Northern Agency Tronox Mines

DRAFT FINAL
Appendix K
Access Road Report

Response, Assessment, and Evaluation Services (RAES)

Contract No. EP-S9-17-03

Task Order 0001

July 26, 2019

Submitted to

U.S. Environmental Protection Agency

Submitted by

Tetra Tech, Inc.

1999 Harrison Street, Suite 500

Oakland, CA 94612

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (CONTINUED)

LIST OF FIGURES

LIST OF FIGURES (CONTINUED)

ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

ANSI	American National Standard Institute
ASPECT	Airborne Spectral and Photometric Environmental Collection Technology
ASTM	ASTM International
AUM	Abandoned uranium mine
bgs	Below ground surface
BSA	Background study area
BSA-5	Background Study Area 5
BSA-9	Background Study Area 9
BSA-10	Background Study Area 10
BSA-13	Background Study Area 13
BSA-14	Background Study Area 14
BSA-15	Background Study Area 15
BSA-18	Background Study Area 18
BSA-19	Background Study Area 19
BSA-20	Background Study Area 20
BSA-21	Background Study Area 21
BSA-22	Background Study Area 22
BSA-24	Background Study Area 24
BSA-25	Background Study Area 25
BSA-26	Background Study Area 26
BSA-29	Background Study Area 29
BSA-30	Background Study Area 30
BSA-31	Background Study Area 31
BTV	Background threshold value
CAS	Chemical Abstract Service
COPC	Contaminant of potential concern
cpm	Count per minute
DEM	Digital elevation model
DQO	Data quality objective
EE/CA	Engineering evaluation/cost analysis
ERG	Environmental Restoration Group, Inc.
GIS	Geographic information system
GPS	Global positioning system
HDOP	Horizontal dilution of precision
HPIC	High pressure ionization chamber
J	Estimated value
Jc	Jurassic Carmel Formation

ACRONYMNS AND ABBREVIATIONS (CONTINUED)

Jml	Jurassic Lower Morrison Formation
Jse	Jurassic Undifferentiated Summerville and Entrada Sandstone
Jste	Jurassic Undifferentiated Summerville, Todilto, and Entrada Sandstone
Kerr-McGee	Kerr-McGee Oil Industries, Inc.
LT	Result less than requested minimum detectable concentration, but greater than sample-specific detectable concentration.
MARSSIM	*Multi-Agency Radiation Survey and Site Investigation Manual*
MARLAP	*Multi-Agency Radiation Laboratory Analytical Protocols Manual*
mg/kg	Milligrams per kilogram
NA	Not applicable
NaI	Sodium iodide
NAUM	Navajo Abandoned uranium mine
NAMLRP	Navajo Abandoned Mine Lands Reclamation Program
NORM	Naturally occurring radioactive material
pCi/g	Picocuries per gram
Q	Qualifier
QA/QC	Quality assurance/quality control
RAES	Response, Assessment and Evaluation Services
RPM	Remedial Project Manager
RPP	Radiation protection program
RSE	Removal site evaluation
RSE Report	Northern Agency Tronox Mines Removal Site Evaluation Report
SAP/QAPP	Sampling Analysis Plan/Quality Assurance Project Plan
SSRSE	Site-specific removal site evaluation
SOP	Standard operating procedure
TENORM	Technologically enhanced naturally occurring radioactive material
Tetra Tech	Tetra Tech, Inc.
TPU	Total propagated uncertainty
U	Not detected. The associated value is the reporting limit
UJ	Not considered detected. The associated value is the reported concentration, which is estimated.
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USL 95	95 percent upper simultaneous limit

ACRONYMNS AND ABBREVIATIONS (CONTINUED)

UTL 95-95	95 percent upper tolerance limit
XRF	X-ray fluorescence

EXECUTIVE SUMMARY

This Access Road Report is Appendix K to the Removal Site Evaluation (RSE) Report for the Northern Agency Tronox Mines. The purpose of this report is to document the data quality objectives (DQOs), sampling and analytical methodology, and results of the access road investigation that was conducted as part of large scale RSE investigation undertaken by Tetra Tech Inc. (Tetra Tech) in support of the U.S. Environmental Protection Agency (USEPA) Region 9 between March 2018 and October 2018. The project involved the characterization of over 39 abandoned uranium mines (AUM), 37 Targets, 22 miles of drainages, 9.8 miles of access roads and footpaths, and 32 background study areas (BSA).

This access road field investigation was performed to (1) determine whether contaminants are being transported from AUMs via vehicular or foot traffic; (2) evaluate access roads and footpaths that may have been impacted from historic mining operations, and (3) determine whether contaminants of potential concern (COPC) in soil samples exceed background levels for road clusters. Due to the wide ranging extent of access roads and footpaths in the project area, this report has been organized to group access roads into clusters which are associated with one or more AUMs.

The access road investigation involved collection of gamma radiation measurements, X-ray fluorescence (XRF) measurements, and XRF confirmation soil samples along access roads and footpaths in the vicinity of the Tronox mines. No data had been collected previously along roads and footpaths. Gamma radiation measurements were collected during field mobilizations to individual AUM mines from April through September 2018. XRF measurements and XRF confirmation samples were collected in September 2018 from surface soils and analyzed for metals and radionuclides. Table K-ES-1 summarizes whether the results of the XRF and gamma radiation surveys and soil sampling indicate potential impacts from mining activities within each access road cluster. The conclusions from the access road investigation are:

- The linear extent of radiological contamination along the access roads and footpaths surveyed was well documented through gamma radiation surveys, and the full linear extent beyond hot spots has been characterized.
- Some access roads are potentially impacted from mining activities conducted at nearby Tronox Mines, as indicated by concentrations of primary analytes or gamma measurements exceeding twice the applied BTV.

In general, the access road investigation was successful at fulfilling the data quality objectives (DQO) in areas where samples were collected. There are many other roads and footpaths in the vicinity of the Tronox mines, therefore data gaps exist for other roads and footpaths where data was not collected and where results suggest the need for additional evaluation of extent of contamination. The data generated during this investigation will be used to assist in developing and evaluating AUM-specific cleanup options in the engineering evaluation/cost analysis (EE/CA).

Table K-ES-1. Summary of Soil Sampling and Gamma Survey Results Potentially Indicating Potential Impacts from Mining Activities on Access Road Clusters

Cluster Number	Cluster Name	Soil Sampling Results Indicate Potential Impacts?	Gamma Survey Results Indicate Potential Impacts?
1	Block K Roads	No (<BTV)	No (median <BTV)
2	Mesa V Mine Complex Roads	Yes (>2x BTV)	Yes (maximum value >2x BTV)
3	Mesa V Mine - 103 Haul Shaft Road	No (<2x BTV)	Yes, central portion of the haul shaft road (median < BTV, maximum value >2x BTV)
4	Mesa IV Mine Complex Road	Yes (>2x BTV)	No (median <BTV)
5	Mesa IV, West Mine Road	Yes (>2x BTV)	Not measured
6	Mesa II 1/2 Mine and Mesa III Mine Roads	Yes (>2x BTV)	Yes (maximum value >2x BTV)
7	Mesa I 3/4 and Mesa II Mine Complex Roads	No (1 detect >2x BTV)	No (median <BTV)
8	Mesa II, Mine 4 Road	Yes (>2x BTV)	No (median <BTV)
9	Mesa I Mine Complex Roads	Yes (>2x BTV)	No (median <BTV)
10	Mesa II Pit Road	Yes (>2x BTV)	Yes (maximum value >2x BTV)
11	Mesa I 1/2 and Mesa I 1/4 Mine Complexes Roads	Not measured	Yes, adjacent to Henry Phillips Mine (maximum value >2x BTV)
12	Mesa I 3/4 Incline Road	Not measured	No (median about same as BTV)

Note:
BTV Background threshold value

1.0 INTRODUCTION

This Access Road Report is included as Appendix K of the Northern Agency Tronox Mines Removal Site Evaluation Report (RSE Report). The Access Road Report presents and documents the data quality objectives (DQO), sampling and analytical methodology, and results of the access road investigation performed along access roads and footpaths leading from the Northern Agency Tronox Mines by Tetra Tech, Inc. (Tetra Tech) in support of the U.S. Environmental Protection Agency (USEPA) under Task Order 0001 of the Response, Assessment, and Evaluation Services (RAES) contract (EP-S9-17-03). The data generated during this investigation will be used to assist in developing and evaluating cleanup options in the engineering evaluation/cost analysis (EE/CA).

Under Task Order 0001, Tetra Tech conducted removal site evaluation (RSE) field investigations at 39 abandoned uranium mine (AUM) sites and 37 Target sites previously operated by, or likely associated with, Kerr-McGee Oil Industries, Inc. (Kerr-McGee), or its successor, Tronox (both Kerr-McGee and Tronox referred to herein as (Tronox) at the Northern Agency Tronox Mines. "Targets" include site potentially contaminated from mine-related waste resulting from Tronox operations that are (1) related to AUM sites ("AUM-related sites") or (2) identified by USEPA as requiring additional characterization ("non-AUM targets"). In addition, Tetra Tech evaluated potential migration pathways including drainages and mine roads that may have been impacted from historic mining operations. Appendix H presents site-specific removal site evaluation (SSRSE) reports for each AUM site and AUM-related Target site, Appendix I presents the non-AUM Target sites evaluation report, and Appendix K presents the drainage investigation report. This appendix presents the results of the access road investigation, which includes evaluation of gamma radiation survey data, X-ray fluorescence (XRF) measurements, and XRF confirmation soil samples.

The AUM sites and Target sites within the Northern Agency have the potential for containing mine related contamination. The mine related contamination may consist of radionuclide and heavy metal soil and sediment concentrations above human health and or ecological risk levels. These mine related contaminants have the potential to be carried offsite via vehicular and foot traffic.

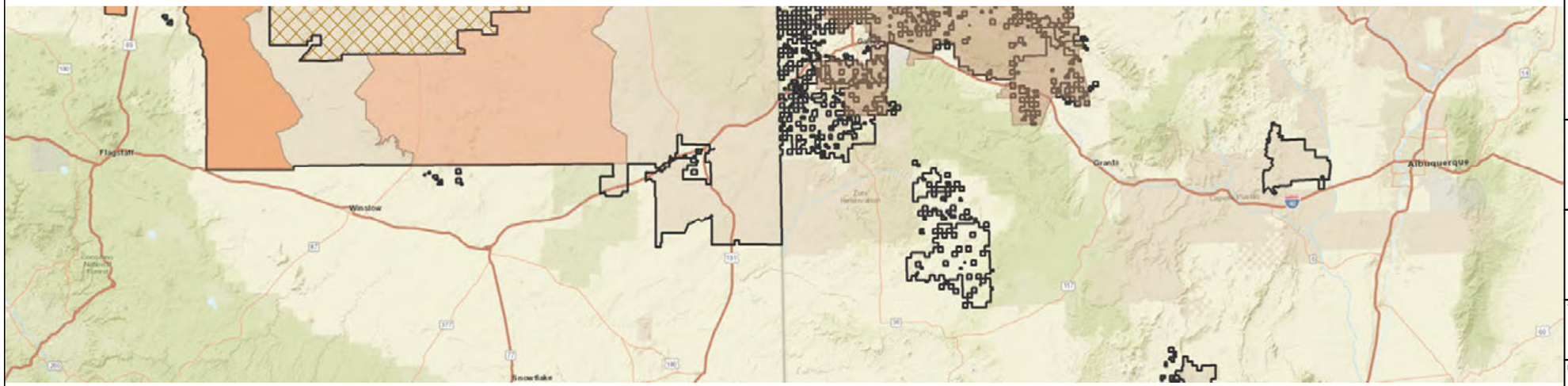
All work performed as part of the access road investigation was conducted in accordance with the Sampling Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) included as Appendix C of the RSE Work Plan submitted May 14, 2018 (Tetra Tech 2018). Deviations to the RSE Work Plan are discussed in the main text of the RSE report. The access roads and footpaths that underwent investigation described in this report are located within the Northern AUM Region, one of six AUM regions identified in the Navajo Nation. Figure K-1 presents an overview map of the different AUM regions in the Navajo Nation and highlights the Northern AUM Region area of interest where the access road investigation took place. This Access Road Report presents the methods, results, and data evaluation of the gamma radiation surveys, XRF field surveys, and soil sampling efforts performed by the Tetra Tech team. The surveys took place between April 2018 and September 2018 within the Sweetwater, Cove, and Lukachukai Chapters of the Navajo Nation, all of which are shown on Figure K-1.

This Access Road Report discusses the gamma and XRF survey and soil sampling results by "cluster" of access roads and footpaths within the same mine complex or general area. In some cases a road cluster encompasses an individual access road or footpath isolated from other roads. Table K-1 presents the access road clusters evaluated in this report along with the mines associated with each road cluster. Road cluster locations are presented in Figure K-2.

Table K-1. Access Road Cluster and Associated Mines

Cluster No.	Road Cluster Name	Associated Mines
1	Block K Roads	Block K Mine
2	Mesa V Mine Complex Roads	Mesa IV 1/2 Mine and Simpson 181; Mesa V Mine 103; Mesa V Adit; Mesa V Incline; and Frank Jr. Mine
3	Mesa V Mine - 103 Haul Shaft Road	Mesa V Mine - 103
4	Mesa IV Mine Complex Road	Mesa IV, Mine No. 1; Mesa IV, Mine No. 3; and Mesa IV, Mine No. 2
5	Mesa IV, West Mine Road	Mesa IV, West Mine
6	Mesa II 1/2 Mine and Mesa III Mine Roads	Mesa II 1/2 Mine and Mesa III Mine
7	Mesa I 3/4 and Mesa II Mine Roads	Mesa I 3/4 Mine No. 2 P150; Mesa II, Mine No. 1 & 2, P-21; and Mesa II, Mine No. 1, P-150
8	Mesa II, Mine 4 Road	Mesa II, Mine 4
9	Mesa I Mine Complex Roads	Mesa I Mine 10; Mesa I Mine 11; Mesa I Mine 12; Mesa I Mine 13; Mesa I Mine 14; and Mesa I Mine 15
10	Mesa II Pit Road	Mesa II Pit
11	Mesa I 1/2 Roads	Mesa I 1/2 Mine, Mesa 1 1/2 West Mine, Mesa I 1/4 Mine, and Henry Phillips Mine
12	Mesa I 3/4 Incline Road	Mesa I 3/4 Incline Mine

Coordinate System: NAD 1983 UTM Zone 12NTransverse Mercator



Affected Chapter Boundary

Navajo Nation Abandonded Uraniun Mine Regions

- Northern Region
- Central Region
- Eastern Region
- North Central Region
- Southern Region
- Western Region
- Navajo Nation
- Hopi Reservation

1 in = 26 mi

1:1,647,360

N
W E
S

26 13 0 26 Miles

REGIONAL OVERVIEW

Prepared For:

Prepared By:

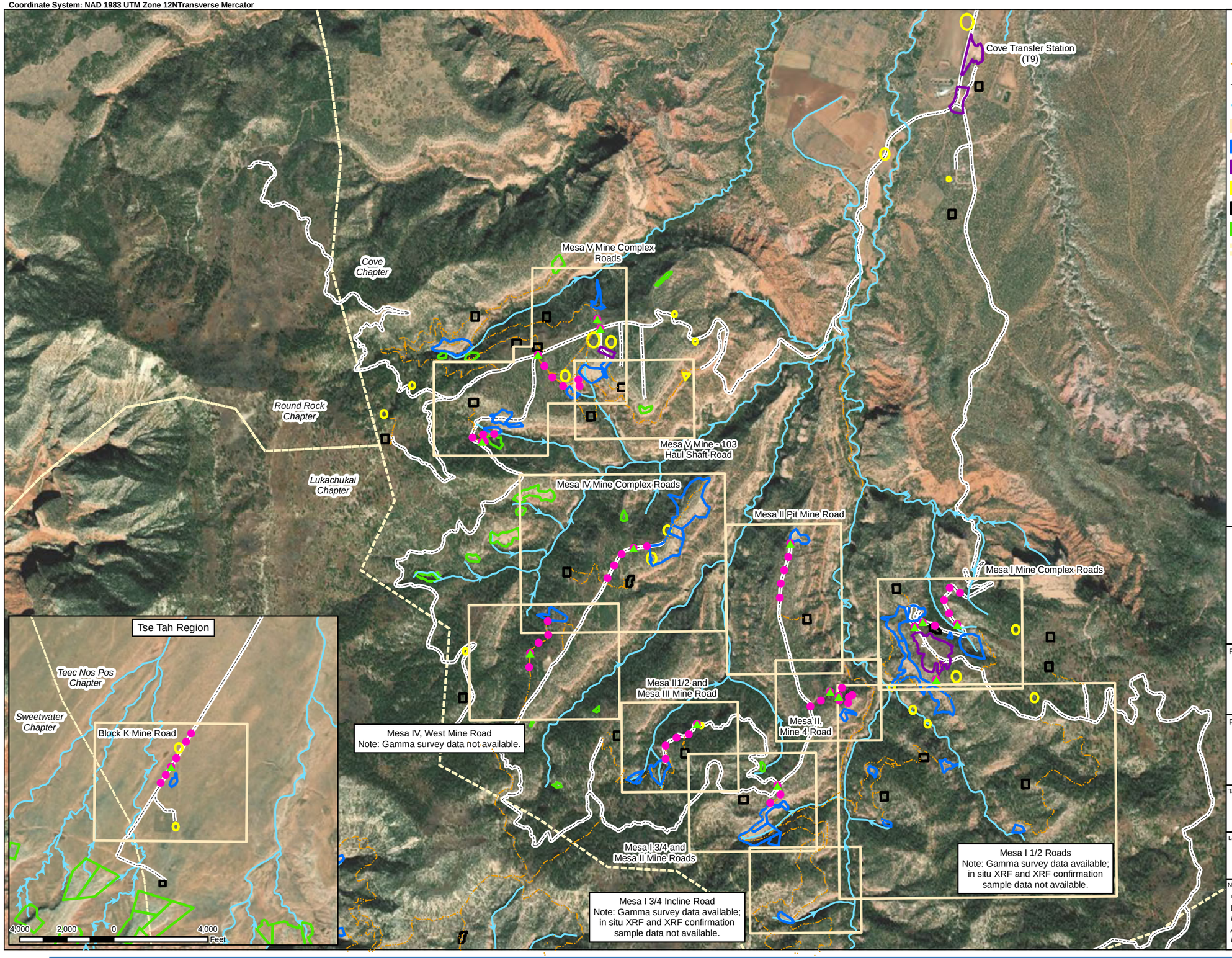
TETRA TECH
1999 Harrison Street, Suite 500
Oakland, CA 94612

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location:	**Date:**
NAVAJO NATION	7/10/2019

Notes:

Figure No.: K-1

Coordinate System: NAD 1983 UTM Zone 12NTransverse Mercator



- XRF Confirmation Soil Sample
- In Situ XRF Measurement
- Access Route - Foot
- Access Route - Vehicular
- Drainage*
- Index
- AUM Site Boundary
- AUM Related Site Boundary
- Non-AUM Target Site Boundary
- Background Location
- Non-Tronox AUM Site
- Affected Chapter Boundary

1 in = 2,200 ft

1:26,400

N W E S

2,200 1,100 0 2,200 Feet

ACCESS ROAD CLUSTER INDEX AND SAMPLE MAP

Prepared For:

Prepared By:

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

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location:	**Date:**
NAVAJO NATION	7/10/2019

Notes:
*U.S Environmental Protection Agency, Region 9, Superfund Program, *Abandoned Uranium Mines and the Navjo Nation Part II Atlas With Geospatial Data. NN_Drainage_HR_AUM.shp.* July, 2007.

Figure No.: K-2

1.1 PURPOSE

In 2018, Tetra Tech conducted a data gap analysis as part of a historical site assessment for the 39 Tronox mines. Based on the results of that data gap analysis, Tetra Tech concluded there was not sufficient data for USEPA to make risk management or cleanup decisions at the AUMs. Therefore, Tetra Tech (2018) developed several DQOs as part of the RSE Work Plan. Survey design and planning processes were integrated into the RSE investigations performed at the access roads associated with the Northern Agency Tronox Mines. The results of the data gap analysis are provided in Appendix A of the RSE Work Plan while a detailed list of DQOs are presented in the SAP/QAPP in Appendix C (Tetra Tech 2018). The objectives of the RSE investigation for the access roads and footpaths were as follows:

- Determine whether contaminants are being transported from AUMs via vehicular or foot traffic.
- Evaluate access roads and footpaths that may have been impacted from historic mining operations
- Determine whether contaminants of potential concern (COPC) in soil samples exceed established background levels for road clusters.

The following subsection presents the DQO Study Questions established for the access roads and footpaths and explains how each of the DQOs were addressed as part of this RSE investigation.

1.2 DATA QUALITY OBJECTIVES

A primary objective of the RSE investigation is to address the DQOs established for both the Baseline Study and Site Characterization Study. The DQOs for the project are presented in Appendix C of the RSE Work Plan (Tetra Tech 2018). DQOs for the access roads are intrinsically connected to the DQOs for the AUMs; however, only a subset of the study questions are specifically applicable to access roads and footpaths. A roadmap for how the Baseline Study DQOs and the Site Characterization Study DQOs are addressed in this access roads report are presented in Table K-2 and Table K-3, respectively.

Table K-2. Baseline Study Data Quality Objective Roadmap

Phase of the RSE	Question No.	Principal Study Question	Activity Performed to Address DQO	Section of Report
Baseline Study	1	What background levels of gamma radiation and the background concentrations of radionuclides and metals in soils and sediment that are representative of conditions at each site?	Background sampling	Section 3.0
	2	What is the lateral extent of mine-related surficial contamination at each site?	Site Mapping	Section 4.1
			Gamma Radiation Survey	Section 4.2
			XRF Survey	Section 4.3
			Soil Samples	Section 5.0
	3	Is there potential for contaminants to migrate offsite via surface water pathways at each site?	-	Migration pathways were not accessed
	4	Is there potential for contaminants to migrate offsite via the groundwater pathway?	-	No groundwater samples collected within access roads
	5	What is the spatial extent, locations, and types of NORM and TENORM at the site?	Site Mapping	Section 4.1
	6	Have the Tronox NAUM risk prioritization factors been evaluated adequately (such as site accessibility, reclamation status, land use, and waste material characteristics)?[1]	-	Section 2.0

Notes:

[1] Tronox NAUM risk prioritization factors are being developed by stakeholder to prioritize cleanup at Northern Agency Tronox Mines.
- No activities were performed to address DQO
DQO Data quality objective
NAUM Navajo Area Uranium Mines
NORM Naturally occurring radioactive material
TENORM Technologically enhanced naturally occurring radioactive material
XRF X-ray fluorescence

Table K-3. Site Characterization Study Data Quality Objective Roadmap

Phase of the RSE	Question No.	Principal Study Question	Activity Performed to Address DQO	Section of Report
Site Characterization Study	1	Did the Baseline Study adequately identify the lateral extent of surficial contamination at the site, downwind areas, and drainages?	Site Mapping	Section 4.1
			Gamma Radiation Survey	Section 4.2
			XRF Survey	Section 4.3
			Soil Samples	Section 5.0
	2	Has the lateral extent of mine-related radionuclides and metals in surface soil, waste, or sediment been adequately defined?	Soil Samples	Section 5.0
	3	What is the lateral and vertical extent of mine-related subsurface radionuclides and metals in soils and waste at each site?	-	Subsurface samples were not collected within access roads
	4	Are mine-related radionuclides and metals in surface soils, waste, and drainage sediments potentially leaching to surface water or groundwater?	-	No geochemical samples collected within access roads
	5	Has groundwater been impacted by historical mining activities? [1]	-	Main RSE Report
	6	What is the distribution of concentrations of radon gas present at accessible mine openings, waste piles, and drainages and is radon gas being emitted from buried waste cells?	-	No radon measured along access roads
	7	Have the physical characteristics of mine waste been adequately evaluated to support modeling, remedy evaluation, and evaluation of the Tronox NAUM risk prioritization factors?[1]	-	No geotechnical samples collected within access roads

Notes:

[1] Tronox NAUM risk prioritization factors are being developed by stakeholder to prioritize cleanup at Northern Agency Tronox Mines.

- Not applicable
DQO Data quality objective
NAUM Navajo Area Uranium Mines
XRF X-ray fluorescence

1.3 REPORT ORGANIZATION

The Access Road Report is organized as follows:

- Section 1.0 presents relevant background information, purpose and objectives, and DQOs.
- Section 2.0 presents a brief description of the access roads and footpaths and discusses the organization of the acess road investigation areas.
- Section 3.0 presents a summary of established background threshold levels for the access roads.
- Section 4.0 presents the sampling field methodology including site mapping, gamma radiation surveys, XRF surveys, soil sampling, and cultural resources surveys.
- Section 5.0 presents field sampling results of the gamma radiation and XRF surveys and soil sampling, discussed by access road cluster.
- Section 6.0 presents conclusions and identifies data gaps and recommendations.
- Section 7.0 presents the references for works cited in this report.

Attachments to this report provide important supporting information and data tables. The summary of attachments are as follows:

- Attachment K1 presents XRF survey and soil sample laboratory results.
- Attachment K2 presents the field documentation completed during the XRF surveys and soil sampling activities.

2.0 SITE SETTING

2.1 PHYSICAL SETTING

The majority of the access road clusters are associated with AUM sites within the Lukachukai Mountains of Apache County, Arizona. One of the roads investigated, associated with Block K Mine, is located in the Tse Tah region in Apache County, Arizona. Access roads are unpaved and were used to travel to and from AUMs and to haul waste from the AUMs. Many roads were constructed on mine benches, and road cuts may have exposed NORM where it was previously covered by top soil. Access roads are predominately on top of the mesas within the Jurassic Lower Morrison Formation (Jml), while the footpaths and smaller roads typically cross several formations. During mining activities, ore may have spilled along roads or footpaths, and vehicles may have tracked contaminated materials along roads. The physical setting of the AUM sites is described in detail within the main RSE report. Figure K-2 shows the locations of each of the road clusters.

From the 10-meter digital elevation model (DEM) available online from the U.S. Geological Survey (USGS), a topographic map was generated using the geographic information system (GIS) and the associated elevations and slopes for the AUM site were modeled. The topography generated from the DEM is provided in Figure K-3. Surface and subsurface geology are described in detail in Appendix A of the RSE Report; the report describes physiographic, lithologic, fluvial, and erosional conditions within the Northern Agency Tronox Mine region. The following discussion focuses on surface geology within the Tse Tah Region and Cove Valley and Lukachukai Mountain Region.

Surface geology within the Tse Tah Region is made up of three primary surface geological formations: Quaternary alluvium (Qa), Salt Wash Member of the Morrison Formation (Jms), and Summerville Formation (Js). Quaternary alluvium occurs primarily in surficial deposits of valley fill and consists mainly of stream-deposited silt, sand, and gravel, aeolian (wind-blown) sand and silt, and colluvial material (O'Sullivan and Beikman 1963). A map showing the regional geological formations for Block K within the Tse Tah Region is provided on Figure K-4. A map showing the soil types of the Block K within the Tse Tah Region is provided on Figure K-5.

Surface geology within the vicinity of the Cove Valley is marked by the occurrence of the Chinle Formation (Trc), a fluvial and lacustrine formation exposed in the broad valleys around the mountains. In contrast to the Tse Tah and Cove Valley, which lies primarily in valleys, the Lukachukai Mountains are characterized by broad flat mesas with steep canyons. Finger-like mesas and deep, steep-walled canyons combine to form very rugged topography. The prominent mesas on the north side of the mountains are numbered I through VI arching toward the northwest. The south side mesas bear such descriptive names as Knife Edge, Flag, and Step.

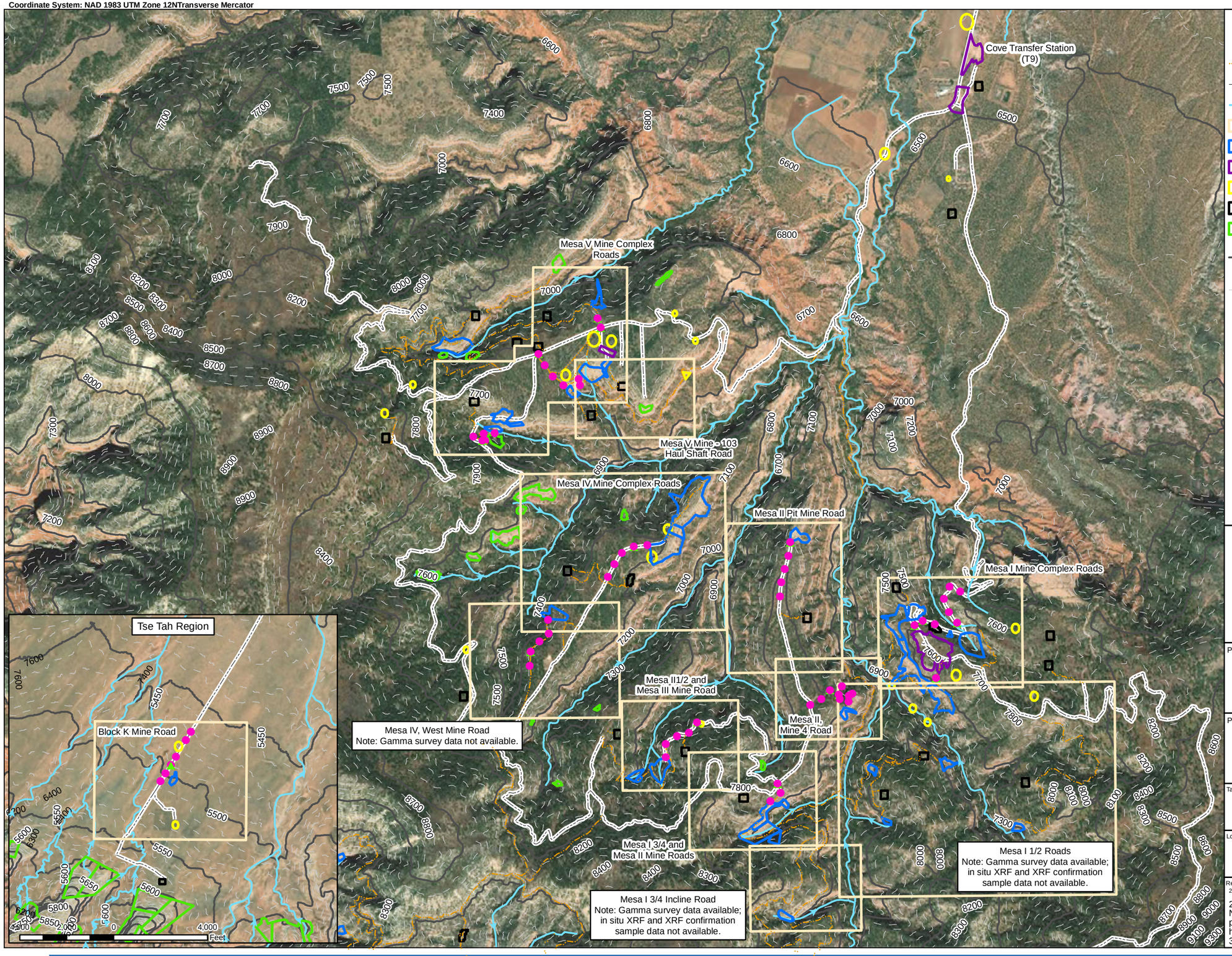
Mesa tops, flanks, and drainages are characterized primarily by members of the Jml. Occurrence of Jml geology and predominance of the Salt Wash Member of the Morrison Formation coincide with prevalence of AUM sites and Target sites in the Cove Region. Uranium ore in the region was mined at the exposed ground surface primarily at mesa tops, rims, and upper canyon walls. Uranium ore bodies are clustered, and typically found at heads of canyons or near back ends of mesas, 30 feet to 80 feet above the base of the Salt Wash Member. The drainages cut down

through the Jml, the Jurassic Summerville and Entrada Sandstone (Jse), and the Tertiary Windgate Sandstone (Trw). A map showing the regional geological formations of the Cove Valley and Lukachukai Mountains is provided on Figure K-4. A map showing the soil types of the Cove Valley and Lukachukai Mountains is provided on Figure K-5.

2.2 PREVIOUS INVESTIGATIONS

Prior to the RSE field investigations conducted by Tetra Tech, no soil samples had been collected along access roads or foot paths. The main text of the RSE report and the individual SSRSE reports provide additional information about previous investigations at the Tronox AUM mine sites. Gamma measurements had been collected within AUM site boundaries during previous investigations. During a preliminary assessment, Weston Solutions (Weston) conducted gamma surveys at many of the Tronox AUM mines. Further discussion on previous investigations can be found in the main text of the RSE report. In 2014 and 2015, USEPA's Airborne Spectral and Photometric Environmental Collection Technology (ASPECT) aircraft conducted flyovers within the Cove and Tse Tah Regions. The ASPECT surveys covered nearly 180 square meters of land. In May 2015, a ground-based characterization effort was organized to collect in situ gamma spectroscopy measurements at select locations and to investigate the ASPECT survey (USEPA 2015). Two road targets were identified and are discussed in Appendix I.

Coordinate System: NAD 1983 UTM Zone 12NTransverse Mercator



- XRF Confirmation Soil Sample
- In Situ XRF Measurement
- Access Route - Foot
- Access Route - Vehicular
- Drainage[1]
- Index
- AUM Site Boundary
- AUM Related Site Boundary
- Non-AUM Target Site Boundary
- Background Location
- Non-Tronox AUM Site
- Major Contour[2] *500 feet - Cove Region* *100 feet - Tse Tah Region*
- Minor Contour[2] *100 feet - Cove Region* *10 feet - Tse Tah Region*

[1]U.S Environmental Protection Agency, Region 9, Superfund Program, *Abandoned Uranium Mines and the Navjo Nation Part II Atlas With Geospatial Data. NN_Drainage_HR_AUM.shp.* July, 2007.

1 in = 2,200 ft

1:26,400

N W E S

2,200 1,100 0 2,200 Feet

ACCESS ROAD TOPOGRAPHIC MAP

Prepared For:

Prepared By:

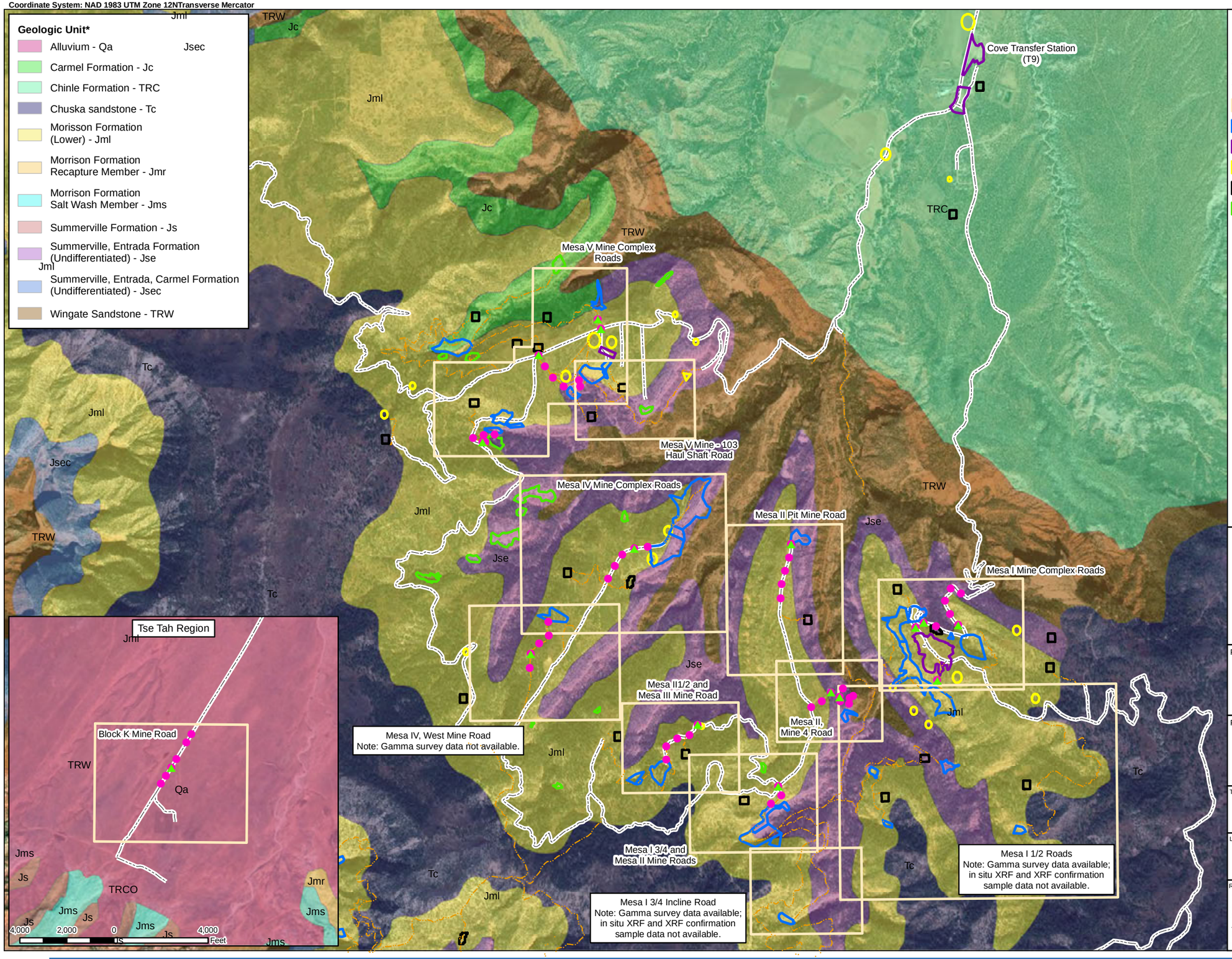
TETRA TECH
1999 Harrison Street, Suite 500
Oakland, CA 94612

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location:	**Date:**
NAVAJO NATION	7/10/2019

Reference:
[2]U.S. Geological Survey, The National Map, 2017, 3DEP products and services: The National Map, 3D Elevation Program Web page, accessed 02/19/2018 at https://nationalmap.gov/3DEP/3dep_prodserv.html.

Figure No.: K-3

Coordinate System: NAD 1983 UTM Zone 12NTransverse Mercator



- XRF Confirmation Soil Sample
- In Situ XRF Measurement
- Access Route - Foot
- Access Route - Vehicular
- Index
- AUM Site Boundary
- AUM Related Site Boundary
- Non-AUM Target Site Boundary
- Background Location
- Non-Tronox AUM Site

1 in = 2,200 ft

1:26,400

N W E S

2,200 1,100 0 2,200 Feet

ACCESS ROAD GEOLOGIC MAP

Prepared For:

Prepared By:

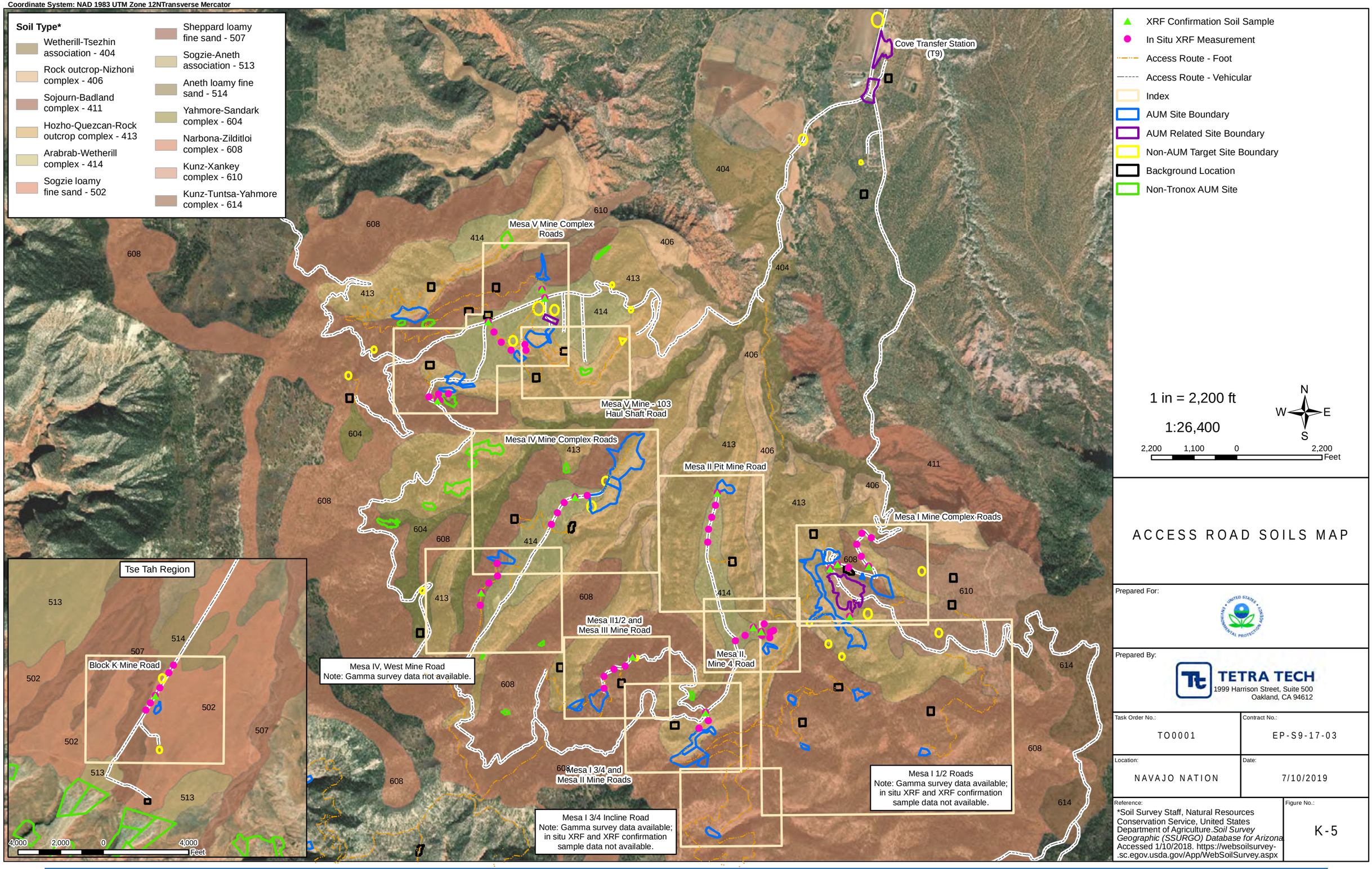
TETRA TECH
1999 Harrison Street, Suite 500
Oakland, CA 94612

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location:	**Date:**
NAVAJO NATION	7/10/2019

Reference:
*O'Sullivan, R.B., and Beikman, H.M. (1963). *Geology, structure, and uranium deposits of the Shiprock quadrangle, New Mexico and Arizona* . Accessed 01/10/2018. https://ngmdb.usgs.gov/Prodesc/proddesc_1389.htm

Figure No.: K-4

Coordinate System: NAD 1983 UTM Zone 12NTransverse Mercator



ACCESS ROAD SOILS MAP

Prepared For:

Prepared By:

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

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location:	**Date:**
NAVAJO NATION	7/10/2019

Reference:
*Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture.*Soil Survey Geographic (SSURGO) Database for Arizona* Accessed 1/10/2018. https://websoilsurvey-.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Figure No.: K-5

3.0 BACKGROUND THRESHOLD VALUES

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation. The results of this investigation are presented in Appendix A of the RSE Report. The RSE background investigation involved a site-specific background investigation and a regional background investigation. There were four primary geologies evaluated as part of the regional background investigation.

BSAs are assigned to each AUM and Target based on the surface geology, as presented in Appendix A of the RSE Report. For each AUM and Target, BTVs were estimated using the most appropriate site-specific and regional soil formation based on the soil sampling and gamma radiation survey results. The BTVs for a given analyte were calculated based on the 95 percent upper tolerance limit (UTL 95-95) or the 95 percent upper simultaneous limit (USL 95). Applied BTVs were selected to represent the unimpacted radiological and chemical conditions at each AUM and Target. The applied BTV for each analyte is the lower of the lower of the site-specific BTV and the regional BTV. Appendix A of the RSE Report presents the site-specific and regional geological BTV for all the BSAs.

BSAs were assigned to each road cluster based on the AUMs with which each access road or footpath is associated. From the set of all relevant site-specific and regional BSAs within a cluster, the lowest of the applied BTVs was conservatively selected for a subset of analytes associated with mining activities called primary analytes, as well as gamma radiation. Table K1-6 in Attachment K1 identifies the applied BTVs for each BSA in a road cluster and the lowest BTV selected for the primary analytes.

Primary analytes are a subset of analytes identified in the Site-Specific RSE reports (Appendix H of the RSE Report) as being typically associated with uranium-vanadium mining activities and generally more hazardous to the environment and human health than secondary analytes. This Access Road Report follows the same protocol for identification of primary and secondary analytes as AUMs, as AUMs are the likely sources of contamination along access roads. A total of 28 analytes were evaluated for this investigation, not including gamma radiation and radon. These analytes include radionuclides and chemical constituents, each with its own applied BTV determined through background investigations. The primary analytes identified include the following:

- Arsenic
- Lead
- Molybdenum
- Radium-226
- Selenium
- Thorium
- Uranium
- Vanadium

The Access Road Report focuses on these eight primary analytes and gamma radiation data to assess potential impacts of mining activities on access roads and footpaths. All other analytes are considered secondary analytes and are not further discussed in this report. Soil sampling results for the full set of analytes collected are presented in tables within Attachment K1. Table K-4 presents the applied BTVs for primary analytes and gamma radiation assigned to each access road cluster.

Table K-4. Summary of Applied Background Threshold Values for Access Road Clusters

Road Cluster Number	Road Cluster Name	Associated Mines	Associated Background Areas	Arsenic (mg/kg)	Lead (mg/kg)	Molybdenum (mg/kg)	Radium-226 (mg/kg)	Selenium (mg/kg)	Thorium (mg/kg)	Uranium (mg/kg)	Vanadium (mg/kg)	Gamma (cpm)
1	Block K Roads	Block K	BSA-5	3.9	5.0	0.34	2.38	0.47	1.9	1.5	11	11,010
2	Mesa V Mine Complex Roads	Mesa IV 1/2 Mine and Simpson 181; Mesa V Mine 103; Mesa V Adit; Mesa V Incline; and Frank Jr. Mine	BSA-18, BSA-19, BSA-20, BSA-21, BSA-22, Jc, JseJste, Jml	1.6	5.8	0.07	0.95	0.78	2.4	0.50	13	11,319
3	Mesa V Mine - 103 Haul Shaft Road	Mesa V Mine - 103	BSA-19, JseJste	2.4	9.3	0.20	1.57	0.84	2.4	1.3	22	11,319
4	Mesa IV Mine Complex Road	Mesa IV, Mine No. 1; Mesa IV, Mine No. 3; and Mesa IV, Mine No. 2	BSA-24, BSA-25, JseJste, Jml	3.5	10.4	0.29	2.23	0.94	3.6	1.5	23	9,703
5	Mesa IV, West Mine Road	Mesa IV, West Mine	BSA-26, Jml	3.5	11.0	0.29	2.23	1.0	4.7	1.5	24	12,602
6	Mesa II 1/2 Mine and Mesa III Mine Roads	Mesa II 1/2 Mine; and Mesa III Mine	BSA-30, BSA-31, Jml	2.2	10.0	0.29	0.87	1.0	4.7	0.60	14	10,433
7	Mesa I 3/4 and Mesa II Mine Complex Roads	Mesa I 3/4 Mine No 2 P150; Mesa II, Mine No. 1 & 2, P-21; and Mesa II, Mine No. 1, P-150	BSA-10, BSA-24, BSA-29, BSA-30, JseJste, Jml	2.0	10.0	0.26	0.85	0.92	3.6	0.60	12	9,703
8	Mesa II, Mine 4 Road	Mesa II, Mine 4	BSA-24, JseJste	4.7	10.4	0.32	2.78	0.94	3.6	2.7	31	9,703
9	Mesa I Mine Complex Roads	Mesa I Mine 10; Mesa I Mine 11; Mesa I Mine 12; Mesa I Mine 13; Mesa I Mine 14; and Mesa I Mine 15	BSA-9, BSA-13, Jml	2.0	7.0	0.16	1.76	0.77	4.7	0.91	13	12,232
10	Mesa II Pit Road	Mesa II Pit	BSA-24, JseJste	4.7	10.4	0.32	2.78	0.94	3.6	2.7	31	9,703
11	Mesa I 1/2 and Mesa I 1/4 Mine Complexes Roads	Mesa I 1/2 Mine, Mesa 1 1/2 West Mine, Mesa I 1/4 Mine, and Henry Phillips Mine	BSA-13, BSA-14, BSA-15, Jml, JseJste	Not applicable – no soil samples were collected								9,854
12	Mesa I 3/4 Incline Road	Mesa I 3/4 Incline Mine	BSA-30	Not applicable – no soil samples were collected								11,378

Notes:

BSA Background study area
BSA-5 Background Study Area 5
BSA-9 Background Study Area 9
BSA-10 Background Study Area 10
BSA-13 Background Study Area 13
BSA-14 Background Study Area 14
BSA-15 Background Study Area 15
BSA-18 Background Study Area 18
BSA-19 Background Study Area 19
BSA-20 Background Study Area 20
BSA-21 Background Study Area 21
BSA-22 Background Study Area 22
BSA-24 Background Study Area 24
BSA-25 Background Study Area 25
BSA-26 Background Study Area 26
BSA-29 Background Study Area 29
BSA-30 Background Study Area 30
BSA-31 Background Study Area 31
BTV Background threshold value
cpm Count per minute
Jc Jurassic Carmel Formation
Jse Jurassic Undifferentiated Summerville and Entrada Sandstone
Jste Jurassic Undifferentiated Summerville, Todilto, and Entrada Sandstone
Jml Jurassic Lower Morrison Formation
mg/kg Milligrams per kilogram

4.0 METHODS

This section presents the access road investigation methods and general approach followed for mapping, performing gamma radiation surveys, XRF surveys, soil sampling, and laboratory analysis of selected metals and radionuclides from access roads and footpaths.

4.1 ACCESS ROAD AND FOOTPATH MAPPING

Access roads and footpaths throughout the Northern Agency were mapped using both existing GIS layers and field verification. Site mapping was performed by a multidisciplinary team of environmental engineers, geologists, and radiation health physicists. The site mapping was completed to gain a better understanding of the road conditions. The objectives for conducting site mapping at the Northern Agency Tronox Mine access roads were:

- Identifying any immediate physical hazards on the access road
- Locating access routes, including foot pathways and roads
- Differentiating naturally occurring radioactive material (NORM) from TENORM through geological assessment and visual observation
- Identifying waste piles within or adjacent to access roads (TENORM)

Site mapping consisted of recording the geospatial location of access roads and footpaths using handheld Trimble Geo 7XH Global Positioning System (GPS) units with subfoot accuracy after post processing. Additionally, the gamma radiation survey Mesa tablets were also capable of recording geospatial locations during the gamma radiation surveys and were used by field staff to geospatially locate access roads discovered during field work.

Figures presenting results for the access road clusters introduced in Section 5.0 present the field mapped access road and footpath features.

4.2 GAMMA RADIATION SURVEY

Tetra Tech performed GPS-based gamma radiation surveys of the access roads and footpaths near many of the Northern Agency Tronox Mines. The gamma radiation survey data was collected between April and September 2018 as part of the Baseline Study and Site Characterization Study for individual AUMs nearby. The GPS-based gamma surveys were performed primarily to define the current location and extent of TENORM, if any, within access roads and footpaths. The gamma radiation surveys performed were conducted following the methods outlined in Appendix C of the RSE Work Plan (Tetra Tech 2018). Field staff used mobile scanning systems with Ludlum Model 44-10 (2- by 2-inch) sodium iodide (NaI) gamma scintillation detectors coupled to Ludlum Model 2221 ratemeters/scalers set in ratemeter mode. The detectors were coupled to Environmental Restoration Group, Inc. (ERG) Model 105 GPS units. The ERG Model 105 GPS consists of a Juniper Mesa 2 field computer and geode GPS receiver. The gamma radiation surveys were conducted by a two-person team traversing access roads and footpaths in both directions and typically a maximum spacing of 2-meters between transects was achieved, resulting in shoulder-to-shoulder coverage. Detector height was 1 meter above ground surface as prescribed in the RSE Work Plan (Tetra Tech 2018). Gamma count rate measurements and associated geospatial coordinates were made and recorded every 1 second. Results of the gamma radiation survey for each drainage surveyed are provided are presented in Section 5.0. Table K-5 provides a summary of which detection systems were used and when they were used during the gamma radiation surveys.

All Ludlum Model 44-10/2221 instrument systems used in the gamma surveys were calibrated in accordance with the *American National Standard Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments* (American National Standard Institute [ANSI] 1997) and Standard Operating Procedure (SOP) 002: Calibration of a Radiological Survey Meter and SOP 001: Calibration of a Radiological Survey Detector in Appendix D of the RSE Work Plan (Tetra Tech 2018). Calibration of the detection systems is required prior to their initial use, at least annually, and after any scheduled or unscheduled maintenance or repair that may affect their operation. General maintenance of the detection systems, such as cleaning, painting, and changing buttons, does not require that they be recalibrated. The instruments were function-checked daily, before and at the end of each work day in accordance with SOP 009: Operational Checkout of Single Detector with Meter in Appendix D of the RSE Work Plan (Tetra Tech 2018). Table K-6 provides a summary of the detection equipment and calibration information.

Table K-5. Detection Systems Used in the RSE Access Road Investigation Survey

Ludlum Model 44-10	Ludlum Model 2221 Ratemeter/Scaler	Dates Used
PR355763	271435	4/24/2018 4/30/2018 5/14/2018 5/22/2018 - 5/26/2018 6/4/2018 6/8/2018 6/25/2018 7/10/2018 - 7/11/2018 7/15/2018 8/14/2018 8/21/2018
PR320678	176947	5/11/2018 6/4/2018 - 6/5/2018 6/20/2018 6/22/2018 6/24/2018 7/10/2018 - 7/11/2018 8/20/2018 9/16/2018 9/29/2018
PR321856	271429	4/24/2018 4/26/2018 5/11/2018 6/4/2018 6/24/2018 - 6/25/2018 7/10/2018 - 7/11/2018 7/14/2018 - 7/15/2018 8/20/2018 9/30/2018
PR355781	271424	4/26/2018 5/22/2018 - 5/23/2018 5/25/2018 6/4/2018 6/24/2018 - 6/25/2018 7/14/2018 9/11/2018
PR355810	271438	7/17/2018 8/14/2018 9/18/2018 9/29/2018
PR355769	282966	4/26/2018 5/14/2018
PR373554	103984	6/5/2018
PR295015	282973	9/29/2018
PR355810	271438	5/23/2018 5/25/2018
PR303716	149940	4/24/2018 5/23/2018 5/26/2018 7/10/2018 - 7/11/2018

Table K-6. Summary of Detection Equipment and Calibration Information

Equipment	Use/Calibration Summary	Relevant RPP SOP No.[1]
Ludlum 2221/ Ludlum 44-10 (or equivalent)	**Use:** Ludlum 2221 ratemeter/scaler instruments were paired with Ludlum 44-10 NaI detectors to measure surface gamma radiation. This detection system was paired with a GPS unit and data logger to record gamma survey and spatial location results in real-time. **Calibration:** Each system (Ludlum 2221/44-10 pair) was calibrated at least annually. Calibration was also performed following any maintenance or repair that could affect functionality. **Functional Checks:** Checks were performed on each system each day that they are used. One check was performed prior to use and one check when all measurement activities had been completed for the day. Checks utilize a standardized source, and net results (source less background counts) must be within ±20% of the results established as part of ongoing control charting.	SOP 001 SOP 002 SOP 009
ERG Model 105 GPS	**Use:** The ERG Model 105 GPS system was used to pair radiation instruments with GPS units to simultaneously record gamma measurements with geospatial locations. The system uses a handheld tablet computer to collect and display survey results in real-time and protect the data from manipulation. **Calibration:** NA **Functional Checks:** NA	NA

Notes:

[1] The SOPs are provided in Appendix D of the RSE Work Plan (Tetra Tech 2018).

ERG Environmental Restoration Group, Inc.
GPS Global positioning system
NA Not applicable
NaI Sodium iodide
RPP Radiation protection program
RSE Removal site evaluation
SOP Standard operating procedure
Tetra Tech Tetra Tech, Inc.

Gamma survey data were collected using the ERG 105 GPS and logged to a binary file such that modifications to the data are precluded. That is, the user has no interaction with the gamma measurements and there are no translation errors in their transmittal. The integrity of the file allows the original field data to be retained and referenced, if necessary, when tracking changes or reverting to the original version. The ERG RadSync and RadScene applications were used to transfer all gamma survey field data to the management computer. Only one computer was used for incoming field data to prevent duplication of data files. Files were not copied manually between the data logger and the project computer. In addition, raw data files were not renamed from their original filename.

The steps taken to validate and verify the gamma survey data were conducted in accordance with SOP 006: Validation and Verification of Gamma Survey Data (from Appendix C [SAP/QAPP] of the RSE Work Plan [Tetra Tech 2018]) as follows:

- The gamma measurements were reviewed in their shapefiles for minimum values to verify that they are within an appropriate range for the Ludlum Model 44-10 and survey

area. If low counts were detected, the cause of the counts was assessed. Invalid measurements could have been made if, for example, a GPS unit was left on unintentionally while traveling in a vehicle.

- The horizontal dilution of precision (HDOP) measurements from the GPS in the GPS-based gamma radiation survey were reviewed to verify that the values do not exceed 3.0. HDOP values that exceed this threshold may have a high positional error and would then be used cautiously during post-processing tasks, such as identifying locations of correlation samples and anomalies.
- Symbology was applied to the gamma measurements, which were then inspected visually for patterns that might indicate detector or cable problems.
- Invalid data of the types described above were removed from the shapefile in accordance with SOP 006.

The steps taken to analyze the gamma survey data were as follows:

- The gamma survey measurements were retained and displayed as cpm. A correlation between HPIC gamma exposure rate and gamma measurements in cpm is presented in Appendix C of the RSE Report. The data were interpreted only in terms of cpm and compared with an applicable BTV.
- The gamma survey measurements were analyzed using statistical software (ProUCL, JMP, and MS Excel), and applicable statistical parameters were generated. Parameters included the number of measurements, arithmetic or geometric mean, median, percentiles, and standard deviation.
- Symbology was applied to the gamma survey measurements according to bins established as multiples of the applicable BTVs.

All QA/QC results and calibration documentation for all radiation detection equipment used in the Northern Agency Tronox Mine RSE investigation are included in the Data Quality Assurance Summary Report as Appendix G of the RSE Report, which presents the daily calibration checks for the gamma radiation surveys within the access roads.

4.3 XRF FIELD SURVEY

Tetra Tech performed an XRF field survey on September 30, 2018, along the access roads and footpaths. The XRF field survey involved the collection of an in situ XRF measurement approximately every 100 feet and the collection of XRF confirmation soil samples with a minimum frequency of 5 percent; at least one XRF confirmation sample was collected per access road or footpath. In total, 71 XRF measurements were collected across the Northern Agency Tronox Mine access roads and footpaths, and 21 XRF confirmation samples were collected.

The XRF confirmation soil samples were collected at a depth of 0 to 3 inches bgs. A summary of the laboratory analytical procedures for the XRF confirmation soil samples for provided in Table K-7. A subset of XRF confirmation soil samples were also submitted for selected radionuclides presented in Table K-8. Table K1-1 in Attachment K1 provides the locations of the in situ XRF measurement locations and the XRF confirmation soil sample locations. The XRF confirmation soil sample geospatial locations and associated laboratory report IDs, as well as the analytical results for all XRF confirmation soil samples, are provided in Attachment K1. The results of the XRF field survey for primary analytes, including the overall summary statistics of the XRF confirmation soil samples, are presented in Section 5.0.

Tetra Tech used the Niton XL5 field portable analyzer (with filter settings of Main Filter: 30 seconds; Low Filter: 15 seconds; and High Filter: 15 seconds) to conduct the XRF field survey. The XL5 is a portable XRF technology that allows for built-in calibration checks (system checks) and lower detection capabilities for various analytes, including arsenic, uranium, and vanadium (all potential COPCs for the Northern Agency Tronox Mines).

Tetra Tech collected XRF confirmation soil samples for laboratory analysis at a minimum of 5 percent of XRF measurement locations and minimized the impact of measurement error introduced by various factors, including soil moisture conditions, effects of particle size, and homogenization on comparability (USEPA 2007). A comparability study between XRF analyzer and laboratory reported concentrations was performed as part of Appendix B of the RSE Report, and strong correlations were found to exist for nine target analytes: arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc. This study, conducted through a linear least squares regression analysis, identified correction factors for the nine analytes. The in situ XRF measurements collected at this site were converted into laboratory predicted values by using the correction factors developed from the regression analysis. See Appendix B of the RSE Report for further details on the procedures for the XRF field survey.

The protocol for the XRF field survey is described below:

1. At each in situ XRF measurement location, the soil from 0 to 3 inches bgs in an approximately 6-inch-square area was cleared of surface debris and thoroughly homogenized in place using a stainless-steel hand trowel or similar. The soil was visually assessed for signs of moisture. The homogenized soil was then patted down in place to provide a uniform surface for the XRF analysis using a stainless-steel hand trowel or a gloved hand. A soil guard (a plastic cover with a thin protective film provided by the manufacturer) was used for all in situ XRF measurements. The XRF analyzer with a soil guard was then placed directly against the homogenized soil for measurement. A single in

situ XRF measurement was taken at each location. Whenever a XRF confirmation soil sample was collected, a duplicate in situ XRF measurement was taken before the soil sample was collected. Once per day per instrument, a series of seven replicate measurements were collected at a random location, and the instrument was not lifted off the ground surface between measurements. XRF measurements were collected in accordance with USEPA SW-846 Method 6200 and SOP 004: Field-Portable X-Ray Fluorecence Analyzer Measurement in Appendix C of the RSE Work Plan (Tetra Tech 2018). Appendix B of the RSE Report describes the XRF field survey in more detail.

2. At a minimum of 5 percent of the in situ XRF measurement locations throughout the RSE program, an XRF confirmation sample was collected immediately after the XRF measurement. The soil collected in the field was placed into a resealable plastic bag. After removing debris, the samples were dried and homogenized in the lab. When the sample was prepared, it was measured in the Tetra Tech field office in Farmington, New Mexico, a minimum of six times with an XRF analyzer and then submitted for laboratory analysis as specified in Table K-7. This is referred to as the ex situ bulk sample. The ex situ bulk samples were used for a correlation study comparing the XRF dataset with the analytical dataset.

All XRF QA/QC results, including daily calibration checks and field replicate checks, are provided in Appendix B of the RSE Report. The results of the XRF field survey are provided in Section 5.0.

Table K-7. Summary of Analytical Methods for XRF Confirmation Soil Samples

Analyte	Type	CAS Number	Analytical Method	Number of XRF Confirmation Samples Analyzed
Aluminum	Metals	7429-90-5	USEPA SW-846 6020B	21
Antimony	Metals	7440-36-0	USEPA SW-846 6020B	21
Arsenic	Metals	7440-38-2	USEPA SW-846 6020B	21
Barium	Metals	7440-39-3	USEPA SW-846 6020B	21
Beryllium	Metals	7440-41-7	USEPA SW-846 6020B	21
Cadmium	Metals	7440-43-9	USEPA SW-846 6020B	21
Calcium	Metals	7440-70-2	USEPA SW-846 6020B	21
Chromium	Metals	7440-47-3	USEPA SW-846 6020B	21
Cobalt	Metals	7440-48-4	USEPA SW-846 6020B	21
Copper	Metals	7440-50-8	USEPA SW-846 6020B	21
Iron	Metals	7439-89-6	USEPA SW-846 6020B	21
Lead	Metals	7439-92-1	USEPA SW-846 6020B	21
Lithium	Metals	7439-93-2	USEPA SW-846 6020B	21
Magnesium	Metals	7439-95-4	USEPA SW-846 6020B	21
Manganese	Metals	7439-96-5	USEPA SW-846 6020B	21
Molybdenum	Metals	7439-98-7	USEPA SW-846 6020B	21
Nickel	Metals	7440-02-0	USEPA SW-846 6020B	21
Potassium-40	Radionuclides	13966-00-2	USEPA 901.1	21
Radium-226	Radionuclides	13982-63-3	USEPA 901.1	21
Radium-228	Radionuclides	15262-20-1	USEPA 901.1	21
Selenium	Metals	7782-49-2	USEPA SW-846 6020B	21
Silver	Metals	7440-22-4	USEPA SW-846 6020B	21
Sodium	Metals	7440-23-5	USEPA SW-846 6020B	21
Thallium	Metals	7440-28-0	USEPA SW-846 6020B	21
Thorium	Metals	-	USEPA SW-846 6020B	21
Uranium	Metals	-	USEPA SW-846 6020B	21
Vanadium	Metals	7440-62-2	USEPA SW-846 6020B	21
Zinc	Metals	7440-66-6	USEPA SW-846 6020B	21

Notes:
- Not applicable
CAS Chemical Abstracts Service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

Table K-8. Summary of Analytical Methods for Select Radionuclides in XRF Confirmation Soil Samples

Decay Series	Analyte	Type	CAS Number	Analytical Method	Number of Surface Soil Samples Analyzed
Uranium	Uranium-238[1]	Radionuclides	7440-61-1	ASTM D3972 Modified	2
	Uranium-234	Radionuclides	13966-29-5	ASTM D3972 Modified	2
	Thorium-230	Radionuclides	14269-63-7	ASTM D3972 Modified	2
	Radium-226	Radionuclides	13982-63-3	USEPA 901.1	2
	Lead-210	Radionuclides	14255-04-0	Eichrom method	2
Actinide	Uranium-235	Radionuclides	15117-96-1	ASTM D3972 Modified	2
Thorium	Thorium-232[1]	Radionuclides	7440-29-1	ASTM D3972 Modified	2
	Radium-228	Radionuclides	15262-20-1	USEPA 901.1	2
	Thorium-228	Radionuclides	14274-82-9	ASTM D3972 Modified	2

Notes:
[1] Measured via alpha and gamma spectroscopy. Only the results from the alpha spectroscopy are presented in the report because the detection limits from the gamma spectroscopy are high.
ASTM ASTM International
bgs Below ground surface
CAS Chemical Abstracts Service
USEPA U.S. Environmental Protection Agency

4.4 CULTURAL AND BIOLOGICAL SURVEYS

Dinetahdoo Cultural Resources Management LLC conducted cultural resource surveys under a separate contract with the USEPA. The survey areas included the access roads and footpaths sampled and surveyed as part of the RSE Investigation. Tetra Tech provided cultural survey assistance to USEPA as needed to support initial consultations with the Navajo Nation Heritage and Historic Preservation Department. On February 13, 2018, Tetra Tech provided USEPA a summary of anticipated RSE field activities and sampling locations to support cultural survey work. Furthermore, a summary of the biological desktop study within the Northern Agency Tronox Mine Region is presented in the main text of the RSE Report.

4.5 QUALITY ASSURANCE/QUALITY CONTROL

QA/QC procedures were implemented throughout the data collection and analysis tasks completed under Task Order 0001. Specific QA/QC procedures were implemented to both minimize and evaluate potential sources of inaccuracy during sample collection and analysis, including field and laboratory quality control sample analysis. The QA/QC procedures were designed to consider relevant guidance from USEPA, as well as from MARSSIM and the *Multi-Agency Radiological Laboratory Analytical Protocols Manual* (MARLAP) (USEPA 2004).

All the project QA/QC data and results are included in appendices to the RSE and not provided in this report; the XRF field survey QA/QC results are in Appendix B, the gamma radiation survey QA/QC results are in Appendix C, and the soil, sediment, and surface water sampling QA/QC results are in Appendix G. All factory calibration documentation for field equipment is provided in the relevant appendices. Laboratory reports are in Appendix L, and data validation reports are in Appendix M. All laboratory analytical reports underwent 100 percent third-party data validation. Tetra Tech underwent numerous random field audits by USEPA's RPM and Radiation Response Team. All QA/QC results, both field and laboratory, met the performance criteria achieved in the SAP/QAPP of the RSE Work Plan (Tetra Tech 2018).

5.0 RESULTS

This section presents the results of the access road investigation and is organized by access road cluster as identified in Table K-1. The results of the XRF survey, XRF confirmation soil sampling, and gamma survey are compared to the applied BTVs for the access roads as identified in Table K-4.

For each road cluster, the following subsections present an overview of investigation results for primary analytes based on in situ XRF measurements and XRF confirmation sampling, as well as an overview of the gamma radiation survey performed. Gamma survey results are presented for the full extent of the gamma survey even in cases where soil sampling was not performed along the full extent of the access road (i.e. Block K access road).

For each road cluster, a soil sample summary table presents primary analyte results, standard summary statistics, and a comparison to the applied BTV. The final row of each table presents the maximum concentration divided by the BTV, which allows evaluation of the magnitude of contamination in each access road. In addition, gamma radiation survey data for each road cluster is evaluated, and compared to the applied BTV and distribution of gamma data from the associated BSA (see Section 3.0) with the most conservative gamma radiation values. A table presenting summary statistics for the gamma radiation survey is presented, followed by two statistical plots. The first plot is an individual value plot showing the spread of gamma radiation survey data collected at the site compared to the BSA gamma survey results. The second plot is a box plot showing the quartiles of the data sets.

The evaluation of soil sampling results and gamma measurements compared to applied BTVs enables determination of apparent contributions from mines and targets through use of waste rock, exposure of NORM in road cuts, and via ore spillage within each road cluster. Primary analyte concentrations in soils and maximum gamma measurement exceeding two times applied BTVs may potentially indicate an impact from NORM or nearby mines or targets; primary analyte concentrations and gamma measurements lower than these thresholds, or with a median gamma measurement less than the applied gamma BTV, are considered to be similar to background levels.

5.1 BLOCK K ACCESS ROAD CLUSTER 1

The Block K access road cluster 1 runs southwest to northeast and is located northeast of the Block K Mine. Six in situ XRF samples and one XRF confirmation soil sample were collected from the Block K access road in September 2018. XRF measurements were collected for metals, and the XRF confirmation samples were submitted to a laboratory for analysis of metals and radionuclides using methods identified in Table K-7 and Table K-8. In addition, a gamma survey was performed along the access road leading to Block K Mine in April 2018.

Soil sampling results are presented in Table K-9 and Figure K-6. No in situ XRF measurement or XRF confirmation samples exceeded the applied BTVs.

Gamma survey summary statistics are provided in Table K-10 and gamma measurements are presented on Figure K-6. The individual value plot presented in Figure K-7 shows that the majority of the gamma radiation measurements are within the range of the background dataset. Only 4 measurements (0.1 percent) exceed the applied gamma BTV of 11,010 cpm. The box plot showing the quartiles of the datasets provided in Figure K-8 shows that the median of the gamma radiation measurement is less than the background data set median and below the applied gamma BTV.

Based on the soil sample results for primary analytes not exceeding the applied BTV and the median and maximum gamma survey measurements below the applied BTV, mining activities conducted at Block K Mine do not appear to have impacted the access roads.

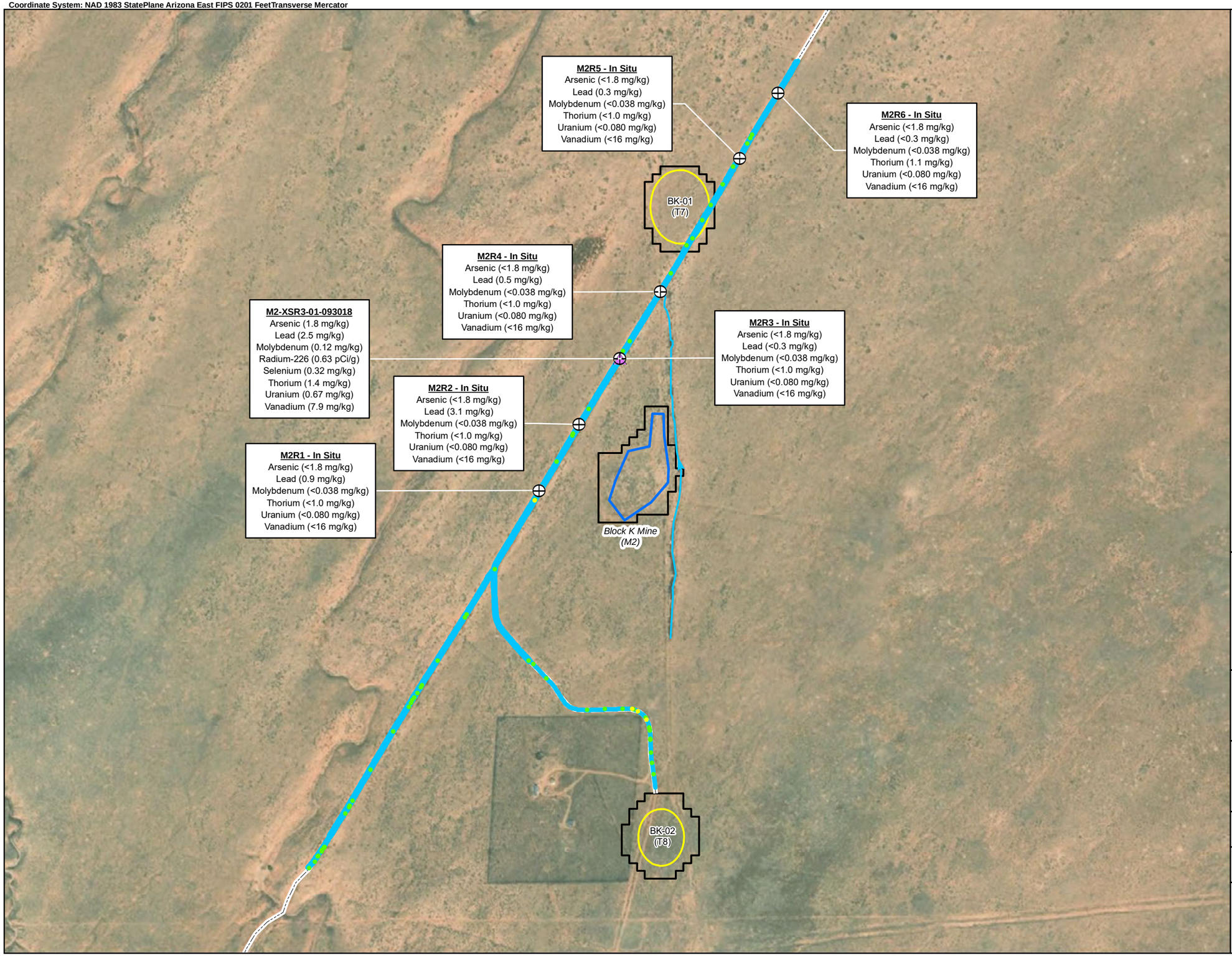
Table K-9. Soil Sampling Results for Primary Analytes for Block K Access Road Cluster 1

Field Sample ID	Cluster ID	Sample Type	Sample Date	Arsenic		Lead		Molybdenum		Radium-226			Selenium		Thorium		Uranium		Vanadium	
				Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Activity (pCi/g)	TPU	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q
M2R1	Block K	In Situ XRF	9/30/2018	<1.8		0.9		<0.038		-			-		<1		<0.08		<16	
M2R2	Block K	In Situ XRF	9/30/2018	<1.8		**3.1**		<0.038		-			-		<1		<0.08		<16	
M2R3	Block K	In Situ XRF	9/30/2018	<1.8		<0.3		<0.038		-			-		<1		<0.08		<16	
M2R4	Block K	In Situ XRF	9/30/2018	<1.8		0.5		<0.038		-			-		<1		<0.08		<16	
M2R5	Block K	In Situ XRF	9/30/2018	<1.8		0.3		<0.038		-			-		<1		<0.08		<16	
M2R6	Block K	In Situ XRF	9/30/2018	<1.8		<0.3		<0.038		-			-		1.13		<0.08		<16	
M2-XSR3-01-093018	Block K	XRF Conf	9/30/2018	**1.8**		2.5		**0.12**	J	**0.63**	0.18	LT	**0.32**	J	**1.4**		**0.67**		**7.9**	
Number of Measurements				7		7		7		1			1		7		7		7	
Number of Detects				1		5		1		1			1		2		1		1	
Number of Nondetects				6		2		6		0			0		5		6		6	
Minimum (mg/kg)				1.8		0.3		0.12		0.6			0.32		1.1		0.7		7.9	
Maximum (mg/kg)				1.8		3.1		0.12		0.6			0.32		1.4		0.7		8	
Average (mg/kg)				1.8		1.5		0.12		0.6			0.32		1.3		0.7		8	
Median (mg/kg)				1.8		0.9		0.12		0.6			0.32		1.3		0.7		8	
Standard Deviation (mg/kg)				-		1.26		-		-			-		0.19		-		-	
90th Percentile (mg/kg)				1.8		2.9		0.12		0.6			0.32		1.4		0.7		8	
95th Percentile (mg/kg)				1.8		3.0		0.12		0.6			0.32		1.4		1		8	
99th Percentile (mg/kg)				1.8		3.1		0.12		0.6			0.32		1.4		1		8	
Relative Standard Deviation				-		0.86		-		-			-		0.15		-		-	
BTV (mg/kg)				3.9		5.0		0.34		2.38			0.47		1.9		1.5		11	
Maximum/BTV (unitless)				0.46		0.62		0.35		0.26			0.68		0.74		0.45		0.72	

Notes:
The maximum concentration is presented in **bold**.
Shaded **red** indicates that the result exceeds the applied BTV (none exceeded the BTV in Block K).

<	The analyte was analyzed for, but was not detected. The reporting limit is shown in the result column.
-	Not analyzed.
BTV	Background threshold value
Conf	Confirmation sample
ID	Identification
J	Estimated value
LT	Result less than requested minimum detectable concentration, but greater than sample-specific detectable concentration.
mg/kg	Milligrams per kilogram
pCi/g	Picocuries per gram
Q	Qualifier
TPU	Total propagated uncertainty
XRF	X-ray fluorescence

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator



XRF Confirmation Soil Sample[1]

In Situ XRF Measurement[1]

Gamma Reading (cpm)[2]

≤ 9,637	≤ Avg. BG
9,637 - 11,010	Avg. BG - 1 x BTV
11,010 - 22,020	1 x BTV - 2 x BTV
22,020 - 33,030	2 x BTV - 3 x BTV
33,030 - 44,040	3 x BTV - 4 x BTV
44,040 - 110,100	4 x BTV - 10 x BTV
≥ 110,100	≥ 10 x BTV

AUM Site Boundary

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Vehicular

Drainage - Field Mapped

Note:
[1]Red font indicates sample COPC concentration above BTV value for the relevant analyte.
'<' indicates a less than limit of detection instrumental non-detect.

1 in = 400 ft

1:4,800

N W E S

0 200 400 800 Feet

BLOCK K MINE
ACCESS ROADS GAMMA RADIATION SURVEY AND SURFACE SOIL SAMPLE RESULTS MAP

Prepared For:

Prepared By:

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

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 7/10/2019

Notes:
[2]The applied gamma BTV is 11,010 cpm derived from BSA-5 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **K-6**

Table K-10. Summary of Gamma Radiation Survey Results for Block K Access Road Cluster 1

Summary Statistic	Units	Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,010
Measurements	#	5,818
Minimum	cpm	4,975
Maximum	cpm	11,697
Average	cpm	7,127
Median	cpm	7,053
Standard Deviation	cpm	920
90th Percentile	cpm	8,321
95th Percentile	cpm	8,745
99th Percentile	cpm	9,748
Measurements Above Gamma BTV	#	4
Measurements Above Gamma BTV	%	0.1

Notes:
BTV Background threshold value
cpm Counts per minute

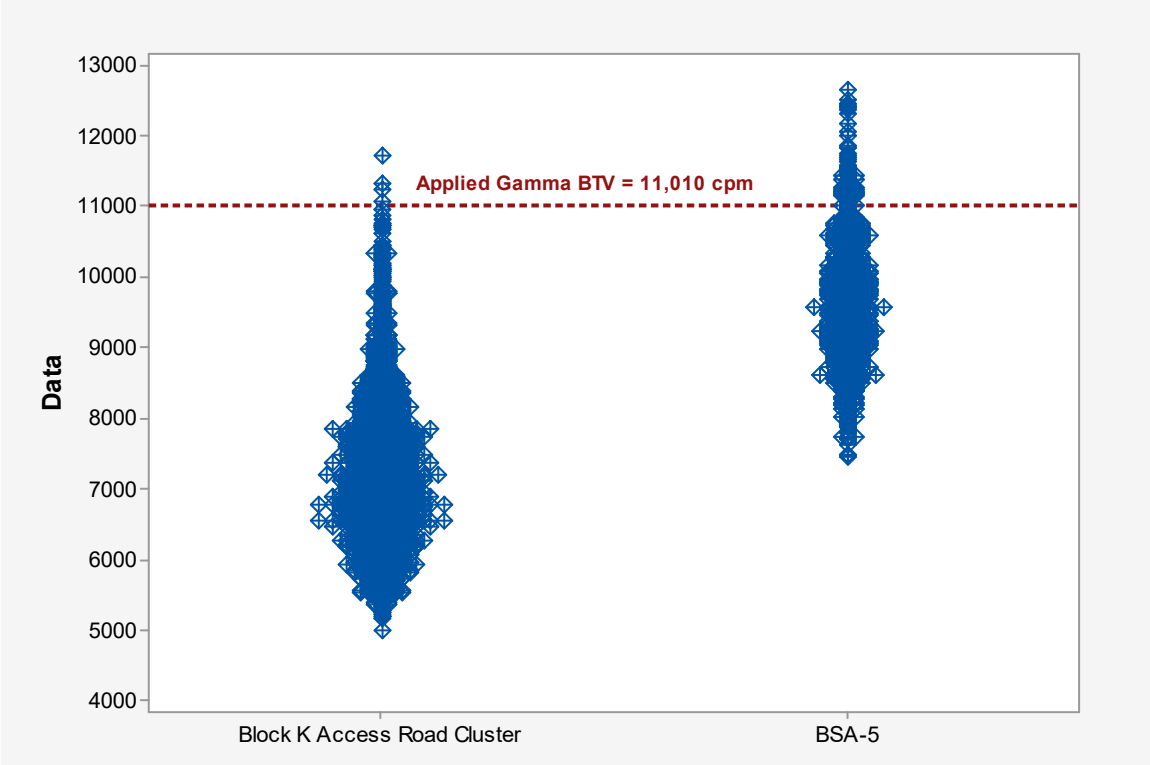


Figure K-7. Individual Value Plot of Gamma Radiation Levels within Block K Access Road Cluster 1 and BSA-5

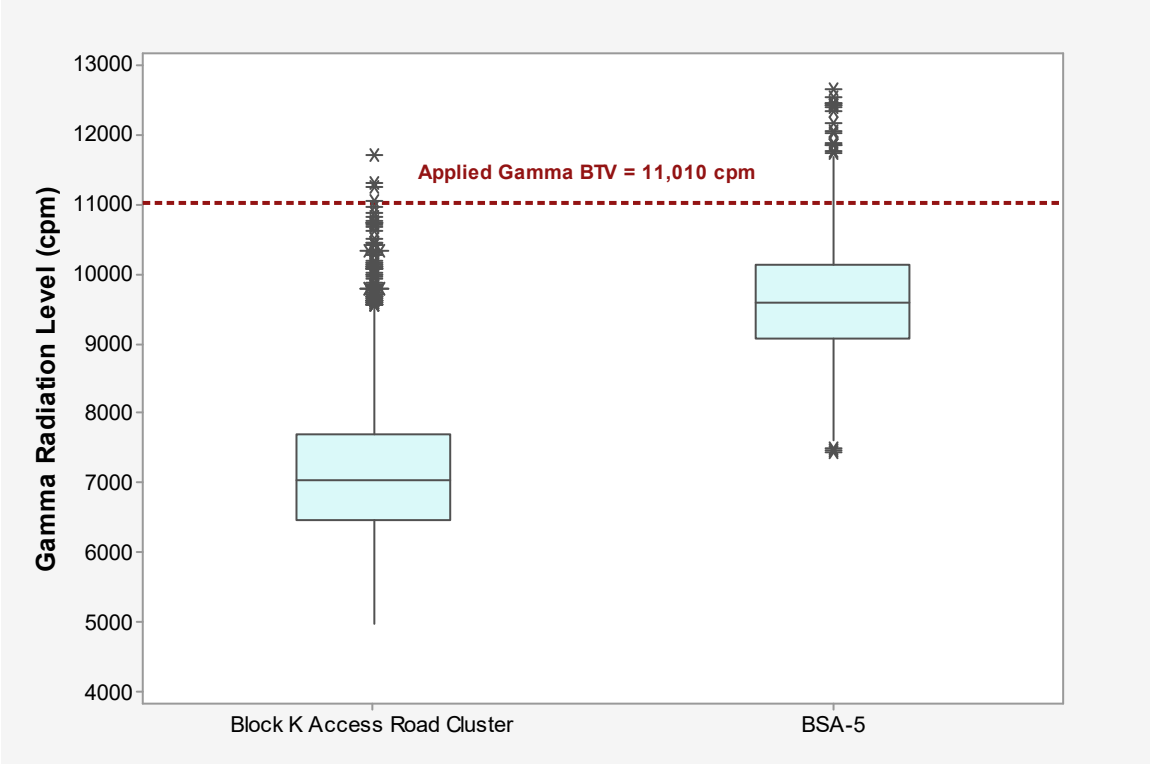


Figure K-8. Box Plot of Gamma Radiation Levels within Block K Access Road Cluster 1 and BSA-5

5.2 MESA V MINE COMPLEX ACCESS ROADS CLUSTER 2

Mesa V Mine complex access roads cluster 2 surrounds Mesa IV 1/2 Mine Simpson 181, Mesa V Mine 103, Mesa V Adit, Mesa V Incline and Frank Jr. Mine. Eighteen in situ XRF samples and four XRF confirmation soil samples were collected from the Mesa V Complex access road cluster in September 2018. XRF measurements were collected for metals, and the XRF confirmation samples were submitted to a laboratory for analysis of metals and radionuclides using methods identified in Table K-7 and Table K-8. In addition, a gamma survey was performed along the access roads and footpaths in the vicinity of the Mesa V Mine Complex in May, June, August, and September 2018.

Soil sampling results are presented in Table K-11 and Figure K-9 through Figure K-11. Results for arsenic, lead, molybdenum, radium-226, thorium, uranium, and vanadium exceeded the applied BTVs in at least one (radium-226) and up to 15 (uranium) samples throughout the extent of the access roads. The maximum concentration of thorium was just under two times the BTV northeast of Mesa V Adit and Mesa V Mine. The maximum concentration of vanadium exceeded the BTV by more than five times in the road between Mesa V Adit and Mesa V Mine. The maximum concentration of radium-226 (from the confirmation soil sample) was under two times the BTV in the road just south of Frank Jr. Mine. The maximum concentration of molybdenum exceeded the BTV by over 40 times in the road north east of Mesa V Mine. The maximum concentrations of arsenic and lead exceeded the BTV by more than ten times in the portion of the road in between Mesa IV 1/2 Mine and Simpson 181 and the north portal of Frank Jr. No. 1 Mine. The maximum concentration of uranium exceeded the BTV by more than 300 times east of the north portal of Frank Jr. No. 1 Mine.

Gamma survey summary statistics are provided in Table K-12 and gamma measurements are presented on Figure K-9 through Figure K-11. The individual value plot presented in Figure K-12 shows the spread of gamma radiation survey data collected within the access road cluster compared to the applied gamma BTV of 11,319 for BSA-19. The majority of the gamma radiation measurements are above the applied gamma BTV. The box plot showing the quartiles of the data sets provided in Figure K-13 shows that the median of the gamma radiation measurements is slightly greater than the applied gamma BTV.

Based on the arsenic, lead, molybdenum, uranium, and vanadium soil sample results for primary analytes exceeding twice the respective BTVs, mining activities conducted at Mesa V Mine, Mesa IV 1/2 Mine and Simpson 181 and potentially the north portal of Frank Jr. No. 1 Mine may have potentially impacted the roads. Further, the median gamma survey measurement is above the applied BTV and the maximum gamma measurement is greater than two times the BTV; therefore, additional investigation may be warranted to further identify the lateral and vertical extent of contamination.

Table K-11. Soil Sampling Results for Primary Analytes for Mesa V Mine Complex Access Roads Cluster 2

Field Sample ID	Cluster ID	Sample Type	Sample Date	Arsenic		Lead		Molybdenum		Radium-226			Selenium		Thorium		Uranium		Vanadium	
				Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Activity (pCi/g)	TPU	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q
M14R1	Mesa V Complex	In Situ XRF	9/30/2018	<1.8		6.2		<0.038		-			-		1.3		<0.08		<16	
M14-XSR1-01-093018	Mesa V Complex	XRF Conf	9/30/2018	1.2		4.3		0.27		**1.29**	0.31		<0.98	U	2.0		1.3		13	
M15R1	Mesa V Complex	In Situ XRF	9/30/2018	<1.8		4.3		<0.038		-			-		1.9		<0.08		<16	
M15-XSR1-01-093018	Mesa V Complex	XRF Conf	9/30/2018	1.1		3.4		0.16	J	0.63	0.21	LT	<1.0	U	2.0	J	0.45		6.9	
M17R1	Mesa V Complex	In Situ XRF	9/30/2018	<1.8		8.0		<0.038		-			-		2.8		0.53		<16	
M17R2	Mesa V Complex	In Situ XRF	9/30/2018	2.3		6.4		<0.038		-			-		**4.3**		1.1		<16	
M17R3	Mesa V Complex	In Situ XRF	9/30/2018	6.2		7.8		<0.038		-			-		4.2		1.3		<16	
M17R4	Mesa V Complex	In Situ XRF	9/30/2018	3.4		6.5		0.89525		-			-		3.0		2.9		<16	
M17R5	Mesa V Complex	In Situ XRF	9/30/2018	3		3.7		<0.038		-			-		1.4		0.33		**69**	
M17R6	Mesa V Complex	In Situ XRF	9/30/2018	<1.8		4.3		<0.038		-			-		3.5		3.6		<16	
M17-XSR1-01-093018	Mesa V Complex	XRF Conf	9/30/2018	1.2		3.8		0.094	J	0.69	0.25	LT	0.38	J	2.4		0.4		6.9	
M18R1	Mesa V Complex	In Situ XRF	9/13/2018	3.9		6.6		1.4		-			-		3.4		3.3		17	
M18R2	Mesa V Complex	In Situ XRF	9/13/2018	2.6		8.2		1.5		-			-		3.2		4.3		21	
M18R3	Mesa V Complex	In Situ XRF	9/13/2018	<1.8		4.2		**3.0**		-			-		2.1		<0.08		<16	
M18R4	Mesa V Complex	In Situ XRF	9/13/2018	<1.8		9.1		2.7		-			-		3.2		1.0		<16	
M18R5	Mesa V Complex	In Situ XRF	9/13/2018	<1.8		6.8		0.91		-			-		2.9		1.3		<16	
M19R1	Mesa V Complex	In Situ XRF	9/30/2018	115		75.6		<0.038		-			-		<1		129		<16	
M19R2	Mesa V Complex	In Situ XRF	9/30/2018	73		<0.3		<0.038		-			-		<1		86		<16	
M19R3	Mesa V Complex	In Situ XRF	9/30/2018	87		<0.3		<0.038		-			-		<1		**184**		<16	
M19R4	Mesa V Complex	In Situ XRF	9/30/2018	<1.8		**100.3**		<0.038		-			-		<1		145		<16	
M19R5	Mesa V Complex	In Situ XRF	9/30/2018	**156**		77.7		<0.038		-			-		<1		105		<16	
M19-XSR2-01-093018	Mesa V Complex	XRF Conf	9/30/2018	1.3		4.7		0.11	J	0.77	0.24	LT	**0.48**	J	2.8		0.48		8.1	
Number of Measurements				22		22		22		4			4		22		22		22	
Number of Detects				14		20		10		4			2		17		19		7	
Number of Nondetects				8		2		12		0			2		5		3		15	
Minimum (mg/kg)				1.1		3.4		0.09		0.6			0.38		1.3		0.3		6.9	
Maximum (mg/kg)				156.0		100.3		2.99		1.3			0.48		4.3		184.1		69	
Average (mg/kg)				32.6		17.6		1.10		0.8			0.43		2.7		35.3		20	
Median (mg/kg)				3.2		6.5		0.90		0.7			0.43		2.8		1.3		13	
Standard Deviation (mg/kg)				52.30		29.24		1.05		0.30			0.07		0.87		60.7		22	
90th Percentile (mg/kg)				106.5		75.8		2.71		1.1			0.47		3.8		132.5		40	
95th Percentile (mg/kg)				129.4		78.8		2.85		1.2			0.48		4.2		149		55	
99th Percentile (mg/kg)				150.7		96.0		2.96		1.3			0.48		4.3		177		66	
Relative Standard Deviation				1.60		1.66		0.96		0.36			0.16		0.32		1.7		1.09	
BTV (mg/kg)				1.6		5.8		0.07		0.95			0.78		2.4		0.50		13	
Maximum/BTV (unitless)				97		17		43		1.4			0.62		1.8		349		5.4	

Notes:
The maximum concentration is presented in **bold**.
Shaded red indicates that the result exceeds the applied BTV.

< The analyte was analyzed for, but was not detected. The reporting limit is shown in the result column.
- Not analyzed.
BTV Background threshold value
Conf Confirmation sample
ID Identification
J Estimated value
LT Result less than requested minimum detectable concentration, but greater than sample-specific detectable concentration.
mg/kg Milligrams per kilogram
pCi/g Picocuries per gram
Q Qualifier
TPU Total propagated uncertainty
U Not detected. The associated value is the reporting limit.
XRF X-ray fluorescence

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator

SHEET 2
SHEET 1

M15-XSR1-01-093018
Arsenic (1.1 mg/kg)
Lead (3.4 mg/kg)
Molybdenum (0.16 mg/kg)
Radium-226 (0.63 pCi/g)
Selenium (<1.0 mg/kg)
Thorium (2 mg/kg)
Uranium (0.45 mg/kg)
Vanadium (<16 mg/kg)

M15R1 - In Situ
Arsenic (<1.8 mg/kg)
Lead (4.3 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (1.9 mg/kg)
Uranium (<0.080 mg/kg)
Vanadium (<16 mg/kg)

M17R1 - In Situ
Arsenic (<1.8 mg/kg)
Lead (8 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (2.8 mg/kg)
Uranium (0.53 mg/kg)
Vanadium (<16 mg/kg)

M17-XSR1-01-093018
Arsenic (1.2 mg/kg)
Lead (3.8 mg/kg)
Molybdenum (0.094 mg/kg)
Radium-226 (0.69 pCi/g)
Selenium (0.38 mg/kg)
Thorium (2.4 mg/kg)
Uranium (0.37 mg/kg)
Vanadium (<16 mg/kg)

M17R2 - In Situ
Arsenic (2.3 mg/kg)
Lead (6.4 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (4.3 mg/kg)
Uranium (1.1 mg/kg)
Vanadium (<16 mg/kg)

M18R5 - In Situ
Arsenic (<1.8 mg/kg)
Lead (6.8 mg/kg)
Molybdenum (0.91 mg/kg)
Thorium (2.9 mg/kg)
Uranium (1.3 mg/kg)
Vanadium (<16 mg/kg)

M17R3 - In Situ
Arsenic (6.2 mg/kg)
Lead (7.8 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (4.2 mg/kg)
Uranium (1.3 mg/kg)
Vanadium (<16 mg/kg)

M17R4 - In Situ
Arsenic (3.4 mg/kg)
Lead (6.5 mg/kg)
Molybdenum (0.9 mg/kg)
Thorium (3 mg/kg)
Uranium (2.9 mg/kg)
Vanadium (<16 mg/kg)

M18R4 - In Situ
Arsenic (<1.8 mg/kg)
Lead (9.1 mg/kg)
Molybdenum (2.7 mg/kg)
Thorium (3.2 mg/kg)
Uranium (0.95 mg/kg)
Vanadium (<16 mg/kg)

M17R5 - In Situ
Arsenic (3 mg/kg)
Lead (3.7 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (1.4 mg/kg)
Uranium (0.33 mg/kg)
Vanadium (<16 mg/kg)

M5-06 (T22)
M5-05 (T21)
M5-07 (T24)
BSA-22 (B22)
BSA-21 (B21)
NA-0344B AUM Related Site (T23)
Mesa V Incline (M15)
Mesa V Adit (M16)
Mesa V Mine - 103 (M17)
Haul Shaft Portal
Middle 1A
Mesa V Mine - 103 Haul Shaft Road

SHEET 1
SHEET 3

Primary analyte results for Mesa V Mine - 103 haul shaft road are not presented in this figure because the applied BTVs for the haul shaft road and the other Mesa V Complex roads are different.

- XRF Confirmation Soil Sample[1]
- In Situ XRF Measurement[1]

Gamma Reading (cpm)[2]

≤ 9,560	≤ Avg. BG
9,560 - 11,319	Avg. BG - 1 x BTV
11,319 - 22,638	1 x BTV - 2 x BTV
22,638 - 33,957	2 x BTV - 3 x BTV
33,957 - 45,276	3 x BTV - 4 x BTV
45,276 - 113,190	4 x BTV - 10 x BTV
≥ 113,190	≥ 10 x BTV

- Haul Shaft Portal
- AUM Site Boundary
- AUM Related Site Boundary
- Non-AUM Target Site Boundary
- Survey Area Boundary
- Background Location
- Access Route - Foot
- Access Route - Vehicular
- Drainage - Field Mapped

Note:
[1]Red font indicates sample COPC concentration above BTV value for the relevant analyte.
'<' indicates a less than limit of detection instrumental non-detect.

1 in = 180 ft

1:2,160

N W E S

0 90 180 360 Feet

MESA V MINE COMPLEX SHEET 1 ACCESS ROAD GAMMA RADIATION SURVEY AND SURFACE SOIL SAMPLE RESULTS MAP

Prepared For:

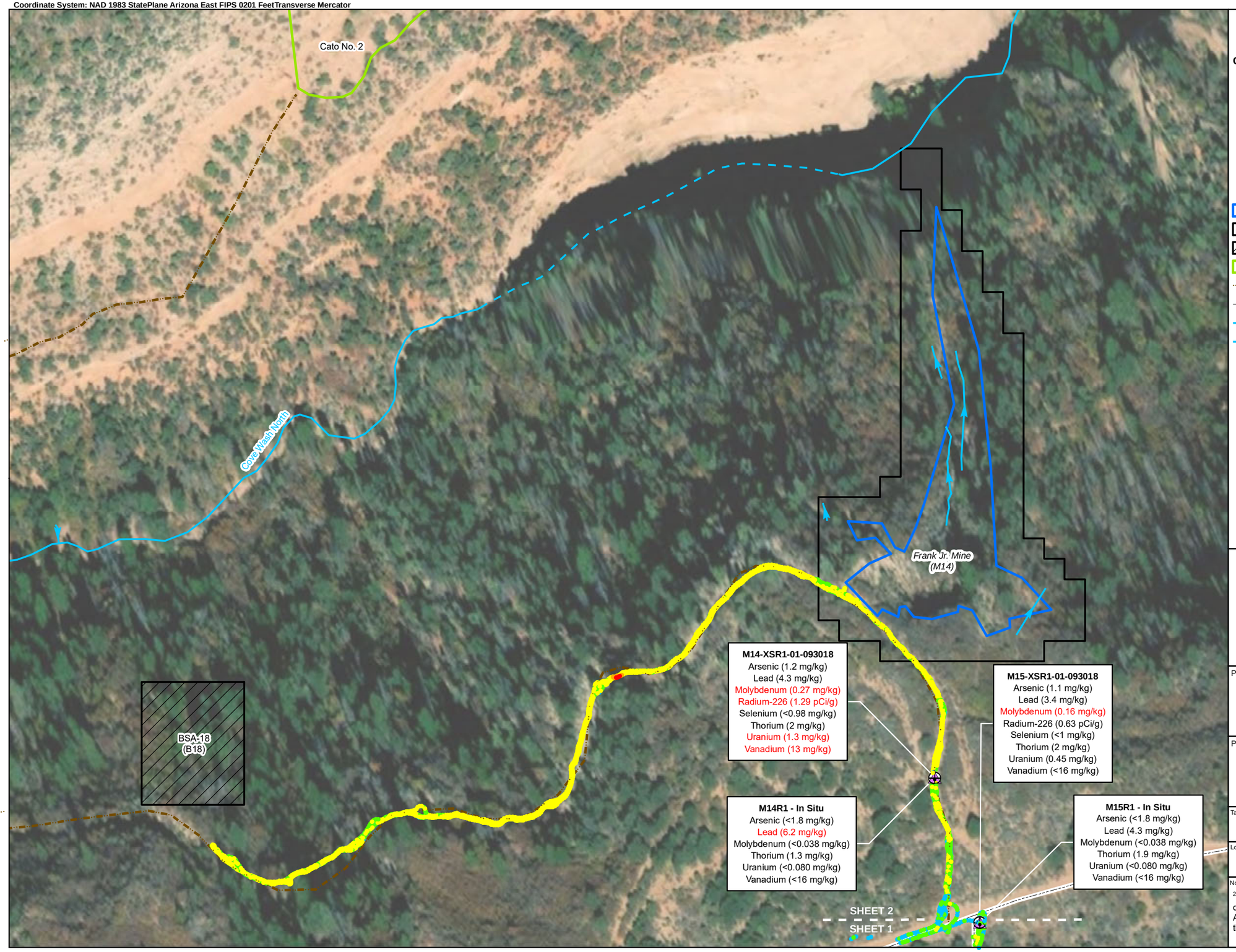
Prepared By:
TETRA TECH
1999 Harrison Street, Suite 500
Oakland, CA 94612

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 7/11/2019

Notes:
[2]The applied gamma BTV is 11,319 cpm derived from BSA-19 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **K-9**

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator



XRF Confirmation Soil Sample[1]

In Situ XRF Measurement[1]

Gamma Reading (cpm)[2]

≤ 9,560	≤ Avg. BG
9,560 - 11,319	Avg. BG - 1 x BTV
11,319 - 22,638	1 x BTV - 2 x BTV
22,638 - 33,957	2 x BTV - 3 x BTV
33,957 - 45,276	3 x BTV - 4 x BTV
45,276 - 113,190	4 x BTV - 10 x BTV
≥ 113,190	≥ 10 x BTV

AUM Site Boundary

Survey Area Boundary

Background Location

Non-Tronox AUM Site

Access Route - Foot

Access Route - Vehicular

Drainage - Estimated Path

Drainage - Field Mapped

Note:
[1]Red font indicates sample COPC concentration above BTV value for the relevant analyte.
'<' indicates a less than limit of detection instrumental non-detect.

1 in = 150 ft

1:1,800

N W E S

0 75 150 300 Feet

MESA V MINE COMPLEX SHEET 2
ACCESS ROAD GAMMA RADIATION SURVEY AND SURFACE SOIL SAMPLE RESULTS MAP

Prepared For:

Prepared By:

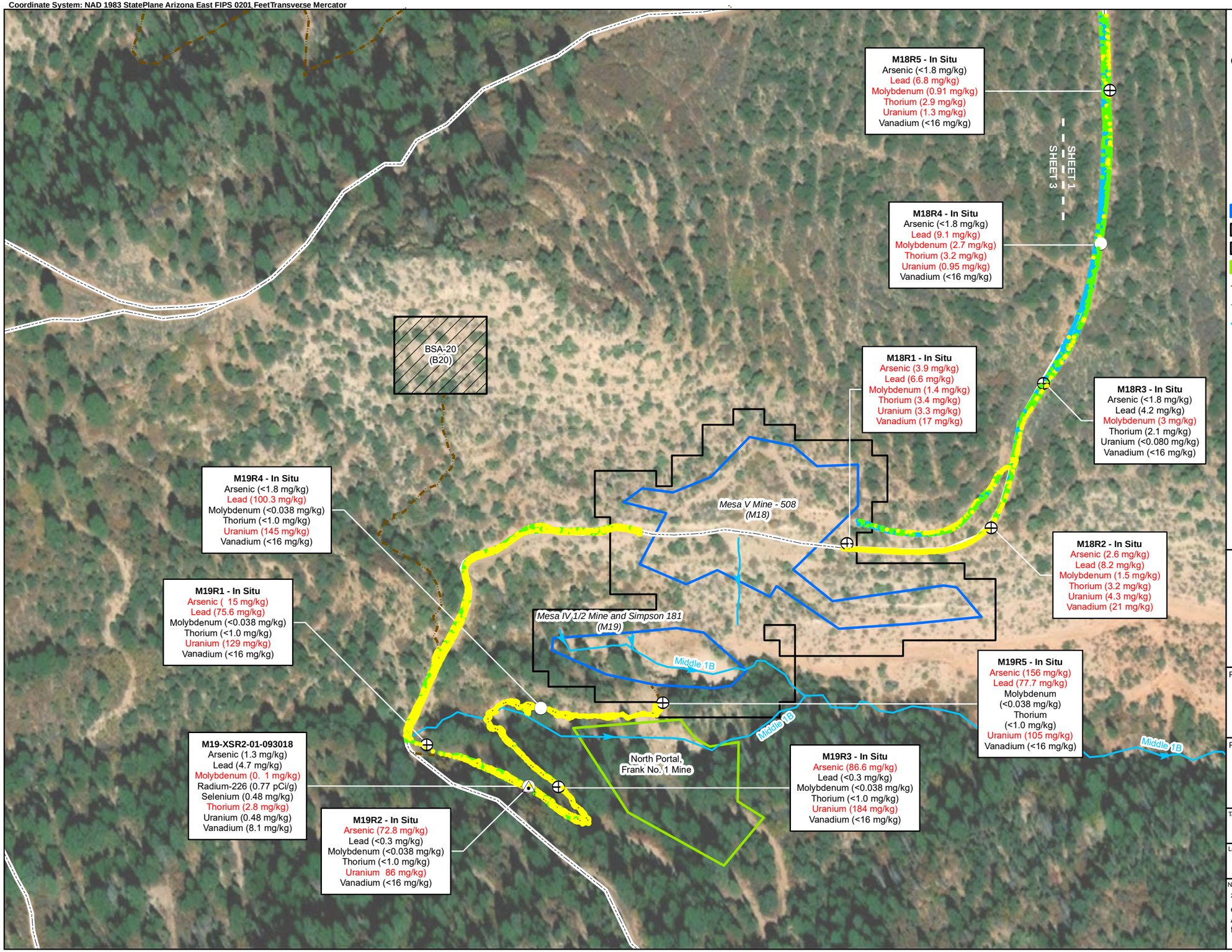
TETRA TECH
1999 Ha rison Street, Suite 500
Oakland, CA 94612

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 7/11/2019

Notes:
[2]The applied gamma BTV is 11,319 cpm derived from BSA-19 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **K-10**

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator



XRF Confirmation Soil Sample[1]

In Situ XRF Measurement[1]

Gamma Reading (cpm)[2]

≤ 9,560	≤ Avg. BG
9,560 - 11,319	Avg. BG - 1 x BTV
11,319 - 22,638	1 x BTV - 2 x BTV
22,638 - 33,957	2 x BTV - 3 x BTV
33,957 - 45,276	3 x BTV - 4 x BTV
45,276 - 113,190	4 x BTV - 10 x BTV
≥ 113,190	≥ 10 x BTV

AUM Site Boundary

Survey Area Boundary

Background Location

Non-Tronox AUM Site

Access Route - Foot

Access Route - Vehicular

Drainage - Field Mapped

Note:
[1]Red font indicates sample COPC concentration above BTV value for the relevant analyte.
'<' indicates a less than limit of detection instrumental non-detect.

1 in = 200 ft

1:2,400

N W E S

0 100 200 400 Feet

MESA V MINE COMPLEX SHEET 3 ACCESS ROAD GAMMA RADIATION SURVEY AND SURFACE SOIL SAMPLE RESULTS MAP

Prepared For:

Prepared By:

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

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 7/11/2019

Notes:
[2]The applied gamma BTV is 11,319 cpm derived from BSA-19 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **K-11**

Table K-12. Summary of Gamma Radiation Survey Results for Mesa V Mine Complex Access Roads Cluster 2

Summary Statistic	Units	Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,319
Measurements	#	10,694
Minimum	cpm	7,030
Maximum	cpm	36,179
Average	cpm	11,894
Median	cpm	11,563
Standard Deviation	cpm	2,221
90th Percentile	cpm	14,639
95th Percentile	cpm	15,811
99th Percentile	cpm	18,705
Measurements Above Gamma BTV	#	5,917
Measurements Above Gamma BTV	%	55

Notes:
BTV Background threshold value
cpm Counts per minute

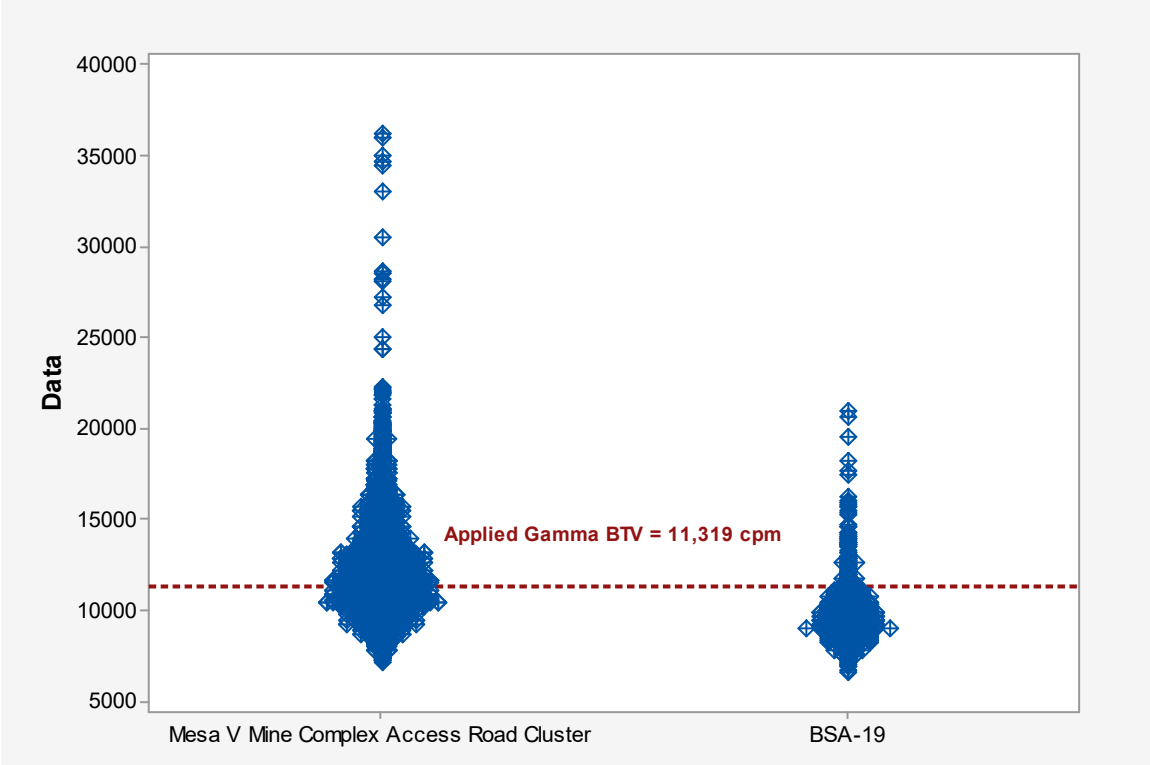


Figure K-12. Individual Value Plot of Gamma Radiation Levels of the Mesa V Mine Complex Access Roads Cluster 2 and BSA-19

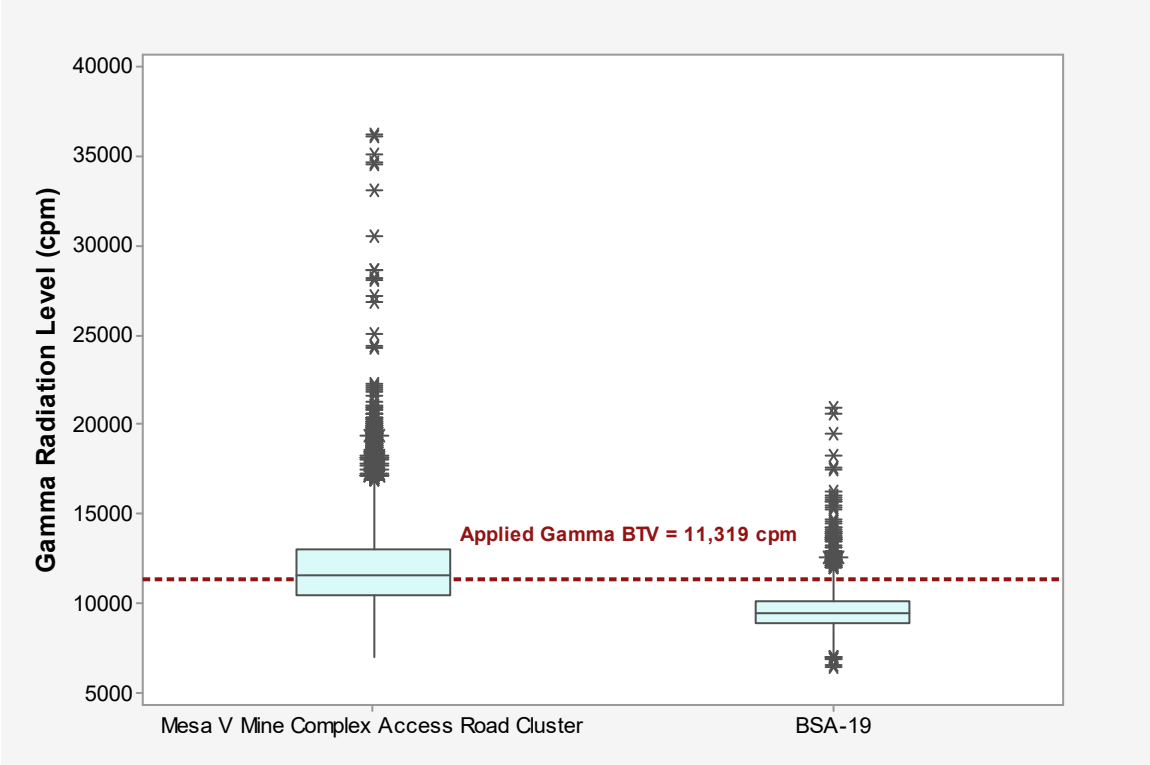


Figure K-13. Box Plot of Gamma Radiation Levels of the Mesa V Mine Complex Access Roads Cluster 2 and BSA-19

5.3 MESA V MINE – 103 HAUL SHAFT ACCESS ROAD CLUSTER 3

Mesa V Mine – 103 Haul Shaft access road cluster 3 surrounds Mesa V Mine – 103 and Mesa V Adit. Non-Tronox mine NA-0318B is located immediately to the north of the haul shaft road. Six in situ XRF samples and two XRF confirmation soil samples were collected from the Mesa V Mine – 103 Haul Shaft access road cluster 3 in September 2018. XRF measurements were collected for metals, and the XRF confirmation samples were submitted to a laboratory for analysis of metals and radionuclides using methods identified in Table K-7 and Table K-8. In addition, a gamma survey was performed along the access road leading to the Mesa V Mine – 103 Haul Shaft and Mesa V Adit in May 2018.

Soil sampling results are presented in Table K-13 and Figure K-14. The maximum concentrations of all primary analytes were less than two times the BTV.

Gamma survey summary statistics are provided in Table K-14 and gamma measurements are presented on Figure K-14. The individual value plot presented in Figure K-15 shows that approximately half of the gamma radiation measurements are within the range of the background dataset; 47 percent of the measurements exceed the applied gamma BTV of 11,319 cpm. Figure K-14 indicates that the central portion of the haul shaft road has gamma measurements exceeding twice the applied gamma BTV. The box plot showing the quartiles of the datasets provided in Figure K-16 shows that the median of the gamma radiation measurement is higher than the background data set median and slightly below the applied gamma BTV. The maximum gamma measurement was approximately three times the applied gamma BTV.

Based on the soil sample results for primary analytes not exceeding the applied BTV, mining activities conducted at Mesa V Mine – 103 and Mesa V Adit do not appear to have impacted the access roads. However, while the median gamma survey measurement is below the applied BTV, the maximum gamma measurement is greater than two times the BTV along the central portion of the haul shaft road near non-Tronox mine NA-0318B; therefore, additional investigation may be warranted to further identify the lateral and vertical extent of contamination.

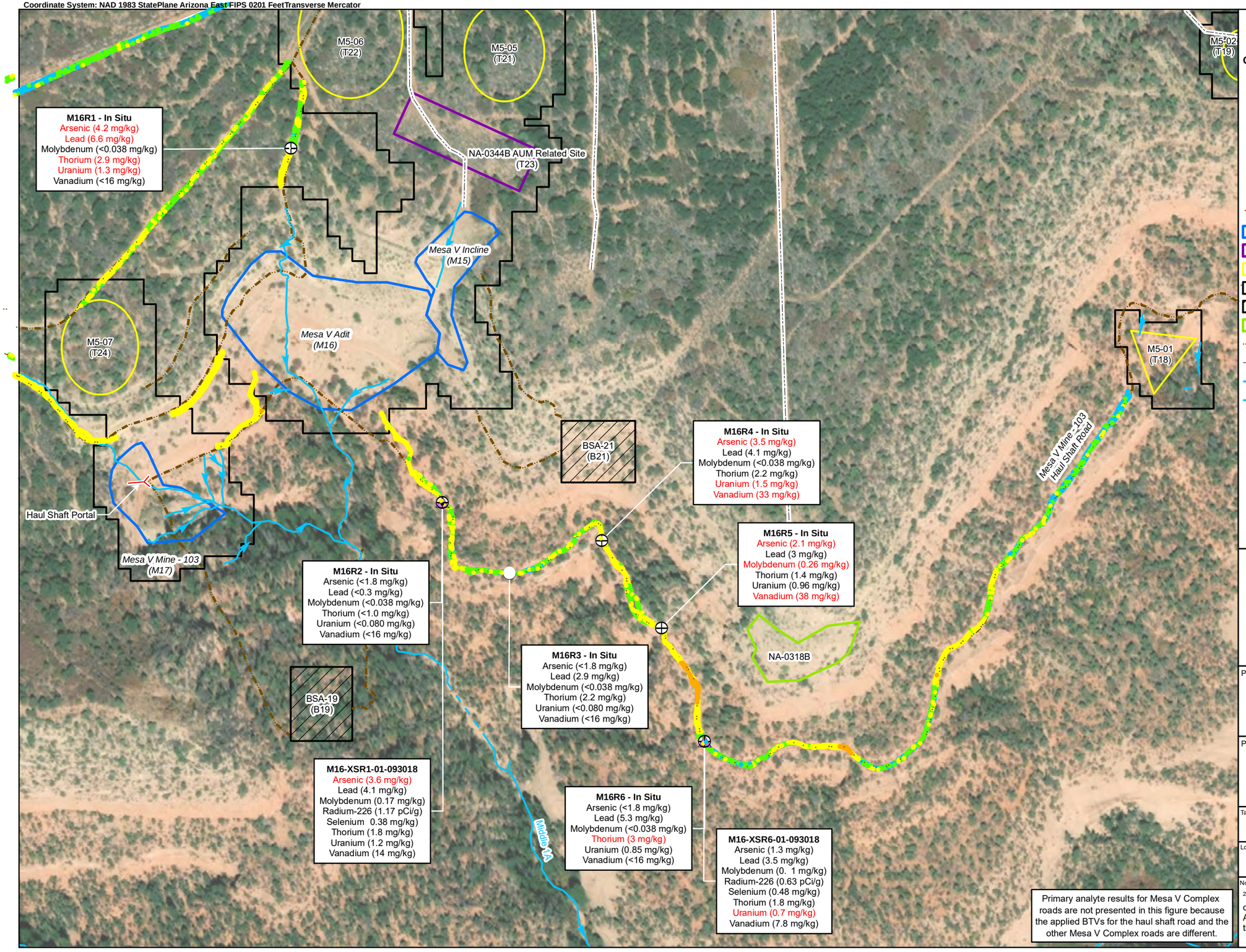
Table K-13. Soil Sampling Results for Primary Analytes for Mesa V Mine – 103 Haul Shaft Access Road Cluster 3

Field Sample ID	Cluster ID	Sample Type	Sample Date	Arsenic		Lead		Molybdenum		Radium-226			Selenium		Thorium		Uranium		Vanadium	
				Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Activity (pCi/g)	TPU	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q
M16R1	Mesa V - 103 Haul Shaft Road	In Situ XRF	9/30/2018	**4.2**		**6.6**		<0.038		-			-		2.9		1.26		<16	
M16R2	Mesa V - 103 Haul Shaft Road	In Situ XRF	9/30/2018	<1.8		<0.3		<0.038		-			-		<1		<0.08		<16	
M16R3	Mesa V - 103 Haul Shaft Road	In Situ XRF	9/30/2018	<1.8		2.9		<0.038		-			-		2.2		<0.08		<16	
M16R4	Mesa V - 103 Haul Shaft Road	In Situ XRF	9/30/2018	3.5		4.1		<0.038		-			-		2.23		**1.47**		33	
M16R5	Mesa V - 103 Haul Shaft Road	In Situ XRF	9/30/2018	2.1		3		**0.261**		-			-		1.38		0.96		**38**	
M16R6	Mesa V - 103 Haul Shaft Road	In Situ XRF	9/30/2018	<1.8		5.3		<0.038		-			-		**3.04**		0.85		<16	
M16-XSR1-01-093018	Mesa V - 103 Haul Shaft Road	XRF Conf	9/30/2018	3.6		4.1		0.17	J	**1.17**	0.28		0.38	J	1.8		1.2		14	
M16-XSR6-01-093018	Mesa V - 103 Haul Shaft Road	XRF Conf	9/30/2018	1.3		3.5		0.11	J	0.63	0.2	LT	**0.48**	J	1.8		0.7		7.8	
Number of Measurements				8		8		8		2			2		8		8		8	
Number of Detects				5		7		3		2			2		7		6		4	
Number of Nondetects				3		1		5		0			0		1		2		4	
Minimum (mg/kg)				1.3		2.9		0.11		0.6			0.38		1.4		0.7		7.8	
Maximum (mg/kg)				4.2		6.6		0.26		1.2			0.48		3.0		1.5		38	
Average (mg/kg)				2.9		4.2		0.18		0.9			0.43		2.2		1.1		23	
Median (mg/kg)				3.5		4.1		0.17		0.9			0.43		2.2		1.1		24	
Standard Deviation (mg/kg)				1.20		1.33		0.08		0.38			0.07		0.60		0.3		15	
90th Percentile (mg/kg)				4.0		5.8		0.24		1.1			0.47		3.0		1.4		37	
95th Percentile (mg/kg)				4.1		6.2		0.25		1.1			0.48		3.0		1		37	
99th Percentile (mg/kg)				4.2		6.5		0.26		1.2			0.48		3.0		1		38	
Relative Standard Deviation				0.41		0.32		0.42		0.42			0.16		0.28		0.3		0.63	
BTV (mg/kg)				2.4		9.3		0.20		1.57			0.84		2.4		1.3		22	
Maximum/BTV (unitless)				1.8		0.71		1.3		0.75			0.57		1.3		1.1		1.7	

Notes:
The maximum concentration is presented in **bold**.
Shaded red indicates that the result exceeds the applied BTV.

<	The analyte was analyzed for, but was not detected. The reporting limit is shown in the result column.
-	Not analyzed.
BTV	Background threshold value
Conf	Confirmation sample
ID	Identification
J	Estimated value
LT	Result less than requested minimum detectable concentration, but greater than sample-specific detectable concentration.
mg/kg	Milligrams per kilogram
pCi/g	Picocuries per gram
Q	Qualifier
TPU	Total propagated uncertainty
XRF	X-ray fluorescence

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator



Primary analyte results for Mesa V Complex roads are not presented in this figure because the applied BTVs for the haul shaft road and the other Mesa V Complex roads are different.

XRF Confirmation Soil Sample[1]

In Situ XRF Measurement[1]

Gamma Reading (cpm)[2]

≤ 9,560	≤ Avg. BG
9,560 - 11,319	Avg. BG - 1 x BTV
11,319 - 22,638	1 x BTV - 2 x BTV
22,638 - 33,957	2 x BTV - 3 x BTV
33,957 - 45,276	3 x BTV - 4 x BTV
45,276 - 113,190	4 x BTV - 10 x BTV
≥ 113,190	≥ 10 x BTV

Haul Shaft Portal

AUM Site Boundary

AUM Related Site Boundary

Non-AUM Target Site Boundary

Survey Area Boundary

Background Location

Non-Tronox AUM Site

Access Route - Foot

Access Route - Vehicular

Drainage - Estimated Path

Drainage - Field Mapped

1 in = 250 ft

1:3,000

N W E S

0 125 250 500 Feet

MESA V MINE - 103 HAUL SHAFT ROAD GAMMA RADIATION SURVEY AND SURFACE SOIL SAMPLE RESULTS MAP

Prepared For:

Prepared By:

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

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 7/10/2019

Notes:

[2]The applied gamma BTV is 11,319 cpm derived from BSA-19 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **K-14**

Table K-14. Summary of Gamma Radiation Survey Results for Mesa V Mine – 103 Haul Shaft Access Road Cluster 3

Summary Statistic	Units	Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,319
Measurements	#	3,078
Minimum	cpm	7,177
Maximum	cpm	33,070
Average	cpm	12,469
Median	cpm	11,140
Standard Deviation	cpm	4,235
90th Percentile	cpm	17,530
95th Percentile	cpm	21,629
99th Percentile	cpm	29,131
Measurements Above Gamma BTV	#	1,449
Measurements Above Gamma BTV	%	47

Notes:
BTV Background threshold value
cpm Counts per minute

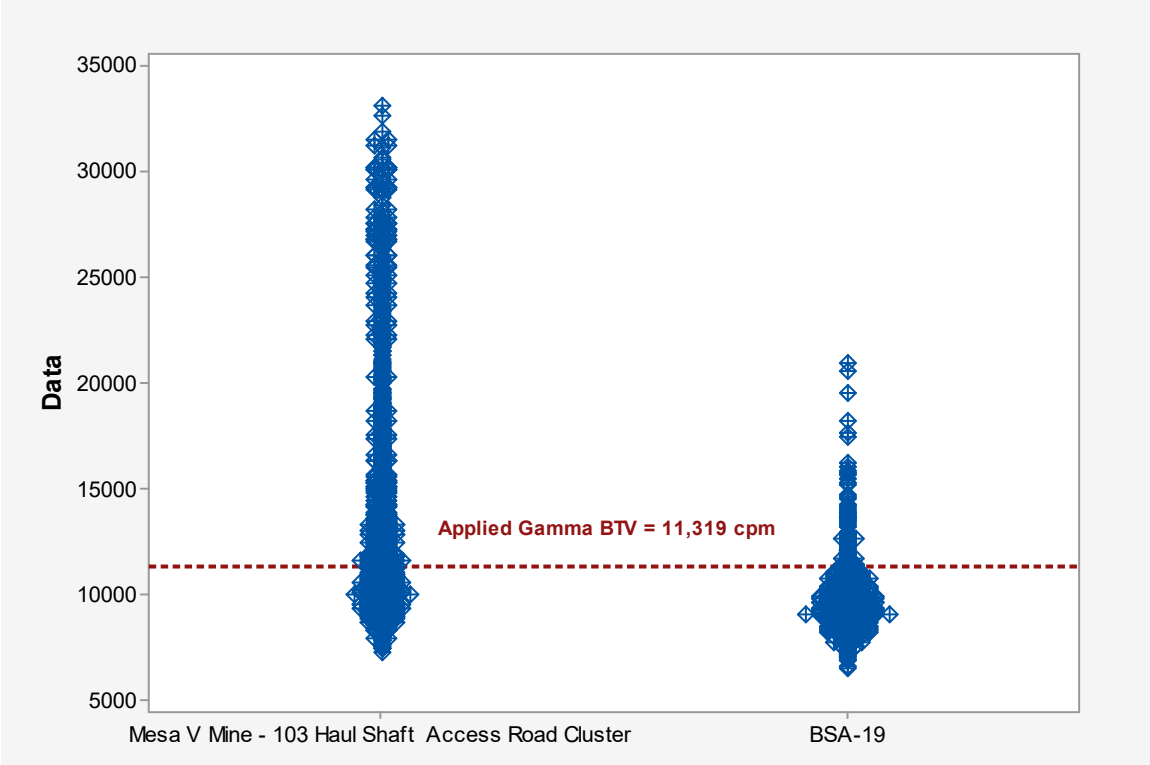


Figure K-15. Individual Value Plot of Gamma Radiation Levels of Mesa V Mine – 103 Haul Shaft Access Road Cluster 3 and BSA-19

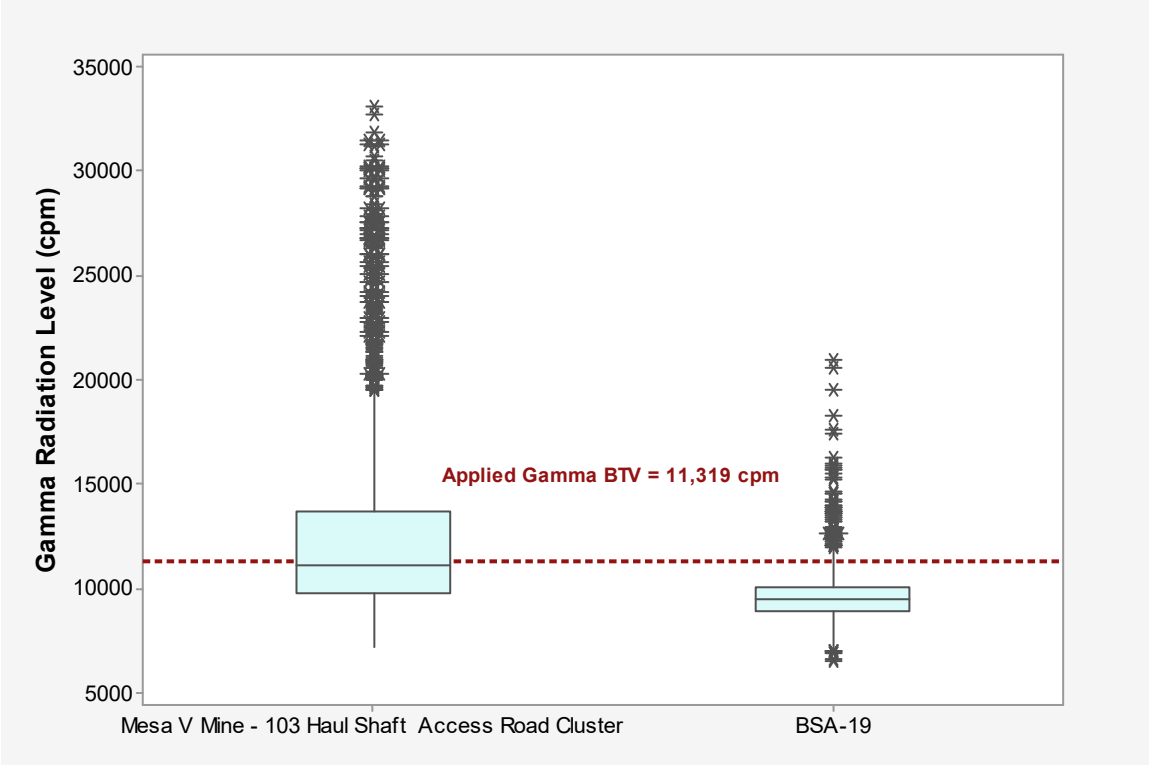


Figure K-16. Box Plot of Gamma Radiation Levels of Mesa V Mine – 103 Haul Shaft Access Road Cluster 3 and BSA-19

5.4 MESA IV MINE COMPLEX ACCESS ROAD CLUSTER 4

Mesa IV Mine Complex access road runs through Mesa IV, Mine No. 2 and the northwestern corner of Mesa IV, Mine No. 3, then along the northern edges of both Mesa IV, Mine No. 3 and Mesa IV, Mine No. 1, where it continues southeast. Five in situ XRF samples and one XRF confirmation soil sample were collected from the Mesa IV Mine Complex access road cluster 4 in September 2018. XRF measurements were collected for metals, and the XRF confirmation samples were submitted to a laboratory for analysis of metals and radionuclides using methods identified in Table K-7 and Table K-8. In addition, a gamma survey was performed along the access road leading to the Mesa IV Mine Complex in June and August 2018.

Soil sampling results are presented in Table K-15 and Figure K-17. Results from one of the thorium, two of the uranium, and five of the molybdenum soil samples exceeded the BTV. The maximum concentration of thorium was less than twice the BTV and the maximum concentration of uranium was just over twice the BTV at the same location (M20R5), the furthest southeastern location. The maximum concentration of molybdenum exceeded the BTV by 32 times and exceeded the BTV in all of the in situ XRF sampling locations. However, the concentration of molybdenum in the confirmation soil sample was below the BTV, and the XRF measurement results for molybdenum are not always a good indication of mine impacts.

Gamma survey summary statistics are provided in Table K-16 and gamma measurements are presented on Figure K-17. The individual value plot presented in Figure K-18 shows that approximately half of the gamma radiation measurements are within the range of the background dataset; 47 percent of the measurements exceed the applied gamma BTV of 9,703 cpm. The box plot showing the quartiles of the datasets provided in Figure K-19 shows that the median of the gamma radiation measurement is higher than the background data set median and approximately equal to the applied gamma BTV. The maximum gamma measurement was less than two times the applied gamma BTV.

Based on the molybdenum and uranium soil sample results for primary analytes exceeding twice the respective BTVs, mining activities conducted at Mesa IV Mine No. 2, Mesa IV Mine No. 3, and Mesa IV Mines No. 1 may have potentially impacted the roads. However, the median gamma survey measurement is below the applied BTV and the maximum gamma measurement is less than two times the BTV; therefore, additional investigation may be warranted to correlate gamma and metals results.

Table K-15. Soil Sampling Results for Primary Analytes for Mesa IV Mine Complex Access Road Cluster 4

Field Sample ID	Cluster ID	Sample Type	Sample Date	Arsenic		Lead		Molybdenum		Radium-226			Selenium		Thorium		Uranium		Vanadium	
				Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Activity (pCi/g)	TPU	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q
M20R1	Mesa IV Mine Complex	In Situ XRF	9/30/2018	<1.8		7.6		5.5		-			-		3.0		0.62		<16	
M20R2	Mesa IV Mine Complex	In Situ XRF	9/30/2018	<1.8		**9.1**		**9.2**		-			-		3.5		1.81		<16	
M20R3	Mesa IV Mine Complex	In Situ XRF	9/30/2018	<1.8		3.6		5.4		-			-		2.3		<0.08		<16	
M20R4	Mesa IV Mine Complex	In Situ XRF	9/30/2018	<1.8		5.5		3.3		-			-		2.7		0.64		<16	
M20R5	Mesa IV Mine Complex	In Situ XRF	9/30/2018	<1.8		**9.1**		4.8		-			-		**4.5**		**3.24**		<16	
M20-XSR2-01-093018	Mesa IV Mine Complex	XRF Conf	9/30/2018	**1.3**		3.6		0.14	J	**0.86**	0.22	LT	**0.4**	J	2.8		0.37		**7.8**	
Number of Measurements				6		6		6		1			1		6		6		6	
Number of Detects				1		6		6		1			1		6		5		1	
Number of Nondetects				5		0		0		0			0		0		1		5	
Minimum (mg/kg)				1.3		3.6		0.14		0.9			0.40		2.3		0.4		7.8	
Maximum (mg/kg)				1.3		9.1		9.20		0.9			0.40		4.5		3.2		8	
Average (mg/kg)				1.3		6.4		4.71		0.9			0.40		3.1		1.3		8	
Median (mg/kg)				1.3		6.6		5.09		0.9			0.40		2.9		0.6		8	
Standard Deviation (mg/kg)				-		2.55		2.97		-			-		0.78		1.2		-	
90th Percentile (mg/kg)				1.3		9.1		7.35		0.9			0.40		4.0		2.7		8	
95th Percentile (mg/kg)				1.3		9.1		8.27		0.9			0.40		4.3		3		8	
99th Percentile (mg/kg)				1.3		9.1		9.01		0.9			0.40		4.5		3		8	
Relative Standard Deviation				-		0.40		0.63		-			-		0.25		0.9		-	
BTV (mg/kg)				3.5		10.4		0.29		2.23			0.94		3.6		1.5		23	
Maximum/BTV (unitless)				0.37		0.88		32		0.39			0.43		1.3		2.2		0.34	

Notes:
The maximum concentration is presented in **bold**.
Shaded red indicates that the result exceeds the applied BTV.

<	The analyte was analyzed for, but was not detected. The reporting limit is shown in the result column.
-	Not analyzed.
BTV	Background threshold value
Conf	Confirmation sample
ID	Identification
J	Estimated value
LT	Result less than requested minimum detectable concentration, but greater than sample-specific detectable concentration.
mg/kg	Milligrams per kilogram
pCi/g	Picocuries per gram
Q	Qualifier
TPU	Total propagated uncertainty
XRF	X-ray fluorescence

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator

East Portal, Frank No. 1 Mine
Frank No. 2
Middle 1C
Middle 1
Middle 1D
Middle 1E
Middle 1G
Middle 2A
Middle 2

M20R2 - In Situ
Arsenic (<1.8 mg/kg)
Lead (9.1 mg/kg)
Molybdenum (9.2 mg/kg)
Thorium (3.5 mg/kg)
Uranium (1.8 mg/kg)
Vanadium (<16 mg/kg)

M20-XSR2-01-093018
Arsenic (1.3 mg/kg)
Lead (3.6 mg/kg)
Molybdenum (0.14 mg/kg)
Radium-226 (0.860 pCi/g)
Selenium (0.40 mg/kg)
Thorium (2.8 mg/kg)
Uranium (0.37 mg/kg)
Vanadium (7.8 mg/kg)

Cov068

M20R1 - In Situ
Arsenic (<1.8 mg/kg)
Lead (7.6 mg/kg)
Molybdenum (5.5 mg/kg)
Thorium (3.0 mg/kg)
Uranium (0.62 mg/kg)
Vanadium (<16 mg/kg)

Mesa IV, Mine No. 2 (M21)
M4-03 (T28)
Mesa IV, Mine No. 3 (M22)
Mesa IV, Mine No. 1 (M20)
M4-04 (T29)

M20R3 - In Situ
Arsenic (<1.8 mg/kg)
Lead (3.6 mg/kg)
Molybdenum (5.4 mg/kg)
Thorium (2.3 mg/kg)
Uranium (<0.080 mg/kg)
Vanadium (<16 mg/kg)

M20R4 - In Situ
Arsenic (<1.8 mg/kg)
Lead (5.5 mg/kg)
Molybdenum (3.3 mg/kg)
Thorium (2.7 mg/kg)
Uranium (0.64 mg/kg)
Vanadium (<16 mg/kg)

BSA-26 (B26)
BSA-25 (B25)

M20R5 - In Situ
Arsenic (<1.8 mg/kg)
Lead (9.1 mg/kg)
Molybdenum (4.8 mg/kg)
Thorium (4.5 mg/kg)
Uranium (3.2 mg/kg)
Vanadium (<16 mg/kg)

Mesa IV, West Mine (M23)

Results for Mesa IV, West Mine access road are not presented in this figure because the applied BTVs for the Mesa IV Mine Complex and the Mesa IV, West Mine access road are different.

XRF Confirmation Soil Sample[1]
In Situ XRF Measurement[1]

Gamma Reading (cpm)[2]

≤ 8,123	≤ Avg. BG
8,123 - 9,703	Avg. BG - 1 x BTV
9,703 - 19,406	1 x BTV - 2 x BTV
19,406 - 29,109	2 x BTV - 3 x BTV
29,109 - 38,812	3 x BTV - 4 x BTV
38,812 - 97,030	4 x BTV - 10 x BTV
≥ 97,030	≥ 10 x BTV

AUM Site Boundary
Non-AUM Target Site Boundary
Survey Area Boundary
Background Location
Non-Tronox AUM Site
Access Route - Foot
Access Route - Vehicular
Drainage[3]
Drainage - Field Mapped

Notes:
[1]Red font indicates sample COPC concentration above BTV value for the relevant analyte.
'<' indicates a less than limit of detection instrumental non-detect.
[2]The applied gamma BTV is 9,703 cpm derived from BSA-24 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 370 ft
1:4,440
N W E S
0 185 370 740 Feet

MESA IV MINE COMPLEX
ACCESS ROAD GAMMA RADIATION SURVEY AND SURFACE SOIL SAMPLE RESULTS MAP

Prepared For:

Prepared By:
TETRA TECH
1999 Harrison Street, Suite 500
Oakland, CA 94612

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 7/10/2019

Reference:
[3]U.S Environmental Protection Agency, Region 9, Superfund Program, *Abandoned Uranium Mines and the Navjo Nation Part II Atlas With Geospatial Data. NN_Drainage_HR_AUM.shp.* July, 2007.

Figure No.: **K-17**

Table K-16. Summary of Gamma Radiation Survey Results for Mesa IV Mine Complex Access Road Cluster 4

Summary Statistic	Units	Gamma Radiation Survey Results
Applied Gamma BTV	cpm	9,703
Measurements	#	2,086
Minimum	cpm	7,113
Maximum	cpm	13,620
Average	cpm	9,607
Median	cpm	9,644
Standard Deviation	cpm	944
90th Percentile	cpm	10,715
95th Percentile	cpm	11,108
99th Percentile	cpm	12,232
Measurements Above Gamma BTV	#	971
Measurements Above Gamma BTV	%	47

Notes:
BTV Background threshold value
cpm Counts per minute

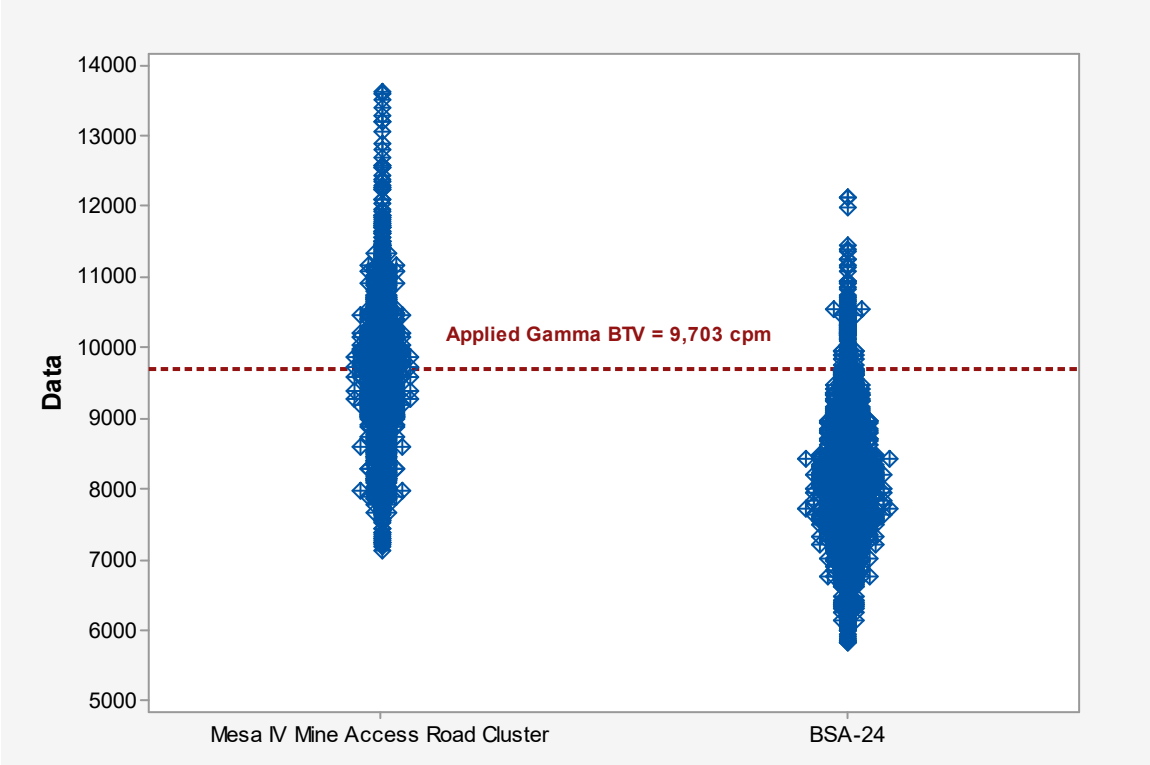


Figure K-18. Individual Value Plot of Gamma Radiation Levels of Mesa IV Mine Complex Access Road Cluster 4 and BSA-24

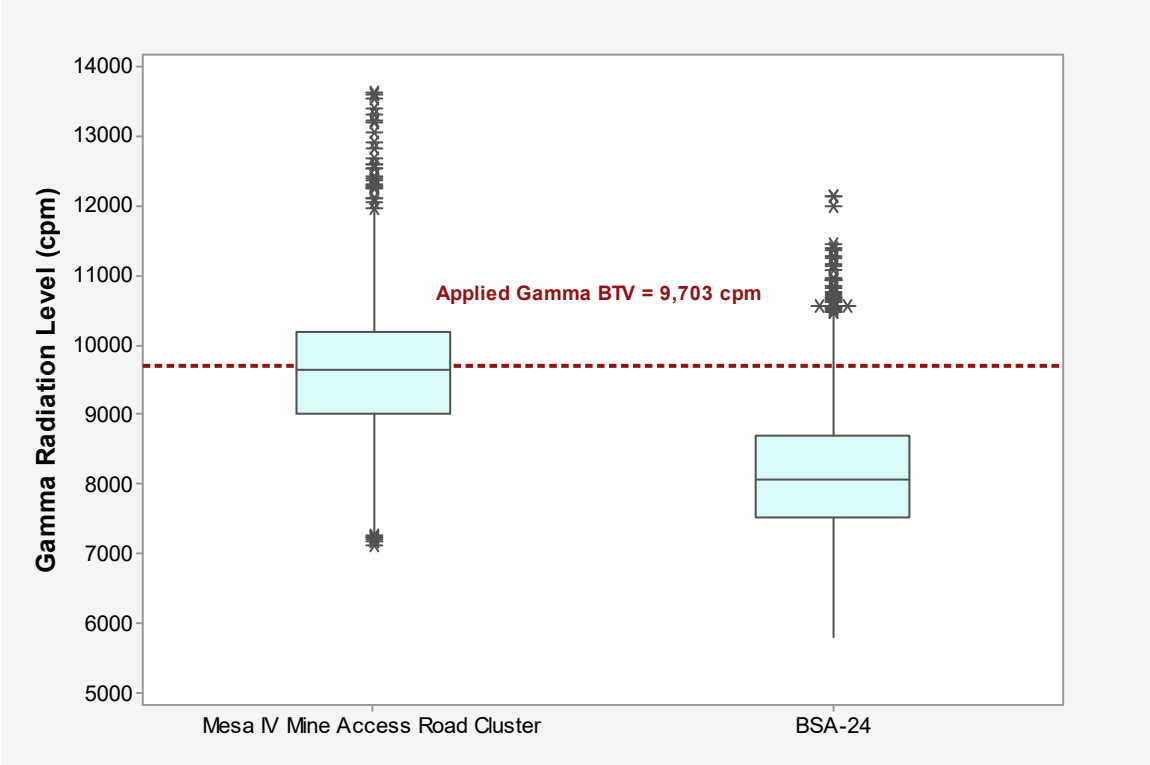


Figure K-19. Box Plot of Gamma Radiation Levels of Mesa IV Mine Complex Access Road Cluster 4 and BSA-24

5.5 MESA IV, WEST MINE ACCESS ROAD CLUSTER 5

The Mesa IV, West Mine access road footpath is located south of Mesa IV, West Mine and leads from the vehicular access route to the mine. Five in situ XRF samples and one XRF confirmation soil sample were collected from the Mesa IV, West Mine access road cluster 5 footpath in September 2018. XRF measurements were collected for metals, and the XRF confirmation samples were submitted to a laboratory for analysis of metals and radionuclides using methods identified in Table K-7 and Table K-8. A gamma survey was not conducted on the Mesa IV, West Mine footpath.

Soil sampling results are presented in Table K-17 and Figure K-20. Results from three of the arsenic, four of the uranium, and all the molybdenum soil samples exceeded the BTV. The maximum concentrations of arsenic and uranium exceed the BTV by just over three times and are supported by the XRF confirmation soil sample at the same location. The maximum concentration of molybdenum exceeded the BTV by over 25 times and exceeded the BTV in all the XRF sampling locations as well as in the XRF confirmation soil sample. The maximum concentration of uranium exceeded the BTV by approximately four times.

Based on the arsenic, molybdenum, and uranium soil sample results for primary analytes that exceeded the respective BTVs, mining activities conducted at Mesa IV, West Mine may have potentially impacted footpaths therefore, additional investigation may be warranted to further identify the lateral and vertical extent of contamination. No gamma survey was conducted at Mesa IV West Mine access road cluster 5 to correlate results with uranium mining activity in the area.

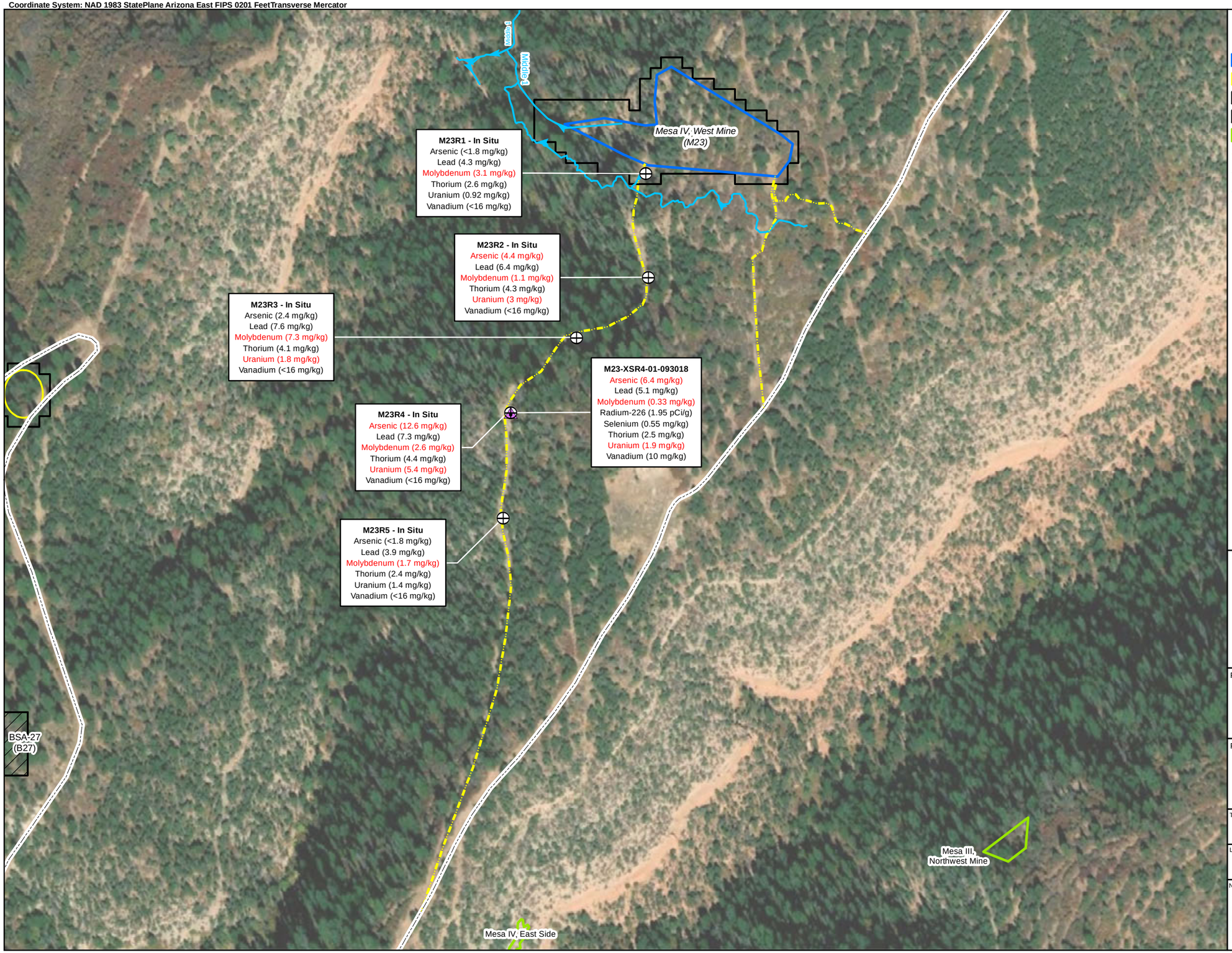
Table K-17. Soil Sampling Results for Primary Analytes for Mesa IV, West Mine Access Road Cluster 5

Field Sample ID	Cluster ID	Sample Type	Sample Date	Arsenic		Lead		Molybdenum		Radium-226			Selenium		Thorium		Uranium		Vanadium	
				Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Activity (pCi/g)	TPU	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q
M23R1	Mesa IV West Mine	In Situ XRF	9/30/2018	<1.8		4.3		3.1		-			-		2.6		0.92		<16	
M23R2	Mesa IV West Mine	In Situ XRF	9/30/2018	4.4		6.4		1.1		-			-		4.3		2.99		<16	
M23R3	Mesa IV West Mine	In Situ XRF	9/30/2018	2.4		**7.6**		**7.3**		-			-		4.1		1.76		<16	
M23R4	Mesa IV West Mine	In Situ XRF	9/30/2018	**12.6**		7.3		2.6		-			-		**4.4**		**5.4**		<16	
M23R5	Mesa IV West Mine	In Situ XRF	9/30/2018	<1.8		3.9		1.7		-			-		2.4		1.4		<16	
M23-XSR4-01-093018	Mesa IV West Mine	XRF Conf	9/30/2018	6.4		5.1		0.33		**1.95**	0.38		**0.55**	J	2.5		1.9		**10**	
Number of Measurements				6		6		6		1			1		6		6		6	
Number of Detects				4		6		6		1			1		6		6		1	
Number of Nondetects				2		0		0		0			0		0		0		5	
Minimum (mg/kg)				2.4		3.9		0.33		2.0			0.55		2.4		0.9		10.0	
Maximum (mg/kg)				12.6		7.6		7.31		2.0			0.55		4.4		5.4		10	
Average (mg/kg)				6.5		5.8		2.68		2.0			0.55		3.4		2.4		10	
Median (mg/kg)				5.4		5.8		2.12		2.0			0.55		3.3		1.8		10	
Standard Deviation (mg/kg)				4.41		1.56		2.48		-			-		0.98		1.6		-	
90th Percentile (mg/kg)				10.7		7.5		5.22		2.0			0.55		4.3		4.2		10	
95th Percentile (mg/kg)				11.7		7.5		6.26		2.0			0.55		4.4		5		10	
99th Percentile (mg/kg)				12.4		7.6		7.10		2.0			0.55		4.4		5		10	
Relative Standard Deviation				0.68		0.27		0.93		-			-		0.29		0.7		-	
BTV (mg/kg)				3.5		11.0		0.29		2.23			1.0		4.7		1.5		24	
Maximum/BTV (unitless)				3.6		0.69		25		0.87			0.55		0.93		3.7		0.42	

Notes:
The maximum concentration is presented in **bold**.
Shaded red indicates that the result exceeds the applied BTV.

<	The analyte was analyzed for, but was not detected. The reporting limit is shown in the result column.
-	Not analyzed.
BTV	Background threshold value
Conf	Confirmation sample
ID	Identification
J	Estimated value
LT	Result less than requested minimum detectable concentration, but greater than sample-specific detectable concentration.
mg/kg	Milligrams per kilogram
pCi/g	Picocuries per gram
Q	Qualifier
TPU	Total propagated uncertainty
XRF	X-ray fluorescence

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator



XRF Confirmation Soil Sample*
In Situ XRF Measurement*
AUM Site Boundary
Non-AUM Target Site Boundary
Survey Area Boundary
Background Location
Non-Tronox AUM Site
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped

Note: Gamma survey data not available.

1 in = 292 ft

1:3,507

N
W E
S

0 135 270 540 Feet

MESA IV, WEST MINE
SURFACE SOIL SAMPLE RESULTS MAP

Prepared For:

Prepared By:

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

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 7/10/2019

Notes:
*Red font indicates sample COPC concentration above BTV value for the relevant analyte. '<' indicates a less than limit of detection instrumental non-detect.

Figure No.: **K-20**

5.6 MESA II 1/2 MINE AND MESA III MINE ACCESS ROAD CLUSTER 6

Mesa II 1/2 Mine and Mesa III Mine access roads cluster 6 is located northeast of Mesa II 1/2 Mine, Mesa II 1/2, Mine 4, and Mesa III Mine. Five in situ XRF samples and one XRF confirmation soil sample were collected along the access road in September 2018. XRF measurements were collected for metals, and the XRF confirmation samples were submitted to a laboratory for analysis of metals and radionuclides using methods identified in Table K-7 and Table K-8. In addition, a gamma survey was performed along the access road leading to the mines in June, August, and September 2018.

Soil sampling results are presented in Table K-18 and Figure K-21. Results from one of the molybdenum, one of the radium-226, four of the vanadium, five of the arsenic, and all the uranium soil samples exceeded the BTV. However, the maximum concentrations of molybdenum, radium-226, and vanadium in soil were less than two times the BTV in all the samples. The maximum concentration of arsenic in soil was slightly over two times the BTV in a sample located north of Mesa II 1/2 Mine. The maximum concentration of uranium in soil exceeded the BTV by over six times.

Gamma survey summary statistics are provided in Table K-19 and gamma measurements are presented on Figure K-21. Sixty-seven percent of the measurements exceed the applied gamma BTV of 10,433 cpm, and the maximum concentration is approximately double the applied BTV. The individual value plot presented in Figure K-22 shows that gamma radiation measurements along the access road are generally higher than those of the background dataset. The box plot showing the quartiles of the datasets provided in Figure K-23 shows that the median of the gamma radiation measurement is higher than the background data set median and the applied gamma BTV.

Based on the arsenic, uranium, and vanadium soil sample results for primary analytes exceeding twice the respective BTVs, mining activities conducted at Mesa II 1/2 Mine and Mesa II Mines may have potentially impacted the roads. Further, the median gamma survey measurement is above the applied BTV and the maximum gamma measurement is greater than two times the BTV; therefore, additional investigation may be warranted to further identify the lateral and vertical extent of contamination.

Table K-18. Soil Sampling Results for Primary Analytes for Mesa II 1/2 and Mesa III Mine Access Road Cluster 6

Field Sample ID	Cluster ID	Sample Type	Sample Date	Arsenic		Lead		Molybdenum		Radium-226				Selenium		Thorium		Uranium		Vanadium	
				Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Activity (pCi/g)	TPU	Q		Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q
M30R1	Mesa II 1/2 Mine and Mesa III Mine	In Situ XRF	9/30/2018	2.3		5		<0.038		-				-		1.3		2.51		**45**	
M30R2	Mesa II 1/2 Mine and Mesa III Mine	In Situ XRF	9/30/2018	**5.6**		5.7		<0.038		-				-		2.3		**3.85**		23	
M30R3	Mesa II 1/2 Mine and Mesa III Mine	In Situ XRF	9/30/2018	3.3		5.1		**0.4**		-				-		2.5		2.87		20	
M30R4	Mesa II 1/2 Mine and Mesa III Mine	In Situ XRF	9/30/2018	3.6		**9.1**		<0.038		-				-		**2.9**		3.08		25	
M30R5	Mesa II 1/2 Mine and Mesa III Mine	In Situ XRF	9/30/2018	<1.8		8.7		<0.038		-				-		2.7		1.39		<16	
M30-XSR5-01-093018	Mesa II 1/2 Mine and Mesa III Mine	XRF Conf	9/30/2018	2.4		5.4		0.17	J	**0.93**	0.27	LT		**0.6**	J	**2.9**		0.83		9.9	
Number of Measurements				6		6		6		1				1		6		6		6	
Number of Detects				5		6		2		1				1		6		6		5	
Number of Nondetects				1		0		4		0				0		0		0		1	
Minimum (mg/kg)				2.3		5.0		0.17		0.9				0.60		1.3		0.8		9.9	
Maximum (mg/kg)				5.6		9.1		0.44		0.9				0.60		2.9		3.9		45	
Average (mg/kg)				3.4		6.5		0.30		0.9				0.60		2.4		2.4		25	
Median (mg/kg)				3.3		5.6		0.30		0.9				0.60		2.6		2.7		23	
Standard Deviation (mg/kg)				1.33		1.88		0.19		-				-		0.60		1.1		13	
90th Percentile (mg/kg)				4.8		8.9		0.41		0.9				0.60		2.9		3.5		37	
95th Percentile (mg/kg)				5.2		9.0		0.42		0.9				0.60		2.9		4		41	
99th Percentile (mg/kg)				5.5		9.1		0.44		0.9				0.60		2.9		4		44	
Relative Standard Deviation				0.39		0.29		0.62		-				-		0.25		0.5		0.52	
BTV (mg/kg)				2.2		10.0		0.29		0.87				1.0		4.7		0.60		14	
Maximum/BTV (unitless)				2.5		0.91		1.5		1.1				0.60		0.62		6.4		3.2	

Notes:
The maximum concentration is presented in **bold**.
Shaded red indicates that the result exceeds the applied BTV.

<	The analyte was analyzed for, but was not detected. The reporting limit is shown in the result column.
-	Not analyzed.
BTV	Background threshold value
Conf	Confirmation sample
ID	Identification
J	Estimated value
LT	Result less than requested minimum detectable concentration, but greater than sample-specific detectable concentration.
mg/kg	Milligrams per kilogram
pCi/g	Picocuries per gram
Q	Qualifier
TPU	Total propagated uncertainty
XRF	X-ray fluorescence

M30R5 - In Situ
Arsenic (<1.8 mg/kg)
Lead (8.7 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (2.7 mg/kg)
Uranium (1.4 mg/kg)
Vanadium (<16 mg/kg)

M30R4 - In Situ
Arsenic (3.6 mg/kg)
Lead (9.1 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (2.9 mg/kg)
Uranium (3.1 mg/kg)
Vanadium (25 mg/kg)

M30R3 - In Situ
Arsenic (3.3 mg/kg)
Lead (5.1 mg/kg)
Molybdenum (0.44 mg/kg)
Thorium (2.5 mg/kg)
Uranium (2.9 mg/kg)
Vanadium (20 mg/kg)

M30R2 - In Situ
Arsenic (5.6 mg/kg)
Lead (5.7 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (2.3 mg/kg)
Uranium (3.9 mg/kg)
Vanadium (23 mg/kg)

M30-XSR5-01-093018
Arsenic (2.4 mg/kg)
Lead (5.4 mg/kg)
Molybdenum (0.17 mg/kg)
Radium-226 (0.93 pCi/g)
Selenium (0.60 mg/kg)
Thorium (2.9 mg/kg)
Uranium (0.83 mg/kg)
Vanadium (9.9 mg/kg)

M30R1 - In Situ
Arsenic (2.3 mg/kg)
Lead (5 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (1.3 mg/kg)
Uranium (2.5 mg/kg)
Vanadium (45 mg/kg)

M2-01 (T32)
BSA-30 (B30)
Middle 2B
Mesa II 1/2 Mine (M30)
Mesa III Mine (M32)
Mesa II 1/2, Mine 4 (M31)

XRF Confirmation Soil Sample[1]
In Situ XRF Measurement[1]

Gamma Reading (cpm)[2]

≤ 8,815	≤ Avg. BG
8,815 - 10,433	Avg. BG - 1 x BTV
10,433 - 20,866	1 x BTV - 2 x BTV
20,866 - 31,299	2 x BTV - 3 x BTV
31,299 - 41,732	3 x BTV - 4 x BTV
41,732 - 104,330	4 x BTV - 10 x BTV
≥ 104,330	≥ 10 x BTV

AUM Site Boundary
Non-AUM Target Site Boundary
Survey Area Boundary
Background Location
Access Route - Foot
Access Route - Vehicular
Drainage - Estimated Path
Drainage - Field Mapped

Note:
[1]Red font indicates sample COPC concentration above BTV value for the relevant analyte. '<' indicates a less than limit of detection instrumental non-detect.

1 in = 210 ft
1:2,520
N W E S
0 105 210 420 Feet

MESA II 1/2 AND MESA III MINE ACCESS ROAD GAMMA RADIATION SURVEY AND SURFACE SOIL SAMPLE RESULTS MAP

Prepared For:

Prepared By:
TETRA TECH
1999 Harrison Street, Suite 500
Oakland, CA 94612

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 7/10/2019

Notes:
[2]The applied gamma background threshold value (BTV) is 10,433 cpm derived from BSA-31 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **K-21**

Table K-19. Summary of Gamma Radiation Survey Results for Mesa II 1/2 Mine and Mesa III Mine Access Road Cluster 6

Summary Statistic	Units	Gamma Radiation Survey Results
Applied Gamma BTV	cpm	10,433
Measurements	#	1,562
Minimum	cpm	7,387
Maximum	cpm	21,153
Average	cpm	11,185
Median	cpm	10,860
Standard Deviation	cpm	1,613
90th Percentile	cpm	13,117
95th Percentile	cpm	14,384
99th Percentile	cpm	16,220
Measurements Above Gamma BTV	#	1,041
Measurements Above Gamma BTV	%	67

Notes:
BTV Background threshold value
cpm Counts per minute

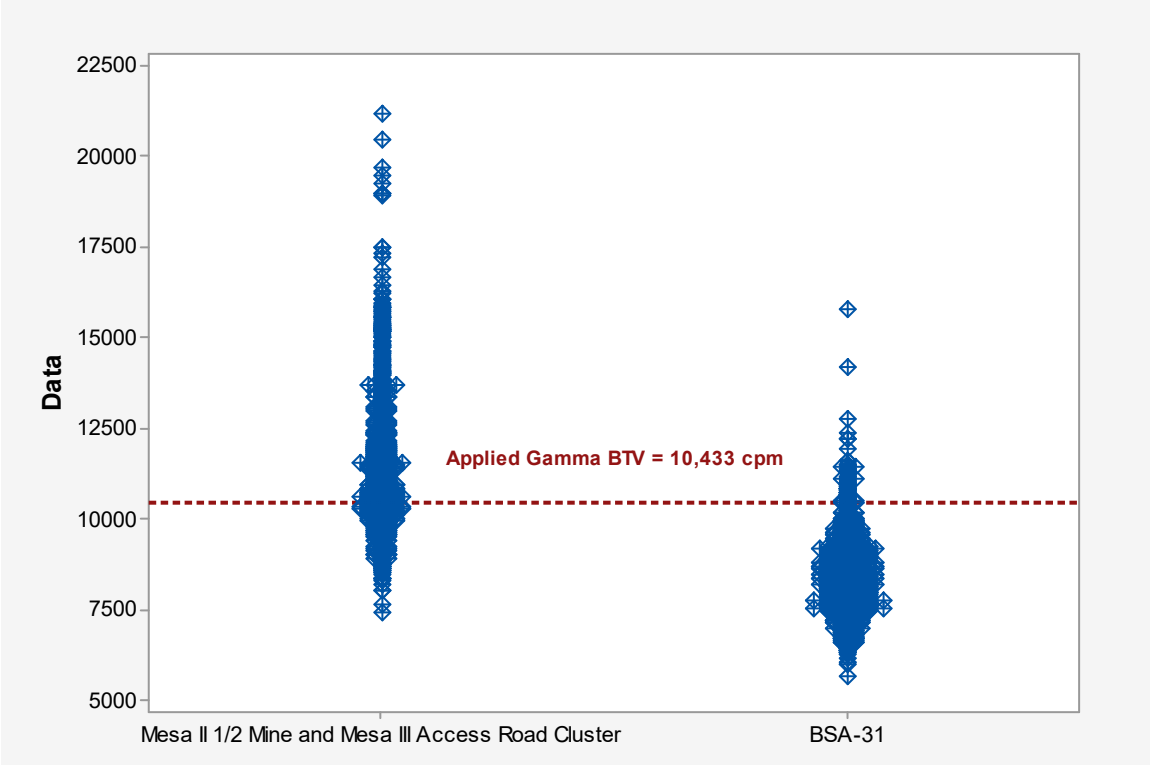


Figure K-22. Individual Value Plot of Gamma Radiation Levels of Mesa II 1/2 Mine and Mesa III Mine Access Roads Cluster 6 and BSA-31

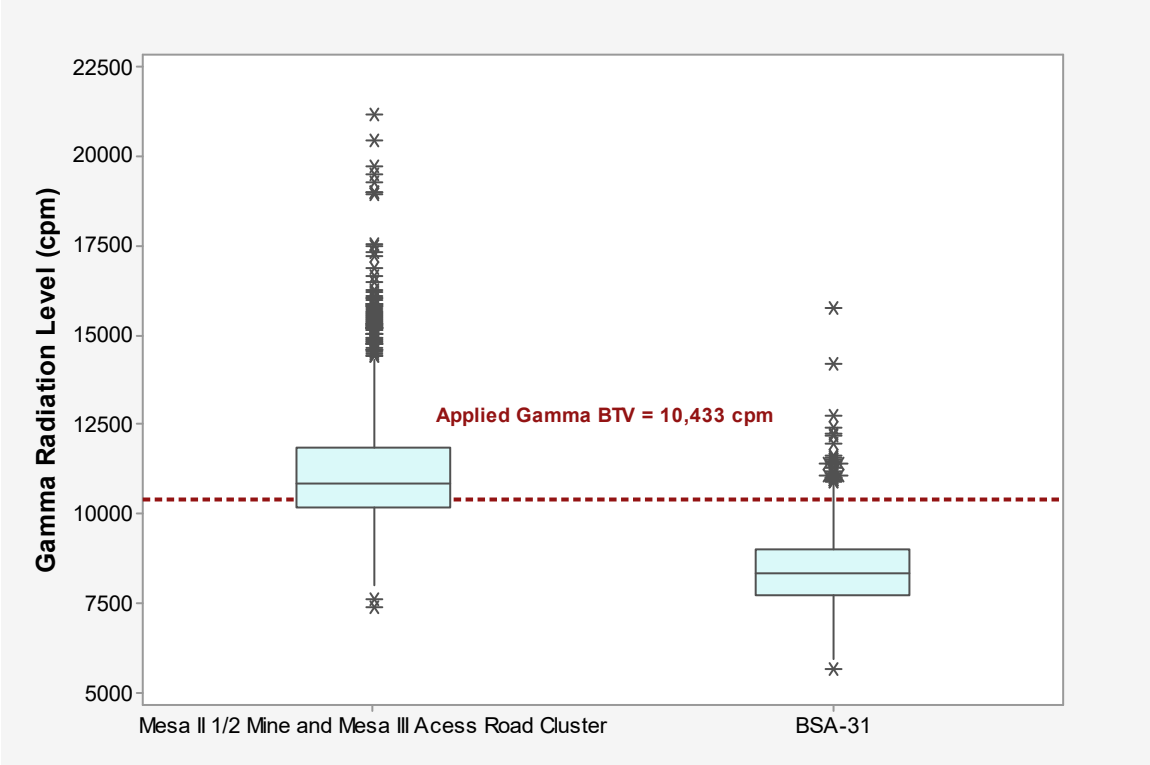


Figure K-23. Box Plot of Gamma Radiation Levels of Mesa II 1/2 Mine and Mesa III Mine Access Roads Cluster 6 and BSA-31

5.7 MESA I 3/4 AND MESA II MINE ACCESS ROAD CLUSTER 7

Mesa I 3/4 and Mesa II Mine access road cluster 7 is located north of Mesa I 3/4 Mine No. 2 P150, Mesa II Mine No. 1 P150, and Mesa II Mine No. 1 & 2, P-21. Three in situ XRF samples and one XRF confirmation soil sample were collected along the access road leading directly to the mines in September 2018. XRF measurements were collected for metals, and the XRF confirmation samples were submitted to a laboratory for analysis of metals and radionuclides using methods identified in Table K-7 and Table K-8. In addition, a gamma survey was performed along the access road leading to the mines, and along an adjacent access road northeast of the mines in June and July 2018.

Soil sampling results are presented in Table K-20 and Figure K-24. Results from one of the molybdenum soil samples exceeded the BTV by just over nine times at location M28R2, located north of the northeastern edge of Mesa II Mine No. 1 P-150. Soil results for all other primary analytes are less than the BTV.

Gamma survey summary statistics are provided in Table K-21 and gamma measurements are presented on Figure K-24. Approximately one quarter of the measurements exceeded the applied gamma BTV of 9,703 cpm, and the maximum concentration is approximately 1.5 times the applied BTV. The individual value plot presented in Figure K-25 shows that gamma radiation measurements along the access road are similar to those of the background dataset. The box plot showing the quartiles of the datasets provided in Figure K-26 shows that the median of the gamma radiation measurement is higher than the background data set median but lower than the applied gamma BTV.

Based on the soil sample results for primary analytes not exceeding twice the applied BTV, the median gamma survey measurement below the applied BTV, and the maximum gamma measurement below twice the BTV; mining activities conducted at Mesa I 3/4 and Mesa II Mines do not appear to have impacted the roads.

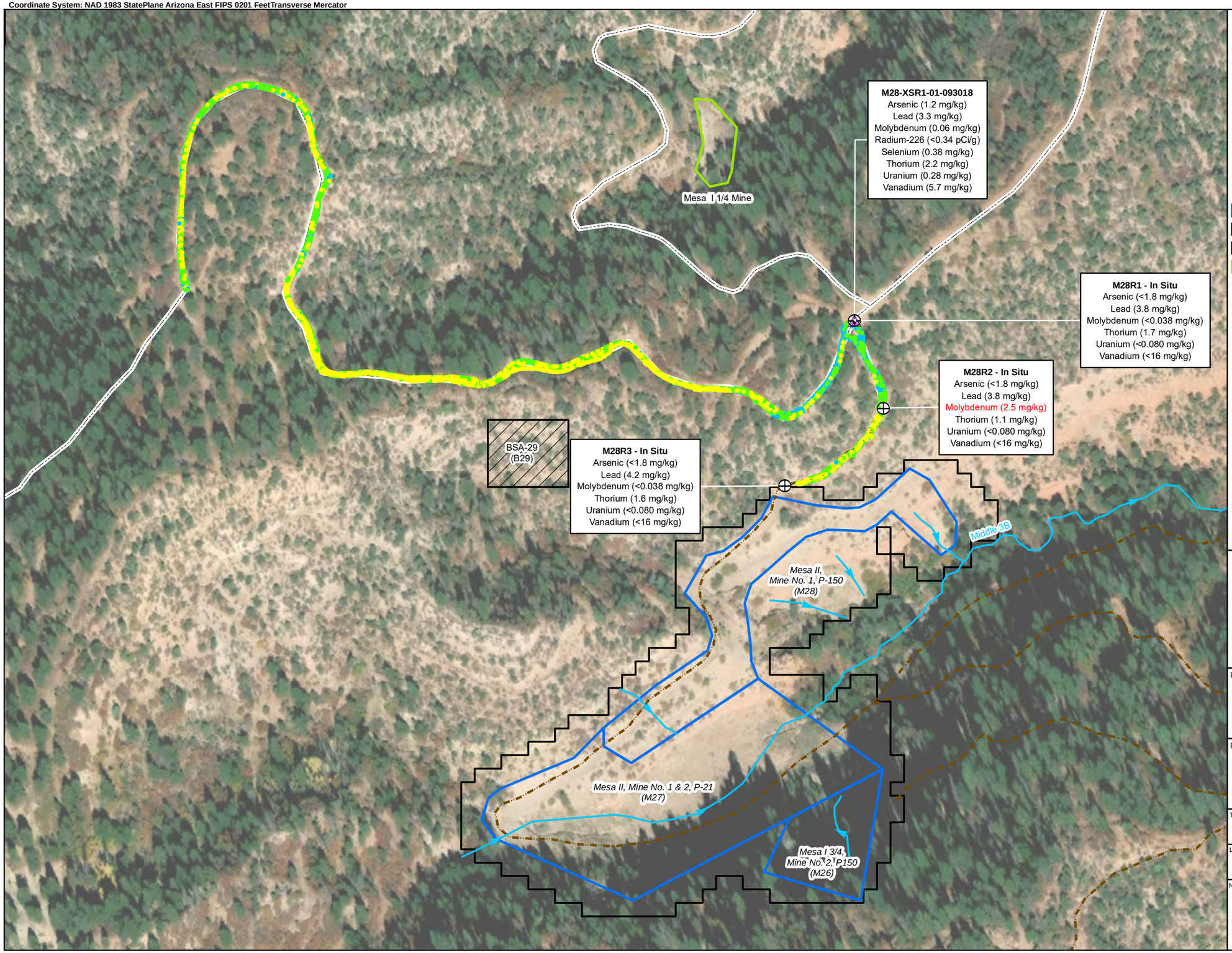
Table K-20. Soil Sampling Results for Primary Analytes for Mesa I 3/4 and Mesa II Mine Access Road Cluster 7

Field Sample ID	Cluster ID	Sample Type	Sample Date	Arsenic		Lead		Molybdenum		Radium-226			Selenium		Thorium		Uranium		Vanadium	
				Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Activity (pCi/g)	TPU	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q
M28R1	Mesa I 3/4 and Mesa II Mine Complex	In Situ XRF	9/30/2018	<1.8		3.8		<0.038		-			-		1.7		<0.08		<16	
M28R2	Mesa I 3/4 and Mesa II Mine Complex	In Situ XRF	9/30/2018	<1.8		3.8		**2.5**		-			-		1.1		<0.08		<16	
M28R3	Mesa I 3/4 and Mesa II Mine Complex	In Situ XRF	9/30/2018	<1.8		**4.2**		<0.038		-			-		1.6		<0.08		<16	
M28-XSR1-02-093018	Mesa I 3/4 and Mesa II Mine Complex	XRF Conf	9/30/2018	**1.2**		3.3		0.06	J	**<0.34**	0.16	U	**0.38**	J	**2.2**		**0.28**		**5.7**	
Number of Measurements				4		4		4		1			1		4		4		4	
Number of Detects				1		4		2		0			1		4		1		1	
Number of Nondetects				3		0		2		1			0		0		3		3	
Minimum (mg/kg)				1.2		3.3		0.06		0.0			0.38		1.1		0.3		5.7	
Maximum (mg/kg)				1.2		4.2		2.46		0.0			0.38		2.2		0.3		6	
Average (mg/kg)				1.2		3.8		1.26		-			0.38		1.7		0.3		6	
Median (mg/kg)				1.2		3.8		1.26		-			0.38		1.7		0.3		6	
Standard Deviation (mg/kg)				-		0.37		1.70		-			-		0.46		-		-	
90th Percentile (mg/kg)				1.2		4.1		2.22		-			0.38		2.1		0.3		6	
95th Percentile (mg/kg)				1.2		4.1		2.34		-			0.38		2.1		0		6	
99th Percentile (mg/kg)				1.2		4.2		2.44		-			0.38		2.2		0		6	
Relative Standard Deviation				-		0.10		1.35		-			-		0.27		-		-	
BTV (mg/kg)				2.0		10.0		0.26		0.85			0.92		3.6		0.60		12	
Maximum/BTV (unitless)				0.60		0.42		9.5		0.00			0.41		0.61		0.47		0.48	

Notes:
The maximum concentration is presented in **bold**.
Shaded red indicates that the result exceeds the applied BTV.

<	The analyte was analyzed for, but was not detected. The reporting limit is shown in the result column.
-	Not analyzed.
BTV	Background threshold value
Conf	Confirmation sample
ID	Identification
J	Estimated value
LT	Result less than requested minimum detectable concentration, but greater than sample-specific detectable concentration.
mg/kg	Milligrams per kilogram
pCi/g	Picocuries per gram
Q	Qualifier
TPU	Total propagated uncertainty
XRF	X-ray fluorescence

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator



XRF Confirmation Soil Sample[1]

In Situ XRF Measurement[1]

Gamma Reading (cpm)[2]

≤ 8,123	≤ Avg. BG
8,123 - 9,703	Avg. BG - 1 x BTV
9,703 - 19,406	1 x BTV - 2 x BTV
19,406 - 29,109	2 x BTV - 3 x BTV
29,109 - 38,812	3 x BTV - 4 x BTV
38,812 - 97,030	4 x BTV - 10 x BTV
≥ 97,030	≥ 10 x BTV

AUM Site Boundary

Survey Area Boundary

Background Location

Non-Tronox AUM Site

Access Route - Foot

Access Route - Vehicular

Drainage - Field Mapped

Note:
[1]Red font indicates sample COPC concentration above BTV value for the relevant analyte.
'<' indicates a less than limit of detection laboratory or instrumental non-detect.

1 in = 230 ft

1:2,760

N W E S

0 115 230 460 Feet

MESA I 3/4 AND MESA II MINE COMPLEX ACCESS ROAD GAMMA RADIATION SURVEY AND SURFACE SOIL SAMPLE RESULTS MAP

Prepared For:

Prepared By:

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

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 7/10/2019

Notes:
[2]The applied gamma BTV is 9,703 cpm derived from BSA-24 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **K-24**

Table K-21. Summary of Gamma Radiation Survey Results for Mesa I 3/4 and Mesa II Mine Complex Access Road Cluster 7

Summary Statistic	Units	Gamma Radiation Survey Results
Applied Gamma BTV	cpm	9,703
Measurements	#	3,869
Minimum	cpm	5,360
Maximum	cpm	14,116
Average	cpm	9,006
Median	cpm	9,019
Standard Deviation	cpm	1,248
90th Percentile	cpm	10,583
95th Percentile	cpm	11,115
99th Percentile	cpm	12,039
Measurements Above Gamma BTV	#	1,058
Measurements Above Gamma BTV	%	27

Notes:
BTV Background threshold value
cpm Counts per minute

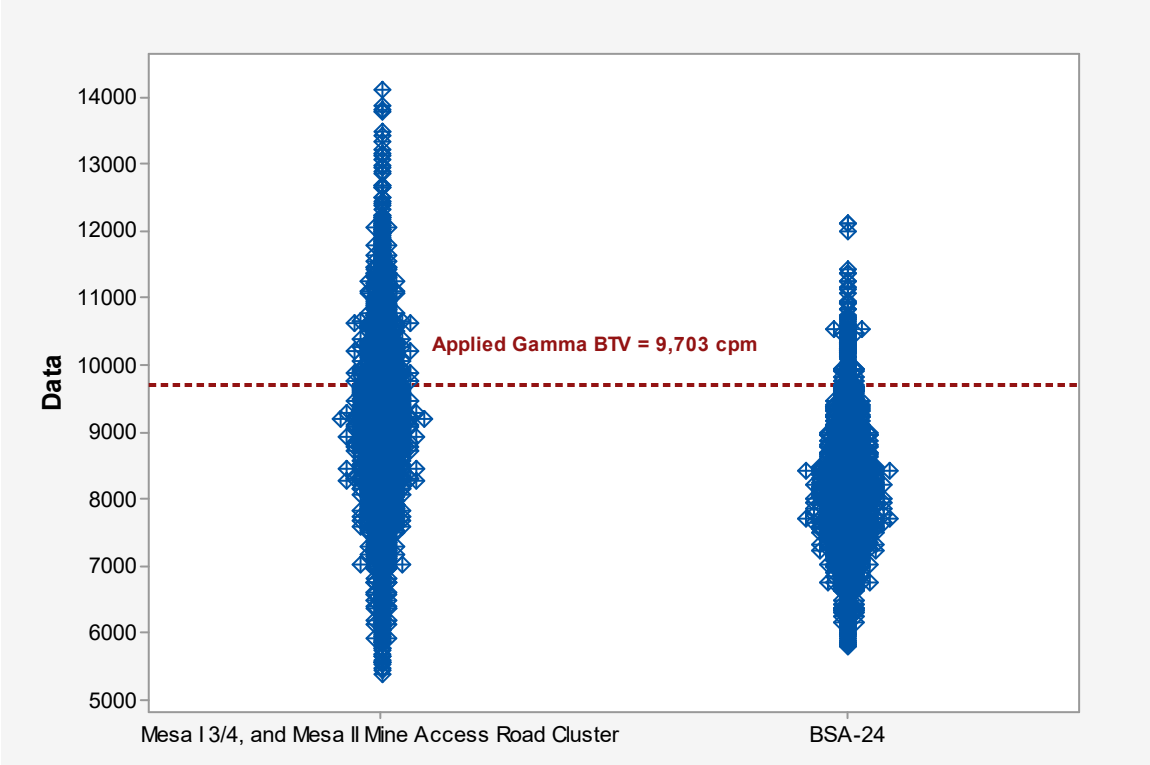


Figure K-25. Individual Value Plot of Gamma Radiation Levels of Mesa I 3/4 and Mesa II Mine Complex Access Road Cluster 7 and BSA-24

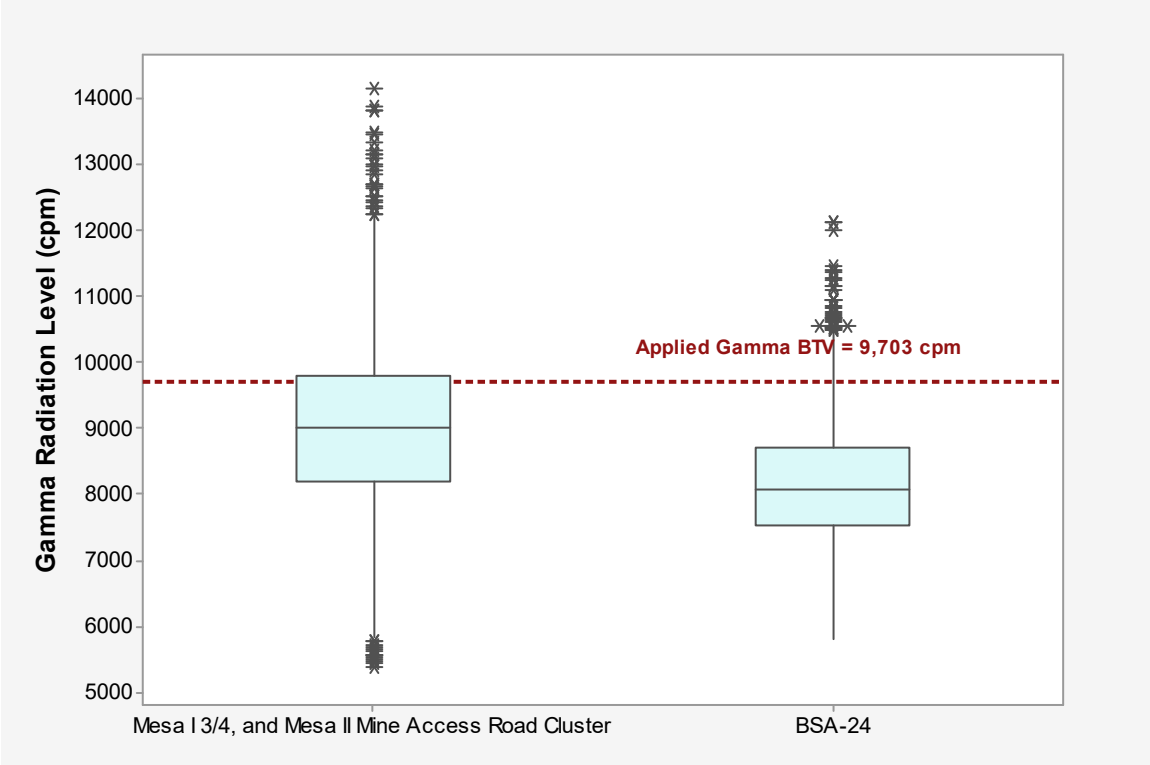


Figure K-26. Box Plot of Gamma Radiation Levels of Mesa I 3/4 and Mesa II Mine Complex Access Road Cluster 7 and BSA-24

5.8 MESA II, MINE 4 ACCESS ROAD CLUSTER 8

Mesa II, Mine 4 access road cluster 8 is located north and northwest of the Mesa II, Mine 4. Nine in situ XRF samples and two XRF confirmation soil samples were collected along the footpath leading from the vehicular access road to Mesa II, Mine 4 in September 2018. XRF measurements were collected for metals, and the XRF confirmation samples were submitted to a laboratory for analysis of metals and radionuclides using methods identified in Table K-7 and Table K-8. In addition, a gamma survey was performed along the same stretch of road in June 2018.

Soil sampling results are presented in Table K-22 and Figure K-27. Results for arsenic, uranium and vanadium in soil exceeded the BTV in one location. Results of thorium in soil at two locations and molybdenum at six locations exceeded the BTV. However, the maximum concentrations of arsenic, thorium, and vanadium were less than two times the BTV in all samples. The maximum concentration of uranium was just over two times the BTV at location M29R7; however, the concentration of uranium in the XRF confirmation sample at that location is below the BTV. The maximum concentration of molybdenum exceeded the BTV by more than ten times in a sample collected north of Mesa II Mine 4. Results for all other primary analytes in soil were less than two times the BTV.

Gamma survey summary statistics are provided in Table K-23 and gamma measurements are presented on Figure K-27. Approximately 30 percent of the measurements exceeded the applied gamma BTV of 9,703 cpm, and the maximum concentration was approximately 1.6 times the applied BTV. The individual value plot presented in Figure K-28 shows that gamma radiation measurements along the access road were slightly higher than those of the background dataset. The box plot showing the quartiles of the datasets provided in Figure K-29 shows that the median of the gamma radiation measurement was higher than the background data set median but lower than the applied gamma BTV.

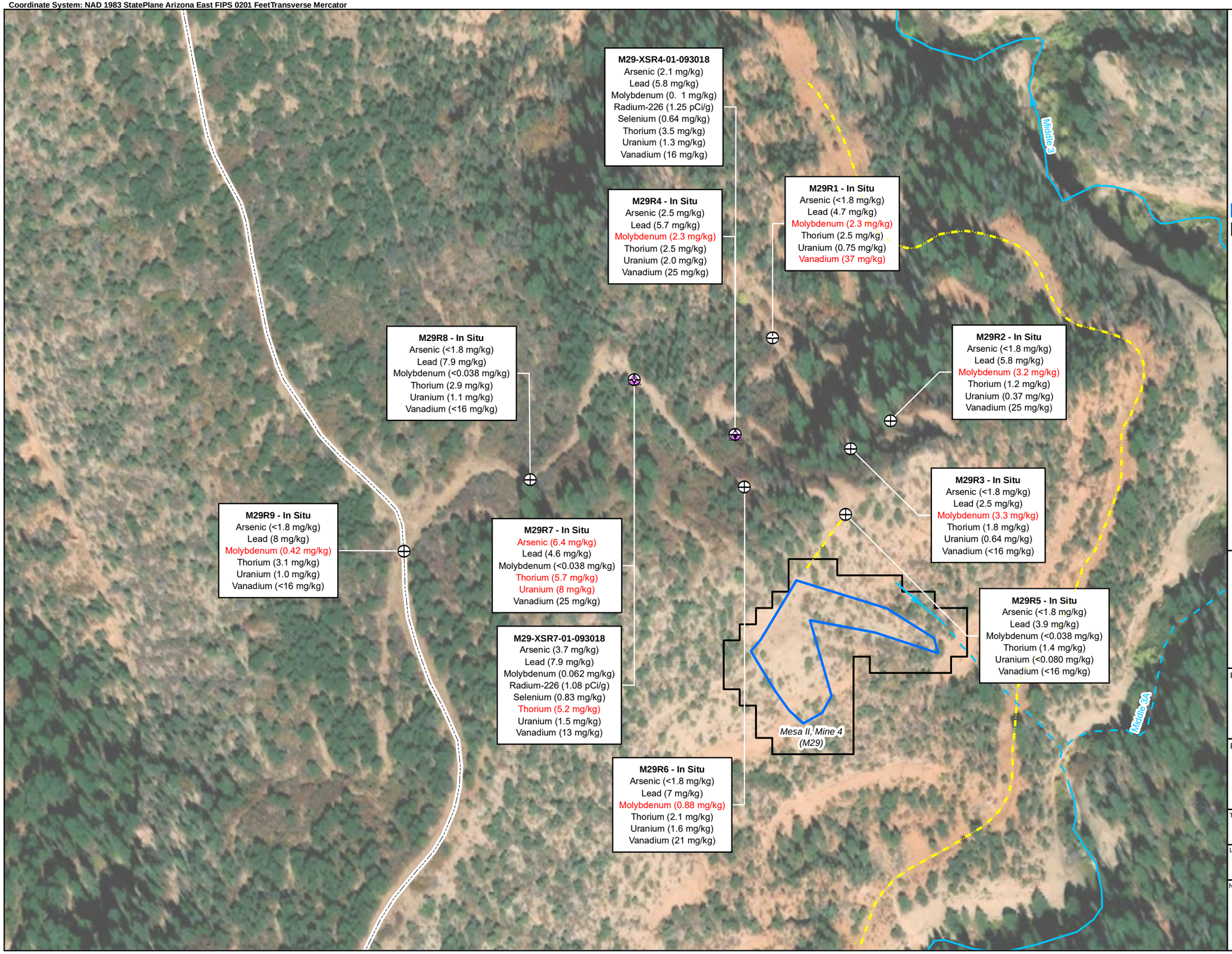
Based on the molybdenum and uranium soil sample results for primary analytes exceeding two times the respective BTVs, mining activities conducted at Mesa II, Mine 4 may have potentially impacted the roads. However, the median gamma survey measurement was below the applied BTV and the maximum gamma measurement was less than two times the BTV; therefore, additional investigation may be warranted to correlate gamma and metals results.

Table K-22. Soil Sampling Results for Primary Analytes for Mesa II, Mine 4 Access Road Cluster 8

Field Sample ID	Cluster ID	Sample Type	Sample Date	Arsenic		Lead		Molybdenum		Radium-226			Selenium		Thorium		Uranium		Vanadium	
				Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Activity (pCi/g)	TPU	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q
M29R1	Mesa II, Mine 4	In Situ XRF	9/30/2018	<1.8		4.7		2.3		-			-		2.5		0.75		**37**	
M29R2	Mesa II, Mine 4	In Situ XRF	9/30/2018	<1.8		5.8		3.2		-			-		1.2		0.37		25	
M29R3	Mesa II, Mine 4	In Situ XRF	9/30/2018	<1.8		2.5		**3.3**		-			-		1.8		0.64		<16	
M29R4	Mesa II, Mine 4	In Situ XRF	9/30/2018	2.5		5.7		2.3		-			-		2.5		2.02		25	
M29R5	Mesa II, Mine 4	In Situ XRF	9/30/2018	<1.8		3.9		<0.038		-			-		1.4		<0.08		<16	
M29R6	Mesa II, Mine 4	In Situ XRF	9/30/2018	<1.8		7		0.9		-			-		2.1		1.61		21	
M29R7	Mesa II, Mine 4	In Situ XRF	9/30/2018	**6.4**		4.6		<0.038		-			-		**5.7**		**7.96**		25	
M29R8	Mesa II, Mine 4	In Situ XRF	9/30/2018	<1.8		7.9		<0.038		-			-		2.9		1.09		<16	
M29R9	Mesa II, Mine 4	In Situ XRF	9/30/2018	<1.8		**8**		0.4		-			-		3.1		1		<16	
M29-XSR4-01-093018	Mesa II, Mine 4	XRF Conf	9/30/2018	2.1		5.8		0.11	J	**1.25**	0.28		0.64	J	3.5		1.3		16	
M29-XSR7-01-093018	Mesa II, Mine 4	XRF Conf	9/30/2018	3.7		7.9		0.062	J	1.08	0.3		**0.83**	J	5.2		1.5		13	
Number of Measurements				11		11		11		2			2		11		11		11	
Number of Detects				4		11		8		2			2		11		10		7	
Number of Nondetects				7		0		3		0			0		0		1		4	
Minimum (mg/kg)				2.1		2.5		0.06		1.1			0.64		1.2		0.4		13.0	
Maximum (mg/kg)				6.4		8.0		3.29		1.3			0.83		5.7		8.0		37	
Average (mg/kg)				3.7		5.8		1.56		1.2			0.74		2.9		1.8		23	
Median (mg/kg)				3.1		5.8		1.57		1.2			0.74		2.5		1.2		25	
Standard Deviation (mg/kg)				1.94		1.80		1.35		0.12			0.13		1.44		2.2		8	
90th Percentile (mg/kg)				5.6		7.9		3.21		1.2			0.81		5.2		2.6		30	
95th Percentile (mg/kg)				6.0		8.0		3.25		1.2			0.82		5.4		5		33	
99th Percentile (mg/kg)				6.3		8.0		3.28		1.2			0.83		5.6		7		36	
Relative Standard Deviation				0.53		0.31		0.86		0.10			0.18		0.50		1.2		0.34	
BTV (mg/kg)				4.7		10.4		0.32		2.78			0.94		3.6		2.7		31	
Maximum/BTV (unitless)				1.4		0.77		10		0.45			0.89		1.6		3.0		1.2	

Notes:
The maximum concentration is presented in **bold**.
Shaded red indicates that the result exceeds the applied BTV.

<	The analyte was analyzed for, but was not detected. The reporting limit is shown in the result column.
-	Not analyzed.
BTV	Background threshold value
Conf	Confirmation sample
ID	Identification
J	Estimated value
LT	Result less than requested minimum detectable concentration, but greater than sample-specific detectable concentration.
mg/kg	Milligrams per kilogram
pCi/g	Picocuries per gram
Q	Qualifier
TPU	Total propagated uncertainty
XRF	X-ray fluorescence



XRF Confirmation Soil Sample[1]

In Situ XRF Measurement[1]

Gamma Reading (cpm)[2]

≤ 8,123	≤ Avg. BG
8,123 - 9,703	Avg. BG - 1 x BTV
9,703 - 19,406	1 x BTV - 2 x BTV
19,406 - 29,109	2 x BTV - 3 x BTV
29,109 - 38,812	3 x BTV - 4 x BTV
38,812 - 97,030	4 x BTV - 10 x BTV
≥ 97,030	≥ 10 x BTV

AUM Site Boundary

Survey Area Boundary

Access Route - Foot

Access Route - Vehicular

Drainage - Estimated Path

Drainage - Field Mapped

Note:
[1]Red font indicates sample COPC concentration above BTV value for the relevant analyte.
'<' indicates a less than limit of detection instrumental non-detect.

1 in = 190 ft

1:2,280

N W E S

0 95 190 380 Feet

MESA II, MINE 4
ACCESS ROAD GAMMA RADIATION SURVEY AND SURFACE SOIL SAMPLE RESULTS MAP

Prepared For:

Prepared By:

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

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 7/10/2019

Notes:
[2]The applied gamma BTV is 9,703 cpm derived from BSA-24 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **K-24**

Table K-23. Summary of Gamma Radiation Survey Results for Mesa II, Mine 4 Access Road Cluster 8

Summary Statistic	Units	Gamma Radiation Survey Results
Applied Gamma BTV	cpm	9,703
Measurements	#	4,314
Minimum	cpm	5,318
Maximum	cpm	15,570
Average	cpm	9,179
Median	cpm	9,141
Standard Deviation	cpm	1,234
90th Percentile	cpm	10,699
95th Percentile	cpm	11,147
99th Percentile	cpm	12,435
Measurements Above Gamma BTV	#	1,368
Measurements Above Gamma BTV	%	32

Notes:
BTV Background threshold value
cpm Counts per minute

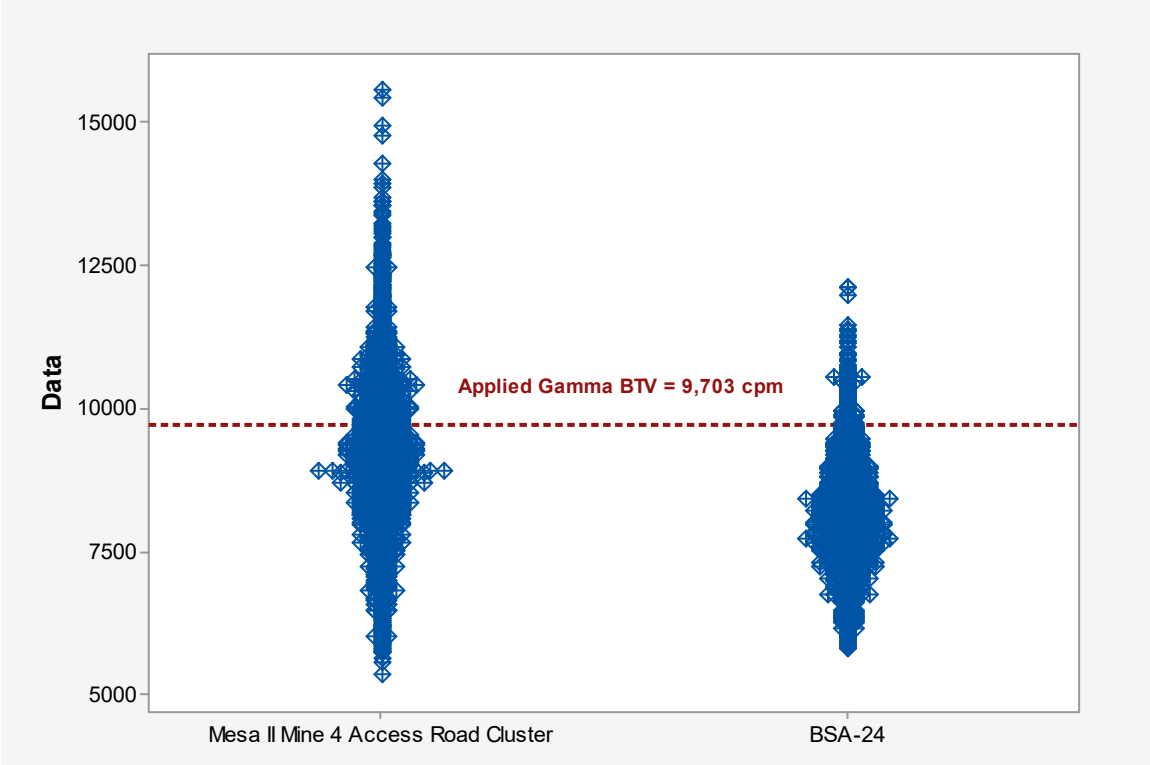


Figure K-28. Individual Value Plot of Gamma Radiation Levels of Mesa II, Mine 4 Access Road Cluster 8 and BSA-24

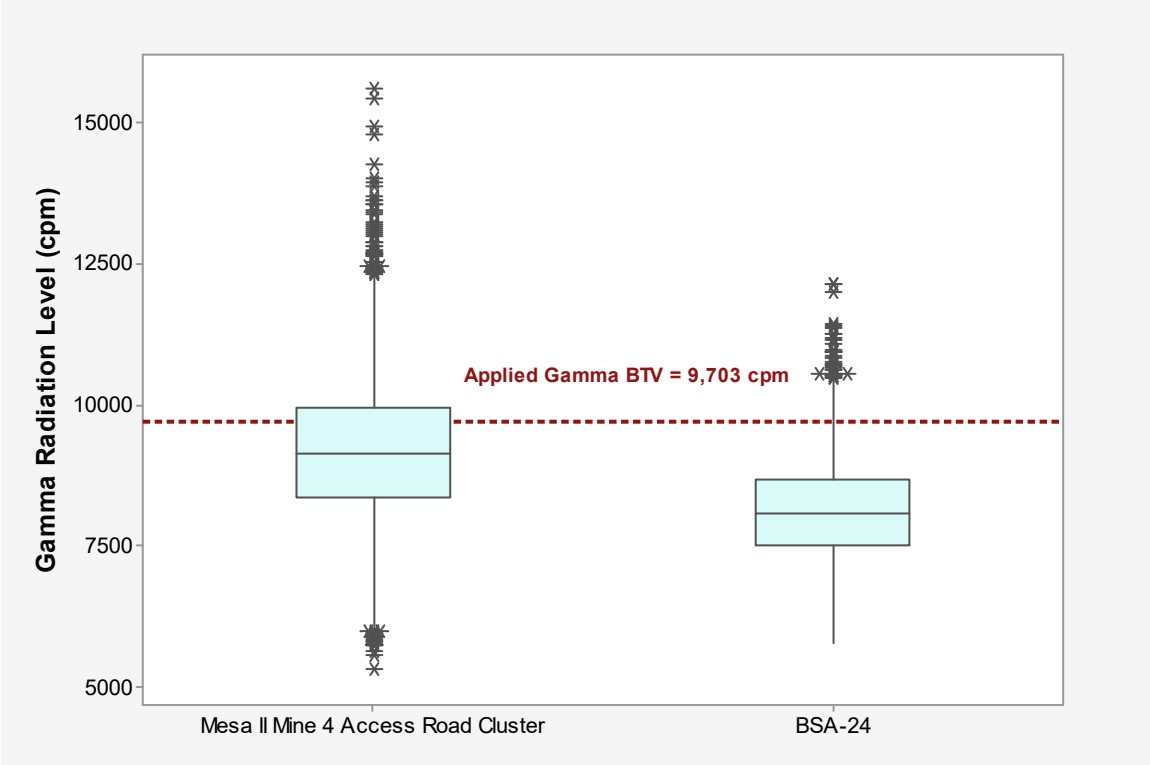


Figure K-29. Box Plot of Gamma Radiation Levels of Mesa II, Mine 4 Access Road Cluster 8 and BSA-24

5.9 MESA I MINES COMPLEX ACCESS ROAD CLUSTER 9

The Mesa I Mine Complex access road cluster 9 is located in the vicinity of the Mesa I Mine Complex, where Mesa I Mines 10 through 15 and Mesa I Camp are located. Both vehicular access roads and footpaths were sampled. Nine in situ XRF samples and four XRF confirmation soil samples were collected in September 2018. XRF measurements were collected for metals, and the XRF confirmation samples were submitted to a laboratory for analysis of metals and radionuclides using methods identified in Table K-7 and Table K-8. In addition, a gamma survey was performed along Mesa I Mine Complex access roads and footpaths in April, May, August, and September 2018.

Soil sampling results are presented in Table K-24 and Figure K-30. Results for arsenic, lead, molybdenum, radium-226, selenium, uranium, and vanadium exceeded the BTV in at least two (lead, radium-226, and selenium) and up to nine (uranium) soil samples. The maximum concentrations of lead, radium-226, and selenium were less than two times the BTV. The maximum concentration of arsenic exceeded the BTV by more than five times in between Mesa I Mine 14 and Mesa I Camp (M7R1), and the collocated XRF confirmation soil sample exceeded the BTV by over four times, supporting the in situ XRF value. The maximum concentration of uranium was from the same location (M7R1) and exceeded the BTV by seven times, and the collocated XRF confirmation soil sample exceeded the BTV by over three times, supporting the in situ XRF value. The maximum concentration of molybdenum exceeded the BTV by over six times between Mesa I Mine 15 and Mesa I Camp (T17R1); however, the collocated XRF confirmation soil sample did not exceed the BTV. The maximum concentration of vanadium exceeded the BTV by eight times, and the collocated XRF confirmation sample exceeded the BTV by four times.

Gamma survey summary statistics are provided in Table K-25 and gamma measurements are presented on Figure K-30. Approximately 36 percent of the measurements exceeded the applied gamma BTV of 12,232 cpm, and the maximum concentration is almost three times the applied BTV. However, the average concentration is less than the applied BTV, and Figure K-30 shows that gamma measurements exceeding twice the applied BTV are limited to a small area of the road north of the Mesa I Camp. The individual value plot presented in Figure K-31 shows that gamma radiation measurements along the access roads are higher than those of the background dataset. The box plot showing the quartiles of the datasets provided in Figure K-32 shows that the median of the gamma radiation measurement is higher than the background data set median but lower than the applied gamma BTV.

Based on the arsenic, molybdenum, uranium, and vanadium soil sample results for primary analytes exceeding twice the respective BTVs, mining activities conducted at Mesa I Mine Complex may have potentially impacted the roads. However, the median gamma survey measurement is below the applied BTV and the maximum gamma measurement is less than two times the BTV; therefore, additional investigation may be warranted to correlate gamma and metals results.

Table K-24. Soil Sampling Results for Primary Analytes for Mesa I Mine Complex Access Road Cluster 9

Field Sample ID	Cluster ID	Sample Type	Sample Date	Arsenic		Lead		Molybdenum		Radium-226			Selenium		Thorium		Uranium		Vanadium	
				Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Activity (pCi/g)	TPU	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q
M6R1	Mesa I Complex	In Situ XRF	9/30/2018	<1.8		2.4		<0.038		-			-		1.6		<0.08		<16	
M6R2	Mesa I Complex	In Situ XRF	9/30/2018	<1.8		7.3		<0.038		-			-		2.8		1.62		18	
M6R3	Mesa I Complex	In Situ XRF	9/30/2018	<1.8		4.6		<0.038		-			-		2.1		0.68		<16	
M6R4	Mesa I Complex	In Situ XRF	9/30/2018	<1.8		2.8		<0.038		-			-		1.3		<0.08		<16	
M6R5	Mesa I Complex	In Situ XRF	9/30/2018	2.2		6.3		<0.038		-			-		2.4		0.96		<16	
M6-XSR1-01-093018	Mesa I Complex	XRF Conf	9/30/2018	1.2		2.5		0.06	J	<0.42	0.23	UJ	0.33	J	1.7		0.32		6.2	
M7R1	Mesa I Complex	In Situ XRF	9/30/2018	**11**		**8.0**		<0.038		-			-		2.7		**6.4**		24	
M7-XSR1-01-093018	Mesa I Complex	XRF Conf	9/30/2018	8.7		5.3		0.48		**2.98**	0.5		0.59	J	2.5		3.5		13	
M8R1	Mesa I Complex	In Situ XRF	9/30/2018	3.2		6.4		0.22		-			-		3.0		1.9		**103**	
M8-XSR1-01-093018	Mesa I Complex	XRF Conf	9/30/2018	3		5.9		0.19		**2.36**	0.41		0.87	J	4.4		1.9		44	
M8R2	Mesa I Complex	In Situ XRF	9/30/2018	<1.8		6.5		<0.038		-			-		**3.3**		2.0		51	
T17R1	Mesa I Complex	In Situ XRF	9/30/2018	<1.8		3.5		**1.1**		-			-		2.2		3.5		<16	
T17-XSR1-01-093018	Mesa I Complex	XRF Conf	9/30/2018	1.9		2.3		0.14	J	1.7	0.31		**0.97**		1.8	J	3.0		7.5	
Number of Measurements				13		13		13		4			4		13		13		13	
Number of Detects				7		13		6		3			4		13		11		8	
Number of Nondetects				6		0		7		1			0		0		2		5	
Minimum (mg/kg)				1.2		2.3		0.06		1.7			0.33		1.3		0.3		6.2	
Maximum (mg/kg)				10.7		8.0		1.11		3.0			0.97		4.4		6.4		103	
Average (mg/kg)				4.4		4.9		0.37		2.3			0.69		2.4		2.3		33	
Median (mg/kg)				3.0		5.3		0.20		2.4			0.73		2.4		1.9		21	
Standard Deviation (mg/kg)				3.72		2.01		0.39		0.64			0.29		0.84		1.7		33	
90th Percentile (mg/kg)				9.5		7.1		0.79		2.9			0.94		3.2		3.5		67	
95th Percentile (mg/kg)				10.1		7.6		0.95		2.9			0.96		3.7		5		85	
99th Percentile (mg/kg)				10.6		7.9		1.08		3.0			0.97		4.3		6		99	
Relative Standard Deviation				0.84		0.41		1.07		0.27			0.42		0.34		0.7		0.98	
BTV (mg/kg)				2.0		7.0		0.16		1.76			0.77		4.7		0.91		13	
Maximum/BTV (unitless)				5.4		1.1		6.9		1.7			1.3		0.94		7.0		7.9	

Notes:
The maximum concentration is presented in **bold**.
Shaded red indicates that the result exceeds the applied BTV.

<	The analyte was analyzed for, but was not detected. The reporting limit is shown in the result column.
-	Not analyzed.
BTV	Background threshold value
Conf	Confirmation sample
ID	Identification
J	Estimated value
mg/kg	Milligrams per kilogram
pCi/g	Picocuries per gram
Q	Qualifier
TPU	Total propagated uncertainty
UJ	Not considered detected. The associated value is the reported concentration, which is estimated.
XRF	X-ray fluorescence

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator

M8-XSR1-01-093018
Arsenic (3 mg/kg)
Lead (5.9 mg/kg)
Molybdenum (0.19 mg/kg)
Radium-226 (2.36 pCi/g)
Selenium (0.87 mg/kg)
Thorium (4.4 mg/kg)
Uranium (1.9 mg/kg)
Vanadium (44 mg/kg)

M8R1 - In Situ
Arsenic (3.2 mg/kg)
Lead (6.4 mg/kg)
Molybdenum (0.22 mg/kg)
Thorium (3.0 mg/kg)
Uranium (1.9 mg/kg)
Vanadium (103 mg/kg)

M6R4 - In Situ
Arsenic (<1.8 mg/kg)
Lead (2.8 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (1.3 mg/kg)
Uranium (<0.080 mg/kg)
Vanadium (<16 mg/kg)

M6R3 - In Situ
Arsenic (<1.8 mg/kg)
Lead (4.6 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (2.1 mg/kg)
Uranium (0.68 mg/kg)
Vanadium (<16 mg/kg)

M6R5 - In Situ
Arsenic (2.2 mg/kg)
Lead (6.3 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (2.4 mg/kg)
Uranium (0.96 mg/kg)
Vanadium (<16 mg/kg)

M6R2 - In Situ
Arsenic (<1.8 mg/kg)
Lead (7.3 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (2.8 mg/kg)
Uranium (1.6 mg/kg)
Vanadium (18 mg/kg)

M6R1 - In Situ
Arsenic (<1.8 mg/kg)
Lead (2.4 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (1.6 mg/kg)
Uranium (<0.080 mg/kg)
Vanadium (<16 mg/kg)

M6-XSR1-01-093018
Arsenic (1.2 mg/kg)
Lead (2.5 mg/kg)
Molybdenum (0.06 mg/kg)
Radium-226 (<0.42 pCi/g)
Selenium (0.33 mg/kg)
Thorium (1.7 mg/kg)
Uranium (0.32 mg/kg)
Vanadium (6.2 mg/kg)

T17R1 - In Situ
Arsenic (<1.8 mg/kg)
Lead (3.5 mg/kg)
Molybdenum (1.1 mg/kg)
Thorium (2.2 mg/kg)
Uranium (3.5 mg/kg)
Vanadium (<16 mg/kg)

M8R2 - In Situ
Arsenic (<1.8 mg/kg)
Lead (6.5 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (3.3 mg/kg)
Uranium (2 mg/kg)
Vanadium (51 mg/kg)

M7-XSR1-01-093018
Arsenic (8.7 mg/kg)
Lead (5.3 mg/kg)
Molybdenum (0.48 mg/kg)
Radium-226 (2.98 pCi/g)
Selenium (0.59 mg/kg)
Thorium (2.5 mg/kg)
Uranium (3.5 mg/kg)
Vanadium (13 mg/kg)

T17-XSR1-01-093018
Arsenic (1.9 mg/kg)
Lead (2.3 mg/kg)
Molybdenum (0.14 mg/kg)
Radium-226 (1.7 pCi/g)
Selenium (0.97 mg/kg)
Thorium (1.8 mg/kg)
Uranium (3 mg/kg)
Vanadium (7.5 mg/kg)

M7R1 - In Situ
Arsenic (10.7 mg/kg)
Lead (8 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (2.7 mg/kg)
Uranium (6.4 mg/kg)
Vanadium (24 mg/kg)

BSA-9 (B9)
BSA-10 (B10)
M1-01 (T13)
M1-03 (T15)
M1-04 (T16)
Middle 3
Middle 3A
Middle 3E
Middle 3F
Mesa I Mine 11 (M4)
Mesa I Mine 15 (M8)
Mesa I Mine 10 (M3)
Mesa I Mine 13 (M6)
Mesa I Mine 12 (M5)
Mesa I Mine 14 (M7)
Mesa I Camp (T17)

XRF Confirmation Soil Sample[1]
In Situ XRF Measurement[1]

Gamma Reading (cpm)[2]

≤ 10,286	≤ Avg. BG
10,286 - 12,232	Avg. BG - 1 x BTV
12,232 - 24,464	1 x BTV - 2 x BTV
24,464 - 36,696	2 x BTV - 3 x BTV
36,696 - 48,928	3 x BTV - 4 x BTV
48,928 - 122,320	4 x BTV - 10 x BTV
≥ 122,320	≥ 10 x BTV

AUM Site Boundary
AUM Related Site Boundary
Non-AUM Target Site Boundary
Survey Area Boundary
Background Location
Access Route - Foot
Access Route - Vehicular
Drainage - Estimated Path
Drainage - Field Mapped

Note:
[1]Red font indicates sample COPC concentration above BTV value for the relevant analyte.
'<' indicates a less than limit of detection laboratory or instrumental non-detect.

1 in = 260 ft

1:3,120

N W E S

0 130 260 520 Feet

MESA I MINE COMPLEX
ACCESS ROAD GAMMA RADIATION SURVEY AND SURFACE SOIL SAMPLE RESULTS MAP

Prepared For:

Prepared By:
TETRA TECH
1999 Harrison Street, Suite 500
Oakland, CA 94612

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 7/10/2019

Notes:
[2]The applied gamma BTV is 12,232 cpm derived from BSA-13 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **K-30**

Table K-25. Summary of Gamma Radiation Survey Results for Mesa I Mine Complex Road Cluster 9

Summary Statistic	Units	Gamma Radiation Survey Results
Applied Gamma BTV	cpm	12,232
Measurements	#	3,726
Minimum	cpm	6,495
Maximum	cpm	35,165
Average	cpm	11,786
Median	cpm	11,329
Standard Deviation	cpm	2,525
90th Percentile	cpm	14,900
95th Percentile	cpm	16,129
99th Percentile	cpm	19,197
Measurements Above Gamma BTV	#	1,351
Measurements Above Gamma BTV	%	36

Notes:
BTV Background threshold value
cpm Counts per minute

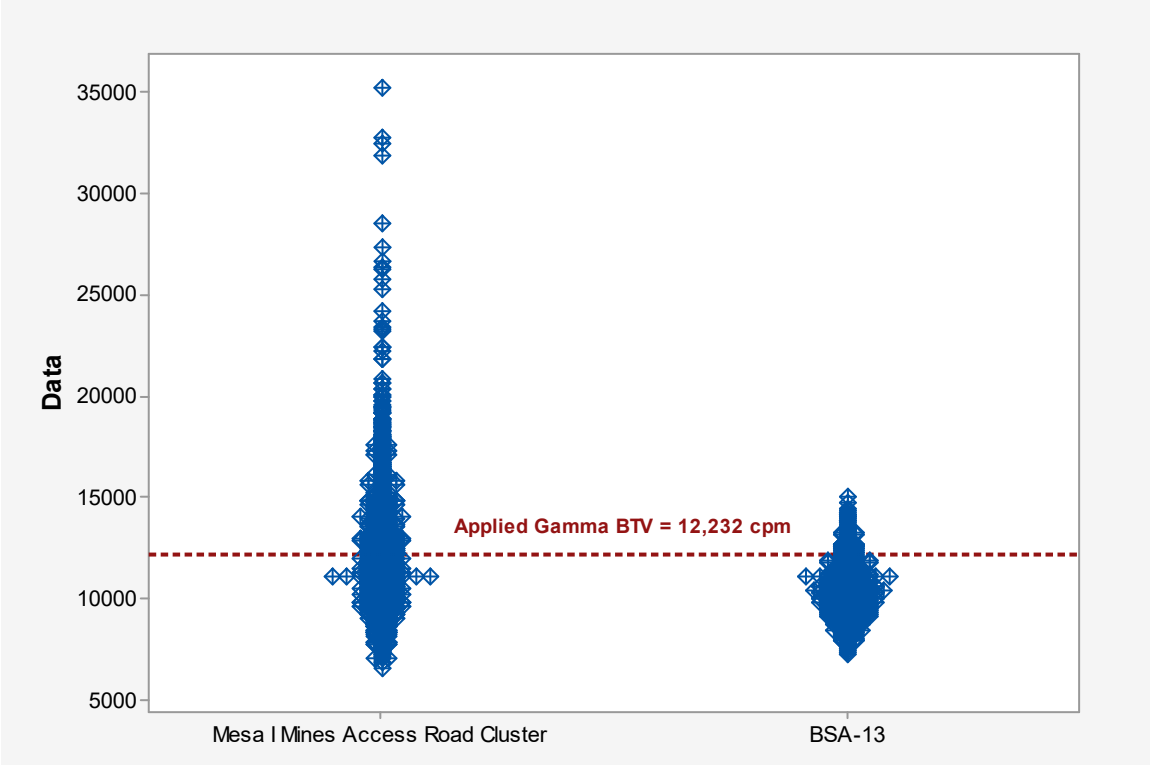


Figure K-31. Individual Value Plot of Gamma Radiation Levels of Mesa I Mine Complex Access Road Cluster 9 and BSA-13

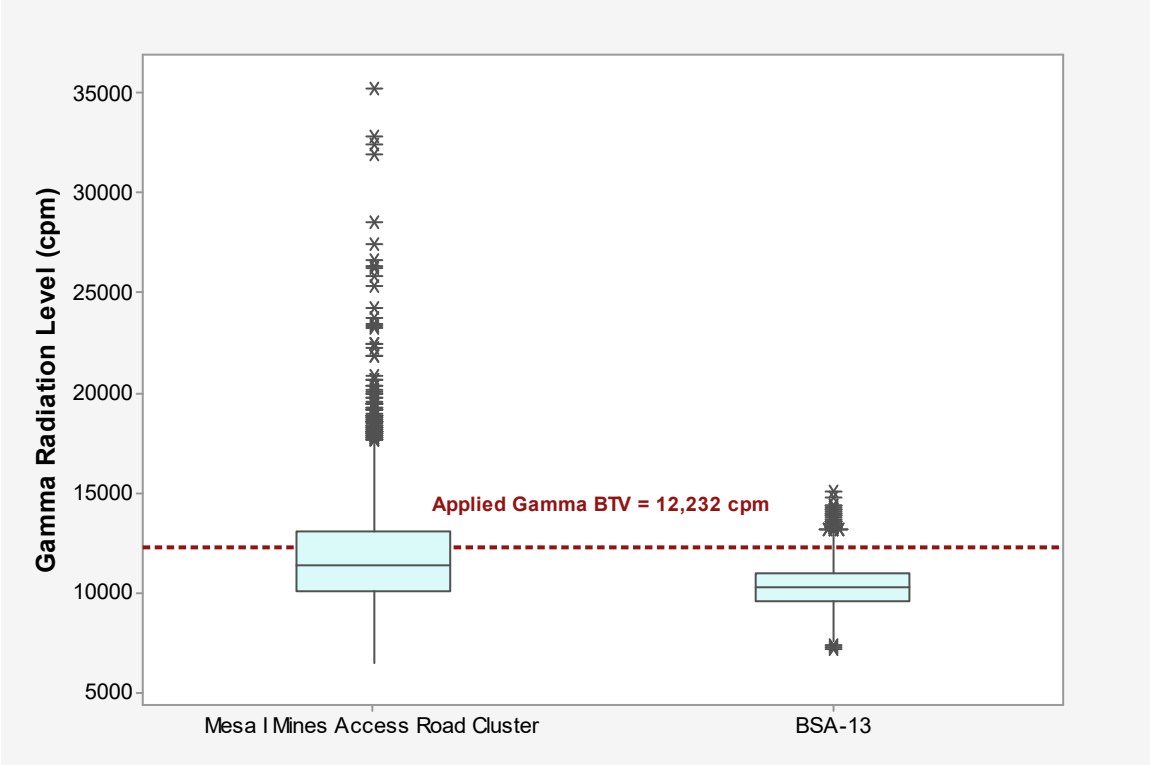


Figure K-32. Box Plot of Gamma Radiation Levels of Mesa I Mine Complex Access Road Cluster 9 and BSA-13

5.10 MESA II PIT ACCESS ROAD CLUSTER 10

Mesa II Pit access road cluster 10 is located east of Mesa II Pit. Five in situ XRF samples and one XRF confirmation soil sample were collected in September 2018. XRF measurements were collected for metals, and the XRF confirmation samples were submitted to a laboratory for analysis of metals and radionuclides using methods identified in Table K-7 and Table K-8. In addition, a gamma survey was performed along the Mesa II Pit access roads in July and August 2018.

Soil sampling results are presented in Table K-26 and Figure K-33. Results from one of the arsenic and molybdenum samples, and three of the uranium samples, exceeded the BTV in soil. The maximum concentration of arsenic was less than two times the BTV. The maximum concentration of uranium exceeded the BTV by just over two times; however, the XRF confirmation soil sample result from the same location (M24R1) only slightly exceeded the BTV. The maximum concentration of molybdenum exceeded the BTV by almost 10 times at one location, M24R2; however, all the other results were less than the BTV.

Gamma survey summary statistics are provided in Table K-27 and gamma measurements are presented on Figure K-33. Approximately 68 percent of the measurements exceeded the applied gamma BTV of 9,703 cpm. The maximum concentration is from a portion of access road on the site east of location M24R5 and is slightly more than two times the applied BTV. The individual value plot presented in Figure K-34 shows that gamma radiation measurements along the access road are higher than those of the background dataset. The box plot showing the quartiles of the datasets provided in Figure K-35 shows that the median of the gamma radiation measurement is higher than the background data set median and the applied gamma BTV.

Based on the molybdenum and uranium soil sample results exceeding two times the respective BTVs, mining activities conducted at Mesa II Pit may have potentially impacted the roads. Further, the median gamma survey measurement is above the applied BTV and the maximum gamma measurement is greater than two times the BTV in one area east of location M24R5; therefore, additional investigation may be warranted to further identify the lateral and vertical extent of contamination.

Table K-26. Soil Sampling Results for Primary Analytes for Mesa II Pit Access Road Cluster 10

Field Sample ID	Figure Cluster ID	Sample Type	Sample Date	Arsenic		Lead		Molybdenum		Radium-226			Selenium		Thorium		Uranium		Vanadium	
				Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Activity (pCi/g)	TPU	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q	Result (mg/kg)	Q
M24R1	Mesa II Pit	In Situ XRF	9/30/2018	3.3		8.3		<0.038		-			-		2.7		**5.77**		<16	
M24R2	Mesa II Pit	In Situ XRF	9/30/2018	**8.7**		9.1		**3.2**		-			-		**3.6**		3.75		17	
M24R3	Mesa II Pit	In Situ XRF	9/30/2018	<1.8		**9.4**		<0.038		-			-		2.9		0.76		<16	
M24R4	Mesa II Pit	In Situ XRF	9/30/2018	3.6		8.2		<0.038		-			-		3.0		2.63		**24**	
M24R5	Mesa II Pit	In Situ XRF	9/30/2018	<1.8		8.9		<0.038		-			-		1.7		2.54		<16	
M24-XSR1-01-093018	Mesa II Pit	XRF Conf	9/30/2018	3.6		6		0.16	J	**2.1**	0.39		**0.50**	J	3.2		2.8		8.3	
Number of Measurements				6		6		6		1			1		6		6		6	
Number of Detects				4		6		2		1			1		6		6		3	
Number of Nondetects				2		0		4		0			0		0		0		3	
Minimum (mg/kg)				3.3		6.0		0.16		2.1			0.50		1.7		0.8		8.3	
Maximum (mg/kg)				8.7		9.4		3.19		2.1			0.50		3.6		5.8		24	
Average (mg/kg)				4.8		8.3		1.68		2.1			0.50		2.8		3.0		16	
Median (mg/kg)				3.6		8.6		1.68		2.1			0.50		2.9		2.7		17	
Standard Deviation (mg/kg)				2.60		1.23		2.14		-			-		0.64		1.7		8	
90th Percentile (mg/kg)				7.2		9.3		2.89		2.1			0.50		3.4		4.8		23	
95th Percentile (mg/kg)				7.9		9.3		3.04		2.1			0.50		3.5		5		23	
99th Percentile (mg/kg)				8.5		9.4		3.16		2.1			0.50		3.5		6		24	
Relative Standard Deviation				0.54		0.15		1.28		-			-		0.23		0.5		0.48	
BTV (mg/kg)				4.7		10.4		0.32		2.78			0.94		3.6		2.7		31	
Maximum/BTV (unitless)				1.9		0.91		10		0.74			0.53		0.99		2.2		0.77	

Notes:
The maximum concentration is presented in **bold**.
Shaded red indicates that the result exceeds the applied BTV.

<	The analyte was analyzed for, but was not detected. The reporting limit is shown in the result column.
-	Not analyzed.
BTV	Background threshold value
Conf	Confirmation sample
ID	Identification
J	Estimated value
LT	Result less than requested minimum detectable concentration, but greater than sample-specific detectable concentration.
mg/kg	Milligrams per kilogram
pCi/g	Picocuries per gram
Q	Qualifier
TPU	Total propagated uncertainty
XRF	X-ray fluorescence

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator

Middle 3

Mesa II Pit (M24)

BSA-24 (B24)

M24R3 - In Situ
Arsenic (<1.8 mg/kg)
Lead (9.4 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (2.9 mg/kg)
Uranium (0.76 mg/kg)
Vanadium (16 mg/kg)

M24R5 - In Situ
Arsenic (<1.8 mg/kg)
Lead (8.9 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (1.6 mg/kg)
Uranium (2.5 mg/kg)
Vanadium (16 mg/kg)

M24R1 - In Situ
Arsenic (3.3 mg/kg)
Lead (8.3 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (2.7 mg/kg)
Uranium (5.8 mg/kg)
Vanadium (16 mg/kg)

M24R2 - In Situ
Arsenic (8.7 mg/kg)
Lead (9.1 mg/kg)
Molybdenum (3.2 mg/kg)
Thorium (3.5 mg/kg)
Uranium (3.8 mg/kg)
Vanadium (17 mg/kg)

M24R4 - In Situ
Arsenic (3.6 mg/kg)
Lead (8.2 mg/kg)
Molybdenum (<0.038 mg/kg)
Thorium (3.0 mg/kg)
Uranium (2.6 mg/kg)
Vanadium (24 mg/kg)

M24-XSR1-01-093018
Arsenic (3.6 mg/kg)
Lead (6 mg/kg)
Molybdenum (0.16 mg/kg)
Radium-226 (2.06 pCi/g)
Selenium (0.50 mg/kg)
Thorium (3.2 mg/kg)
Uranium (2.8 mg/kg)
Vanadium (8.3 mg/kg)

Middle 2

XRF Confirmation Soil Sample[1]

Gamma Reading (cpm)[2]

≤ 8,123	≤ Avg. BG
8,123 - 9,703	Avg. BG - 1 x BTV
9,703 - 19,406	1 x BTV - 2 x BTV
19,406 - 29,109	2 x BTV - 3 x BTV
29,109 - 38,812	3 x BTV - 4 x BTV
38,812 - 97,030	4 x BTV - 10 x BTV
≥ 97,030	≥ 10 x BTV

AUM Site Boundary
Survey Area Boundary
Background Location
Access Route - Foot
Access Route - Vehicular
Drainage - Estimated Path
Drainage - Field Mapped

Note:
[1]Red font indicates sample COPC concentration above BTV value for the relevant analyte.
'<' indicates a less than limit of detection instrumental non-detect.

1 in = 270 ft

1:3,240

0 135 270 540 Feet

N E S W

MESA II PIT MINE
ACCESS ROAD GAMMA RADIATION SURVEY AND SURFACE SOIL SAMPLE RESULTS MAP

Prepared For:

Prepared By:

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

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 7/10/2019

Notes:
[2]The applied gamma BTV is 9,703 cpm derived from BSA-24 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **K-33**

Table K-27. Summary of Gamma Radiation Survey Results for Mesa II Pit Access Road Cluster 10

Summary Statistic	Units	Gamma Radiation Survey Results
Applied Gamma BTV	cpm	9,703
Measurements	#	2,655
Minimum	cpm	7,126
Maximum	cpm	20,233
Average	cpm	10,136
Median	cpm	10,215
Standard Deviation	cpm	1,036
90th Percentile	cpm	11,277
95th Percentile	cpm	11,689
99th Percentile	cpm	12,660
Measurements Above Gamma BTV	#	1,799
Measurements Above Gamma BTV	%	68

Notes:
BTV Background threshold value
cpm Counts per minute

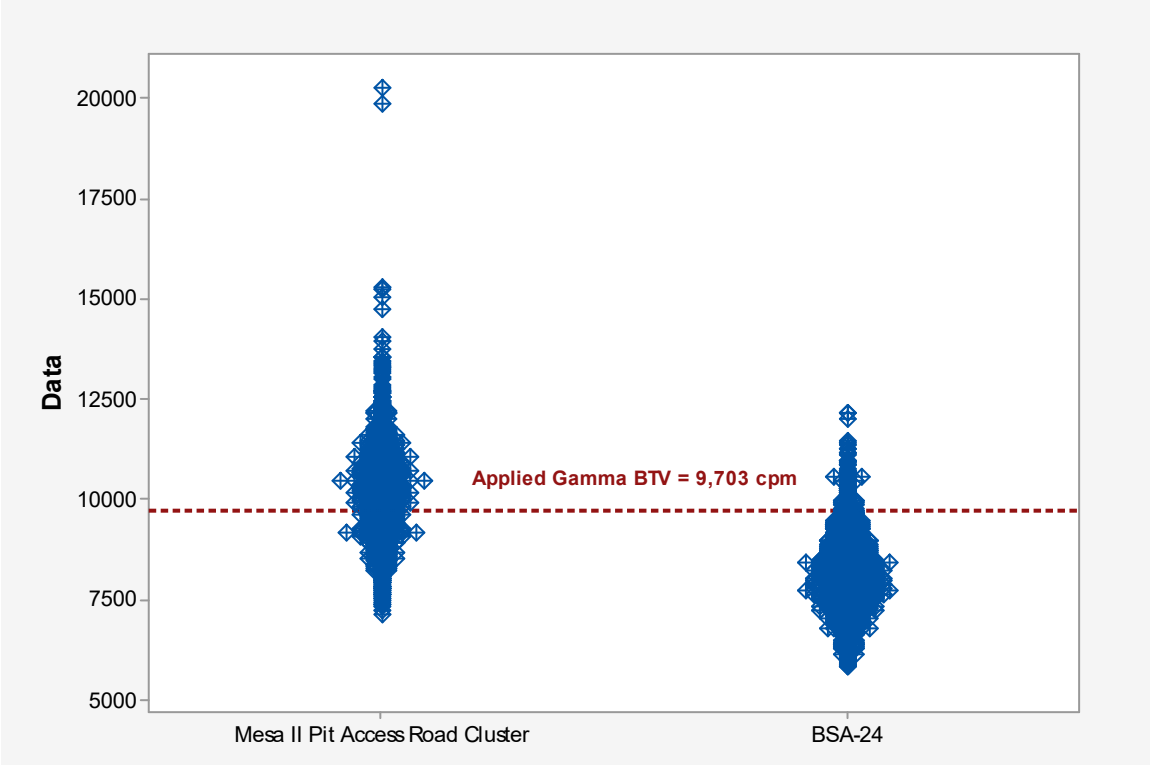


Figure K-34. Individual Value Plot of Gamma Radiation Levels of Mesa II Pit Access Road Cluster 10 and BSA-24

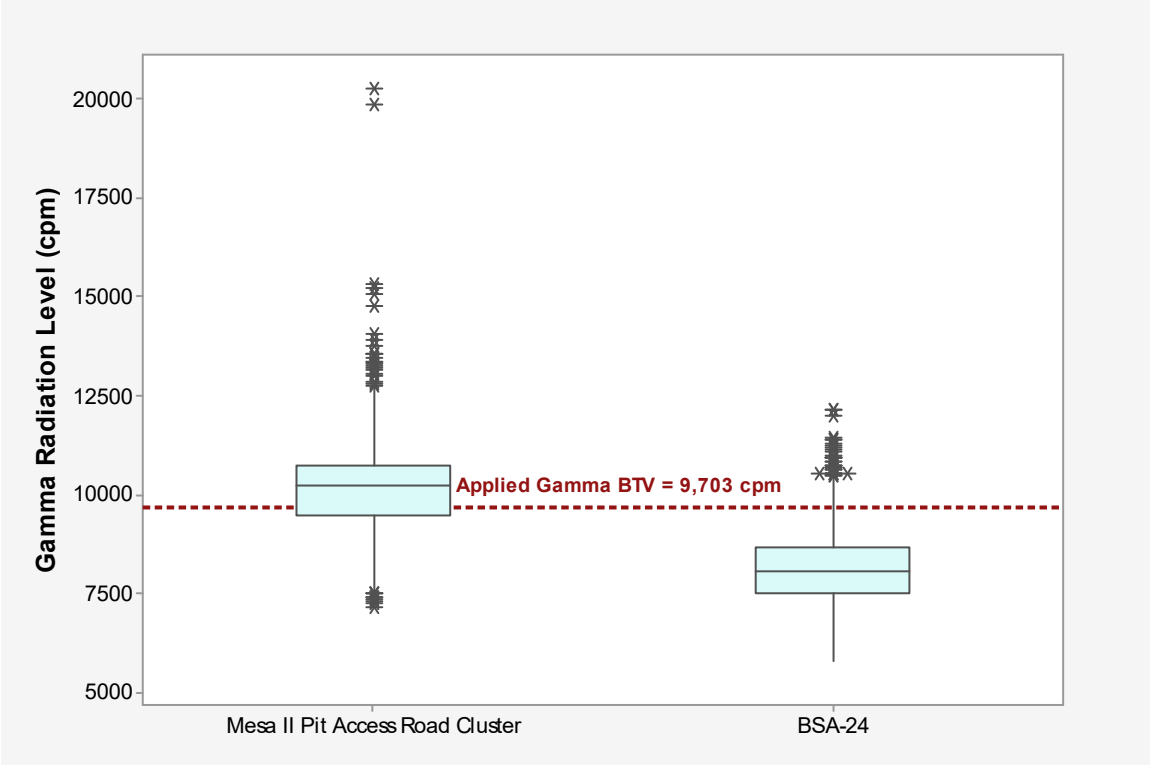


Figure K-35. Box Plot of Gamma Radiation Levels of Mesa II Pit Access Road Cluster 10 and BSA-24

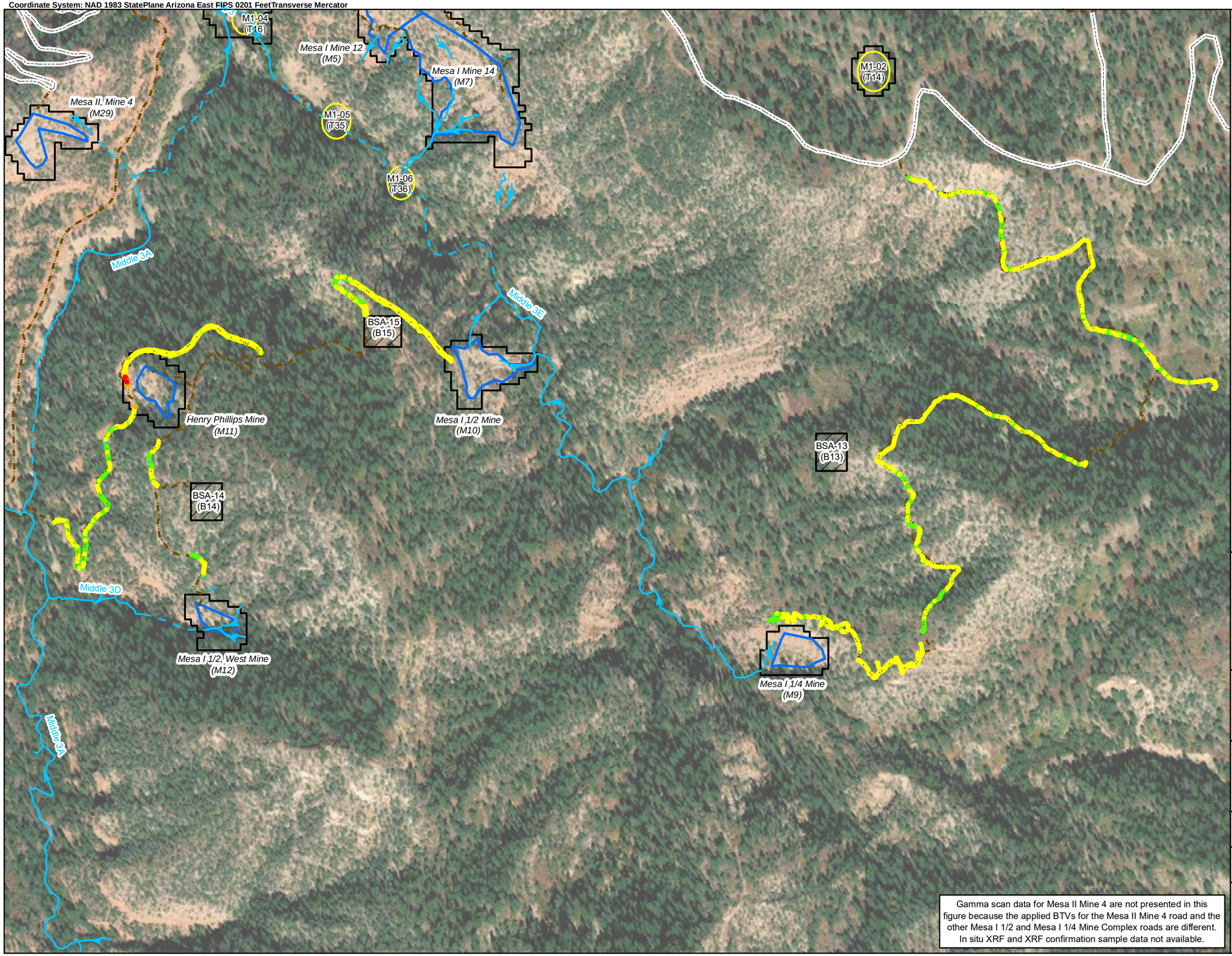
5.11 MESA I 1/2 AND MESA I 1/4 MINE COMPLEXES ACCESS ROAD CLUSTER 11

Mesa I 1/2 and Mesa I 1/4 Mine Complexes access road cluster 11 is a series of footpaths in the vicinity of Mesa 1 1/4 Mine, Mesa 1 1/2 Mine, Henry Phillips Mine, and Mesa 1 1/2, West Mine. A gamma survey was performed along the Mesa II Pit access roads in July 2018. An XRF survey was not conducted along the footpaths.

Gamma survey summary statistics are provided in Table K-28 and gamma measurements are presented on Figure K-36. Approximately 52 percent of the measurements exceeded the applied gamma BTV of 9,854 cpm, and the maximum concentration was almost four times the applied BTV. The individual value plot presented in Figure K-37 shows that the majority of footpath gamma measurements are similar to the applied gamma BTV, but that a few measurements exceeded the BTV by two to four times. Figure K-38 shows that gamma measurements that exceeded two times the applied BTV are located in an area to the west of Henry Phillips Mine. The box plot showing the quartiles of the datasets provided in Figure K-37 shows that the median of the gamma radiation measurement is higher than the background data set median and approximately equal to the applied gamma BTV.

The gamma radiation survey results indicate that footpaths in the vicinity of Mesa I 1/2 and Mesa I 1/4 Mine Complexes do not appear to be generally impacted by mining activities as the median gamma survey measurement is just slightly above the applied BTV; however, the section of footpath near the Henry Phillips Mine exhibited gamma radiation more than two times the BTV; therefore, the additional investigation may be warranted to further identify the lateral and vertical extent of contamination near the mine.

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator



Gamma Reading (cpm)*

≤ 7,661	≤ Avg. BG
7,661 - 9,854	Avg. BG - 1 x BTV
9,854 - 19,708	1 x BTV - 2 x BTV
19,708 - 29,562	2 x BTV - 3 x BTV
29,562 - 39,416	3 x BTV - 4 x BTV
39,416 - 98,540	4 x BTV - 10 x BTV
≥ 98,540	≥ 10 x BTV

- AUM Site Boundary
- Non-AUM Target Site Boundary
- Survey Area Boundary
- Background Location
- Access Route - Foot
- Access Route - Vehicular
- Drainage - Estimated Path
- Drainage - Field Mapped

1 in = 500 ft

1:6,000

N W E S

0 250 500 1,000 Feet

Gamma scan data for Mesa II Mine 4 are not presented in this figure because the applied BTVs for the Mesa II Mine 4 road and the other Mesa I 1/2 and Mesa I 1/4 Mine Complex roads are different. In situ XRF and XRF confirmation sample data not available.

MESA I 1/2 AND MESA I 1/4 MINE COMPLEXES ACCESS ROADS GAMMA RADIATION SURVEY

Prepared For:

Prepared By:

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

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 7/10/2019

Notes:
*The applied gamma BTV is 9,854 cpm derived from BSA-14 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **K-36**

Table K-28. Summary of Gamma Radiation Survey Results for Mesa I 1/2 and Mesa I 1/4 Mine Complexes Access Road Cluster 11

Summary Statistic	Units	Gamma Radiation Survey Results
Applied Gamma BTV	cpm	9,854
Measurements	#	7,243
Minimum	cpm	6,194
Maximum	cpm	37,436
Average	cpm	10,198
Median	cpm	9,907
Standard Deviation	cpm	2,290
90th Percentile	cpm	12,087
95th Percentile	cpm	12,943
99th Percentile	cpm	19,909
Measurements Above Gamma BTV	#	3,732
Measurements Above Gamma BTV	%	52

Notes:
BTV Background threshold value
cpm Counts per minute

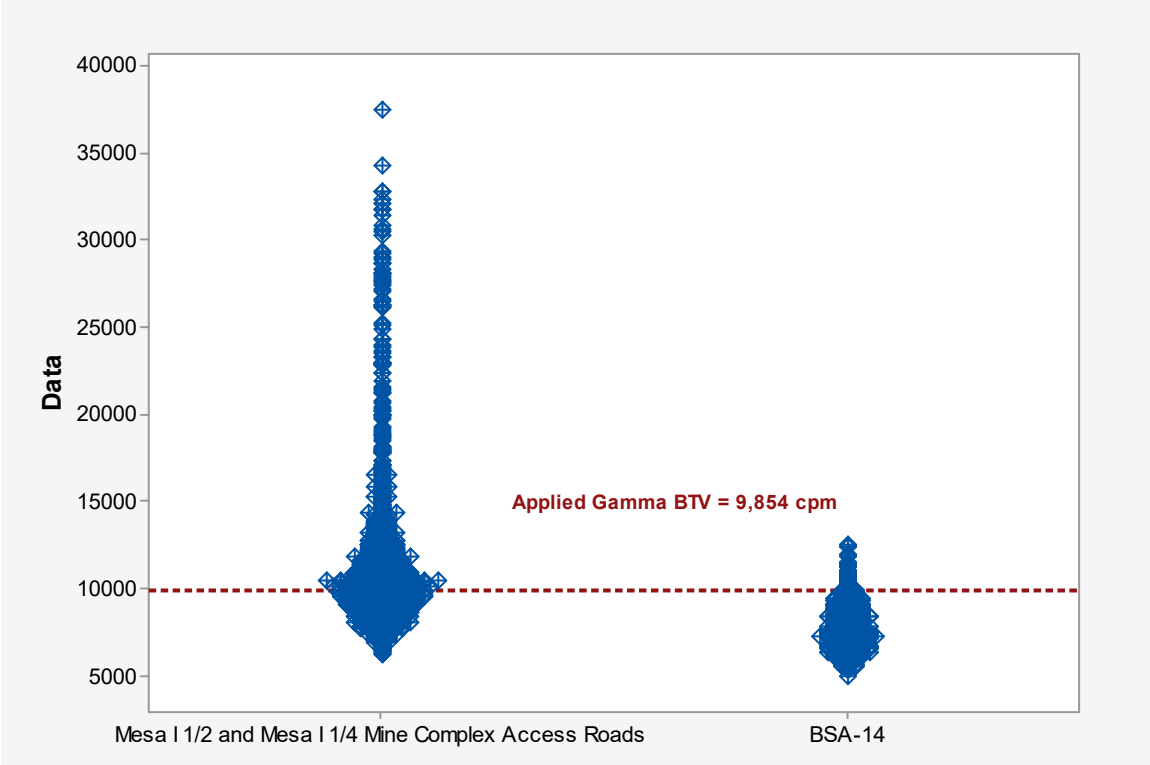


Figure K-37. Individual Value Plot of Gamma Radiation Levels of Mesa I 1/2 and Mesa I 1/4 Mine Complexes Access Road Cluster 11 and BSA-14

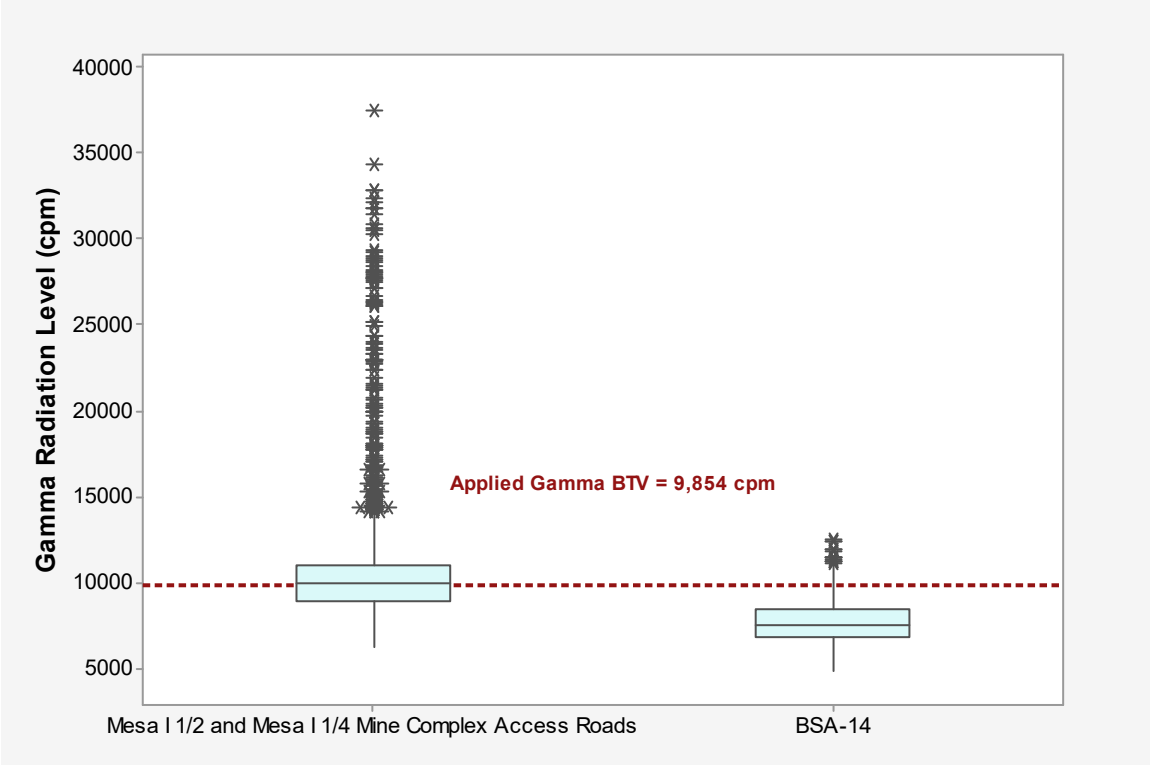


Figure K-38. Box Plot of Gamma Radiation Levels of Mesa I 1/2 and Mesa I 1/4 Mine Complexes Access Road Cluster 11 and BSA-14

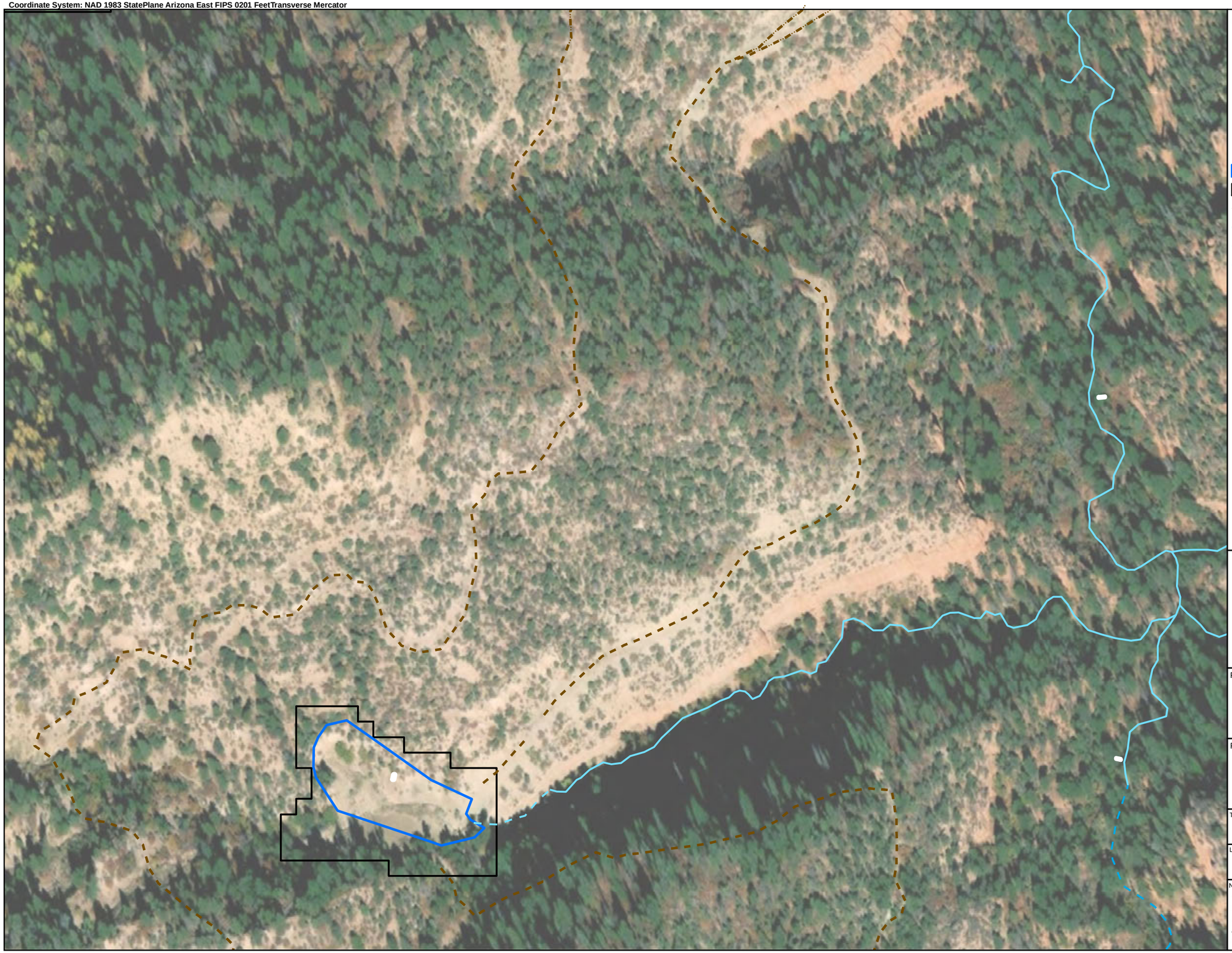
5.12 MESA I 3/4 INCLINE ACCESS ROAD CLUSTER 12

The Mesa I 3/4 Incline access road cluster 12 is located north of Mesa I 3/4 Incline Mine. A gamma survey was performed along the footpath leading to the Mesa I 3/4 Incline in June and July 2018. An XRF survey was not conducted along the footpath.

Gamma survey summary statistics are provided in Table K-29 and gamma measurements are presented on Figure K-39. Approximately 52 percent of the measurements exceeded the applied gamma BTV of 11,378 cpm, and the maximum concentration is less than two times the applied BTV. The individual value plot presented in Figure K-40 shows that the gamma measurement distribution from the access road is similar to the background distribution. The box plot showing the quartiles of the datasets provided in Figure K-41 shows that the median of the gamma radiation measurement is higher than the background data set median and just above the applied gamma BTV.

The gamma radiation survey results indicate that Mesa I 3/4 Incline access road does not appear to be impacted, because the median gamma measurement is approximately equal to the applied BTV, and none of the measurements exceeded two times the applied BTV.

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator



Gamma Reading (cpm)[1]

≤ 9,207	≤ Avg. BG
9,207 - 11,378	Avg. BG - 1 x BTV
11,378 - 22,756	1 x BTV - 2 x BTV
22,756 - 34,134	2 x BTV - 3 x BTV
34,134 - 45,512	3 x BTV - 4 x BTV
45,512 - 113,780	4 x BTV - 10 x BTV
≥ 113,780	≥ 10 x BTV

- AUM Site Boundary
- Survey Area Boundary
- Access Route - Foot
- Drainage[2]
- Drainage - Estimated Path
- Drainage - Field Mapped

Note:
In situ XRF and XRF confirmation sample data not available.
[1]The applied gamma BTV is 11,378 cpm derived from BSA-30 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 200 ft

1:2,400

N W E S

0 100 200 400 Feet

MESA I 3/4 INCLINE
ACCESS ROAD GAMMA RADIATION SURVEY

Prepared For:

Prepared By:

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

Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 7/10/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *Abandoned Uranium Mines and the Navjo Nation Part II Atlas With Geospatial Data. NN_Drainage_HR_AUM.shp.* July, 2007.

Figure No.: **K-39**

Table K-29. Summary of Gamma Radiation Survey Results for Mesa I 3/4 Incline Access Road Cluster 12

Summary Statistic	Units	Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,378
Measurements	#	3,221
Minimum	cpm	6,786
Maximum	cpm	20,924
Average	cpm	11,673
Median	cpm	11,468
Standard Deviation	cpm	1,945
90th Percentile	cpm	14,233
95th Percentile	cpm	14,988
99th Percentile	cpm	17,117
Measurements Above Gamma BTV	#	1,664
Measurements Above Gamma BTV	%	52

Notes:
BTV Background threshold value
cpm Counts per minute

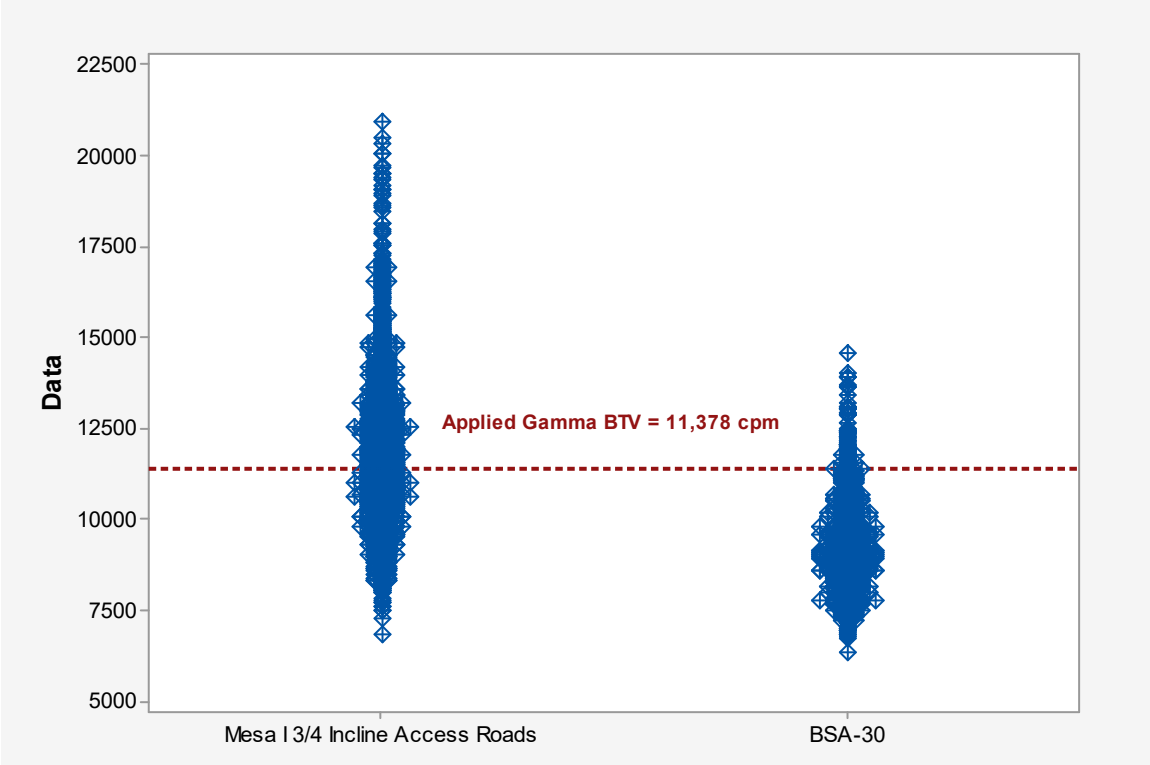


Figure K-40. Individual Value Plot of Gamma Radiation Levels Mesa I 3/4 Incline Access Road Cluster 12 and BSA-30

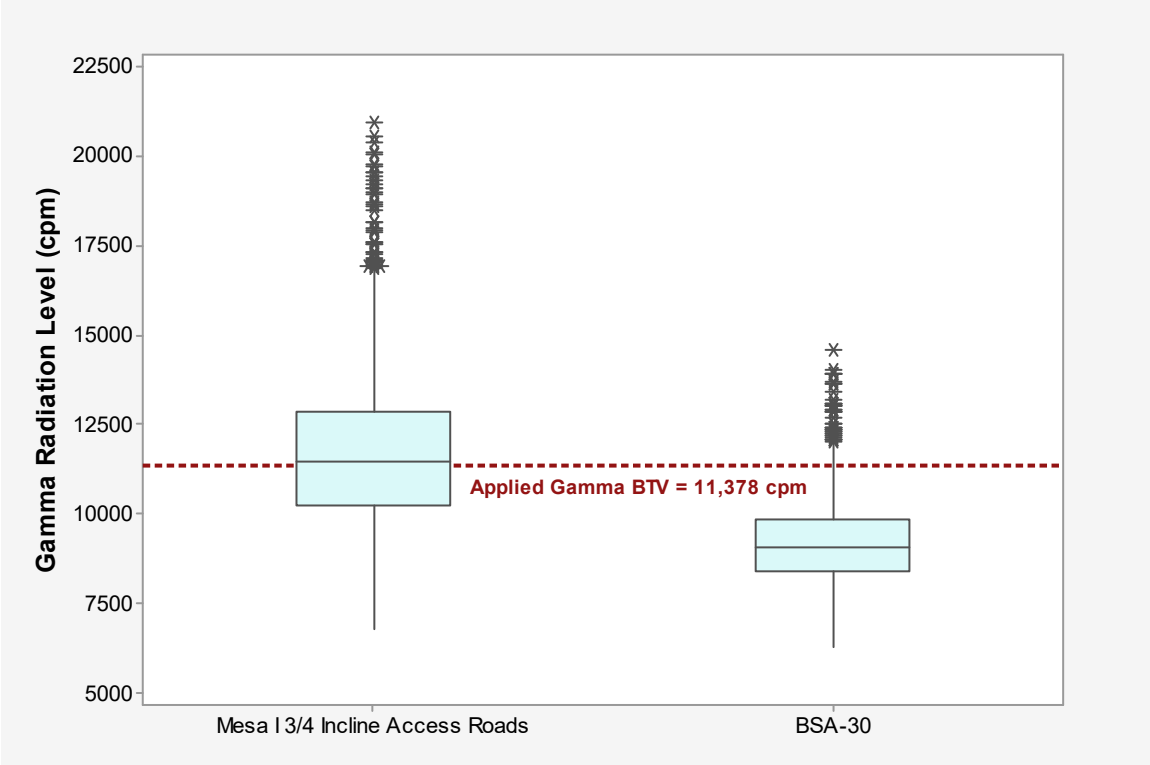


Figure K-41. Box Plot of Gamma Radiation Levels of Mesa I 3/4 Incline Access Road Cluster 12 and BSA-30

6.0 CONCLUSIONS

An RSE investigation of the Northern Agency Tronox Mine access roads and footpaths was performed by Tetra Tech during the 2018 field season. Gamma radiation measurements were collected during field mobilizations to individual AUM mines from April through September 2018. XRF measurements and XRF confirmation samples were collected in September 2018 from surface soils and analyzed for metals and radionuclides. No data had been collected previously along access roads and footpaths. Table K-30 summarizes whether the results of the XRF and gamma radiation surveys and soil sampling indicate potential impacts from mining activities within each road cluster. The conclusions from the access road investigation are:

- The linear extent of radiological contamination along the access roads and footpaths surveyed was well documented through gamma radiation surveys, and the full linear extent beyond hot spots has been characterized.
- Some access roads are potentially impacted from mining activities conducted at nearby Tronox Mines, as indicated by concentrations of primary analytes or gamma measurements exceeding two times the applied BTV.

In general, the access road investigation was successful at fulfilling the DQOs in areas where samples were collected. There are many other roads and footpaths in the vicinity of the Tronox mines, therefore data gaps exist for other roads and footpaths where data was not collected and where results suggest the need for additional evaluation of extent of contamination.

Table K-30. Summary of Soil Sampling and Gamma Survey Results Potentially Indicating Potential Impacts from Mining Activities on Access Road Clusters

Cluster No.	Cluster Name	Soil Sampling Results Indicate Potential Impacts?	Gamma Survey Results Indicate Potential Impacts?
1	Block K Roads	No (<BTV)	No (median <BTV)
2	Mesa V Mine Complex Roads	Yes (>2x BTV)	Yes (maximum value >2x BTV)
3	Mesa V Mine - 103 Haul Shaft Road	No (<2x BTV)	Yes, central portion of the haul shaft road (median < BTV, maximum value >2x BTV)
4	Mesa IV Mine Complex Road	Yes (>2x BTV)	No (median <BTV)
5	Mesa IV, West Mine Road	Yes (>2x BTV)	Not measured
6	Mesa II 1/2 Mine and Mesa III Mine Roads	Yes (>2x BTV)	Yes (maximum value >2x BTV)
7	Mesa I 3/4 and Mesa II Mine Complex Roads	No (1 detect >2x BTV)	No (median <BTV)
8	Mesa II, Mine 4 Road	Yes (>2x BTV)	No (median <BTV)
9	Mesa I Mine Complex Roads	Yes (>2x BTV)	No (median <BTV)
10	Mesa II Pit Road	Yes (>2x BTV)	Yes (maximum value >2x BTV)
11	Mesa I 1/2 and Mesa I 1/4 Mine Complexes Roads	Not measured	Yes, adjacent to Henry Phillips Mine (maximum value >2x BTV)
12	Mesa I 3/4 Incline Road	Not measured	No (median about same as BTV)

Notes:
BTV Background threshold value

7.0 REFERENCES

American National Standard Institute (ANSI). 1997. *Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments*. ANSI N323A-1997.

Tetra Tech, Inc. (Tetra Tech). 2018. "Northern Agency Tronox Mines Removal Site Evaluation Work Plan." Response, Assessment, and Evaluation Services. Contract No. EP-S9-17-02. Task Order 0001. May 14.

U.S. Environmental Protection Agency (USEPA). 2004. *Multi-Agency Radiological Laboratory Analytical Protocols Manual*. EPA 402-B-04-001A. July.

USEPA. 2007. "Method 6200: Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment." February.

USEPA. 2015. Navajo Nation Aerial Radiological Survey. Draft Final. May and December.

ATTACHMENT K1

XRF FIELD SURVEY AND SOIL SAMPLING RESULT TABLES

Table K1-1. Summary of Geospatial XRF Measurement Sampling Locations for the Access Roads

Unique_X[1]	Roads Cluster Number[2]	Cluster Name	Depth (inches)	Sample Type	Date Sampled	Latitude	Longitude
M2R3	1	Block K Road	0-3	XRF measurement	9/30/2018	36.91598938	-109.2835558
M2R4	1	Block K Road	0-3	XRF measurement	9/30/2018	36.91676729	-109.2829589
M2R5	1	Block K Road	0-3	XRF measurement	9/30/2018	36.91831076	-109.2817912
M2R6	1	Block K Road	0-3	XRF measurement	9/30/2018	36.91906766	-109.2812257
M14R1	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.54452183	-109.2470126
M15R1	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.54388341	-109.246775
M17R1	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.54229285	-109.2517885
M17R2	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.54154899	-109.2512899
M17R3	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.5408147	-109.2506677
M17R4	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.5402528	-109.2498242
M17R5	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.54062918	-109.2485883
M18R1	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/13/2018	36.53817566	-109.2540437
M18R2	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/13/2018	36.53825986	-109.253
M18R3	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/13/2018	36.53909942	-109.2526108
M18R4	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/13/2018	36.53991292	-109.2521858
M18R5	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/13/2018	36.5408124	-109.2521094
M19R1	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.53702406	-109.257104
M19R2	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.5367726	-109.2563669
M19R3	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.53676979	-109.2561508
M19R4	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.53722817	-109.2562735
M19R5	2	Mesa V Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.53725641	-109.2553884
M16R1	3	Mesa V Mine - 103 Haul Shaft Road	0-3	XRF measurement	9/30/2018	36.54235013	-109.247891
M16R2	3	Mesa V Mine - 103 Haul Shaft Road	0-3	XRF measurement	9/30/2018	36.53974909	-109.2465507
M16R3	3	Mesa V Mine - 103 Haul Shaft Road	0-3	XRF measurement	9/30/2018	36.53922417	-109.2459455
M16R4	3	Mesa V Mine - 103 Haul Shaft Road	0-3	XRF measurement	9/30/2018	36.53945922	-109.2451071
M16R5	3	Mesa V Mine - 103 Haul Shaft Road	0-3	XRF measurement	9/30/2018	36.53881341	-109.2445732
M16R6	3	Mesa V Mine - 103 Haul Shaft Road	0-3	XRF measurement	9/30/2018	36.53797873	-109.2441921
M17R6	3	Mesa V Mine - 103 Haul Shaft Road	0-3	XRF measurement	9/30/2018	36.54020501	-109.2485161
M20R1	4	Mesa IV Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.52984517	-109.2433737
M20R2	4	Mesa IV Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.52975041	-109.2444468
M20R3	4	Mesa IV Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.52938442	-109.2454069
M20R4	4	Mesa IV Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.52864751	-109.246013
M20R5	4	Mesa IV Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.52785418	-109.2465621
M23R1	5	Mesa IV, West Mine Road	0-3	XRF measurement	9/30/2018	36.5251544	-109.2513847
M23R2	5	Mesa IV, West Mine Road	0-3	XRF measurement	9/30/2018	36.52426936	-109.2513674
M23R3	5	Mesa IV, West Mine Road	0-3	XRF measurement	9/30/2018	36.52376267	-109.2521337
M23R4	5	Mesa IV, West Mine Road	0-3	XRF measurement	9/30/2018	36.52312555	-109.2528393
M23R5	5	Mesa IV, West Mine Road	0-3	XRF measurement	9/30/2018	36.5222297	-109.2529285
M30R1	6	Mesa II ½ Mine and Mesa III Mine Roads	0-3	XRF measurement	9/30/2018	36.51617058	-109.2422132
M30R2	6	Mesa II ½ Mine and Mesa III Mine Roads	0-3	XRF measurement	9/30/2018	36.517033	-109.2421939

Table K1-1. Summary of Geospatial XRF Measurement Sampling Locations for the Access Roads (Continued)

Unique_X[1]	Roads Cluster Number[2]	Cluster Name	Depth (inches)	Sample Type	Date Sampled	Latitude	Longitude
M30R3	6	Mesa II ½ Mine and Mesa III Mine Roads	0-3	XRF measurement	9/30/2018	36.51751787	-109.2412956
M30R4	6	Mesa II ½ Mine and Mesa III Mine Roads	0-3	XRF measurement	9/30/2018	36.51772151	-109.2403354
M30R5	6	Mesa II ½ Mine and Mesa III Mine Roads	0-3	XRF measurement	9/30/2018	36.51837903	-109.2396713
M28R1	7	Mesa 1 ¾ and Mesa II Mine Roads	0-3	XRF measurement	9/30/2018	36.51432999	-109.2333455
M28R2	7	Mesa 1 ¾ and Mesa II Mine Roads	0-3	XRF measurement	9/30/2018	36.51373897	-109.2331141
M28R3	7	Mesa 1 ¾ and Mesa II Mine Roads	0-3	XRF measurement	9/30/2018	36.51322328	-109.2339388
M29R1	8	Mesa II, Mine 4 Road	0-3	XRF measurement	9/30/2018	36.52052449	-109.2280589
M29R2	8	Mesa II, Mine 4 Road	0-3	XRF measurement	9/30/2018	36.52005796	-109.2272544
M29R3	8	Mesa II, Mine 4 Road	0-3	XRF measurement	9/30/2018	36.51990631	-109.227529
M29R4	8	Mesa II, Mine 4 Road	0-3	XRF measurement	9/30/2018	36.51999074	-109.2283219
M29R5	8	Mesa II, Mine 4 Road	0-3	XRF measurement	9/30/2018	36.51954036	-109.2275688
M29R6	8	Mesa II, Mine 4 Road	0-3	XRF measurement	9/30/2018	36.51969995	-109.2282613
M29R7	8	Mesa II, Mine 4 Road	0-3	XRF measurement	9/30/2018	36.52030235	-109.229012
M29R8	8	Mesa II, Mine 4 Road	0-3	XRF measurement	9/30/2018	36.51975193	-109.2297343
M29R9	8	Mesa II, Mine 4 Road	0-3	XRF measurement	9/30/2018	36.51936251	-109.230605
M6R1	9	Mesa I Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.52448522	-109.2187887
M6R2	9	Mesa I Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.52516978	-109.2194197
M6R3	9	Mesa I Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.52603871	-109.2197955
M6R4	9	Mesa I Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.52681347	-109.2193191
M6R5	9	Mesa I Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.5264779	-109.2184993
M7R1	9	Mesa I Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.52093507	-109.2205409
M8R1	9	Mesa I Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.52466068	-109.2215261
M8R2	9	Mesa I Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.52443013	-109.2205454
T17R1	9	Mesa I Mine Complex Roads	0-3	XRF measurement	9/30/2018	36.52436796	-109.2221851
M24R1	10	Mesa II Pit Road	0-3	XRF measurement	9/30/2018	36.52986398	-109.2319555
M24R2	10	Mesa II Pit Road	0-3	XRF measurement	9/30/2018	36.52899238	-109.2321366
M24R3	10	Mesa II Pit Road	0-3	XRF measurement	9/30/2018	36.52813965	-109.2324664
M24R4	10	Mesa II Pit Road	0-3	XRF measurement	9/30/2018	36.5272756	-109.2327574
M24R5	10	Mesa II Pit Road	0-3	XRF measurement	9/30/2018	36.52638744	-109.2328718

Notes:

[1] Unique_X is a unique identification for an in situ XRF measurement, which is the mine site ID and the sample ID.

[2] Roads Cluster Names for each Roads Cluster Number.

1	Block K Road
2	Mesa V Mine Complex Roads
3	Mesa V Mine - 103 Haul Shaft Road
4	Mesa IV Mine Complex Roads
5	Mesa IV, West Mine Road
6	Mesa II 1/2 Mine and Mesa III Mine Roads
7	Mesa 1 3/4 and Mesa II Mine Roads
8	Mesa II, Mine 4 Road
9	Mesa I Mine Complex Roads
10	Mesa II Pit Road

XRF X-ray fluorescence

Table K1-2. Summary of Geospatial XRF Confirmation Sampling Locations for the Access Roads

Sample ID	Roads Cluster Number[1]	Cluster Name	Depth (inches)	Activity	Analyses	Sample Type	Sample QC	Date Sampled	Latitude	Longitude
M2-XSR3-01-093018	1	Block K Road	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.915989	-109.283556
M14-XSR1-01-093018	2	Mesa V Mine Complex Roads	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.544522	-109.247013
M15-XSR1-01-093018	2	Mesa V Mine Complex Roads	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.543883	-109.246775
M17-XSR1-01-093018	2	Mesa V Mine Complex Roads	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.542293	-109.251789
M19-XSR2-01-093018	2	Mesa V Mine Complex Roads	0-3	XRF Confirmation	XRF Conf Long2	Field Sample	Primary	9/30/2018	36.536773	-109.256367
M19-XSR2-02-093018	2	Mesa V Mine Complex Roads	0-3	XRF Confirmation	XRF Conf Long2	Field Duplicate	Duplicate	9/30/2018	36.536773	-109.256367
M16-XSR1-01-093018	3	Mesa V Mine - 103 Haul Shaft Road	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.539749	-109.246551
M16-XSR6-01-093018	3	Mesa V Mine - 103 Haul Shaft Road	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.537979	-109.244192
M20-XSR2-01-093018	4	Mesa IV Mine Complex Roads	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.52975	-109.244447
M23-XSR4-01-093018	5	Mesa IV, West Mine Road	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.523126	-109.252839
M30-XSR5-01-093018	6	Mesa II ½ Mine and Mesa III Mine Roads	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.518379	-109.239671
M28-XSR1-01-093018	7	Mesa 1 ¾ and Mesa II Mine Roads	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.51433	-109.233346
M28-XSR1-02-093018	7	Mesa 1 ¾ and Mesa II Mine Roads	0-3	XRF Confirmation	XRF Conf Short	Field Duplicate	Duplicate	9/30/2018	36.51433	-109.233346
M29-XSR4-01-093018	8	Mesa II, Mine 4 Road	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.519991	-109.228322
M29-XSR7-01-093018	8	Mesa II, Mine 4 Road	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.520302	-109.229012
M6-XSR1-01-093018	9	Mesa I Mine Complex Roads	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.524485	-109.218789
M7-XSR1-01-093018	9	Mesa I Mine Complex Roads	0-3	XRF Confirmation	XRF Conf Long2	Field Sample	Primary	9/30/2018	36.520935	-109.220541
M7-XSR1-02-093018	9	Mesa I Mine Complex Roads	0-3	XRF Confirmation	XRF Conf Short	Field Duplicate	Duplicate	9/30/2018	36.520935	-109.220541
M8-XSR1-01-093018	9	Mesa I Mine Complex Roads	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.524661	-109.221526
T17-XSR1-01-093018	9	Mesa I Mine Complex Roads	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.524368	-109.222185
M24-XSR1-01-093018	10	Mesa II Pit Road	0-3	XRF Confirmation	XRF Conf Short	Field Sample	Primary	9/30/2018	36.529864	-109.231956

Notes:

[1] Unique_X is a unique identification for an in situ XRF measurement, which is the mine site ID and the sample ID.

[2] Roads Cluster Names for each Roads Cluster Number.

1	Block K Road
2	Mesa V Mine Complex Roads
3	Mesa V Mine - 103 Haul Shaft Road
4	Mesa IV Mine Complex Roads
5	Mesa IV, West Mine Road
6	Mesa II 1/2 Mine and Mesa III Mine Roads
7	Mesa 1 3/4 and Mesa II Mine Roads
8	Mesa II, Mine 4 Road
9	Mesa I Mine Complex Roads
10	Mesa II Pit Road

QC Quality control

XRF X-ray fluorescence

Table K1-3. XRF Field Survey Results for the Access Roads

Roads Cluster Number[2]	Survey Unit	Unique_X[1]	Date Collected	Arsenic (mg/kg)	Q	Iron (mg/kg)	Q	Lead (mg/kg)	Q	Manganese (mg/kg)	Q	Molybdenum (mg/kg)	Q	Thorium (mg/kg)	Q	Uranium (mg/kg)	Q	Vanadium (mg/kg)	Q	Zinc (mg/kg)	Q
1	R3	M2R3	9/30/2018	<1.8	QU	1,657		<0.27	QU	<81		<0.038	QU	<1.0	QU	<0.077	QU	<16	QU	<7.8	QU
1	R4	M2R4	9/30/2018	<1.8	QU	2,306		0.50		86		<0.038	QU	<1.0	QU	<0.077	QU	<16	QU	<7.8	QU
1	R5	M2R5	9/30/2018	<1.8	QU	1,755		0.30		<81		<0.038	QU	<1.0	QU	<0.077	QU	<16	QU	<7.8	QU
1	R6	M2R6	9/30/2018	<1.8	QU	2,211		<0.27	QU	<81		<0.038	QU	1.1		<0.077	QU	<16	QU	<7.8	QU
1	R2	M2R2	9/30/2018	<1.8	QU	3,053		3.1		126		<0.038	QU	<1.0	QU	<0.077	QU	<16	QU	8	
1	R1	M2R1	9/30/2018	<1.8	QU	1,986		0.90		<81		<0.038	QU	<1.0	QU	<0.077	QU	<16	QU	<7.8	QU
2	R1	M18R1	9/13/2018	3.9		7,731		6.6		244		1.4		3.4		3.3		17		18	
2	R2	M18R2	9/13/2018	2.6		8,009		8.2		203		1.5		3.2		4.3		21		16	
2	R3	M18R3	9/13/2018	<1.8	QU	4,507		4.2		196		3.0		2.1		<0.077	QU	<16	QU	8.7	
2	R4	M18R4	9/13/2018	<1.8	QU	5,909		9.1		366		2.7		3.2		1.0		<16	QU	15	
2	R5	M18R5	9/13/2018	<1.8	QU	7,499		6.8		299		0.91		2.9		1.3		<16	QU	18	
2	R1	M14R1	9/30/2018	<1.8	QU	4,259		6.2		196		<0.038	QU	1.3		<0.077	QU	<16	QU	12	
2	R1	M15R1	9/30/2018	<1.8	QU	3,847		4.3		199		<0.038	QU	1.9		<0.077	QU	<16	QU	10	
2	R1	M17R1	9/30/2018	<1.8	QU	6,200		8.0		305		<0.038	QU	2.8		0.53		<16	QU	14	
2	R2	M17R2	9/30/2018	2.3		7,054		6.4		303		<0.038	QU	4.3		1.1		<16	QU	15	
2	R3	M17R3	9/30/2018	6.2		9,130		7.8		306		<0.038	QU	4.2		1.3		<16	QU	22	
2	R4	M17R4	9/30/2018	3.4		6,784		6.5		263		0.90		3.0		2.9		<16	QU	16	
2	R5	M17R5	9/30/2018	3.0		5,350		3.7		183		<0.038	QU	1.4		0.33		69		14	
2	R5	M19R5	9/30/2018	156		316,457		78		1,168		<0.038	QU	<1.0	QU	105		<16	QU	131	
2	R4	M19R4	9/30/2018	<1.8	QU	311,235		100		1,311		<0.038	QU	<1.0	QU	145		<16	QU	234	
2	R3	M19R3	9/30/2018	87		358,588		<0.27	QU	696		<0.038	QU	<1.0	QU	184		<16	QU	138	
2	R2	M19R2	9/30/2018	73		387,380		<0.27	QU	1,063		<0.038	QU	<1.0	QU	86		<16	QU	155	
2	R1	M19R1	9/30/2018	115		356,903		76		1,031		<0.038	QU	<1.0	QU	129		<16	QU	119	
3	R1	M16R1	9/30/2018	4.2		5,677		6.6		359		<0.038	QU	2.9		1.3		<16	QU	13	
3	R2	M16R2	9/30/2018	<1.8	QU	2,081		<0.27	QU	110		<0.038	QU	<1.0	QU	<0.077	QU	<16	QU	<7.8	QU
3	R3	M16R3	9/30/2018	<1.8	QU	3,697		2.9		160		<0.038	QU	2.2		<0.077	QU	<16	QU	11	
3	R4	M16R4	9/30/2018	3.5		4,701		4.1		167		<0.038	QU	2.2		1.5		33		14	
3	R5	M16R5	9/30/2018	2.1		3,827		3.0		119		0.26		1.4		1.0		38		13	
3	R6	M16R6	9/30/2018	<1.8	QU	6,163		5.3		242		<0.038	QU	3.0		0.85		<16	QU	19	
3	R6	M17R6	9/30/2018	<1.8	QU	4,701		4.3		182		<0.038	QU	3.5		3.6		<16	QU	13	
4	R1	M20R1	9/30/2018	<1.8	QU	4,529		7.6		204		5.5		3.0		0.62		<16	QU	13	
4	R2	M20R2	9/30/2018	<1.8	QU	5,776		9.1		428		9.2		3.5		1.8		<16	QU	17	
4	R3	M20R3	9/30/2018	<1.8	QU	4,251		3.6		106		5.4		2.3		<0.077	QU	<16	QU	18	
4	R4	M20R4	9/30/2018	<1.8	QU	5,716		5.5		317		3.3		2.7		0.64		<16	QU	14	
4	R5	M20R5	9/30/2018	<1.8	QU	8,477		9.1		316		4.8		4.5		3.2		<16	QU	20	
5	R1	M23R1	9/30/2018	<1.8	QU	4,035		4.3		192		3.1		2.6		0.92		<16	QU	14	
5	R2	M23R2	9/30/2018	4.4		9,617		6.4		324		1.1		4.3		3.0		<16	QU	27	

Table K1-3. XRF Field Survey Results for the Access Roads (Continued)

Roads Cluster Number[2]	Survey Unit	Unique_X[1]	Date Collected	Arsenic (mg/kg)	Q	Iron (mg/kg)	Q	Lead (mg/kg)	Q	Manganese (mg/kg)	Q	Molybdenum (mg/kg)	Q	Thorium (mg/kg)	Q	Uranium (mg/kg)	Q	Vanadium (mg/kg)	Q	Zinc (mg/kg)	Q
5	R3	M23R3	9/30/2018	2.4		7,540		7.6		272		7.3		4.1		1.8		<16	QU	20	
5	R4	M23R4	9/30/2018	13		9,488		7.3		216		2.6		4.4		5.4		<16	QU	21	
5	R5	M23R5	9/30/2018	<1.8	QU	3,786		3.9		164		1.7		2.4		1.4		<16	QU	13	
6	R1	M30R1	9/30/2018	2.3		4,991		5.0		173		<0.038	QU	1.3		2.5		45		14	
6	R2	M30R2	9/30/2018	5.6		6,589		5.7		247		<0.038	QU	2.3		3.9		23		19	
6	R3	M30R3	9/30/2018	3.3		6,665		5.1		208		0.44		2.5		2.9		20		19	
6	R4	M30R4	9/30/2018	3.6		10,019		9.1		418		<0.038	QU	2.9		3.1		25		34	
6	R5	M30R5	9/30/2018	<1.8	QU	7,358		8.7		278		<0.038	QU	2.7		1.4		<16	QU	22	
7	R3	M28R3	9/30/2018	<1.8	QU	4,365		4.2		154		<0.038	QU	1.6		<0.077	QU	<16	QU	13	
7	R2	M28R2	9/30/2018	<1.8	QU	3,742		3.8		136		2.5		1.1		<0.077	QU	<16	QU	15	
7	R1	M28R1	9/30/2018	<1.8	QU	4,019		3.8		164		<0.038	QU	1.7		<0.077	QU	<16	QU	13	
8	R1	M29R1	9/30/2018	<1.8	QU	5,265		4.7		235		2.3		2.5		0.75		37		18	
8	R2	M29R2	9/30/2018	<1.8	QU	4,566		5.8		178		3.2		1.2		0.37		25		17	
8	R3	M29R3	9/30/2018	<1.8	QU	2,861		2.5		108		3.3		1.8		0.64		<16	QU	14	
8	R4	M29R4	9/30/2018	2.5		7,569		5.7		276		2.3		2.5		2.0		25		23	
8	R5	M29R5	9/30/2018	<1.8	QU	4,126		3.9		150		<0.038	QU	1.4		<0.077	QU	<16	QU	14	
8	R6	M29R6	9/30/2018	<1.8	QU	6,567		7.0		277		0.88		2.1		1.6		21		19	
8	R7	M29R7	9/30/2018	6.4		12,882		4.6		736		<0.038	QU	5.7		8.0		25		40	
8	R8	M29R8	9/30/2018	<1.8	QU	6,870		7.9		369		<0.038	QU	2.9		1.1		<16	QU	18	
8	R9	M29R9	9/30/2018	<1.8	QU	6,154		8.0		346		0.42		3.1		1.0		<16	QU	16	
9	R1	M6R1	9/30/2018	<1.8	QU	4,084		2.4		119		<0.038	QU	1.6		<0.077	QU	<16	QU	12	
9	R2	M6R2	9/30/2018	<1.8	QU	5,513		7.3		226		<0.038	QU	2.8		1.6		18		14	
9	R3	M6R3	9/30/2018	<1.8	QU	5,057		4.6		241		<0.038	QU	2.1		0.68		<16	QU	12	
9	R4	M6R4	9/30/2018	<1.8	QU	3,907		2.8		140		<0.038	QU	1.3		<0.077	QU	<16	QU	10	
9	R5	M6R5	9/30/2018	2.2		5,427		6.3		171		<0.038	QU	2.4		1.0		<16	QU	13	
9	R1	M7R1	9/30/2018	11		7,278		8.0		329		<0.038	QU	2.7		6.4		24		20	
9	R1	M8R1	9/30/2018	3.2		5,849		6.4		194		0.22		3.0		1.9		103		14	
9	R2	M8R2	9/30/2018	<1.8	QU	5,925		6.5		237		<0.038	QU	3.3		2.0		51		15	
9	R1	T17R1	9/30/2018	<1.8	QU	5,365		3.5		370		1.1		2.2		3.5		<16	QU	14	
10	R1	M24R1	9/30/2018	3.3		9,157		8.3		208		<0.038	QU	2.7		5.8		<16	QU	25	
10	R2	M24R2	9/30/2018	8.7		9,746		9.1		286		3.2		3.6		3.8		17		33	
10	R3	M24R3	9/30/2018	<1.8	QU	6,119		9.4		292		<0.038	QU	2.9		0.76		<16	QU	19	
10	R4	M24R4	9/30/2018	3.6		7,199		8.2		532		<0.038	QU	3.0		2.6		24		24	
10	R5	M24R5	9/30/2018	<1.8	QU	4,182		8.9		214		<0.038	QU	1.7		2.5		<16	QU	14	

Table K1-3. XRF Field Survey Results for the Access Roads (Continued)

Notes:

[1] Unique_X is a unique identification for an in situ XRF measurement, which is the mine site ID and the sample ID.

[2] Roads Cluster Names for each Roads Cluster Number.

1 Block K Road
2 Mesa V Mine Complex Roads
3 Mesa V Mine - 103 Haul Shaft Road
4 Mesa IV Mine Complex Roads
5 Mesa IV, West Mine Road
6 Mesa II 1/2 Mine and Mesa III Mine Roads
7 Mesa 1 3/4 and Mesa II Mine Roads
8 Mesa II, Mine 4 Road
9 Mesa I Mine Complex Roads
10 Mesa II Pit Road

mg/kg Milligrams per kilogram
QU Qualifier is given to a reported value where the XRF reported value is detected but is less than XRF_{MIN} and also less than XRF_{O}. This value is nondetect and reported as the maximum observed laboratory method detection limit for that analyte.
XRF X-ray fluorescence
XRF_{MIN} Minimum XRF value used in the development of the correlation for the given analyte
XRF_{O} XRF value that would equal a laboratory concentration of zero

Table K1-4. Laboratory Analytical Results for XRF Confirmation Soil Samples (0 to 3 inches bgs) (1 of 3)

Analyte	Units	Sample ID											
		M2-XSR3-01-093018		M14-XSR1-01-093018		M15-XSR1-01-093018		M17-XSR1-01-093018		M19-XSR2-01-093018		M16-XSR1-01-093018	
		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Roads Cluster Number		1		2		2		2		2		3	
Roads Cluster Name		Block K Road		Mesa V Mine Complex Roads		Mesa V Mine Complex Roads		Mesa V Mine Complex Roads		Mesa V Mine Complex Roads		Mesa V Mine - 103 Haul Shaft Road	
Aluminum	mg/kg	2,900		3,800		2,800		3,200		3,700		3,800	
Antimony	mg/kg	0.041	J	0.041	J	0.043	J	0.033	J	0.04	J	0.04	J
Arsenic	mg/kg	1.8		1.2		1.1		1.2		1.3		3.6	
Barium	mg/kg	77		63		98		190		100		74	
Beryllium	mg/kg	0.18		0.23		0.22		0.27		0.33		0.23	
Cadmium	mg/kg	0.039	J	<0.2	U	<0.2	U	0.027	J	0.033	J	0.036	J
Calcium	mg/kg	17,000		2,800		1,600		2,000		4,800	J	11,000	
Chromium	mg/kg	2.4		2.8		2.4		2.6		2.9		2.2	
Cobalt	mg/kg	1.4		2.2		1.9		1.9		2.3		2	
Copper	mg/kg	2.4		3.4		3		3.3		4.4		4.3	
Iron	mg/kg	3,000		4,700		3,800		4,200		5,300		4,400	
Lead	mg/kg	2.5		4.3		3.4		3.8		4.7		4.1	
Lithium	mg/kg	4.7		8.2		3.8		3.6		4.4		7	
Magnesium	mg/kg	2,100		2,300		1,200	J	1,200		1,600		2,500	
Manganese	mg/kg	110		120		180		230		170		260	
Mercury	mg/kg	-		-		-		-		-		-	
Molybdenum	mg/kg	0.12	J	0.27		0.16	J	0.094	J	0.11	J	0.17	J
Nickel	mg/kg	2.4		2.8		2.4		2.7		3.1		2.9	
Potassium-40	pCi/g	11.5		11.4		14.9		15.3		18.6		14.3	
Radium-226	pCi/g	0.63	LT	1.29		0.63	LT	0.69	LT	0.77	LT	1.17	
Radium-228	pCi/g	<0.56	U	<0.71	U	<0.6	U	<0.8	U	<0.79	U	<0.73	U
Selenium	mg/kg	0.32	J	<0.98	U	<1	U	0.38	J	0.48	J	0.38	J
Silver	mg/kg	0.0091	J	0.015	J	0.011	J	0.011	J	0.012	J	0.018	J
Sodium	mg/kg	<91	U	17	J	<100	U	15	J	17	J	17	J
Thallium	mg/kg	0.03		0.031		0.031		0.034		0.04		0.035	
Thorium	mg/kg	1.4		2		2	J	2.4		2.8		1.8	
Uranium	mg/kg	0.67		1.3		0.45		0.37		0.48		1.2	
Vanadium	mg/kg	7.9		13		6.9		6.9		8.1		14	
Zinc	mg/kg	8	J	10		7.8	J	8.5		9.5		9.6	

Table K1-4. Laboratory Analytical Results for XRF Confirmation Soil Samples (0 to 3 inches bgs) (2 of 3)

Analyte	Units	Sample ID											
		M16-XSR6-01-093018		M20-XSR2-01-093018		M23-XSR4-01-093018		M30-XSR5-01-093018		M28-XSR1-01-093018		M29-XSR4-01-093018	
		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Roads Cluster Number		3		4		5		6		7		8	
Roads Cluster Name		Mesa V Mine - 103 Haul Shaft Road		Mesa IV Mine Complex Roads		Mesa IV, West Mine Road		Mesa II 1/2 Mine and Mesa III Mine Roads		Mesa 1 3/4 and Mesa II Mine Roads		Mesa II, Mine 4 Road	
Aluminum	mg/kg	4,000		3,000		4,900		4,800		2,400		4,900	
Antimony	mg/kg	0.038	J	0.036	J	0.043	J	0.047	J	0.035	J	0.075	J
Arsenic	mg/kg	1.3		1.3		6.4		2.4		1.2		2.1	
Barium	mg/kg	160		48		120		94		96		120	
Beryllium	mg/kg	0.28		0.23		0.35		0.34		0.24		0.38	
Cadmium	mg/kg	0.036	J	<0.19	U	0.039	J	0.048	J	<0.18	U	0.044	J
Calcium	mg/kg	14,000		1,300		3,700		6,400		4,300		21,000	
Chromium	mg/kg	5.1		2.6		2.2		3.3		1.6		3.8	
Cobalt	mg/kg	1.9		1.6		3.8		3.4		1.6		3.3	
Copper	mg/kg	2.4		2.4		7.9		7.4		3.4		7.5	
Iron	mg/kg	3,500		4,100		6,300		5,800		3,300		6,500	
Lead	mg/kg	3.5		3.6		5.1		5.4		3.3		5.8	
Lithium	mg/kg	9.2		4		9.1		6.4		2.9		8.2	
Magnesium	mg/kg	3,500		1,300		3,400		2,700		1,100		3,400	
Manganese	mg/kg	180		110		130		280		150		250	
Mercury	mg/kg	-		-		-		-		-		-	
Molybdenum	mg/kg	0.11	J	0.14	J	0.33		0.17	J	0.06	J	0.11	J
Nickel	mg/kg	2.8		2.2		3.5		4.6		1.8	J	5	
Potassium-40	pCi/g	14.1		14.1		13.5		19.3		17.8		16.3	
Radium-226	pCi/g	0.63	LT	0.86	LT	1.95		0.93	LT	<0.34	U	1.25	
Radium-228	pCi/g	<0.64	U	<0.58	U	<0.8	U	<0.77	U	<0.45	UJ	<0.53	UJ
Selenium	mg/kg	0.48	J	0.4	J	0.55	J	0.6	J	0.38	J	0.64	J
Silver	mg/kg	<0.048	U	0.011	J	0.024	J	0.016	J	0.0082	J	0.031	J
Sodium	mg/kg	25	J	<97	U	24	J	21	J	16	J	34	J
Thallium	mg/kg	0.027		0.028		0.051		0.045		0.025		0.047	
Thorium	mg/kg	1.8		2.8		2.5		2.9		2.2		3.5	
Uranium	mg/kg	0.7		0.37		1.9		0.83		0.28		1.3	
Vanadium	mg/kg	7.8		7.8		10		9.9		5.7		16	
Zinc	mg/kg	12		7.5	J	15		13		7.5	J	16	

Table K1-4. Laboratory Analytical Results for XRF Confirmation Soil Samples (0 to 3 inches bgs) (3 of 3)

Analyte	Units	Sample ID											
		M29-XSR7-01-093018		M6-XSR1-01-093018		M7-XSR1-01-093018		M8-XSR1-01-093018		T17-XSR1-01-093018		M24-XSR1-01-093018	
		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Roads Cluster Number		8		9		9		9		9		10	
Roads Cluster Name		Mesa II, Mine 4 Road		Mesa I Mine Complex Roads		Mesa I Mine Complex Roads		Mesa I Mine Complex Roads		Mesa I Mine Complex Roads		Mesa II Pit Road	
Aluminum	mg/kg	7,700		3,300		4,500		3,800		2,800		4,900	
Antimony	mg/kg	0.074	J	0.04	J	0.043	J	0.12		0.041	J	0.032	J
Arsenic	mg/kg	3.7		1.2		8.7		3		1.9		3.6	
Barium	mg/kg	150		37		150	J	120		44		150	
Beryllium	mg/kg	0.5		0.2		0.32		0.39		0.24		0.36	
Cadmium	mg/kg	0.1	J	<0.18	U	0.067	J	<0.19	U	<0.19	U	0.04	J
Calcium	mg/kg	180,000		11,000		28,000	J	6,400		3,500	J	18,000	
Chromium	mg/kg	6		4.8		2.1		6.4		1.6		2.1	
Cobalt	mg/kg	5.1		1.6		2.9		2.9		1.5		3.7	
Copper	mg/kg	16		2.3		8.6		6		4.6		10	
Iron	mg/kg	9,100		3,000		5,500		6,000		3,200		5,900	
Lead	mg/kg	7.9		2.5		5.3		5.9		2.3		6	
Lithium	mg/kg	14		9.5		6.6		6.4		3.3		8.2	
Magnesium	mg/kg	7,400		3,500		2,900		2,600		1,400	J	3,800	
Manganese	mg/kg	1500		120		380	J	140		280		160	
Mercury	mg/kg	-		-		-		-		-		-	
Molybdenum	mg/kg	0.062	J	0.06	J	0.48		0.19		0.14	J	0.16	J
Nickel	mg/kg	8.3		2.6		3.3		9.4		2.4		3.6	
Potassium-40	pCi/g	14.4		14.4		17.1		14.2		13.5		13.2	
Radium-226	pCi/g	1.08		<0.42	UJ	2.98		2.36		1.7		2.06	
Radium-228	pCi/g	<0.72	UJ	<0.55	UJ	<0.81	U	<0.54	UJ	<0.61	U	<0.81	U
Selenium	mg/kg	0.83	J	0.33	J	0.59	J	0.87	J	0.97		0.5	J
Silver	mg/kg	0.032	J	<0.045	U	0.039	J	0.032	J	0.018	J	<0.05	U
Sodium	mg/kg	180		19	J	30	J	27	J	<94	U	39	J
Thallium	mg/kg	0.06		0.021		0.082		0.055		0.034		0.04	
Thorium	mg/kg	5.2		1.7		2.5		4.4		1.8	J	3.2	
Uranium	mg/kg	1.5		0.32		3.5		1.9		3		2.8	
Vanadium	mg/kg	13		6.2		13		44		7.5		8.3	
Zinc	mg/kg	27		9.5		14		14		6.9	J	16	

Notes:

-	Not analyzed
bgs	Below ground surface
J	Estimated value
LT	Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration.
mg/kg	Milligrams per kilogram
pCi/g	Picocuries per gram
Q	Qualifier
U	Not detected. The associated value is the reporting limit.
UJ	Not considered detected. The associated value is the reported concentration, which is estimated.
XRF	X-ray fluorescence

Table K1-5. Extended Radionuclides Laboratory Analytical Results (0 to 3 inches bgs)

Decay Series	Analyte	Units	M19-XSR2-01-093018			M7-XSR1-01-093018		
			Activity	TPU	Q	Activity	TPU	Q
Roads Cluster Number			2			9		
Roads Cluster Name			Mesa V Mine Complex Roads			Mesa I Mine Complex Roads		
Uranium	Uranium-238[1]	pCi/g	0.45	0.14		2.14	0.44	
	Uranium-234	pCi/g	0.67	0.19		2.01	0.42	
	Thorium-230	pCi/g	0.79	0.18	M3	2.72	0.46	M3
	Radium-226	pCi/g	0.77	0.24	LT	2.98	0.5	
	Lead-210	pCi/g	1.06	0.45		2.29	0.69	
Actinide	Uranium-235	pCi/g	<0.027	0.037	U	0.109	0.068	
Thorium	Thorium-232[1]	pCi/g	0.63	0.14		0.44	0.10	
	Radium-228	pCi/g	<0.79	0.42	U	<0.81	0.5	U
	Thorium-228	pCi/g	0.66	0.16	M3	0.45	0.12	M3

Notes:

[1] Measured via alpha spectroscopy.

bgs Below ground surface

LT Result less than requested minimum detectable concentration, but greater than sample-specific detectable concentration.

M3 The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.

pCi/g Picocuries per gram

Q Qualifier

TPU Total propagated uncertainty

U Undetected value. The associated value is the reporting limit.

Table K1-6. Selected Applied BTVs for Each Road Cluster

Roads Cluster Number	Roads Cluster Name	Associated Mines	Applicable BSA	Applied BTVs (Mine-Specific) [1]								
				Arsenic mg/kg	Lead mg/kg	Molybdenum mg/kg	Radium-226 mg/kg	Selenium mg/kg	Thorium mg/kg	Uranium mg/kg	Vanadium mg/kg	Gamma cpm
1	Block K Road	Block K Mine	BSA-5	**3.9**	**5.0**	**0.34**	**2.38**	**0.47**	**1.9**	**1.5**	**11**	**11,010**
2	Mesa V Complex Roads	Mesa IV 1/2 Mine and Simpson 181; Mesa V Mine; Mesa V Adit; Mesa V Incline; Mesa VI Mine; Frank Jr. Mine	BSA-18 and Jc	3.6	9.5	0.52	1.98	0.90	3.2	1.7	22	11,920
			BSA-19 and JseJste	2.4	9.3	0.20	1.57	0.84	**2.4**	1.3	22	11,319
			BSA-20 and Jml	**1.6**	**5.8**	**0.07**	**0.95**	**0.78**	4.3	**0.5**	**13**	**11,330**
			BSA-21 and Jml	3.5	10.0	0.29	2.23	0.99	4.5	1.5	24	14,566
			BSA-22 and Jml	2.2	9.7	0.29	1.54	0.93	3.6	1.3	15	11,907
3	Mesa V Mine - 103 Haul Shaft Road	Mesa V Mine 103 Haul Shaft	BSA-19 and JseJste	**2.4**	**9.3**	**0.20**	**1.57**	**0.84**	**2.4**	**1.3**	**22**	**11,319**
4	Mesa IV Mine Complex Roads	Mesa IV, Mine No. 1; Mesa IV, Mine No. 3; Mesa IV, Mine No. 2	BSA-24 and JseJste	4.7	**10.4**	0.32	2.78	**0.94**	**3.6**	2.7	31	**9,703**
			BSA-25 and Jml	**3.5**	11.0	**0.29**	**2.23**	0.99	4.7	**1.5**	**23**	11,274
5	Mesa IV, West Mine Road	Mesa IV, West Mine	BSA-26 and Jml	**3.5**	**11.0**	**0.29**	**2.23**	**1.00**	**4.7**	**1.5**	**24**	**12,602**
6	Mesa II 1/2 Mine and Mesa III Mine Roads	Mesa II 1/2 Mine; Mesa III Mine	BSA-30 and Jml	**2.2**	**10.0**	**0.29**	**0.87**	**1.00**	**4.7**	**0.6**	22	14,566
			BSA-31 and Jml	2.5	11.0	**0.29**	1.62	**1.00**	**4.7**	1.1	**14**	**10,433**
7	Mesa 1 3/4 and Mesa II Mine Roads	Mesa I 3/4 Mine No 2 P150; Mesa II, Mine No. 1 & 2, P-21; Mesa II, Mine No. 1, P-150	BSA-10 and JseJste	4.8	**10.0**	0.34	4.15	0.98	3.6	3.4	31	15,781
			BSA-24 and JseJste	4.7	10.4	0.32	2.78	0.94	3.6	2.7	31	**9,703**
			BSA-29 and JseJste	**2.0**	11.0	**0.26**	**0.85**	**0.92**	**3.6**	1.1	**12**	11,423
			BSA-30 and Jml	2.2	**10.0**	0.29	0.87	1.00	4.7	**0.6**	22	14,566
8	Mesa II, Mine 4 Road	Mesa II, Mine 4	BSA-24 and JseJste	**4.7**	**10.4**	**0.32**	**2.78**	**0.94**	**3.6**	**2.7**	**31**	**9,703**
9	Mesa I Mine Complex Roads	Mesa I Mine 10; Mesa I Mine 11; Mesa I Mine 12; Mesa I Mine 13; Mesa I Mine 14; Mesa I Mine 15	BSA-9 and Jml	2.5	**7.0**	**0.16**	2.23	**0.77**	**4.7**	1.5	15	14,566
			BSA-13 and Jml	**2.0**	11.0	0.26	**1.76**	0.93	**4.7**	**0.9**	**13**	**12,232**
10	Mesa II Pit Road	Mesa II Pit	BSA-24 and JseJste	**4.7**	**10.4**	**0.32**	**2.78**	**0.94**	**3.6**	**2.7**	**31**	**9,703**
11	Mesa 1 1/2 and Mesa 1 1/4 Mine Complexes	Mesa I 1/2 Mine, Mesa 1 1/2 West Mine, Mesa I 1/4 Mine, and Henry Phillips Mine	BSA-15 and Jml	-	-	-	-	-	-	-	-	11,132
			BSA-14 and Jml	-	-	-	-	-	-	-	-	**9,854**
			BSA-13 and Jml	-	-	-	-	-	-	-	-	12,232
			BSA-14 and Jml	-	-	-	-	-	-	-	-	**9,854**
12	Mesa I 3/4 Incline Road	Mesa I 3/4 Incline Mine	BSA-30 and Jml	-	-	-	-	-	-	-	-	**11,378**

Notes:

[1] Selected BTV is based on the minimum BTV for each analytes. Bold font indicates selected BTV.

\- No BTV considered; soil samples are not available in this road cluster

BSA Background study area
BSA-5 Background Study Area 5
BSA-9 Background Study Area 9
BSA-10 Background Study Area 10
BSA-13 Background Study Area 13
BSA-14 Background Study Area 14
BSA-15 Background Study Area 15
BSA-18 Background Study Area 18
BSA-19 Background Study Area 19
BSA-20 Background Study Area 20
BSA-21 Background Study Area 21
BSA-22 Background Study Area 22
BSA-24 Background Study Area 24
BSA-25 Background Study Area 25
BSA-26 Background Study Area 26
BSA-29 Background Study Area 29
BSA-30 Background Study Area 30
BSA-31 Background Study Area 31
BTV Background threshold value
cpm Count per minute
Jc Jurassic Carmel Formation
Jse Jurassic Undifferentiated Summerville and Entrada Sandstone
Jste Jurassic Undifferentiated Summerville, Todilto, and Entrada Sandstone
Jml Jurassic Lower Morrison Formation
mg/kg Milligrams per kilogram

ATTACHMENT K2

FIELD DOCUMENTATION

Roads Cluster Number 1

Block K Road

XRF Field Form

Site Type: AUM
AUM Site: Block K
Tetra Tech ID: M2
Sampling team: JH, AS
XRF Color: Block

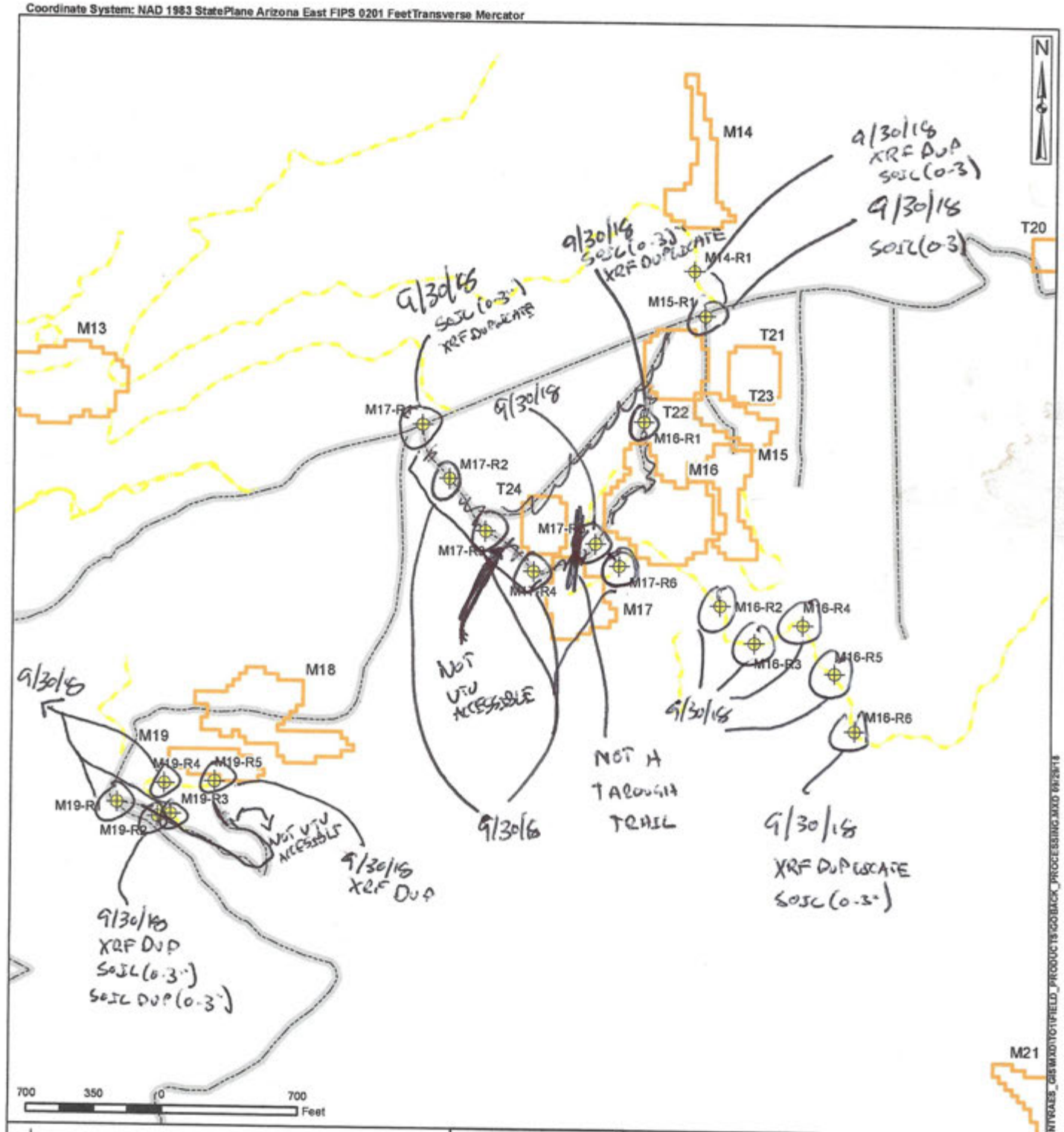
Date: 9/30/2018
Weather: Sunny ~80 clear skies
Page No.: 1/1
GPS Color: White

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
R1	9/30/18	10:34	N	U - <LOD V - 13						Reading #4
R2		10:41	N	U - <LOD V - 25						
R3		1048	N	U - <LOD V - 4	U - <LOD V - 13	~~N~~ Y	M2-XSR3-01-093018			Blank XRF Reading #7
R4		1103	N	U - <LOD V - 12						
R5		1109	~~N~~	U - <LOD V - 12						Reading #9
R6	↓	1113	N	U - <LOD V - 16						XRF replicate

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator



XRF Measurement
Access Route - Foot
Access Route - Vehicular

Prepared for: USEPA Region 9

Prepared By: TETRA TECH

GROUP F ROADS XRF LOCATIONS

Task Order No.:	Contract No.:	Figure No.:
TO 001	EP-S9-17-03	
Location: CHAPTER NAVAJO NATION	Date: 9/29/2018	

C:\USERS\JMEDINA\DOCUMENTS\FIELD DEPLOYMENT\RAES_GIS\MXD\TOTFIELD_PRODUCTS\GOBACK_PROCESSING.MXD 09/29/18

Roads Cluster Number 2
Mesa V Mine Complex Roads

XRF Field Form

Site Type:
AUM Site:
Tetra Tech ID: M16 / M15 / M14
Sampling team:
XRF Color:

Date:
Weather:

Page No.:
GPS Color:

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

	XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
M16	R1	9/30/16	1254	N	V 34 U 4	V 41 U 4	Y	M16-XSR1-01-093016	N	—	SAMPLE @ 1300
	—										
M15	R1	9/30/16	1325	N	21 <4	/	Y	M15-XSR1-01-093018	N	—	Forgot to take Dup. XRF readings
	—										
M14	R1	9/30/16	1333	N	28 <3	31 4	Y	M14-XSR1-01-093018	N	—	
	—										
	—										

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

XRF Field Form

Site Type:
AUM Site:
Tetra Tech ID: M16 / M15 / M14
Sampling team:
XRF Color:

Date:
Weather:

Page No.:
GPS Color:

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

	XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
M16	R1	9/30/16	1254	N	V 34 U 4	V 41 U 4	Y	M16-XSR1-01-093016	N	—	SAMPLE @ 1300
	—										
M15	R1	9/30/16	1325	N	21 <4	/	Y	M15-XSR1-01-093018	N	—	Forgot to take Dup. XRF readings
	—										
M14	R1	9/30/16	1333	N	28 <3	31 4	Y	M14-XSR1-01-093018	N	—	
	—										
	—										

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

XRF Field Form

Site Type: Road
AUM Site:
Tetra Tech ID: M17
Sampling team: Josh & Monk
XRF Color: Blue

Date: 9/30/18
Weather: Sunny
Page No.: 1 of 1
GPS Color: Red

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
R1	9/30/18	12:17	no	25 <3	30 <3	yes	M17-XSR1-01-093018	no ~~yes~~	~~M17-XSR1-02-093018~~	Sample Time 1225
R2	9/30/18	1226	no	<8313 <90	—	no	—	no	—	
R3	9/30/18	1242	no	38 4	—	no	—	no	—	
R4	9/30/18	1232	no	37 6	—	no	—	no	—	
R5	9/30/18	1309	no	109 <3	—	no	—	no	—	
R6	9/30/18	1515 ~~1335~~ JM	no	<30 7	—	no	—	no	—	

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

XRF Field Form

Site Type:
AUM Site:
Tetra Tech ID: M19
Sampling team: Josh & Mark
XRF Color: Blue

Date: 9/30/18
Weather:

Page No.: 1 of 1
GPS Color: Red

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
R5	9/30/18	11:30	no	<171 <139	<193 <142	no	—	no	—	Duplicate readings because PI was off
R4	9/30/18	11:35	no	<175 189	—	no	—	no	—	
R3	9/30/18	11:39	no	<208 239	—	no	—	no	—	
R2	9/30/18	11:43	no	<211 <133	<211 138	yes	M19-XSR2-01-093018	yes	M19-XSR2-02-093018	Sample Time 1150
R1	9/30/18	11:51	no	168 <197	—	no	—	no	—	

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes section and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

Roads Cluster Number 3
Mesa V Mine - 103 Haul Shaft Road

XRF Field Form

Site Type: Rocel
AUM Site:
Tetra Tech ID: MB/MW
Sampling team:
XRF Color:

Date:
Weather:

Page No.:
GPS Color:

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
MB R1	9/30/18	10:12	no	151 5	138 5	yes	MB-XSR1-01-093018	no	—	Sample Time 10:18
MB R2	9/30/18	10:20	no	86 5	—	N	—	N	—	
MW R2	9/30/18	1523	N	13 <3	—	N	—	N	—	
R3	9/30/18	1525	no	24 <3	—	no	—	N	—	
R4	9/30/18	1529	no	64 4	—	no	—	no	—	
R5	9/30/18	1531	no	70 4	—	no	—	no	—	
R6	9/30/18	1534	no	31 3	28 6	yes	MW6R6-01-093018	no	—	Sample Time: 1540

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

XRF Field Form

Site Type:
AUM Site:
Tetra Tech ID: M16 / M15 / M14
Sampling team:
XRF Color:

Date:
Weather:

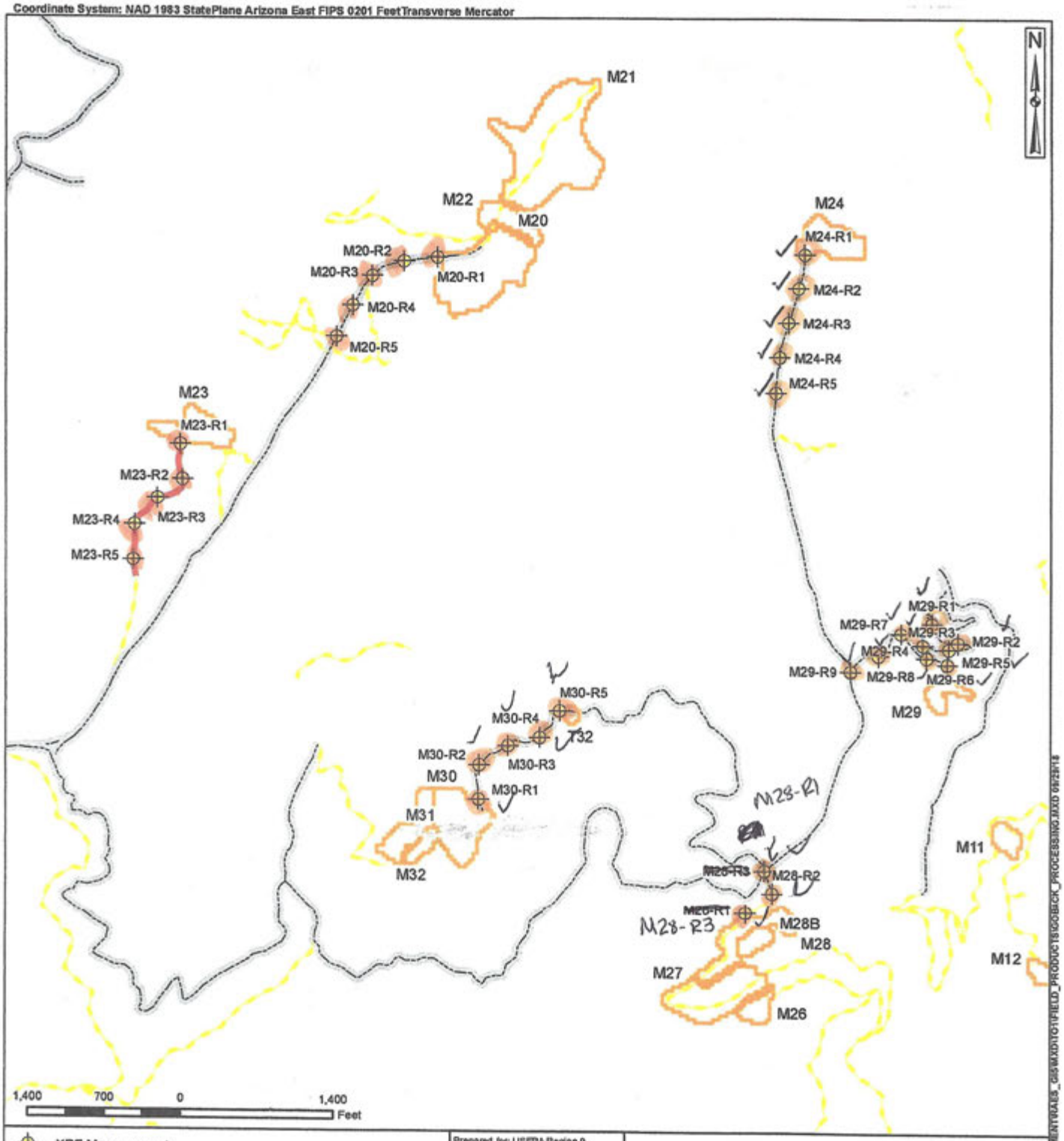
Page No.:
GPS Color:

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

	XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
M16	R1	9/30/16	1254	N	V 34 U 4	V 41 U 4	Y	M16-XSR1-01-093016	N	—	SAMPLE @ 1300
	—										
M15	R1	9/30/16	1325	N	21 <4	/	Y	M15-XSR1-01-093018	N	—	Forgot to take Dup. XRF readings
	—										
M14	R1	9/30/16	1333	N	28 <3	31 4	Y	M14-XSR1-01-093018	N	—	
	—										
	—										

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator



XRF Measurement

Roads to Scan

Access Route - Foot

Access Route - Vehicular

Prepared for: USEPA Region 9

Prepared By:

TETRA TECH

GROUPS G AND H ROADS SCANNING AND XRF LOCATIONS

Task Order No.:	Contract No.:	Figure No.:
TO 001	EP-S9-17-03	
Location: CHAPTER NAVAJO NATION	**Date:** 9/29/2018	

C:\USERS\MHENNING\DOCUMENTS\EMVFIELD DEPLOYMENT\MAPS_GIS\MXD\TO1\FIELD_PRODUCTS\GOOD\CK_PROCESSING.MXD 09/29/18

Roads Cluster Number 4
Mesa IV Mine Complex Roads

AUM Roads

XRF Field Form

Site Type: M20
AUM Site:
Tetra Tech ID: MH AD
Sampling team:
XRF Color: White

Date: 9/30/18
Weather: Sunny, windy, high of 75°F

Page No.: 1
GPS Color: Blue

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
R1	9/30/18	1357	No	V 23 U 3						
R2		1400	No	V <12 U 5	V=26 U=4 Yes	Yes	M20-XSR2-01-093018			Sample @ 1406
R3		1407	No	V <17 U <6						
R4		1410	No	V 29 U <3						
R5		1413	No	V 29 U 6						

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes section and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

Roads Cluster Number 5
Mesa IV, West Mine Road

XRF Field Form

Site Type: M23 Roads
AUM Site:
Tetra Tech ID: AO M1t
Sampling team:
XRF Color: White

Date: 9/30/18
Weather: Sonny, windy, high of 75°F
Page No.: 1
GPS Color: Blue

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
R1	9/30/18	1435	Yes	V 41 U 3						adjusted due to rocks and vegetation
R2		1438	No	V 33 U 6						Recding # 43
R3		1443	No	V 26 U 5						
R4		1445	Yes	V 34 U 9	V 35 U 11	Yes	M23-XSR4-01-093018	No	Sample @ 1450	moved going into better soil to sample
R5		1451	No	V 11 U 4						

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

Roads Cluster Number 6

Mesa II 1/2 Mine and Mesa III Mine Roads

XRF Form

Site Type: AUM Road
AUM Site: M30
Tetra Tech ID:
Sampling team: AD, MH
XRF Color: White

Date: 9/30/18
Weather: Sunny, clear, windy, high of 75°
Page No.: 1
GPS Color: Blue

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
R1	9/30/18	1209	NO	V 79 U 5						walking path cannot drive after berm
R2	"	1214	No	V 51 U 7						Reading #26
R3	"	1218	Yes	V 74 U 6						slightly adjusted to move reading into road
R4	"	1221	No	V 54 U 6						
R5	"	1224	No	V 43 U 4	V 41 U <3	Yes	M30-XS25-01-093018	No		Sample @ 1230

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

Roads Cluster Number 7

Mesa 1 3/4 and Mesa II Mine Roads

XRF Field Form

Site Type: AUM Roads
AUM Site: M28
Tetra Tech ID:
Sampling team: AD, MH
XRF Color: White

Date: 9/30/18
Weather: Sunny, wind, high of 75°F
Page No.: 1
GPS Color: Blue

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
R3	9/30/18	1249	No	V 24 U <3						
R2	↓	1252	No	V 14 U <3						adjusted to XRF finer sand on road
R1	↓	1255	No	V 21 U <3	V 20 U 3	Yes	M28-XSR1-01-093018	Yes	M28-XSR1-02-093018	Sample @ 1300

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

Roads Cluster Number 8

Mesa II, Mine 4 Road

XRF Field Form

Site Type: AUM
AUM Site: M29 Roads (Mesa II Mine No.4)
Tetra Tech ID:
Sampling team: AD MH
XRF Color: white

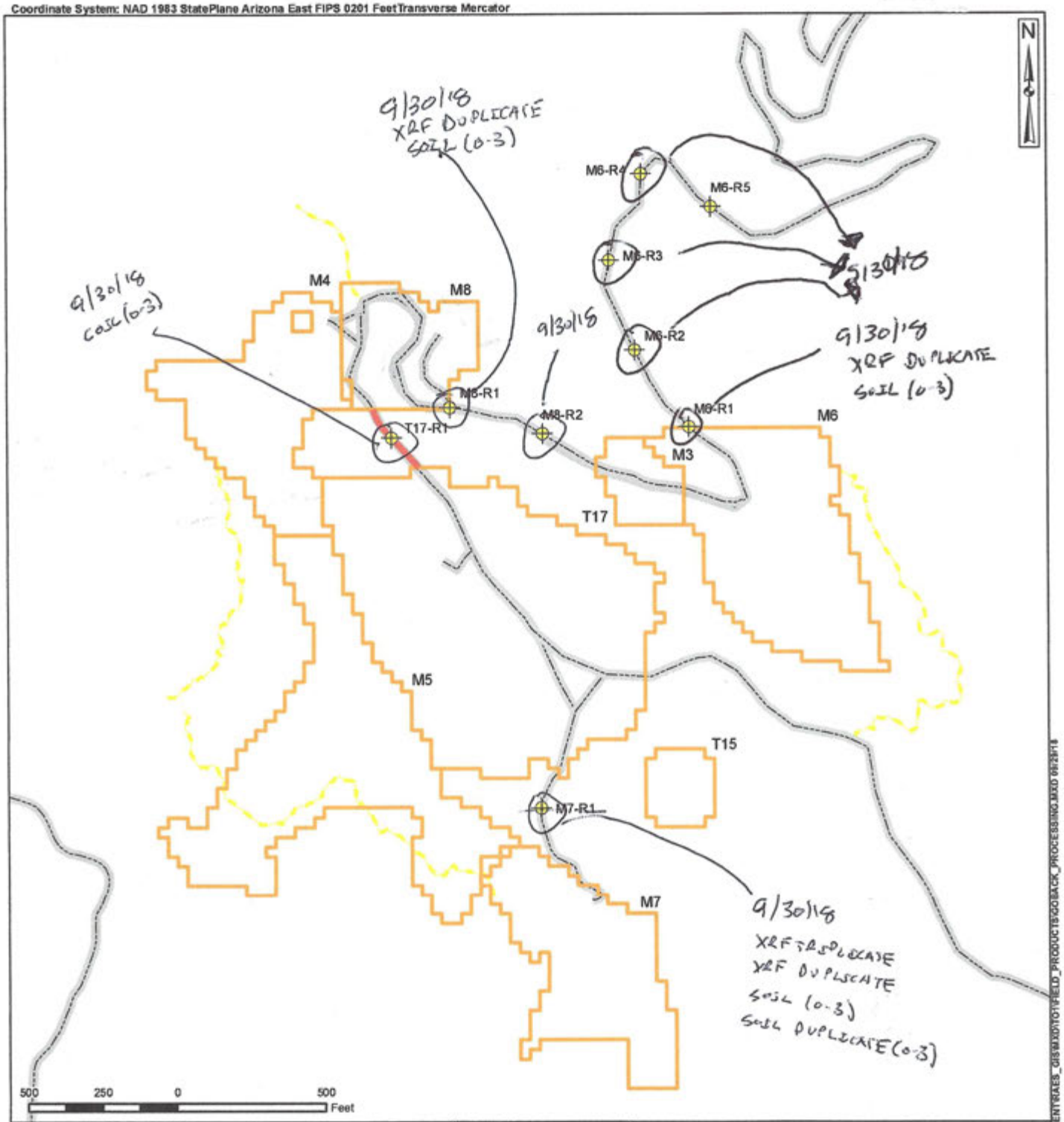
Date: 9/30/18
Weather: Sunny, clear
Page No.: 1
GPS Color: blue

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
R1	9/30/18	1049	No	V 69 U <4						
R2		1052	No	V 54 U <3						
R3		1056	No	V 34 U <4						
R4		1059	No	V 54 U 5	V 57 U 4	YES	M29-XSR4-01-093018	No		Sample time 1105
R5		1109	No	V 40 U <3						
R6		1127	Yes	V 48 U 4					Reading # 20	Slightly adjusted to be in less rocky area
R7		1130	No	V 54 U 12	V 38 U 12	YES	M29-XSR7-01-093018		Sample @ 1138	in gray patch of soil on road
R8		1139	No	V 41 U 4						
R9	↓	1142	No	V 37 U 4						
X7	↓	1118	Yes	V 194 U 8						Steep unstable slope. Reading # 19

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes section and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 FeetTransverse Mercator



XRF Measurement
Roads to Scan
Access Route - Foot
Access Route - Vehicular

Prepared for: USEPA Region 9

Prepared By: TETRA TECH

GROUP F ROADS XRF LOCATIONS

Task Order No.:	Contract No.:	Figure No.:
TO 001	EP-S9-17-03	
Location: CHAPTER NAVAJO NATION	Date: 9/29/2018	

C:\USERS\UMETERNING\DOCUMENTS\ARCMAP\FIELD DEPLOYMENT\GAES_GIS\MXD\101\FIELD_PRODUCTS\GOBACK_PROCESSING.MXD 9/29/18

Roads Cluster Number 9
Mesa I Mine Complex Roads

XRF Field Form

Site Type:
AUM Site:
Tetra Tech ID: MG
Sampling team:
XRF Color:

Date:
Weather:

Page No.:
GPS Color:

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
R1	9/30/18	10:27	N	34 <3	27 <5	Y	M6-XS1-01-093018	N	—	SAMPLE @ 1030
R2	9/30/18	10:32	N	45 4	—	N	—	N	—	
R3	9/30/18	10:34	N	33 3	—	N	—	N	—	
R4	9/30/18	10:37	N	28 <4	—	N	—	N	—	
R5	9/30/18	10:40	N	31 4	—	N	—	N	—	
—										
—										

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

XRF Field Form

Site Type: Road
AUM Site: [illegible]
Tetra Tech ID: M7
Sampling team: Josie, Mark
XRF Color: Blue

Date: 9/30/18
Weather: Sunny, no clouds
Page No.: 1 of 1
GPS Color: red

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
M7-R1	9/30/18	9:45	no	52 10	46 12	yes	M7-XSR1-01-093018	yes	M7-XSR1-02-093018	Sample Time 955

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

XRF Field Form

Site Type: Rocel
AUM Site:
Tetra Tech ID: MB/MW
Sampling team:
XRF Color:

Date:
Weather:

Page No.:
GPS Color:

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
MB R1	9/30/18	10:12	no	151 5	138 5	yes	MB-XSR1-01-093018	no	—	Sample Time 10:18
MB R2	9/30/18	10:20	no	86 5	—	N	—	N	—	
MW R2	9/30/18	1523	N	13 <3	—	N	—	N	—	
R3	9/30/18	1525	no	24 <3	—	no	—	N	—	
R4	9/30/18	1529	no	64 4	—	no	—	no	—	
R5	9/30/18	1531	no	70 4	—	no	—	no	—	
R6	9/30/18	1534	no	31 3	28 6	yes	MW6R6-01-093018	no	—	Sample Time: 1540

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

XRF Field Form

Site Type:
AUM Site:
Tetra Tech ID: T17
Sampling team: Josh & Mark
XRF Color: Blue

Date: 9/30/18
Weather:

Page No.: 1 of 1
GPS Color: Red

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
R-1	9/30/18	10:02	no	31 7	44 7	yes	T17-XS1R1-01-093018 ~~T17-R1-01-01~~	no		BT: 10:10

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

Roads Cluster Number 10

Mesa II Pit Road

XRF Field Form

Site Type: AUM
AUM Site: M24 Mesa II Pit
Tetra Tech ID:
Sampling team: AD, MH
XRF Color: White

Date: 9/30/18
Weather: Sunny, clear, windy, high of 75°F
Page No.: 1
GPS Color: Blue

Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
R1	9/30/18	1005	No	V 40 U 10	V 28 U 8	Yes	M24-XSR1-01-093018	N	—	Triplicate 1017 sample time
R2		1023	No	V 43 U 7						
R3		1026	No	V 35 U 3						
R4		1029	No	V 52 U 6						
R5		1032	No	V 29 U 5						

Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are collected with in situ XRF measurements.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.