD.

Mining Practices

The following description of mining practices in the ALSD was taken from "An Overview of the Uranium Industry" (NMEMD, 1979) and from "Uranium Mining and Processing" (Kerr-McGee, undated). The uranium mines in the ALSD were conventional underground mines. A diagram of a typical underground uranium mine operated by Kerr-McGee Corporation in the ALSD is provided as Figure 1-5. Mine operations included vertical mine shafts sunk to the appropriate ore depth and a station with ancillary drifts, pockets, trenches, and sumps. Shafts were typically around 15 feet in diameter and concrete-lined, with hoisting compartments through skips to bring ore and waste rock to the surface and for the conveyance of miners and materials. Groundwater flowed to the shaft and down to a collecting sump at the bottom of the shaft where it was pumped to the surface.

Aboveground, the main pad area might include main and auxiliary buildings, a shaft-area pad with a head frame up to 100-feet high, oil and fuel storage, a power facilities area, a concrete batch plant, an ore storage pad, a materials storage yard, and a powder magazine. The main building contained the hoist room, warehouse, maintenance shops, and administrative offices.

Mine development included horizontal drifts driven outward from the shaft and beneath the elevation of the ore zones. The drifts were approximately 9 feet wide by 9 feet high and were supported by rock bolts, wood and/or steel sets. Haulage drifts generally paralleled the long axes of the ore bodies. Short drifts, called crosscuts, were driven as normal to the haulage drift as required to reach the extremities of the ore bodies. As drifts extended further from the shaft, ventilation holes of 36 to 72 inches in diameter were drilled to maintain air quality, typically functioning as exhaust while the main shaft functioned as the fresh air intake. The ore bodies were outlined by longhole drilling, which were probed to determine the location of the ore and to dewater the ore bodies.

Extraction, "stoping", of an ore body began once development was complete. Generally, there were three stoping methods employed: open stopes, room and pillar stopes, and square set stopes. The selection for each ore body depended on the stability of the ground and the size and shape of the ore body. Once mined, drifts were typically backfilled, sometimes with mill tailings to prevent collapse.

Mine water re-circulation, sometimes referred to as in-situ stope leaching or solution mining, was commonly performed to ALSD mines (NMEMD, 1979). The process is described as follows: In the early years of mining, when retreat began from a worked-out area, the roof collapsed, making it difficult to continue ore recovery using traditional techniques. To further increase recovery, mine owners drilled holes to the top of the collapsed zone and sprayed water through these holes onto the low-grade shattered ore. Mine water is slightly alkaline and a small amount of leaching occurs as the water runs through the shattered zone into collection sumps. The enriched water was then pumped to ion exchange plants where the uranium was removed from the water. The water was then returned for further leaching. After a period of time, no further leaching can occur. The shattered zone was then allowed to "sit" until further oxidation of the ore occurred through natural processes, usually about two weeks (same).

Mine-related wastes from the uranium mines commonly consist of low-grade ore of insufficient quality to process economically, overburden (waste rock) that was removed to access high-grade ore, or residuals from mine dewatering activities. Most of the mines in the ALSD conducted extensive dewatering to access ore below the water table. Most effluent from dewatering received little or no treatment before discharge to the ground or surface drainages during the majority of the mine operational period, causing perennial stream flows in major drainages that were otherwise ephemeral. Treatment of pre-discharge mine waters to extract uranium (ion exchange plants) and Ra-226 (settling ponds with bioremediation) was incorporated into most mine operations beginning in the 1970s. Other environmental impacts may have been caused by erosion and leaching of mine waste materials, some of which were deposited into arroyos where they remain today, and by the reported operation of on-site heap-leach and stope-leaching operations.

Additionally, the mine water effluent infiltrated and recharged the shallow alluvium directly or through impoundment infiltration and overflow. From 30 years of mining operations, approximately 80 billion gallons of mine water was extracted from the subsurface and discharged to surface drainages, the majority being discharged into the San Mateo Creek Basin (EPA, 2015a). The effluent discharges may impact regional bedrock drinking water aquifers and shallow alluvial aquifers. These aquifers are accessed by scattered private residences and nearby municipal or community water supply systems. Moreover, extensive dewatering of underground workings during mine operations created a regionally extensive cone of depression into which oxygenated groundwater currently is flowing. The oxygenated groundwater may dissolve and mobilize unmined uranium and associated constituents within the aquifers (same).

Most of the uranium mine sites in the ALSD have undergone some form of surface reclamation, although some mines still have physical hazards such as open adits, vent holes, and shafts, as well as uncontrolled waste rock and ore piles on-site. Some reclamations occurred prior to the New Mexico Mining Act of 1993 and all occurred prior to the promulgation of uranium mine cleanup and reclamation guidelines by the state of New Mexico in 2016, which specifies a limit of 5.0 pCi/g Ra-226, averaged over the first 15 centimeters of soil below the surface, averaged over any area of 100 square meters.

Four uranium mills operated in the ALSD (Figure 1-2). Milling activities occurred at the Phillips Petroleum Mill from 1958 to 1982, at the Homestake Mill from 1957 to 1990, at the Anaconda-Bluewater Mill from 1953 to 1982, and at the Rio Algom Mill from 1958 to 2002 (EPA, 2015a). The Department of Energy (DOE), with Nuclear Regulatory Commission (NRC) oversight, is responsible for long-term surveillance and maintenance duties at the Phillips Petroleum and Anaconda-Bluewater Mills. The NRC, in coordination with the EPA and the New Mexico Environment Department (NMED), currently regulates ongoing remedial activities at the Homestake Mill Superfund site. The NRC also oversees reclamation in coordination with the NMED at the Rio Algom Mill (same).

SEMS Sites in the ALSD

In November 2014, the United States District Court for the Southern District of New York approved a settlement agreement to resolve fraudulent conveyance claims against Kerr-McGee Corporation and related subsidiaries of Anadarko Petroleum Corporation. Settlement proceeds were distributed in January 2015, and the EPA received funding for the assessment and subsequent cleanup of over fifty Tronox NAUM sites located in both EPA Region 6 and EPA Region 9 jurisdictional areas.

Twenty-two legacy uranium mine operations are eligible for Litigation Trust funding in the EPA Region 6 Tronox NAUM. Twenty-one of the 22 eligible mines are located within the ALSD, the other mine is located in the adjacent Smith Lake Sub-District (SLSD). Of the 21 eligible mines within the ALSD, only 11 surface operational areas are associated with these mines due to several of the eligible mines being operated through a geographically central main shaft. All of these mines have undergone some form of closure operations and removal of operational surface features. Some of these mines were operated as "wet mines," where the underground workings were dewatered and the collected mine water discharged to nearby surface drainage features such as creeks and arroyos. Little environmental data currently exists on the Tronox NAUM in general, or specifically, regarding risks to public health, the environment and/or any threat abatement actions that may be necessary. EPA Region 6 has been tasked to obtain the data required to evaluate the risks posed by these legacy mine sites and conduct appropriate risk abatement activities.

The Tronox NAUM Area within the ALSD is divided into two stand-alone mine Sites, the Section 10 and Spencer (U.S. Department of the Interior's Bureau of Land Management [BLM]- led) Mines, and three geographic sub-areas (GSAs), and the East (Sections 35 and 36 Mines), Central (mines east of State Highway 509; Sections 17, 19, 30, and 33 Mines), and West (Sections 22, 24, and 30W Mines) GSAs (Figure 1-2). The Tronox Sections 32 and 33 Mines site is located in the SLSD (note that although the Site is located technically within the ALSD of the GMD, EPA considers it more closely aligned with the SLSD and will therefore be considered within the SLSD for the purposes of this EE/CA report). As more information is gathered about orphan mines and mines with PRPs, further GSAs may be identified.

Land ownership within the Tronox NAUM Area varies predominantly by geographic section; that is, the vast majority of the geographic sections have one land owner. The majority of land in each of the areas referenced above is privately owned, with the East GSA also including lands owned by the State of New Mexico, the Central GSA also including lands owned by the BLM, and the BLM and the Spencer Mine also being located on land owned by the BLM. The Sections 32 and 33 Mines also include land owned by the Navajo Nation. Ownership of the Tronox NAUM Area and surrounding lands is illustrated on Figure 1-6.

In addition to the Tronox sites, other SEMS sites in the ALSD include the Ann Lee Uranium Mine, the John Bully Uranium Mine, the Sandstone Uranium Mine, and the Homestake-New Mexico Partners Uranium Mine (Figure 1-2). The PRP for the Ann Lee, John Bully and the Sandstone mines is United Nuclear, while Homestake Mining Company is the PRP for its namesake mine.

The Section 10 Mine is the subject of this EE/CA; activities associated with the East, Central and West GSAs as well as the Sections 32 and 33 Mines will be reported under separate EE/CAs.

1.2.3 Site Location

The Section 10 Mine Site is located in the ALSD approximately 20 miles north of Grants, Cibola County, New Mexico, and 9 miles northwest of the intersection of New Mexico State Highways 509 and 605 (Figure 1-2). The Site area is shown on the Ambrosia Lake quadrangle United States Geological Survey (USGS) Topographical Map. The Site is composed of a former underground uranium mine that is located in Section 10, Township 14 North, Range 10 West of the New Mexico Principal Baseline and Meridian. The Site also includes related surface areas impacted by associated mining operations from the mine. A Site Layout Map is provided as Figure 1-7.

The Site area lies approximately 7,130 to 7,150 feet in elevation above mean sea level. It is located immediately 1.5 miles east of Pistol Butte and 0.5 miles north of Loma de la Gloria. The Site occurs within the Semiarid Tablelands ecoregion, which is characterized by dry plains, mesas, valleys, and canyons formed from sedimentary rocks.

The Site is accessed through an un-named road west of New Mexico State Highway 509. The road is in generally good condition, but can become very muddy and rutted after rain or snow.

The Site is currently undeveloped, though livestock grazing occurs there. There are currently no residences on the Site and it is unlikely that the property would be used for residential development due to the remoteness of the area.

1.2.4 Operational Status

Section 10 Mine (Kermac Mine No. 10) drilling began in 1955 by Mid Continent and Dunn Bros following claims made by Stella Dysart at the ore body's eastern extent at the Dysart #1 Mine. Drilling continued until 1956 when Kerr-McGee (Kermac) obtained control of the property in 1956 and installed a shaft (Holmquist, 1970).

The Section 10 Mine was reported by Holmquist to be 510-feet deep (Holmquist, 1970) and by Anderson to be 520-feet deep (Anderson, 1981). The Site consists of a tri-compartment, vertical shaft and headframe with an approximately 6-foot high, 36-inch wide vent shaft located 300 feet east-northeast of the shaft. The mine went into production in 1957 and produced uranium ore from a cluster of deposits in the upper sands of the Westwater Canyon Member of the Morrison Formation (Holmquist, 1970). Although, as noted previously, the Westwater Canyon Member furnishes most of the water supply in the ALSD, the Section 10 Westwater Canyon Formation is on the up-dip side on the east side of Ambrosia Lake; therefore, the Section 10 Mine does not appear to have been a wet mine. Relatedly, no evidence was uncovered regarding the presence of an ion exchange plant or settling ponds associated with the Site.

Kermac closed the mine in 1959 with plans for lessees Spahr and Allmon to take over operations. Subsequent operations by the lessees drove an incline below the former bottom mine level and discovered higher grade ore (.23%) than that discovered by Kermac (0.05%). The mine closed again in 1962 before control reverted back to Stella Dysart. Homestake-Sapin gained control in 1964 and shipped from protore stockpiles. A total of 130,767 tons of 0.20% ore was produced (Holmquist, 1970).

By 1981, Cobb Nuclear Corporation obtained mining claims over most of the southern half of Section 10 which included the Section 10 Mine (Anderson, 1981). Plans were made to reopen the mine if market conditions became favorable but operations have not resumed as of the date of this report. A June 2017 investigation of the Section 10 Mine as part of the RSE determined that the total shaft has been altered to an approximate 291-foot depth either due to mine shaft collapse, backfill, or other unknown activities. See section 1.4.2.5 for additional details about the June 2017 investigation.

For the Section 10 Mine, EPA was unable to determine precise locations where mine ore was staged prior to milling. Ore from the mines was milled at the Rio Algom Uranium Mill (Figure 1-2).

1.2.5 Structures, Topography, and Vegetation

The Section 10 Mine site has not undergone reclamation (i.e., under the New Mexico Mining Act of 1993, whose release standard reads, "*the permit area will be reclaimed to a condition that allows for re-establishment of a self-containing ecosystem appropriate for the life of the surrounding areas following closure unless conflicting with the approved post-mining land use*"). The buildings and all aboveground structures except the head frame have been removed, but the shaft remains open. The open mine shaft is surrounded by a chain-link fence. Other features remaining at the site include concrete slabs, piles of material presumed to be sub-economic ore (waste pile), metal debris, two cattle ponds, and a vent hole with a 36-inch diameter steel casing (Figure 1-7). The vent hole is covered with a steel plate that is not attached to the casing.

The Section 10 Mine Site occupies approximately 70 acres and lies approximately 6,920 to 7,200 feet in elevation above mean sea level. It is located east of Little Haystack Mountain and southwest of San Mateo Mesa. The site area occurs within the Semiarid Tablelands ecoregion, which is characterized by dry plains, mesas, valleys, and canyons formed from sedimentary rocks. It supports arid and semi-arid grasslands, shrub/scrub zones, savannas, and woodlands. A detailed description of site vegetation is presented in *The Natural Resources Evaluation* (January 2017) performed by Marron and Associates (Marron) and is provided as Appendix A. The Natural Resources Evaluation was conducted during the time that the Section 10 Mine Site was part of the West GSA; therefore, the Evaluation covers the entirety of the West GSA and is not specific to just the Site.

As discussed by Marron, the Site is located within primarily Desert Grassland and Great Basin Desert Scrub vegetation communities. The grassland community most closely resembles the Plains-Mesa Grassland community in structural components. In total, 104 species representing 34 families of vascular plants were identified on the West GSA Site, representing seven distinct natural plant communities: Plains Mesa Grassland, Shrubby Grassland, Great Basin Desert Scrub, Juniper Savannah, Coniferous Woodland, Arroyo Riparian, and Disclimax. Specific to Section 10, Plains-Mesa Grassland is the largest plant community, supported over 40% absolute vegetation cover, and was heavily dominated by blue grama (*Bouteloua gracilis*) and galleta (*Pleurapis jamesii*). Great Basin Scrub communities, dominated by rabbitbrush, blue gramma, and galleta, and the Arroyo Riparian community, consisting of vegetation within waterway channels and dominated by rabbitbrush and western wheat grass, also occur within Section 10.

1.2.6 Geology, Hydrogeology, and Soils

The geology and hydrology of Section 10 was covered previously in Section 1.2.2 ALSD; however, there is no surface expression of the Permian or Triassic periods formations in Section

10 and mining activities were not conducted in these formations. A geologic map of the mine vicinity is provided as Figure 1-8.

Soils at the study area consist of the following U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS 2016) map units listed by highest percent occurrence in the study area: Sparank-San Mateo-Zia complex, 0-to-3% slopes (soil unit: 230); Marianolake-Skyvillage complex, 1-to-8% slopes (soil unit: 210); Uranium Mined Lands (Soil unit 265); and the Querencia-Lavodnas association, 2-to-15% slopes. The study area soils are expected to be comprised of sandy loam and silty clay loam surface textures, according to NRCS mapping. They are generally well drained, not hydric, or slightly hydric, moderately susceptible to wind and water erosion, and occur more than 200 centimeters from groundwater depth. For additional details about Site soils, refer to Appendix A Natural Resources Evaluation Report. A Site Soils Map is provided as Figure 1-9.

1.2.7 Hydrologic Setting

The Site is within the San Mateo Creek local watershed and in the Rio San Jose 8-digit Hydrologic Unit Code 13020207, which occurs in the larger Middle Rio Grande drainage basin. Surface water drainage flow from the Section 10 Mine occurs to the north through sheet flow to Martin Draw (Figure 1-10). Martin Draw flows generally to the southeast into the Arroyo del Puerto. The Arroyo del Puerto flows into San Mateo Creek approximately 9 miles south-southeast of the Site. Martin Draw, the Arroyo del Puerto, and San Mateo Creek are intermittent streams in the vicinity of the Mines.

1.2.8 Surrounding Land Use and Population

McKinley County, New Mexico has a total land area of approximately 5,455 square miles and a population of 71,492 (2010 US Census; American Fact Finder, factfinder2.census.gov). The closest community to the Site is San Mateo (Cibola County), which has a population of 161. The Census Tracts immediately surrounding the Site (Census Tract 9440 and 9460) have populations of 2,186 and 5,677 persons, respectively, with the majority of the population occurring on the Navajo Nation.

There are currently no residences located on or near the Site. The nearest residences are located in Section 18 of T14N, R9W, approximately 3 miles east-southeast of the Site, and in Section 34 of T14N, R10W, approximately 3.7 miles south of the Site.

Many sections of the Ambrosia Lake Valley are used for livestock grazing and cattle were noted in Section 10. Hunting activities are popular in the area. Although public access to the Site is moderately restricted through perimeter barbed wire fencing and locked gates, trespass hunting activities are possible. It is presumed that hunting likely occurs on the Site, both with and without permission.

1.2.9 Historical/Cultural Resources

In consideration of future corrective actions at the Site, a cultural resources survey was conducted to meet the requirements of Section 106 of the National Historic Preservation Act. A team of archaeologists conducted the survey over the Site between 10 October 2016 and 03 November 2016. The Cultural Resources Survey Report is provided as Appendix B. The survey included all areas that were shown to be contaminated above the action level (discussed in Section 2.2.1), plus an additional 50-foot buffer zone around the contaminated area.

The Cultural Resource Survey Report has been submitted to the State Historic Preservation Office (SHPO) and the Trust Archeologist in the State Land Office (SLO) for review. EPA will also extend an invitation for consultation to the Tribes that have identified an interest to the NM SHPO in potential consultation on federal undertakings in McKinley County, New Mexico. Any further actions required by the SHPO, the SLO, or from tribal consultation will be considered during final alternative selection and included in final alternative design. A Cultural Resources Protection Plan will be developed prior to the initiation of removal activities and will include protections for historical/cultural resources documented during the survey, as applicable. The plan will include mitigation requirements determined by the stakeholders, including the SHPO and Tribes. Removal activities will be scheduled to provide adequate time to institute the mitigation activities to avoid any disturbance to the Sites visually identified until clearance is provided to the EPA.

1.2.10 Sensitive Ecosystems and Wildlife

As mentioned in Section 1.2.3, a natural resource survey was performed to identify protected species and general wildlife habitat, and general vegetation and vegetative community types for the Site area (Appendix A). Information gained during the survey was used during the completion of an Ecological Risk Assessment (Section 1.5.3). Marron conducted the survey within the Site boundary in September 2016 and October 2016. The Evaluation was conducted during the time that the Section 10 Mine Site was part of the West GSA; therefore, the Evaluation covers the entirety of the West GSA and is not specific to just the Site. The Site boundary, as outlined in Section 2.3, was adjusted to include the extent of contamination based on the action level discussed in Section 2.2.1.

At least 36 bird species and 11 mammal species, or signs of them, were either observed at the West GSA site. Five reptiles were observed at the site. No amphibians were observed, but at least two were expected. No designated or proposed critical habitat occurs within the site.

Overall, birds were not present in abundance, though it is expected that many more species would be present during the spring migration and breeding season. A possible reason for the low number of birds was lack of vertical structure, as there is hardly any vegetation present above knee height. Common bird species included scaled quail, roadrunner, horned larks, vesper sparrow, western meadowlark, chipping sparrow, Brewer’s sparrow, wintering white-crowned sparrow, dark-eyed junco, loggerhead shrike, golden eagle, northern harrier, western burrowing owl, American kestrel, and prairie falcon. Red-tailed hawks were not observed but are most likely present on the Site. The American kestrel, prairie falcon, and northern harrier are likely flyovers, as no suitable nesting habitat for these species is present on Site.

Several big game and common wildlife species or their signs were observed including elk, mule deer, mountain lion, and coyote. Neither bobcat, gray fox, nor their signs were observed but are expected to be present on the Site. Burrowing mammals, such as the banner-tailed kangaroo rat, Gunnerson’s prairie dog, Ord’s kangaroo rat, Botta’s pocket gopher, cottontail rabbit, and the black-tailed jackrabbit, or their signs, were observed on Site. Burrowing wildlife would be affected adversely to varying degrees by the removal of vegetation and a 1-foot layer of soil during a removal action.

Six species of reptiles were observed during the Evaluation. Most common were the plateau striped whiptail and the southwestern lizard. There were no amphibians present during the survey.

An Environmental Protection Plan will be developed prior to the initiation of removal activities and will identify sensitive ecological habitats and species documented during the survey. Removal activities may be scheduled to avoid certain critical periods of the year such as nesting or breeding seasons. The areas of concern will be visually identified to avoid any disturbance until clearance is provided to the EPA.

1.2.11 Regional Climate

Climate at the Site can be described as semi-arid although the mountainous terrain results in a large variation of temperature and precipitation. Monthly climate data is available for the period from 1 April 1918 to 29 February 1988 from a meteorological data station (#297918) at San Mateo, New Mexico. Winter temperatures range from 16 ˚F to 63 ˚F, averaging 49 ˚F during the day. Summer temperatures range between 31 ˚F to 83 ˚F (Western Regional Climate Center [WRCC], 2015), averaging 75 ˚F during the day.

There is considerable variation in monthly precipitation totals although most of the precipitation in the Site area occurs during late summer thunderstorms. Monthly precipitation generally varies between 0.28 inches (February) and 2.11 inches (August), with an annual average of 8.66 inches (WRCC, 2015).

1.3 PREVIOUS REMOVAL ACTIONS

No SEMS removal actions have previously been performed at the Site. EPA has been unable to find any record of reclamation activity at the Site pursuant to the Mining Act Reclamation Program under the New Mexico Mining Act of 1993.

1.4 NATURE AND EXTENT OF SOIL CONTAMINATION

The nature and extent of the contamination was defined through surface gamma scans and surface and subsurface soil sample collection as described in Sections 1.4.2.2 and 1.4.2.3. Based on the results of the risk assessment (Section 1.5), the COC for the Section 10 Mine Site is Ra-226.

1.4.1 Previous Investigations

A Pre-assessment Screen and Determination: Rio Algom Mines and Quivira Mill Site, McKinley County, New Mexico, was performed by the New Mexico Office of Natural Resources Trustee in September 2010. This report documents the pathways by which natural resources have been adversely affected by a release from various Rio Algom Mining LLC (RAML) mines and mills in McKinley County, including the Section 10 Mine (New Mexico Office of Natural Resources Trustee, 2010).

In 2011, as part of the EPA San Mateo Creek Basin assessment activities, the EPA Airborne Spectral Photometric Environmental Collection Technology (ASPECT) platform (airplane) conducted an aerial gamma screening survey of the ALSD, including the Section 10 Mine Site (Dynamac, 2011). The ASPECT survey indicated high levels of gamma radiation, ranging to greater than 45 micro roentgens per hour (μR/hr) (with a terrestrial background between 5 to 10 μR/h) at the Site. Results of the survey indicated that wastes from these mines have migrated off-site and onto adjacent properties (Figure 1-11).

The EPA Region 6 EMB conducted a Documented Release Sampling Report (DRS) at the Section 10 Mine Site on 26 February 2013 that included collecting surface gamma radiation measurements in addition to conducting sampling and performing chemical/radiological analyses of surface soil. The specific sampling objectives for the DRS were to collect data that could be used to document a potential release of hazardous substances to the environment and that may potentially warrant further site investigation and/or reclamation. Based on the results of the DRS sampling event, soil contamination attributable to the Site was documented. (Weston, 2013).

1.4.2 Current Investigations

EPA initiated an RSE of the Site, including the development of a background reference area (BRA), completion of surface gamma surveys, collection of subsurface soil samples, and completion of a subsurface geophysical investigation. The RSE determined the nature and extent of contamination above an action level. The following sections describe the activities included in each stage of the investigation. As discussed previously in Section 1.2.3, Section 1.2.4, Section 1.2.7, and Section 1.2.8, a natural resource evaluation and a cultural resource survey of the Site were also performed.

1.4.2.1 Background Reference Area Study

In order to provide a point of reference by which Site conditions can be compared to “pre-mining” conditions, a background radiation level was established by the EPA. Site cleanup levels are typically established as concentrations in excess of background levels that have been characterized in carefully selected BRAs. Selection criteria for the BRA are provided in Section 4.5 of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) and include absence of contamination, and similarity in physical, chemical, geological, radiological, and biological characteristics to the contaminated areas being evaluated.

Several areas were evaluated for the Section 10 Mine to meet the MARSSIM guidelines. Gamma scans were conducted in several locations to identify a potential BRA. Ultimately, an area up-gradient of the Section 10 Mine with no known impact from mining activities (i.e., haul roads, stockpiles, etc.) within Section 10 of Township 14 North, Range 10 West was selected (approximately 2,500 feet southwest of the Section 10 Mine surface expression; see Figure 1-12). The identified BRA exhibits similar physical, chemical, geological, radiological and biological characteristics as the Site.

A square area of approximately 0.75 acres was selected within Section 10 to represent the BRA. One-minute, stationary gamma measurements using a 2-inch by 2-inch sodium iodide (NaI) detector were collected from 20 evenly-spaced points within a rectangular-shaped grid in the BRA. The starting point for the grid was randomly generated. Soil samples were co-located with the stationary gamma measurements and submitted to Eberline Services, Inc. in Oak Ridge, Tennessee, for gamma spectroscopy analysis.

EPA conducted radiation toxicity modeling using two different models that considered contribution to human health impacts from all of the isotopes in the Uranium-238 (U-238) and Uranium-235 (U-235) decay chains. Ra-226, a daughter product in the U-238 decay chain, was determined to be the COC (see Section 2.2.1) for which a background value was calculated.

Statistical analysis of the background data set was performed using ProUCL 5.1 (EPA, 2015b). The average (mean) concentration for Ra-226 in the 20 samples is 1.52 pCi/g, the median is 1.545 pCi/g (indicating lack of skewness), and the standard deviation is 0.146 pCi/g. The coefficient of variation was 0.0963, indicating a homogeneous background data set in accordance with MARSSIM guidance. A goodness-of-fit test indicated that the data set was normally distributed as well as gamma and log normally distributed. However, the normal distribution was selected as the most appropriate model. Dixon's outlier test did not identify any outliers. A histogram, box plot, and quantile-quantile plot were generated and visual inspection indicated a well-behaving data set without outliers that confirmed a normal distribution. Finally, a background threshold value (BTV) was calculated at a 95% upper tolerance limit with 95% coverage (UTL95-95), equaling 1.87 pCi/g Ra-226. This BTV represents the upper limit of the background data set such that 95% of background values are less than 1.87 pCi/g with 95% confidence. The UTL95-95 was selected as an appropriate and defensible BTV as recommended by EPA's *ProUCL Version 5.1, User Guide, Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations*, EPA/600/R-07/041, October 2015 to reduce decision errors.

The average (mean) of the 20 1-minute gamma measurements is 16,258 cpm, the median is 16,335 cpm (again, indicating lack of skewness), and the standard deviation is 313 cpm. Again using ProUCL, a normal distribution was confirmed and a UTL95-95 of 17,009 cpm was calculated as the BTV. A summary of background laboratory analytical results and field measurements is provided in Table 1-1. The Eberline Analytical Services, Inc. Analytical Data Package is provided as Appendix C. The background ProUCL statistical results are provided as Appendix D.

1.4.2.2 Surface Gamma Survey

As part of the RSE, the EPA determined the lateral extent of surface contamination at the Site by conducting a gamma scanning survey in June 2016 using the following three basic data recording techniques that all used a 2-inch by 2-inch NaI detector paired with a GPS.

- Areas with fairly level topography and little vegetative obstructions were surveyed using an array of five detectors mounted on a utility terrain vehicle, which was driven in transects across the properties.
- Areas with some topographical relief and vegetative obstructions were surveyed using a single detector mounted on a cart that was pushed in transects across the properties.
- Areas not conducive to using wheeled vehicles were surveyed using a single detector and backpack-mounted GPS unit carried by site personnel over transects in a walkover survey.

The distance between transects varied depending on whether the area being scanned was clearly contaminated, not contaminated, or at the border of contamination and non-contamination based on initial gamma measurements. Initial transects were approximately 200-feet apart until these distinctions became apparent. Areas at the borders of contamination and non-contamination received the most tightly spaced transects, ranging approximately 20-to-30 feet apart. Non-contaminated and contaminated areas received successively less tightly spaced transects, respectively. Maximum distances between transects in clearly contaminated areas ranged from approximately 150 to 200 feet; distances between transects in non-contaminated areas were approximately 100 feet. The survey was conducted throughout approximately 75% of the section to verify that there was no spread of contamination in a non-contiguous manner by undocumented mining activities.

The results of the gamma scanning survey were plotted in counts per minute (cpm) on a map using color-coded icons to represent the detector measurements (Figure 1-12). Measurements were displayed in six ranges of values, two of which were relative to the BTV and the action level. Derivation of the action level in pCi/g and its conversion to cpm is described in detail in Section 2.2.1. The figure reflects areas below the BTV, areas of contamination above the BTV but below the action level, and areas above the action level. The maximum surface gamma measurement was 575,483 cpm, approximately 34 times the BTV and 24 times the action level.

The results of the gamma scanning survey were then plotted similarly on a second map in pCi/g using color-coded icons to represent the converted measurements (Figure 1-13). Scan values greater than the BTV were converted to pCi/g similarly to the conversion of the action level in pCi/g to cpm as described in Section 2.2.1.

1.4.2.3 Soil Sample Collection

Soil samples were collected and analyzed by gamma spectroscopy to confirm the gamma survey measurements and to estimate the depth of radiological contamination. Soil samples were also collected and analyzed for Target Analyte List (TAL) Metals plus uranium to determine if these constituents posed a threat to human health and the environment.

EPA collected surface soil samples in Section 10 from June 2016 through February 2017 to verify that radioactive contamination existed in areas of elevated gamma survey measurements. Ten surface soil grab samples were collected and analyzed via gamma spectroscopy, including two samples upgradient of the mine, one sample downgradient of the mine, and seven samples from the sub-economic ore pile. Sample locations are shown on Figure 1-14.

To determine vertical extent of radiological contamination, subsurface soil grab samples were collected in November 2016. Sample locations were distributed throughout the surface-contaminated areas using the Visual Sample Plan (VSP) program (Pacific Northwest National Laboratory, Version 7.7). The samples were collected at a density of one sample for each 2 acres. The samples were collected by digging a 1-foot-deep hole, and collecting a sample from the bottom of the hole using a bucket auger. A total of 11 subsurface samples including one duplicate, were collected for gamma spectroscopy analysis. The sample locations are provided on Figure 1-15.

The soil samples were dried, ground/pulverized as necessary, and sieved, then analyzed in EPA's field laboratory using gamma spectroscopy with an on-site Multi-Channel Analyzer (MCA) for Ra-226. The MCA measured the gamma radiation emitted by Bismuth-214 (Bi-214) rather than Ra-226, since Ra-226 does emit a strong gamma signal. Samples were held in a sealed Marinelli jar for a minimum of 21 days to ensure that the Bi-214 and Ra-226 were in equilibrium before being analyzed on the MCA. Seventeen samples were analyzed in the EPA field laboratory and four were also submitted to Eberline Services, Inc. in Oak Ridge, Tennessee, for gamma spectroscopy analysis, as verification of the on-site MCA results. The Eberline Analytical Services, Inc. Analytical Data Package is provided as Appendix C.

Two surface soil grab samples collected upgradient of the mine and one surface soil grab sample collected downgradient were all below the action level of 6.8 pCi/g Ra-226 (See Section 2.2.1 for derivation of action level). Seven grab surface soil samples collected from the sub-economic ore pile were all above the action level. All 10 subsurface soil samples and one field duplicate were below the Action Level. Surface soil sample results were used in the human health and ecological risk assessments (Section 1.5) and subsurface soil samples were used to determine an estimated removal volume after an action level was developed for the Site (see Section 2.2.1).

Additionally, the EPA Team collected eight surface soil samples plus one duplicate for analysis of Target Analyte List (TAL) Metals plus uranium (chemical toxicity). Samples were submitted to Hall Environmental Analysis Laboratory in Albuquerque, New Mexico for analysis. The surface soil sample locations are shown on Figure 1-14. The metals analytical results were also used in the human health and ecological risk assessments (Section 1.5). The Hall Laboratory analytical data package is provided as Appendix E. All eight soil sample results plus one field duplicate for TAL metals plus uranium were below the New Mexico Environment Department (NMED) Industrial/Occupational Soil Screening Levels (Cancer Target Risk [TR]=1E-05, Non-Cancer Total Hazard Quotient [THQ]=1) (NMED, 2019). The soil sample analytical results for gamma spectroscopy are provided in Tables 1-2 and 1-3. The metals analytical results are provided in Table 1-4.

1.4.2.4 Radon Monitoring

In order to ensure EPA worker health during RSE activities, the EPA collected seven radon samples from within and near enclosed spaces (i.e. the mineshaft and a ventilation shaft) to determine potential hazards to people working near the shafts. From 28 October 2016 through 3 November 2016, EPA collected two short-term (6-day) radon samples from inside of the mine shaft. Both samples were lowered into the shaft on string. One sample was collected 50 feet below ground surface (bgs) and one sample was collected 100 feet bgs.

From 29 June 2017 through 5 July of 2017, EPA collected short-term radon samples from aboveground near the mine and ventilation shafts. One sample was collected on the ground at the very edge of the mine shaft and two samples were collected from approximately 5 feet and 20 feet from the mine shaft. At the ventilation shaft, EPA collected one sample from the partially-opened ventilation shaft and one from 20 feet from the ventilation shaft. Samples were submitted to Accustar Laboratory in Medway, Massachusetts, for analysis. The radon sample locations are shown on Figure 1-16.

The two samples collected from inside of the mine shaft at depths of 50 feet and 100 feet were both significantly above the 4 pCi/l level recommended for indoor exposure (6,304.9 and 8,170.5 pCi/l, respectively) by EPA. Samples collected from the edge of the mine shaft and the ventilation shaft were both above 4 pCi/l (11.1 and 1,247.9 pCi/l, respectively). Samples collected 5 feet and 20 feet from the edge of the mine shaft and from 20 feet from the edge of the ventilation shaft were all below 4 pCi/l. Results of the radon samples are presented in Table 1-5. The Accustar Laboratory analytical report is provided in Appendix F.

1.4.2.5 Mine Shaft Investigation

On 18 July 2017, the EPA Team subcontracted a well-logging company to investigate the Section 10 Mine shaft and the ventilation shaft. The well-loggers lowered a camera into the mine shaft and reached "fill material" (soil) at 291 feet bgs. No side tunnels were noted at any point. The mine was reported to be over 500 feet deep (Holmquist, 1970, and Anderson, 1981), which suggests that either the mine was partially filled intentionally or there was collapse of materials from the walls of the shaft.

The camera was lowered into the ventilation shaft and reached fill material at 351 feet bgs. The vent casing appeared to continue into the fill material, suggesting that the vent hole casing continued even deeper. The mine shaft and vent hole video surveillance logging report is presented as Appendix G.

1.4.2.6 Reclamation Plan

A post-remedial reclamation plan will be developed for implementation upon completion of remedial activities. The reclamation plan will be comprised of two parts, natural regrading and revegetation.

Natural Regrading

Post-remedial natural regrading will seek to return the topography of the site to a pre-disturbed (pre-mining) natural state. The regrading will provide erosion-resistant slopes and stream channels, with an aim toward minimizing long-term operation and maintenance costs.

Currently the surface water drainage features on-site consist of sheet flow from the Section 10 Mine northward to Martin Draw (Figure 1-10). Martin Draw flows generally to the southeast into the Arroyo del Puerto. The Arroyo del Puerto flows into San Mateo Creek approximately 9 miles south-southeast of the Site. Martin Draw, the Arroyo del Puerto, and San Mateo Creek are intermittent streams.

Conceptual Revegetation Plan

Based on the results of the site-specific natural resource evaluation (Appendix A) and the associated soil and vegetation sample analytical results, Marron developed a draft conceptual revegetation plan for the Site assuming removal actions would be implemented (Appendix H). A final revegetation plan will be developed by reviewing and updating the conceptual plan with actual post-removal conditions before revegetation implementation. The assumed objectives considered in developing the conceptual revegetation plan were grazing capacity, suitability for wildlife use, and ecosystem sustainability. The conceptual revegetation plan was developed to comply with the standards of:

- NMED and NMEMNRD *Joint Guidance for Cleanup and Reclamation of Existing Uranium Mining Operations in New Mexico*, March 2016 (Attachments 1 and 2).
- New Mexico State Land Office Reclamation Plan for State Mineral Lease Rule 5 Template (7-14-15).

As described in the plan, the Site was divided into two reclamation units for planting purposes:

- Unit 1 – Plains Mesa Grassland (Loamy Soils)
- Unit 2 – Great Basin Scrub/Rabbitbrush (Clay Loam Soils)

Units 1 and 2 would be grassland and scrub communities to provide habitat for keystone species such as prairie dogs and associated animals such as burrowing owl. They also provide browse and forage for elk and deer, graze for cattle, cover for a variety of small mammals and reptiles, and nesting sites for small songbirds. All vegetation provides erosion control. Grasses provide a food source for mammals and insects. Insects provide a food source for reptiles, mammals, and birds.

Potential enhancements to maximize water availability to vegetation, wildlife, or livestock, as well as prevent seedbed loss and sedimentation due to sheet flow during large storm events, were included in the revegetation plan. Post-remedial regrade discussed above may render these enhancements unnecessary. A final determination will be made to include or exclude these enhancements based on post-remedial conditions.

The conceptual revegetation plan details the proper times of the year for specific activities to minimize the disturbance to wildlife and to maximize the potential for plants to become established. The plan also specifies soil amendments and nutrients to prepare the soil for reseeding, specific seed mixes to be used in each unit, mulching, and watering schedules.

1.5 HUMAN HEALTH AND ECOLOGICAL RISK EVALUATION

Risk assessments were performed to evaluate the potential impacts of site-derived contaminants on human health and the environment in the event that no cleanup action is taken. Results of the human health and ecological risk assessments were used to determine whether residual levels of contaminants in site media are protective of human health and the environment and may be left in their current state, or if a cleanup action should be considered. Calculations and methodology used in performing the human health and ecological risk assessments are described in Appendix I.

1.5.1 Screening to Identify Contaminants of Potential Concern

Analytical results of soil samples collected during the RSE at the Site served as input data for the human health and ecological risk assessments (Weston, 2019). These samples were analyzed for radioisotopes via gamma spectroscopy, and some samples were also analyzed for TAL Metals. The metals analysis was performed to assess the actual or potential risk from sub-economic or proto-ore, which was brought to surface during the mining operations but was not sent to the mill for further processing. The analytical results used in the risk evaluations are summarized in Appendix I, Tables I-1 and I-2. All of the metals sampling results were screened against the EPA (2019a) Regional Screening Levels (RSLs) (https://semspub.epa.gov/work/03/2229055.pdf)) and the local background concentrations to determine the contaminants of potential concern (COPCs). Table I-2 summarizes the metals data screening process, showing contaminants that were considered, the minimum and maximum concentrations detected, associated RSLs, and background concentrations. It either identifies each contaminant as a COPC or explains why it was screened from consideration. Aluminum, cobalt, iron, and manganese exceeded RSLs but did not exceed background levels. Arsenic, selenium, uranium, and vanadium were identified as non-radionuclide COPCs. All isotopes of the U-235 and U-238 decay chains were carried through a risk assessment to determine if they should be identified as COCs to be addressed in a cleanup action.

1.5.2 Human Health Risk Assessment

Cancer is the major effect of concern from radionuclides. The potential excess lifetime cancer risk on human receptors from exposure to radium in soil was assessed for the Section 10 Mine Site. Radionuclides in the soil may be absorbed by plants and consumed by livestock and humans.

Persons working at the Site may be exposed to contaminated dust by inhalation of particulate matter. Whole body (external) radiation may be experienced by people on or near the Site itself.

The Site is currently undeveloped, though livestock grazing is common in the area. There are currently no residences in the former mining area of the Section 10 Mine Site and it is highly unlikely that the property would be used for residential development due to the remoteness of the area. Cattle ranching is considered to remain the likely future use of the Site. A rancher may be exposed to radiological contaminants through incidental ingestion of soil, external radiation from contaminants, inhalation of fugitive dusts, and consumption of meat, and to non-radiological contaminants through incidental ingestion of soil, dermal absorption of soil contaminants, inhalation of fugitive dusts, and consumption of meat.

1.5.2.1 Human Health Risk Assessment Assumptions

The current and future use of the Site is cattle ranching. Risk estimates based on a ranching land-use scenario were calculated for isotopes in the U-235 and U-238 decay chains (calculated from measured Ra-226 concentrations in soil). Again, the ranching land-use scenario considers routes of exposure from radioisotopes to be soil incidental ingestion, external radiation from contaminants in soil, inhalation of fugitive dust, and consumption of site-grown beef. Note that a radon inhalation pathway for outdoor radon is not addressed (as opposed to *indoor* radon, which is) in EPA's guidance on conducting radiological risk assessments at CERCLA sites (EPA, 2014). An EPA review of radon data collected at uranium mine and mill sites in the vicinity of the Site verified that clean-air dilution of radon emissions from those sites rapidly reduces the airborne concentrations to inconsequential levels (less than the EPA recommended limit for indoor concentrations of 4 pCi/l) (RAML, 2016).

The risk characterization considered all isotopes of the U-235 and U-238 decay chains defined by the EPA Preliminary Remediation Goal (PRG) Calculator for Radionuclides (EPA, 2019b). The risk assessment identified Ra-226 as the most significant radiological human health COPC. Radium-226 is typically selected as the radionuclide of interest at uranium mine sites for the following reasons: (a) it is found to be a significant contributor of radiological risk to human health, (b) its decay products give off strong gamma radiation that is easy and cost-effective to measure, (c) a cleanup standard is provided in the State of New Mexico's *Joint Guidance for the Cleanup* *and Reclamation of Existing Uranium Mining Operations in New Mexico* (NMEMNRD et al, March 2016), and (d) Ra-226 is the radionuclide for which historical cleanup limits have been specified.

The risk characterization also considered cancer risk estimates and non-cancer hazard quotients (HQs) for non-radionuclide COPCs. Additional human health risk assumptions and details about the risk assessment process are presented in Appendix I.

1.5.2.2 Human Health Risk Estimates

The PRG Calculator was used to calculate risk estimates for a rancher potentially exposed to radionuclides in soil, applying maximum and average (mean) Ra-226 concentrations to assess the range of potential risk. EPA manages risk to achieve 10^{-6} to 10^{-4} overall excess cancer risks. As shown in Table I-1 (Appendix I), the current total cancer risk for isotopes of the U-235 and U-238 decay chains for the Section 10 Mine Site area exceeds the 10^{-4} excess cancer risk level. These results indicate the need for a response action to control releases and prevent radionuclide exposure. Note that these risk estimates also include contribution of background levels as calculated from the Ra-226 BTV of 1.9 pCi/g (Appendix I, Table I-1).

The RSL Calculator was used to develop the non-radionuclide risk estimates for the outdoor ranching activities (Appendix I, Table I-3). There is potential for noncancer health effects from exposure to uranium. Additionally, arsenic yielded a potential cancer risk of 1E-05. The elevated non-radionuclide concentrations in soil were located in close proximity to the elevated radionuclides. It is anticipated that site actions to address radionuclide exposure by human receptors will be protective for exposure of human receptors to both radionuclides and non-radionuclide chemicals.

1.5.3 Ecological Risk Evaluation

The Section 10 Mine Site is located in a remote area with the revegetated, previously disturbed mine area potentially providing habitat for ecological receptors. Wildlife inhabiting the Site may directly ingest radionuclides and chemicals, which may then be transported to organs or other sites within the wildlife receptors. Radionuclides and chemicals in the soil may be absorbed by plants consumed by wildlife. Radionuclides such as uranium and daughter progeny including radium may be inhaled on dust particles, creating alpha-particle-emitting sources in the lungs of wildlife receptors. A screening level ecological risk assessment (i.e., Steps 1 and 2 of the EPA's 8-step ecological risk assessment process [EPA, 1997]) was performed to assess potential risk to ecological receptors from both radionuclide and non-radionuclide chemical contaminants. The results of the screening level ecological risk characterization are included in Appendix I, Table I-4 (radionuclides) and Table I-5 (metals). A refinement of conservative screening level assumptions (i.e., Step 3a of the EPA's 8-step ecological risk assessment process [EPA, 2001]) was also performed to consider how the risk estimates would change if more realistic assumptions were used. The results of the refined ecological risk characterization are included in Appendix I, Table I-6. The process and conclusions are described below.

1.5.3.1 Ecological Risk-Based Screening Values

Literature-based ecological screening benchmark values for direct contact and food-chain evaluations are used to characterize potential ecological effects. The following sources were used to identify proposed ecological screening benchmark values for radionuclides and non-radionuclide chemicals:

- EPA Ecological Soil Screening Levels (Eco-SSLs) (http://www.epa.gov/ecotox/ecossl)
- Los Alamos National Laboratory (LANL) ECORISK database, Release 4.1 (LANL, 2017).

The Eco-SSLs include values for plant, soil invertebrate, bird, and mammal exposure to metals through direct contact and the food chain. The Eco-SSLs are based on no-effect toxicity values to (1) ensure risks are not underestimated and (2) provide a defensible conclusion that negligible ecological risk exists or that certain contaminants and exposure pathways can be eliminated from consideration (EPA, 1997).

The LANL ECORISK database includes ecological screening levels (ESLs) for avian, mammalian, earthworm, and plant exposure models for radionuclides and non-radionuclide chemicals in soil. The LANL ECORISK database provides both no-effect and low-effect ESLs. The no-effect ESL is protective of wildlife populations and sensitive individuals because it represents an exposure that is not associated with adverse impacts of low-level, long-term chemical effects (i.e., adverse effects on ability of individuals to develop into viable organisms, search for mates, breed successfully, and produce live and equally viable offspring). The low-effect ESL applies a lowest-observed-adverse-effect-level-based toxicity reference value that is the lowest chronic effect level and is generally considered to be protective of wildlife populations (LANL, 2017).

1.5.3.2 Ecological Risk Estimates

Screening level risk characterization was performed using the hazard quotient (HQ) method to compare maximum soil concentrations to Eco-SSLs and no-effect ESLs. An HQ of less than one indicates that the concentration is unlikely to cause adverse ecological effects. An HQ greater than one indicates that the potential for ecological risk is present and therefore the risk assessment process should continue (EPA, 2005). The screening process considered the isotopes of the U-235 and U-238 decay chains, though ESLs were not available for all isotopes. The screening-level ecological risk assessment indicates potential for risk to ecological receptors from Ra-226, Th-230, aluminum, arsenic, barium, lead, mercury, selenium, uranium, and vanadium (Table I-4 for radionuclides and Table I-5 for metals, Appendix I). Concentrations of aluminum, barium, and lead were below background levels (Table I-4, Appendix I); therefore, these three metals were not considered to be contaminants of potential ecological concern (COPEC).

A screening-level ecological risk assessment uses conservative screening-level assumptions such as 100% site use, 100% bioavailability, 100% diet consisting of the most contaminated dietary media, and no-effect toxicity data to evaluate risk to populations of upper level organisms. Under more realistic site use conditions, the potential risk to individual organisms would be reduced. The representative average soil concentration and low-effect ecological screening values were used to refine these risk estimates. The refined ecological risk assessment indicates potential for risk to ecological receptors from exposure to Ra-226 (soil invertebrates only), selenium, and vanadium (Appendix I, Table I-6).

Locations where elevated levels of selenium and vanadium were measured are co-located with locations of elevated Ra-226. ESLs for radionuclides are higher (less stringent) than the proposed action level for protection of human health. Thus, it is anticipated that site actions to address radionuclide exposure by human receptors will be protective for exposure of ecological receptors to both radionuclides and non-radionuclide chemicals.

1.5.4 Evaluation of Grazing of Forage by Domesticated Animals and Wildlife

EPA collected 22 vegetative metals uptake samples within the entire West GSA in order to determine the current vegetative nutrient values and uptake of potential hazardous constituents available to grazing animals (domesticated animals and wildlife). Two of the native plant vegetation samples (P-11 and P-12) were collected from the Section 10 Mine. Tissue samples were analyzed for nutrients (iron, zinc, copper, and manganese) and for toxicity metals (molybdenum, uranium, vanadium, and selenium).

The results of the evaluation of the vegetative metals uptake samples are included in Table I-7 and sample locations are illustrated on Figure 1-17. Tissue concentrations were compared to maximum tolerable limits (MTLs) developed by the National Research Council's Committee on Minerals and Toxic Substances in Diets and Water for Animals (National Research Council, 2005). The MTL is defined as "the dietary level that, when fed for a defined period of time, will not impair animal health or performance." Tissue concentrations are also compared to concentrations of trace elements in mature leaf tissue that are considered sufficient or normal and excessive or toxic (Kabata-Pendias and Pendias, 1992). As shown in Table I-7, nutrient concentrations are less than MTLs for animals and within or less than sufficient/normal concentrations for plants, while the P12 tissue sample for the toxic metal selenium exceeds thresholds for animals and plants. An elevated selenium concentration (81 milligram per kilogram [mg/kg]) was measured in soil collected from an area approximately northwest of the Kermac Mine where the P12 tissue sample was collected. While selenium is a common micronutrient supplement for cattle and sheep, it can be toxic at elevated concentrations. Native selenium has been found in the sandstone formations in the GMB area (Brookins, 1982) and as an impurity, it may have been a waste metal in the uranium mine wastes.

2.0 REMOVAL ACTION OBJECTIVES

The first step in developing removal alternatives is to establish RAOs. These objectives are typically based on COPCs, ARARs, and the findings of the human health and ecological risk assessments. General response actions describing measures that will satisfy the RAOs are then developed. This includes estimating the areas or volumes to which the response actions may be applied.

The main objective of this removal action is to mitigate the actual or potential risks to human health and or the environment posed by the excess radiological on-site contamination, and to the extent feasible, reclaim the entire Site for the expected future land use – livestock grazing. Removal action alternatives will address mine wastes and surface soils/debris that were contaminated by mine wastes as part of mine operations. The risk posed by potential contaminant migration to groundwater will be addressed by the EPA Region 6 Remedial section as part of a San Mateo Creek Basin groundwater investigation; however, proposed actions are consistent with and will contribute to any contemplated future remedial actions regarding groundwater through source control by greatly reducing or eliminating the potential for contaminants to migrate from the surface to groundwater. Removal action alternatives also do not address any potential contamination from mill tailings directly, though indirect address may occur.

As stated in Section 1.5.2, there are currently no residences in the Section 10 Mine area of ALSD. Due to the remoteness of the area, it is unlikely that the property will be used for residential development after the radioactive contamination is removed from the soil. Many sections of the Ambrosia Lake Valley are used for livestock grazing, although some sections are not currently grazed due to the current radioactive contamination in the surface soil. Consequently, it is more likely that the property will continue to be used for grazing than converted to future residential use.

2.1 STATUTORY LIMIT

Pursuant to Section 104(c)(1), CERCLA places statutory limits of 2 million dollars and 12 months on Fund-financed removal actions. The statutory limits do not apply to this action since the selected action will be funded by proceeds of settlement from an enforcement action and not by the Fund.

2.2 REMOVAL ACTION SCOPE

The scope of the response action will be to address excess radiological contamination in surface and subsurface soils/debris and is intended to be the final action for the soils at the Site. Options to be analyzed include response actions that would allow unrestricted/uncontrolled grazing use and associated ranching activities. Characterization of the Site identified the primary environmental concern to be radiological contamination.

2.2.1 Action Level

In June 2014, EPA issued OSWER 9285.6-20, *Radiation Risk Assessment at CERCLA Sites: Q&A* (EPA, 2014). According to this guidance, risks from radionuclide exposures at CERCLA sites should be estimated in a manner analogous to that used for chemical contaminants. The estimates of intake values for parameters associated with site-specific routes of exposure estimated for the land use should be coupled with the appropriate slope factors for each radionuclide and exposure pathway. The guidance further recommends the use of EPA's on-line PRG Calculator for this assessment. When calculating radiological threat abatement levels, the total incremental lifetime cancer risk attributed to radiation exposure is estimated as the sum of the risks from all radionuclides in all exposure pathways. Accordingly, the EPA Team used the PRG Calculator and coordinated with the national radiation expert in EPA's Office of Superfund Remediation and Technology Innovation (OSRTI) to calculate a site-specific soil Derived Concentration Guideline Level (DCGL).

The DCGL is a term referenced in MARSSIM, a document prepared collaboratively by four Federal agencies having authority and control over radioactive materials: EPA, Nuclear Regulatory Commission (NRC), Department of Energy (DOE), and Department of Defense (DOD). The MARSSIM, published in 2000, provides a nationally consistent consensus approach to conducting radiation surveys and investigations at potentially contaminated sites. In addition to planning, conducting, and assessing radiological surveys of surface soils and building surfaces, the document provides a decision-making process to determine if site conditions are in compliance with dose-based or risk-based regulatory criteria. As defined by MARSSIM, the DCGL is a radionuclide-specific soil concentration determined through pathway modeling that would result in a risk equal to the release criterion above background. EPA used a cancer morbidity risk of $1x10^{-4}$ as the release criterion *above,* or *exclusive* of, background.

Four exposure pathways were considered to develop the DCGL: (1) incidental ingestion of soil; (2) inhalation of soil particulates; (3) direct, external exposure to ionizing gamma radiation in soil; and (4) meat (ranched beef) consumption. These four exposure pathways were considered to be the only pathways applicable for the Site, taking into account its potential future land use of cattle grazing and associated ranching activities. Note that a radon inhalation pathway for outdoor radon is not addressed (as opposed to *indoor* radon, which is) in EPA's guidance on conducting radiological risk assessments at CERCLA sites (EPA, 2014). An open mine shaft and an air-ventilation vent hole do remain at the Site; however, any remedial/removal action plan contemplated at the site by EPA will include closure of the open shaft and vent hole. Radon samples were collected at the site for worker safety purposes and are reported in report section 1.4.2.4.

A combination of three land-use scenario templates in the PRG Calculator were used to develop the DCGL: the "Composite Worker", to model Outdoor ranching activities; the "Indoor Worker", to model ranching activities inside a Truck; and "Farmer", to model the consumption of site-raised beef. Two cattle ranchers who operate on lands near the Site were interviewed to determine a reasonable maximum amount of time a cattle rancher might spend on this activity. Consequently, EPA used a value of 400 hours per year (1.6 hours per day [interview] for 250 days per year [PRG Calculator default value for Composite and Indoor Worker]) for annual exposure frequency. EPA used a value of 25 years for lifetime exposure duration, which is the PRG Calculator default value for a Composite and Indoor Worker. Of the 1.6 hours per day spent on ranching activities, 50% (0.8 hours) were determined to be spent outdoors and the remaining 0.8 hours were determined to be spent inside a truck. This determination was made from Table 16-24 of the 2011 Exposure Factors Handbook (Time Spent in Truck/day, Western Census Region, 95th percentile, revealing a figure of approximately 50% of an 8-hour day) (EPA, 2011). A truck was estimated to provide a gamma shielding factor of 0.7 (Appendix I, Attachment 2). EPA used PRG Calculator default values representing a Composite Worker for soil ingestion and inhalation rates. PRG Calculator default values represent reasonable maximum exposure to broad-based populations, typically 90 to 95 percentile values, which are well above the mean.

EPA used PRG Calculator default values for beef consumption (165.3 grams per day) for 350 days per year. Cattle were considered to graze on-site % of the time annually, based on research citing that rangeland experts suggest only 25-to-50% of arid rangeland in fair to good condition should be consumed or used by livestock in order to leave sufficient vegetation for regeneration and wildlife use (Hurd et al, 2007). EPA considered that a rancher would consume 48% of beef from on-site animals, based on the 50th percentile value for "percent of home-raised meat consumed by Western households who farm" presented in Table 13-19 of EPA's 2011 Exposure Factors Handbook (EPA, 2011). EPA used PRG Calculator Beef default values for fodder and soil intake rates. The PRG Calculator-produced echo of input values is provided in Appendix J.

The radiological contaminants of concern include the entire U-238 decay chain up to, and including, thallium-206 (Tl-206), of which Ra-226 is a member, and the entire U-235 decay chain up to, and including, thallium-207 (Tl-207). It is assumed the U-238 and U-235 decay chains exist in secular equilibrium (due to lack of ore processing at the site; see Section 1.2.4) and that the U-235 concentration is 2.2% of the total uranium (U-238, U-235, and U-234) concentration (Argonne National Laboratory, 2007). The PRG Calculator-produced output is provided in Appendix J.

The action level established for the Site for a ranching land-use scenario is 6.8 pCi/g for Ra-226, reflecting a PRG Calculator-derived DCGL of 4.9 pCi/g above the Ra-226 BTV of 1.9 pCi/g. The action-level calculations are presented in Appendix J. Although the cumulative DCGL of 4.9 pCi/g represents the concentration of each radioisotope in the U-238 decay chain which together represent a cancer morbidity risk of 1in 10,000 persons (commonly referred to as a $1x10^{-4}$ risk), the action level is established for Ra-226 because: (a) it was found to be a significant contributor of radiological risk to human health (44% [Ra-226 plus short-lived daughter progeny through polonium-214] (see Appendix J); (b) the U-238 decay chain is in equilibrium, with analysis of Ra-226 (or specifically its short-lived daughter radioisotope Bi-214cost-effective due to its readily identifiable gamma ray energy signature via gamma spectroscopy, (c) a cleanup standard is provided in the State of New Mexico's *Joint Guidance for the Cleanup and Reclamation of Existing Uranium Mining Operations in New Mexico* (NMEMNRD et al, March 2016), and (d) Ra-226 is the radionuclide for which historical cleanup limits have been specified. Note that when addressing contamination associated with Ra-226, contamination associated with the full U-238 and U-235 decay chains will also be addressed, as they are co-located with Ra-226.

An action level of 6.8 pCi/g represents a cancer risk of $1.4x10^{-4}$, inclusive of background conditions. This risk-based action level is proposed for the following reasons:

- It is within the risk range (10^{-6} to 10^{-4} overall excess cancer risks) cited in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR 300.430(e) (2)(I)). More specifically, it is less than the risk, $2x10^{-4}$, that EPA has a history of accepting for radionuclides at uranium mining-waste sites as protective, per discussion with OSRTI.
- It is distinguishable from background and therefore measurable in the field.
- It is above the analytical detection limit.
- It meets the standard (5.0 pCi/g Ra-226 above background, averaged over the first 15 centimeters of soil below the surface, averaged over any area of 100 square meters) set forth in the State of New Mexico's *Joint Guidance for the Cleanup and Reclamation of Existing Uranium Mining Operations in New Mexico* (NMEMNRD, et al., March 2016).

Under a ranching land-use scenario and at the low end of the range within which EPA manages risk ($1x10^{-6}$), a PRG Calculator-derived DCGL for Ra-226 equals 0.05 pCi/g. This concentration is below the analytical detection limit of 0.1 pCi/g for Ra-226.

As surface soil contamination was measured during the RSE in part via gamma scanning, a scanning-equivalent DCGL in cpm was calculated by the following analysis. Using Microshield® gamma ray shielding and dose assessment software (Microshield version 6.02 [Grove, 2008]), the exposure rate above an infinite plane of Ra-226 at 1.0 pCi/g was calculated to be 1.93 µR/hr. From Table 6.7 in MARSSIM, the response factor for a 2-inch by 2-inch NaI detector exposed to Ra-226 is 760 cpm/µR/hr. Given a DCGL of 4.9 pCi/g, a 2-inch by 2-inch NaI gamma detector would have a reading of 7,187 cpm above background. Adding this value to the BTV in cpm of 17,009, a cpm-equivalent action level of 24,192 was calculated to correlate to the action level of 6.8 pCi/g.

2.2.1.1 RESRAD Calculator

The OSWER 9285.6-20 guidance document states that although EPA recommends using the PRG Calculator to model radionuclide risk to ensure consistency with CERCLA, the NCP and EPA's Superfund guidance for remedial sites, an alternative model may be used if justification is developed (EPA, 2014). Justification should include the model runs using both the recommended EPA PRG Calculator and the alternative model. Pursuant to this goal as an independent check of PRG Calculator results, EPA reviewed several available modeling programs to determine an appropriate alternative model. While none of the models reviewed provided a direct excess risk value, all of the available models would calculate an excess dose value that could be converted to a comparable excess risk value. EPA selected to also model excess radiological risk (converted from excess dose) and calculated a soil action level for this Site using the RESRAD On-Site 7.2 software developed by Argonne National Laboratory. The RESRAD model is well established and is generally viewed as the default go to model in the Health Physics community. PRG Calculator input values, including default values, for all parameters across the four exposure pathways noted previously as well as the U-238 and U-235 decay-chain contaminants of concern were replicated in RESRAD to the maximum extent possible to comport with OSWER 9285.6-20 guidance. The same four exposure pathways considered in the PRG Calculator, described in the preceding sub-section, were duplicated in RESRAD.

The RESRAD model outcome of 8.4 pCi/g Ra-226, when added to the BTV of 1.9 pCi/g, results in an action level of 10.3 pCi/g for Ra-226. The modeled run results indicated a significant difference between the two models used. Differences in modeled run results are common due to the way that each model addresses and weighs the various input parameters. EPA reviewed the input parameters for accuracy in both models and found no input errors. EPA determined that the action level derived by the PRG Calculator was appropriate and valid for this Site since the PRG Calculator was designed by EPA for the specific needs of the agency for the calculation of excess radiological risk. The RESRAD output is provided in Appendix J for reference and comparison to the PRG output.

2.2.2 Principal Threat Waste Level

The EPA *Guidance on Principal Threat and Low Level Threat Waste* recommends treatment of principal threat waste when practicable (EPA, 1991a). The guidance aligns with, and supports, the NCP, promulgated on 8 March 1990, which states that EPA expects to use ”treatment to address the principal threats posed by a site, wherever practicable” (40 CFR Section 300.430(a)(1)(iii)). The expectation is derived from the mandates of CERCLA § 121 and the guidance was developed to communicate the types of remedies that the EPA generally anticipates to find appropriate for specific types of wastes. It reflects EPA’s belief that certain source materials are addressed best through treatment because of technical limitations to the long-term reliability of containment technologies or the serious consequences of exposure should a release occur.

The concept of principal threat waste and low-level threat waste as developed by EPA in the NCP is to be applied on a site-specific basis when characterizing source material. Source material is defined as that which includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to ground water, to surface water, to air, or acts as a source for direct exposure. Examples of source materials include drummed wastes, contaminated soil and debris, “pools” of dense non-aqueous phase liquids (NAPLs) submerged beneath ground water or in fractured bedrock, NAPLs floating on ground water, and contaminated sediments and sludges. Principal threat wastes are in turn those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. They include liquids and other highly mobile materials (e.g., solvents) or materials having high concentrations of toxic compounds. No “threshold level” of toxicity/risk has been established to equate to “principal threat”; however, where toxicity and mobility of source material combine to pose a potential risk of 10^{-3} or greater, generally, treatment alternatives should be evaluated. In summary, determinations as to whether a source material is a principal or low-level threat waste should be based on the inherent toxicity as well as a consideration of the physical state of the material, the potential mobility of the wastes in the particular environmental setting, and the lability and degradation products of the material.

These determinations serve as general guidelines and do not dictate the selection of a particular remedial alternative. In fact, the preamble to the NCP (55 FR at 8703, March 8, 1990) states that there may be situations where wastes identified as constituting a principal threat may be contained rather than treated due to difficulties in treating the wastes. Specific situations that may limit the use of treatment include:

- Treatment technologies are not technically feasible or are not available within a reasonable time frame.
- The extraordinary volume of materials or complexity of the site make implementation of treatment technologies impractical.
- Implementation of a treatment-based remedy would result in greater overall risk to human health and the environment due to risks posed to workers or the surrounding community during implementation.
- Severe effects across environmental media resulting from implementation would occur.

Aside from the expectation that treatment would be used to addressed principal threat waste when practicable, the selection of an appropriate waste management strategy is determined solely through the remedy selection process outlined in the NCP (i.e., all remedy selection decisions are site-specific and must be based on a comparative analysis of the alternatives using the nine criteria in accordance with the NCP). Independent of the expectation, selected remedies must be protective, ARAR-compliant, and cost-effective, and must use permanent solutions or treatment to the maximum extent practicable.

For the Section 10 Mine, Ra-226 is not characterized as a *principal threat waste* based on the following analysis of RSE data and all the guidance document criteria.

- There exists an area of approximately 20 acres where the average Ra-226 concentration equals approximately 57 pCi/g, representing an excess cancer-incidence risk, inclusive of background, of approximately $1x10^{-3}$. However, as discussed above, toxicity is not the sole determining factor in defining a waste material as a principal threat waste. In particular, mobility of the waste should be considered.
- There exists no highly mobile waste at the Site. Specifically, there exists no threat of contaminant migration to groundwater or surface water at the Site.
- Contaminant mobility to air or direct exposure to the contaminant has been nullified effectively and reliably via containment technologies at numerous DOE sites with similar contaminants, specifically through repository cells with engineered caps.
- There is not a feasible treatment method for Ra-226 in soil (see Section 3.1).

For these reasons, based on the RSE data for the Site, EPA has determined that Ra-226 does not meet the criteria established in the guidance document referenced above for a *principal threat waste* on this Site.

2.3 SURFACE AREA AND VOLUME ESTIMATE OF CONTAMINATED MEDIA

The lateral and vertical extent of areas exceeding the action level were determined via gamma scanning and soil sampling, respectively, then plotting the results geographically using Environmental Systems Research Institute's (ESRI) ArcGIS ArcMap version 10.3. The lateral and vertical extent of contamination that requires corrective action is based on comparisons to the action level (24,192 cpm [lateral extent] and 6.8 pCi/g Ra-226 [vertical extent]). EPA added a 500-foot buffer around the outermost elevated sample, without extending beyond the lateral extent of contamination, to demarcate the areal extent of vertical contamination above the RAL, given the nature of soil sampling providing less than 100% assessment coverage.

The total surface area exceeding the action level was established to be 857,700 square feet (ft^2) or 20 acres. The total volume of soil exceeding the action level was determined to be 39,058 CY, consisting of a surface area of approximately 20 acres at a 1-foot depth and a waste stockpile volume of approximately 7,291 CY. The areal extent of contamination and the associated removal-volumetric calculations are illustrated in Figure 2-1 and in Table 2-1 below.

Table 2-1
Removal Volume Estimates
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

	Surface Area		Volume
Zone	**Square Feet**	**Acres**	**Cubic Yards**
1 ft. Excavation Area	857,700	20	31,767
Waste Pile (Aboveground)	NA	NA	7,291
TOTAL	**857,700**	**20**	**39,058**

2.4 REMOVAL ACTION SCHEDULE

The NCP requires a public comment period of at least 30 days following release of the EE/CA report by the EPA (40 CFR 300.415(n)(4)(iii)). The EPA will respond to significant comments received during the public comment period, and will publish an Action Memorandum following the response to comments. Upon concurrence by representatives of EPA, the State of New Mexico, and involved parties regarding the threat to public health and the environment and the proposed alternative to resolve the threat, the EPA will begin removal operations within 6 to 9 months of the signed memorandum. The removal start date will be contingent on multiple factors including weather, contract approval, and funding availability. The EPA will provide public notification of the schedule for this process upon issuance of the Action Memorandum.

3.0 REMOVAL ACTION ALTERNATIVES

EPA guidance for preparing EE/CAs suggests identifying and assessing a limited number of alternatives appropriate for addressing the RAOs (EPA, 1993). Removal technologies applicable to each alternative are identified and discussed with respect to their effectiveness and implementability. Technologies that were initially considered, but were screened as infeasible for technical reasons are presented and discussed in Section 3.1 and a discussion of ARARs is provided in Section 3.2. The applicable technologies are then assembled into removal alternatives in Sections 3.4 through 3.7. Based on knowledge and experience with removal actions at similar sites, the following four removal action alternatives were evaluated for the Section 10 Mine Site:

Alternative 1: No Further Action

Alternative 2: Excavation and Off-Site Disposal of Contaminated Soils at a Licensed Low-Level Radioactive Waste Facility

Alternative 3: Excavation, Consolidation, and Long-Term Management of the Radiologically Contaminated Soils/Debris at a Non-Incised On-Site Repository

Alternative 4: Capping of Contaminated Soil in Place

The alternatives have been developed to mitigate potential threats posed by controlling human exposure to wastes with concentrations of Ra-226 above the action level. These alternatives were also developed based on federal guidance as described in Section 3.2. Section 4.0 and Section 5.0 evaluate the alternatives individually and comparatively using the criteria established by the EPA. Figure 2-1 illustrates the excavation areas and presents the volumes of contaminated soil that would be transferred off-site for Alternative 2, or would be relocated to an on-site repository for Alternative 3, or capped in place for Alternative 4. Table K-1 in Appendix K summarizes the alternatives, presenting the estimated costs and schedules for each. Several other alternatives were considered but ruled out as not viable, as described below in Section 3.1.

The conceptual design assumptions used for each alternative are discussed in the following sections. As described in Section 2.3, the area and depth estimates used to calculate the removal action volumes were determined through Arc-GIS analysis based on plotting on-site gamma scanning and soil sampling data. As additional site data are obtained, it is anticipated that the volume estimate would be refined. However, the EPA considers the volume estimates summarized in Figure 2-1 to be sufficiently accurate for the purposes of comparing costs and conceptual designs in this EE/CA.

3.1 ALTERNATIVES SCREENED FROM CONSIDERATION

The process of identifying and evaluating alternatives to meet the RAOs began with an initial screening of alternatives to determine if any were considered to be technically or administratively infeasible. The following alternatives were screened from consideration during the prescreening process for the East GSA EE/CA (TDD 0001/17-040) (Weston, 2020), which also apply to the Section 10 Mine Site. See Section 3.1 of the East GSA EE/CA for the detailed discussion and reasoning for screening the following alternatives from consideration:

- Institutional Controls
- Vegetative Extraction (Phytoremediation)
- Soil Washing
- Soil Sorting

In addition to the above alternatives screened in the East GSA EE/CA (Weston 2020), specific to the Section 10 Mine Site, the alternative of constructing a long-term, on-site, incised repository was also screened from consideration.

- On-Site Incised Repository

Due to the unknown locations and conditions of historic subsurface mining facilities, deep excavations at the Section 10 Mine Site are not recommended without first collecting additional information. Due to the unknown extent of the engineering challenges that would be involved and the costly and highly specialized underground mapping operation that would be undertaken to collect such information of the existing underground facilities, this alternative was screened from further consideration.

3.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

This EE/CA was developed following the basic methodology outlined in 40 CFR §300.415 and further discussed in the EE/CA Guidance (EPA, 1993). Section 121(d) of CERCLA requires that response actions comply with state and federal ARARs unless a waiver is justified. ARARs are used to assist in determining the appropriate extent of site cleanup, to scope and formulate removal action alternatives, and to govern the implementation of a selected response action (EPA, 1988 and 1989). The following sections provide a definition of ARARs and describe the ARARs that are specific to the Site.

3.2.1 Terms and Definitions

The NCP provides that response actions must attain ARARs to the extent practicable, considering the exigencies of the situation (40 CFR 300.415(j)). As discussed in the EPA *Guidance on the Consideration of ARARs during Removal Actions* (EPA, 1991b), NTCRAs will generally, where practicable, allow for greater compliance with ARARs than time-critical removal actions (TCRAs).

In the course of conducting the EE/CA for the Site, ARARs as well as other “To Be Considered” (TBC) criteria were identified from policy or guidance documents that may be pertinent to evaluating and implementing removal options. ARARs and TBC criteria are defined as follows:

- Applicable Requirements are cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental 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 cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site and are well-suited to the particular site.
- TBC Criteria consist of advisories, criteria, or guidance that were developed by EPA, 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.

The EPA 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 which, 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 removal action can occur.
- Action-Specific ARARs include performance, design, or other controls on the specific activities to be performed as part of the removal action for a site.

ARARs and TBC criteria for the East GSA Site, along with a brief description of each, are provided in Tables 3-1, 3-2, and 3-3, respectively.

3.2.2 Other Considerations and Assumptions

The following additional considerations and assumptions were made during the ARAR identification process.

3.2.2.1 Occupational Safety and Health Administration

The Occupational Safety and Health Administration (OSHA) has promulgated standards for the protection of workers who may be exposed to hazardous substances at Resource Conservation and Recovery Act (RCRA) or CERCLA sites (29 CFR Parts 1910.120 and 1926.65). The EPA requires compliance with OSHA standards in the NCP (40 CFR 300.150), but not through the ARAR process. Therefore, OSHA standards are not considered ARARs. Since the requirements, standards, and regulations of OSHA are not ARARs and cannot be waived, they will be complied with during the removal action.

3.2.2.2 Uranium Mill Tailings Radiation Control Act

Uranium Mill Tailings Radiation Control Act (UMTRCA) programs are categorized under Title I and Title II. Title I addresses specific inactive uranium processing sites, and Title II addresses active sites that are required to have a license from the NRC. Under UMTRCA, the EPA was directed to devise standards for both the control and cleanup of excess radiation from uranium mill tailings. The Section 10 Mine is not a listed site under Title I of UMTRCA, nor would Section 10

Mine wastes be classified under Title II. However, UMTRCA requirements may be TBCs under certain circumstances, as reflected in Table 3-1.

3.2.2.3 Multi-Agency Radiation Survey and Site Investigation Manual

The activities conducted as part of this removal action shall be conducted in a manner consistent with MARSSIM specifications to facilitate implementation of a final status survey at the completion of mitigation activities. MARSSIM is guidance, not a promulgated standard, and thus is not an ARAR, though it may be applied as a TBC.

For the purposes of the final status survey, the DCGL referenced in MARSSIM will be equivalent to 4.9 pCi/g of Ra-226, a value equivalent to the PRG Calculator result (i.e., the action level exclusive of background; see section 2.2.1). The DCGL is a radionuclide-specific soil concentration that would result in a risk equal to the release criterion (i.e., 4.9 pCi/g above background). If radioactivity is relatively evenly distributed over a large area, MARSSIM considers the average concentration over the entire area (termed $DCGL_W$; meaning DCGL for a ”wide area”). Thus, more specifically, the $DCGL_W$ will be equivalent to 4.9 pCi/g of Ra-226.

Concentrations greater than the $DCGL_W$ are allowed provided that the average concentration over the survey area is less than the $DCGL_W$. The MARSSIM approach allows for calculation of a higher DCGL, for small areas of concentrated radioactivity within the ‘wide area’, based upon “area weighting factors.” This value is termed the $DCGL_{emc}$ (“emc” represents the elevated measurement comparison). The $DCGL_{emc}$ is typically a multiple of the $DCGL_W$ and will differ depending on the distance between sample points collected during the MARSSIM final status survey (over-arching release criterion prescribed by MARSSIM) in each survey unit. This approach accounts for the fact that the resident will receive a greater dose from a smaller area of contaminated soil than from the more homogenously contaminated ‘wide area’, but because the $DCGL_{emc}$ is not exceeded, the average dose to a receptor is still in compliance with the release criterion, assuming the survey unit passes an appropriate statistical test. Calculations of $DCGL_{emc}$ values will be calculated post-removal as part of final status surveys.

3.3 ENGINEERING AND LOGISTICAL CONCERNS APPLICABLE TO MOST ALTERNATIVES

Alternatives 2 through 4 each require the following common components and activities:

- Plans and submittals
- Mobilization and site setup
- Clearing and grubbing
- Site security and access controls
- Road and haul route improvements
- Road and haul route maintenance
- On-site traffic control
- Air monitoring and dust control
- Storm water management, erosion control, and maintenance
- Site reclamation

The costs for these common activities are included in the estimated cost for each alternative (Appendix K).

3.3.1 Plans and Submittals

Prior to mobilization activities, construction plans, drawings, and specifications would need to be prepared for Alternatives 2 through 4. Work Plans and construction drawings and specifications will consider information presented in the Natural Resource Evaluation (Appendix A) and Cultural Resource Survey (Appendix B) as well as recommendations or requirements from the New Mexico SHPO, New Mexico SLO, or tribal consultation.

Additional required plans would include, at a minimum, a Removal Action Work Plan to include a Health and Safety Plan, Environmental Protection Plan, Quality Assurance Project Plan, Field Sampling/Monitoring Plan, Site Access and Security Plan, Traffic Control Plan, Storm Water Management and Erosion Control Plan, Cultural Resource Protection Plan, Dust Control Plan, and Final Status Survey Plan.

The design process will also require an evaluation of the potential environmental footprint of the project, prepared in accordance with the EPA guidance document *Methodology for Understanding* *and Reducing a Project's Environmental Footprint* (EPA, 2012) and the *ASTM International Standard Guide for Greener Cleanups, E2983-16e1* (ASTM, 2016).

3.3.2 Mobilization and Site Setup

A gamma activity survey in conjunction with soil sampling has been completed to delineate the areas to be excavated. Temporary on-site facilities for project management and project controls would be mobilized to the Site for the duration of the project. Temporary on-site facilities would be constructed for decontamination of personnel and equipment (e.g., tools, salvageable equipment, passenger vehicles and heavy equipment). Aboveground electrical lines cross the site. A subsurface utility survey is necessary to identify and/or verify the location of buried utilities. Areas scheduled for utility surveys would include excavation, borrow and transfer areas, heavy equipment traversing paths, areas slated for drainage way improvements, and areas where material may be stockpiled.

To prepare the Site for implementation of Alternatives 2, 3, and 4, the ecological and cultural resource surveys of the repository area would be reviewed prior to mobilization. If necessary, additional surveys would be performed by EPA-approved biologists or archeologists. Based on the information gathered in the survey completed and for the purposes of this EE/CA, and consistent with other CERCLA actions taken in this area, it is assumed that cultural resources can be avoided or protected during site work activities.

As stated in Section 1.2.10, an Environmental Protection Plan will be developed prior to the initiation of removal activities and will identify sensitive ecological habitats and species documented during the survey. Removal activities may be scheduled to avoid certain critical periods of the year such as nesting or breeding seasons.

3.3.3 Site Security and Access Control

Security would be maintained during all non-working hours while site work is occurring. The Site Manager and the Health and Safety Officer would be responsible for personnel while they are on the Site. To restrict access, the Site would remain completely fenced throughout the duration of construction activities occurring using Alternatives 2, 3, and4, along with appropriate signage designating potential hazards and contacts to obtain additional information. Temporary fencing would be used whenever the permanent fence must be removed for construction access. Alternate entrances that may be required for portions of the work would be secured when not in use.

The EPA and its authorized representatives, including its contractors, would have access to the Site at all times. A Site Access and Security Plan would describe the activities used to monitor and control access to the Site during implementation of the response actions using Alternatives 2, 3, and 4 and the periods of work performance.

3.3.4 Road and Haul Route Improvements

Currently, there is a basic network of roads present on the Site that were used for mining and/or mining related operations in the past. Prior to any work occurring, the current road network will be evaluated to determine the feasibility of using the roads in their current condition for Alternatives 2, 3, and 4. If the existing road network requires improvement, appropriate improvements will be made to sustain the anticipated removal activities on the Site.

All roads for long-term use during the removal action will have appropriately sized gravel surfacing, which would need to be maintained for the duration of the removal action. Without surfacing, many of the Site roads would become unusable during precipitation events due to the high clay content of the soils composing those roads.

3.3.5 Road and Haul Route Maintenance

The alternatives being considered (2, 3, and 4) require haul traffic both on-site and off-site for a few months to achieve completion. During transport, traffic controls would be necessary for on-site and off-site haulage. A Traffic Control Plan will be developed and followed throughout the removal action operations.

It is possible that rail transportation may be an alternative for off-site disposal of the waste at a licensed low-level radioactive waste facility (Alternative 2); however, the cost estimate in this report assumed truck transport of the waste materials to an approved disposal facility. Table 3-4 presents cost estimates of different transportation options at these facilities.

Off-road haul routes would be maintained so that dust, debris, or mud are not created, and so that these items are not tracked onto paved surfaces. Earthen haul routes would be shaped or otherwise improved so that they are free draining and would not easily erode. Signs and barriers would be provided, if necessary, to contain traffic along the designated routes.

3.3.6 Air Monitoring and Dust Control

As part of the Site Sampling and Analysis Plan, specific methods and procedures would be included for air quality monitoring, collecting, analyzing, and evaluating air samples within and at the perimeter of work zones as described for Alternatives 2, 3, and 4. Prior to commencing dust generating activities in the contaminated excavation areas, perimeter work zone samples would be collected to establish background alpha and beta activity concentrations in ambient air. The background air samples would be used to establish the COPC activity concentrations that are naturally occurring in the air and are unrelated to the removal activities occurring at the Site. Perimeter and work zone air monitoring stations would be positioned and operated to monitor emissions during grubbing, excavation, stockpiling, loading of bulk-carriers, stockpile management, and site reclamation.

The Dust Control Plan, referenced in Section 3.3.1, will detail how air monitoring results and dust suppression measures would be implemented to document that potential off-site migration of contaminants at unacceptable radiological activity concentrations does not occur, to maintain compliant air quality conditions and a safe working environment, and to protect the health of workers, the general public, and the environment during removal operations using Alternatives 2, 3, and 4. Dust controls would also be used to minimize fugitive dust generated from soil imported from off-site borrow sources. Perimeter air monitoring would be performed during earthmoving activities associated with site reclamation. Frequent water or water/tackifier solution spraying would be used during soil moving activities at the Site and during construction and waste placement work at the repository, if selected. Appropriate Stop Work protocols will be incorporated in the Dust Control Plan for seasonal high-wind events when dust suppression using watering or a water/tackifier solution is ineffective.

For costing purposes, it was assumed that water for dust control would be obtained and hauled from Grants, New Mexico, and stored on-site in mobile water tank trailer towers.

3.3.7 Stormwater Management, Erosion Control, and Maintenance

As described above, the Site is located in an arid to semi-arid area of New Mexico. While thunder storms and significant moisture events are generally confined to the monsoon season, significant snow events can occur, along with flash flooding events. Stormwater management and erosion control are of significant concern based on the size and the extent of the excavation activities associated with Alternatives 2, 3, and4 of this removal action. As referenced in Section 3.3.1, a Stormwater Management and Erosion Control Plan will be prepared to address stormwater management and erosion control procedures during the duration of the removal activities on this Site.

Excavated areas would be graded and re-contoured to reduce overland and low-energy concentrated flow rates and patterns. A natural regrading design would seek to integrate the post-removal reclaimed area topography and existing drainage patterns to facilitate the development of a stable land surface for the development of a viable post-removal ecosystem. All removal related activities at the Site must be evaluated for potential impacts on federally-listed species and critical habitat for certification to meet the substantive requirements of the Notice of Intent, under the National Pollutant Discharge Elimination System (NPDES) Multi-Sector General Permit. Once the Site has been stabilized, monitoring of construction stormwater runoff would cease and post-removal site controls would be initiated. The cost estimates include provisions for ongoing cover maintenance, and fence inspection and repair at the final repository for Alternative 3.

3.3.8 Site Reclamation

Prior to initiation of reclamation activities, topographical and meteorological data for the Site would be collected to produce a conceptual plan for reclamation. The plan would strive to return the topography of the Site to pre-mining conditions, which would provide a stable land surface, reduced erosion effects, and a sustainable ecosystem. The plan would also provide strategies for using on-site fill materials to reduce costs associated with importing backfill. The plan would be available for review by stakeholders prior to commencement of activities.

Grading where excavation of mine or mine-related waste materials has occurred using Alternative 3 would be performed to aid in erosion control (i.e., a slope of 4H:1V or flatter) where erodible soils are present. Re-contouring of the Site would include filling excavations to restore natural drainage conditions. On-site, clean backfill soil may be used for re-contouring the landscape. The material would be compacted and in-place soil density and moisture testing would be performed to ensure a minimum of 85% relative compaction is achieved. Revegetation of excavated contaminated areas would be completed to reduce erosion potential while improving grazing suitability and wildlife habitat. Areas to be revegetated will require tilling and soil amendments following re-contouring efforts. As summarized in Section 1.4.2.6, a conceptual revegetation plan was developed for the Section 10 Mine Site. The conceptual revegetation plan is included in Appendix H.

Vegetation establishment would help to minimize erosion and increase the durability of the cover of the repository. Vegetation should attempt to emulate the local ecological conditions including structure, function, diversity, and dynamics of native plant communities in the area. A diverse mixture of native and naturalized plants would maximize water efficiency of water usage and remain more resilient given variable and unpredictable changes in the environment resulting from pathogen and pest outbreaks, disturbances (e.g., grazing, fire, etc.), and climatic fluctuations. Therefore, the vegetation plan for the repository cover would include species that are sustainable, once established, under typical climate and resource use patterns.

3.4 ALTERNATIVE 1: NO FURTHER ACTION

Under Alternative 1, no new treatment, containment, or removal action would occur at the Section 10 Mine Site. The no-action alternative has been included as a requirement in Section 300.430(e) of the NCP and to provide a basis for the comparison of the remaining alternatives.

3.4.1 Site Work Activities

This alternative would include no new site work activities. Impacted materials would be left in place. The current site conditions such as slope, surface treatment, and aspect that have been graded would not be modified. Since the current site conditions do not provide a radon or gamma radiation barrier, future site visitors may be exposed to radiation hazards. The potential for contact with eroded radioactive material or exposure to fugitive dust may also occur due to the lack of stabilization measures.

3.4.2 Post-Excavation and Site Reclamation Activities

Since there would be no new work activities at the Site under this alternative, there would be no site reclamation.

3.4.3 Site Controls and Security

The public and livestock are currently restricted access to the Section 10 Mine Site by chain-link fence around the mine shaft and a cattle guard. However, the fence can be damaged or bypassed, presenting a potential exposure to gamma radiation, fugitive dust, and radon emissions for unauthorized personnel.

3.4.4 Stormwater and Erosion Control

No new stormwater or erosion control activities would be implemented under Alternative 1.

3.4.5 Operation and Maintenance Activities

The Site would require operation and maintenance (O&M) to ensure that the current level of protectiveness provided by the existing fencing is maintained. Existing storm water and erosion controls would be maintained as necessary.

3.5 ALTERNATIVE 2: EXCAVATION AND OFF-SITE DISPOSAL OF CONTAMINATED SOILS AT A LICENSED LOW-LEVEL RADIOACTIVE WASTE FACILITY

Alternative 2 assumes that contaminated soils with concentrations greater than the action level of 6.8 pCi/g Ra-226 would be excavated and disposed of off-site at a licensed disposal facility permitted to receive the waste, or at a processing mill that would reprocess and then dispose of the soil.

Work recently completed by EPA identified three licensed disposal facilities within the western United States that are authorized to accept low-level radioactive waste and/or naturally occurring low-level radioactive soil with Ra-226 concentrations ranging from 2 pCi/g to approximately 500 pCi/g:

- Clean Harbors, Deer Trail, Colorado

- U.S. Ecology, Beatty, Nevada
- U.S. Ecology, Grand View, Idaho

Transportation and disposal pricing from December 2019 was used (See Table 3-4). This information was used to develop the detailed cost estimates included in Appendix K. The estimate assumes a transportation and disposal rate of $130.00/ton, which includes the pricing to transport, process, and dispose of the waste at the Clean Harbors Landfill in Deer Trail, Colorado.

3.5.1 Off-Site Rule

Alternative 2 would require compliance with the Off-Site Rule of CERCLA. In general, the Off-Site Rule requires that facilities that accept contaminated or hazardous wastes from a CERCLA site must be in compliance with all applicable regulations and laws (i.e., they must be approved to take those wastes and be in compliance with the applicable federal, state, and local requirements to do so). A licensed disposal facility for Alternative 2 would have existing approval under the Off-Site Rule.

3.5.2 Site Work Activities

The initial site removal work includes clearing and grubbing to remove organic debris. Stormwater controls would be implemented during these activities and continued throughout the excavation and backfill process. Contaminated soil would be excavated by a combination of heavy mining equipment including scrapers, bulldozers, graders, excavators, front-end loaders, and haul trucks. Contaminated soil would be loaded onto haul trucks for transport directly to the final disposal facility. Alternatively, transportation by rail or a combination of trucking and rail may be an option. Material would need to be trucked from the Site to Milan, New Mexico, where a transfer station would need to be established. The material could then be loaded to rail cars and shipped to the selected disposal facility.

In addition to the site removal work, an existing steel headworks structure will be demolished and disposed of and an existing vertical adit shaft and vertical vent shaft will be plugged using polyurethane foam (PUF). Figures M-2 and M-3 (Appendix M) illustrate example typical details of adit and vent shaft closures, respectively.

Contaminated areas of the Section 10 Mine Site as shown in Figure 2-1 would be excavated. The on-site excavation and trucking activities are estimated to take 2 months, with planning expected to take an additional 3 months before construction mobilization, for a total removal time of 5 months before completion.

Traffic controls would be in place in order to maintain safe driving conditions due to equipment and vehicles entering and leaving the site. During the course of the removal action it is estimated that approximately 2,700 truckloads (assuming 45,000 pounds/load for highway legal trucks) would be required to remove waste material from the Site at a rate of 150 trucks per day. As an alternative, rail transport from the Site might be evaluated to minimize transportation costs, as there is a rail line approximately 0.5 miles east of the Site. The largest equipment that can reasonably be used on the Site, with quick travel times, and that would cause minimal damage to access routes, should be considered to maximize efficiency. Under this alternative, it was assumed that the majority of traffic would use the existing and upgraded access roads to move the waste.

3.5.3 Post-Excavation and Site Reclamation Activities

Concurrent with the excavation activities, confirmation testing of the bottom and side soils in each excavated area would help determine the remaining vertical and lateral extent of contamination. Excavation would continue until the action level is met.

After the mine and mine-related waste are removed from the Section 10 Mine Site, the area would be reclaimed for livestock grazing and wildlife habitat. Clean fill soil and rock used to construct and repair roads, or used as general fill or rock armoring, would be obtained from segregated overburden (if feasible) or a borrow area located off-site. Excavated areas would be recontoured and possibly backfilled with on-site, clean soil as required to restore grades and promote positive drainage. At least 6 inches of the top soil would be tilled and enriched with soil amendments to serve as growing media. Revegetation efforts would follow the final Revegetation Plan developed from the draft conceptual Revegetation Plan (Appendix H) and modified for final post removal conditions. Progressive revegetation would occur for disturbed and reclaimed areas after completion of removal activities in each removal unit.

3.5.4 Site Controls and Security

During the Alternative 2 removal and reclamation activities, Site access would be restricted by a newly installed fence. Domestic livestock would not be allowed to enter the Site until reclaimed. Once vegetation is re-established and the Site has stabilized, perimeter fencing may be removed. Reclamation activities may take 5 years or more before adequate vegetation is re-established in place and final stabilization is achieved.

3.5.5 Stormwater and Erosion Control

Stormwater management and erosion control are of significant concern based on the size and the extent of the excavation activities associated with Alternative 2. As referenced in Section 3.3.1 and 3.3.7 above, a Stormwater Management and Erosion Control Plan would be prepared to address stormwater management and erosion control procedures during the duration of the removal activities on this Site. The Site would be returned to a sustainable topography with natural features to reduce the risk of erosion.

Excavated areas would be graded and recontoured to reduce overland and low-energy concentrated flow rates and patterns. The natural regrading design integrates the post-removal reclaimed area topography and existing drainage patterns to facilitate the development of a stable land surface for the development of a viable post removal ecosystem. All removal related activities at the Site must be evaluated for potential impacts on federally-listed species and critical habitat for certification to meet the substantive requirements of the Notice of Intent, under the NPDES Multi-Sector General Permit. Once the Site has been stabilized, monitoring of construction stormwater runoff would cease and post removal site controls would be initiated.

Recontouring of the Site would include filling excavations to restore natural drainage conditions. On-site, clean backfill soil may be used for recontouring the landscape. The material would be compacted and in-place soil density and moisture testing would be performed to ensure a minimum of 85% relative compaction is achieved. Revegetation and reclamation activities described above would further contribute to stormwater and erosion control once the removal action is complete.

3.5.6 Operation and Maintenance Activities

Operation and maintenance of the Site during the removal and reclamation activities would be the responsibility of the EPA. After completion of reclamation activities, O&M would be conveyed to Tronox at a date to be determined. Tronox is expected to inspect and maintain stormwater and erosion control features for perpetuity. Monitoring and maintenance of revegetation efforts would occur for an estimated 12 years following revegetation (Appendix H).

3.6 ALTERNATIVE 3: EXCAVATION, CONSOLIDATION AND LONG-TERM MANAGEMENT OF THE RADIOLOGICALLY CONTAMINATED SOILS/DEBRIS AT A NON-INCISED ON-SITE REPOSITORY

In Alternative 3, contaminated mine and mine-related wastes greater than the action level of 6.8 pCi/g Ra-226 would be excavated, transported, and consolidated into a non-commercial, newly created repository located on the Section 10 Mine Site.

3.6.1 Engineering Design

Alternative 3 uses an engineered cover as part of the removal solution. The conceptual model used for the capping options included in the cost analysis for this alternative is described below. Figure M-1 (Appendix M) illustrates the final grading plan of the proposed design of a 40,000 CY, 8.7-acre repository.

Regarding the remediation of mine wastes, Title I UMTRCA standards (Subpart A of 40 CFR 192(d)), which are TBCs, offer the following guidance. Remediation should:

- Be designed to be effective for up to 1,000 years to the extent reasonably achievable, but for up to 200 years at a minimum.
- Provide reasonable assurance that releases of radon-222 will not exceed an average release rate of 20 picocuries per square meter per second (pCi/m^2-s).

Several critical factors were considered in designing a cover. These design elements are discussed briefly below and assumptions are made in order to prepare the cost analysis for the alternative. These assumptions may change upon further investigation of the Site. Ultimately the containment design would be based on comprehensive planning and site-specific risk analysis.

- **Longevity of the Cover –** The engineered cover would be designed to be effective for up to 1,000 years to the extent reasonably achievable, for up to 200 years at a minimum; this lifespan is highly dependent upon continuing maintenance of the cover and would require long-term monitoring. The net present value (NPV) for the long-term inspections and maintenance of the cover for 100 years is included in the cost estimate.
- **Protection from Radon Emanation** – The final cap thickness for Alternative 3 would be determined based on NRC guidance and using Regulatory Guide 3.64, Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers (NRC, 1989). Preliminary calculations were performed for this report following State of New Mexico Guidance limiting the release rate of radon-222 through the cover to 20 pCi/m^2-s (Appendix L), which resulted in a cap thickness of 3 feet.
- **Water Infiltration –** The cover must protect the contaminated soils and reduce leachate development by minimizing the infiltration of water from precipitation. The cover design would incorporate drainage features and use evapotranspiration to limit water infiltration.
- **Erosion Control –** Cap shaping, sloping, and proper drainage patterns are also important to ensure stability of the final consolidated material. The current area has had problems with erosion of cover soils. For this reason, the cost estimates presented for this alternative uses a maximum 20H:1V slope ratio (5% grade) and incorporate drainage features. Water diversion, velocity breaks, rock intermixed with the surface layer, and placement of rip rap or other protective lining in concentrated flow areas are expected to be the most effective surficial erosion mitigation measures. The repository would be positioned at a sufficient distance from any surface water features to be protective of surface waters. Similarly, information obtained during the ecological and cultural resource surveys would be considered in the repository location placement.
- **Cover Design –** The cost estimate uses an evapotranspiration cover assumed design with a 3-foot-thick radon barrier comprised of a 2-foot layer of native soil or borrow material and overlain by a 1-foot thick layer of soil, mixed with both rock and organic material, which would be used on the top of the radon cover to promote revegetation and control erosion.

  Although the final design may vary, the major cost factors—thickness of cover and source of material—would likely not be significantly different from the cost estimate assumptions. Final design parameters for the consolidation repository would be determined by EPA in consultation with the State of New Mexico and other key stakeholders as necessary. All engineering and design parameters for the proposed repository are consistent with the *Joint Guidance for the Cleanup and Reclamation of Existing Uranium Mining Operations in New Mexico,* March 2016.

3.6.2 Site Work Activities

The initial Section 10 Mine Site removal work includes clearing and grubbing and removal of organic debris. Stormwater controls would be implemented during these activities and continued throughout the excavation and site restoration process. Contaminated soil would be excavated by a combination of heavy mining equipment including scrapers, bulldozers, graders, excavators, front-end loaders, and haul trucks. Since the repository is located within the contamination area, contaminated soil would be transported directly to the final disposal facility by the excavation equipment rather than haul trucks. Areas excavated would include impacted areas as shown in Figure 2-1.

During the course of the removal action it is estimated that approximately 1,000 truckloads (assuming 34 CY capacity off-road haul trucks) would be required to transport clean fill material from the borrow site to the repository site. The largest equipment that can reasonably be used on-site, with quick travel times, and that would cause minimal damage to access routes should be considered to maximize efficiency. Under this alternative, the majority of traffic would use the existing and upgraded access roads. The preferred route would be developed in consultation with Tronox during the design phase.

In addition to the site removal work, an existing steel headworks structure will be demolished and disposed of and an existing vertical adit shaft and vertical vent shaft will be plugged using PUF. Figures M-2 and M-3 (Appendix M) illustrate example typical details of adit and vent shaft closures, respectively.

The on-site excavation and trucking activities are estimated to take approximately 2 months, with planning expected to take an additional 3 months before construction mobilization, for a total implementation time of 5 months before completion.

3.6.3 Post-Excavation and Site Reclamation Activities

Post-excavation and site reclamation activities are consistent between Alternative 3 and those described for Alternative 2 in Section 3.5.3.

3.6.4 Site Controls and Security

During the Alternative 3 removal and reclamation activities, Site access would be restricted by a fence. Domestic livestock would not be allowed to enter the Site until reclaimed. Once vegetation is re-established and the Site has stabilized, perimeter fencing may be removed. Reclamation activities may take 5 years or more before adequate vegetation has been re-established and final stabilization is achieved.

3.6.5 Stormwater and Erosion Control

As for Alternative 2, stormwater management and erosion control are of significant concern based on the size and the extent of the excavation activities associated with Alternative 3. Controls for Alternative 3 would be consistent with those previously described for Alternative 2 (Section 3.5.5).

3.6.6 Operation and Maintenance Activities

Operation and maintenance of the Site during the removal and reclamation activities would be the responsibility of the EPA. After completion of reclamation activities, O&M would be conveyed to Tronox at a date to be determined. Tronox is expected to inspect and maintain storm water and erosion control features for perpetuity. Monitoring and maintenance of revegetation efforts would occur for an estimated 12 years following revegetation (Appendix H). The repository grades/slopes, cap condition, cap vegetation, erosion control measures, access roads, fencing, and other site operation and maintenance would require more frequent inspections and a higher level of scrutiny than the other reclaimed and revegetated areas of the Section 10 Mine Site. The cap would be inspected for differential settling, erosional rilling and gullying, wildlife damage, unauthorized access, and revegetation success. Repairs and maintenance would be completed accordingly.

3.7 ALTERNATIVE 4: CAPPING OF CONTAMINATED SOIL IN PLACE

In Alternative 4, contaminated mine and mine-related wastes greater than the action level of 6.8 pCi/g Ra-226 would be capped in place at the Section 10 Mine Site. This alternative would involve excavating clean material from onsite or importing the material from another location. This alternative envisions ultimately a future land-use of cattle ranching across the capped site, which would require cap thickness(es) able to attenuate risk emanating from all ranching routes of exposure (i.e., direct external gamma, inhalation of soil particulates, incidental ingestion of soil, and beef consumption). Varying surface and subsurface Ra-226 concentrations across the Site would require the development of statistical units for which varying cap thicknesses would be calculated, based on an appropriate Ra-226 concentration (e.g. the 95UCL mean or the maximum single-point concentration) and subsequent risk modeling with the PRG Calculator. Alternatively, an 'over-design', one-size cap thickness can be considered for the entire site, calculated to attenuate the risk from a ranching scenario using the appropriate Ra-226 concentration of the most elevated statistical unit. For the purposes of comparing remedial alternatives in this EE/CA, the latter cap-design approach was used and a cap thickness of 3 feet was calculated to attenuate the risk of a Ra-226 concentration of 57 pCi/g for a ranching scenario.

In order to cover 20-contaminated acres with a 3-foot cover, approximately 106,000 CY of cover material would be required. The above value of cover material has an added 10% contingency amount, taking into account the topography of the large area.

3.7.1 Engineering Design

Alternative 4 uses an engineered cover as the removal solution. The conceptual model used for the capping-in-place alternative included in the cost analysis is described below. The excavation area shown on Figure 2-1 illustrates the area that would be capped in place.

Several critical factors were considered in designing a cover. These design elements are discussed briefly below and assumptions are made in order to prepare the cost analysis for the alternative. These assumptions may change upon further investigation of the Site. Ultimately the containment design would be based on comprehensive planning and site-specific risk analysis.

- **Longevity of the Cover –** The engineered cover would be designed similar to what is outlined for Alternative 3 in Section 3.6.1.
- **Protection from All Routes of Exposure for a Ranching Scenario** – The final cap thickness(es) for Alternative 4 would be based on risk modeling of a ranching scenario via the PRG Calculator.
- **Water Infiltration –** The assumptions used for water infiltration were similar to those for Alternative 3 in Section 3.6.1.

- **Erosion Control –** Cap shaping, sloping, and proper drainage patterns are important to ensure stability of the final capped material. The current area has had problems with erosion of cover soils. For this reason, the cost estimate presented for this alternative assumes that transitions from the capped area to existing grades would be achieved with slopes no greater than 4H:1V. Water diversion, velocity breaks, rock intermixed with the surface layer, and placement of rip rap or other protective lining in concentrated flow areas are expected to be the most effective surficial erosion mitigation measures. Surface water features such as arroyos will have to be studied to determine how capping in place will affect storm water drainage in these areas. In addition to studying the areas being capped, the borrow area where fill material will be taken for the cap would have to be designed to control drainage patters and erosion due to stormwater events.
- **Cover Design –** The cost estimate uses assumptions similar to those for Alternative 3 in Section 3.6.1. Although the final design may vary, the major cost factors—thickness of cover and source of material—would likely not be significantly different from the cost estimate assumptions. Final design parameters for the consolidation repository would be determined by EPA in consultation with the State of New Mexico and other key stakeholders as necessary.

3.7.2 Site Work Activities

The initial Section 10 Mine Site removal work includes clearing and grubbing and removal of organic debris. Stormwater controls would be implemented during these activities and continued throughout the excavation and site restoration process. Clean fill material would be excavated from the designated borrow area, and transported and placed on top of contaminated soil. The fill material would be compacted and seeded. The earthwork would be accomplished using a combination of heavy mining equipment including scrapers, bulldozers, graders, excavators, front-end loaders, and haul trucks.

During the course of the removal action it is estimated that approximately 3,800 truckloads (assuming 34 CY capacity off-road haul trucks) would be required to transport clean fill material. The largest equipment that can reasonably be used on-site, with quick travel times, and that would cause minimal damage to access routes should be considered to maximize efficiency. Under this alternative, the majority of traffic would use the existing and upgraded access roads to move capping material to the Site. The preferred route would be developed in consultation with Tronox during the design phase.

In addition to the site removal work, an existing steel headworks structure will be demolished and disposed of and an existing vertical adit shaft and a vertical vent shaft will be plugged using PUF. Figures M-2 and M-3 (Appendix M) illustrate example typical details of adit and vent shaft closures, respectively.

Excavation, placing of fill material, and trucking activities for Alternative 4 are estimated to take approximately 2 months, with planning expected to take an additional 3 months before construction mobilization, for a total implementation time of 5 months before completion.

3.7.3 Post-Excavation and Site Reclamation Activities

Site reclamation activities are consistent between Alternative 4 and those described for Alternative 2 in Section 3.5.3.

3.7.4 Site Controls and Security

Site controls and security would be consistent between Alternative 4 and those described for Alternative 3 in Section 3.6.4.

3.7.5 Stormwater and Erosion Control

As with Alternative 2, storm water management and erosion control are of significant concern based on the size and the extent of the excavation activities associated with Alternative 4. Controls for Alternative 4 would be consistent with those previously described for Alternative 2 in Section 3.5.5.

3.7.6 Operation and Maintenance Activities

Operation and maintenance of the Site would be consistent between Alternative 4 and those described for Alternative 3 in Section 3.6.6.

4.0 ANALYSIS OF ALTERNATIVES

The detailed analysis of alternatives is intended to provide the relevant information required to select a preferred remedy. Each alternative was evaluated on the basis of effectiveness, implementability, and cost, as set forth in the NCP and EPA guidance on conducting an EE/CA for a removal action (EPA, 1993). A summary of the analyses of the individual alternatives is included as Table 4-1.

4.1 ALTERNATIVE ANALYSIS APPROACH

4.1.1 Effectiveness

Effectiveness refers to the ability of an alternative to meet the RAOs. The following criteria are used to evaluate effectiveness:

Overall Protection of Human Health and the Environment – This criterion provides a final check to assess whether each alternative provides adequate protection of human health and the environment. The assessment of overall protection draws on the evaluation of the other criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Evaluation of the overall protectiveness of an alternative would focus on whether a specific alternative achieves adequate protection and would describe how site risks posed through each pathway addressed by the EE/CA are eliminated, reduced, or controlled through treatment, engineering, or institutional controls. This evaluation would allow for consideration of whether an alternative poses any unacceptable short-term or cross-media impacts.

Long-Term Effectiveness and Permanence – This criterion evaluates 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 would be the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes remaining at the Site.

Short-Term Effectiveness – This criterion evaluates the effects that the alternative would have on human health and the environment during its construction and implementation phase. It includes both radiation exposure risks to the contaminated soils and risks to the workers and communities from construction work and traffic during implementation and the time necessary to complete the action.

Compliance with ARARs – This criterion is used to determine whether each alternative would meet the identified ARARs. The detailed analyses would summarize which requirements are applicable or relevant and appropriate to an alternative and describe how the alternative meets these requirements.

4.1.2 Implementability

This criterion evaluates the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required to construct and provide O&M. The following criteria are used to evaluate implementability:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials

Also considered is the reliability of the technology, the ability to monitor the effectiveness of the remedy, and the ease of undertaking additional remedial actions, if necessary.

4.1.3 Cost

Cost estimates were prepared for Alternatives 2, 3, and 4 to compare the alternatives and support remedy selection. The types of costs that were assessed in accordance with 40 CFR 300.430 (e)(9)(iii)(G) include the following: (1) capital costs, including both direct and indirect costs; (2) annual operations and maintenance costs; and (3) net present value (NPV) of capital and O&M costs. Capital costs were included as 2016 dollars. In accordance with EPA guidance, the cost estimates were prepared to provide accuracy in the range of 50% greater to 30% lower than actual costs.

An NPV analysis relates costs that occur over different time periods to present costs by discounting all future costs to the present value. This allows the cost of removal alternatives to be compared on the basis of a single figure that represents the capital required in 2020 dollars to construct, operate, and maintain the removal alternative throughout its planned life. The NPV calculations were based on a discount rate of 7% (EPA, 2000), which represents the average rate of return on private investment, before taxes and after inflation. Cost estimate details are located in Appendix K.

The scope and costs presented for the various alternatives are based on the best available information regarding current site conditions and readily available information on the applicability and effectiveness of the selected removal actions. However, uncertainties and data gaps remain because the site characterization was based on a limited number of samples, observations, and analyses. In preparing the cost estimates, conservative assumptions have been used and an overall contingency has been added to each alternative to account for these uncertainties. Changes in the cost elements are likely as new information is available and site conditions change during the removal action design. Cost assumptions are included in Appendix K.

Actual costs may vary from these estimates depending on variations in actual site conditions from those estimated, such as weather conditions; inflation; actual fuel costs; actual insurance and bonding costs; the availability and market costs of materials, equipment, and labor; changes in regulatory requirements; and other factors that are difficult to estimate or control.

CERCLA and the NCP require that every remedy selected must be cost-effective. A removal alternative is cost-effective if its “costs are proportional to its overall effectiveness” (40 CFR 300.430(f) (1) (ii) (D)). Overall effectiveness of a removal alternative is determined by evaluating protectiveness, long-term effectiveness, and short-term effectiveness. Overall effectiveness is then compared to cost to determine whether the remedy is cost-effective.

4.2 UNAVOIDABLE IMPACTS COMMON TO ALL ALTERNATIVES

Except for Alternative 1 (No Further Action), each of the removal action alternatives would result in an overall improvement to the local environment. However, for Alternatives 2, 3, and 4, it is important to note that there would be some unavoidable impacts. These include:

- Short-term inconvenience to local populations using New Mexico Highways 509 and 605; general disturbance from heavy equipment activity for the assumed construction periods; and increased truck traffic in the area.

- Disruption of cattle grazing and wildlife access to the removal action areas due to the construction activities and for vegetation re-establishment.
- Long-term O&M activities are required for maintenance of the cover, stormwater diversion measures, revegetation efforts, and fencing.
- Increased risks of traffic fatalities due to off-site trucking of waste material (Table 4-2).
- Increase in greenhouse gas emissions due to off-site and on-site trucking of waste material and clean fill material (Table 4-2).

4.3 ALTERNATIVE 1: NO FURTHER ACTION

The No Further Action alternative does not provide protection to human or environmental exposure, nor is it considered a permanent remedy because it does not reduce the concentration, volume, or mobility of the hazardous waste on the Site. The No Further Action alternative has been included as a requirement of the NCP and to provide a basis for the comparison of the remaining alternatives. No new activities would occur at the Site under this alternative; however, implementation of Alternative 1, No Further Action, would require the following O&M steps to maintain the existing level of protection:

- Erosion and stormwater control maintenance.
- Fencing maintenance and repair.

4.3.1 Effectiveness

This alternative would not minimize the potential exposure to, or transport of, contaminated soils from the Section 10 Mine Site. This alternative would not provide control through treatment of soils with concentrations of Ra-226 above the action level or reduce volume or mobility of contaminants and thus would not reduce risks to human health or the environment. The resultant risks associated with the No Further Action Alternative would be similar to those that existed at the time of the RSE. Therefore, increased protection of human health and the environment would not be achieved under the alternative.

Surface water discharge from the Site would have continued potential to transport contaminated soils to the downstream watershed. Site workers and visitors would continue to be potentially exposed to windborne and waterborne contaminants. The Site would continue to be unacceptable for livestock grazing use.

Other than routine storm water pollution prevention plan maintenance, no controls or long-term measures would be implemented to control contaminated soils at the Site under the No Further Action Alternative; therefore, this alternative offers no long-term or short-term effectiveness in reducing potential risks to human and ecological receptors.

The effectiveness of the No Further Action Alternative is considered low for achieving the removal action goals.

4.3.2 Implementability

This alternative is easily implemented because there are no construction or permitting considerations. EPA guidance requires that the reliability of the technology be considered along with feasibility. Since No Further Action is inherently an unreliable remedy, this criterion is rated low.

4.3.3 Cost

The total cost of Alternative 1 is estimated to be $1,617,000 (Table K-1, Appendix K). There are no new direct or indirect capital costs, and annual O&M costs are estimated at $17,000 per year. To determine whether the remedy is cost-effective the overall effectiveness is compared to cost. Because the overall effectiveness of Alternative 1 is low, the cost-effectiveness of Alternative 1 is low.

4.4 ALTERNATIVE 2: OFF-SITE DISPOSAL AT A LICENSED LOW-LEVEL RADIOACTIVE WASTE FACILITY

Implementation of Alternative 2, excavation and off-site disposal of all wastes, would require the following steps:

- Excavation of all excess radiologically contaminated wastes on the Site (Figure 2-1).
- Off-site disposal of excavated contaminated wastes.
- Site reclamation with erosion and stormwater controls, recontouring and revegetation.

4.4.1 Effectiveness

Alternative 2 would provide a high level of protection of human health and the environment. All soils above the action level would be excavated within the Site boundary and removed for off-site transportation and disposal at a licensed low-level radioactive waste facility. This alternative would significantly minimize potential exposure to contaminated soils from the Site. This alternative would provide control of mobility and a reduction in risk to human health and the environment at the Site. Potential exposures during excavation, transport, and at the final disposal site would be managed through engineering controls.

Federal and state ARARs would be met for the Site under Alternative 2. Action -specific ARARs for this alternative include federal and state hazardous waste management regulations to the extent applicable; federal and state standards for protection of workers, the public, and the environment from low-level radioactivity; the New Mexico Administrative Code (NMAC) 20.2 for air quality control regulations; and federal rules and regulations pertaining to the on-site accumulation of wastes in stockpiles and the control of stormwater discharges during construction activities. The U.S. Department of Transportation rules and regulations on manifesting and the on-site and off-site transport of hazardous materials would also be action-specific ARARs for implementation of Alternative 2. Federal requirements for hazardous waste disposal would be ARARs if the removal action encounters wastes subject to these requirements.

Short-term effectiveness under Alternative 2 is medium because of the disturbance of the entire waste area and the large amount of trucking to transport the entire waste amount. The primary considerations for short-term effectiveness are protection of the community, workers, and environmental impacts during and after implementation. Alternative 2 involves excavation, material transfer, stockpile development/management, loading of bulk carriers, and site restoration activities. Heavy construction equipment would be used to clear and grub, excavate, transfer, load, and grade impacted materials. 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 obtained from Grants, New Mexico, 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 (e.g., marked or fenced) to ensure access by authorized personnel only.

Bulk carriers hauling the removal-action-derived contaminated wastes off-site would be covered, secured, and weighed to document compliance with total and axle load limits. Truck traffic would be coordinated under an Off-Site Transportation Plan for routes, times of operation, and on-site traffic rules. Emergency spill containment and cleanup contingencies would also be included in the transportation plan to address material spills. Due to the large number of truckloads (approximately 2,700 loads of contaminated soil leaving the Site) and the long drive to the disposal facility (up to 5 hours one-way), it is estimated that the time period of implementation of Alternative 2 would be 2 months, following 3 months of planning and permitting. This alternative also has the highest amount of trucking and heavy equipment use in vehicle hours; therefore, it has the highest potential for additional vehicular accidents and for increased wear and tear on infrastructure, it produces the highest amount of air pollution (from particulate matter in vehicle exhaust), and it uses the greatest amount of fossil fuels. A risk of 0.04 additional fatalities and 5,279 metric tons of greenhouse gas emissions, calculated as a carbon dioxide equivalent (CO_2e), are estimated due to the increased truck traffic (see Table 4-2).

Long-term effectiveness of this alternative is high. Since all contaminated soils would be excavated and removed from the Site, potential exposure reductions to those accessing the Site would be permanent. Alternative 2 is expected to effectively mitigate the long-term effects on potential on-site human and ecological receptors.

4.4.2 Implementability

Alternative 2 rates medium in technical and administrative implementability since it is technically feasible and would use conventional techniques, materials, or labor for the excavation and associated activities. The Site is 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 off-site disposal facility. Rail shipment is a possibility; a transload facility to transfer material from trucks to railcars could be established as close as 0.5 miles from the Site. The cost of setting up the facility, stationing an excavator with scaling bucket, maintaining a water supply for dust control, providing security at the Site, and scheduling would need to be evaluated against the cost of trucking.

Alternative 2 would be administratively feasible since shipping of waste is fairly common and would only require scheduling and obtaining the necessary permits. All contaminated soil is anticipated to be accepted by permitted facilities, although due to the large quantity of material to be disposed off-site, it is possible that one facility may not ultimately be able to accept all of the waste.

The excavation of contaminated material would be accomplished using a variety of conventional equipment. Heavy construction equipment needed for this project such as scrapers, excavators, dozers, loaders, and compactors and/or bulk carriers are commercially available. Working space is available for establishing temporary construction office trailers. Electricity is already available at the Site and portable sanitary services and refuse disposal are locally available. Construction materials for the site reclamation activities (localized drainage structures, erosion control, recontouring, and seeding), and an off-site laboratory for sample analysis are commercially available.

Trained and experienced labor is available for site work activities. Special certifications and training requirements are commercially available. Health and safety training to comply with OSHA regulations, including radiation and hazardous material handling training, is available.

Water for dust control can be obtained and hauled from Grants, New Mexico, and stored on-site in mobile water tank trailer towers.

4.4.3 Cost

The total cost of Alternative 2 is estimated to be $16,087,000 (Table K-2, Appendix K). The overall effectiveness is compared to cost to determine whether the remedy is cost-effective. The long-term effectiveness and permanence is high while the short-term effectiveness is medium. Because the cost is very high, the cost-effectiveness of Alternative 2 is low.

4.5 ALTERNATIVE 3: EXCAVATION, CONSOLIDATION AND LONG-TERM MANAGEMENT OF THE RADIOLOGICALLY CONTAMINATED SOILS/DEBRIS AT A NON-INCISED ON-SITE REPOSITORY

Implementation of Alternative 3, constructing a capped repository located on the Site, would require the following steps:

- Design, siting, and construction of an aboveground repository.
- Excavation of all excess radiologically contaminated wastes on the Site (Figure 2-1).
- Transportation to and placement of contaminated wastes in the constructed repository.
- Construction of an engineered, clean-soil cap over the repository.
- Site reclamation with erosion and stormwater controls, recontouring, and revegetation.

4.5.1 Effectiveness

Alternative 3 would protect human health and the environment as all contaminated soils would be placed in a covered repository. These activities would prevent direct contact between wastes and humans and the environment in the future. Long-term maintenance of the cover and stormwater infrastructure would be necessary.

Federal and state ARARs would be met for the Site under Alternative 3. The repository design would include a cover to fully contain and isolate contaminated soils. Stormwater controls would be included in the design so that surface water would be diverted from the area. The cover is a physical barrier that offers protection from water infiltration to the contaminated soils, protects groundwater resources, and also provides adequate shielding from ionizing radiation to protect human health and the environment.

The activities set forth for the removal action would provide compliance with location-specific ARARs. A Cultural Resources Protection Plan would be developed for monitoring protocols during the work activities and would include a review and evaluation of potential impacts to historic properties and locations. Natural resource (e.g., biological and botanical) surveys have been conducted at the Site and information from these surveys would be included in the Environmental Protection Plan. The plan would include a review and evaluation of potential impacts on government-protected species and critical habitats.

The removal action would provide compliance with action-specific ARARs. These include federal and state hazardous waste management regulations, to the extent applicable; federal and state standards for protection of workers, the public, and environment from low-level radioactivity; the NMAC 20.2 for air quality control regulations; and federal rules and regulations pertaining to on-site accumulation of stockpiled wastes, protection and monitoring of groundwater, and the control of stormwater discharges during construction activities, to the extent applicable.

Short-term effectiveness under Alternative 3 is high. The primary considerations in the rating for short-term effectiveness are protection of the community, workers, and environmental impacts during and after implementation. Alternative 3 involves excavation, material transfer, stockpile development/management, and site reclamation activities. Heavy equipment would be used to clear and grub, excavate, transfer, load, and grade impacted materials. Potential exposure and protection procedures for workers engaged in these activities would be addressed in detail under a site safety and health plan. During excavation and material handling activities, measures would be taken to reduce fugitive dust emissions and associated impacts to workers. Water would be available on-site 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 (e.g., marked or fenced) to control access by authorized personnel only.

On-site truck traffic would be coordinated under the previously referenced Traffic Control Plan for the Site. On-site truck accidental spill containment and cleanup procedures would be included in the aforementioned plan. It is estimated that the time period of implementation of Alternative 3 would be approximately 2 months, following 3 months of planning and permitting. Minimal risk of additional fatalities and 71 metric tons of CO_2e emissions are estimated due to the increased truck traffic (see Table 4-2).

The long-term effectiveness of Alternative 3 is medium because it is dependent on the future maintenance activities at the repository. If properly maintained, the cover, repository, and diversion structures would minimize water infiltration and the cap would prohibit human or animal disturbance to the contaminated soils.

4.5.2 Implementability

Alternative 3 rates high in regards to technical implementability. It is technically feasible and would require conventional techniques, materials, and labor for the excavation and associated activities since the sites 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 exposure to human and environmental receptors.

Alternative 3 is administratively feasible. The contaminated soils may be transported within the site boundary, which would include the repository. Transportation permits would not be necessary. Construction of an engineered cover would not require permitting because contaminated soils are considered low-level radioactive materials and are not a RCRA hazardous waste. In addition, permits are not required for on-site CERCLA actions. On-site CERCLA actions must comply with the substantive requirements of any state or local permit, but not the administrative requirements.

The excavation of contaminated material would be accomplished using a variety of conventional equipment. Heavy mining equipment needed for this project, such as scrapers, excavators, dozers, loaders, and compactors and/or bulk carriers, are commercially available. Working space is available for establishing temporary construction office trailers. Electricity is already available at the Site and portable sanitary services and refuse disposal are locally available. Construction materials for the cover and site restoration activities (recontouring and seeding) and an off-site laboratory for sample analysis are commercially available. During non-construction periods, best management practices would be employed in accordance with stormwater control plans to help secure the Site during extreme storm events to protect human health and wildlife. On-site water would be required for construction water and is readily accessible. It would need to be treated and stored on-site in a water farm.

Trained and experienced labor is available for site work activities. Special certifications and training requirements are commercially available. Health and safety training to comply with OSHA regulations, including radiation and hazardous material handling training, is available.

4.5.3 Cost

The total cost of Alternative 3 is estimated to be $6,465,000 (Table K-3, Appendix K). The overall effectiveness is compared to the cost to determine whether the remedy is cost-effective. The long-term effectiveness is medium and the short-term effectiveness is medium. The cost is also medium, so the cost-effectiveness of Alternative 3 is medium.

4.6 ALTERNATIVE 4: CAPPING OF CONTAMINATED SOIL IN PLACE

Implementation of Alternative 4, capping in place, would require the following steps:

- Design, siting, and construction of an aboveground cap.

- Excavation and transportation of clean-soil cap material.
- Construction of an engineered, clean-soil cap over the contaminated area.
- Site reclamation with erosion and stormwater controls, recontouring, and revegetation.

4.6.1 Effectiveness

The effectiveness of Alternative 4 would be consistent with that for Alternative 3 as described in Section 4.5.1. It is estimated that the time period of implementation of Alternative 4 would be approximately 2 months, following 3 months of planning and permitting. Minimal risk of additional fatalities and 270 metric tons of CO_2e emissions are estimated due to the increased truck traffic (see Table 4-2).

4.6.2 Implementability

The implementability of Alternative 4 would be medium. Alternative 4 is readily implementable and technically feasible, but administrative implementability is medium as MARSSIM does not address subsurface contamination; thus, Alternative 4 would require a site-specific, unique compliance standard.

4.6.3 Cost

The total cost of Alternative 4 is estimated to be approximately $7,916,000 (Table K-4 Appendix K). The overall effectiveness is compared to the cost to determine whether the remedy is cost-effective. The long-term effectiveness is medium and the short-term effectiveness is medium. The cost is also medium, so the cost-effectiveness of Alternative 4 is medium.

5.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This Section of the EE/CA provides a comparison of the four removal action alternatives and options as described in Section 3 using the analyses presented in Section 4. Alternatives screened from further consideration are not compared. In addition, and based on EPA guidance, there are five core (key) elements in “greener cleanup activities” that should be considered throughout the remedy selection process (EPA, 2016). These key elements include: (a) minimizing total energy use and increasing the percentage of renewable energy; (b) minimizing air pollutants and greenhouse gas emissions; (c) minimizing water use and negative impacts on water resources; (d) protecting ecosystem services; and (e) improving materials management and waste reduction efforts by reducing, reusing, or recycling whenever feasible (EPA, 2012). This analysis compares the effects each removal action alternative, described in Section 3.0, has on the five key “green” elements. Each of the five elements was qualitatively scored for each alternative (1, 2, 3, and 4) using a numerical ranking system 1-4, with a 1 being best and a 4 being worst (i.e., low scores are greener cleanup alternatives). The alternative’s Greener Cleanup Assessment Score was derived from the sum of the five scores for that alternative. The results of this assessment are summarized in Appendix N.

5.1 EFFECTIVENESS

Alternative 1: No Further Action does not protect human health of ranchers or recreational visitors (hunters) to the Site or protect the environment. The effectiveness of this alternative is low. Alternative 2: Off-Site Disposal, Alternative 3: Non-Incised Repository Construction, , and Alternative 4: Capping of Contaminated Soil in Place each provide for protection of human health and the environment to ranchers and hunters for the Site, and are individually rated high. The Site would be suitable for unrestricted grazing use under Alternatives 2, 3, and 4. Any chance for exposure would occur prior to and during removal activities. Grazing and open space use may or may not be limited based on erosion and vegetation performance and cover maintenance requirements.

Alternatives 2, 3, and 4comply with the ARARs and are equal under this criterion. Alternative 1 retains the greatest chance for contaminant mobility and would rank below the other alternatives.

The short-term effectiveness is considered medium for Alternative 2 and high for Alternatives 3 and 4. Alternatives 3 and 4 require excavation or capping of the entire contaminated soil area; however, Alternative 2 requires a large transportation effort to remove all contaminated soil off-site. Alternatives 3 and 4 do not require off-site transport of the waste, but contaminated soil would need to be transported to the on-site repository or capping area. Alternatives 2, 3, and 4 would have a potential impact to workers and on-site visitors during construction activities. The number of trucks required to transport the contaminated soil to an off-site disposal facility would increase risk of traffic accidents and increase the carbon footprint for Alternative 2, whereas Alternatives 3 and 4 would introduce much lower risks for traffic accidents and greenhouse gas emissions.

Under each of the action alternatives, engineering controls would prevent off-site impacts from materials such as windborne dust. Alternative 1 has the lowest short-term and long-term effectiveness and is not considered a permanent solution and is ranked low. Alternative 2, ranked high, provides better long-term effectiveness and permanence because the waste would be managed by a third party in a location with waste from other sites. Alternatives 3 and 4 were rated medium for long-term effectiveness and permanence. Although waste would be managed in an engineered repository or capped area, maintenance of the cover would be required.

5.2 IMPLEMENTABILITY

Implementation of Alternative 1, No Further Action, is ranked low because no action is taken. Alternative 2 is technically feasible to implement and would use conventional techniques, materials, and labor for the excavation and associated activities. However, Alternative 2 requires a large amount of off-site trucking, and providing enough trucks each day to maintain production levels may be difficult to schedule and obtain. Alternative 2 is ranked medium for implementability.

Alternatives 3 and 4 are easily implemented as they are technically feasible and would use conventional techniques, materials, or labor for the excavation and associated activities. Alternative 3 is also administratively feasible since the waste material and the repository are on one contiguous site. Alternative 4 is technically feasible but administratively would require a site-specific, unique compliance standard as MARSSIM does not address subsurface soils. Alternatives 3 ranked high and Alternative 4 ranked medium for implementability.

All action alternatives require a large amount of water for dust control and revegetation efforts. Water is available at Grants, New Mexico, and potentially closer to the project site. Additional sources of water should be investigated during the planning phase.

5.3 COST-EFFECTIVENESS

Alternative 1 only involves O&M costs to maintain existing fencing and is the least expensive, but also the least cost-effective option because it does not address risks posed by leaving contaminated material in its current state. Alternative 2, removing the waste from the Site and disposing of it in a licensed low-level radioactive waste facility, has the highest long-term effectiveness; however, because of the high cost associated with this alternative, it has a low cost-effectiveness rating compared to Alternatives 3 and 4. Alternatives 2, 3, and 4 would allow unrestricted use of the Site. The most cost-effective alternative is Alternative 3, which involves on-site consolidation of wastes. Use restrictions would be applicable at the repository site, but the Site would be restored for controlled and restricted access for perpetuity under the stipulations of a federal enforcement document.

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FIGURES

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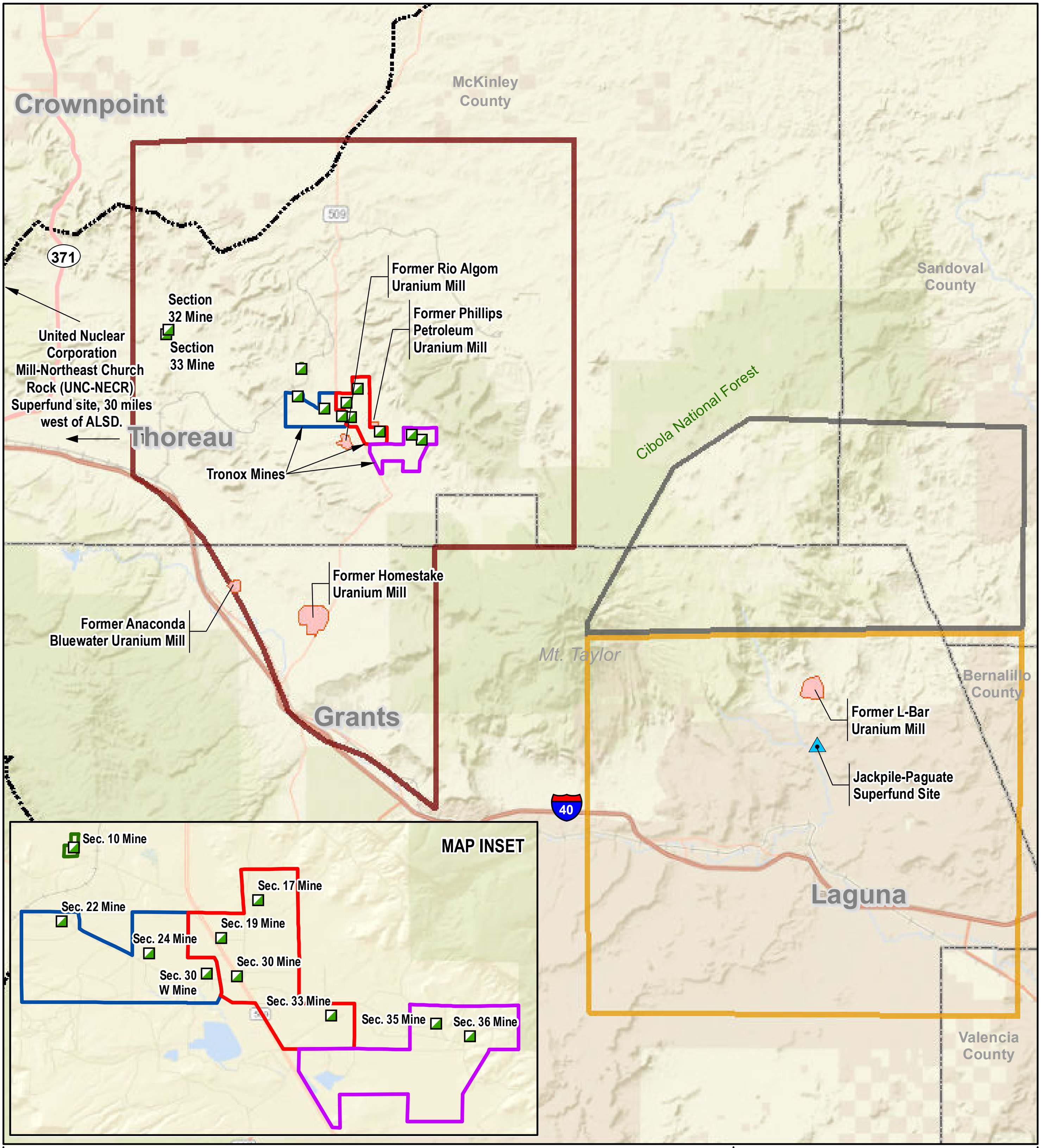

LEGEND

- Ambrosia Lake Sub-District of the Grants Mining District
- Laguna Sub-District of the Grants Mining District
- Marquez Sub-District of the Grants Mining District
- West GSA Mines Site
- Central GSA Mines Site
- East GSA Mines Site
- Section 10 Mine Site
- Uranium Mill Site
- County Boundary
- Continental Divide
- Tronox Surface Expression

0 7.5 15
Miles

New Mexico

N

SSID: A6PK
SEMS: NMN000605371
TDD: 0001/17-044
SOURCE: ESRI ONLINE IMAGERY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

USEPA REGION 6

FIGURE 1-1
SITE LOCATION MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

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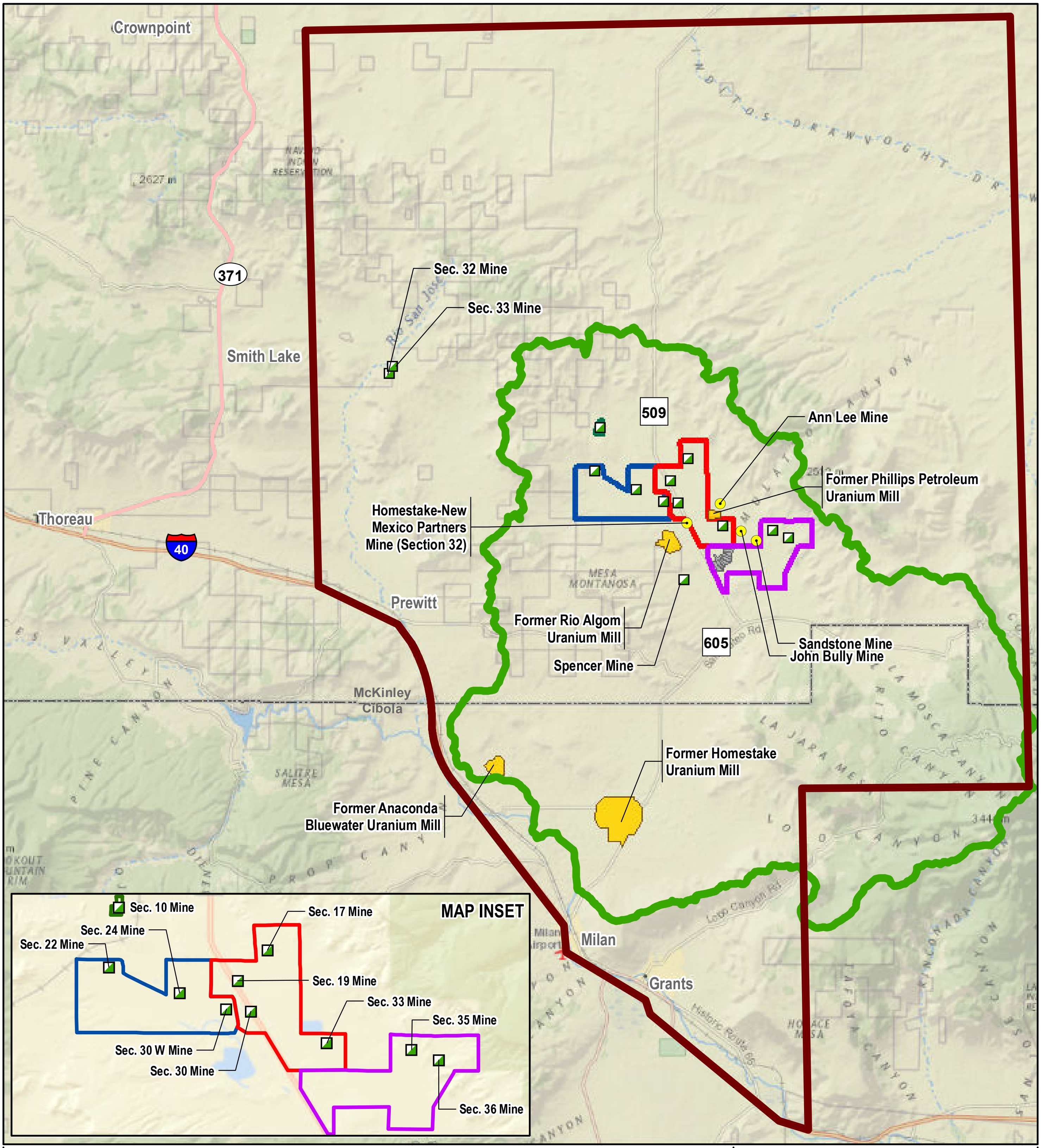

LEGEND

- Ambrosia Lake Sub-District
- San Mateo Creek Basin
- West GSA Mines Site
- Central GSA Mines Site
- East GSA Mines Site
- Section 10 Mine Site
- Uranium Mill Site
- Former Rio Algom Uranium Mill Evaporation Ponds
- Tronox Surface Expression
- Non-Tronox Surface Expression (SEMS Site)

0 2 4 6 8
Miles

N

TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY

USEPA REGION 6

FIGURE 1-2
SITE AREA MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

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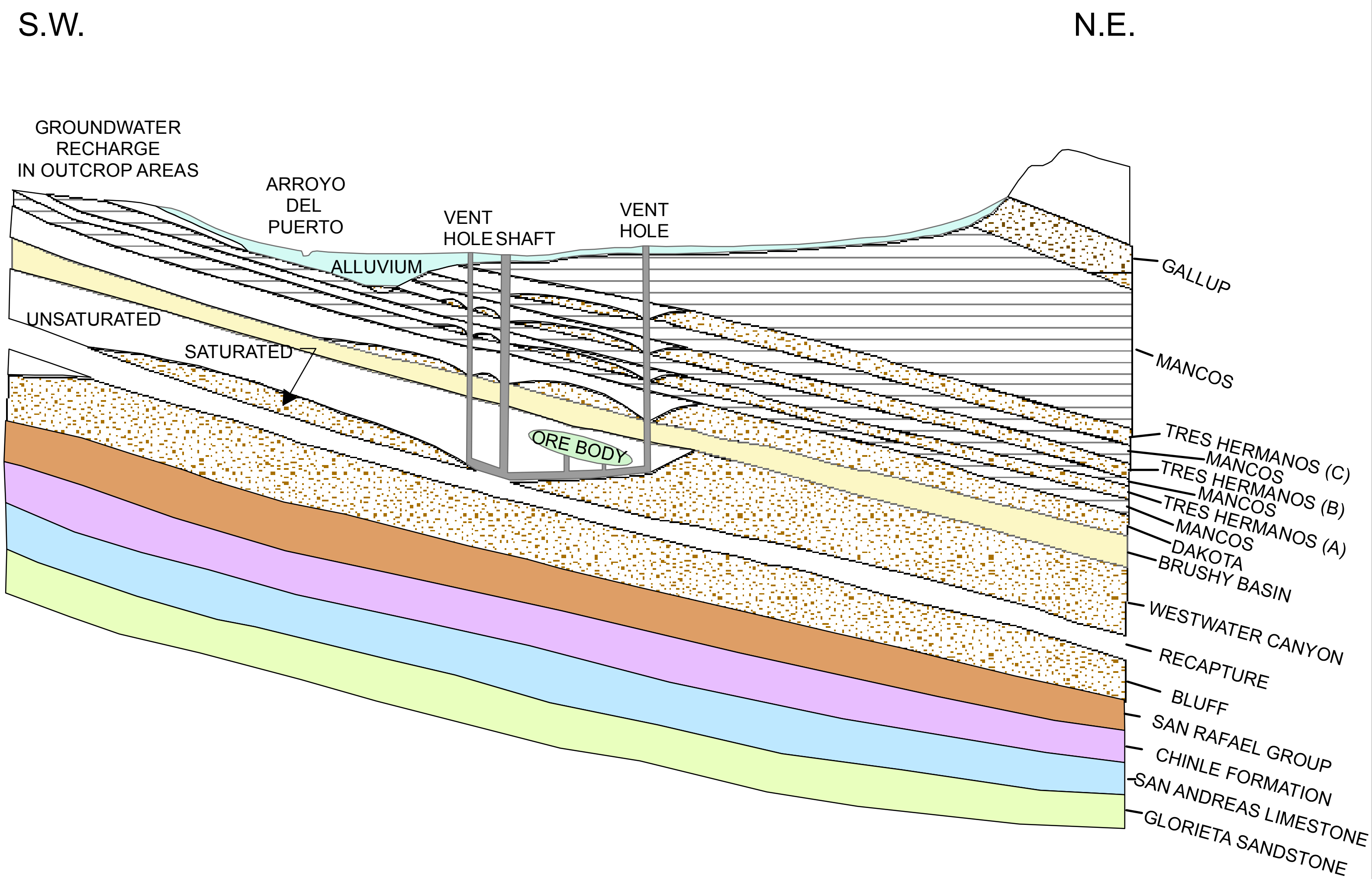
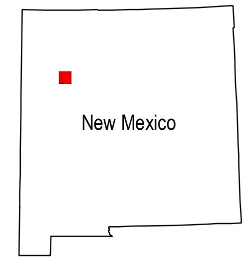


GENERALIZED CROSS-SECTION OF AMBROSIA LAKE AREA



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SEMS ID: NMN000605371
SOURCE: Los Alamos Scientific Laboratory, 1977. "Geology and Hydrology in the Vicinity of the Inactive Uranium Mill Tailings Pile, Ambrosia Lake, New Mexico"

USEPA REGION 6

FIGURE 1-3
AMBROSIA LAKE GEOLOGIC
CROSS-SECTION
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

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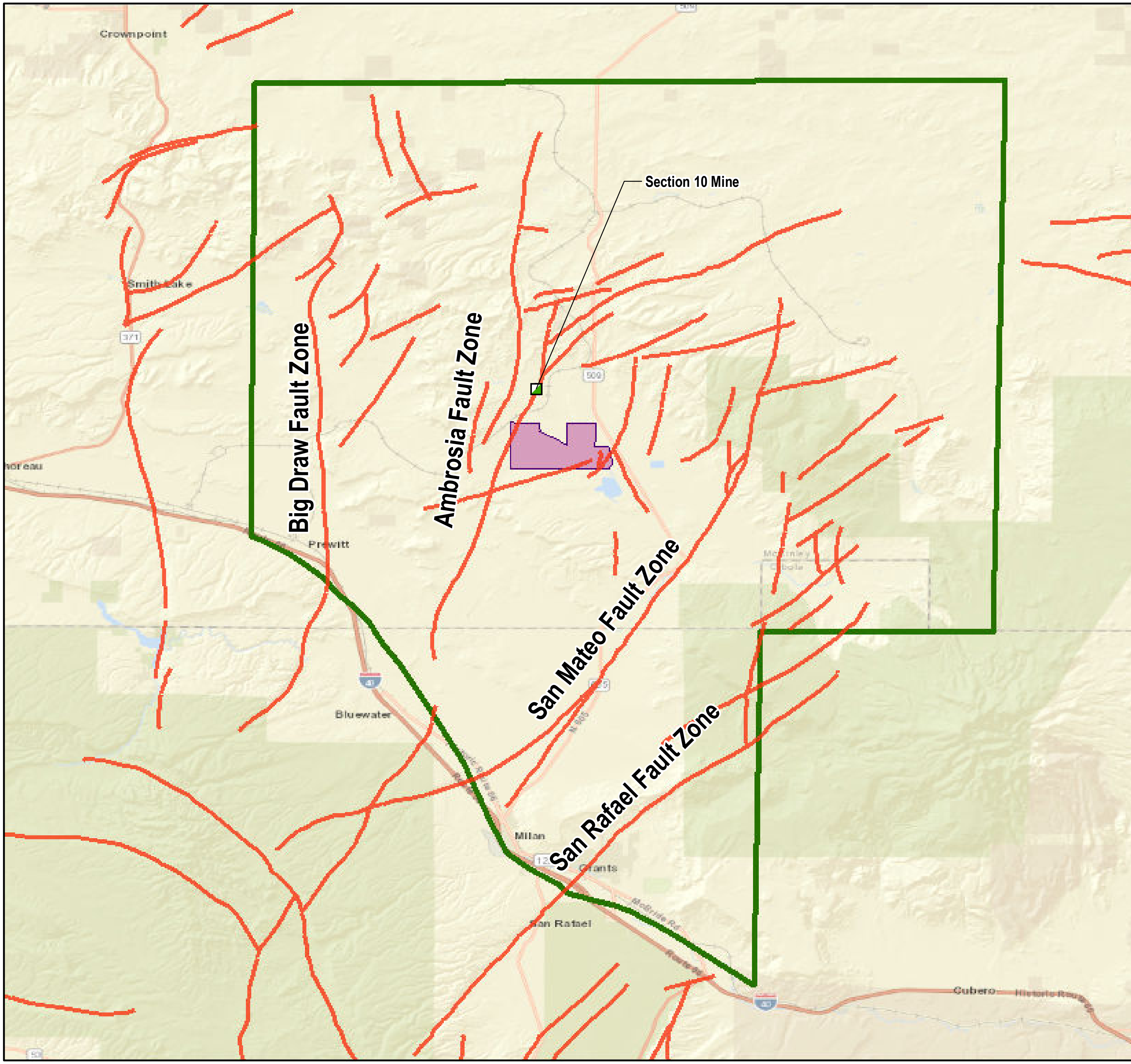

Legend

- Ambrosia Lake Sub-District
- West GSA Mines Site
- Fault Line
- Section 10 Mine

Note:

- Fault lines sourced from Green, G.N., and Jones, G.E., 1997, The Digital Geologic Map of New Mexico in ARC/INFO Format: U.S. Geological Survey Open-File Report 97-0052, 9p.; http://pubs.usgs.gov/of/1992/ofr-92-0052.
- GIS metadata sourced from https://pubs.usgs.gov/of/2005/1351/documents/NMmetadata.htm

N

0 5 10

Miles

TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY

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FIGURE 1-4
AMBROSIA LAKE FAULT ZONE MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

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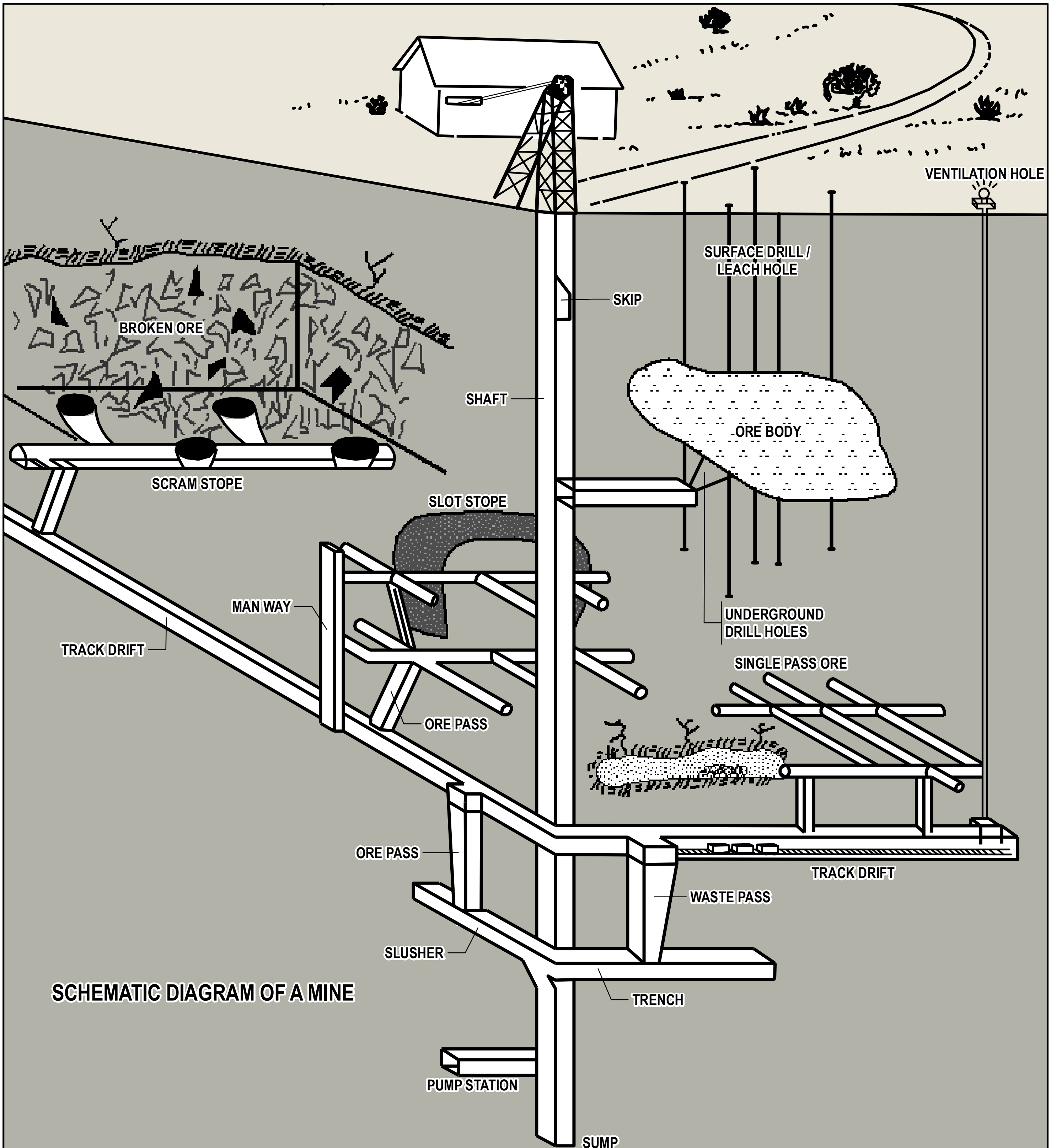


SCHEMATIC DIAGRAM OF A MINE

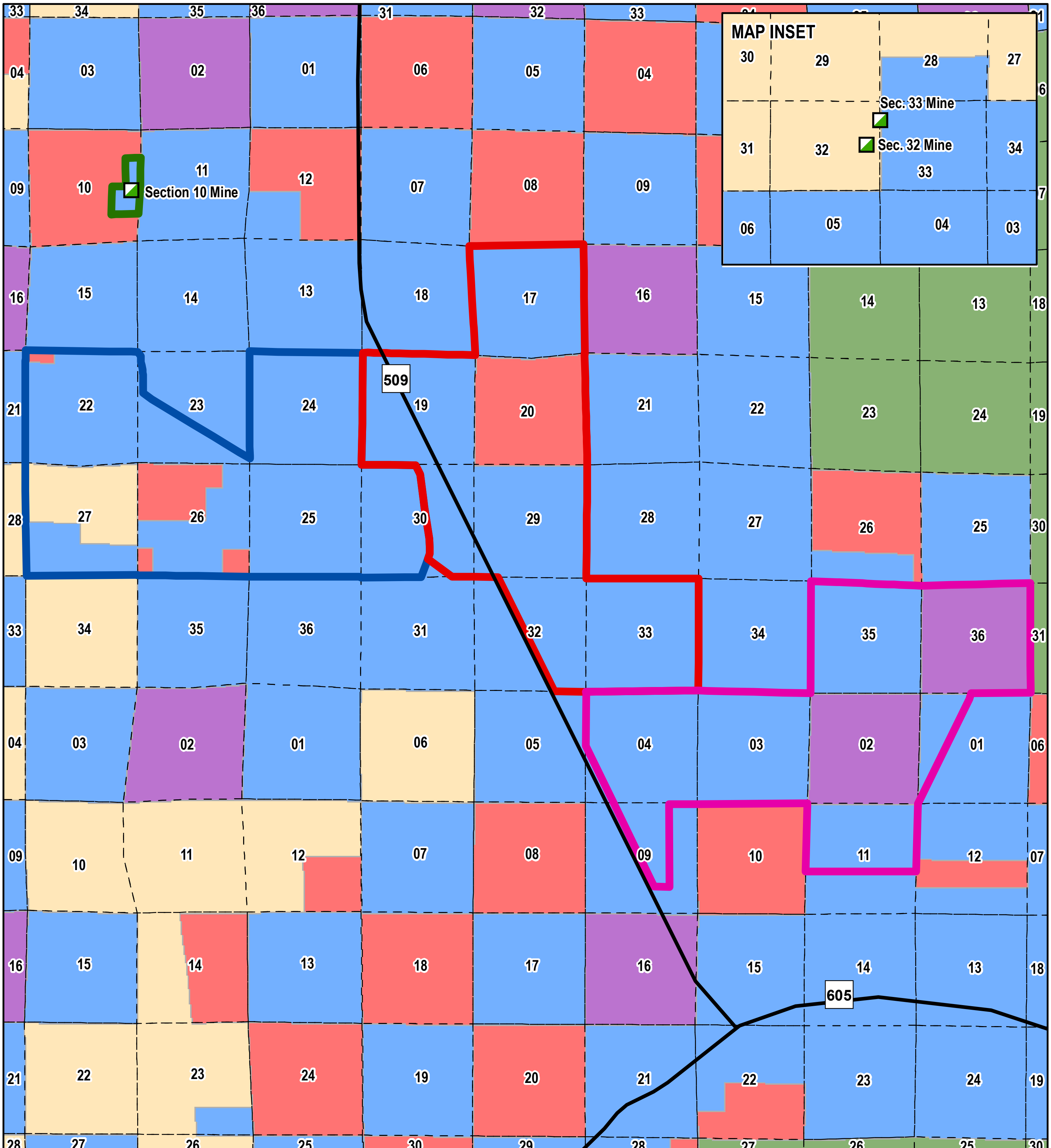
USEPA REGION 6

FIGURE 1-5
TYPICAL UNDERGROUND URANIUM MINE DIAGRAM
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: Kerr McGee Nuclear Corporation, Undated. “Uranium Mining and Processing”

FILE: Z:\TRONOX-WEST-GSA_GIS\mxd\Misc\EECA\Section 10 EECA Maps\Figure 1-5 - Typical Underground Uranium Mine Diagram.mxd 11:40:18 AM 2/7/2020 GRANTSGIS



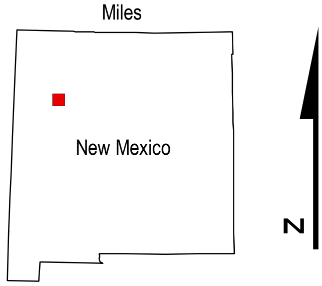
LEGEND

Land Ownership

- BLM
- Forest Service
- Navajo Allotment
- Private
- State

- Section Boundary
- Section 10 Mine Site
- West GSA Mines Site
- Central GSA Mines Site
- East GSA Mines Site
- Tronox Surface Expression

0 1 2
Miles



TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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FIGURE 1-6
LAND OWNERSHIP MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
DEC 2017	20600.012.001.1044	AS SHOWN

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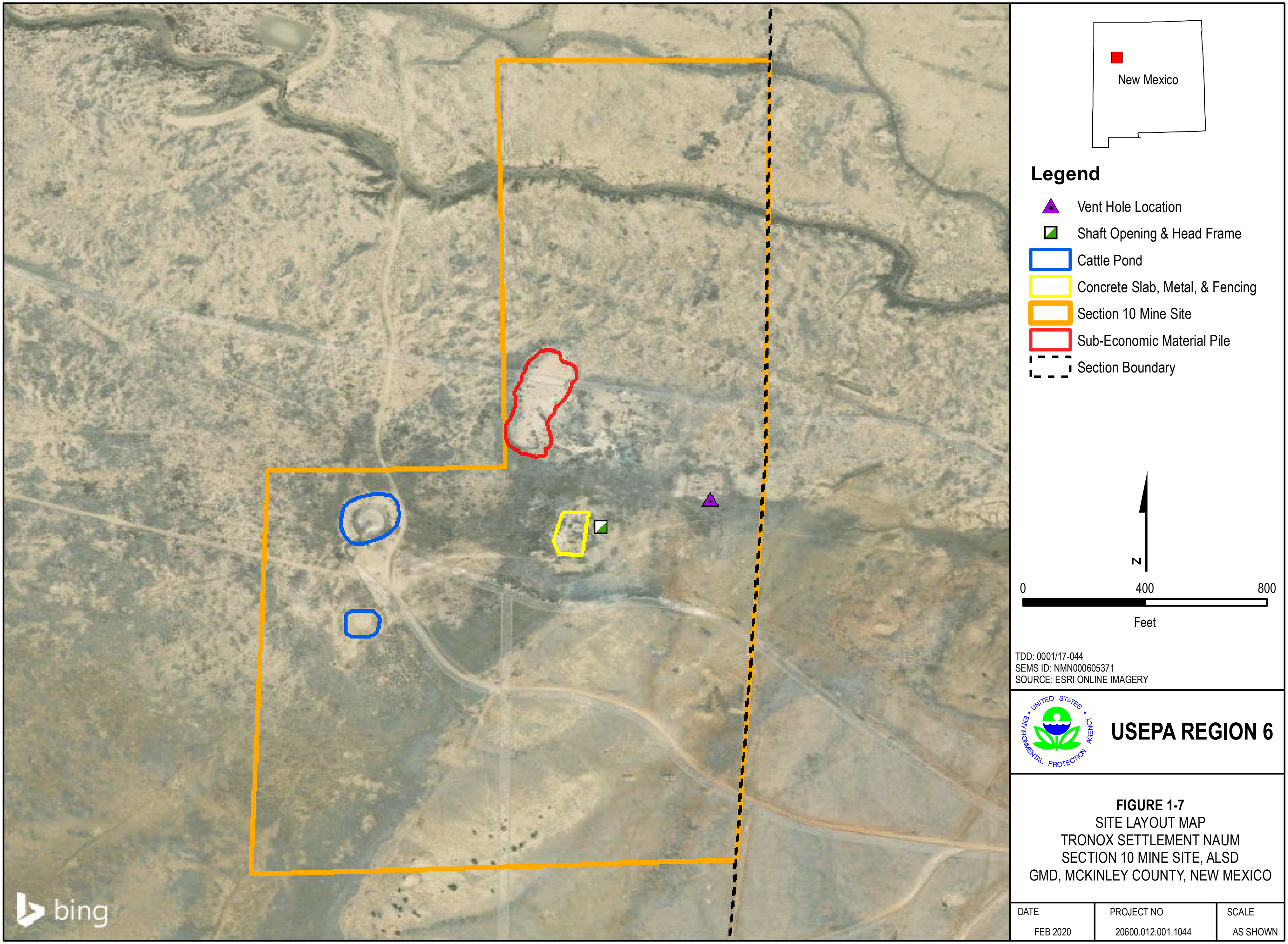

TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY

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FIGURE 1-7
SITE LAYOUT MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

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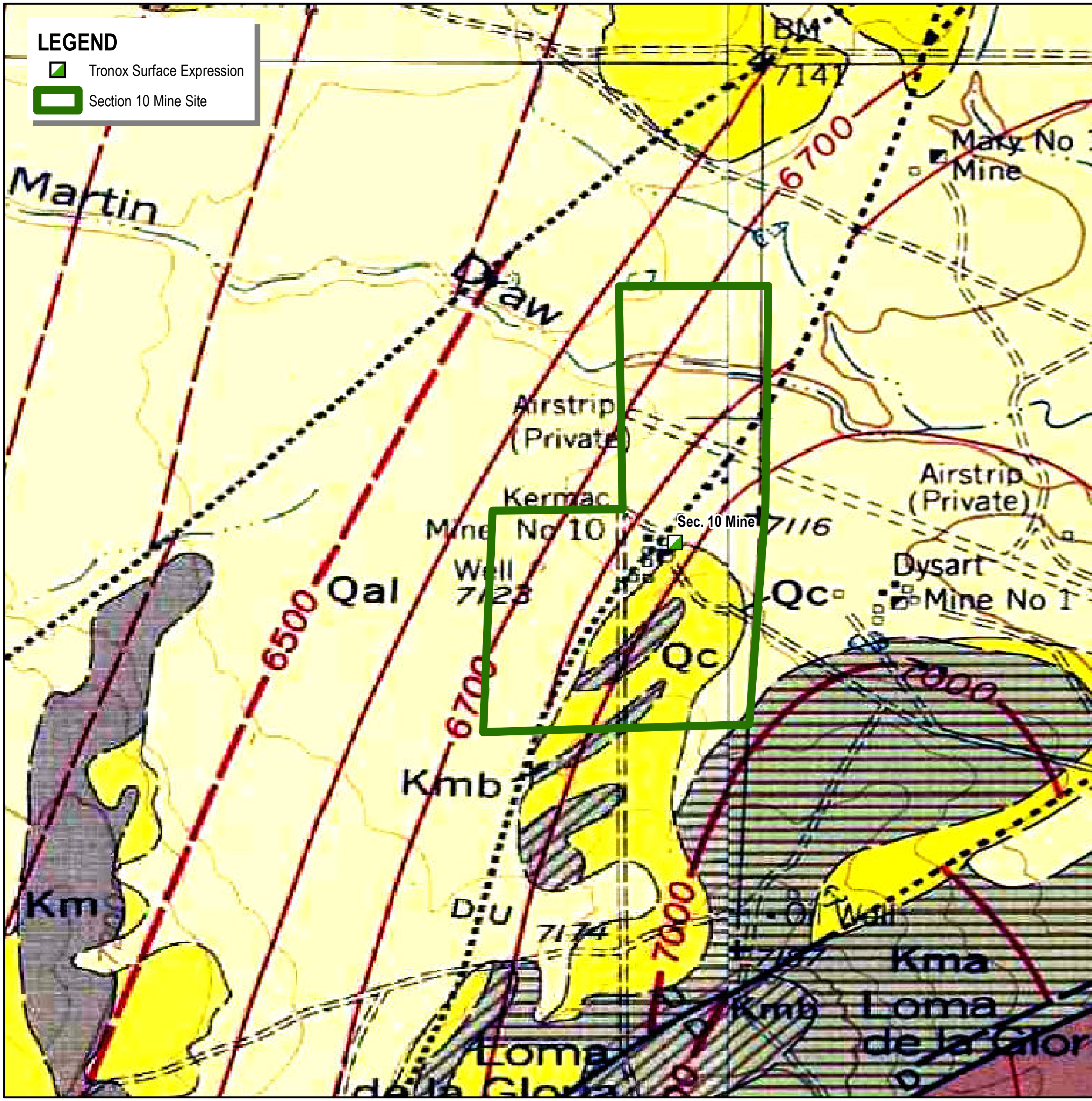

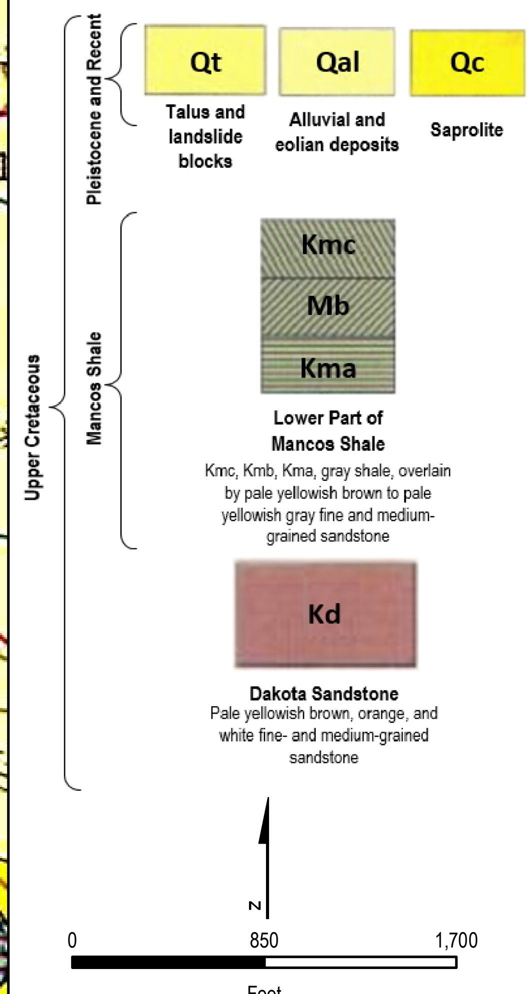

TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY; USGS GEOLOGY

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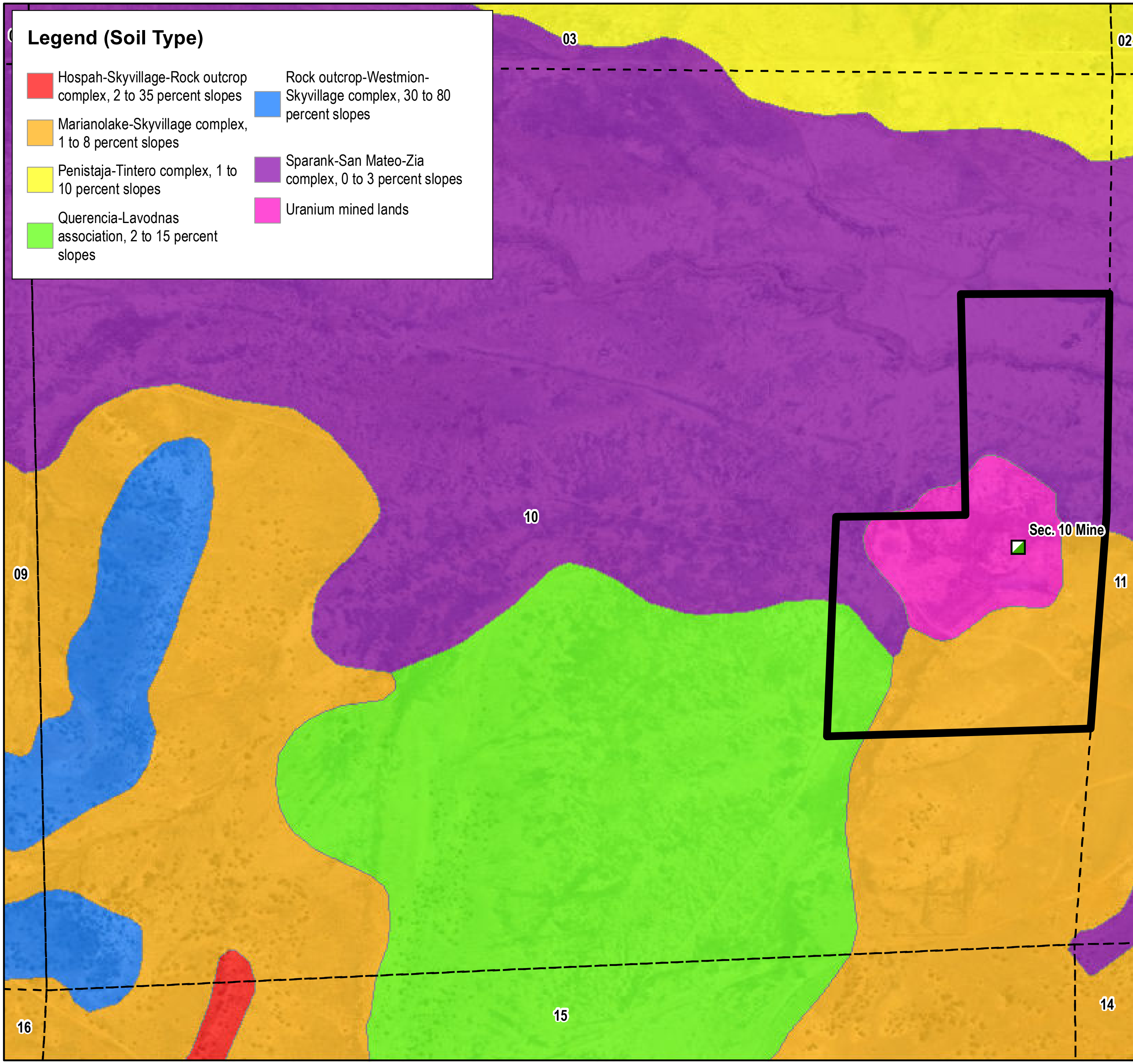
FIGURE 1-8
SITE GEOLOGY MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

FILE: Z:\TRONOX-WEST-GSA_GIS\mxd\Misc\EECA\Section 10 EECA Maps\Figure 1-8 - Site Geology Map.mxd 12:05:05 PM 2/7/2020 GRANTSGIS



LEGEND

Tronox Surface Expression

Section Boundary

Section 10 Mine Site

N

0 800 1,600

Feet

TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY; USDA Soil Survey Geographic (SSURGO) Database (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx)

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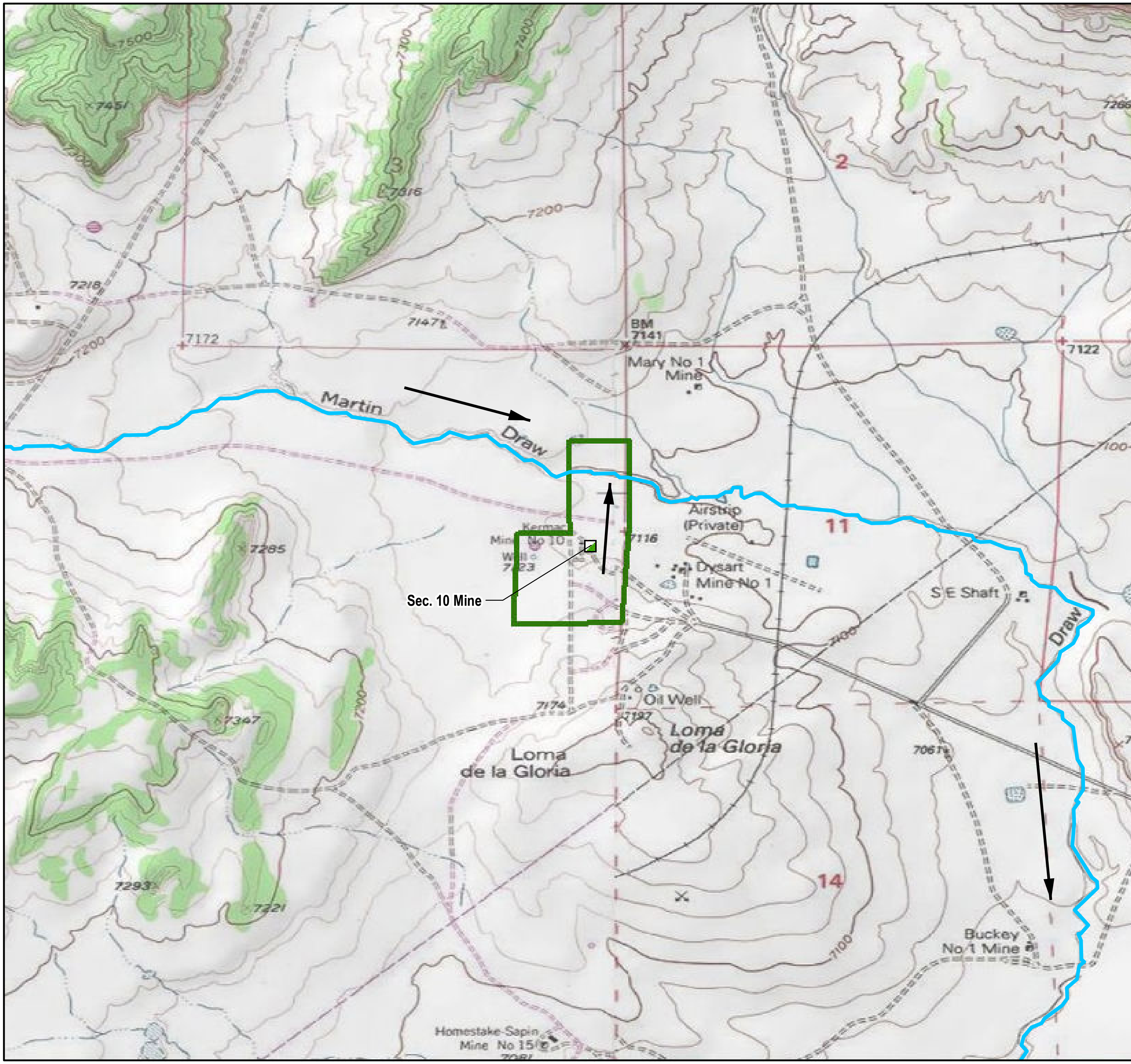
FIGURE 1-9
SITE SOILS MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

FILE: Z:\TRONOX-WEST-GSA_GIS\mxd\Misc\EECA\Section 10 EECA Maps\Figure 1-9 - Site Soils Map.mxd 12:06:11 PM 2/7/2020 GRANTSGIS



Legend

- Tronox Surface Expression
- Flow Direction
- Surface Drainage
- Section 10 Mine Site

N

0 2,000 4,000

Feet

TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY

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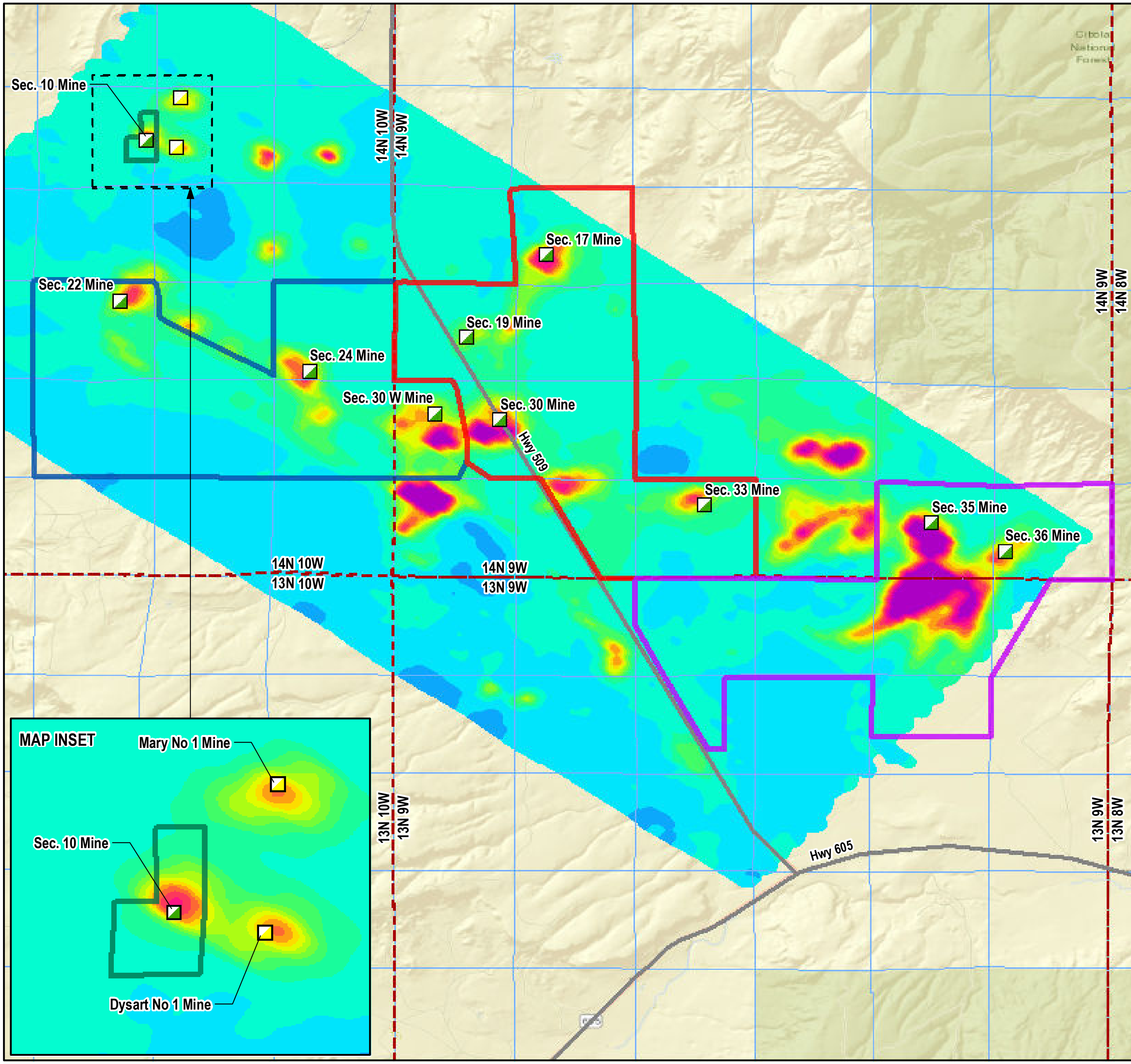
FIGURE 1-10
SITE SURFACE DRAINAGE MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

FILE: Z:\TRONOX-WEST-GSA_GIS\mxd\Misc\EECA\Section 10 EECA Maps\Figure 1-10 - Site Surface Drainage Map.mxd 12:06:58 PM 2/7/2020 GRANTSGIS



New Mexico

Legend

- West GSA Mines Site
- Central GSA Mines Site
- East GSA Mines Site
- Section 10 Mine Site
- Section Boundary
- Non-Tronox Surface Expression
- Tronox Surface Expression

Exposure Rate (microR/hr)

- < 5.0000
- 5.0000 : 10.000
- 10.000 : 15.000
- 15.000 : 20.000
- 20.000 : 25.000
- 25.000 : 30.000
- 30.000 : 35.000
- 35.000 : 40.000
- 40.000 : 45.000
- > 45.000

Note:
- Dynamac Corporation, 2011. Aerial Radiological Surveys, Ambrosia Lake Uranium Mines, Ambrosia, New Mexcio, 2011. EPA Emergency Management National Decontamination Team.
- Data collected August 22-25, 2011

0 2
Miles
N

TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY

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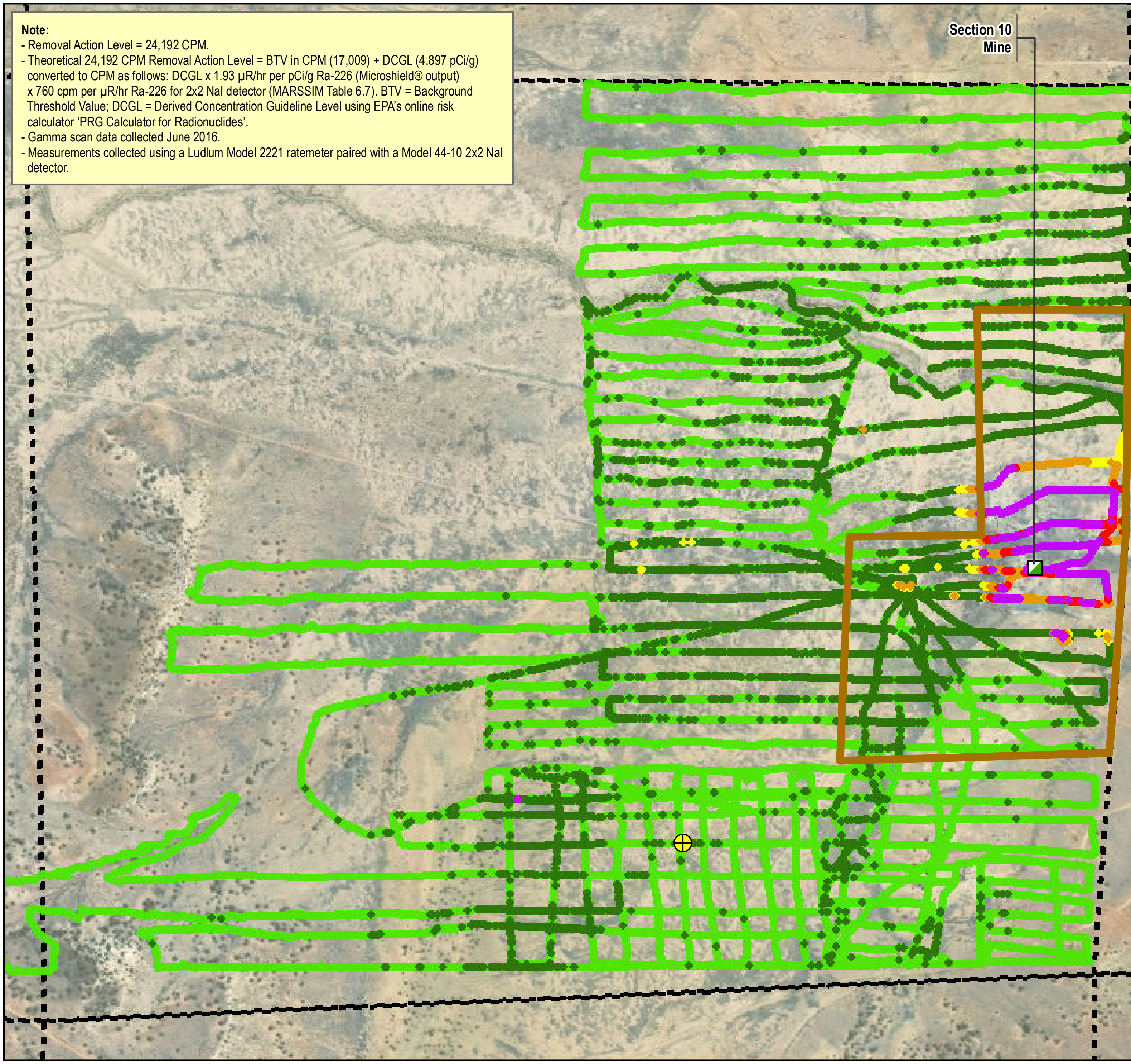
FIGURE 1-11
ASPECT AERIAL GAMMA SURVEY MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

FILE: Z:\TRONOX-WEST-GSA_GIS\mxd\Misc\EECA\Section 10 EECA Maps\Figure 1-11 - ASPECT Aerial Gamma Survey Map.mxd 12:08:46 PM 2/7/2020 GRANTSGIS

Note:
- Removal Action Level = 24,192 CPM.
- Theoretical 24,192 CPM Removal Action Level = BTV in CPM (17,009) + DCGL (4.897 pCi/g) converted to CPM as follows: DCGL x 1.93 µR/hr per pCi/g Ra-226 (Microshield® output) x 760 cpm per µR/hr Ra-226 for 2x2 NaI detector (MARSSIM Table 6.7). BTV = Background Threshold Value; DCGL = Derived Concentration Guideline Level using EPA's online risk calculator 'PRG Calculator for Radionuclides'.
- Gamma scan data collected June 2016.
- Measurements collected using a Ludlum Model 2221 ratemeter paired with a Model 44-10 2x2 NaI detector.



New Mexico

LEGEND

- Background Reference Area
- Tronox Surface Expression
- Section 10 Mine Site
- Section Boundary

Gamma Scan Results In Counts Per Minute (CPM)

- 0 - 17,009 (Background Threshold Value)
- 17,010 - 24,192 (Removal Action Level)
- 24,193 - 28,934
- 28,935 - 43,602
- 43,603 - 58,270
- 58,271 - 575,483

N

0 1,000
Feet

TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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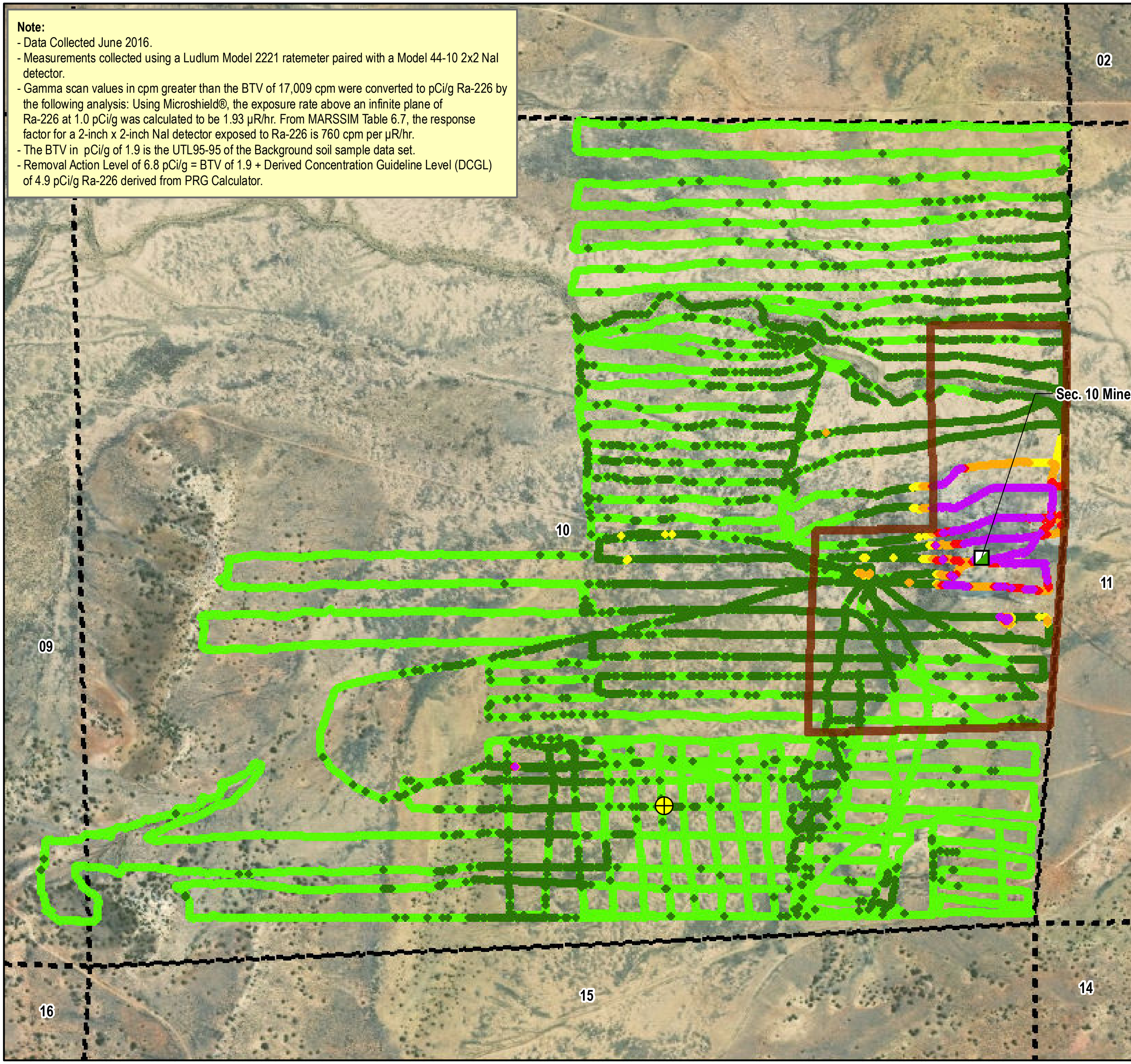
FIGURE 1-12
GAMMA SCANNING SURVEY RESULTS MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

FILE: Z:\TRONOX-WEST-GSA_GIS\mxd\Misc\EECA\Section 10 EECA Maps\Figure 1-12 - Gamma Scanning Survey Results Map.mxd 12:11:39 PM 2/7/2020 GRANTSGIS



Note:
- Data Collected June 2016.
- Measurements collected using a Ludlum Model 2221 ratemeter paired with a Model 44-10 2x2 NaI detector.
- Gamma scan values in cpm greater than the BTV of 17,009 cpm were converted to pCi/g Ra-226 by the following analysis: Using Microshield®, the exposure rate above an infinite plane of Ra-226 at 1.0 pCi/g was calculated to be 1.93 μR/hr. From MARSSIM Table 6.7, the response factor for a 2-inch x 2-inch NaI detector exposed to Ra-226 is 760 cpm per μR/hr.
- The BTV in pCi/g of 1.9 is the UTL95-95 of the Background soil sample data set.
- Removal Action Level of 6.8 pCi/g = BTV of 1.9 + Derived Concentration Guideline Level (DCGL) of 4.9 pCi/g Ra-226 derived from PRG Calculator.

New Mexico

LEGEND

- Background Reference Area
- Tronox Surface Expression
- Section 10 Mine Site
- Section Boundary

Gamma Scan Results

In Picocuries Per Gram (pCi/g)

- 0 - 1.9 (Background Threshold Value)
- 2.0 - 6.8 (Removal Action Level)
- 6.9 - 10
- 10.1 - 20
- 20.1 - 30
- 30.1 +

N

0 900 1,800

Feet

TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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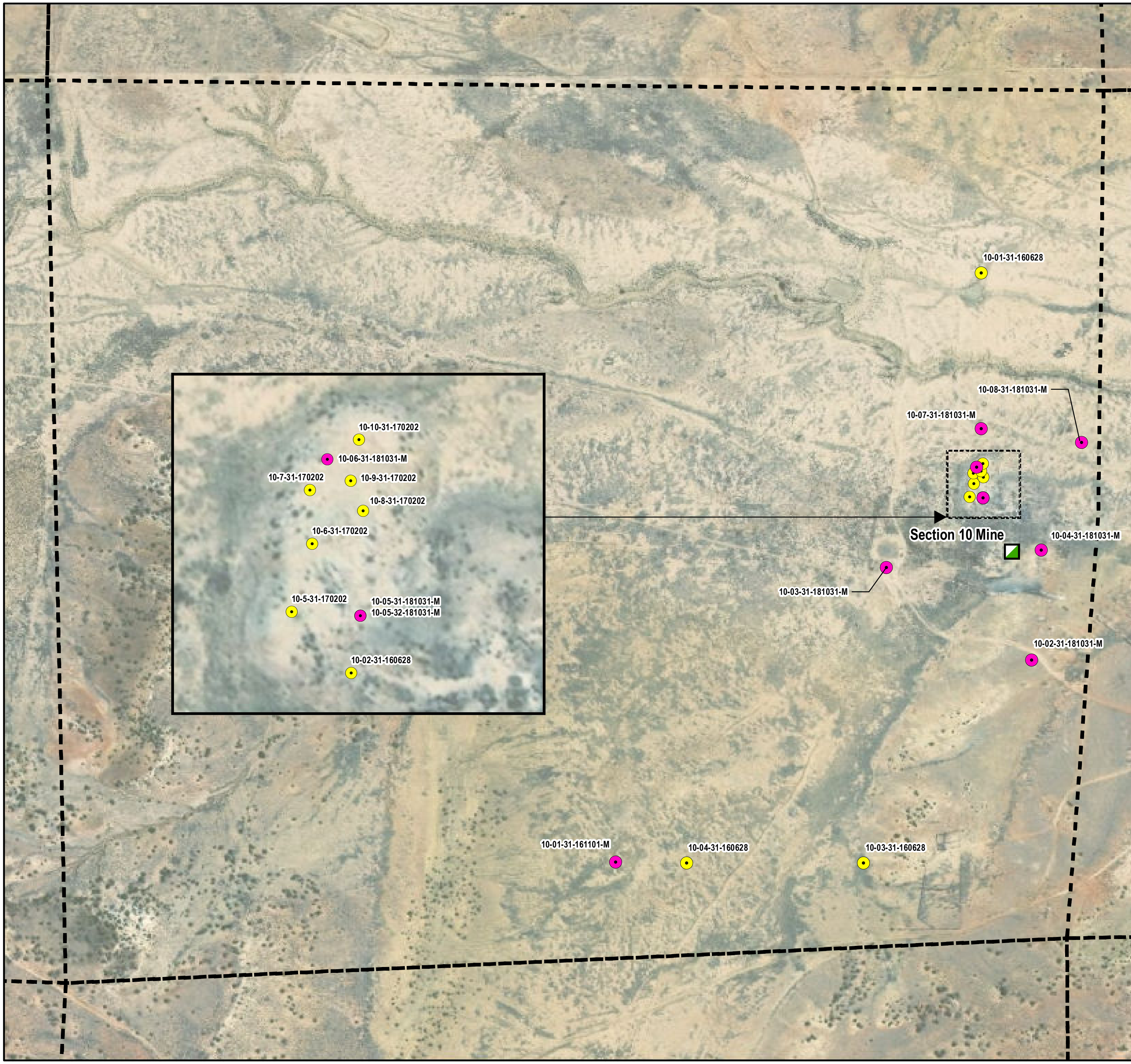
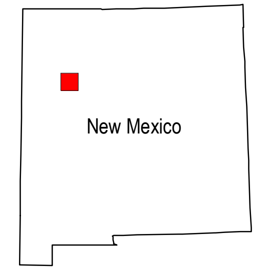
FIGURE 1-13
ESTIMATED Ra-226 CONCENTRATION MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

FILE: Z:\TRONOX-WEST-GSA_GIS\mxd\Misc\EECA\Section 10 EECA Maps\Figure 1-13 - Estimated Ra-226 Concentration Map.mxd 12:13:27 PM 2/7/2020 GRANTSGIS





LEGEND

- Soil Sample Analyzed for TAL Metals
- Surface (0"-6") Sample Location
- Tronox Surface Expression
- Section Boundary

NOTE:
- Soil samples collected 0-1 ft. below ground surface.

N

0 1,000
Feet

TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY

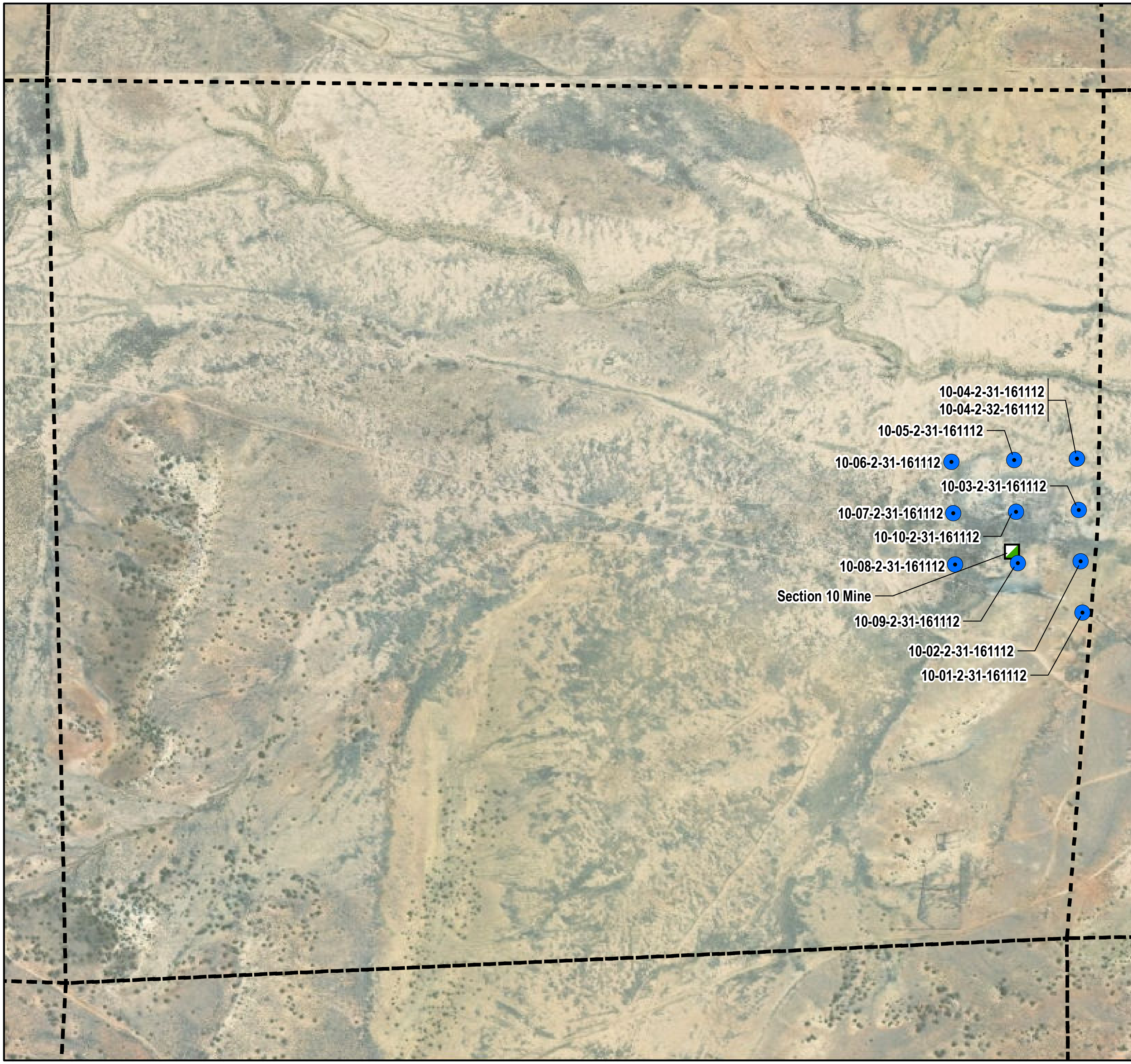
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

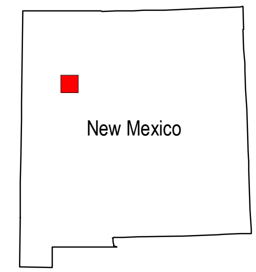
USEPA REGION 6

FIGURE 1-14
SURFACE SOIL SAMPLE LOCATION MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

FILE: Z:\TRONOX-WEST-GSA_GIS\mxd\Misc\EECA\Section 10 EECA Maps\Figure 1-14 - Surface Soil Sample Location Map.mxd 12:17:44 PM 2/7/2020 GRANTSGIS





LEGEND

Tronox Surface Expression

Section Boundary

Subsurface (12" - 18")
Soil Sample Concentration

<6.8 pCi/g (Proposed Action Level)

NOTE:
- Subsurface soil samples were collected May - August 2016

N

0 1,000

Feet

TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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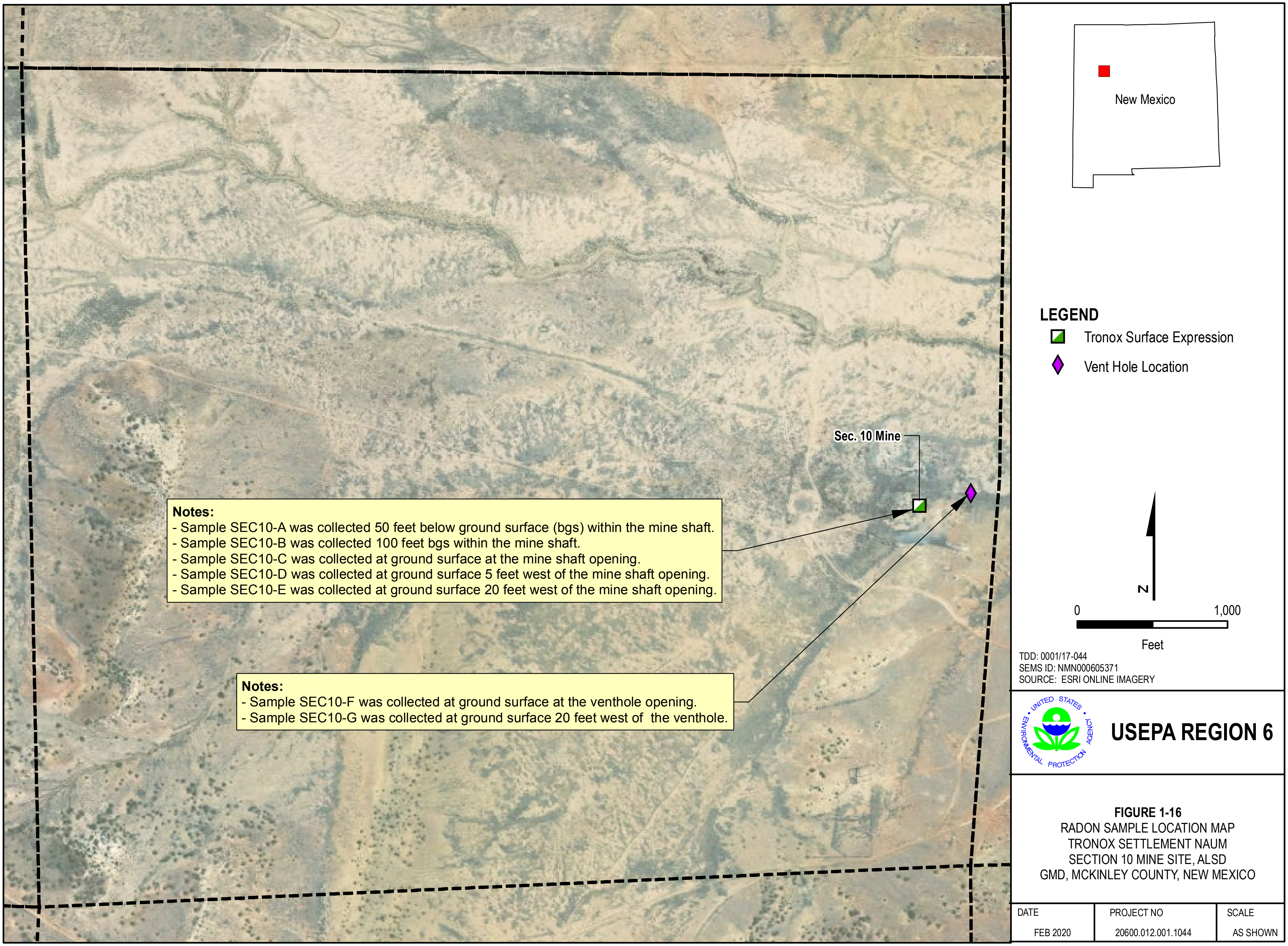
FIGURE 1-15
SUBSURFACE SOIL SAMPLE LOCATION MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

FILE: Z:\TRONOX-WEST-GSA_GIS\mxd\Misc\EECA\Section 10 EECA Maps\Figure 1-15 - Subsurface Soil Sample Location Map.mxd 12:18:37 PM 2/7/2020 GRANTSGIS



TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY

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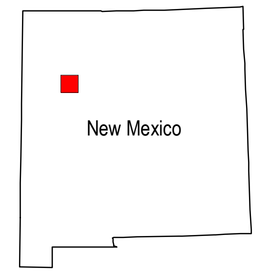
FIGURE 1-16
RADON SAMPLE LOCATION MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

FILE: Z:\TRONOX-WEST-GSA_GIS\mxd\Misc\EECA\Section 10 EECA Maps\Figure 1-16 - Radon Sample Location Map.mxd 12:20:00 PM 2/7/2020 GRANTSGIS



LEGEND

- Tronox Surface Expression
- Soil and Vegetation Sample Location

N

0 1,000

Feet

TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY

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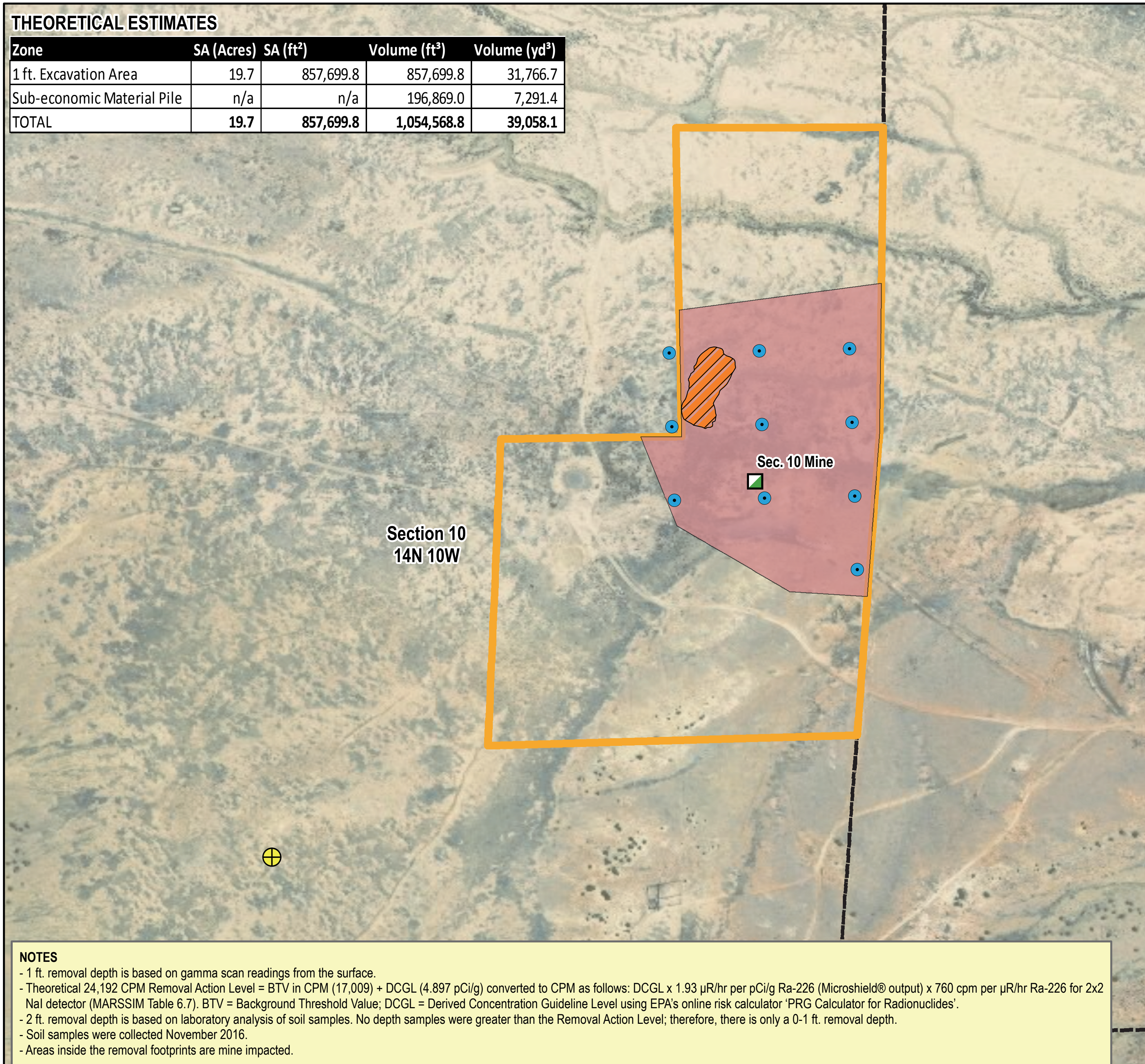
FIGURE 1-17
SOIL AND VEGETATION
SAMPLE LOCATION MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

FILE: Z:\TRONOX-WEST-GSA_GIS\mxd\Misc\EECA\Section 10 EECA Maps\Figure 1-17 - Soil and Vegetation Sample Location Map.mxd 12:20:58 PM 2/7/2020 GRANTSGIS

THEORETICAL ESTIMATES

Zone	SA (Acres)	SA (ft²)	Volume (ft³)	Volume (yd³)
1 ft. Excavation Area	19.7	857,699.8	857,699.8	31,766.7
Sub-economic Material Pile	n/a	n/a	196,869.0	7,291.4
TOTAL	**19.7**	**857,699.8**	**1,054,568.8**	**39,058.1**



Legend

- Background Reference Area
- Tronox Surface Expression
- Section 10 Mine Site
- Section Boudary
- Sub Economic Material Pile

Soil Sample (2 ft. depth)

Concentration (pCi/g Ra-226)

- < 6.8 (Removal Action Level)

Depth of Excavation Area

- 0-1 ft. (Theoretical 24,192 CPM Removal Action Level)

N

0 600 1,200

Feet

TDD: 0001/17-044
SEMS ID: NMN000605371
SOURCE: ESRI ONLINE IMAGERY

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NOTES

- 1 ft. removal depth is based on gamma scan readings from the surface.
- Theoretical 24,192 CPM Removal Action Level = BTV in CPM (17,009) + DCGL (4.897 pCi/g) converted to CPM as follows: DCGL x 1.93 µR/hr per pCi/g Ra-226 (Microshield® output) x 760 cpm per µR/hr Ra-226 for 2x2 NaI detector (MARSSIM Table 6.7). BTV = Background Threshold Value; DCGL = Derived Concentration Guideline Level using EPA's online risk calculator 'PRG Calculator for Radionuclides'.
- 2 ft. removal depth is based on laboratory analysis of soil samples. No depth samples were greater than the Removal Action Level; therefore, there is only a 0-1 ft. removal depth.
- Soil samples were collected November 2016.
- Areas inside the removal footprints are mine impacted.

FIGURE 2-1
SOIL REMOVAL ESTIMATE MAP
TRONOX SETTLEMENT NAUM
SECTION 10 MINE SITE, ALSD
GMD, MCKINLEY COUNTY, NEW MEXICO

DATE	PROJECT NO	SCALE
FEB 2020	20600.012.001.1044	AS SHOWN

FILE: Z:\TRONOX-WEST-GSA_GIS\mxd\Misc\EECA\Section 10 EECA Maps\Figure 2-1 - Soil Removal Estimate Map.mxd 12:24:36 PM 2/7/2020 GRANTSGIS

TABLES

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Table 1-1
Background Reference Area Summary of Field and Laboratory Measurements
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Sample ID	[1]Ludlum 2"x2" NaI One-Minute Stationary Measurement (counts per minute [cpm])	Laboratory Gamma Spectroscopy Result Radium-226 (picocuries per gram [pCi/g])
10-01-61-160714	16,361	1.43
10-02-61-160714	16,232	1.73
10-03-61-160714	16,312	1.36
10-04-61-160714	16,238	1.45
10-05-61-160714	16,358	1.57
10-06-61-160714	16,363	1.44
10-07-61-160714	16,415	1.55
10-08-61-160714	16,541	1.40
10-09-61-160714	16,362	1.44
10-10-61-160714	16,581	1.56
10-11-61-160714	16,739	1.61
10-12-61-160714	16,464	1.58
10-13-61-160714	16,680	1.27
10-14-61-160714	16,302	1.53
10-15-61-160714	16,055	1.71
10-16-61-160714	16,127	1.54
10-17-61-160714	15,816	1.71
10-18-61-160714	15,781	1.78
10-19-61-160714	15,941	1.59
10-20-61-160714	15,497	1.22
Mean	***16,258***	***1.5***
Standard Deviation	***306***	***0.15***
Coefficient of Variance	***0.02***	***0.1***

[1]One-minute stationary gamma measurements were collected with a Ludlum Model 2221 Rate Meter attached to a Model 44-10 Sodium Iodide (NaI) 2-inch by 2-inch Scintillator Probe.

Table 1-2
Summary of Surface Soil Sample Radium-226 Results
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Sample ID[1,2]	Latitude	Longitude	Collection Method	Sample Type	Radium-226 (picocuries per gram [pCi/g])[6]		Figure Depicting Sample Location
					Field Laboratory Multichannel Analyzer (MCA)[3,4]	Off-site Commercial Laboratory[5]	
10-01-31-160628	35.461000	-107.877000	Grab	Field Sample	n/a	1.46	1-14
10-02-31-160628	35.457000	-107.877000	Grab	Field Sample	n/a	14.7	1-14
10-03-31-160628	35.451000	-107.879000	Grab	Field Sample	n/a	0.924	1-14
10-04-31-160628	35.451000	-107.882000	Grab	Field Sample	n/a	1.37	1-14
10-05-31-170202	35.457203	-107.877198	Grab	Field Sample	21.8	n/a	1-14
10-06-31-170202	35.457429	-107.877129	Grab	Field Sample	51.6	n/a	1-14
10-07-31-170202	35.457608	-107.877137	Grab	Field Sample	18.1	n/a	1-14
10-08-31-170202	35.457540	-107.876961	Grab	Field Sample	20.1	n/a	1-14
10-09-31-170202	35.457639	-107.877001	Grab	Field Sample	125.2	n/a	1-14
10-10-31-170202	35.457775	-107.876974	Grab	Field Sample	82.8	n/a	1-14

1 All samples collected from 0-6 inches below ground surface.

2 First two digits of the sample number indicate the section from which they were collected.

3 MCA and offsite laboratory both analyzed for Bismuth-214. Samples were held for 21 days before analysis so that Bismuth-214 was in equilibrium with Radium-226.

4 n/a denotes that the sample was not analyzed with the MCA.

5 n/a denotes that the sample was not sent for offsite laboratory analysis.

6 Sample results above the 6.8 pCi/g Removal Action Level (RAL) are shaded in gray.

Table 1-3
Summary of Subsurface Soil Sample Radium-226 Results
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Sample ID[1,2]	Latitude	Longitude	Collection Method	Sample Type	Radium-226 (picocuries per gram [pCi/g])		Figure Depicting Sample Location
					Field Laboratory Multichannel Analyzer (MCA)[3,4]	Off-site Commercial Laboratory[5]	
10-01-2-31-161112	35.455244	-107.875290	Grab	Field Sample	2.1	n/a	1-15
10-02-2-31-161112	35.456115	-107.875321	Grab	Field Sample	3.3	n/a	1-15
10-03-2-31-161112	35.456985	-107.875352	Grab	Field Sample	4.6	n/a	1-15
10-04-2-31-161112	35.457856	-107.875383	Grab	Field Sample	3.3	n/a	1-15
10-04-2-32-161112	35.457856	-107.875383	Grab	Field Duplicate	3.3	n/a	1-15
10-05-2-31-161112	35.457830	-107.876447	Grab	Field Sample	3.4	n/a	1-15
10-06-2-31-161112	35.457805	-107.877511	Grab	Field Sample	2.5	n/a	1-15
10-07-2-31-161112	35.456935	-107.877480	Grab	Field Sample	2.9	n/a	1-15
10-08-2-31-161112	35.456064	-107.877449	Grab	Field Sample	1.9	n/a	1-15
10-09-2-31-161112	35.456089	-107.876385	Grab	Field Sample	2.6	n/a	1-15
10-10-2-31-161112	35.456960	-107.876416	Grab	Field Sample	3.3	n/a	1-15

[1] All samples collected from 12-18 inches below ground surface.

[2] First two digits of the sample number indicate the section from which they were collected.

[3] MCA and offsite laboratory both analyzed for Bismuth-214. Samples were held for 21 days before analysis so that Bismuth-214 was in equilibrium with Radium-226.

[4] No sample results are above the 6.8 pCi/g Removal Action Level (RAL).

[5] n/a denotes that the sample was not sent for offsite laboratory analysis.

Table 1-4
Summary of Surface Soil Sample Metals Results
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Values in milligrams per kilogram (mg/kg)

Analyte[1]	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Silver	Sodium	Thallium	Mercury	Selenium	Vanadium	Zinc	Uranium	Figure Depicting Sample Location
State Screening Level[2]	1,290,000	519	35.9	255,000	2,580	1,110	32,400,000	505	388	51,900	908,000	800	5,680,000	160,000	25,700	76,200,000	6,490	37,300,000	13	112	6,490	6,530	389,000	3,880	
State Background[3]	54423	1	5.9	727	1	n/a	35808	55.5	8.8	21	20898	18.1	n/a	366.8	27.9	n/a	n/a	n/a	n/a	n/a	1	71.4	44.3	n/a	
Sample Number[4]																									
10-01-31-161101-M	6100	ND[6]	5.6	100	0.38	0.18	17000	3.4	2.2	19	12000	12	4200	140	3.5	1700	ND	47	ND	ND	82	160	38	73	1-14
10-02-31-181031-M	11000	ND	3.5	190	0.55	ND	12000	5.2	3.2	3	12000	5.7	3200	200	5.7	2300	ND	150	ND	0.014	ND	14	25	ND	1-14
10-03-31-181031-M	12000	ND	ND	77	0.62	ND	3300	7	4.7	6.2	13000	14	2900	210	7.1	3900	ND	180	ND	0.017	ND	38	38	ND	1-14
10-04-31-181031-M	10000	ND	4.2	73	0.61	ND	9500	5.3	2.7	3.2	10000	8.2	4100	140	4.8	2700	ND	150	ND	0.026	15	77	24	6.2	1-14
10-05-31-181031-M	14000	ND	ND	110	0.91	ND	10000	2.2	3	6.3	12000	6.8	3300	240	3.9	3400	ND	490	ND	0.028	87	110	26	70	1-14
10-05-32-181031-M	15000	ND	ND	100	0.97	ND	10000	2.5	3.1	6.4	12000	6.5	3700	260	4.1	3700	ND	560	ND	0.033	77	120	29	67	1-14
10-06-31-181031-M	6000	ND	20	210	0.56	ND	4100	ND	1.8	ND	10000	8.7	1700	140	1.6	880	ND	150	ND	0.12	86	250	17	310	1-14
10-07-31-181031-M	17000	ND	7.1	75	0.8	ND	5300	9.7	5.3	7.8	16000	5.4	4200	190	9.2	4700	ND	190	ND	0.022	ND	26	44	ND	1-14
10-08-31-181031-M	22000	ND	ND	88	1	ND	6800	13	6.1	9.5	19000	5.5	5300	240	11	5800	ND	210	ND	0.019	ND	34	53	ND	1-14

[1] Analytes are from the Targeted Analyte List (https://www.epa.gov/sites/production/files/2015-10/documents/ism23a-c.pdf) plus Uranium.

[2] NM-specific screening levels from: NMED Industrial/ Occupational Soil Screening Levels (Cancer Target Risk [TR]=1E-05, Non-Cancer Total Hazard Quotient [THQ]=1), June 2019 (https://www.env.nm.gov/hazardous-waste/guidance-documents/).

[3] NM-specific background values were obtained from: https://www.epa.gov/chemical-research/guidance-developing-ecological-soil-screening-levels.

[4] First two digits of the sample number indicate the section from which the sample was collected.

[5] n/a indicates that the NM-specific screening level or NM-specific background is not available for that element.

[6] ND indicates that the analyte was not detected.

Table 1-5
Summary of Radon Sample Results
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Sample number	Date placed	Date collected	Description of location	Radon-222 picocuries per liter (pCi/l)[1]	Figure Depicting Sample Location
SEC10A	10/28/2016	11/3/2016	Inside mine shaft, 50' deep	6,304.9	1-16
SEC10B	10/28/2016	11/3/2016	Inside mine shaft, 100' deep	8,170.5	1-16
SEC10C	6/29/2017	7/5/2017	Edge of mine shaft	11.1	1-16
SEC10D	6/29/2017	7/5/2017	5' from edge of mine shaft	0.7	1-16
SEC10E	6/29/2017	7/5/2017	20' from edge of mine shaft	0.9	1-16
SEC10F	6/29/2017	7/5/2017	Top of ventilation shaft	1,247.9	1-16
SEC10G	6/29/2017	7/5/2017	20' from ventilation shaft	2.1	1-16

[1]The EPA and Centers for Disease Control (CDC) acceptable exposure level for indoor radon exposure is 4 picocuries per liter (pCi/l). There is no recommended exposure level for outdoor radon.

Table 3-1
Chemical-Specific ARARs and TBC Information
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Media	Requirement	Requirement Synopsis	Status and Rationale
Hazardous Wastes	FEDERAL **Resource Conservation and Recovery Act (RCRA) of 1976, as amended** –42 USC 6901 *et seq.*; 40 CFR 261 Subpart C	Provides for "cradle-to-grave" regulation of hazardous wastes. Per 42 USC 6903(27), RCRA does not regulate "source, special nuclear, or byproduct material" as defined in the Atomic Energy Act. Per 40 CFR 261.4(b)(7), wastes derived from the extraction, beneficiation and processing of ores are not hazardous wastes. U.S. EPA does not anticipate encountering RCRA hazardous wastes during this removal action. However, if hazardous wastes (e.g., buried drums containing solvents) are discovered, toxicity characteristic leaching procedure (TCLP) limits would be ARARs for characterizing hazardous waste.	Substantive requirements may be applicable if wastes that are subject to the Act are encountered.
Hazardous Materials	FEDERAL **Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), as amended –** And regulations at 40 CFR Part 192, Subparts A-E	Protect the public and the environment from uranium mill tailings. Some requirements (e.g., 40 CFR 192.02, 192.12, 192.32) may be ARARs.	TBC
Other	FEDERAL **Code of Federal Regulations (CFR), Title 10, Part 20** Nuclear Regulatory Commission (NRC) Regulations – Standards for Protection Against Radiation; Subpart D – Radiation Dose Limits	Establishes standards for protection against ionizing radiation resulting from activities conducted under licenses issued by the NRC.	Substantive requirements may be applicable or relevant and appropriate if source, byproduct or special nuclear material is encountered.

Table 3-1 (Continued)
Chemical-Specific ARARs and TBC Information
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Media	Requirement	Requirement Synopsis	Status and Rationale
Other	FEDERAL **EPA Directive on Protective Cleanup Levels for Radioactive Contamination at CERCLA sites.** OSWER Directive 9200.4-18	Provides guidance for cleanup levels for CERCLA sites with radioactive contamination. Cleanup of radionuclides are governed by risk established in the NCP when ARARS are not available or sufficiently protective.	TBC.

Table 3-1 (Continued)
Chemical-Specific ARARs and TBC Information
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Media	Requirement	Requirement Synopsis	Status and Rationale
Other	FEDERAL **EPA Directive on Conducting Risk Assessments for Radioactive Contamination at CERCLA sites.** OSWER Directive 9285.6-20	Provides guidance in a Q&A format, giving answers to several commonly asked questions regarding risk assessments at radioactively contaminated CERCLA sites.	TBC.

Media	Requirement	Requirement Synopsis	Status and Rationale
Hazardous Waste	STATE **20.4 New Mexico Administrative Code (NMAC) –** Hazardous Waste Management	Establishes criteria for the classification of hazardous waste and for the treatment, storage, and disposal of hazardous waste. The state Act incorporates most Federal RCRA regulations, including the definition of solid waste, which excludes “source, byproduct or special nuclear material.” New Mexico’s definition of hazardous waste also excludes wastes from the extraction, beneficiation, and processing of ores and minerals. Although hazardous waste is not expected, the requirement to characterize waste to determine whether it is hazardous is an ARAR.	Substantive requirements may be applicable or relevant and appropriate if wastes that are subject to the Act are encountered.

Table 3-1 (Continued)
Chemical-Specific ARARs and TBC Information
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Media	Requirement	Requirement Synopsis	Status and Rationale
Soil	STATE **Joint Guidance for the Cleanup and Reclamation of Existing Uranium Mining Operations in New Mexico** (New Mining and Minerals Division and the New Mexico Environment Department; March 2016)	Provides general guidance for cleanup and reclamation of existing uranium mine sites. Prepared by the New Mexico Mining and Minerals Division and the New Mexico Environment Department.	TBC – The numeric criteria listed in the guidance are not promulgated numeric standards but are recommended to satisfy NMAC 19.10 (New Mexico Mining Commission action-specific requirements). (1) The concentration of Ra-226 in land averaged over any area of 100 square meters ("m^2") shall not exceed the background level by more than (a) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and (b) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface. (2) Site post-reclamation radiation level ("PRRL") for gamma radiation should not exceed the site-specific value of gamma radiation that correlates to 5 pCi/g Ra-226 above background at the 95th percentile value. (3) For sites at which contaminated material exceeding the target radium activity level discussed above is emplaced in an on-site repository, cover material for the repository must achieve radon flux equal or less than 20 $pCi/m^2/s$.

Table 3-1 (Continued)
Chemical-Specific ARARs and TBC Information
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Media	Requirement	Requirement Synopsis	Status and Rationale
Water	STATE **20.6.2 NMAC –** New Mexico Water Quality Ground and Surface Water Protections	Establishes water quality standards and regulations to prevent or abate water pollution from discharges.	Substantive requirements may be relevant and appropriate to surface runoff on tribal trust land, and may be applicable to surface runoff on non-tribal lands.
Water	STATE **20.6.4 NMAC –** New Mexico Standards for Interstate and Intrastate Surface Waters	Establishes water quality standards that consist of the designated use or uses of surface waters, water quality criteria necessary to protect the use or uses, and an anti-degradation policy.	Substantive requirements may be relevant and appropriate to surface runoff on tribal lands, and may be applicable to surface runoff on non-tribal lands.
Other	STATE **20.3.4 NMAC –** Standards for Protection Against Radiation	Establishes standards for protection against ionizing radiation resulting from activities conducted pursuant to licenses or registrations issued by the Department.	Substantive requirements may be relevant and appropriate.

Notes:
ARAR = applicable or relevant and appropriate requirements
CERCLA = Comprehensive Environmental Response Compensation and Liability Act
NCP = National Oil and Hazardous Substances Pollution Contingency Plan
pCi/g = pico Curies per gram
CFR = Code of Federal Regulations
NPL = National Priorities List
OSWER = Office of Solid Waste and Emergency Response
TBC = To Be Considered

Table 3-2
Location-Specific ARARs and TBC Information
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Media	Requirement	Requirement Synopsis	Status and Rationale
Cultural Resources	FEDERAL **The Native American Graves Protection And Repatriation Act –** 25 United States Code (USC) Section 3001 *et seq* and its regulations Title 43 CFR Part 10.	Protects Native American graves from desecration through the removal and trafficking of human remains and cultural items including funerary and sacred objects.	Substantive requirements applicable if Native American burials or cultural items are identified within area to be disturbed.
Cultural Resources	FEDERAL **National Historic Preservation Act –** 16 USC 470 *et seq*; 36 CFR Part 800	Provides for the protection of sites with historic places and structures.	Substantive requirements applicable if eligible resources identified within area to be disturbed.
Cultural Resources	FEDERAL **Archeological Resources Protection Act of 1979 –** 16 USC Sections 470aa-mm; 43 CFR Part 7	Prohibits removal of or damage to archaeological resources unless by permit or exception.	Substantive requirements applicable if eligible resources are identified within area to be disturbed.
Cultural Resources	FEDERAL **American Indian Religious Freedom Act –** 42 USC Section 1996 *et seq*.	Protects religious, ceremonial, and burial sites, and the free practice of religions by Native American groups.	Substantive requirements applicable if Native American sacred sites are identified within area to be disturbed.
Wildlife	FEDERAL **Endangered Species Act –** 16 USC Sections 1531-1544, Title 50 CFR Parts 17 and 402	Regulates the protection of threatened and endangered species or critical habitat of such species.	Substantive requirements applicable if protected species are identified within area to be disturbed.
Cultural Resources	STATE **New Mexico Cultural Properties Act** – New Mexico Statutes Annotated (NMSA) 1978 Sections 18-6-1 through 18-6-27	Requires the identification of cultural resources, assessment of impact on those resources that may be caused by the proposed remedy, and consultation with the State Historic Preservation Officer.	Substantive requirements applicable to response actions on non-tribal lands in New Mexico.

Notes:
ARAR = applicable or relevant and appropriate requirements
TBC = To Be Considered

Table 3-3
Action-Specific ARARs and TBC Information
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Media/ Activity	Requirement	Requirement Synopsis	Status and Rationale
Solid Wastes	FEDERAL **Resource Conservation and Recovery Act (RCRA) of 1976, as amended –** 42 USC 6901 *et seq*.	Regulates disposal of solid waste. Per 42 USC 6903(27), RCRA does not regulate "source, special nuclear, or byproduct material" as defined in the Atomic Energy Act, but may apply to other wastes, including ores containing uranium in concentrations less than 500 ppm.	Substantive requirements may be applicable to wastes that are subject to the Act.
Solid Waste	FEDERAL **Criteria for Classification of Solid Waste Disposal Facilities** – 40 CFR 257 and 258	Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment and, thereby, constitute prohibited open dumps.	Substantive requirements relevant and appropriate for siting disposal repositories.
Hazardous Materials	FEDERAL **Federal Hazardous Materials Transportation Law (formerly Hazardous Materials Transportation Act) –** 49 CFR Parts 171, 172, 173, 174	Provides protection against the risks to life, property, and the environment that are inherent in transportation of hazardous materials in commerce.	Substantive requirements applicable to transportation of materials subject to the Act, including radionuclides.
Water	FEDERAL **EPA Guidance for Developing Best Management Practices for Storm Water –** Publication EPA/832/R-92006	Guidance for developing stormwater BMPs for industrial facilities.	TBC.
Water	FEDERAL **Clean Water Act (CWA) –** Section 402, National Pollutant Discharge Elimination System (NPDES) Stormwater discharges (40 CFR parts 122, 125).	On-site and off-site discharges from site are required to meet the substantive CWA requirements, including discharge limitations, monitoring and best management practices.	Substantive requirements may be applicable.

Media/ Activity	Requirement	Requirement Synopsis	Status and Rationale
Water	FEDERAL **CWA –** Section 404, dredged or fill material, 33 CFR Parts 320-330, 40 CFR 230.	Regulates discharge of dredge or fill material into waters of the U.S.	Substantive requirements may be applicable to activities impacting waters of the U.S.
Air	STATE **20.2 NMAC –** Air Quality	Establishes ambient air quality standards, performance standards for specific sources of air pollutants, and specifies monitoring methods.	Substantive requirements may be relevant and appropriate to sources during removal action.

Media/ Activity	Requirement	Requirement Synopsis	Status and Rationale
Mining	STATE **19.10 NMAC –** Regulation of Non-Coal Mining	Establishes requirements for mine reclamation and close-out plans. The New Mexico Ming Act (NMMA), administered under NMMC Regulations, contemplates returning an area affected by mining activity to pre-mining conditions. The regulations apply to all currently-operating mines as well as to mines that operated for a minimum of two years between January 1, 1970 and June 18, 1993. Defines “reclamation” as the employment of measures to mitigate disturbance and stabilize the permit area so as to “minimize future impact” on the environment and to protect air and water quality [Section 69-36-3(K); 19.10.1.7(R)(1)]. Section 69-36-7.H.2 of the NMMA requires the “protection of human health and safety, the environment, wildlife and domestic animals.” Also, sections 19.10.3.304.D.7.b, 19.10.5.507.B(2), 19.10.5.508.B and 19.10.6.603.C NMAC of the NMMC regulations have similar requirements. Section 69-36-11(B)(3) requires that existing sites be reclaimed so as to re-establish a self-sustaining ecosystem.	Substantive requirements are relevant and appropriate.
Wildlife	STATE **New Mexico Wildlife Conservation Act** – NMSA 178 Sections 17-2-37 thru 17-2-46	Provides for the protection of threatened and endangered species.	Substantive requirements may be applicable if protected species are identified within area to be disturbed.

Media/ Activity	Requirement	Requirement Synopsis	Status and Rationale
Plants	STATE **New Mexico Endangered Plant Species Act –** NMSA 1978, Section 75-6-1	Provides for the regulation and protection of threatened and endangered plant species. Endangered plant species means any plant species whose prospects of survival within the state are in jeopardy or are likely within the foreseeable future.	Substantive requirements may be applicable if protected species are identified within area to be disturbed.
Plants	STATE **New Mexico Endangered Plants Regulations** – Section 19.21 New Mexico Administrative Code (NMAC)	Establishes requirements for the protection of threatened and endangered flora and fauna.	Substantive requirements applicable if such species are identified within area to be disturbed.
Plants	STATE **New Mexico Noxious Weed Control Act** – NMSA 1978, Sections 76-7-1 through 76-7-30	Addresses the management and control of noxious weeds because of their negative impact on the economy or the environment.	Relevant and appropriate requirement if noxious weed plant species that are not indigenous to New Mexico are found at the Site or within areas to be disturbed.

Notes:
ARAR = applicable or relevant and appropriate requirements
CFR = Code of Federal Regulations
CWA = Clean Water Act
EPA = U.S. Environmental Protection Agency
NMAC = New Mexico Administrative Code
NMSA = New Mexico Statutes Annotated
TBC = To Be Considered

Table 3-4
Off-Site Transportation and Disposal Pricing
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Company	Landfill/Mill	Miles (one-way)	Transportation Costs ($/ton)	Disposal/Processing Costs ($/ton)	2019 Total Costs ($/ton)	Comments
Clean Harbors						
Truck from Grants, NM Direct Landfill Disposal	Deer Trail, CO	550	$55.00	$75.00	**$130.00**	Transportation cost based on budgetary quote of $5,500 per truck.
US Ecology						
Truck from Grants, NM Direct Landfill Disposal	Beatty, NV	610	$210.00	Included in Transportation Costs	$210.00	
Truck from Grants, NM Direct Landfill Disposal	Grand View, ID	870	$295.00	Included in Transportation Costs	$295.00	

Notes:
1) Assumed 100 tons per truck load for Clean Harbors.
2) May need to address questions such as the need for prevailing wage payment for transportation and other contract requirements that could increase costs.
3) Budgetary quotes were received from US Ecology and Clean Harbors in December 2019.
4) A price of $130/ton was used in the EE/CA cost estimate, which should allow processing and transport by truck to the Deer Trails Landfill (shown in bold).
5) Rail transport is possible but costing would require additional effort.

Table 4-1
Summary of Analysis of Alternatives
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Removal Alternative	Evaluation Criteria					
	Protection of Human Health and the Environment	**Compliance with ARARs**	**Short-Term Effectiveness**	**Long-Term Effectiveness and Permanence**	**Implementability**	**Cost Effectiveness**
Alternative1: No Further Action	Low – No additional protection provided.	Not Applicable	Low – No action.	Low – Does not provide any effectiveness or permanence.	Low – No action.	Low – No action.
Alternative 2: Excavation and Off-Site Disposal of Contaminated Soils at a Licensed Low-Level Radioactive Waste Facility	High – Protection provided by waste being placed in an off-site engineered repository.	High – Complies with ARARs.	Medium – Disturbance of the entire waste area during excavation, large off-site transport effort, and longer time to implement.	High – Waste is managed with other waste at a processing facility or landfill permitted to receive the waste.	Medium – Readily implementable. Administratively and technically feasible; however, the large amount of trucks needed to maintain production levels may be difficult to schedule.	Low
Alternative 3: Excavation and Disposal of Contaminated Soil at a Non-Incised, On-Site Repository	High – Protection provided by waste being placed in an on-site engineered repository. Maintenance of cap will be required.	High – Complies with ARARs.	High – Disturbance of the entire waste area during excavation, however all transport effort is on-site.	Medium – Waste is managed in an engineered repository. Maintenance of the cover is required.	High – Readily implementable. Administratively and technically feasible.	Medium
Alternative 5: Capping of Contaminated Soil in Place	High – Protection provided by waste being placed in an on-site engineered repository. Maintenance of cap will be required.	High – Complies with ARARs.	High – Disturbance of the entire waste area during excavation, however all transport effort is on-site.	Medium – Waste is managed beneath an engineered cap. Maintenance of the cover is required.	Medium – Readily implementable. Technically feasible but subsurface contamination is not addressed by MARSSIM.	Medium

Table 4-2
Estimated Risk of Fatalities and Greenhouse Gas Emissions Due to Off-Site Trucking
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

	Truckloads of Waste	Miles Round Trip to Transport Waste	Truckloads of Fill	Miles Round Trip to Transport Fill	Total Miles	Estimated Fatalities due to Off-Site Trucking [1]	Estimated Greenhouse Gas Emissions due to Off-Site Trucking [2] (metric tons CO_2e)
Alternative 1, No Further Action	0	0	0	0	0	0.00	0
Alternative 2, Excavation and Off-Site Processing and Disposal of Contaminated Soils at Licensed Low-Level Radioactive Waste Facility (Clean Harbors, Deer Trail, CO)	2,700	1,100	100	40	2,974,000	0.04	5,279
Alternative 3, Excavation and Disposal of Contaminated Soil at a Non-Incised, On-Site Repository	0	0	1,000	40	40,000	0.00	71
Alternative 4, Capping of Contaminated Soil in Place	0	0	3,800	40	152,000	0.00	270

Notes:
CO_2e= Carbon Dioxide Equivalent

1. A rate of 1.40 fatalities per 100 million large truck miles traveled was calculated as shown below using data (2010 - 2014) from the National Center for Statistics and Analysis. (2016, May). Large trucks: 2014 data. (Traffic Safety Facts. Report No. DOT HS 812 279). Washington, DC: National Highway Traffic Safety Administration (https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812279).

	People Killed in Crashes Involving Large Trucks	Large-Truck Miles Traveled (millions)	Fatality Rate per 100 Million Large-Truck-Miles Traveled
2010	3,686	286,527	1.29
2011	3,781	267,594	1.41
2012	3,944	269,207	1.47
2013	3,981	275,017	1.45
2014	3,903	279,132	1.40
Average from 2010 - 2014			**1.40 fatalities per 100 million miles traveled**

2. Metric tons of CO2e per large truck mile traveled was calculated as shown below using data and methods from the EPA GHG Equivalencies Calculator - Calculations and References (https://www.epa.gov/energy/ghg-equivalencies-calculator-calculations-and-references). Carbon dioxide emissions per gallon of diesel fuel was obtained from the US Energy Information Administration Frequently Asked Questions (http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=11). Mileage for Combination Trucks (Classification Types 8-13) was obtained from the FHWA Highway Statistics Table VM-1 based on 2012 and 2013 data (https://www.fhwa.dot.gov/policyinformation/statistics/2013/vm1.cfm).

$$\frac{22.38 \text{ lb CO2/gallon diesel fuel}}{2{,}205 \text{ lb CO2/metric ton CO2}} \times \frac{1 \text{ CO2e}}{0.986 \text{ CO2}} \times \frac{1}{5.8 \text{ miles/gallon}} = 0.001775$$

metric tons CO2e per miles traveled

APPENDIX A

NATURAL RESOURCES EVALUATION REPORT

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Natural Resources Evaluation

Tronox Navajo Area Uranium Mines

Western Geographic Sub Area

McKinley County, New Mexico

Prepared for
US Evironmental Protection Agency Region 6
Weston Solutions

January 2017

CONTENTS

APPENDIX A. FIGURES 1-4

APPENDIX B. SOIL CHARACTERISITCS, VEGETATION TRANSECTS, SAMPLES

APPENDIX C. SPECIES LISTS, LOCATIONS

INTRODUCTION

The US Environmental Protection Agency (USEPA) proposes to initiate mine waste removal on several former uranium mine sites to reestablish pre-mine habitats and promote restoration to a sustainable arid grassland ecology. The sites are located within the Ambrosia Lake Sub-District (ALSD) area of the Grants Mining District of the Western Geographic Sub Area within McKinley County, New Mexico (Figure 1a in Appendix D). The reclamation study area consists of former underground uranium mines (Kermac #10, #23, Mine #24, Homestake Sapin #25) and associated lands. For the purposes of this report, the study area totals approximately 2,300 acres. It is located in Township 14 North, Range 10 West Sections 10, 11, 15, 22, 23, 24, 25, 26, and Range 9 West; Section 30 30. It appears on the *Ambrosia Lake* and *Goat Mountain, New Mexico* US Geological Survey 7.5-minute quadrangle maps (Figure 1a). The area is eligible for abatement activities subject to the Tronox Navajo Area Uranium Mine (NAUM) settlement, and this study area has been identified as the West Geographic Sub Area.

The Tronox NAUM Area comprises approximately 100 square miles within the ALSD in McKinley County, New Mexico. The ALSD is located within an area of uranium mineralization that extends approximately 100-miles long and 25-miles wide encompassing portions of McKinley, Cibola, Sandoval, and Bernalillo counties of New Mexico. The study area is located approximately 17 miles north of Grants, and 5.0 miles from the intersection of New Mexico State Highways 509 and 605 (Figure 1a).

Proposed Action

The USEPA proposes to excavate at least 12 inches of top soils throughout the site once reclamation areas are identified based on soils and vegetation sampling for uranium levels. Scraped areas would be revegetated and recontoured to restore, to the extent feasible, pre-mining site conditions. Several million cubic yards of soils (potentially ranging from 1 to 3 feet of removal) over the study area surface could be removed and disposed of at an approved site outside the study area.

Methods

Existing site conditions as they pertain to natural resources considerations relative to reclamation were characterized by obtaining field observational data, documented physical site properties, literature review information, and soil sampling results for the study area.

In-field and desktop investigations were performed. Existing soil and watershed conditions were identified through a review of federal and state agency reports and webtools. Revegetation, and site recommendations are tailored to site-specific conditions and based on recommendations from agricultural and reclamation sources from the vicinity. Federal and state listed, as well as otherwise protected species were identified through agency database query. Soil and vegetation samples were collected by Weston Solutions and select results provided for use in generating recommendations for this report.

Field surveys were performed to identify protected species, wildlife habitat, and vegetative community types/percent cover and water resources. For the purposes of evaluating natural resources at the site, approximately 17 percent of the study area (about 400 acres) was targeted for intensive ground surveys (Figure 1b). Other areas were assessed via reconnaissance as feasible, as many areas can be accessed via vehicle. Field surveys were conducted during September and October of 2016. Full ground surveys were completed within each survey polygon (Figure 1b).

Fifteen 50-meter long vegetation transects were identified via a random, then arbitrary method within community. Each transect was read at 1 centimeter intervals to generate an estimate of cover by species within each community. Along 13 of the 15 transects, vegetation clippings were obtained and soil samples were taken from 12 inches deep (Weston Solutions 2016). A wildlife trail camera was placed at a pond location. Wildlife or their sign were identified based on photos or observations, and identification of listed species or habitat suitable for listed species was provided. Waterways and wetland areas as present within surveyed areas were addressed. Reconnaissance surveys were completed to characterize those areas outside the ground survey polygons.

Individuals certified with at a minimum 24-hour hazardous waste operations and emergency response (HAZWOPER) level of training entered the site. No respiratory personal protective equipment use was warranted based on low radioactivity levels present at the site.

EXISTING CONDITIONS/PRELIMINARY RECOMMENDATIONS

Topography and Climate

The study area occurs from approximately 6,920 to 7,200 feet in elevation above mean sea level. It is located east of Little Haystack Mountain and southwest of San Mateo Mesa (Figure 1a).

Climate summaries for nearby San Mateo, New Mexico indicate that the area is semiarid with a total average annual precipitation of 8.66 inches. Average monthly maximum temperatures range from 40.6 degrees Fahrenheit (°F) in January to 83.1°F in July. Average minimum monthly temperatures range from 16.0°F in January to 55.3°F in July with freezing being common from November through April. There is generally a pronounced peak in rainfall during the monsoon months from July to October (Western Regional Climate Summaries 2016.

Soils/Soil Chemistry and Fertility

Soils at the study area consists of the following US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS 2015) map units listed by highest percent occurrence in the study area: Penistaja-Tintero complex, 1 to 10 percent slopes (soil unit: 205); Marianolake-Skyvillage complex, 1 to 8 percent slopes (soil unit: 210); Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes (soil unit: 220); Sparank-San Mateo-Zia complex, 0 to 3 percent slopes (soil unit: 230); and Uranium Mined Lands (Soil unit 265).

The NRCS soil data were accessed for more detailed physical and chemical characteristics of area soils (Appendix A). The study area soils are expected to be comprised of sandy loam and silty clay loam surface textures, according to NRCS mapping. They are generally well drained; not hydric or slightly hydric; moderately susceptible to wind and water erosion; and occur more than 200 centimeters from ground water depth. They are rated "very limited" for ponded reservoirs due to seepage and slope; and have limited water capacity. The soils at the study area are located more than 200 centimeters from any restrictive layer (loss of water or air infiltration), except areas in the southern periphery (unit 220), which are rated at 89 centimeters from such a layer. This is a favorable indicator for successful revegetation.

Soil chemistry and fertility parameters were obtained via laboratory analysis of samples collected from the site (Weston 2016). Detailed results are provided in Appendix A. In general, analyses indicate that area soils have low fertility; are low in boron, zinc, and phosphorus; high in calcium, magnesium, and sodium;

and have a low carbon/nitrogen ratio. While NRCS rating identified an expected pH ranging from 7.7 to7.9 for the study area, the pH of soil samples ranged from 7.9 to 9.0 (Appendix B).

Vegetation

The study area occurs within the Semiarid Tablelands ecoregion (Griffith et al. 2006). This ecoregion is characterized by dry plains, mesas, valleys, and canyons formed from sedimentary rocks. It supports arid and semi-arid grasslands, shrub/scrub zones, savannas, and woodlands.

According to Dick-Peddie (1993) the study area occurs primarily within Desert Grassland and Great Basin Desert Scrub vegetation communities. In the field, the grassland community most closely resembles the Plains-Mesa Grassland community in structural components, and this is the nomenclature used. The dominant component communities and associated species present at the study area are discussed in detail below. Vegetation communities at the site were identified and mapped based on ground surveys and reconnaissance (Figure 2). Surveys were conducted during late summer and early fall of 2016. In total, 104 species representing 34 families of vascular plants were identified at the study area (Appendix B).

<u>Vegetation Summary</u>

Approximately 2,258 acres within the 2,302-acre study area are estimated to be vegetated. The unvegetated areas were occupied by rock-covered slopes, roads, or other human-made features. The study area is generally flat and for the most part lacks microhabitat conditions associated with aspect or slope. It is dominated by large expanses of a mixture of Great Basin Desert Shrub communities and Plains Mesa Grassland. In some areas, these communities intermix forming an ecotone Shrubby Grassland community dominated by grasses but often with a diffuse distribution of shrubs. Warm season grasses dominate the grassland communities. Only 3 of the 21 species of grasses documented on the site [western wheatgrass (*Pascopyrum smithii*), foxtail barley (*Hordeum jubatum*), and squirrel-tail (*Elymus elymoides*)] were cold season species. Both the wheatgrass and foxtail barley were found principally in the riparian areas, squirrel tail was scattered in the grasslands and in the riparian habitats.

Many factors (disturbance, soil texture, soil nutrient content, and aspect) influence vegetation composition; however within the relatively flat study area, soil texture appears to be an important determinant of community type. The distribution of the grassland communities closely overlaps the location of the fine loamy Penistaja Series soils (Appendix B). Many Great Basin Desert Scrub communities occurred on the clay loams or clay soils, of the Sparank-San Mateo-Zia Complex.

Woodland and savanna communities are uncommon in the study area and contribute less than 1 percent of the total vegetation cover.

Arroyo riparian vegetation occurs within the channels and active floodplains of all ephemeral waterways within the study area. All these drainages are historically tributaries of Arroyo del Puerto. The vegetation within these drainages is codominated by a mixture of shrubs and grasses. Although widespread across the study area, these Arroyo Riparian communities account for only about 1 to 2 percent of the total vegetation cover.

In aggregate, the grassland, shrubland, savanna, woodland, and riparian vegetation types form 8 distinct natural plant communities/series (Table 1). A disclimax (weedy vegetation) area occurs in the southeast corner of the study area. The plant community series were identified following Dick-Peddie (1993), except when no applicable series has been published and adapting was necessary.

Historical Photo Comparison

A historic aerial photograph of the study area from 1954 was compared with current study area conditions. Substantial changes in vegetation communities were noted. The Juniper Savanna habitat, which currently just enters the western edge of the study area in Section 22, extended about ¼ mile eastward in 1954 into the northeast ¼ of Section 22. Pronounced surface scraping visible on current aerial photography suggests that these trees were removed by mining operations.

Coniferous woodland located in the southern portion of Section 22 has the exactly the same footprint in 1954 as currently observed. The only difference is that the tree density within this community has increased since 1954.

Based on the density and extent of vegetation observed on the 1954 photographs, the historic waterway system appears to have been much less incised, with water spilling across a broader floodplain than what currently exists. Areas of channels that were incised in 1954 appear to have supported much denser vegetation than currently exists. Finally, 5 stock ponds currently occur along the main channel of Arroyo del Puerto extending from the western edge to the eastern edge of the study area. None of these ponds were present in 1954.

Grasslands were far more abundant and contiguous in 1954. The large patch of grassland that currently dominates Section 24 extended southward to cover most of Section 25 in 1954. Additionally, most of Section 30 appears to have been covered by grassland. Both of these areas now support a grass/rabbitbrush community.

Great Basin shrub communities appear to have been present in 1954. Shrubs appear to have dominated the sheet-flow flood zones that parallel the arroyos. Shrub communities mixed with pockets of grassland also covered Sections 23 and 26. Today these areas still support these communities, but the shrubs are more abundant today and appear to dominate in areas that had been subject to surface disturbance.

To restore to 1954 conditions, grassland habitats would have to be expanded throughout much of the study area and the waterways would have to be restored to a more free-flowing condition.

Vegetation Transects and Community Discussion

Percent cover and species composition data were collected from 1-centimeter intervals along 50-meter-long vegetation transects (Table 1, Figure 2). Fifteen transects were used. The final placement of transects was based on a stratified, arbitrary, random technique, with the general location of transects being selected randomly, but the final placement being arbitrary to best reflect the typical vegetation structure within the community.

An estimate of percent absolute cover was calculated for all species present within transects. The compiled data from each transect is provided in Appendix B (accompanied by the soil sample number collected from 13 or 15 transects). Table 2 presents a compilation by community type.

Some plant communities were so large that multiple transects were required. In communities where multiple transects occurred, the data were combined. Five community types presented in Table 2 are the results of combined transects. Communities are discussed in detail by type.

Table 1 – Area of Dominant Plant Communities and Associated Transects

COMMUNITY TYPE	SERIES: PRINCIPAL COMPONENT VEGETATION	EST. ACRES	TRANSECTS
Plains-Mesa Grassland	Blue Grama/Galleta	763.26	1, 2, 4, 12, 13
Shrubby Grassland (Ecotone)	Blue Grama /Galleta/Saltbush	260.11	4, 9
Great Basin Desert Scrub	Saltbush/Blue Grama/Galleta	565.7	9, 10, 11
	Rabbitbrush/ Blue Grama/Galleta (Grassy Rabbitbrush Scrub)	454.75	3, 15
	Saltbush/Dropseed/Snakeweed/Annuals	130.78	5
Juniper Savanna	One-seed Juniper/Galleta	4.78	6
Coniferous Woodland	One-seed Juniper/Pinyon Pine/Bigelow Sage	0.90	7
Arroyo Riparian	Rabbitbrush/Saltbush/Galleta	33.09	8, 14
Disclimax	Summer Cypress (Invasive Weed)	45.30	None

Plains-Mesa Grassland
Plains-Mesa Grassland is the largest plant community in the study area, covering approximately 763 acres. It is concentrated in Township 14 North, Range 10 West, in the center of Section 24; the northeast and southeast corners of Section 25; the northwest corner of Section 26 and within Section 10. This community supported over 40 percent absolute vegetation cover (Table 2), and was heavily dominated by blue grama (*Bouteloua gracilis*) and galleta (*Pleurapis jamesii*). Together these 2 grasses accounted for 75 percent of the vegetative cover. Secondary grasses such as ring muhly (*Muhlenbergia torreyi*), Wright's muhly (*Muhlenbergia wrightii*), and spike dropseed (*Sporobolus contractus*) were present, but appeared infrequently and accounted for little more than 1.5 percent of the overall vegetative cover.

Shrubs appeared sporadically, with winterfat *(Krascheninnikovia lanata)* being the most common, and four-wing saltbush (*Atriplex canescens*), and horsebush (*Tetradymia canescens*) being thinly distributed, often in small localized enclaves. Ecologically this community type is important as nearly all the Gunnison's prairie dog towns in the study area occur within Plains-Mesa Grassland, and concurrently the documented western burrowing owls were within these prairie dog towns.

Shrubby Grassland (Ecotone)
The Shrubby Grassland Ecotone community occurs principally in the western third of the study area in Section 22, with a smaller piece of this community occurring near the southeast corner of Section 30. At both locations, this community occurs mostly within the overlap zone of Great Basin Shrub and Grassland communities, and the vegetation is a mixture of both. This entire community is patchy in nature often with small stands of grassland interrupted by enclaves of four-wing saltbush or other subshrubs. Vegetative cover was over 40 percent with nearly half of this cover composed of blue grama and nearly a quarter from four-wing saltbush. Portions of this community also support Gunnison's prairie dog colonies.

Great Basin Desert Scrub
Shrub communities dominate the Great Basin. Depending upon moisture, temperature, and soils, these communities can vary in composition. Within the study area, 3 Great Basin Desert scrub communities were defined, all of which had either four-wing-saltbush or rabbitbrush as their principal shrub components, and all of which had substantial grass cover. The most abundant of these communities was dominated by Saltbush/Blue Grama/Galleta. It covered over 500 acres and was found within the southwest corner of Section 24; the southern portion of Section 23; the northern portion of Section 2;

and the northwest corner of Section 25. The proportion of saltbush to grasses within this community varied across the study area, but overall saltbush accounts for nearly half of the overall vegetative cover. In addition to the native shrubs and grasses, the nonnative weed summer cypress (*Bassia scoparia*) also was abundant, accounting for nearly a quarter of the total vegetative cover within this community.

The second most abundant of the Great Basin Scrub communities was dominated by rabbitbrush/blue grama/galleta. This community is concentrated along the eastern edge of the study area within: Section 30 and Section 24. A portion also occurs within Sections 22 and 10. This community has nearly 60 percent vegetative cover with a third of it from rabbitbrush and another third from blue grama. The remaining third is composed principally of a mixture of grasses such as galleta, Wright's muhly, and dropseed (*Sporobolus*) species. Along its margins, the shrub component of this community thins and intergrades into Plains Mesa Grassland.

The last of these Great Basin Shrub communities is dominated by four-wing saltbush intermixed with dropseed and snakeweed (*Gutierrezia sarothrae*). This community is confined to northwest corner of the study area within Section 15. It has some of the lowest overall vegetative cover in the study area (approximately 25.9 percent) and more than half of this cover is derived from annual weedy species. Fourwing saltbush accounts for about a quarter of the cover and of all the remaining grasses -less than a quarter. This site appears to have suffered substantial surface disturbance in the past and is not fully recovered.

Juniper Savanna

The Juniper Savanna community is limited to the western edge of the study area within Section 22. It is dominated by one-seed juniper (*Juniperus monosperma*) and covers less than 5 acres of the study area. It had the lowest overall vegetative coverage (22.4 percent) of the communities. Grasses accounted for more than half of this cover and Junipers about 3.6 percent. This community is located adjacent to the most persistent water source and is heavily grazed. Although it occupies a small area relative to other communities, it provides tree structure to the western half of the study area.

Coniferous Woodland

A tiny sliver of woodland community (less than an acre in size) extends into the study area within Section 22. Like the Juniper Savanna, this woodland habitat has low vegetative cover (27.12 percent) with nearly half of the vegetative cover dominated by grasses. The pinyon (*Pinus edulis*) and one-seed juniper trees account for less than a third of the cover. Although very small, the community is important in that it provides the only trees in the southwestern portion of the study area.

Arroyo Riparian

A series of ephemeral waterways, all historic tributaries of Arroyo del Puerto, cross the study area. Many convey surface water runoff as sheet flow that can spread across broad areas. Human intervention has altered or curtailed the flows of these waterways. Berms have been installed across many segments of Arroyo del Puerto interrupting stormwater surges and collecting the runoff in stock ponds. Approximately 33 acres of this Arroyo Riparian community type is spread out in linear form across approximately 4 miles of the study area. With the exception of small segments of waterways in the sections 10 and 30, remaining Arroyo Riparian habitat is confined to sections 22, 23, 25, and 26.

The Arroyo Riparian community consists of vegetation within waterway channels, as well as the various ponds. The dominant vegetation within the active channels was consistent across all arroyo segments. Usually it was dominated by rabbitbrush and western wheat grass. Together, these species account for more than 50 percent of the vegetative cover in the arroyos. In some locations, four-wing saltbush can be locally abundant, but most remaining vegetative cover varies among a dozen species of grasses and herbs such as gumweed (*Grindelia nuda*), galleta, and purple aster (*Machaeranthera canescens*).

Stock ponds along channels are dominated by weedy vegetation such as summer cypress with small amounts of MacDougall verbena (*Verbena Macdouglii*) and western wheat grass often occurring along the edge of the ponds. Satellite aerial photography from 1996 to 2014 and field observations suggest that these ponds (with one exception) rarely have water present. The exception is a stock pond located in Section 22. This pond is collecting runoff directly from nearby steep slopes. The dominant vegetation was knotweed (*Polygonum aviculare*), spike rush (*Eleocharis* sp.), foxtail barley, marsh aster (*Aster subulatus*), and curly dock (*Rumex crispus*). Nearly all these plants are wetland indicator species. Surface water was present throughout September and most of October 2016 when the other ponds were dry.

Disclimax

An area of approximately 45 acres located in the southeast corner of the study area within Section 30 is dominated by the invasive annual weed summer cypress. This annual weed can choke out other vegetation leaving an unproductive habitat for wildlife. Since the overwhelming dominant within this area was an annual invasive weed, vegetation cover data was not collected.

Table 2 - Species/Approximate Percent Cover at Vegetation Transects

VEGETATION COMMUNITY AND SERIES	PLANT SPECIES	TRANSECTS	PERCENT COVER
Plains Mesa Grassland		1,2,4,12,13	
	Bouteloua gracilis		26.57
	Pleuraphis jamesii		5.5
	Bassia scoparia		2.02
	Salsola tragus		1.74
	Krascheninnikovia lanata		1.27
	Artemisia bigelovii		1.16
	Muhlenbergia wrightii		1.02
	Atriplex canescens		0.97
	Muhlenbergia torreyii		0.66
	Tetradymia canescens		0.192
	Sporobolus contractus		0.08
	Gutierrezia sarothrae		0.05
	Elymus elymoides		0.03
			Total: 41.26
Shrubby Grassland (Ecotone)		4,9	
	Atriplex canescens		12.2
	Bassia scoparia		4.81
	Pleuraphis jamesii		3.40
	Bouteloua gracilis		20.25
	Muhlenbergia torreyi		1.47
			Total: 42.13
Great Basin Desert Scrub – (Saltbush/Blue Grama/Galleta)		9,10,11	
	Atriplex canescens		20.4

VEGETATION COMMUNITY AND SERIES	PLANT SPECIES	TRANSECTS	PERCENT COVER
	Bassia scoparia		8.56
	Bouteloua gracilis		8.3
	Pleuraphis jamesii		2.16
	Panicum obtusum		1.94
	Elymus elymoides		1.64
	Grindelia nuda		0.27
	Pascopyrum smithii		0.26
	Gutierrezia sarothrae		0.21
	Scleropogon brevifolius		0.1
	Sporobolus airoides		0.08
			Total: 43.92
Great Basin Desert Scrub – (Rabbitbrush/ Blue Grama/Galleta (Grassy Rabbitbrush Scrub)-		3,15	
	Bouteloua gracilis		22.69
	Ericameria nauseosa		22.12
	Pleuraphis jamesii		6.77
	Grindelia nuda		2.22
	Pascopyrum smithii		1.57
	Muhlenbergia wrightii		1.39
	Gutierrezia sarothrae		0.87
	Bassia scoparia		0.83
	Sporobolus airoides		0.63
	Sporobolus contractus		0.03
			Total: 59.12
Great Basin Desert Scrub- (Saltbush/Dropseed/Snakeweed/Annuals)		5	
	Machaeranthera canescens		8.38
	Atriplex canescens		6.18
	Salsola tragus		4.16
	Gutierrezia sarothrae		2.24
	Bassia scoparia		1.86
	Pascopyrum smithii		1.42
	Sporobolus contractus		1.70
			Total: 25.94
Juniper Savanna		6	
	Pleuraphis jamesii		6.94
	Sporobolus airoides		3.98
	Juniperus monosperma		3.6
	Atriplex canescens		2.52
	Krascheninnikovia lanata		1.62
	Gutierrezia sarothrae		1.36
	Bouteloua gracilis		1.2
	Aristida purpurea		0.9

VEGETATION COMMUNITY AND SERIES	PLANT SPECIES	TRANSECTS	PERCENT COVER
	Acnatherum hymenoides		0.3
			Total: 22.42
Coniferous Woodland		7	
	Bouteloua gracilis		13.90
	Juniperus monosperma		6.88
	Artemisia bigelovii		4.58
	Krascheninnikovia lanata		0.96
	Pleuraphis jamesii		0.52
	Erigeron sp		0.28
			Total: 27.12
Arroyo Riparian		8,14	
	Ericameria nauseosa		14.06
	Pascopyrum smithii		12.28
	Grindelia nuda		6.58
	Atriplex canescens		3.88
	Pleuraphis jamesii		2.64
	Bassia scoparia		2.13
	Machaeranthera canescens		1.94
	Bouteloua gracilis		1.76
	Sporobolus airoides		1.44
	Bouteloua hirsuta		0.12
	Gutierrezia sarothrae		0.11
	Ambrosia acanthicarpa		0.06
			Total: 47.00

New Mexico Noxious Weeds

The following three New Mexico Department of Agriculture Category C noxious weeds species were observed in the study area: saltcedar, Russian olive, and Siberian elm. None of these occurred in abundance. Siberian elms are mostly confined to the main paved access route that bisects the site.

Russian olive is represented by a handful of trees that are widely scattered. One salt cedar occurs at the pond in Section 22 other diminutive specimens were observed along the waterways. No special treatment of these weeds is recommended.

To prevent establishment of weeds during the revegetation process, it is recommended that the contractor be required to wash all machinery prior to each site entry (if equipment is used at other sites during the reclamation process) and upon leaving the site to reduce likelihood of transporting seeds into and from the site. In addition, the application of mulch would reduce weedy species establishment.

Wildlife

Wildlife Summary

Several common species or their sign were observed within the study area. A list of species observed onsite, as well as those expected to occur there based on other area surveys, is provided in Appendix B.

Eleven species of mammals or their sign, including elk, mule deer, gophers, rabbits, kangaroo rats, prairie dogs, mountain lion, and coyote were observed. Large prairie dog towns occur in and around the study area. It is likely that bats roost within the cliff faces present nearby and hunt at stock ponds since the presence of water would support insects. Migratory *Myotis* species would be expected to roost in cliffs from March through October, and would be active at the ponds at night.

Thirty-six species of birds were observed, including residents such as: quail and roadrunner; songbirds such as sparrows, juncos, towhee, and meadowlark; insect hunting species such as flycatchers, shrikes, and phoebes; waterfowl and wading birds, and several birds of prey including hawks, falcons, eagles, and owls. Many other species of songbirds and raptors are likely present in the area during migration and nesting seasons.

Five reptiles were observed including three snakes and two lizards. Amphibians were not observed, but at least two species are expected in the area.

It is recommended that nearby cliff and rock outcrop areas and pinyon/juniper woodlands be avoided during proposed reclamation activities, which would harm these areas rather than improve them. Avoidance of perch trees for raptors is also recommended. Prairie dogs colonies support burrowing owl nests. Vegetation clearing, especially in areas that support owl burrows, should be limited to the late fall and winter months (October to February).

<u>Wildlife Discussion</u>

In total, 53 vertebrate species were observed during the surveys of the study area (Appendix C), including a wide range of birds with both upland and waterfowl species present. Based on the species list collected on other surveys in the area, approximately 70 species of vertebrates could be present within the study area. There are large populations of burrowing mammals present. Gunnison's prairie dog colonies cover hundreds of acres within the area.

There are also some elk and mule deer, as well as large predators such as mountain lion and coyote present, all of which are likely to leave the area during construction.

Birds

The survey was conducted late summer into the fall, and many more species, especially during spring migration, are likely to occur in the study area during the breeding season. Overall, birds were not present in great abundance. One possible reason for low bird population levels is the general lack of vertical structure at the site. Aside from four-wing saltbush and rabbitbrush, hardly any shrubs above knee height are present, excluding the small enclaves of juniper and pinyon trees along the extreme western end of the study area. The remaining trees are principally Siberian elms along the main entrance road with a few Russian olives and salt cedars.

Most birds observed occurred in small flocks within shrubby stands of four-wing saltbush and rabbitbrush, or flyovers. Non-migratory resident birds, such as scaled quail (*Callipepla squamata*) and roadrunner (*Geococcyz californianus*), were diffusely spread across the study area mostly in the shrub/grassland ecotone areas.

Within the grassland habitats, birds represented by species such as horned larks (*Eremophila alpestris*), vesper sparrow (*Pooecetes gramineus*), and the occasional western meadowlark (*Sturnella neglecta*).

The brushy habitats supported a variety of sparrows including chipping sparrow (*Spizella passerine*), Brewer's sparrow (*Spizella breweri*), wintering white-crowned sparrow (*Zonotrichia leucophrys*), dark-eyed junco (*Junco hyemalis*), and loggerhead shrike (*Lanius ludovicianus*).

The greatest diversity of birds occurred at the stock pond located within Section 22. The presence of water throughout September and October not only provided a water source for upland birds but also supported the use of shore birds and waterfowl such as great-blue heron (*Ardea Herodias*), killdeer (*Charadrius vociferous*), mallard (*Anas platyrhynchos*), gadwall (*Anas strepera*), northern shoveler (*Anas clypeata*), and northern pintail (*Anas acuta*). More than half the birds observed in the study area occurred at or near the wet stock pond, and the waterfowl and shorebirds were found only at this pond.

The following 5 bird-of-prey species were observed within the study area: golden eagle (*Aquila chrysaetos*), northern harrier (*Circus cyaneus*), western burrowing owl (*Athene cunicularia*), American kestrel (*Falco sparverius*), and prairie falcon (*Falco mexicanus*). One species that was expected, but not observed, was red-tailed hawk (*Buteo jamaicensis*). However, based on other surveys of the general area, this species is likely to be present. The American kestrel, prairie falcon, and northern harrier appeared to be fly-overs. Aside from hunting, very little suitable habitat was observed in the survey area.

Golden eagles were observed onsite during every visit. At least 3 different golden eagles were present. The large prairie dog colonies within the area provide an excellent prey base for this species, and on two occasions golden eagles were observed perching on the Siberian elm trees along the main paved access road at the eastern edge of the study area (figures 3a,3b). There is no suitable nesting habitat present for golden eagle within or immediately adjacent to the study area, but suitable nesting habitat does occur on east facing cliffs along the east side of Little Haystack Mountain located within Section 20; which is approximately 1.5 miles west of the western edge of the study area, and Mesa Redonda, which is approximately 1.9 miles to the west (Figure 3b). Multiple large whitewash areas that could be golden eagle nest sites were observed along this cliff face.

Additional suitable nesting habitat for golden eagle was also observed on multiple cliff faces within Sections 34, 35, and 36 of Township 15 North, Range 10 West, and within sections 1, 2, and 3 of Township 14 North, Range 10 West.

This habitat occurs between 1.5 and 2.0 miles north of the portion of the study area within Section 10. Some whitewash was noted present these cliffs, but no specific areas appeared to support an active golden eagle nest site. Golden eagles are reported to hunt on a daily basis in a 7-mile radius around their nest sites and any potential golden eagle nesting habitat in the general area would be close enough for their use of the study area, which supports a prey base.

Western burrowing owls are a ground-dwelling species that usually occupy burrows created by mammals such as prairie dogs. During the nesting season, they can use several burrows, moving their young from burrow to burrow, as they mature. These burrows are usually clustered in tight proximity and, for the purpose of this report, clustered burrows (that were used by burrowing owls in 2016) are referred to as activity areas. During the course of the survey, 6 of these burrowing-owl activity areas were identified that in aggregate contained 16 burrows used by burrowing owl (Figure 2, Appendix C). During the survey, western burrowing owls were observed within 3 of these activity areas. All the owls observed occurred within Gunnison's prairie dog towns and nearly all of them occurred within the Plains Mesa Grassland community type. The 3 western burrowing owls observed during the survey were located near burrows

1, 2, and 9 (Appendix C). Since surveys were not completed for the entire area, it is likely that many additional owls were present in the study area but were not identified.

Mammals

Eleven species of mammals were observed in the survey area, and based on surveys of nearby areas, others would be expected. The larger mammals present included both herbivores and predators. At the time of the survey, elk (*Cervuus elaphus*) were active in the western portion of the study area. Mule deer (*Odocoileus hemionus*) tracks and droppings were observed along the western edge of the study area. Tracks of both of these species were observed at the stock pond in Section 22. Elk were photographed on a wildlife camera at this location. Both these species could occur anywhere within the study area.

There were no observations or sign of bobcat (*Lynx rufus*) or gray fox (*Urocyon cinereoargenteus*), but both are expected in the general area. Mountain lion (*Puma concolor*) and coyote (*Canis latrans*) were present. Tracks of a solitary (likely juvenile) mountain lion were observed at the stock pond within Section 22. A rancher, who uses the study area, stated that in 2016 a female mountain lion and 2 nearly adult cubs were observed along the edge of savanna/woodlands on the west side of the study area in Section 22. Coyote observations and signs (scat and tracks) occurred in all plant communities within the study area. Most large mammals (both herbivores and predators) are likely to leave the area when reclamation begins and return when vegetation has developed sufficiently to provide cover and a prey base.

The presence of small burrowing mammals within the study area is important to the restoration process in that they provide the potential for soil mixing deep below the surface. The most likely species to do this within the study area are the banner-tailed kangaroo rat (*Dipodomys spectabilis*) and Gunnison's prairie dog (*Cynomys gunnisoni*). Banner-tailed kangaroo rats were present, but sporadic in their distribution, occurring primarily within the Plains Mesa Grassland and the Great Basin Desert Scrub - Rabbitbrush Grassland habitat. Kangaroo rats are strictly nocturnal and are not easily observed.

Although their activity level drops in the winter, they have been reported to be active on warm days. Banner-tailed kangaroo rats have complex burrow systems that can exceed 1 meter in depth (Gano and States 1982) and extend outward for several meters from the center of the mound. The centralized mound associated with the burrow system often exhibits substantial amounts of soils mixing from collapsed burrows. Much of the burrow system for typical banner-tailed kangaroo rat mounds is likely to occur below the 12-inch deep soil removal zone.

Many rats may survive the soil removal by remaining in their deep burrows. However, with the removal of vegetative surface cover above the burrow, no surface food will be available for quite some time. However, banner-tailed kangaroo rats often maintain multiple granaries in the lower parts of the burrow systems. These granaries can have 2 to 8 pounds of grain stored in them. It is likely that after the soil removal the banner-tailed kangaroo rats that survived the process will be able to persist for some time on their stored grains and may be able to hang on long enough for the new growth from the seed material.

Gunnison's prairie dogs can have a much larger subsurface footprint than banner-tailed kangaroo rats. Their burrow systems can be several meters deep and can extend outward more than 10 meters. The deep and steeply aligned burrows of Gunnison's prairie dogs allow points for surface soils to be conveyed downward, well below the surface. Gunnison's prairie dog burrow systems are much deeper than the proposed soil removal level and active burrow systems are likely to persist through the soil removal process. However, unlike the banner-tailed kangaroo rat, Gunnison's prairie dogs do not maintain granaries and may not survive the removal of vegetation. Gunnison's prairie dogs were widespread and abundant, covering at least 473 acres or approximately 20 percent of the entire study area (Figure 3a). Spot checks around the periphery of the area verified that the Gunnison's prairie dogs extend far beyond the study limits and would likely return to the site when vegetation has reestablished. Prairie dogs are a keystone species, providing habitat for a variety of other species such as the western burrowing owl, reptiles, and other mammals. Their colonies within the study area are wholly confined to the grassland habitats, concentrated in Sections 23, 24, 25, and 26.

Rough field estimates suggested that approximately 10 to 15 percent of the burrows within these colonies were active at the time of the survey.

Other burrowing animals observed within the study area included Ord's kangaroo rat (*Dipodomys ordii*) and Botta's pocket gopher (*Thomomys bottae*). Ord's kangaroo rats are much smaller than banner-tailed kangaroo rats, and, consequently, their burrows are smaller (rarely over 3 inches in diameter). Although their burrow systems may reach as deep as the banner-tailed kangaroo rat, there are fewer burrows present. Ord's kangaroo rats were locally common in areas with firm soils within the grassland habitats throughout the study area. The Ord's kangaroo rat burrows are small but deep enough to extend below the soil removal zone, and many are likely to survive the soil removal process. Like the banner-tailed kangaroo rat, they also maintain granaries.

Botta's pocket gopher appeared sporadically in the study area, mostly in areas of looser soil. Pocket gophers generally have shallow burrows, which are usually less than 1 meter deep and often much more shallow, are generally only 5- to 35-centimeters deep but can be upwards of 45 meters in length (Gano and States 1982). It is likely that most Botta's pocket gopher burrows would be taken by the soil removal process.

Both cottontail (*Sylvilagus auduboni*) and black-tailed jackrabbit (*Lepus californicus*) were present and widespread but did not occur in great abundance. Their burrow systems are deep enough to be unaffected by the proposed soil removal. Those near the periphery of the study area are likely to move into adjacent vegetated habitats when surface clearing begins.

Reptiles and Amphibians

Six species of reptiles were observed within the study area. Most common were the plateau striped whiptail (*Aspidoscelis velox*) and the southwestern lizard (*Sceloporus cowlesi*). The plateaus striped whiptail was found within most egetation communities in the study area. A prairie rattlesnake (*Crotalus viridis*) and bull snake (*Pituophis catenifer*) were also observed. The most uncommon reptile observation was a wandering (western terrestrial) garter snake (*Thamnophis elegans vagrans*), which was observed only at the stock pond within Section 22.

There were no amphibians present during the survey. However, the stock pond habitat is suitable for tiger salamander (*Ambystoma tigrinum*), and it is likely that spadefoot toads (*Spea multiplicata*) could also be present. The observed reptiles have the capacity to flee short-distances and many may move to the edge of removal areas, but suitable habitat for their reoccupation of the site would not be available until vegetation is reestablished.

Grazing/Rangeland Value

The NRCS soil data were accessed for expected range production characteristics of area soils (Appendix B). Range production ratings are given in pounds per acre per year. Ratings are provided for a normal year, favorable year, and unfavorable year, respectively.

The most common soil unit present within the study area moderately well rated for range production: Penistaja-Tintero complex, 1 to 10 percent slopes (soil unit: 205): 953, 1359, 547.

The second most common soil unit present within the study area is well rated for range production: Sparank-San Mateo-Zia complex, 0 to 3 percent slopes (soil unit: 230): 2177, 3557, 1102.

The remaining soil units are rated as follows: Marianolake-Skyvillage complex, 1 to 8 percent (soil unit: 220): 813, 1200, 416; Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes (soil unit: 230): 794, 1171, 407; Uranium mined lands (soil unit: 265) are not rated for range production.

According to NRCS Rangeland productivity and plant composition expectations for the study area soils, blue grama and western wheatgrass would be expected to comprise approximately 40 percent of the characteristic vegetative grass cover for based on soils and ecological identification. Field observations generally support expectations for blue grama in terms of composition, but western wheatgrass expectations are not supported. Generally, winterfat coverage is lower and rabbitbrush is higher than expected. Overall, grass coverage is lower than expected, based on soils and ecological site identification. Successful revegetation would be expected to increase range production at the site significantly in some areas and result in little change in others.

It is recommended that a five-year target composition and percent cover be identified to determine whether the effort is successful at meeting objectives. The site should be surveyed during the late summer (September) of the third year after planting to determine percent cover, species composition, and wildlife use as compared to the existing condition and to the objective condition.

Any deficiencies in meeting five-year objectives or alteration of five-year objectives could be identified at that time. This should be repeated after the five-year term in September as well. Range production should be estimated and evaluated during monitoring activities by a qualified range specialist to determine what level of grazing may be appropriate after objectives are met, or in keeping with any modified objectives.

Elk, deer, and cattle were observed at the study area. Grazing activity is high in some areas, and in others is low and has not reduced vegetative cover across the range. Coverage data from the vegetation transects confirms this observation.

Federal and State Listed and Otherwise Protected Species

Federally listed and otherwise protected species were identified through a review of U.S. Fish and Wildlife Service (USFWS); and State of New Mexico agency lists (New Mexico Department of Game and Fish [NMDGF] and New Mexico Energy Mineral and Natural Resources Department [NMED] Forestry Division). The USFWS maintains lists of federal endangered, threatened, proposed, and candidate species of plants and animals. It also administers the Migratory Bird Treaty Act and Bald and Golden Eagle Protection acts. The NMDGF maintains lists of state endangered and threatened animals. The NMED Forestry Division maintains a list of state endangered plant species. Species lists are provided in Appendix C.

The potential for the proposed soil removal and revegetation to result in effects/impacts to species in McKinley County appearing on at least one of the previously cited agency lists was evaluated. Nine federal and state listed species were eliminated from consideration and 3 were evaluated further.

Critical Habitat

No designated or proposed critical habitat occurs within the study area. The CP-2 unit of designated critical habitat for the Mexican spotted owl is located approximately 12 miles southeast of the study area within the Cibola National Forest (USFWS 2016b).

Listed or Otherwise Protected Species Eliminated from Further Analysis

The project would result in no effect/impact to the following eliminated species, for which, no suitable habitat is present in the study area and none appears to be present within the action area (Table 3).

Table 3 – Protected Species Eliminated from Further Analysis

Group	Name	Status	Habitat	Rationale for Removal
Plants				
	Zuni fleabane (*Erigeron rhizomatus*)	USFWS E EMNRD E	Sparsely vegetated slopes in pinyon-juniper woodlands on Chinle/Baca formation soils	No suitable habitat
	Gooding's onion (*Allium gooddingii*)	EMNRD E	Forested slopes above 7,500 feet in elevation	No suitable habitat
	Parish's alkali grass (*Puccinellia parishii*)	EMNRD E	Alkaline seeps and wetlands	No suitable habitat
Fishes				
	Zuni blue-head sucker (*Catostomus discobolus Yarrowi*)	USFWS E NMDGF E	Perennial waterways in the Rio Nutria watershed	No suitable habitat
Group	**Name**	**Status**	**Habitat**	**Rationale for Removal**
Birds				
	Southwestern willow flycatcher (*Empidonax traillii extimus*)	USFWS E NMDGF E	Nests in dense willow and cottonwood riparian woodlands	No suitable habitat
	Mexican spotted owl (*Strix occidentalis lucida*)	USFWS T	Nests in old growth conifer habitat	No suitable habitat
	Yellow-billed cuckoo (*Coccyzus americanus*)	USFWS T NMDGF S	Nests in canopy cover of riparian woodlands	No suitable habitat
	Bald eagle (*Haliaeetus leucocephalus alascanus*)	BGEPA NMDGF T	Nests along large lakes and rivers, winters in riparian areas	No suitable habitat
	Least tern (*Sternula antillarum*)	NMDGF E	Nest in depressions in sand or gravel bars near water	No suitable habitat
	Costa's hummingbird (*Calypte costae*)	NMDGF T	Nests in Hidalgo County, rare as a vagrant in other parts of state	No suitable habitat

E – Endangered, T – Threatened, BGEPA –Bald and Golden Eagle Protection Act

Listed or Otherwise Protected Species Evaluated Further

Potential project-related impacts to 3 listed species that may occur within the study area or immediately adjacent areas are evaluated further (Table 4).

Table 4 –Listed and Otherwise Protected Species with Potential to occur at the Study Area

Group	Name	Status	Habitat
Birds			
	Golden eagle (*Aquila chrysaetos*)	BGEPA	Nest in arid remote cliff habitats
	Peregrine falcons (*Falco peregrinus anatum/ tundrius*)	NMDGF T	Steep mountain or shoreline cliffs near water
	Gray vireo (*Vireo vicinior*)	NMDGF T	Sloped undeveloped Pinyon/Juniper woodlands

T – Threatened, BGEPA – Bald and Golden Eagle Protection Act

Birds

Golden eagle (*Aquila chrysaetos*) – Golden eagles are protected under the Bald and Golden Eagle Protection Act from harm and harassment. This is a very large bird of prey with a wingspan of up to 71 inches. Their breeding range extends throughout Canada and much of the western United States. They occur in open areas at lower to middle elevations throughout New Mexico. Preferred nesting sites are cavities within ledges and cliffs of mountainsides, mesa escarpments, and canyon walls.

The cliffs that golden eagles typically use are greater than 30 meters in height, although they can use cliffs of only 10 meters in height. The nesting cliffs are normally located directly adjacent to suitable foraging habitats. In New Mexico, this species begins courtship and nest construction as early as February.

There are several rock outcrops, mesas, and cliffs located within the vicinity of the study area, and this species is known to occur in the region. Telescopic observations of cliffs within the vicinity were conducted to determine whether nests or sign were present. Several areas of whitewash on cliffs were observed. However, the cliffs sufficient to provide nesting habitat for this species occur over 1 mile from the study area.

This species was observed perching in elm trees located within the study area (Figures 3a and 3b) and likely hunts there, as prairie dogs are abundant. It is recommended that removal activities avoid the perch trees, or that artificial perches be installed to allow this species continued use of the site.

Gray vireo (*Vireo vicinior*) – This is a state threatened bird that is protected under the MBTA. It is found through much of the western United States and northern Mexico. It normally occurs in open rolling woodland, juniper savanna, and chaparral. It is found in arid lands, typically in pinyon-juniper habitat along steep or rolling slopes. This vireo is an insectivore. In New Mexico, it is found during the months of April through September when insects are most abundant.

No suitable nesting habitat for this species occurs within the study area, as small woodland parcels present do not provide enough cover. However, suitable habitat occurs around much of the periphery of the study boundary. This species likely nests in the vicinity, and it is possible that a territory occurs near the study. If vegetation clearing is complete prior to the onset of the general migratory bird nest season (March 15 through September 30), individuals and nests would not be directly impacted.

However, potential indirect impacts associated with noise and activity during construction could not be avoided once excavation and planting begins if the species is nesting within approximately 0.25 mile of construction activity. It is recommended that species-specific surveys for gray vireo be conducted (male territorial calls played at intervals) during the nest season (May 15 to September 30) prior to the planned fall/winter clearing to determine whether the species is nesting in the immediate area if reclamation will occur within 0.25 miles of habitat.

If it does, the proximity of territories relative to the proposed work area should be estimated. Work schedules can be sequenced in areas proximal to territories if needed to provide a buffer during the nest season. The NMDGF does not currently provide a required buffer distance for avoiding indirect impacts to this species. Marron recommends a 0.25-mile buffer. However, if the species is identified within the area, the NMDGF should be contacted regarding specific avoidance requirements.

Peregrine falcons (*Falco peregrinus anatum/tundrius*) – Peregrine falcons are protected as a State of New Mexico threatened species. These subspecies breed south of the Arctic tundra region of North America, southward to Mexico. In New Mexico, they breed locally in mountainous areas and occur during migration and winter essentially statewide, though primarily in the eastern plains (NMDGF 2015). They summer and nest on tall, steep, rocky cliffs associated with forest or woodland in close proximity to water. No suitable steep cliff habitat occurs within the study area, but the nearby cliff habitat suitable for eagles could also provide nest sites for this species.

Migratory Birds

The Migratory Bird Treaty Act (16 United States Code (USC). 703-712), as amended, protects migratory birds, their parts, eggs, and occupied nests from take, pursuit, import/export, hunting, and capture. A list of birds protected under the Act is available in Title 50 of the Code of Federal Regulations (CFR) Section 10.13.

Suitable nesting habitat for area tree and ground-nesting birds occurs within and adjacent to the study area. During fall 2016 surveys, occupied burrows, which were used as nest sites by western burrowing owls, were present in abandoned prairie dogs towns. Several occupied burrows were observed. Since ground surveys were not completed for the entire study area, existing nests may be present but were unidentified. In addition, the construction of new nests prior to the onset of reclamation is likely.

It is recommended that vegetation clearing within the site be initiated and completed outside the general migratory bird nesting season for the area (March 15 to September 30) to prevent destruction of occupied nests.

Raptors such as hawks and owls that may nest in the area begin nesting earlier in the year (late January to early March), but are most likely to use woodlands and cliffs, which would not be cleared or reclaimed under the currently proposed action. If it is necessary to clear vegetation during the nesting season, a preconstruction nest survey should be provided at least two weeks ahead of work to identify any occupied nests within the area. If occupied nests would be removed, a USFWS permit would be required first.

Other Listed Species

The Bureau of Land Management (BLM) maintains a list of sensitive species for lands it manages and evaluates proposed activities for consistency with the appropriate approved resource management plan. The New Mexico Heritage Program list of critically imperiled species (S1) was reviewed for informational purposes, as this is not a *protected* category.

BLM Sensitive Species

Table 5 – BLM Sensitive Species Verified in the Farmington District

Group	Name	Habitat
Plants	Brack's fishhook cactus	Nacimiento formation soils in San Juan County
	Aztec gilia	Nacimiento formation soils in San Juan County
	San Juan milk weed	San Juan County
	Mancos saltbush	Mancos clay in San Juan County
Mammals	***Gunnison's prairie dog**	**Grasslands**
	Spotted bat	Cliffs near open water
	Townsend's big eared bat	Caves, mine shafts
Birds	Yellow-billed cuckoo	Riparian woodlands
	Bald eagle	Nests near large water bodies
	***Western burrowing owl**	**Grasslands/prairie dog burrows**
	Southwestern willow flycatcher	Riparian woodlands
	Pinyon jay	Pinyon woodland/mixed conifer
	Bendire's thrasher	Desert canyons/scrub
Amphibians	Northern leopard frog	Wetland/spring/riparian
Fishes	Zuni blue head sucker	Aquatic, Rio Nutria area
	Flannelmouth sucker	Aquatic, San Juan Basin

***Present in study area**

Western burrowing owl (*Athene cunicularia hypugaea*) — This owl is protected under the Migratory Bird Treaty Act and is a BLM sensitive species. It occurs on plains, treeless valleys, and mesas and prefers empty prairie dog or other rodent burrows that it can use for nesting and shelter, but can excavate its own burrows if needed. This species is found throughout the mid and lower elevations of New Mexico. It inhabits bare ground near areas such as golf courses and airports; open desert of yucca, cactus, and mesquite; and grassland-juniper habitats. Occupied nesting habitat for this species occurs within the study area.

Occupied burrows used as nest sites by western burrowing owls are present in abandoned prairie dogs towns. Several occupied burrows were observed, and many others are likely present within unsurveyed areas. This species tends toward a moderate to high nest site fidelity, and pairs are likely to attempt to nest in the same location during future years. The following measures are recommended to prevent direct impacts and reduce indirect impacts to this species:

Timing restrictions for vegetation clearing are recommended to avoid direct impacts to this species (avoid clearing during the general nest season of March 15 through September 30).

During the later summer prior to the onset of removal activities, a survey of all areas, which may support owl nests located within the final removal zone, should be provided. To the extent feasible, all occupied burrows (or clusters of burrows, likely used by a single pair) should be identified. Where a cluster of burrows that was occupied is removed, it is recommended that 2 artificial burrows be installed to offset the loss of nesting habitat in the area. Artificial burrows could be removed (outside nesting season) once the area is revegetated and supports prairie dogs again, potentially during final reclamation closeout activities.

Gunnison's prairie dog (*Cynomys gunnisoni*) – This BLM sensitive species occurs in southeastern Utah, southwestern Colorado, northwestern New Mexico and northern Arizona where they occur primarily on lower elevation, warm and dry plains and plateaus. They are approximately 12 to 14 inches and weigh from 1.5 to 2.5 lbs. Their coats are yellow-toned buff merged with black-colored hairs. Gunnison's prairie dogs typically inhabit large colonies of up to several hundred individuals that are divided into smaller territories occupied by communal groups or solitary individuals. They are a diurnal species that mates from mid-March until mid-May and produces 4 to 5 pups per year. They occur in high desert, grasslands, meadows and even floodplain often found among shrubs such as rabbitbrush, sagebrush, and saltbush. They are very susceptible to plague, pest control measures, and protracted drought.

Gunnison's prairie dogs were widespread and abundant in the study area, and active colonies cover at least 473 acres or approximately 20 percent of the entire study area (Figure 3a) and adjacent areas.

Active burrow systems are likely to persist through the soil removal process, but Gunnison's prairie dogs do not maintain granaries and may not remain in the study area after the removal of vegetation. Once vegetation is successfully established, they would likely return. If large numbers of individuals flee the removal and migrate to adjacent areas, the adjacent populations may experience food shortage and other pressures associated with an increased density and reduced resources. It may be possible to relocate individuals occupying the study area to suitable but unoccupied areas within the vicinity, if such areas are available; or, to temporarily provide grain drops to support them within the study area while vegetation establishes. Either of these activities should be included in monitoring activities to determine whether successful. It is recommended that the USEPA coordinate with the BLM prior to undertaking removal to obtain specific information regarding these populations.

Spotted bat (Euderma maculatum)/ Townsend's big-ear bat (Corynorhinus townsendii) – Spotted bats are BLM sensitive and protected as a threatened species by the State of New Mexico. Townsend's big-ear bat is a BLM-sensitive species. These bats are cliff and cave dwellers whose diurnal roosts are the cracks and crevices, but are also known to roost in human-made structures. No suitable caves, cliffs or canyons occur within the study area. These species may roost within nearby cliff habitats and could hunt at the pond in Section 22 when it supports insects. The activity is not likely to impact bats if the pond is avoided, or if other suitable hunting habitats are available within the vicinity.

New Mexico Heritage Critically Imperiled Species

New Mexico Heritage ranks native species into several categories. Heritage categories are not associated with a legal protective mechanism. Critically imperiled ranked species for McKinley County are provided in Table 5. Most are waterfowl that would be transients within the study area, if they were present. Several are federally listed species for the County. The Northern leopard frog could occur within study area stock ponds if they were nearly perennially wet, but current conditions are not likely suitable to support frogs.

Table 5 – New Mexico Heritage Critically Imperiled (S1) Species for McKinley County

Group	Name	Habitat
Birds	Ring-necked duck	Lacustrine/riparian
	Little blue heron	Lacustrine/riparian
	Bald eagle	Nests near large water bodies
	Least tern	Lacustrine/riparian
	Southwestern willow flycatcher	Riparian woodlands
	Marsh wren	Lacustrine/riparian
	Costa's hummingbird	Desert canyons/stream edges
Amphibians	Northern leopard frog	Wetland/spring/riparian
Fishes	Zuni blue head sucker	Aquatic, Rio Nutria area

Watershed

The study area occurs within the San Mateo Creek local watershed and in the Rio San Jose 8-digit Hydrologic Unit Code 13020207, which occurs in the larger Middle Rio Grande drainage Basin.

Waterways

The study area occurs along and north of the Arroyo del Puerto, which is tributary to San Mateo Creek. Martin Draw passes through the northern study area parcel. Waterways in the vicinity are poorly defined and segmented. They do not currently appear to connect to San Mateo Creek, which confluences with the Arroyo del Puerto south of the study area.

Several unnamed small and partially defined waterways were also observed during field surveys, but they lose bed and bank features downslope/downstream, or end in stock ponds or sheet flow.

A historical 1954 aerial photograph of the area pre-mine development was obtained (Figure 4, Appendix A). The image indicates that area surface flows were more regular (possibly near perennial in some segments), channels were more organized and sinuous, and a riparian corridor was present along stretches of both Martin Draw and the Arroyo del Puerto. In 1954 a branch of Arroyo del Puerto extended into and across the northern third of Section 22.

A clearly defined channel also existed in the extreme southwest corner of Section 24. A less defined series of channels and a large sheet flow area was evident along the eastern edge of Section 24.

Wetlands

One wetland was observed in the study area. It occurs in association with the stock pond located in Section 22. This pond maintained some surface water throughout the late summer and early fall of 2016. It was dominated by a mixture of wetland indicator plants that included obligate, facultative wetland and facultative species. Based on the persistence of surface water, the dominance of wetland plant species, and the reduced soils noted in the bottom of the pond, this site appears to meet wetland criteria. However, it is not located within a regulated water. Shrubby wetland vegetation (such as coyote willow and Russian olive) appears occasionally in small pockets within portions of the Arroyo del Puerto drainage system, none of these areas meet hydrology or soil criteria for a wetland.

There are a number of small stock ponds scattered along, and within, the channel of Arroyo del Puerto that do occasionally collect water. Most support the weedy annual summer cypress. Summer cypress is a wetland indicator, but it is also a fast growing weed that can persist on very little water. Most of these stock ponds do not appear to collect water frequently enough or long enough to qualify as wetland.

Watershed Impacts/Recommendations

Watershed impacts resulting from uranium mining activities area are well documented, and identification and reclamation of legacy uranium mine surface and ground water quality are ongoing in the Ambrosia Lake Sub-District. No water quality analysis was completed for this report. The successful removal of uranium contaminated soils and revegetation of the site would be expected to reduce surface water contact with uranium, which is expected to improve water quality.

Small arroyos that pass through study area do not support wetlands or a riparian corridor and appear to convey insufficient flows to justify augmentation. It is recommended that existing arroyos remain unaltered during reclamation. Alteration is likely to result in sediment being transported to downstream areas and is not likely to result in improvement to the area habitat.

However, it is recommended that a hydrologic analysis be conducted prior to finalizing a revegetation plan to determine whether flows in local arroyos are sufficient to warrant extending them into large reclaimed grassland areas or implementing some other augmentation to improve the watershed.

Several stock pond features are present at the study area. One of these in Section 22 retains sufficient flows to support wetland vegetation. It is recommended that stock pond features remain unscraped, as feasible, as they pool water for wildlife and plant use after storm events. Additionally, the vegetation present around the pond could be augmented to provide improved riparian habitat and tree canopy for area birds. Tree shading would also reduce evaporation and improve growing conditions for plants. The increase in cover would improve wildlife habitat.

REVEGETATION/SOIL AMMEDMENT SUMMARY

The revegetation strategy of the removal area, once identified, will be based on an ecological approach that would attempt to restore arid grassland conditions to sustain native animal and plant communities and enhance wildlife use of the area.

A Draft Revegtation Plan for the proposed removal area will be prepared prior to the identification of the final removal area for review by cooperating agencies. The following summarizes the elements expected to be addressed in the Draft Revegetation Plan.

Revegetation and Seed Mix Recommendations

Information used to develop the re-vegetation strategy will obtained from the following sources:

1. Historic aerial photographs that predate the uranium mining activities within the study area will be reviewed.

2. Additional ground surveys will be conducted. Vegetation-covered transects will be identified and surveyed to provide reference sites documenting the dominant perennial vegetation composition and cover within each plant community on the site.

3. Survey findings from nearby areas will be reviewed and un-mined adjacent habitats will be surveyed briefly for comparison, if authorization for entry is obtained.

4. Data from previous and ongoing mining and reclamation actions in the area will be reviewed

The recommended seed mix and application rate will be determined based on the updated location of the removal area.

Recommendations for planting of cover crops, mulching, watering, and amending soils, as well as special planting recommendations for pond areas will also be provided.

Recommendations for amending soils are expected to address the following soil issues: Carbon/nitrogen ratio, texture, and water holding capacity.

The addition of traditional organic soil amendments such as sawdust, bark, compost, and manure; as well as the addition of humate, and their potential application rates at the site will be addressed.

SUMMARY OF RECOMMENDATIONS

The following summarizes measures that are recommended to preserve existing resources/features or improve the study area. Other measures directly related to reclamation activities will be provided in a draft revegetation plan for the removal zone.

- Avoid cliffs and slopes located adjacent to the study area, which provide bird nesting and bat roosting habitat.

- Avoid juniper and pinyon pine trees when removing vegetation.

- Clear vegetation during the fall and winter months outside the general nesting season for migratory birds.

- Provide a species-specific survey for gray vireo to determine whether they are nesting within 0.25 mile of the study area if areas within this distance of suitable pinyon/juniper habitat will be included in reclamation.

- Replace lost burrow clusters occupied by western burrowing owls with artificial nest boxes (2 per cluster).

- Conduct a hydrological analysis of the removal area, once identified, to determine whether sufficient surface flows are present to warrant arroyo extension or other improvement.

- Provide relocation or grain drops to allow small mammals to become re-established while vegetation becomes established, in coordination with the BLM.

- Provide removal site monitoring during September at 3 and 5 years post planting to compare observations with project objectives relative to plant species composition, percent cover, wildlife use, and range production.

- Avoid existing ponds or excavate new ponds in downslope areas to collect surface flows that would promote wildlife use of the area.

  - Plant species such as cottonwood to provide cover and habitat structure to the wetted pond.

16053

PHOTOS

Photo A – Plains Mesa Grassland Vegetation

Photo B – Shrubby Grassland Vegetation

Photo C - Great Basin Desert Scrub Vegetation

Photo D - Great Basin Desert Scrub Vegetation - Saltbush/Dropseed/Snakeweed/Annuals

Photo E - Great Basin Desert Scrub Vegetation - Rabbitbrush/Blue Grama/Galleta

Photo F - Arroyo Riparian Vegetation

Photo G – Juniper Savanna Vegetation

Photo H – Coniferous Woodland Vegetation

Photo G - Elk at Stock Pond

Photo H – Great Blue Heron at Stock Pond

Photo I – Prairie Dog at Grassland Colony

Photo J – Western Terrestrial Garter Snake

Photo K – Golden Eagle Leaving Perch Tree

Whitewash on Cliffs West of Study Area

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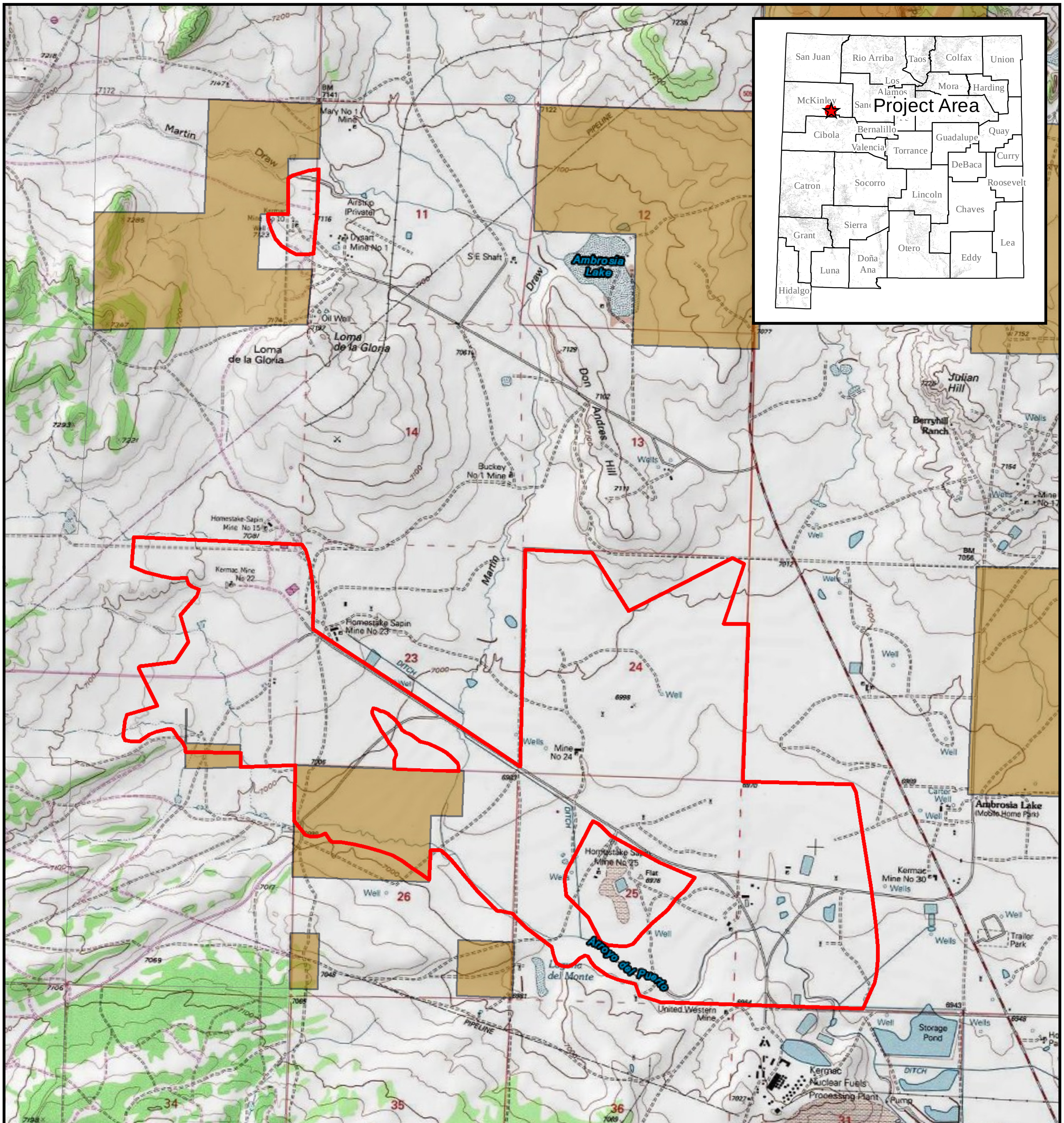
APPENDIX A

Figures 1-4



Study Area

Land Ownership

BLM

Private

Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
McKinley County, New Mexico

0 0.5 1 2 Kilometers

0 0.425 0.85 1.7 Miles

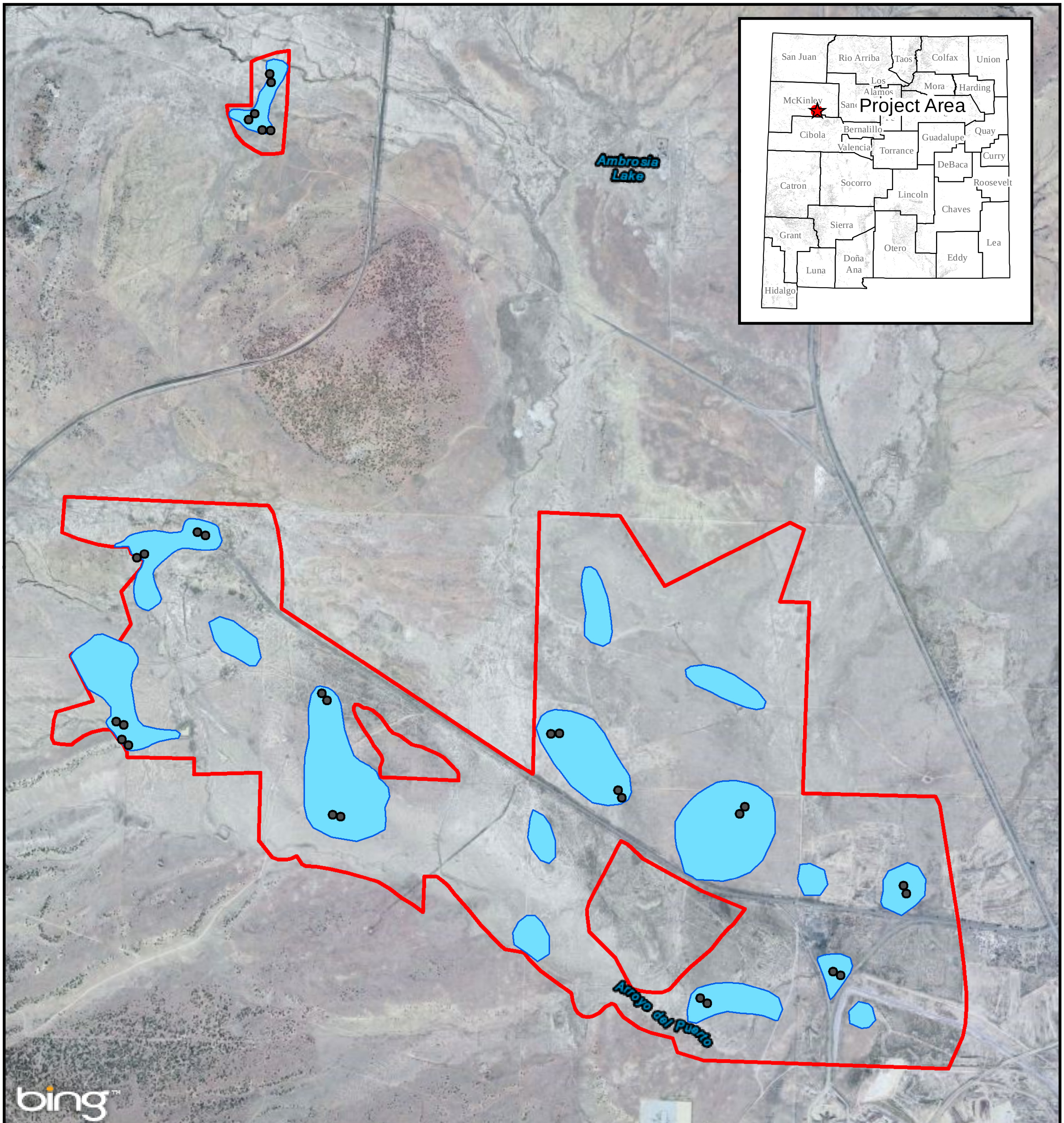
N

1:40,000

MARRON and ASSOCIATES

Figure 1a
Project Location Map

USEPA Tronox Western GSA Mines, McKinley County, New Mexico



Study Area

Ground Survey Area

Transect Endpoints

Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
McKinley County, New Mexico

0 0.5 1 2 Kilometers

0 0.35 0.7 1.4 Miles

N

1:33,000

MARRON and ASSOCIATES

Figure 1b
Survey Area Map

USEPA Tronox Mines, McKinley County, New Mexico

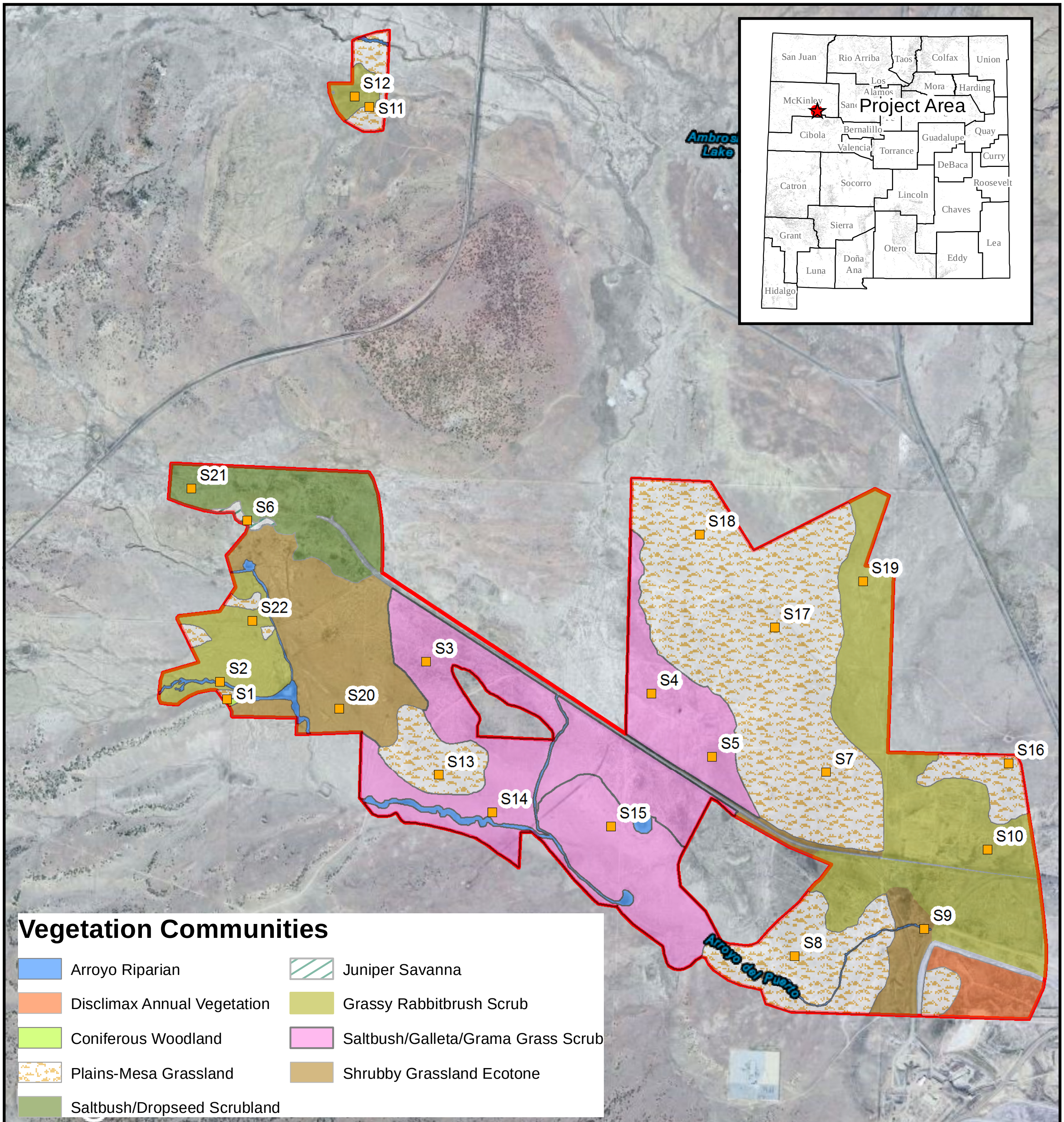


Figure 2
Vegetation Communities

Study Area

Soil Sample Location

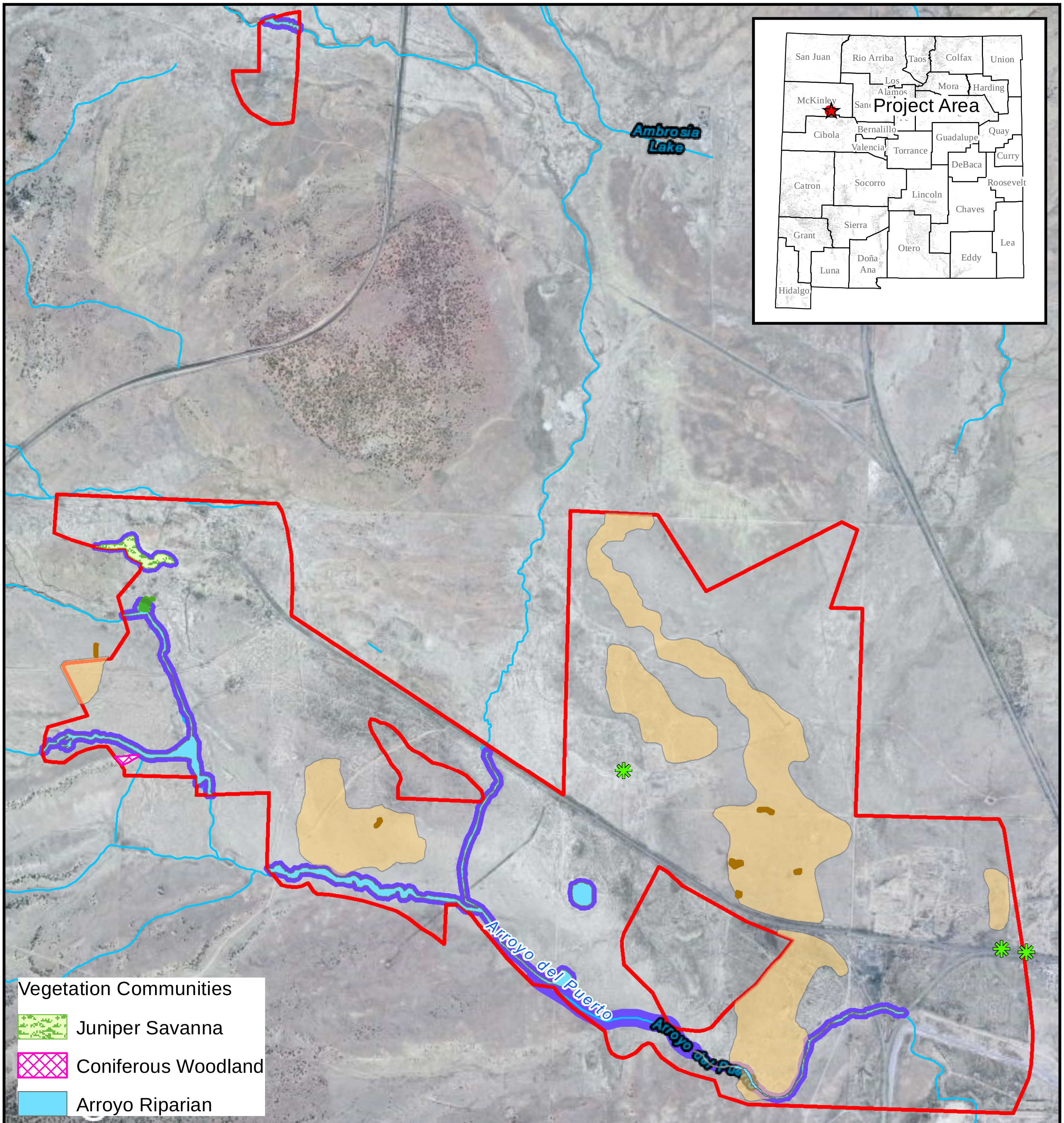
Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
McKinley County, New Mexico

0 0.5 1 2 Kilometers
0 0.35 0.7 1.4 Miles

N
1:34,000

USEPA Tronox Mines, McKinley County, New Mexico



MARRON and ASSOCIATES

Figure 3a
Resources

Study Area
Prairie Dog Colony
Burrowing Owl Area
Exclusion Area
Wetland
Perch Trees
Stream or River

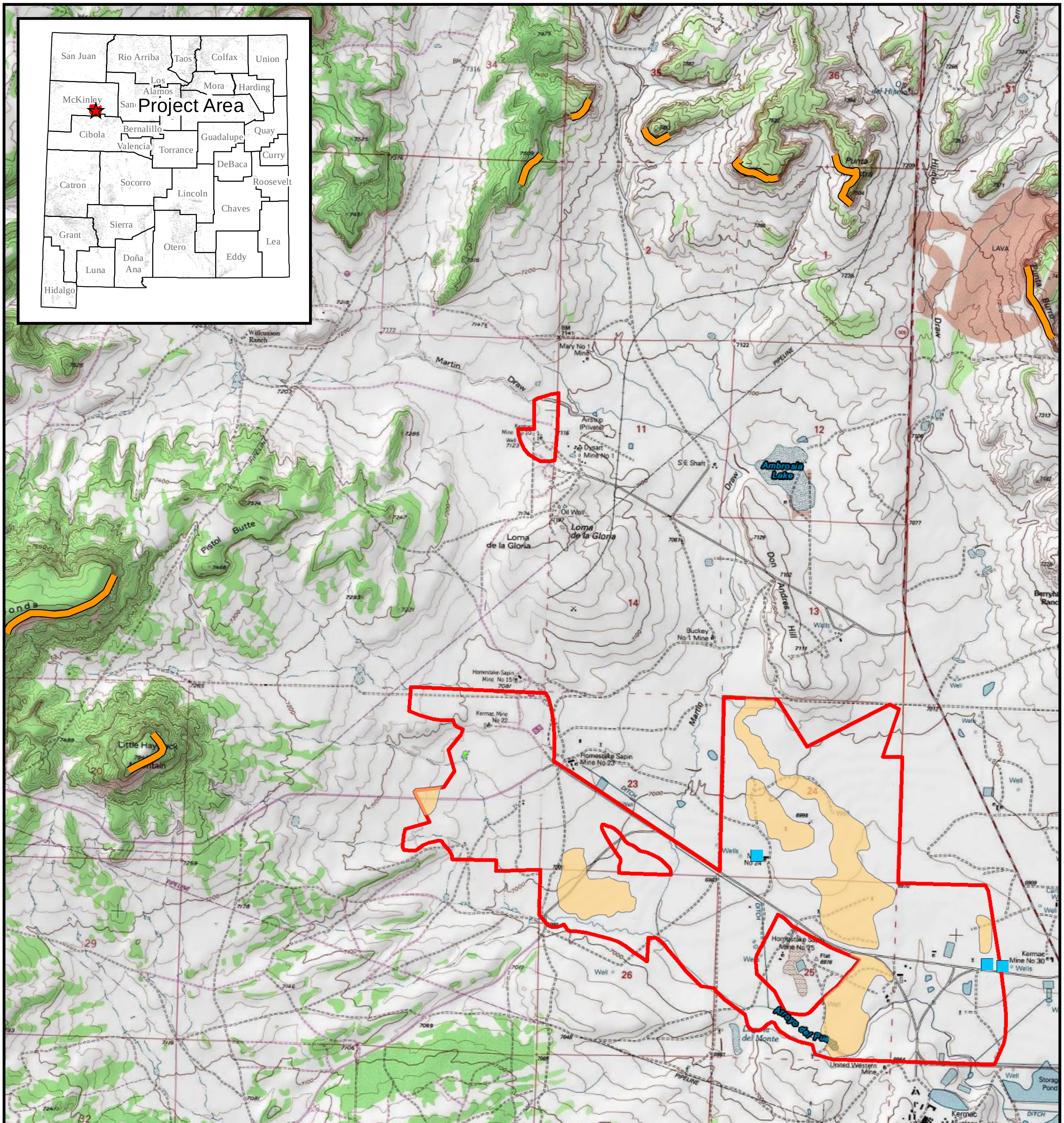
T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
Bernalillo County, New Mexico

Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

0 0.5 1 2 Kilometers
0 0.35 0.7 1.4 Miles

N
1:30,500

USEPA Tronox Western GSA Mines, McKinley County, New Mexico



Study Area

Prairie Dog Colony

Potential Eagle Nest Area

Perch Trees

Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
Bernalillo County, New Mexico

MARRON and ASSOCIATES

Figure 3b
Golden Eagle Resources

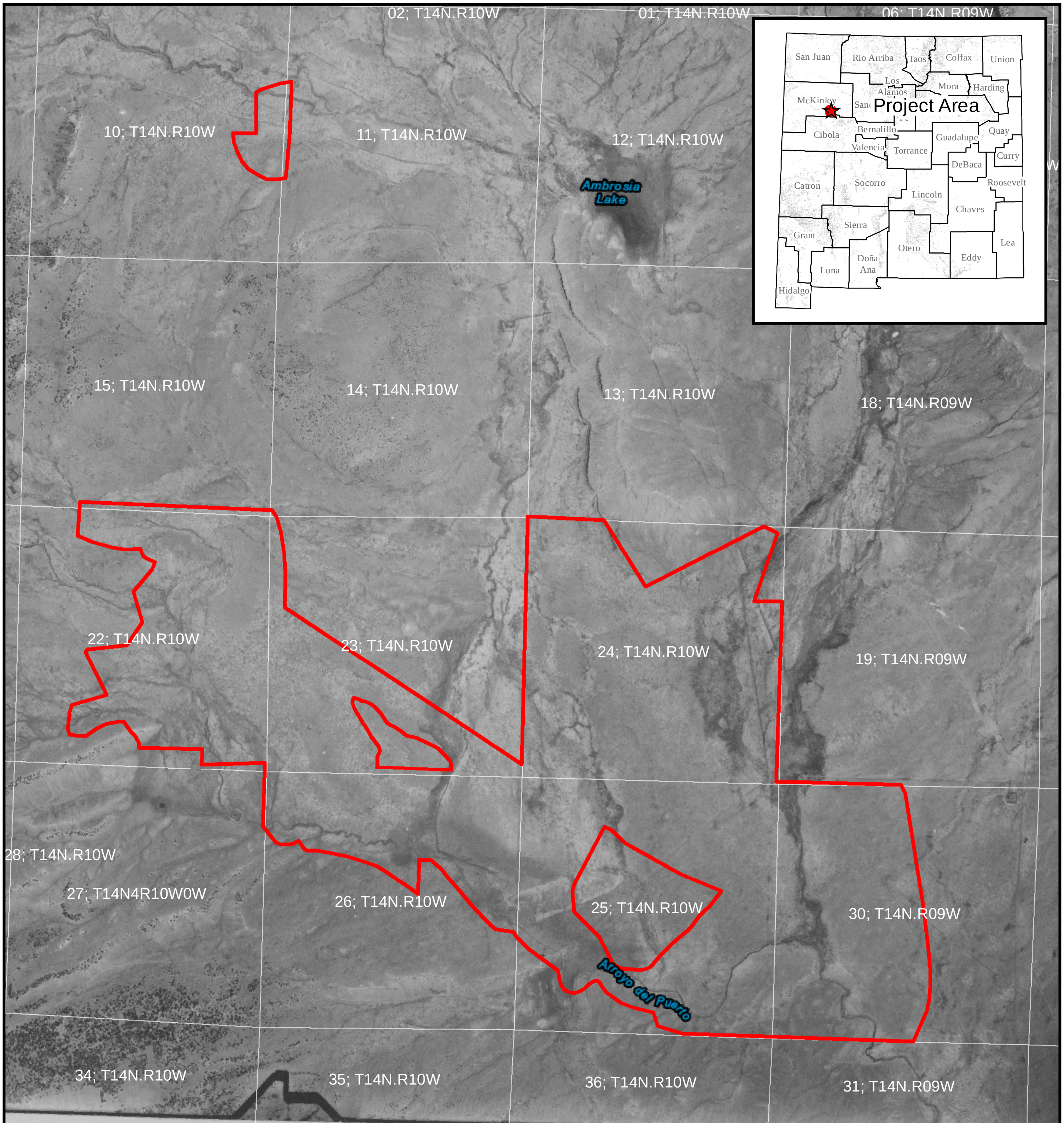
0 0.75 1.5 3 Kilometers

0 0.5 1 2 Miles

N

1:50,000

USEPA Tronox Western GSA Mines, McKinley County, New Mexico



MARRON and ASSOCIATES

Figure 4
Project Area
1954 Aerial Photo

Study Area

Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
McKinley County, New Mexico

0 0.5 1 2 Kilometers
0 0.4 0.8 1.6 Miles

N
1:35,000

USEPA Tronox Western GSA Mines, McKinley County, New Mexico

APPENDIX B

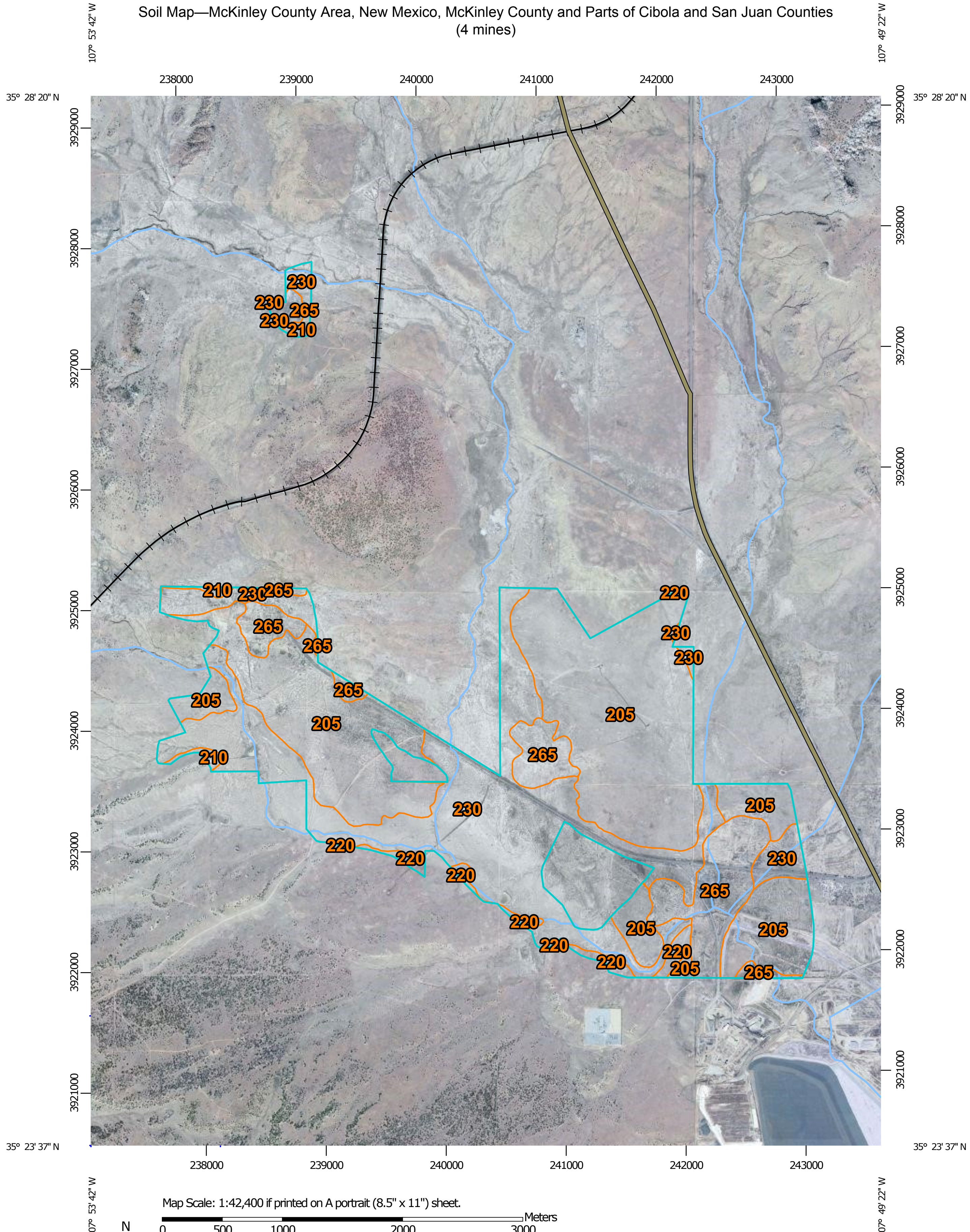
Soil Characteristics

Soil and Plant Sampling Results

Vegetation Sampling Results

Vegetation Transect Tables

Soil Map—McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
(4 mines)



Map Scale: 1:42,400 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 2000, 4000, 8000, 12000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
Survey Area Data: Version 11, Sep 26, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

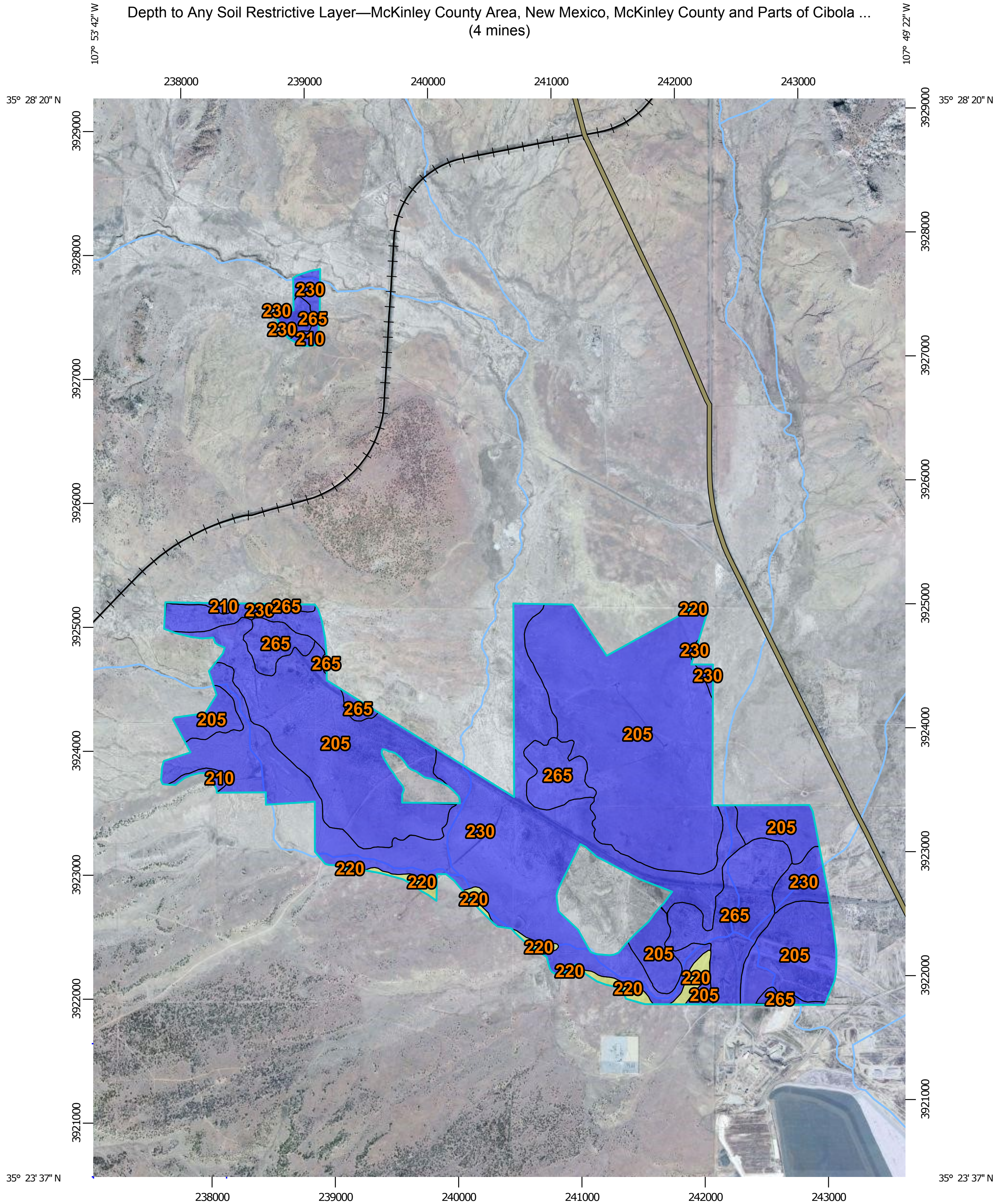
Date(s) aerial images were photographed: May 21, 2010—Nov 7, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NM692)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
205	Penistaja-Tintero complex, 1 to 10 percent slopes	1,166.7	50.7%
210	Marianolake-Skyvillage complex, 1 to 8 percent slopes	20.1	0.9%
220	Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes	41.3	1.8%
230	Sparank-San Mateo-Zia complex, 0 to 3 percent slopes	787.0	34.2%
265	Uranium mined lands	285.3	12.4%
Totals for Area of Interest		**2,300.3**	**100.0%**

Depth to Any Soil Restrictive Layer—McKinley County Area, New Mexico, McKinley County and Parts of Cibola ...
(4 mines)



Map Scale: 1:42,400 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 2000, 4000, 8000, 12000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Lines

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Points

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
Survey Area Data: Version 11, Sep 26, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 21, 2010—Nov 7, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Depth to Any Soil Restrictive Layer

Depth to Any Soil Restrictive Layer— Summary by Map Unit — McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NM692)				
Map unit symbol	**Map unit name**	**Rating (centimeters)**	**Acres in AOI**	**Percent of AOI**
205	Penistaja-Tintero complex, 1 to 10 percent slopes	>200	1,166.7	50.7%
210	Marianolake-Skyvillage complex, 1 to 8 percent slopes	>200	20.1	0.9%
220	Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes	89	41.3	1.8%
230	Sparank-San Mateo-Zia complex, 0 to 3 percent slopes	>200	787.0	34.2%
265	Uranium mined lands	>200	285.3	12.4%
Totals for Area of Interest			**2,300.3**	**100.0%**

Description

A "restrictive layer" is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers.

This theme presents the depth to any type of restrictive layer that is described for each map unit. If more than one type of restrictive layer is described for an individual soil type, the depth to the shallowest one is presented. If no restrictive layer is described in a map unit, it is represented by the "> 200" depth class.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

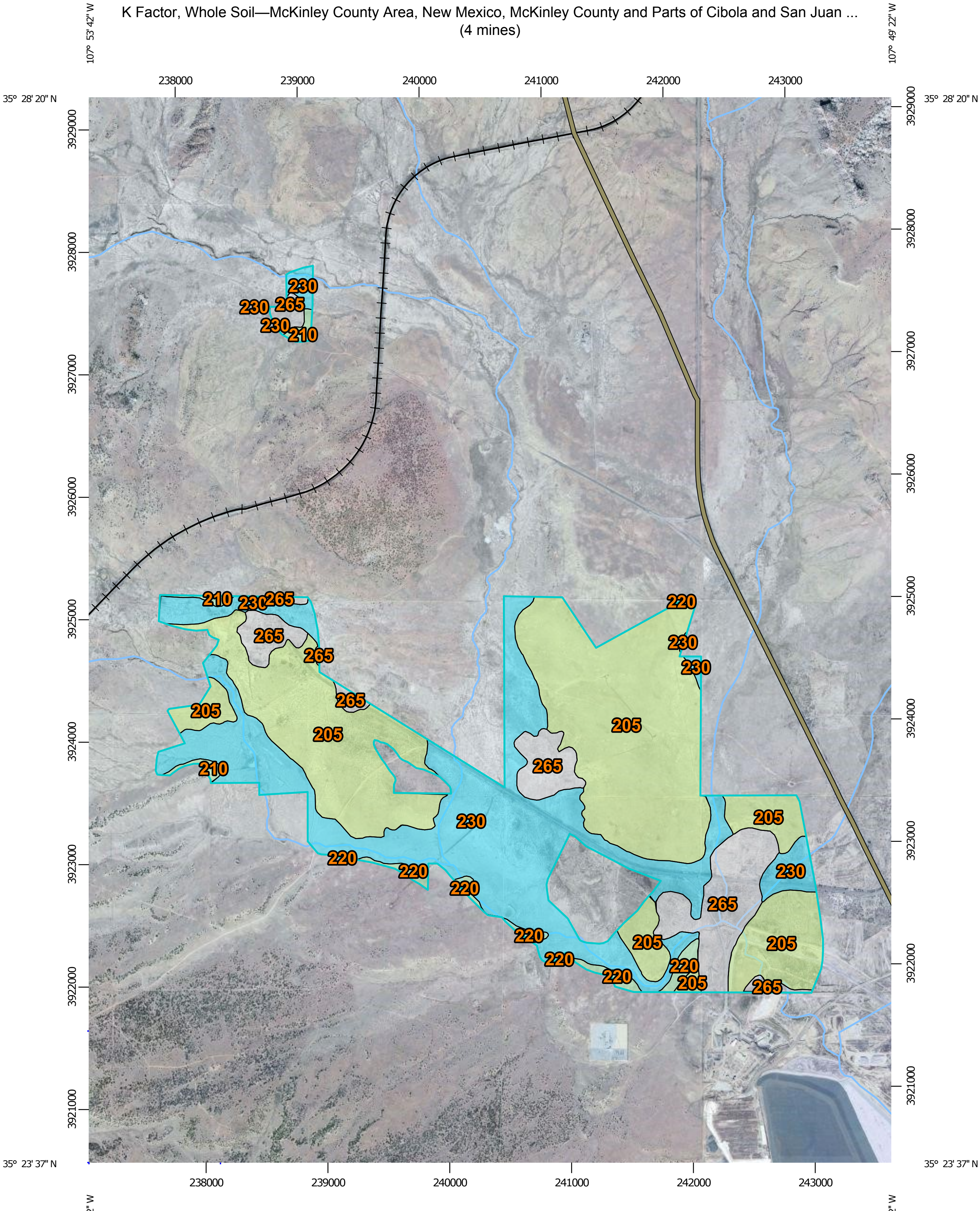
Units of Measure: centimeters

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Interpret Nulls as Zero: No



Map Scale: 1:42,400 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 2000, 4000, 8000, 12000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Soil Rating Lines

- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Soil Rating Points

- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
Survey Area Data: Version 11, Sep 26, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 21, 2010—Nov 7, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

K Factor, Whole Soil

K Factor, Whole Soil— Summary by Map Unit — McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NM692)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
205	Penistaja-Tintero complex, 1 to 10 percent slopes	.24	1,166.7	50.7%
210	Marianolake-Skyvillage complex, 1 to 8 percent slopes	.28	20.1	0.9%
220	Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes	.28	41.3	1.8%
230	Sparank-San Mateo-Zia complex, 0 to 3 percent slopes	.37	787.0	34.2%
265	Uranium mined lands		285.3	12.4%
Totals for Area of Interest			**2,300.3**	**100.0%**

Description

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kw (whole soil)" indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

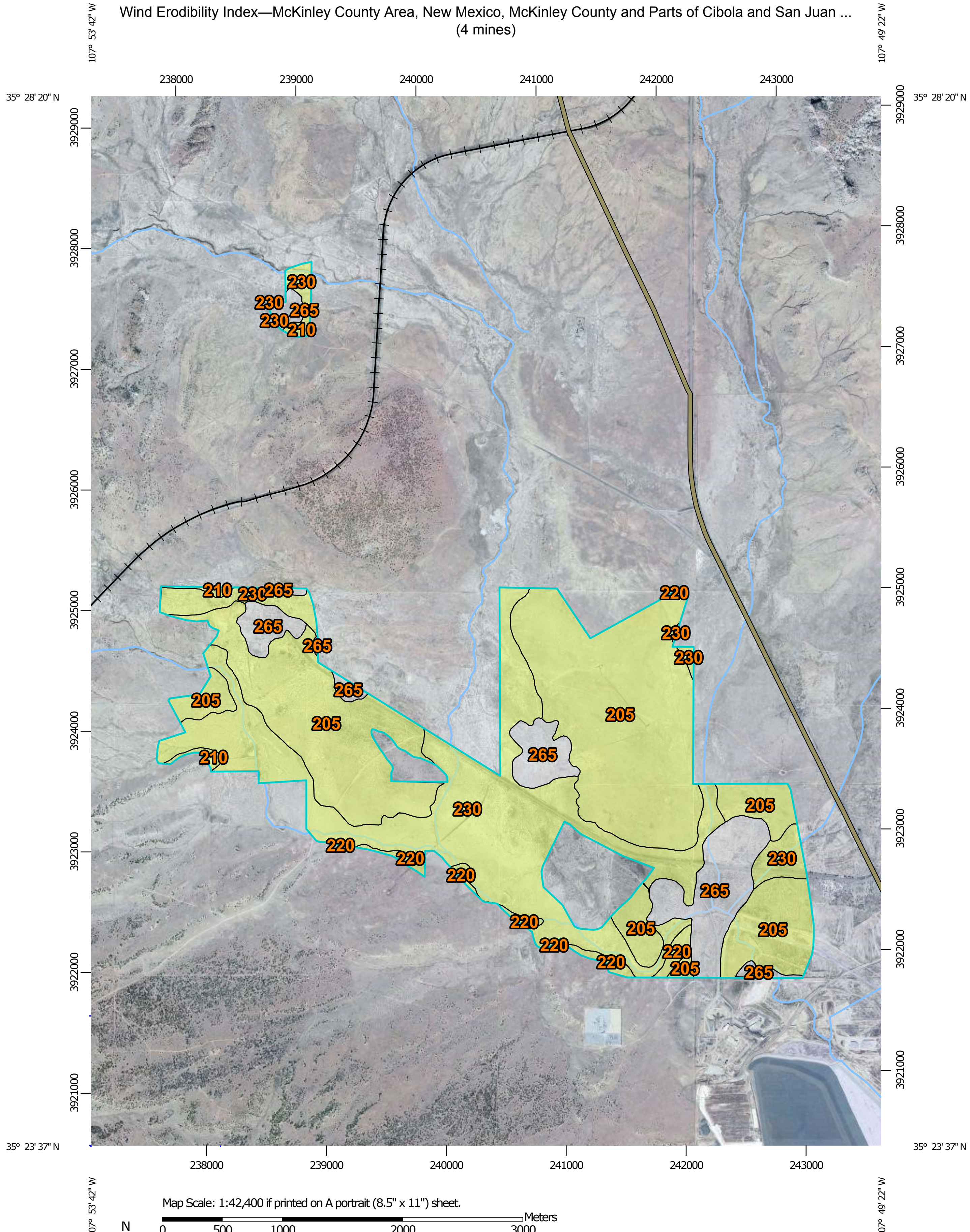
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)



Map Scale: 1:42,400 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 2000, 4000, 8000, 12000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- 0
- 38
- 48
- 56
- 86
- 134
- 160
- 180
- 220
- 250
- 310
- Not rated or not available

Soil Rating Lines

- 0
- 38
- 48
- 56
- 86
- 134
- 160
- 180
- 220
- 250
- 310
- Not rated or not available

Soil Rating Points

- 0
- 38
- 48
- 56
- 86
- 134
- 160
- 180
- 220
- 250
- 310
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
Survey Area Data: Version 11, Sep 26, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 21, 2010—Nov 7, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Wind Erodibility Index

Wind Erodibility Index— Summary by Map Unit — McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NM692)				
Map unit symbol	Map unit name	Rating (tons per acre per year)	Acres in AOI	Percent of AOI
205	Penistaja-Tintero complex, 1 to 10 percent slopes	86	1,166.7	50.7%
210	Marianolake-Skyvillage complex, 1 to 8 percent slopes	86	20.1	0.9%
220	Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes	86	41.3	1.8%
230	Sparank-San Mateo-Zia complex, 0 to 3 percent slopes	86	787.0	34.2%
265	Uranium mined lands		285.3	12.4%
Totals for Area of Interest			**2,300.3**	**100.0%**

Description

The wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Rating Options

Units of Measure: tons per acre per year

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

Soil Quality - Organic Matter

Organic matter percent is the weight of decomposed plant and animal residue and expressed as a weight percentage of the soil material less than 2 mm in diameter.

Significance

Organic matter influences the physical and chemical properties of soils far more than the proportion to the small quantities present would suggest. The organic fraction influences plant growth through its influence on soil properties. It encourages granulation and good tilth, increases porosity and lowers bulk density, promotes water infiltration, reduces plasticity and cohesion, and increases the available water capacity. It has a high capacity to adsorb and exchange cations and is important to pesticide binding. It furnishes energy to micro-organisms in the soil. As it decomposes, it releases nitrogen, phosphorous, and sulfur. The distribution of organic carbon according to depth indicates different episodes of soil deposition or soil formation.

Soils that are very high in organic matter have poor engineering properties and subside upon drying.

Measurement Laboratory measurements are made using a dry combustion method to determine percent total carbon. For an estimate of organic carbon in calcareous soils, the carbon present in carbonate compounds, such as CaCO3, must be calculated and then subtracted from the total carbon. This is done using the equation: percent organic carbon = percent total carbon - [% less than 2mm CaCO3 x 0.12]. The results are given as the percent of organic carbon in dry soil. To convert the figures for organic carbon to those for organic matter, multiply the organic carbon percentage by 1.724. To convert the figures for organic matter to those for organic carbon, divide the organic matter percentage by 1.724. The detailed procedures are outlined in Soil Survey Investigations Report No. 42, Soil Survey Laboratory Methods Manual, Version 4.0, November 2004, USDA, NRCS.

Estimates Color and feel are the major properties used to estimate the amount of organic matter. Color comparisons in areas of similar materials can be made against laboratory data so that a soil scientist can make estimates. In general, black or dark colors indicate high amounts of organic matter. The contrast of color between the A horizon and subsurface horizons is also a good indicator.

Total organic carbon (TOC) is the carbon (C) stored in *soil organic matter* (SOM). Organic carbon (OC) enters the soil through the decomposition of plant and animal residues, root exudates, living and dead microorganisms, and soil biota. SOM is the organic fraction of soil exclusive of non- decomposed plant and animal residues. Nevertheless, most analytical methods do not distinguish between decomposed and non-decomposed residues. SOM is a heterogeneous, dynamic substance that varies in particle size, C content, decomposition rate, and turnover time.

Soil organic carbon (SOC) is the main source of energy for soil microorganisms. The ease and speed with which SOC becomes available is related to the SOM fraction in which it resides. In this respect, SOC can be partitioned into fractions based on the size and breakdown rates of the SOM in which it is contained (table 1). The first three fractions are part of the active pool of SOM. Carbon sources in this pool are relatively easy to break down.

SOM contains approximately 58% C; therefore, a factor of 1.72 can be used to convert OC to SOM. There is more inorganic C than TOC in calcareous soils. TOC is expressed as percent C per 100 g of soil.

Factors Affecting

Inherent - Soil texture, climate, and time all affect SOC accumulation. Soils rich in clay protect SOM from decomposition by stabilizing substances that bind to clay surfaces. Aggregation, enabled by the presence of clay,also protects SOM from microbial mineralization. Extractable aluminum and allophanes (present in volcanic soils) can form stable compounds with SOM that resist microbial decomposition. Warm temperatures decrease SOC content by increasing decomposition rates, while high mean annual precipitation increases accumulation by stimulating the production of plant biomass and associated SOC. With time, the breakdown of SOM produces humus- carbon, which resists decomposition by microorganisms.

Carbon loss via soil erosion results in SOC variations along the slope gradient. Level topography tends to have much more SOC than other slope classes. Both elevation and topographic gradients to some extent control local climate, vegetation distribution and soil properties, as well as associated biogeochemical processes, including SOC dynamics. Microclimate cooling with elevation may favor SOC accumulation. An analysis of factors affecting C in the conterminous United States concluded that the effects of land use, topography (elevation and slope), and mean annual precipitation on SOC are more obvious than that of mean annual temperature. However, when other variables are highly restricted, there is clearly a decline in SOC with increasing temperature.

Dynamic - Depending upon the rate of C mineralization, the amount and stage of decomposition of plant residues and organic amendments added to soil controls accrual of SOC. Turnover times for various organic materials shows that humus-carbon mineralizes slowly and thus accumulates in the soil, whereas microbial biomass C may disappear relatively quickly (table 1). Soil aggregates of different sizes and stability are possible sites for physical protection of SOM from decomposition and C mineralization. Soil disturbance and destruction of aggregates may be the major factor responsible for increasing exposure of SOM physically protected in aggregates to biodegradation.

Soil Organic Matter Fraction——Particle Size (mm)——Turnover Time (years)——Description

plant residues————————-equal 2.0————————less than 5—————-recognizable plant shoots and roots

particulate organic matter———0.06 - 2.0————————less than 100————-partially decomposed plant material, hyphae, seeds, etc

soil microbial biomass————variable————————less than 3—————-living pool of soil organic matter, particularly bacteria and fungi

humus——————————equal to 0.0053————100 to 5000—————-ultimate stage of decomposition, dominated by stable compounds

Crop residues incorporated in or left on the soil surface reduce erosion and SOC losses in sediment. Liming to increase the pH of acidic soil increases microbial activity, organic matter decomposition, and CO2 release. Diversity of the soil microbial population also affects SOC. For example, while soil bacteria aggressively participate in C loss by mineralization, some fungi, such as mycorrhizae, are believed to slow the decay of SOM by aggregating it with clay and minerals. SOM and SOC are more resistant inside aggregates than in free form. Soil depth affects the distribution of SOC. Thus, plowed deep soils tend to accumulate SOC in layers beneath the disturbed top soils because of restricted mineralization rates.

Relationship to Soil Function

SOC is one of the most important constituents of the soil due to its capacity to affect plant growth as both a source of energy and a trigger for nutrient availability through mineralization. SOC fractions in the active pool, previously described, are the main source of energy and nutrients for soil microorganisms. Humus participates in aggregate stability, and nutrient and water holding capacity.

OC compounds, such as polysaccharides (sugars) bind mineral particles together into microaggregates. Glomalin, a SOM substance that may account for 20% of soil carbon, glues aggregates together and stabilizes soil structure making soil resistant to erosion, but porous enough to allow air, water and plant roots to move through the soil. Organic acids (e.g., oxalic acid), commonly released from decomposing organic residues and manures, prevents phosphorus fixation by clay minerals and improve its plant availability, especially in subtropical and tropical soils. An increase in SOM, and therefore total C, leads to greater biological diversity in the soil, thus increasing biological control of plant diseases and pests. Data also reveals that interaction between dissolved OC released from manure with pesticides may increase or decrease pesticide movement through soil into groundwater.

Problems with Poor Carbon Levels

A direct effect of poor SOC is reduced microbial biomass, activity, and nutrient mineralization due to a shortage of energy sources. In non-calcareous soils, aggregate stability, infiltration, drainage, and airflow are reduced. Scarce SOC results in less diversity in soil biota with a risk of the food chain equilibrium being disrupted, which can cause disturbance in the soil environment (e.g., plant pest and disease increase, accumulation of toxic substances).

Improving Carbon Levels

Compiled data shows that farming practices have resulted in the loss of an estimated 4.4x109 tons of C from soils of the United States, most of which is OC. To compensate for these losses, practices such as no-till may increase SOC (figure 1). Other practices that increase SOC include continuous application of manure and compost, and use of summer and/or winter cover crops. Burning, harvesting, or otherwise removing residues decreases SOC.

Measuring Total Organic Carbon

Presently, no methods exist to measure TOC in the field. Attempts have been made to develop color charts that match color to TOC content, but the correlation is better within soil landscapes and only for limited soils. Near infrared spectroscopy has been attempted to measure C directly in the field, but it is expensive. Numerous laboratory methods are available.

Reference:

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. (http://soils.usda.gov)

Edwards JH, CW Wood, DL Thurlow, and ME Ruf. 1999. Tillage and crop rotation effects on fertility status of a Hapludalf soil. Soil Sci. Soc. Am. J. 56:1577-1582.

Sikora LJ and DE Stott. 1996. Soil Organic Carbon and Nitrogen. In: Doran JW, Jones AJ, editors. Methods for assessing soil quality. Madison, WI. p 157-167.

Time needed: Laboratory methods are variable.

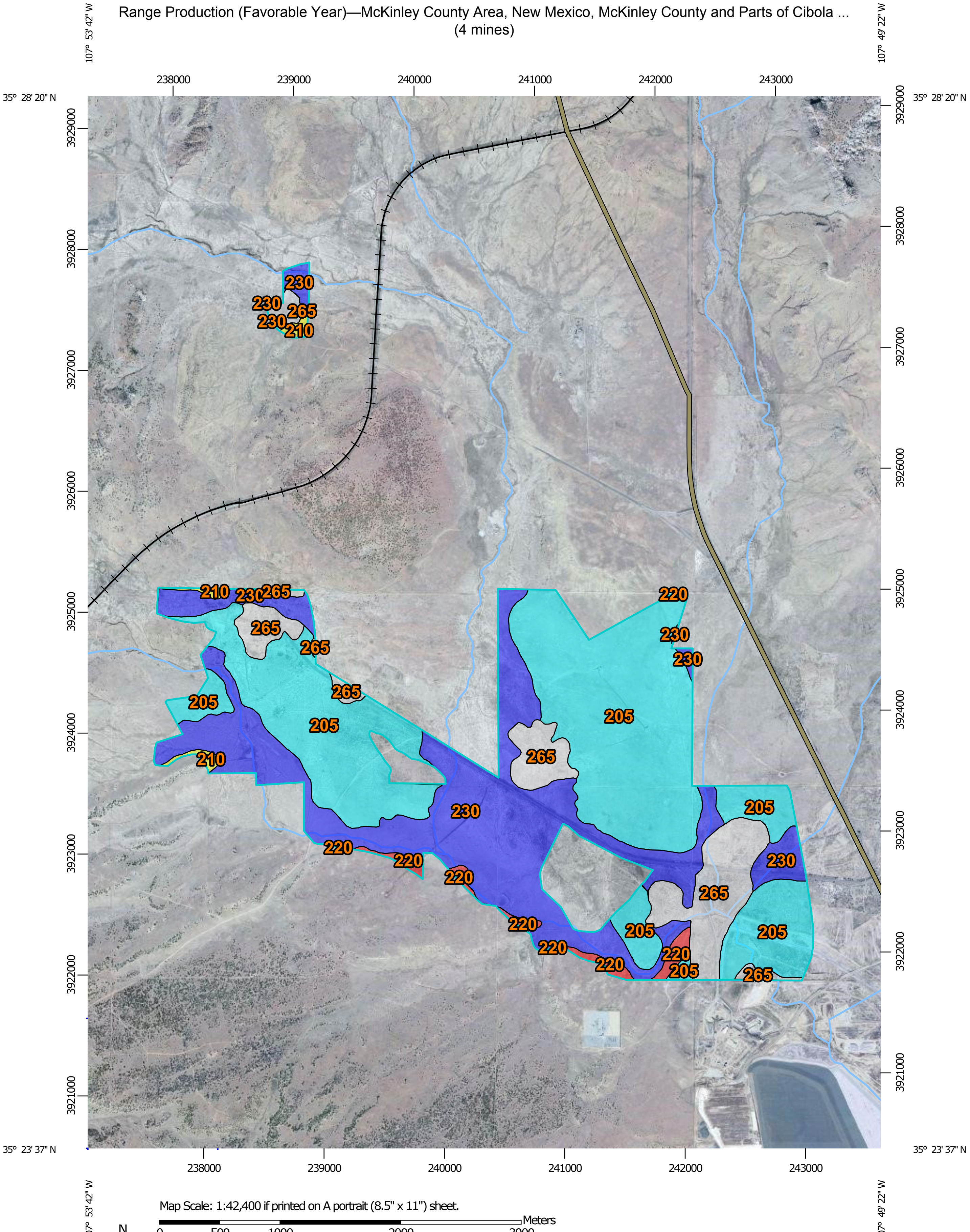
Report—Soil Quality - Organic Matter

Soil Quality - Organic Matter–McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties					
Map symbol and soil name	**Horizon Name**	**Depth (inches)**	**Organic matter low (Pct)**	**Organic matter RV (Pct)**	**Organic matter high (Pct)**
205—Penistaja-Tintero complex, 1 to 10 percent slopes					
Penistaja	A	0-3	1.0	1.5	2.0
	Bt	3-19	0.5	0.8	1.0
	Bk	19-65	0.5	0.8	1.0
Tintero	A	0-4	0.5	0.8	1.0
	Bt	4-16	0.5	0.8	1.0
	Bk1	16-48	0.5	0.8	1.0
	Bk2	48-65	0.5	0.8	1.0
210—Marianolake-Skyvillage complex, 1 to 8 percent slopes					
Marianolake	A	0-5	1.0	1.5	2.0
	Bt	5-11	0.5	0.8	1.0
	Btk	11-47	0.5	0.8	1.0
	Bk	47-65	0.5	0.8	1.0
Skyvillage	A	0-2	0.5	0.8	1.0
	Bw1	2-5	0.2	0.4	0.6
	Bw2	5-9	0.2	0.4	0.6
	Bk	9-15	0.2	0.4	0.6
	2R	15-20	—	—	—

Soil Quality - Organic Matter–McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties					
Map symbol and soil name	**Horizon Name**	**Depth (inches)**	**Organic matter low (Pct)**	**Organic matter RV (Pct)**	**Organic matter high (Pct)**
220—Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes					
Hagerwest	A	0-2	0.5	0.8	1.0
	Bt	2-13	0.2	0.5	0.8
	Bk1	13-19	0.2	0.5	0.8
	Bk2	19-35	0.2	0.5	0.8
	2R	35-40	—	—	—
Bond	A	0-2	1.0	1.5	2.0
	Bt1	2-5	0.5	0.7	0.9
	Bt2	5-14	0.5	0.7	0.9
	R	14-20	—	—	—
230—Sparank-San Mateo-Zia complex, 0 to 3 percent slopes					
Sparank	A	0-2	1.0	1.5	2.0
	C1	2-25	0.5	0.8	1.0
	C2	25-65	0.5	0.8	1.0
San mateo	A	0-2	1.0	1.5	2.0
	C1	2-15	0.5	0.8	1.0
	C2	15-30	0.5	0.8	1.0
	C3	30-39	0.5	0.8	1.0
	C4	39-45	0.5	0.8	1.0
	C5	45-65	0.5	0.8	1.0
Zia	A	0-3	1.0	1.5	2.0
	Bw	3-12	0.5	0.8	1.0
	2C1	12-20	0.5	0.8	1.0
	2C2	20-28	0.5	0.8	1.0
	2C3	28-70	0.5	0.8	1.0
265—Uranium mined lands					
Uranium mined lands	C	0-60	—	—	—

Data Source Information

Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
Survey Area Data: Version 11, Sep 26, 2014



Map Scale: 1:42,400 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 2000, 4000, 8000, 12000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- <= 1171
- > 1171 and <= 1200
- > 1200 and <= 1359
- > 1359 and <= 3557
- Not rated or not available

Soil Rating Lines

- <= 1171
- > 1171 and <= 1200
- > 1200 and <= 1359
- > 1359 and <= 3557
- Not rated or not available

Soil Rating Points

- <= 1171
- > 1171 and <= 1200
- > 1200 and <= 1359
- > 1359 and <= 3557
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
Survey Area Data: Version 11, Sep 26, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 21, 2010—Nov 7, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Range Production (Favorable Year)

Range Production (Favorable Year)— Summary by Map Unit — McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NM692)				
Map unit symbol	Map unit name	Rating (pounds per acre per year)	Acres in AOI	Percent of AOI
205	Penistaja-Tintero complex, 1 to 10 percent slopes	1359	1,166.7	50.7%
210	Marianolake-Skyvillage complex, 1 to 8 percent slopes	1200	20.1	0.9%
220	Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes	1171	41.3	1.8%
230	Sparank-San Mateo-Zia complex, 0 to 3 percent slopes	3557	787.0	34.2%
265	Uranium mined lands		285.3	12.4%
Totals for Area of Interest			**2,300.3**	**100.0%**

Description

Total range production is the amount of vegetation that can be expected to grow annually in a well managed area that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. Yields are adjusted to a common percent of air-dry moisture content.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Rating Options

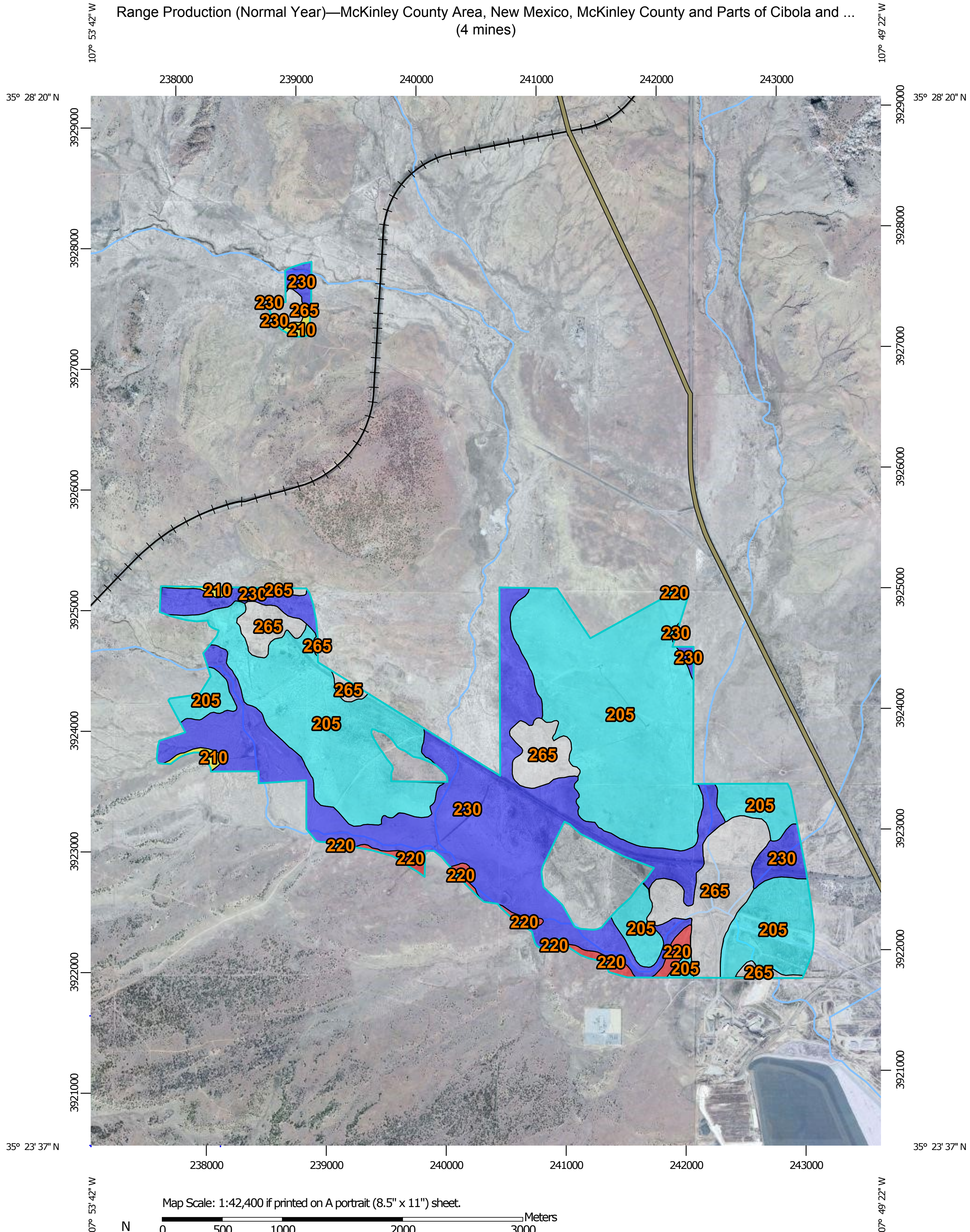
Units of Measure: pounds per acre per year

Aggregation Method: Weighted Average

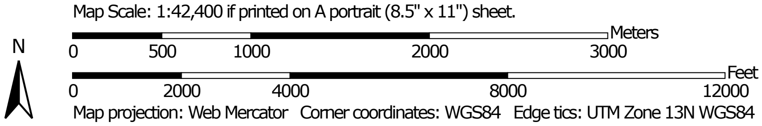
Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

Interpret Nulls as Zero: Yes



Map Scale: 1:42,400 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- <= 794
- > 794 and <= 813
- > 813 and <= 953
- > 953 and <= 2177
- Not rated or not available

Soil Rating Lines

- <= 794
- > 794 and <= 813
- > 813 and <= 953
- > 953 and <= 2177
- Not rated or not available

Soil Rating Points

- <= 794
- > 794 and <= 813
- > 813 and <= 953
- > 953 and <= 2177
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
Survey Area Data: Version 11, Sep 26, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 21, 2010—Nov 7, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Range Production (Normal Year)

Range Production (Normal Year)— Summary by Map Unit — McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NM692)				
Map unit symbol	Map unit name	Rating (pounds per acre per year)	Acres in AOI	Percent of AOI
205	Penistaja-Tintero complex, 1 to 10 percent slopes	953	1,166.7	50.7%
210	Marianolake-Skyvillage complex, 1 to 8 percent slopes	813	20.1	0.9%
220	Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes	794	41.3	1.8%
230	Sparank-San Mateo-Zia complex, 0 to 3 percent slopes	2177	787.0	34.2%
265	Uranium mined lands		285.3	12.4%
Totals for Area of Interest			**2,300.3**	**100.0%**

Description

Total range production is the amount of vegetation that can be expected to grow annually in a well managed area that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation. In a normal year, growing conditions are about average. Yields are adjusted to a common percent of air-dry moisture content.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Rating Options

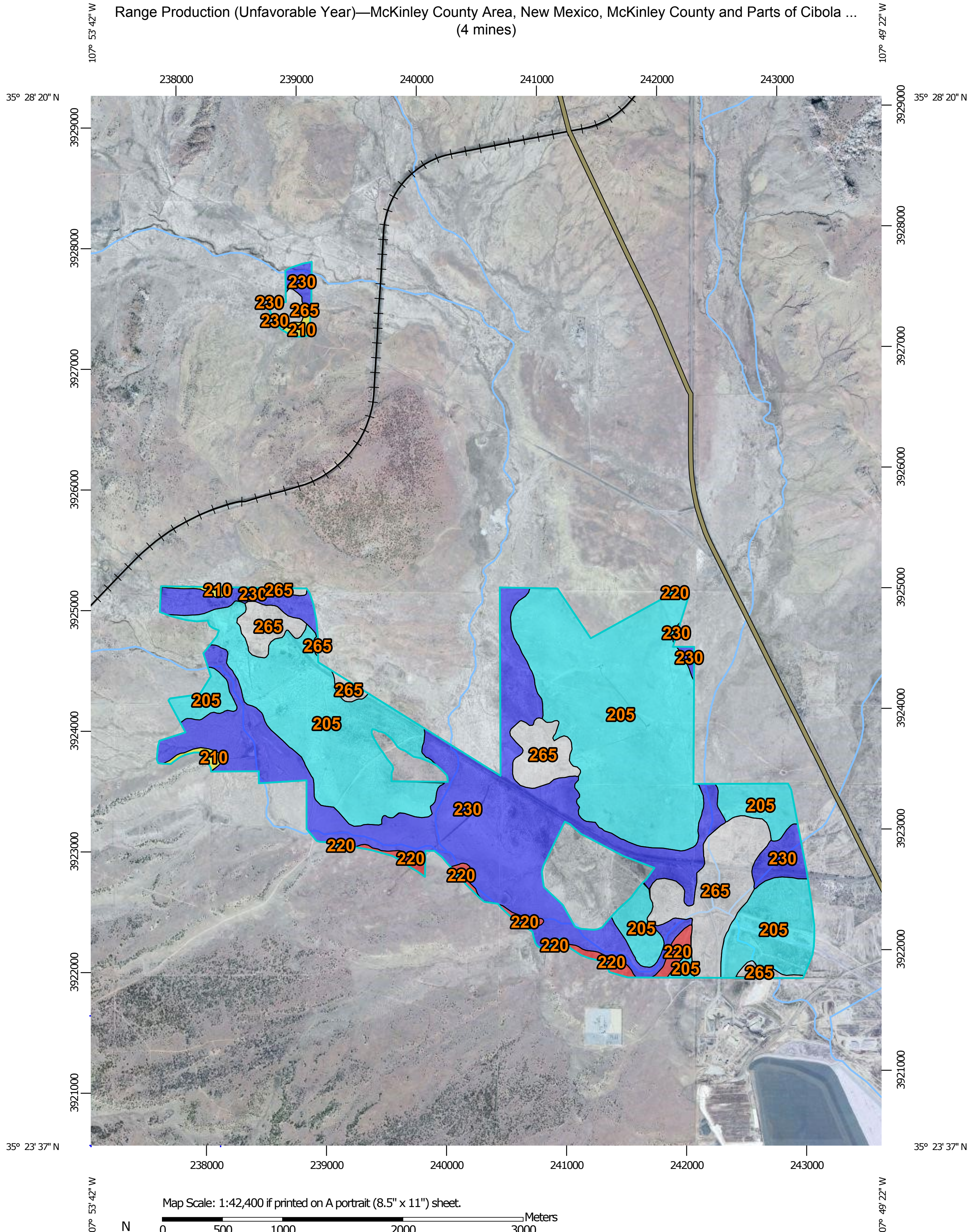
Units of Measure: pounds per acre per year

Aggregation Method: Weighted Average

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

Interpret Nulls as Zero: Yes



Map Scale: 1:42,400 if printed on A portrait (8.5" x 11") sheet.

Meters: 0 500 1000 2000 3000

Feet: 0 2000 4000 8000 12000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- <= 407
- > 407 and <= 416
- > 416 and <= 547
- > 547 and <= 1102
- Not rated or not available

Soil Rating Lines

- <= 407
- > 407 and <= 416
- > 416 and <= 547
- > 547 and <= 1102
- Not rated or not available

Soil Rating Points

- <= 407
- > 407 and <= 416
- > 416 and <= 547
- > 547 and <= 1102
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
Survey Area Data: Version 11, Sep 26, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 21, 2010—Nov 7, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Range Production (Unfavorable Year)

Range Production (Unfavorable Year)— Summary by Map Unit — McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NM692)				
Map unit symbol	**Map unit name**	**Rating (pounds per acre per year)**	**Acres in AOI**	**Percent of AOI**
205	Penistaja-Tintero complex, 1 to 10 percent slopes	547	1,166.7	50.7%
210	Marianolake-Skyvillage complex, 1 to 8 percent slopes	416	20.1	0.9%
220	Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes	407	41.3	1.8%
230	Sparank-San Mateo-Zia complex, 0 to 3 percent slopes	1102	787.0	34.2%
265	Uranium mined lands		285.3	12.4%
Totals for Area of Interest			**2,300.3**	**100.0%**

Description

Total range production is the amount of vegetation that can be expected to grow annually in a well managed area that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture. Yields are adjusted to a common percent of air-dry moisture content.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Rating Options

Units of Measure: pounds per acre per year

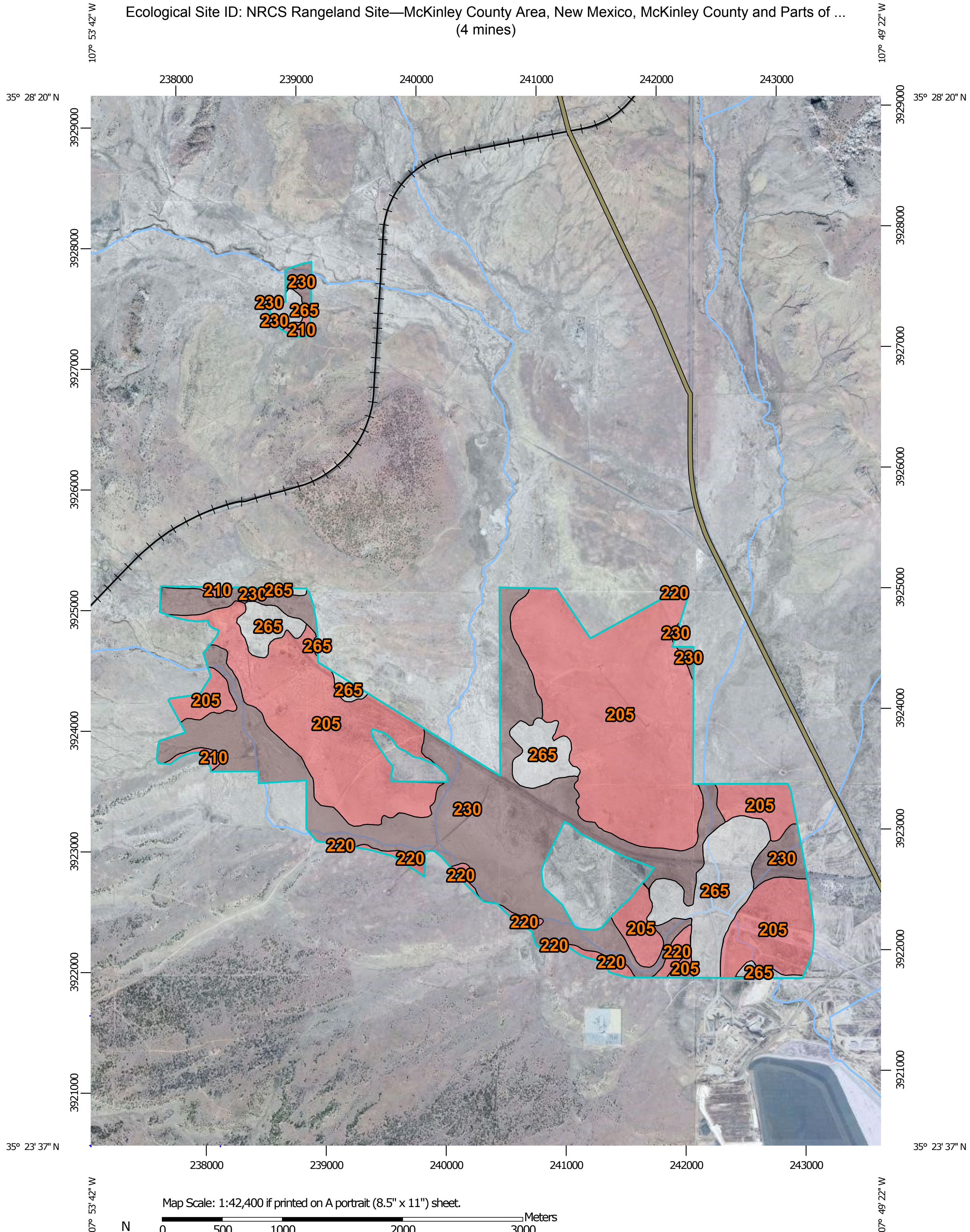
Aggregation Method: Weighted Average

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

Interpret Nulls as Zero: Yes

Ecological Site ID: NRCS Rangeland Site—McKinley County Area, New Mexico, McKinley County and Parts of ...
(4 mines)



Map Scale: 1:42,400 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 2000, 4000, 8000, 12000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

R035XA112NM

R035XA119NM

Not rated or not available

Soil Rating Lines

R035XA112NM

R035XA119NM

Not rated or not available

Soil Rating Points

R035XA112NM

R035XA119NM

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
Survey Area Data: Version 11, Sep 26, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 21, 2010—Nov 7, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Ecological Site ID: NRCS Rangeland Site

Ecological Site ID: NRCS Rangeland Site— Summary by Map Unit — McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NM692)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
205	Penistaja-Tintero complex, 1 to 10 percent slopes	R035XA112NM	1,166.7	50.7%
210	Marianolake-Skyvillage complex, 1 to 8 percent slopes	R035XA112NM	20.1	0.9%
220	Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes	R035XA112NM	41.3	1.8%
230	Sparank-San Mateo-Zia complex, 0 to 3 percent slopes	R035XA119NM	787.0	34.2%
265	Uranium mined lands		285.3	12.4%
Totals for Area of Interest			**2,300.3**	**100.0%**

Description

An "ecological site ID" is the symbol assigned to a particular ecological site. An "ecological site" is the product of all the environmental factors responsible for its development. It has characteristic soils that have developed over time; a characteristic hydrology, particularly infiltration and runoff, that has developed over time; and a characteristic plant community (kind and amount of vegetation). The vegetation, soils, and hydrology are all interrelated. Each is influenced by the others and influences the development of the others. For example, the hydrology of the site is influenced by development of the soil and plant community. The plant community on an ecological site is typified by an association of species that differs from that of other ecological sites in the kind and/or proportion of species or in total production. Descriptions of ecological sites are provided in the Field Office Technical Guide, which is available in local offices of the Natural Resources Conservation Service.

Rating Options

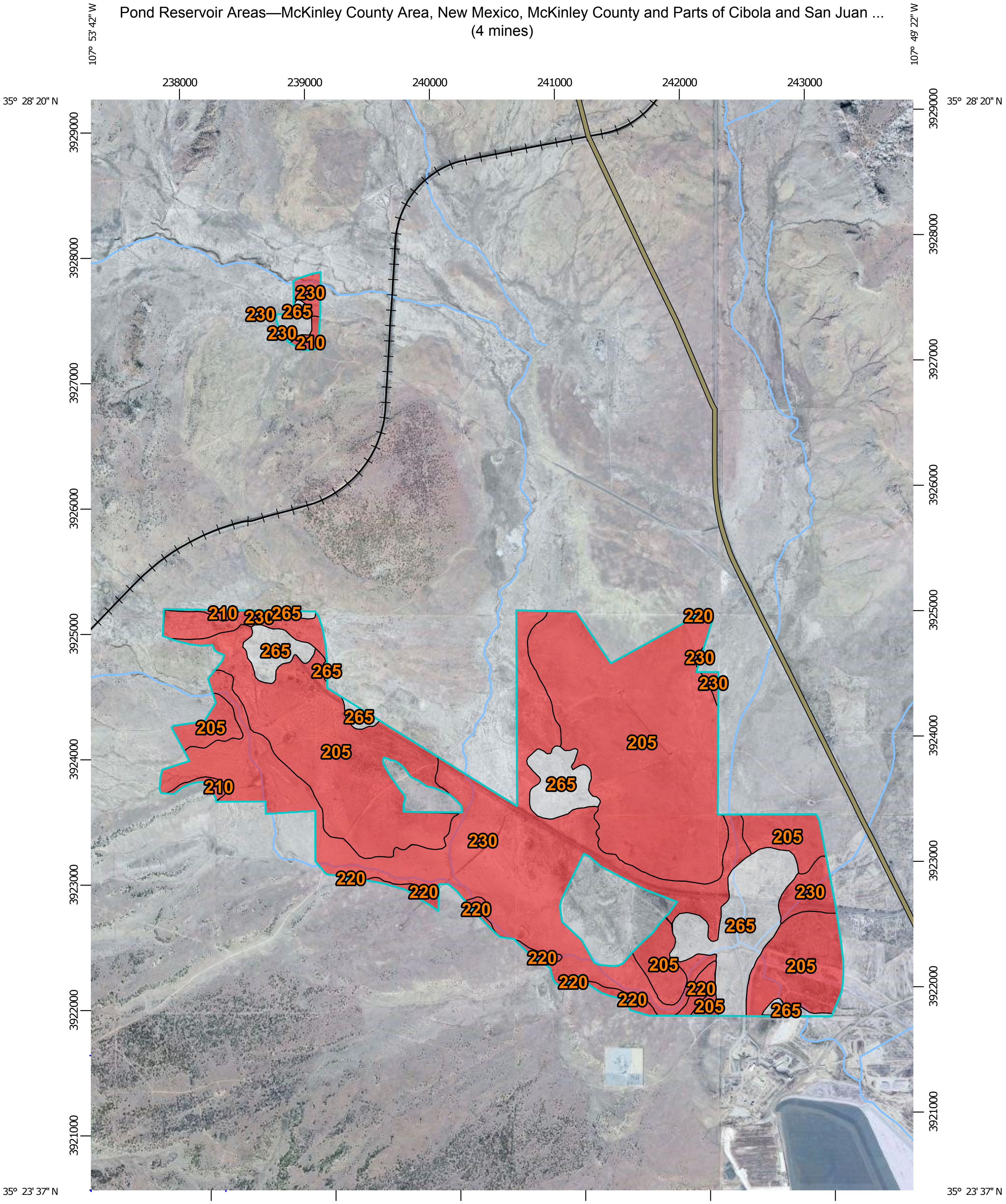
Class: NRCS Rangeland Site

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Lower

Pond Reservoir Areas—McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan ...
(4 mines)



Map Scale: 1:42,400 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 2000, 4000, 8000, 12000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

Very limited

Somewhat limited

Not limited

Not rated or not available

Soil Rating Lines

Very limited

Somewhat limited

Not limited

Not rated or not available

Soil Rating Points

Very limited

Somewhat limited

Not limited

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
Survey Area Data: Version 11, Sep 26, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 21, 2010—Nov 7, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Pond Reservoir Areas

Pond Reservoir Areas— Summary by Map Unit — McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NM692)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
205	Penistaja-Tintero complex, 1 to 10 percent slopes	Very limited	Penistaja (45%)	Seepage (1.00)	1,166.7	50.7%
			Tintero (40%)	Seepage (1.00)		
				Slope (0.32)		
210	Marianolake-Skyvillage complex, 1 to 8 percent slopes	Very limited	Marianolake (50%)	Seepage (1.00)	20.1	0.9%
				Slope (0.08)		
			Skyvillage (30%)	Depth to bedrock (1.00)		
				Seepage (0.54)		
				Slope (0.08)		
220	Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes	Very limited	Hagerwest (50%)	Seepage (1.00)	41.3	1.8%
				Depth to bedrock (0.69)		
			Bond (35%)	Depth to bedrock (1.00)		
				Slope (0.08)		
230	Sparank-San Mateo-Zia complex, 0 to 3 percent slopes	Very limited	San Mateo (35%)	Seepage (1.00)	787.0	34.2%
			Zia (20%)	Seepage (1.00)		
			Escawetter (1%)	Seepage (1.00)		
265	Uranium mined lands	Not rated	Uranium mined lands (95%)		285.3	12.4%
Totals for Area of Interest					**2,300.3**	**100.0%**

Pond Reservoir Areas— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Very limited	2,015.1	87.6%
Null or Not Rated	285.3	12.4%
Totals for Area of Interest	**2,300.3**	**100.0%**

Description

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the saturated hydraulic conductivity (Ksat) of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the specified use. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

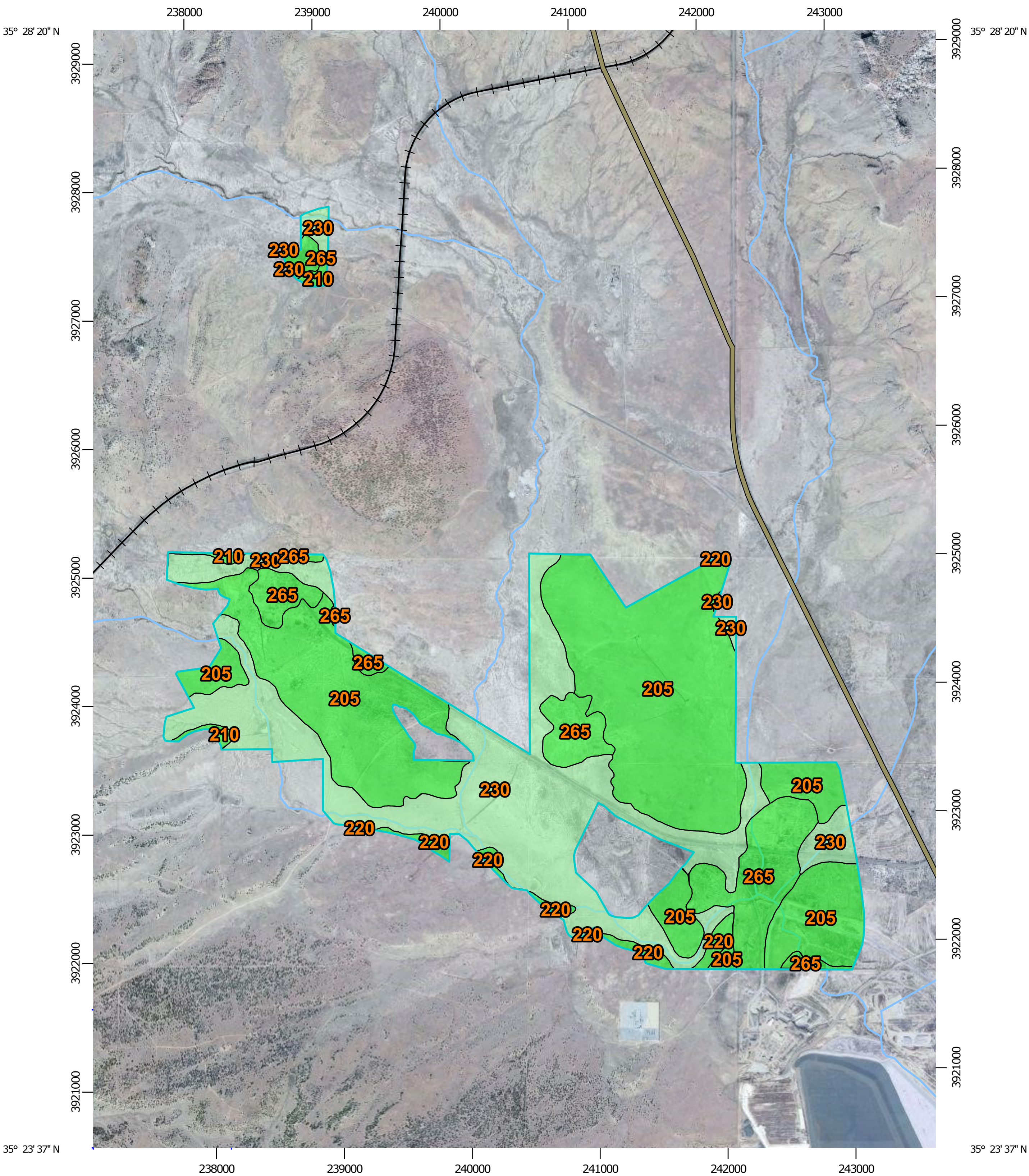
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

Hydric Rating by Map Unit—McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San ...
(4 mines)



Map Scale: 1:42,400 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 2000, 4000, 8000, 12000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Soil Rating Lines

- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Soil Rating Points

- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
Survey Area Data: Version 11, Sep 26, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 21, 2010—Nov 7, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydric Rating by Map Unit

Hydric Rating by Map Unit— Summary by Map Unit — McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NM692)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
205	Penistaja-Tintero complex, 1 to 10 percent slopes	0	1,166.7	50.7%
210	Marianolake-Skyvillage complex, 1 to 8 percent slopes	0	20.1	0.9%
220	Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes	0	41.3	1.8%
230	Sparank-San Mateo-Zia complex, 0 to 3 percent slopes	1	787.0	34.2%
265	Uranium mined lands	0	285.3	12.4%
Totals for Area of Interest			**2,300.3**	**100.0%**

Description

This rating indicates the percentage of map units that meets the criteria for hydric soils. Map units are composed of one or more map unit components or soil types, each of which is rated as hydric soil or not hydric. Map units that are made up dominantly of hydric soils may have small areas of minor nonhydric components in the higher positions on the landform, and map units that are made up dominantly of nonhydric soils may have small areas of minor hydric components in the lower positions on the landform. Each map unit is rated based on its respective components and the percentage of each component within the map unit.

The thematic map is color coded based on the composition of hydric components. The five color classes are separated as 100 percent hydric components, 66 to 99 percent hydric components, 33 to 65 percent hydric components, 1 to 32 percent hydric components, and less than one percent hydric components.

In Web Soil Survey, the Summary by Map Unit table that is displayed below the map pane contains a column named 'Rating'. In this column the percentage of each map unit that is classified as hydric is displayed.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006).

References:

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.

Soil Survey Staff. 2006. Keys to soil taxonomy. 10th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.

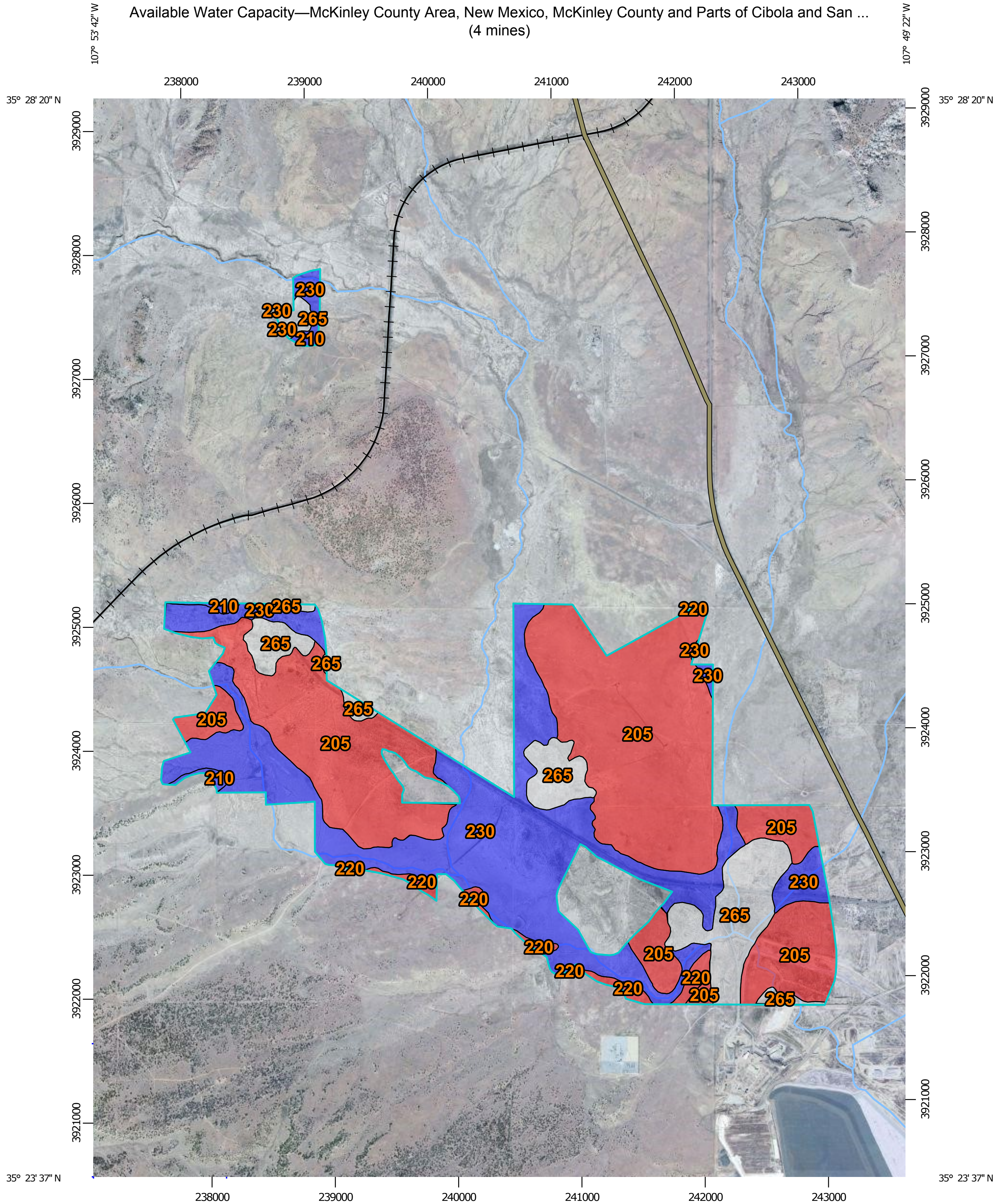
Rating Options

Aggregation Method: Percent Present

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Available Water Capacity—McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San ...
(4 mines)



Map Scale: 1:42,400 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 2000, 4000, 8000, 12000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- <= 0.14
- > 0.14 and <= 0.18
- Not rated or not available

Soil Rating Lines

- <= 0.14
- > 0.14 and <= 0.18
- Not rated or not available

Soil Rating Points

- <= 0.14
- > 0.14 and <= 0.18
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

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This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
Survey Area Data: Version 11, Sep 26, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 21, 2010—Nov 7, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Available Water Capacity

Available Water Capacity— Summary by Map Unit — McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NM692)				
Map unit symbol	**Map unit name**	**Rating (centimeters per centimeter)**	**Acres in AOI**	**Percent of AOI**
205	Penistaja-Tintero complex, 1 to 10 percent slopes	0.14	1,166.7	50.7%
210	Marianolake-Skyvillage complex, 1 to 8 percent slopes	0.18	20.1	0.9%
220	Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes	0.14	41.3	1.8%
230	Sparank-San Mateo-Zia complex, 0 to 3 percent slopes	0.18	787.0	34.2%
265	Uranium mined lands		285.3	12.4%
Totals for Area of Interest			**2,300.3**	**100.0%**

Description

Available water capacity (AWC) refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in centimeters of water per centimeter of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure, with corrections for salinity and rock fragments. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. It is not an estimate of the quantity of water actually available to plants at any given time.

Available water supply (AWS) is computed as AWC times the thickness of the soil. For example, if AWC is 0.15 cm/cm, the available water supply for 25 centimeters of soil would be 0.15 x 25, or 3.75 centimeters of water.

For each soil layer, AWC is recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: centimeters per centimeter

Aggregation Method: Dominant Component

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

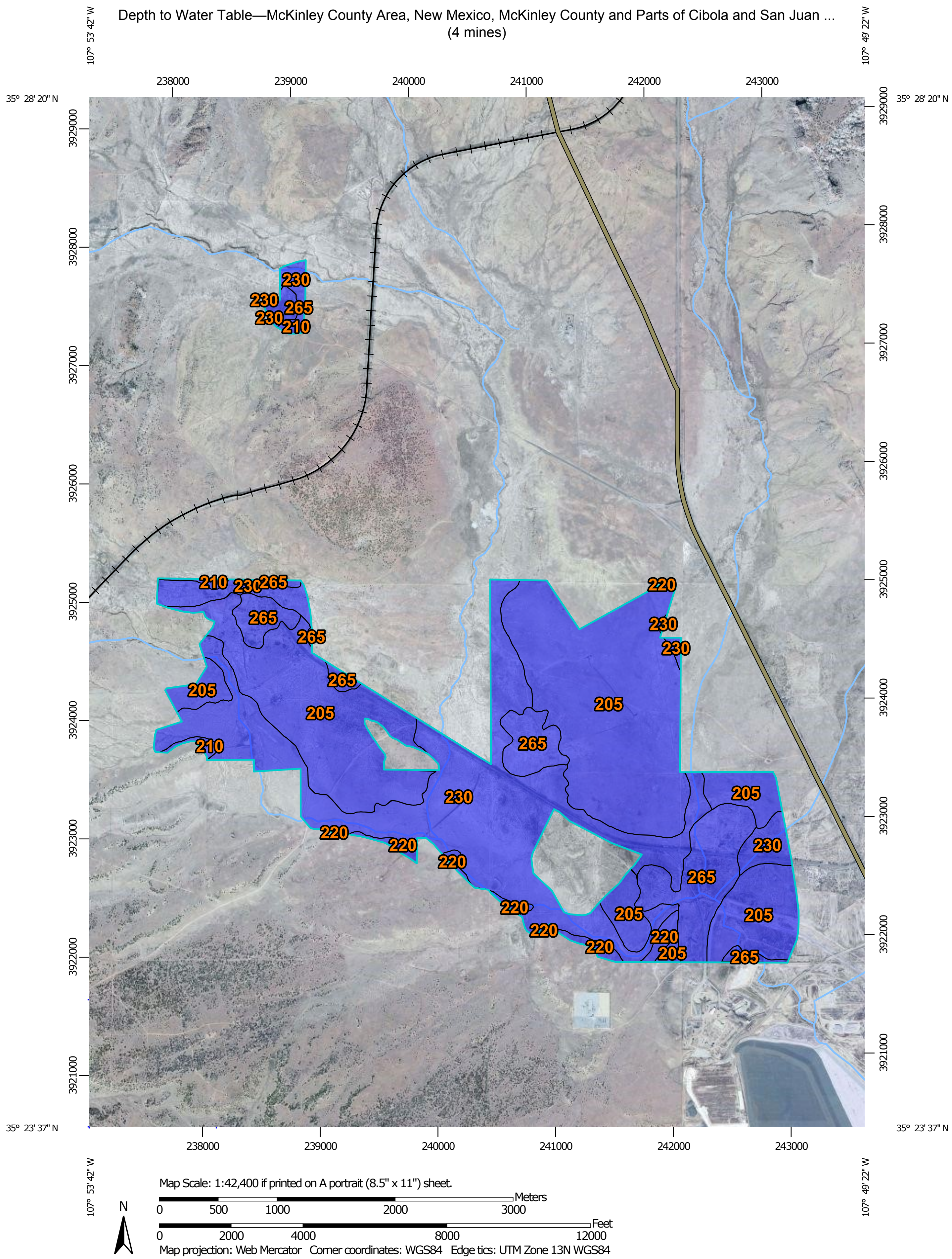
Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 36

Units of Measure: Inches


107° 53' 42" W
107° 49' 22" W
238000
239000
240000
241000
242000
243000
35° 28' 20" N
35° 28' 20" N
3929000
3928000
3927000
3926000
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205
265
35° 23' 37" N
35° 23' 37" N
107° 53' 42" W
107° 49' 22" W
Map Scale: 1:42,400 if printed on A portrait (8.5" x 11") sheet.
Meters
0
500
1000
2000
3000
Feet
0
2000
4000
8000
12000
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Lines

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Points

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

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Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 21, 2010—Nov 7, 2010

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Depth to Water Table

Depth to Water Table— Summary by Map Unit — McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NM692)				
Map unit symbol	**Map unit name**	**Rating (centimeters)**	**Acres in AOI**	**Percent of AOI**
205	Penistaja-Tintero complex, 1 to 10 percent slopes	>200	1,166.7	50.7%
210	Marianolake-Skyvillage complex, 1 to 8 percent slopes	>200	20.1	0.9%
220	Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes	>200	41.3	1.8%
230	Sparank-San Mateo-Zia complex, 0 to 3 percent slopes	>200	787.0	34.2%
265	Uranium mined lands	>200	285.3	12.4%
Totals for Area of Interest			**2,300.3**	**100.0%**

Description

"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: centimeters

Aggregation Method: Dominant Component

Component Percent Cutoff: *None Specified*

Tie-break Rule: Lower

Interpret Nulls as Zero: No

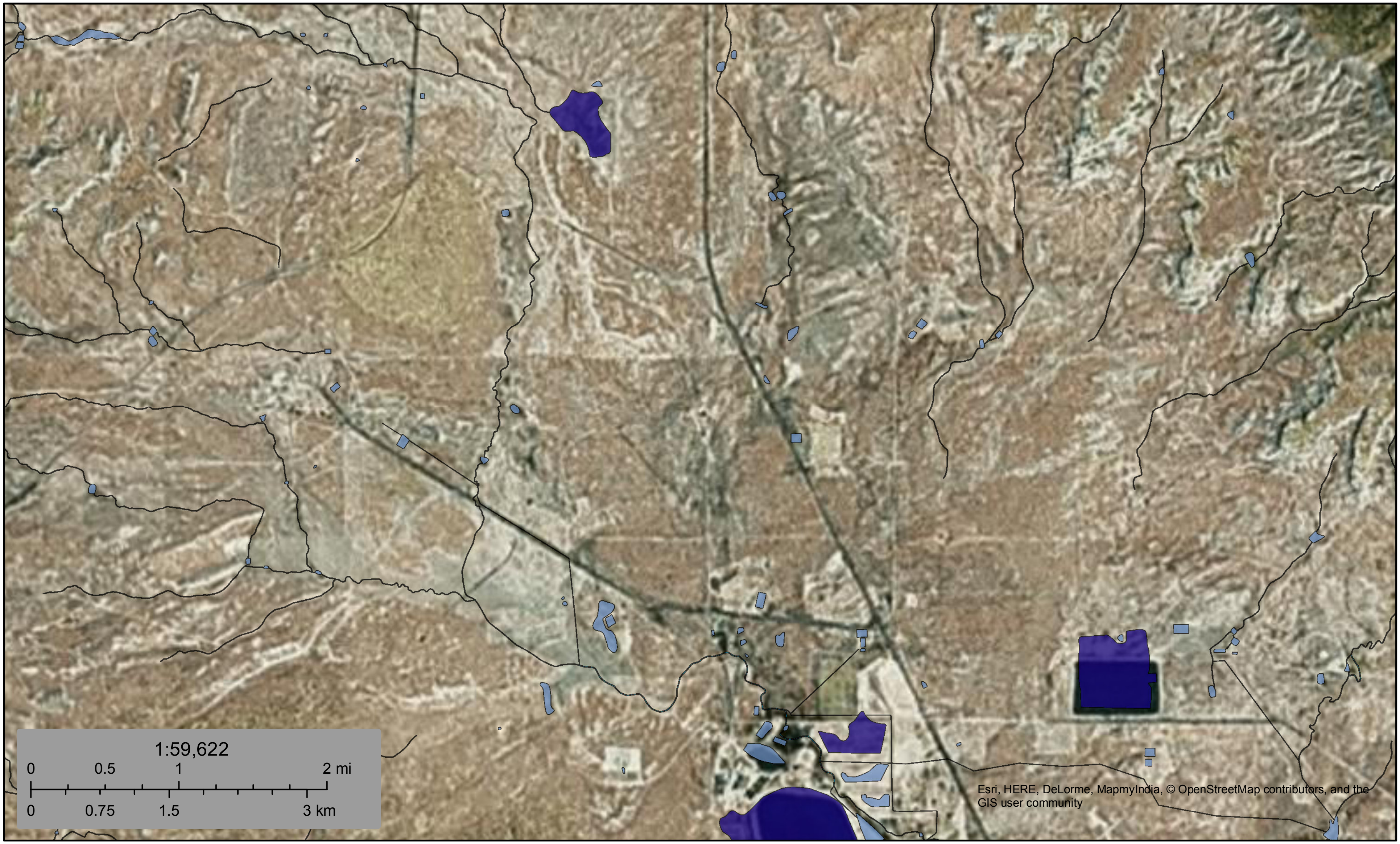
Beginning Month: January

Ending Month: December

U.S. Fish and Wildlife Service

National Wetlands Inventory

tronox 4 mines



November 7, 2016

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

IAS Laboratories

2515 East University Drive
Phoenix, Arizona 85034
(602) 273-7248
Fax (602) 275-3836

Date: November 30, 2016
Submitted by: Weston Solutions
Report To: David Bordelon
Report #: 6654639
Date Received: November 21, 2016

SOIL ANALYSIS

Sender I.D.	Lab No	* Total Carbon %	* Total Nitrogen %	* C:N	** Water Holding Capacity - 0 Bar %
WGSA-S01-160922	920	2.93	0.113	26:1	26.07
WGSA-S02-160922	921	1.175	0.093	13:1	26.92
WGSA-S03-160922	922	1.164	0.101	12:1	29.30
WGSA-S04-160922	923	0.932	0.041	23:1	20.27
WGSA-S05-160922	924	1.524	0.092	17:1	28.75
WGSA-S06-160926	925	4.138	0.088	47:1	26.46
WGSA-S07-160926	926	1.058	0.040	26:1	22.53
WGSA-S08-160926	927	1.683	0.051	33:1	26.09
WGSA-S09-160926	928	1.177	0.074	16:1	28.21
WGSA-S10-160926	929	1.67	0.044	38:1	27.46
WGSA-S11-161101	930	2.25	0.010	225:1	27.43
WGSA-S12-161101	931	0.809	0.001	809:1	22.31
WGSA-S13-161101	932	1.661	0.074	22:1	26.78
WGSA-S14-161101	933	1.219	0.110	11:1	33.66
WGSA-S15-161101	934	1.242	0.0418	30:1	32.69
WGSA-S16-161116	935	1.775	0.454	4:1	27.10
WGSA-S17-161116	936	1.338	0.065	21:1	31.85
WGSA-S18-161116	937	1.271	0.645	2:1	29.25
WGSA-S19-161116	938	1.79	0.044	41:1	28.42
WGSA-S20-161116	939	1.179	0.989	1:1	30.33
WGSA-S21-161116	940	1.491	0.039	38:1	17.33
WGSA-S22-161116	941	1.077	0.949	1:1	53.45

*AOAC Official Method 993.13

**ASTM D3152-72

IAS Laboratories

2515 East University Drive
Phoenix, Arizona 85034
(602) 273-7248
Fax (602) 275-3836

Date: November 30, 2016
Submitted by: Weston Solutions
Report To: David Bordelon
Report #: 6654639
Date Received: November 21, 2016

PLANT ANALYSIS

Sender I.D.	Lab No	* Iron ppm	* Zinc ppm	* Copper ppm	* Manganese ppm	* Molybdenum ppm	* Uranium ppm	* Vanadium ppm	* Selenium ppm
WGSA-P01-160922	397	1320.4	63.1	3.8	20.4	1.07	<0.50	<0.04	<0.61
WGSA-P02-160922	398	394.0	40.3	7.1	27.7	0.81	<0.50	<0.04	<0.81
WGSA-P03-160922	399	198.5	17.2	3.5	38.8	0.46	8.95	<0.04	<1.41
WGSA-P04-160922	400	65.8	20.0	3.8	1.3	0.34	10.25	<0.04	1.25
WGSA-P05-160922	401	77.6	13.5	3.4	6.2	0.54	6.34	<0.04	<0.65
WGSA-P06-160926	402	160.0	16.3	4.7	1.2	0.90	12.33	<0.04	<0.65
WGSA-P07-160926	403	164.2	5.6	1.5	3.8	2.09	<0.50	<0.04	<0.65
WGSA-P08-160926	404	605.6	12.1	4.4	94.1	0.89	3.2	<0.04	<0.65
WGSA-P09-160926	405	98.5	25.0	4.3	31.3	87.61	0.64	<0.04	17.45
WGSA-P10-160926	406	213.1	16.3	5.6	39.4	3.44	<0.50	<0.04	<0.65
WGSA-P11-161101	407	275.1	23.9	3.5	22.6	1.47	<0.50	<0.04	<0.65
WGSA-P12-161101	408	157.8	40.4	6.4	8.2	1.98	4.63	<0.04	205.24
WGSA-P13-161101	409	583.8	14.8	4.5	64.0	0.83	4.93	<0.04	<0.65
WGSA-P14-161101	410	387.9	9.8	2.4	52.5	0.71	1.32	<0.04	<0.90
WGSA-P15-161101	411	255.5	8.9	1.5	15.8	0.56	<0.50	<0.04	<0.65

*EPA 3050B

IAS Laboratories

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Date: November 30, 2016
Submitted by: Weston Solutions
Report To: David Bordelon
Report #: 6654639
Date Received: November 21, 2016

PLANT ANALYSIS

Sender I.D.	Lab No	* Iron ppm	* Zinc ppm	* Copper ppm	* Manganese ppm	* Molybdenum ppm	* Uranium ppm	* Vanadium ppm	* Selenium ppm
WGSA-P16-161116	412	260.9	10.6	4.9	56.7	0.98	1.4	<0.04	<0.65
WGSA-P17-161116	413	356.0	13.0	2.9	41.4	0.83	5.2	<0.04	<0.65
WGSA-P18-161116	414	633.8	10.5	3.2	60.8	1.07	11.9	<0.04	<0.65
WGSA-P19-161116	415	505.0	11.8	2.7	43.8	0.86	5.5	<0.04	<0.65
WGSA-P20-161116	416	760.2	17.3	5.4	53.6	2.30	7.5	<0.04	<0.65
WGSA-P21-161116	417	486.0	14.1	4.0	77.9	0.64	9.1	<0.04	<0.65
WGSA-P22-161116	418	220.1	9.9	2.4	44.9	0.57	6.5	<0.04	<0.65

*EPA 3050B

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SOIL ANALYSIS REPORT

Today's Date: 11/30/2016
Grower: WGSA
Submitted By: David Bordelon
Send Report To: Weston Solutions
Report Number: 6654639
Crop: Native Plants
Date Received: 11/21/2016

VL = Very Low
L = Low
M = Medium
H = High
VH = Very High

Sender Sample Id	Depth	Lab #	pH	Calcium (Ca) PPM	Magnesium (Mg) PPM	Sodium (Na) PPM	Potash (K) PPM	Iron (Fe) PPM	Zinc (Zn) PPM	Manganese (Mn) PPM	Copper (Cu) PPM	Salinity (EC x K) dS/m	Nitrate Nitrogen (NO3-N) PPM	Phosphorus (Bicarb - Soluble P) PPM	Computed % Sodium (ESP)	Sulfur (SO4-S) PPM	Boron (B) PPM	Free Lime Level
S01-160922		920	9.0	6200 VH	430 VH	56 L	85 L	3.5 M	.12 VL	.34 VL	.15 L	.5 VL	9.1 L	5.9 L	.7	3.3 VL	.38 L	High
S02-160922		921	8.1	6100 VH	230 H	93 L	240 M	8.3 M	.22 L	1.5 M	.59 M	1.6 L	8.4 L	7.8 L	1.2	120 VH	.45 L	High
S03-160922		922	8.3	4200 H	410 VH	86 L	470 H	8.8 M	.14 VL	1.7 M	.74 M	.9 L	12.0 M	4.3 VL	1.4	3.9 VL	.39 L	Medium
S04-160922		923	8.7	1800 L	120 M	58 L	300 M	8.6 M	.46 L	1.6 M	.48 M	.4 VL	11.0 M	6.7 L	2.3	4.1 VL	.25 VL	Medium
S05-160922		924	8.5	6800 VH	400 VH	60 L	610 H	6.0 M	.34 L	1.6 M	.76 M	.9 L	10.0 L	7.1 L	.7	9.1 L	.43 L	High
S06-160926		925	7.9	33000 VH	290 H	120 M	290 M	2.8 M	.28 L	.91 L	.50 M	5.3 VH	12.0 M	4.8 VL	.3	1100 VH	.63 L	High
S07-160926		926	8.5	4600 H	210 M	53 L	140 L	5.6 M	.15 VL	1.4 M	.38 M	.9 L	8.6 L	5.3 L	.9	12 M	.22 VL	Medium
S08-160926		927	8.5	6800 VH	420 VH	60 L	390 M	6.1 M	.16 VL	1.8 M	.65 M	.7 L	11.0 M	6.2 L	.7	9.6 L	.28 VL	High
S09-160926		928	8.3	3400 M	220 M	52 L	310 M	16.0 M	2.9 M	3.9 M	2.3 H	.6 L	10.0 L	10.0 M	1.1	15 M	.24 VL	Medium
S10-160926		929	8.6	7000 VH	360 H	69 L	220 M	4.7 M	.16 VL	1.4 M	.50 M	.5 VL	8.9 L	5.8 L	.8	8.1 L	.21 VL	High
S11-161101		930	8.6	7200 VH	1000 VH	110 M	120 L	4.8 M	.07 VL	1.9 M	.20 L	1.0 L	9.1 L	4.3 VL	1.1	23 H	.38 L	High
S12-161101		931	8.6	1400 L	96 M	49 L	100 L	5.5 M	.34 L	1.1 M	.35 M	.3 VL	7.9 L	4.7 VL	2.6	5.1 VL	.10 VL	Low

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SOIL ANALYSIS REPORT

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Grower: WGSA
Submitted By: David Bordelon
Send Report To: Weston Solutions
Report Number: 6654639
Crop: Native Plants
Date Received: 11/21/2016

VL = Very Low
L = Low
M = Medium
H = High
VH = Very High

Sender Sample Id	Depth	Lab #	pH	Calcium (Ca) PPM	Magnesium (Mg) PPM	Sodium (Na) PPM	Potash (K) PPM	Iron (Fe) PPM	Zinc (Zn) PPM	Manganese (Mn) PPM	Copper (Cu) PPM	Salinity (EC x K) dS/m	Nitrate Nitrogen (NO3-N) PPM	Phosphorus (Bicarb - Soluble P) PPM	Computed % Sodium (ESP)	Sulfur (SO4-S) PPM	Boron (B) PPM	Free Lime Level
S13-161101		932	8.7	7400 VH	260 H	60 L	270 M	7.5 M	.08 VL	.90 L	.37 M	.5 VL	8.3 L	4.8 VL	.7	5.1 VL	.33 L	High
S14-161101		933	8.3	7800 VH	310 H	220 H	270 M	13.0 M	.31 L	2.1 M	.89 M	1.5 L	12.0 M	7.9 L	2.2	72 VH	.55 L	High
S15-161101		934	8.2	7100 VH	340 H	140 M	460 H	7.7 M	.32 L	2.4 M	1.0 H	1.8 L	17.0 M	9.2 L	1.5	110 VH	.43 L	High
S16-161116		935	8.6	7400 VH	370 H	49 L	150 M	4.5 M	.09 VL	1.2 M	.46 M	.5 VL	10.0 L	4.8 VL	.5	3.0 VL	.20 VL	High
S17-161116		936	8.4	5300 H	620 VH	74 L	920 VH	12.0 M	2.3 M	1.8 M	.55 M	1.4 L	8.7 L	5.9 L	.9	15 M	.42 L	Medium
S18-161116		937	8.4	7600 VH	520 VH	170 M	160 M	9.7 M	.92 M	2.0 M	.83 M	1.1 L	12.0 M	5.2 L	1.7	27 H	.68 L	High
S19-161116		938	8.2	7200 VH	330 H	94 L	440 H	5.4 M	.22 L	1.9 M	.77 M	1.7 L	44.0 H	6.2 L	1.0	54 VH	.40 L	High
S20-161116		939	7.9	7800 VH	330 H	230 H	210 M	7.8 M	.42 L	2.4 M	.93 M	5.3 VH	74.0 VH	7.8 L	2.3	500 VH	.53 L	High
S21-161116		940	8.1	6200 VH	310 H	100 L	120 L	6.1 M	.19 VL	1.4 M	.68 M	1.3 L	45.0 H	6.3 L	1.3	27 H	.50 L	Medium
S22-161116		941	8.2	6200 VH	450 VH	200 M	290 M	7.5 M	.15 VL	1.9 M	.87 M	1.7 L	30.0 H	5.1 L	2.4	57 VH	.49 L	Medium

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SOIL ANALYSIS REPORT

Today's Date: 11/30/2016
Grower: WGSA
Submitted By: David Bordelon
Send Report To: Weston Solutions
Report Number: 6654639
Crop: Native Plants
Date Received: 11/21/2016

VL = Very Low
L = Low
M = Medium
H = High
VH = Very High

Sender Sample Number	Depth	Lab #	Organic Matter %	Cation Exchange Capacity MEQ/100G	Gypsum Requirement Tons/Acre	Sand %	Silt %	Clay %	SoilTexture
S01-160922		920				72	20	8	Sandy Loam
S02-160922		921				40	20	40	Clay
S03-160922		922				30	26	44	Clay
S04-160922		923				74	10	16	Sandy Loam
S05-160922		924				34	32	34	Clay Loam
S06-160926		925				36	26	38	Clay Loam
S07-160926		926				70	15	15	Sandy Loam
S08-160926		927				44	30	26	Loam
S09-160926		928				52	19	29	Sandy Clay Loam
S10-160926		929				48	28	24	Sandy Clay Loam
S11-161101		930				32	32	36	Clay Loam
S12-161101		931				74	11	15	Sandy Loam
S13-161101		932				56	24	20	Sandy Clay Loam
S14-161101		933				14	30	56	Clay
S15-161101		934				18	24	58	Clay
S16-161116		935				46	31	23	Loam
S17-161116		936				40	18	42	Clay
S18-161116		937				28	22	50	Clay
S19-161116		938				32	26	42	Clay
S20-161116		939				22	28	50	Clay
S21-161116		940				22	38	40	Clay
S22-161116		941				36	20	44	Clay

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SOIL FERTILITY RECOMMENDATIONS

Lb/1000 Sq Ft

Grower: WGSA

Send To: Weston Solutions

Report No: 6654639 Date: 11/21/2016 Page: 4

												AMENDMENTS			
Sender Number	Crop	Nitrogen N	Phosphate P2O5	Potash K2O	Magnesium Mg	Sulfur S	Iron Fe	Zinc Zn	Manganese Mn	Copper Cu	Boron B	Elemental Sulfur	Gypsum	Lime	Leaching of Excess Salts
S01-160922	Native Plants	2 a	2 b	1 c				.2 g	.4 j	.02 i	.02 h	30 *			
S02-160922	Native Plants	2 a	2 b		3.5 d			.1 g			.02 h	5 *			
S03-160922	Native Plants	1 a	2.5 b					.2 g			.02 h	10 *			
S04-160922	Native Plants	2 a	2 b					.1 g			.02 h	15 *	50 #		
S05-160922	Native Plants	2 a	2 b					.1 g			.02 h	10 *			
S06-160926	Native Plants	1 a	2.5 b		5 d			.1 g	.4 j		.02 h				Yes
S07-160926	Native Plants	2 a	2 b	1 c				.2 g			.02 h	10 *			
S08-160926	Native Plants	2 a	2 b					.2 g			.02 h	10 *			
S09-160926	Native Plants	2 a	2 b								.02 h	10 *			
S10-160926	Native Plants	2 a	2 b					.2 g			.02 h	15 *			
S11-161101	Native Plants	2 a	2.5 b	1 c				.2 g		.02 i	.02 h	15 *			
S12-161101	Native Plants	2 a	2.5 b	1 c				.1 g			.02 h	15 *	50 #		
S13-161101	Native Plants	2 a	2.5 b		5 d			.2 g	.4 j		.02 h	15 *			
S14-161101	Native Plants	1 a	2 b		4 d			.1 g			.02 h	10 *			
S15-161101	Native Plants	1 a	2 b		1 d			.1 g			.02 h	5 *			
S16-161116	Native Plants	2 a	2.5 b					.2 g			.02 h	15 *			
S17-161116	Native Plants	2 a	2 b						.1 j		.02 h	10 *			Yes
S18-161116	Native Plants	1 a	2 b								.02 h	10 *			
S19-161116	Native Plants		2 b		2 d			.1 g			.02 h	5 *			
S20-161116	Native Plants		2 b		3 d			.1 g			.02 h				Yes
S21-161116	Native Plants		2 b	1 c				.2 g			.02 h	5 *			
S22-161116	Native Plants		2 b					.2 g			.02 h	5 *			

Native Plants
a) Broadcast nitrogen and water then water the nitrogen into the soil.
b) Broadcast phosphorus and till into soil where possible. Phosphorus works best when it is closest to the roots.
c) Broadcast potassium and till into the soil. Then water the potassium into the ground.
d) Apply magnesium to balance the salts and to increase the water holding capacity of the soil.
g) Use zinc sulfate. Mix the zinc in water and then spray the zinc solution onto soil; then till.
j) Use manganese sulfate form. Best if mixed in water and sprayed on soil then tilled.
i) Copper sulfate can be used. Mix in water and spray on soil then till.
h) Apply boron by dissolving it in water and they spray it over the soil. If you cannot find a boron fertilizer you can use 20 mule team borax located in the laundry

SOIL FERTILITY RECOMMENDATIONS

Lb/1000 Sq Ft

Grower: WGSA Send To: Weston Solutions

Report No: 6654639 Date: 11/21/2016 Page: 5

Sender Number	Crop	Nitrogen N	Phosphate P2O5	Potash K2O	Magnesium Mg	Sulfur S	Iron Fe	Zinc Zn	Manganese Mn	Copper Cu	AMENDMENTS Boron B	Elemental Sulfur	Gypsum	Lime	Leaching of Excess Salts

isle. If you use borax, mix 1 tbsp into 5 gallons of water. Then apply 2 gallons of solution per 1000 sqft.

#) Apply gypsum to balance the salts and to increase the amount of oxygen in the soil to reduce root rot.

*) Incorporate elemental sulfur into the soil to reduce the soil pH. Disper/sul or SSP are sulfur products that should dissolve readily and can be used if you can't till. This sulfur application will also help increase the overall concentration of the soil. Sulfur is needed for enzyme formation in nitrogen utilization.

N) Irrigate with extra water to reduce the overall salinity and potassium. Salinity at 5 dS/m is high enough to harm some native plants and potassium concentrations over 900 ppm can cause plant leaf margin to yellow.

Transect 1

Species	Begin	End	Total
BASC	685	700	15
BASC	720	746	26
BASC	795	801	6
BASC	1108	1117	9
BASC	1340	1348	8
BASC	1370	1372	2
BASC	1386	1401	15
BASC	1403	1441	38
BASC	1510	1525	15
BASC	1548	1561	13
BASC	1578	1582	4
BASC	1603	1608	5
BASC	1658	1663	5
BASC	1683	1701	18
BASC	1718	1726	8
BASC	1895	1908	13
BASC	1925	1931	6
BASC	1948	1961	13
BASC	2236	2258	22
BASC	2268	2281	13
BASC	2345	2358	13
BASC	2534	2558	24
BASC	2562	2575	13
BASC	2588	2561	-27
BASC	2710	2718	8
BASC	2738	2751	13
BASC	2778	2792	14
BASC	2855	2868	13

Pleuraphis jamesii	607	12.14
Bassia scoparia	507	10.14
Bouteloua gracilis	446	8.92
Salsola tragus	436	8.72
Krashcinnokovia lanata	96	1.92
Muhlenbergia torreyi	18	0.36
Elymus elymoides	8	0.16
Sporobolus conctractus	3	0.06
	2121	42.42

BASC	2870	2882	12	
BASC	2891	2901	10	
BASC	4308	4321	13	
BASC	4518	4531	13	
BASC	4554	4561	7	
BASC	4576	4591	15	
BASC	4618	4621	3	
BASC	4648	4650	2	
BASC	4678	4681	3	
BASC	4695	4702	7	
BASC	4721	4730	9	
BASC	4745	4754	9	
BASC	4759	4771	12	
BASC	4805	4820	15	
BASC	4871	4891	20	
BASC	4891	4902	11	
BASC	4950	4958	8	
BASC	4968	4981	13	507
BOGR	0	29	29	
BOGR	36	45	9	
BOGR	58	92	34	
BOGR	151	175	24	
BOGR	565	570	5	
BOGR	576	581	5	
BOGR	590	610	20	
BOGR	618	635	17	
BOGR	664	670	6	
BOGR	2618	2628	10	
BOGR	3118	3172	54	
BOGR	3359	3381	22	

BOGR	3394	3423	29	
BOGR	3431	3480	49	
BOGR	3494	3518	24	
BOGR	3561	3582	21	
BOGR	3641	3670	29	
BOGR	3959	4018	59	446
ELEL	4108	4116	8	8
KRLA	885	902	17	
KRLA	1218	1252	34	
KRLA	3173	3191	18	
KRLA	3608	3635	27	96
MUTO	3191	3205	14	
MUTO	4038	4042	4	18
PLJA	208	342	134	
PLJA	348	394	46	
PLJA	410	515	105	
PLJA	548	552	4	
PLJA	918	938	20	
PLJA	3208	3354	146	
PLJA	3590	3608	18	
PLJA	3690	3743	53	
PLJA	3772	3810	38	
PLJA	3846	3889	43	607
SATR	1148	1167	19	
SATR	1172	1181	9	
SATR	1623	1640	17	
SATR	1778	1791	13	
SATR	1825	1836	11	
SATR	1862	1878	16	
SATR	2004	2008	4	

SATR	2071	2076	5	
SATR	2082	2088	6	
SATR	2140	2151	11	
SATR	2172	2183	11	
SATR	2188	2199	11	
SATR	2291	2302	11	
SATR	2378	2391	13	
SATR	2401	2418	17	
SATR	2450	2562	112	
SATR	2501	2507	6	
SATR	2826	2831	5	
SATR	2845	2851	6	
SATR	2911	2916	5	
SATR	2921	2942	21	
SATR	3049	3061	12	
SATR	3108	3116	8	
SATR	4156	4162	6	
SATR	4202	4231	29	
SATR	4275	4290	15	
SATR	4358	4360	2	
SATR	4371	4390	19	
SATR	4475	4491	16	436
SPCO	1202	1205	3	3
			2121	42.42%

Transect 2

Species	Begin	End	Total	
ARBI	331	362	31	
ARBI	3559	3608	49	
ARBI	3877	3894	17	
ARBI	3829	3858	29	
ARBI	3879	3901	22	
ARBI	4208	4251	43	
ARBI	4577	4610	33	
ARBI	4690	4708	18	
ARBI	4830	4855	25	
ARBI	4928	4951	23	290
BOGR	72	93	21	
BOGR	141	172	31	
BOGR	228	231	3	
BOGR	404	431	27	
BOGR	451	481	30	
BOGR	489	518	29	
BOGR	541	544	3	
BOGR	571	602	31	
BOGR	611	628	17	
BOGR	651	666	15	
BOGR	789	825	36	
BOGR	840	851	11	
BOGR	861	908	47	
BOGR	925	961	36	
BOGR	979	991	12	
BOGR	985	1002	17	
BOGR	1025	1036	11	
BOGR	1059	1130	71	
BOGR	1145	1185	40	
BOGR	1198	1229	31	

Bouteloua gracilis	1505	30.1
Pleuraphis jamesii	311	6.22
Artemisia bigelovii	290	5.8
Krascheninnikovia lanata	128	2.52
Tetradymia canescns	48	0.96
Gutierrezia sarothrae	13	0.26
	2295	45.86

BOGR	1270	1285	15
BOGR	1310	1330	20
BOGR	1351	1368	17
BOGR	1442	1451	9
BOGR	1461	1503	42
BOGR	1531	1534	3
BOGR	1541	1549	8
BOGR	1570	1575	5
BOGR	1670	1681	11
BOGR	1685	1702	17
BOGR	1728	1775	47
BOGR	1790	1830	40
BOGR	1872	1885	13
BOGR	1919	1928	9
BOGR	2000	2019	19
BOGR	2035	2061	26
BOGR	2075	2090	15
BOGR	2160	2221	61
BOGR	2251	2308	57
BOGR	2325	2348	23
BOGR	2370	2388	18
BOGR	2392	2416	24
BOGR	2535	2542	7
BOGR	2553	2561	8
BOGR	2578	2611	33
BOGR	2622	2645	23
BOGR	2680	2702	22
BOGR	2711	2735	24
BOGR	2848	2892	44
BOGR	2908	2920	12
BOGR	2928	2993	65
BOGR	3018	3039	21

BOGR	3060	3085	25		
BOGR	3099	3115	16		
BOGR	3128	3150	22		
BOGR	3188	3225	37		
BOGR	3208	3289	81		
BOGR	3351	3380	29		
BOGR	4511	4529	18	1505	
GUSA	2768	2781	13	13	
KRLA	444	451	7		
KRLA	768	775	7		
KRLA	1630	1655	25		
KRLA	2055	2108	53		
KRLA	2240	2251	11		
KRLA	2791	2810	19		
KRLA	3005	3011	6	128	
PLJA	0	48	48		
PLJA	172	210	38		
PLJA	266	296	30		
PLJA	362	391	29		
PLJA	681	732	51		
PLJA	741	753	12		
PLJA	1948	1958	10		
PLJA	1978	1989	11		
PLJA	2118	2148	30		
PLJA	4051	4083	32		
PLJA	4951	4971	20	311	
TECA	4441	4489	48	48	2295
			2295	45.90%	

Transect 3

Species	Begin	End	Total				
PASM	3195	3241	46				
PASM	3781	3870	89		Pascopyrum smithii	157	3.14
PASM	4049	4071	22	157			
BASC	4208	4218	10				
BASC	4248	4261	13				
BASC	4328	4355	27				
BASC	4801	4803	2				
BASC	4818	4831	13				
BASC	4971	4989	18	83	Bassia scoparia	83	1.66
BOGR	0	31	31				
BOGR	51	141	90				
BOGR	161	241	80				
BOGR	481	510	29				
BOGR	571	602	31				
BOGR	710	731	21				
BOGR	749	761	12				
BOGR	820	851	31				
BOGR	908	931	23				
BOGR	951	985	34				
BOGR	1185	1359	174				
BOGR	1471	1545	74				
BOGR	1555	1604	49				
BOGR	1789	2048	259				
BOGR	2760	2902	142				
BOGR	3566	3780	214				
BOGR	3971	3989	18				
BOGR	4471	4478	7				
BOGR	4506	4531	25				

BOGR	4571	4608	37				
BOGR	4678	4701	23	1404	Bouteloua gracilis	1404	28.08
ERNA	291	410	119				
ERNA	1604	1789	185				
ERNA	2055	2071	16				
ERNA	2079	2401	322				
ERNA	2401	2491	90				
ERNA	2630	2760	130				
ERNA	2902	3141	239				
ERNA	3285	3494	209	1310	Ericameria nauseosa	1310	26.02
GUSA	775	785	10				
GUSA	1048	1061	13				
GUSA	1071	1099	28				
GUSA	1455	1471	16	67	Gutierrezia sarothrae	67	1.34
PLJA	3850	3971	121				
PLJA	4091	4172	81				
PLJA	4720	4748	28				
PLJA	4778	4801	23				
PLJA	4861	4868	7				
PLJA	4938	4971	33	293	Pleuraphis jamesii	293	5.86
SPAR	671	710	39				
SPAR	3908	3932	24	63	Sporobolus airoides	63	1.26
SPCO	4638	4641	3	3	Sporobolus contractus	3	0.06
			3380				
				3380		3380	67.42

Transect 4

Species	Begin	End	Total			
ATCA	205	220	15			
ATCA	335	351	16			
ATCA	789	821	32			
ATCA	1410	1421	11			
ATCA	1938	1961	23			
ATCA	2039	2096	57			
ATCA	2415	2435	20			
ATCA	3080	3131	51			
ATCA	4248	4261	13	238	4.76	Atriplex canescens
BOGR	235	246	11			
BOGR	670	736	66			
BOGR	765	795	30			
BOGR	850	878	28			
BOGR	970	990	20			
BOGR	1010	1030	20			
BOGR	1140	1180	40			
BOGR	1190	1210	20			
BOGR	1240	1290	50			
BOGR	1345	1360	15			
BOGR	1378	1410	32			
BOGR	1440	1461	21			
BOGR	1536	1575	39			
BOGR	1592	1654	62			
BOGR	1685	1710	25			
BOGR	1725	1742	17			
BOGR	1765	1778	13			
BOGR	1800	1821	21			
BOGR	1851	1872	21			

BOGR	1901	1938	37
BOGR	1965	1983	18
BOGR	1998	2031	33
BOGR	2125	2155	30
BOGR	2175	2204	29
BOGR	2216	2245	29
BOGR	2312	2369	57
BOGR	2455	2481	26
BOGR	2501	2530	29
BOGR	2531	2592	61
BOGR	2661	2672	11
BOGR	2755	2778	23
BOGR	2829	2949	120
BOGR	2851	2872	21
BOGR	2901	2932	31
BOGR	2972	3039	67
BOGR	3138	3187	49
BOGR	3218	3331	113
BOGR	3380	3385	5
BOGR	3401	3448	47
BOGR	3529	3551	22
BOGR	3576	3600	24
BOGR	3660	3681	21
BOGR	3728	3735	7
BOGR	3890	3903	13
BOGR	3948	3963	15
BOGR	3976	4011	35
BOGR	4120	4131	11
BOGR	4176	4203	27
BOGR	4340	4349	9

BOGR	4399	4425	26			
BOGR	4430	4491	61			
BOGR	4531	4578	47			
BOGR	4889	4943	54			
BOGR	4981	5000	19	1778	35.56	Bouteloua gracilis
MUTO	385	421	36			
MUTO	485	510	25			
MUTO	4589	4675	86	147	2.94	Muhlenbergia torreyi
PLJA	4066	4081	15	15	0.3	Pleuraphis jamesii
			2178			

Transect 5

Species	Begin	End	Total			
AGSM	2780	2790	10			
AGSM	3035	3040	5			
AGSM	4280	4310	30			
AGSM	4320	4346	26	71	1.42	Pascopyrum smithii
ATCA	229	265	36			
ATCA	468	481	13			
ATCA	1030	1135	105			
ATCA	3130	3160	30			
ATCA	3521	3541	20			
ATCA	3550	3580	30			
ATCA	3730	3805	75	309	6.18	Atriplex canescens
BASC	295	301	6			
BASC	742	751	9			
BASC	3710	3726	16			
BASC	3850	3896	46			
BASC	4570	4580	10			
BASC	4815	4821	6	93	1.86	Bassia scoparia
GUSP	1735	1755	20			
GUSP	1815	1851	36			
GUSP	1855	1886	31			
GUSP	2020	2025	5			
GUSP	2065	2085	20	112	2.24	Gutierrezia sarothrae
MACA	562	571	9			
MACA	810	831	21			
MACA	901	911	10			
MACA	951	1022	71			
MACA	1135	1221	86			
MACA	1270	1305	35			

419	8.38
308	6.18
208	4.16
112	2.24
93	1.86

MACA	1320	1365	45			
MACA	1481	1505	24			
MACA	2580	2600	20			
MACA	2755	2775	20			
MACA	2815	2858	43			
MACA	2870	2905	35	419	8.38	Machaeranthera canescens
SATR	51	72	21			
SATR	201	222	21			
SATR	2325	2381	56			
SATR	2410	2441	31			
SATR	2675	2710	35			
SATR	2980	3009	29			
SATR	3490	3495	5			
SATR	4900	4905	5			
SATR	4948	4950	2			
SATR	4970	4973	3	208	4.16	Salsola tragus
SPCO	1405	1445	40			
SPCO	1660	1705	45	85	1.7	Sporobolus contractus
			1297	25.94%	25.9	

71	1.42
85	1.7
1296	25.94

Transect 6

Species	Begin	End	Total			
ACHY	2825	2840	15	15	0.3	Acnatherum hymenoides
ARPU	2575	2587	12			
ARPU	2615	2648	33	45	0.9	Aristida purpurea
ATCA	3915	3980	65			
ATCA	4079	4125	46			
ATCA	4600	4615	15	126	2.52	Atriplex canescens
BOGR	2210	2255	45			
BOGR	2260	2275	15	60	1.2	Bouteloua gracilis
GUSA	2170	2190	20			
GUSA	3760	3790	30			
GUSA	4125	4143	18	68	1.36	Gutierrezia sarothrae
JUMO	1290	1460	170			
JUMO	0	10	10	180	3.6	Juniperus monosperma
KRLA	1830	1855	25			
KRLA	3018	3028	10			
KRLA	3426	3430	4			
KRLA	4570	4581	11			
KRLA	4950	4981	31	81	1.62	Kraschenninnikovia lanata
PLJA	155	223	68			
PLJA	750	760	10			
PLJA	785	810	25			
PLJA	830	845	15			
PLJA	850	870	20			
PLJA	928	930	2			
PLJA	976	993	17			
PLJA	1028	1040	12			
PLJA	1126	1135	9			
PLJA	1148	1170	22			

PLJA	2970	2985	15			
PLJA	3160	3180	20			
PLJA	3190	3211	21			
PLJA	3291	3311	20			
PLJA	3340	3360	20			
PLJA	3381	3410	29			
PLJA	3510	3515	5			
PLJA	4348	4365	17	347	6.94	Pleruaphis jamesii
SPAI	2277	2380	103			
SPAI	2430	2461	31			
SPAI	3850	3915	65	199	3.98	Sporobolus airoides
			1121	22.42%	22.42	

Transect 7

Species	Begin	End	Total			
ARBI	145	165	20			
ARBI	675	715	40			
ARBI	981	1002	21			
ARBI	1490	1500	10			
ARBI	1555	1570	15			
ARBI	1860	1872	12			
ARBI	2285	2296	11			
ARBI	3285	3301	16			
ARBI	3330	3351	21			
ARBI	3495	3518	23			
ARBI	3558	3562	4			
ARBI	4365	4401	36	229	4.58	Artemisia bigelovii
BOGR	20	38	18			
BOGR	68	87	19			
BOGR	265	279	14			
BOGR	581	595	14			
BOGR	805	845	40			
BOGR	875	903	28			
BOGR	1221	1243	22			
BOGR	1389	1408	19			
BOGR	1436	1489	53			
BOGR	1930	1981	51			
BOGR	1990	2011	21			
BOGR	2246	2262	16			
BOGR	2745	2791	46			
BOGR	2802	2868	66			
BOGR	2888	2972	84			
BOGR	3149	3165	16			

BOGR	4090	4096	6			
BOGR	4288	4301	13			
BOGR	4495	4508	13			
BOGR	4538	4575	37			
BOGR	4637	4667	30			
BOGR	4775	4780	5			
BOGR	4790	4810	20			
BOGR	4840	4851	11			
BOGR	4920	4926	6			
BOGR	4979	5006	27	695	13.9	Bouteloua gracilis
ERSP	3927	3941	14	14	0.28	Erigeron species
JUMO	1605	1798	193			
JUMO	2490	2641	151	344	6.88	Juniprus monosperma
KRLA	3210	3228	18			
KRLA	4718	4748	30	48	0.96	
PLJA	3691	3708	17			Krascheninnikovia lanata
PLJA	3858	3867	9	26	0.52	Pleuraphis jamesii
			1356		27.12	
			27.12%			

Transect 8

Species	Begin	End	Total			
AMAC	1825	1831	6	6	0.12	Ambrosia acanthicarpa
ATCA	25	111	86	86	1.72	Atriplex canescens
BOGR	1980	2011	31			
BOGR	2051	2114	63			
BOGR	2265	2305	40			
BOGR	3430	3450	20			
BOGR	4590	4612	22	176	3.52	Bouteloua gracilis
BOHI	4246	4258	12	12	0.24	Bouteloua hirsuta
ERNA	2018	2051	33			
ERNA	2330	2501	171			
ERNA	3280	3330	50			
ERNA	4080	4240	160			
ERNA	4640	4660	20			
ERNA	4730	4841	111			
ERNA	4889	5068	179			
ERNA	2140	2240	100			
ERNA	4460	4580	120	944	18.88	Ericameria nauseousa
GUSA	3890	3901	11	11	0.22	Gutierrezia sarothrae
PIJA	141	238	97			
PIJA	1630	1672	42			
PIJA	1751	1814	63			
PIJA	4051	4076	25			
PIJA	4331	4368	37	264	5.28	Pleuraphis jamesii
GRNU	595	831	236			
GRNU	920	951	31			
GRNU	1058	1080	22			
GRNU	1179	1182	3	292	5.84	Grindelia nuda
SPAR	261	331	70			
SPAR	458	532	74	144	2.88	Sporobolus airoides
			1935	38.70%	38.70%	

Transect 9

Species	Begin	End	Total			
ATCA	183	210	27			
ATCA	401	450	49			
ATCA	1361	1558	197			
ATCA	1610	1628	18			
ATCA	1718	1737	19			
ATCA	1888	2118	230			
ATCA	2408	2438	30			
ATCA	2567	2670	103			
ATCA	3351	3441	90			
ATCA	3678	3708	30			
ATCA	3629	3691	62			
ATCA	4378	4451	73			
ATCA	4475	4482	7			
ATCA	4951	5000	49	984	19.68	Atriplex canescens
BASC	10	18	8			
BASC	21	28	7			
BASC	102	116	14			
BASC	178	183	5			
BASC	630	634	4			
BASC	691	693	2			
BASC	819	861	42			
BASC	862	893	31			
BASC	948	961	13			
BASC	968	983	15			
BASC	1032	1041	9			
BASC	1053	1064	11			
BASC	1096	1116	20			
BASC	1131	1154	23			

BASC	1171	1186	15			
BASC	1202	1210	8			
BASC	1230	1268	38			
BASC	1294	1302	8			
BASC	1660	1664	4			
BASC	1668	1672	4			
BASC	2148	2172	24			
BASC	2185	2195	10			
BASC	2538	2567	29			
BASC	2828	2835	7			
BASC	3160	3198	38			
BASC	3221	3236	15			
BASC	3245	3250	5			
BASC	3268	3280	12			
BASC	3468	3490	22			
BASC	3930	3968	38	481	9.62	Bassia scoparia
BOGR	2891	2895	4			
BOGR	3761	3782	21			
BOGR	4207	4291	84			
BOGR	4305	4329	24			
BOGR	4351	4376	25			
BOGR	4608	4640	32			
BOGR	4748	4781	33			
BOGR	4918	4942	24	247	4.94	Bouteloua gracilis
PLJA	456	468	12			
PLJA	471	491	20			
PLJA	502	515	13			
PLJA	526	541	15			
PLJA	718	730	12			
PLJA	2951	2988	37			

PLJA	3011	3046	35			
PLJA	3548	3571	23			
PLJA	3601	3634	33			
PLJA	4025	4031	6			
PLJA	4110	4160	50			
PLJA	4188	4192	4			
PLJA	4501	4533	32			
PLJA	4856	4889	33	325	6.5	Pleuraphis jamesii
			2037	40.74%	40.74	

Transect 10

Species	Begin	End	Total			
ATCA	270	310	40			
ATCA	368	465	97			
ATCA	670	740	70			
ATCA	830	861	31			
ATCA	2990	3068	78			
ATCA	3660	3741	81			
ATCA	3840	3905	65	462	9.24	Atriplex canescens
BASC	501	512	11			
BASC	541	548	7			
BASC	563	572	9			
BASC	898	914	16			
BASC	941	952	11			
BASC	1041	1058	17			
BASC	1220	1225	5			
BASC	1271	1288	17			
BASC	1298	1321	23			
BASC	1350	1385	35			
BASC	1520	1551	31			
BASC	1578	1592	14			
BASC	1918	1928	10			
BASC	1976	1981	5			
BASC	2038	2051	13			
BASC	2156	2172	16			
BASC	2268	2302	34			
BASC	2328	2339	11			
BASC	2371	2378	7			
BASC	2401	2408	7			
BASC	2628	2639	11			

BASC	2691	2699	8				
BASC	2748	2759	11				
BASC	2789	2792	3				
BASC	2819	2830	11				
BASC	2912	2918	6				
BASC	3141	3162	21				
BASC	3210	3258	48				1
BASC	3278	3291	13				
BASC	3411	3418	7				
BASC	3480	3519	39				
BASC	3919	3941	22				
BASC	4021	4041	20				
BASC	4098	4105	7				
BASC	4226	4251	25				
BASC	4382	4414	32				
BASC	4491	4503	12				
BASC	4540	4603	63				
BASC	4605	4631	26				
BASC	4715	4748	33				
BASC	4795	4835	40				
BASC	4930	4940	10				
BASC	4955	4960	5				
BASC	4968	4999	31	803	16.06	Bassia scoparia	
ELEL	971	1026	55				
ELEL	1060	1071	11				
ELEL	1090	1218	128				
ELEL	1658	1676	18				
ELEL	2940	2948	8				
ELEL	3445	3471	26	246	4.92	Elymus elymoides	
GRNU	740	781	41	41	0.82	Grindelia nuda	

PAOB	0	270	270			
PAOB	321	342	21	291	5.82	Panicum obtusum
SCBR	865	881	16	16	0.32	Scleropogon brevifolius
SPAR	1769	1781	12	12	0.24	Sporobolus airoides
			1871	37.42%	37.42	

Transect 11

Species	Begin	End	Total			
ATCA	151	201	50			
ATCA	929	962	33			
ATCA	1048	1118	70			
ATCA	1170	1291	121			
ATCA	1331	1482	151			
ATCA	1518	1621	103			
ATCA	1735	1821	86			
ATCA	1859	1898	39			
ATCA	1972	2138	166			
ATCA	2370	2460	90			
ATCA	2630	2671	41			
ATCA	2920	2975	55			
ATCA	3080	3170	90			
ATCA	3340	3480	140			
ATCA	3810	3981	171			
ATCA	4338	4480	142			
ATCA	4725	4780	55			
ATCA	4928	4940	12	1615	32.3	Atriplex canescens
BOGR	0	15	15			
BOGR	41	130	89			
BOGR	216	230	14			
BOGR	270	318	48			
BOGR	340	351	11			
BOGR	392	411	19			
BOGR	431	478	47			
BOGR	501	545	44			
BOGR	620	678	58			
BOGR	715	775	60			

BOGR	778	792	14			
BOGR	1291	1331	40			
BOGR	1482	1518	36			
BOGR	1621	1659	38			
BOGR	1659	1735	76			
BOGR	1821	1859	38			
BOGR	1945	1972	27			
BOGR	2151	2182	31			
BOGR	2461	2485	24			
BOGR	2505	2530	25			
BOGR	2560	2601	41			
BOGR	2690	2720	11			
BOGR	2810	2830	3			
BOGR	2871	2920	11			
BOGR	3560	3581	21			
BOGR	3659	3701	42			
BOGR	3738	3770	32			
BOGR	4021	4061	40			
BOGR	4190	4210	20			
BOGR	4301	4325	24	999	19.98	Bouteloua gracilis
PASM	830	841	11			
PASM	876	899	23			
PASM	4890	4896	6	40	0.8	Pascopyrum smithii
GUSA	2219	2251	32	32	0.64	
			2686	53.72%	53.72	

Transect 12

Species	Begin	End	Total
BOGR	39	60	21
BOGR	100	111	11
BOGR	155	171	16
BOGR	211	230	19
BOGR	258	281	23
BOGR	299	315	16
BOGR	326	345	19
BOGR	371	392	21
BOGR	418	441	23
BOGR	531	548	17
BOGR	560	611	51
BOGR	650	669	19
BOGR	678	693	15
BOGR	736	791	55
BOGR	828	838	10
BOGR	847	891	44
BOGR	905	935	30
BOGR	971	1021	50
BOGR	1040	1071	31
BOGR	1028	1038	10
BOGR	1180	1248	68
BOGR	1271	1332	61
BOGR	1358	1378	20
BOGR	1399	1422	23
BOGR	1458	1471	13
BOGR	1525	1568	43
BOGR	1578	1602	24
BOGR	1661	1681	20
BOGR	1692	1740	48
BOGR	1745	1769	24

BOGR	1791	1808	17
BOGR	1825	1838	13
BOGR	1848	1858	10
BOGR	1872	1893	21
BOGR	1935	1951	16
BOGR	1991	2018	27
BOGR	2056	2091	35
BOGR	2160	2181	21
BOGR	2221	2246	25
BOGR	2251	2281	30
BOGR	2360	2391	31
BOGR	2401	2408	7
BOGR	2470	2481	11
BOGR	2678	2681	3
BOGR	2665	2685	20
BOGR	3081	3102	21
BOGR	3189	3220	31
BOGR	3230	3241	11
BOGR	3360	3381	21
BOGR	3661	3692	31
BOGR	3775	3821	46
BOGR	3891	3950	59
BOGR	3950	3981	31
BOGR	3976	3981	5
BOGR	4010	4030	20
BOGR	4065	4071	6
BOGR	4108	4112	4
BOGR	4121	4131	10
BOGR	4193	4205	12
BOGR	4250	4271	21
BOGR	4302	4368	66
BOGR	4389	4415	26

BOGR	4426	4461	35			
BOGR	4508	4518	10			
BOGR	4548	4556	8			
BOGR	4590	4602	12			
BOGR	4618	4631	13			
BOGR	4675	4691	16			
BOGR	4788	4821	33			
BOGR	4852	4873	21			
BOGR	4918	4935	17			
BOGR	4990	5000	10	1728	34.56	Bouteloua gracilis
PIJA	2515	2540	25			
PLJA	2770	2781	11			
PLJA	2825	2835	10			
PLJA	3134	3152	18			
PLJA	3408	3480	72			
PLJA	3528	3551	23			
PLJA	3585	3621	36			
PLJA	3701	3741	40			
PLJA	3860	3878	18			
PLJA	4718	4741	23			
PLJA	4958	4972	14	290	5.8	Pleuraphis jamesii
			2018	40.36%	40.36	

Transect 13

Species	Begin	End	Total			
ATCA	4780	4785	5	5	0.1	Atriplex canescens
BOGR	0	20	20			
BOGR	51	108	57			
BOGR	190	210	20			
BOGR	440	461	21			
BOGR	480	491	11			
BOGR	605	635	30			
BOGR	870	901	31			
BOGR	1360	1381	21			
BOGR	1408	1426	18			
BOGR	1610	1620	10			
BOGR	1665	1671	6			
BOGR	1730	1791	61			
BOGR	1928	1938	10			
BOGR	2015	2041	26			
BOGR	2011	2022	11			
BOGR	2151	2231	80			
BOGR	2301	2348	47			
BOGR	2410	2428	18			
BOGR	2485	2496	11			
BOGR	2520	2531	11			
BOGR	2595	2631	36			
BOGR	2670	2701	31			
BOGR	2735	2761	26			
BOGR	2880	2901	21			
BOGR	3035	3065	30			
BOGR	3108	3140	32			
BOGR	3190	3231	41			

BOGR	3310	3330	20			
BOGR	3348	3361	13			
BOGR	3395	3401	6			
BOGR	3431	3442	11			
BOGR	3520	3541	21			
BOGR	3670	3691	21			
BOGR	3765	3801	36			
BOGR	3838	3851	13			
BOGR	3920	3945	25			
BOGR	3961	3988	27			
BOGR	4008	4032	24			
BOGR	4061	4082	21			
BOGR	4102	4108	6			
BOGR	4132	4199	67			
BOGR	4266	4293	27			
BOGR	4340	4362	22			
BOGR	4398	4418	20			
BOGR	4495	4472	-23			
BOGR	4540	4561	21			
BOGR	4620	4640	20			
BOGR	4730	4742	12			
BOGR	4960	5000	40	1187	23.74	Bouteloua gracilis
KRLA	21	33	12			
KRLA	158	170	12			
KRLA	308	336	28			
KRLA	635	662	27			
KRLA	1305	1308	3			
KRLA	2578	2583	5			
KRLA	3280	3288	8	95	1.9	Krascheninnikovia lanata
MUWR	930	1105	175			

MUWR	1180	1261	81	256	5.12	Muhlenbergia wrightii
PLJA	780	791	11			
PLJA	1958	2005	47			
PLJA	2239	2301	62			
PLJA	4502	4528	26			
PLJA	535	541	6	152	3.04	Pleuraphis jamesii
SPCO	810	821	11			
SPCO	2062	2070	8	19	0.38	Sporobolus contractus
			1714	34.28%		
				1714	34.28	

Transect 14

Species	Begin	End	Total			
ATCA	1080	1150	70			
ATCA	1282	1341	59			
ATCA	1405	1518	113			
ATCA	1558	1618	60	302	6.04	Atriplex canescens
BASC	1876	1948	72			
BASC	3590	3641	51			
BASC	3761	3782	21			
BASC	4430	4438	8			
BASC	4620	4671	51			
BASC	4905	4910	5			
BASC	4986	4991	5	213	4.26	Bassia scoparia
ERNA	760	940	180			
ERNA	1948	2230	282	462	9.24	Ericameria nauseosa
GRNU	1806	1813	7			
GRNU	2306	2331	25			
GRNU	2458	2470	12			
GRNU	2994	3011	17			
GRNU	3036	3065	29			
GRNU	3995	4205	210			
GRNU	4365	4385	20			
GRNU	4715	4761	46	366	7.32	Grindelia nuda
MACA	1840	1861	21			
MACA	3920	3931	11			
MACA	3978	3983	5			
MACA	4010	4033	23			
MACA	4445	4495	50			
MACA	4548	4565	17			
MACA	4755	4822	67	194	3.88	Machaeranthera canescens

PASM	940	1012	72			
PASM	0	365	365			
PASM	405	437	32			
PASM	495	585	90			
PASM	608	651	43			
PASM	1672	1706	34			
PASM	2245	2253	8			
PASM	3328	3545	217			
PASM	3685	3726	41			
PASM	3735	3891	156			
PASM	4033	4166	133			
PASM	4221	4258	37	1228	24.56	Pascopyrum smithii
			2765	55.30%	55.3	
				2765		

Transect 15

Species	Begin	End	Total			
B0GR	2272	2291	19			
BOGR	488	621	133			
BOGR	641	689	48			
BOGR	910	935	25			
BOGR	1039	1278	239			
BOGR	1589	1621	32			
BOGR	1640	1841	201			
BOGR	2031	2178	147			
BOGR	4620	4641	21	865	17.3	Bouteloua gracilis
ERNA	0	130	130			
ERNA	196	357	161			
ERNA	442	461	19			
ERNA	935	1039	104			
ERNA	1968	2031	63			
ERNA	2667	2714	47			
ERNA	3421	3538	117			
ERNA	4105	4143	38			
ERNA	4641	4735	94			
ERNA	4871	5000	129	902	18.04	Ericameria nauseosa
GRNU	3710	3831	121			
GRNU	3865	3895	30			
GRNU	3910	3981	71	222	4.44	Grindelia nuda
GUSA	2935	2941	6			
GUSA	3048	3062	14	20	0.4	Gutierrezia sarothrae
MUWR	3640	3710	70			
MUWR	4802	4871	69	139	2.78	Muhlenbergia wrightii
PLJA	1480	1501	21			
PLJA	2798	2942	144			
PLJA	3038	3058	20			
PLJA	3062	3261	199	384	7.68	Pleuraphis jamesii
			2532	50.64%	50.64	

APPENDIX C

USFWS County List

NMDGF County List

New Mexico Forestry State Endangered Plants List

New Mexico Noxious Weed List

New Mexico Heritage S1 Species

BLM Sensitive Species

UTM Locations of Burrows Occupied by Western Burrowing Owl

Plant and Animals Observed or Likely to Occur within the Study Area

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Mexico Ecological Services Field Office
2105 OSUNA ROAD NE
ALBUQUERQUE, NM 87113
PHONE: (505)346-2525 FAX: (505)346-2542
URL: www.fws.gov/southwest/es/NewMexico/;
www.fws.gov/southwest/es/ES_Lists_Main2.html

Consultation Code: 02ENNM00-2017-SLI-0053 October 27, 2016
Event Code: 02ENNM00-2017-E-00059
Project Name: USEPA Tronox Mines

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

Thank you for your recent request for information on federally listed species and important wildlife habitats that may occur in your project area. The U.S. Fish and Wildlife Service (Service) has responsibility for certain species of New Mexico wildlife under the Endangered Species Act (ESA) of 1973 as amended (16 USC 1531 et seq.), the Migratory Bird Treaty Act (MBTA) as amended (16 USC 701-715), and the Bald and Golden Eagle Protection Act (BGEPA) as amended (16 USC 668-668c). We are providing the following guidance to assist you in determining which federally imperiled species may or may not occur within your project area and to recommend some conservation measures that can be included in your project design.

FEDERALLY-LISTED SPECIES AND DESIGNATED CRITICAL HABITAT

Attached is a list of endangered, threatened, and proposed species that may occur in your project area. Your project area may not necessarily include all or any of these species. Under the ESA, it is the responsibility of the Federal action agency or its designated representative to determine if a proposed action "may affect" endangered, threatened, or proposed species, or designated critical habitat, and if so, to consult with the Service further. Similarly, it is the responsibility of the Federal action agency or project proponent, not the Service, to make "no effect" determinations. If you determine that your proposed action will have "no effect" on threatened or endangered species or their respective critical habitat, you do not need to seek concurrence with the Service. Nevertheless, it is a violation of Federal law to harm or harass any federally-listed threatened or endangered fish or wildlife species without the appropriate permit.

If you determine that your proposed action may affect federally-listed species, consultation with the Service will be necessary. Through the consultation process, we will analyze information contained in a biological assessment that you provide. If your proposed action is associated with Federal funding or permitting, consultation will occur with the Federal agency under section 7(a)(2) of the ESA. Otherwise, an incidental take permit pursuant to section 10(a)(1)(B) of the ESA (also known as a habitat conservation plan) is necessary to harm or harass federally listed threatened or endangered fish or wildlife species. In either case, there is no mechanism for authorizing incidental take "after-the-fact." For more information regarding formal consultation and HCPs, please see the Service's Consultation Handbook and Habitat Conservation Plans at www.fws.gov/endangered/esa-library/index.html#consultations.

The scope of federally listed species compliance not only includes direct effects, but also any interrelated or interdependent project activities (e.g., equipment staging areas, offsite borrow material areas, or utility relocations) and any indirect or cumulative effects that may occur in the action area. The action area includes all areas to be affected, not merely the immediate area involved in the action. Large projects may have effects outside the immediate area to species not listed here that should be addressed. If your action area has suitable habitat for any of the attached species, we recommend that species-specific surveys be conducted during the flowering season for plants and at the appropriate time for wildlife to evaluate any possible project-related impacts.

Candidate Species and Other Sensitive Species

A list of candidate and other sensitive species in your area is also attached. Candidate species and other sensitive species are species that have no legal protection under the ESA, although we recommend that candidate and other sensitive species be included in your surveys and considered for planning purposes. The Service monitors the status of these species. If significant declines occur, these species could potentially be listed. Therefore, actions that may contribute to their decline should be avoided.

Lists of sensitive species including State-listed endangered and threatened species are compiled by New Mexico state agencies. These lists, along with species information, can be found at the following websites:

Biota Information System of New Mexico (BISON-M): www.bison-m.org

New Mexico State Forestry. The New Mexico Endangered Plant Program:
www.emnrd.state.nm.us/SFD/ForestMgt/Endangered.html

New Mexico Rare Plant Technical Council, New Mexico Rare Plants: nmrareplants.unm.edu

Natural Heritage New Mexico, online species database: nhnm.unm.edu

WETLANDS AND FLOODPLAINS

Under Executive Orders 11988 and 11990, Federal agencies are required to minimize the destruction, loss, or degradation of wetlands and floodplains, and preserve and enhance their natural and beneficial values. These habitats should be conserved through avoidance, or mitigated to ensure that there would be no net loss of wetlands function and value.

We encourage you to use the National Wetland Inventory (NWI) maps in conjunction with ground-truthing to identify wetlands occurring in your project area. The Service's NWI program website, www.fws.gov/wetlands/Data/Mapper.html integrates digital map data with other resource information. We also recommend you contact the U.S. Army Corps of Engineers for permitting requirements under section 404 of the Clean Water Act if your proposed action could impact floodplains or wetlands.

MIGRATORY BIRDS

The MBTA prohibits the taking of migratory birds, nests, and eggs, except as permitted by the Service's Migratory Bird Office. To minimize the likelihood of adverse impacts to migratory birds, we recommend construction activities occur outside the general bird nesting season from March through August, or that areas proposed for construction during the nesting season be surveyed, and when occupied, avoided until the young have fledged.

We recommend review of Birds of Conservation Concern at website www.fws.gov/migratorybirds/CurrentBirdIssues/Management/BCC.html to fully evaluate the effects to the birds at your site. This list identifies birds that are potentially threatened by disturbance and construction.

BALD AND GOLDEN EAGLES

The bald eagle (*Haliaeetus leucocephalus*) was delisted under the ESA on August 9, 2007. Both the bald eagle and golden eagle (*Aquila chrysaetos*) are still protected under the MBTA and BGEPA. The BGEPA affords both eagles protection in addition to that provided by the MBTA, in particular, by making it unlawful to "disturb" eagles. Under the BGEPA, the Service may issue limited permits to incidentally "take" eagles (e.g., injury, interfering with normal breeding, feeding, or sheltering behavior nest abandonment). For information on bald and golden eagle management guidelines, we recommend you review information provided at www.fws.gov/midwest/eagle/guidelines/bgepa.html.

On our web site www.fws.gov/southwest/es/NewMexico/SBC_intro.cfm, we have included conservation measures that can minimize impacts to federally listed and other sensitive species. These include measures for communication towers, power line safety for raptors, road and highway improvements, spring developments and livestock watering facilities, wastewater facilities, and trenching operations.

We also suggest you contact the New Mexico Department of Game and Fish, and the New Mexico Energy, Minerals, and Natural Resources Department, Forestry Division for information regarding State fish, wildlife, and plants.

Thank you for your concern for endangered and threatened species and New Mexico's wildlife habitats. We appreciate your efforts to identify and avoid impacts to listed and sensitive species in your project area. For further consultation on your proposed activity, please call 505-346-2525 or email nmesfo@fws.gov and reference your Service Consultation Tracking Number.

Attachment

Official Species List

Provided by:

New Mexico Ecological Services Field Office
2105 OSUNA ROAD NE
ALBUQUERQUE, NM 87113
(505) 346-2525
http://www.fws.gov/southwest/es/NewMexico/
http://www.fws.gov/southwest/es/ES_Lists_Main2.html

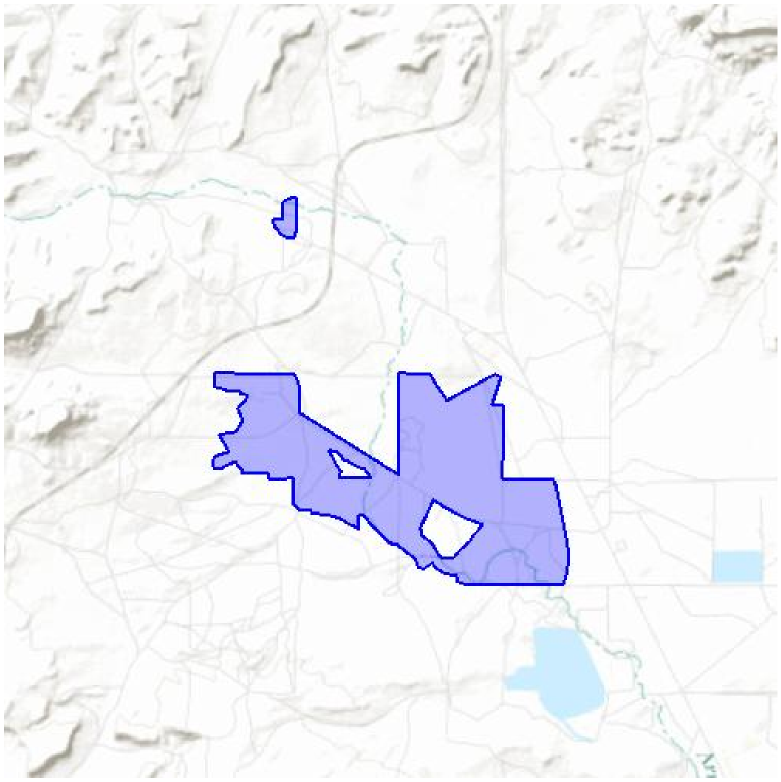
Consultation Code: 02ENNM00-2017-SLI-0053
Event Code: 02ENNM00-2017-E-00059

Project Type: LAND - RESTORATION / ENHANCEMENT

Project Name: USEPA Tronox Mines
Project Description: Mine cleanup and vegetation recovery

Please Note: The FWS office may have modified the Project Name and/or Project Description, so it may be different from what was submitted in your previous request. If the Consultation Code matches, the FWS considers this to be the same project. Contact the office in the 'Provided by' section of your previous Official Species list if you have any questions or concerns.

Project Location Map:



Project Coordinates: The coordinates are too numerous to display here.

Project Counties: McKinley, NM

Endangered Species Act Species List

There are a total of 5 threatened or endangered species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section further below for critical habitat that lies within your project. Please contact the designated FWS office if you have questions.

Birds	Status	Has Critical Habitat	Condition(s)
Mexican Spotted owl *(Strix occidentalis lucida)* Population: Wherever found	Threatened	Final designated	
Southwestern Willow flycatcher *(Empidonax traillii extimus)* Population: Wherever found	Endangered	Final designated	
Yellow-Billed Cuckoo *(Coccyzus americanus)* Population: Western U.S. DPS	Threatened	Proposed	
Fishes			
Zuni Bluehead Sucker *(Catostomus discobolus yarrowi)* Population: Wherever found	Endangered	Final designated	
Flowering Plants			
Zuni fleabane *(Erigeron rhizomatus)* Population: Wherever found	Threatened		

Critical habitats that lie within your project area

There are no critical habitats within your project area.

Biota Information System of New Mexico

Maintained by:

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Disclaimer Policy

Print Page

Database Query

Your search terms were as follows:

County Name
McKinley

Status
State NM: Endangered
State NM: Threatened

8 species returned.

Taxonomic Group	# Species	Taxonomic Group	# Species
Fish	1	Birds	7

Export to Excel

Species ID	Common Name	Scientific Name	Photo	USGS Distribution Map	County	Status
040370	**Bald Eagle**	Haliaeetus leucocephalus			McKinley	State NM: Threatened
040384	**Peregrine Falcon**	Falco peregrinus		no map	McKinley	State NM: Threatened
040385	**Arctic Peregrine Falcon**	Falco peregrinus tundrius	no photo	no map	McKinley	State NM: Threatened
042070	**Least Tern**	Sternula antillarum			McKinley	State NM: Endangered
040925	**Costa's Hummingbird**	Calypte costae			McKinley	State NM: Threatened
040521	**Southwestern Willow Flycatcher**	Empidonax traillii extimus		no map	McKinley	State NM: Endangered
042200	**Gray Vireo**	Vireo vicinior			McKinley	State NM: Threatened
010496	**Zuni Bluehead Sucker**	Catostomus discobolus yarrowi		no map	McKinley	State NM: Endangered

Close Window

NEW MEXICO STATE ENDANGERED PLANT SPECIES (19.21.2.8 NMAC)

Detailed information and images of many of these and other rare plants can be found at the New Mexico Rare Plants website (http//nmrareplants.unm.edu/index.html) (plants marked with an * are not listed on the NMRPTC website)

Botanical Name	**Common Name**	**New Mexico Counties**
Aliciella formosa	Aztec gilia	San Juan
Allium gooddingii *	Gooding's onion	San Juan, McKinley, Catron, Lincoln, Santa Fe
Amsonia tharpii	Tharp's bluestar	Eddy
Argemone pleiacantha subsp. pinnatisecta (A. pinnatisecta)	Sacramento prickly poppy	Otero
Astragalus humillimus	Mancos milkvetch	San Juan
Cirsium vinaceum	Sacramento Mountains thistle	Otero
Cirsium wrightii	Wright's marsh thistle	Chaves, Grant, Guadalupe, Otero, Sierra, Socorro
Cleome multicaulis (Peritoma multicaulis)	slender spiderflower	Grant, Hidalgo
Coryphantha scheeri var. scheeri	Scheer's pincushion cactus	Chavez, Eddy
Cylindropuntia viridiflora	Santa Fe cholla	Santa Fe
Cypripedium parviflorum var. pubescens *	golden lady's slipper	San Juan, Grant, San Miguel
Echinocereus fendleri var. kuenzleri	Kuenzler's hedgehog cactus	Chavez, Eddy, Lincoln, Otero
Erigeron hessii	Hess' fleabane	Catron
Erigeron rhizomatus	Zuni fleabane	Catron, McKinley, San Juan
Eriogonum gypsophilum	gypsum wild buckwheat	Eddy
Escobaria duncanii	Duncan's pincushion cactus	Sierra
Escobaria organensis	Organ Mountain pincushion cactus	Doña Ana
Escobaria sneedii var. leei	Lee's pincushion cactus	Eddy

Escobaria sneedii var. sneedii	Sneed's pincushion cactus	Doña Ana
Escobaria villardii	Villard's pincushion cactus	Doña Ana, Otero
Hedeoma todsenii	Todsen's pennyroyal	Otero, Sierra
Helianthus paradoxus	Pecos sunflower	Cibola, Valencia, Socorro, Guadalupe, Chavez
Hexalectris nitida	shining coralroot	Eddy, Otero
Hexalectris spicata *	crested coralroot	Sierra, Otero, Hidalgo
Ipomopsis sancti-spiritus	Holy Ghost ipomopsis	San Miguel
Lepidospartum burgessii	gypsum scalebroom	Otero
Lilium philadelphicum *	wood lily	Otero, Los Alamos, Sandoval, San Miguel, Santa Fe
Mammillaria wrightii var. wilcoxii *	Wilcox pincushion cactus	Hidalgo, Grant, Doña Ana, Luna
Opuntia arenaria	sand prickly pear	Doña Ana, Luna, Socorro
Pediocactus knowltonii	Knowlton's cactus	San Juan
Pediomelum pentaphyllum	Chihuahua scurfpea	Hidalgo
Peniocereus greggii	night-blooming cereus	Doña Ana, Grant, Hidalgo, Luna
Polygala rimulicola var. mescalerorum	San Andres milkwort	Doña Ana
Puccinellia parishii	Parish's alkali grass	Catron, Cibola, Grant, Hidalgo, McKinley, Sandoval, San Juan
Sclerocactus cloveriae subsp. brackii	Brack's cactus	San Juan, Rio Arriba, Sandoval
Sclerocactus mesae-verdae	Mesa Verde cactus	San Juan
Spiranthes magnicamporum *	lady tresses orchid	Bernalillo, Santa Fe, Guadalupe, Rio Arriba

NM - BLM SPECIAL STATUS PLANT SPECIES LIST

UPDATED WITH ESA STATUS SPECIES 1/4/12 — **FIELD OFFICE OCCURRENCE - VERIFIED, HYPOTHETICAL, PERIPERAL (WITHIN OFFICE BDRY BUT NOT ON BLM)** — STATUS

FAMILY	SPECIES	COMMON NAME	RIO PUERCO - NM110	SOCORRO - NM120	FARMINGTON - NM210	TAOS - NM220	LAS CRUCES - NM030	ROSWELL - NM510	CARLSBAD - NM520	NATURESERVE GLOBAL RANK	NATURESERVE STATE RANK	FWS STATUS	STATE STATUS	USFS STATUS	BLM SPECIAL STATUS LIST
NYCTAGINACEAE	*ABRONIA BIGELOVII*	SAND VERBENA, GALISTEO	VERIFIED			PERIPHERAL				G3	S3	NONE	SPECIES OF CONCERN	SENSITIVE	**BLM SENSITIVE**
ACAROSPORACEAE	*ACAROSPORA CLAUZADEANA*	LICHEN, ACAROSPORA CLAUZADEANA						VERIFIED		G1G2		PETITIONED / NEGATIVE 90 DAY FINDING			**BLM SENSITIVE**
POLEMONIACEAE	*ALICIELLA FORMOSA*	GILIA, AZTEC			VERIFIED					G2	S2	PETITIONED / NEGATIVE 90 DAY FINDIN	ENDANGERED	NONE	**BLM SENSITIVE**
APOCYNACEAE	*AMSONIA FUGATEI*	AMSONIA, FUGATE'S		VERIFIED						G2	S2	SPECIES OF CONCERN	SPECIES OF CONCERN	NONE	**BLM SENSITIVE**
APOCYNACEAE	*AMSONIA THARPII*	BLUESTAR, THARP'S							VERIFIED	G1	S1	SPECIES OF CONCERN + PETITIONED - POSITIVE 90 DAY FINDING	ENDANGERED	NONE	**BLM SENSITIVE**
NYCTAGINACEAE	*ANULOCAULIS LEIOSOLENUS VAR. HOWARDII*	RINGSTEM, HOWARD'S GYP					VERIFIED			G2T2	SNR	NONE	SPECIES OF CONCERN	NONE	**BLM SENSITIVE**
RANUNCULACEAE	*AQUILEGIA CHRYSANTHA VAR. CHAPLINEI*	COLUMBINE, CHAPLINE'S					VERIFIED		VERIFIED	G4T2	S2	NONE	SPECIES OF CONCERN	SENSITIVE	**BLM SENSITIVE**
ASCLEPIADACEAE	*ASCLEPIAS SANJUANENSIS*	MILKWEED, SAN JUAN			VERIFIED					GUQ	S3	NONE	SPECIES OF CONCERN	NONE	**BLM SENSITIVE**
FABACEAE	*ASTRAGALUS COBRENSIS VAR. MAGUIREI*	MILKVETCH, COPPERMINE					VERIFIED			G4T2	S2,S1?	SPECIES OF CONCERN	SPECIES OF CONCERN	SENSITIVE	**BLM SENSITIVE**
FABACEAE	*ASTRAGALUS GYPSODES*	MILKVETCH, GYPSUM							VERIFIED	G3	S3	NONE	SPECIES OF CONCERN	NONE	**BLM SENSITIVE**
FABACEAE	*ASTRAGALUS KNIGHTII*	MILKVETCH, KNIGHT'S	VERIFIED							NONE	NONE	NONE	SPECIES OF CONCERN	NONE	**BLM SENSITIVE**
FABACEAE	*ASTRAGALUS RIPLEYI*	MILKVETCH, RIPLEY	HYPOTHETICAL			VERIFIED				G3	S3?	SPECIES OF CONCERN	SPECIES OF CONCERN	SENSITIVE	**BLM SENSITIVE**
FABACEAE	*DERMATOPHYLLUM GUADALUPENSE*	MESCALBEAN, GUADALUPE					VERIFIED		VERIFIED	G1		PETITIONED / NEGATIVE 90 FINDING	SPECIES OF CONCERN		**BLM SENSITIVE**
CACTACEAE	*ECHINOCEREUS X ROETTERI VAR. ROETTERI*	CACTUS, ROETTER'S HEDGEHOG					VERIFIED			NONE	NONE	NONE	NONE	NONE	**BLM SENSITIVE**
ASTERACEAE	*ERIGERON ACOMANUS*	FLEABANE, ACOMA	VERIFIED		HYPOTHETICAL					GNR	SNR	NONE	SPECIES OF CONCERN	SENSITIVE	**BLM SENSITIVE**
CACTACEAE	*ESCOBARIA DUNCANII*	CACTUS, DUNCAN'S PINCUSHION					VERIFIED			G1G2	S1	SPECIES OF CONCERN	ENDANGERED	NONE	**BLM SENSITIVE**
CACTACEAE	*ESCOBARIA VILLARDII*	CACTUS, VILLARD'S PINCUSHION					VERIFIED			G2	S2	SPECIES OF CONCERN	ENDANGERED	SENSITIVE	**BLM SENSITIVE**
ASTERACEAE	*LEPIDOSPARTUM BURGESSII*	SCALEBROOM, GYPSUM					VERIFIED			G2	S1	SPECIES OF CONCERN	ENDANGERED	NONE	**BLM SENSITIVE**
LINACEAE	*LINUM ALLREDII*	FLAX, ALLRED'S							VERIFIED	NONE	NONE	NONE	NONE	NONE	**BLM SENSITIVE**
LOASACEAE	*MENTZELIA HUMILUS VAR. GUADALUPENSIS*	STICKLEAF, GUADALUPE					VERIFIED			G4T2	SNR	NONE	SPECIES OF CONCERN	NONE	**BLM SENSITIVE**
CACTACEAE	*OPUNTIA ARENARIA*	PRICKLYPEAR, SAND					VERIFIED			G2	S2	SPECIES OF CONCERN	ENDANGERED	NONE	**BLM SENSITIVE**
CACTACEAE	*OPUNTIA X VIRIDIFLORA*	CHOLLA, SANTA FE				VERIFIED				G1G2	S1	SPECIES OF CONCERN	ENDANGERED	NONE	**BLM SENSITIVE**
FABACEAE	*PEDIOMELUM PENTAPHYLLUM*	SCURFPEA, CHIHUAHUA					VERIFIED			G1	SH,S1	SPECIES OF CONCERN + PETITIONED - POSITIVE 90 DAY FINDING	ENDANGERED	SENSITIVE	**BLM SENSITIVE**
CACTACEAE	*PENIOCEREUS GREGGII VAR GREGGII*	CEREUS, NIGHT-BLOOMING					VERIFIED			G3G4T2	S1	SPECIES OF CONCERN	ENDANGERED	NONE	**BLM SENSITIVE**
SCROPHULARIACEAE	*PENSTEMON ALAMOSENSIS*	BEARDTONGUE, ALAMO					VERIFIED			G3	S3	SPECIES OF CONCERN	SPECIES OF CONCERN	SENSITIVE	**BLM SENSITIVE**
SCROPHULARIACEAE	*PENSTEMON CARDINALIS SSP. REGALIS*	PENSTEMON, GUADALUPE							VERIFIED	G3T2	S2	NONE	SPECIES OF CONCERN	SENSITIVE	**BLM SENSITIVE**
ASTERACEAE	*PERITYLE CERNUA*	CLIFF DAISY, NODDING					VERIFIED			G2	S2	SPECIES OF CONCERN	SPECIES OF CONCERN	NONE	**BLM SENSITIVE**
CHENOPODIACEAE	*PROATRIPLEX PLEIANTHA*	SALTBUSH, MANCOS			VERIFIED					G3	S3?	SPECIES OF CONCERN	SPECIES OF CONCERN	NONE	**BLM SENSITIVE**
POACEAE	*PUCCINELLIA PARISHII*	ALKALIGRASS, PARISH'S	VERIFIED	HYPOTHETICAL	HYPOTHETICAL		VERIFIED			G2	S2,S1	SPECIES OF CONCERN	ENDANGERED	SENSITIVE	**BLM SENSITIVE**
CACTACEAE	*SCLEROCACTUS CLOVERAE SSP. BRACKII*	CACTUS, BRACK'S HARDWALL			VERIFIED					G3T1	S1	SPECIES OF CONCERN	ENDANGERED	NONE	**BLM SENSITIVE**
CACTACEAE	*SCLEROCACTUS PAPYRACANTHUS*	CACTUS, GRAMA GRASS	VERIFIED	HYPOTHETICAL	HYPOTHETICAL	VERIFIED	VERIFIED	HYPOTHETICAL		G4	S2S3,S4	SPECIES OF CONCERN	NONE	NONE	**BLM SENSITIVE**
SCROPHULARIACEAE	*SCROPHULARIA MACRANTHA*	FIGWORT, MIMBRES					VERIFIED			G2	S2	SPECIES OF CONCERN	SPECIES OF CONCERN	SENSITIVE	**BLM SENSITIVE**
BRASSICACEAE	*SIBARA GRISEA*	THELYPODY, TEXAS; SIBARA, GRAY					VERIFIED			G3	S3?	NONE	SPECIES OF CONCERN	NONE	**BLM SENSITIVE**
BRASSICACEAE	*STREPTANTHUS PLATYCARPUS*	JEWELFLOWER, BROADPOD							VERIFIED	G1?Q	S1?	PETITIONED / NEGATIVE 90 DAY FINDIN	SPECIES OF CONCERN	NONE	**BLM SENSITIVE**
ASTERACEAE	*TOWNSENDIA GYPSOPHILA*	TOWNSEND DAISY, GYPSUM	VERIFIED							G2	S2	SPECIES OF CONCERN	SPECIES OF CONCERN	NONE	**BLM SENSITIVE**

New Mexico BLM Sensitive Animal Species List (Final) - August 2011

SPECIES	COMMON NAME	FARMINGTON - LLNMFO1000	TAOS - LLNMF02000	RIO PUERCO - LLNMA01000	SOCORRO - LLNMA02000	LAS CRUCES - LLNML00000	ROSWELL - LLNMP01000	CARLSBAD - LLNMP02000
AMPHIBIANS (3)								
Anaxyrus (Bufo) microscaphus	Southwestern Toad	NONE	NONE	PERIPHERAL	VERIFIED	VERIFIED	NONE	NONE
Lithobates (Rana) yavapaiensis	Lowland Leopard Frog	NONE	NONE	NONE	HYPOTHETICAL	VERIFIED	NONE	NONE
Lithobates (Rana) pipiens	Northern Leopard Frog	VERIFIED	VERIFIED	VERIFIED	PERIPHERAL	NONE	NONE	NONE
ARTHROPODS (2)								
Lytta mirifica	Anthony Blister Beetle	NONE	NONE	NONE	NONE	VERIFIED	NONE	NONE
Ochlodes yuma anasazi	Yuma Skipper	NONE	VERIFIED	NONE	NONE	NONE	NONE	NONE
BIRDS (12)								
Haliaeetus leucocephalus	Bald Eagle	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED
Tympanuchus pallidicinctus	Lesser Prairie-chicken	NONE	PERIPHERAL	NONE	NONE	NONE	VERIFIED	VERIFIED
Coccyzus americanus occidentalis	Western Yellow-billed Cuckoo	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED
Athene cunicularia hypugaea	Western Burrowing Owl	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED
Gymnorhinus cyanocephalus	Piñon Jay	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED	PERIPHERAL
Toxostoma bendirei	Bendire's Thrasher	VERIFIED	PERIPHERAL	VERIFIED	VERIFIED	VERIFIED	PERIPHERAL	NONE
Vireo bellii arizonae	Bell's Vireo	NONE	NONE	NONE	NONE	VERIFIED	PERIPHERAL	VERIFIED
Anthus spragueii	Sprague's Pipit	NONE	NONE	NONE	PERIPHERAL	VERIFIED	VERIFIED	VERIFIED
Ammodramus savannarum ammolegus	Arizona Grasshopper Sparrow	NONE	NONE	NONE	NONE	VERIFIED	NONE	NONE
Ammodramus bairdii	Baird's Sparrow	NONE	NONE	NONE	NONE	VERIFIED	NONE	NONE
Passerina ciris	Painted Bunting	NONE	NONE	NONE	NONE	VERIFIED	PERIPHERAL	VERIFIED
Calcarius ornatus	Chestnut-collared Longspur	PERIPHERAL	VERIFIED	NONE	VERIFIED	VERIFIED	VERIFIED	VERIFIED
CRUSTACEANS (5)								
Streptocephalus thomasbowmani	Thomas Bowman's Fairy Shrimp	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Streptocephalus moorei	Moore's Fairy Shrimp	NONE	NONE	NONE	NONE	VERIFIED	NONE	NONE
Phallocryptus (Branchinella) sublettei	Sublette's Fairy Shrimp	NONE	NONE	NONE	NONE	VERIFIED	NONE	NONE
Eulimnadia follisimilis	Clam Shrimp	NONE	NONE	NONE	VERIFIED	NONE	VERIFIED	NONE
Lepidurus lemmoni	Lynch's Tadpole Shrimp	NONE	NONE	NONE	NONE	VERIFIED	NONE	NONE
FISH (17)								
Oncorhynchus clarki virginalis	Rio Grande Cutthroat Trout	NONE	PERIPHERAL	PERIPHERAL	PERIPHERAL	PERIPHERAL	PERIPHERAL	NONE
Agosia chrysogaster	Longfin Dace	NONE	NONE	NONE	PERIPHERAL	VERIFIED	NONE	NONE

Astyanax mexicanus	Mexican Tetra	NONE	NONE	NONE	EXTIRPATED	EXTIRPATED	VERIFIED	VERIFIED			
Catostomus discobolus discobolus	Bluehead Sucker	VERIFIED	HYPOTHETICAL	PERIPHERAL	PERIPHERAL	NONE	NONE	NONE			
Catostomus latipinnis	Flannelmouth Sucker	VERIFIED	HYPOTHETICAL	NONE	NONE	HYPOTHETICAL	NONE	NONE			
Catostomus plebeius	Rio Grande Sucker	NONE	VERIFIED	PERIPHERAL	PERIPHERAL	VERIFIED	PERIPHERAL	PERIPHERAL			
Gila pandora	Rio Grande Chub	NONE	VERIFIED	PERIPHERAL	PERIPHERAL	PERIPHERAL	VERIFIED	VERIFIED			
Ictiobus bubalus	Smallmouth Buffalo	NONE	HYPOTHETICAL	HISTORICAL	HISTORICAL	VERIFIED	HISTORICAL	VERIFIED			
Macrhybopsis aestivalis aestivalis	Speckled Chub	NONE	PERIPHERAL	EXTIRPATED	EXTIRPATED	EXTIRPATED	VERIFIED	VERIFIED			
Percina macrolepida	Bigscale Logperch	NONE	INTRODUCED	NONE	NONE	NONE	VERIFIED	VERIFIED			
Phenacobius mirabilis	Suckermouth Minnow	NONE	VERIFIED	NONE	NONE	NONE	VERIFIED	NONE			
Catostomus clarki	Desert Sucker	NONE	NONE	NONE	PERIPHERAL	NONE	NONE	NONE			
Catostomus insignis	Sonora Sucker	NONE	NONE	NONE	PERIPHERAL	VERIFIED	NONE	NONE			
Cycleptus elongatus	Blue Sucker	NONE	EXTIRPATED	EXTIRPATED	EXTIRPATED	EXTIRPATED	PERIPHERAL	VERIFIED			
Cyprinodon pecosensis	Pecos Pupfish	NONE	NONE	NONE	NONE	NONE	VERIFIED	VERIFIED			
Etheostoma lepidum	Greenthroat Darter	NONE	NONE	NONE	NONE	NONE	VERIFIED	VERIFIED			
Gila robusta	Roundtail Chub	HYPOTHETICAL	HYPOTHETICAL	PERIPHERAL	PERIPHERAL	VERIFIED	NONE	NONE			
Ictalurus lupus	Headwater Catfish	NONE	NONE	NONE	NONE	NONE	VERIFIED	VERIFIED			
Macrhybopsis tetranema	Peppered Chub	NONE	PERIPHERAL	NONE	NONE	NONE	NONE	NONE			
Moxostoma congestum	Gray Redhorse	NONE	HISTORICAL	HISTORICAL	HISTORICAL	PERIPHERAL	HISTORICAL	VERIFIED			
Notropis jemezanus	Rio Grande Shiner	NONE	EXTIRPATED	PERIPHERAL	EXTIRPATED	EXTIRPATED	VERIFIED	VERIFIED			
MAMMALS (12)											
Choeronycteris mexicana	Mexican Long-tongued Bat	NONE	NONE	NONE	NONE	VERIFIED	NONE	PERIPHERAL			
Lasiurus xanthinus	Western Yellow Bat	NONE	NONE	NONE	NONE	VERIFIED	NONE	NONE			
Lasiurus blossevillii	Western Red Bat	NONE	NONE	NONE	VERIFIED	VERIFIED	PERIPHERAL	NONE			
Euderma maculatum	Spotted Bat	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED	PERIPHERAL			
Idionycteris phyllotis	Allen's Lappet-browed Bat	NONE	NONE	PERIPHERAL	VERIFIED	VERIFIED	NONE	NONE			
Corynorhinus townsendii	Townsend's Big-eared Bat	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED	VERIFIED			
Lepus callotis	White-sided Jack Rabbit	NONE	NONE	NONE	NONE	VERIFIED	NONE	NONE			
Cynomys ludovicianus	Black-tailed Prairie Dog	NONE	VERIFIED	PERIPHERAL	PERIPHERAL	VERIFIED	VERIFIED	VERIFIED			
Cynomys gunnisoni	Gunnison's Prairie Dog	VERIFIED	VERIFIED	VERIFIED	VERIFIED	NONE	NONE	NONE			
Thomomys bottae (umbrinus) paguatae	Cebolleta Pocket Gopher	PERIPHERAL	NONE	VERIFIED	PERIPHERAL	NONE	NONE	NONE			
Zapus hudsonius luteus	Meadow (New Mexico) Jumping Mouse	PERIPHERAL	HYPOTHETICAL	HYPOTHETICAL	HYPOTHETICAL	HYPOTHETICAL	NONE	NONE			
Nasua narica	White-nosed Coati	NONE	NONE	NONE	NONE	VERIFIED	NONE	NONE			
MOLLUSCS (1)											

Popenaias popeii	Texas Hornshell	NONE	NONE	NONE	NONE	NONE	NONE	VERIFIED
REPTILES (7)								
Heloderma suspectum suspectum	Reticulate Gila Monster	NONE	NONE	NONE	NONE	VERIFIED	NONE	NONE
Sceloporus arenicolus	Sand Dune Lizard	NONE	NONE	NONE	NONE	NONE	VERIFIED	VERIFIED
Aspidoscelis dixoni	Gray-checkered Whiptail	NONE	NONE	NONE	NONE	VERIFIED	NONE	NONE
Thamnophis eques megalops	Mexican Garter Snake	NONE	NONE	NONE	NONE	VERIFIED	NONE	NONE
Thamnophis rufipunctatus	Narrow-headed Garter Snake	NONE	NONE	NONE	PERIPHERAL	VERIFIED	NONE	NONE
Trachemys gaigeae gaigeae	Big Bend Slider	NONE	NONE	NONE	VERIFIED	VERIFIED	NONE	NONE
Pseudemys gorzugi	Western River Cooter	NONE	NONE	NONE	NONE	NONE	VERIFIED	VERIFIED

NM STATE UNIVERSITY

New Mexico Department of Agriculture
Office of the Director/Secretary
MSC 3189
New Mexico State University
P.O. Box 30005
Las Cruces, NM 88003-8005
575-646-3007

October 19, 2016

MEMORANDUM

TO: General Public

FROM: Director/Secretary Jeff Witte

SUBJECT: New Mexico Noxious Weed List Update

The Director of the New Mexico Department of Agriculture has selected the following plant species *(see attached New Mexico Noxious Weed List)* to be targeted as noxious weeds for control or eradication pursuant to the Noxious Weed Management Act of 1998.

Petitions to add new plant species to the state noxious weed list were solicited and received by the New Mexico Department of Agriculture (NMDA) from Cooperative Weed Management Areas, individuals, agencies, and organizations. The petitions were reviewed by the New Mexico Weed List Advisory Committee using ecological, distribution, impact, and legal status criteria within the State of New Mexico and adjoining states and countries. Based on their extensive knowledge and experience, experts from the New Mexico State University Plant Sciences Department added several species as well.

This list does not include every plant species with the potential to negatively impact the state's environment or economy. Landowners and land managers are encouraged to recognize plant species listed on the federal noxious weed list and other western states' noxious weed lists as potentially having negative impacts and to manage them accordingly.

New Mexico Noxious Weed List

Updated September 2016

Class A Species

Class A species are currently not present in New Mexico, or have limited distribution. Preventing new infestations of these species and eradicating existing infestations is the highest priority.

Common Name	Scientific Name
Alfombrilla	*Drymaria arenariodes*
Black henbane	*Hyoscyamus niger*
Brazillian egeria	*Egeria densa*
Camelthorn	*Alhagi psuedalhagi*
Canada thistle	*Cirsium arvense*
Dalmation toadflax	*Linaria dalmatica*
Diffuse knapweed	*Centaurea diffusa*
Dyer’s woad	*Isatis tinctoria*
Giant salvinia	*Salvinia molesta*
Hoary cress	*Cardaria spp.*
Leafy spurge	*Euphorbia esula*
Oxeye daisy	*Leucanthemum vulgare*
Purple loosestrife	*Lythrum salicaria*
Purple starthistle	*Centaurea calcitrapa*
Ravenna grass	*Saccharum ravennae*
Scentless chamomile	*Matricaria perforata*
Scotch thistle	*Onopordum acanthium*
Spotted knapweed	*Centaurea biebersteinii*
Yellow starthistle	*Centaurea solstitialis*
Yellow toadflax	*Linaria vulgaris*

Class B Species

Class B Species are limited to portions of the state. In areas with severe infestations, management should be designed to contain the infestation and stop any further spread.

Common Name	Scientific Name
African rue	*Peganum harmala*
Bull thistle	*Cirsium vulgare*
Chicory	*Cichorium intybus*
Halogeton	*Halogeton glomeratus*
Malta starthistle	*Centaurea melitensis*
Perennial pepperweed	*Lepidium latifolium*
Poison hemlock	*Conium maculatum*

Quackgrass	*Elytrigia repens*
Russian knapweed	*Acroptilon repens*
Spiny cocklebur	*Xanthium spinosum*
Teasel	*Dipsacus fullonum*

Class C Species

Class C species are wide-spread in the state. Management decisions for these species should be determined at the local level, based on feasibility of control and level of infestation.

Common Name	**Scientific Name**
Cheatgrass	*Bromus tectorum*
Curlyleaf pondweed	*Potamogeton crispus*
Eurasian watermilfoil	*Myriophyllum spicatum*
Giant cane	*Arundo donax*
Hydrilla	*Hydrilla verticllata*
Jointed goatgrass	*Aegilops cylindrica*
Musk thistle	*Carduus nutans*
Parrotfeather	*Myriophyllum aquaticum*
Russian olive	*Elaeagnus angustifolia*
Saltcedar	*Tamarix spp.*
Siberian elm	*Ulmus pumila*
Tree of heaven	Ailanthus altissima

Watch List Species

Watch List species are species of concern in the state. These species have the potential to become problematic. More data is needed to determine if these species should be listed. When these species are encountered please document their location and contact appropriate authorities.

Common Name	**Scientific Name**
Crimson fountaingrass	*Pennisetum setaceum*
Meadow knapweed	*Centaurea pratensis*
Myrtle spurge	*Euphorbia myrsinites*
Pampas grass	*Cortaderia sellonana*
Sahara mustard	*Brassica tournefortii*
Syrian beancaper	*Zygophyllum fabago L.*
Wall rocket	*Diplotaxis tenuifolia*

Locations of Western Burrowing Owl Burrows within the Survey Area

BURROW #	UTM EAST ZONE 13 NAD 83	UTM NORTH ZONE 13 NAD 83
1	241505.7297	3922980.38
2	241472.6848	3923157.886
3	241487.4199	3923139.379
4	241513.5852	3923151.711
5	241623.2205	3923441.085
6	241633.8896	3923442.272
7	241665.5226	3923447.213
8	241692.4228	3923426.135
9	241841.9656	3923108.906
10	241838.1861	3923103.704
11	241826.4991	3923102.94
12	237973.95	3924292.401
13	237974.4592	3924350.441
14	239533.3621	3923386.432
15	239521.6627	3923361.00
16	239515.1164	3923356.98

Animals Observed or Expected to Occur at the Study Area

BIRDS

Family Anatidae: Ducks, Geese, Swans
Gadwall (*Anas strepera*)
Mallard (*Anas platyrhynchos*)
Northern shoveler (*Anas clypeata*)
Northern pintail (*Anas acuta)*

Family Odontophoridae: New World Quail
Scaled quail (*Callipepla squamata*)

Family Columbidae: Pigeons, Doves
Mourning dove (*Zenaida macroura)*

Family Cuculidae: Cuckoos, Roadrunners, Anis
Greater roadrunner (*Geococcyz californianus*)

Family Charadriidae: Plovers
Killdeer (*Charadrius vociferous*)

Family Ardeidae: Bitterns, Herons
Great blue heron (*Ardea herodias*)

Family Cathartidae: American Vultures
Turkey vulture (*Cathartes aura*)

Family Accipitridae: Kites, Eagles, Hawks
Golden eagle (*Aquila chrysaetos)*
Northern harrier (*Circus cyaneus*)

Family Strigidae: Typical Owls
Burrowing owl (*Athene cunicularia*)

Family Picidae: Woodpeckers
Northern flicker (*Colaptes auratus*)

Family Falconidae: Caracaras, Falcons
American kestrel (*Falco sparverius*)
Prairie falcon (*Falco mexicanus*)

Family Tyrannidae: Tyrant Flycatchers
Say's phoebe (*Sayornis saya*)
Ash-throated flycatcher (*Myiarchus cinerascens*)
Western kingbird (*Tyrannus verticalis*)
Cassin’s kingbird (*Tyrannus vociferans*)

Family Laniidae: Shrikes
Loggerhead shrike (*Lanius ludovicianus*)

Family Corvidae: Jays, Magpies, Crows
Common raven (*Corvus corax*)
American crow (*Corvus brachyrhynchos*)

Family Alaudidae: Larks
Horned Lark (*Eremophila alpestris*)

Family Hirundinidae: Swallows
Cliff swallow (Petrochelidon pyrrhonota)

Family Mimidae: Mockingbirds, Thrashers
Northern mockingbird (*Mimus polyglottos*)

Family Fringillidae: Finches
House finch (*Haemorhous mexicanus)*

Family Emberizidae: Sparrows
Abert's towhee (*Melozone aberti*)
Chipping sparrow (*Spizella passerine*)
Lark sparrow (*Chondestes grammacus*)
Vesper sparrow (*Pooecetes gramineus*)
Brewer's sparrow (*Spizella breweri*)
Sage sparrow (*Amphispiza belli*)
White-crowned sparrow (*Zonotrichia leucophrys*)
Dark-eyed junco (*Junco hyemalis*)

Family Icteridae: Blackbirds, Orioles
Western Meadowlark (*Sturnella neglecta*)

<u>REPTILES</u>

Crotaphytidae
Aspidoscelis velox (Plateau striped whiptail)

Phrynosomatidae
Scleoporus cowlesi (Southwestern lizard)
Phrynosoma hernandesi (Greater Short-horned lizard)

Colubridae
Thamnophis elegans vagrans (Wandering Garter Snake)
Pituophis catenifer (Bull snake)

Viperidae
*Crotalus viridis (*Prairie rattlesnake)

MAMMALS

CANIDAE
Canis latrans (Coyote) Tracks Scat

FELIDAE
Puma concolor (Mountain lion) (Tracks)

CRICETIDAE
**Neotoma* sp. (Woodrat) N*. albigula* or *N. stephensi*

GEOMYIDAE
**Thomomys bottae (Botta's pocket gopher)*

HETEROMYIDAE
**Dipodomys ordii* (Ord's kangaroo rat)
**Dipodomys spetabilis* (Banner-tailed kangaroo rat)

LEPORIDAE
**Sylvilagus auduboni* (desert cottontail)
**Lepus californicus* (Black-tailed jackrabbit)

SCIURIDAE
**Cynomys gunnisoni* (Gunnison's prairie dog)

CERVIDAE
**Cervus elaphus* (Elk)
**Odocoileus hemionus* (Mule deer)

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SCIURIDAE
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CERVIDAE
**Cervus elaphus* (Elk)
**Odocoileus hemionus* (Mule deer)

APPENDIX B

CULTURAL RESOURCES SURVEY REPORT

Redacted due to sensitive cultural concerns by the Navajo Nation Tribal Historical Preservation Officer and the New Mexico State Historical Preservation Officer.

APPENDIX C

EBERLINE ANALYTICAL SERVICES, INC. ANALYTICAL DATA PACKAGES

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BACKGROUND REFERENCE AREA SOIL SAMPLES

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	16-08019
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
		Gamma - Run 1											
16-08019-01	LCS	KNOWN	08/04/16 00:00	8/4/2016	8/15/2016	16-08019	Cobalt-60	LANL ER-130 Modified	1.37E+02	5.48E+00			pCi/g
16-08019-01	LCS	KNOWN	08/04/16 00:00	8/4/2016	8/15/2016	16-08019	Cesium-137	LANL ER-130 Modified	8.69E+01	3.48E+00			pCi/g
16-08019-01	LCS	SPIKE	08/04/16 00:00	8/4/2016	8/15/2016	16-08019	Cobalt-60	LANL ER-130 Modified	1.39E+02	9.61E+00	1.20E+01	1.45E+00	pCi/g
16-08019-01	LCS	SPIKE	08/04/16 00:00	8/4/2016	8/15/2016	16-08019	Cesium-137	LANL ER-130 Modified	8.40E+01	8.10E+00	9.18E+00	2.10E+00	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	-2.89E-02	1.46E-01	1.46E-01	2.40E-01	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	2.09E-02	7.92E-02	7.92E-02	1.36E-01	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	4.82E-01	4.82E-01	4.83E-01	7.51E-01	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	6.89E+00	3.99E+00	4.00E+00	9.80E+00	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	6.23E-03	6.18E-02	6.18E-02	9.75E-02	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	9.36E-02	1.03E-01	1.03E-01	1.71E-01	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	2.09E-02	7.92E-02	7.92E-02	1.36E-01	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.78E-01	4.23E-01	4.23E-01	6.81E-01	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.62E-03	1.11E-01	1.11E-01	1.88E-01	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.79E+00	3.14E-01	3.27E-01	7.59E-01	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.36E+00	2.12E-01	2.23E-01	2.79E-01	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.10E+01	2.66E+00	2.87E+00	1.56E+00	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	-8.77E+00	9.10E+00	9.11E+00	1.16E+01	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	2.33E+00	2.42E-01	2.70E-01	4.88E-01	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	1.60E+00	1.98E-01	2.15E-01	3.08E-01	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	1.36E+00	2.12E-01	2.23E-01	2.79E-01	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.17E-01	1.91E+00	1.91E+00	2.44E+00	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.86E+00	2.70E-01	2.86E-01	1.58E-01	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.47E+00	2.88E-01	2.98E-01	7.28E-01	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.43E+00	1.97E-01	2.10E-01	5.35E-01	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.28E+01	2.82E+00	3.05E+00	1.56E+00	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	1.76E+00	7.64E+00	7.64E+00	1.22E+01	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	2.01E+00	2.19E-01	2.43E-01	3.10E-01	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	1.60E+00	2.02E-01	2.18E-01	3.17E-01	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	1.43E+00	1.97E-01	2.10E-01	5.35E-01	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.68E+00	1.84E+00	1.85E+00	2.45E+00	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.66E+00	2.82E-01	2.94E-01	1.58E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	16-08019
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.99E+00	2.23E-01	2.45E-01	5.93E-01	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.73E+00	2.16E-01	2.33E-01	2.72E-01	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.60E+01	2.81E+00	3.11E+00	9.61E-01	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	4.80E+00	5.88E+00	5.88E+00	9.68E+00	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	1.83E+00	2.08E-01	2.28E-01	2.72E-01	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	1.74E+00	1.83E-01	2.04E-01	2.89E-01	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	1.73E+00	2.16E-01	2.33E-01	2.72E-01	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.61E+00	1.85E+00	1.85E+00	3.10E+00	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.72E+00	2.18E-01	2.35E-01	1.56E-01	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.85E+00	2.92E-01	3.07E-01	4.86E-01	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.36E+00	2.18E-01	2.28E-01	2.53E-01	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.34E+01	2.74E+00	2.99E+00	1.26E+00	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	-5.36E+00	6.52E+00	6.53E+00	8.86E+00	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	2.21E+00	3.18E-01	3.37E-01	2.58E-01	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	1.51E+00	2.22E-01	2.35E-01	2.23E-01	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	1.36E+00	2.18E-01	2.28E-01	2.53E-01	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.31E+00	1.44E+00	1.44E+00	2.41E+00	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.64E+00	2.26E-01	2.41E-01	1.17E-01	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	2.17E+00	4.69E-01	4.82E-01	8.30E-01	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.45E+00	3.78E-01	3.85E-01	5.77E-01	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.17E+01	3.65E+00	3.81E+00	2.12E+00	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	1.72E+01	1.55E+01	1.56E+01	2.54E+01	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	2.06E+00	3.21E-01	3.38E-01	4.73E-01	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	1.64E+00	3.18E-01	3.29E-01	5.29E-01	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	1.45E+00	3.78E-01	3.85E-01	5.77E-01	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.89E+00	2.24E+00	2.25E+00	3.72E+00	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.27E+00	3.10E-01	3.17E-01	2.64E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	16-08019
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.86E+00	2.39E-01	2.58E-01	3.46E-01	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.57E+00	1.79E-01	1.96E-01	1.49E-01	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.33E+01	2.57E+00	2.84E+00	1.15E+00	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	-7.54E-02	5.83E+00	5.83E+00	8.76E+00	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	2.16E+00	2.17E-01	2.43E-01	2.35E-01	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	1.62E+00	1.77E-01	1.95E-01	2.71E-01	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	1.57E+00	1.79E-01	1.96E-01	1.49E-01	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.13E+00	1.51E+00	1.51E+00	2.04E+00	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.50E+00	2.02E-01	2.16E-01	1.02E-01	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.94E+00	2.85E-01	3.02E-01	3.31E-01	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.44E+00	2.18E-01	2.30E-01	2.10E-01	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.21E+01	2.55E+00	2.79E+00	3.89E+00	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	1.04E+00	6.10E+00	6.10E+00	9.59E+00	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	2.17E+00	3.14E-01	3.33E-01	2.64E-01	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	1.58E+00	2.40E-01	2.53E-01	2.37E-01	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	1.44E+00	2.18E-01	2.30E-01	2.10E-01	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.75E+00	2.09E+00	2.09E+00	3.47E+00	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.40E+00	2.22E-01	2.33E-01	1.76E-01	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.81E+00	2.46E-01	2.63E-01	3.40E-01	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.55E+00	1.75E-01	1.92E-01	1.75E-01	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.24E+01	2.48E+00	2.74E+00	9.43E-01	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	8.83E+00	6.74E+00	6.76E+00	1.09E+01	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	2.01E+00	2.16E-01	2.40E-01	2.80E-01	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	1.59E+00	1.56E-01	1.76E-01	2.19E-01	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	1.55E+00	1.75E-01	1.92E-01	1.75E-01	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.07E+00	1.83E+00	1.84E+00	3.05E+00	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.49E+00	1.98E-01	2.12E-01	1.03E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	16-08019
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.87E+00	3.03E-01	3.18E-01	6.01E-01	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.40E+00	2.09E-01	2.21E-01	2.87E-01	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.21E+01	2.57E+00	2.81E+00	1.45E+00	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	1.95E+00	6.70E+00	6.70E+00	1.08E+01	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	1.85E+00	2.08E-01	2.29E-01	3.41E-01	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	1.43E+00	2.19E-01	2.31E-01	3.71E-01	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	1.40E+00	2.09E-01	2.21E-01	2.87E-01	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	4.54E+00	2.23E+00	2.24E+00	8.00E+00	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.56E+00	2.42E-01	2.55E-01	2.38E-01	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.84E+00	2.40E-01	2.57E-01	4.60E-01	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.44E+00	1.78E-01	1.93E-01	2.03E-01	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.22E+01	2.48E+00	2.73E+00	1.22E+00	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	8.51E-01	5.58E+00	5.58E+00	8.50E+00	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	2.02E+00	2.21E-01	2.44E-01	2.84E-01	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	1.53E+00	1.83E-01	1.99E-01	2.70E-01	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	1.44E+00	1.78E-01	1.93E-01	2.03E-01	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.38E+00	1.58E+00	1.58E+00	2.64E+00	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.62E+00	2.09E-01	2.25E-01	2.07E-01	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.86E+00	2.75E-01	2.91E-01	6.75E-01	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.56E+00	2.15E-01	2.29E-01	1.68E-01	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.15E+01	2.50E+00	2.73E+00	3.83E+00	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	6.68E+00	5.24E+00	5.25E+00	9.53E+00	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	1.80E+00	3.03E-01	3.16E-01	2.63E-01	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	1.59E+00	2.30E-01	2.44E-01	2.28E-01	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	1.56E+00	2.15E-01	2.29E-01	1.68E-01	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.56E+00	1.75E+00	1.75E+00	2.93E+00	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.69E+00	3.19E-01	3.30E-01	5.06E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical Final Report of Analysis	Report To:	Work Order Details:	
	David Bordelon	SDG:	16-08019
	Weston Solutions, Inc.	Purchase Order:	0090911
	13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
	Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.86E+00	2.97E-01	3.12E-01	3.46E-01	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.61E+00	2.30E-01	2.45E-01	2.57E-01	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.05E+01	2.51E+00	2.72E+00	4.08E+00	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	6.00E+00	6.58E+00	6.58E+00	1.13E+01	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	2.17E+00	3.20E-01	3.39E-01	2.67E-01	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	1.71E+00	2.47E-01	2.62E-01	2.40E-01	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	1.61E+00	2.30E-01	2.45E-01	2.57E-01	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.82E+00	1.05E+00	1.06E+00	1.72E+00	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.82E+00	3.59E-01	3.71E-01	4.01E-01	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.94E+00	2.46E-01	2.65E-01	4.33E-01	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.58E+00	1.78E-01	1.96E-01	1.95E-01	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.25E+01	2.43E+00	2.69E+00	8.15E-01	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	7.50E-01	5.67E+00	5.67E+00	8.59E+00	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	2.09E+00	2.19E-01	2.44E-01	2.30E-01	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	1.60E+00	1.71E-01	1.90E-01	2.53E-01	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	1.58E+00	1.78E-01	1.96E-01	1.95E-01	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.28E+00	1.54E+00	1.54E+00	2.03E+00	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.66E+00	1.85E-01	2.04E-01	9.91E-02	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.73E+00	2.68E-01	2.83E-01	3.27E-01	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.27E+00	2.15E-01	2.24E-01	2.53E-01	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.19E+01	2.55E+00	2.79E+00	3.95E+00	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	-1.86E+00	6.88E+00	6.88E+00	9.76E+00	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-212	LANL ER-130 Modified	2.00E+00	3.01E-01	3.18E-01	2.51E-01	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Lead-214	LANL ER-130 Modified	1.45E+00	2.57E-01	2.67E-01	2.63E-01	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Radium-226	LANL ER-130 Modified	1.27E+00	2.15E-01	2.24E-01	2.53E-01	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.74E+00	1.99E+00	1.99E+00	3.34E+00	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.85E+00	3.26E-01	3.40E-01	3.17E-01	pCi/g

Eberline Analytical
Final Report of Analysis

Report To:	
David Bordelon	
Weston Solutions, Inc.	
13702 Coursey Blvd, #7A	
Baton Rouge, LA 70817	

Work Order Details:	
SDG:	16-08019
Purchase Order:	0090911
Analysis Category:	ENVIRONMENTAL
Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Actinium-228	LANL ER-130 Modified	2.04E+00	3.24E-01	3.40E-01	5.92E-01	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.53E+00	2.25E-01	2.38E-01	2.62E-01	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.28E+01	2.71E+00	2.95E+00	8.90E-01	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	2.28E+00	7.31E+00	7.31E+00	1.19E+01	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Lead-212	LANL ER-130 Modified	1.99E+00	2.22E-01	2.44E-01	3.36E-01	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Lead-214	LANL ER-130 Modified	1.58E+00	2.01E-01	2.17E-01	3.09E-01	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Radium-226	LANL ER-130 Modified	1.53E+00	2.25E-01	2.38E-01	2.62E-01	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.16E+00	1.70E+00	1.70E+00	2.81E+00	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.78E+00	2.69E-01	2.84E-01	2.52E-01	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.48E+00	5.79E-01	5.83E-01	1.08E+00	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.71E+00	3.53E-01	3.64E-01	5.30E-01	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.29E+01	3.86E+00	4.03E+00	2.15E+00	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	-4.08E+00	1.38E+01	1.38E+01	2.15E+01	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Lead-212	LANL ER-130 Modified	2.40E+00	3.58E-01	3.78E-01	5.18E-01	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Lead-214	LANL ER-130 Modified	1.51E+00	3.26E-01	3.35E-01	5.30E-01	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Radium-226	LANL ER-130 Modified	1.71E+00	3.53E-01	3.64E-01	5.30E-01	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.71E+00	1.86E+00	1.87E+00	3.07E+00	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.74E+00	4.18E-01	4.28E-01	5.60E-01	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.92E+00	2.88E-01	3.05E-01	6.58E-01	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.54E+00	2.12E-01	2.26E-01	2.27E-01	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.17E+01	3.02E+00	3.22E+00	2.84E+00	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	2.52E+00	6.72E+00	6.72E+00	1.08E+01	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Lead-212	LANL ER-130 Modified	2.14E+00	2.23E-01	2.48E-01	4.11E-01	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Lead-214	LANL ER-130 Modified	1.71E+00	1.99E-01	2.18E-01	2.80E-01	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Radium-226	LANL ER-130 Modified	1.54E+00	2.12E-01	2.26E-01	2.27E-01	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.91E+00	2.08E+00	2.08E+00	3.44E+00	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.60E+00	2.53E-01	2.66E-01	2.64E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	16-08019
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.47E+00	5.05E-01	5.11E-01	1.22E+00	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.71E+00	3.78E-01	3.88E-01	5.31E-01	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.24E+01	4.00E+00	4.16E+00	3.10E+00	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	-2.24E+00	1.43E+01	1.43E+01	2.27E+01	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Lead-212	LANL ER-130 Modified	2.64E+00	4.43E-01	4.64E-01	5.08E-01	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Lead-214	LANL ER-130 Modified	1.50E+00	4.07E-01	4.14E-01	5.52E-01	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Radium-226	LANL ER-130 Modified	1.71E+00	3.78E-01	3.88E-01	5.31E-01	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.13E-01	1.55E+00	1.55E+00	2.36E+00	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/16/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.90E+00	3.91E-01	4.03E-01	4.74E-01	pCi/g
		Gamma - Run 2											
16-08019-01	LCS	KNOWN	08/04/16 00:00	8/4/2016	8/26/2016	16-08019	Cobalt-60	LANL ER-130 Modified	1.37E+02	5.48E+00			pCi/g
16-08019-01	LCS	KNOWN	08/04/16 00:00	8/4/2016	8/26/2016	16-08019	Cesium-137	LANL ER-130 Modified	8.69E+01	3.48E+00			pCi/g
16-08019-01	LCS	SPIKE	08/04/16 00:00	8/4/2016	8/26/2016	16-08019	Cobalt-60	LANL ER-130 Modified	1.38E+02	7.80E+00	1.05E+01	7.52E-01	pCi/g
16-08019-01	LCS	SPIKE	08/04/16 00:00	8/4/2016	8/26/2016	16-08019	Cesium-137	LANL ER-130 Modified	8.85E+01	7.27E+00	8.57E+00	1.40E+00	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08019	Actinium-228	LANL ER-130 Modified	-1.60E-02	8.18E-02	8.18E-02	1.24E-01	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08019	Bismuth-214	LANL ER-130 Modified	2.42E-02	4.30E-02	4.31E-02	7.68E-02	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08019	Potassium-40	LANL ER-130 Modified	-3.41E-02	2.70E-01	2.70E-01	3.85E-01	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	-1.16E-01	2.48E+00	2.48E+00	4.05E+00	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08019	Lead-212	LANL ER-130 Modified	4.53E-02	3.55E-02	3.55E-02	6.22E-02	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08019	Lead-214	LANL ER-130 Modified	8.89E-02	4.35E-02	4.37E-02	8.74E-02	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08019	Radium-226	LANL ER-130 Modified	2.42E-02	4.30E-02	4.31E-02	7.68E-02	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.97E-01	5.55E-01	5.55E-01	7.51E-01	pCi/g
16-08019-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08019	Thallium-208	LANL ER-130 Modified	2.67E-02	5.89E-02	5.89E-02	8.78E-02	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	2.23E+00	6.96E-01	7.05E-01	1.26E+00	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.74E+00	3.48E-01	3.59E-01	1.73E-01	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	1.99E+01	3.78E+00	3.92E+00	3.23E+00	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	-4.56E+00	1.35E+01	1.35E+01	2.05E+01	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.66E+00	4.30E-01	4.52E-01	4.69E-01	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.53E+00	4.00E-01	4.07E-01	5.30E-01	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.74E+00	3.48E-01	3.59E-01	1.73E-01	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	3.17E+00	1.65E+00	1.65E+00	2.61E+00	pCi/g
16-08019-03	DUP	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.60E+00	3.50E-01	3.59E-01	3.07E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	16-08019
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.61E+00	5.23E-01	5.29E-01	9.93E-01	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.39E+00	3.31E-01	3.38E-01	4.45E-01	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.31E+01	3.85E+00	4.03E+00	1.85E+00	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	9.25E+00	1.37E+01	1.37E+01	2.36E+01	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.58E+00	4.41E-01	4.60E-01	5.12E-01	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.69E+00	3.47E-01	3.58E-01	6.29E-01	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.39E+00	3.31E-01	3.38E-01	4.45E-01	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.44E+00	1.59E+00	1.59E+00	2.48E+00	pCi/g
16-08019-04	DO	10-01-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.64E+00	4.04E-01	4.13E-01	6.97E-01	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.74E+00	2.91E-01	3.05E-01	4.81E-01	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.73E+00	2.12E-01	2.30E-01	2.02E-01	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.62E+01	3.03E+00	3.32E+00	1.42E+00	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	2.86E+00	6.60E+00	6.60E+00	1.06E+01	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.26E+00	3.74E-01	3.92E-01	2.61E-01	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.79E+00	2.50E-01	2.66E-01	2.42E-01	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.73E+00	2.12E-01	2.30E-01	2.02E-01	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.14E+00	1.60E+00	1.60E+00	2.64E+00	pCi/g
16-08019-05	TRG	10-02-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.58E+00	2.09E-01	2.24E-01	9.55E-02	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	2.01E+00	2.90E-01	3.08E-01	5.53E-01	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.45E+00	2.31E-01	2.43E-01	2.95E-01	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.36E+01	2.75E+00	3.01E+00	2.24E+00	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	-2.67E+00	8.39E+00	8.39E+00	1.17E+01	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.20E+00	2.38E-01	2.63E-01	3.40E-01	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.68E+00	2.22E-01	2.38E-01	3.51E-01	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.45E+00	2.31E-01	2.43E-01	2.95E-01	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.12E+00	1.77E+00	1.77E+00	2.37E+00	pCi/g
16-08019-06	TRG	10-03-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.65E+00	2.44E-01	2.59E-01	2.22E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical Final Report of Analysis	Report To:	Work Order Details:	
	David Bordelon	SDG:	16-08019
	Weston Solutions, Inc.	Purchase Order:	0090911
	13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
	Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.89E+00	2.28E-01	2.48E-01	3.96E-01	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.68E+00	1.99E-01	2.17E-01	2.32E-01	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.43E+01	2.61E+00	2.89E+00	7.99E-01	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	1.67E+00	5.63E+00	5.63E+00	8.59E+00	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.15E+00	2.21E-01	2.47E-01	2.75E-01	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.78E+00	1.81E-01	2.03E-01	2.95E-01	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.68E+00	1.99E-01	2.17E-01	2.32E-01	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.72E+00	1.73E+00	1.73E+00	2.88E+00	pCi/g
16-08019-07	TRG	10-04-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.62E+00	1.98E-01	2.15E-01	1.79E-01	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.75E+00	2.80E-01	2.94E-01	3.99E-01	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.50E+00	1.90E-01	2.05E-01	1.90E-01	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.20E+01	2.64E+00	2.87E+00	1.37E+00	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	6.33E-01	6.30E+00	6.30E+00	9.82E+00	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.25E+00	3.49E-01	3.67E-01	2.20E-01	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.76E+00	2.44E-01	2.60E-01	2.42E-01	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.50E+00	1.90E-01	2.05E-01	1.90E-01	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.12E+00	1.19E+00	1.20E+00	1.99E+00	pCi/g
16-08019-08	TRG	10-05-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.62E+00	2.31E-01	2.45E-01	1.63E-01	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.79E+00	3.12E-01	3.25E-01	5.34E-01	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.69E+00	2.31E-01	2.47E-01	2.85E-01	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.24E+01	2.68E+00	2.91E+00	1.26E+00	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	-1.90E+00	6.96E+00	6.97E+00	1.03E+01	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	1.98E+00	2.18E-01	2.40E-01	3.80E-01	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.69E+00	2.14E-01	2.31E-01	3.16E-01	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.69E+00	2.31E-01	2.47E-01	2.85E-01	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.50E+00	1.80E+00	1.80E+00	2.41E+00	pCi/g
16-08019-09	TRG	10-06-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.90E+00	2.50E-01	2.68E-01	2.10E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	16-08019
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	2.24E+00	4.58E-01	4.72E-01	7.71E-01	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.73E+00	3.48E-01	3.59E-01	4.93E-01	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.00E+01	3.82E+00	3.96E+00	3.45E+00	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	1.38E+01	1.35E+01	1.35E+01	2.45E+01	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.55E+00	4.30E-01	4.49E-01	4.95E-01	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.56E+00	3.28E-01	3.38E-01	5.19E-01	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.73E+00	3.48E-01	3.59E-01	4.93E-01	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.24E+00	1.53E+00	1.53E+00	2.40E+00	pCi/g
16-08019-10	TRG	10-07-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.61E+00	3.66E-01	3.75E-01	2.91E-01	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.85E+00	2.38E-01	2.56E-01	4.13E-01	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.48E+00	1.73E-01	1.89E-01	1.76E-01	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.32E+01	2.54E+00	2.81E+00	1.13E+00	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	-6.72E-01	5.40E+00	5.40E+00	8.06E+00	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.02E+00	2.17E-01	2.40E-01	2.11E-01	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.60E+00	1.77E-01	1.95E-01	2.61E-01	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.48E+00	1.73E-01	1.89E-01	1.76E-01	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.74E+00	1.97E+00	1.98E+00	3.27E+00	pCi/g
16-08019-11	TRG	10-08-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.71E+00	1.99E-01	2.17E-01	9.65E-02	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.95E+00	2.97E-01	3.14E-01	4.55E-01	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.51E+00	1.92E-01	2.07E-01	2.07E-01	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.04E+01	2.41E+00	2.63E+00	9.18E-01	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	1.94E+00	5.59E+00	5.59E+00	9.04E+00	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.14E+00	3.46E-01	3.63E-01	2.29E-01	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.61E+00	2.30E-01	2.44E-01	2.53E-01	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.51E+00	1.92E-01	2.07E-01	2.07E-01	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.61E+00	9.95E-01	9.98E-01	1.59E+00	pCi/g
16-08019-12	TRG	10-09-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.46E+00	2.11E-01	2.24E-01	8.75E-02	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	**16-08019**
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	2.11E+00	3.29E-01	3.47E-01	5.75E-01	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.58E+00	2.34E-01	2.48E-01	3.26E-01	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.09E+01	2.55E+00	2.77E+00	1.30E+00	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	6.36E+00	6.88E+00	6.89E+00	1.20E+01	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	1.98E+00	2.14E-01	2.37E-01	3.34E-01	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.64E+00	2.04E-01	2.21E-01	3.23E-01	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.58E+00	2.34E-01	2.48E-01	3.26E-01	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	3.63E+00	1.70E+00	1.71E+00	2.35E+00	pCi/g
16-08019-13	TRG	10-10-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.68E+00	2.48E-01	2.62E-01	4.48E-02	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.91E+00	5.14E-01	5.23E-01	8.40E-01	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.46E+00	3.86E-01	3.93E-01	6.27E-01	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.09E+01	3.78E+00	3.92E+00	2.53E+00	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	-5.91E-01	4.06E+00	4.06E+00	2.28E+01	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.51E+00	4.51E-01	4.69E-01	5.44E-01	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.62E+00	3.76E-01	3.85E-01	6.12E-01	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.46E+00	3.86E-01	3.93E-01	6.27E-01	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	2.28E+00	1.66E+00	1.66E+00	2.59E+00	pCi/g
16-08019-14	TRG	10-11-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.44E+00	3.87E-01	3.94E-01	5.35E-01	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.92E+00	2.49E-01	2.68E-01	4.46E-01	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.51E+00	1.83E-01	1.99E-01	2.12E-01	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.25E+01	2.47E+00	2.72E+00	9.69E-01	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	3.23E+00	5.54E+00	5.54E+00	9.08E+00	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.08E+00	2.14E-01	2.39E-01	2.75E-01	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.77E+00	1.74E-01	1.97E-01	2.54E-01	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.51E+00	1.83E-01	1.99E-01	2.12E-01	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.50E+00	1.41E+00	1.41E+00	2.35E+00	pCi/g
16-08019-15	TRG	10-12-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.59E+00	2.03E-01	2.19E-01	1.44E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical Final Report of Analysis	Report To:	Work Order Details:	
	David Bordelon	SDG:	16-08019
	Weston Solutions, Inc.	Purchase Order:	0090911
	13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
	Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.86E+00	2.70E-01	2.86E-01	3.48E-01	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.30E+00	1.94E-01	2.05E-01	2.20E-01	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.21E+01	2.61E+00	2.85E+00	1.11E+00	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	3.63E+00	6.40E+00	6.40E+00	1.05E+01	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.23E+00	3.45E-01	3.64E-01	2.36E-01	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.52E+00	2.17E-01	2.31E-01	2.14E-01	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.30E+00	1.94E-01	2.05E-01	2.20E-01	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.85E+00	1.35E+00	1.36E+00	2.23E+00	pCi/g
16-08019-16	TRG	10-13-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.56E+00	2.35E-01	2.48E-01	2.45E-01	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.95E+00	3.96E-01	4.09E-01	6.13E-01	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.54E+00	2.56E-01	2.68E-01	3.64E-01	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.27E+01	2.69E+00	2.93E+00	1.58E+00	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	-1.76E-01	7.55E+00	7.55E+00	1.17E+01	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.06E+00	2.27E-01	2.50E-01	3.66E-01	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.77E+00	2.02E-01	2.22E-01	2.80E-01	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.54E+00	2.56E-01	2.68E-01	3.64E-01	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.98E+00	2.08E+00	2.09E+00	3.48E+00	pCi/g
16-08019-17	TRG	10-14-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.82E+00	2.77E-01	2.93E-01	4.88E-02	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	2.14E+00	6.00E-01	6.10E-01	1.06E+00	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.56E+00	3.68E-01	3.76E-01	5.72E-01	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.41E+01	4.16E+00	4.34E+00	2.95E+00	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	2.62E+00	1.30E+01	1.30E+01	2.18E+01	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.20E+00	4.20E-01	4.35E-01	5.31E-01	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.84E+00	3.99E-01	4.10E-01	6.13E-01	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.56E+00	3.68E-01	3.76E-01	5.72E-01	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.36E+00	1.63E+00	1.63E+00	2.52E+00	pCi/g
16-08019-18	TRG	10-15-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.73E+00	3.83E-01	3.93E-01	3.04E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:

David Bordelon
Weston Solutions, Inc.
13702 Coursey Blvd, #7A
Baton Rouge, LA 70817

Work Order Details:

SDG:	**16-08019**
Purchase Order:	0090911
Analysis Category:	ENVIRONMENTAL
Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.93E+00	2.69E-01	2.86E-01	4.11E-01	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.69E+00	1.74E-01	1.95E-01	5.34E-02	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.52E+01	2.74E+00	3.03E+00	1.16E+00	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	5.87E+00	6.68E+00	6.68E+00	1.11E+01	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.32E+00	2.36E-01	2.64E-01	2.73E-01	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.92E+00	1.74E-01	2.00E-01	2.39E-01	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.69E+00	1.74E-01	1.95E-01	5.34E-02	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.29E+00	1.45E+00	1.45E+00	2.42E+00	pCi/g
16-08019-19	TRG	10-16-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.54E+00	2.05E-01	2.19E-01	1.46E-01	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Actinium-228	LANL ER-130 Modified	1.75E+00	2.70E-01	2.84E-01	3.70E-01	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Bismuth-214	LANL ER-130 Modified	1.58E+00	2.09E-01	2.25E-01	2.21E-01	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Potassium-40	LANL ER-130 Modified	2.41E+01	2.79E+00	3.05E+00	1.06E+00	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Protactinium-234m	LANL ER-130 Modified	4.73E+00	6.29E+00	6.30E+00	1.05E+01	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-212	LANL ER-130 Modified	2.31E-01	1.53E-01	1.53E-01	2.34E-01	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Lead-214	LANL ER-130 Modified	1.62E+00	2.33E-01	2.48E-01	2.59E-01	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Radium-226	LANL ER-130 Modified	1.58E+00	2.09E-01	2.25E-01	2.21E-01	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thorium-234	LANL ER-130 Modified	1.53E+00	1.77E+00	1.77E+00	2.96E+00	pCi/g
16-08019-20	TRG	10-17-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08019	Thallium-208	LANL ER-130 Modified	1.46E+00	2.03E-01	2.17E-01	2.05E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	16-08020
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
		Gamma Run 1											
16-08020-01	LCS	KNOWN	08/04/16 00:00	8/4/2016	8/15/2016	16-08020	Cobalt-60	LANL ER-130 Modified	1.37E+02	5.48E+00			pCi/g
16-08020-01	LCS	KNOWN	08/04/16 00:00	8/4/2016	8/15/2016	16-08020	Cesium-137	LANL ER-130 Modified	8.69E+01	3.48E+00			pCi/g
16-08020-01	LCS	SPIKE	08/04/16 00:00	8/4/2016	8/15/2016	16-08020	Cobalt-60	LANL ER-130 Modified	1.43E+02	8.34E+00	1.11E+01	7.61E-01	pCi/g
16-08020-01	LCS	SPIKE	08/04/16 00:00	8/4/2016	8/15/2016	16-08020	Cesium-137	LANL ER-130 Modified	9.08E+01	8.15E+00	9.39E+00	8.64E-01	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08020	Actinium-228	LANL ER-130 Modified	8.83E-02	1.30E-01	1.30E-01	2.67E-01	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08020	Bismuth-214	LANL ER-130 Modified	5.38E-02	7.79E-02	7.80E-02	1.46E-01	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08020	Cesium-137	LANL ER-130 Modified	-2.21E-02	4.50E-02	4.50E-02	6.90E-02	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08020	Potassium-40	LANL ER-130 Modified	-2.37E-02	4.50E-01	4.50E-01	7.52E-01	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08020	Protactinium-234m	LANL ER-130 Modified	3.28E-01	3.75E+00	3.75E+00	6.93E+00	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08020	Lead-212	LANL ER-130 Modified	5.40E-02	5.64E-02	5.65E-02	9.93E-02	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08020	Lead-214	LANL ER-130 Modified	7.08E-02	8.09E-02	8.10E-02	1.45E-01	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08020	Radium-226	LANL ER-130 Modified	5.38E-02	7.79E-02	7.80E-02	1.46E-01	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08020	Thorium-234	LANL ER-130 Modified	2.69E-01	3.89E-01	3.89E-01	6.43E-01	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/15/2016	16-08020	Thallium-208	LANL ER-130 Modified	-7.46E-03	1.31E-01	1.31E-01	2.14E-01	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Actinium-228	LANL ER-130 Modified	2.00E+00	2.99E-01	3.16E-01	5.27E-01	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Bismuth-214	LANL ER-130 Modified	1.68E+00	2.20E-01	2.36E-01	2.89E-01	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Cesium-137	LANL ER-130 Modified	4.45E-01	1.27E-01	1.29E-01	1.76E-01	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Potassium-40	LANL ER-130 Modified	2.32E+01	2.79E+00	3.03E+00	1.28E+00	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Protactinium-234m	LANL ER-130 Modified	1.08E+01	8.88E+00	8.90E+00	1.43E+01	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Lead-212	LANL ER-130 Modified	1.91E+00	2.14E-01	2.35E-01	3.24E-01	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Lead-214	LANL ER-130 Modified	1.65E+00	1.95E-01	2.12E-01	3.15E-01	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Radium-226	LANL ER-130 Modified	1.68E+00	2.20E-01	2.36E-01	2.89E-01	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Thorium-234	LANL ER-130 Modified	1.66E+00	1.87E+00	1.87E+00	3.12E+00	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Thallium-208	LANL ER-130 Modified	1.79E+00	2.56E-01	2.72E-01	1.55E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:

David Bordelon
Weston Solutions, Inc.
13702 Coursey Blvd, #7A
Baton Rouge, LA 70817

Work Order Details:

SDG: **16-08020**
Purchase Order: 0090911
Analysis Category: ENVIRONMENTAL
Sample Matrix: SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Actinium-228	LANL ER-130 Modified	2.11E+00	3.09E-01	3.28E-01	5.46E-01	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Bismuth-214	LANL ER-130 Modified	1.78E+00	2.55E-01	2.71E-01	3.56E-01	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Cesium-137	LANL ER-130 Modified	5.03E-01	1.46E-01	1.48E-01	2.07E-01	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Potassium-40	LANL ER-130 Modified	2.24E+01	2.68E+00	2.92E+00	9.69E-01	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Protactinium-234m	LANL ER-130 Modified	1.01E+01	9.71E+00	9.72E+00	1.60E+01	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Lead-212	LANL ER-130 Modified	2.17E+00	2.31E-01	2.56E-01	2.97E-01	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Lead-214	LANL ER-130 Modified	1.68E+00	2.24E-01	2.40E-01	3.16E-01	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Radium-226	LANL ER-130 Modified	1.78E+00	2.55E-01	2.71E-01	3.56E-01	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Thorium-234	LANL ER-130 Modified	2.39E+00	1.89E+00	1.90E+00	2.52E+00	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Thallium-208	LANL ER-130 Modified	1.89E+00	2.56E-01	2.74E-01	2.64E-01	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Actinium-228	LANL ER-130 Modified	1.94E+00	3.02E-01	3.18E-01	6.37E-01	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Bismuth-214	LANL ER-130 Modified	1.59E+00	1.91E-01	2.08E-01	2.27E-01	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Cesium-137	LANL ER-130 Modified	2.40E-01	1.03E-01	1.03E-01	1.59E-01	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Potassium-40	LANL ER-130 Modified	2.22E+01	2.49E+00	2.73E+00	1.10E+00	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Protactinium-234m	LANL ER-130 Modified	3.33E+00	5.88E+00	5.88E+00	9.50E+00	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Lead-212	LANL ER-130 Modified	1.96E+00	2.08E-01	2.31E-01	2.68E-01	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Lead-214	LANL ER-130 Modified	1.90E+00	1.89E-01	2.12E-01	2.69E-01	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Radium-226	LANL ER-130 Modified	1.59E+00	1.91E-01	2.08E-01	2.27E-01	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Thorium-234	LANL ER-130 Modified	1.56E+00	1.57E+00	1.58E+00	2.09E+00	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Thallium-208	LANL ER-130 Modified	1.43E+00	1.89E-01	2.03E-01	1.04E-01	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Actinium-228	LANL ER-130 Modified	1.78E+00	2.69E-01	2.84E-01	3.72E-01	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Bismuth-214	LANL ER-130 Modified	1.22E+00	1.88E-01	1.98E-01	1.66E-01	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Cesium-137	LANL ER-130 Modified	1.19E-02	6.35E-02	6.35E-02	9.70E-02	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Potassium-40	LANL ER-130 Modified	2.09E+01	2.50E+00	2.72E+00	1.10E+00	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Protactinium-234m	LANL ER-130 Modified	2.80E+00	6.11E+00	6.11E+00	9.59E+00	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Lead-212	LANL ER-130 Modified	1.95E+00	2.90E-01	3.07E-01	1.98E-01	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Lead-214	LANL ER-130 Modified	1.40E+00	2.22E-01	2.34E-01	2.27E-01	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Radium-226	LANL ER-130 Modified	1.22E+00	1.88E-01	1.98E-01	1.66E-01	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Thorium-234	LANL ER-130 Modified	1.61E+00	9.58E-01	9.62E-01	1.57E+00	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/15/2016	16-08020	Thallium-208	LANL ER-130 Modified	1.67E+00	2.28E-01	2.44E-01	1.17E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	16-08020
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
		Gamma Run 2											
16-08020-01	LCS	KNOWN	08/04/16 00:00	8/4/2016	8/26/2016	16-08020	Cobalt-60	LANL ER-130 Modified	1.37E+02	5.48E+00			pCi/g
16-08020-01	LCS	KNOWN	08/04/16 00:00	8/4/2016	8/26/2016	16-08020	Cesium-137	LANL ER-130 Modified	8.69E+01	3.48E+00			pCi/g
16-08020-01	LCS	SPIKE	08/04/16 00:00	8/4/2016	8/26/2016	16-08020	Cobalt-60	LANL ER-130 Modified	1.38E+02	7.79E+00	1.05E+01	1.14E+00	pCi/g
16-08020-01	LCS	SPIKE	08/04/16 00:00	8/4/2016	8/26/2016	16-08020	Cesium-137	LANL ER-130 Modified	8.81E+01	7.20E+00	8.50E+00	8.58E-01	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08020	Actinium-228	LANL ER-130 Modified	-5.09E-04	6.43E-02	6.43E-02	1.07E-01	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08020	Bismuth-214	LANL ER-130 Modified	3.61E-02	4.94E-02	4.94E-02	8.87E-02	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08020	Potassium-40	LANL ER-130 Modified	6.82E-02	2.22E-01	2.22E-01	4.10E-01	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08020	Protactinium-234m	LANL ER-130 Modified	0.00E+00	1.53E+00	1.53E+00	3.49E+00	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08020	Lead-212	LANL ER-130 Modified	-1.91E-02	4.17E-02	4.17E-02	5.92E-02	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08020	Lead-214	LANL ER-130 Modified	2.04E-03	4.79E-02	4.79E-02	7.13E-02	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08020	Radium-226	LANL ER-130 Modified	3.61E-02	4.94E-02	4.94E-02	8.87E-02	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08020	Thorium-234	LANL ER-130 Modified	2.07E-01	5.59E-01	5.59E-01	7.51E-01	pCi/g
16-08020-02	MBL	BLANK	08/04/16 00:00	8/4/2016	8/26/2016	16-08020	Thallium-208	LANL ER-130 Modified	-1.41E-02	6.53E-02	6.53E-02	9.97E-02	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Actinium-228	LANL ER-130 Modified	1.99E+00	2.48E-01	2.68E-01	3.71E-01	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Bismuth-214	LANL ER-130 Modified	1.72E+00	2.05E-01	2.23E-01	2.55E-01	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Potassium-40	LANL ER-130 Modified	2.39E+01	2.65E+00	2.92E+00	1.15E+00	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Protactinium-234m	LANL ER-130 Modified	3.78E-01	6.14E+00	6.14E+00	9.26E+00	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Lead-212	LANL ER-130 Modified	2.05E+00	2.22E-01	2.45E-01	2.59E-01	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Lead-214	LANL ER-130 Modified	1.89E+00	2.13E-01	2.34E-01	3.00E-01	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Radium-226	LANL ER-130 Modified	1.72E+00	2.05E-01	2.23E-01	2.55E-01	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Thorium-234	LANL ER-130 Modified	2.39E+00	1.48E+00	1.49E+00	2.43E+00	pCi/g
16-08020-03	DUP	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Thallium-208	LANL ER-130 Modified	1.61E+00	2.08E-01	2.23E-01	1.49E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	16-08020
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Actinium-228	LANL ER-130 Modified	1.96E+00	2.58E-01	2.77E-01	5.30E-01	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Bismuth-214	LANL ER-130 Modified	1.74E+00	2.08E-01	2.27E-01	2.38E-01	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Potassium-40	LANL ER-130 Modified	2.47E+01	2.70E+00	2.98E+00	1.02E+00	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Protactinium-234m	LANL ER-130 Modified	4.05E+00	6.47E+00	6.47E+00	1.01E+01	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Lead-212	LANL ER-130 Modified	2.12E+00	2.30E-01	2.54E-01	3.32E-01	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Lead-214	LANL ER-130 Modified	2.02E+00	1.99E-01	2.25E-01	2.86E-01	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Radium-226	LANL ER-130 Modified	1.74E+00	2.08E-01	2.27E-01	2.38E-01	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Thorium-234	LANL ER-130 Modified	1.90E+00	2.01E+00	2.02E+00	3.37E+00	pCi/g
16-08020-04	DO	10-18-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Thallium-208	LANL ER-130 Modified	1.37E+00	1.96E-01	2.08E-01	1.94E-01	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Actinium-228	LANL ER-130 Modified	1.84E+00	2.63E-01	2.79E-01	3.62E-01	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Bismuth-214	LANL ER-130 Modified	1.71E+00	2.32E-01	2.48E-01	2.44E-01	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Potassium-40	LANL ER-130 Modified	2.26E+01	2.61E+00	2.86E+00	7.28E-01	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Protactinium-234m	LANL ER-130 Modified	1.55E-01	6.26E+00	6.26E+00	9.64E+00	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Lead-212	LANL ER-130 Modified	1.13E+00	2.66E-01	2.72E-01	3.22E-01	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Lead-214	LANL ER-130 Modified	1.75E+00	2.55E-01	2.71E-01	2.30E-01	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Radium-226	LANL ER-130 Modified	1.71E+00	2.32E-01	2.48E-01	2.44E-01	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Thorium-234	LANL ER-130 Modified	1.34E+00	1.39E+00	1.39E+00	2.31E+00	pCi/g
16-08020-05	TRG	10-19-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Thallium-208	LANL ER-130 Modified	1.33E+00	2.19E-01	2.29E-01	9.24E-02	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Actinium-228	LANL ER-130 Modified	1.79E+00	2.73E-01	2.88E-01	8.97E-01	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Bismuth-214	LANL ER-130 Modified	1.22E+00	2.01E-01	2.11E-01	3.08E-01	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Potassium-40	LANL ER-130 Modified	2.18E+01	2.70E+00	2.92E+00	1.58E+00	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Protactinium-234m	LANL ER-130 Modified	1.92E+00	7.26E+00	7.26E+00	1.16E+01	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Lead-212	LANL ER-130 Modified	1.84E+00	2.04E-01	2.25E-01	4.39E-01	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Lead-214	LANL ER-130 Modified	1.38E+00	2.11E-01	2.22E-01	3.19E-01	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Radium-226	LANL ER-130 Modified	1.22E+00	2.01E-01	2.11E-01	3.08E-01	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Thorium-234	LANL ER-130 Modified	1.41E+00	1.57E+00	1.57E+00	2.62E+00	pCi/g
16-08020-06	TRG	10-20-61-160714	07/14/16 00:00	8/4/2016	8/29/2016	16-08020	Thallium-208	LANL ER-130 Modified	1.43E+00	2.21E-01	2.33E-01	4.63E-02	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

SURFACE SOIL SAMPLES

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	**16-07036**
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-07036-01	LCS	KNOWN	07/12/16 00:00	7/12/2016	8/3/2016	16-07036	Cobalt-60	LANL ER-130 Modified	1.37E+02	5.48E+00			pCi/g
16-07036-01	LCS	KNOWN	07/12/16 00:00	7/12/2016	8/3/2016	16-07036	Cesium-137	LANL ER-130 Modified	8.69E+01	3.48E+00			pCi/g
16-07036-01	LCS	SPIKE	07/12/16 00:00	7/12/2016	8/3/2016	16-07036	Cobalt-60	LANL ER-130 Modified	1.35E+02	7.83E+00	1.05E+01	1.09E+00	pCi/g
16-07036-01	LCS	SPIKE	07/12/16 00:00	7/12/2016	8/3/2016	16-07036	Cesium-137	LANL ER-130 Modified	8.93E+01	7.91E+00	9.14E+00	1.29E+00	pCi/g
16-07036-02	MBL	BLANK	07/12/16 00:00	7/12/2016	8/3/2016	16-07036	Actinium-228	LANL ER-130 Modified	1.06E-01	1.44E-01	1.44E-01	2.90E-01	pCi/g
16-07036-02	MBL	BLANK	07/12/16 00:00	7/12/2016	8/3/2016	16-07036	Bismuth-214	LANL ER-130 Modified	9.61E-03	8.99E-02	8.99E-02	1.51E-01	pCi/g
16-07036-02	MBL	BLANK	07/12/16 00:00	7/12/2016	8/3/2016	16-07036	Potassium-40	LANL ER-130 Modified	1.56E-01	2.45E-01	2.45E-01	6.41E-01	pCi/g
16-07036-02	MBL	BLANK	07/12/16 00:00	7/12/2016	8/3/2016	16-07036	Protactinium-234m	LANL ER-130 Modified	4.58E-01	5.87E+00	5.87E+00	8.79E+00	pCi/g
16-07036-02	MBL	BLANK	07/12/16 00:00	7/12/2016	8/3/2016	16-07036	Lead-212	LANL ER-130 Modified	2.51E-02	5.81E-02	5.81E-02	9.63E-02	pCi/g
16-07036-02	MBL	BLANK	07/12/16 00:00	7/12/2016	8/3/2016	16-07036	Lead-214	LANL ER-130 Modified	1.21E-01	1.01E-01	1.01E-01	1.62E-01	pCi/g
16-07036-02	MBL	BLANK	07/12/16 00:00	7/12/2016	8/3/2016	16-07036	Radium-226	LANL ER-130 Modified	9.61E-03	8.99E-02	8.99E-02	1.51E-01	pCi/g
16-07036-02	MBL	BLANK	07/12/16 00:00	7/12/2016	8/3/2016	16-07036	Thorium-234	LANL ER-130 Modified	3.35E-01	3.84E-01	3.85E-01	6.41E-01	pCi/g
16-07036-02	MBL	BLANK	07/12/16 00:00	7/12/2016	8/3/2016	16-07036	Thallium-208	LANL ER-130 Modified	1.84E-01	1.77E-01	1.77E-01	2.32E-01	pCi/g
16-07036-03	DUP	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Actinium-228	LANL ER-130 Modified	1.62E+00	2.50E-01	2.63E-01	4.44E-01	pCi/g
16-07036-03	DUP	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Bismuth-214	LANL ER-130 Modified	1.62E+00	2.03E-01	2.19E-01	2.15E-01	pCi/g
16-07036-03	DUP	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Potassium-40	LANL ER-130 Modified	2.20E+01	2.51E+00	2.75E+00	9.02E-01	pCi/g
16-07036-03	DUP	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Protactinium-234m	LANL ER-130 Modified	-2.09E-01	5.78E+00	5.78E+00	8.85E+00	pCi/g
16-07036-03	DUP	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Lead-212	LANL ER-130 Modified	2.02E+00	2.93E-01	3.11E-01	2.18E-01	pCi/g
16-07036-03	DUP	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Lead-214	LANL ER-130 Modified	1.57E+00	2.21E-01	2.35E-01	2.01E-01	pCi/g
16-07036-03	DUP	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Radium-226	LANL ER-130 Modified	1.62E+00	2.03E-01	2.19E-01	2.15E-01	pCi/g
16-07036-03	DUP	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Thorium-234	LANL ER-130 Modified	2.22E+00	1.30E+00	1.31E+00	2.13E+00	pCi/g
16-07036-03	DUP	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Thallium-208	LANL ER-130 Modified	1.44E+00	2.02E-01	2.16E-01	1.41E-01	pCi/g
16-07036-04	DO	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Actinium-228	LANL ER-130 Modified	1.84E+00	2.63E-01	2.80E-01	3.27E-01	pCi/g
16-07036-04	DO	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Bismuth-214	LANL ER-130 Modified	1.46E+00	2.17E-01	2.29E-01	2.36E-01	pCi/g
16-07036-04	DO	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Potassium-40	LANL ER-130 Modified	2.28E+01	2.57E+00	2.82E+00	7.21E-01	pCi/g
16-07036-04	DO	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Protactinium-234m	LANL ER-130 Modified	2.74E+00	5.47E+00	5.48E+00	8.99E+00	pCi/g
16-07036-04	DO	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Lead-212	LANL ER-130 Modified	1.91E+00	2.81E-01	2.98E-01	2.45E-01	pCi/g
16-07036-04	DO	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Lead-214	LANL ER-130 Modified	1.67E+00	2.34E-01	2.49E-01	2.34E-01	pCi/g
16-07036-04	DO	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Radium-226	LANL ER-130 Modified	1.46E+00	2.17E-01	2.29E-01	2.36E-01	pCi/g
16-07036-04	DO	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Thorium-234	LANL ER-130 Modified	1.26E+00	1.47E+00	1.47E+00	2.46E+00	pCi/g
16-07036-04	DO	10-01-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Thallium-208	LANL ER-130 Modified	1.39E+00	2.02E-01	2.14E-01	8.54E-02	pCi/g
16-07036-05	TRG	10-02-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Actinium-228	LANL ER-130 Modified	1.04E+00	5.10E-01	5.13E-01	8.87E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	16-07036
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
16-07036-05	TRG	10-02-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Bismuth-214	LANL ER-130 Modified	1.47E+01	1.17E+00	1.39E+00	8.08E-01	pCi/g
16-07036-05	TRG	10-02-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Potassium-40	LANL ER-130 Modified	1.86E+01	3.54E+00	3.67E+00	3.55E+00	pCi/g
16-07036-05	TRG	10-02-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Protactinium-234m	LANL ER-130 Modified	2.69E+01	2.36E+01	2.37E+01	3.90E+01	pCi/g
16-07036-05	TRG	10-02-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Lead-212	LANL ER-130 Modified	2.06E+00	4.06E-01	4.20E-01	5.88E-01	pCi/g
16-07036-05	TRG	10-02-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Lead-214	LANL ER-130 Modified	1.53E+01	1.37E+00	1.58E+00	9.01E-01	pCi/g
16-07036-05	TRG	10-02-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Radium-226	LANL ER-130 Modified	1.47E+01	1.17E+00	1.39E+00	8.08E-01	pCi/g
16-07036-05	TRG	10-02-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Thorium-234	LANL ER-130 Modified	8.24E+00	3.52E+00	3.54E+00	5.75E+00	pCi/g
16-07036-05	TRG	10-02-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Thallium-208	LANL ER-130 Modified	4.70E-01	2.24E-01	2.25E-01	2.15E-01	pCi/g
16-07036-06	TRG	10-03-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Actinium-228	LANL ER-130 Modified	1.04E+00	2.48E-01	2.54E-01	4.05E-01	pCi/g
16-07036-06	TRG	10-03-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Bismuth-214	LANL ER-130 Modified	9.24E-01	1.64E-01	1.70E-01	2.12E-01	pCi/g
16-07036-06	TRG	10-03-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Potassium-40	LANL ER-130 Modified	1.32E+01	1.84E+00	1.96E+00	1.07E+00	pCi/g
16-07036-06	TRG	10-03-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Protactinium-234m	LANL ER-130 Modified	1.32E+00	5.87E+00	5.87E+00	9.48E+00	pCi/g
16-07036-06	TRG	10-03-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Lead-212	LANL ER-130 Modified	1.22E+00	1.50E-01	1.63E-01	2.55E-01	pCi/g
16-07036-06	TRG	10-03-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Lead-214	LANL ER-130 Modified	1.10E+00	1.75E-01	1.84E-01	2.69E-01	pCi/g
16-07036-06	TRG	10-03-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Radium-226	LANL ER-130 Modified	9.24E-01	1.64E-01	1.70E-01	2.12E-01	pCi/g
16-07036-06	TRG	10-03-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Thorium-234	LANL ER-130 Modified	1.47E+00	1.35E+00	1.35E+00	1.83E+00	pCi/g
16-07036-06	TRG	10-03-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Thallium-208	LANL ER-130 Modified	8.41E-01	1.60E-01	1.66E-01	2.34E-01	pCi/g
16-07036-07	TRG	10-04-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Actinium-228	LANL ER-130 Modified	1.83E+00	4.33E-01	4.43E-01	7.41E-01	pCi/g
16-07036-07	TRG	10-04-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Bismuth-214	LANL ER-130 Modified	1.37E+00	3.14E-01	3.21E-01	5.01E-01	pCi/g
16-07036-07	TRG	10-04-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Potassium-40	LANL ER-130 Modified	1.95E+01	3.29E+00	3.44E+00	1.62E+00	pCi/g
16-07036-07	TRG	10-04-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Protactinium-234m	LANL ER-130 Modified	1.65E+01	1.06E+01	1.06E+01	2.10E+01	pCi/g
16-07036-07	TRG	10-04-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Lead-212	LANL ER-130 Modified	2.23E+00	4.05E-01	4.21E-01	4.99E-01	pCi/g
16-07036-07	TRG	10-04-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Lead-214	LANL ER-130 Modified	1.57E+00	3.40E-01	3.49E-01	5.52E-01	pCi/g
16-07036-07	TRG	10-04-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Radium-226	LANL ER-130 Modified	1.37E+00	3.14E-01	3.21E-01	5.01E-01	pCi/g
16-07036-07	TRG	10-04-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Thorium-234	LANL ER-130 Modified	2.35E+00	1.43E+00	1.44E+00	2.25E+00	pCi/g
16-07036-07	TRG	10-04-31-160628	06/28/16 00:00	7/12/2016	8/4/2016	16-07036	Thallium-208	LANL ER-130 Modified	1.29E+00	3.74E-01	3.80E-01	6.40E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
Jeff Wright	SDG:	17-03072
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, Bldg 7, Suite A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
17-03072-01	LCS	KNOWN	03/20/17 00:00	3/17/2017	3/20/2017	17-03072	Cobalt-60	LANL ER-130 Modified	6.21E+01	2.48E+00			pCi/g
17-03072-01	LCS	KNOWN	03/20/17 00:00	3/17/2017	3/20/2017	17-03072	Cesium-137	LANL ER-130 Modified	3.94E+01	1.58E+00			pCi/g
17-03072-01	LCS	SPIKE	03/20/17 00:00	3/17/2017	3/20/2017	17-03072	Cobalt-60	LANL ER-130 Modified	6.18E+01	3.71E+00	4.88E+00	4.41E-01	pCi/g
17-03072-01	LCS	SPIKE	03/20/17 00:00	3/17/2017	3/20/2017	17-03072	Cesium-137	LANL ER-130 Modified	3.89E+01	3.31E+00	3.86E+00	4.87E-01	pCi/g
17-03072-02	MBL	BLANK	03/20/17 00:00	3/17/2017	3/20/2017	17-03072	Actinium-228	LANL ER-130 Modified	6.23E-02	5.21E-02	5.22E-02	1.24E-01	pCi/g
17-03072-02	MBL	BLANK	03/20/17 00:00	3/17/2017	3/20/2017	17-03072	Bismuth-214	LANL ER-130 Modified	2.31E-02	4.71E-02	4.71E-02	7.93E-02	pCi/g
17-03072-02	MBL	BLANK	03/20/17 00:00	3/17/2017	3/20/2017	17-03072	Cesium-137	LANL ER-130 Modified	1.67E-02	2.13E-02	2.13E-02	3.80E-02	pCi/g
17-03072-02	MBL	BLANK	03/20/17 00:00	3/17/2017	3/20/2017	17-03072	Potassium-40	LANL ER-130 Modified	2.00E-01	2.15E-01	2.15E-01	4.98E-01	pCi/g
17-03072-02	MBL	BLANK	03/20/17 00:00	3/17/2017	3/20/2017	17-03072	Protactinium-234m	LANL ER-130 Modified	1.14E-01	2.97E+00	2.97E+00	4.57E+00	pCi/g
17-03072-02	MBL	BLANK	03/20/17 00:00	3/17/2017	3/20/2017	17-03072	Lead-212	LANL ER-130 Modified	2.19E-02	2.34E-02	2.34E-02	3.97E-02	pCi/g
17-03072-02	MBL	BLANK	03/20/17 00:00	3/17/2017	3/20/2017	17-03072	Lead-214	LANL ER-130 Modified	2.90E-02	3.53E-02	3.53E-02	1.00E-01	pCi/g
17-03072-02	MBL	BLANK	03/20/17 00:00	3/17/2017	3/20/2017	17-03072	Radium-226	LANL ER-130 Modified	2.31E-02	4.71E-02	4.71E-02	7.93E-02	pCi/g
17-03072-02	MBL	BLANK	03/20/17 00:00	3/17/2017	3/20/2017	17-03072	Thorium-234	LANL ER-130 Modified	2.03E-01	1.70E-01	1.70E-01	2.82E-01	pCi/g
17-03072-02	MBL	BLANK	03/20/17 00:00	3/17/2017	3/20/2017	17-03072	Thallium-208	LANL ER-130 Modified	-2.91E-02	6.17E-02	6.18E-02	8.26E-02	pCi/g
17-03072-03	DUP	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Actinium-228	LANL ER-130 Modified	5.16E-01	2.57E-01	2.58E-01	5.82E-01	pCi/g
17-03072-03	DUP	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Bismuth-214	LANL ER-130 Modified	2.32E+01	1.33E+00	1.78E+00	3.36E-01	pCi/g
17-03072-03	DUP	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Cesium-137	LANL ER-130 Modified	-1.28E-02	3.91E-02	3.92E-02	1.15E-01	pCi/g
17-03072-03	DUP	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Potassium-40	LANL ER-130 Modified	2.08E+01	2.34E+00	2.58E+00	2.05E+00	pCi/g
17-03072-03	DUP	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Protactinium-234m	LANL ER-130 Modified	4.09E+01	1.22E+01	1.24E+01	1.87E+01	pCi/g
17-03072-03	DUP	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Lead-212	LANL ER-130 Modified	3.82E-01	1.45E-01	1.46E-01	4.42E-01	pCi/g
17-03072-03	DUP	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Lead-214	LANL ER-130 Modified	2.36E+01	5.91E+00	6.03E+00	4.51E-01	pCi/g
17-03072-03	DUP	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Radium-226	LANL ER-130 Modified	2.32E+01	1.33E+00	1.78E+00	3.36E-01	pCi/g
17-03072-03	DUP	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Thorium-234	LANL ER-130 Modified	4.17E+01	4.39E+00	4.88E+00	4.93E+00	pCi/g
17-03072-03	DUP	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Thallium-208	LANL ER-130 Modified	8.06E-01	6.68E-01	6.69E-01	2.23E-01	pCi/g
17-03072-04	DO	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Actinium-228	LANL ER-130 Modified	6.01E-01	3.55E-01	3.57E-01	6.64E-01	pCi/g
17-03072-04	DO	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Bismuth-214	LANL ER-130 Modified	2.32E+01	1.35E+00	1.80E+00	4.06E-01	pCi/g
17-03072-04	DO	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Cesium-137	LANL ER-130 Modified	-3.22E-01	9.73E-02	9.87E-02	1.15E-01	pCi/g
17-03072-04	DO	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Potassium-40	LANL ER-130 Modified	1.97E+01	2.15E+00	2.38E+00	1.69E+00	pCi/g
17-03072-04	DO	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Protactinium-234m	LANL ER-130 Modified	4.81E+01	1.16E+01	1.18E+01	3.05E+01	pCi/g
17-03072-04	DO	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Lead-212	LANL ER-130 Modified	4.84E-01	1.72E-01	1.74E-01	4.34E-01	pCi/g
17-03072-04	DO	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Lead-214	LANL ER-130 Modified	2.41E+01	6.04E+00	6.17E+00	4.74E-01	pCi/g
17-03072-04	DO	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Radium-226	LANL ER-130 Modified	2.32E+01	1.35E+00	1.80E+00	4.06E-01	pCi/g
17-03072-04	DO	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Thorium-234	LANL ER-130 Modified	4.25E+01	4.23E+00	4.76E+00	4.39E+00	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical	Report To:	Work Order Details:	
Final Report of Analysis	**Jeff Wright**	*SDG:*	**17-03072**
	Weston Solutions, Inc.	*Purchase Order:*	0090911
	13702 Coursey Blvd, Bldg 7, Suite A	*Analysis Category:*	ENVIRONMENTAL
	Baton Rouge, LA 70817	*Sample Matrix:*	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
17-03072-04	DO	10-05-31-170202	02/02/17 12:30	3/17/2017	3/20/2017	17-03072	Thallium-208	LANL ER-130 Modified	4.07E-01	9.15E-02	9.38E-02	1.35E-02	pCi/g
17-03072-05	TRG	10-06-31-170202	02/02/17 12:35	3/17/2017	3/20/2017	17-03072	Actinium-228	LANL ER-130 Modified	7.26E-01	2.82E-01	2.85E-01	6.59E-01	pCi/g
17-03072-05	TRG	10-06-31-170202	02/02/17 12:35	3/17/2017	3/20/2017	17-03072	Bismuth-214	LANL ER-130 Modified	5.60E+01	3.48E+00	4.51E+00	3.62E-01	pCi/g
17-03072-05	TRG	10-06-31-170202	02/02/17 12:35	3/17/2017	3/20/2017	17-03072	Cesium-137	LANL ER-130 Modified	6.15E-03	3.85E-02	3.85E-02	1.18E-01	pCi/g
17-03072-05	TRG	10-06-31-170202	02/02/17 12:35	3/17/2017	3/20/2017	17-03072	Potassium-40	LANL ER-130 Modified	2.00E+01	2.38E+00	2.59E+00	2.13E+00	pCi/g
17-03072-05	TRG	10-06-31-170202	02/02/17 12:35	3/17/2017	3/20/2017	17-03072	Protactinium-234m	LANL ER-130 Modified	5.96E+01	1.47E+01	1.50E+01	2.07E+01	pCi/g
17-03072-05	TRG	10-06-31-170202	02/02/17 12:35	3/17/2017	3/20/2017	17-03072	Lead-210	LANL ER-130 Modified	1.97E+01	2.55E+00	2.55E+00	4.00E+00	pCi/g
17-03072-05	TRG	10-06-31-170202	02/02/17 12:35	3/17/2017	3/20/2017	17-03072	Lead-212	LANL ER-130 Modified	-1.84E+01	2.32E+00	2.51E+00	2.59E-01	pCi/g
17-03072-05	TRG	10-06-31-170202	02/02/17 12:35	3/17/2017	3/20/2017	17-03072	Lead-214	LANL ER-130 Modified	5.45E+01	6.52E+00	7.09E+00	3.98E-01	pCi/g
17-03072-05	TRG	10-06-31-170202	02/02/17 12:35	3/17/2017	3/20/2017	17-03072	Radium-226	LANL ER-130 Modified	5.60E+01	3.48E+00	4.51E+00	3.62E-01	pCi/g
17-03072-05	TRG	10-06-31-170202	02/02/17 12:35	3/17/2017	3/20/2017	17-03072	Thorium-234	LANL ER-130 Modified	6.14E+01	5.80E+00	6.60E+00	5.73E+00	pCi/g
17-03072-05	TRG	10-06-31-170202	02/02/17 12:35	3/17/2017	3/20/2017	17-03072	Thallium-208	LANL ER-130 Modified	6.45E-01	1.48E-01	1.52E-01	8.45E-02	pCi/g
17-03072-06	TRG	10-07-31-170202	02/02/17 12:40	3/17/2017	3/20/2017	17-03072	Actinium-228	LANL ER-130 Modified	2.89E-01	2.03E-01	2.03E-01	3.27E-01	pCi/g
17-03072-06	TRG	10-07-31-170202	02/02/17 12:40	3/17/2017	3/20/2017	17-03072	Bismuth-214	LANL ER-130 Modified	1.86E+01	1.86E+00	2.09E+00	2.53E-01	pCi/g
17-03072-06	TRG	10-07-31-170202	02/02/17 12:40	3/17/2017	3/20/2017	17-03072	Cesium-137	LANL ER-130 Modified	2.07E-02	2.57E-02	2.57E-02	7.88E-02	pCi/g
17-03072-06	TRG	10-07-31-170202	02/02/17 12:40	3/17/2017	3/20/2017	17-03072	Potassium-40	LANL ER-130 Modified	1.93E+01	2.38E+00	2.58E+00	1.40E+00	pCi/g
17-03072-06	TRG	10-07-31-170202	02/02/17 12:40	3/17/2017	3/20/2017	17-03072	Protactinium-234m	LANL ER-130 Modified	2.35E+01	1.12E+01	1.13E+01	1.30E+01	pCi/g
17-03072-06	TRG	10-07-31-170202	02/02/17 12:40	3/17/2017	3/20/2017	17-03072	Lead-212	LANL ER-130 Modified	8.74E-01	3.43E-01	3.46E-01	3.39E-01	pCi/g
17-03072-06	TRG	10-07-31-170202	02/02/17 12:40	3/17/2017	3/20/2017	17-03072	Lead-214	LANL ER-130 Modified	1.82E+01	5.85E+00	5.92E+00	5.12E-01	pCi/g
17-03072-06	TRG	10-07-31-170202	02/02/17 12:40	3/17/2017	3/20/2017	17-03072	Radium-226	LANL ER-130 Modified	1.86E+01	1.86E+00	2.09E+00	2.53E-01	pCi/g
17-03072-06	TRG	10-07-31-170202	02/02/17 12:40	3/17/2017	3/20/2017	17-03072	Thorium-234	LANL ER-130 Modified	1.73E+01	2.19E+00	2.37E+00	2.90E+00	pCi/g
17-03072-06	TRG	10-07-31-170202	02/02/17 12:40	3/17/2017	3/20/2017	17-03072	Thallium-208	LANL ER-130 Modified	3.97E-01	1.07E-01	1.09E-01	7.27E-02	pCi/g
17-03072-07	TRG	10-08-31-170202	02/02/17 12:45	3/17/2017	3/20/2017	17-03072	Actinium-228	LANL ER-130 Modified	1.96E-01	4.72E-01	4.72E-01	6.46E-01	pCi/g
17-03072-07	TRG	10-08-31-170202	02/02/17 12:45	3/17/2017	3/20/2017	17-03072	Bismuth-214	LANL ER-130 Modified	2.19E+01	1.58E+00	1.94E+00	4.56E-01	pCi/g
17-03072-07	TRG	10-08-31-170202	02/02/17 12:45	3/17/2017	3/20/2017	17-03072	Cesium-137	LANL ER-130 Modified	-1.41E-02	4.70E-02	4.70E-02	1.67E-01	pCi/g
17-03072-07	TRG	10-08-31-170202	02/02/17 12:45	3/17/2017	3/20/2017	17-03072	Potassium-40	LANL ER-130 Modified	2.15E+01	3.12E+00	3.31E+00	2.66E+00	pCi/g
17-03072-07	TRG	10-08-31-170202	02/02/17 12:45	3/17/2017	3/20/2017	17-03072	Protactinium-234m	LANL ER-130 Modified	2.08E+01	1.38E+01	1.38E+01	2.25E+01	pCi/g
17-03072-07	TRG	10-08-31-170202	02/02/17 12:45	3/17/2017	3/20/2017	17-03072	Lead-212	LANL ER-130 Modified	9.57E-01	2.60E-01	2.64E-01	4.42E-01	pCi/g
17-03072-07	TRG	10-08-31-170202	02/02/17 12:45	3/17/2017	3/20/2017	17-03072	Lead-214	LANL ER-130 Modified	2.15E+01	1.34E+00	1.73E+00	4.11E-01	pCi/g
17-03072-07	TRG	10-08-31-170202	02/02/17 12:45	3/17/2017	3/20/2017	17-03072	Radium-226	LANL ER-130 Modified	2.19E+01	1.58E+00	1.94E+00	4.56E-01	pCi/g
17-03072-07	TRG	10-08-31-170202	02/02/17 12:45	3/17/2017	3/20/2017	17-03072	Thorium-234	LANL ER-130 Modified	1.12E+01	1.74E+00	1.83E+00	2.47E+00	pCi/g
17-03072-07	TRG	10-08-31-170202	02/02/17 12:45	3/17/2017	3/20/2017	17-03072	Thallium-208	LANL ER-130 Modified	5.65E-01	3.49E-01	3.50E-01	3.37E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical **Final Report of Analysis**	*Report To:*	*Work Order Details:*	
	Jeff Wright	*SDG:*	**17-03072**
	Weston Solutions, Inc.	*Purchase Order:*	0090911
	13702 Coursey Blvd, Bldg 7, Suite A	*Analysis Category:*	ENVIRONMENTAL
	Baton Rouge, LA 70817	*Sample Matrix:*	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
17-03072-08	TRG	10-09-31-170202	02/02/17 12:50	3/17/2017	3/20/2017	17-03072	Actinium-228	LANL ER-130 Modified	6.75E-01	4.85E-01	4.86E-01	9.16E-01	pCi/g
17-03072-08	TRG	10-09-31-170202	02/02/17 12:50	3/17/2017	3/20/2017	17-03072	Bismuth-214	LANL ER-130 Modified	1.40E+02	8.54E+00	1.12E+01	5.59E-01	pCi/g
17-03072-08	TRG	10-09-31-170202	02/02/17 12:50	3/17/2017	3/20/2017	17-03072	Cesium-137	LANL ER-130 Modified	6.53E-02	5.97E-02	5.98E-02	1.80E-01	pCi/g
17-03072-08	TRG	10-09-31-170202	02/02/17 12:50	3/17/2017	3/20/2017	17-03072	Potassium-40	LANL ER-130 Modified	2.31E+01	2.95E+00	3.18E+00	3.11E+00	pCi/g
17-03072-08	TRG	10-09-31-170202	02/02/17 12:50	3/17/2017	3/20/2017	17-03072	Protactinium-234m	LANL ER-130 Modified	1.27E+02	2.61E+01	2.69E+01	3.50E+01	pCi/g
17-03072-08	TRG	10-09-31-170202	02/02/17 12:50	3/17/2017	3/20/2017	17-03072	Lead-212	LANL ER-130 Modified	-4.40E+01	5.46E+00	5.91E+00	4.06E-01	pCi/g
17-03072-08	TRG	10-09-31-170202	02/02/17 12:50	3/17/2017	3/20/2017	17-03072	Lead-214	LANL ER-130 Modified	1.35E+02	1.61E+01	1.76E+01	6.34E-01	pCi/g
17-03072-08	TRG	10-09-31-170202	02/02/17 12:50	3/17/2017	3/20/2017	17-03072	Radium-226	LANL ER-130 Modified	1.40E+02	8.54E+00	1.12E+01	5.59E-01	pCi/g
17-03072-08	TRG	10-09-31-170202	02/02/17 12:50	3/17/2017	3/20/2017	17-03072	Thorium-234	LANL ER-130 Modified	1.24E+02	1.02E+01	1.20E+01	6.70E+00	pCi/g
17-03072-08	TRG	10-09-31-170202	02/02/17 12:50	3/17/2017	3/20/2017	17-03072	Thallium-208	LANL ER-130 Modified	7.47E-01	1.82E-01	1.86E-01	1.72E-01	pCi/g
17-03072-09	TRG	10-10-31-170202	02/02/17 12:55	3/17/2017	3/20/2017	17-03072	Actinium-228	LANL ER-130 Modified	6.42E-01	3.86E-01	3.88E-01	6.17E-01	pCi/g
17-03072-09	TRG	10-10-31-170202	02/02/17 12:55	3/17/2017	3/20/2017	17-03072	Bismuth-214	LANL ER-130 Modified	7.90E+01	7.81E+00	8.80E+00	6.70E-01	pCi/g
17-03072-09	TRG	10-10-31-170202	02/02/17 12:55	3/17/2017	3/20/2017	17-03072	Cesium-137	LANL ER-130 Modified	5.18E-03	5.05E-02	5.05E-02	1.56E-01	pCi/g
17-03072-09	TRG	10-10-31-170202	02/02/17 12:55	3/17/2017	3/20/2017	17-03072	Potassium-40	LANL ER-130 Modified	2.19E+01	2.84E+00	3.06E+00	2.24E+00	pCi/g
17-03072-09	TRG	10-10-31-170202	02/02/17 12:55	3/17/2017	3/20/2017	17-03072	Protactinium-234m	LANL ER-130 Modified	5.65E+01	2.33E+01	2.35E+01	2.23E+01	pCi/g
17-03072-09	TRG	10-10-31-170202	02/02/17 12:55	3/17/2017	3/20/2017	17-03072	Lead-210	LANL ER-130 Modified	5.79E+01	5.90E+00	5.90E+00	4.37E+00	pCi/g
17-03072-09	TRG	10-10-31-170202	02/02/17 12:55	3/17/2017	3/20/2017	17-03072	Lead-212	LANL ER-130 Modified	-1.54E+01	5.15E+00	5.21E+00	3.04E-01	pCi/g
17-03072-09	TRG	10-10-31-170202	02/02/17 12:55	3/17/2017	3/20/2017	17-03072	Lead-214	LANL ER-130 Modified	7.88E+01	2.52E+01	2.56E+01	8.06E-01	pCi/g
17-03072-09	TRG	10-10-31-170202	02/02/17 12:55	3/17/2017	3/20/2017	17-03072	Radium-226	LANL ER-130 Modified	7.90E+01	7.81E+00	8.80E+00	6.70E-01	pCi/g
17-03072-09	TRG	10-10-31-170202	02/02/17 12:55	3/17/2017	3/20/2017	17-03072	Thorium-234	LANL ER-130 Modified	5.99E+01	5.35E+00	6.17E+00	5.06E+00	pCi/g
17-03072-09	TRG	10-10-31-170202	02/02/17 12:55	3/17/2017	3/20/2017	17-03072	Thallium-208	LANL ER-130 Modified	4.51E-01	1.29E-01	1.31E-01	7.31E-02	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

SUBSURFACE SOIL SAMPLES

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	17-01139
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
17-01139-01	LCS	KNOWN	01/27/17 00:00	1/27/2017	1/31/2017	17-01139	Cobalt-60	LANL ER-130 Modified	6.21E+01	2.48E+00			pCi/g
17-01139-01	LCS	KNOWN	01/27/17 00:00	1/27/2017	1/31/2017	17-01139	Cesium-137	LANL ER-130 Modified	3.94E+01	1.58E+00			pCi/g
17-01139-01	LCS	SPIKE	01/27/17 00:00	1/27/2017	1/31/2017	17-01139	Cobalt-60	LANL ER-130 Modified	6.14E+01	3.48E+00	4.69E+00	3.82E-01	pCi/g
17-01139-01	LCS	SPIKE	01/27/17 00:00	1/27/2017	1/31/2017	17-01139	Cesium-137	LANL ER-130 Modified	3.80E+01	3.31E+00	3.84E+00	4.18E-01	pCi/g
17-01139-02	MBL	BLANK	01/27/17 00:00	1/27/2017	1/30/2017	17-01139	Actinium-228	LANL ER-130 Modified	8.14E-02	6.81E-02	6.82E-02	1.45E-01	pCi/g
17-01139-02	MBL	BLANK	01/27/17 00:00	1/27/2017	1/30/2017	17-01139	Bismuth-214	LANL ER-130 Modified	-1.81E-02	3.89E-02	3.89E-02	5.52E-02	pCi/g
17-01139-02	MBL	BLANK	01/27/17 00:00	1/27/2017	1/30/2017	17-01139	Potassium-40	LANL ER-130 Modified	0.00E+00	1.55E-01	1.55E-01	3.08E-01	pCi/g
17-01139-02	MBL	BLANK	01/27/17 00:00	1/27/2017	1/30/2017	17-01139	Protactinium-234m	LANL ER-130 Modified	1.17E+00	2.36E+00	2.36E+00	4.28E+00	pCi/g
17-01139-02	MBL	BLANK	01/27/17 00:00	1/27/2017	1/30/2017	17-01139	Lead-212	LANL ER-130 Modified	-6.39E-03	2.53E-02	2.53E-02	3.67E-02	pCi/g
17-01139-02	MBL	BLANK	01/27/17 00:00	1/27/2017	1/30/2017	17-01139	Lead-214	LANL ER-130 Modified	1.83E-02	2.80E-02	2.80E-02	4.94E-02	pCi/g
17-01139-02	MBL	BLANK	01/27/17 00:00	1/27/2017	1/30/2017	17-01139	Radium-226	LANL ER-130 Modified	-1.81E-02	3.89E-02	3.89E-02	5.52E-02	pCi/g
17-01139-02	MBL	BLANK	01/27/17 00:00	1/27/2017	1/30/2017	17-01139	Thorium-234	LANL ER-130 Modified	1.61E-01	1.72E-01	1.72E-01	2.80E-01	pCi/g
17-01139-02	MBL	BLANK	01/27/17 00:00	1/27/2017	1/30/2017	17-01139	Thallium-208	LANL ER-130 Modified	5.28E-02	5.39E-02	5.40E-02	1.03E-01	pCi/g
17-01139-03	DUP	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Actinium-228	LANL ER-130 Modified	1.49E+00	2.20E-01	2.33E-01	4.39E-01	pCi/g
17-01139-03	DUP	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Bismuth-214	LANL ER-130 Modified	1.09E+00	1.49E-01	1.59E-01	1.93E-01	pCi/g
17-01139-03	DUP	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Potassium-40	LANL ER-130 Modified	1.93E+01	2.52E+00	2.71E+00	8.06E-01	pCi/g
17-01139-03	DUP	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Protactinium-234m	LANL ER-130 Modified	1.12E+00	5.89E+00	5.89E+00	8.43E+00	pCi/g
17-01139-03	DUP	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-212	LANL ER-130 Modified	1.29E+00	1.42E-01	1.57E-01	1.54E-01	pCi/g
17-01139-03	DUP	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-214	LANL ER-130 Modified	1.06E+00	1.21E-01	1.32E-01	1.70E-01	pCi/g
17-01139-03	DUP	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Radium-226	LANL ER-130 Modified	1.09E+00	1.49E-01	1.59E-01	1.93E-01	pCi/g
17-01139-03	DUP	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thorium-234	LANL ER-130 Modified	5.74E-01	5.80E-01	5.80E-01	8.50E-01	pCi/g
17-01139-03	DUP	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thallium-208	LANL ER-130 Modified	1.30E+00	2.33E-01	2.42E-01	2.71E-01	pCi/g
17-01139-04	DO	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Actinium-228	LANL ER-130 Modified	1.52E+00	1.98E-01	2.13E-01	3.42E-01	pCi/g
17-01139-04	DO	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Bismuth-214	LANL ER-130 Modified	1.10E+00	1.69E-01	1.78E-01	2.02E-01	pCi/g
17-01139-04	DO	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Potassium-40	LANL ER-130 Modified	1.81E+01	2.42E+00	2.59E+00	1.01E+00	pCi/g
17-01139-04	DO	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Protactinium-234m	LANL ER-130 Modified	7.83E-01	6.58E+00	6.58E+00	9.19E+00	pCi/g
17-01139-04	DO	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-212	LANL ER-130 Modified	1.31E+00	1.47E-01	1.62E-01	1.66E-01	pCi/g
17-01139-04	DO	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-214	LANL ER-130 Modified	1.09E+00	1.12E-01	1.25E-01	1.61E-01	pCi/g
17-01139-04	DO	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Radium-226	LANL ER-130 Modified	1.10E+00	1.69E-01	1.78E-01	2.02E-01	pCi/g
17-01139-04	DO	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thorium-234	LANL ER-130 Modified	1.83E+00	8.59E-01	8.64E-01	1.41E+00	pCi/g
17-01139-04	DO	10-01-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thallium-208	LANL ER-130 Modified	1.41E+00	2.59E-01	2.69E-01	3.17E-01	pCi/g
17-01139-05	TRG	10-02-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Actinium-228	LANL ER-130 Modified	1.62E+00	4.15E-01	4.23E-01	2.06E-01	pCi/g
17-01139-05	TRG	10-02-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Bismuth-214	LANL ER-130 Modified	1.31E+00	1.94E-01	2.05E-01	1.13E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:		Work Order Details:	
David Bordelon		*SDG:*	**17-01139**
Weston Solutions, Inc.		*Purchase Order:*	0090911
13702 Coursey Blvd, #7A		*Analysis Category:*	ENVIRONMENTAL
Baton Rouge, LA 70817		*Sample Matrix:*	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
17-01139-05	TRG	10-02-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Potassium-40	LANL ER-130 Modified	2.34E+01	2.74E+00	3.00E+00	9.07E-01	pCi/g
17-01139-05	TRG	10-02-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Protactinium-234m	LANL ER-130 Modified	5.47E+00	4.21E+00	4.22E+00	6.21E+00	pCi/g
17-01139-05	TRG	10-02-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-212	LANL ER-130 Modified	1.91E+00	5.43E-01	5.52E-01	1.72E-01	pCi/g
17-01139-05	TRG	10-02-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-214	LANL ER-130 Modified	1.36E+00	4.42E-01	4.47E-01	1.39E-01	pCi/g
17-01139-05	TRG	10-02-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Radium-226	LANL ER-130 Modified	1.31E+00	1.94E-01	2.05E-01	1.13E-01	pCi/g
17-01139-05	TRG	10-02-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thorium-234	LANL ER-130 Modified	5.92E+00	1.37E+00	1.40E+00	2.12E+00	pCi/g
17-01139-05	TRG	10-02-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thallium-208	LANL ER-130 Modified	1.59E+00	3.23E-01	3.33E-01	1.11E-01	pCi/g
17-01139-06	TRG	10-03-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Actinium-228	LANL ER-130 Modified	1.59E+00	1.86E-01	2.03E-01	2.74E-01	pCi/g
17-01139-06	TRG	10-03-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Bismuth-214	LANL ER-130 Modified	3.86E+00	3.15E-01	3.72E-01	1.66E-01	pCi/g
17-01139-06	TRG	10-03-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Potassium-40	LANL ER-130 Modified	1.99E+01	2.05E+00	2.29E+00	6.46E-01	pCi/g
17-01139-06	TRG	10-03-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Protactinium-234m	LANL ER-130 Modified	4.28E+00	3.59E+00	3.60E+00	5.85E+00	pCi/g
17-01139-06	TRG	10-03-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-212	LANL ER-130 Modified	1.44E+00	1.79E-01	1.93E-01	1.30E-01	pCi/g
17-01139-06	TRG	10-03-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-214	LANL ER-130 Modified	3.52E+00	4.36E-01	4.72E-01	1.35E-01	pCi/g
17-01139-06	TRG	10-03-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Radium-226	LANL ER-130 Modified	3.86E+00	3.15E-01	3.72E-01	1.66E-01	pCi/g
17-01139-06	TRG	10-03-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thorium-234	LANL ER-130 Modified	5.00E+00	1.08E+00	1.11E+00	1.63E+00	pCi/g
17-01139-06	TRG	10-03-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thallium-208	LANL ER-130 Modified	1.50E+00	2.30E-01	2.42E-01	5.49E-02	pCi/g
17-01139-07	TRG	10-04-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Actinium-228	LANL ER-130 Modified	1.42E+00	3.66E-01	3.73E-01	3.45E-01	pCi/g
17-01139-07	TRG	10-04-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Bismuth-214	LANL ER-130 Modified	1.32E+00	1.85E-01	1.97E-01	1.50E-01	pCi/g
17-01139-07	TRG	10-04-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Potassium-40	LANL ER-130 Modified	1.68E+01	2.03E+00	2.20E+00	7.34E-01	pCi/g
17-01139-07	TRG	10-04-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Protactinium-234m	LANL ER-130 Modified	1.35E+01	5.46E+00	5.51E+00	1.05E+01	pCi/g
17-01139-07	TRG	10-04-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-212	LANL ER-130 Modified	1.27E+00	3.80E-01	3.86E-01	1.45E-01	pCi/g
17-01139-07	TRG	10-04-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-214	LANL ER-130 Modified	1.31E+00	4.28E-01	4.33E-01	1.35E-01	pCi/g
17-01139-07	TRG	10-04-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Radium-226	LANL ER-130 Modified	1.32E+00	1.85E-01	1.97E-01	1.50E-01	pCi/g
17-01139-07	TRG	10-04-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thorium-234	LANL ER-130 Modified	1.33E+01	1.69E+00	1.82E+00	2.19E+00	pCi/g
17-01139-07	TRG	10-04-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thallium-208	LANL ER-130 Modified	1.20E+00	2.44E-01	2.52E-01	1.02E-01	pCi/g
17-01139-08	TRG	10-04-2-32-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Actinium-228	LANL ER-130 Modified	1.85E+00	1.93E-01	2.15E-01	1.74E-01	pCi/g
17-01139-08	TRG	10-04-2-32-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Bismuth-214	LANL ER-130 Modified	1.31E+00	1.56E-01	1.70E-01	1.45E-01	pCi/g
17-01139-08	TRG	10-04-2-32-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Potassium-40	LANL ER-130 Modified	2.28E+01	2.33E+00	2.61E+00	6.45E-01	pCi/g
17-01139-08	TRG	10-04-2-32-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Protactinium-234m	LANL ER-130 Modified	1.69E+01	5.30E+00	5.37E+00	7.39E+00	pCi/g
17-01139-08	TRG	10-04-2-32-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-212	LANL ER-130 Modified	1.53E+00	1.86E-01	2.02E-01	8.00E-02	pCi/g
17-01139-08	TRG	10-04-2-32-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-214	LANL ER-130 Modified	1.35E+00	1.80E-01	1.93E-01	1.20E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	SDG:	17-01139
Weston Solutions, Inc.	Purchase Order:	0090911
13702 Coursey Blvd, #7A	Analysis Category:	ENVIRONMENTAL
Baton Rouge, LA 70817	Sample Matrix:	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
17-01139-08	TRG	10-04-2-32-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Radium-226	LANL ER-130 Modified	1.31E+00	1.56E-01	1.70E-01	1.45E-01	pCi/g
17-01139-08	TRG	10-04-2-32-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thorium-234	LANL ER-130 Modified	1.08E+01	1.44E+00	1.54E+00	2.24E+00	pCi/g
17-01139-08	TRG	10-04-2-32-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thallium-208	LANL ER-130 Modified	1.70E+00	2.35E-01	2.50E-01	9.17E-02	pCi/g
17-01139-09	TRG	10-05-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Actinium-228	LANL ER-130 Modified	1.86E+00	4.76E-01	4.85E-01	2.35E-01	pCi/g
17-01139-09	TRG	10-05-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Bismuth-214	LANL ER-130 Modified	1.40E+00	1.95E-01	2.08E-01	1.67E-01	pCi/g
17-01139-09	TRG	10-05-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Potassium-40	LANL ER-130 Modified	2.23E+01	2.63E+00	2.86E+00	8.85E-01	pCi/g
17-01139-09	TRG	10-05-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Protactinium-234m	LANL ER-130 Modified	3.05E+00	3.06E+00	3.07E+00	4.79E+00	pCi/g
17-01139-09	TRG	10-05-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-212	LANL ER-130 Modified	1.98E+00	5.59E-01	5.68E-01	1.52E-01	pCi/g
17-01139-09	TRG	10-05-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-214	LANL ER-130 Modified	1.40E+00	4.57E-01	4.63E-01	1.56E-01	pCi/g
17-01139-09	TRG	10-05-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Radium-226	LANL ER-130 Modified	1.40E+00	1.95E-01	2.08E-01	1.67E-01	pCi/g
17-01139-09	TRG	10-05-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thorium-234	LANL ER-130 Modified	2.60E+00	1.06E+00	1.07E+00	1.72E+00	pCi/g
17-01139-09	TRG	10-05-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thallium-208	LANL ER-130 Modified	1.63E+00	3.07E-01	3.18E-01	8.09E-02	pCi/g
17-01139-10	TRG	10-06-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Actinium-228	LANL ER-130 Modified	1.47E+00	1.69E-01	1.85E-01	2.44E-01	pCi/g
17-01139-10	TRG	10-06-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Bismuth-214	LANL ER-130 Modified	1.10E+00	1.38E-01	1.49E-01	1.10E-01	pCi/g
17-01139-10	TRG	10-06-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Potassium-40	LANL ER-130 Modified	1.97E+01	2.02E+00	2.26E+00	5.66E-01	pCi/g
17-01139-10	TRG	10-06-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Protactinium-234m	LANL ER-130 Modified	2.37E+00	2.16E+00	2.16E+00	3.50E+00	pCi/g
17-01139-10	TRG	10-06-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-212	LANL ER-130 Modified	1.20E+00	1.52E-01	1.64E-01	6.61E-02	pCi/g
17-01139-10	TRG	10-06-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-214	LANL ER-130 Modified	1.09E+00	1.46E-01	1.56E-01	8.72E-02	pCi/g
17-01139-10	TRG	10-06-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Radium-226	LANL ER-130 Modified	1.10E+00	1.38E-01	1.49E-01	1.10E-01	pCi/g
17-01139-10	TRG	10-06-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thorium-234	LANL ER-130 Modified	1.40E+00	8.05E-01	8.08E-01	1.32E+00	pCi/g
17-01139-10	TRG	10-06-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thallium-208	LANL ER-130 Modified	1.33E+00	1.88E-01	2.00E-01	9.20E-02	pCi/g
17-01139-11	TRG	10-07-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Actinium-228	LANL ER-130 Modified	1.53E+00	2.69E-01	2.80E-01	3.44E-01	pCi/g
17-01139-11	TRG	10-07-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Bismuth-214	LANL ER-130 Modified	1.45E+00	2.31E-01	2.43E-01	1.72E-01	pCi/g
17-01139-11	TRG	10-07-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Potassium-40	LANL ER-130 Modified	2.23E+01	2.17E+00	2.45E+00	7.71E-01	pCi/g
17-01139-11	TRG	10-07-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Protactinium-234m	LANL ER-130 Modified	2.28E+00	3.04E+00	3.04E+00	6.14E+00	pCi/g
17-01139-11	TRG	10-07-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-212	LANL ER-130 Modified	1.67E+00	1.54E-01	1.76E-01	1.58E-01	pCi/g
17-01139-11	TRG	10-07-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-214	LANL ER-130 Modified	1.20E+00	3.48E-01	3.53E-01	1.64E-01	pCi/g
17-01139-11	TRG	10-07-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Radium-226	LANL ER-130 Modified	1.45E+00	2.31E-01	2.43E-01	1.72E-01	pCi/g
17-01139-11	TRG	10-07-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thorium-234	LANL ER-130 Modified	1.68E+00	1.02E+00	1.02E+00	1.68E+00	pCi/g
17-01139-11	TRG	10-07-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thallium-208	LANL ER-130 Modified	1.70E+00	7.83E-01	7.88E-01	2.26E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

Eberline Analytical
Final Report of Analysis

Report To:	Work Order Details:	
David Bordelon	*SDG:*	**17-01139**
Weston Solutions, Inc.	*Purchase Order:*	0090911
13702 Coursey Blvd, #7A	*Analysis Category:*	ENVIRONMENTAL
Baton Rouge, LA 70817	*Sample Matrix:*	SO

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
17-01139-12	TRG	10-08-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Actinium-228	LANL ER-130 Modified	1.34E+00	1.95E-01	2.07E-01	3.68E-01	pCi/g
17-01139-12	TRG	10-08-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Bismuth-214	LANL ER-130 Modified	9.77E-01	1.74E-01	1.81E-01	2.28E-01	pCi/g
17-01139-12	TRG	10-08-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Potassium-40	LANL ER-130 Modified	2.45E+01	3.06E+00	3.31E+00	6.84E-01	pCi/g
17-01139-12	TRG	10-08-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Protactinium-234m	LANL ER-130 Modified	0.00E+00	6.48E+00	6.48E+00	8.99E+00	pCi/g
17-01139-12	TRG	10-08-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-212	LANL ER-130 Modified	1.30E+00	1.46E-01	1.60E-01	1.55E-01	pCi/g
17-01139-12	TRG	10-08-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-214	LANL ER-130 Modified	8.87E-01	1.18E-01	1.27E-01	1.94E-01	pCi/g
17-01139-12	TRG	10-08-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Radium-226	LANL ER-130 Modified	9.77E-01	1.74E-01	1.81E-01	2.28E-01	pCi/g
17-01139-12	TRG	10-08-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thorium-234	LANL ER-130 Modified	2.27E+00	9.76E-01	9.83E-01	1.59E+00	pCi/g
17-01139-12	TRG	10-08-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thallium-208	LANL ER-130 Modified	1.14E+00	2.26E-01	2.34E-01	2.72E-01	pCi/g
17-01139-13	TRG	10-09-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Actinium-228	LANL ER-130 Modified	1.43E+00	3.69E-01	3.76E-01	2.67E-01	pCi/g
17-01139-13	TRG	10-09-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Bismuth-214	LANL ER-130 Modified	1.07E+00	1.93E-01	2.00E-01	1.12E-01	pCi/g
17-01139-13	TRG	10-09-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Potassium-40	LANL ER-130 Modified	2.19E+01	2.53E+00	2.77E+00	7.17E-01	pCi/g
17-01139-13	TRG	10-09-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Protactinium-234m	LANL ER-130 Modified	6.85E+00	4.24E+00	4.26E+00	5.71E+00	pCi/g
17-01139-13	TRG	10-09-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-212	LANL ER-130 Modified	1.48E+00	4.26E-01	4.33E-01	1.19E-01	pCi/g
17-01139-13	TRG	10-09-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-214	LANL ER-130 Modified	1.14E+00	3.73E-01	3.78E-01	1.41E-01	pCi/g
17-01139-13	TRG	10-09-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Radium-226	LANL ER-130 Modified	1.07E+00	1.93E-01	2.00E-01	1.12E-01	pCi/g
17-01139-13	TRG	10-09-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thorium-234	LANL ER-130 Modified	5.84E+00	1.13E+00	1.17E+00	1.68E+00	pCi/g
17-01139-13	TRG	10-09-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thallium-208	LANL ER-130 Modified	1.17E+00	2.35E-01	2.43E-01	1.34E-01	pCi/g
17-01139-14	TRG	10-10-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Actinium-228	LANL ER-130 Modified	1.46E+00	1.68E-01	1.84E-01	2.53E-01	pCi/g
17-01139-14	TRG	10-10-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Bismuth-214	LANL ER-130 Modified	1.69E+00	1.86E-01	2.06E-01	1.16E-01	pCi/g
17-01139-14	TRG	10-10-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Potassium-40	LANL ER-130 Modified	2.22E+01	2.25E+00	2.52E+00	4.95E-01	pCi/g
17-01139-14	TRG	10-10-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Protactinium-234m	LANL ER-130 Modified	2.16E+01	5.52E+00	5.63E+00	7.17E+00	pCi/g
17-01139-14	TRG	10-10-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-212	LANL ER-130 Modified	1.36E+00	1.66E-01	1.80E-01	1.23E-01	pCi/g
17-01139-14	TRG	10-10-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Lead-214	LANL ER-130 Modified	1.69E+00	2.17E-01	2.34E-01	1.15E-01	pCi/g
17-01139-14	TRG	10-10-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Radium-226	LANL ER-130 Modified	1.69E+00	1.86E-01	2.06E-01	1.16E-01	pCi/g
17-01139-14	TRG	10-10-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thorium-234	LANL ER-130 Modified	8.70E+00	1.35E+00	1.42E+00	2.23E+00	pCi/g
17-01139-14	TRG	10-10-2-31-161112	11/12/16 00:00	1/27/2017	1/30/2017	17-01139	Thallium-208	LANL ER-130 Modified	1.50E+00	2.10E-01	2.23E-01	1.20E-01	pCi/g

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

APPENDIX D

BACKGROUND PROUCL STATISTICAL RESULTS

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Section 10
Background Ra-226 BTV_UTL95-95

Background Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.15/16/2019 8:19:18 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
New or Future K Observations	1
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	20	Number of Distinct Observations	16
Minimum	1.22	First Quartile	1.43
Second Largest	1.73	Median	1.545
Maximum	1.73	Third Quartile	1.595
Mean	1.52	SD	0.146
Coefficient of Variation	0.0963	Skewness	-0.32
Mean of logged Data	0.414	SD of logged Data	0.0985

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.396	d2max (for USL)	2.557

Normal GOF Test

Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.905	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.129	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.192	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	1.87	90% Percentile (z)	1.707
95% UPL (t)	1.779	95% Percentile (z)	1.76
95% USL	1.894	99% Percentile (z)	1.86

Gamma GOF Test

A-D Test Statistic	0.358	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.141	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.193	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	110.3	k star (bias corrected MLE)	93.8
Theta hat (MLE)	0.0138	Theta star (bias corrected MLE)	0.0162
nu hat (MLE)	4412	nu star (bias corrected)	3752
MLE Mean (bias corrected)	1.52	MLE Sd (bias corrected)	0.157

Section 10
Background Ra-226 BTV_UTL95-95 (continued)

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	1.793	90% Percentile	1.724
95% Hawkins Wixley (HW) Approx. Gamma UPL	1.795	95% Percentile	1.786
95% WH Approx. Gamma UTL with 95% Coverage	1.898	99% Percentile	1.908
95% HW Approx. Gamma UTL with 95% Coverage	1.902		
95% WH USL	1.926	95% HW USL	1.931

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.946	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.146	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.192	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	1.915	90% Percentile (z)	1.716
95% UPL (t)	1.801	95% Percentile (z)	1.779
95% USL	1.946	99% Percentile (z)	1.902

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	20	95% UTL with 95% Coverage	1.73
Approx, f used to compute achieved CC	1.053	Approximate Actual Confidence Coefficient achieved by UTL	0.642
		Approximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	1.73	95% BCA Bootstrap UTL with 95% Coverage	1.73
95% UPL	1.73	90% Percentile	1.712
90% Chebyshev UPL	1.969	95% Percentile	1.73
95% Chebyshev UPL	2.173	99% Percentile	1.73
95% USL	1.73		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Section 10
Background Gamma Count BTV_UTL95-95

Background Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.15/16/2019 8:30:02 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
New or Future K Observations	1
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	20	Number of Distinct Observations	20
Minimum	15497	First Quartile	16109
Second Largest	16680	Median	16335
Maximum	16739	Third Quartile	16425
Mean	16258	SD	313.4
Coefficient of Variation	0.0193	Skewness	-0.794
Mean of logged Data	9.696	SD of logged Data	0.0194

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.396	d2max (for USL)	2.557

Normal GOF Test

Shapiro Wilk Test Statistic	0.946	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.905	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.167	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.192	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	17009	90% Percentile (z)	16659
95% UPL (t)	16813	95% Percentile (z)	16773
95% USL	17059	99% Percentile (z)	16987

Gamma GOF Test

A-D Test Statistic	0.441	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.16	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.193	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2806	k star (bias corrected MLE)	2385
Theta hat (MLE)	5.795	Theta star (bias corrected MLE)	6.817
nu hat (MLE)	112220	nu star (bias corrected)	95389
MLE Mean (bias corrected)	16258	MLE Sd (bias corrected)	332.9

Section 10
Background Gamma Count BTV_UTL95-95 (cont'd)

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	16820	90% Percentile	16686
95% Hawkins Wixley (HW) Approx. Gamma UPL	16821	95% Percentile	16809
95% WH Approx. Gamma UTL with 95% Coverage	17022	99% Percentile	17042
95% HW Approx. Gamma UTL with 95% Coverage	17024		
95% WH USL	17074	95% HW USL	17076

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.942	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.171	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.192	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	17029	90% Percentile (z)	16664
95% UPL (t)	16824	95% Percentile (z)	16782
95% USL	17082	99% Percentile (z)	17006

Nonparametric Distribution Free Background Statistics

Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	20	95% UTL with 95% Coverage	16739
Approx, f used to compute achieved CC	1.053	Approximate Actual Confidence Coefficient achieved by UTL	0.642
		Approximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	16739	95% BCA Bootstrap UTL with 95% Coverage	16739
95% UPL	16736	90% Percentile	16591
90% Chebyshev UPL	17221	95% Percentile	16683
95% Chebyshev UPL	17658	99% Percentile	16728
95% USL	16739		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

APPENDIX E

HALL ENVIRONMENTAL ANALYSIS LABORATORY
ANALYTICAL RESULTS DATA PACKAGE

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Hall Environmental Analysis Laboratory, Inc.

Date Reported: **12/17/2018**

CLIENT: Weston Solutions, Inc.
Client Sample ID: 10-02-31-181031-M
Project: 1 Weston 04217013 181108 002
Collection Date: 10/31/2018
Lab ID: 1811683-001
Matrix: SOIL
Received Date: 11/9/2018 8:40:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 7471: MERCURY							Analyst: **rde**
Mercury	ND	0.032		mg/Kg	1	11/27/2018 4:45:44 PM	41736
EPA METHOD 6010B: SOIL METALS							Analyst: **ELS**
Aluminum	11000	300		mg/Kg	100	11/15/2018 2:20:27 PM	41542
Antimony	~~ND~~ UJL	4.9		mg/Kg	2	11/16/2018 11:00:24 AM	41542
Arsenic	ND	4.9		mg/Kg	2	11/16/2018 11:00:24 AM	41542
Barium	190	0.20		mg/Kg	2	11/16/2018 11:00:24 AM	41542
Beryllium	0.55	0.30		mg/Kg	2	11/16/2018 11:00:24 AM	41542
Cadmium	ND	0.20		mg/Kg	2	11/16/2018 11:00:24 AM	41542
Calcium	12000	120		mg/Kg	5	11/16/2018 9:28:04 AM	41542
Chromium	5.2	0.59		mg/Kg	2	11/16/2018 11:00:24 AM	41542
Cobalt	3.2	0.59		mg/Kg	2	11/30/2018 3:05:09 PM	41542
Copper	3.0	0.59		mg/Kg	2	11/16/2018 11:00:24 AM	41542
Iron	12000	250		mg/Kg	100	11/15/2018 2:20:27 PM	41542
Lead	5.7	0.49		mg/Kg	2	11/16/2018 11:00:24 AM	41542
Magnesium	3200	120		mg/Kg	5	11/16/2018 9:28:04 AM	41542
Manganese	200	0.20		mg/Kg	2	11/16/2018 11:00:24 AM	41542
Nickel	5.7	0.99		mg/Kg	2	11/30/2018 3:05:09 PM	41542
Potassium	2300	250		mg/Kg	5	11/16/2018 9:28:04 AM	41542
Selenium	ND	4.9		mg/Kg	2	11/16/2018 11:00:24 AM	41542
Silver	~~ND~~ UJL	0.49		mg/Kg	2	11/16/2018 11:00:24 AM	41542
Sodium	150	120		mg/Kg	5	11/16/2018 9:28:04 AM	41542
Thallium	~~ND~~ UJL	4.9		mg/Kg	2	11/16/2018 11:00:24 AM	41542
Uranium	~~ND~~ UJL	9.9		mg/Kg	2	11/16/2018 11:00:24 AM	41542
Vanadium	14	4.9		mg/Kg	2	11/16/2018 11:00:24 AM	41542
Zinc	25	4.9		mg/Kg	2	11/30/2018 3:05:09 PM	41542

& 6/20/19

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Weston Solutions, Inc. **Client Sample ID:** 10-03-31-181031-M
Project: 1 Weston 04217013 181108 002 **Collection Date:** 10/31/2018
Lab ID: 1811683-002 **Matrix:** SOIL **Received Date:** 11/9/2018 8:40:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 7471: MERCURY						Analyst: **rde**	
Mercury	ND	0.032		mg/Kg	1	11/27/2018 4:50:53 PM	41736
EPA METHOD 6010B: SOIL METALS						Analyst: **ELS**	
Aluminum	12000	300		mg/Kg	100	11/15/2018 2:22:24 PM	41542
Antimony	~~ND~~ UJL	12		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Arsenic	ND	12		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Barium	77	0.49		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Beryllium	ND	0.74		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Cadmium	ND	0.49		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Calcium	3300	120		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Chromium	7.0	1.5		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Cobalt	4.7	1.5		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Copper	6.2	1.5		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Iron	13000	250		mg/Kg	100	11/15/2018 2:22:24 PM	41542
Lead	14	1.2		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Magnesium	2900	120		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Manganese	210	0.49		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Nickel	7.1	2.5		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Potassium	3900	250		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Selenium	ND	12		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Silver	~~ND~~ UJL	1.2		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Sodium	180	120		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Thallium	~~ND~~ UJL	12		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Uranium	~~ND~~ UJL	25		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Vanadium	38	12		mg/Kg	5	11/16/2018 9:42:04 AM	41542
Zinc	38	12		mg/Kg	5	11/16/2018 9:42:04 AM	41542

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Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:			
*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Weston Solutions, Inc. **Client Sample ID:** 10-04-31-181031-M
Project: 1 Weston 04217013 181108 002 **Collection Date:** 10/31/2018
Lab ID: 1811683-003 **Matrix:** SOIL **Received Date:** 11/9/2018 8:40:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 7471: MERCURY						Analyst: **rde**	
Mercury	ND	0.032		mg/Kg	1	11/27/2018 4:52:36 PM	41736
EPA METHOD 6010B: SOIL METALS						Analyst: **ELS**	
Aluminum	10000	300		mg/Kg	100	11/15/2018 2:24:21 PM	41542
Antimony	~~ND~~ UJL	4.9		mg/Kg	2	11/16/2018 11:09:53 AM	41542
Arsenic	ND	4.9		mg/Kg	2	11/16/2018 11:09:53 AM	41542
Barium	73	0.20		mg/Kg	2	11/16/2018 11:09:53 AM	41542
Beryllium	0.61	0.30		mg/Kg	2	11/16/2018 11:09:53 AM	41542
Cadmium	ND	0.20		mg/Kg	2	11/16/2018 11:09:53 AM	41542
Calcium	9500	120		mg/Kg	5	11/16/2018 9:43:54 AM	41542
Chromium	5.3	0.59		mg/Kg	2	11/16/2018 11:09:53 AM	41542
Cobalt	2.7	0.59		mg/Kg	2	11/30/2018 3:11:21 PM	41542
Copper	3.2	0.59		mg/Kg	2	11/16/2018 11:09:53 AM	41542
Iron	10000	250		mg/Kg	100	11/15/2018 2:24:21 PM	41542
Lead	8.2	0.49		mg/Kg	2	11/16/2018 11:09:53 AM	41542
Magnesium	4100	120		mg/Kg	5	11/16/2018 9:43:54 AM	41542
Manganese	140	0.20		mg/Kg	2	11/16/2018 11:09:53 AM	41542
Nickel	4.8	0.98		mg/Kg	2	11/30/2018 3:11:21 PM	41542
Potassium	2700	250		mg/Kg	5	11/16/2018 9:43:54 AM	41542
Selenium	15	4.9		mg/Kg	2	11/30/2018 3:11:21 PM	41542
Silver	~~ND~~ UJL	0.49		mg/Kg	2	11/16/2018 11:09:53 AM	41542
Sodium	150	120		mg/Kg	5	11/16/2018 9:43:54 AM	41542
Thallium	~~ND~~ UJL	4.9		mg/Kg	2	11/16/2018 11:09:53 AM	41542
Uranium	~~ND~~ UJL	9.8		mg/Kg	2	11/16/2018 11:09:53 AM	41542
Vanadium	77	4.9		mg/Kg	2	11/16/2018 11:09:53 AM	41542
Zinc	24	4.9		mg/Kg	2	11/30/2018 3:11:21 PM	41542

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Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	D	Sample Diluted Due to Matrix	E	Value above quantitation range
	H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
	ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
	PQL	Practical Quanitative Limit	RL	Reporting Detection Limit
	S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Weston Solutions, Inc.
Project: 1 Weston 04217013 181108 002
Lab ID: 1811683-004 **Matrix:** SOIL

Client Sample ID: 10-05-31-181031-M
Collection Date: 10/31/2018
Received Date: 11/9/2018 8:40:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 7471: MERCURY						Analyst: **rde**	
Mercury	ND	0.033		mg/Kg	1	11/27/2018 4:54:20 PM	41736
EPA METHOD 6010B: SOIL METALS						Analyst: **ELS**	
Aluminum	14000	290		mg/Kg	100	11/15/2018 2:26:18 PM	41542
Antimony	~~ND~~ UJL	12		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Arsenic	ND	12		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Barium	110	0.49		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Beryllium	0.91	0.73		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Cadmium	ND	0.49		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Calcium	10000	120		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Chromium	2.2	1.5		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Cobalt	3.0	1.5		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Copper	6.3	1.5		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Iron	12000	240		mg/Kg	100	11/15/2018 2:26:18 PM	41542
Lead	6.8	1.2		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Magnesium	3300	120		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Manganese	240	0.49		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Nickel	3.9	2.4		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Potassium	3400	240		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Selenium	87	12		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Silver	~~ND~~ UJL	1.2		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Sodium	490	120		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Thallium	~~ND~~ UJL	12		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Uranium	70 JL	24		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Vanadium	110	12		mg/Kg	5	11/16/2018 9:45:45 AM	41542
Zinc	26	12		mg/Kg	5	11/16/2018 9:45:45 AM	41542

6/20/19

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Analytical Report
Lab Order **1811683**
Date Reported: **12/17/2018**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Weston Solutions, Inc.
Project: 1 Weston 04217013 181108 002
Lab ID: 1811683-005 **Matrix:** SOIL

Client Sample ID: 10-05-32-181031-M
Collection Date: 10/31/2018
Received Date: 11/9/2018 8:40:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 7471: MERCURY						Analyst: **rde**	
Mercury	ND	0.033		mg/Kg	1	11/27/2018 4:56:04 PM	41736
EPA METHOD 6010B: SOIL METALS						Analyst: **ELS**	
Aluminum	15000	300		mg/Kg	100	11/15/2018 2:34:53 PM	41542
Antimony	~~ND~~ UJL	12		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Arsenic	ND	12		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Barium	100	0.49		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Beryllium	0.97	0.74		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Cadmium	ND	0.49		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Calcium	10000	120		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Chromium	2.5	1.5		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Cobalt	3.1	1.5		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Copper	6.4	1.5		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Iron	12000	250		mg/Kg	100	11/15/2018 2:34:53 PM	41542
Lead	6.5	1.2		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Magnesium	3700	120		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Manganese	260	0.49		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Nickel	4.1	2.5		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Potassium	3700	250		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Selenium	77	12		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Silver	~~ND~~ UJL	1.2		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Sodium	560	120		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Thallium	~~ND~~ UJL	12		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Uranium	67 JL	25		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Vanadium	120	12		mg/Kg	5	11/16/2018 9:47:36 AM	41542
Zinc	29	12		mg/Kg	5	11/16/2018 9:47:36 AM	41542

RB 6/20/19

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	D	Sample Diluted Due to Matrix	E	Value above quantitation range
	H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
	ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
	PQL	Practical Quanitative Limit	RL	Reporting Detection Limit
	S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Weston Solutions, Inc.
Project: 1 Weston 04217013 181108 002
Lab ID: 1811683-006 **Matrix:** SOIL

Client Sample ID: 10-06-31-181031-M
Collection Date: 10/31/2018
Received Date: 11/9/2018 8:40:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 7471: MERCURY							Analyst: **rde**
Mercury	0.12	0.033		mg/Kg	1	11/27/2018 5:01:23 PM	41736
EPA METHOD 6010B: SOIL METALS							Analyst: **ELS**
Aluminum	6000	290		mg/Kg	100	11/15/2018 2:36:52 PM	41542
Antimony	~~ND~~ UJL	12		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Arsenic	20	12		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Barium	210	0.48		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Beryllium	ND	0.73		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Cadmium	ND	0.48		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Calcium	4100	120		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Chromium	ND	1.5		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Cobalt	1.8	1.5		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Copper	ND	1.5		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Iron	10000	240		mg/Kg	100	11/15/2018 2:36:52 PM	41542
Lead	8.7	1.2		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Magnesium	1700	120		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Manganese	140	0.48		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Nickel	ND	2.4		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Potassium	880	240		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Selenium	86	12		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Silver	~~ND~~ UJL	1.2		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Sodium	150	120		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Thallium	~~ND~~ UJL	12		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Uranium	310 JL	24		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Vanadium	250	12		mg/Kg	5	11/16/2018 9:49:28 AM	41542
Zinc	17	12		mg/Kg	5	11/16/2018 9:49:28 AM	41542

6/20/19

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

Analytical Report
Lab Order **1811683**
Date Reported: **12/17/2018**

CLIENT: Weston Solutions, Inc.
Project: 1 Weston 04217013 181108 002
Lab ID: 1811683-007 **Matrix:** SOIL

Client Sample ID: 10-07-31-181031-M
Collection Date: 10/31/2018
Received Date: 11/9/2018 8:40:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 7471: MERCURY							Analyst: **rde**
Mercury	ND	0.033		mg/Kg	1	11/27/2018 5:03:09 PM	41736
EPA METHOD 6010B: SOIL METALS							Analyst: **ELS**
Aluminum	17000	290		mg/Kg	100	11/15/2018 2:38:50 PM	41542
Antimony	ND	12		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Arsenic	~~ND~~ UJL	12		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Barium	75	0.48		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Beryllium	0.80	0.73		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Cadmium	ND	0.48		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Calcium	5300	120		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Chromium	9.7	1.5		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Cobalt	5.3	1.5		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Copper	7.8	1.5		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Iron	16000	240		mg/Kg	100	11/15/2018 2:38:50 PM	41542
Lead	5.4	1.2		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Magnesium	4200	120		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Manganese	190	0.48		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Nickel	9.2	2.4		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Potassium	4700	240		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Selenium	ND	12		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Silver	~~ND~~ UJL	1.2		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Sodium	190	120		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Thallium	~~ND~~ UJL	12		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Uranium	~~ND~~ UJL	24		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Vanadium	26	12		mg/Kg	5	11/16/2018 9:51:13 AM	41542
Zinc	44	12		mg/Kg	5	11/16/2018 9:51:13 AM	41542

& 6/20/19

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	D	Sample Diluted Due to Matrix	E	Value above quantitation range
	H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
	ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
	PQL	Practical Quanitative Limit	RL	Reporting Detection Limit
	S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Weston Solutions, Inc.
Project: 1 Weston 04217013 181108 002
Lab ID: 1811683-008 **Matrix:** SOIL

Client Sample ID: 10-08-31-181031-M
Collection Date: 10/31/2018
Received Date: 11/9/2018 8:40:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 7471: MERCURY						Analyst:	**rde**
Mercury	ND	0.032		mg/Kg	1	11/27/2018 5:04:56 PM	41736
EPA METHOD 6010B: SOIL METALS						Analyst:	**ELS**
Aluminum	22000	300		mg/Kg	100	11/15/2018 2:40:47 PM	41542
Antimony	~~ND~~ UJL	12		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Arsenic	ND	12		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Barium	88	0.49		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Beryllium	1.0	0.74		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Cadmium	ND	0.49		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Calcium	6800	120		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Chromium	13	1.5		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Cobalt	6.1	1.5		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Copper	9.5	1.5		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Iron	19000	250		mg/Kg	100	11/15/2018 2:40:47 PM	41542
Lead	5.5	1.2		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Magnesium	5300	120		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Manganese	240	0.49		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Nickel	11	2.5		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Potassium	5800	250		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Selenium	ND	12		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Silver	~~ND~~ UJL	1.2		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Sodium	210	120		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Thallium	~~ND~~ UJL	12		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Uranium	~~ND~~ UJL	25		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Vanadium	34	12		mg/Kg	5	11/16/2018 9:53:04 AM	41542
Zinc	53	12		mg/Kg	5	11/16/2018 9:53:04 AM	41542

6/20/19

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Weston Solutions, Inc.
Project: 1 Weston 04217013 181108 002
Lab ID: 1811683-009 **Matrix:** SOIL

Client Sample ID: 23-02-31-181101-M
Collection Date: 11/1/2018
Received Date: 11/9/2018 8:40:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 7471: MERCURY						Analyst: **rde**	
Mercury	ND	0.032		mg/Kg	1	11/27/2018 5:06:42 PM	41736
EPA METHOD 6010B: SOIL METALS						Analyst: **ELS**	
Aluminum	15000	290		mg/Kg	100	11/15/2018 2:42:44 PM	41542
Antimony	~~ND~~ UJL	12		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Arsenic	ND	12		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Barium	81	0.49		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Beryllium	0.78	0.74		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Cadmium	ND	0.49		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Calcium	12000	120		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Chromium	8.7	1.5		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Cobalt	5.2	1.5		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Copper	6.6	1.5		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Iron	17000	250		mg/Kg	100	11/15/2018 2:42:44 PM	41542
Lead	5.7	1.2		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Magnesium	3500	120		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Manganese	170	0.49		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Nickel	9.6	2.5		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Potassium	3500	250		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Selenium	ND	12		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Silver	~~ND~~ UJL	1.2		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Sodium	200	120		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Thallium	~~ND~~ UJL	12		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Uranium	~~ND~~ UJL	25		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Vanadium	42	12		mg/Kg	5	11/16/2018 10:01:22 AM	41542
Zinc	41	12		mg/Kg	5	11/16/2018 10:01:22 AM	41542

& 6/20/19

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

DATA QUALITY ASSURANCE REVIEW

SITE NAME Tronox Section 10 Mine

WORK ORDER NUMBER 20600.012.001.1044.06 TDD NUMBER 0001/17-044

PROJECT NUMBER ________ SDG NUMBER 1811683

Weston Solutions, Inc. (WESTON®) has completed a QA review for Work Order Number 20600.012.001.1044.06, SDG No. 1811683, Tronox Section 10 Mine. Nine samples were analyzed for Target Analyte List (TAL) metals plus uranium by Hall Environmental Analysis Laboratory, Inc. Sample numbers are listed below.

SAMPLE NUMBERS

10-02-31-181031-M	10-03-31-181031-M	10-04-31-181031-M
10-05-31-181031-M	10-05-32-181031-M	10-06-31-181031-M
10-07-31-181031-M	10-08-31-181031-M	23-02-31-181101-M

This data package was validated to determine if Quality Control (QC) specifications were achieved, following *USEPA National Functional Guidelines for Organic Superfund Methods Data Review* (January, 2017), *USEPA National Functional Guidelines for Inorganic Superfund Data Review* (January, 2017), *USEPA Contract Laboratory Program National Functional Guidelines for High Resolution Superfund Methods Data Review* (April, 2016), *Quality Assurance/Quality Control Guidance for Removal Activities* (September, 2011), and/or the Regional Protocol for Holding Times, Blanks, and VOA Preservation (April 13, 1989). Specific data qualifications are listed in the following discussion.

REVIEWER Gloria J. Switalski DATE June 20, 2019

Data Qualifiers

Data Qualifier Definitions were supplied by the Office of Solid Waste and Emergency Response (September 1989) and are included in the Functional Guidelines. Data qualifiers may be combined (UJ, QJ) with the corresponding combination of meanings. Additional qualifiers may be added to provide additional, more specific information (JL, UB, QJK), modifying the meaning of the primary qualifier. Additional qualifiers utilized by WESTON are H, L, K, B, and Q.

U - The material was analyzed for, but was not detected. The associated numerical value is the sample quantitation or detection limit, which has been adjusted for sample weight/sample volume, extraction volume, percent solids, sample dilution or other analysis specific parameters.

An additional qualifier, "B", may be appended to indicate that while the analyte was detected in the sample, the presence of the analyte may be attributable to blank contamination and the analyte is therefore considered undetected with the sample detection or quantitation limit for the analyte being elevated.

J - The analyte was analyzed for, but the associated numerical value may not be consistent with the amount actually present in the environmental sample or may not be consistent with the sample detection or quantitation limit. The value is an estimated quantity. The data should be seriously considered for decision-making and are usable for many purposes.

An additional qualifier will be appended to the "J" qualifier that indicates the bias in the reported results:

L Low bias

H High bias

K Unknown bias

Q The reported concentration is less than the sample quantitation limit for the specific analyte in the sample.

The L and H qualifier will only be employed when a single qualification is required. When more than one quality control parameter affects the analytical result and a conflict results in assigning a bias, the result will be flagged JK.

R - Quality Control indicates that data are unusable for all purposes. The analyte was analyzed for, but the presence or absence of the analyte has not been verified. Resampling and reanalysis are necessary for verification to confirm or deny the presence of an analyte.

N - The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification."

METALS DATA EVALUATION

1. Analytical Method:

Samples were prepared and analyzed for metals and mercury using the procedures specified in **SW-846 Methods 6010B and 7471.**

2. Holding Times:

All samples met established holding time criteria of 180 days for ICP metals and 28 days for mercury. No qualifications are placed on the data.

3. Initial Calibration:

Level 4 data validation is not being performed on this data set at this time. In the event that level 4 validation is performed, this validation report will be revised to include the level 4 findings. No qualifications are placed on the data.

4. Continuing Calibration:

Level 4 data validation is not being performed on this data set at this time. In the event that level 4 validation is performed, this validation report will be revised to include the level 4 findings. No qualifications are placed on the data.

5. CRDL Standard:

Level 4 data validation is not being performed on this data set at this time. In the event that level 4 validation is performed, this validation report will be revised to include the level 4 findings. No qualifications are placed on the data.

6. Blanks:

A. Laboratory Blanks:

Target analytes were not detected in the method blanks at concentrations that warrant blank action. No qualifications are placed on the data.

B. Field Blanks:

No field blank samples were submitted with this analytical package. No qualifications are placed on the data.

7. ICP Interference Check:

Level 4 data validation is not being performed on this data set at this time. In the event that level 4 validation is performed, this validation report will be revised to include the level 4 findings. No qualifications are placed on the data.

8. Laboratory Control Sample (LCS):

The laboratory analyzed LCS and recoveries for these analyses were within the control limits provided. No qualifications are placed on the data.

9. Duplicate Sample Analysis:

A. Laboratory Duplicate Analysis:

Sample 10-02-31-181031-M underwent matrix spike/matrix spike duplicate analysis for the soil matrix for ICP metals and mercury. QC criteria are that the relative percent difference (RPD) values for the duplicate sample analysis be less than 20% for aqueous samples and less than 35% for soil samples for concentrations greater than five times the practical quantitation limit (PQL). For sample concentrations less than five times the PQL, the QC criteria are that the absolute difference between the samples is less than the PQL for the aqueous matrix or less than two times the PQL for the soil matrix. All QC criteria were met with the following exception:

SAMPLE ID	ANALYTE	RPD	CONTROL LIMITS	QUALIFIER FLAG
10-02-31-181031-M	Thallium	37.3	35	None, samples ND

B. Field Duplicate Analysis:

The following sample pair was submitted as field duplicates for the soil matrix for ICP metals and mercury: 10-05-31-181031-M/10-05-32-181031-M. The RPD values for the field duplicate sample analysis were within the QC criteria of less than 30% for aqueous samples and less than 50% for soil samples for concentrations greater than five times the PQL. For sample concentrations less than five times the PQL, the absolute difference between the samples is less than two times the PQL for aqueous samples or less than 3.5 times the PQL for the soil samples. All QC criteria were met. No qualifications are placed on the data.

10. Matrix Spikes/Matrix Spike Duplicates (MS/MSD):

Sample 10-02-31-181031-M underwent MS/MSD analysis for the soil matrix for ICP metals and mercury. Recoveries of the following spiked analytes were outside of the control limits provided:

SAMPLE ID	ANALYTE	%R/%R	CONTROL LIMITS	QUALIFIER FLAG
10-02-31-181031-M	Calcium	-65.6/-8.11	75-125%	None, sample conc >4X
	Antimony	14.1/13.2		UJL
	Barium	43.4/OK		None, sample conc >4X
	Manganese	-76.9/-20.0		None, sample conc >4X
	Silver	73.5/OK		UJL
	Thallium	29.2/42.6		UJL
	Uranium	42.3/38.2		JL/UJL

11. ICP Serial Dilution:

Level 4 data validation is not being performed on this data set at this time. In the event that level 4 validation is performed, this validation report will be revised to include the level 4 findings. No qualifications are placed on the data.

12. Sample Quantitation and Reporting Limits:

Level 4 data validation is not being performed on this data set at this time. In the event that level 4 validation is performed, this validation report will be revised to include the level 4 findings. No qualifications are placed on the data.

All ICP metals analytes in all samples were analyzed at a 2, 5, or 100-fold dilution. PQL for these analytes in these samples were elevated as a result of the dilutions performed.

13. Laboratory Contact

No laboratory contact was required.

14. Overall Assessment:

Antimony, silver, thallium, and uranium results in all soil samples were estimated due to low MS and/or MSD recoveries.

The analytical data is acceptable for use with the qualifications listed above.

APPENDIX F

ACCUSTAR ANALYTICAL RESULTS DATA PACKAGE

AccuStar

Laboratoire Professionnel D'analyse du Radon Depuis 1984

Radon in Air

NELAC NY 11769
NRPP 101193 AL
NRSB ARL0017

EPA Method #402-R-92-004
Charcoal Canister
NRPP Device Code 2014, 1165
NRSB Device Code 10313, 10335

Laboratory Report for:

Weston Solutions Inc.-K. Warr
5599 San Felipe Suite 700
Houston TX 77056

Property Tested: Project # 1-WESTON-0642-1707

Site #TO0005100801

Log Number	Device Number	Test Exposure Duration:		Area Tested	Result (pCi/L)
2132878	589850	06/29/2017 10:55 am	07/05/2017 1:45 pm	SEC10-C	11.1
2132879	589851	06/29/2017 11:00 am	07/05/2017 1:45 pm	SEC10-D	0.7
2132880	589852	06/29/2017 11:15 am	07/05/2017 1:45 pm	SEC10-E	0.9
2132881	589853	06/29/2017 11:20 am	07/05/2017 1:50 pm	SEC10-F	1247.9
2132882	589854	06/29/2017 11:21 am	07/05/2017 1:50 pm	SEC10-G	2.1

Comment: Weston Solutions Inc.-K. Warr was e-mailed a copy of this report.

Distributed by: Weston Solutions Inc.-K. Warr

Date Received: 07/07/2017 Date Logged: 07/07/2017 Date Analyzed: 07/07/2017 Date Reported: 07/07/2017

Report Reviewed By: Michele Cleveland Report Approved By: [signature]

Shawn Price, Director of Laboratory Operations, AccuStar Labs

Disclaimer:

The uncertainty of this radon measurement is ~+/- 10 %. Factors contributing to uncertainty include statistical variations, daily and seasonal variations in radon concentrations, sample collection techniques and operation of the dwelling. Interference with test conditions may influence the test results.

This report may only be transferred to a third party in its entirety. Analytical results relate to the samples AS RECEIVED BY THE LABORATORY. Results shown on this report represent levels of radon gas measured between the dates shown in the room or area of the site identified above as "Property Tested". Incorrect information will affect results. The results may not be construed as either predictive or supportive of measurements conducted in any area of this structure at any other time. AccuStar Labs, its employees and agents are not responsible for the consequences of any action taken or not taken based upon the results reported or any verbal or written interpretation of the results.

AccuStar
Professional Radon Laboratory Services Since 1984

Radon in Air

NELAC NY 11769
NRPP 101193 AL
NRSB ARL0017

EPA Method #402-R-92-004
Charcoal Canister
NRPP Device Code 2014
NRSB Device Code 10313

Laboratory Report for:

Weston Solutions Inc.-K. Warr
5599 San Felipe Suite 700
Houston TX 77056

Property Tested: Project # 0642-161104-0001

Site # TO0005100801
Not Indicated 539424 539425

Log Number	Device Number	Test Exposure Duration:		Area Tested	Result (pCi/L)
2007334	539424	10/28/2016 12:15 pm	11/03/2016 12:00 pm	SEC10-A	6304.9
2007335	539441	10/28/2016 12:15 pm	11/03/2016 12:00 pm	SEC10-B	8170.5
2007336	539425	10/28/2016 11:15 am	11/03/2016 11:15 am	SEC23-A	44.0

Comment: Weston Solutions Inc.-K. Warr was e-mailed a copy of this report.

Distributed by: Weston Solutions Inc.-K. Warr

Date Received: 11/07/2016 Date Logged: 11/07/2016 Date Analyzed: 11/07/2016 Date Reported: 11/07/2016

Report Reviewed By: Michele Cleveland Report Approved By: Carolyn D. Koke
Carolyn D. Koke, President, AccuStar Labs

Disclaimer:
The uncertainty of this radon measurement is ~+/- 10 %. Factors contributing to uncertainty include statistical variations, daily and seasonal variations in radon concentrations, sample collection techniques and operation of the dwelling. Interference with test conditions may influence the test results.

This report may only be transferred to a third party in its entirety. Analytical results relate to the samples AS RECEIVED BY THE LABORATORY. Results shown on this report represent levels of radon gas measured between the dates shown in the room or area of the site identified above as "Property Tested". Incorrect information will affect results. The results may not be construed as either predictive or supportive of measurements conducted in any area of this structure at any other time. AccuStar Labs, its employees and agents are not responsible for the consequences of any action taken or not taken based upon the results reported or any verbal or written interpretation of the results.

APPENDIX G

MINE SHAFT AND VENTILATION HOLE VIDEO SURVEILLANCE LOGGING DATA

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Southwest Exploration Services, LLC
borehole geophysics & video services

Southwest Exploration Services, LLC
25811 S. Ariz. Avenue Chandler, AZ. 85248
Phone: (480) 926-4558 Fax: (480) 926-4579 Web: www.swexp.com

Client: **Weston Solutons** Survey Date: **July 18, 2017**
Address: **13702 Coursey Blvd, Bldg 7** Invoice: **8019** Run: **1**
City: **Baton Rouge** State: **LA** Zip: **70817** Well Name: **Section 10 well**
Requested By: **Weston Solutions** P.O.: Well Owner:
Copy To: **Weston Solutions** Camera: **Mine Camera**
Reason For Survey: **General Inspection** Zero Datum: **Ground Level**
Location: **Ambrosia Lake / Graants New Mexico** Depth: **600 Ft** Vehicle: **750**
Field: **Ambrosia Lake**
Csg. I.D.@ Surface **120 In.** I.D. Reference: **Well Records** Casing Buildup: **None**
Operator: **Don Eckman** Lat.: Long.: Sec: Twp: Rge:

Wellbore Snapshots

12.8 Ft (See Other Side)


0024.8' Ft (See Other Side)


0028.6' Ft (See Other Side)


0084.3' Ft (See Other Side)


0124.3' Ft (See Other Side)


0130.1' Ft (See Other Side)


0153.2' Ft (See Other Side)


0177.4' Ft (See Other Side)


0184.1' Ft (See Other Side)


0249.8' Ft (See Other Side)


0273.4' Ft (See Other Side)


0291.2' Ft (See Other Side)


True Depths: (SideScan-Feet)	WELLBORE / CASING INFORMATION
	Due to a lack of centralization, camera swung side to side all through
	survey.
	Metal pipe against corner of shaft, starts at surface. Appears to be attached at surface only.
	Surface vault appears to be stable and intact.
24.8'	Open hole begins. Several large undercut sections visible.
	Stability of formation unknown.
120'	Formation appears to be competent.
130.1'	Bottom of metal pipe.
176'	Inspected one of several distinctive foramtion layers. Several low to
	high angle fractures were observed below 120 ft.
291.4'	Bottom fill. PVC pipe seen in corner of shaft . appx. 1 ft. exposed.
	Recorded from bottom to surface.

Notes:

12 WELLBORE SHAPSHOTS

12.8 Ft (Enlargement)

0024.8' Ft (Enlargement)

0028.6' Ft (Enlargement)

0084.3' Ft (Enlargement)

0124.3' Ft (Enlargement)

0130.1' Ft (Enlargement)

0153.2' Ft (Enlargement)

0177.4' Ft (Enlargement)

0184.1' Ft (Enlargement)

0249.8' Ft (Enlargement)

0273.4' Ft (Enlargement)

0291.2' Ft (Enlargement)

Southwest Exploration Services, LLC
borehole geophysics & video services

Southwest Exploration Services, LLC
25811 S. Arizona Avenue Chandler, AZ. 85248
Phone: (480) 926-4558 Fax: (480) 926-4579 Web: www.swexp.com

Client: **Weston Solutions**
Survey Date: **July 18, 2017**
Address: **13702 Coursey Blvd, Bldg. 7**
Invoice: **8019** Run: **1**
City: **Banton Rouge** State: **LA** Zip: **70817**
Well Name: **Section 10 Survey**
Requested By: **Weston Solutions** P.O.:
Well Owner:
Copy To: **Weston Solutions**
Camera: **Mine Camera**
Reason For Survey: **General Inspection**
Zero Datum: **Ground Level**
Location: **Ambroisa Lake / Grants New Mexico**
Depth: **600 Ft** Vehicle: **750**
Field: **Ambrosia Lake**
Csg. I.D.@ Surface **36 In.** I.D. Reference: **Well Records** Casing Buildup: **Light, Increasing W/ Depth**
Operator: **Don Eckman** Lat.: Long.: Sec: Twp: Rge:

Wellbore Snapshots

0061.6' Ft (See Other Side)

0080.1' Ft (See Other Side)

0084.5' Ft (See Other Side)

0117.8' Ft (See Other Side)

0119.2' Ft (See Other Side)

0193.2' Ft (See Other Side)

0196.5' Ft (See Other Side)

0198.6' Ft (See Other Side)

0204.7' Ft (See Other Side)

0243.5' Ft (See Other Side)

0345.8' Ft (See Other Side)

0351.3' Ft (See Other Side)

True Depths: (SideScan-Feet)	WELLBORE / CASING INFORMATION
	Zeroed side view at ground level. 4.7 ft. of casing is above
	ground level.
	Due to casing size could not centralize camera in hole.
21.6'	Casing joint. During survey all seen joints look to be in goog condition.
	At this point casing seems to reduce to undetermined size.
54'	Start of minor scaling.
61.6'	Well appears to become deviated causing camera to trail down low
	side of hole. This was an issue in getting camera to rotate
	approiately.
79.4'	Possible hole in casing. Water seems to be seeping from hole.
	Scaling increases, and continues to increase with depth.
198'	Casing may be deformed due to side loading.
206'	Again casing appears to be deformed.
243'	Issue with camera rotating aginst casing.
351.6'	Bottom fill. Casing seems to continue into fill.
	Recored back up to 78.4 ft.

Notes:

12 WELLBORE SHAPSHOTS

0061.6' Ft (Enlargement)

0080.1' Ft (Enlargement)

0084.5' Ft (Enlargement)

0117.8' Ft (Enlargement)

0119.2' Ft (Enlargement)

0193.2' Ft (Enlargement)

0196.5' Ft (Enlargement)

0198.6' Ft (Enlargement)

0204.7' Ft (Enlargement)

0243.5' Ft (Enlargement)

0345.8' Ft (Enlargement)

0351.3' Ft (Enlargement)

APPENDIX H

REVEGETATION PLAN

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Draft Revegetation Plan

Tronox Navajo Area Uranium Mines
Western Geographic Sub Area
McKinley County, New Mexico

Prepared for
US Evironmental Protection Agency Region 6
Weston Solutions

February 2017

CONTENTS

1 - INTRODUCTION

The US Environmental Protection Agency (USEPA) proposes to initiate a mine waste removal on approximately 1,860 acres consisting of several former uranium mine sites and associated lands to reestablish pre-mine arid grassland and scrub habitats. The removal areas are located within the Ambrosia Lake Sub-District (ALSD) area of the Grants Mining District of the Western Geographic Sub Area within McKinley County, New Mexico (Figure 1a in Appendix D). The reclamation study area consists of former underground uranium mines (Kermac #10, #23, Mine #24, Homestake Sapin #25) and associated lands. For the purposes of this report, the study area totals approximately 2,300 acres and the current removal area of approximately 1,860 acres occurs within its boundaries. However, the final removal area will be determined once ongoing analyses are evaluated.

The area is eligible for abatement activities subject to the Tronox Navajo Area Uranium Mine (NAUM) settlement, and has been identified as the West Geographic Sub Area.

The USEPA proposes to excavate at least 12 inches of top soils throughout the removal area and dispose of them at a nearby previously disturbed location, then revegetate and re-contour the site to restore, to the extent feasible, pre-mining conditions.

Revegetation Objectives

The USEPA identified the following re-vegetation objectives:

- Restore Grazing/Forage to Pre-mine Condition
- Restore Suitability for Wildlife Use
- Sustainability

Revegetation Standards

This plan has been developed to comply with the following standards:

- New Mexico Environment Department and New Mexico Energy, Minerals, and Natural Resources Department Mining and Minerals Division Joint Guidance for the cleanup and reclamation of existing uranium mines in New Mexico, March 2016 (Attachments 1 and 2).

- New Mexico State Land Office Reclamation Plan for State Mineral Lease Rule 5 Template (7-14-15).

Geographical Description of Removal Area

The removal area is located within the ALSD in McKinley County, New Mexico. The ALSD is located within an area of uranium mineralization that extends approximately 100 miles long and 25 miles wide encompassing portions of McKinley, Cibola, Sandoval, and Bernalillo counties of New Mexico. The study area occurs from approximately 6,920 to 7,200 feet in elevation above mean sea level. It is located east of Little Haystack Mountain and southwest of San Mateo Mesa (Figure 1a).

Removal Area Location

The WGSA removal area consists of approximately 1,860-acres of former underground uranium mines and associated lands selected for remediation within a larger study area of 2,300 acres (Figures 1a-1c in Appendix A). The site is located in the ALSD, McKinley County, New Mexico approximately 17 miles northwest of Grants, New Mexico and 5.0 miles northwest of the intersection of New Mexico State Highways 509 and 605 (Figure 1b).

In relation to regional population centers, the site is located approximately 70 air miles and 100 road miles west/northwest of Albuquerque, New Mexico; 340 air miles and 540 road miles from Denver Colorado; and approximately 280 air miles and 360 road miles northeast of Phoenix, Arizona.

The removal are is located in Township 14 North, Range 10 West Sections 10, 11, 15, 22, 23, 24, 25, 26, and Range 9 West; Section 30. It appears on the *Ambrosia Lake* and *Goat Mountain, New Mexico* US Geological Survey 7.5-minute quadrangle maps (Figure 1a). The geographic center of the site is located at approximately Universal Trans Mercator (UTM) Z13S, North American Datum (NAD) 83 240566 3923265 (Latitude 35.419035 degrees north/Longitude 107.85731366044111 degrees west).

<u>Site Access/Constraints</u>
The total distance from Interstate 40 (I-40) to the site is approximately 19 miles. The site is accessed directly from the New Mexico 509 roadway (NM 509). This is a secondary two-lane (11-foot wide lanes) with unpaved shoulders and 3-foot wide paved taper. NM 509 is accessed via the New Mexico 605 roadway (NM 605) approximately 5 miles south of the entrance to the site.

NM 605 has a similar typical section. NM 605 extends approximately 13.5 miles southward to its junction with historic U.S. 66, in Milan, New Mexico. It is a four-lane divided roadway with a median, 12-foot wide lanes, and 8-foot wide exterior paved shoulders. It is located 0.2 mile from Interstate 40 (I-40). No constraining bridges or underpasses occur between I-40 and the entrance to the site.

Access to the site from the north is available via NM 509 approximately 30 miles to its junction with the Navajo 9 roadway, another secondary roadway with 11-foot wide lanes, but with 6 foot paved shoulders. The Navajo 9 junction with NM 371 (also a 2 lane roadway with 6-shoulder facility) occurs approximately 20 Miles to the west. NM 371 meets I-40 approximately 28.5 miles south. There are no constraining bridges or underpasses. The total distance from the site access road to I-25 via the north route is approximately 83 miles.

East of the junction with NM 509, Navajo 9 becomes NM 197. It terminates at US Highway 550 near Cuba, New Mexico, approximately 64.5 miles from the junction of NM 509. The total distance from the turnoff to the site to Cuba, New Mexico is approximately 95 miles. No low bridges or underpasses appear to be present.

<u>Land Ownership</u>
Land ownership is private and Bureau of Land Management (BLM). Land ownership is depicted on figure 1 (Appendix A).

Summary of Site Conditions

The removal area occurs within the Semiarid Tablelands ecoregion (Griffith et al. 2006). This ecoregion is characterized by dry plains, mesas, valleys, and canyons formed from sedimentary rocks. It supports grasslands, savannas, woodlands, and desert scrub communities (Dick-Peddie 1993).

<u>Vegetation</u>
The study area supports Plains-Mesa Grassland, Great Basin Desert Scrub, Arroyo Riparian vegetation communities, as well as a small area of Juniper Savanna. Plains-Mesa Grassland vegetation occurs in in the center of Section 24; the northeast and southeast corners of Section 25; the northwest corner of Section 26, and Section 10, and within Section 30.

It is dominated by blue grama (*Bouteloua gracilis*) and galleta (*Pleurapis jamesii*) grass, which account for most vegetative cover. Associate grasses such as ring muhly (*Muhlenbergia torreyi*), spike muhly (*Muhlenbergia* wrightii), spike dropseed (*Sporobolus contractus*) and several shrubs such as winterfat (*Krascheninnikovia lanata*), four-wing saltbush (*Atriplex canescens*), and horsebush (*Tetradymia canescens*) are also present.

Two scrub communities are present. The largest is a four-wing saltbush community dominated by four-wing saltbush (*Atriplex canescens*), blue grama, galleta, alkali sacaton (*Sporobolus airoides*), and snakeweed (*Gutierrezia sarothrae*). This community is located within the southwest corner of Section 24; the southern portion of Section 23; the northern portion of Section 26; and the northwest corner of Section 25. A rabbitbrush scrub community dominated by rubber rabbitbrush (*Ericameria nauseosa*), blue grama and galleta is located within Section 22, the east side of Section 24; the center of Section 25, the east side of Section 10. A small area also occurs within the northwest corner of Section 30.

The Arroyo Riparian community is confined to a few ephemeral waterways dominated by rabbitbrush, western wheat grass, galleta, gumweed (*Graindelia nuda*), and hoary purple aster (*Machaeranthera canescens*). With the exception of small segments of waterways in the Section 30, Arroyo Riparian habitat is confined to sections 22, 23, 25, and 26.

Juniper Savanna is dominated by one-seed juniper (*Juniperus monosperma*) and at one location in section 22.

<u>Existing Soils</u>
Soils at the study area consists of the following US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS 2015) map units listed by highest percent occurrence in the study area: Penistaja-Tintero complex, 1 to 10 percent slopes (soil unit: 205); Marianolake-Skyvillage complex, 1 to 8 percent slopes (soil unit: 210); Hagerwest-Bond fine sandy loams, 1 to 8 percent slopes (soil unit: 220); Sparank-San Mateo-Zia complex, 0 to 3 percent slopes (soil unit: 230); and Uranium Mined Lands (Soil unit 265).

Area soils are generally well drained; not hydric or slightly hydric; moderately susceptible to wind and water erosion; and occur more than 200 centimeters from ground water depth. Soil chemistry and fertility parameters were obtained via laboratory analysis of samples collected from the site (Weston 2016). Detailed results are provided in Appendix A. In general, analyses indicate that area soils have low fertility; are low in boron, zinc, and phosphorus; high in calcium, magnesium, and sodium; and have a low carbon/nitrogen ratio. The pH of soil sampled throughout the area range from 7.9 to 9.0.

<u>Special Features</u>
One special feature is present at the site:

- Pond wetland (augmented with planting)

<u>Restricted Areas</u>
The following areas must be avoided (Figure 1c):

- Eagle perch trees (sections 24 and 30)
- Groups of juniper trees/juniper savanna area (north section 22)
- Coniferous woodland area (south section 22, not within the current removal area)

Ecological Function

Grassland and grassland/shrub communities provide habitat for keystone species such as prairie dogs and associated animals, such as burrowing owl. They also provide browse and forage for elk, deer, and graze for cattle; cover for a variety of small mammals and reptiles; and nest sites for small songbirds. The savanna area provides some small mammal habitat and potential nest sites for birds, including raptors. Trees provide perch sites for raptors, and vertical structure for songbirds.

A pond feature retains stormwater flows near the western edge of the removal area, which supports tree canopy, food crop, and wetland vegetation growth and provides water for wildlife, including waterfowl and important predators.

All vegetation provides erosion control. Grasses provide a food source for mammals and insects. Insects provide a food source for reptiles, mammals and birds. An arroyo conveys stormwater flows through the site.

2 - RECLAMATION GOALS /PERFORMANCE

Reclamation Units

The removal area has been divided into four reclamation units for planting purposes. Each unit is associated with specific soil preparation and seeding methodology. Unit boundaries were defined based on existing vegetation, soils characteristics, 2016 soil sampling data and historic aerial photography. Some portions of the study area are not included in the removal area. As a result, disjunct parcels occur within units. All units with the exception of Unit 4 are associated with one soil treatment and planting schedule. The two components of Unit 4 (4a and 4b) are treated differently both in preparation and planting.

Reclamation Unit Boundaries

Reclamation units are identified in Figure 2. The reclamation units are:

- Unit 1 – Plains Mesa Grassland (loam soils)
- Unit 2 – Great Basin Scrub/Rabbitbrush (clay loam soils)
- Unit 3 – Great Basin Scrub/Four-wing saltbush Scrub (clay soils)
- Units 4a/b – Arroyo /Pond Wetland (clay soils)

Defining points along the boundaries of reclamation units (or center point for disconnected units/unit portions) are provided in Figure 2 and associated with UTM coordinates provided in Table A1 (Appendix A).

Unit Performance Goals and Standards

The general objective for reclamation units is to meet or exceed the percent cover observed during field evaluations. The minimum percent cover is based on observations of existing conditions, which were evaluated by community type. Some areas will be avoided for removal and some communities are combined for revegetation purposes to reduce the number of units and complexity of reclamation.

Unit 1-Plains Mesa Grassland

This is a large grassland community with low shrub cover. The objective for this unit is to meet a minimum total 37 percent cover comprised of mostly of grasses, equal or greater than the current percent cover, and reflect the general species composition of the area (Table 2.1).

Table 2.1 – Target Range for Percent Cover by Species: Unit 1

Species	Range Percent Cover
Blue grama (*Bouteloua gracilis*)	
Galleta (*Pleuraphis jamesii*)	
Spike muhly (*Muhlenbergia wrightii*)	
Western wheat grass (*Pascopyrum smithii*)	
Spike dropseed (*Sporobolus contractus*)	
Subtotal	**35-40%**
Winterfat (*Krascheninnkovia lanata*)	
Subtotal	**2-5%**
Total	**37 -45%**

Unit 2-Great Basin Scrub/Rabbitbrush

This is principally a shrub community that provides at least 25 percent ground cover of grasses. The objective for this unit is to meet a minimum total of 50 percent overall cover; nearly half of shrubs with a ground cover of grasses equal to or greater than the current percent cover, and reflect the general species composition of the area (Table 2.2).

Table 2.2 – Target Range for Percent Cover by Species: Unit 2

Species	Percent Cover Range
Blue grama *Bouteloua gracilis*)	
Galleta (*Pleuraphis jamesii*)	
Western wheat grass (*Pascopyrum smithii*)	
Alkali sacaton (*Sporobolus airoides*)	
Spike muhly (*Muhlenbergia wrightii*)	
Subtotal - Grasses	**25-30%**
Rubber rabbitbrush *Ericameria nauseosa*)	
Subtotal - Shrubs	**25-30%**
Total	**50-60%**

Unit 3- Great Basin Scrub-Saltbush

This is a shrub community dominated by four-wing saltbush with a limited ground cover of grasses. The objective for this unit is to meet a minimum total 30 percent cover comprised of grasses and shrubs, equal to or greater than the current percent cover, and reflect the general species composition of the area (Table 2.3).

Table 2.3 – Target Range for Percent Cover by Species: Unit 3

Species	Range Percent Cover
Galleta (*Pleuraphis jamesii*)	
Western wheat grass (*Pascopyrum smithii*)	
Blue grama *Bouteloua gracilis*)	
Alkali sacaton (*Sporobolus airoides*)	
Vine mesquite (Panicum obtusum)	
Spike dropseed(*Sporobolus contractus*)	
Hoary tansyaster (*Macheranthera canescens*)	
Subtotal - Grasses and Forbes	**15-20%**
Four-wing saltbush (*Atriplex canescens*)	
Subtotal - Shrubs	**15-20%**
Total	**30-40%**

Unit 4a- Arroyo

This unit is confined to an arroyo system located along the southern site boundary. Vegetation is comprised of forbs, shrubs and grasses. The objective for this unit is to meet a minimum total 40 percent cover, equal to or greater than the current percent cover, and reflect the general species composition of the area (Table 2.4).

Table 2.4 – Target Range for Percent Cover by Species: Unit 4a

Species	Range Percent Cover
Galleta (*Pleuraphis jamesii*)	
Western wheat grass (*Pascopyrum smithii*)	
Blue grama *Bouteloua gracilis*)	
Alkali sacaton (*Sporobolus airoides*)	
Common sunflower (*Helianthus annuus*)	
Hoary tansy aster (*Machaeranthera canescens*)	
Subtotal - Grasses and Forbes	**25-30%**
Four-wing saltbush (*Atriplex canescens*)	
Rubber rabbitbrush *Ericameria nauseosa*)	
Subtotal - Shrubs	**15-20%**
Total	**40-50%**

Unit 4b- Pond Wetland

This unit consists of an existing stock tank and immediately surrounding area located along the western edge of the site within Section 22. Stormwater runoff from surrounding slopes and arroyos collects in the pond with sufficient frequency to sustain wetland vegetation. The objective for this unit is to increase shrub, tree and ground cover. No existing wetland vegetation would be removed. Trees and shrubs would be planted, and the 4a seed mix would be raked into surrounding soils (Table 2.5).

Table 2.5 – Target Range for Percent Cover by Species: Unit 4b

Species	Range Percent Cover
Coyote willow (*Salix exigua*)	
Torrey wolfberry (*Lycium torreyi*)	
Subtotal - Shrubs	**15-20%**
Rio Grande cottonwood **(***Populus deltoides***)**	
Subtotal - Trees	**5-10%**
Total	**20-30%**

Ecological Function

Unit 1 - Grassland communities are to provide burrow systems and nesting habitat for keystone species such as Gunnison's prairie dogs and nesting habitat for burrowing owl; as well as some browse/forage for elk, deer, and graze for cattle; cover for a variety of small mammals and reptiles; and nest sites for small songbirds. Grasses provide a food source for mammals and insects. Insects provide a food source for reptiles, mammals and birds.

Unit 2- Grassy shrublands dominated by rabbitbrush are to provide structure for nesting birds and small wildlife. The grassy groundcover provides habitat for small colonial mammals and forage for elk as well as graze for cattle. The larger open areas along the edges of this unit may also provide habitat for prairie dogs.

Unit 3 – The four-wing saltbush and limited grassland community is to provide cover and habitat for small mammals and nesting habitat for small songbirds and predatory birds, particularly species such as the loggerhead shrike and sparrows; as well as and provide forage for elk, livestock and cover to small mammals.

Unit 4a - Arroyo riparian communities are to provide shade, food and cover to wildlife and livestock as well as nest sites to birds. Arroyos will direct and slow stormwater flows as well as prevent seedbed loss and sedimentation due to sheetflow during large storm events.

Unit 4b- pond wetland is to be planted to add vertical structure, increase shade and cover; provide a wider range of water and food resources to birds, reptiles, insects, mammals, and amphibians. If a permanent water source feature (windmill) is successfully added, a constant water source, perennial wetland function (such as sediment catchment and surface water quality improvement), and aquatic habitat once present in the vicinity, but not currently available, would be restored.

3 – RECLAMATION/REVEGTATION WORK PLAN

Due to the size of the reclamation area, it may be necessary to complete revegetation by reclamation unit over a period of several years. Reclamation tasks shall be completed for each reclamation unit in the order provided in Table 3.1. Seasonal limitations associated with each task, if any, are identified by color coding (green-suitable, red- unsuitable) in the schedule below.

Work Schedule: Task Order by Monthly Task Suitability

Task Order	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Install BMPs	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable
Clear/Grub*	Suitable	Suitable	Suitable	Suitable	Suitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable
Remove Soil	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable
Grade	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable
Constructed Features	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable
Soil Preparation	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable
Stabilizing Cover Crop	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable
Seeding/Planting	Suitable	Suitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Suitable
Irrigation	Suitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable
Vegetation Monitoring	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Suitable	Suitable	Suitable	Suitable

Unsuitable - **Suitable**

*Avoid nesting season or provide preconstruction surveys

Staging Areas /Limitations

Materials used in Reclamation Unit 4b will include live plants. The staging area for this unit is be located close enough to a water source to allow for watering the material awaiting planting, but not within a potential flood area.

- No staging area will be placed within a restricted location.
- The contractor will site staging areas more than 200 feet from the arroyo/pond banks.
- All staging areas will be graded/vegetated according to their assigned reclamation unit specifications prior to completion of work.

Availability of Water and Limitations of Use

Water piped through the site is expected to be available for use in watering the site to establish vegetation. This water is expected to be available for 5 growing seasons of reclamation effort. Water needed for dust control during excavation and grading, as well as irrigation, is also expected to be available from this source.

Revegetation Schedule

The revegetation schedule is dependent upon the seeding and planting schedule, which will occur in the fall. Soil preparation and soil amendment predate the planting and must be completed sequentially prior to fall seeding and planting.

Clearing and Grubbing

Once restricted areas have been identified, the removal of shrubs and other vegetation may proceed. Because of sensitivity of nesting birds, this operation should be completed outside the nesting season (March to September). If it cannot be completed outside the nesting season, a detailed survey of every the clearing zone for active bird nests must be completed prior to the onset of clearing and grubbing.

Constructed Features

Constructed features will include installation of protective fencing and planting protections at the Unit 4b pond wetland, as well as the construction of a windmill to provide a small but continuous source of water at the wetland, if this option is feasible (depending upon depth to water). In addition, artificial burrows may be installed in several locations within Unit 1 (Figure 3c) to temporarily replace lost nest sites for western burrowing owls.

Soil Preparation—Fertilizers, Micronutrients and Soil Amendments

Soil preparation would occur upon completion of clearing, grubbing, and soil removal within the reclamation area. Since it appears that the soil removal will consist of a protracted series of events, the soil preparation may occur sequentially as tracts of land are cleared and excavated. The pace of soil preparation will be dependent upon the rate of soil removal. However, within each calendar year applications of fertilizers, micronutrients, and amendments must be completed by the middle of September.

Seeding, Planting, Cover Crop and Mulching

Seeding and planting is recommended for the fall when seeds/plants are dormant. The cover crop would be planted at the same time, as it is included in the seed mix. Mulching would occur immediately after seeding. However, clearing and excavation processes will be ongoing year round leaving open areas that could be vulnerable to erosion. A sterile interim-cover crop is recommended to stabilize these areas until the site is ready for fall planting. Water would be broadcast to establish cover crops. The cover crop would be mowed in the fall and disked into the soil prior to seeding.

Watering

If an interim cover crop is used, then watering would likely be required to establish and maintain it. Since the primary reclamation plants will be seeded in the fall, they should germinate from winter and early spring moisture. Precipitation events should be monitored during the growing season and, if a drought develops, watering should be implemented as described in the revegetation section.

Grading Plan and Constructed Features

There are no specific grading requirements or constructed features within Units 2 or 3.

Re-contouring of the Unit 4a arroyo channel after excavating to reflect pre-removal ratios is recommended. The purpose is to maintain the flow along the channel once removal is complete to avoid overbank sheet flows that could result in scouring or sedimentation in seeded areas, as well as restore original function.

Unit 1 constructed features would consist of installing artificial burrows in created soil berms to provide suitable nest sites for western burrowing owls while pre-reclamation conditions re-develop (Figure 3c).

Unit 4b constructed features are to provide protection to plantings to allow vegetation to establish, and a permanent source of water to a localized area (If windmill is installed). No grading of this area is recommended. Once removal is complete, small drainages on slopes surrounding this unit are expected to reestablish without grading.

Soil Preparation

Upon completion of excavation, soil should be graded and smoothed to remove high or low spots created by excavation that might impede soil preparation or the seeding process. Access to the soil preparation areas will be available via temporary roads created during the excavation. Staging areas will be those used during the excavation process.

Once the surface soil is removed the entire site should be evaluated to determine whether special equipment may be necessary to prepare the soil for planting. Large portions of the study area have clay or clay loam soils at the 12-inch deep soil removal level. The tilling process to incorporate soil amendments may be difficult in clay soil, particularly if the soil is wet.

Soil analysis from the study area indicated carbon to nitrogen (C/N) ratios ranged from as low as 1:1 to a high as 809:1. Even in areas where the ratio was close to a desirable 30:1, the actual carbon and nitrogen levels were low. A ratio of 30:1 promotes rapid composting. Researchers report optimum values ranging from 20 to 31:1 (Whatcom 2016). Because nitrogen levels are low throughout most of the removal area, these levels must first be adjusted; then soil amendments added to balance the C/N ratio to a desirable level of 30:1.

<u>Discussion of Soil Amendment Sources</u>
Traditional organic soil amendments include sawdust, bark, and manure. Other potential sources of amendments are compost and humate, both of which are available locally. The following is a discussion of each of these products and their potential application rates at the site (Potential sources are provided in Appendix B).

Humate
Humate is a naturally occurring material composed of highly weathered organic compounds including salts of humic, ulmic, and fulvic acids. It is used principally as a soil amendment in agriculture. Humate, when used as a soil amendment or conditioner, has many useful properties which include: an increase in root density, an increase in soil depth, retention of soil moisture, increase in soil aeration, and a decrease in soil density.

By whole rock analysis, humate contains 80 percent organic material (most of which is carbon) and 20 percent inorganic material. Humate contains 2 to 5 percent nitrogen. New Mexico humate also contains gypsum ($CaSO_4$), pyrite (FeS_2), and siderite ($FeCO_3$), sources of calcium, sulfur, and iron (Sandia National Laboratories 2012, 2013).

The application of humate can raise the C/N ratio, increase the available nitrogen, and increase the available micronutrients. One of these micronutrients is Boron, which was low within most samples in the removal area.

Recent studies (Lodhi et. al. 2013) indicate that the C/N ratio within humates generally ranges from 30.92 to 44.16. New Mexico material near Cuba was found to have a C/N ratio of 30 to 40:1. Nitrogen content within state humates ranges from 1 to 5 percent (Peace 2016).

Based on a desired C/N ratio of 30:1, and that the soil amendment is to be applied to the top 6 inches of soil, the recommended application of humate was calculated. To calculate the proper amount of humate to add to the soil to reach a C/N ratio of 30:1, the existing level of nitrogen was used as the starting point. The existing levels of nitrogen vary widely across the site. Four of the 22 samples had medium levels of nitrogen present. The higher the levels of existing nitrogen, the more humate will need to be added to reach the C/N ratio of 30:1.

When humate is used, specific standards should be applied to the material. Accepted industry standards set a minimum of 70 percent humic substances (i.e. humic, fulvic and ulmic acids). Humate comes out of the ground at approximately 22 percent moisture content. Exposed to the dry southwest atmosphere is loses moisture rapidly. When used as a soil amendment no specific moisture content is needed, but from the economic standpoint as far as weight it should not me more than 22 percent moisture.

Run of mine material excavated from the mine varies in particle size from ablation (almost powder) to 90 millimeters (mm) in size. As the material dries it breaks down into smaller particle sizes. Smaller particles are released into the soil quicker than larger particles. Particles 1-2 millimeters in size fast-release in a few weeks to a month or two. Particles can be screened to calibrate the size. However, using runoff mine material provides a wider range of particle sizes from the powder that would release into the soil very quickly to pieces over in inch in size that would be much slower release. The run of mine material may be most suitable for the reclamation process as it provides a slow release of material over time.

Table 3.1 presents the existing nitrogen in ppm for 22 samples collected, as well as the volume of humate in pounds that would need to be added to elevate the C/N ratio to 30:1. Fifty percent of samples indicated medium, high or very high nitrogen levels. Nearly all of these were samples taken within Unit 3. Conversely, most of the samples taken from Units 1 and 2 indicate low levels of nitrogen. These account for the higher levels of humate recommended for Samples SO19-SO22. The soil samples are taken at point locations and as they represent a localized area they can as a single point be high or low.

To adjust for individual variation in points the soil sample data for the points within each of the planting units were averaged. There are currently at least three humate mines in New Mexico that are providing commercial sources of humate and are located approximately 2 to 2.5 hours driving time from the study area (Appendix B).

Table 3.1 - Application Rates of Humate to Adjust C/N at Sample Sites

Soil Sample	Nitrate Nitrogen PPM	Pounds/Humate to achieve 30:1 C/N
S01-1609	9.1	764
S02-1609	8.4	705
S03-1609	12	1008
S04-1609	11	924
S05-1609	10	840
S06-1609	12	1008

Soil Sample	Nitrate Nitrogen PPM	Pounds/Humate to achieve 30:1 C/N
S07-1609	8.6	722
S08-1609	11	924
S09-1609	10	840
S010-1609	8.9	747
S011-1611	9.1	764
S012-1611	7.9	663
S013-1611	8.3	697
S014-1611	12	1008
S015-1611	17	1428
S016-1611	10	840
S017-1611	8.7	730
S018-1611	12	1008
S019-1611	44	3696
S020-1611	74	6216
S021-1611	45	3780
S022-1611	30	2520

Sawdust

Sawdust is a common amendment used to improve C/N ratio, which varies depending upon weathering. Nearly all the sawdust available in New Mexico is from pine trees. Fresh pine sawdust (2 months) can have a C/N ratio of 625:1) (Whatcom 2016). Applications of amendments with such a high C/N ratio would probably require the application of additional nitrogen at a rate of 5 to 10 pounds per ton of fresh sawdust. However the C/N ratio in sawdust weather for 3 years declines to about 142:1. Uncomposted sawdust is slow to break down and can tie up nitrogen (CSU Extension 2016). If uncomposted sawdust is used, the C/N ratio must be determined prior to application to determine whether additional nitrogen is needed.

US Forest Service studies (Koll et. al 2010) found applications rates of 7.6 tons of pine sawdust per acre provided amendment properties similar to peat and hardwood sawdust. On average, dry sawdust weighs approximately 353 pounds per cubic yard. Recommended application rates of dry, weathered sawdust are 7 to 10 tons or 40 to 55 cubic yards per acre. Although there are numerous lumberyards in New Mexico, state directories currently only list four active sawmill operations (Appendix B).

Manure

Manure is a byproduct of diary operations and feed yards. Composted dairy manure C/N ratios vary. If manure is a selected soil amendment, the use of dry composted dairy manure and testing of sources is recommended to allow accurate calculation of application rates. Application rates vary from 30 to 100 cubic yards per acre, with 50 cubic yards per acre being typical. Dry manure contains about 2.5 cubic yards per ton. Studies in Vermont (Magdoff and Van Es 2009) found that within heavy clay soils, organic matter levels were only maintained at rates equal to 20 tons or more of manure per acre, which would be approximately 50 cubic yards per acre. There are many dairy manure sources in New Mexico (Appendix B).

Compost

Composted material is available at a variety of locations in New Mexico. Most offer municipal yard waste, which includes leaves, brush, and grass clippings. Fresh yard trimmings can contain 1.2 to 2.3 percent nitrogen, 0.2 to 0.3 percent phosphorus, 0.5-1.0 percent potassium, 50-60 percent organic matter. Because of the uncertainty of the origin of the source material for the compost, rates of application can vary from 40 to 270 cubic yards per acre with a typical rate of application of 50 cubic yards per acre.

Many municipal compost sources are vegetative-product based, but incorporate bio-solids, feed, and stable beddings, which can increase levels of nitrogen and may have lower the C/N ratio. If compost is derived principally from wood and brush cuttings, it may have a substantially higher C/N ratio and may require the application of nitrogen.

Typically, composted material is applied at a rate of 40 to 50 cubic yards per acre, but this may vary depending upon the material. Particle size of the compost material can also vary. Active compost facilities nearest to the site are listed in Appendix B.

Recommended Amendment Procedure

The recommended source of carbon for amending removal area soils is humate sourced from New Mexico. Based on soil sample analysis, nitrogen is low at about half of sampling locations. Boron, Zinc, Sulfur and Phosphate were low at nearly all locations. The pH is high in all of the reclamation units, and more than half of samples ranged from 8.5-9.0. The removal area average pH is 8.4. Sulfur will be added to the soil to adjust the pH.

The rate of application of nitrogen, micronutrients, and amendments will vary slightly between the reclamation units. The application rates of nitrogen and micronutrients were adjusted to account for the use of humate as the primary carbon soil amendment (If humate is not the selected carbon source, these rates must be adjusted). Table 3.2 provides the application rates per unit. Unit 4b is excluded as it will be planted but not cleared or graded. Humate contains nitrogen and many micronutrients needed in the removal area soils. However, the addition of sulfur, zinc, boron, nitrogen and phosphorus is recommended.

The soils should be amended according to the following order to ensure efficacy:

1. **Add humate**, run of mine (minimum 70 percent humic substances/ 22 percent moisture) plus **Sulfur** in the form of S-granules at 90 percent purity and approximately 0.3 centimeters (cm) particle size.

2. **Zinc** and **Boron** can be mixed in water then sprayed onto prepared soils and allowed to dry prior to application of next in sequence.

3. **Nitrogen** in ammonium and nitrate form (UN 32 16 percent Urea, 8 percent nitrate) plus **Phosphorus** in the form of rock phosphate applied together and tilled to six inches.

Carbon

Humate should be acquired from New Mexico sources for which the micronutrient composition is known. If other sources are used, then a chemical analysis should be completed on micronutrient content, and adjustments to the application rate of fertilizers and micronutrients may be required (minimum 70 percent humic substances [humic, fulvic and ulmic acids], with no more than 22 percent moisture content). Screened or run of mine material would be acceptable, but run of mine material provides a slow release of material over time most suitable for reclamation.

Humate is to be broadcast and tilled/disked into soil to a depth of 6 inches. If humate is unavailable, use of dry, composted dairy manure is recommended. Final application rates to be determined after testing. Spread with a manure spreader and disk/till into the soil to a depth of 6 inches.

Table 3.2 - Pounds per Acre Application of Soil Amendments within Reclamation Units

Reclamation Unit	Nitrogen	Phosphorus	Zinc	Boron	Sulfur	Humate
1	70	100	8	1	500	800-1000
2	70	100	8	1	550	1000-1300
3	10	100	8	1	350	1800-2200
4a	50	100	8	1	500	800-1000

Nitrogen and Micronutrients

Sulfur in the form of S-granules at 90 percent purity and approximately 0.3 centimeters (cm) particle size should be used.

Zinc sulfate should be mixed into water and the subsequent zinc solution should be sprayed onto the soil and tilled in.

Boron fertilizer should be dissolved in water and sprayed onto the soil. If boron fertilizer cannot be found than 20 Mule Team Borax can be utilized by mixing 1tbsp into 5 gallons of water and applying spray applying 85 gallons per acre.

Nitrogen will all be added in solid form and should be broadcast across the reclamation units and subsequently tilled into the soil to a depth of 6 inches. After the application of nitrogen, the site should be watered to prevent the formation of hot spots in the soil.

Rock Phosphorus and elemental sulfur should be broadcast and tilled into the soil.

Seeding and Planting

It is recommended that seeding and planting not occur less than 4 weeks after the application of humate/sulfur to ensure a stable soil pH. Seventeen vascular plant species were selected for revegetation, including warm and cold season grasses, riparian and upland shrubs, and a riparian tree. Table 3.3 provides a list of plant species recommended for the revegetation of the removal area, and summary of specific soil needs and seasonal attributes for each species.

Table 3.3 – Revegetation Species

Species	Season	Soil Type	Sodium/pH Tolerance	Precip. Needs (inches)	Flowering	Rhizomes
GRASSES						
Galleta (*Pleuraphis jamesii*)	Warm	All	Tolerant	5-16	Summer	Yes
Blue Grama (*Bouteloua gracilis*)	Warm	Clay	Moderate pH 6.5 to 8.3	12-14	Summer	Short
Spike dropseed *Sporobolus contractus*)	Warm	Sandy	Fairly Tolerant	8-10	Summer	No
Alkali sacaton (*Sporobolus airoides*)	Warm	Clay	Tolerant of Saline pH 6.5 to 8.6	6-10	Summer	No
Vine mesquite *Panicum obtusum*)	Warm	Clay	pH 4.8-7.0	8	Summer	Stolon-iferous
Western Wheatgrass (*Pascopyrum smithii*)	Cool	Fine/heavy well drained	Tolerant	10 to 12 best @12-20 seeded	Seeds in June	Yes
Bottlebrush squirreltail (Elymus elymoides)	Cool	Fine texture to coarse/ gravelly	Tolerant Moderately saline	8-10	Spring-Summer	No
Spike muhly (*Muhlenbergia wrightii*)	Warm	Fine to coarse	Moderate	12-16 or lower	Summer	No
SHRUBS						
Winterfat (*Krascheninnikovia lanata*)	NA	All Soils	Fairly Tolerant	5 -20	Spring - Fall	No
Four-wing saltbush (*Atriplex canescens)*	NA	Calcareous soils	Very Tolerant	8 -15	Summer	No
Rubber rabbitbrush (*Ericameria nauseosa*)	NA	Medium to coarse	Moderate pH 5.4 to 8.2	6 -18	Fall-winter	No
Coyote willow (*Salix exigua*)	NA	Sand, loam or clay	Moderate pH 7.0-7.6 or ranging	persistent	Spring	A root sprouts
Torrey wolfberry (*Lycium torreyi*)	NA	Alkali soils	Tolerant Alkaline	8-15	April-October	No
TREES						
Cottonwood (*Populus deltoides ssp. wislizeni*)	NA	Most soils	Tolerant	6-15	Spring	No
FORBS						
Hoary tansyaster (*Macheranthera* canescens)	NA	Wide range	pH6.0-8.4 Alkaline/saline	8-15	Summer	No
Common sunflower (*Helianthus annuus*)	NA	Wide range	5.5-8.0	8-15	Summer	No
COVER CROP						
Quickguard (Sterile Triticate)	Cool	Wide range	Tolerant	1 -10	Sterile	No

Seed Application Methods and Times

Due to the types and sizes of seeds being used, seeding will require both drilling and broadcast methods. There are no restrictions as to the sourcing of the seeds, but all seeds should be certified weed-free and should be from regional southwestern or Great Basin area suppliers. Specific varieties have been recommended for several grass species. The seeding specifications apply to all reclamation units. Unless otherwise noted in the contract, the prescribed mix and rate will be uniformly applied over each reclamation unit. Prior to shipping, the seed mix should be divided by the seed supplier into those that are to be drilled, and those to be broadcast.

The seedbed will be prepared to a depth of 6 inches by tilling with a disc, harrow, or chiseling tool. All competitive vegetation will be uprooted during seedbed preparation, and the soil will be uniformly worked to a surface free of clods, large stones, or other foreign material that would interfere with seeding equipment. The extent of seedbed preparation will not exceed the area detailed in the plans. On slopes of 3:1 or less, a combination of drill seeding and broadcast seeding will be used.

Drill seeders must be capable of handling a variety of different seed textures. Drill rows will be no greater than 12 inches on center. All drilling will be completed parallel to the contour of the land where practical. Seed will be drilled to a depth of 0.25 to 0.50 inches.

Steeper slopes (greater than 3:1) will be broadcast seeded. Broadcast seeding will also be used for certain tiny seeds that need to be planted at shallow depths or those with fluffy seed coats. Broadcast seeding can be accomplished with hand held spreader, all-terrain-vehicle mounted, tractor-mounted, or other methods acceptable to the USEPA and capable of spreading seed uniformly may be used. The volume of seeds should be doubled for those species that are specified for drilling but need to be broadcast on steep slopes.

Vehicles and other equipment unrelated to the seeding process will not travel over seeded areas. If rain or some other event prevents seeding to the proper depth, the contractor will again prepare the seedbed. The contractor will protect and care for seeded areas until final acceptance of the work and will repair all damage to seeded areas caused by pedestrian or vehicular traffic.

Each bag of seed will be sealed and labeled by the seed provider in accordance with federal and New Mexico Department of Agriculture labeling laws. The seed analysis will be no older than live (5 months) for seed shipped interstate and no older than 9 months for seed shipped intrastate. Additionally, the contractor will furnish documentation as to origin and pure live-seed content as determined by a certified testing laboratory. Pure, live seed shall be defined as percent purity times percent germination including dormant seed, divided by 100.

Areas will be seeded at the onset of the dormant period in the fall, from the middle of September until the beginning of summer. The recommended cover crop (Quickguard Sterile Triticate) will be incorporated into the seed mix. Fall planting is recommended in order to minimize the failure of seeding due to sporadic or insufficient precipitation. Planting into the dormant season allows the seeds to take advantage of the winter moisture. However, if sufficient irrigation water is available to establish and maintain seeded material, seeding may be completed throughout the growing season into the fall.

Mulching

Barley straw mulch will be applied at a rate of 2,000 to 3,000 pounds of air-dry straw per acre and crimped. Rotted or moldy straw will not be used. Mulching will not be permitted when wind velocity exceeds 15 miles per hour. The mulch shall be spread uniformly over the area either by hand or with a mechanical mulch spreader. When spread by hand, the bales of mulch shall be torn apart and fluffed before spreading.

Planted Material

All planted material must be acquired from local or regional sources so material is naturalized to the area climate. It is recommended that acquired plant material be in 1 gallon stem pots 4x4x14 inches deep, or some similar container. Care must be taken when transporting material to ensure that the root balls are not desiccated in the process. Once the material arrives at the site, it should be inspected to ensure it is healthy and meets the pot specification requirements. If the material must be stored prior to planting, it should be placed in a shaded area and should be inspected on a daily basis and watered as needed.

Fall planting is recommended, and the material should be going into fall dormancy at the time of planting. The leaves on the planted material should be falling or already have fallen at the time of planting.

Potted material should be planted to the top of the surface layer in the pot and immediately watered after installation. A log will be kept identifying the height of shrubs, and both height and stem diameter at the base of the planted trees will be recorded when they are planted. This information will serve as a baseline for future monitoring.

During the first month after installation in the planted areas, it should be inspected on a weekly basis by the revegetation manager to make sure there is no damage from wildlife.

Some potted material (cottonwood) will be eaten by elk and mule deer if not protected. Protection cages will be installed around each planted cottonwood tree (Figure 3b). Cages will be constructed by placing three T-posts (each 8-feet long) in a triangular position around each tree, approximately 18 inches from the trunk. Chicken wire will be wrapped around the T-posts from the ground to the top of the 8-foot T-posts. This wire will be left in place until the trees are 4 to 8 inches in diameter at which time the bark should be thick enough that wildlife or livestock would not affect their growth.

Watering

If seeding occurs in the fall (including the cover crop), the seeded material is not to be watered. The seeds will be planted while dormant, and under normal winter conditions, will receive sufficient moisture to germinate the following spring. Water may be necessary during the following growing season if drought conditions develop. The seeded areas should be inspected at least twice weekly in the spring and early summer.

If drought occurs when seedlings are establishing, intense watering may be necessary until the root systems develop. This may require watering lightly several times a week (soaking down to at least 1 inch). If drought persists through the summer, water should be applied to the maturing vegetation weekly at the rate of the expected monthly annual precipitation for the area (based on climate history data).

The establishment of a cover crop as an erosion control measure during the spring or summer will require intensive water. If the area is not mulched, water would need to be applied every day for the first 15 days such that the soil at a depth of 1 inch will hold water consistently. If the site is mulched and crimped, then water can be applied every 2 to 3 days for 15 days when the seeds should have germinated, and the seedlings develop root systems.

Since piped water is expected to be available, it is recommended that the contractor develop a rotation watering system using trucks or install a temporary sprinkler system at seeded areas to increase the likelihood of successful vegetation establishment.

Rooted material should be watered when planted, and for weekly for several weeks after planting. However, since this material will be planted during the dormant season, it should require only periodic watering in the winter during dry periods (once bi-weekly) to prevent the root balls from drying out. Water should be applied on a weekly basis during the following spring until the plants are established. If drought conditions occur during the growing season, then watering may be needed every few days.

Seed Mix Specifications

Unit 1

Unit 1 covers approximately 644 acres. The seed mix for this unit is designed to produce a grassland community with scattered low growing shrubs such as winterfat. This grassland community would intergrade into surrounding shrub communities around the periphery forming an ecotone shrub/grassland mixture. The seed mixture was adjusted to account for the clay and clay loam soils found in the 12 inch deep soils samples found within Unit 1. The surface soils on which the existing grassland communities occur within Unit 1 are a mixture of sandy loams and loams. Species such as blue grama favor these coarser well drained soils and may not thrive as well on the clay soils located at 12 inches below the surface. However, galleta can thrive in both loamy and clay soils. Because of its wider range of soil texture tolerance a higher percentage of galleta was included in the seed mix than would normally be applied to reestablish the blue grama/galleta community. Although western wheatgrass was sporadic in the existing grasslands it was added to the mixture because it adds a cool season grass component.

Unit 1 components will require 9.41 pounds of native seed and 10 pounds of cover crop seed per acre (Table 3.4). Approximately 0.51 pounds of this seed mix consists of either tiny seeds or fluffy seeds for which general broadcast seeding is recommended either by equipment or by hand. The remaining 8.9 pounds of native seed and the 10 pounds of cover crop seed will be installed via drilling. The Unit 1 areas are generally flat to slightly rolling, but none have grades likely to exceed 3:1 slopes.

Table 3.4- Unit 1 Seed Mix

Species	Lbs/acre (pls)	Seeds /lb	Pls/sq foot	Depth (inches)	Variety
DRILLED SEED					
Blue grama (*Bouteloua gracilis*)	2.0	711,000	32.6	¼ to ½	-
Galleta (*Pleuraphis jamesii*)	4.0	160,000	14.6	¼ to ½	Viva
Spike muhly (*Muhlenbergia wrightii)*	0.4	1,635,000	15.0	1/4 to 1/2	El Vado
Western wheat grass (*Pascopyrum smithii*)	2.5	110,000	6.3	1/4 to 1/2	Arriba
Total Natives	**8.9**		**68.5**		
Cover Crop	10.0	13,000	3.0	¼ to ½	Quickquard
Total Drilled	**18.9**		**71.5**		
BROADCAST SEED					
Spike dropseed (*Sporobolus contractus*)	0.01	2,885,000	0.6	Surface to ¼	-
Winterfat (*Krascheninnkovia lanata*)	0.50	111,000	1.2	Surface to ¼	-
Total Broadcast	**0.51**		**1.8**		

Unit 2

Units 2 covers approximately 384 acres. The seed mix for this unit is designed to produce a shrub/grassland community dominated by rabbitbrush intermixed with grasses. Blue grama is the most common extant grass within all of the Unit 2 areas and is associated with galleta which is generally only about a ¼ of the cover of blue grama. Because some of the soil samples collected in Unit 2 were clay the percentage of galleta in the seed mixed was upped in the same manner described for Unit 1. Western wheatgrass is uncommon within all of the Unit 2 areas, but was noted in the shade of the rabbitbrush shrubs and within low areas where stormwater would briefly accumulate. It is anticipated that it will develop around the rabbitbrush. The Unit 2 planting areas will require 10.35 pounds of native seed and 10.0 pounds of cover crop seed per acre (Table 3.5). Approximately 0.6 pounds of this seed mix consists of either tiny seeds or fluffy seeds for which general broadcast seeding is recommended either by equipment or by hand. The remaining 9.75 pounds of native seed and the 10 pounds of cover crop seed will be installed via drilling. Most the Unit 2 areas are flat and slopes greater than 3:1 are not expected.

Table 3.5 - Unit 2 Seed Mix

Species	Lbs/Acre (PLS)	Seeds/ Lb	PLS/Sq Foot	Depth (inches)	Variety
DRILLED SEED					
Blue grama (*Bouteloua gracilis*)	2.0	711,000	32.6	¼ to ½	-
Galleta (*Pleuraphis jamesii*)	4	160,000	14.6	¼ to ½	Viva
Western wheat grass (*Pascopyrum smithii*)	3	110,000	7.5	¼ to ½	Arriba
Spike muhly (*Muhlenbergia wrightii)*	0.25	1,635,000	9.3	¼ to ½	El Vado
Bottlebrush Squirreltail (*Elymus elymoides*)	0.5	192,000	2.2	¼ to ½	-
Total Natives	**9.75**		**66.2**		
Cover Crop	10	13,000	3.0	¼ to ½	Quickquard
Total Drilled	**19.75**		**69.2**		
BROADCAST SEED					
Alkali sacaton (*Sporobolus airoides*)	0.25	1,750,000	10.0	Surface to ¼	-
Rubber rabbitbrush (*Ericameria nauseosa*)	0.35	330000	2.6	Surface to ¼	-
Total Broadcast	**0.6**		**12.6**		

Unit 3

Unit 3 covers approximately 804 acres. It seed mix is designed to produce a composite of existing shrub communities in the study area that include a Saltbush/Blue Grama/Galleta community, a Saltbush/Dropseed community, and a shrubby grassland ecotone community. Soil samples taken on site found a dominance of clay and clay loam soils throughout the unit. Large portions of this unit occur on old floodplains of waterways subtended by clay soils. Based on the existing vegetation, soil texture and chemistry, the proposed seed mix should produce a shrub community dominated by four-wing saltbush with a groundcover of principally blue grama, and galleta, and secondary grasses of bottlebrush squirrel tail, western wheatgrass, alkali sacaton, and vine mesquite. It is expected that the density of the four-wing saltbush will vary dependent upon the soil texture but in areas where shrubs do not thrive the mixture of grasses should fill in the gaps. Hoary tansyaster also appeared abundantly in portions of the existing plant communities and has been added to the seed mixture. Unit 3 will require 9.61 pounds of native seed and 10 pounds of cover crop seed per acre (Table 3.6).

Approximately 0.36 pounds of this seed mix consists of either tiny seeds or fluffy seeds for which general broadcast seeding is recommended either by equipment or by hand. The remaining 9.25 pounds of native seed and the 10 pounds of cover crop seed will be installed via drilling. Unit 3 is flat; there should be no slopes steeper than 3:1.

Table 3.6 -Unit 3 Seed Mix

Species	Lbs/Acre (PLS)	Seeds/Lb	PLS/Sq Foot	Depth (inches)	Variety
DRILLED SEED					
Galleta (*Pleuraphis jamesii*)	4	160,000	14.6	¼ to ½	Viva
Blue grama (*Bouteloua gracilis*)	2.0	711,000	32.6	¼ to ½	-
Western wheat grass (*Pascopyrum smithii*)	1.5	110,000	3.8	¼ to ½	Arriba
Vine mesquite (*Panicum obtusum*)	0.25	145,000	0.8	¼ to ½	-
Four-wing saltbush (*Atriplex canescens*)	1.5	70,000	2.4	½ to ¾	De-winged
Total Natives	**9.25**		**54.2**		
Cover Crop	10	13,000	3.0	¼ to ½	Quickquard
Total Drilled	**19.25**		**57.2**		
BROADCAST SEED					
Alkali sacaton (*Sporobolus airoides*)	0.25	1,750,000	10.0	Surface to ¼	-
Spike dropseed (*Sporobolus contractus*)	0.01	2,885,000	0.6	Surface to ¼	-
Hoary tansyaster (*Macheranthera canescens*)	0.1	1,066,900	2.0	Surface to ¼	-
Total Broadcast	**0.36**		**12.6**		

<u>Unit 4a</u>

Units 4a consists of arroyo riparian habitat within the study area and covers about 28 acres in long thin segments. Within these areas rabbitbrush and western wheat grass often dominate, many times associated with four-wing saltbush, galleta and to a lesser degree alkali sacaton, blue grama and hoary tansyaster. A seed mix has been developed to mimic the current vegetation within these ephemeral waterways. Segments of Unit 4 that require revegetation will require 9.05 pounds of native seed and 10 pounds of cover crop seed per acre (Table 3.7). Approximately 0.7 pounds of the native seed mix consists of either tiny seeds or fluffy seeds for which general broadcast seeding is recommended either by equipment or by hand. The remaining 8.35 pounds of native seed and the 10 pounds of cover crop seed will be installed via drilling. By definition these waterways have bed and bank structure, often with steep slopes that may require broadcast seeding. Most of the channel bottoms are flat enough to use equipment for seeding.

Table 3.7 -Unit 4a Seed Mix

Species	Lbs/Acre (PLS)	Seeds/ Lb	PLS/ Sq Foot	Depth (inches)	Variety
DRILLED SEED					
Four-wing saltbush (*Atriplex canescens*)	0.25	70,000	0.4	½ to ¾	De-winged
Galleta (*Pleuraphis jamesii*)	2	160,000	7.3	¼ to ½	Viva
Western wheat grass (*Pascopyrum smithii*)	4	110,000	10.1	¼ to ½	Arriba
Blue grama (*Bouteloua gracilis*)	2.0	711,000	32.6	¼ to ½	-
Common sunflower (*Helianthus annuus*)	0.1	60,000	0.1	¼ to ½	Wild Seed

Species	Lbs/Acre (PLS)	Seeds/ Lb	PLS/ Sq Foot	Depth (inches)	Variety
Total Natives	**8.35**		**50.5**		
Cover Crop	10	13,000	3.0	¼ to ½	Quickquard
Total Drilled	**18.25**		**53.5**		
BROADCAST SEED					
Rubber rabbitbrush (*Ericameria nauseosa*)	0.35	330000	2.6	Surface to ¼	-
Alkali sacaton (*Sporobolus airoides*)	0.25	1,750,000	10.0	Surface to ¼	-
Hoary tansyaster (*Macheranthera canescens*)	0.1	1,066,900	2.4	Surface to ¼	-
Total Broadcast	**0.7**		**15.0**		

Unit 4b

Unit 4b consists of a stock pond wetland area nearly 2 acres in area. It was the only pond in the study area that provided pooled surface water during 2016. Water collects from ephemeral runoff from nearby slopes. The presence of wetland vegetation indicates that water is fairly persistent at the site. The proposed revegetation of this area would consist of augmenting existing conditions to provide a permanent to semi-permanent watering hole such as those historically present in the area.

Seeded Material would consist only of common sunflower. This would provide a food source for insects during spring and summer, and birds in the fall. Seeds would be raked into bare ground around the pond to a depth of 025-0.5 inches. Planted material would consist of rooted shrubs and trees to augment the herbaceous wetland vegetation that is already present. Cottonwood, coyote willow and Torrey wolfberry are recommended.

Each species should be placed in designated bank locations (Figures 3a and 3b). The cottonwood trees will be planted with the root crown set at the edge of the maximum pool size. Coyote willow will be planted in two bands along much of the pond edge. One band being set just below the maximum pool line within the edge of the water, and the other just above the edge of the water; and spaced approximately 5 feet apart within these bands A cluster of coyote willows with 3-4 rows present will be planted in a grid along the west-central edge of the pond as indicated on. Torrey wolf berry will be planted along the upland slopes just above the southern edge of the ponded area, just above the maximum pool size. It can be planted anywhere from one row to three rows wide depending upon the slope. They should be planted approximately 5 feet apart along this slope. The exact placement of the planted shrubby material will be determined when more topographic data is available for the site.

Planted material is vulnerable to damage from livestock. Once planted, Unit 4b will be fenced for 5-years to allow for the establishment of woody vegetation. The fence should consist of three-strand class 1, 12 ½ gauge, 2-point barbed wire strung on 5 foot tall studded T-posts. The wire should be strung around the periphery of Unit 4b except to provide an invagination in the wire perimeter has been left to allow wildlife and cattle to the deepest part of the stock pond.

Table 3.8a -Unit 4b Seed

Species	Lbs /Acre (PLS)	Seeds/Lb	PLS/Sq Foot	Depth (inches)	Variety
Raked Seed					
Common sunflower (*Helianthus annuus*)	0.5	60,000	0.3	¼ to ½	Wild Seed

Table 3.8b -Unit 4b Planted Material

Species	Quantity	Type	Specification
Plantings			
Cottonwood (*Populus deltoides ssp. wislizeni*)	26	Tree	1 gallon stem pots 4x4x14 inches deep
Coyote willow (*Salix exigua*)	270	Tall shrub	1 gallon stem pots 4x4x14 inches deep
Torrey wolfberry (*Lycium torreyi*)	70	Low shrub	1 gallon stem pots 4x4x14 inches deep

<u>Retain Existing Vegetation</u>

Areas meeting the following criteria are to retain existing vegetation. No earthwork is to be completed in these areas.

- Avoidance areas Identified on Figure 2
- Slopes steeper than 2:1
- Arroyo bottom when slopes steeper than 3:1

4- PERFORMANCE MONITORING

Monitoring Plan

<u>Monitoring Period</u>

The USEPA proposes to provide annual monitoring during the growing season beginning at 2 years post seeding/planting for a period of 12 years from seeding – per reclamation unit. Performance standards are based on achieving or surpassing existing conditions with regard to percent cover and species composition. Conditions have naturalized since the mine ceased operations. No formal reference plots were available outside the site, but nearby areas were observed to estimate cover and species composition for informal comparison.

<u>Assessment Methods</u>

The following assessment methods are proposed in order to evaluate revegetation success prior to final abandonment/closeout:

- <u>Percent foliar cover (line transect)</u>

Twenty-five permanent 100 meter transects would be established on the reclamation site to be distributed over the reclamation units relative to unit size and complexity. For each of the reclamation units, the proposed number of transects and performance goals are provided below (Tables 4.1- 4.4):

Unit 1: 8 Transects

The objective for this unit is to meet a minimum total 37 percent cover comprised of grasses and shrubs equal or increase the current percent cover, and reflect the general species composition of the area.

Table 4.1

Vegetative Type	Percent Cover
Subtotal - Grasses	35-40%
Subtotal - Shrubs	2-5%
Total	**37 -45%**

Unit 2: 6 Transects

The objective for this unit is to meet a minimum total 50 percent cover comprised of grasses/forbs and shrubs equal or increase the current percent cover, and reflect the general species composition of the area.

Table 4.2

Vegetative type	Percent Cover
Subtotal - Grasses	25-35%
Subtotal - Shrubs	25-30%
Total	**50 -60%**

Unit 3: 7 Transects

The objective for this unit is to meet a minimum total 30 percent cover comprised of grasses and shrubs equal or increase the current percent cover, and reflect the general species composition of the area.

Table 4.3

Vegetative type	Percent Cover
Subtotal - Grasses/Forbs	15-20%
Subtotal - Shrubs	15-20%
Total	**30-40%**

Unit 4a: 3 Transects

The objective for this unit is to meet a minimum total 45 percent cover comprised of grasses and shrubs eto qual or increase the current percent cover, and reflect the general species composition of the area.

Table 4.4

Vegetative Type	Percent Cover
Subtotal - Grasses	25-30%
Subtotal - Shrubs	15 -20%
Total	**40 -50%**

Unit 4b: 1 Transect

The objective for this unit is to meet a minimum total 40 percent cover comprised of grasses and shrubs/trees equal or increase the current percent cover, and reflect the general species composition of the area.

Table 4.5

Vegetative Type	Percent Cover
Subtotal - Shrubs	15-20%
Subtotal - Trees	5 -10%
Total	**20 -30%**

- Photo point monitoring

At least 25 permanent photo points, each located at an endpoint of a line transect (at least one per reclamation unit/subunit) will be established to provide qualitative documentation of revegetation success.

- Species List

A complete species list for plants observed within the line transects and within a 25-foot area on either side (50 foot swath) will be provided for each transect. New species or species absent relative to previous monitoring years will be identified and total number of plant species observed provided.

Timeline

The target timeline for meeting performance standards is at or before the end of the of the 12 year monitoring period.

Ecological Function Indicators

During the monitoring period, field visits to the site will include documentation of the presence or absence of qualitative indicators that the site is providing the desired ecological function.

Unit 1

- Presence of Prairie dog colonies and burrowing owls
- Evidence of small mammal use (burrows, trails, scat)
- Presence of Insects

Units 2 and 3

- Growth of shrubs (stem diameter, height)
- Browse/forage activity by elk, deer
- Bird nests
- Presence of insects

Unit 4a

- Growth of grass and shrubs (stem diameter, height)
- Hydrology indicators such as sediment lines and debris

Unit 4b

- Survival of at least 50 percent trees and shrubs
- Growth of shrubs/trees (stem diameter, height)
- Evidence of wildlife use (tracks, observations, photo-documentation)
- Presence of persistent water (if windmill installed)

Sustainability

The following indicators of site sustainability will be provided in the monitoring report.

- Presence of prairie dogs and owls for 5 or more repeated years
- Growth of shrubs/trees (stem diameter, height)
- Size/vigor/condition of planted material

5 - ADAPTIVE MANAGEMENT PLAN

Parties Responsible for Adaptive Management

The USEPA is the responsible party for implementing revegetation and subsequent monitoring. Long-term maintenance requirements will be identified by USEPA in coordination with landowners and management agencies.

Potential Challenges

At least five types of events that could reduce either the short-term or long-term success of revegetation have been identified. These are: (1) site flooding leading to sedimentation; (2) site scouring leading to loss of vegetation and soil; (3) protracted drought resulting in a loss of surface hydrology and loss of vegetation; (4) infestation of invasive species supplanting desired species; and (5) over use by wildlife or livestock. These events are described in more detail in the paragraphs that follow.

Flooding or Siltation of Planted Area

Flooding of the unit could lead to the deposition of fine silts and clays that bury emergent vegetation or the deposition of sediment over seeded areas such that germinating seeds are not able to reach the surface. The impacts of siltation are most damaging during the first season when seeds are germinating or seedlings are growing (sediment deposits of 1-inch deep or more could affect seed germination or bury seedlings).

- Units 1, 2 and 3 have few drainages and a low potential for flooding.
- Unit 4 is historically an area that carries much of the area surface flow. During large flow events, water could overtop the channel sheet flow.
- Unit 4 includes the arroyo and pond wetland. Large flow events could potentially bury the constructed features at the wetland or cover planted and seeded material.

Action for Flooding, Siltation, and Sedimentation

Following large storm events, these actions are advised:

1. The reclamation unit (in particular Units 4a and 4b) should be inspected immediately, and an evaluation of the level of siltation should be completed. In Unit 4b, an examination of the constructed features and planted material in should be completed.

2. If siltation of at least 1 inch on seeded areas, or other damage is detected, the USEPA should be contacted.

3. If substantial amounts of sediment have been deposited on un-germinated seeds, or if seedlings are buried, an evaluation of the extent of the damage should be completed. Small areas of damage can be reseeded by hand. Large areas may require the use of equipment. Watering may be necessary to re-establish the vegetation.

4. If substantial sediment buildup occurs within the wetland pond Unit 4b, removal of material may be necessary. Any planted material buried by silt may need to be replanted.

Flood Scouring of Seeded areas, Planted Areas and Constructed Features

In the event of a large flow event within arroyos, scour could remove displace seeds, plants, or soil amendments, fertilizers and micronutrients, and damage constructed features.

- Unit 4a is vulnerable to scour along its length during large flow events.
- Unit 4b is vulnerable to scour from storm events that could undermine constructed structures or cut away the banks.

Action for Scouring from Flooding

1. The reclamation units should be inspected immediately, and an evaluation extent of scouring and cutting should be completed. These three observations should be documented:
    a) Determine whether the scouring was deeper than 1 inch of the surface, which would have removed seeds or established vegetation.
    b) Determine whether the scouring was deeper than 6-inches, which would remove the soil treated with amendments, fertilizers, or micronutrients.
    c) Determine whether the scouring was deeper than 6 inches below the surface, which would alter the contours of the landscape. Within Unit 4a, a determination should be made as to whether the constructed features are damaged.
2. If substantial scour has occurred to planted areas or if constructed features have been damaged, then the USEPA should be contacted.
3. Shallow scours less than 1 inch that remove vegetation but do no impact the subsoil can be mitigated by spreading a thin layer of soil over the area (approximately 1-inch) and reseeding and mulching.

   Scours to a depth of 6 inches will likely need localized recontouring followed by reapplication of amendments, fertilizers, micronutrients, seeding, and mulching. Cuts deeper than 6 inches may require regrading of a broader area to return the contours to the pre-flood conditions with the ultimate response developed in coordination with the designing engineer and USEPA.
4. Damage to the constructed features may require repair or design modifications. A certified engineer in cooperation with the USEPA should complete any modification of the designs.

Drought

The proposed revegetation plan is designed to accommodate local average rainfall patterns, in particular the summer monsoon season. The current drought status of the removal area is currently classified as *not in drought* (National Drought Mitigation Center). An evaluation of area temperature averages and drought status should be conducted prior to seeding or planting. Regular monitoring should occur during the revegetation process along with inspection of seeded sites to determine whether supplemental watering is required. The fall planting schedule was identified in anticipation of dry conditions. However, changing short or long term climate patterns should be considered.

In all units drought could result in the failure of seeded material to germinate, the death of seedlings, or the death/weakening of planted or established vegetation.

Action for Drought

1. Supplemental water is expected to be available. However, if not available, and weather monitoring indicates that precipitation levels are below 50 percent of normal and are likely to continue, then consideration should be given to postponing planting.
2. If drought conditions develop after planting, weekly monitoring of the seeded and planted areas should be implemented to look for signs of stress (withered leaves, brown leaves, yellowing).
3. If supplemental water is available, it should be provided to the planted and seeded material. Watering should reflect natural events of a good monsoon season (minimum of 0.5 inches per week from July 1 through September 30). The reclamation area is so large that regular watering of the entire area may be impractical. If full watering of the site is not possible, then a triage approach is recommended.
   a) The planted wetland vegetation in Unit 4b is most vulnerable and should be watered first.
   b) Areas where seeded vegetation has rooted and is growing should be watered next, (replacing established vegetation is more difficult than reseeding).
   c) Seeded areas that have germinated would be third in the list.
   d) Seeded areas that have not germinated should be watered last.

<u>Invasive Species</u>
Three New Mexico noxious weed species are currently present (Siberian elm, salt cedar, and Russian olive).

- Siberian elm trees are scattered along the main paved access route into the site within Unit 2 (Section 30, T14N, R9W). One very large tree occurs in Unit 3 (S24, T14N, R10W), A few others saplings were scattered across Unit 3, but are not expected to spread. Since these trees are known perch sites for golden eagles they have been excluded from clearing.

- One large salt cedar and some seedlings occur within Unit 4b (Section 22, T14N, R10W). Aside from portions of Unit 4a the remainder of the site does not provide suitable conditions for this species to spread.

- Russian olive is very restricted to a few trees in the study area, occurring in a few low spots portions of Unit 4a and Unit 2 in Section 30.

No specific removal plan is needed for the few scattered Class C species. With the exception of a single salt cedar at the pond in Unit 4b, salt cedar and Russian olives will be removed by the clearing and grubbing.

Action for Invasive Species

1. If the salt cedars present do sprout, they will be spot treated with spray on herbicide (Arsenal), or if there is concern about killing desirable seeded vegetation, the top of each individual stem can be cut off during the early spring and concentrated herbicide applied directly to the fresh cut with a small paintbrush.

2. Mechanical clearing of the few Russian olives present will occur during the grubbing process. No other treatment is necessary.

3. If patches of other species of weeds invade the site after the clearing, then grubbing and excavation is recommended followed immediately by herbicide.

Overuse by Wildlife and Livestock

Livestock will be excluded from the site during the revegetation process and should not damage vegetation. However, deer and elk occur in the area. Elk will graze on grasses once they sprout and it would be difficult to exclude them from the seeded areas. Elk and deer will eat saplings of riparian woody species, cottonwoods in particular.

- Unit 1 supports graze, some browse and limited cover for elk or deer, but supports prairie dogs and associated burrowing owl nests.

- Unit 2 and 3 support browse, forage and some cover for elk and deer.

- Unit 4b provides water for wildlife.

Action for Overuse by Wildlife and Livestock

1. Livestock should be excluded from the area until the native vegetation has become fully established (5 years recommended).
2. If deer or elk are damaging seeded areas, the New Mexico Department of Game and Fish (NMDGF) should be contacted. NMDGF maintains a Wildlife Depredation and Nuisance Abatement Program designed to reduce wildlife damage to property.
3. Damage from browsing may occur to the planted vegetation in Unit 4a. Wire cages have been recommended to avoid or reduce browsing. However, these cages can be damaged. Therefore, they must be periodically inspected and repaired or replaced, as needed.

Procedures for Modifying Performance Standards and Timeframe

As reclamation proceeds, altering the work plan and performance standards may be required. Deviations from expected performance will become evident during the annual monitoring of the site. The reclamation management contractor and USEPA will be notified of a need to modify any of the following due to availability of materials, natural events that alter the landscape/potential for success, or other events:

- Soil amendments
- Seed Mix
- Planting Material
- Constructed features
- Performance goals
- Performance standards

In coordination with state agency stakeholders, the USEPA will determine whether modifications are acceptable and develop new standards if needed, which will be provided to the contractor as soon as feasible for implementation.

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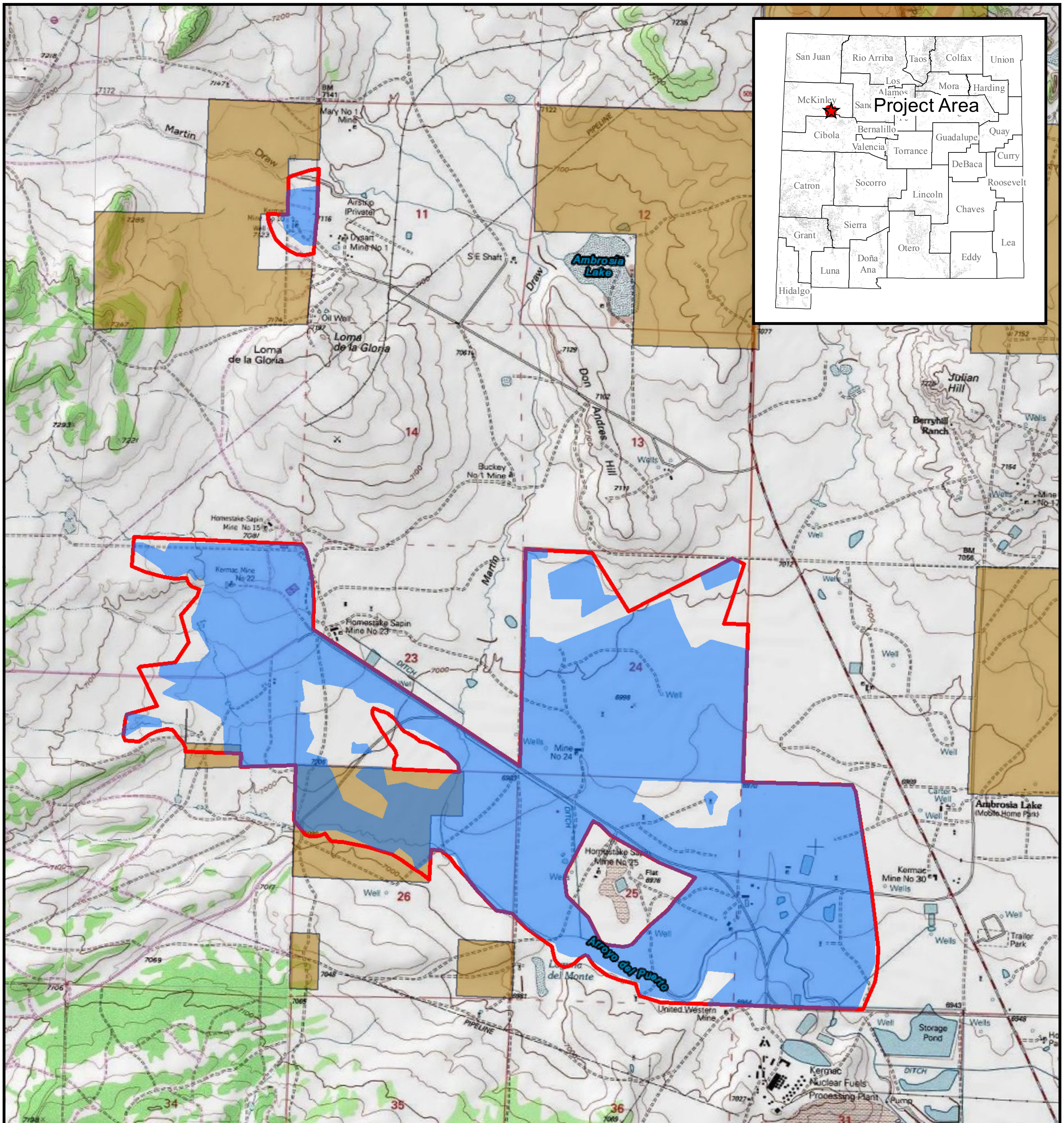
APPENDIX A

Figures

Exhibits



Study Area

Removal Area

Land Ownership

BLM

Private

Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
McKinley County, New Mexico

0 0.5 1 2 Kilometers

0 0.425 0.85 1.7 Miles

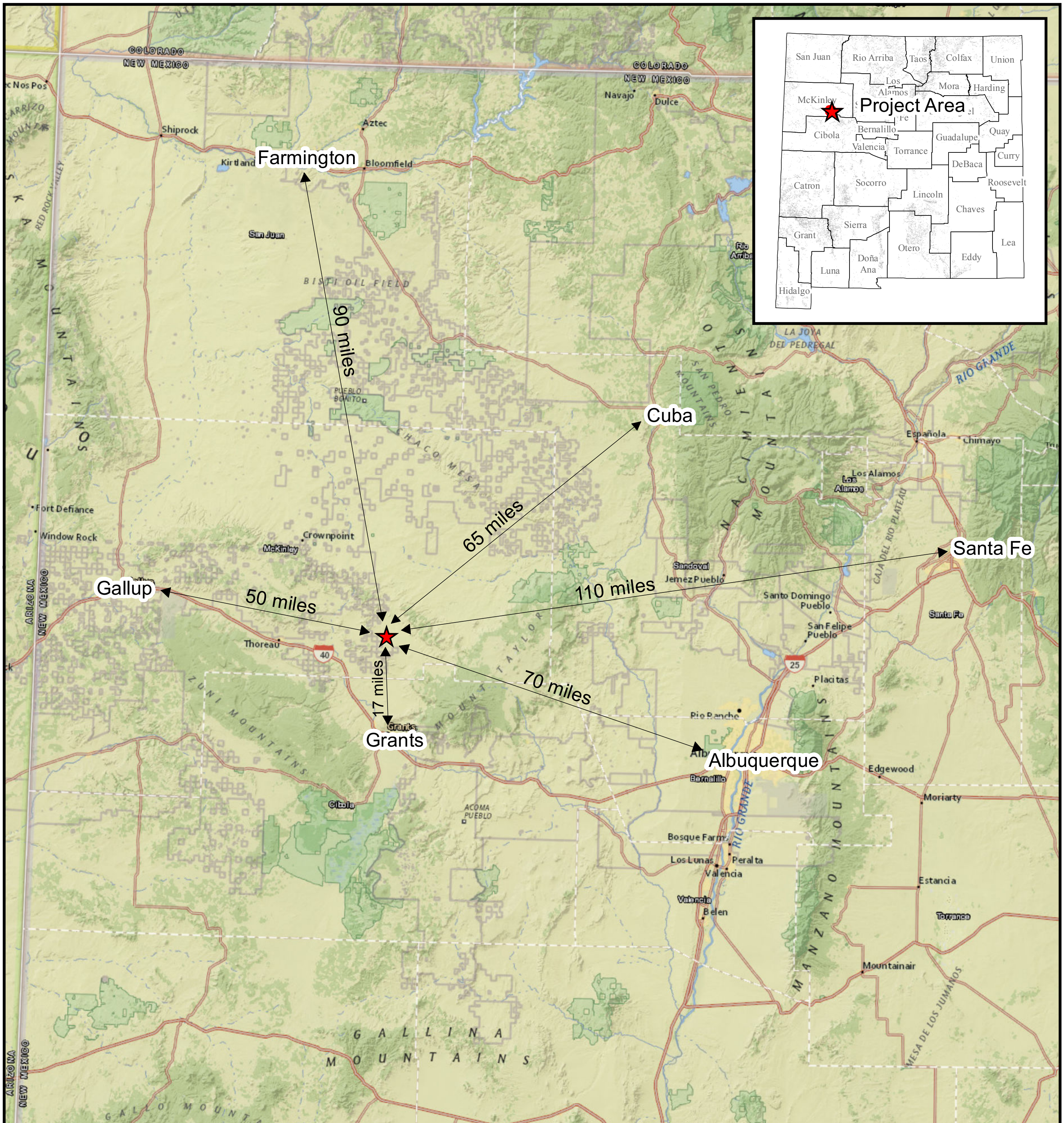
N

1:40,000

MARRON and ASSOCIATES

Figure 1a
Project Location Map

USEPA Tronox Western GSA Mines, McKinley County, New Mexico - Re-Vegetation



Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
McKinley County, New Mexico

★ Study Area

0 25 50 100 Kilometers
0 15 30 60 Miles

N

1:1,700,000

MARRON and ASSOCIATES

Figure 1b
Reference
Distance Map

USEPA Tronox Western GSA Mines, McKinley County, New Mexico - Re-Vegetation

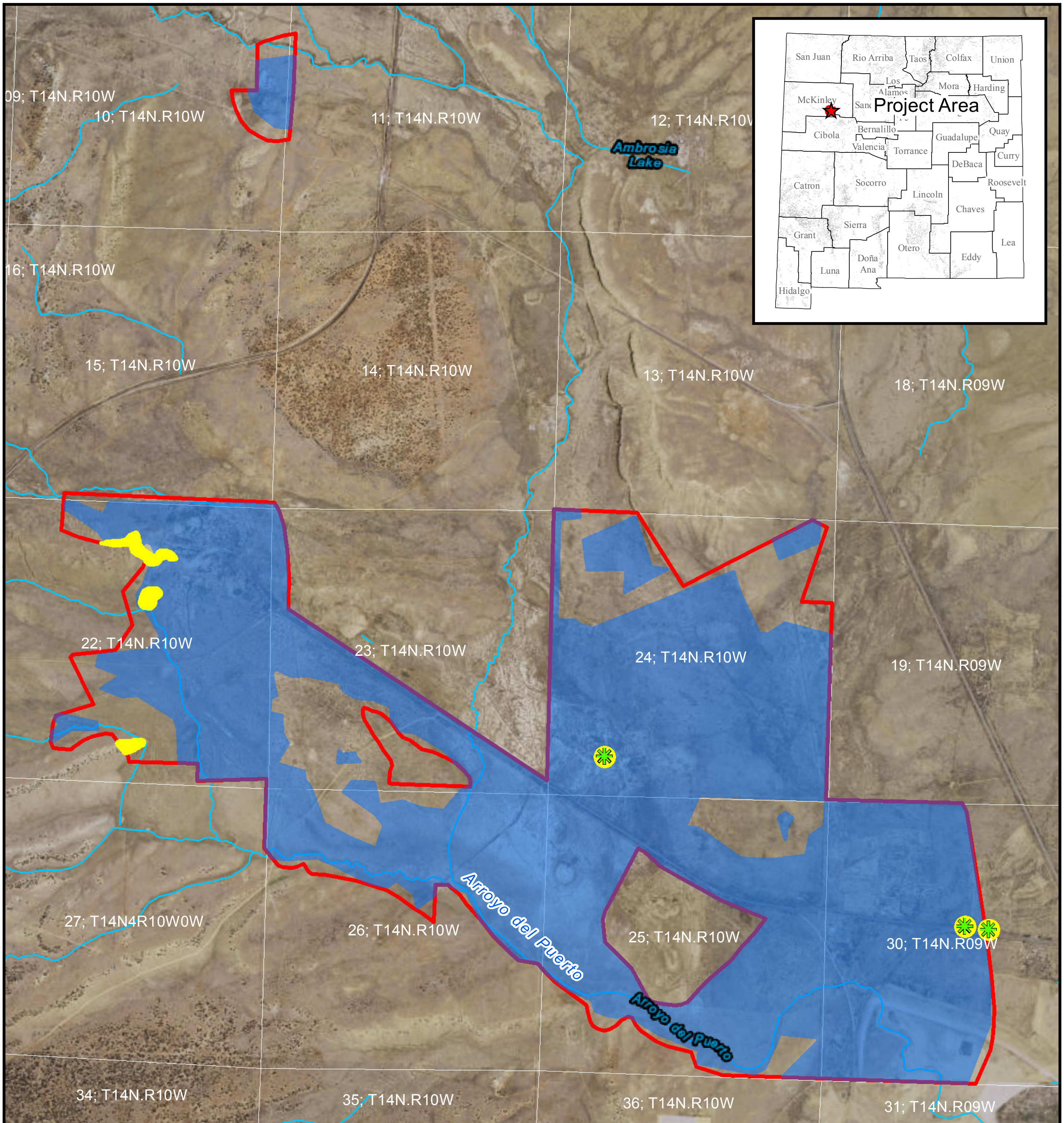


Figure 1c
Restricted Areas

Study Area

Avoidance Area

Perch Trees

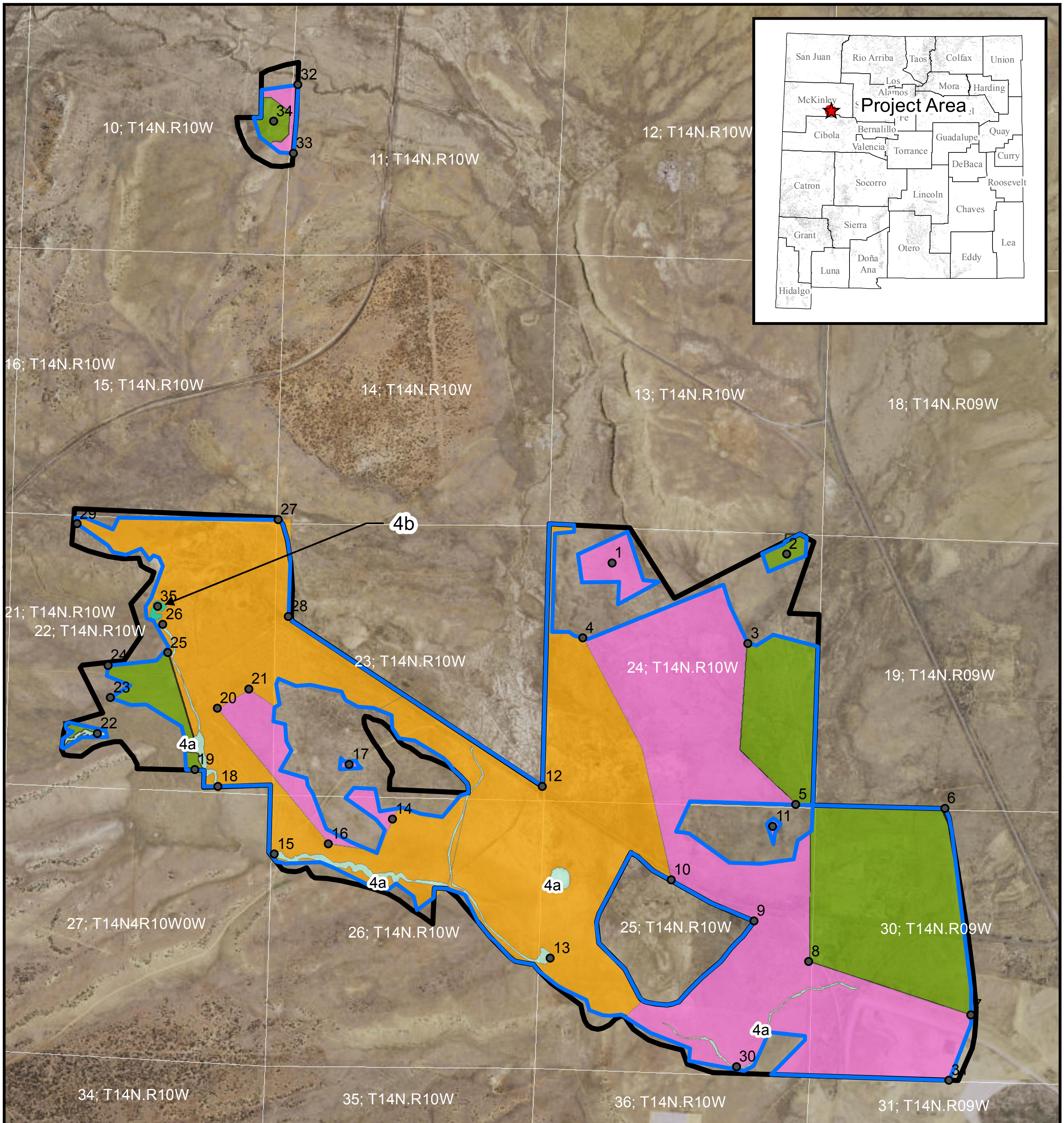
T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
Bernalillo County, New Mexico
Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

0 0.5 1 2 Kilometers
0 0.375 0.75 1.5 Miles

N

1:32,000

USEPA Tronox 4 Western GSA Mines, McKinley County, New Mexico - Re-Vegetation



Study Area
Removal Area
Unit 1
Unit 2
Unit 3
Unit 4a
Unit 4b

T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
McKinley County, New Mexico
Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

0 0.5 1 2 Kilometers

0 0.35 0.7 1.4 Miles

N

1:33,000

MARRON and ASSOCIATES

Figure 2
Reclamation Units

USEPA Tronox Western GSA Mines, McKinley County, New Mexico - Re-Vegetation

Reclamation Unit ID Sites			
Point ID		UTM	
Id	Unit	Xcoord	Ycoord
1	1	240957.9511	3924853.883
2	2	241998.2174	3924908.09
3	1/2	241767.8827	3924373.994
4	2/3	240785.6605	3924408.067
5	1/2	242053.1848	3923414.875
6	2	242940.2208	3923391.416
7	1/2	243095.0539	3922161.973
8	1/2	242130.8447	3922479.85
9	1	241806.0655	3922723.421
10	1/3	241309.9847	3922967.686
11	1	241916.0932	3923286.668
12	3	240544.1856	3923524.701
13	3/4	240591.089	3922502.266
14	1/3	239652.3917	3923329.548
15	4	238948.8093	3923121.238
16	1/3	239271.2251	3923182.641
17	1	239394.4024	3923653.111
18	4	238612.9929	3923524.598
19	2	238473.5245	3923622.966
20	1/3	238609.294	3923990.372
21	1/3	238797.2529	3924102.122
22	4	237896.1325	3923840.168
23	2	237972.9668	3924053.499
24	2	237957.7633	3924244.364
25	2/3	238313.1746	3924319.88
26	4	238284.4983	3924489.196
27	3	238970.1908	3925112.158
28	3	239031.2442	3924534.651
29	3	237774.6162	3925087.572
30	1/4	241698.9222	3921853.037
31	1	242964.4419	3921774.241
32	1	239087.876	3927704.409
33	1	239060.8616	3927293.924
34	2	238942.932	3927486.505
35	4b	238252.5715	3924595.943

Figure 3a
Unit 4b Conceptual Planting Overview

Removal Area
Unit 4b
Salix exigua (Coyote Willow)
Lycium torreyi (Wolfberry)
Populus deltoides (Cottonwood)

T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
McKinley County, New Mexico
Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

N
1:1,000

MARRON and ASSOCIATES

USEPA Tronox Western GSA Mines, McKinley County, New Mexico - Re-Vegetation

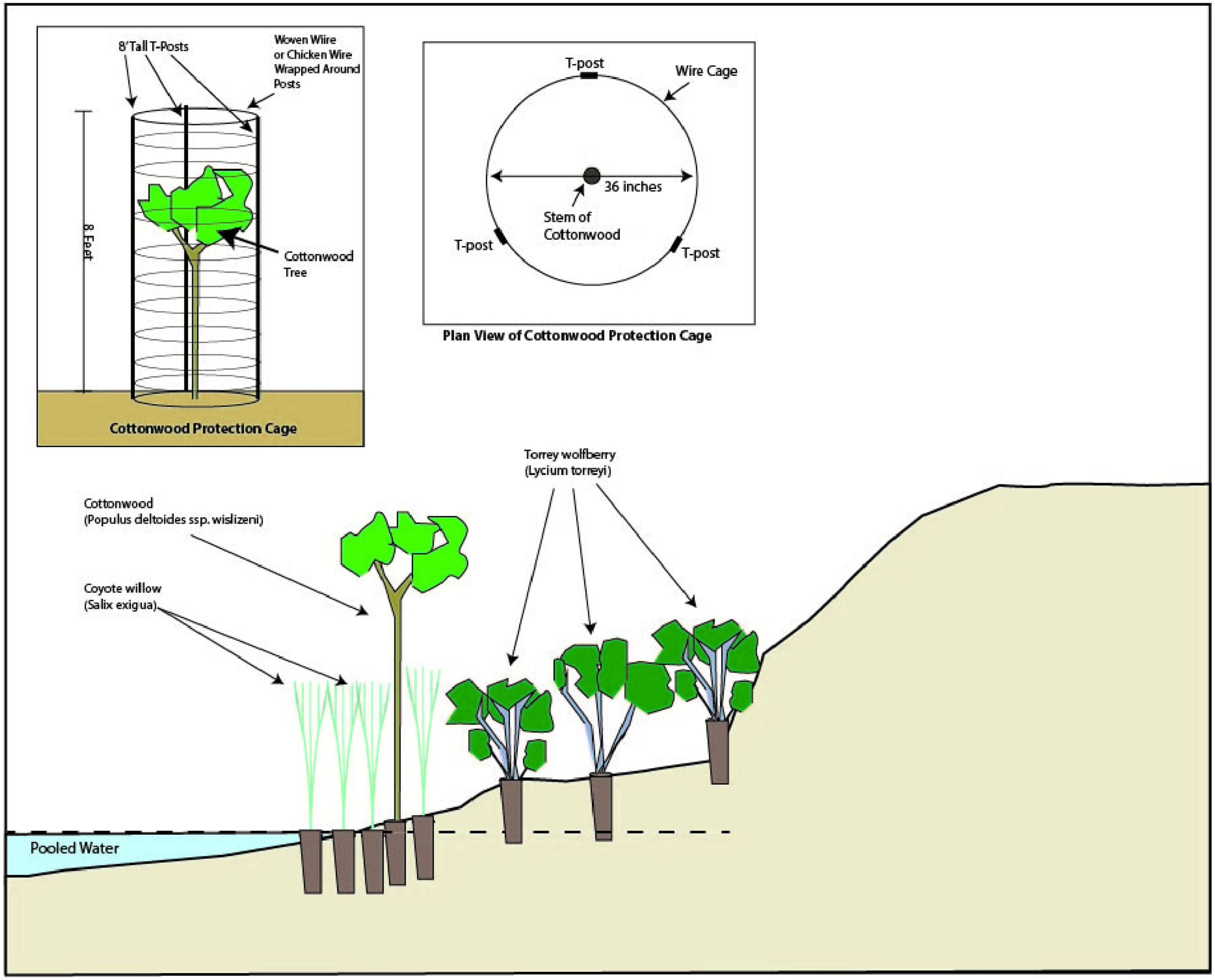


Figure 3b
Conceptual Planting Plan View
Unit 4b

T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
McKinley County, New Mexico
Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

N

Scale:
*Fig not to scale

MARRON and ASSOCIATES

USEPA Tronox Western GSA Mines, McKinley County, New Mexico - Re-Vegetation

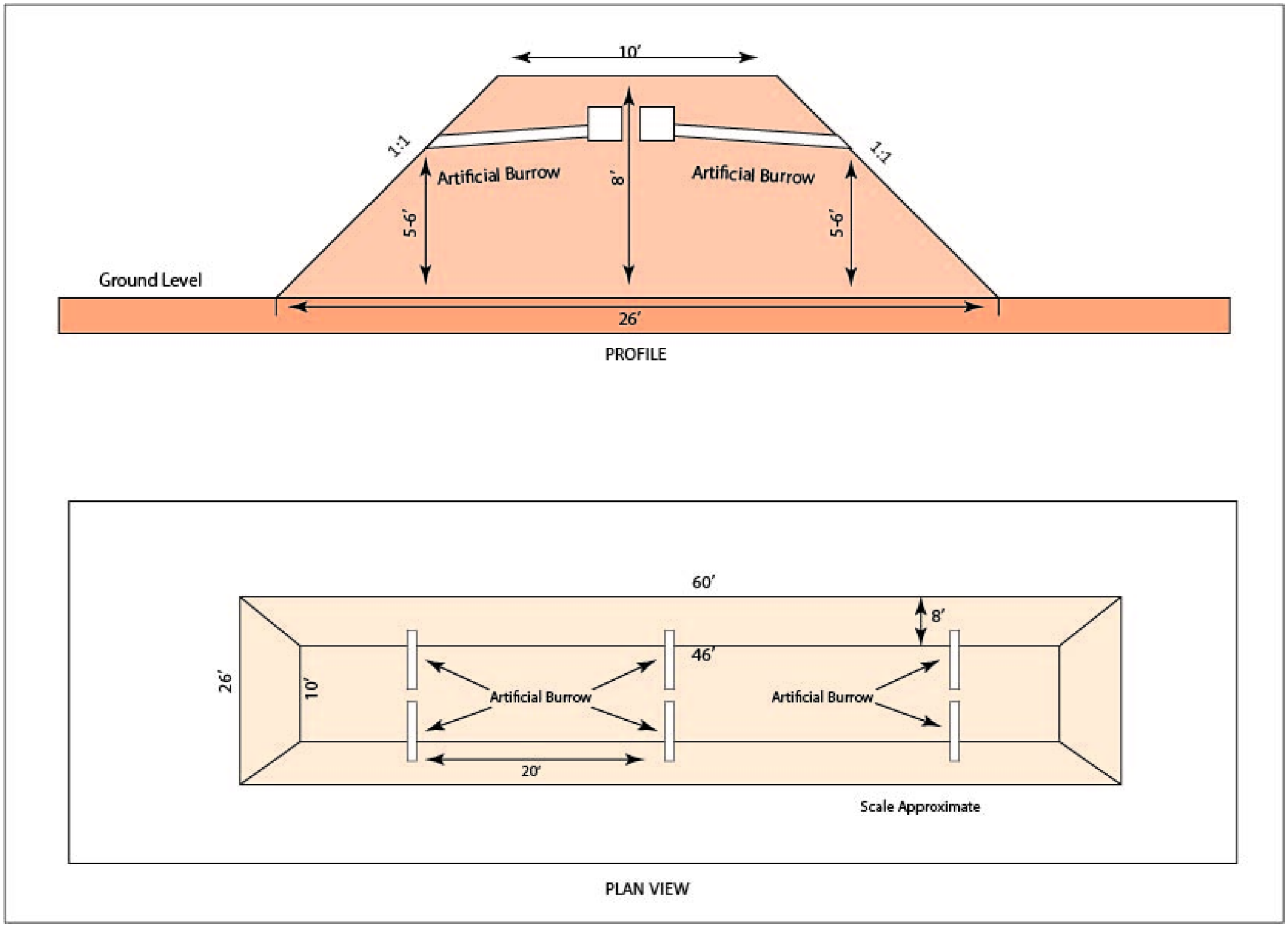


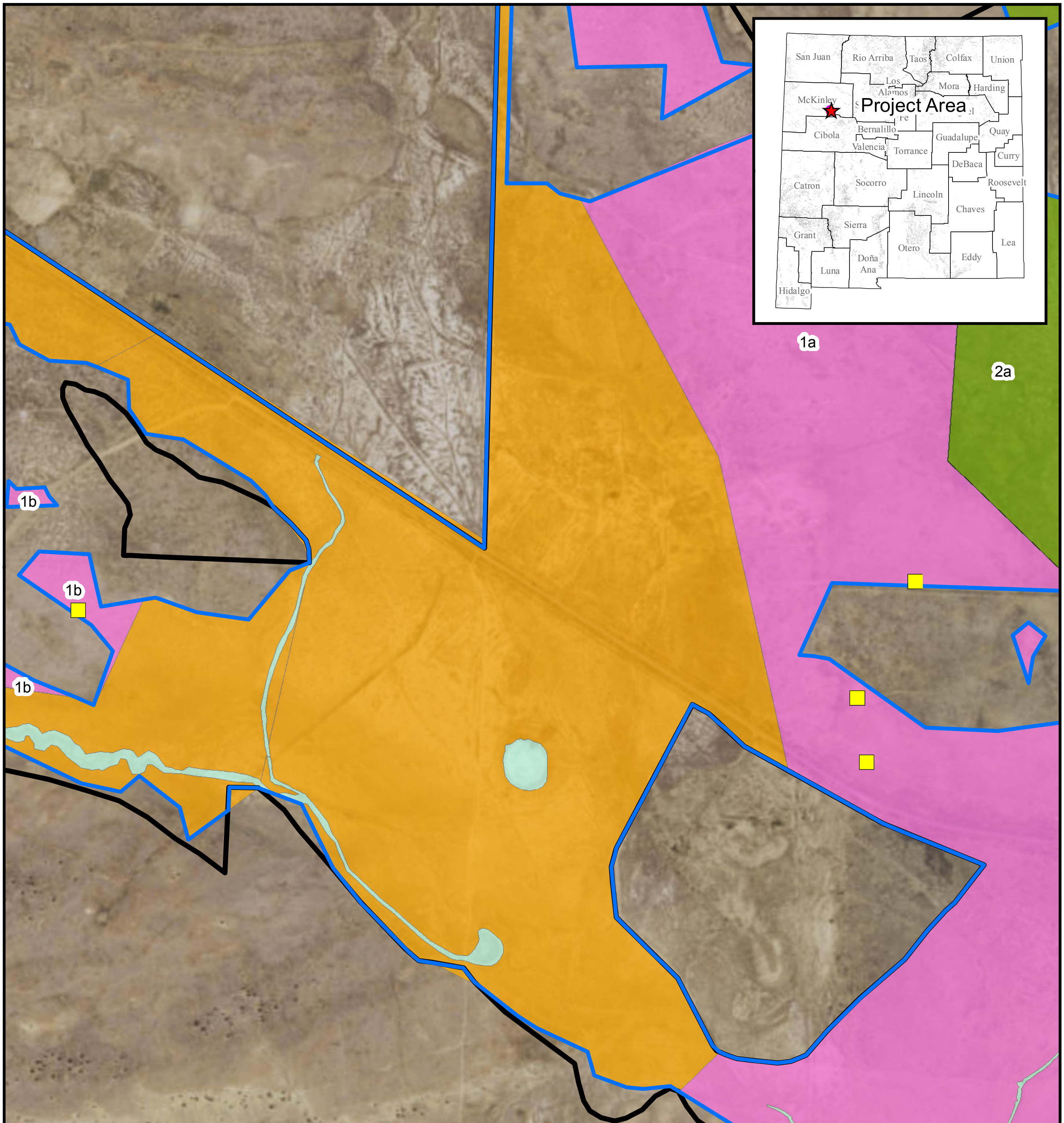
Figure 3c
Burrow Placement
Conceptual Plan

T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
McKinley County, New Mexico
Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

N

Scale:
*Fig not to scale

USEPA Tronox Western GSA Mines, McKinley County, New Mexico - Re-Vegetation



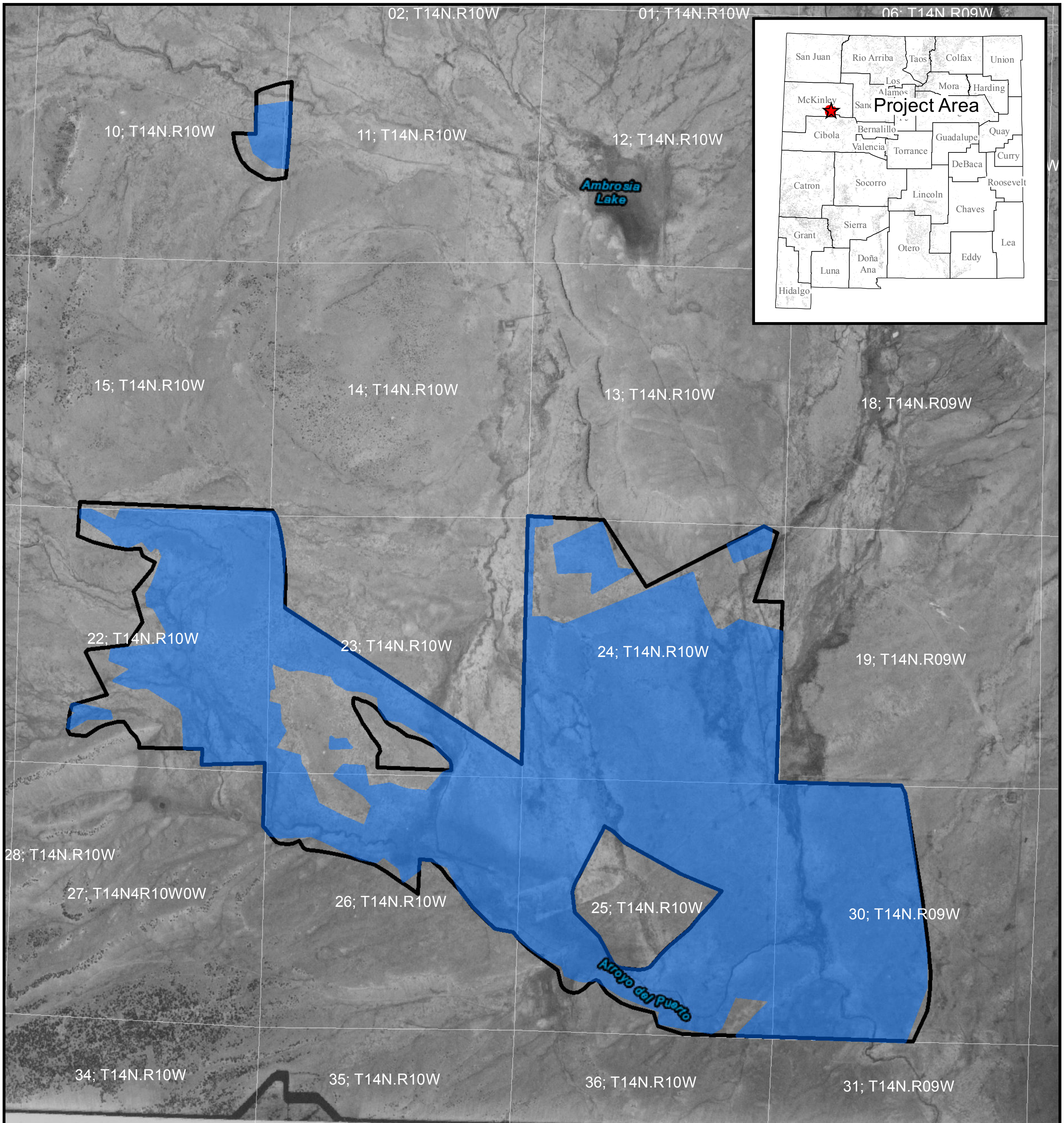
Study Area
Removal Area
Unit 1
Unit 2
Unit 3
Unit 4
Berm

Figure 3d
Berm Locations

T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
McKinley County, New Mexico
Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

0 0.225 0.45 0.9 Kilometers
0 0.15 0.3 0.6 Miles
N
1:14,000

USEPA Tronox Western GSA Mines, McKinley County, New Mexico - Re-Vegetation



MARRON and ASSOCIATES

Figure 4
Project Area
1954 Aerial Photo

Study Area

Removal Area

Goat Mountain, NM &
Ambrosia Lake, NM
USGS 7.5' Quadrangles

T 14N, R 10W & 9W;
Sec. 10, 11, 15, 22, 23, 24, 25, 26, 30
McKinley County, New Mexico

0 0.5 1 2 Kilometers
0 0.4 0.8 1.6 Miles

N
1:35,000

USEPA Tronox Western GSA Mines, McKinley County, New Mexico

APPENDIX B

Soil Amendment Sources **

(**Marron is not affiliated with any listed source. Inclusion of sources is for information purposes and not intended to provide an endorsement.)

Appendix B

Humate Sources

Menefee Mining Corporation
36 Duke City Rd,
Cuba, NM 87103
575-289-0259

Mesa Verde Resources
P.O. box 1368
Placitas, NM 87043
Contact: Bruce Reid
505-362-3777

Horizon Ag Products
23 Cubita Road, Cuba,
NM 87013. Sandoval County
Contact: Steve Brady
575-289-2565

Sawdust Sources

Olguin Sawmill
Taos , New Meixco-
Sawdust available 575-758-1506

El Molino Sawmill
Alto, NM
575-336-1237-
Boards, firewood, uncertain about sawdust

Spotted Owl Timber,
Santa Fe, NM 505-474-5326
Sawdust, mulch and landscaping material

Mt. Taylor Manufacturing LLC.
Milan, NM.
505-877-0890 Albuquerque,
Milan 505 287-9469
Possibly sawdust and compost from wood products

Dairy Manure Sources

De Smet Dairy and Creamery
2405 McNew Rd
Bosque Farms, NM 87068
(505) 916-0475

Old Windmill Dairy
52 Paso Ranch Rd
Estancia, NM 87016
(505) 384-0033

asband Dairy
7116 Isleta Blvd SW
Albuquerque, NM 87105
(505) 873-2171

Mickey's Cash & Carry Dairy
5102 Coors Blvd SW
Albuquerque, NM 87105
(505) 873-0542

Edeal Dairy
147 Edeal Rd
Los Lunas, NM 87031
(505) 865-9517

Creamland Dairies
1201 W Apache St
Farmington, NM, 87401
(505) 325-0281

Willard Dairy
190 Dairy Rd
Willard, NM 87063
(505) 384-0573

Pareo Farm Inc
PO Box 489,
Veguita, NM 87062
(505) 864-8103

Caballo Dairy
1 Caballo Alto Rd
Arrey, NM 87930
(575) 267-3061

Gonzalez Dairy Inc
14310 Stern Dr
Mesquite, NM 88048
(575) 233-4801

F&A Dairy Products, Inc.
355 Crawford Blvd
Las Cruces, NM 88007
(575) 647-1696

Las Uvas Valley Dairy
Las Uvas Diary Rd
Hatch, NM 87937
(575) 267-3037

Compost Sources

Albuquerque/Bernalillo County Water Utility Authority, Soils Amendment Facility 7401 Access Road NW
Albuquerque, NM 87102
4201 2nd St. SW (waste water treatment plant)
Albuquerque, NM 87105
Contact: Joe Bailey, Supervisor
E-mail: jbailey@abcwua.org
Phone: 505-205-5721 or 505-873-6989
Feedstocks: 20% solids (municipal biosolids), waste horse stable bedding, pulverized green waste, bark fines and chips
Quantity produced: 45,000 cu. yds. per year capacity.

Barela Landscaping
7713 Bates Rd. SE
Albuquerque, NM 87105
Contact: Eddie Barela, owner
E-mail: cb0513@myway.com
Phone: 505-877-8522
Feedstocks: yard trimmings, steer manure, dairy manure, chili peelings Quantity produced: 40,000 cu. yds. per year

Barela Timber management Co
Contact: Ralph Barela
viga@newmexico.com
699 Harlan Dr.
Las Vegas, NM 87701
Phone: 505-617-1966, 505-425-9479, 505-454-4311 60,000 cu. yds. Capacity
Compost, Colored Mulches, Aged Mulch, Vigas

Midwest Bio-Systems
3333 Majestic Ridge -207B
Las Cruces, NM 88011
Contact: Greg Berry
Phone: 575-521-3692 Fax 521-3699
E-mail: gberry@totacc.com
Applications: Composting systems, microbe applications and Aeromaster turning equipment, Compost and balanced soil fertility consulting.

Mountain Rich Soils
HCR 74, Box 22612
El Prado, NM 87529
Contact: Dave West
Phone: 505-758-4150
Email: growfoodnow@tierralucero.org
Feedstocks: alfalfa, forest waste, manure, straw, humates, Production: approx. 10,000 cu. yds. per year

Sandoval County Landfill
Contact: Buster Roseberry
Phone: 505-269-6120

E-mail: rmsanchez@sandovalcounty.com
Feedstocks: Green waste, cow manure, horse manure
Future feedstocks to include biosolids and municipal solid waste
Quantity Produced: to be determined
Application: county projects, general public

Santa Fe, City of
73 Paseo Real
Santa Fe, NM 87507
General Information 505-955-4650
Contact: Sherman Bilbo, Compost
Phone: 505-955-4681
E-mail: swbilbo@santafenm.gov
Website: www.santafenm.gov/compost
Feedstocks: wood chips, biosolids, horse stable bedding
Quantity produced: 30,000-35,000 Cubic Yards per year will eventually be produced .
The composting operation processes all biosolids with appropriate high-carbon feedstocks to produce a marketable soil conditioner product. (Screened Compost $11.50/cubic yard; Unscreened Compost $9.00/cubic yard; Compost Overs $6.00/cubic yard)

Santa Fe Solid Waste Management Agency Caja del Rio Landfill
149 Wildlife Way
Santa Fe, NM 87507 Contact: Randall Kippenbrock, Executive Director
E-mail: rkippenbrock@sfswma.org
Phone: 505-424-1850 ext. 100 or 505-820-0208 (Transfer Station)
Feedstocks: ground green waste and horse manure / stable bedding
Qty Produced: Actual 2004 = 10,000 Tons
Application: DOT Erosion Control Compost, currently some sales sold as mulch. If loaded, charge for compost is $6 / cu. yd.; screened compost is $10 / cu. yd. Mulch $2 / cu. yd.

Soilutions, Inc.
P.O. Box 1479
Tijeras, NM 87059
9008 Bates Road, SE (no zip - Delivery address)
Albuquerque, NM
Contact: Jim Brooks, Misch Lehrer, Walter Dods
Phone: 505-877-0220 or 505-281-8425
E-mail: walter@soilutions.net
Feedstocks: Yard trimmings, selected animal manures, stall bedding, agricultural and food processing residuals
Quantity Produced: 5,000-10,000 cu. yds. annually
Products Available: Premium Compost, soil blends, mulches, NMDOT erosion control products, composting worms, green waste, food waste and C&D recycling services
Comments: Company is actively pursuing nitrogen sources as well as distributorships in New Mexico.
Quantity Produced: 300,000+ cu. Yds. Per year
Types of equipment: extensive
Application: Wholesale, retail, golf courses and other turf grass applications, etc.

APPENDIX I

HUMAN HEALTH AND ECOLOGICAL RISK EVALUATION

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HUMAN HEALTH AND ECOLOGICAL RISK EVALUATION

Uranium mine wastes are known to contain elevated levels of radium-226 (Ra-226) and associated progeny. Radium-226, a daughter product in the uranium-238 (U-238) decay chain, has been found to be the predominant contributor of radiological risk to human health and is the radionuclide for which historical cleanup limits have been specified at uranium mines. Radium-226 has been identified as a human health contaminant of potential concern (COPC) at the Section 10 Mine Site to be addressed as part of cleanup actions. Radium is formed when uranium and thorium undergo natural decay in the environment. During the decay processes, alpha, beta, and gamma radiation are released. Results of Site investigations have indicated the need for a response action to control releases and prevent human exposure to radiation at the Site. Table I-1 summarizes the radionuclide analytical results and the human health risks associated with Ra-226 and other isotopes of the Uranium-235 (U-235) and U-238 decay chains at the Section 10 Mine Site, assuming no action is taken. EPA considered contributions to human health and ecological risks from all of the isotopes in the U-238 and U-235 decay chains. Note that the risk estimates presented in Table I-1 also include contribution of the background level of Ra-226 (1.3 pCi/g). The estimated cancer risk associated with some of the waste soil currently present at the Section 10 Mines Site exceeds the EPA 10^{-4} overall cancer risk threshold, and therefore it is anticipated that action will be taken to reduce the human health risk.

Several other non-radionuclide metals were also identified as exceeding human health screening levels and background (Table I-2). Table I-3 summarizes the human health risks associated with non-radionuclide metals. Tables I-4, I-5 and I-6 present the results of an ecological risk assessment for the Section 10 Mines Site. Table I-7 presents an evaluation of the grazing of forage by domesticated animals and wildlife.

The following sections describe the risk assessment process. Based on this evaluation it is concluded that Site actions are required to address radiological human health risks at the Section 10 Mines Site, and that actions taken to address radionuclides will be protective for non-radionuclide chemical exposure and for exposure of ecological receptors.

1. Analytical Data Used in Risk Assessment Calculations

Analytical results of soil samples collected during the Removal Site Evaluation at the Section 10 Mine Site (WESTON, 2019) served as input data for the human health and ecological risk assessments. These samples were analyzed for radioisotopes (i.e., Ra-226) via gamma spectroscopy in the field using an on-site Multi-Channel Analyzer (MCA). Four of the surface samples were also analyzed in an off-site laboratory as verification of the on-site MCA results.

Surface soil (0-6 inch below ground surface [bgs]) samples were collected to verify that radioactive contamination existed in areas of elevated gamma. Ten surface soil samples were collected from the Section 10 Mines Site. To determine vertical extent of contamination, subsurface soil samples (12-18 inch bgs) were collected from “mine impact” (direct impact from surface related mining operations) and “sheet flow” (mining operation surface water discharge) areas throughout the surface-contaminated areas. The samples were collected in “mine areas” at a density of one sample for each 2 acres. A total of 10 subsurface samples plus one field duplicate were collected from the Section 10 Mine Site.

In October 2018, eight surface soil samples plus one duplicate were collected from the Section 10 Mine Site for analysis of TAL (EPA Method 6010B) metals. The metals analysis was performed to evaluate if common mining-related heavy metals present a potential risk to human health or the environment. A minimal number of samples were analyzed for TAL metals and uranium metals due to consistent geochemistry and limited historical processing for metals other than uranium as product. There is no history of non-uranium metals mining in the ALSD. The analytical results used in the evaluations are summarized in Table I-1 and Table I-2.

Additionally, EPA collected two vegetative metals uptake samples in order to determine the current vegetative nutrient values and uptake of potential hazardous constituents available to grazing animals (domesticated animals and wildlife). The analytical results are presented in Table I-7. Native plant tissue samples were analyzed for nutrients (iron, zinc, copper, and manganese) and for toxicity metals (molybdenum, uranium, vanadium, and selenium).

2. Screening to Identify Contaminants of Potential Concern

The non-radionuclide sampling results were screened against the November 2019 EPA [2019a] residential Regional Screening Levels (RSLs) (https://semspub.epa.gov/work/03/2229055.pdf), the New Mexico Environment Department (NMED, 2019) generic soil screening levels (SSLs) for residential land use and the local background concentrations to identify human health non-radionuclide COPCs. Table I-2 summarizes this screening process, showing contaminants that were considered, the minimum and maximum concentrations, associated RSLs and SSLs, and background concentrations, and either identifies each contaminant as a COPC or explains why it was screened from consideration. Screening levels were adjusted to a target cancer risk of 10^{-6} and a target hazard quotient of 0.1 to account for additive risk. Aluminum, arsenic, cobalt, iron, manganese, selenium, uranium, and vanadium concentrations exceeded the most stringent of their respective RSLs.

Site-specific background levels were not available. Background levels for the metals were obtained from literature values for New Mexico (EPA, 2007) and the Western United States (Shacklette and Boernren, 1984). These background levels are also considered in the risk evaluation. Background information is important to risk managers because the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) program, generally, does not clean up to concentrations below natural or anthropogenic background levels (EPA, 2002). Aluminum, cobalt, iron and manganese concentrations do not exceed background levels. However the following four metals exceed their background levels:

- The maximum arsenic concentration (20 mg/kg) exceeds the mean concentration (5.9 mg/kg).
- The maximum selenium concentration (87 mg/kg) exceeds the mean concentration (0.29 mg/kg)
- The maximum uranium concentration (310 mg/kg) exceeds the mean concentration (2.5 mg/kg)
- The maximum vanadium concentration (250 mg/kg) exceeds the mean concentration (71.4 mg/kg)

As shown in Table I-2, arsenic, selenium, uranium and vanadium were identified as non-radionuclide human health COPCs in soil. A streamlined risk assessment for these metals is presented below.

3. Streamlined Human Health Risk Assessment

The results of the streamlined human health risk assessment are summarized in Table I-1 for radionuclides. Cancer is the major effect of concern from radionuclides. Radium is known to cause bone, head, and nasal passage tumors in humans; and radon, via inhalation exposure, causes lung cancer in humans. The potential excess lifetime cancer risk on human receptors from exposure to Ra-226 and other isotopes of the U-235 and U-238 decay chains in soil was assessed for the Section 10 Mine Site. Radionuclides in the soil may be absorbed by plants and consumed by livestock and humans. Persons working at the Site may be exposed to contaminated dust by inhalation of particulate matter. Whole body (external) radiation may be experienced by people on or near the Site itself. Key assumptions used in the human health risk evaluation are described below.

Many sections of the Ambrosia Lake valley are used for grazing cattle, although some sections are not currently grazed due to the radioactive contamination in the surface soil. There are currently no residences in the former mining area of the Section 10 Mine Site and it is unlikely that the property would be used for residential development due to the remoteness of the area. Cattle ranching is considered to remain as the future use of the site. A rancher may be exposed to radiological contaminants through incidental ingestion of soil, external radiation from contaminants, inhalation of fugitive dusts, and meat consumption taking into account the potential future land use of grazing and associated ranching activities.

The indoor and outdoor radon inhalation pathway was not included in this assessment. The indoor inhalation pathway was not considered because there are no occupied buildings on the site and no future plans for site development. An EPA review of outdoor radon data collected at uranium mine and mill sites (WESTON, 2012; Rio Algom Mining, 2016) in the vicinity of the Section 10 Mine site verified that clean-air dilution of radon emissions from those sites rapidly reduces the airborne concentrations to inconsequential levels (i.e., less than the EPA recommended limit for *indoor* concentrations of 4 pCi/L).

The risk to a rancher from potential exposure to isotopes of the U-235 and U-238 decay chains was evaluated at the Section 10 Mines area. The EPA Preliminary Remediation Goal (PRG) calculator (https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search) was used to calculate site-specific risk estimates for exposure from soil incidental ingestion, external exposure, inhalation of particulates (details are included in Attachment 1), and consumption of meat (i.e., beef). The risk estimates considered the isotopes of the U-235 decay chain (i.e., Th-231, Pa-231, Ac-227, Th-227, Fr-223, Ra-223, At-219, Rn-219, Bi-215, Po-215, Pb-211, Bi-211, Tl-207, Po-211, and stable Pb-207) and the U-238 decay chain (i.e., Th-234, Pa-234m, U-234, Pa-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, At-218, Bi-214, Rn-218, Po-214, Tl-210, Pb-210, Pb-210, Bi-210, Hg-206, Po-210, Tl-206 and stable Pb-206) as being in secular equilibrium. The assumption of secular equilibrium is that the parent is continually being renewed. The single isotopes of U-235 and U-238 were selected, and the calculator identified all the daughters in the chain. The risk estimates for each daughter are combined with the parent on a fractional basis. The fractional basis is determined by branching fractions where a progeny may decay into more than one isotope. The resulting risk estimate is now based on secular equilibrium of the full chain (EPA [2019] PRG Calculator User's Guide (https://epa-prgs.ornl.gov/radionuclides/prg_guide.html).

A combination of three land-use scenario templates in the PRG Calculator were used to develop the risk estimates: the "Composite Worker" to model outdoor ranching activities; the "Indoor Worker" to model ranching activities inside a truck; and "Farmer" to model the consumption of site-raised beef. A number of conservative default assumptions presented in the PRG and calculators and literature sources were reviewed to develop conservative assumptions for calculating risk estimates for the rancher. EPA derived PRG Calculator default values to represent reasonable maximum exposure to broad-based populations, typically 90-95 percentile values, which are well above the mean. These assumptions are described below.

- Ranching was assumed to occur on the site 5 days per week for 50 weeks per year for 25 years, which is the default exposure frequency and duration of an indoor worker and composite worker (EPA, 2019b).
- Two cattle ranchers who operate on lands near the Site were interviewed to determine a reasonable amount of time a cattle rancher might spend on this activity. Consequently, EPA used a value of 400 hours per year (1.6 hours/day [interviews] for 250 days/year [PRG Calculator default value for Composite and Indoor Worker]) for annual exposure

frequency. Half of this time was determined to be spent outdoors (0.8 hours; see discussion below).

- Traveling in a vehicle will limit external exposure to radionuclides; a rancher was assumed half of their exposure time (0.8 hours per day) in a truck (EPA, 2011, Table 16-24: Time Spent in Truck, Doers. Western Census Region, 95 percentile; 235 minutes/day = 3.9 hours = approximately 50% of an 8-hour workday). A vehicle was estimated to provide a gamma shielding factor of 0.7 by a Certified Health Physicist conducting a reproducible field experiment (Attachment 2). No cover layer was assumed for exposure outside a vehicle.

- A default composite worker soil intake rate of 100 milligrams per day (mg/day) (EPA, 2019b) was applied for a rancher.

- Inhalation rate of a rancher was assumed to be 60 cubic meters/day based on the PRG Calculator default value for an outdoor worker (EPA, 2019b).

- Average body weights of 80 kilograms for an adult was assumed over the exposure period (EPA, 2019b).

- Inhalation of chemicals adsorbed to respirable particles (particles less than or equal to 10 micrometers in diameter) was assessed using a default particulate emission factor (PEF) equal to 2.57E+09 cubic meters per kilogram. The default PEF was derived using default values adjusted to apply to the climate zone for Albuquerque, New Mexico and a 250-acre source size (approximately equivalent to one million square meters, the largest Area Correction Factor choice in the PRG Calculator [the site equals approximately 5 million square meters]). The PEF equation relates the contaminant concentration in soil with the concentration of respirable particles in the air due to fugitive dust emissions from contaminated soils. The relationship is derived by Cowherd, et al. (Cowherd, 1985; as cited by EPA, 2019b) for a rapid assessment procedure applicable to a typical hazardous waste site, where the surface contamination provides a relatively continuous and constant potential for emission over an extended period of time (i.e., years). This represents an annual average emission rate based on wind erosion that should be compared with chronic health criteria; it is not appropriate for evaluating the potential for more acute exposures (EPA, 2019b).

- It is assumed that 48% of meat consumed by a rancher was home-produced (i.e., from on-Site animals), which is based on the 50th percentile value for "percent of home-raised meat consumed by Western households who farm" presented in Table 13-19 of EPA's 2011 Exposure Factors Handbook. Default home produced meat consumption rate of 165.3 grams/day for 350 days/year was assumed based on the default PRG Calculator value for beef (EPA, 2019b). These values are an annual consumption rates so an exposure frequency (EF) of 350 days/year was applied.

- Cattle were considered to graze on Site 33 percent of the time annually, based on research citing that rangeland experts suggest only 25 to 50 percent of arid rangeland in fair to good condition should be consumed or utilized by livestock in order to leave sufficient vegetation for re-generation (Hurd et al, 2007).

- Concentrations in beef were estimated from soil concentrations using radionuclide-specific transfer factors incorporated in the PRG Calculator. The PRG Calculator default mass loading factor of 0.25 was applied for all forage (EPA, 2019b). A forage intake rate of 11.77 kg/day and a soil intake rate of 0.5 kg/day were applied (EPA, 2019b; PRG Calculator default for beef) for cattle.

EPA manages risk to achieve 10^{-6} to 10^{-4} (1E-06 to 1E-04) overall excess cancer risks. EPA risk assessment guidance suggests that the average of the concentration is regarded as a reasonable estimate of the concentration likely to be contacted over time (EPA, 1989). Because of the uncertainty associated with any estimate of the representative average, the 95th percentile upper confidence limit (95UCL) on the arithmetic mean is generally used as the reasonable maximum exposure concentration (EPA, 1989) [Attachment 3]. Risk estimates were calculated using the reasonable maximum exposure point concentration (EPC). The EPC is based on the lower of the maximum detected and the 95% UCL on the mean. As shown in Table I-1, total cancer risks for the isotopes of the U-235 and U-238 decay chains (expressed as Ra-226 concentrations) for the Section 10 Mine Site equaled or exceeded the 10^{-4} (1E-04) overall cancer risk threshold. The total cancer risks in surface and subsurface soils were 6E-03 and 2E-04, respectively. These results indicate the need for a response action to control releases and prevent radionuclide exposure. Note that these risk estimates also include contribution of the background level of Ra-226 (1.9 pCi/g).

For the non-radionuclide COPCs (i.e., arsenic, selenium, uranium and vanadium), the USEPA RSL calculator (https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) was used to develop site-specific risk-based screening levels and to calculate cancer risk estimates, and non-cancer hazard quotients (HQs) for exposure from soil incidental ingestion, dermal absorption and inhalation of particulates. Of the non-radionuclide COPCs, only arsenic is considered to have carcinogenic effects. Systemic, non-cancer effects are of concern for all the non-radionuclide COPCs. Dermal contact with selenium, vanadium and uranium is not quantified because these metals are not considered to be dermally absorbed through the skin and do not have EPA-recommended dermal absorption factors. The “Composite Worker” land-use scenario template in the RSL Calculator was used to develop the risk estimates for the outdoor ranching activities (details are included in Attachment 1). External exposure is not an exposure route for non-radionuclides, so ranching activities inside a truck are not evaluated for the non-radionuclides. In addition, risk-based screening levels were developed for the home-grown meat exposure pathway for metals following methods used for radionuclides in the PRG Calculator (details are included in Attachment 1). The sum of ratios approach was used to estimate human health risk from beef consumption. For cancer effects, the site-specific concentration is divided by its cancer-based screening level for residential soil to meat consumption and this ratio is multiplied by 10^{-6} (1E-06) to calculate a cancer risk estimate. Individual cancer risk estimates are summed to represent a total cancer risk. The site-specific concentration is divided by its non-cancer-based screening level for residential soil to meat consumption to calculate a HQ. The individual HQs for each scenario (ranching - inside a truck, ranching-outdoors, and beef consumption) and for each COPC are summed to represent a total non-cancer hazard index (HI). A HI of one or less is generally considered "safe." A ratio greater than one suggests that, at a minimum, further evaluation (EPA, 2017a) is necessary.

As shown in Table I-3, using maximum non-radionuclide chemical concentrations in soil, the total non-radionuclide HI was 4. Uranium was the only individual non-radionuclide COPC to have an HI greater than 1 (HI, 1.4). Arsenic, selenium, and vanadium had an HI less than one. For non-cancer hazard estimates, dose additivity is most properly applied to compounds that induce the same non-cancer effect. Segregation of HI by the major target tissue/organ effects should be performed if the total HI for multiple contaminants exceeds one. The target system for uranium (urinary) differs from the remaining COPCs – arsenic (cardiovascular, dermal), selenium (nervous, hematologic, dermal), and vanadium (dermal). As the non-cancer hazard index for non-radionuclide COPC exposure slightly exceeded the threshold of one, adverse non-cancer health effects from exposure to uranium in soil at the Section 10 Mine Site are possible. The only non-radionuclide carcinogenic COPC was arsenic. Cumulative cancer risks from arsenic using the maximum detected concentration yielded a carcinogenic risk of 1E-05 (See Table I-3). The elevated arsenic concentration in surface soil (20 mg/kg at 10-06-31-181031-M) was located in close proximity to the elevated radionuclides in surface soil. It is anticipated that site actions to address radionuclide exposure by human receptors will be protective for exposure of human receptors to both radionuclides and non-radionuclide chemicals.

4. Ecological Risk Evaluation

The Section 10 Mines Site is located in a remote area with the revegetated, previously disturbed mine area potentially providing habitat for ecological receptors. Wildlife inhabiting the Site may directly ingest radionuclides and chemicals, which may then be transported to organs or other sites within the wildlife receptors. Radionuclides and chemicals in the soil may be absorbed by plants consumed by wildlife. Radionuclides such as radium, radon, and daughter progeny may be inhaled, creating alpha-particle-emitting sources in the lungs of wildlife receptors. A screening level ecological risk assessment (i.e., Steps 1 and 2 of EPA's 8-step ecological risk assessment process [EPA, 1997]) was performed to assess potential risk to ecological receptors from both radionuclide and non-radionuclide chemical contaminants. The results of the screening level ecological risk characterization are included in Table I-3. A refinement of conservative screening level assumptions (i.e., Step 3a of EPA's 8-step ecological risk assessment process [EPA, 2001]) was also performed to consider how the risk estimates would change if more realistic assumptions were used. The results of the refined ecological risk characterization are included in Table I-4.

4.1 Ecological Risk-Based Screening Values

Literature-based ecological screening benchmark values for direct contact and food-chain evaluations are used to characterize potential ecological effects. The following sources were used to identify proposed ecological screening benchmark values for radionuclides and chemicals:

- EPA Ecological Soil Screening Levels (Eco-SSLs) (http://www.epa.gov/ecotox/ecossl)
- Los Alamos National Laboratory (LANL) ECORISK database, Release 4.1 (LANL, 2017).
- New Mexico Environment Department (NMED, 2017) Tier 1 ecological screening levels (ESLs)

The Eco-SSLs include values for plant, soil invertebrate, bird, and mammal exposure to metals through direct contact and the food chain. Eco-SSLs are also available for protection of birds and mammals from the three primary feeding groups (herbivores, insectivores, and carnivores). The Eco-SSLs are based on no-effect toxicity values 1) to ensure risks are not underestimated, and 2) to provide a defensible conclusion that negligible ecological risk exist or that certain contaminants and exposure pathways can be eliminated from consideration (EPA, 1997). The Eco-SSLs are intended to be conservative screening values that can be used to eliminate contaminants clearly not associated with unacceptable risks (EPA, 2005a – 2005h, 2006, and 2007b – 2007e).

The LANL EcoRisk database includes ecological screening levels (ESLs) for avian, mammalian, earthworm, and plant exposure models for radionuclides and chemicals in soil. 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. The ESLs for upper level wildlife are based on incidental ingestion of soil while feeding, preening, or nesting on the ground, and ingestion of food sources that have bio-accumulated contaminants. The wildlife functional feeding guilds for birds and mammals used to develop ESLs include herbivores, insectivores, and carnivores. The LANL EcoRisk database provides both no-effect and low-effect ESLs. The no-effect ESL is based on a no-observed-adverse-effect-level (NOAEL)-based toxicity reference value (TRV) that is protective of wildlife populations and sensitive individuals because it represents an exposure that is not associated with adverse impacts of low-level, long-term chemical effects (i.e., adverse effects on ability of individuals to develop into viable organisms, search for mates, breed successfully, and produce live and equally viable offspring). The NOAEL values are often extremely conservative and protective, and are designed to be an indication of no impacts if not exceeded (LANL, 2017). The low-effect ESL applies a lowest-observed-adverse-effect-level- based TRV that is the lowest chronic effect level and is generally considered to be protective of wildlife populations.

The NMED has developed Tier 1 ESLs protective of plant community, deer mouse, horned lark, Kit fox (evaluated at sites greater than 267 acres), Pronghorn (evaluated at sites greater than 342 acres), and Red-tailed hawk (evaluated at sites greater than 177 acres). The key receptors selected as the representative species represent the primary producers as well as the three levels of consumer (primary, secondary, and tertiary) for the most common receptors found at hazardous waste sites in New Mexico. For plants, the Tier 1 screening level is based on an effect concentration for plant communities. For wildlife receptors, the Tier 1 screening level is based on NOAEL-based toxicity reference values (NMED, 2017).

4.2 Ecological Risk Estimates

Screening level risk characterization was performed using the hazard quotient (HQ) method to compare maximum surface (0-6 in bgs) soil concentrations to Eco-SSLs and no-effect ESLs. An HQ of less than 1 indicates that the concentration is unlikely to cause adverse ecological effects. An HQ greater than 1 indicates that the potential for ecological risk is present and therefore the risk assessment process should continue. An HQ of 1 is the condition where the exposure and the dose associated with no adverse chronic effects are equal, indicating adverse effects at or below this soil concentration are unlikely (EPA, 2005a). The screening process considered the isotopes of the U-235 and U-238 decay chains, though ESLs were not available for all isotopes. The screening-level ecological risk assessment indicates potential for risk to ecological receptors from exposure to Ra-226, Th-230, aluminum, arsenic, barium, lead, mercury, selenium, uranium and vanadium (Table I-4 for radionuclides; Table I-5 for metals). Concentrations of aluminum, barium, and lead were below background levels (Table I-6); these three metals are not considered to be chemicals of potential ecological concern (COPEC).

A screening-level ecological risk assessment uses conservative screening-level assumptions such as 100% site use, 100% bioavailability, 100% diet consists of the most contaminated dietary, and no-effect toxicity data to evaluate risk to populations of upper level organisms. Under more realistic site use conditions, the potential risk to individual organisms would be reduced. The average soil concentration and low effect ecological screening values were used to refine these risk estimates. In the refined ecological risk characterization (Table I-6), risks were calculated using a representative average exposure point concentration (i.e., 95% UCL on the mean). The average surface soil concentration of Ra-226 exceeds the low effect ESL for soil invertebrates (i.e., HQ>1), indicating potential risk to this receptor group. Maximum concentrations of arsenic, lead and mercury do not exceed low-effect ESLs (i.e., HQ ≤1) for any receptor group, indicating these metals are not considered to pose risk to populations of higher level organisms. The maximum concentration of selenium exceeds low-effect ESLs for plants, soil invertebrates, avian herbivores, insectivores and carnivores, and mammalian herbivores and insectivores (i.e., HQ>1). The maximum concentration of vanadium exceeds low-effect ESLs for plants, and avian herbivores, insectivores and carnivores (i.e., HQ>1). Note that vanadium was not detected in native plant tissue samples collected from the Section 10 Mine Site (Table I-7), suggesting limited bioavailability of vanadium. The refined ecological risk assessment indicates potential for risk to ecological receptors from exposure to Ra-226 (soil invertebrates only), selenium, and vanadium (Table I-6). Locations where elevated levels of selenium and vanadium were measured are co-located with locations of elevated Ra-226. ESLs for radionuclides are higher (less stringent) than the proposed action level for protection of human health. Thus, it is anticipated that site actions to address radionuclide exposure by human receptors will be protective for exposure of ecological receptors to radionuclides. Selenium, molybdenum, and vanadium are common metals in association with uranium in the Grants Mineral Belt deposits (Brookins, 1982). As an impurity, they may have been a waste metal in the uranium mine waste. Actions to address uranium are also expected to be protective of ecological receptors.

5. Evaluation of Grazing of Forage by Domesticated Animals and Wildlife

The results of the evaluation of the vegetative metals uptake samples are included in Table I-7. Twenty-two surface vegetation samples were collected to determine the current vegetative nutrient values and uptake of potential hazardous constituents available to grazing animals (domesticated animals and wildlife) within the entire West GSA (which included the Section 10 Mine at the time of collection) (WESTON, 2019). Two of the native plant vegetation samples (P-11 and P-12) were collected from the Section 10 mine. Tissue concentrations were compared to maximum tolerable limits (MTLs) developed by the National Research Council's Committee on Minerals and Toxic Substances in Diets and Water for Animals (NRC, 2005), which are defined as dietary level, that, when fed for a defined period of time, will not impair animal health or performance. Tissue concentrations are also compared to concentrations of trace elements in mature leaf tissue that are considered sufficient or normal and excessive or toxic (Kabata-Pendias and Pendias, 1992). As shown in Table I-6, nutrient concentrations are less than MTLs for animals and within or less than sufficient/normal concentrations for plants while the P12 tissue sample for the toxic metal selenium exceeds thresholds for animals and plants. An elevated selenium concentration (81 mg/kg) was measured in soil collected from an area approximately northwest of the Kermac Mine where the P12 tissue sample was collected. While selenium is a common micronutrient supplement for cattle and sheep, it can be toxic at elevated concentrations. Native selenium has been found in the sandstone formations the Grants Mineral belt area (Brookins, 1982) and as an impurity, it may have been a waste metal in the uranium mine waste.

6. Appendix I References

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Appendix I List of Tables

Appendix I Table I- 1
Summary of Radionuclide Risk Estimates for Section 10 Mine Site Soils
Streamlined HHRA

Cancer Risk[a]	Surface Soil			Subsurface Soil		
	95UCL Radium-226 EPC			95UCL Radium-226 EPC		
	Secular Equilibrium Risk for U-235[#]	Secular Equilibrium Risk for U-238*	Uranium TOTAL	Secular Equilibrium Risk for U-235[#]	Secular Equilibrium Risk for U-238*	Uranium TOTAL
Section 10 (pCi/g)	4.55	101.1	105.6	0.156	3.46	3.61
Rancher - Soil Outdoors						
Ingestion	1.56E-06	1.59E-04	1.61E-04	5.50E-08	5.45E-06	5.51E-06
Inhalation	6.95E-09	7.11E-08	7.81E-08	2.44E-10	2.43E-09	2.67E-09
External Exposure	6.06E-06	4.90E-04	4.96E-04	2.13E-07	1.68E-05	1.70E-05
Subtotal	7.63E-06	6.49E-04	6.57E-04	2.68E-07	2.23E-05	2.25E-05
Rancher - Soil Inside Truck						
External Exposure	2.42E-06	1.96E-04	1.98E-04	8.52E-08	6.71E-06	6.80E-06
Subtotal	2.42E-06	1.96E-04	1.98E-04	8.52E-08	6.71E-06	6.80E-06
Rancher - Beef Consumption						
Beef Consumption	2.09E-04	4.65E-03	4.86E-03	7.35E-06	1.59E-04	1.66E-04
TOTAL	2.19E-04	5.50E-03	**6E-03**	7.70E-06	1.88E-04	**2E-04**

Notes:

[a] Cancer risk calculated using the U.S. EPA's on-line PRG Calculator (https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search). Output provided in Attachment 1. Concentrations also include background contribution (1.3 pCi/g Ra-226).

* assumes in secular equilibrium with radium-226 (no decay)

istope in U-235 decay chain; assume all isotopes in secular equilibrium (no decay); concentration based 0.008163 times radium-226 concentration, where U-235 activity is approximately 2% of natural uranium ((Human Health Fact Sheet, August 2005; Argonne Nat'l Laboratory; U-238, U-234, U-235) and assuming secular equilibrium and solving for U-235 (i.e., 0.02 x [U-238 + U-234 + U-235]= U-235). U total is simply referring to the concentrations of just U-235 in secular equilibrium plus U-238 in secular equilibrium (which includes U-234 in decay chain, whose concentration is typically included under the 'ordinary' definition of U total).

HHRA human health risk assessment
pCi/g picocuries per gram
PRG preliminary remediation goal
UCL upper confidence limit

Appendix I Table I-2
Summary of Non-Radionuclide Analytical Results for Section 10 Mine Site Soils
Streamlined HHRA

Chemical name	Number detected^	Number analyzed^	Minimum concentration	Maximum concentration	Sample ID for maximum	EPA Residential November 2019 Residential Regional Screening Level[a]	NMED June 2019 Residential Soil Screening Level[b]	Mean Background [c]	COPC?
Non-Radionuclides									
Aluminum	8	8	6,000	22,000	10-08-31-181031-M	7,700	7,800	54,423	No; ASL; BBC#
Antimony	0	8	ND	ND	---	3.1	3.1	1.0	ND
Arsenic	2	8	5.5	20	10-06-31-181031-M	0.68	0.71	5.9	Yes; ASL; ABC
Barium	8	8	73	210	10-06-31-181031-M	1,500	1,556	727	No; BSL
Beryllium	8	8	0.38	1	10-08-31-181031-M	16	16	1.0	No; BSL
Cadmium	1	8	0.18	0.18	10-01-31-161101-M	7.1	7.1	NA	No; BSL
Calcium	8	8	3,300	17,000	10-01-31-161101-M	--	1.30E+07 (NUT)	35,809	No; BSL
Chromium	7	8	2.5	13	10-08-31-181031-M	12,000	9.7	55.5	No; BSL
Cobalt	8	8	1.8	6.1	10-08-31-181031-M	2.3	2.3	8.8	No; ASL; BBC#
Copper	7	8	3	19	10-01-31-161101-M	310	313	21	No; BSL
Iron	8	8	10,000	19,000	10-08-31-181031-M	5,500	5,475	20,898	No; ASL; BBC#
Lead	8	8	5.40	14	10-03-31-181031-M	400	400	18.1	No; BSL
Magnesium	8	8	1,700	5,300	10-08-31-181031-M	--	3.39E+05 (NUT)	7400 [d]	No; BSL
Manganese	8	8	140	260	10-05-31-181031-M*	180	1055	366.8	No; ASL; BBC#
Mercury[$]	7	8	0.014	0.12	10-06-31-181031-M	11	2.3	0.046 [d]	No; BSL
Nickel	8	8	1.6	11	10-08-31-181031-M	150	156	27.9	No; BSL
Potassium	8	8	880	5,800	10-08-31-181031-M	--	1.56E+07 (NUT)	18000 [d]	No; BSL
Silver	0	8	ND	ND	---	39	39	NA	ND
Sodium	8	8	47	560	10-05-31-181031-M*	--	7.82E+06 (NUT)	9700 [d]	No; BSL
Thallium	0	8	ND	ND	---	0.078	0.078	9.1 [d]	ND
Selenium	4	8	15	87	10-05-31-181031-M*	39	39	0.29	Yes; ASL; ABC
Uranium	4	8	6.2	310	10-06-31-181031-M	16	23	2.5 [d]	Yes; ASL; ABC
Vanadium	8	8	14	250	10-06-31-181031-M	39	39	71.4	Yes; ASL; ABC
Zinc	8	8	17	53	10-08-31-181031-M	2,300	2346	44.3	No; BSL

All concentrations in mg/kg (ppm)

ASL - Above screening level

ABC - Above background concentration

BSL - Below screening level

BBC - Below background concentration

COPC - chemical of potential concern

NUT - essential nutrient; resident value from NMED, 2019

a EPA Rresidential Regional Screening Level based on target risk of 10^{-6} and target hazard quotient of 0.1.

b NMED residential generic soil screening level based on target risk of 10^{-5} and target hazard quotient of 1, adjusted by a factor of 10 to account for additive risk.

c Average concentration, New Mexico, Background Soil Concentration Database, EcoSSL Attachment 1-4, Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs), Review of Background Concentrations for Metals, OSWER Directive 92857-55, Revised July 2007. https://www.epa.gov/sites/production/files/2015-09/documents/ecossl_attachment_1-4.pdf. Average for cadmium is value for "not specified".

d Mean for Western US (Shacklette, H.T. and J.G. Boernren. 1984. Element Concentrations in Soil and Other Surface Materials of the Counterminous United States. USGS Professional Paper 1270)

$ lowest value for elemental mercury and mercury salts

maximum concentration is less than 2 times the mean background

^ includes field duplicates, maximum value taken from duplicate and normal sample

Appendix I Table I-3

Summary of Non-Radionuclide Noncancer Hazard Index and Risks for Section 10 Mine Soils

Streamlined HHRA

Non-radionuclide COPC	EPC* (mg/kg)	Ranching - Outside HQ	Site-Raised Beef HQ	Hazard Index
Arsenic	20	0.04	0.041	0.08
Selenium	87	0.01	0.065	0.08
Uranium	310	1.3	0.058	1.4
Vanadium	250	0.04	0.022	0.06
Hazard Index		1.4	0.2	1.6

Non-radionuclide COPC	EPC* (mg/kg)	Ranching - Outside Cancer Risk	Site-Raised Beef Risk	Carcinogenic Risk
Arsenic	20	6.7E-06	6.5E-06	1E-05

*EPC = Exposure point concentration set at maximum because arsenic, selenium, and uranium had 50% or less detections; vanadium had a small sample size (n=8)

COPC chemical of potential concern

HHRA human health risk assessment

HQ hazard quotient

Appendix I Table I-4
Screening Level Ecological Risk Characterization For Section 10 Mine Surface Soil - Radionuclides

COPEC	Frequency of Detection#	Range of Detected Concentrations* Minimum (mg/kg)	Range of Detected Concentrations* Maximum (mg/kg)	Location of Maximum Concentration	Background[a,b]	Plant EcoSSL[d]	Plant HQ (max)	Soil invertebrates EcoSSL[d]	Soil invertebrates HQ (max)	Avian herbivore EcoSSL[d]	Avian herbivore HQ (max)	Avian ground insectivore EcoSSL[d]	Avian ground insectivore HQ (max)	Avian carnivore EcoSSL[d]	Avian carnivore HQ (max)	Mammalian herbivore EcoSSL[d]	Mammalian herbivore HQ (max)	Mammalian ground insectivore EcoSSL[d]	Mammalian ground insectivore HQ (max)	Mammalian carnivore EcoSSL[d]	Mammalian carnivore HQ (max)
Surface Soil (0-6 in bgs)																					
Uranium 238 Decay Chain Isotopes																					
U-238**	--	--	125.2	--	--	400	0.3	1100	0.1	3300	0.0	4000	0.0	4200	0.0	2000	0.1	2100	0.1	2100	0.1
Th-234**	--	--	125.2	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Pa-234m**	--	--	125.2	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Pa-234**	--	--	125.2	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
U-234**	--	--	125.2	--	--	440	0.3	2200	0.1	14000	0.0	69000	0.0	260000	0.0	36000	0.0	140000	0.0	110000	0.0
Th-230**	--	--	125.2	--	--	200	0.6	52	**2**	1200	0.1	2200	0.0	17000	0.0	9900	0.0	81000	0.0	68000	0.0
Radium 226 (pCi/g)*	10/10	0.924	125.2	10-09-31-170202	1.9	54	**2**	1.5	**100**	34	**4**	8.2	**20**	61	**2**	340	0.4	510	0.2	370	0.3
Rn-222**	--	--	125.2	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Po-218**	--	--	125.2	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Pb-214**	--	--	125.2	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
At-218**	--	--	125.2	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Bi-214**	--	--	125.2	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Rn-218**	--	--	125.2	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Po-214**	--	--	125.2	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Tl-210**	--	--	125.2	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Pb-210**	--	--	125.2	--	--	3400	0.0	1200	0.1	6000	0.0	6200	0.0	8500	0.0	4400	0.0	4500	0.0	4400	0.0
Bi-210**	--	--	125.2	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Po-210**	--	--	125.2	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Uranium 235 Decay Chain Isotopes																					
Uranium-235[&]	--	--	5.6	--	0.086	440	0.0	1600	0.0	6300	0.0	9500	0.0	10000	0.0	4700	0.0	5200	0.0	5200	0.0
Th-231	--	--	5.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Pa-231	--	--	5.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Ac-227	--	--	5.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Th-227	--	--	5.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Fr-223	--	--	5.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Ra-223	--	--	5.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
At-219	--	--	5.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Rn-219	--	--	5.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Bi-215	--	--	5.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Po-215	--	--	5.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Pb-211	--	--	5.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Bi-211	--	--	5.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Tl-207	--	--	5.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Po-211	--	--	5.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Subsurface Soil (12-18 in bgs)																					
Uranium 238 Decay Chain Isotopes																					
U-238**	--	--	4.6	--	--	400	0.0	1100	0.0	3300	0.0	4000	0.0	4200	0.0	2000	0.0	2100	0.0	2100	0.0
Th-234**	--	--	4.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Pa-234m**	--	--	4.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Pa-234**	--	--	4.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
U-234**	--	--	4.6	--	--	440	0.0	2200	0.0	14000	0.0	69000	0.0	260000	0.0	36000	0.0	140000	0.0	110000	0.0
Th-230**	--	--	4.6	--	--	200	0.0	52	0.1	1200	0.0	2200	0.0	17000	0.0	9900	0.0	81000	0.0	68000	0.0
Radium 226 (pCi/g)*	11/11	1.9	4.6	10-03-2-31-161112	1.9	54	0.1	1.5	0.0	34	0.1	8.2	0.0	61	0.1	340	0.0	510	0.0	370	0.0
Rn-222**	--	--	4.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Po-218**	--	--	4.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Pb-214**	--	--	4.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
At-218**	--	--	4.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Bi-214**	--	--	4.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Rn-218**	--	--	4.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Po-214**	--	--	4.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Tl-210**	--	--	4.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Pb-210**	--	--	4.6	--	--	3400	0.0	1200	0.0	6000	0.0	6200	0.0	8500	0.0	4400	0.0	4500	0.0	4400	0.0
Bi-210**	--	--	4.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Po-210**	--	--	4.6	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Uranium 235 Decay Chain Isotopes																					
Uranium-235[&]	--	--	0.21	--	0.086	440	0.0	1600	0.0	6300	0.0	9500	0.0	10000	0.0	4700	0.0	5200	0.0	5200	0.0
Th-231	--	--	0.21	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Pa-231	--	--	0.21	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Ac-227	--	--	0.21	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Th-227	--	--	0.21	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Fr-223	--	--	0.21	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Ra-223	--	--	0.21	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
At-219	--	--	0.21	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Rn-219	--	--	0.21	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Bi-215	--	--	0.21	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Po-215	--	--	0.21	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Pb-211	--	--	0.21	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Bi-211	--	--	0.21	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Tl-207	--	--	0.21	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Po-211	--	--	0.21	--	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--

Bold values indicate concentrations that exceed ecological screening level or background; bold and shading indicates HQ exceeds unity (based on one significant figure).
includes duplicate sample
* dataset includes minimum/maximimum of MCA and offsite laboratory results
COPEC = chemical of potential environmental concern
HQ = Hazard quotient = maximum concentration / screening level
max= maximum concentration
NSL - no screening level
a Background threshold value for radium-226 as reported in the East GSA Removal Site Evaluation Report (Weston, September 2019).

d LANL ESL Version 4.1; values for avian herbivore (American robin), avian insectivore (American robin), and avian intermediate carnivore (Amercian kestrel); mammalian herbivore (desert cottontail); mammalian insectivore (montane shrew) and mammalian top carnivore (red fox).
** isotope in U-238 decay chain; assumes in secular equilibrium with radium-226
& isotope in U-235 decay chain; assume all isotopes in secular equilibrium; concentration based 0.045 times radium-226 concentration, where U-235 activity is approximately 2.2% of natural uranium (U-238, U-234, U-235) and assuming secular equilibrium and solving for U-235 (i.e., 0.022 x [U-238 + U-234 + U-235]= U-235) U total is simply referring to the concentrations of just U-235 in secular equilibrium plus U-238 in secular equilibrium (which includes U-234 in decay chain, whose concentration is typically included under the 'ordinary' definition of U total).

Appendix I Table I-5
Screening Level Ecological Risk Characterization For West Geographic Sub Area (GSA) Section 10 Mine Surface Soil - Metals

COPEC	Frequency of Detection[#]	Range of Detected Concentrations*		Location of Maximum Concentration	Background[a]	Plant				Soil invertebrates		Avian herbivore		Avian ground insectivore		Omnivore (Horned Lark)		Avian carnivore		Top Carnivore (Red-tailed hawk; 177 acres)		Mammalian herbivore		Mammalian ground insectivore		Omniovore (Deer mouse)		Mammalian carnivore		Carnivore (Kit fox; 267 acres)		Herbivore (Longhorn antelope; 342 acres)	
		Minimum (mg/kg)	Maximum (mg/kg)			EcoSSL[c]	HQ (max)	NMED Tier 1 ESL[d]	HQ (max)	EcoSSL[c]	HQ (max)	EcoSSL[c]	HQ (max)	EcoSSL[c]	HQ (max)	NMED Tier 1 ESL[d]	HQ (max)	EcoSSL[c]	HQ (max)	NMED Tier 1 ESL[d]	HQ (max)	EcoSSL[c]	HQ (max)	EcoSSL[c]	HQ (max)	NMED Tier 1 ESL[d]	HQ (max)	EcoSSL[c]	HQ (max)	NMED Tier 1 ESL[d]	HQ (max)	NMED Tier 1 ESL[d]	HQ (max)
Non-Radionuclides																																	
Aluminum*	8/8	6,000	22,000	10-08-31-181031-M	54,423	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	520	**42**	NSL	--	4000	**5.5**	NSL	--	NSL	--	564	**39**	NSL	--	2500	**8.8**	NSL	--
Antimony[$]	0/8	ND	ND	---	1.0	11	--	11.4	--	78	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	10	--	0.27	--	0.536	--	4.9	--	2.380	--	NSL	--
Arsenic	2/8	5.5	20.0	10-06-31-181031-M	5.9	18	**1.1**	18	**1.1**	NSL	--	67	0.3	43	0.5	10.6	**1.9**	1100	0.02	81.5	0.2	170	0.1	46	0.4	9.5	**2.1**	170	0.1	42.0	0.5	36.1	0.6
Barium	8/8	73	210	10-06-31-181031-M	727	NSL	--	118	**1.8**	330	0.6	NSL	--	NSL	--	348	0.6	NSL	--	2680	0.1	3200	0.1	200	**1.1**	471	0.4	9100	0.02	2090	0.1	NSL	--
Beryllium	8/8	0.38	1.00	10-08-31-181031-M	1.0	NSL	--	2.5	0.4	40	0.03	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	21	0.05	34	0.03	4.8	0.2	90	0.01	21.5	0.05	NSL	--
Cadmium	1/8	0.18	0.18	10-01-31-161101-M	NA	32	0.006	32	0.006	140	0.001	28	0.006	0.77	0.2	7.0	0.03	630	0.0003	53.5	0.003	73	0.002	0.36	0.5	7.0	0.03	84	0.002	31.1	0.006	NSL	--
Calcium	8/8	3,300	17,000	10-01-31-161101-M	35,809	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--
Chromium	7/8	2.5	13	10-08-31-181031-M	55.5	NSL	--	NSL	--	NSL	--	78	0.2	26	0.5	12.6	**1.0**	780	0.02	96.8	0.1	380	0.03	34	0.4	21.8	0.6	180	0.07	97.0	0.1	NSL	--
Cobalt	8/8	1.8	6.1	10-08-31-181031-M	8.8	13	0.5	13	0.5	NSL	--	270	0.02	120	0.05	36.0	0.2	1300	0.005	277	0.02	2100	0.003	230	0.03	66.6	0.09	470	0.01	296	0.02	58	0.1
Copper	7/8	3	19	10-01-31-161101-M	21	70	0.3	70	0.3	80	0.2	76	0.3	28	0.7	19.2	**1.0**	1600	0.01	147	0.1	1100	0.02	49	0.4	50.9	0.4	560	0.03	226	0.08	NSL	--
Iron	8/8	10,000	19,000	10-08-31-181031-M	20,898	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Lead	8/8	5.4	14	10-03-31-181031-M	18.1	120	0.1	120	0.1	1700	0.01	46	0.3	11	**1.3**	7.7	**1.8**	510	0.03	59.3	0.2	1200	0.01	56	0.3	42.7	0.3	460	0.03	190	0.07	173	0.08
Magnesium	8/8	1,700	5,300	10-08-31-181031-M	7,400 [b]	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--
Manganese	8/8	140	260	10-05-31-181031-M*	367	220	**1.2**	220	**1.2**	450	0.6	4300	0.1	4300	0.1	847	0.3	65000	0.004	6520	0.04	5300	0.05	4000	0.07	468	0.6	6200	0.04	2080	0.1	5770	0.05
Mercury	7/8	0.014	0.12	10-06-31-181031-M	0.046 [b]	34	0.004	34.9	0.003	0.05	**2.4**	0.067	**1.8**	0.013	**9.2**	0.1	**1.3**	0.058	**2.1**	0.692	0.2	23	0.005	1.7	0.07	12.8	0.009	76	0.002	57.0	0.002	NSL	--
Nickel	8/8	1.6	11	10-08-31-181031-M	27.9	38	0.3	38	0.3	280	0.04	210	0.05	NSL	--	31.7	0.3	2800	0.004	244	0.05	340	0.03	NSL	--	15.5	0.7	130	0.08	68.7	0.2	289	0.04
Potassium	8/8	880	5,800	10-08-31-181031-M	18,000 [b]	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--
Silver	0/8	ND	ND	---	NA	560	--	560	--	NSL	--	69	--	4.2	--	10.4	--	930	--	73.5	--	1500	--	14	--	54.7	--	990	--	243	--	2.9	--
Sodium	8/8	47	560	10-05-31-181031-M*	9,700 [b]	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--	NUT	--
Thallium[$]	0/8	ND	ND	---	9.1 [b]	0.05	--	0.05	--	NSL	--	6.9	--	4.5	--	1.66	--	48	--	12.7	--	1.2	--	0.42	--	0.065	--	5	--	0.29	--	NSL	--
Selenium	4/8	15	87	10-05-31-181031-M*	0.29	0.52	**167**	0.52	**167**	4.1	**21**	2.2	**40**	1.2	**73**	1.37	**64**	83	**1.0**	10.6	**8.2**	2.7	**32**	0.63	**138**	1.3	**67**	2.8	**31**	5.78	**15**	NSL	--
Uranium	4/8	6.2	310	10-06-31-181031-M	2.5 [b]	76	**4**	NSL	--	NSL	--	1500	0.2	1100	0.3	NSL	--	14000	0.02	NSL	--	1000	0.3	480	0.6	NSL	--	4800	0.1	NSL	--	NSL	--
Vanadium	8/8	14	250	10-06-31-181031-M	71.4	NSL	--	60	**4.2**	NSL	--	13	**19**	7.8	**32**	1.6	**153**	140	**1.8**	12.5	**20**	1300	0.2	280	0.9	37.8	**6.6**	580	0.4	168.0	**1.5**	289	0.9
Zinc	8/8	17	53	10-08-31-181031-M	44.3	160	0.3	160	0.3	120	0.4	950	0.06	46	**1.2**	313	0.2	30000	0.002	2410	0.02	6800	0.008	79	0.7	685	0.08	10000	0.005	3050	0.02	2890	0.02

Bold values indicate concentrations that exceed ecological screening level; bold and shading indicates HQ exceeds unity (based on one significant figure). Thick border around HQ>1 indicates maximum concentration also exceeds background.

COPEC = chemical of potential environmental concern

HQ = Hazard quotient = maximum concentration / screening level

max= maximum concentration

NSL - no screening level

a Average concentration, New Mexico, Background Soil Concentration Database, EcoSSL Attachment 1-4, Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs), Review of Background Concentrations for Metals, OSWER Directive 92857-55, Revised July 2007. https://www.epa.gov/sites/production/files/2015-09/documents/ecossl_attachment_1-4.pdf. Average for cadmium is value for "not specified".

b mean for Western US (Shacklette, H.T. and J.G. Boernren. 1984. Element Concentrations in Soil and Other Surface Materials of the Counterminous United States. USGS Professional Paper 1270)

c EPA Ecological Soil Screening Levels (EcoSSL) http://www.epa.gov/chemical-research/interim-ecological-soil-screening-level-documents Last updated September 29, 2016. $ LANL (2017) ESL Version 4.1; values for avian herbivore (American robin), avian insectivore (American robin), and avian intermediate carnivore (Amercian kestrel); mammalian herbivore (desert cottontail); mammalian insectivore (montane shrew) and mammalian top carnivore (red fox); ESL for plant for antimony

d NMED (2017). Risk Assessment Guidance for Site Investigations and Remediation. Volume II -Soil Screening Guidance for Ecological Risk Assessments. March 2017. Tier 1 ecological screening level (ESL).

^ only analyzed in 2015 samples

includes duplicate sample

* NMED ESLs are pH dependent; aluminum is identified as a COPC only at sites where the soil pH is less than 5.5 (U.S. EPA. Ecological Soil Screening Level for Aluminum, Interim Final. OSWER Directive 9285.7-6. November 2003).

Appendix I Table I-6
Refined Ecological Risk Characterization For Section 10 Mine Surface Soil

COPEC	Maximum of Detected Concentrations (mg/kg)	Background[a,b]	Plant		Soil invertebrates		Avian herbivore		Avian ground insectivore		Avian carnivore		Mammalian herbivore		Mammalian ground insectivore		Mammalian carnivore	
			Low Effect ESL[d]	Low Effect HQ	Low Effect ESL[d]	Low Effect HQ	Low Effect ESL[d]	Low Effect HQ	Low Effect ESL[d]	Low Effect HQ	Low Effect ESL[d]	Low Effect HQ	Low Effect ESL[d]	Low Effect HQ	Low Effect ESL[d]	Low Effect HQ	Low Effect ESL[d]	Low Effect HQ
Aluminum	22000	54,423	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--	NSL	--
Arsenic	20.0	5.9	91	0.2	68	0.3	340	0.1	150	0.1	7400	0.003	27	0.7	31	0.6	1300	0.02
Barium	210.0	727	260	0.8	3200	0.07	1200	0.2	1400	0.2	44000	0.005	14000	0.02	10,000	0.02	190,000	0.001
Lead	14.0	18.1	570	0.02	8400	0.002	36	0.4	23	0.6	160	0.09	600	0.02	170	0.08	7000	0.002
Mercury	0.12	0.046	64	0.002	1	0.2	0.67	0.2	0.13	0.9	0.58	0.2	230	0.001	17	0.01	760	0.0002
Selenium	87	0.29	3	**29**	41	**2.1**	1.9	**46**	1.4	**62**	7.5	**12**	3.4	**26**	1	**87**	130	0.7
Uranium	310	2.5	250	**1.2**	NSL	--	15000	0.02	11000	0.03	140,000	0.002	2600	0.1	1200	0.3	12000	0.03
Vanadium	250	71.4	80	**3.1**	NSL	--	13	**19**	9.5	**26**	110	**2.3**	1500	0.2	610	0.4	6900	0.04
Surface Soil																		
Radium 226 (pCi/g)*	101.1	1.9	540	0.2	15	**6.7**	340	0.3	82	**1.2**	610	0.2	3400	0.0	5100	0.0	3700	0.0
Th-230 (pCi/g)**	101.1	1.9	2000	0.1	520	0.0	12000	0.0	22000	0.0	170000	0.0	210000	0.0	1100000	0.0	680000	0.0

Bold values indicate concentrations that exceed ecological screening level; bold and shading indicates HQ exceeds unity (based on one significant figure). Thick border around HQ>1 indicates maximum concentration also exceeds background.

COPEC = chemical of potential environmental concern

HQ = Hazard quotient = maximum concentration / screening level

NSL - no screening level

a Background threshold value for radium-226 as reported in the Section 10 Mine Removal Site Evaluation Report (Weston, September 2019).

b Average concentration, New Mexico, Background Soil Concentration Database, EcoSSL Attachment 1-4, Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs), Review of Background Concentrations for Metals, OSWER Directive 92857-55, Revised July 2007. https://www.epa.gov/sites/production/files/2015-09/documents/ecossl_attachment_1-4.pdf.

c mean for Western US (Shacklette, H.T. and J.G. Boernren. 1984. Element Concentrations in Soil and Other Surface Materials of the Counterminous United States. USGS Professional Paper 1270)

d LANL low effect ESL Version 4.1; values for avian herbivore (American robin), avian insectivore (American robin), and avian intermediate carnivore (Amercian kestrel); mammalian herbivore (desert cottontail); mammalian insectivore (montane shrew) and mammalian top carnivore (red fox)

* 95% upper confidence limit (95UCL) concentration of radium-226

** istope in U-238 decay chain; assumes in secular equilibrium with radium-226

Table I-7
Comparison of Plant Tissue Concentrations to Maximum Tolerable Limits for Animals and Normal/Toxic Limits for Plants
Section 10 Mine

Plant Analysis Sample I.D.	Iron ppm	Zinc ppm	Copper ppm	Manganese ppm	Molybdenum ppm	Uranium ppm	Vanadium ppm	Selenium ppm
WGSA-P11-161101	275.1	23.9	3.5	22.6	1.47	<0.50	<0.04	<0.65
WGSA-P12-161101	157.8	40.4	6.4	8.2	1.98	4.63	<0.04	**205.24**
Maximum Tolerable Limits (MTL) of Minerals in the Feed (mg/kg dry matter) [a]								
Rodents	500	500	500	2000	7	100 - 400**	NA	5
Poultry	500	500	250	2000	100	NA	25 (<5 laying hens)	3
Swine	3000	1000	250	1000	150	NA	10	4
Horse	500	500	250	400	5*	NA	10	5
Cattle	500	500	40	2000	5*	NA	50	5
Sheep	500	300	15	2000	5*	NA	50	5
Trace Elements in Mature Leaf Tissue* (ppm dry weight) [b]**								
Sufficient/Normal	NA	27 - 150	5 - 30	30 - 300	0.2 - 5	NA	0.2 - 1.5	0.01 - 2
Toxic/Excessive	NA	100 - 400	20 - 100	400 - 1000	10 - 50	NA	5 - 10	5 - 30

Bold and shading indicates concentration exceeds lowest MTL for animals and/or is in toxic range for plants.

* toxicosis caused by <25 mg/kg is often associated with inadequate available copper; cattle show overt toxicosis when dietary molybdenum level is at 100 mg/kg or higher regardless of dietary copper or sulfur levels.

**Maximum tolerable intake for domestic animals is probably between 100 and 400 mg/kg diet.

*** Values are not given for very sensitive or highly tolerant plant species.

[a] defined as dietary level, that, when fed for a defined period of time, will not impair animal health or performance.

ppm = parts per million = millgrams per kilogram (mg/kg)

References:

[a] National Research Council (NRC). 2005. Mineral Tolerance of Animal. 2nd Revised Edition. The National Academies Press. Washington, D.C.

[b] Kabata-Pendias, Alina and Henryk Pendias. 1992. Trace Elements in Soils and Plants. 2nd Edition. CRC Press. Boca Raton, FL.

Attachment 1
PRG Calculator Input and Output

Appendix I Attachment 1, Table A.1-1
Site-specific Equation Inputs for Soil Chemicals - Meat Consumption
Section 10 Mine

Intake Equation/Exposure Parameter	Rancher - Adult	
Target Hazard Quotient (THQ, unitless)	1	
Target Risk (TR, unitless)	1E-06	
Body Weight (BW, kg)	80	a
Exposure Frequency (EF, days/yr) - home grown meat	350	a
Exposure Duration (ED, yrs)	25	a
Averaging Time (ATnc)- noncarcinogens (yrs)	ED	a
Averaging Time (ATc)- carcinogens (yrs)	70	a
Ingestion Rate (IR_c, mg/day) - homegrown meat	165300	b
Fraction ingested (FI) - home grown meat	0.48	c
Fraction onsite	0.33	d
Meat Intake Factor - noncancer (MIF nc)	5.0E+02	
Meat Intake Factor - cancer (MIF c)	1.41E-03	

EXPOSURE ALGORITHMS for
SL meat-nc = THQ x AT nc x BW / (EF x ED x 1/RfD x IR meat x FI x 10^{-6} kg/mg) = MIF nc x 1/RfD
SL meat-c = TR x AT c x BW / (EF x ED x SF x IR meat x FI x 10^{-6} kg/mg) = (MIF c /(FI * SF)

a - Default value (USEPA, 2014)
b - default value for beef (USEPA, 2019)
c - USEPA, 2011.
c- Hurd et al, 2007

Appendix I Attachment 1, Table A.1-2
Site-specific Screening Levels and Hazard Index for Soil-to-Meat Consumption
Section 10 Mine

Chemical	Reference Dose (mg/kg-day)	Screening Level-Meat - noncancer	Beef Transfer Coefficient (day/kg)[a]	Soil-to-Dry Plant Uptake[a]	Screening Level Soil to Meat - noncancer	Soil Concentration (mg/kg)	Noncancer Hazard Quotient
Arsenic	3.0E-04	0.31	2.0E-03	4.0E-02	488	20	0.041
Selenium	5.0E-03	5.21	1.5E-02	2.5E-02	1325	87	0.066
Uranium (Soluble Salts)	2.0E-04	0.21	2.0E-04	8.5E-03	5261	310	0.059
Vanadium	5.0E-03	5.21	2.5E-03	5.5E-03	11179	250	0.022
							0.2

Chemical	Slope Factor $(mg/kg\text{-}day)^{-1}$	Screening Level-Meat - cancer	Beef Transfer Coefficient (day/kg)[a]	Soil-to-Dry Plant Uptake[a]	Screening Level Soil to Meat - cancer	Soil Concentration (mg/kg)	Cancer Risk
Arsenic	1.5E+00	0.00196	2.0E-03	4.0E-02	3.1	20	7E-06

a ORNL RAIS

SL meat-nc = THQ x AT nc x BW / (EF x ED x 1/RfD x IR meat x FI x 10^{-6} kg/mg) = (MIFnc / FI *1/RfD) * 1/ (1/RfD) = 500 / (0.48 x (1/RfD)

SL meat-c =TR x AT c x BW / (EF x ED x SF x IR meat x FI x 10^{-6} kg/mg) = MIFc / SF x FI = 1.41E-3 / SF *0.48

SL-res-meat-nc-ing (mg/kg) = SL-meat-nc / {BTF x ([Forage Intake * PUFdry] + Soil intake)}

Hazard quotient (HQ) = Concentration/SL-nc

SL-res-meat-c-ing (mg/kg) = SL-meat-c / {BTF x ([Forage Intake * PUFdry] + Soil intake)}

Risk = (Concentration/SL-c)*1E-6

Forage intake = 11.77 kg/day *.33 (fraction onsite) = 3.8841 kg/day

Soil intake = 0.5 kg/day *.33 (fraction onsite) = 0.165 kg/day

Appendix I Attachment 1, Table A.1-3
Chemical-Specific Parameters
Section 10 Mine

ANALYSIS	Beef Transfer Coefficient (day/kg)	Soil-to-Dry Plant Uptake	Soil-to-Wet Plant Uptake	BTF, BV Dry and BV Wet Reference
Arsenic, Inorganic	0.002	0.04	0.01	Baes, C. F., III, Sharp, R. D., Sjoreen, A. L., and Shor, R. W. 1984. A Review and Analysis of Parameters for Assessing Transport
Selenium	0.015	0.025	0.00625	
Uranium (Soluble Salts)	0.0002	0.0085	0.002125	
Vanadium and Compounds	0.0025	0.0055	0.001375	

Source: ORNL RAIS

Site-specific

Composite Worker Soil Inputs - Secular Equilibrium

Section 10 Surface Soil

Variable	Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	14.9421
B (PEF Dispersion Constant)	18.7762	17.9869
City (Climate Zone)	Default	Albuquerque, NM (3)
C (PEF Dispersion Constant)	216.108	205.1782
Cover thickness for GSF_o (gamma shielding factor) cm	0 cm	0 cm
F(x) (function dependent on U_m/U_t) unitless	0.194	0.0553
PEF (particulate emission factor) m^3/kg	1359344438	2573243853.79163
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	31.86507598808449
A_s (acres)	0.5	250
Site area for ACF (area correction factor) m^2	1000029 m^2	1000029 m^2
ED_w (exposure duration - composite worker) yr	25	25
EF_w (exposure frequency - composite worker) day/yr	250	250
ET_w (exposure time - composite worker) hr/day	8	0.8
IRA_w (inhalation rate - composite worker) m^3/day	60	60
IRS_w (soil intake rate - composite worker) mg/day	100	100
t_w (time - composite worker) yr	25	25
TR (target cancer risk) unitless	1.0E-06	1.0E-04
U_m (mean annual wind speed) m/s	4.69	4.02
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

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Site-specific
Composite Worker PRGs for Soil - Secular Equilibrium

Isotope	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)
Secular Equilibrium PRG for U-235	*2.91E+02*	*6.55E+04*	*7.51E+01*	*5.97E+01*
Secular Equilibrium PRG for U-238	*6.35E+01*	*1.42E+05*	*2.06E+01*	*1.56E+01*

Output generated 15DEC2019:16:28:52

Composite Worker Risk for Soil - Secular Equilibrium

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
*Secular Equilibrium Risk for U-235	1.56E-06	6.95E-09	6.06E-06	7.63E-06
*Secular Equilibrium Risk for U-238	1.59E-04	7.11E-08	4.90E-04	6.49E-04
*Total Risk	1.61E-04	7.80E-08	4.96E-04	6.57E-04

Site-specific

Indoor Worker Soil Inputs - Secular Equilibrium

Variable	Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	14.9421
B (PEF Dispersion Constant)	18.7762	17.9869
City (Climate Zone)	Default	Albuquerque, NM (3)
C (PEF Dispersion Constant)	216.108	205.1782
Cover thickness for GSF_h (gamma shielding factor) cm	0 cm	0 cm
F(x) (function dependent on U_m/U_t) unitless	0.194	0.0553
PEF (particulate emission factor) m^3/kg	1359344438	6609630249.811598
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	81.84858572694108
A_s (acres)	0.5	0.5
Site area for ACF (area correction factor) m^2	1000029 m^2	1000029 m^2
ED_{iw} (exposure duration - indoor worker) yr	25	25
EF_{iw} (exposure frequency - indoor worker) day/yr	250	250
ET_{iw} (exposure time - indoor worker) hr/day	8	0.8
GSF_i (indoor gamma shielding factor) unitless	0.4	0.7
IRA_{iw} (inhalation rate - indoor worker) m^3/day	60	0
IRS_{iw} (soil intake rate - indoor worker) mg/day	50	0
t_{iw} (time - indoor worker) yr	25	25
TR (target cancer risk) unitless	1.0E-06	1.0E-04
U_m (mean annual wind speed) m/s	4.69	4.02
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Section 10 Surface Soil

Site-specific

Indoor Worker PRGs for Soil - Secular Equilibrium

Isotope	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)
Secular Equilibrium PRG for U-235	-	-	*1.07E+02*	*1.07E+02*
Secular Equilibrium PRG for U-238	-	-	*2.95E+01*	*2.95E+01*

Indoor Worker Risk for Soil - Secular Equilibrium

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
*Secular Equilibrium Risk for U-235	0.00E+00	0.00E+00	4.24E-06	4.24E-06
*Secular Equilibrium Risk for U-238	0.00E+00	0.00E+00	3.43E-04	3.43E-04
*Total Risk	0.00E+00	0.00E+00	3.47E-04	3.47E-04

Site-specific
Farmer Soil Inputs - Secular Equilibrium

Section 10 Surface Soil

Variable	Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	14.9421
B (PEF Dispersion Constant)	18.7762	17.9869
City (Climate Zone)	Default	Albuquerque, NM (3)
C (PEF Dispersion Constant)	216.108	205.1782
Cover thickness for GSF_a (gamma shielding factor) cm	0 cm	0 cm
Cover thickness for GSF_b (gamma shielding factor) cm	0 cm	0 cm
$CF_{far-produce}$ (contaminated plant fraction) unitless	1	1
$CF_{far-apple}$ (contaminated apple fraction) unitless	1	1
$CF_{far-asparagus}$ (contaminated asparagus fraction) unitless	1	1
$CF_{far-beef}$ (beef contaminated fraction) unitless	1	0.48
$CF_{far-berry}$ (contaminated berry fraction) unitless	1	1
$CF_{far-broccoli}$ (contaminated broccoli fraction) unitless	1	1
$CF_{far-beet}$ (contaminated beet fraction) unitless	1	1
$CF_{far-cabbage}$ (contaminated cabbage fraction) unitless	1	1
$CF_{far-cereal grain}$ (contaminated cereal grain fraction) unitless	1	1
$CF_{far-citrus}$ (contaminated citrus fraction) unitless	1	1
$CF_{far-corn}$ (contaminated corn fraction) unitless	1	1
$CF_{far-carrot}$ (contaminated carrot fraction) unitless	1	1
$CF_{far-cucumber}$ (contaminated cucumber fraction) unitless	1	1
$CF_{far-dairy}$ (dairy contaminated fraction) unitless	1	1
$CF_{far-egg}$ (egg contaminated fraction) unitless	1	1
$CF_{far-fish}$ (fish contaminated fraction) unitless	1	1
$CF_{far-goat milk}$ (goat milk contaminated fraction) unitless	1	1
$CF_{far-goat meat}$ (goat meat contaminated fraction) unitless	1	1
$CF_{far-lettuce}$ (contaminated lettuce fraction) unitless	1	1
$CF_{far-lima bean}$ (contaminated lima bean fraction) unitless	1	1
$CF_{far-okra}$ (contaminated okra fraction) unitless	1	1
$CF_{far-onion}$ (contaminated onion fraction) unitless	1	1
$CF_{far-poultry}$ (poultry contaminated fraction unitless)	1	1
$CF_{far-peach}$ (contaminated peach fraction) unitless	1	1
$CF_{far-pea}$ (contaminated pea fraction) unitless	1	1
$CF_{far-pear}$ (contaminated pear fraction) unitless	1	1
$CF_{far-potato}$ (contaminated potato fraction) unitless	1	1
$CF_{far-pumpkin}$ (contaminated pumpkin fraction) unitless	1	1

Site-specific

Farmer Soil Inputs - Secular Equilibrium

Variable	Default Value	Form-input Value
$CF_{far\text{-}rice}$ (contaminated rice fraction) unitless	1	1
$CF_{far\text{-}sheep}$ (sheep contaminated fraction) unitless	1	1
$CF_{far\text{-}sheep\ milk}$ (sheep milk contaminated fraction) unitless	1	1
$CF_{far\text{-}snap\ bean}$ (contaminated snap bean fraction) unitless	1	1
$CF_{far\text{-}strawberry}$ (contaminated strawberry fraction) unitless	1	1
$CF_{far\text{-}swine}$ (swine contaminated fraction) unitless	1	1
$CF_{far\text{-}tomato}$ (contaminated tomato fraction) unitless	1	1
ED_{far} (exposure duration - farmer) yr	40	25
$ED_{far\text{-}a}$ (exposure duration - farmer adult) yr	34	25
$ED_{far\text{-}c}$ (exposure duration - farmer child) yr	6	0
$EF_{far\text{-}a}$ (exposure frequency - farmer adult) day/yr	350	350
$EF_{far\text{-}c}$ (exposure frequency - farmer child) day/yr	350	0
$IFAP_{far\text{-}adj}$ (age-adjusted apple ingestion factor) g	1182020	741125
$IFAS_{far\text{-}adj}$ (age-adjusted asparagus ingestion factor) g	492870	343874.99999999994
$IFB_{far\text{-}adj}$ (age-adjusted beef ingestion factor) g	2098950	1446375
$IFBE_{far\text{-}adj}$ (age-adjusted berry ingestion factor) g	471450	309750
$IFBR_{far\text{-}adj}$ (age-adjusted broccoli ingestion factor) g	450310	308874.99999999994
$IFBT_{far\text{-}adj}$ (age-adjusted beet ingestion factor) g	411600	296625
$IFCB_{far\text{-}adj}$ (age-adjusted cabbage ingestion factor) g	1043980	749875
$IFCG_{far\text{-}adj}$ (age-adjusted cereal grain ingestion factor) g	1190210	1190210
$IFCI_{far\text{-}adj}$ (age-adjusted citrus ingestion factor) g	4090100	2707249.9999999995
$IFCO_{far\text{-}adj}$ (age-adjusted corn ingestion factor) g	1044470	717500
$IFCR_{far\text{-}adj}$ (age-adjusted carrot ingestion factor) g	318290	213500
$IFCU_{far\text{-}adj}$ (age-adjusted cucumber ingestion factor) g	688800	480375
$IFD_{far\text{-}adj}$ (age-adjusted dairy ingestion factor) g	10138030	5918500
$IFE_{far\text{-}adj}$ (age-adjusted egg ingestion factor) g	775810	521500
$IFFI_{far\text{-}adj}$ (age-adjusted fish ingestion factor) g	10018960	7278250
$IFLE_{far\text{-}adj}$ (age-adjusted lettuce ingestion factor) g	455070	328125
$IFLI_{far\text{-}adj}$ (age-adjusted lima bean ingestion factor) g	415870	295749.99999999994
$IFOK_{far\text{-}adj}$ (age-adjusted okra ingestion factor) g	370510	264250
$IFON_{far\text{-}adj}$ (age-adjusted onion ingestion factor) g	338800	238000
$IFP_{far\text{-}adj}$ (age-adjusted poultry ingestion factor) g	1376550	939750
$IFPC_{far\text{-}adj}$ (age-adjusted peach ingestion factor) g	1435420	902125
$IFPE_{far\text{-}adj}$ (age-adjusted pea ingestion factor) g	437500	277375

Site-specific

Farmer Soil Inputs - Secular Equilibrium

Variable	Default Value	Form-input Value
$IFPR_{far-adj}$ (age-adjusted pear ingestion factor) g	874300	524125
$IFPT_{far-adj}$ (age-adjusted potato ingestion factor) g	1807750	1240750.0000000002
$IFPU_{far-adj}$ (age-adjusted pumpkin ingestion factor) g	866040	567000
$IFRI_{far-adj}$ (age-adjusted rice ingestion factor) g	1126230	774375
$IFSN_{far-adj}$ (age-adjusted snap bean ingestion factor) g	702730	474250
$IFST_{far-adj}$ (age-adjusted strawberry ingestion factor) g	535080	354375
$IFSW_{far-adj}$ (age-adjusted swine ingestion factor) g	1171520	809375
$IFTO_{far-adj}$ (age-adjusted tomato ingestion factor) g	1194270	824250
$IRAP_{far-a}$ (apple ingestion rate - farmer adult) g/day	84.7	84.7
$IRAP_{far-c}$ (apple ingestion rate - farmer child) g/day	82.9	82.9
$IRAS_{far-a}$ (asparagus ingestion rate - farmer adult) g/day	39.3	39.3
$IRAS_{far-c}$ (asparagus ingestion rate - farmer child) g/day	12.0	12.0
IRB_{far-a} (beef ingestion rate - farmer adult) g/day	165.3	165.3
IRB_{far-c} (beef ingestion rate - farmer child) g/day	62.8	0
$IRBE_{far-a}$ (berry ingestion rate - farmer adult) g/day	35.4	35.4
$IRBE_{far-c}$ (berry ingestion rate - farmer child) g/day	23.9	23.9
$IRBR_{far-a}$ (broccoli ingestion rate - farmer adult) g/day	35.3	35.3
$IRBR_{far-c}$ (broccoli ingestion rate - farmer child) g/day	14.4	14.4
$IRBT_{far-a}$ (beet ingestion rate - farmer adult) g/day	33.9	33.9
$IRBT_{far-c}$ (beet ingestion rate - farmer child) g/day	3.9	3.9
$IRCB_{far-a}$ (cabbage ingestion rate - farmer adult) g/day	85.7	85.7
$IRCB_{far-c}$ (cabbage ingestion rate - farmer child) g/day	11.5	11.5
$IRCG_{far-a}$ (cereal grain ingestion rate - farmer adult) g/day	91.9	91.9
$IRCG_{far-c}$ (cereal grain ingestion rate - farmer child) g/day	46.0	46.0
$IRCI_{far-a}$ (citrus ingestion rate - farmer adult) g/day	309.4	309.4
$IRCI_{far-c}$ (citrus ingestion rate - farmer child) g/day	194.4	194.4
$IRCO_{far-a}$ (corn ingestion rate - farmer adult) g/day	82.0	82.0
$IRCO_{far-c}$ (corn ingestion rate - farmer child) g/day	32.7	32.7
$IRCR_{far-a}$ (carrot ingestion rate - farmer adult) g/day	24.4	24.4
$IRCR_{far-c}$ (carrot ingestion rate - farmer child) g/day	13.3	13.3
$IRCU_{far-a}$ (cucumber ingestion rate - farmer adult) g/day	54.9	54.9
$IRCU_{far-c}$ (cucumber ingestion rate - farmer child) g/day	16.9	16.9
IRD_{far-a} (dairy ingestion rate - farmer adult) g/day	676.4	676.4
IRD_{far-c} (dairy ingestion rate - farmer child) g/day	994.7	994.7

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Variable	Default Value	Form-input Value
IRE_{far-a} (egg ingestion rate - farmer adult) g/day	59.6	59.6
IRE_{far-c} (egg ingestion rate - farmer child) g/day	31.7	31.7
$IRFI_{far-a}$ (fish ingestion rate - farmer adult) g/day	831.8	831.8
$IRFI_{far-c}$ (fish ingestion rate - farmer child) g/day	57.4	57.4
$IRLE_{far-a}$ (lettuce ingestion rate - farmer adult) g/day	37.5	37.5
$IRLE_{far-c}$ (lettuce ingestion rate - farmer child) g/day	4.2	4.2
$IRLI_{far-a}$ (lima bean ingestion rate - farmer adult) g/day	33.8	33.8
$IRLI_{far-c}$ (lima bean ingestion rate - farmer child) g/day	6.5	6.5
$IROK_{far-a}$ (okra ingestion rate - farmer adult) g/day	30.2	30.2
$IROK_{far-c}$ (okra ingestion rate - farmer child) g/day	5.3	5.3
$IRON_{far-a}$ (onion ingestion rate - farmer adult) g/day	27.2	27.2
$IRON_{far-c}$ (onion ingestion rate - farmer child) g/day	7.2	7.2
IRP_{far-a} (poultry ingestion rate - farmer adult) g/day	107.4	107.4
IRP_{far-c} (poultry ingestion rate - farmer child) g/day	46.9	46.9
$IRPC_{far-a}$ (peach ingestion rate - farmer adult) g/day	103.1	103.1
$IRPC_{far-c}$ (peach ingestion rate - farmer child) g/day	99.3	99.3
$IRPE_{far-a}$ (pea ingestion rate - farmer adult) g/day	31.7	31.7
$IRPE_{far-c}$ (pea ingestion rate - farmer child) g/day	28.7	28.7
$IRPR_{far-a}$ (pear ingestion rate - farmer adult) g/day	59.9	59.9
$IRPR_{far-c}$ (pear ingestion rate - farmer child) g/day	76.9	76.9
$IRPT_{far-a}$ (potato ingestion rate - farmer adult) g/day	141.8	141.8
$IRPT_{far-c}$ (potato ingestion rate - farmer child) g/day	57.3	57.3
$IRPU_{far-a}$ (pumpkin ingestion rate - farmer adult) g/day	64.8	64.8
$IRPU_{far-c}$ (pumpkin ingestion rate - farmer child) g/day	45.2	45.2
$IRRI_{far-a}$ (rice ingestion rate - farmer adult) g/day	88.5	88.5
$IRRI_{far-c}$ (rice ingestion rate - farmer child) g/day	34.8	34.8
$IRSN_{far-a}$ (snap bean ingestion rate - farmer adult) g/day	54.2	54.2
$IRSN_{far-c}$ (snap bean ingestion rate - farmer child) g/day	27.5	27.5
$IRST_{far-a}$ (strawberry ingestion rate - farmer adult) g/day	40.5	40.5
$IRST_{far-c}$ (strawberry ingestion rate - farmer child) g/day	25.3	25.3
$IRSW_{far-a}$ (swine ingestion rate - farmer adult) g/day	92.5	92.5
$IRSW_{far-c}$ (swine ingestion rate - farmer child) g/day	33.7	33.7
$IRTO_{far-a}$ (tomato ingestion rate - farmer adult) g/day	94.2	94.2
$IRTO_{far-c}$ (tomato ingestion rate - farmer child) g/day	34.9	34.9

Site-specific

Farmer Soil Inputs - Secular Equilibrium

Variable	Default Value	Form-input Value
MLF_{apple} (apple mass loading factor) unitless	0.000160	0.000160
$MLF_{asparagus}$ (asparagus mass loading factor) unitless	0.0000790	0.0000790
MLF_{berry} (berry mass loading factor) unitless	0.000166	0.000166
$MLF_{broccoli}$ (broccoli mass loading factor) unitless	0.00101	0.00101
MLF_{beet} (beet mass loading factor) unitless	0.000138	0.000138
$MLF_{cabbage}$ (cabbage mass loading factor) unitless	0.000105	0.000105
$MLF_{cereal\ grain}$ (cereal grain mass loading factor) unitless	0.250	0.250
MLF_{citrus} (citrus mass loading factor) unitless	0.000157	0.000157
MLF_{corn} (corn mass loading factor) unitless	0.000145	0.000145
MLF_{carrot} (carrot mass loading factor) unitless	0.0000970	0.0000970
$MLF_{cucumber}$ (cucumber mass loading factor) unitless	0.0000400	0.0000400
$MLF_{lettuce}$ (lettuce mass loading factor) unitless	0.0135	0.0135
$MLF_{lima\ bean}$ (lima bean mass loading factor) unitless	0.00383	0.00383
MLF_{okra} (okra mass loading factor) unitless	0.0000800	0.0000800
MLF_{onion} (onion mass loading factor) unitless	0.0000970	0.0000970
MLF_{peach} (peach mass loading factor) unitless	0.000150	0.000150
MLF_{pea} (pea mass loading factor) unitless	0.000178	0.000178
MLF_{pear} (pear mass loading factor) unitless	0.000160	0.000160
MLF_{potato} (potato mass loading factor) unitless	0.000210	0.000210
$MLF_{pumpkin}$ (pumpkin mass loading factor) unitless	0.0000580	0.0000580
MLF_{rice} (rice mass loading factor) unitless	0.250	0.250
$MLF_{snap\ bean}$ (snap bean mass loading factor) unitless	0.00500	0.00500
$MLF_{strawberry}$ (strawberry mass loading factor) unitless	0.0000800	0.0000800
MLF_{tomato} (tomato mass loading factor) unitless	0.00159	0.00159
p_m (density of milk) kg/L	1.03	1.03
t_{far} (time - farmer) yr	40	25
TR (target cancer risk) unitless	1.0E-06	1.0E-04
F(x) (function dependent on U_m/U_t) unitless	0.194	0.0553
PEF (particulate emission factor) m^3/kg	1359344438	6609630249.811598
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	81.84858572694108
A_s (acres)	0.5	0.5
Slab size for ACF (area correction factor) m^2	1000029 m^2	1000029 m^2
ED_{far} (exposure duration - farmer) yr	40	25
$ED_{far\text{-}a}$ (exposure duration - farmer adult) yr	34	25

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Site-specific

Farmer Soil Inputs - Secular Equilibrium

Variable	Default Value	Form-input Value
ED_{far-c} (exposure duration - farmer child) yr	6	0
EF_{far} (exposure frequency) day/yr	350	350
EF_{far-a} (exposure frequency - farmer adult) day/yr	350	350
EF_{far-c} (exposure frequency - farmer child) day/yr	350	0
ET_{far} (exposure time - farmer) hr/day	24	0
ET_{far-a} (exposure time - farmer adult) hr/day	24	0
ET_{far-c} (exposure time - farmer child) hr/day	24	0
ET_{far-i} (indoor exposure time fraction) hr/day	10.008	0
ET_{far-o} (outdoor exposure time fraction) hr/day	12.168	0
f_{p-beef} (animal on-site fraction) unitless	1	0.33
$f_{p-dairy}$ (animal on-site fraction) unitless	1	1
$f_{p-goat\ milk}$ (animal on-site fraction) unitless	1	1
f_{p-goat} (animal on-site fraction) unitless	1	1
$f_{p-poultry}$ (animal on-site fraction) unitless	1	1
$f_{p-sheep}$ (animal on-site fraction) unitless	1	1
$f_{p-sheep\ milk}$ (animal on-site fraction) unitless	1	1
$f_{p-swine}$ (animal on-site fraction) unitless	1	1
f_{s-beef} (fraction of year animal on site) unitless	1	1
$f_{s-dairy}$ (fraction of year animal on site) unitless	1	1
$f_{s-goat\ milk}$ (fraction of year animal on site) unitless	1	1
f_{s-goat} (fraction of year animal on site) unitless	1	1
$f_{s-poultry}$ (fraction of year animal on site) unitless	1	1
$f_{s-sheep}$ (fraction of year animal on site) unitless	1	1
$f_{s-sheep\ milk}$ (fraction of year animal on site) unitless	1	1
$f_{s-swine}$ (fraction of year animal on site) unitless	1	1
GSF_i (gamma shielding factor - indoor)	0.4	0
$IFA_{far-adj}$ (age-adjusted soil inhalation factor) m^3	259000	0
$IFS_{far-adj}$ (age-adjusted soil ingestion factor) mg	1610000	0
IRA_{far-a} (inhalation rate - farmer adult) m^3/day	20	0
IRA_{far-c} (inhalation rate - farmer child) m^3/day	10	0
IRS_{far-a} (soil ingestion rate - farmer adult) mg/day	100	0
IRS_{far-c} (soil ingestion rate - farmer child) mg/day	200	0
$MLF_{pasture}$ (pasture plant mass loading factor) unitless	0.25	0.25
Q_{p-beef} (beef fodder intake rate) kg/day	11.77	11.77

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Site-specific
Farmer Soil Inputs - Secular Equilibrium

Variable	Default Value	Form-input Value
$Q_{p\text{-}dairy}$ (dairy fodder intake rate) kg/day	20.3	20.3
$Q_{p\text{-}goat\ milk}$ (goat milk fodder intake rate) kg/day	1.59	1.59
$Q_{p\text{-}goat}$ (goat fodder intake rate) kg/day	1.27	1.27
$Q_{p\text{-}poultry}$ (poultry fodder intake rate) kg/day	0.2	0.2
$Q_{p\text{-}sheep}$ (sheep fodder intake rate) kg/day	1.75	1.75
$Q_{p\text{-}sheep\ milk}$ (sheep milk fodder intake rate) kg/day	3.15	3.15
$Q_{p\text{-}swine}$ (swine fodder intake rate) kg/day	4.7	4.7
$Q_{s\text{-}beef}$ (beef soil intake rate) kg/day	0.5	0.5
$Q_{s\text{-}dairy}$ (dairy soil intake rate) kg/day	0.4	0.4
$Q_{s\text{-}goat\ milk}$ (goat milk soil intake rate) kg/day	0.29	0.29
$Q_{s\text{-}goat}$ (goat soil intake rate) kg/day	0.23	0.23
$Q_{s\text{-}poultry}$ (poultry soil intake rate) kg/day	0.022	0.022
$Q_{s\text{-}sheep}$ (sheep soil intake rate) kg/day	0.32	0.32
$Q_{s\text{-}sheep\ milk}$ (sheep milk soil intake rate) kg/day	0.57	0.57
$Q_{s\text{-}swine}$ (swine soil intake rate) kg/day	0.37	0.37
t_{far} (time - farmer) yr	40	25
TR (target cancer risk) unitless	1.0E-06	1.0E-04
U_m (mean annual wind speed) m/s	4.69	4.02
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Site-specific

Farmer PRGs for Soil - Secular Equilibrium

Isotope	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Produce Consumption PRG TR=0.0001 (pCi/g)	Beef Consumption PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)
Secular Equilibrium PRG for U-235	-	-	-	-	*1.86E+02*	*1.86E+02*
Secular Equilibrium PRG for U-238	-	-	-	-	*9.57E+00*	*9.57E+00*

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Farmer Risk for Soil - Secular Equilibrium

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Produce Consumption Risk	Beef Risk	Total Risk
*Secular Equilibrium Risk for U-235	0.00E+00	0.00E+00	0.00E+00	-	2.45E-06	2.45E-06
*Secular Equilibrium Risk for U-238	0.00E+00	0.00E+00	0.00E+00	-	1.06E-03	1.06E-03
*Total Risk	0.00E+00	0.00E+00	0.00E+00	-	1.06E-03	1.06E-03

Site-specific

Composite Worker Soil Inputs - Secular Equilibrium

Section 10 Subsurface Soil

Variable	Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	14.9421
B (PEF Dispersion Constant)	18.7762	17.9869
City (Climate Zone)	Default	Albuquerque, NM (3)
C (PEF Dispersion Constant)	216.108	205.1782
Cover thickness for GSF_{o} (gamma shielding factor) cm	0 cm	0 cm
F(x) (function dependent on U_{m}/U_{t}) unitless	0.194	0.0553
PEF (particulate emission factor) m^3/kg	1359344438	2573243853.79163
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	31.86507598808449
A_s (acres)	0.5	250
Site area for ACF (area correction factor) m^2	1000029 m^2	1000029 m^2
ED_w (exposure duration - composite worker) yr	25	25
EF_w (exposure frequency - composite worker) day/yr	250	250
ET_w (exposure time - composite worker) hr/day	8	0.8
IRA_w (inhalation rate - composite worker) m^3/day	60	60
IRS_w (soil intake rate - composite worker) mg/day	100	100
t_w (time - composite worker) yr	25	25
TR (target cancer risk) unitless	1.0E-06	1.0E-04
U_m (mean annual wind speed) m/s	4.69	4.02
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

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Site-specific

Composite Worker PRGs for Soil - Secular Equilibrium

Isotope	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)
Secular Equilibrium PRG for U-235	*2.91E+02*	*6.55E+04*	*7.51E+01*	*5.97E+01*
Secular Equilibrium PRG for U-238	*6.35E+01*	*1.42E+05*	*2.06E+01*	*1.56E+01*

Composite Worker Risk for Soil - Secular Equilibrium

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
*Secular Equilibrium Risk for U-235	5.36E-08	2.38E-10	2.08E-07	2.61E-07
*Secular Equilibrium Risk for U-238	5.45E-06	2.43E-09	1.68E-05	2.22E-05
*Total Risk	5.50E-06	2.67E-09	1.70E-05	2.25E-05

Site-specific

Indoor Worker Soil Inputs - Secular Equilibrium

Section 10 Subsurface Soil

Variable	Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	14.9421
B (PEF Dispersion Constant)	18.7762	17.9869
City (Climate Zone)	Default	Albuquerque, NM (3)
C (PEF Dispersion Constant)	216.108	205.1782
Cover thickness for GSF_h (gamma shielding factor) cm	0 cm	0 cm
F(x) (function dependent on U_m/U_t) unitless	0.194	0.0553
PEF (particulate emission factor) m^3/kg	1359344438	6609630249.811598
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	81.84858572694108
A_s (acres)	0.5	0.5
Site area for ACF (area correction factor) m^2	1000029 m^2	1000029 m^2
ED_{iw} (exposure duration - indoor worker) yr	25	25
EF_{iw} (exposure frequency - indoor worker) day/yr	250	250
ET_{iw} (exposure time - indoor worker) hr/day	8	0.8
GSF_i (indoor gamma shielding factor) unitless	0.4	0.7
IRA_{iw} (inhalation rate - indoor worker) m^3/day	60	0
IRS_{iw} (soil intake rate - indoor worker) mg/day	50	0
t_{iw} (time - indoor worker) yr	25	25
TR (target cancer risk) unitless	1.0E-06	1.0E-04
U_m (mean annual wind speed) m/s	4.69	4.02
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

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Site-specific

Indoor Worker PRGs for Soil - Secular Equilibrium

Isotope	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)
Secular Equilibrium PRG for U-235	-	-	*1.07E+02*	*1.07E+02*
Secular Equilibrium PRG for U-238	-	-	*2.95E+01*	*2.95E+01*

Output generated 15DEC2019:16:23:11

Site-specific

Indoor Worker Risk for Soil - Secular Equilibrium

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
*Secular Equilibrium Risk for U-235	0.00E+00	0.00E+00	1.45E-07	1.45E-07
*Secular Equilibrium Risk for U-238	0.00E+00	0.00E+00	1.17E-05	1.17E-05
*Total Risk	0.00E+00	0.00E+00	1.19E-05	1.19E-05

Output generated 15DEC2019:16:23:11

Section 10 Subsurface Soil

Variable	Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	14.9421
B (PEF Dispersion Constant)	18.7762	17.9869
City (Climate Zone)	Default	Albuquerque, NM (3)
C (PEF Dispersion Constant)	216.108	205.1782
Cover thickness for GSF_a (gamma shielding factor) cm	0 cm	0 cm
Cover thickness for GSF_b (gamma shielding factor) cm	0 cm	0 cm
$CF_{far-produce}$ (contaminated plant fraction) unitless	1	1
$CF_{far-apple}$ (contaminated apple fraction) unitless	1	1
$CF_{far-asparagus}$ (contaminated asparagus fraction) unitless	1	1
$CF_{far-beef}$ (beef contaminated fraction) unitless	1	0.48
$CF_{far-berry}$ (contaminated berry fraction) unitless	1	1
$CF_{far-broccoli}$ (contaminated broccoli fraction) unitless	1	1
$CF_{far-beet}$ (contaminated beet fraction) unitless	1	1
$CF_{far-cabbage}$ (contaminated cabbage fraction) unitless	1	1
$CF_{far-cereal grain}$ (contaminated cereal grain fraction) unitless	1	1
$CF_{far-citrus}$ (contaminated citrus fraction) unitless	1	1
$CF_{far-corn}$ (contaminated corn fraction) unitless	1	1
$CF_{far-carrot}$ (contaminated carrot fraction) unitless	1	1
$CF_{far-cucumber}$ (contaminated cucumber fraction) unitless	1	1
$CF_{far-dairy}$ (dairy contaminated fraction) unitless	1	1
$CF_{far-egg}$ (egg contaminated fraction) unitless	1	1
$CF_{far-fish}$ (fish contaminated fraction) unitless	1	1
$CF_{far-goat milk}$ (goat milk contaminated fraction) unitless	1	1
$CF_{far-goat meat}$ (goat meat contaminated fraction) unitless	1	1
$CF_{far-lettuce}$ (contaminated lettuce fraction) unitless	1	1
$CF_{far-lima bean}$ (contaminated lima bean fraction) unitless	1	1
$CF_{far-okra}$ (contaminated okra fraction) unitless	1	1
$CF_{far-onion}$ (contaminated onion fraction) unitless	1	1
$CF_{far-poultry}$ (poultry contaminated fraction unitless)	1	1
$CF_{far-peach}$ (contaminated peach fraction) unitless	1	1
$CF_{far-pea}$ (contaminated pea fraction) unitless	1	1
$CF_{far-pear}$ (contaminated pear fraction) unitless	1	1
$CF_{far-potato}$ (contaminated potato fraction) unitless	1	1
$CF_{far-pumpkin}$ (contaminated pumpkin fraction) unitless	1	1

Site-specific

Farmer Soil Inputs - Secular Equilibrium

Variable	Default Value	Form-input Value
$CF_{far\text{-}rice}$ (contaminated rice fraction) unitless	1	1
$CF_{far\text{-}sheep}$ (sheep contaminated fraction) unitless	1	1
$CF_{far\text{-}sheep\ milk}$ (sheep milk contaminated fraction) unitless	1	1
$CF_{far\text{-}snap\ bean}$ (contaminated snap bean fraction) unitless	1	1
$CF_{far\text{-}strawberry}$ (contaminated strawberry fraction) unitless	1	1
$CF_{far\text{-}swine}$ (swine contaminated fraction) unitless	1	1
$CF_{far\text{-}tomato}$ (contaminated tomato fraction) unitless	1	1
ED_{far} (exposure duration - farmer) yr	40	25
$ED_{far\text{-}a}$ (exposure duration - farmer adult) yr	34	25
$ED_{far\text{-}c}$ (exposure duration - farmer child) yr	6	0
$EF_{far\text{-}a}$ (exposure frequency - farmer adult) day/yr	350	350
$EF_{far\text{-}c}$ (exposure frequency - farmer child) day/yr	350	0
$IFAP_{far\text{-}adj}$ (age-adjusted apple ingestion factor) g	1182020	741125
$IFAS_{far\text{-}adj}$ (age-adjusted asparagus ingestion factor) g	492870	343874.99999999994
$IFB_{far\text{-}adj}$ (age-adjusted beef ingestion factor) g	2098950	1446375
$IFBE_{far\text{-}adj}$ (age-adjusted berry ingestion factor) g	471450	309750
$IFBR_{far\text{-}adj}$ (age-adjusted broccoli ingestion factor) g	450310	308874.99999999994
$IFBT_{far\text{-}adj}$ (age-adjusted beet ingestion factor) g	411600	296625
$IFCB_{far\text{-}adj}$ (age-adjusted cabbage ingestion factor) g	1043980	749875
$IFCG_{far\text{-}adj}$ (age-adjusted cereal grain ingestion factor) g	1190210	1190210
$IFCI_{far\text{-}adj}$ (age-adjusted citrus ingestion factor) g	4090100	2707249.9999999995
$IFCO_{far\text{-}adj}$ (age-adjusted corn ingestion factor) g	1044470	717500
$IFCR_{far\text{-}adj}$ (age-adjusted carrot ingestion factor) g	318290	213500
$IFCU_{far\text{-}adj}$ (age-adjusted cucumber ingestion factor) g	688800	480375
$IFD_{far\text{-}adj}$ (age-adjusted dairy ingestion factor) g	10138030	5918500
$IFE_{far\text{-}adj}$ (age-adjusted egg ingestion factor) g	775810	521500
$IFFI_{far\text{-}adj}$ (age-adjusted fish ingestion factor) g	10018960	7278250
$IFLE_{far\text{-}adj}$ (age-adjusted lettuce ingestion factor) g	455070	328125
$IFLI_{far\text{-}adj}$ (age-adjusted lima bean ingestion factor) g	415870	295749.99999999994
$IFOK_{far\text{-}adj}$ (age-adjusted okra ingestion factor) g	370510	264250
$IFON_{far\text{-}adj}$ (age-adjusted onion ingestion factor) g	338800	238000
$IFP_{far\text{-}adj}$ (age-adjusted poultry ingestion factor) g	1376550	939750
$IFPC_{far\text{-}adj}$ (age-adjusted peach ingestion factor) g	1435420	902125
$IFPE_{far\text{-}adj}$ (age-adjusted pea ingestion factor) g	437500	277375

Site-specific
Farmer Soil Inputs - Secular Equilibrium

Variable	Default Value	Form-input Value
$IFPR_{far-adj}$ (age-adjusted pear ingestion factor) g	874300	524125
$IFPT_{far-adj}$ (age-adjusted potato ingestion factor) g	1807750	1240750.0000000002
$IFPU_{far-adj}$ (age-adjusted pumpkin ingestion factor) g	866040	567000
$IFRI_{far-adj}$ (age-adjusted rice ingestion factor) g	1126230	774375
$IFSN_{far-adj}$ (age-adjusted snap bean ingestion factor) g	702730	474250
$IFST_{far-adj}$ (age-adjusted strawberry ingestion factor) g	535080	354375
$IFSW_{far-adj}$ (age-adjusted swine ingestion factor) g	1171520	809375
$IFTO_{far-adj}$ (age-adjusted tomato ingestion factor) g	1194270	824250
$IRAP_{far-a}$ (apple ingestion rate - farmer adult) g/day	84.7	84.7
$IRAP_{far-c}$ (apple ingestion rate - farmer child) g/day	82.9	82.9
$IRAS_{far-a}$ (asparagus ingestion rate - farmer adult) g/day	39.3	39.3
$IRAS_{far-c}$ (asparagus ingestion rate - farmer child) g/day	12.0	12.0
IRB_{far-a} (beef ingestion rate - farmer adult) g/day	165.3	165.3
IRB_{far-c} (beef ingestion rate - farmer child) g/day	62.8	0
$IRBE_{far-a}$ (berry ingestion rate - farmer adult) g/day	35.4	35.4
$IRBE_{far-c}$ (berry ingestion rate - farmer child) g/day	23.9	23.9
$IRBR_{far-a}$ (broccoli ingestion rate - farmer adult) g/day	35.3	35.3
$IRBR_{far-c}$ (broccoli ingestion rate - farmer child) g/day	14.4	14.4
$IRBT_{far-a}$ (beet ingestion rate - farmer adult) g/day	33.9	33.9
$IRBT_{far-c}$ (beet ingestion rate - farmer child) g/day	3.9	3.9
$IRCB_{far-a}$ (cabbage ingestion rate - farmer adult) g/day	85.7	85.7
$IRCB_{far-c}$ (cabbage ingestion rate - farmer child) g/day	11.5	11.5
$IRCG_{far-a}$ (cereal grain ingestion rate - farmer adult) g/day	91.9	91.9
$IRCG_{far-c}$ (cereal grain ingestion rate - farmer child) g/day	46.0	46.0
$IRCI_{far-a}$ (citrus ingestion rate - farmer adult) g/day	309.4	309.4
$IRCI_{far-c}$ (citrus ingestion rate - farmer child) g/day	194.4	194.4
$IRCO_{far-a}$ (corn ingestion rate - farmer adult) g/day	82.0	82.0
$IRCO_{far-c}$ (corn ingestion rate - farmer child) g/day	32.7	32.7
$IRCR_{far-a}$ (carrot ingestion rate - farmer adult) g/day	24.4	24.4
$IRCR_{far-c}$ (carrot ingestion rate - farmer child) g/day	13.3	13.3
$IRCU_{far-a}$ (cucumber ingestion rate - farmer adult) g/day	54.9	54.9
$IRCU_{far-c}$ (cucumber ingestion rate - farmer child) g/day	16.9	16.9
IRD_{far-a} (dairy ingestion rate - farmer adult) g/day	676.4	676.4
IRD_{far-c} (dairy ingestion rate - farmer child) g/day	994.7	994.7

Site-specific
Farmer Soil Inputs - Secular Equilibrium

Variable	Default Value	Form-input Value
IRE_{far-a} (egg ingestion rate - farmer adult) g/day	59.6	59.6
IRE_{far-c} (egg ingestion rate - farmer child) g/day	31.7	31.7
$IRFI_{far-a}$ (fish ingestion rate - farmer adult) g/day	831.8	831.8
$IRFI_{far-c}$ (fish ingestion rate - farmer child) g/day	57.4	57.4
$IRLE_{far-a}$ (lettuce ingestion rate - farmer adult) g/day	37.5	37.5
$IRLE_{far-c}$ (lettuce ingestion rate - farmer child) g/day	4.2	4.2
$IRLI_{far-a}$ (lima bean ingestion rate - farmer adult) g/day	33.8	33.8
$IRLI_{far-c}$ (lima bean ingestion rate - farmer child) g/day	6.5	6.5
$IROK_{far-a}$ (okra ingestion rate - farmer adult) g/day	30.2	30.2
$IROK_{far-c}$ (okra ingestion rate - farmer child) g/day	5.3	5.3
$IRON_{far-a}$ (onion ingestion rate - farmer adult) g/day	27.2	27.2
$IRON_{far-c}$ (onion ingestion rate - farmer child) g/day	7.2	7.2
IRP_{far-a} (poultry ingestion rate - farmer adult) g/day	107.4	107.4
IRP_{far-c} (poultry ingestion rate - farmer child) g/day	46.9	46.9
$IRPC_{far-a}$ (peach ingestion rate - farmer adult) g/day	103.1	103.1
$IRPC_{far-c}$ (peach ingestion rate - farmer child) g/day	99.3	99.3
$IRPE_{far-a}$ (pea ingestion rate - farmer adult) g/day	31.7	31.7
$IRPE_{far-c}$ (pea ingestion rate - farmer child) g/day	28.7	28.7
$IRPR_{far-a}$ (pear ingestion rate - farmer adult) g/day	59.9	59.9
$IRPR_{far-c}$ (pear ingestion rate - farmer child) g/day	76.9	76.9
$IRPT_{far-a}$ (potato ingestion rate - farmer adult) g/day	141.8	141.8
$IRPT_{far-c}$ (potato ingestion rate - farmer child) g/day	57.3	57.3
$IRPU_{far-a}$ (pumpkin ingestion rate - farmer adult) g/day	64.8	64.8
$IRPU_{far-c}$ (pumpkin ingestion rate - farmer child) g/day	45.2	45.2
$IRRI_{far-a}$ (rice ingestion rate - farmer adult) g/day	88.5	88.5
$IRRI_{far-c}$ (rice ingestion rate - farmer child) g/day	34.8	34.8
$IRSN_{far-a}$ (snap bean ingestion rate - farmer adult) g/day	54.2	54.2
$IRSN_{far-c}$ (snap bean ingestion rate - farmer child) g/day	27.5	27.5
$IRST_{far-a}$ (strawberry ingestion rate - farmer adult) g/day	40.5	40.5
$IRST_{far-c}$ (strawberry ingestion rate - farmer child) g/day	25.3	25.3
$IRSW_{far-a}$ (swine ingestion rate - farmer adult) g/day	92.5	92.5
$IRSW_{far-c}$ (swine ingestion rate - farmer child) g/day	33.7	33.7
$IRTO_{far-a}$ (tomato ingestion rate - farmer adult) g/day	94.2	94.2
$IRTO_{far-c}$ (tomato ingestion rate - farmer child) g/day	34.9	34.9

Site-specific
Farmer Soil Inputs - Secular Equilibrium

Variable	Default Value	Form-input Value
MLF_{apple} (apple mass loading factor) unitless	0.000160	0.000160
$MLF_{asparagus}$ (asparagus mass loading factor) unitless	0.0000790	0.0000790
MLF_{berry} (berry mass loading factor) unitless	0.000166	0.000166
$MLF_{broccoli}$ (broccoli mass loading factor) unitless	0.00101	0.00101
MLF_{beet} (beet mass loading factor) unitless	0.000138	0.000138
$MLF_{cabbage}$ (cabbage mass loading factor) unitless	0.000105	0.000105
$MLF_{cereal\ grain}$ (cereal grain mass loading factor) unitless	0.250	0.250
MLF_{citrus} (citrus mass loading factor) unitless	0.000157	0.000157
MLF_{corn} (corn mass loading factor) unitless	0.000145	0.000145
MLF_{carrot} (carrot mass loading factor) unitless	0.0000970	0.0000970
$MLF_{cucumber}$ (cucumber mass loading factor) unitless	0.0000400	0.0000400
$MLF_{lettuce}$ (lettuce mass loading factor) unitless	0.0135	0.0135
$MLF_{lima\ bean}$ (lima bean mass loading factor) unitless	0.00383	0.00383
MLF_{okra} (okra mass loading factor) unitless	0.0000800	0.0000800
MLF_{onion} (onion mass loading factor) unitless	0.0000970	0.0000970
MLF_{peach} (peach mass loading factor) unitless	0.000150	0.000150
MLF_{pea} (pea mass loading factor) unitless	0.000178	0.000178
MLF_{pear} (pear mass loading factor) unitless	0.000160	0.000160
MLF_{potato} (potato mass loading factor) unitless	0.000210	0.000210
$MLF_{pumpkin}$ (pumpkin mass loading factor) unitless	0.0000580	0.0000580
MLF_{rice} (rice mass loading factor) unitless	0.250	0.250
$MLF_{snap\ bean}$ (snap bean mass loading factor) unitless	0.00500	0.00500
$MLF_{strawberry}$ (strawberry mass loading factor) unitless	0.0000800	0.0000800
MLF_{tomato} (tomato mass loading factor) unitless	0.00159	0.00159
p_m (density of milk) kg/L	1.03	1.03
t_{far} (time - farmer) yr	40	25
TR (target cancer risk) unitless	1.0E-06	1.0E-04
F(x) (function dependent on U_m/U_t) unitless	0.194	0.0553
PEF (particulate emission factor) m^3/kg	1359344438	6609630249.811598
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	81.84858572694108
A_s (acres)	0.5	0.5
Slab size for ACF (area correction factor) m^2	1000029 m^2	1000029 m^2
ED_{far} (exposure duration - farmer) yr	40	25
ED_{far-a} (exposure duration - farmer adult) yr	34	25

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Variable	Default Value	Form-input Value
ED_{far-c} (exposure duration - farmer child) yr	6	0
EF_{far} (exposure frequency) day/yr	350	350
EF_{far-a} (exposure frequency - farmer adult) day/yr	350	350
EF_{far-c} (exposure frequency - farmer child) day/yr	350	0
ET_{far} (exposure time - farmer) hr/day	24	0
ET_{far-a} (exposure time - farmer adult) hr/day	24	0
ET_{far-c} (exposure time - farmer child) hr/day	24	0
ET_{far-i} (indoor exposure time fraction) hr/day	10.008	0
ET_{far-o} (outdoor exposure time fraction) hr/day	12.168	0
f_{p-beef} (animal on-site fraction) unitless	1	0.33
$f_{p-dairy}$ (animal on-site fraction) unitless	1	1
$f_{p-goat\ milk}$ (animal on-site fraction) unitless	1	1
f_{p-goat} (animal on-site fraction) unitless	1	1
$f_{p-poultry}$ (animal on-site fraction) unitless	1	1
$f_{p-sheep}$ (animal on-site fraction) unitless	1	1
$f_{p-sheep\ milk}$ (animal on-site fraction) unitless	1	1
$f_{p-swine}$ (animal on-site fraction) unitless	1	1
f_{s-beef} (fraction of year animal on site) unitless	1	1
$f_{s-dairy}$ (fraction of year animal on site) unitless	1	1
$f_{s-goat\ milk}$ (fraction of year animal on site) unitless	1	1
f_{s-goat} (fraction of year animal on site) unitless	1	1
$f_{s-poultry}$ (fraction of year animal on site) unitless	1	1
$f_{s-sheep}$ (fraction of year animal on site) unitless	1	1
$f_{s-sheep\ milk}$ (fraction of year animal on site) unitless	1	1
$f_{s-swine}$ (fraction of year animal on site) unitless	1	1
GSF_i (gamma shielding factor - indoor)	0.4	0
$IFA_{far-adj}$ (age-adjusted soil inhalation factor) m^3	259000	0
$IFS_{far-adj}$ (age-adjusted soil ingestion factor) mg	1610000	0
IRA_{far-a} (inhalation rate - farmer adult) m^3/day	20	0
IRA_{far-c} (inhalation rate - farmer child) m^3/day	10	0
IRS_{far-a} (soil ingestion rate - farmer adult) mg/day	100	0
IRS_{far-c} (soil ingestion rate - farmer child) mg/day	200	0
$MLF_{pasture}$ (pasture plant mass loading factor) unitless	0.25	0.25
Q_{p-beef} (beef fodder intake rate) kg/day	11.77	11.77

Site-specific

Farmer Soil Inputs - Secular Equilibrium

Variable	Default Value	Form-input Value
$Q_{p\text{-}dairy}$ (dairy fodder intake rate) kg/day	20.3	20.3
$Q_{p\text{-}goat\ milk}$ (goat milk fodder intake rate) kg/day	1.59	1.59
$Q_{p\text{-}goat}$ (goat fodder intake rate) kg/day	1.27	1.27
$Q_{p\text{-}poultry}$ (poultry fodder intake rate) kg/day	0.2	0.2
$Q_{p\text{-}sheep}$ (sheep fodder intake rate) kg/day	1.75	1.75
$Q_{p\text{-}sheep\ milk}$ (sheep milk fodder intake rate) kg/day	3.15	3.15
$Q_{p\text{-}swine}$ (swine fodder intake rate) kg/day	4.7	4.7
$Q_{s\text{-}beef}$ (beef soil intake rate) kg/day	0.5	0.5
$Q_{s\text{-}dairy}$ (dairy soil intake rate) kg/day	0.4	0.4
$Q_{s\text{-}goat\ milk}$ (goat milk soil intake rate) kg/day	0.29	0.29
$Q_{s\text{-}goat}$ (goat soil intake rate) kg/day	0.23	0.23
$Q_{s\text{-}poultry}$ (poultry soil intake rate) kg/day	0.022	0.022
$Q_{s\text{-}sheep}$ (sheep soil intake rate) kg/day	0.32	0.32
$Q_{s\text{-}sheep\ milk}$ (sheep milk soil intake rate) kg/day	0.57	0.57
$Q_{s\text{-}swine}$ (swine soil intake rate) kg/day	0.37	0.37
t_{far} (time - farmer) yr	40	25
TR (target cancer risk) unitless	1.0E-06	1.0E-04
U_m (mean annual wind speed) m/s	4.69	4.02
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Site-specific

Farmer PRGs for Soil - Secular Equilibrium

Isotope	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Produce Consumption PRG TR=0.0001 (pCi/g)	Beef Consumption PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)
Secular Equilibrium PRG for U-235	*-*	*-*	*-*	*-*	*1.86E+02*	*1.86E+02*
Secular Equilibrium PRG for U-238	*-*	*-*	*-*	*-*	*9.57E+00*	*9.57E+00*

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Site-specific

Farmer Risk for Soil - Secular Equilibrium

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Produce Consumption Risk	Beef Risk	Total Risk
****Secular Equilibrium Risk for U-235**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**-**	**8.40E-08**	**8.40E-08**
****Secular Equilibrium Risk for U-238**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**-**	**3.62E-05**	**3.62E-05**
**Total Risk*	*0.00E+00*	*0.00E+00*	*0.00E+00*	*-*	*3.62E-05*	***3.62E-05***

Output generated 15DEC2019:16:16:14

Site-specific
Composite Worker Equation Inputs for Soil

*** Inputted values different from Composite Worker defaults are highlighted.**

Section 10 Soil Metals

Variable	Composite Worker Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	14.9421
A (VF Dispersion Constant)	11.911	14.9421
A (VF Dispersion Constant - Mass Limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	17.9869
B (VF Dispersion Constant)	18.4385	17.9869
B (VF Dispersion Constant - Mass Limit)	18.4385	18.4385
$City_{PEF}$ (Climate Zone) Selection	Default	Albuquerque, NM
$City_{VF}$ (Climate Zone) Selection	Default	Albuquerque, NM
C (PEF Dispersion Constant)	216.108	205.1782
C (VF Dispersion Constant)	209.7845	205.1782
C (VF Dispersion Constant - Mass Limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.0553
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density - mass limit) g/cm^3	1.5	1.5
PEF (particulate emission factor) m^3/kg	1359344438	2573243853.7916
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	31.865075988084
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	31.865075988084
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
A_s (PEF acres)	0.5	250
A_s (VF acres)	0.5	250
A_s (VF mass-limit acres)	0.5	0.5
AF_w (skin adherence factor - composite worker) mg/cm^2	0.12	0.12
AT_w (averaging time - composite worker)	365	365
BW_w (body weight - composite worker)	80	80
ED_w (exposure duration - composite worker) yr	25	25
EF_w (exposure frequency - composite worker) day/yr	250	250

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Site-specific
Composite Worker Equation Inputs for Soil

*** Inputted values different from Composite Worker defaults are highlighted.**

Variable	Composite Worker Soil Default Value	Form-input Value
ET_w (exposure time - composite worker) hr	8	1.6
THQ (target hazard quotient) unitless	0.1	1
IR_w (soil ingestion rate - composite worker) mg/day	100	100
LT (lifetime) yr	70	70
SA_w (surface area - composite worker) cm^2/day	3527	3527
TR (target risk) unitless	1.0E-06	1.0E-06
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.02
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5
VF_{ml} (volitization factor - mass limit) m^3/kg	.	0

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Site-specific

Composite Worker Regional Screening Levels (RSL) for Soil

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA
Arsenic, Inorganic	7440-38-2	No	No	Inorganics	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6
Selenium	7782-49-2	No	No	Inorganics	-		-		5.00E-03	U	2.00E-02	U	1	-	1
Uranium	NA	No	No	Inorganics	-		-		2.00E-04	U	4.00E-05	U	1	-	1
Vanadium and Compounds	7440-62-2	No	No	Inorganics	-		-		5.04E-03	U	1.00E-04	U	0.026	-	1

Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Chemical Type	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)
-	-	-	2.90E+01	-	-		888.15	U	1670	U	INORGANIC	-	-
-	-	-	5.00E+00	-	-		958.15	U	1770	U	INORGANIC	-	-
-	-	-	4.50E+02	-	-		4093.15	U	13700	U	INORGANIC	7.49E-02	3.34E-05
-	-	-	1.00E+03	-	-		3683.15	U	11300	U	INORGANIC	-	-

D_A\ (cm^2/s)	Particulate Emission Factor (m³/kg)	Volatilization Factor (m³/kg)	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL THQ=1 (mg/kg)	Dermal SL THQ=1 (mg/kg)	Inhalation SL THQ=1 (mg/kg)	Noncarcinogenic SL THI=1 (mg/kg)	Screening Level (mg/kg)
-	2.57E+09	-	3.63E+00	1.72E+01	3.67E+04	3.00E+00	5.84E+02	2.76E+03	8.45E+05	4.82E+02	3.00E+00 ca
-	2.57E+09	-	-	-	-	-	5.84E+03	-	1.13E+09	5.84E+03	5.84E+03 nc
-	2.57E+09	-	-	-	-	-	2.34E+02	-	2.25E+06	2.34E+02	2.34E+02 nc
-	2.57E+09	-	-	-	-	-	5.89E+03	-	5.64E+06	5.88E+03	5.88E+03 nc

Site-specific
Composite Worker Risk for Soil

Chemical	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)
Arsenic, Inorganic	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-	2.90E+01
Selenium	-		-		5.00E-03	U	2.00E-02	U	1	-	1	-	-	-	5.00E+00
Uranium	-		-		2.00E-04	U	4.00E-05	U	1	-	1	-	-	-	4.50E+02
Vanadium and Compounds	-		-		5.04E-03	U	1.00E-04	U	0.026	-	1	-	-	-	1.00E+03
**Total Risk/HI*	-		-		-		-		-	-	-	-	-	-	-

Chemical	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H\` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Chemical Type	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)
Arsenic, Inorganic	-	-		888.15	U	1670	U	INORGANIC	-	-	-	2.57E+09
Selenium	-	-		958.15	U	1770	U	INORGANIC	-	-	-	2.57E+09
Uranium	-	-		4093.15	U	13700	U	INORGANIC	7.49E-02	3.34E-05	-	2.57E+09
Vanadium and Compounds	-	-		3683.15	U	11300	U	INORGANIC	-	-	-	2.57E+09
**Total Risk/HI*	-	-		-		-			-	-	-	-

Chemical	Volatilization Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion HQ	Dermal HQ	Inhalation HQ	Noncarcinogenic HI
Arsenic, Inorganic	-	2.00E+01	5.50E-06	1.16E-06	5.45E-10	6.67E-06	3.42E-02	7.25E-03	2.37E-05	4.15E-02
Selenium	-	8.70E+01	-	-	-	-	1.49E-02	-	7.72E-08	1.49E-02
Uranium	-	3.10E+02	-	-	-	-	1.33E+00	-	1.38E-04	1.33E+00
Vanadium and Compounds	-	2.50E+02	-	-	-	-	4.25E-02	-	4.44E-05	4.25E-02
**Total Risk/HI*	-	-	*5.50E-06*	*1.16E-06*	*5.45E-10*	*6.67E-06*	*1.42E+00*	*7.25E-03*	*2.06E-04*	*1.43E+00*

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Appendix I (Continued)
Human Health and Ecological Risk Evaluation
Tronox Navajo Area Uranium Mines, Section 10 Mine
McKinley County, New Mexico

Attachment 2
Recommended Shielding Factor for a Pick-up Truck

MEMO

DATE: September 26, 2016

TO: Keith Delhomme

FROM: Rick Haaker

RF Haaker

SUBJECT: Recommended shielding factor for a pick-up truck

Mr. Delhomme directed me to provide a gamma radiation transmission factor for a pick-up truck. A transmission factor in this case may be thought of as the proportion of gamma radiation level measured inside of the cab compared to the level at the same location in the absence of the truck, Equation 1.

$$Eq.1: \quad Transmission\ Factor = \frac{Gamma\ radiation\ level\ inside\ of\ cab}{Gamma\ radiation\ level\ if\ no\ truck\ is\ present}$$

A 2010 extended cab Honda Ridgeline was chosen for the gamma radiation measurements. The Honda extended cab Ridgeline is considered a comparatively small pickup, having a curb weight of approximately 4,500 pounds. Radiation levels inside and outside a 2014 Toyota Corolla 4-door sedan were also measured to give an estimate of the transmission factor for a rather light vehicle by modern standards. The weights of some selected vehicles are provided in Table 1.

Table 1.

Vehicle	Weight, lbs[1]
2016 Ford F-250 Super Cab	6,200 to 7,460
2016 Ford F-350 Super Cab	6,298 to 7,508
2016 Ford F-450 Crew Cab	8,611
1983 Mazda B-2000 Pickup	2,590[2]
2014 Toyota Corolla 4-door sedan	~2,900 [3]

Measurement Method

Two gamma radiation intensities were measured in the front seats of each vehicle, one in the driver seat and the other in the front passenger seat. The measurements were taken with a Ludlum 44-10 2-inch by 2-inch gamma scintillation detector coupled with a Ludlum 2221 ratemeter/scaler. In each case the detector was held about 15 inches above the seat and about 12 inches toward the dashboard from the seat back, as shown in Figure 1. Once the indoor measurements were made the vehicles were moved and then the gamma radiation intensities were re-measured. The results are summarized in Table 2.

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[1] https://www.fleet.ford.com/truckbbas/topics/2016/16_SD_Pickups_SB_Updates.pdf
[2] http://articles.mcall.com/1984-09-01/news/2429550_1_pickup-bed-small-pickup-mazda
[3] https://en.wikipedia.org/wiki/Toyota_Corolla_(E170)

http://articles.mcall.com/1984-09-01/news/2429550_1_pickup-bed-small-pickup-mazda

Table 2. Gamma Transmission Factor

Vehicle	Transmission Factor
2010 Honda Ridgeline extended cab	0.71 (95% CI: 0.69 – 0.73)
2014 Toyota Corolla	0.74 (95% CI: 0.72 – 0.77)

The 95% confidence intervals overlap, thus the gamma radiation transmission results for a Honda Ridgeline and a Toyota Corolla should not be considered significantly different. Most modern pickups are heavier than a 2010 Honda Ridgeline and most likely allow less gamma radiation transmission into the vehicle. Few ranchers are expected to work out of very small sedans or very old small foreign pickups. A gamma radiation transmission value of 0.7 is recommended. Based on the measurements taken, it is not likely to greatly overestimate or underestimate the true gamma transmission factor for pickups.

The specific measurement data is provided in Table 3.

Vehicle	Inside the vehicle (gross counts in 1 minute)		Background after vehicle moved (gross counts in 1 minute)	
	Driver side	Passenger side	Driver side	Passenger side
Honda Ridgeline	10,541	10,732	14,861	15,089
Toyota Corolla	10,732	11,140	14,452	15,058

Ludlum 2221 # 183990 with Ludlum 44-10 #RN19764, cal date June 9, 2016

Attachment 3
ProUCL Output

Appendix I, Attachment 3
Section 10 Mine
ProUCL Output

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.111/14/2019 3:53:54 PM
From File	Section10 summary tv.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Ra-226_SS

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.924	Mean	33.81
Maximum	125.2	Median	19.1
SD	41.08	Std. Error of Mean	12.99
Coefficient of Variation	1.215	Skewness	1.538

Normal GOF Test

Shapiro Wilk Test Statistic	0.794	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.315	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.262	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	57.62	95% Adjusted-CLT UCL (Chen-1995)	61.92
		95% Modified-t UCL (Johnson-1978)	58.67

Gamma GOF Test

A-D Test Statistic	0.369	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.767	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.186	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.278	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.63	k star (bias corrected MLE)	0.508
Theta hat (MLE)	53.65	Theta star (bias corrected MLE)	66.58
nu hat (MLE)	12.6	nu star (bias corrected)	10.16
MLE Mean (bias corrected)	33.81	MLE Sd (bias corrected)	47.44
		Approximate Chi Square Value (0.05)	4.039
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	3.396

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	85	95% Adjusted Gamma UCL (use when n<50)	101.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.891	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.232	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.262	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.079	Mean of logged Data	2.547
Maximum of Logged Data	4.83	SD of logged Data	1.76

Assuming Lognormal Distribution

95% H-UCL	1015	90% Chebyshev (MVUE) UCL	122.9
95% Chebyshev (MVUE) UCL	158.3	97.5% Chebyshev (MVUE) UCL	207.5
99% Chebyshev (MVUE) UCL	304		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	55.17	95% Jackknife UCL	57.62
95% Standard Bootstrap UCL	54.4	95% Bootstrap-t UCL	83.2
95% Hall's Bootstrap UCL	94.46	95% Percentile Bootstrap UCL	53.97
95% BCA Bootstrap UCL	60.44		
90% Chebyshev(Mean, Sd) UCL	72.78	95% Chebyshev(Mean, Sd) UCL	90.43
97.5% Chebyshev(Mean, Sd) UCL	114.9	99% Chebyshev(Mean, Sd) UCL	163.1

Suggested UCL to Use

95% Adjusted Gamma UCL	101.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Ra-226_SB

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	1.95	Mean	2.999
Maximum	4.643	Median	3.129
SD	0.79	Std. Error of Mean	0.25
Coefficient of Variation	0.264	Skewness	0.668

Normal GOF Test

Shapiro Wilk Test Statistic	0.918	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.842	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.219	Lilliefors GOF Test
5% Lilliefors Critical Value	0.262	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.457	95% Adjusted-CLT UCL (Chen-1995)	3.467
		95% Modified-t UCL (Johnson-1978)	3.466

Gamma GOF Test

A-D Test Statistic	0.376	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.725	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.194	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.266	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	16.39	k star (bias corrected MLE)	11.54
Theta hat (MLE)	0.183	Theta star (bias corrected MLE)	0.26
nu hat (MLE)	327.8	nu star (bias corrected)	230.8
MLE Mean (bias corrected)	2.999	MLE Sd (bias corrected)	0.883
		Approximate Chi Square Value (0.05)	196.7
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	191.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.52	95% Adjusted Gamma UCL (use when n<50)	3.621

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.94	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.196	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.262	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.668	Mean of logged Data	1.067
Maximum of Logged Data	1.535	SD of logged Data	0.262

Assuming Lognormal Distribution

95% H-UCL	3.565	90% Chebyshev (MVUE) UCL	3.748
95% Chebyshev (MVUE) UCL	4.088	97.5% Chebyshev (MVUE) UCL	4.559
99% Chebyshev (MVUE) UCL	5.485		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.41	95% Jackknife UCL	3.457
95% Standard Bootstrap UCL	3.38	95% Bootstrap-t UCL	3.516
95% Hall's Bootstrap UCL	3.576	95% Percentile Bootstrap UCL	3.42
95% BCA Bootstrap UCL	3.432		
90% Chebyshev(Mean, Sd) UCL	3.749	95% Chebyshev(Mean, Sd) UCL	4.089
97.5% Chebyshev(Mean, Sd) UCL	4.56	99% Chebyshev(Mean, Sd) UCL	5.486

Suggested UCL to Use

95% Student's-t UCL 3.457

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

APPENDIX J

PRG CALCULATOR OUT, DCGL AND RA-226 CONTRIBUTION CALCULATIONS, AND RESRAD OUTPUT

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PRG Calculator Output

Site-Specific
Composite Worker Soil Inputs - Secular Equilibrium

*** Inputted values different from Composite Worker defaults are highlighted.**

Variable	Composite Worker Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	14.9421
B (PEF Dispersion Constant)	18.7762	17.9869
City (Climate Zone)	Default	Albuquerque, NM (3)
C (PEF Dispersion Constant)	216.108	205.1782
F(x) (function dependent on U_m/U_t) unitless	0.194	0.0553
PEF (particulate emission factor) m^3/kg	1359344438	2370938158.760359
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	29.359877603759233
A_s (acres)	0.5	500
ED_w (exposure duration - composite worker) yr	25	25
EF_w (exposure frequency - composite worker) day/yr	250	250
ET_w (exposure time - composite worker) hr/day	8	0.8
IRA_w (inhalation rate - composite worker) m^3/day	60	60
IRS_w (soil intake rate - composite worker) mg/day	100	100
t_w (time - composite worker) yr	25	25
TR (target cancer risk) unitless	1.0E-06	1.0E-04
U_m (mean annual wind speed) m/s	4.69	4.02
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

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Site-Specific
Composite Worker PRGs for Soil - Secular Equilibrium

Isotope	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)
**Secular Equilibrium PRG for U-235*	*2.91E+02*	*6.03E+04*	*7.51E+01*	***5.97E+01***
**Secular Equilibrium PRG for U-238*	*6.35E+01*	*1.31E+05*	*2.06E+01*	***1.56E+01***

Output generated 22MAY2019:10:31:51

Site-Specific
Composite Worker Individual Contribution PRGs for Soil - Secular Equilibrium

Isotope	Parent	Fractional Contribution of Progeny	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Adult Soil Ingestion Slope Factor (risk/pCi)	Particulate Emission Factor (m³/kg)	Lambda (1/yr)	Halflife (yr)
**Secular Equilibrium PRG for U-235*	*U-235*	-		-	-	-	-	-	-
Ac-227	U-235	1.00E+00	S	1.49E-07	1.98E-10	2.01E-10	2.37E+09	3.18E-02	2.18E+01
At-219	U-235	8.28E-07	-	0.00E+00	0.00E+00	0.00E+00	2.37E+09	3.90E+05	1.78E-06
Bi-211	U-235	1.00E+00	-	0.00E+00	1.90E-07	0.00E+00	2.37E+09	1.70E+05	4.07E-06
Bi-215	U-235	8.03E-07	-	0.00E+00	1.08E-06	0.00E+00	2.37E+09	4.79E+04	1.45E-05
Fr-223	U-235	1.38E-02	S	4.07E-11	1.35E-07	4.88E-12	2.37E+09	1.66E+04	4.19E-05
Pa-231	U-235	1.00E+00	F	7.62E-08	1.27E-07	1.54E-10	2.37E+09	2.12E-05	3.28E+04
Pb-211	U-235	1.00E+00	S	4.03E-11	2.91E-07	2.63E-13	2.37E+09	1.01E+04	6.87E-05
Po-211	U-235	2.76E-03	-	0.00E+00	3.76E-08	0.00E+00	2.37E+09	4.24E+07	1.64E-08
Po-215	U-235	1.00E+00	-	0.00E+00	7.48E-10	0.00E+00	2.37E+09	1.23E+10	5.65E-11
Ra-223	U-235	1.00E+00	S	2.92E-08	4.55E-07	1.23E-10	2.37E+09	2.21E+01	3.13E-02
Rn-219	U-235	1.00E+00	-	0.00E+00	2.35E-07	0.00E+00	2.37E+09	5.52E+06	1.26E-07
Th-227	U-235	9.86E-01	S	3.50E-08	4.45E-07	2.06E-11	2.37E+09	1.35E+01	5.12E-02
Th-231	U-235	1.00E+00	S	1.50E-12	2.49E-08	9.07E-13	2.37E+09	2.38E+02	2.91E-03
Tl-207	U-235	9.97E-01	-	0.00E+00	1.59E-08	0.00E+00	2.37E+09	7.64E+04	9.08E-06
U-235	U-235	1.00E+00	S	2.50E-08	5.51E-07	4.92E-11	2.37E+09	9.84E-10	7.04E+08
**Secular Equilibrium PRG for U-238*	*U-238*	-		-	-	-	-	-	-
At-218	U-238	2.00E-04	-	0.00E+00	2.74E-11	0.00E+00	2.37E+09	1.46E+07	4.76E-08
Bi-210	U-238	1.00E+00	S	4.55E-10	2.77E-09	3.74E-12	2.37E+09	5.05E+01	1.37E-02
Bi-214	U-238	1.00E+00	S	6.18E-11	7.34E-06	1.47E-13	2.37E+09	1.83E+04	3.79E-05
Hg-206	U-238	1.90E-08	-	0.00E+00	4.83E-07	0.00E+00	2.37E+09	4.47E+04	1.55E-05
Pa-234	U-238	1.60E-03	S	1.20E-12	6.62E-06	9.66E-13	2.37E+09	9.06E+02	7.65E-04
Pa-234m	U-238	1.00E+00	-	0.00E+00	9.06E-08	0.00E+00	2.37E+09	3.11E+05	2.23E-06
Pb-210	U-238	1.00E+00	S	1.59E-08	1.48E-09	5.99E-10	2.37E+09	3.12E-02	2.22E+01
Pb-214	U-238	1.00E+00	S	7.77E-11	9.94E-07	2.21E-13	2.37E+09	1.36E+04	5.10E-05
Po-210	U-238	1.00E+00	S	1.45E-08	4.51E-11	1.44E-09	2.37E+09	1.83E+00	3.79E-01
Po-214	U-238	1.00E+00	-	0.00E+00	3.85E-10	0.00E+00	2.37E+09	1.33E+11	5.21E-12
Po-218	U-238	1.00E+00	-	1.39E-11	6.84E-15	0.00E+00	2.37E+09	1.17E+05	5.90E-06
Ra-226	U-238	1.00E+00	S	2.82E-08	2.50E-08	2.95E-10	2.37E+09	4.33E-04	1.60E+03

Site-Specific
Composite Worker Individual Contribution PRGs for Soil - Secular Equilibrium

Isotope	1000029 m² Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (mg/kg)
**Secular Equilibrium PRG for U-235*	-	-	*2.91E+02*	*6.03E+04*	*7.51E+01*	***5.97E+01***	-
Ac-227	1.00E+00	1.00E+00	7.95E+02	1.27E+05	8.83E+05	**7.89E+02**	1.75E-11
At-219	9.00E-01	1.00E+00	-	-	-	**-**	-
Bi-211	1.00E+00	1.00E+00	-	-	9.21E+02	**9.21E+02**	2.61E-18
Bi-215	1.00E+00	1.00E+00	-	-	2.01E+08	**2.01E+08**	4.32E-23
Fr-223	1.00E+00	1.00E+00	2.37E+06	3.38E+10	9.37E+04	**9.02E+04**	2.90E-19
Pa-231	1.00E+00	1.00E+00	1.04E+03	2.49E+05	1.38E+03	**5.90E+02**	3.59E-08
Pb-211	1.00E+00	1.00E+00	6.09E+05	4.70E+08	6.03E+02	**6.02E+02**	6.74E-17
Po-211	1.00E+00	1.00E+00	-	-	1.69E+06	**1.69E+06**	5.73E-24
Po-215	1.00E+00	1.00E+00	-	-	2.34E+05	**2.34E+05**	1.45E-25
Ra-223	1.00E+00	1.00E+00	1.30E+03	6.50E+05	3.85E+02	**2.97E+02**	6.59E-14
Rn-219	1.00E+00	1.00E+00	-	-	7.47E+02	**7.47E+02**	1.03E-19
Th-227	1.00E+00	1.00E+00	7.87E+03	5.49E+05	3.99E+02	**3.80E+02**	8.56E-14
Th-231	1.00E+00	1.00E+00	1.77E+05	1.26E+10	7.04E+03	**6.77E+03**	2.78E-16
Tl-207	1.00E+00	1.00E+00	-	-	1.11E+04	**1.11E+04**	4.75E-19
U-235	1.00E+00	1.00E+00	3.25E+03	7.58E+05	3.18E+02	**2.89E+02**	1.60E-03
**Secular Equilibrium PRG for U-238*	-	-	*6.35E+01*	*1.31E+05*	*2.06E+01*	***1.56E+01***	-
At-218	9.00E-01	1.00E+00	-	-	3.55E+10	**3.55E+10**	8.18E-28
Bi-210	1.00E+00	1.00E+00	4.28E+04	4.17E+07	6.33E+04	**2.55E+04**	3.16E-16
Bi-214	1.00E+00	1.00E+00	1.09E+06	3.07E+08	2.39E+01	**2.39E+01**	9.51E-16
Hg-206	1.00E+00	1.00E+00	-	-	1.91E+10	**1.91E+10**	4.69E-25
Pa-234	1.00E+00	1.00E+00	1.04E+08	9.89E+12	1.65E+04	**1.65E+04**	3.03E-17
Pa-234m	1.00E+00	1.00E+00	-	-	1.93E+03	**1.93E+03**	7.54E-19
Pb-210	1.00E+00	1.00E+00	2.67E+02	1.19E+06	1.18E+05	**2.66E+02**	4.90E-11
Pb-214	1.00E+00	1.00E+00	7.26E+05	2.44E+08	1.76E+02	**1.76E+02**	1.73E-16
Po-210	1.00E+00	1.00E+00	1.11E+02	1.31E+06	3.89E+06	**1.11E+02**	2.00E-12
Po-214	1.00E+00	1.00E+00	-	-	4.55E+05	**4.55E+05**	6.86E-27
Po-218	9.00E-01	1.00E+00	-	1.36E+09	2.85E+10	**1.30E+09**	2.76E-24
Ra-226	1.00E+00	1.00E+00	5.43E+02	6.74E+05	7.01E+03	**5.04E+02**	2.01E-09

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Site-Specific
Composite Worker Individual Contribution PRGs for Soil - Secular Equilibrium

Isotope	Parent	Fractional Contribution of Progeny	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Adult Soil Ingestion Slope Factor (risk/pCi)	Particulate Emission Factor (m^3/kg)	Lambda (1/yr)	Halflife (yr)
Rn-218	U-238	2.00E-07	-	0.00E+00	3.39E-09	0.00E+00	2.37E+09	6.24E+08	1.11E-09
Rn-222	U-238	1.00E+00	-	2.28E-12	1.69E-09	0.00E+00	2.37E+09	6.62E+01	1.05E-02
Th-230	U-238	1.00E+00	F	3.41E-08	8.45E-10	7.73E-11	2.37E+09	9.19E-06	7.54E+04
Th-234	U-238	1.00E+00	S	3.08E-11	1.77E-08	9.51E-12	2.37E+09	1.05E+01	6.60E-02
Tl-206	U-238	1.34E-06	-	0.00E+00	6.11E-09	0.00E+00	2.37E+09	8.67E+04	7.99E-06
Tl-210	U-238	2.10E-04	-	0.00E+00	1.34E-05	0.00E+00	2.37E+09	2.80E+05	2.47E-06
U-234	U-238	1.00E+00	S	2.78E-08	2.53E-10	5.11E-11	2.37E+09	2.82E-06	2.46E+05
U-238	U-238	1.00E+00	S	2.36E-08	1.24E-10	4.66E-11	2.37E+09	1.55E-10	4.47E+09

Site-Specific
Composite Worker Individual Contribution PRGs for Soil - Secular Equilibrium

Isotope	1000029 m² Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (mg/kg)
Rn-218	1.00E+00	1.00E+00	-	-	2.59E+11	**2.59E+11**	2.62E-30
Rn-222	1.00E+00	1.00E+00	-	8.32E+09	1.03E+05	**1.03E+05**	6.29E-17
Th-230	1.00E+00	1.00E+00	2.07E+03	5.57E+05	2.07E+05	**2.04E+03**	2.38E-08
Th-234	1.00E+00	1.00E+00	1.68E+04	6.16E+08	9.87E+03	**6.22E+03**	6.95E-15
Tl-206	1.00E+00	1.00E+00	-	-	2.14E+10	**2.14E+10**	2.15E-25
Tl-210	1.00E+00	1.00E+00	-	-	6.21E+04	**6.21E+04**	2.34E-20
U-234	1.00E+00	1.00E+00	3.13E+03	6.82E+05	6.91E+05	**3.11E+03**	5.18E-08
U-238	1.00E+00	1.00E+00	3.43E+03	8.02E+05	1.42E+06	**3.41E+03**	8.73E-04

Site-Specific
Composite Worker Risk for Soil - Secular Equilibrium

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
**Secular Equilibrium Risk for U-235*	*1.37E-08*	*6.63E-11*	*5.32E-08*	***6.70E-08***
**Secular Equilibrium Risk for U-238*	*1.57E-06*	*7.63E-10*	*4.85E-06*	***6.42E-06***
**Total Risk*	*1.59E-06*	*8.29E-10*	*4.90E-06*	***6.49E-06***

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Site-Specific
Composite Worker Individual Risk Contributions for Soil - Secular Equilibrium

Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Adult Soil Ingestion Slope Factor (risk/pCi)	Concentration (pCi/g)	Particulate Emission Factor (m^3/kg)	Lambda (1/yr)	Halflife (yr)
**Secular Equilibrium Risk for U-235*		-	-	-	-	-	-	-
Ac-227	S	1.49E-07	1.98E-10	2.01E-10	0.04	2.37E+09	3.18E-02	2.18E+01
At-219	-	0.00E+00	0.00E+00	0.00E+00	0.04	2.37E+09	3.90E+05	1.78E-06
Bi-211	-	0.00E+00	1.90E-07	0.00E+00	0.04	2.37E+09	1.70E+05	4.07E-06
Bi-215	-	0.00E+00	1.08E-06	0.00E+00	0.04	2.37E+09	4.79E+04	1.45E-05
Fr-223	S	4.07E-11	1.35E-07	4.88E-12	0.04	2.37E+09	1.66E+04	4.19E-05
Pa-231	F	7.62E-08	1.27E-07	1.54E-10	0.04	2.37E+09	2.12E-05	3.28E+04
Pb-211	S	4.03E-11	2.91E-07	2.63E-13	0.04	2.37E+09	1.01E+04	6.87E-05
Po-211	-	0.00E+00	3.76E-08	0.00E+00	0.04	2.37E+09	4.24E+07	1.64E-08
Po-215	-	0.00E+00	7.48E-10	0.00E+00	0.04	2.37E+09	1.23E+10	5.65E-11
Ra-223	S	2.92E-08	4.55E-07	1.23E-10	0.04	2.37E+09	2.21E+01	3.13E-02
Rn-219	-	0.00E+00	2.35E-07	0.00E+00	0.04	2.37E+09	5.52E+06	1.26E-07
Th-227	S	3.50E-08	4.45E-07	2.06E-11	0.04	2.37E+09	1.35E+01	5.12E-02
Th-231	S	1.50E-12	2.49E-08	9.07E-13	0.04	2.37E+09	2.38E+02	2.91E-03
Tl-207	-	0.00E+00	1.59E-08	0.00E+00	0.04	2.37E+09	7.64E+04	9.08E-06
U-235	S	2.50E-08	5.51E-07	4.92E-11	0.04	2.37E+09	9.84E-10	7.04E+08
**Secular Equilibrium Risk for U-238*		-	-	-	-	-	-	-
At-218	-	0.00E+00	2.74E-11	0.00E+00	1	2.37E+09	1.46E+07	4.76E-08
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	1	2.37E+09	5.05E+01	1.37E-02
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	1	2.37E+09	1.83E+04	3.79E-05
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	1	2.37E+09	4.47E+04	1.55E-05
Pa-234	S	1.20E-12	6.62E-06	9.66E-13	1	2.37E+09	9.06E+02	7.65E-04
Pa-234m	-	0.00E+00	9.06E-08	0.00E+00	1	2.37E+09	3.11E+05	2.23E-06
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	1	2.37E+09	3.12E-02	2.22E+01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	1	2.37E+09	1.36E+04	5.10E-05
Po-210	S	1.45E-08	4.51E-11	1.44E-09	1	2.37E+09	1.83E+00	3.79E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	1	2.37E+09	1.33E+11	5.21E-12
Po-218	-	1.39E-11	6.84E-15	0.00E+00	1	2.37E+09	1.17E+05	5.90E-06
Ra-226	S	2.82E-08	2.50E-08	2.95E-10	1	2.37E+09	4.33E-04	1.60E+03

Site-Specific
Composite Worker Individual Risk Contributions for Soil - Secular Equilibrium

1000029 m² Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	Ingestion CDI (pCi)	Inhalation CDI (pCi)	External Exposure CDI (pCi)	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
-	-	-	-	-	*1.37E-08*	*6.63E-11*	*5.32E-08*	***6.70E-08***
1.00E+00	1.00E+00	2.50E+01	2.11E-04	2.28E-02	5.03E-09	3.15E-11	4.53E-12	**5.07E-09**
9.00E-01	1.00E+00	2.50E+01	2.11E-04	2.05E-02	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
1.00E+00	1.00E+00	2.50E+01	2.11E-04	2.28E-02	0.00E+00	0.00E+00	4.35E-09	**4.35E-09**
1.00E+00	1.00E+00	2.50E+01	2.11E-04	2.28E-02	0.00E+00	0.00E+00	1.99E-14	**1.99E-14**
1.00E+00	1.00E+00	2.50E+01	2.11E-04	2.28E-02	1.68E-12	1.18E-16	4.27E-11	**4.44E-11**
1.00E+00	1.00E+00	2.50E+01	2.11E-04	2.28E-02	3.86E-09	1.61E-11	2.91E-09	**6.78E-09**
1.00E+00	1.00E+00	2.50E+01	2.11E-04	2.28E-02	6.57E-12	8.51E-15	6.64E-09	**6.64E-09**
1.00E+00	1.00E+00	2.50E+01	2.11E-04	2.28E-02	0.00E+00	0.00E+00	2.37E-12	**2.37E-12**
1.00E+00	1.00E+00	2.50E+01	2.11E-04	2.28E-02	0.00E+00	0.00E+00	1.71E-11	**1.71E-11**
1.00E+00	1.00E+00	2.50E+01	2.11E-04	2.28E-02	3.08E-09	6.16E-12	1.04E-08	**1.35E-08**
1.00E+00	1.00E+00	2.50E+01	2.11E-04	2.28E-02	0.00E+00	0.00E+00	5.36E-09	**5.36E-09**
1.00E+00	1.00E+00	2.50E+01	2.11E-04	2.28E-02	5.08E-10	7.28E-12	1.00E-08	**1.05E-08**
1.00E+00	1.00E+00	2.50E+01	2.11E-04	2.28E-02	2.27E-11	3.17E-16	5.68E-10	**5.90E-10**
1.00E+00	1.00E+00	2.50E+01	2.11E-04	2.28E-02	0.00E+00	0.00E+00	3.62E-10	**3.62E-10**
1.00E+00	1.00E+00	2.50E+01	2.11E-04	2.28E-02	1.23E-09	5.27E-12	1.26E-08	**1.38E-08**
-	-	-	-	-	*1.57E-06*	*7.63E-10*	*4.85E-06*	***6.42E-06***
9.00E-01	1.00E+00	6.25E+02	5.27E-03	5.14E-01	0.00E+00	0.00E+00	2.82E-15	**2.82E-15**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	2.34E-09	2.40E-12	1.58E-09	**3.92E-09**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	9.20E-11	3.26E-13	4.19E-06	**4.19E-06**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	0.00E+00	0.00E+00	5.24E-15	**5.24E-15**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	9.66E-13	1.01E-17	6.05E-09	**6.05E-09**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	0.00E+00	0.00E+00	5.17E-08	**5.17E-08**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	3.75E-07	8.37E-11	8.46E-10	**3.76E-07**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	1.38E-10	4.10E-13	5.67E-07	**5.67E-07**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	8.97E-07	7.65E-11	2.57E-11	**8.97E-07**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	0.00E+00	0.00E+00	2.20E-10	**2.20E-10**
9.00E-01	1.00E+00	6.25E+02	5.27E-03	5.14E-01	0.00E+00	7.33E-14	3.51E-15	**7.68E-14**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	1.84E-07	1.48E-10	1.43E-08	**1.98E-07**

Site-Specific
Composite Worker Individual Risk Contributions for Soil - Secular Equilibrium

Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Adult Soil Ingestion Slope Factor (risk/pCi)	Concentration (pCi/g)	Particulate Emission Factor (m^3/kg)	Lambda (1/yr)	Halflife (yr)
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	1	2.37E+09	6.24E+08	1.11E-09
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	1	2.37E+09	6.62E+01	1.05E-02
Th-230	F	3.41E-08	8.45E-10	7.73E-11	1	2.37E+09	9.19E-06	7.54E+04
Th-234	S	3.08E-11	1.77E-08	9.51E-12	1	2.37E+09	1.05E+01	6.60E-02
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	1	2.37E+09	8.67E+04	7.99E-06
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	1	2.37E+09	2.80E+05	2.47E-06
U-234	S	2.78E-08	2.53E-10	5.11E-11	1	2.37E+09	2.82E-06	2.46E+05
U-238	S	2.36E-08	1.24E-10	4.66E-11	1	2.37E+09	1.55E-10	4.47E+09

Site-Specific
Composite Worker Individual Risk Contributions for Soil - Secular Equilibrium

1000029 m² Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	Ingestion CDI (pCi)	Inhalation CDI (pCi)	External Exposure CDI (pCi)	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	0.00E+00	0.00E+00	3.87E-16	**3.87E-16**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	0.00E+00	1.20E-14	9.66E-10	**9.66E-10**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	4.83E-08	1.80E-10	4.83E-10	**4.90E-08**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	5.94E-09	1.62E-13	1.01E-08	**1.61E-08**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	0.00E+00	0.00E+00	4.67E-15	**4.67E-15**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	0.00E+00	0.00E+00	1.61E-09	**1.61E-09**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	3.19E-08	1.47E-10	1.45E-10	**3.22E-08**
1.00E+00	1.00E+00	6.25E+02	5.27E-03	5.71E-01	2.91E-08	1.25E-10	7.06E-11	**2.93E-08**

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Site-Specific
Indoor Worker Soil Inputs - Secular Equilibrium

*** Inputted values different from Indoor Worker defaults are highlighted.**

Variable	Indoor Worker Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	14.9421
B (PEF Dispersion Constant)	18.7762	17.9869
City (Climate Zone)	Default	Albuquerque, NM (3)
C (PEF Dispersion Constant)	216.108	205.1782
F(x) (function dependent on U_m/U_t) unitless	0.194	0.0553
PEF (particulate emission factor) m^3/kg	1359344438	6609630249.811598
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	81.84858572694108
A_s (acres)	0.5	0.5
ED_{iw} (exposure duration - indoor worker) yr	25	25
EF_{iw} (exposure frequency - indoor worker) day/yr	250	250
ET_{iw} (exposure time - indoor worker) hr/day	8	0.8
GSF_i (indoor gamma shielding factor) unitless	0.4	0.7
IRA_{iw} (inhalation rate - indoor worker) m^3/day	60	0
IRS_{iw} (soil intake rate - indoor worker) mg/day	50	0
t_{iw} (time - indoor worker) yr	25	25
TR (target cancer risk) unitless	1.0E-06	1.0E-04
U_m (mean annual wind speed) m/s	4.69	4.02
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

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Site-Specific
Indoor Worker PRGs for Soil - Secular Equilibrium

Isotope	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)
**Secular Equilibrium PRG for U-235*	-	-	*1.07E+02*	***1.07E+02***
**Secular Equilibrium PRG for U-238*	-	-	*2.95E+01*	***2.95E+01***

Site-Specific
Indoor Worker Individual Contribution PRGs for Soil - Secular Equilibrium

Isotope	Parent	Fractional Contribution of Progeny	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Adult Soil Ingestion Slope Factor (risk/pCi)	Particulate Emission Factor (m³/kg)	Lambda (1/yr)	Halflife (yr)
**Secular Equilibrium PRG for U-235*	*U-235*	-		-	-	-	-	-	-
Ac-227	U-235	1.00E+00	S	1.49E-07	1.98E-10	2.01E-10	6.61E+09	3.18E-02	2.18E+01
At-219	U-235	8.28E-07	-	0.00E+00	0.00E+00	0.00E+00	6.61E+09	3.90E+05	1.78E-06
Bi-211	U-235	1.00E+00	-	0.00E+00	1.90E-07	0.00E+00	6.61E+09	1.70E+05	4.07E-06
Bi-215	U-235	8.03E-07	-	0.00E+00	1.08E-06	0.00E+00	6.61E+09	4.79E+04	1.45E-05
Fr-223	U-235	1.38E-02	S	4.07E-11	1.35E-07	4.88E-12	6.61E+09	1.66E+04	4.19E-05
Pa-231	U-235	1.00E+00	F	7.62E-08	1.27E-07	1.54E-10	6.61E+09	2.12E-05	3.28E+04
Pb-211	U-235	1.00E+00	S	4.03E-11	2.91E-07	2.63E-13	6.61E+09	1.01E+04	6.87E-05
Po-211	U-235	2.76E-03	-	0.00E+00	3.76E-08	0.00E+00	6.61E+09	4.24E+07	1.64E-08
Po-215	U-235	1.00E+00	-	0.00E+00	7.48E-10	0.00E+00	6.61E+09	1.23E+10	5.65E-11
Ra-223	U-235	1.00E+00	S	2.92E-08	4.55E-07	1.23E-10	6.61E+09	2.21E+01	3.13E-02
Rn-219	U-235	1.00E+00	-	0.00E+00	2.35E-07	0.00E+00	6.61E+09	5.52E+06	1.26E-07
Th-227	U-235	9.86E-01	S	3.50E-08	4.45E-07	2.06E-11	6.61E+09	1.35E+01	5.12E-02
Th-231	U-235	1.00E+00	S	1.50E-12	2.49E-08	9.07E-13	6.61E+09	2.38E+02	2.91E-03
Tl-207	U-235	9.97E-01	-	0.00E+00	1.59E-08	0.00E+00	6.61E+09	7.64E+04	9.08E-06
U-235	U-235	1.00E+00	S	2.50E-08	5.51E-07	4.92E-11	6.61E+09	9.84E-10	7.04E+08
**Secular Equilibrium PRG for U-238*	*U-238*	-		-	-	-	-	-	-
At-218	U-238	2.00E-04	-	0.00E+00	2.74E-11	0.00E+00	6.61E+09	1.46E+07	4.76E-08
Bi-210	U-238	1.00E+00	S	4.55E-10	2.77E-09	3.74E-12	6.61E+09	5.05E+01	1.37E-02
Bi-214	U-238	1.00E+00	S	6.18E-11	7.34E-06	1.47E-13	6.61E+09	1.83E+04	3.79E-05
Hg-206	U-238	1.90E-08	-	0.00E+00	4.83E-07	0.00E+00	6.61E+09	4.47E+04	1.55E-05
Pa-234	U-238	1.60E-03	S	1.20E-12	6.62E-06	9.66E-13	6.61E+09	9.06E+02	7.65E-04
Pa-234m	U-238	1.00E+00	-	0.00E+00	9.06E-08	0.00E+00	6.61E+09	3.11E+05	2.23E-06
Pb-210	U-238	1.00E+00	S	1.59E-08	1.48E-09	5.99E-10	6.61E+09	3.12E-02	2.22E+01
Pb-214	U-238	1.00E+00	S	7.77E-11	9.94E-07	2.21E-13	6.61E+09	1.36E+04	5.10E-05
Po-210	U-238	1.00E+00	S	1.45E-08	4.51E-11	1.44E-09	6.61E+09	1.83E+00	3.79E-01
Po-214	U-238	1.00E+00	-	0.00E+00	3.85E-10	0.00E+00	6.61E+09	1.33E+11	5.21E-12
Po-218	U-238	1.00E+00	-	1.39E-11	6.84E-15	0.00E+00	6.61E+09	1.17E+05	5.90E-06
Ra-226	U-238	1.00E+00	S	2.82E-08	2.50E-08	2.95E-10	6.61E+09	4.33E-04	1.60E+03

Site-Specific
Indoor Worker Individual Contribution PRGs for Soil - Secular Equilibrium

Isotope	1000029 m² Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	Total Indoor GSF Soil Volume	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (mg/kg)
**Secular Equilibrium PRG for U-235*	-	-	-	-	-	*1.07E+02*	***1.07E+02***	-
Ac-227	1.00E+00	1.00E+00	7.00E-01	-	-	1.26E+06	**1.26E+06**	1.10E-14
At-219	9.00E-01	1.00E+00	7.00E-01	-	-	-	**-**	-
Bi-211	1.00E+00	1.00E+00	7.00E-01	-	-	1.32E+03	**1.32E+03**	1.83E-18
Bi-215	1.00E+00	1.00E+00	7.00E-01	-	-	2.88E+08	**2.88E+08**	3.03E-23
Fr-223	1.00E+00	1.00E+00	7.00E-01	-	-	1.34E+05	**1.34E+05**	1.95E-19
Pa-231	1.00E+00	1.00E+00	7.00E-01	-	-	1.97E+03	**1.97E+03**	1.08E-08
Pb-211	1.00E+00	1.00E+00	7.00E-01	-	-	8.61E+02	**8.61E+02**	4.71E-17
Po-211	1.00E+00	1.00E+00	7.00E-01	-	-	2.41E+06	**2.41E+06**	4.01E-24
Po-215	1.00E+00	1.00E+00	7.00E-01	-	-	3.34E+05	**3.34E+05**	1.02E-25
Ra-223	1.00E+00	1.00E+00	7.00E-01	-	-	5.50E+02	**5.50E+02**	3.56E-14
Rn-219	1.00E+00	1.00E+00	7.00E-01	-	-	1.07E+03	**1.07E+03**	7.22E-20
Th-227	1.00E+00	1.00E+00	7.00E-01	-	-	5.70E+02	**5.70E+02**	5.70E-14
Th-231	1.00E+00	1.00E+00	7.00E-01	-	-	1.01E+04	**1.01E+04**	1.87E-16
Tl-207	1.00E+00	1.00E+00	7.00E-01	-	-	1.58E+04	**1.58E+04**	3.33E-19
U-235	1.00E+00	1.00E+00	7.00E-01	-	-	4.54E+02	**4.54E+02**	1.02E-03
**Secular Equilibrium PRG for U-238*	-	-	-	-	-	*2.95E+01*	***2.95E+01***	-
At-218	9.00E-01	1.00E+00	7.00E-01	-	-	5.07E+10	**5.07E+10**	5.73E-28
Bi-210	1.00E+00	1.00E+00	7.00E-01	-	-	9.04E+04	**9.04E+04**	8.93E-17
Bi-214	1.00E+00	1.00E+00	7.00E-01	-	-	3.41E+01	**3.41E+01**	6.66E-16
Hg-206	1.00E+00	1.00E+00	7.00E-01	-	-	2.73E+10	**2.73E+10**	3.28E-25
Pa-234	1.00E+00	1.00E+00	7.00E-01	-	-	2.36E+04	**2.36E+04**	2.12E-17
Pa-234m	1.00E+00	1.00E+00	7.00E-01	-	-	2.76E+03	**2.76E+03**	5.28E-19
Pb-210	1.00E+00	1.00E+00	7.00E-01	-	-	1.69E+05	**1.69E+05**	7.73E-14
Pb-214	1.00E+00	1.00E+00	7.00E-01	-	-	2.52E+02	**2.52E+02**	1.21E-16
Po-210	1.00E+00	1.00E+00	7.00E-01	-	-	5.55E+06	**5.55E+06**	4.01E-17
Po-214	1.00E+00	1.00E+00	7.00E-01	-	-	6.50E+05	**6.50E+05**	4.81E-27
Po-218	9.00E-01	1.00E+00	7.00E-01	-	-	4.06E+10	**4.06E+10**	8.86E-26
Ra-226	1.00E+00	1.00E+00	7.00E-01	-	-	1.00E+04	**1.00E+04**	1.01E-10

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Site-Specific
Indoor Worker Individual Contribution PRGs for Soil - Secular Equilibrium

Isotope	Parent	Fractional Contribution of Progeny	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Adult Soil Ingestion Slope Factor (risk/pCi)	Particulate Emission Factor (m^3/kg)	Lambda (1/yr)	Halflife (yr)
Rn-218	U-238	2.00E-07	-	0.00E+00	3.39E-09	0.00E+00	6.61E+09	6.24E+08	1.11E-09
Rn-222	U-238	1.00E+00	-	2.28E-12	1.69E-09	0.00E+00	6.61E+09	6.62E+01	1.05E-02
Th-230	U-238	1.00E+00	F	3.41E-08	8.45E-10	7.73E-11	6.61E+09	9.19E-06	7.54E+04
Th-234	U-238	1.00E+00	S	3.08E-11	1.77E-08	9.51E-12	6.61E+09	1.05E+01	6.60E-02
Tl-206	U-238	1.34E-06	-	0.00E+00	6.11E-09	0.00E+00	6.61E+09	8.67E+04	7.99E-06
Tl-210	U-238	2.10E-04	-	0.00E+00	1.34E-05	0.00E+00	6.61E+09	2.80E+05	2.47E-06
U-234	U-238	1.00E+00	S	2.78E-08	2.53E-10	5.11E-11	6.61E+09	2.82E-06	2.46E+05
U-238	U-238	1.00E+00	S	2.36E-08	1.24E-10	4.66E-11	6.61E+09	1.55E-10	4.47E+09

Site-Specific
Indoor Worker Individual Contribution PRGs for Soil - Secular Equilibrium

Isotope	1000029 m² Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	Total Indoor GSF Soil Volume	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (mg/kg)
Rn-218	1.00E+00	1.00E+00	7.00E-01	-	-	3.70E+11	**3.70E+11**	1.83E-30
Rn-222	1.00E+00	1.00E+00	7.00E-01	-	-	1.48E+05	**1.48E+05**	4.40E-17
Th-230	1.00E+00	1.00E+00	7.00E-01	-	-	2.96E+05	**2.96E+05**	1.64E-10
Th-234	1.00E+00	1.00E+00	7.00E-01	-	-	1.41E+04	**1.41E+04**	3.07E-15
Tl-206	1.00E+00	1.00E+00	7.00E-01	-	-	3.06E+10	**3.06E+10**	1.51E-25
Tl-210	1.00E+00	1.00E+00	7.00E-01	-	-	8.88E+04	**8.88E+04**	1.64E-20
U-234	1.00E+00	1.00E+00	7.00E-01	-	-	9.88E+05	**9.88E+05**	1.63E-10
U-238	1.00E+00	1.00E+00	7.00E-01	-	-	2.02E+06	**2.02E+06**	1.47E-06

Site-Specific
Indoor Worker Risk for Soil - Secular Equilibrium

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
**Secular Equilibrium Risk for U-235*	*0.00E+00*	*0.00E+00*	*3.73E-08*	***3.73E-08***
**Secular Equilibrium Risk for U-238*	*0.00E+00*	*0.00E+00*	*3.39E-06*	***3.39E-06***
**Total Risk*	*0.00E+00*	*0.00E+00*	*3.43E-06*	***3.43E-06***

Site-Specific
Indoor Worker Individual Risk Contributions for Soil - Secular Equilibrium

Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Adult Soil Ingestion Slope Factor (risk/pCi)	Concentration (pCi/g)	Particulate Emission Factor (m^3/kg)	Lambda (1/yr)	Halflife (yr)
**Secular Equilibrium Risk for U-235*		-	-	-	-	-	-	-
Ac-227	S	1.49E-07	1.98E-10	2.01E-10	0.04	6.61E+09	3.18E-02	2.18E+01
At-219	-	0.00E+00	0.00E+00	0.00E+00	0.04	6.61E+09	3.90E+05	1.78E-06
Bi-211	-	0.00E+00	1.90E-07	0.00E+00	0.04	6.61E+09	1.70E+05	4.07E-06
Bi-215	-	0.00E+00	1.08E-06	0.00E+00	0.04	6.61E+09	4.79E+04	1.45E-05
Fr-223	S	4.07E-11	1.35E-07	4.88E-12	0.04	6.61E+09	1.66E+04	4.19E-05
Pa-231	F	7.62E-08	1.27E-07	1.54E-10	0.04	6.61E+09	2.12E-05	3.28E+04
Pb-211	S	4.03E-11	2.91E-07	2.63E-13	0.04	6.61E+09	1.01E+04	6.87E-05
Po-211	-	0.00E+00	3.76E-08	0.00E+00	0.04	6.61E+09	4.24E+07	1.64E-08
Po-215	-	0.00E+00	7.48E-10	0.00E+00	0.04	6.61E+09	1.23E+10	5.65E-11
Ra-223	S	2.92E-08	4.55E-07	1.23E-10	0.04	6.61E+09	2.21E+01	3.13E-02
Rn-219	-	0.00E+00	2.35E-07	0.00E+00	0.04	6.61E+09	5.52E+06	1.26E-07
Th-227	S	3.50E-08	4.45E-07	2.06E-11	0.04	6.61E+09	1.35E+01	5.12E-02
Th-231	S	1.50E-12	2.49E-08	9.07E-13	0.04	6.61E+09	2.38E+02	2.91E-03
Tl-207	-	0.00E+00	1.59E-08	0.00E+00	0.04	6.61E+09	7.64E+04	9.08E-06
U-235	S	2.50E-08	5.51E-07	4.92E-11	0.04	6.61E+09	9.84E-10	7.04E+08
**Secular Equilibrium Risk for U-238*		-	-	-	-	-	-	-
At-218	-	0.00E+00	2.74E-11	0.00E+00	1	6.61E+09	1.46E+07	4.76E-08
Bi-210	S	4.55E-10	2.77E-09	3.74E-12	1	6.61E+09	5.05E+01	1.37E-02
Bi-214	S	6.18E-11	7.34E-06	1.47E-13	1	6.61E+09	1.83E+04	3.79E-05
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	1	6.61E+09	4.47E+04	1.55E-05
Pa-234	S	1.20E-12	6.62E-06	9.66E-13	1	6.61E+09	9.06E+02	7.65E-04
Pa-234m	-	0.00E+00	9.06E-08	0.00E+00	1	6.61E+09	3.11E+05	2.23E-06
Pb-210	S	1.59E-08	1.48E-09	5.99E-10	1	6.61E+09	3.12E-02	2.22E+01
Pb-214	S	7.77E-11	9.94E-07	2.21E-13	1	6.61E+09	1.36E+04	5.10E-05
Po-210	S	1.45E-08	4.51E-11	1.44E-09	1	6.61E+09	1.83E+00	3.79E-01
Po-214	-	0.00E+00	3.85E-10	0.00E+00	1	6.61E+09	1.33E+11	5.21E-12
Po-218	-	1.39E-11	6.84E-15	0.00E+00	1	6.61E+09	1.17E+05	5.90E-06
Ra-226	S	2.82E-08	2.50E-08	2.95E-10	1	6.61E+09	4.33E-04	1.60E+03

Site-Specific
Indoor Worker Individual Risk Contributions for Soil - Secular Equilibrium

1000029 m² Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	Total Indoor GSF Soil Volume	Ingestion CDI (pCi)	Inhalation CDI (pCi)	External Exposure CDI (pCi)	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
-	-	-	-	-	-	*0.00E+00*	*0.00E+00*	*3.73E-08*	***3.73E-08***
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.60E-02	0.00E+00	0.00E+00	3.17E-12	**3.17E-12**
9.00E-01	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.44E-02	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.60E-02	0.00E+00	0.00E+00	3.04E-09	**3.04E-09**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.60E-02	0.00E+00	0.00E+00	1.39E-14	**1.39E-14**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.60E-02	0.00E+00	0.00E+00	2.99E-11	**2.99E-11**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.60E-02	0.00E+00	0.00E+00	2.03E-09	**2.03E-09**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.60E-02	0.00E+00	0.00E+00	4.65E-09	**4.65E-09**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.60E-02	0.00E+00	0.00E+00	1.66E-12	**1.66E-12**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.60E-02	0.00E+00	0.00E+00	1.20E-11	**1.20E-11**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.60E-02	0.00E+00	0.00E+00	7.28E-09	**7.28E-09**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.60E-02	0.00E+00	0.00E+00	3.75E-09	**3.75E-09**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.60E-02	0.00E+00	0.00E+00	7.01E-09	**7.01E-09**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.60E-02	0.00E+00	0.00E+00	3.97E-10	**3.97E-10**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.60E-02	0.00E+00	0.00E+00	2.53E-10	**2.53E-10**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	1.60E-02	0.00E+00	0.00E+00	8.81E-09	**8.81E-09**
-	-	-	-	-	-	*0.00E+00*	*0.00E+00*	*3.39E-06*	***3.39E-06***
9.00E-01	1.00E+00	7.00E-01	0.00E+00	0.00E+00	3.60E-01	0.00E+00	0.00E+00	1.97E-15	**1.97E-15**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	1.11E-09	**1.11E-09**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	2.93E-06	**2.93E-06**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	3.67E-15	**3.67E-15**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	4.23E-09	**4.23E-09**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	3.62E-08	**3.62E-08**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	5.92E-10	**5.92E-10**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	3.97E-07	**3.97E-07**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	1.80E-11	**1.80E-11**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	1.54E-10	**1.54E-10**
9.00E-01	1.00E+00	7.00E-01	0.00E+00	0.00E+00	3.60E-01	0.00E+00	0.00E+00	2.46E-15	**2.46E-15**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	9.98E-09	**9.98E-09**

Site-Specific
Indoor Worker Individual Risk Contributions for Soil - Secular Equilibrium

Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Adult Soil Ingestion Slope Factor (risk/pCi)	Concentration (pCi/g)	Particulate Emission Factor (m^3/kg)	Lambda (1/yr)	Halflife (yr)
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	1	6.61E+09	6.24E+08	1.11E-09
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	1	6.61E+09	6.62E+01	1.05E-02
Th-230	F	3.41E-08	8.45E-10	7.73E-11	1	6.61E+09	9.19E-06	7.54E+04
Th-234	S	3.08E-11	1.77E-08	9.51E-12	1	6.61E+09	1.05E+01	6.60E-02
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	1	6.61E+09	8.67E+04	7.99E-06
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	1	6.61E+09	2.80E+05	2.47E-06
U-234	S	2.78E-08	2.53E-10	5.11E-11	1	6.61E+09	2.82E-06	2.46E+05
U-238	S	2.36E-08	1.24E-10	4.66E-11	1	6.61E+09	1.55E-10	4.47E+09

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Site-Specific
Indoor Worker Individual Risk Contributions for Soil - Secular Equilibrium

1000029 m² Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	Total Indoor GSF Soil Volume	Ingestion CDI (pCi)	Inhalation CDI (pCi)	External Exposure CDI (pCi)	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	2.71E-16	**2.71E-16**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	6.76E-10	**6.76E-10**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	3.38E-10	**3.38E-10**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	7.09E-09	**7.09E-09**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	3.27E-15	**3.27E-15**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	1.13E-09	**1.13E-09**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	1.01E-10	**1.01E-10**
1.00E+00	1.00E+00	7.00E-01	0.00E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	4.95E-11	**4.95E-11**

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Site-Specific
Farmer Soil Inputs - Secular Equilibrium

*** Inputted values different from Farmer defaults are highlighted.**

Variable	Farmer Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	14.9421
B (PEF Dispersion Constant)	18.7762	17.9869
City (Climate Zone)	Default	Albuquerque, NM (3)
C (PEF Dispersion Constant)	216.108	205.1782
$CF_{far\text{-}produce}$ (contaminated plant fraction) unitless	1	1
$CF_{far\text{-}apple}$ (contaminated apple fraction) unitless	1	1
$CF_{far\text{-}asparagus}$ (contaminated asparagus fraction) unitless	1	1
$CF_{far\text{-}beef}$ (beef contaminated fraction) unitless	1	.48
$CF_{far\text{-}berry}$ (contaminated berry fraction) unitless	1	1
$CF_{far\text{-}broccoli}$ (contaminated broccoli fraction) unitless	1	1
$CF_{far\text{-}beet}$ (contaminated beet fraction) unitless	1	1
$CF_{far\text{-}cabbage}$ (contaminated cabbage fraction) unitless	1	1
$CF_{far\text{-}cereal\ grain}$ (contaminated cereal grain fraction) unitless	1	1
$CF_{far\text{-}citrus}$ (contaminated citrus fraction) unitless	1	1
$CF_{far\text{-}corn}$ (contaminated corn fraction) unitless	1	1
$CF_{far\text{-}carrot}$ (contaminated carrot fraction) unitless	1	1
$CF_{far\text{-}cucumber}$ (contaminated cucumber fraction) unitless	1	1
$CF_{far\text{-}dairy}$ (dairy contaminated fraction) unitless	1	1
$CF_{far\text{-}egg}$ (egg contaminated fraction) unitless	1	1
$CF_{far\text{-}fish}$ (fish contaminated fraction) unitless	1	1
$CF_{far\text{-}goat\ milk}$ (goat milk contaminated fraction) unitless	1	1
$CF_{far\text{-}goat\ meat}$ (goat meat contaminated fraction) unitless	1	1
$CF_{far\text{-}lettuce}$ (contaminated lettuce fraction) unitless	1	1
$CF_{far\text{-}lima\ bean}$ (contaminated lima bean fraction) unitless	1	1
$CF_{far\text{-}okra}$ (contaminated okra fraction) unitless	1	1
$CF_{far\text{-}onion}$ (contaminated onion fraction) unitless	1	1
$CF_{far\text{-}poultry}$ (poultry contaminated fraction unitless)	1	1
$CF_{far\text{-}peach}$ (contaminated peach fraction) unitless	1	1
$CF_{far\text{-}pea}$ (contaminated pea fraction) unitless	1	1
$CF_{far\text{-}pear}$ (contaminated pear fraction) unitless	1	1

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Site-Specific
Farmer Soil Inputs - Secular Equilibrium

*** Inputted values different from Farmer defaults are highlighted.**

Variable	Farmer Soil Default Value	Form-input Value
$CF_{far\text{-}potato}$ (contaminated potato fraction) unitless	1	1
$CF_{far\text{-}pumpkin}$ (contaminated pumpkin fraction) unitless	1	1
$CF_{far\text{-}rice}$ (contaminated rice fraction) unitless	1	1
$CF_{far\text{-}sheep}$ (sheep contaminated fraction) unitless	1	1
$CF_{far\text{-}sheep\ milk}$ (sheep milk contaminated fraction) unitless	1	1
$CF_{far\text{-}snap\ bean}$ (contaminated snap bean fraction) unitless	1	1
$CF_{far\text{-}strawberry}$ (contaminated strawberry fraction) unitless	1	1
$CF_{far\text{-}swine}$ (swine contaminated fraction) unitless	1	1
$CF_{far\text{-}tomato}$ (contaminated tomato fraction) unitless	1	1
ED_{far} (exposure duration - farmer) yr	40	25
$ED_{far\text{-}a}$ (exposure duration - farmer adult) yr	34	25
$ED_{far\text{-}c}$ (exposure duration - farmer child) yr	6	0
$EF_{far\text{-}a}$ (exposure frequency - farmer adult) day/yr	350	350
$EF_{far\text{-}c}$ (exposure frequency - farmer child) day/yr	350	350
$IFAP_{far\text{-}adj}$ (age-adjusted apple ingestion factor) g	1182020	741125
$IFAS_{far\text{-}adj}$ (age-adjusted asparagus ingestion factor) g	492870	343874.99999999994
$IFB_{far\text{-}adj}$ (age-adjusted beef ingestion factor) g	2098950	1446375
$IFBE_{far\text{-}adj}$ (age-adjusted berry ingestion factor) g	471450	309750
$IFBR_{far\text{-}adj}$ (age-adjusted broccoli ingestion factor) g	450310	308874.99999999994
$IFBT_{far\text{-}adj}$ (age-adjusted beet ingestion factor) g	411600	296625
$IFCB_{far\text{-}adj}$ (age-adjusted cabbage ingestion factor) g	1043980	749875
$IFCG_{far\text{-}adj}$ (age-adjusted cereal grain ingestion factor) g	1190210	1190210
$IFCI_{far\text{-}adj}$ (age-adjusted citrus ingestion factor) g	4090100	2707249.9999999995
$IFCO_{far\text{-}adj}$ (age-adjusted corn ingestion factor) g	1044470	717500
$IFCR_{far\text{-}adj}$ (age-adjusted carrot ingestion factor) g	318290	213500
$IFCU_{far\text{-}adj}$ (age-adjusted cucumber ingestion factor) g	688800	480375
$IFD_{far\text{-}adj}$ (age-adjusted dairy ingestion factor) g	10138030	5918500
$IFE_{far\text{-}adj}$ (age-adjusted egg ingestion factor) g	775810	521500
$IFFI_{far\text{-}adj}$ (age-adjusted fish ingestion factor) g	10018960	7278250
$IFLE_{far\text{-}adj}$ (age-adjusted lettuce ingestion factor) g	455070	328125

Site-Specific
Farmer Soil Inputs - Secular Equilibrium

*** Inputted values different from Farmer defaults are highlighted.**

Variable	Farmer Soil Default Value	Form-input Value
$IFLI_{far\text{-}adj}$ (age-adjusted lima bean ingestion factor) g	415870	295749.99999999994
$IFOK_{far\text{-}adj}$ (age-adjusted okra ingestion factor) g	370510	264250
$IFON_{far\text{-}adj}$ (age-adjusted onion ingestion factor) g	338800	238000
$IFP_{far\text{-}adj}$ (age-adjusted poultry ingestion factor) g	1376550	939750
$IFPC_{far\text{-}adj}$ (age-adjusted peach ingestion factor) g	1435420	902125
$IFPE_{far\text{-}adj}$ (age-adjusted pea ingestion factor) g	437500	277375
$IFPR_{far\text{-}adj}$ (age-adjusted pear ingestion factor) g	874300	524125
$IFPT_{far\text{-}adj}$ (age-adjusted potato ingestion factor) g	1807750	1240750.0000000002
$IFPU_{far\text{-}adj}$ (age-adjusted pumpkin ingestion factor) g	866040	567000
$IFRI_{far\text{-}adj}$ (age-adjusted rice ingestion factor) g	1126230	774375
$IFSN_{far\text{-}adj}$ (age-adjusted snap bean ingestion factor) g	702730	474250
$IFST_{far\text{-}adj}$ (age-adjusted strawberry ingestion factor) g	535080	354375
$IFSW_{far\text{-}adj}$ (age-adjusted swine ingestion factor) g	1171520	809375
$IFTO_{far\text{-}adj}$ (age-adjusted tomato ingestion factor) g	1194270	824250
$IRAP_{far\text{-}a}$ (apple ingestion rate - farmer adult) g/day	84.7	84.7
$IRAP_{far\text{-}c}$ (apple ingestion rate - farmer child) g/day	82.9	82.9
$IRAS_{far\text{-}a}$ (asparagus ingestion rate - farmer adult) g/day	39.3	39.3
$IRAS_{far\text{-}c}$ (asparagus ingestion rate - farmer child) g/day	12.0	12.0
$IRB_{far\text{-}a}$ (beef ingestion rate - farmer adult) g/day	165.3	165.3
$IRB_{far\text{-}c}$ (beef ingestion rate - farmer child) g/day	62.8	0
$IRBE_{far\text{-}a}$ (berry ingestion rate - farmer adult) g/day	35.4	35.4
$IRBE_{far\text{-}c}$ (berry ingestion rate - farmer child) g/day	23.9	23.9
$IRBR_{far\text{-}a}$ (broccoli ingestion rate - farmer adult) g/day	35.3	35.3
$IRBR_{far\text{-}c}$ (broccoli ingestion rate - farmer child) g/day	14.4	14.4
$IRBT_{far\text{-}a}$ (beet ingestion rate - farmer adult) g/day	33.9	33.9
$IRBT_{far\text{-}c}$ (beet ingestion rate - farmer child) g/day	3.9	3.9
$IRCB_{far\text{-}a}$ (cabbage ingestion rate - farmer adult) g/day	85.7	85.7
$IRCB_{far\text{-}c}$ (cabbage ingestion rate - farmer child) g/day	11.5	11.5
$IRCG_{far\text{-}a}$ (cereal grain ingestion rate - farmer adult) g/day	91.9	91.9
$IRCG_{far\text{-}c}$ (cereal grain ingestion rate - farmer child) g/day	46.0	46.0

Site-Specific
Farmer Soil Inputs - Secular Equilibrium

*** Inputted values different from Farmer defaults are highlighted.**

Variable	Farmer Soil Default Value	Form-input Value
$IRCI_{far-a}$ (citrus ingestion rate - farmer adult) g/day	309.4	309.4
$IRCI_{far-c}$ (citrus ingestion rate - farmer child) g/day	194.4	194.4
$IRCO_{far-a}$ (corn ingestion rate - farmer adult) g/day	82.0	82.0
$IRCO_{far-c}$ (corn ingestion rate - farmer child) g/day	32.7	32.7
$IRCR_{far-a}$ (carrot ingestion rate - farmer adult) g/day	24.4	24.4
$IRCR_{far-c}$ (carrot ingestion rate - farmer child) g/day	13.3	13.3
$IRCU_{far-a}$ (cucumber ingestion rate - farmer adult) g/day	54.9	54.9
$IRCU_{far-c}$ (cucumber ingestion rate - farmer child) g/day	16.9	16.9
IRD_{far-a} (dairy ingestion rate - farmer adult) g/day	676.4	676.4
IRD_{far-c} (dairy ingestion rate - farmer child) g/day	994.7	994.7
IRE_{far-a} (egg ingestion rate - farmer adult) g/day	59.6	59.6
IRE_{far-c} (egg ingestion rate - farmer child) g/day	31.7	31.7
$IRFI_{far-a}$ (fish ingestion rate - farmer adult) g/day	831.8	831.8
$IRFI_{far-c}$ (fish ingestion rate - farmer child) g/day	57.4	57.4
$IRLE_{far-a}$ (lettuce ingestion rate - farmer adult) g/day	37.5	37.5
$IRLE_{far-c}$ (lettuce ingestion rate - farmer child) g/day	4.2	4.2
$IRLI_{far-a}$ (lima bean ingestion rate - farmer adult) g/day	33.8	33.8
$IRLI_{far-c}$ (lima bean ingestion rate - farmer child) g/day	6.5	6.5
$IROK_{far-a}$ (okra ingestion rate - farmer adult) g/day	30.2	30.2
$IROK_{far-c}$ (okra ingestion rate - farmer child) g/day	5.3	5.3
$IRON_{far-a}$ (onion ingestion rate - farmer adult) g/day	27.2	27.2
$IRON_{far-c}$ (onion ingestion rate - farmer child) g/day	7.2	7.2
IRP_{far-a} (poultry ingestion rate - farmer adult) g/day	107.4	107.4
IRP_{far-c} (poultry ingestion rate - farmer child) g/day	46.9	46.9
$IRPC_{far-a}$ (peach ingestion rate - farmer adult) g/day	103.1	103.1
$IRPC_{far-c}$ (peach ingestion rate - farmer child) g/day	99.3	99.3
$IRPE_{far-a}$ (pea ingestion rate - farmer adult) g/day	31.7	31.7
$IRPE_{far-c}$ (pea ingestion rate - farmer child) g/day	28.7	28.7
$IRPR_{far-a}$ (pear ingestion rate - farmer adult) g/day	59.9	59.9
$IRPR_{far-c}$ (pear ingestion rate - farmer child) g/day	76.9	76.9

Site-Specific
Farmer Soil Inputs - Secular Equilibrium

*** Inputted values different from Farmer defaults are highlighted.**

Variable	Farmer Soil Default Value	Form-input Value
$IRPT_{far-a}$ (potato ingestion rate - farmer adult) g/day	141.8	141.8
$IRPT_{far-c}$ (potato ingestion rate - farmer child) g/day	57.3	57.3
$IRPU_{far-a}$ (pumpkin ingestion rate - farmer adult) g/day	64.8	64.8
$IRPU_{far-c}$ (pumpkin ingestion rate - farmer child) g/day	45.2	45.2
$IRRI_{far-a}$ (rice ingestion rate - farmer adult) g/day	88.5	88.5
$IRRI_{far-c}$ (rice ingestion rate - farmer child) g/day	34.8	34.8
$IRSN_{far-a}$ (snap bean ingestion rate - farmer adult) g/day	54.2	54.2
$IRSN_{far-c}$ (snap bean ingestion rate - farmer child) g/day	27.5	27.5
$IRST_{far-a}$ (strawberry ingestion rate - farmer adult) g/day	40.5	40.5
$IRST_{far-c}$ (strawberry ingestion rate - farmer child) g/day	25.3	25.3
$IRSW_{far-a}$ (swine ingestion rate - farmer adult) g/day	92.5	92.5
$IRSW_{far-c}$ (swine ingestion rate - farmer child) g/day	33.7	33.7
$IRTO_{far-a}$ (tomato ingestion rate - farmer adult) g/day	94.2	94.2
$IRTO_{far-c}$ (tomato ingestion rate - farmer child) g/day	34.9	34.9
MLF_{apple} (apple mass loading factor) unitless	0.000160	0.000160
$MLF_{asparagus}$ (asparagus mass loading factor) unitless	0.0000790	0.0000790
MLF_{berry} (berry mass loading factor) unitless	0.000166	0.000166
$MLF_{broccoli}$ (broccoli mass loading factor) unitless	0.00101	0.00101
MLF_{beet} (beet mass loading factor) unitless	0.000138	0.000138
$MLF_{cabbage}$ (cabbage mass loading factor) unitless	0.000105	0.000105
$MLF_{cereal\ grain}$ (cereal grain mass loading factor) unitless	0.250	0.250
MLF_{citrus} (citrus mass loading factor) unitless	0.000157	0.000157
MLF_{corn} (corn mass loading factor) unitless	0.000145	0.000145
MLF_{carrot} (carrot mass loading factor) unitless	0.0000970	0.0000970
$MLF_{cucumber}$ (cucumber mass loading factor) unitless	0.0000400	0.0000400
$MLF_{lettuce}$ (lettuce mass loading factor) unitless	0.0135	0.0135
$MLF_{lima\ bean}$ (lima bean mass loading factor) unitless	0.00383	0.00383
MLF_{okra} (okra mass loading factor) unitless	0.0000800	0.0000800
MLF_{onion} (onion mass loading factor) unitless	0.0000970	0.0000970
MLF_{peach} (peach mass loading factor) unitless	0.000150	0.000150

Site-Specific
Farmer Soil Inputs - Secular Equilibrium

*** Inputted values different from Farmer defaults are highlighted.**

Variable	Farmer Soil Default Value	Form-input Value
MLF_{pea} (pea mass loading factor) unitless	0.000178	0.000178
MLF_{pear} (pear mass loading factor) unitless	0.000160	0.000160
MLF_{potato} (potato mass loading factor) unitless	0.000210	0.000210
$MLF_{pumpkin}$ (pumpkin mass loading factor) unitless	0.0000580	0.0000580
MLF_{rice} (rice mass loading factor) unitless	0.250	0.250
$MLF_{snap\ bean}$ (snap bean mass loading factor) unitless	0.00500	0.00500
$MLF_{strawberry}$ (strawberry mass loading factor) unitless	0.0000800	0.0000800
MLF_{tomato} (tomato mass loading factor) unitless	0.00159	0.00159
p_m (density of milk) kg/L	1.03	1.03
t_{far} (time - farmer) yr	40	25
TR (target cancer risk) unitless	1.0E-06	1.0E-04
F(x) (function dependent on U_m/U_t) unitless	0.194	0.0553
PEF (particulate emission factor) m^3/kg	1359344438	2370938158.760359
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	29.359877603759233
A_s (acres)	0.5	500
ED_{far} (exposure duration - farmer) yr	40	25
ED_{far-a} (exposure duration - farmer adult) yr	34	25
ED_{far-c} (exposure duration - farmer child) yr	6	0
EF_{far} (exposure frequency) day/yr	350	350
EF_{far-a} (exposure frequency - farmer adult) day/yr	350	350
EF_{far-c} (exposure frequency - farmer child) day/yr	350	350
ET_{far} (exposure time - farmer) hr/day	24	24
ET_{far-a} (exposure time - farmer adult) hr/day	24	24
ET_{far-c} (exposure time - farmer child) hr/day	24	24
ET_{far-i} (indoor exposure time fraction) hr/day	10.008	0
ET_{far-o} (outdoor exposure time fraction) hr/day	12.168	0
f_{p-beef} (animal on-site fraction) unitless	1	.33
$f_{p-dairy}$ (animal on-site fraction) unitless	1	1
$f_{p-goat\ milk}$ (animal on-site fraction) unitless	1	1
f_{p-goat} (animal on-site fraction) unitless	1	1

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Site-Specific
Farmer Soil Inputs - Secular Equilibrium

*** Inputted values different from Farmer defaults are highlighted.**

Variable	Farmer Soil Default Value	Form-input Value
$f_{p\text{-}poultry}$ (animal on-site fraction) unitless	1	1
$f_{p\text{-}sheep}$ (animal on-site fraction) unitless	1	1
$f_{p\text{-}sheep\ milk}$ (animal on-site fraction) unitless	1	1
$f_{p\text{-}swine}$ (animal on-site fraction) unitless	1	1
$f_{s\text{-}beef}$ (fraction of year animal on site) unitless	1	1
$f_{s\text{-}dairy}$ (fraction of year animal on site) unitless	1	1
$f_{s\text{-}goat\ milk}$ (fraction of year animal on site) unitless	1	1
$f_{s\text{-}goat}$ (fraction of year animal on site) unitless	1	1
$f_{s\text{-}poultry}$ (fraction of year animal on site) unitless	1	1
$f_{s\text{-}sheep}$ (fraction of year animal on site) unitless	1	1
$f_{s\text{-}sheep\ milk}$ (fraction of year animal on site) unitless	1	1
$f_{s\text{-}swine}$ (fraction of year animal on site) unitless	1	1
GSF_i (gamma shielding factor - indoor)	0.4	0
$IFA_{far\text{-}adj}$ (age-adjusted soil inhalation factor) m^3	259000	0
$IFS_{far\text{-}adj}$ (age-adjusted soil ingestion factor) mg	1610000	0
$IRA_{far\text{-}a}$ (inhalation rate - farmer adult) m^3/day	20	0
$IRA_{far\text{-}c}$ (inhalation rate - farmer child) m^3/day	10	0
$IRS_{far\text{-}a}$ (soil ingestion rate - farmer adult) mg/day	100	0
$IRS_{far\text{-}c}$ (soil ingestion rate - farmer child) mg/day	200	0
$MLF_{pasture}$ (pasture plant mass loading factor) unitless	0.25	0.25
$Q_{p\text{-}beef}$ (beef fodder intake rate) kg/day	11.77	11.77
$Q_{p\text{-}dairy}$ (dairy fodder intake rate) kg/day	20.3	20.3
$Q_{p\text{-}goat\ milk}$ (goat milk fodder intake rate) kg/day	1.59	1.59
$Q_{p\text{-}goat}$ (goat fodder intake rate) kg/day	1.27	1.27
$Q_{p\text{-}poultry}$ (poultry fodder intake rate) kg/day	0.2	0.2
$Q_{p\text{-}sheep}$ (sheep fodder intake rate) kg/day	1.75	1.75
$Q_{p\text{-}sheep\ milk}$ (sheep milk fodder intake rate) kg/day	3.15	3.15
$Q_{p\text{-}swine}$ (swine fodder intake rate) kg/day	4.7	4.7
$Q_{s\text{-}beef}$ (beef soil intake rate) kg/day	0.5	0.5
$Q_{s\text{-}dairy}$ (dairy soil intake rate) kg/day	0.4	0.4

Site-Specific
Farmer Soil Inputs - Secular Equilibrium

*** Inputted values different from Farmer defaults are highlighted.**

Variable	Farmer Soil Default Value	Form-input Value
$Q_{s\text{-}goat\ milk}$ (goat milk soil intake rate) kg/day	0.29	0.29
$Q_{s\text{-}goat}$ (goat soil intake rate) kg/day	0.23	0.23
$Q_{s\text{-}poultry}$ (poultry soil intake rate) kg/day	0.022	0.022
$Q_{s\text{-}sheep}$ (sheep soil intake rate) kg/day	0.32	0.32
$Q_{s\text{-}sheep\ milk}$ (sheep milk soil intake rate) kg/day	0.57	0.57
$Q_{s\text{-}swine}$ (swine soil intake rate) kg/day	0.37	0.37
t_{far} (time - farmer) yr	40	25
TR (target cancer risk) unitless	1.0E-06	1.0E-04
U_m (mean annual wind speed) m/s	4.69	4.02
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Site-Specific
Farmer PRGs for Soil - Secular Equilibrium

Isotope	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Produce Consumption PRG TR=0.0001 (pCi/g)	Beef Consumption PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)
**Secular Equilibrium PRG for U-235*	-	-	-	-	*1.86E+02*	***1.86E+02***
**Secular Equilibrium PRG for U-238*	-	-	-	-	*9.57E+00*	***9.57E+00***

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Site-Specific
Farmer Individual Contribution PRGs for Soil - Secular Equilibrium

Isotope	Parent	Fractional Contribution of Progeny	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Food Ingestion Slope Factor (risk/pCi)	Soil Ingestion Slope Factor (risk/pCi)	Plant to Beef Transfer Factor (pCi/kg per pCi/d)	Particulate Emission Factor (m^3/kg)	Lambda (1/yr)	Halflife (yr)	1000029 m^2 Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor
**Secular Equilibrium PRG for U-235*	*U-235*	-		-	-	-	-	-	-	-	-	-	-
Ac-227	U-235	1.00E+00	S	1.49E-07	1.98E-10	2.45E-10	2.90E-10	2.00E-05	2.37E+09	3.18E-02	2.18E+01	1.00E+00	1.00E+00
At-219	U-235	8.28E-07	-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-02	2.37E+09	3.90E+05	1.78E-06	9.00E-01	1.00E+00
Bi-211	U-235	1.00E+00	-	0.00E+00	1.90E-07	0.00E+00	0.00E+00	2.00E-03	2.37E+09	1.70E+05	4.07E-06	1.00E+00	1.00E+00
Bi-215	U-235	8.03E-07	-	0.00E+00	1.08E-06	0.00E+00	0.00E+00	2.00E-03	2.37E+09	4.79E+04	1.45E-05	1.00E+00	1.00E+00
Fr-223	U-235	1.38E-02	S	4.07E-11	1.35E-07	1.01E-11	1.69E-11	3.00E-02	2.37E+09	1.66E+04	4.19E-05	1.00E+00	1.00E+00
Pa-231	U-235	1.00E+00	F	7.62E-08	1.27E-07	2.26E-10	2.98E-10	5.00E-06	2.37E+09	2.12E-05	3.28E+04	1.00E+00	1.00E+00
Pb-211	U-235	1.00E+00	S	4.03E-11	2.91E-07	5.81E-13	9.55E-13	7.00E-04	2.37E+09	1.01E+04	6.87E-05	1.00E+00	1.00E+00
Po-211	U-235	2.76E-03	-	0.00E+00	3.76E-08	0.00E+00	0.00E+00	5.00E-03	2.37E+09	4.24E+07	1.64E-08	1.00E+00	1.00E+00
Po-215	U-235	1.00E+00	-	0.00E+00	7.48E-10	0.00E+00	0.00E+00	5.00E-03	2.37E+09	1.23E+10	5.65E-11	1.00E+00	1.00E+00
Ra-223	U-235	1.00E+00	S	2.92E-08	4.55E-07	3.39E-10	5.99E-10	1.70E-03	2.37E+09	2.21E+01	3.13E-02	1.00E+00	1.00E+00
Rn-219	U-235	1.00E+00	-	0.00E+00	2.35E-07	0.00E+00	0.00E+00	0.00E+00	2.37E+09	5.52E+06	1.26E-07	1.00E+00	1.00E+00
Th-227	U-235	9.86E-01	S	3.50E-08	4.45E-07	7.03E-11	1.29E-10	2.30E-04	2.37E+09	1.35E+01	5.12E-02	1.00E+00	1.00E+00
Th-231	U-235	1.00E+00	S	1.50E-12	2.49E-08	3.22E-12	5.96E-12	2.30E-04	2.37E+09	2.38E+02	2.91E-03	1.00E+00	1.00E+00
Tl-207	U-235	9.97E-01	-	0.00E+00	1.59E-08	0.00E+00	0.00E+00	2.00E-02	2.37E+09	7.64E+04	9.08E-06	1.00E+00	1.00E+00
U-235	U-235	1.00E+00	S	2.50E-08	5.51E-07	9.44E-11	1.48E-10	3.90E-04	2.37E+09	9.84E-10	7.04E+08	1.00E+00	1.00E+00
**Secular Equilibrium PRG for U-238*	*U-238*	-		-	-	-	-	-	-	-	-	-	-
At-218	U-238	2.00E-04	-	0.00E+00	2.74E-11	0.00E+00	0.00E+00	1.00E-02	2.37E+09	1.46E+07	4.76E-08	9.00E-01	1.00E+00
Bi-210	U-238	1.00E+00	S	4.55E-10	2.77E-09	1.30E-11	2.40E-11	2.00E-03	2.37E+09	5.05E+01	1.37E-02	1.00E+00	1.00E+00
Bi-214	U-238	1.00E+00	S	6.18E-11	7.34E-06	2.65E-13	4.03E-13	2.00E-03	2.37E+09	1.83E+04	3.79E-05	1.00E+00	1.00E+00
Hg-206	U-238	1.90E-08	-	0.00E+00	4.83E-07	0.00E+00	0.00E+00	1.00E-02	2.37E+09	4.47E+04	1.55E-05	1.00E+00	1.00E+00
Pa-234	U-238	1.60E-03	S	1.20E-12	6.62E-06	3.00E-12	5.37E-12	5.00E-06	2.37E+09	9.06E+02	7.65E-04	1.00E+00	1.00E+00
Pa-234m	U-238	1.00E+00	-	0.00E+00	9.06E-08	0.00E+00	0.00E+00	5.00E-06	2.37E+09	3.11E+05	2.23E-06	1.00E+00	1.00E+00
Pb-210	U-238	1.00E+00	S	1.59E-08	1.48E-09	1.18E-09	1.72E-09	7.00E-04	2.37E+09	3.12E-02	2.22E+01	1.00E+00	1.00E+00
Pb-214	U-238	1.00E+00	S	7.77E-11	9.94E-07	4.85E-13	7.92E-13	7.00E-04	2.37E+09	1.36E+04	5.10E-05	1.00E+00	1.00E+00
Po-210	U-238	1.00E+00	S	1.45E-08	4.51E-11	2.25E-09	3.27E-09	5.00E-03	2.37E+09	1.83E+00	3.79E-01	1.00E+00	1.00E+00

Site-Specific
Farmer Individual Contribution PRGs for Soil - Secular Equilibrium

Isotope	Total Indoor GSF Soil Volume	Dry Soil-to-plant transfer factor (pCi/g-fresh plant per pCi/g-dry soil)	K_d Distribution coefficient (L/kg)	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Produce Consumption PRG TR=0.0001 (pCi/g)	Beef Consumption PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (mg/kg)
**Secular Equilibrium PRG for U-235*	-	-	-	-	-	-	-	*1.86E+02*	***1.86E+02***	-
Ac-227	0.00E+00	1.00E-01	1.70E+03	-	-	-	-	1.93E+04	**1.93E+04**	7.19E-13
At-219	0.00E+00	9.00E-01	1.00E+01	-	-	-	-	-	**-**	-
Bi-211	0.00E+00	5.00E-01	4.80E+02	-	-	-	-	-	**-**	-
Bi-215	0.00E+00	5.00E-01	4.80E+02	-	-	-	-	-	**-**	-
Fr-223	0.00E+00	1.00E-01	2.50E+02	-	-	-	-	2.26E+04	**2.26E+04**	1.16E-18
Pa-231	0.00E+00	1.00E-01	2.00E+03	-	-	-	-	8.37E+04	**8.37E+04**	2.53E-10
Pb-211	0.00E+00	1.26E-02	1.50E+02	-	-	-	-	2.99E+05	**2.99E+05**	1.36E-19
Po-211	0.00E+00	2.76E-04	2.10E+02	-	-	-	-	-	**-**	-
Po-215	0.00E+00	2.76E-04	2.10E+02	-	-	-	-	-	**-**	-
Ra-223	0.00E+00	1.95E-02	1.00E+00	-	-	-	-	2.07E+02	**2.07E+02**	9.47E-14
Rn-219	0.00E+00	0.00E+00	0.00E+00	-	-	-	-	-	**-**	-
Th-227	0.00E+00	2.41E-03	2.00E+01	-	-	-	-	7.89E+03	**7.89E+03**	4.12E-15
Th-231	0.00E+00	2.41E-03	2.00E+01	-	-	-	-	1.70E+05	**1.70E+05**	1.11E-17
Tl-207	0.00E+00	6.00E-01	1.50E+03	-	-	-	-	-	**-**	-
U-235	0.00E+00	7.13E-03	4.00E-01	-	-	-	-	3.36E+03	**3.36E+03**	1.38E-04
**Secular Equilibrium PRG for U-238*	-	-	-	-	-	-	-	*9.57E+00*	***9.57E+00***	-
At-218	0.00E+00	9.00E-01	1.00E+01	-	-	-	-	-	**-**	-
Bi-210	0.00E+00	5.00E-01	4.80E+02	-	-	-	-	1.80E+03	**1.80E+03**	4.50E-15
Bi-214	0.00E+00	5.00E-01	4.80E+02	-	-	-	-	8.82E+04	**8.82E+04**	2.57E-19
Hg-206	0.00E+00	1.00E+00	6.30E+03	-	-	-	-	-	**-**	-
Pa-234	0.00E+00	1.00E-01	2.00E+03	-	-	-	-	3.94E+09	**3.94E+09**	1.27E-22
Pa-234m	0.00E+00	1.00E-01	2.00E+03	-	-	-	-	-	**-**	-
Pb-210	0.00E+00	1.26E-02	1.50E+02	-	-	-	-	1.48E+02	**1.48E+02**	8.85E-11
Pb-214	0.00E+00	1.26E-02	1.50E+02	-	-	-	-	3.58E+05	**3.58E+05**	8.53E-20
Po-210	0.00E+00	2.76E-04	2.10E+02	-	-	-	-	1.12E+01	**1.12E+01**	1.98E-11

Site-Specific
Farmer Individual Contribution PRGs for Soil - Secular Equilibrium

Isotope	Parent	Fractional Contribution of Progeny	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Food Ingestion Slope Factor (risk/pCi)	Soil Ingestion Slope Factor (risk/pCi)	Plant to Beef Transfer Factor (pCi/kg per pCi/d)	Particulate Emission Factor (m^3/kg)	Lambda (1/yr)	Halflife (yr)	1000029 m^2 Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor
Po-214	U-238	1.00E+00	-	0.00E+00	3.85E-10	0.00E+00	0.00E+00	5.00E-03	2.37E+09	1.33E+11	5.21E-12	1.00E+00	1.00E+00
Po-218	U-238	1.00E+00	-	1.39E-11	6.84E-15	0.00E+00	0.00E+00	5.00E-03	2.37E+09	1.17E+05	5.90E-06	9.00E-01	1.00E+00
Ra-226	U-238	1.00E+00	S	2.82E-08	2.50E-08	5.14E-10	6.77E-10	1.70E-03	2.37E+09	4.33E-04	1.60E+03	1.00E+00	1.00E+00
Rn-218	U-238	2.00E-07	-	0.00E+00	3.39E-09	0.00E+00	0.00E+00	0.00E+00	2.37E+09	6.24E+08	1.11E-09	1.00E+00	1.00E+00
Rn-222	U-238	1.00E+00	-	2.28E-12	1.69E-09	0.00E+00	0.00E+00	0.00E+00	2.37E+09	6.62E+01	1.05E-02	1.00E+00	1.00E+00
Th-230	U-238	1.00E+00	F	3.41E-08	8.45E-10	1.19E-10	1.66E-10	2.30E-04	2.37E+09	9.19E-06	7.54E+04	1.00E+00	1.00E+00
Th-234	U-238	1.00E+00	S	3.08E-11	1.77E-08	3.39E-11	6.25E-11	2.30E-04	2.37E+09	1.05E+01	6.60E-02	1.00E+00	1.00E+00
Tl-206	U-238	1.34E-06	-	0.00E+00	6.11E-09	0.00E+00	0.00E+00	2.00E-02	2.37E+09	8.67E+04	7.99E-06	1.00E+00	1.00E+00
Tl-210	U-238	2.10E-04	-	0.00E+00	1.34E-05	0.00E+00	0.00E+00	2.00E-02	2.37E+09	2.80E+05	2.47E-06	1.00E+00	1.00E+00
U-234	U-238	1.00E+00	S	2.78E-08	2.53E-10	9.55E-11	1.48E-10	3.90E-04	2.37E+09	2.82E-06	2.46E+05	1.00E+00	1.00E+00
U-238	U-238	1.00E+00	S	2.36E-08	1.24E-10	8.66E-11	1.34E-10	3.90E-04	2.37E+09	1.55E-10	4.47E+09	1.00E+00	1.00E+00

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Site-Specific
Farmer Individual Contribution PRGs for Soil - Secular Equilibrium

Isotope	Total Indoor GSF Soil Volume	Dry Soil-to-plant transfer factor (pCi/g-fresh plant per pCi/g-dry soil)	K_d Distribution coefficient (L/kg)	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Produce Consumption PRG TR=0.0001 (pCi/g)	Beef Consumption PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (mg/kg)
Po-214	0.00E+00	2.76E-04	2.10E+02	-	-	-	-	-	**-**	-
Po-218	0.00E+00	2.76E-04	2.10E+02	-	-	-	-	-	**-**	-
Ra-226	0.00E+00	1.95E-02	1.00E+00	-	-	-	-	1.36E+02	**1.36E+02**	7.45E-09
Rn-218	0.00E+00	0.00E+00	0.00E+00	-	-	-	-	-	**-**	-
Rn-222	0.00E+00	0.00E+00	0.00E+00	-	-	-	-	-	**-**	-
Th-230	0.00E+00	2.41E-03	2.00E+01	-	-	-	-	4.59E+03	**4.59E+03**	1.06E-08
Th-234	0.00E+00	2.41E-03	2.00E+01	-	-	-	-	1.61E+04	**1.61E+04**	2.68E-15
Tl-206	0.00E+00	6.00E-01	1.50E+03	-	-	-	-	-	**-**	-
Tl-210	0.00E+00	6.00E-01	1.50E+03	-	-	-	-	-	**-**	-
U-234	0.00E+00	7.13E-03	4.00E-01	-	-	-	-	3.32E+03	**3.32E+03**	4.84E-08
U-238	0.00E+00	7.13E-03	4.00E-01	-	-	-	-	3.67E+03	**3.67E+03**	8.12E-04

Site-Specific
Farmer Risk for Soil - Secular Equilibrium

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Produce Consumption Risk	Beef Risk	Total Risk
**Secular Equilibrium Risk for U-235*	*0.00E+00*	*0.00E+00*	*0.00E+00*	-	*2.15E-08*	***2.15E-08***
**Secular Equilibrium Risk for U-238*	*0.00E+00*	*0.00E+00*	*0.00E+00*	-	*1.04E-05*	***1.04E-05***
**Total Risk*	*0.00E+00*	*0.00E+00*	*0.00E+00*	-	*1.05E-05*	***1.05E-05***

Site-Specific
Farmer Individual Risk Contributions for Soil - Secular Equilibrium

Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Food Ingestion Slope Factor (risk/pCi)	Soil Ingestion Slope Factor (risk/pCi)	Plant to Beef Transfer Factor (pCi/kg per pCi/d)	Concentration (pCi/g)	Particulate Emission Factor (m³/kg)	Lambda (1/yr)	Halflife (yr)	1000029 m² Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	Total Indoor GSF Soil Volume
**Secular Equilibrium Risk for U-235*		-	-	-	-	-	-	-	-	-	-	-	-
Ac-227	S	1.49E-07	1.98E-10	2.45E-10	2.90E-10	2.00E-05	0.04	2.37E+09	3.18E-02	2.18E+01	1.00E+00	1.00E+00	0.00E+00
At-219	-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-02	0.04	2.37E+09	3.90E+05	1.78E-06	9.00E-01	1.00E+00	0.00E+00
Bi-211	-	0.00E+00	1.90E-07	0.00E+00	0.00E+00	2.00E-03	0.04	2.37E+09	1.70E+05	4.07E-06	1.00E+00	1.00E+00	0.00E+00
Bi-215	-	0.00E+00	1.08E-06	0.00E+00	0.00E+00	2.00E-03	0.04	2.37E+09	4.79E+04	1.45E-05	1.00E+00	1.00E+00	0.00E+00
Fr-223	S	4.07E-11	1.35E-07	1.01E-11	1.69E-11	3.00E-02	0.04	2.37E+09	1.66E+04	4.19E-05	1.00E+00	1.00E+00	0.00E+00
Pa-231	F	7.62E-08	1.27E-07	2.26E-10	2.98E-10	5.00E-06	0.04	2.37E+09	2.12E-05	3.28E+04	1.00E+00	1.00E+00	0.00E+00
Pb-211	S	4.03E-11	2.91E-07	5.81E-13	9.55E-13	7.00E-04	0.04	2.37E+09	1.01E+04	6.87E-05	1.00E+00	1.00E+00	0.00E+00
Po-211	-	0.00E+00	3.76E-08	0.00E+00	0.00E+00	5.00E-03	0.04	2.37E+09	4.24E+07	1.64E-08	1.00E+00	1.00E+00	0.00E+00
Po-215	-	0.00E+00	7.48E-10	0.00E+00	0.00E+00	5.00E-03	0.04	2.37E+09	1.23E+10	5.65E-11	1.00E+00	1.00E+00	0.00E+00
Ra-223	S	2.92E-08	4.55E-07	3.39E-10	5.99E-10	1.70E-03	0.04	2.37E+09	2.21E+01	3.13E-02	1.00E+00	1.00E+00	0.00E+00
Rn-219	-	0.00E+00	2.35E-07	0.00E+00	0.00E+00	0.00E+00	0.04	2.37E+09	5.52E+06	1.26E-07	1.00E+00	1.00E+00	0.00E+00
Th-227	S	3.50E-08	4.45E-07	7.03E-11	1.29E-10	2.30E-04	0.04	2.37E+09	1.35E+01	5.12E-02	1.00E+00	1.00E+00	0.00E+00
Th-231	S	1.50E-12	2.49E-08	3.22E-12	5.96E-12	2.30E-04	0.04	2.37E+09	2.38E+02	2.91E-03	1.00E+00	1.00E+00	0.00E+00
Tl-207	-	0.00E+00	1.59E-08	0.00E+00	0.00E+00	2.00E-02	0.04	2.37E+09	7.64E+04	9.08E-06	1.00E+00	1.00E+00	0.00E+00
U-235	S	2.50E-08	5.51E-07	9.44E-11	1.48E-10	3.90E-04	0.04	2.37E+09	9.84E-10	7.04E+08	1.00E+00	1.00E+00	0.00E+00
**Secular Equilibrium Risk for U-238*		-	-	-	-	-	-	-	-	-	-	-	-
At-218	-	0.00E+00	2.74E-11	0.00E+00	0.00E+00	1.00E-02	1	2.37E+09	1.46E+07	4.76E-08	9.00E-01	1.00E+00	0.00E+00
Bi-210	S	4.55E-10	2.77E-09	1.30E-11	2.40E-11	2.00E-03	1	2.37E+09	5.05E+01	1.37E-02	1.00E+00	1.00E+00	0.00E+00
Bi-214	S	6.18E-11	7.34E-06	2.65E-13	4.03E-13	2.00E-03	1	2.37E+09	1.83E+04	3.79E-05	1.00E+00	1.00E+00	0.00E+00
Hg-206	-	0.00E+00	4.83E-07	0.00E+00	0.00E+00	1.00E-02	1	2.37E+09	4.47E+04	1.55E-05	1.00E+00	1.00E+00	0.00E+00
Pa-234	S	1.20E-12	6.62E-06	3.00E-12	5.37E-12	5.00E-06	1	2.37E+09	9.06E+02	7.65E-04	1.00E+00	1.00E+00	0.00E+00
Pa-234m	-	0.00E+00	9.06E-08	0.00E+00	0.00E+00	5.00E-06	1	2.37E+09	3.11E+05	2.23E-06	1.00E+00	1.00E+00	0.00E+00
Pb-210	S	1.59E-08	1.48E-09	1.18E-09	1.72E-09	7.00E-04	1	2.37E+09	3.12E-02	2.22E+01	1.00E+00	1.00E+00	0.00E+00

Site-Specific
Farmer Individual Risk Contributions for Soil - Secular Equilibrium

Dry Soil-to-plant transfer factor (pCi/g-fresh plant per pCi/g-dry soil)	K_d Distribution coefficient (L/kg)	Ingestion CDI (pCi)	Inhalation CDI (pCi)	External Exposure CDI (pCi)	Produce Consumption CDI (pCi)	Beef CDI (pCi)	Ingestion Risk	Inhalation Risk	External Exposure Risk	Produce Consumption Risk	Beef Risk	Total Risk
-	-	-	-	-	-	-	*0.00E+00*	*0.00E+00*	*0.00E+00*	-	*2.15E-08*	***2.15E-08***
1.00E-01	1.70E+03	0.00E+00	0.00E+00	0.00E+00	-	8.47E-01	0.00E+00	0.00E+00	0.00E+00	-	2.08E-10	**2.08E-10**
9.00E-01	1.00E+01	0.00E+00	0.00E+00	0.00E+00	-	1.29E+03	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
5.00E-01	4.80E+02	0.00E+00	0.00E+00	0.00E+00	-	1.71E+02	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
5.00E-01	4.80E+02	0.00E+00	0.00E+00	0.00E+00	-	1.71E+02	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
1.00E-01	2.50E+02	0.00E+00	0.00E+00	0.00E+00	-	1.27E+03	0.00E+00	0.00E+00	0.00E+00	-	1.77E-10	**1.77E-10**
1.00E-01	2.00E+03	0.00E+00	0.00E+00	0.00E+00	-	2.12E-01	0.00E+00	0.00E+00	0.00E+00	-	4.78E-11	**4.78E-11**
1.26E-02	1.50E+02	0.00E+00	0.00E+00	0.00E+00	-	2.30E+01	0.00E+00	0.00E+00	0.00E+00	-	1.34E-11	**1.34E-11**
2.76E-04	2.10E+02	0.00E+00	0.00E+00	0.00E+00	-	1.58E+02	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
2.76E-04	2.10E+02	0.00E+00	0.00E+00	0.00E+00	-	1.58E+02	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
1.95E-02	1.00E+00	0.00E+00	0.00E+00	0.00E+00	-	5.72E+01	0.00E+00	0.00E+00	0.00E+00	-	1.94E-08	**1.94E-08**
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
2.41E-03	2.00E+01	0.00E+00	0.00E+00	0.00E+00	-	7.32E+00	0.00E+00	0.00E+00	0.00E+00	-	5.07E-10	**5.07E-10**
2.41E-03	2.00E+01	0.00E+00	0.00E+00	0.00E+00	-	7.32E+00	0.00E+00	0.00E+00	0.00E+00	-	2.35E-11	**2.35E-11**
6.00E-01	1.50E+03	0.00E+00	0.00E+00	0.00E+00	-	1.93E+03	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
7.13E-03	4.00E-01	0.00E+00	0.00E+00	0.00E+00	-	1.26E+01	0.00E+00	0.00E+00	0.00E+00	-	1.19E-09	**1.19E-09**
-	-	-	-	-	-	-	*0.00E+00*	*0.00E+00*	*0.00E+00*	-	*1.04E-05*	***1.04E-05***
9.00E-01	1.00E+01	0.00E+00	0.00E+00	0.00E+00	-	3.22E+04	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
5.00E-01	4.80E+02	0.00E+00	0.00E+00	0.00E+00	-	4.27E+03	0.00E+00	0.00E+00	0.00E+00	-	5.57E-08	**5.57E-08**
5.00E-01	4.80E+02	0.00E+00	0.00E+00	0.00E+00	-	4.27E+03	0.00E+00	0.00E+00	0.00E+00	-	1.13E-09	**1.13E-09**
1.00E+00	6.30E+03	0.00E+00	0.00E+00	0.00E+00	-	3.49E+04	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
1.00E-01	2.00E+03	0.00E+00	0.00E+00	0.00E+00	-	5.29E+00	0.00E+00	0.00E+00	0.00E+00	-	2.54E-14	**2.54E-14**
1.00E-01	2.00E+03	0.00E+00	0.00E+00	0.00E+00	-	5.29E+00	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
1.26E-02	1.50E+02	0.00E+00	0.00E+00	0.00E+00	-	5.76E+02	0.00E+00	0.00E+00	0.00E+00	-	6.78E-07	**6.78E-07**

Site-Specific
Farmer Individual Risk Contributions for Soil - Secular Equilibrium

Isotope	ICRP Lung Absorption Type	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Food Ingestion Slope Factor (risk/pCi)	Soil Ingestion Slope Factor (risk/pCi)	Plant to Beef Transfer Factor (pCi/kg per pCi/d)	Concentration (pCi/g)	Particulate Emission Factor (m³/kg)	Lambda (1/yr)	Halflife (yr)	1000029 m² Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	Total Indoor GSF Soil Volume
Pb-214	S	7.77E-11	9.94E-07	4.85E-13	7.92E-13	7.00E-04	1	2.37E+09	1.36E+04	5.10E-05	1.00E+00	1.00E+00	0.00E+00
Po-210	S	1.45E-08	4.51E-11	2.25E-09	3.27E-09	5.00E-03	1	2.37E+09	1.83E+00	3.79E-01	1.00E+00	1.00E+00	0.00E+00
Po-214	-	0.00E+00	3.85E-10	0.00E+00	0.00E+00	5.00E-03	1	2.37E+09	1.33E+11	5.21E-12	1.00E+00	1.00E+00	0.00E+00
Po-218	-	1.39E-11	6.84E-15	0.00E+00	0.00E+00	5.00E-03	1	2.37E+09	1.17E+05	5.90E-06	9.00E-01	1.00E+00	0.00E+00
Ra-226	S	2.82E-08	2.50E-08	5.14E-10	6.77E-10	1.70E-03	1	2.37E+09	4.33E-04	1.60E+03	1.00E+00	1.00E+00	0.00E+00
Rn-218	-	0.00E+00	3.39E-09	0.00E+00	0.00E+00	0.00E+00	1	2.37E+09	6.24E+08	1.11E-09	1.00E+00	1.00E+00	0.00E+00
Rn-222	-	2.28E-12	1.69E-09	0.00E+00	0.00E+00	0.00E+00	1	2.37E+09	6.62E+01	1.05E-02	1.00E+00	1.00E+00	0.00E+00
Th-230	F	3.41E-08	8.45E-10	1.19E-10	1.66E-10	2.30E-04	1	2.37E+09	9.19E-06	7.54E+04	1.00E+00	1.00E+00	0.00E+00
Th-234	S	3.08E-11	1.77E-08	3.39E-11	6.25E-11	2.30E-04	1	2.37E+09	1.05E+01	6.60E-02	1.00E+00	1.00E+00	0.00E+00
Tl-206	-	0.00E+00	6.11E-09	0.00E+00	0.00E+00	2.00E-02	1	2.37E+09	8.67E+04	7.99E-06	1.00E+00	1.00E+00	0.00E+00
Tl-210	-	0.00E+00	1.34E-05	0.00E+00	0.00E+00	2.00E-02	1	2.37E+09	2.80E+05	2.47E-06	1.00E+00	1.00E+00	0.00E+00
U-234	S	2.78E-08	2.53E-10	9.55E-11	1.48E-10	3.90E-04	1	2.37E+09	2.82E-06	2.46E+05	1.00E+00	1.00E+00	0.00E+00
U-238	S	2.36E-08	1.24E-10	8.66E-11	1.34E-10	3.90E-04	1	2.37E+09	1.55E-10	4.47E+09	1.00E+00	1.00E+00	0.00E+00

Site-Specific
Farmer Individual Risk Contributions for Soil - Secular Equilibrium

Dry Soil-to-plant transfer factor (pCi/g-fresh plant per pCi/g-dry soil)	K_d Distribution coefficient (L/kg)	Ingestion CDI (pCi)	Inhalation CDI (pCi)	External Exposure CDI (pCi)	Produce Consumption CDI (pCi)	Beef CDI (pCi)	Ingestion Risk	Inhalation Risk	External Exposure Risk	Produce Consumption Risk	Beef Risk	Total Risk
1.26E-02	1.50E+02	0.00E+00	0.00E+00	0.00E+00	-	5.76E+02	0.00E+00	0.00E+00	0.00E+00	-	2.79E-10	**2.79E-10**
2.76E-04	2.10E+02	0.00E+00	0.00E+00	0.00E+00	-	3.95E+03	0.00E+00	0.00E+00	0.00E+00	-	8.89E-06	**8.89E-06**
2.76E-04	2.10E+02	0.00E+00	0.00E+00	0.00E+00	-	3.95E+03	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
2.76E-04	2.10E+02	0.00E+00	0.00E+00	0.00E+00	-	3.95E+03	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
1.95E-02	1.00E+00	0.00E+00	0.00E+00	0.00E+00	-	1.43E+03	0.00E+00	0.00E+00	0.00E+00	-	7.36E-07	**7.36E-07**
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
2.41E-03	2.00E+01	0.00E+00	0.00E+00	0.00E+00	-	1.83E+02	0.00E+00	0.00E+00	0.00E+00	-	2.18E-08	**2.18E-08**
2.41E-03	2.00E+01	0.00E+00	0.00E+00	0.00E+00	-	1.83E+02	0.00E+00	0.00E+00	0.00E+00	-	6.21E-09	**6.21E-09**
6.00E-01	1.50E+03	0.00E+00	0.00E+00	0.00E+00	-	4.81E+04	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
6.00E-01	1.50E+03	0.00E+00	0.00E+00	0.00E+00	-	4.81E+04	0.00E+00	0.00E+00	0.00E+00	-	0.00E+00	**0.00E+00**
7.13E-03	4.00E-01	0.00E+00	0.00E+00	0.00E+00	-	3.15E+02	0.00E+00	0.00E+00	0.00E+00	-	3.01E-08	**3.01E-08**
7.13E-03	4.00E-01	0.00E+00	0.00E+00	0.00E+00	-	3.15E+02	0.00E+00	0.00E+00	0.00E+00	-	2.73E-08	**2.73E-08**

DCGL and Ra-226 Risk Contribution Calculations

Derived Concentration Guideline Level (DCGL) and
Percentage Ra-226 Risk Contribution Calculations
Using PRG Calculator Output

	Indoor Worker (Inside Truck) Risk	Composite Worker (Outdoor) Risk	Farmer (Beef Ingestion) Risk	Total Risk
*Secular Equilibrium Risk for U-235 and U-238	3.43E-06	6.49E-06	1.05E-05	**2.04E-05**

PRG Calculator- Derived DCGL (Derived Concentration Guideline Level) =
Target Cancer Risk (1E-04) ÷ Total Risk(2.04E-05) = 4.897 pCi/g

	Indoor Worker (Inside Truck) Risk	Composite Worker (Outdoor) Risk	Farmer (Beef Ingestion) Risk	Total Risk
Risk of Ra-226 through Po-214	3.34E-06	4.96E-06	7.37E-07	**9.03E-06**

% Contribution of Ra-226 through Po-214 Risk to Total Risk = 44%

RESRAD Output

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Part III: Intake Quantities and Health Risk Factors

Cancer Risk Slope Factors Summary Table
Risk Library: DCFPAK3.02 Morbidity

Menu	Parameter	Current Value	Base Case*	Parameter Name
Sf-1	Ground external radiation slope factors, 1/yr per (pCi/g):			
Sf-1	Ac-227+D	1.63E-06	1.98E-10	SLPF(1,1)
Sf-1	Pa-231	1.27E-07	1.27E-07	SLPF(2,1)
Sf-1	Pb-210+D	4.25E-09	1.48E-09	SLPF(3,1)
Sf-1	Pb-210+D1	1.72E-08	1.48E-09	SLPF(4,1)
Sf-1	Po-210	4.51E-11	4.51E-11	SLPF(5,1)
Sf-1	Ra-226+D	8.37E-06	2.50E-08	SLPF(6,1)
Sf-1	Th-230	8.45E-10	8.45E-10	SLPF(8,1)
Sf-1	U-234	2.53E-10	2.53E-10	SLPF(10,1)
Sf-1	U-235+D	5.76E-07	5.51E-07	SLPF(12,1)
Sf-1	U-238	1.24E-10	1.24E-10	SLPF(13,1)
Sf-1	U-238+D	1.19E-07	1.24E-10	SLPF(14,1)
Sf-2	Inhalation, slope factors, 1/(pCi):			
Sf-2	Ac-227+D	2.13E-07	1.49E-07	SLPF(1,2)
Sf-2	Pa-231	7.62E-08	7.62E-08	SLPF(2,2)
Sf-2	Pb-210+D	1.63E-08	1.59E-08	SLPF(3,2)
Sf-2	Pb-210+D1	1.63E-08	1.59E-08	SLPF(4,2)
Sf-2	Po-210	1.45E-08	1.45E-08	SLPF(5,2)
Sf-2	Ra-226+D	2.82E-08	2.81E-08	SLPF(6,2)
Sf-2	Th-230	3.41E-08	3.41E-08	SLPF(8,2)
Sf-2	U-234	2.78E-08	2.78E-08	SLPF(10,2)
Sf-2	U-235+D	2.50E-08	2.50E-08	SLPF(12,2)
Sf-2	U-238	2.36E-08	2.36E-08	SLPF(13,2)
Sf-2	U-238+D	2.37E-08	2.36E-08	SLPF(14,2)
Sf-3	Food ingestion, slope factors, 1/(pCi):			
Sf-3	Ac-227+D	6.54E-10	2.45E-10	SLPF(1,3)
Sf-3	Pa-231	2.26E-10	2.26E-10	SLPF(2,3)
Sf-3	Pb-210+D	1.19E-09	1.18E-09	SLPF(3,3)
Sf-3	Pb-210+D1	1.19E-09	1.18E-09	SLPF(4,3)
Sf-3	Po-210	2.25E-09	2.25E-09	SLPF(5,3)
Sf-3	Ra-226+D	5.15E-10	5.14E-10	SLPF(6,3)
Sf-3	Th-230	1.19E-10	1.19E-10	SLPF(8,3)
Sf-3	U-234	9.55E-11	9.55E-11	SLPF(10,3)
Sf-3	U-235+D	9.76E-11	9.43E-11	SLPF(12,3)
Sf-3	U-238	8.66E-11	8.66E-11	SLPF(13,3)
Sf-3	U-238+D	1.21E-10	8.66E-11	SLPF(14,3)
Sf-3	Water ingestion, slope factors, 1/(pCi):			
Sf-3	Ac-227+D	4.87E-10	2.01E-10	SLPF(1,4)
Sf-3	Pa-231	1.72E-10	1.72E-10	SLPF(2,4)
Sf-3	Pb-210+D	8.93E-10	8.84E-10	SLPF(3,4)
Sf-3	Pb-210+D1	8.93E-10	8.84E-10	SLPF(4,4)
Sf-3	Po-210	1.78E-09	1.78E-09	SLPF(5,4)
Sf-3	Ra-226+D	3.85E-10	3.85E-10	SLPF(6,4)
Sf-3	Th-230	9.14E-11	9.14E-11	SLPF(8,4)
Sf-3	U-234	7.07E-11	7.07E-11	SLPF(10,4)
Sf-3	U-235+D	7.17E-11	6.95E-11	SLPF(12,4)
Sf-3	U-238	6.40E-11	6.40E-11	SLPF(13,4)

Cancer Risk Slope Factors Summary Table (continued)
Risk Library: DCFPAK3.02 Morbidity

Menu	Parameter	Current Value	Base Case*	Parameter Name
Sf-3	U-238+D	8.71E-11	6.40E-11	SLPF(14,4)
Sf-3	Soil ingestion, slope factors, 1/(pCi):			
Sf-3	Ac-227+D	6.54E-10	2.45E-10	SLPF(1,5)
Sf-3	Pa-231	2.26E-10	2.26E-10	SLPF(2,5)
Sf-3	Pb-210+D	1.19E-09	1.18E-09	SLPF(3,5)
Sf-3	Pb-210+D1	1.19E-09	1.18E-09	SLPF(4,5)
Sf-3	Po-210	2.25E-09	2.25E-09	SLPF(5,5)
Sf-3	Ra-226+D	5.15E-10	5.14E-10	SLPF(6,5)
Sf-3	Th-230	1.19E-10	1.19E-10	SLPF(8,5)
Sf-3	U-234	9.55E-11	9.55E-11	SLPF(10,5)
Sf-3	U-235+D	9.76E-11	9.43E-11	SLPF(12,5)
Sf-3	U-238	8.66E-11	8.66E-11	SLPF(13,5)
Sf-3	U-238+D	1.21E-10	8.66E-11	SLPF(14,5)
Sf-Rn	Radon Inhalation slope factors, 1/(pCi):			
Sf-Rn	Rn-222	1.80E-12	1.80E-12	SLPFRN(1,1)
Sf-Rn	Po-218	3.70E-12	3.70E-12	SLPFRN(1,2)
Sf-Rn	Pb-214	6.20E-12	6.20E-12	SLPFRN(1,3)
Sf-Rn	Bi-214	1.50E-11	1.50E-11	SLPFRN(1,4)
Sf-Rn	Radon K factors, (mrem/WLM):			
Sf-Rn	Rn-222 Indoor	3.88E+02	3.88E+02	KFACTR(1,1)
Sf-Rn	Rn-222 Outdoor	3.88E+02	3.88E+02	KFACTR(1,2)

*Base Case means Default.Lib w/o Associate Nuclide contributions.

Risk Slope and Environmental Transport Factors for the Ground Pathway

Nuclide (i)	Slope(i)*	ETFG(i,t) At Time in Years (dimensionless) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ac-227	1.990E-10	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
At-218	2.740E-11	3.872E-02	3.872E-02	3.872E-02	3.872E-02	3.872E-02	3.872E-02	3.872E-02	3.872E-02
At-219	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Bi-210	2.770E-09	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Bi-211	1.900E-07	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Bi-214	7.340E-06	3.872E-02	3.872E-02	3.872E-02	3.872E-02	3.872E-02	3.872E-02	3.872E-02	3.872E-02
Bi-215	1.080E-06	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Fr-223	1.350E-07	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Hg-206	4.830E-07	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Pa-231	1.270E-07	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Pa-234	6.620E-06	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Pa-234m	9.060E-08	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Pb-210	1.480E-09	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Pb-211	2.910E-07	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Pb-214	9.940E-07	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Po-210	4.510E-11	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Po-211	3.760E-08	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Po-214	3.850E-10	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Po-215	7.480E-10	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Po-218	6.840E-15	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Ra-223	4.550E-07	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Ra-226	2.500E-08	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Rn-218	3.390E-09	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Rn-219	2.350E-07	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Rn-222	1.690E-09	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Th-227	4.450E-07	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Th-230	8.450E-10	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Th-231	2.490E-08	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Th-234	1.780E-08	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Tl-206	6.110E-09	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Tl-207	1.590E-08	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
Tl-210	1.340E-05	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
U-234	2.530E-10	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
U-235	5.510E-07	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02	3.876E-02
U-238	1.240E-10	3.874E-02	3.874E-02	3.874E-02	3.874E-02	3.874E-02	3.874E-02	3.874E-02	3.874E-02

* - Units are 1/yr per (pCi/g) at infinite depth and area. Multiplication by ETFG(i,t) converts to site conditions.

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 0.000E+00 years

Radio-	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total
Nuclide	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	Ingestion*
Ac-227	6.976E-03	0.000E+00	9.705E-02	0.000E+00	1.140E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.237E+00
Pa-231	6.976E-03	0.000E+00	2.831E+01	0.000E+00	1.140E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.945E+01
Pb-210	6.976E-03	0.000E+00	4.529E+00	0.000E+00	1.140E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.669E+00
Po-210	6.976E-03	0.000E+00	2.345E+01	0.000E+00	1.140E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.459E+01
Ra-226	6.976E-03	0.000E+00	8.898E+00	0.000E+00	1.140E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.004E+01
Th-230	6.976E-03	0.000E+00	4.691E-01	0.000E+00	1.140E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.609E+00
U-234	6.976E-03	0.000E+00	1.650E+00	0.000E+00	1.140E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.790E+00
U-235	6.976E-03	0.000E+00	1.650E+00	0.000E+00	1.140E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.790E+00
U-238	6.976E-03	0.000E+00	1.650E+00	0.000E+00	1.140E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.790E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 0.000E+00 years

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	1.445E-06	0.1210	3.405E-08	0.0029	0.000E+00	0.0000	2.223E-09	0.0002	0.000E+00	0.0000	1.706E-08	0.0014
Pa-231	1.181E-07	0.0099	1.275E-08	0.0011	0.000E+00	0.0000	1.533E-07	0.0128	0.000E+00	0.0000	6.173E-09	0.0005
Pb-210	4.026E-09	0.0003	2.783E-09	0.0002	0.000E+00	0.0000	1.321E-07	0.0111	0.000E+00	0.0000	3.313E-08	0.0028
Po-210	4.240E-11	0.0000	2.453E-09	0.0002	0.000E+00	0.0000	1.233E-06	0.1032	0.000E+00	0.0000	6.229E-08	0.0052
Ra-226	7.863E-06	0.6583	4.779E-09	0.0004	0.000E+00	0.0000	1.113E-07	0.0093	0.000E+00	0.0000	1.425E-08	0.0012
Th-230	8.188E-10	0.0001	5.941E-09	0.0005	0.000E+00	0.0000	1.397E-09	0.0001	0.000E+00	0.0000	3.394E-09	0.0003
U-234	2.353E-10	0.0000	4.656E-09	0.0004	0.000E+00	0.0000	3.779E-09	0.0003	0.000E+00	0.0000	2.611E-09	0.0002
U-235	5.355E-07	0.0448	4.186E-09	0.0004	0.000E+00	0.0000	3.862E-09	0.0003	0.000E+00	0.0000	2.668E-09	0.0002
U-238	1.108E-07	0.0093	3.961E-09	0.0003	0.000E+00	0.0000	4.771E-09	0.0004	0.000E+00	0.0000	3.296E-09	0.0003
Total	1.008E-05	0.8438	7.557E-08	0.0063	0.000E+00	0.0000	1.646E-06	0.1378	0.000E+00	0.0000	1.449E-07	0.0121

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water Dependent Pathways

Radio-Nuclide	Water risk	Water fract.	Fish risk	Fish fract.	Plant risk	Plant fract.	Meat risk	Meat fract.	Milk risk	Milk fract.	All Pathways** risk	All Pathways** fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.498E-06	0.1255
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.903E-07	0.0243
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.721E-07	0.0144
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.298E-06	0.1086
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.993E-06	0.6692
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.155E-08	0.0010
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.128E-08	0.0009
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.462E-07	0.0457
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.228E-07	0.0103
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.194E-05	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 0.000E+00 years

Radon Pathway	Radionuclides Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent   Water-dep. == Water-dependent

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	9.967E-07	0.0835	2.349E-08	0.0020	0.000E+00	0.0000	0.000E+00	0.0000	1.002E-09	0.0001	0.000E+00	0.0000	1.177E-08	0.0010
Pa-231	5.663E-07	0.0474	2.331E-08	0.0020	0.000E+00	0.0000	0.000E+00	0.0000	1.545E-07	0.0129	0.000E+00	0.0000	1.146E-08	0.0010
Pb-210	2.837E-09	0.0002	3.625E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	9.375E-07	0.0785	0.000E+00	0.0000	6.588E-08	0.0055
Po-210	9.471E-13	0.0000	5.480E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.865E-08	0.0024	0.000E+00	0.0000	1.392E-09	0.0001
Ra-226	7.821E-06	0.6548	6.303E-09	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	5.079E-07	0.0425	0.000E+00	0.0000	4.222E-08	0.0035
Th-230	4.366E-08	0.0037	5.973E-09	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	3.503E-09	0.0003	0.000E+00	0.0000	3.578E-09	0.0003
U-234	2.386E-10	0.0000	4.656E-09	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	3.779E-09	0.0003	0.000E+00	0.0000	2.611E-09	0.0002
U-235	5.356E-07	0.0448	4.191E-09	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	3.902E-09	0.0003	0.000E+00	0.0000	2.671E-09	0.0002
U-238	1.108E-07	0.0093	3.962E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	4.771E-09	0.0004	0.000E+00	0.0000	3.296E-09	0.0003
Total	1.008E-05	0.8438	7.557E-08	0.0063	0.000E+00	0.0000	0.000E+00	0.0000	1.646E-06	0.1378	0.000E+00	0.0000	1.449E-07	0.0121

Total Risk Across All Pathways = 1.19E-05. DCGL = Target Risk of 0.0001 ÷ Total Risk of 1.19E-05 = 8.4 pCi/g

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.033E-06	0.0865
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.556E-07	0.0633
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.010E-06	0.0846
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.010E-08	0.0025
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.377E-06	0.7014
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.671E-08	0.0047
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.128E-08	0.0009
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.464E-07	0.0458
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.228E-07	0.0103
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.194E-05	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+00 years

Radio-	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total
Nuclide	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	Ingestion*
Ac-227	6.919E-03	0.000E+00	1.454E-01	0.000E+00	1.131E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.276E+00
Pa-231	6.953E-03	0.000E+00	2.822E+01	0.000E+00	1.136E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.936E+01
Pb-210	6.964E-03	0.000E+00	4.540E+00	0.000E+00	1.138E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.678E+00
Po-210	6.918E-03	0.000E+00	2.237E+01	0.000E+00	1.130E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.350E+01
Ra-226	6.959E-03	0.000E+00	8.879E+00	0.000E+00	1.137E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.002E+01
Th-230	6.976E-03	0.000E+00	4.691E-01	0.000E+00	1.140E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.609E+00
U-234	6.953E-03	0.000E+00	1.645E+00	0.000E+00	1.136E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.781E+00
U-235	6.953E-03	0.000E+00	1.645E+00	0.000E+00	1.136E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.781E+00
U-238	6.953E-03	0.000E+00	1.645E+00	0.000E+00	1.136E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.781E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 1.000E+00 years

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	1.435E-06	0.1205	3.383E-08	0.0028	0.000E+00	0.0000	2.213E-09	0.0002	0.000E+00	0.0000	1.695E-08	0.0014
Pa-231	1.177E-07	0.0099	1.271E-08	0.0011	0.000E+00	0.0000	1.528E-07	0.0128	0.000E+00	0.0000	6.152E-09	0.0005
Pb-210	4.019E-09	0.0003	2.778E-09	0.0002	0.000E+00	0.0000	1.319E-07	0.0111	0.000E+00	0.0000	3.307E-08	0.0028
Po-210	4.231E-11	0.0000	2.448E-09	0.0002	0.000E+00	0.0000	1.230E-06	0.1033	0.000E+00	0.0000	6.217E-08	0.0052
Ra-226	7.844E-06	0.6587	4.768E-09	0.0004	0.000E+00	0.0000	1.110E-07	0.0093	0.000E+00	0.0000	1.422E-08	0.0012
Th-230	8.188E-10	0.0001	5.941E-09	0.0005	0.000E+00	0.0000	1.397E-09	0.0001	0.000E+00	0.0000	3.394E-09	0.0003
U-234	2.345E-10	0.0000	4.640E-09	0.0004	0.000E+00	0.0000	3.766E-09	0.0003	0.000E+00	0.0000	2.602E-09	0.0002
U-235	5.337E-07	0.0448	4.172E-09	0.0004	0.000E+00	0.0000	3.849E-09	0.0003	0.000E+00	0.0000	2.659E-09	0.0002
U-238	1.104E-07	0.0093	3.948E-09	0.0003	0.000E+00	0.0000	4.755E-09	0.0004	0.000E+00	0.0000	3.285E-09	0.0003
Total	1.005E-05	0.8437	7.524E-08	0.0063	0.000E+00	0.0000	1.642E-06	0.1379	0.000E+00	0.0000	1.445E-07	0.0121

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.488E-06	0.1250
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.894E-07	0.0243
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.718E-07	0.0144
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.295E-06	0.1087
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.974E-06	0.6696
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.155E-08	0.0010
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.124E-08	0.0009
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.444E-07	0.0457
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.224E-07	0.0103
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.191E-05	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 1.000E+00 years

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	9.576E-07	0.0804	2.257E-08	0.0019	0.000E+00	0.0000	0.000E+00	0.0000	9.631E-10	0.0001	0.000E+00	0.0000	1.131E-08	0.0009
Pa-231	5.955E-07	0.0500	2.397E-08	0.0020	0.000E+00	0.0000	0.000E+00	0.0000	1.540E-07	0.0129	0.000E+00	0.0000	1.179E-08	0.0010
Pb-210	2.746E-09	0.0002	3.553E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	9.305E-07	0.0781	0.000E+00	0.0000	6.488E-08	0.0054
Po-210	1.495E-13	0.0000	8.652E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.525E-09	0.0004	0.000E+00	0.0000	2.197E-10	0.0000
Ra-226	7.799E-06	0.6549	6.398E-09	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	5.357E-07	0.0450	0.000E+00	0.0000	4.415E-08	0.0037
Th-230	4.704E-08	0.0040	5.975E-09	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	3.729E-09	0.0003	0.000E+00	0.0000	3.597E-09	0.0003
U-234	2.382E-10	0.0000	4.641E-09	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	3.767E-09	0.0003	0.000E+00	0.0000	2.602E-09	0.0002
U-235	5.339E-07	0.0448	4.178E-09	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	3.893E-09	0.0003	0.000E+00	0.0000	2.662E-09	0.0002
U-238	1.104E-07	0.0093	3.949E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	4.755E-09	0.0004	0.000E+00	0.0000	3.285E-09	0.0003
Total	1.005E-05	0.8437	7.524E-08	0.0063	0.000E+00	0.0000	0.000E+00	0.0000	1.642E-06	0.1379	0.000E+00	0.0000	1.445E-07	0.0121

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.924E-07	0.0833
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.853E-07	0.0659
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.002E-06	0.0841
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.753E-09	0.0004
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.385E-06	0.7042
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.034E-08	0.0051
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.125E-08	0.0009
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.446E-07	0.0457
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.224E-07	0.0103
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.191E-05	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+00 years

Radio-	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total
Nuclide	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	Ingestion*
Ac-227	6.810E-03	0.000E+00	1.435E-01	0.000E+00	1.113E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.256E+00
Pa-231	6.907E-03	0.000E+00	2.804E+01	0.000E+00	1.129E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.916E+01
Pb-210	6.941E-03	0.000E+00	4.524E+00	0.000E+00	1.134E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.658E+00
Po-210	6.886E-03	0.000E+00	2.227E+01	0.000E+00	1.125E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.339E+01
Ra-226	6.926E-03	0.000E+00	8.837E+00	0.000E+00	1.132E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.969E+00
Th-230	6.976E-03	0.000E+00	4.691E-01	0.000E+00	1.140E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.609E+00
U-234	6.907E-03	0.000E+00	1.634E+00	0.000E+00	1.129E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.763E+00
U-235	6.907E-03	0.000E+00	1.634E+00	0.000E+00	1.129E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.763E+00
U-238	6.907E-03	0.000E+00	1.634E+00	0.000E+00	1.129E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.763E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 3.000E+00 years

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	1.417E-06	0.1197	3.339E-08	0.0028	0.000E+00	0.0000	2.189E-09	0.0002	0.000E+00	0.0000	1.673E-08	0.0014
Pa-231	1.169E-07	0.0099	1.263E-08	0.0011	0.000E+00	0.0000	1.518E-07	0.0128	0.000E+00	0.0000	6.112E-09	0.0005
Pb-210	4.003E-09	0.0003	2.768E-09	0.0002	0.000E+00	0.0000	1.314E-07	0.0111	0.000E+00	0.0000	3.294E-08	0.0028
Po-210	4.215E-11	0.0000	2.439E-09	0.0002	0.000E+00	0.0000	1.225E-06	0.1035	0.000E+00	0.0000	6.193E-08	0.0052
Ra-226	7.807E-06	0.6594	4.745E-09	0.0004	0.000E+00	0.0000	1.105E-07	0.0093	0.000E+00	0.0000	1.415E-08	0.0012
Th-230	8.188E-10	0.0001	5.941E-09	0.0005	0.000E+00	0.0000	1.397E-09	0.0001	0.000E+00	0.0000	3.394E-09	0.0003
U-234	2.329E-10	0.0000	4.610E-09	0.0004	0.000E+00	0.0000	3.741E-09	0.0003	0.000E+00	0.0000	2.585E-09	0.0002
U-235	5.302E-07	0.0448	4.144E-09	0.0004	0.000E+00	0.0000	3.824E-09	0.0003	0.000E+00	0.0000	2.642E-09	0.0002
U-238	1.097E-07	0.0093	3.922E-09	0.0003	0.000E+00	0.0000	4.724E-09	0.0004	0.000E+00	0.0000	3.263E-09	0.0003
Total	9.986E-06	0.8435	7.459E-08	0.0063	0.000E+00	0.0000	1.635E-06	0.1381	0.000E+00	0.0000	1.438E-07	0.0121

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.469E-06	0.1241
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.875E-07	0.0243
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.711E-07	0.0145
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.290E-06	0.1089
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.936E-06	0.6704
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.155E-08	0.0010
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.117E-08	0.0009
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.408E-07	0.0457
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.216E-07	0.0103
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.184E-05	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 3.000E+00 years

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent   Water-dep. == Water-dependent

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	8.838E-07	0.0746	2.083E-08	0.0018	0.000E+00	0.0000	0.000E+00	0.0000	8.889E-10	0.0001	0.000E+00	0.0000	1.044E-08	0.0009
Pa-231	6.499E-07	0.0549	2.519E-08	0.0021	0.000E+00	0.0000	0.000E+00	0.0000	1.531E-07	0.0129	0.000E+00	0.0000	1.240E-08	0.0010
Pb-210	2.571E-09	0.0002	3.335E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	8.754E-07	0.0739	0.000E+00	0.0000	6.095E-08	0.0051
Po-210	3.727E-15	0.0000	2.157E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.128E-10	0.0000	0.000E+00	0.0000	5.476E-12	0.0000
Ra-226	7.756E-06	0.6551	6.577E-09	0.0006	0.000E+00	0.0000	0.000E+00	0.0000	5.890E-07	0.0497	0.000E+00	0.0000	4.782E-08	0.0040
Th-230	5.378E-08	0.0045	5.981E-09	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	4.217E-09	0.0004	0.000E+00	0.0000	3.637E-09	0.0003
U-234	2.376E-10	0.0000	4.610E-09	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	3.742E-09	0.0003	0.000E+00	0.0000	2.585E-09	0.0002
U-235	5.304E-07	0.0448	4.151E-09	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	3.873E-09	0.0003	0.000E+00	0.0000	2.645E-09	0.0002
U-238	1.097E-07	0.0093	3.922E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	4.724E-09	0.0004	0.000E+00	0.0000	3.263E-09	0.0003
Total	9.986E-06	0.8435	7.459E-08	0.0063	0.000E+00	0.0000	0.000E+00	0.0000	1.635E-06	0.1381	0.000E+00	0.0000	1.438E-07	0.0121

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.160E-07	0.0774
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.406E-07	0.0710
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.423E-07	0.0796
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.185E-10	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.399E-06	0.7094
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.761E-08	0.0057
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.117E-08	0.0009
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.410E-07	0.0457
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.216E-07	0.0103
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.184E-05	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+01 years

Radio-	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total
Nuclide	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	Ingestion*
Ac-227	6.470E-03	0.000E+00	1.377E-01	0.000E+00	1.057E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.195E+00
Pa-231	6.748E-03	0.000E+00	2.739E+01	0.000E+00	1.103E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.849E+01
Pb-210	6.854E-03	0.000E+00	4.468E+00	0.000E+00	1.120E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.588E+00
Po-210	6.800E-03	0.000E+00	2.199E+01	0.000E+00	1.111E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.310E+01
Ra-226	6.813E-03	0.000E+00	8.692E+00	0.000E+00	1.113E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.805E+00
Th-230	6.976E-03	0.000E+00	4.691E-01	0.000E+00	1.140E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.609E+00
U-234	6.748E-03	0.000E+00	1.596E+00	0.000E+00	1.103E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.699E+00
U-235	6.748E-03	0.000E+00	1.596E+00	0.000E+00	1.103E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.699E+00
U-238	6.748E-03	0.000E+00	1.596E+00	0.000E+00	1.103E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.699E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
  and water-dependent water, fish, plant, meat, milk pathways

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 1.000E+01 years

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent   Water-dep. == Water-dependent

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	1.358E-06	0.1170	3.201E-08	0.0028	0.000E+00	0.0000	2.113E-09	0.0002	0.000E+00	0.0000	1.604E-08	0.0014
Pa-231	1.142E-07	0.0098	1.234E-08	0.0011	0.000E+00	0.0000	1.483E-07	0.0128	0.000E+00	0.0000	5.971E-09	0.0005
Pb-210	3.949E-09	0.0003	2.730E-09	0.0002	0.000E+00	0.0000	1.296E-07	0.0112	0.000E+00	0.0000	3.249E-08	0.0028
Po-210	4.158E-11	0.0000	2.406E-09	0.0002	0.000E+00	0.0000	1.209E-06	0.1041	0.000E+00	0.0000	6.109E-08	0.0053
Ra-226	7.680E-06	0.6616	4.668E-09	0.0004	0.000E+00	0.0000	1.087E-07	0.0094	0.000E+00	0.0000	1.392E-08	0.0012
Th-230	8.187E-10	0.0001	5.941E-09	0.0005	0.000E+00	0.0000	1.397E-09	0.0001	0.000E+00	0.0000	3.394E-09	0.0003
U-234	2.276E-10	0.0000	4.504E-09	0.0004	0.000E+00	0.0000	3.656E-09	0.0003	0.000E+00	0.0000	2.525E-09	0.0002
U-235	5.180E-07	0.0446	4.049E-09	0.0003	0.000E+00	0.0000	3.736E-09	0.0003	0.000E+00	0.0000	2.581E-09	0.0002
U-238	1.071E-07	0.0092	3.832E-09	0.0003	0.000E+00	0.0000	4.615E-09	0.0004	0.000E+00	0.0000	3.188E-09	0.0003
Total	9.782E-06	0.8428	7.247E-08	0.0062	0.000E+00	0.0000	1.611E-06	0.1388	0.000E+00	0.0000	1.412E-07	0.0122

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.408E-06	0.1213
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.809E-07	0.0242
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.688E-07	0.0145
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.272E-06	0.1096
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.807E-06	0.6726
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.155E-08	0.0010
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.091E-08	0.0009
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.284E-07	0.0455
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.188E-07	0.0102
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.161E-05	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 1.000E+01 years

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	6.676E-07	0.0575	1.573E-08	0.0014	0.000E+00	0.0000	0.000E+00	0.0000	6.714E-10	0.0001	0.000E+00	0.0000	7.883E-09	0.0007
Pa-231	8.046E-07	0.0693	2.860E-08	0.0025	0.000E+00	0.0000	0.000E+00	0.0000	1.497E-07	0.0129	0.000E+00	0.0000	1.412E-08	0.0012
Pb-210	2.042E-09	0.0002	2.649E-09	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	6.955E-07	0.0599	0.000E+00	0.0000	4.842E-08	0.0042
Po-210	9.114E-21	0.0000	5.274E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.758E-16	0.0000	0.000E+00	0.0000	1.339E-17	0.0000
Ra-226	7.605E-06	0.6552	7.093E-09	0.0006	0.000E+00	0.0000	0.000E+00	0.0000	7.467E-07	0.0643	0.000E+00	0.0000	5.867E-08	0.0051
Th-230	7.706E-08	0.0066	6.001E-09	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	6.252E-09	0.0005	0.000E+00	0.0000	3.799E-09	0.0003
U-234	2.363E-10	0.0000	4.505E-09	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	3.656E-09	0.0003	0.000E+00	0.0000	2.526E-09	0.0002
U-235	5.183E-07	0.0447	4.060E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	3.807E-09	0.0003	0.000E+00	0.0000	2.586E-09	0.0002
U-238	1.071E-07	0.0092	3.832E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	4.615E-09	0.0004	0.000E+00	0.0000	3.188E-09	0.0003
Total	9.782E-06	0.8428	7.247E-08	0.0062	0.000E+00	0.0000	0.000E+00	0.0000	1.611E-06	0.1388	0.000E+00	0.0000	1.412E-07	0.0122

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.919E-07	0.0596
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.970E-07	0.0859
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.486E-07	0.0645
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.897E-16	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.418E-06	0.7252
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.312E-08	0.0080
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.092E-08	0.0009
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.287E-07	0.0456
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.188E-07	0.0102
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.161E-05	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+01 years

Radio-	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total
Nuclide	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	Ingestion*
Ac-227	5.749E-03	0.000E+00	1.246E-01	0.000E+00	9.396E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.064E+00
Pa-231	6.315E-03	0.000E+00	2.563E+01	0.000E+00	1.032E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.666E+01
Pb-210	6.588E-03	0.000E+00	4.294E+00	0.000E+00	1.077E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.371E+00
Po-210	6.537E-03	0.000E+00	2.114E+01	0.000E+00	1.068E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.221E+01
Ra-226	6.499E-03	0.000E+00	8.292E+00	0.000E+00	1.062E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.354E+00
Th-230	6.975E-03	0.000E+00	4.690E-01	0.000E+00	1.140E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.609E+00
U-234	6.315E-03	0.000E+00	1.494E+00	0.000E+00	1.032E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.526E+00
U-235	6.315E-03	0.000E+00	1.494E+00	0.000E+00	1.032E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.526E+00
U-238	6.315E-03	0.000E+00	1.494E+00	0.000E+00	1.032E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.526E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
  and water-dependent water, fish, plant, meat, milk pathways

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 3.000E+01 years

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent   Water-dep. == Water-dependent

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	1.227E-06	0.1116	2.892E-08	0.0026	0.000E+00	0.0000	1.933E-09	0.0002	0.000E+00	0.0000	1.449E-08	0.0013
Pa-231	1.069E-07	0.0097	1.155E-08	0.0011	0.000E+00	0.0000	1.388E-07	0.0126	0.000E+00	0.0000	5.588E-09	0.0005
Pb-210	3.787E-09	0.0003	2.618E-09	0.0002	0.000E+00	0.0000	1.243E-07	0.0113	0.000E+00	0.0000	3.116E-08	0.0028
Po-210	3.988E-11	0.0000	2.308E-09	0.0002	0.000E+00	0.0000	1.159E-06	0.1054	0.000E+00	0.0000	5.859E-08	0.0053
Ra-226	7.329E-06	0.6665	4.454E-09	0.0004	0.000E+00	0.0000	1.037E-07	0.0094	0.000E+00	0.0000	1.328E-08	0.0012
Th-230	8.187E-10	0.0001	5.941E-09	0.0005	0.000E+00	0.0000	1.396E-09	0.0001	0.000E+00	0.0000	3.394E-09	0.0003
U-234	2.130E-10	0.0000	4.215E-09	0.0004	0.000E+00	0.0000	3.421E-09	0.0003	0.000E+00	0.0000	2.363E-09	0.0002
U-235	4.848E-07	0.0441	3.789E-09	0.0003	0.000E+00	0.0000	3.496E-09	0.0003	0.000E+00	0.0000	2.415E-09	0.0002
U-238	1.003E-07	0.0091	3.586E-09	0.0003	0.000E+00	0.0000	4.319E-09	0.0004	0.000E+00	0.0000	2.983E-09	0.0003
Total	9.253E-06	0.8415	6.738E-08	0.0061	0.000E+00	0.0000	1.541E-06	0.1401	0.000E+00	0.0000	1.343E-07	0.0122

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

Water Dependent Pathways

Radio-Nuclide	Water risk	Water fract.	Fish risk	Fish fract.	Plant risk	Plant fract.	Meat risk	Meat fract.	Milk risk	Milk fract.	All Pathways** risk	All Pathways** fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.273E-06	0.1158
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.628E-07	0.0239
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.619E-07	0.0147
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.220E-06	0.1110
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.450E-06	0.6776
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.155E-08	0.0011
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.021E-08	0.0009
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.945E-07	0.0450
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.112E-07	0.0101
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.100E-05	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 3.000E+01 years

Radon Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
	Radionuclides							
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	2.995E-07	0.0272	7.057E-09	0.0006	0.000E+00	0.0000	0.000E+00	0.0000	3.012E-10	0.0000	0.000E+00	0.0000	3.536E-09	0.0003
Pa-231	1.034E-06	0.0941	3.339E-08	0.0030	0.000E+00	0.0000	0.000E+00	0.0000	1.403E-07	0.0128	0.000E+00	0.0000	1.653E-08	0.0015
Pb-210	1.058E-09	0.0001	1.372E-09	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	3.603E-07	0.0328	0.000E+00	0.0000	2.509E-08	0.0023
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	7.191E-06	0.6540	7.881E-09	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	1.014E-06	0.0923	0.000E+00	0.0000	7.695E-08	0.0070
Th-230	1.411E-07	0.0128	6.065E-09	0.0006	0.000E+00	0.0000	0.000E+00	0.0000	1.404E-08	0.0013	0.000E+00	0.0000	4.397E-09	0.0004
U-234	2.406E-10	0.0000	4.216E-09	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	3.423E-09	0.0003	0.000E+00	0.0000	2.364E-09	0.0002
U-235	4.854E-07	0.0441	3.812E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	3.621E-09	0.0003	0.000E+00	0.0000	2.426E-09	0.0002
U-238	1.003E-07	0.0091	3.587E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	4.319E-09	0.0004	0.000E+00	0.0000	2.984E-09	0.0003
Total	9.253E-06	0.8415	6.738E-08	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	1.541E-06	0.1401	0.000E+00	0.0000	1.343E-07	0.0122

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.104E-07	0.0282
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.224E-06	0.1114
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.878E-07	0.0353
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.290E-06	0.7540
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.656E-07	0.0151
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.024E-08	0.0009
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.953E-07	0.0450
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.112E-07	0.0101
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.100E-05	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+02 years

Radio-	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total
Nuclide	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	Ingestion*
Ac-227	4.352E-03	0.000E+00	9.589E-02	0.000E+00	7.112E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.071E-01
Pa-231	5.006E-03	0.000E+00	2.032E+01	0.000E+00	8.180E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.114E+01
Pb-210	5.641E-03	0.000E+00	3.677E+00	0.000E+00	9.218E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.599E+00
Po-210	5.598E-03	0.000E+00	1.810E+01	0.000E+00	9.148E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.902E+01
Ra-226	5.532E-03	0.000E+00	7.058E+00	0.000E+00	9.041E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.962E+00
Th-230	6.973E-03	0.000E+00	4.689E-01	0.000E+00	1.140E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.608E+00
U-234	5.006E-03	0.000E+00	1.184E+00	0.000E+00	8.180E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.002E+00
U-235	5.006E-03	0.000E+00	1.184E+00	0.000E+00	8.180E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.002E+00
U-238	5.006E-03	0.000E+00	1.184E+00	0.000E+00	8.180E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.002E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 1.000E+02 years

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	9.435E-07	0.1024	2.223E-08	0.0024	0.000E+00	0.0000	1.503E-09	0.0002	0.000E+00	0.0000	1.114E-08	0.0012
Pa-231	8.474E-08	0.0092	9.152E-09	0.0010	0.000E+00	0.0000	1.100E-07	0.0119	0.000E+00	0.0000	4.429E-09	0.0005
Pb-210	3.238E-09	0.0004	2.238E-09	0.0002	0.000E+00	0.0000	1.063E-07	0.0115	0.000E+00	0.0000	2.664E-08	0.0029
Po-210	3.409E-11	0.0000	1.973E-09	0.0002	0.000E+00	0.0000	9.912E-07	0.1076	0.000E+00	0.0000	5.010E-08	0.0054
Ra-226	6.244E-06	0.6775	3.795E-09	0.0004	0.000E+00	0.0000	8.835E-08	0.0096	0.000E+00	0.0000	1.132E-08	0.0012
Th-230	8.184E-10	0.0001	5.939E-09	0.0006	0.000E+00	0.0000	1.396E-09	0.0002	0.000E+00	0.0000	3.393E-09	0.0004
U-234	1.688E-10	0.0000	3.341E-09	0.0004	0.000E+00	0.0000	2.712E-09	0.0003	0.000E+00	0.0000	1.873E-09	0.0002
U-235	3.843E-07	0.0417	3.004E-09	0.0003	0.000E+00	0.0000	2.771E-09	0.0003	0.000E+00	0.0000	1.914E-09	0.0002
U-238	7.948E-08	0.0086	2.843E-09	0.0003	0.000E+00	0.0000	3.423E-09	0.0004	0.000E+00	0.0000	2.365E-09	0.0003
Total	7.740E-06	0.8399	5.452E-08	0.0059	0.000E+00	0.0000	1.308E-06	0.1419	0.000E+00	0.0000	1.132E-07	0.0123

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.784E-07	0.1062
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.083E-07	0.0226
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.384E-07	0.0150
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.043E-06	0.1132
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.348E-06	0.6888
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.155E-08	0.0013
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.094E-09	0.0009
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.920E-07	0.0425
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.811E-08	0.0096
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.216E-06	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 1.000E+02 years

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	1.811E-08	0.0020	4.267E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.821E-11	0.0000	0.000E+00	0.0000	2.138E-10	0.0000
Pa-231	1.008E-06	0.1094	3.090E-08	0.0034	0.000E+00	0.0000	0.000E+00	0.0000	1.112E-07	0.0121	0.000E+00	0.0000	1.533E-08	0.0017
Pb-210	1.059E-10	0.0000	1.373E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.605E-08	0.0039	0.000E+00	0.0000	2.510E-09	0.0003
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	5.909E-06	0.6412	7.503E-09	0.0008	0.000E+00	0.0000	0.000E+00	0.0000	1.103E-06	0.1197	0.000E+00	0.0000	8.201E-08	0.0089
Th-230	3.389E-07	0.0368	6.299E-09	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	4.781E-08	0.0052	0.000E+00	0.0000	6.919E-09	0.0008
U-234	3.326E-10	0.0000	3.345E-09	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	2.731E-09	0.0003	0.000E+00	0.0000	1.877E-09	0.0002
U-235	3.862E-07	0.0419	3.065E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	3.035E-09	0.0003	0.000E+00	0.0000	1.945E-09	0.0002
U-238	7.948E-08	0.0086	2.844E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	3.424E-09	0.0004	0.000E+00	0.0000	2.365E-09	0.0003
Total	7.740E-06	0.8399	5.452E-08	0.0059	0.000E+00	0.0000	0.000E+00	0.0000	1.308E-06	0.1419	0.000E+00	0.0000	1.132E-07	0.0123

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.877E-08	0.0020
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.166E-06	0.1265
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.880E-08	0.0042
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.102E-06	0.7706
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.999E-07	0.0434
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.285E-09	0.0009
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.942E-07	0.0428
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.811E-08	0.0096
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.216E-06	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+02 years

Radio-	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total
Nuclide	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	Ingestion*
Ac-227	2.232E-03	0.000E+00	4.925E-02	0.000E+00	3.647E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.140E-01
Pa-231	2.577E-03	0.000E+00	1.046E+01	0.000E+00	4.212E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.088E+01
Pb-210	3.660E-03	0.000E+00	2.386E+00	0.000E+00	5.981E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.984E+00
Po-210	3.632E-03	0.000E+00	1.174E+01	0.000E+00	5.935E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.234E+01
Ra-226	3.618E-03	0.000E+00	4.615E+00	0.000E+00	5.912E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.206E+00
Th-230	6.963E-03	0.000E+00	4.682E-01	0.000E+00	1.138E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.606E+00
U-234	2.577E-03	0.000E+00	6.097E-01	0.000E+00	4.212E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.031E+00
U-235	2.577E-03	0.000E+00	6.097E-01	0.000E+00	4.212E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.031E+00
U-238	2.577E-03	0.000E+00	6.097E-01	0.000E+00	4.212E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.031E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
  and water-dependent water, fish, plant, meat, milk pathways

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 3.000E+02 years

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent   Water-dep. == Water-dependent

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	4.845E-07	0.0834	1.142E-08	0.0020	0.000E+00	0.0000	7.725E-10	0.0001	0.000E+00	0.0000	5.721E-09	0.0010
Pa-231	4.363E-08	0.0075	4.712E-09	0.0008	0.000E+00	0.0000	5.664E-08	0.0098	0.000E+00	0.0000	2.281E-09	0.0004
Pb-210	2.107E-09	0.0004	1.457E-09	0.0003	0.000E+00	0.0000	6.916E-08	0.0119	0.000E+00	0.0000	1.734E-08	0.0030
Po-210	2.219E-11	0.0000	1.284E-09	0.0002	0.000E+00	0.0000	6.451E-07	0.1111	0.000E+00	0.0000	3.260E-08	0.0056
Ra-226	4.098E-06	0.7056	2.491E-09	0.0004	0.000E+00	0.0000	5.798E-08	0.0100	0.000E+00	0.0000	7.427E-09	0.0013
Th-230	8.172E-10	0.0001	5.930E-09	0.0010	0.000E+00	0.0000	1.394E-09	0.0002	0.000E+00	0.0000	3.388E-09	0.0006
U-234	8.692E-11	0.0000	1.720E-09	0.0003	0.000E+00	0.0000	1.396E-09	0.0002	0.000E+00	0.0000	9.645E-10	0.0002
U-235	1.978E-07	0.0341	1.546E-09	0.0003	0.000E+00	0.0000	1.427E-09	0.0002	0.000E+00	0.0000	9.857E-10	0.0002
U-238	4.092E-08	0.0070	1.464E-09	0.0003	0.000E+00	0.0000	1.763E-09	0.0003	0.000E+00	0.0000	1.218E-09	0.0002
Total	4.868E-06	0.8382	3.202E-08	0.0055	0.000E+00	0.0000	8.356E-07	0.1439	0.000E+00	0.0000	7.192E-08	0.0124

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.025E-07	0.0865
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.073E-07	0.0185
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.007E-08	0.0155
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.790E-07	0.1169
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.166E-06	0.7173
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.153E-08	0.0020
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.168E-09	0.0007
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.018E-07	0.0347
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.537E-08	0.0078
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.807E-06	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 3.000E+02 years

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent   Water-dep. == Water-dependent

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	5.976E-12	0.0000	1.408E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.010E-15	0.0000	0.000E+00	0.0000	7.056E-14	0.0000
Pa-231	5.250E-07	0.0904	1.603E-08	0.0028	0.000E+00	0.0000	0.000E+00	0.0000	5.704E-08	0.0098	0.000E+00	0.0000	7.952E-09	0.0014
Pb-210	1.473E-13	0.0000	1.911E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.017E-11	0.0000	0.000E+00	0.0000	3.493E-12	0.0000
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	3.371E-06	0.5804	4.361E-09	0.0008	0.000E+00	0.0000	0.000E+00	0.0000	6.507E-07	0.1120	0.000E+00	0.0000	4.826E-08	0.0083
Th-230	7.294E-07	0.1256	6.789E-09	0.0012	0.000E+00	0.0000	0.000E+00	0.0000	1.227E-07	0.0211	0.000E+00	0.0000	1.247E-08	0.0021
U-234	9.420E-10	0.0002	1.730E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	1.530E-09	0.0003	0.000E+00	0.0000	9.796E-10	0.0002
U-235	2.011E-07	0.0346	1.646E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	1.805E-09	0.0003	0.000E+00	0.0000	1.035E-09	0.0002
U-238	4.092E-08	0.0070	1.465E-09	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	1.764E-09	0.0003	0.000E+00	0.0000	1.218E-09	0.0002
Total	4.868E-06	0.8382	3.202E-08	0.0055	0.000E+00	0.0000	0.000E+00	0.0000	8.356E-07	0.1439	0.000E+00	0.0000	7.192E-08	0.0124

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.193E-12	0.0000
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.060E-07	0.1043
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.400E-11	0.0000
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.074E-06	0.7015
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.714E-07	0.1500
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.182E-09	0.0009
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.055E-07	0.0354
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.537E-08	0.0078
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.807E-06	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+03 years

Radio-	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total
Nuclide	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	Ingestion*
Ac-227	2.186E-04	0.000E+00	4.824E-03	0.000E+00	3.572E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.055E-02
Pa-231	2.524E-04	0.000E+00	1.025E+00	0.000E+00	4.125E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.066E+00
Pb-210	1.386E-03	0.000E+00	9.039E-01	0.000E+00	2.266E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.130E+00
Po-210	1.375E-03	0.000E+00	4.445E+00	0.000E+00	2.247E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.670E+00
Ra-226	1.427E-03	0.000E+00	1.820E+00	0.000E+00	2.332E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.053E+00
Th-230	6.911E-03	0.000E+00	4.647E-01	0.000E+00	1.129E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.594E+00
U-234	2.524E-04	0.000E+00	5.971E-02	0.000E+00	4.125E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.010E-01
U-235	2.524E-04	0.000E+00	5.971E-02	0.000E+00	4.125E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.010E-01
U-238	2.524E-04	0.000E+00	5.971E-02	0.000E+00	4.125E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.010E-01

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 1.000E+03 years

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent   Water-dep. == Water-dependent

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	4.746E-08	0.0230	1.118E-09	0.0005	0.000E+00	0.0000	7.566E-11	0.0000	0.000E+00	0.0000	5.604E-10	0.0003
Pa-231	4.273E-09	0.0021	4.615E-10	0.0002	0.000E+00	0.0000	5.548E-09	0.0027	0.000E+00	0.0000	2.234E-10	0.0001
Pb-210	8.110E-10	0.0004	5.606E-10	0.0003	0.000E+00	0.0000	2.662E-08	0.0129	0.000E+00	0.0000	6.673E-09	0.0032
Po-210	8.533E-12	0.0000	4.938E-10	0.0002	0.000E+00	0.0000	2.481E-07	0.1204	0.000E+00	0.0000	1.254E-08	0.0061
Ra-226	1.642E-06	0.7968	9.979E-10	0.0005	0.000E+00	0.0000	2.323E-08	0.0113	0.000E+00	0.0000	2.976E-09	0.0014
Th-230	8.111E-10	0.0004	5.886E-09	0.0029	0.000E+00	0.0000	1.384E-09	0.0007	0.000E+00	0.0000	3.362E-09	0.0016
U-234	8.513E-12	0.0000	1.685E-10	0.0001	0.000E+00	0.0000	1.367E-10	0.0001	0.000E+00	0.0000	9.446E-11	0.0000
U-235	1.938E-08	0.0094	1.515E-10	0.0001	0.000E+00	0.0000	1.398E-10	0.0001	0.000E+00	0.0000	9.654E-11	0.0000
U-238	4.008E-09	0.0019	1.433E-10	0.0001	0.000E+00	0.0000	1.726E-10	0.0001	0.000E+00	0.0000	1.193E-10	0.0001
Total	1.719E-06	0.8340	9.981E-09	0.0048	0.000E+00	0.0000	3.054E-07	0.1482	0.000E+00	0.0000	2.664E-08	0.0129

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

Water Dependent Pathways

Radio-Nuclide	Water risk	Water fract.	Fish risk	Fish fract.	Plant risk	Plant fract.	Meat risk	Meat fract.	Milk risk	Milk fract.	All Pathways** risk	All Pathways** fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.921E-08	0.0239
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.051E-08	0.0051
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.467E-08	0.0168
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.611E-07	0.1267
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.669E-06	0.8100
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.144E-08	0.0056
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.082E-10	0.0002
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.977E-08	0.0096
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.443E-09	0.0022
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.061E-06	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 1.000E+03 years

Radon Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	3.902E-24	0.0000	9.195E-26	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.924E-27	0.0000	0.000E+00	0.0000	4.607E-26	0.0000
Pa-231	5.066E-08	0.0246	1.547E-09	0.0008	0.000E+00	0.0000	0.000E+00	0.0000	5.504E-09	0.0027	0.000E+00	0.0000	7.674E-10	0.0004
Pb-210	1.482E-23	0.0000	1.922E-23	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.046E-21	0.0000	0.000E+00	0.0000	3.513E-22	0.0000
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	4.725E-07	0.2293	6.114E-10	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	9.122E-08	0.0443	0.000E+00	0.0000	6.766E-09	0.0033
Th-230	1.168E-06	0.5669	7.308E-09	0.0035	0.000E+00	0.0000	0.000E+00	0.0000	2.076E-07	0.1007	0.000E+00	0.0000	1.874E-08	0.0091
U-234	2.805E-09	0.0014	1.871E-10	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	6.284E-10	0.0003	0.000E+00	0.0000	1.396E-10	0.0001
U-235	2.045E-08	0.0099	1.843E-10	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	2.589E-10	0.0001	0.000E+00	0.0000	1.128E-10	0.0001
U-238	4.010E-09	0.0019	1.438E-10	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	1.733E-10	0.0001	0.000E+00	0.0000	1.196E-10	0.0001
Total	1.719E-06	0.8340	9.981E-09	0.0048	0.000E+00	0.0000	0.000E+00	0.0000	3.054E-07	0.1482	0.000E+00	0.0000	2.664E-08	0.0129

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.044E-24	0.0000
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.848E-08	0.0284
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.431E-21	0.0000
Po-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.711E-07	0.2772
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.402E-06	0.6803
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.760E-09	0.0018
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.100E-08	0.0102
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.446E-09	0.0022
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.061E-06	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

APPENDIX K

COST ESTIMATE DETAILS

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Table K-1

SUMMARY OF ALTERNATIVE COSTS
Tronox Navajo Area Uranium Sites Section 10 Mine; McKinley County, New Mexico

Source: WESTON, 2019

ALTERNATIVE	DESCRIPTION	CAPITAL COST (2020)	ANNUAL O&M COST		PRESENT WORTH (2020)	PLANNING DURATION	CONSTRUCTION DURATION	TOTAL DURATION
			First 12 Years	All 99 Years				
1	No Further Action	$ -	$ -	$ 16,914	$ 1,617,000	-	-	-
2	Excavation and Off-Site Disposal of Contaminated Soil at a Licensed Low-Level Radioactive Facility	$ 15,581,171	$ 33,178	$ 16,914	$ 16,087,000	3 Months	1.9 Months	0.4 Years
3	Excavation and Disposal of Contaminated Soil at an On-Site Repository	$ 5,539,247	$ 61,098	$ 30,830	$ 6,465,000	3 Months	2.1 Months	0.4 Years
4	Capping of Contaminated Soil in Place	$ 6,990,547	$ 61,098	$ 30,830	$ 7,916,000	3 Months	2 Months	0.4 Years

Key Assumptions:
1) Planning duration (3 months) was provided by EPA based on an expectation that much of the planning work will be performed concurrently with initial construction efforts (such as clearing and grubbing).
2) Durations assume construction will continue year-round.

Table K-2

ALTERNATIVE 2 - PRELIMINARY CONSTRUCTION COST ESTIMATE
Excavation and Off-Site Disposal of Contaminated Soil at a Licensed Low-Level Radioactive Facility
Tronox Navajo Area Uranium Sites Section 10 Mine; McKinley County, New Mexico

Effort Legend
START CONTRACTOR / EPA
CONSTRUCTION CONTRACTOR

Item	Description	Quantity	Unit	Unit Cost	Extension	Item Total	Duration
CAPITAL COSTS:							
1	Engineering Costs (Design Costs)						
	Project Manager	100	HR	$175	$17,500		
	Project Engineer	200	HR	$160	$32,000		
	Design Engineer	300	HR	$100	$30,000		
	CAD/GIS Operator	400	HR	$85	$34,000		
	Admin	100	HR	$78	$7,840		
	Expenses	1	LS	$5,000	$5,000		***3.0***
	Subtotal Engineering Costs					***$126,340***	***Months***
2	Planning Documents (Work Plan, Health & Safety Plan, QA Plan, and SWPPP)						
	Project Manager	50	HR	$175	$8,750		
	Project Engineer	300	HR	$160	$48,000		
	CAD/GIS Operator	100	HR	$85	$8,500		
	Admin	50	HR	$78	$3,920		
	Expenses	1	LS	$1,000	$1,000		Concurrent with
	Subtotal Planning Documents					***$70,170***	Item 1
3	Resource Surveys						
	Geotechnical Testing and Report	2	EA	$25,000	$50,000		
	Pre-Project Aerial LIDAR Survey	20	AC	$180	$3,600		
	Post-Project Aerial LIDAR Survey	20	AC	$180	$3,600		Concurrent with
	Subtotal Resource Surveys					***$57,200***	Other Work
4	Mobilization/Demobilization	1	LS	$234,484	$234,484		***0.5***
	Subtotal Mob/Demob					***$234,484***	***Months***
5	Improve/Blaze Access Roads						
	Gravel Road Surfacing (8" Depth)	5,867	SY	$9.18	$53,867		
	Dozer, D-9 (2)	1	DAY	$5,449.25	$5,449		
	Grader (1)	1	DAY	$2,416.76	$2,417		
	Backhoe Loader (2)	1	DAY	$1,849.04	$1,849		
	6000 Gal Water Truck (4)	2	DAY	$2,869.89	$5,740		
	Laborer (5)	21	HR	$82.54	$1,733		***0.1***
	Subtotal Improve Access Road					***$71,056***	***Months***
6	Construction Water						
	Construction Water, including Hauling	1,266,000	GAL	$0.05	$63,300		
	Portable Water Tower Trailer, 10,000 gallons (2)	98	DAY	$1,775	$173,950		Concurrent with
	Subtotal Construction Water					***$237,250***	Other Work
7	Clearing and Grubbing						
	Dozer, D-9 (3)	7	DAY	$5,449.25	$38,145		
	Crawler Loader (1)	3	DAY	$3,424.74	$10,274		
	Brush Chipper, 12"	3	DAY	$1,645.91	$4,938		
	6000 Gal Water Truck (3)	7	DAY	$2,869.89	$20,089		
	Laborer (10)	223	HR	$82.54	$18,406		***0.1***
	Subtotal Clearing and Grubbing					***$91,852***	***Months***
8	Fence Construction / Repair						
	Fence Materials	2,640	LF	$24.26	$64,037		
	Flatbed Truck (1)	9	DAY	$1,649.32	$14,844		
	Manual Fence Post Auger (1)	9	DAY	$1,539.96	$13,860		
	Laborer (3)	264	HR	$82.54	$21,790		Concurrent with
	Subtotal Fence Construction/Repair					***$114,530***	Other Work
9	Erosion and Sediment Control						
	Silt Fence	16,000	LF	$0.31	$4,963		
	Hay Bales	4,000	LF	$4.32	$17,271		
	Loader, Skid Steer, 30 H.P. (1)	10	DAY	$1,743.83	$17,438		
	Flatbed Truck (1)	10	DAY	$1,649.32	$16,493		
	Laborer (2)	197	HR	$82.54	$16,260		Concurrent with
	Subtotal Erosion and Sediment Control					***$72,425***	Other Work
10	Headworks Removal						
	Flatbed Truck (1)	2	DAY	$1,649.32	$3,299		
	Structural Steel Foreman (1)	20	HR	$93.50	$1,870		
	Structural Steel Worker (1)	20	HR	$90.10	$1,802		
	Truck Driver (1)	20	HR	$94.08	$1,882		
	Laborer (2)	40	HR	$82.54	$3,302		Concurrent with
	Subtotal Headworks Removal					***$12,154***	Other Work
11	Fill Adit and Vent Shaft and Plug with Polyurethane Foam (PUF)						
	Dump Truck, 34 CY, Off-Road (1)	4	DAY	$3,531.98	$14,128		
	Backhoe Loader (1)	4	DAY	$3,211.04	$12,844		
	Pump, Concrete, Truck Mounted, 4" Line, 80' Boom (1)	1	DAY	$3,935.63	$3,936		
	Polyurethane Foam	32	CY	$350.00	$11,097		
	Laborer (2)	65	HR	$82.54	$5,365		***0.2***
	Subtotal Fill Adit and Vent Shaft and Plug with Polyurethane Foam (PUF)					***$47,370***	***Months***

Table K-2 (Continued)

ALTERNATIVE 2 - PRELIMINARY CONSTRUCTION COST ESTIMATE
Excavation and Off-Site Disposal of Contaminated Soil at a Licensed Low-Level Radioactive Facility
Tronox Navajo Area Uranium Sites Section 10 Mine; McKinley County, New Mexico

Effort Legend
START CONTRACTOR / EPA
CONSTRUCTION CONTRACTOR

12	On-Site Waste Consolidation and Stockpiling for Transport to Offsite Facility						
	Scraper (3)	28	DAY	$4,971.40	$139,199		
	Loader (1)	1	DAY	$3,935.63	$3,936		
	Backhoe Loader (1)	6	DAY	$3,211.04	$19,266		
	6000 Gal Water Truck (2)	19	DAY	$2,869.89	$54,528		
	Laborer (4)	364	HR	$82.54	$30,044		Concurrent with
	Subtotal Waste Consolidation and Stockpiling					***$246,973***	Item 13
13	Transport and Disposal (Clean Harbors, Deer Trail, CO)						
	Loader (2)	38	DAY	$3,935.63	$149,554		*Total Number*
	Grader (1) (road maintenance)	19	DAY	$2,416.76	$45,918		*of Off-Site*
	6000 Gal Water Truck (1)	19	DAY	$2,869.89	$54,528		*Truck Loads*
	Transport Legal Load and Disposal Fee (estimated at 45,000 lbs/load)	60,930	TON	$55.00	$3,351,176		*2,708*
	Truck Mobilization Fee (300 trucks)	300	EA	$1,289.15	$386,745		
	Truck Tarp (300 trucks)	300	EA	$120.75	$36,225		
	Disposal at Facility	60,930	TON	$75.00	$4,569,786		***0.8***
	Subtotal Off-Site Transport and Disposal					***$8,593,933***	***Months***
14	Confirmation Sampling - will happen concurrently with field work						
	Develop Sampling and Analysis Plan (SAP)						
	Geologist	80	HR	$105	$8,400		
	Project Manager	20	HR	$175	$3,500		
	Admin	20	HR	$78	$1,568		
	Sampling						
	Sampling Team (two 2-person crews)	300	HR	$85	$25,500		
	Mileage Albuquerque, NM to Sites (1 round trip per week)	265	MI	$0.54	$143		
	Per Diem (4 people)	30	DAY	$142	$4,260		
	Miscellaneous Field Supplies and Expenses	1	LS	$750	$750		
	Lab Analysis (15 samples per 2,000 m^2 survey area = 30 samples per acre)	600	EA	$75	$45,000		
	Reporting						
	Geologist	10	HR	$105	$1,050		
	Project Manager	3	HR	$175	$438		
	Project Engineer	3	HR	$160	$400		
	CAD/GIS Operator	10	HR	$85	$850		
	Admin	3	HR	$78	$196		
	Copying	1	LS	$31	$31		Concurrent with
	Subtotal Confirmation Sampling					***$92,086***	Other Work
15	Site Restoration (staging areas, general disturbance areas)						
	Tractor (2)	6	DAY	$1,967.72	$11,806		
	Grader (3)	11	DAY	$2,416.76	$26,584		
	Flat Bed Truck (1)	4	DAY	$1,649.32	$6,597		
	Power Mulcher (1)	2	DAY	$1,960.70	$3,921		
	6000 Gal Water Truck (2)	8	DAY	$2,869.89	$22,959		
	Laborer (5)	182	HR	$82.54	$15,022		
	Seed Mix	20	AC	$291.85	$5,837		
	Soil Amendments (Humate)	20	AC	$108.56	$2,171		
	Fertilizer	20	AC	$840.42	$16,808		
	Mulch	20	AC	$2,999.57	$59,991		***0.2***
	Subtotal Site Restoration					***$171,699***	***Months***
16	Per Diem						
	Construction Crew Per Diem (40 people)	1,954	DAY	$142	$277,509		Concurrent with
	Subtotal Construction Crew Per Diem					***$277,509***	Other Work
17	Contractor Project Management						
	Project Manager	400	HR	$175	$70,000		
	Site Superintendent, H&S Officer, and QA/QC Officer	1,500	HR	$163	$245,003		
	Site Foreman (3)	1,500	HR	$113	$169,542		
	Admin (2)	1,000	HR	$78	$78,401		
	Site Vehicles- 4WD Trucks (8)	2	MO	$2,365.31	$4,731		
	Site Vehicles (6)	2	MO	$1,000.00	$2,000		
	Mileage Albuquerque, NM to Site (106 mi/each way)	8,990	MI	$0.54	$4,854		
	Fuel for Vehicles	195	MO	$1,600.00	$312,686		
	Port-o-let Rental (4)	2	MO	$458.73	$917		
	Job Trailers (2)	2	MO	$322.54	$645		
	Storage Boxes (2)	2	MO	$102.14	$204		
	Field Office Lights/HVAC (1)	2	MO	$517.87	$1,036		
	Telephone/internet (1)	2	MO	$100.88	$202		
	Field Office Equipment	2	MO	$238.92	$478		
	Field Office Supplies	2	MO	$86.31	$173		
	Trash (2 dumpsters)	2	MO	$435.00	$870		
	Air Monitoring Equipment	2	MO	$8,800.00	$17,600		
	Truck Scales	2	MO	$300.00	$600		Concurrent with
	Subtotal Contractor Project Management					***$909,941***	Other Work

Table K-2 (Continued)

ALTERNATIVE 2 - PRELIMINARY CONSTRUCTION COST ESTIMATE
Excavation and Off-Site Disposal of Contaminated Soil at a Licensed Low-Level Radioactive Facility
Tronox Navajo Area Uranium Sites Section 10 Mine; McKinley County, New Mexico

Effort Legend
START CONTRACTOR / EPA
CONSTRUCTION CONTRACTOR

SUBTOTAL CAPITAL COSTS:							***$11,426,971***	***Project Durations***
18	Construction Observation/Owner's Representative - 6% (Items 4 - 12, and 14 - 17)		6%	x	$2,579,328		***$154,760***	
19	Contingency - 25% (Items 1 - 17)		25%	x	$11,426,971		***$2,856,743***	
20	Indirect Costs - 8% (Items 1 - 17, and 19)		8%	x	$14,283,714		***$1,142,697***	*Planning*
TOTAL CAPITAL COSTS:							***$15,581,171***	*3.0*
PRSC COSTS (O & M):								*Months*
21	Additional Effort for First 12-years O&M							
	Quarterly Inspections (2 person crew, 1 day, 10 hrs/day)	80	HR	$85	$6,800			*Construction*
	Mileage Albuquerque, NM to Site (round trip)	848	MI	$0.54	$458			*49*
	Inspection Crew Per Diem	8	DAY	$140	$1,120			*Work Days*
	Preparation of Semi-annual Reports (Professional Engineer)	40	HR	$120	$4,800			--------------------
	Assumed Annual Maintenance Costs (revegetation, watering, fence repairs)	1	LS	$20,000	$20,000			*1.9*
	Subtotal: Additional First 12-years Annual PRSC Costs:				**$33,178**			*Months*
	Present Value - O&M costs for 12 years (@ -7% discount rate)						***$263,520***	
22	99 Years O&M Costs							*TOTAL*
	Annual Inspection (2 person crew, 2 days, 10hrs/day)	40	HR	$85	$3,400			
	Mileage Albuquerque, NM to Site (round trip)	212	MI	$0.555	$118			*126*
	Inspection Crew Per Diem	4	DAY	$129	$516			*Work Days*
	Assumed Annual Maintenance Costs	1	LS	$10,000	$10,000			--------------------
	Preparation of Annual Report (Professional Engineer)	24	HR	$120	$2,880			*4.9*
	Subtotal 99-years Annual PRSC Costs:				**$16,914**			*Months*
	Present Value - O&M costs for 99 years (@ -7% discount rate)						***$241,330***	--------------------
TOTAL ESTIMATED COST							*$16,086,021*	*0.4*
TOTAL ESTIMATED COST (rounded up to nearest $1,000)							***$16,087,000***	*Years*

Key Assumptions:

1) Labor factor is based on the Gallup, New Mexico city cost index for Site and Infrastructure, Demolition (RSMeans, page 586).
2) Materials factor is based on the Gallup, New Mexico city cost index for Site and Infrastructure, Demolition (RSMeans, page 586).
3) Equipment factor is based on the Gallup, New Mexico city cost index for Contractor Equipment (RSMeans, page 586).
4) Costing assumes that the EPA will contract directly with a construction subcontractor/manager working out of the Grants, NM area.
5) Mileage is estimated to be 106 miles one way from Albuquerque, NM to the field site
6) Costs were developed assuming a 10-hour work day and 6 working days per week.
7) Mobilization costs include transportation of needed equipment and personnel (e.g. heavy equipment, office trailers, and additional supplies/equipment).
8) Equipment rates are based on monthly rental rates from RS Means Heavy Construction Cost Data, 30th Annual Edition, 2016. All unit rates are marked up to include an operator, laborors are separate for ground support.
9) Unit costs and production rates are based on rates obtained from RS Means Heavy Construction Cost Data, 30th Annual Edition, 2016. Unit costs include materials, equipment, and labor.
10) Per diem rates are based on the maximum Federal 2020 CONUS Per Diem Rates.
11) Present value of post removal site control (PRSC) costs assume quarterly SWPPP insepctions and an annual general inspection and report for the first 12 years. Costs also assume minor fencing, revegetation, and water system repairs during each inspection.
12) Present Value Subtotal for PRSC costs assume a discount rate of 7.0%.
13) Costs for low level radiological waste transport and disposal were obtained from quotes from vendors in Decebmer 2019.
14) For detailed information on personnel and equipment rates, quantities, and cost adjustment factors, see Tables K-5 thru K-7.
15) The average density of all wastes were assumed to be 1.3 tons per cubic yard. A capacity of 45,000 lb/load was assumed, which is 22.5 tons/load. Loose cubic yards assumed a 20% swell factor.

Abbreviations:

CY = Cubic yards	CF = cubic foot	EA = each	HR = hour
LB = pound	LF = linear feet	LS = Lump sum	MO = Month
MSF = thousand square feet	SF = square feet	SY = square yards	AC = Acre
MI = Mile			

Table K-4

ALTERNATIVE 4 - PRELIMINARY CONSTRUCTION COST ESTIMATE
Capping of Contaminated Soil in Place
Tronox Navajo Area Uranium Sites Section 10 Mine; McKinley County, New Mexico

Effort Legend
START CONTRACTOR / EPA
CONSTRUCTION CONTRACTOR

Item	Description	Quantity	Unit	Unit Cost	Extension	Item Total	Duration
CAPITAL COSTS:							
1	Engineering Costs (Design Costs)						
	Project Manager	100	HR	$175	$17,500		
	Project Engineer	200	HR	$160	$32,000		
	Design Engineer	300	HR	$100	$30,000		
	CAD/GIS Operator	400	HR	$85	$34,000		
	Admin	100	HR	$78	$7,840		
	Expenses	1	LS	$5,000	$5,000		***3.0***
	Subtotal Engineering Costs					***$126,340***	***Months***
2	Planning Documents (Work Plan, Health & Safety Plan, QA Plan, and SWPPP)						
	Project Manager	50	HR	$175	$8,750		
	Project Engineer	300	HR	$160	$48,000		
	CAD/GIS Operator	100	HR	$85	$8,500		
	Admin	50	HR	$78	$3,920		
	Expenses	1	LS	$1,000	$1,000		Concurrent with
	Subtotal Planning Documents					***$70,170***	Item 1
3	Resource Surveys						
	Geotechnical Testing and Report	2	EA	$25,000	$50,000		
	Pre-Project Aerial LIDAR Survey	20	AC	$180	$3,600		
	Post-Project Aerial LIDAR Survey	20	AC	$180	$3,600		Concurrent with
	Subtotal Resource Surveys					***$57,200***	Other Work
4	Mobilization/Demobilization	1	LS	$427,648	$427,648		***0.5***
	Subtotal Mob/Demob					***$427,648***	***Months***
5	Improve/Blaze Access Roads						
	Gravel Road Surfacing (8" Depth)	5,867	SY	$9.18	$53,867		
	Dozer, D-9 (2)	1	DAY	$5,449.25	$5,449		
	Grader (1)	1	DAY	$2,416.76	$2,417		
	Backhoe Loader (2)	1	DAY	$1,849.04	$1,849		
	6000 Gal Water Truck (4)	2	DAY	$2,869.89	$5,740		
	Laborer (5)	21	HR	$82.54	$1,733		***0.1***
	Subtotal Improve Access Road					***$71,056***	***Months***
6	Construction Water						
	Construction Water, including Hauling	914,000	GAL	$0.05	$45,700		
	Portable Water Tower Trailer, 10,000 gallons (2)	103	DAY	$1,775	$182,825		Concurrent with
	Subtotal Construction Water					***$228,525***	Other Work
7	Clearing and Grubbing						
	Dozer, D-9 (3)	7	DAY	$5,449.25	$38,145		
	Crawler Loader (1)	3	DAY	$3,424.74	$10,274		
	Brush Chipper, 12"	3	DAY	$1,645.91	$4,938		
	6000 Gal Water Truck (3)	7	DAY	$2,869.89	$20,089		
	Laborer (10)	223	HR	$82.54	$18,406		***0.1***
	Subtotal Clearing and Grubbing					***$91,852***	***Months***
8	Fence Construction / Repair						
	Fence Materials	2,640	LF	$24.26	$64,037		
	Flatbed Truck (1)	9	DAY	$1,649.32	$14,844		
	Manual Fence Post Auger (1)	9	DAY	$1,539.96	$13,860		
	Laborer (3)	264	HR	$82.54	$21,790		Concurrent with
	Subtotal Fence Construction/Repair					***$114,530***	Other Work
9	Erosion and Sediment Control						
	Silt Fence	16,000	LF	$0.31	$4,963		
	Hay Bales	4,000	LF	$4.32	$17,271		
	Loader, Skid Steer, 30 H.P. (1)	10	DAY	$1,743.83	$17,438		
	Flatbed Truck (1)	10	DAY	$1,649.32	$16,493		
	Laborer (2)	197	HR	$82.54	$16,260		Concurrent with
	Subtotal Erosion and Sediment Control					***$72,425***	Other Work
10	Headworks Removal						
	Flatbed Truck (1)	2	DAY	$1,649.32	$3,299		
	Structural Steel Foreman (1)	20	HR	$93.50	$1,870		
	Structural Steel Worker (1)	20	HR	$90.10	$1,802		
	Truck Driver (1)	20	HR	$94.08	$1,882		
	Laborer (2)	40	HR	$82.54	$3,302		Concurrent with
	Subtotal Headworks Removal					***$12,154***	Other Work
11	Fill Adit and Vent Shaft and Plug with Polyurethane Foam (PUF)						
	Dump Truck, 34 CY, Off-Road (1)	4	DAY	$3,531.98	$14,128		
	Backhoe Loader (1)	4	DAY	$3,211.04	$12,844		
	Pump, Concrete, Truck Mounted, 4" Line, 80' Boom (1)	1	DAY	$3,935.63	$3,936		
	Polyurethane Foam	32	CY	$350.00	$11,097		
	Laborer (2)	65	HR	$82.54	$5,365		***0.2***
	Subtotal Fill Adit and Vent Shaft and Plug with Polyurethane Foam (PUF)					***$47,370***	***Months***

ALTERNATIVE 4 - PRELIMINARY CONSTRUCTION COST ESTIMATE
Capping of Contaminated Soil in Place
Tronox Navajo Area Uranium Sites Section 10 Mine; McKinley County, New Mexico

Effort Legend
START CONTRACTOR / EPA
CONSTRUCTION CONTRACTOR

12	Excavation, Transportation, and Stockpile of Clean Cover Material						
	Excavator (1)	15	DAY	$5,940.45	$89,107		
	Loader (3)	70	DAY	$3,935.63	$275,494		
	Dozer, D-9 (1)	24	DAY	$5,449.25	$130,782		Number of Loads
	Dump Truck, 34 CY, Off-Road (6)	128	DAY	$3,531.98	$452,094		*3,758*
	6000 Gal Water Truck (2)	47	DAY	$2,869.89	$134,885		
	Laborer (7)	1,612	HR	$82.54	$133,052		***0.9***
	Excavation, Transportation, and Stockpile of Clean Cover Material					***$1,215,414***	***Months***
13	Construction of Clean Soil Cover						
	Dozer, D-9 (3)	61	DAY	$5,449.25	$332,404		
	Loader (2)	26	DAY	$3,935.63	$102,326		
	Grader (2)	11	DAY	$2,416.76	$26,584		
	Sheepsfoot Roller, Dozer Towed (1)	11	DAY	$2,416.76	$26,584		
	Smooth Drum Roller, Dozer Towed (1)	11	DAY	$2,318.42	$25,503		
	6000 Gal Water Truck (2)	41	DAY	$2,869.89	$117,666		
	Laborer (6)	1,217	HR	$82.54	$100,450		
	Compaction Testing	53	EA	$200.00	$10,648		Concurrent with
	Subtotal Construction of Clean Soil Cover					***$742,165***	Item 12
14	Confirmation Sampling - will happen concurrently with field work						
	Develop Sampling and Analysis Plan (SAP)						
	Geologist	80	HR	$105	$8,400		
	Project Manager	20	HR	$175	$3,500		
	Admin	20	HR	$78	$1,568		
	Sampling						
	Sampling Team (two 2-person crews)	300	HR	$85	$25,500		
	Mileage Albuquerque, NM to Sites (1 round trip per week)	265	MI	$0.54	$143		
	Per Diem (4 people)	30	DAY	$142	$4,260		
	Miscellaneous Field Supplies and Expenses	1	LS	$750	$750		
	Lab Analysis (15 samples per 2,000 m^2 survey area = 30 samples per acre)	600	EA	$75	$45,000		
	Reporting						
	Geologist	10	HR	$105	$1,050		
	Project Manager	3	HR	$175	$438		
	Project Engineer	3	HR	$160	$400		
	CAD/GIS Operator	10	HR	$85	$850		
	Admin	3	HR	$78	$196		
	Copying	1	LS	$31	$31		Concurrent with
	Subtotal Confirmation Sampling					***$92,086***	Other Work
15	Site Restoration (staging areas, general disturbance areas)						
	Tractor (2)	6	DAY	$1,967.72	$11,806		
	Grader (3)	11	DAY	$2,416.76	$26,584		
	Flat Bed Truck (1)	4	DAY	$1,649.32	$6,597		
	Power Mulcher (1)	2	DAY	$1,960.70	$3,921		
	6000 Gal Water Truck (2)	8	DAY	$2,869.89	$22,959		
	Laborer (5)	182	HR	$82.54	$15,022		
	Seed Mix	20	AC	$291.85	$5,837		
	Soil Amendments (Humate)	20	AC	$108.56	$2,171		
	Fertilizer	20	AC	$840.42	$16,808		
	Mulch	20	AC	$2,999.57	$59,991		***0.2***
	Subtotal Site Restoration					***$171,699***	***Months***
16	Per Diem						
	Construction Crew Per Diem (40 people)	3,086	DAY	$142	$438,171		Concurrent with
	Subtotal Construction Crew Per Diem					***$438,171***	Other Work

Table K-4 (Continued)

ALTERNATIVE 4 - PRELIMINARY CONSTRUCTION COST ESTIMATE
Capping of Contaminated Soil in Place
Tronox Navajo Area Uranium Sites Section 10 Mine; McKinley County, New Mexico

Effort Legend
START CONTRACTOR / EPA
CONSTRUCTION CONTRACTOR

17	Contractor Project Management						
	Project Manager	500	HR	$175	$87,500		
	Site Superintendent, H&S Officer, and QA/QC Officer	1,600	HR	$163	$261,336		
	Site Foreman (3)	1,600	HR	$113	$180,845		
	Admin (2)	1,100	HR	$78	$86,241		
	Site Vehicles- 4WD Trucks (8)	2	MO	$2,365.31	$4,731		
	Site Vehicles (6)	2	MO	$1,000.00	$2,000		
	Mileage Albuquerque, NM to Site (106 mi/each way)	9,463	MI	$0.54	$5,110		
	Fuel for Vehicles	206	MO	$1,600.00	$329,143		
	Port-o-let Rental (4)	2	MO	$458.73	$917		
	Job Trailers (2)	2	MO	$322.54	$645		
	Storage Boxes (2)	2	MO	$102.14	$204		
	Field Office Lights/HVAC (1)	2	MO	$517.87	$1,036		
	Telephone/internet (1)	2	MO	$100.88	$202		
	Field Office Equipment	2	MO	$238.92	$478		
	Field Office Supplies	2	MO	$86.31	$173		
	Trash (2 dumpsters)	2	MO	$435.00	$870		
	Air Monitoring Equipment	2	MO	$8,800.00	$17,600		
	Subtotal Contractor Project Management					***$979,030***	Other Work
SUBTOTAL CAPITAL COSTS:						***$4,957,834***	***Project***
18	Construction Observation/Owner's Representative - 6% (Items 4 - 17)		6%	x	$4,957,834	***297470.0671***	***Durations***
19	Contingency - 25% (Items 1 - 17)		25%	x	$4,957,834	***1239458.613***	
20	Indirect Costs - 8% (Items 1 - 17, and 19)		8%	x	$6,197,293	***495783.4451***	*Planning*
TOTAL CAPITAL COSTS:						***$6,990,547***	*3.0*
PRSC COSTS (O & M):							*Months*
21	Additional Effort for First 12-years O&M						
	Quarterly Inspections (2 person crew, 2 days, 10 hrs/day)	160	HR	$85	$13,600		*Construction*
	Mileage Albuquerque, NM to Site (round trip)	848	MI	$0.54	$458		*51*
	Inspection Crew Per Diem	16	DAY	$140	$2,240		*Work Days*
	Preparation of Semi-annual Reports (Professional Engineer)	40	HR	$120	$4,800		--------------------
	Assumed Annual Maintenance Costs (revegetation, watering, fence repairs)	1	LS	$40,000	$40,000		*2.0*
	Subtotal: Additional First 12-years Annual PRSC Costs:				**$61,098**		*Months*
	Present Value - O&M costs for 12 years (@ -7% discount rate)					***$485,280***	
22	99 Years O&M Costs						*TOTAL*
	Annual Inspection (2 person crew, 4 days, 10hrs/day)	80	HR	$85	$6,800		
	Mileage Albuquerque, NM to Site (round trip)	212	MI	$0.555	$118		*129*
	Inspection Crew Per Diem	8	DAY	$129	$1,032		*Work Days*
	Assumed Annual Maintenance Costs	1	LS	$20,000	$20,000		--------------------
	Preparation of Annual Report (Professional Engineer)	24	HR	$120	$2,880		*5.0*
	Subtotal 99-years Annual PRSC Costs:				**$30,830**		*Months*
	Present Value - O&M costs for 99 years (@ -7% discount rate)					***$439,880***	--------------------
TOTAL ESTIMATED COST						*$7,915,707*	*0.4*
TOTAL ESTIMATED COST (rounded up to nearest $1,000)						***$7,916,000***	*Years*

Key Assumptions:

1) Labor factor is based on the Gallup, New Mexico city cost index for Site and Infrastructure, Demolition (RSMeans, page 586).
2) Materials factor is based on the Gallup, New Mexico city cost index for Site and Infrastructure, Demolition (RSMeans, page 586).
3) Equipment factor is based on the Gallup, New Mexico city cost index for Contractor Equipment (RSMeans, page 586).
4) Costing assumes that the EPA will contract directly with a construction subcontractor/manager working out of the Grants, NM area.
5) Mileage is estimated to be 106 miles one way from Albuquerque, NM to the field site
6) Costs were developed assuming a 10-hour work day and 6 working days per week.
7) Mobilization costs include transportation of needed equipment and personnel (e.g. heavy equipment, office trailers, and additional supplies/equipment).
8) Equipment rates are based on monthly rental rates from RS Means Heavy Construction Cost Data, 30th Annual Edition, 2016. All unit rates are marked up to include an operator, laborors are separate for ground support.
9) Unit costs and production rates are based on rates obtained from RS Means Heavy Construction Cost Data, 30th Annual Edition, 2016. Unit costs include materials, equipment, and labor.
10) Per diem rates are based on the maximum Federal 2020 CONUS Per Diem Rates.
11) Present value of post removal site control (PRSC) costs assume quarterly SWPPP insepctions and an annual general inspection and report for the first 12 years. Costs also assume minor fencing, revegetation, and water system repairs during each inspection.
12) Present Value Subtotal for PRSC costs assume a discount rate of 7.0%.
13) Costs for low level radiological waste transport and disposal were obtained from quotes from vendors in Decebmer 2019.
14) For detailed information on personnel and equipment rates, quantities, and cost adjustment factors, see Tables K-5 thru K-7.
15) The average density of all wastes were assumed to be 1.3 tons per cubic yard. A capacity of 45,000 lb/load was assumed, which is 22.5 tons/load. Loose cubic yards assumed a 20% swell factor.

Abbreviations:

CY = Cubic yards	CF = cubic foot	EA = each	HR = hour
LB = pound	LF = linear feet	LS = Lump sum	MO = Month
MSF = thousand square feet	SF = square feet	SY = square yards	AC = Acre
MI = Mile			

Table K-5

Equipment and Personnel Rates for the Section 10 Mine Site

Reference: RS Means Heavy Construction Cost Data 2016

Equipment and Operator Unit Prices for the Section 10 Mine Site

Equipment/Personnel	RS Means	Equipment Hourly Operating Cost	Equipment Rental per Month	Equipment Cost per Day	EPA Provided Operator/ Driver Hourly Rate	Equipment + Operator	Total per Day, including O&P
Manual Fence Post Auger	RSM 01 54 33.20 0095	$ 0.60	$ 54.00	$ 8.10	$ 111.29	$ 1,120.96	**$ 1,539.96**
Backhoe Loader (40 hp)	RSM 01 54 33.20 0400	$ 14.85	$ 2,175.00	$ 233.08	$ 111.29	$ 1,345.94	**$ 1,849.04**
Excavator (7 CY)	RSM 01 54 33.20 0340	$ 218.85	$ 26,300.00	$ 3,211.28	$ 111.29	$ 4,324.13	**$ 5,940.45**
Brush Chipper, 12" (130 hp)	RSM 01 54 33.20 0550	$ 27.45	$ 2,525.00	$ 372.69	$ 82.54	$ 1,198.08	**$ 1,645.91**
Grader (30,000 lbs)	RSM 01 54 33.20 1910	$ 43.05	$ 5,550.00	$ 646.33	$ 111.29	$ 1,759.19	**$ 2,416.76**
Power Mulcher	RSM 01 54 33.20 2860	$ 23.95	$ 1,925.00	$ 314.36	$ 111.29	$ 1,427.22	**$ 1,960.70**
Sheepsfoot Roller, Towed (50 hp)	RSM 01 54 33.20 3150	$ 27.05	$ 3,150.00	$ 393.00	$ -	$ 393.00	**$ 539.90**
Smooth Drum Vibratory Roller, (125 hp)	RSM 01 54 33.20 3400	$ 32.10	$ 6,525.00	$ 574.75	$ 111.29	$ 1,687.61	**$ 2,318.42**
Scraper (21 cy)	RSM 01 54 33.20 3550	$ 173.20	$ 19,900.00	$ 2,505.89	$ 111.29	$ 3,618.75	**$ 4,971.40**
Dozer, D-6 (200 hp)	RSM 01 54 33.20 4260	$ 76.95	$ 11,700.00	$ 1,224.50	$ 111.29	$ 2,337.36	**$ 3,211.04**
Dozer, D-9 (500 hp)	RSM 01 54 33.20 4370	$ 170.65	$ 29,500.00	$ 2,853.72	$ 111.29	$ 3,966.58	**$ 5,449.25**
Crawler Loader (3 CY)	RSM 01 54 33.20 4560	$ 87.45	$ 13,000.00	$ 1,380.06	$ 111.29	$ 2,492.91	**$ 3,424.74**
Front End Loader (8 CY)	RSM 01 54 33.20 4810	$ 113.75	$ 15,800.00	$ 1,751.94	$ 111.29	$ 2,864.80	**$ 3,935.63**
1 Loader, Skid Steer (30 hp)	RSM 01 54 33.20 4880	$ 10.40	$ 1,350.00	$ 156.50	$ 111.29	$ 1,269.36	**$ 1,743.83**
Dump Trail Only (20 CY)	RSM 01 54 33.20 5400	$ 5.80	$ 1,400.00	$ 112.44	$ -	$ 112.44	**$ 154.48**
Dump Truck, 34 CY, Off-Road (50 ton)	RSM 01 54 33.20 5610	$ 102.35	$ 15,600.00	$ 1,630.17	$ 94.08	$ 2,570.98	**$ 3,531.98**
Tractor, with Attachment	RSM 01 54 33.40 6465	$ 21.35	$ 2,725.00	$ 319.47	$ 111.29	$ 1,432.33	**$ 1,967.72**
6,000 Gal Water Truck	RSM 01 54 33.40 6950	$ 87.60	$ 7,000.00	$ 1,148.22	$ 94.08	$ 2,089.03	**$ 2,869.89**
Flatbed Truck (20,000 lb)	RSM 01 54 33.40 7290	$ 21.60	$ 1,125.00	$ 259.75	$ 94.08	$ 1,200.56	**$ 1,649.32**
Truck Tractor, 6 x 4 (450 hp)	RSM 01 54 33.40 7600	$ 62.10	$ 3,450.00	$ 755.17	$ 94.08	$ 1,695.98	**$ 2,329.92**
Portable Water Tower Trailer, 10,000 gallons	RSM 01 54 33.40.6925	$ 9.45	$ 1,775.00	$ 163.53	$ -	$ 163.53	**$ 224.65**
Pump, Concrete, Truck Mounted, 4" Line, 80' Boom	RSM 01 54 33.10.2120	$ 24.70	$ 7,950.00	$ 556.17	$ 94.08	$ 1,496.98	**$ 2,056.53**

Table K-5 (Continued)

Construction and Engineering Personnel Rates for the Section 10 Mine Site

Personnel	Source	Hourly Rate	Daily Rate
Truck Driver	RS Means Crew Data	$ 94.08	$ 940.81
Laborer	RS Means Crew Data	$ 82.54	$ 825.39
Foreman	RS Means Crew Data	$ 113.03	$ 1,130.28
Equipment Operator	RS Means Crew Data	$ 111.29	$ 1,112.86
Site Superintendent	Engineering Estimate	$ 163.34	$ 1,633.35
Admin	RS Means Crew Data	$ 78.40	$ 784.01
Sampling Team/Scientist	Engineering Estimate	$ 85.00	$ 850.00
CAD/GIS Operator	Engineering Estimate	$ 85.00	$ 850.00
Design Engineer	Engineering Estimate	$ 100.00	$ 1,000.00
Geologist	Engineering Estimate	$ 105.00	$ 1,050.00
Professional Engineer	Engineering Estimate	$ 120.00	$ 1,200.00
Project Engineer	Engineering Estimate	$ 160.00	$ 1,600.00
Project Manager	Engineering Estimate	$ 175.00	$ 1,750.00
Structural Steel Foreman	RS Means 2016	$ 93.50	$ 935.00
Structural Steel Worker	RS Means 2017	$ 90.10	$ 901.00

Per Diem and Mileage Rates

Allowance	Source	Lodging	M&IE	Total
Per Diem Rate (per Day)	www.gsa.gov	$ 96.00	$ 55.00	$ 151.00
Mileage Rate (per Mile)	www.gsa.gov	--	--	$ 0.58

Key Assumptions:

1) Hourly labor rates were taken from RS Means trade data (RS Means, inside back cover) and escalated from 2016 to 2020 rates.
2) Daily rates assume a 10-hour work day.
3) Weekly and Monthly rates assume a 6-day work week.
4) RS Means production rates assume 8-hour work days. Equipment production rates were increased by 25% to account for the longer 10-hour work days.
5) Per diem and mileage rates are based on the maximum Federal 2020 CONUS Per Diem Rates.

Table K-6

Material and Work Quantities and Unit Prices for the Section 10 Mine Site

Reference: RS Means Heavy Construction Cost Data 2016

Waste Material Earthwork Areas and Volumes

Remediation Area - Alternative 2	Depth (ft)	Surface Area (ft^2)	Surface Area (Acres)	Volume (ft^3)	Volume (CY)
Waste Material Volume					
1-Foot Depth Area	1	857,700	20	857,700	31,767
Sub-Economic Material Pile	-	-	-	196,869	7,291
Totals of Excavation		**857,700**	**20**	**857,700**	**39,058**
Transported Volume, CY	Applying a 20% Swell Factor				46,870
Transported Weight, TONS	Assuming 1.3 Tons per CY				60,930
Number of Loads	Assuming 45,000 lb/load				2,708
Remediation Area - Alternative 3	**Depth (ft)**	**Surface Area (ft^2)**	**Surface Area (Acres)**	**Volume (ft^3)**	**Volume (CY)**
Waste Material Volume					
1-Foot Depth Areas	1	857,700	20	857,700	31,767
Sub-Economic Material Pile	-	-	-	196,869	7,291
1-Foot Depth Areas within Repository Footprint*	1	378,972	8.7	378,972	14,036
Totals of Excavation		**478,728**	**11**	**478,728**	**25,022**
Transported Volume, CY	Applying a 20% Swell Factor				30,026

* Areas in the cleanup zone that overlap with the footprint of the repository were removed from the total waste volume estimates since that material would remain in place.

Cap Earthwork Areas and Volumes

Section 10 Mine Repository Cap Volume - Alternative 3	
Estimated Cap Volume for 40,000 CY Repository from Preliminary Design, CY	28,547
In-Place Cap Volume - Alternative 4	
Estimated Cap Footprint, Acres	20
Estimated Cap Footprint, SY	96,800
Estimated Cap Footprint, Square Feet	871,200
Cap Thickness, ft	3
Estimated Cap Volume for In-Place Preliminary Design, CF	2,613,600
Estimated Cap Volume for In-Place Preliminary Design, CY	96,800
Estimated Cap Volume for In-Place Preliminary Design Applying 10% Factor to Account for Topography, CY	106,480

Revegetation Areas

Revegetation Area - Alternative 2, 3, & 4	(MSF)	(ft^2)	(Acres)*
Removal Area / Repository Area / Cap Area	858	857,700	20

Polyurethane Foam (PUF) Plugs for Adit and Vent Shafts

Adit and Vent Shaft Closure Fill Material and PUF Plug Volumes	Depth (ft)	Diameter (in)	Diameter (ft)	Volume (ft^3)	Volume (CY)
Fill Material Volume					
Shaft (less 20 feet for PUF plug and surface cover)	271.4	120	10	21,316	790
Vent (less 20 feet for PUF plug and surface cover)	331.6	36	3	2,344	87
Shaft - Polyurethane Foam	10	120	10	785	29
Vent - Polyurethane Foam	10	36	3	71	3
Shaft - Fill Above Polyurethane Foam	10	120	10	785	29
Vent - Fill Above Polyurethane Foam	10	36	3	71	3
Total Fill Material Below Foam, CY					877
Total Fill Material Above Foam, CY					32
Total Polyurethane Foam, CY					32

Table K-6 (Continued)

Material and Work Quantities and Unit Prices for the Section 10 Mine Site

Reference: RS Means Heavy Construction Cost Data 2016

Study Area Quantities and Unit Prices

Work Item	Quantity	Unit	Unit Price	Extended Price	Reference	Assumptions
Cultural Resources Mitigation	1	Each	$ 200,000.00	$ 200,000.00	Priced by NV5	
Geotechnical Testing and Report	2	Each	$ 25,000.00	$ 50,000.00	RSM 02 32 13.10	Assumed two studies for project
Aerial Survey (LIDAR)	20	AC	$ 180.00	$ 3,600.00	RSM 02 21 13.16 2000	Assumed price x2 due to small area

Construction Quantities and Unit Prices

Work Item	Quantity	Unit	Unit Price	Extended Price	Reference	Assumptions
Road Gravel (Materials) - All Alternatives	5,867	SY	$ 9.18	$ 53,867.40	RSM 01 55 23.50 0100	0.5 miles of road, 20 feet wide
Fence Repair (Materials)	2,640	LF	$ 24.26	$ 64,036.69	RSM 32 31 13.20 0200	Assumed 0.5 miles for duration of project
Silt Fence (Materials)	16,000	LF	$ 0.31	$ 4,962.93	RSM 31 25 14.16 1000	Assumed 800 feet required per acre
Hay Bales (Materials)	4,000	LF	$ 4.32	$ 17,271.00	RSM 31 25 14.16 1250	Assumed 200 feet required per acre
Seeds (Materials) - All Alternatives	20	AC	$ 291.85	$ 5,837.00	RSM 32 92 19.14 5300	
Soil Amendments (Humate) (Materials) - All Alternatives	20	AC	$ 108.56	$ 2,171.28	RSM 32 91 13.23 4050	Assumed $250/ton delivered, at 700 lb/acre
Fertilizer (Materials) - All Alternatives	20	AC	$ 840.42	$ 16,808.40	RSM 32 91 13.23 4150	
Multch (Materials) - All Alternatives	20	AC	$ 2,999.57	$ 59,991.40	RSM 32 91 13.16 0700	
Waste Soil Transportation	60,930	TON	$ 55.00	$ 3,351,176.40	Facility Quote	Assumed 1.3 tons per CY, and 20% swell
Waste Soil Processing Fee	60,930	TON	$ 75.00	$ 4,569,786.00	Facility Quote	Assumed 1.3 tons per CY, and 20% swell
Truck Mobilization Fee	300	Each	$ 1,289.15	$ 386,745.00	Facility Quote	Assumed 300 trucks, 2-day rotation
Truck Tarp	300	Each	$ 120.75	$ 36,225.00	Facility Quote	Assumed 300 trucks, 2-day rotation
Job Trailers	1	MO	$ 322.54	$ 322.54	RSM 01 52 13.20 0350	Assumed a 138 kV Transmossion Trai
Storage Boxes	1	MO	$ 102.14	$ 102.14	RSM 01 52 13.20 1250	Assumed a 138 kV Transmossion Boxe
Field Office Lights/HVAC	1	MO	$ 517.87	$ 517.87	RSM 01 52 13.40 0160	Assumed a 138 kV Transmossion Ligh
Telephone/internet	1	MO	$ 100.88	$ 100.88	RSM 01 52 13.40 0140	Assumed a 138 kV Transmossion Tele
Portable Toilet	2	MO	$ 229.36	$ 458.73	RSM 01 54 33.40 6410	
Field Office Equipment	1	MO	$ 238.92	$ 238.92	RSM 01 52 13.40 0100	Assumed a 138 kV Transmossion Equi
Field Office Supplies	1	MO	$ 86.31	$ 86.31	RSM 01 52 13.40 0120	Assumed a 138 kV Transmossion Supp
Trash (2 dumpsters)	1	MO	$ 435.00	$ 435.00	Engineering Estimate	Assumed a 138 kV Transmossion dump
Air Monitoring Equipment	2	MO	$ 4,400.00	$ 8,800.00	Vendor Quote	Assumed a 138 kV Transmossion Equi
Site Vehicles- 4WD Trucks	3	MO	$ 788.44	$ 2,365.31	RSM 01 54 33.40 7200	
Site Vehicles	2	MO	$ 500.00	$ 1,000.00	Engineering Estimate	
Fuel for Vehicles	1	MO	$ 1,600.00	$ 1,600.00	Engineering Estimate	$2.40/gal, 15 mi/gal, 10,000 miles/month
Truck Scales	1	MO	$ 300.00	$ 300.00	Engineering Estimate	Assumed a 138 kV Transmossion Scal
Construction Water, including Hauling - Alternative 2	1,266,000	GAL	$ 0.05	$ 63,300.00	Engineering Estimate	Assumed 2 gal/CY for excavation, 30 gal/CY for hauling dust control
Construction Water, including Hauling - Alternative 3	811,000	GAL	$ 0.05	$ 40,550.00	Engineering Estimate	Assumed 2 gal/CY for excavation, 30 gal/CY for hauling dust control
Construction Water, including Hauling - Alternative 4	914,000	GAL	$ 0.05	$ 45,700.00	Engineering Estimate	Assumed 2 gal/CY for excavation, 30 gal/CY for hauling dust control
Portable Water Tower Trailer, 10,000 gallons	2	MO	$ 1,775.00	$ 3,550.00	RSM 33 16 13.23 7200	
Compaction Test (Field) - Alternative 3	27	EA	$ 200.00	$ 5,356.90	RS Means 01 45 23.50 4400	Assumed 1 test per 2,000 CY
Compaction Test (Field) - Alternative 4	53	EA	$ 200.00	$ 10,648.00	RS Means 01 45 23.50 4401	Assumed 1 test per 2,000 CY
Radiological Confirmation Sample (Lab) - Alternative 2	600	EA	$ 75.00	$ 45,000.00	Engineering Estimate	Assumed 30 samples per acre, $60/lab sample, $15/sample for shipping
Radiological Confirmation Sample (Lab) - Alternative 3	339	EA	$ 75.00	$ 25,425.00	Engineering Estimate	Assumed 30 samples per acre, $60/lab sample, $15/sample for shipping
Radiological Confirmation Sample (Lab) - Alternative 4	600	EA	$ 75.00	$ 45,000.00	Engineering Estimate	Assumed 30 samples per acre, $60/lab sample, $15/sample for shipping
Polyurethante Foam	32	CY	$ 350.00	$ 11,097.39	Academic Paper	Price from paper in 1994 adjusted for 2019
Selective Demolition, Radio Towers, Self Supported, 60'	1	EA	$ 2,962.00	$ 2,962.00	RSM 02 41 13.78 0700	Treat headframe as a radio tower for demo purposes

Notes:

1) Unless noted otherwise, quantity items are applicable to Alternatives, 2, 3, and 4.

Table K-7

Markup Factors for Gallup, New Mexico

Reference: RS Means Heavy Construction Cost Data 2016
RS Means Online, Historical Cost Indexes, accessed December 2019

The majority of the work will be Excavation (as defined by RSMeans) by Equipment Operators, Laborers, and Foremen

Labor[1]

Category	Workers Comp %	Fixed Overhead	Home Office Overhead	Profit	Gallup, NM Installation Factor	Rad Trained Personnel	Time Factor	Total Factor
Excavation	0.144	0.163	0.13	0.1	0.041	0.1	1.15	2.18

Materials[2]

Profit	Gallup, NM Materials Factor	New Mexico Sales Tax	Time Factor	Total Factor
0.1	-0.067	0.05125	1.15	1.24

Equipment[3]

Profit	Gallup, NM Equipment Factor	Time Factor	Total Factor
0.1	0.086	1.15	1.37

Time[4]

Historical Cost Indexes		
January 2020	January 2016	Time Factor
239.1	207.3	1.15

[1] Labor factor is based on the Gallup, New Mexico city cost index for Site and Infrastructure, Demolition (RSMeans, page 586).
Workers Comp % is based on New Mexico rates for Excavation (RSMeans, page 620).

[2] Materials factor is based on the Gallup, New Mexico city cost index for Site and Infrastructure, Demolition (RSMeans, page 586).

[3] Equipment factor is based on the Gallup, New Mexico city cost index for Contractor Equipment (RSMeans, page 586).

[4] Time factor is based on adjusting 2016 RS Means cost data to January 2020, using RS Means Historical Cost Indexes (RS Means, page 563) and online data from www.rsmeans.com, accessed in December 2019 to obtain January 2020 cost index.

APPENDIX L

LONG-TERM STORAGE FACILITY (REPOSITORY)
RADON FLUX CALCULATIONS

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Alternative 3 (Non-Incised, On-Site Repository)

	Type of Material	[1]Thickness of Layer (cm) (x)	[2]Porosity of Material (Unitless) (n)	[3]Density of Material (g/cm^3) (ρ)	[4]Radon Emanation Coefficient (Unitless) (E)	[4]Radon Decay Constant (1/s) (λ)	[3]Long-term Average Moisture Content (Dry weight percentage) (w)	[4]Specific Gravity of Soils (Unitless) (G)
Contaminated Soils	Native soil	500	0.305660377	1.84	0.35	2.10E-06	10	2.65
Cover layer	Native soil	91.44	0.305660377	1.84	0.35	2.10E-06	10	2.65

	[3]Specific Activity of Ra-226 (pCi/g) (R)	[2]Moisture saturation fractions (Unitless) (m)	[2]Radon Diffusion Coefficients (cm^2/s) (D)	[2]Inverse relaxation length (1/cm) (b)	[2]Interface constants (cm^2/s) (a)	[4]Equilibrium distrubution Coffecient of Radon in Water and Air (pCi/cm^3) (k)	[2]Radon Flux from the bare contaminated soil (pCi/m^2-s) (J_t)	[2]Radon Flux from the Cover (pCi/m^2-s) (J_c)
Contaminated Soils	150	0.6020	5.75E-03	0.0191	0.0002	0.2600	106	
Cover layer	1	0.6020	5.75E-03	0.0191	0.0002	0.2600		**18.5**

State of New Mexico Guidance Radon Flux Limit: 20

[1]Thickness of cover layer was determined by trial and error in order to determine the maximum thickness with a Radon Flux result less than or equal to the state of New Mexico guidance limit of 20 pCi/m2-s. A cover thickness of 91.44 centimeters is equivalent to 3 feet. The contaminated soil thickness of 500 centimeters = 16.4 feet. The long-term storage facility (repository) design (Non-Incised, Surface, On-Site [Alternative 3]) features a contaminated-soils thickness greater than 500 centimeters; the radon flux calculated result remains the same (18.5 pCi/m^2-s) beyond a thickness of 500 centimeters.
[2]Value calculated per NRC Regulatory Guide 3.64 formulas noted below. The NRC Regulatory Guide 3.64 formulas were designed with uranium mill tailings in mind; therefore, the subscripts 't' and 'c' in the formulas below refer to 'tailings' and 'cover', respectively. In this case, the formulas and terms with the 't' subscript are used for 'Contaminated Soils' and the formulas and terms with the 'c' subscript are used for 'Cover layer'.
[3]Value obtained from Design Engineer or Project Manager .
[4]Value obtained from NRC Regulatory Guide 3.64.

NRC Regulatory Guide 3.64 Radon Flux Formulas:

$$J_t = 10^4 * R * \rho * E * \sqrt{\lambda * D} * \text{hyperbolic tangent of } (x * \sqrt{\lambda/D})$$

$$J_c = \frac{2*J_t * e^{-b_c * x_c}}{1 + \sqrt{a_t/a_c}}$$

$$D = 0.07 * e^{-4 * (m - (m * n^2) + (m^5))}$$

$$m = \frac{10^{-2} * \rho * w}{n * \rho_w}$$; ρ_w is the mass density of water = 1 g/cm3

$$n = 1 - \frac{\rho}{G*\rho_w}$$; ρ_w is the mass density of water = 1 g/cm^3

$$b = \sqrt{\lambda/D}$$

$$a = n^2 * D * (1-((1-k) * m))^2$$

APPENDIX M

LONG-TERM STORAGE FACILITY (REPOSITORY) PRELIMINARY DESIGN DRAWINGS

APPENDIX N

GREEN ALTERNATIVES ASSESSMENT

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Green Alternatives Assessment

Based on EPA Guidance, there are five core (key) elements in "greener cleanup activities" that should be considered throughout the remedy selection process (EPA, 2016). These key elements include: minimizing total energy use and increasing the percentage of renewable energy; minimizing air pollutants and greenhouse gas emissions; minimizing water use and negative impacts on water resources; protecting ecosystem services; and improving materials management and waste reduction efforts by reducing, reusing, or recycling whenever feasible (EPA, 2012). This analysis compares the effects each removal action alternative, described in Section 3.0, has on the five key "green" elements. Each of the five elements was qualitatively scored for each alternative (1, 2, 3, and 4) using a numerical ranking system 1-4, with a 1 being best and a 4 being worst (i.e., low scores are greener cleanup alternatives). The alternative's Greener Cleanup Assessment Score was derived from the sum of the five scores for that alternative. The results of this assessment are summarized in Table N-1.

Total Energy Use and Percentage of Renewable Energy

Out of the four removal action alternatives, Alternative 1, the No Action Alternative is the only alternative that requires no energy. For the other alternatives, energy usage can be broken into two main categories: electrical usage and direct fossil fuel combustion. All of the alternatives have relatively low electrical requirements. The main electricity demands are expected to be for power to pump water from the onsite supply well, operation of the water treatment system to be constructed as part of the removal action, and for the office trailers brought in to support personnel; particularly for heating and cooling the trailers. Alternative 2 would have higher electrical demand than Alternatives 3 and 4 since the off-site disposal facility would require additional office support and water. Since active removal work is expected to be conducted during daylight hours, lighting requirements are expected to be minimal for all alternatives. The primary expected lighting needs would be during the darkest winter months, should work occur during those periods, to illuminate the on-site office trailer and equipment yards. Grid power is potentially available at the site which will preclude the need for temporary on-site generators, eliminating a potential source of fossil fuel consumption.

The greatest fossil fuel consumption will be for heavy equipment and trucks used during the excavation and transportation. The transportation requirement of each alternative is summarized in Table 4-2. The use of biodiesel in place of diesel for heavy equipment use or transportation is recommended. Given that the ability to use biodiesel does not vary between alternatives and it is unknown if biodiesel fuels will be ultimately used, this analysis assumes heavy equipment will be operated using traditional petroleum-based fuel sources.

Excluding Alternative 1, which does not require any energy consumption, Alternative 3 will have the lowest fossil fuel consumption, followed by Alternatives 4 and 2. Alternative 4 requires significant hauling of clean fill material which will require additional fossil fuel consumption not required for Alternative 3. Alternative 2 has fossil fuel demands estimated to be more than an order of magnitude greater than any other alternative due to having the greatest number of loads transported off-site and farthest distance to the off-site disposal facility. The alternatives rank as follows in order of least fossil fuel consumption to most: 1, 3, 4, and 2.

Air Pollutants and Greenhouse Gas Emissions

Relevant air pollutants include greenhouse gases, nitrogen oxides (NOx), sulfur oxides (SOx), particulate matter less than 10 microns in size (PM10), and hazardous air pollutants (HAPs). Fossil fuel combustion is expected to be the only source of HAPs as well as the major source of greenhouse gases, NOx, SOx, and PM10. Estimated greenhouse gas emissions due to off-site trucking are summarized in Table 4-2.

PM10 is generated during excavating and grading activities, including excavating material, hauling or otherwise handling excavated material, placing and compacting earthen materials, and driving on unpaved roads. Dust generation can be reduced through dust suppression methods, such as applying water, covering material in open trucks, using soil tackifiers, covering stockpiles, limiting on-site vehicle speed, and revegetating excavated areas as quickly as possible. Due to the factors discussed above, the air pollution emissions will be highest for alternatives that transport waste off-site.

As with energy demand, the greatest air pollution generation will be from the operation of heavy equipment during excavation activities and from trucks used to transport materials and waste. Thus, the ranking for air pollution is the same as for energy consumption. The alternatives rank as follows from least air pollution generated to most: 1, 3, 4, and 2. As with energy demand, Alternative 2 is expected to create air pollution that is an order of magnitude greater than the other alternatives due to the significant number of loads transported off-site and distance to the off-site repository.

Water Use and Impacts on Water Resources

Surface waters in the area are ephemeral and are generally only present for a day or two after rains occur during summer monsoon periods. Because of this, a local water source is unavailable; water demand will have to be meet with water trucked in from outside or by installing a well. Water use should also be considered as part of the energy demand transportation requirements and thus should be minimized both because of the impact on water resources and because of associated increase in electrical and fossil fuel demands. The main use of water, regardless of which alternative is selected, will be for dust suppression and soil moisture conditioning to achieve the required relative density for compacted soil, followed by equipment decontamination. Thus, the alternatives with the highest excavation, consolidation, and transportation requirements will also have the highest water use.

Water use will not be the only impact on water resources. The creation of impervious caps reduces the infiltration of stormwater, resulting in higher peak flows in the receiving stream. The creation of engineered soil caps will temporarily increase runoff until vegetation is well established and final stabilization is achieved, which could take as long as 10 years. The higher peak flows will result in an increased risk of flooding and higher rates of erosion, which would impact water quality. This effect will increase in direct proportion to the footprint of any impervious cap. If the waste is disposed of at licensed facility, the size of the cap in relation to the volume of waste may be reduced due consolidation with waste from other sites. However, these facilities are also the most likely to use impervious caps. The risk of increasing peak flows can be mitigated by diverting the runoff for another use, such as irrigation, or to an area it can infiltrate into the ground, such as bioswales and stormwater detention basins. In addition to reducing infiltration, a cap can potentially change drainage patterns. However, this effect can be reduced by mimicking the slope of existing terrain.

Sediment runoff, particularly during excavation activities, can also degrade water quality during the project. Sediment runoff will increase nutrient loading and suspended solids in the receiving water. Since the sediment runoff would largely be from contaminated soil, another potential impact is the migration of radiation into nearby water resources. The greater the excavation footprint and duration of excavation, the greater expected impact. Sediment runoff can be minimized by avoiding excavation activities during the monsoon season, minimizing the amount of soil disturbed at a given time, and using sediment controls (e.g., reseeding bare soil as quickly as possible; installing silt fence, straw wattles and fiber rolls; and constructing stormwater detention basins). Migration of waste off-site through stormwater is a general concern for water bodies. With the exception of Alternative 1, the No Action Alternative, all of the alternatives provide long term mitigation of waste migration offsite.

Given all the factors outlined above, the alternatives rank as follows for water use and impact on water resources from best to worst: 3, 4, 2 and 1.

Materials Management and Waste Reduction

Materials management and waste reduction efforts consider the total amount of materials used on-site and the percentage of those materials that are produced from recycled material, reused material, or waste material. Excluding fuels, which are evaluated separately, imported materials include the earth and rock materials in caps, geotextile fabrics, temporary fencing, silt fencing, culverts, large rock for riprap, and other water management and sediment and erosion control devices. The alternatives will all generate cleared vegetation in proportion to the amount of land disturbed. These factors are expected to apply regardless of which alternative is selected (i.e., whether on or off-site, all are expected to require varying amounts of the above materials).

Given these factors, the alternatives rank as follows for impact on materials management and waste reduction from best to worst: 1, 3, 4, and 2.

Ecosystem Services

The negative effect on water resources described above is one of the ecosystem services impacts. Degrading water quality and quantity will affect the flora and fauna that depend on these sources. Increased nutrient loading could cause algae blooms in downstream water bodies and increased suspended solids could inhibit stream life by blocking sunlight that allows photosynthesis. The more effective alternatives will be more protective of ecosystem services.

Given that none of the alternatives disturb previously undisturbed areas, or areas with hazardous waste, long term habitat degradation on land is unlikely in all alternatives. However, removal activities themselves will cause a temporary disruption to wildlife. Noise, ground disturbing work, and any artificial light can all impact sensitive species. To minimize these impacts, it is recommended to avoid conducting operations during nesting or breeding seasons whenever possible.

Given all the factors outlined above, the alternatives rank as follows for impact on ecosystem services from best to worst: 3, 4, 2, and 1.

Summary

A summary of the rankings for each of the core elements can be found in Table N-1. The table also presents an overall greenness score for each alternative. The score was calculated by summing the ranks each alternative received for each of the five core areas. The overall ranking of alternatives for greenness, from best to worse, are as follows: 3, 1, 4, and 2.

References

USEPA. 2009. *Principles for Greener Cleanups*. August 27.

USEPA. 2012. *Methodology for Understanding and Reducing a Project's Environmental Footprint*. February.

USEPA. 2016. *Memorandum: Consideration of Greener Cleanup Activities in the Superfund Cleanup Process*. August 2.

List of Tables

Table N-1 Green Alternatives Assessment Summary

	Minimizes Total Energy Use and Maximizes Use of Renewable Energy	Minimizes Air Pollutants and Greenhouse Gas Emissions	Minimizes Water Use and Impacts to Water Resources	Reduce, Reuse, and Recycle Materials and Waste	Protect Land and Ecosystems	TOTAL
Alternative 1, No Further Action	1	1	4	1	4	**11**
Alternative 2, Excavation and Off-Site Processing and Disposal of Contaminated Soils at Licensed Low-Level RadioActive Waste Facility (Clean Harbors, Deer Trail, CO)	4	4	3	4	3	**18**
Alternative 3, Excavation and Disposal of Contaminated Soil at the On-Site Repository	2	2	1	2	1	**8**
Alternative 4, Capping of Contaminated Soil in Place	3	3	2	3	2	**13**

APPENDIX O

TDD NO. 0001/17-044

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U.S. EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Vendor : WESTON SOLUTIONS, INC.

TDD # : 0001/17-044
Amendment # :
Contract # : EP-S5-17-02

TDD Title : Tronox NAUM Section 10
Purpose : TDD INITIATION
Priority : HIGH
Overtime Authorized : Yes
Invoice Unit :

Verbal Date :
Start Date : 08/15/2017
Completion Date : 08/15/2018
Effective Date : 08/15/2017

SSID : 0600
Project/Site Name : Tronox NAUM Section 10
Project Address :
County : McKinley
City :
State : NM
Zip Code :

Work Area : Response / Removal
Work Area Code :
Activity : Engineering Evaluation / Cost Analysis (EE/CA)
Activity Code : EE
Operable Unit :
Emergency Code :
FPN :
Performance Based : No

Authorized TDD Ceiling :

	Amount	LOE (Hours)
Previous Action(s) :	$0.00	0.00
This Action :	$0.00	0.00
New Total :	$0.00	0.00

Specific Elements :

Description of Work :

See Schedule

Region Specific :

CERCLIS: :

Misc 2 :

Accounting and Appropriation Information: **SFO:**

Line	Budget / FY	Approp	Budget Org	Program Element	Object Class	Site Project	Cost Org	DCN Line-ID	Funding Category	TDD Amount

U.S. EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Vendor : WESTON SOLUTIONS, INC.

TDD # : 0001/17-044
Amendment # :
Contract # : EP-S5-17-02

Project Officer : Will LaBombard (Signature) (Date)	**Branch Mail Code:** **Phone Number :** 214-665-7199 **Fax Number :**
Contracting Officer Representative William Rhotenberry (Signature) (Date)	**Branch Mail Code :** **Phone Number :** 214-665-8372 **Fax Number :**
Contract Specialist: Brian Delaney (Signature) (Date)	**Branch Mail Code :** **Phone Number :** 214-665-7473 **Fax Number :**
Contracting Officer : Brian Delaney Electronically Signed by Brian Delaney 08/15/2017 (Signature) (Date)	**Branch Mail Code :** **Phone Number :** 214-665-7473 **Fax Number :**
Other Agency Official (Signature) (Date)	**Branch Mail Code :** **Phone Number :** **Fax Number :**

Description of Work:The initial funding ceiling for this TDD is set at $100,000. This site has a Reimbursable Account (TR2, TR2B, etc.) and all TDD costs shall be invoiced against this SSID-specific TO funding. The contractor shall notify the PO and COR when the TR2B funding is 85% expended. When this special account funding is not available, costs shall be invoiced against the oldest 6A00E or 6A00S funding on the task order.

The contractor shall use SSID A6PK on all forms, reports, emails, communications, and deliverables.

The Contractor shall conduct assessments, sampling and other taskings such as archaeological assessments in support of an Engineering Evaluation/Cost Assessment (EE/CA). The EE/CA shall be conducted utilizing established procedures and protocols from previous Tronox NAUM sites.

Warren Zehner will be the alternate COR on this TDD.

U.S. EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Vendor : WESTON SOLUTIONS, INC.

TDD # : 0001/17-044
Amendment # : 001
Contract # : EP-S5-17-02

TDD Title : Tronox NAUM Section 10
Purpose : INCREMENTAL FUNDING,EXTEND POP
Priority : HIGH
Overtime Authorized : Yes
Invoice Unit :

Verbal Date :
Start Date : 03/28/2018
Completion Date : 12/18/2018
Effective Date : 03/28/2018

SSID : 0600
Project/Site Name : Tronox NAUM Section 10
Project Address :
County : McKinley
City :
State : NM
Zip Code :

Work Area : Response / Removal
Work Area Code :
Activity : Engineering Evaluation / Cost Analysis (EE/CA)
Activity Code : EE
Operable Unit :
Emergency Code :
FPN :
Performance Based : No

Authorized TDD Ceiling :

	Amount	LOE (Hours)
Previous Action(s) :	$0.00	0.00
This Action :	$0.00	0.00
New Total :	$0.00	0.00

Specific Elements :

Description of Work :

See Schedule

Region Specific :

CERCLIS: :

Misc 2 :

Accounting and Appropriation Information: **SFO:**

Line	Budget / FY	Approp	Budget Org	Program Element	Object Class	Site Project	Cost Org	DCN Line-ID	Funding Category	TDD Amount

U.S. EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Vendor : WESTON SOLUTIONS, INC.

TDD # : 0001/17-044
Amendment # : 001
Contract # : EP-S5-17-02

Project Officer : Will LaBombard (Signature) (Date)		Branch Mail Code:	
		Phone Number :	214-665-7199
		Fax Number :	
Contracting Officer Representative William Rhotenberry (Signature) (Date)		Branch Mail Code :	
		Phone Number :	214-665-8372
		Fax Number :	
Contract Specialist: Michael J. Pheeny (Signature) (Date)		Branch Mail Code :	
		Phone Number :	214-665-2798
		Fax Number :	
Contracting Officer : Michael J. Pheeny Electronically Signed by Michael J. Pheeny (Signature)	04/05/2018 (Date)	Branch Mail Code :	
		Phone Number :	214-665-2798
		Fax Number :	
Other Agency Official (Signature) (Date)		Branch Mail Code :	
		Phone Number :	
		Fax Number :	

Description of Work:
Amendment 001 - Extend the TDD POP to 12/18/2018 and increase the funding ceiling by $100,000 (for a new ceiling of $200,000) so that work can continue.
Base ORIG - The initial funding ceiling for this TDD is set at $100,000. This site has a Reimbursable Account (TR2, TR2B, etc.) and all TDD costs shall be invoiced against this SSID-specific TO funding. The contractor shall notify the PO and COR when the TR2B funding is 85% expended. When this special account funding is not available, costs shall be invoiced against the oldest 6A00E or 6A00S funding on the task order.

The contractor shall use SSID A6PK on all forms, reports, emails, communications, and deliverables.

The Contractor shall conduct assessments, sampling and other taskings such as archaeological assessments in support of an Engineering Evaluation/Cost Assessment (EE/CA). The EE/CA shall be conducted utilizing established procedures and protocols from previous Tronox NAUM sites.

Warren Zehner will be the alternate COR on this TDD.

Technical Direction Document

U.S. EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733
Vendor : WESTON SOLUTIONS, INC.

TDD # : 0001/17-044
Amendment # : 002
Contract # : EP-S5-17-02

TDD Title : Tronox NAUM Section 10
Purpose : EXTEND POP
Priority : HIGH
Overtime Authorized : Yes
Invoice Unit :

Verbal Date :
Start Date : 03/28/2018
Completion Date : 08/14/2019
Effective Date : 03/28/2018

SSID : 0600
Project/Site Name : Tronox NAUM Section 10
Project Address :
County : McKinley
City :
State : NM
Zip Code :

Work Area : Response / Removal
Work Area Code :
Activity : Engineering Evaluation / Cost Analysis (EE/CA)
Activity Code : EE
Operable Unit :
Emergency Code :
FPN :
Performance Based : No

Authorized TDD Ceiling :

	Amount	LOE (Hours)
Previous Action(s) :	$0.00	0.00
This Action :	$0.00	0.00
New Total :	$0.00	0.00

Specific Elements :

Description of Work :

See Schedule

Region Specific :

CERCLIS: :

Misc 2 :

Accounting and Appropriation Information: **SFO:**

Line	Budget / FY	Approp.	Budget Org	Program Element	Object Class	Site Project	Cost Org	DCN Line-ID	Funding Category	TDD Amount

U.S. EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Vendor : WESTON SOLUTIONS, INC.

TDD # : 0001/17-044
Amendment # : 002
Contract # : EP-S5-17-02

Project Officer : Will LaBombard		**Branch Mail Code:**	
(Signature)	(Date)	**Phone Number :**	214-665-7199
		Fax Number :	
Contracting Officer Representative William Rhotenberry		**Branch Mail Code :**	
(Signature)	(Date)	**Phone Number :**	214-665-8372
		Fax Number :	
Contract Specialist: Michael J. Pheeny		**Branch Mail Code :**	
(Signature)	(Date)	**Phone Number :**	214-665-2798
		Fax Number :	
Contracting Officer : Michael J. Pheeny		**Branch Mail Code :**	
Electronically Signed by Michael J. Pheeny (Signature)	08/13/2018 (Date)	**Phone Number :**	214-665-2798
		Fax Number :	
Other Agency Official		**Branch Mail Code :**	
(Signature)	(Date)	**Phone Number :**	
		Fax Number :	

Description of Work:
Amendment 002 - Extend the TDD POP to 08/14/2019 so that work can continue. No other changes needed.
Amendment 001 - Extend the TDD POP to 12/18/2018 and increase the funding ceiling by $100,000 (for a new ceiling of $200,000) so that work can continue.
Base ORIG - The initial funding ceiling for this TDD is set at $100,000. This site has a Reimbursable Account (TR2, TR2B, etc.) and all TDD costs shall be invoiced against this SSID-specific TO funding. The contractor shall notify the PO and COR when the TR2B funding is 85% expended. When this special account funding is not available, costs shall be invoiced against the oldest 6A00E or 6A00S funding on the task order.

The contractor shall use SSID A6PK on all forms, reports, emails, communications, and deliverables.

The Contractor shall conduct assessments, sampling and other taskings such as archaeological assessments in support of an Engineering Evaluation/Cost Assessment (EE/CA). The EE/CA shall be conducted utilizing established procedures and protocols from previous Tronox NAUM sites.

Warren Zehner will be the alternate COR on this TDD.

Technical Direction Document

U.S. EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Vendor : WESTON SOLUTIONS, INC.

TDD # : 0001/17-044
Amendment # : 003
Contract # : EP-S5-17-02

TDD Title : Tronox NAUM Section 10
Purpose : CHANGE COR
Priority : HIGH
Overtime Authorized : Yes
Invoice Unit :

Verbal Date :
Start Date : 03/28/2018
Completion Date : 08/14/2019
Effective Date : 03/28/2018

SSID : 0600
Project/Site Name : Tronox NAUM Section 10
Project Address :
County : McKinley
City :
State : NM
Zip Code :

Work Area : Response / Removal
Work Area Code :
Activity : Engineering Evaluation / Cost Analysis (EE/CA)
Activity Code : EE
Operable Unit :
Emergency Code :
FPN :
Performance Based : No

Authorized TDD Ceiling :

	Amount	LOE (Hours)
Previous Action(s) :	$0.00	0.00
This Action :	$0.00	0.00
New Total :	$0.00	0.00

Specific Elements :

Description of Work :

See Schedule

Region Specific :

CERCLIS: :

Misc 2 :

Accounting and Appropriation Information: **SFO:**

Line	Budget / FY	Approp.	Budget Org	Program Element	Object Class	Site Project	Cost Org	DCN Line-ID	Funding Category	TDD Amount

U.S. EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Vendor : WESTON SOLUTIONS, INC.

TDD # : 0001/17-044
Amendment # : 003
Contract # : EP-S5-17-02

Project Officer : Will LaBombard (Signature) (Date)	**Branch Mail Code:** **Phone Number :** 214-665-7199 **Fax Number :**
Contracting Officer Representative William Rhotenberry (Signature) (Date)	**Branch Mail Code :** **Phone Number :** 214-665-8372 **Fax Number :**
Contract Specialist: Brian Delaney (Signature) (Date)	**Branch Mail Code :** **Phone Number :** 214-665-7473 **Fax Number :**
Contracting Officer : Brian Delaney Electronically Signed by Brian Delaney 12/14/2018 (Signature) (Date)	**Branch Mail Code :** **Phone Number :** 214-665-7473 **Fax Number :**
Other Agency Official (Signature) (Date)	**Branch Mail Code :** **Phone Number :** **Fax Number :**

Description of Work:
Amendment 003 - Change the primary COR for this TDD to Warren Zehner.
Amendment 002 - Extend the TDD POP to 08/14/2019 so that work can continue. No other changes needed.
Amendment 001 - Extend the TDD POP to 12/18/2018 and increase the funding ceiling by $100,000 (for a new ceiling of $200,000) so that work can continue.
Base ORIG - The initial funding ceiling for this TDD is set at $100,000. This site has a Reimbursable Account (TR2, TR2B, etc.) and all TDD costs shall be invoiced against this SSID-specific TO funding. The contractor shall notify the PO and COR when the TR2B funding is 85% expended. When this special account funding is not available, costs shall be invoiced against the oldest 6A00E or 6A00S funding on the task order.

The contractor shall use SSID A6PK on all forms, reports, emails, communications, and deliverables.

The Contractor shall conduct assessments, sampling and other taskings such as archaeological assessments in support of an Engineering Evaluation/Cost Assessment (EE/CA). The EE/CA shall be conducted utilizing established procedures and protocols from previous Tronox NAUM sites.

Warren Zehner will be the alternate COR on this TDD.

U.S. EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Vendor : WESTON SOLUTIONS, INC.

TDD # : 0001/17-044
Amendment # : 004
Contract # : EP-S5-17-02

TDD Title : Tronox NAUM Section 10
Purpose : EXTEND POP,INCREMENTAL FUNDING
Priority : HIGH
Overtime Authorized : Yes
Invoice Unit :

Verbal Date :
Start Date : 03/28/2018
Completion Date : 08/14/2019
Effective Date : 03/28/2018

SSID : 0600
Project/Site Name : Tronox NAUM Section 10
Project Address :
County : McKinley
City :
State : NM
Zip Code :

Work Area : Response / Removal
Work Area Code :
Activity : Engineering Evaluation / Cost Analysis (EE/CA)
Activity Code : EE
Operable Unit :
Emergency Code :
FPN :
Performance Based : No

Authorized TDD Ceiling :

	Amount	LOE (Hours)
Previous Action(s) :	$0.00	0.00
This Action :	$0.00	0.00
New Total :	$0.00	0.00

Specific Elements :

Description of Work :

See Schedule

Region Specific :

CERCLIS: :

Misc 2 :

Accounting and Appropriation Information: **SFO:**

Line	Budget / FY	Approp	Budget Org	Program Element	Object Class	Site Project	Cost Org	DCN Line-ID	Funding Category	TDD Amount

U.S. EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Vendor : WESTON SOLUTIONS, INC.

TDD # : 0001/17-044
Amendment # : 004
Contract # : EP-S5-17-02

Project Officer : Will LaBombard		**Branch Mail Code:**	
(Signature)	(Date)	**Phone Number :**	214-665-7199
		Fax Number :	
Contracting Officer Representative William Rhotenberry		**Branch Mail Code :**	
(Signature)	(Date)	**Phone Number :**	214-665-8372
		Fax Number :	
Contract Specialist: Brian Delaney		**Branch Mail Code :**	
(Signature)	(Date)	**Phone Number :**	214-665-7473
		Fax Number :	
Contracting Officer : Brian Delaney		**Branch Mail Code :**	
Electronically Signed by Brian Delaney (Signature)	04/16/2019 (Date)	**Phone Number :**	214-665-7473
		Fax Number :	
Other Agency Official		**Branch Mail Code :**	
(Signature)	(Date)	**Phone Number :**	
		Fax Number :	

Description of Work:
Amendment 004 - Extend the TDD POP to 08/14/2020 and increase the funding ceiling by $125,000 (from $200,000 to $325,000) for additional LOE within the existing specific elements of this TDD. Funding for this amendment is from the Tronox NAUM TR2 account A6PK.
Amendment 003 - Change the primary COR for this TDD to Warren Zehner.
Amendment 002 - Extend the TDD POP to 08/14/2019 so that work can continue. No other changes needed.
Amendment 001 - Extend the TDD POP to 12/18/2018 and increase the funding ceiling by $100,000 (for a new ceiling of $200,000) so that work can continue.
Base ORIG - The initial funding ceiling for this TDD is set at $100,000. This site has a Reimbursable Account (TR2, TR2B, etc.) and all TDD costs shall be invoiced against this SSID-specific TO funding. The contractor shall notify the PO and COR when the TR2B funding is 85% expended. When this special account funding is not available, costs shall be invoiced against the oldest 6A00E or 6A00S funding on the task order.

The contractor shall use SSID A6PK on all forms, reports, emails, communications, and deliverables.

The Contractor shall conduct assessments, sampling and other taskings such as archaeological assessments in support of an Engineering Evaluation/Cost Assessment (EE/CA). The EE/CA shall be conducted utilizing established procedures and protocols from previous Tronox NAUM sites.

Warren Zehner will be the alternate COR on this TDD.

Technical Direction Document

U.S. EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Vendor : WESTON SOLUTIONS, INC.

TDD # : 0001/17-044
Amendment # : 005
Contract # : EP-S5-17-02

TDD Title : Tronox NAUM Section 10
Purpose : CORRECT COMPLETION DATE FIELD
Priority : HIGH
Overtime Authorized : Yes
Invoice Unit :

Verbal Date :
Start Date : 03/28/2018
Completion Date : 08/14/2020
Effective Date : 03/28/2018

SSID : 0600
Project/Site Name : Tronox NAUM Section 10
Project Address :
County : McKinley
City :
State : NM
Zip Code :

Work Area : Response / Removal
Work Area Code :
Activity : Engineering Evaluation / Cost Analysis (EE/CA)
Activity Code : EE
Operable Unit :
Emergency Code :
FPN :
Performance Based : No

Authorized TDD Ceiling :

	Amount	LOE (Hours)
Previous Action(s) :	$0.00	0.00
This Action :	$0.00	0.00
New Total :	$0.00	0.00

Specific Elements :

Description of Work :
See Schedule

Region Specific :
CERCLIS: :
Misc 2 :

Accounting and Appropriation Information: **SFO:**

Line	Budget / FY	Approp.	Budget Org	Program Element	Object Class	Site Project	Cost Org	DCN Line-ID	Funding Category	TDD Amount

U.S. EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Vendor : WESTON SOLUTIONS, INC.

TDD # : 0001/17-044
Amendment # : 005
Contract # : EP-S5-17-02

Project Officer : Will LaBombard	(Signature)	(Date)
Branch Mail Code:	Phone Number : 214-665-7199	Fax Number :
Contracting Officer Representative William Rhotenberry	(Signature)	(Date)
Branch Mail Code :	Phone Number : 214-665-8372	Fax Number :
Contract Specialist: Brian Delaney	(Signature)	(Date)
Branch Mail Code :	Phone Number : 214-665-7473	Fax Number :
Contracting Officer : Brian Delaney	Electronically Signed by Brian Delaney (Signature)	04/29/2019 (Date)
Branch Mail Code :	Phone Number : 214-665-7473	Fax Number :
Other Agency Official	(Signature)	(Date)
Branch Mail Code :	Phone Number :	Fax Number :

Description of Work:
Amendment 005 - Amendment 4 extended the POP to 8/14/2020, but the "Completion Date" field was not changed from 8/14/2019. This amendment corrects the "Completion Date" field to also reflect 8/14/2020.
Amendment 004 - Extend the TDD POP to 08/14/2020 and increase the funding ceiling by $125,000 (from $200,000 to $325,000) for additional LOE within the existing specific elements of this TDD. Funding for this amendment is from the Tronox NAUM TR2 account A6PK.
Amendment 003 - Change the primary COR for this TDD to Warren Zehner.
Amendment 002 - Extend the TDD POP to 08/14/2019 so that work can continue. No other changes needed.
Amendment 001 - Extend the TDD POP to 12/18/2018 and increase the funding ceiling by $100,000 (for a new ceiling of $200,000) so that work can continue.
Base ORIG - The initial funding ceiling for this TDD is set at $100,000. This site has a Reimbursable Account (TR2, TR2B, etc.) and all TDD costs shall be invoiced against this SSID-specific TO funding. The contractor shall notify the PO and COR when the TR2B funding is 85% expended. When this special account funding is not available, costs shall be invoiced against the oldest 6A00E or 6A00S funding on the task order.

The contractor shall use SSID A6PK on all forms, reports, emails, communications, and deliverables.

The Contractor shall conduct assessments, sampling and other taskings such as archaeological assessments in support of an Engineering Evaluation/Cost Assessment (EE/CA). The EE/CA shall be conducted utilizing established procedures and protocols from previous Tronox NAUM sites.

Warren Zehner will be the alternate COR on this TDD.