Northern Agency Tronox Mines

FINAL
Appendix I
Non-AUM Target Sites
Data Evaluation Report

Response, Assessment, and Evaluation Services (RAES)

Contract No. EP-S9-17-03

Task Order 0001

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Submitted by

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TABLE OF CONTENTS

Section			Page
ACRONYMS AND ABBREVIATIONS			ix
EXECUTIVE SUMMARY			ES-1
1.0	INTRODUCTION		1-1
	1.1	ABANDONED URANIUM MINE AND TARGETS	1-1
	1.2	PURPOSE	1-9
	1.3	DATA QUALITY OBJECTIVES	1-10
	1.4	REPORT ORGANIZATION	1-12
2.0	METHODS		2-1
	2.1	NON-AUM TARGET MAPPING	2-1
	2.2	GAMMA RADIATION SURVEY	2-2
	2.3	GAMMA CORRELATION	2-7
		2.3.1 Gamma-Radium Correlation	2-8
		2.3.2 Gamma-Exposure Rate Correlation	2-8
	2.4	XRF FIELD SURVEY	2-10
	2.5	SOIL SAMPLING	2-11
		2.5.1 XRF Confirmation Soil Sampling (0 to 3 Inches)	2-11
		2.5.2 Surface Soil Sampling (0 to 6 Inches)	2-11
		2.5.3 Shallow Subsurface Soil Sampling (6 to 12 Inches)	2-12
	2.6	QUALITY ASSURANCE/QUALITY CONTROL	2-12
	2.7	CULTURAL AND BIOLOGICAL SURVEYS	2-13
	2.8	STATEMENT ON ACCESSIBILITY	2-13
	2.9	SITE CLASSIFICATION	2-13
	2.10	IDENTIFICATION OF CONTAMINANTS OF POTENTIAL CONCERN	2-14
3.0	NON-AUM TARGET GROUPINGS AND SETTING		3-1
	3.1	NON-AUM TARGET GROUPINGS AND LOCATIONS	3-1
	3.2	PREVIOUS INVESTIGATIONS	3-11
	3.3	GEOLOGY AND SOILS	3-13
		3.3.1 Tse Tah Region	3-14
		3.3.2 Cove Valley	3-19
		3.3.3 Lukachukai Mountains	3-22
	3.4	DEVELOPMENT OF BACKGROUND THRESHOLD VALUES	3-35
4.0	GROUP A FIELD SAMPLING RESULTS		4-1
	4.1	NON-AUM TARGET T1 (BR-01)	4-1
		4.1.1 Access, Physical Conditions, and Field Observations	4-1
		4.1.2 Gamma Radiation Survey and Field XRF Measurements	4-5

TABLE OF CONTENTS (CONTINUED)

Section		Page
	4.1.3 XRF Confirmation and Soils Sampling Overview	4-5
	4.1.4 Applied Background Threshold Values	4-17
	4.1.5 Gamma Radiation Survey Results	4-19
	4.1.6 Soil Sampling Results	4-26
	4.1.7 Primary Contaminant Mapping	4-37
	4.1.8 Conclusions	4-54
4.2	NON-AUM TARGET T3 (BR-03)	4-56
	4.2.1 Access, Physical Conditions, and Field Observations	4-56
	4.2.2 Gamma Radiation Survey and Field XRF Measurements	4-60
	4.2.3 XRF Confirmation Sampling Overview	4-60
	4.2.4 Applied Background Threshold Values	4-66
	4.2.5 Gamma Radiation Survey Results	4-68
	4.2.6 Soil Sampling Results	4-75
	4.2.7 Primary Contaminant Mapping	4-80
	4.2.8 Conclusions	4-96
4.3	NON-AUM TARGET T4 (BR-04)	4-98
	4.3.1 Access, Physical Conditions, and Field Observations	4-98
	4.3.2 Gamma Radiation Survey and Field XRF Measurements	4-102
	4.3.3 XRF Confirmation Sampling Overview	4-102
	4.3.4 Applied Background Threshold Values	4-109
	4.3.5 Gamma Radiation Survey Results	4-111
	4.3.6 Soil Sampling Results	4-118
	4.3.7 Primary Contaminant Mapping	4-124
	4.3.8 Conclusions	4-140
4.4	NON-AUM TARGET T5 (BR-05)	4-142
	4.4.1 Access, Physical Conditions, and Field Observations	4-142
	4.4.2 Gamma Radiation Survey and Field XRF Measurements	4-146
	4.4.3 XRF Confirmation Sampling Overview	4-146
	4.4.4 Applied Background Threshold Values	4-152
	4.4.5 Gamma Radiation Survey Results	4-154
	4.4.6 Soil Sampling Results	4-161
	4.4.7 Primary Contaminant Mapping	4-166
	4.4.8 Conclusions	4-182
4.5	NON-AUM TARGET T6 (BR-06)	4-184
	4.5.1 Access, Physical Conditions, and Field Observations	4-184
	4.5.2 Gamma Radiation Survey and Field XRF Measurements	4-188

TABLE OF CONTENTS (CONTINUED)

Section			Page
		4.5.3 XRF Confirmation Sampling Overview	4-188
		4.5.4 Applied Background Threshold Values	4-194
		4.5.5 Gamma Radiation Survey Results	4-196
		4.5.6 Soil Sampling Results	4-203
		4.5.7 Primary Contaminant Mapping	4-208
		4.5.8 Conclusions	4-223
5.0	GROUP B FIELD SAMPLING RESULTS		5-1
	5.1 NON-AUM TARGET T7 (BK-01)		5-1
		5.1.1 Access, Physical Conditions, and Field Observations	5-1
		5.1.2 Gamma Radiation Survey and Field XRF Measurements	5-5
		5.1.3 XRF Confirmation Sampling Overview	5-5
		5.1.4 Applied Background Threshold Values	5-11
		5.1.5 Gamma Radiation Survey Results	5-13
		5.1.6 Soil Sampling Results	5-20
		5.1.7 Primary Contaminant Mapping	5-25
		5.1.8 Conclusions	5-40
	5.2 NON-AUM TARGET T8 (BK-02)		5-42
		5.2.1 Access, Physical Conditions, and Field Observations	5-42
		5.2.2 Gamma Radiation Survey and Field XRF Measurements	5-46
		5.2.3 XRF Confirmation Sampling Overview	5-46
		5.2.4 Applied Background Threshold Values	5-52
		5.2.5 Gamma Radiation Survey Results	5-54
		5.2.6 Soil Sampling Results	5-61
		5.2.7 Primary Contaminant Mapping	5-66
		5.2.8 Conclusions	5-81
6.0	GROUP C FIELD SAMPLING RESULTS		6-1
	6.1 NON-AUM TARGET T10 (CT-01)		6-1
		6.1.1 Access, Physical Conditions, and Field Observations	6-1
		6.1.2 Gamma Radiation Survey and Field XRF Measurements	6-5
		6.1.3 XRF Confirmation Sampling Overview	6-5
		6.1.4 Applied Background Threshold Values	6-11
		6.1.5 Gamma Radiation Survey Results	6-13
		6.1.6 Soil Sampling Results	6-20
		6.1.7 Primary Contaminant Mapping	6-25
		6.1.8 Conclusions	6-41

TABLE OF CONTENTS (CONTINUED)

Section		Page
6.2	NON-AUM TARGET T11 (CT-02)	6-43
6.2.1	Access, Physical Conditions, and Field Observations	6-43
6.2.2	Gamma Radiation Survey and Field XRF Measurements	6-47
6.2.3	XRF Confirmation Sampling Overview	6-47
6.2.4	Applied Background Threshold Values	6-53
6.2.5	Gamma Radiation Survey Results	6-55
6.2.6	Soil Sampling Results	6-62
6.2.7	Primary Contaminant Mapping	6-67
6.2.8	Conclusions	6-83
6.3	NON-AUM TARGET T12 (CT-03)	6-85
6.3.1	Access, Physical Conditions, and Field Observations	6-85
6.3.2	Gamma Radiation Survey and Field XRF Measurements	6-89
6.3.3	XRF Confirmation and Soils Sampling	6-89
6.3.4	Applied Background Threshold Values	6-95
6.3.5	Gamma Radiation Survey Results	6-97
6.3.6	Soil Sampling Results	6-104
6.3.7	Primary Contaminant Mapping	6-110
6.3.8	Conclusions	6-126
7.0	GROUP D FIELD SAMPLING RESULTS	7-1
7.1	NON-AUM TARGET T13 (M1-01)	7-1
7.1.1	Access, Physical Conditions, and Field Observations	7-1
7.1.2	Gamma Radiation Survey and Field XRF Measurements	7-5
7.1.3	XRF Confirmation Sampling Overview	7-5
7.1.4	Applied Background Threshold Value	7-11
7.1.5	Gamma Radiation Survey Results	7-13
7.1.6	Soil Sampling Results	7-20
7.1.7	Primary Contaminant Mapping	7-25
7.1.8	Conclusions	7-41
7.2	NON-AUM TARGET T14 (M1-02)	7-43
7.2.1	Access, Physical Conditions, and Field Observations	7-43
7.2.2	Gamma Radiation Survey and Field XRF Measurements	7-47
7.2.3	XRF Confirmation Sampling Overview	7-47
7.2.4	Applied Background Threshold Values	7-53
7.2.5	Gamma Radiation Survey Results	7-55
7.2.6	Soil Sampling Results	7-62

TABLE OF CONTENTS (CONTINUED)

Section		Page
	7.2.7 Primary Contaminant Mapping	7-67
	7.2.8 Conclusions	7-83
7.3	NON-AUM TARGET T15 (M1-03)	7-85
	7.3.1 Access, Physical Conditions, and Field Observations	7-85
	7.3.2 Gamma Radiation Survey and Field XRF Measurements	7-89
	7.3.3 XRF Confirmation Sampling Overview	7-89
	7.3.4 Applied Background Threshold Values	7-95
	7.3.5 Gamma Radiation Survey Results	7-97
	7.3.6 Soil Sampling Results	7-104
	7.3.7 Primary Contaminant Mapping	7-109
	7.3.8 Conclusions	7-125
8.0	GROUP F FIELD SAMPLING RESULTS	8-1
8.1	NON-AUM TARGET T18 (M5-01)	8-1
	8.1.1 Access, Physical Conditions, and Field Observations	8-1
	8.1.2 Gamma Radiation Survey and Field XRF Measurements	8-5
	8.1.3 XRF Confirmation Sampling Overview	8-5
	8.1.4 Applied Background Threshold Values	8-11
	8.1.5 Gamma Radiation Survey Results	8-13
	8.1.6 Soil Sampling Results	8-20
	8.1.7 Primary Contaminant Mapping	8-25
	8.1.8 Conclusions	8-41
8.2	NON-AUM TARGET T19 (M5-02)	8-43
	8.2.1 Access, Physical Conditions, and Field Observations	8-43
	8.2.2 Gamma Radiation Survey and Field XRF Measurements	8-47
	8.2.3 XRF Confirmation Sampling Overview	8-47
	8.2.4 Applied Background Threshold Values	8-53
	8.2.5 Gamma Radiation Survey Results	8-55
	8.2.6 Soil Sampling Results	8-62
	8.2.7 Primary Contaminant Mapping	8-67
	8.2.8 Conclusions	8-83
8.3	NON-AUM TARGET T20 (M5-03)	8-85
	8.3.1 Access, Physical Conditions, and Field Observations	8-85
	8.3.2 Gamma Radiation Survey and Field XRF Measurements	8-89
	8.3.3 XRF Confirmation Sampling Overview	8-89
	8.3.4 Applied Background Threshold Values	8-95

TABLE OF CONTENTS (CONTINUED)

Section		Page
	8.3.5 Gamma Radiation Survey Results	8-97
	8.3.6 Soil Sampling Results	8-104
	8.3.7 Primary Contaminant Mapping	8-109
	8.3.8 Conclusions	8-125
8.4	NON-AUM TARGET T21 (M5-05)	8-127
	8.4.1 Access, Physical Conditions, and Field Observations	8-127
	8.4.2 Gamma Radiation Survey and Field XRF Measurements	8-131
	8.4.3 XRF Confirmation Sampling Overview	8-131
	8.4.4 Applied Background Threshold Values	8-137
	8.4.5 Gamma Radiation Survey Results	8-139
	8.4.6 Soil Sampling Results	8-146
	8.4.7 Primary Contaminant Mapping	8-151
	8.4.8 Conclusions	8-167
8.5	NON-AUM TARGET T22 (M5-06)	8-169
	8.5.1 Access, Physical Conditions, and Field Observations	8-169
	8.5.2 Gamma Radiation Survey and Field XRF Measurements	8-173
	8.5.3 XRF Confirmation Sampling Overview	8-173
	8.5.4 Applied Background Threshold Values	8-179
	8.5.5 Gamma Radiation Survey Results	8-181
	8.5.6 Soil Sampling Results	8-188
	8.5.7 Primary Contaminant Mapping	8-193
	8.5.8 Conclusions	8-209
8.6	NON-AUM TARGET T24 (M5-07)	8-211
	8.6.1 Access, Physical Conditions, and Field Observations	8-211
	8.6.2 Gamma Radiation Survey and Field XRF Measurements	8-215
	8.6.3 XRF Confirmation Sampling Overview	8-215
	8.6.4 Applied Background Threshold Values	8-221
	8.6.5 Gamma Radiation Survey Results	8-223
	8.6.6 Soil Sampling Results	8-230
	8.6.7 Primary Contaminant Mapping	8-235
	8.6.8 Conclusions	8-251
8.7	NON-AUM TARGET T25 (M5-08)	8-253
	8.7.1 Access, Physical Conditions, and Field Observations	8-253
	8.7.2 Gamma Radiation Survey and Field XRF Measurements	8-257
	8.7.3 XRF Confirmation Sampling Overview	8-257
	8.7.4 Applied Background Threshold Values	8-263

TABLE OF CONTENTS (CONTINUED)

Section			Page
		8.7.5 Gamma Radiation Survey Results	8-265
		8.7.6 Soil Sampling Results	8-272
		8.7.7 Primary Contaminant Mapping	8-277
		8.7.8 Conclusions	8-293
	8.8	NON-AUM TARGET T26 (M5-09)	8-295
		8.8.1 Access, Physical Conditions, and Field Observations	8-295
		8.8.2 Gamma Radiation Survey and Field XRF Measurements	8-299
		8.8.3 XRF Confirmation Sampling Overview	8-299
		8.8.4 Applied Background Threshold Values	8-305
		8.8.5 Gamma Radiation Survey Results	8-307
		8.8.6 Soil Sampling Results	8-314
		8.8.7 Primary Contaminant Mapping	8-319
		8.8.8 Conclusions	8-335
9.0		GROUP G FIELD SAMPLING RESULTS	9-1
	9.1	NON-AUM TARGET T27 (M4-02)	9-1
		9.1.1 Access, Physical Conditions, and Field Observations	9-1
		9.1.2 Gamma Radiation Survey and Field XRF Measurements	9-5
		9.1.3 XRF Confirmation Sampling Overview	9-5
		9.1.4 Applied Background Threshold Values	9-11
		9.1.5 Gamma Radiation Survey Results	9-13
		9.1.6 Soil Sampling Results	9-20
		9.1.7 Primary Contaminant Mapping	9-25
		9.1.8 Conclusions	9-40
10.0		GROUP H FIELD SAMPLING RESULTS	10-1
	10.1	NON-AUM TARGET T30 (M1-07)	10-1
		10.1.1 Access, Physical Conditions, and Field Observations	10-1
		10.1.2 Gamma Radiation Survey and Field XRF Measurements	10-5
		10.1.3 XRF Confirmation Sampling Overview	10-5
		10.1.4 Applied Background Threshold Values	10-11
		10.1.5 Gamma Radiation Survey Results	10-13
		10.1.6 Soil Sampling Results	10-20
		10.1.7 Primary Contaminant Mapping	10-25
		10.1.8 Conclusions	10-41
	10.2	NON-AUM TARGET T31 (M1-08)	10-43
		10.2.1 Access, Physical Conditions, and Field Observations	10-43

TABLE OF CONTENTS (CONTINUED)

Section **Page**

10.2.2 Gamma Radiation Survey and Field XRF Measurements 10-47
10.2.3 XRF Confirmation Sampling Overview 10-47
10.2.4 Applied Background Threshold Values 10-53
10.2.5 Gamma Radiation Survey Results 10-55
10.2.6 Soil Sampling Results 10-62
10.2.7 Primary Contaminant Mapping 10-67
10.2.8 Conclusions 10-83
10.3 NON-AUM TARGET T32 (M2-01) 10-85
10.3.1 Access, Physical Conditions, and Field Observations 10-85
10.3.2 Gamma Radiation Survey and Field XRF Measurements 10-89
10.3.3 XRF Confirmation Sampling Overview 10-89
10.3.4 Applied Background Threshold Values 10-95
10.3.5 Gamma Radiation Survey Results 10-97
10.3.6 Soil Sampling Results 10-104
10.3.7 Primary Contaminant Mapping 10-109
10.3.8 Conclusions 10-125
11.0 GROUP I FIELD SAMPLING RESULTS 11-1
11.1 NON-AUM TARGET T33 (KE-01) 11-1
11.1.1 Access, Physical Conditions, and Field Observations 11-1
11.1.2 Gamma Radiation Survey and Field XRF Measurements 11-5
11.1.3 XRF Confirmation Sampling Overview 11-5
11.1.4 Applied Background Threshold Values 11-11
11.1.5 Gamma Radiation Survey Results 11-13
11.1.6 Soil Sampling Results 11-20
11.1.7 Primary Contaminant Mapping 11-25
11.1.8 Conclusions 11-41
12.0 REFERENCES 12-1

ATTACHMENTS

Attachment I1. Photographic Log
Attachment I2. Target Field Forms
Attachment I3. Validated XRF Data
Attachment I4. List of Tables
Attachment I5. List of Figures

ACRONYMS AND ABBREVIATIONS

ABA	Acid-base accounting
AGP	Acid generation potential
amsl	Above mean sea level
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-1	Background Study Area 1
BSA-2	Background Study Area 2
BSA-4	Background Study Area 4
BSA-5	Background Study Area 5
BSA-7	Background Study Area 7
BSA-8	Background Study Area 8
BSA-9	Background Study Area 9
BSA-11	Background Study Area 11
BSA-12	Background Study Area 12
BSA-16	Background Study Area 16
BSA-17	Background Study Area 17
BSA-19	Background Study Area 19
BSA-21	Background Study Area 21
BSA-22	Background Study Area 22
BSA-27	Background Study Area 27
BSA-30	Background Study Area 30
BSA-32	Background Study Area 32
BTV	Background threshold value
$CaCO_3$	Calcium carbonate
CAS	Chemical Abstract Service
COPC	Contaminant of potential concern
cpm	Count per minute
DQO	Data quality objective
EE/CA	Engineering evaluation/cost analysis
ERG	Environmental Restoration Group, Inc.
FSP	Field sampling plan
GPS	Global positioning system

ACRONYMS AND ABBREVIATIONS (CONTINUED)

HDOP	Horizontal dilution of precision
HPIC	High pressure ionization chamber
Jc	Jurassic Carmel Formation
Jm	Jurassic Morrison Formation
Jmb	Jurassic Brushy Basin Member of the Upper Morrison Formation
Jml	Jurassic Lower Morrison Formation
Jmr	Jurassic Recapture Member of the Lower Morrison Formation
Jms	Jurassic Salt Wash Member of the Lower Morrison Formation
Jmu	Jurassic Upper Morrison Formation
Jmw	Jurassic Westwater Canyon Member of the Upper Morrison Formation
Js	Jurassic Summerville Formation
Jse	Jurassic Undifferentiated Summerville and Entrada
Jste	Jurassic Undifferentiated Summerville, Todilto, and Entrada Sandstone
K-40	Potassium-40
Kerr-McGee	Kerr-McGee Oil Industries, Inc.
m^2	Square meter
MARSSIM	*Multi-Agency Radiation Survey and Site Investigation Manual*
MARLAP	*Multi-Agency Radiation Laboratory Analytical Protocols Manual*
MCAP	Mine Category Assessment Protocol
MDL	Method detection limit
mg/kg	Milligram per kilogram
MUSYM	Map unit symbol
NaI	Sodium iodide
NAUM	Navajo Abandoned uranium mine
NAMLRP	Navajo Abandoned Mine Lands Reclamation Program
Neptune	Neptune and Company, Inc.
NFA	No further action
NNP	Net neutralization potential
NORM	Naturally occurring radioactive material
NRCS	U.S. Natural Resources Conservation Service
pCi/g	Picocuries per gram
pCi/L	Picocuries per liter
ppt $CaCO_3$	Tons of calcium carbonate equivalent per 1,000 tons of material
Qa	Quaternary alluvium
QA/QC	Quality assurance/quality control

ACRONYMS AND ABBREVIATIONS (CONTINUED)

Ra-226	Radium-226
Ra-228	Radium-228
RAES	Response, assessment, and evaluation services
RCRA	Resource Conservation and Recovery Act
Roux	Roux Associates
RPM	Remedial Project Manager
RSE	Removal site evaluation
RSE Report	Northern Agency Tronox Mines Removal Site Evaluation Report
RSE Work Plan	Northern Agency Tronox Mines Removal Site Evaluation Work Plan
RSSI	Radiation survey and site investigation
SAP/QAPP	Sampling Analysis Plan/Quality Assurance Project Plan
SPLP	Synthetic precipitation leaching procedure
SSRSE	Site-specific removal site evaluation
SOP	Standard operating procedure
Tc	Triassic Chuska Formation
TCLP	Toxicity characteristic leaching procedure
TENORM	Technologically enhanced naturally occurring radioactive material
Tetra Tech	Tetra Tech, Inc.
Trc	Triassic Chinle Formation
Trw	Triassic Wingate Formation
TSG	TerraSpectra Geomatics
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USL 95	95 percent upper simultaneous limit
UTL 95-95	95 percent upper tolerance limit
UTV	Utility vehicle
VCA	Vanadium Corporation of America
Weston	Weston Solutions, Inc.
XRF	X-ray fluorescence

EXECUTIVE SUMMARY

This Non-Abandoned Uranium Mine (AUM) Target Sites (Target) Data Evaluation Report is included as Appendix I of the Northern Agency Tronox Mines Removal Site Evaluation (RSE) Report (RSE Report). This report presents and documents the objectives, methodology, and results of the RSE performed at 26 non-AUM Targets believed to be unrelated to but in the same study area as the 38 AUMs that are undergoing RSEs under the 2015 Tronox Settlement Agreement and are the primary subject of this RSE Report. The data generated during this investigation will be used to support risk screening and assist in determining the basis for no further action (NFA), additional investigation, or a removal action for each non-AUM Target. Risk screening and determining the basis for further action will be documented in an engineering evaluation/cost analysis (EE/CA) for Northern Agency Tronox Mines.

In 2014 and 2015, the U.S. Environmental Protection Agency's (USEPA) Airborne Spectral and Photometric Environmental Collection Technology (ASPECT) aircraft conducted flyovers within the Tse Tah, Cove Valley, and Lukachukai Mountains Regions of the Navajo Nation. The ASPECT surveys covered nearly 180 square miles of land. In May 2015, a ground-based characterization effort was organized to collect in situ gamma spectroscopy measurements at select locations and to ground truth the ASPECT survey (USEPA 2015). Based on the results of the ASPECT survey, USEPA identified AUMs and areas of concern requiring additional characterization.

Under contact with USEPA Region 9, Weston Solutions, Inc. (Weston) developed a Mine Category Assessment Protocol (MCAP) in support of the Tronox settlement (Weston 2016). The MCAP project concentrated on assessing and prioritizing Tronox mines future assessment and cleanup located within the Northern Agency of the Navajo Nation. The MCAP effort was applied to any additional mines within a 0.5-mile radius of the Tronox mines and other non-mine areas of concern (non-AUM Targets). Non-AUM Targets identified included locations determined by an analysis of the ASPECT flyover gamma survey data set. Weston evaluated data anomalies and elevated outliers revealed during the analysis and also reviewed historical documentation and aerial photographs to identify additional areas of concern. Weston also visited a portion of the non-AUM Target locations in April and September 2016 during the MCAP reconnaissance survey to confirm ASPECT flyover survey data and non-AUM Target identification (Weston 2016).

A total of 38 Targets were identified in the ASPECT and MCAP reports requiring further evaluation. Twelve Targets are not addressed in this report for the following reasons: four are contained in part or entirely within an AUM boundary (T2, T16, T28, and T29); five are AUM-related (T9, T17, T23, T37, and T38); two are located within a drainage (T35 and T36); and one is inaccessible because of extreme terrain and health and safety concerns (T34). Therefore, of the 38 Targets identified, 26 are non-AUM Targets and are addressed in this report. Appendix H of the RSE Report addresses the AUM-related or AUM-encompassed Targets while Appendix J addresses the Targets located within drainages.

The objectives of the RSE investigation for non-AUM Targets were as follows:

- Identify contaminants of potential concern (COPC) that exceed established background levels at each non-AUM Target

- Evaluate potential mining-related sources of gamma radiation identified in USEPA's ASPECT surveys at non-AUM Targets
- Define the lateral and vertical extent of contamination at non-AUM Targets related to any identified technologically enhanced naturally occurring radioactive material (TENORM)

Tetra Tech conduct a phased sampling approach, which included a Baseline Study and Goback sampling to step out from elevated gamma and X-ray fluorescence (XRF) measurement locations and to address missed transects or survey units. Both phases were completed during the 2018 field season. The Baseline Study was performed in April through June 2018, and the Goback sampling was performed in July through September 2018. Data quality objectives for the non-AUM Targets are limited to the Baseline Study because mining activity and associated mine waste was not expected at non-AUM Targets and, therefore, a Site Characterization Study would not be required. The field sampling activities conducted at the 26 non-AUM Targets were performed in accordance with the Field Sampling Plan (FSP), included as Appendix F of the RSE Work Plan, and as part of the Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP), included as Appendix C of the RSE Work Plan (Tetra Tech 2018).

The field investigation included site mapping, XRF field surveys, gamma radiation surveys, XRF confirmation sampling, surface soil sampling, and subsurface soil sampling. In situ XRF measurements were conducted in accordance with USEPA SW-846 Method 6200. Laboratory analyses at all Targets included USEPA SW-846 Methods 6010, 6020, and 7471 for metals; and USEPA Method 901.1 for potassium-40, radium-226, and radium-228. At select Targets, additional analyses were conducted to evaluate isotopic thorium and uranium by ASTM D3972 Modified; lead-210 by Eichrom; leachable metals and radionuclides after synthetic precipitation leaching procedure (SPLP) by USEPA SW-846 Method 1312; leachable metals after toxicity characteristic leaching procedure (TCLP) extraction by USEPA SW-846 Method 1311; and acid-base accounting (ABA), total sulfides, and paste pH by modified Sobek.

A background study was performed for each Target and a regional geological background study was conducted within each geologic unit across the Tse Tah, Cove Valley, and Lukachukai Mountains Regions. The background study was performed to identify background threshold values (BTV) for gamma radiation and radionuclides and chemicals in soil. The lowest of the Target-specific and the regional geology BTVs was selected as the applied BTV for each analyte and used for the background comparison analysis presented in this report. Appendix A of the RSE Report presents the Target-specific and regional geological BTVs.

Tetra Tech developed a process for the identification of COPCs for the non-AUM Targets. The soil concentrations of metals at each non-AUM Target were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples, as well as through laboratory metal and radiological analysis of surface and subsurface soil samples. An applied BTV was used to represent background conditions at each non-AUM Target. A criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background. As an additional refinement, those metals exceeding twice the BTV were also evaluated to identify the primary COPCs. Table I-ES-1 summarizes COPC findings by Target.

Table I-ES-1. COPC Screening Summary at Non-AUM Targets Addressed in Report

Target ID	Target Name	Gamma Activity above BTV in >5% of Population	Number of Grid Averaged Gamma Survey Units > BTV?	Number of All Analytes > BTV	XRF Primary Analytes above BTV in >5% of Population	XRF Primary Analytes above 2X BTV in >5% of Population
T1	BR-01	Yes	121 units	27, including Ra-226	As, Fe, Pb, Mn, Mo, Th, U, Zn	As, Fe, Pb, Mn, Mo, Th, U, Zn
T3	BR-03	No	None	3	Mo, Th, V	V
T4	BR-04	Yes	59 units	26, including Ra-226	As, Fe, Pb, Mn, Mo, Th, U, V, Zn	As, Pb, Th, U, V
T5	BR-05	Yes	10 units	22, including Ra-226	As, Pb, Th, U, V	As, U
T6	BR-06	Yes	None	7	Fe, Pb, Mn, Th, U	U
T7	BK-01	No	None	2	Mo, Th	None
T8	BK-02	No	None	5	Fe, Pb, Mo, Th, U	U
T10	CT-01	Yes	30 units	5, including Ra-226	As, Mo, U, V	As
T11	CT-02	Yes	None	3	As, Mn, U	As, U
T12	CT-03	Yes	None	12	As, Fe, Mn, Mo, U, V	U
T13	M1-01	Yes	30 units	15	As, Fe, Pb, Mn, Mo, Th, U, V, Zn	As, Pb, Th, U, V
T14	M1-02	Yes	3 units	7	Pb, Mn, Mo, U, Zn	U
T15	M1-03	No	None	9	As, Fe, Pb, Mn, Mo, U, V, Zn	As, Pb, U
T18	M5-01	No	1 unit	7	As, Fe, Mn, Th, U	None
T19	M5-02	Yes	23 units	13, including Ra-226	As, Fe, Pb, Mn, Mo, Th, U, V	As, U, V
T20	M5-03	Yes	1 unit	9	As, Pb, Mo, U, V, Zn	U, V
T21	M5-05	Yes	55 units	10, including Ra-226	As, Pb, Mo, U, V, Zn	As, U, V

Table I-ES-1. COPC Screening Summary at Non-AUM Targets Addressed in Report (Continued)

Target ID	Target Name	Gamma Activity above BTV in >5% of Population	Number of Grid Averaged Gamma Survey Units > BTV?	Number of All Analytes > BTV	XRF Primary Analytes above BTV in >5% of Population	XRF Primary Analytes above 2X BTV in >5% of Population
T22	M5-06	Yes	28 units	10	As, Fe, Pb, Mn, Mo, U, V, Zn	As, Pb, U, V
T24	M5-07	Yes	22 units	22, including Ra-226	As, Fe, Pb, Mn, Mo, Th, U, V, Zn	As, Th, U, V
T25	M5-08	No	1 unit	6	Fe, Mn, Mo, U, V	V
T26	M5-09	No	None	15, including Ra-226	As, Fe, Pb, Mn, Mo, U, V, Zn	As, Pb, U, V
T27	M4-02	No	None	8	Fe, Pb, Mn, Mo, U, V, Zn	U, V
T30	M1-07	Yes	None	7	As, Pb, Mo, U, V, Zn	U
T31	M1-08	Yes	6 units	7	As, Pb, Mn, Mo, U, V, Zn	U
T32	M2-01	No	None	7	As, Pb, Mn, Mo, U, V, Zn	U
T33	KE-01	Yes	None	20, including Ra-226	As, Fe, Mo, Th, U, V, Zn	As, U

Notes:
AUM Abandoned uranium mine
BTV Background threshold value
COPC Contaminant of potential concern
As Arsenic
Fe Iron
Mn Manganese
Mo Molybdenum
Pb Lead
Ra-226 Radium-226
Th Thorium
U Uranium
V Vanadium
Zn Zinc

Following the background comparison analysis, the non-AUM Targets were also evaluated to document the presence of NORM, TENORM, and other historic features that may account for elevated gamma activity and elevated metals and radionuclide concentrations at some of the Targets. Table I-ES-2 summarizes these observations and historical information by Target.

Table I-ES-2. NORM/TENORM Screening Summary at Non-AUM Targets Addressed in Report

Target ID	Target Name	NORM Observed?	TENORM Observed?	Historic Features Present?
T1	BR-01	NORM exposed in borrow pit	No piles observed, soil used for highway construction	None
T3	BR-03	No	No	None
T4	BR-04	NORM verified and mapped	No	None
T5	BR-05	Outcropping observed	No	None
T6	BR-06	No	No	None
T7	BK-01	No	No	None
T8	BK-02	No	No	None
T10	CT-01	No	No waste observed, but elevated gamma along fence line in comparison to plowed field.	None
T11	CT-02	No	No	None
T12	CT-03	No	No	None
T13	M1-01	Outcropping observed	No	None
T14	M1-02	NORM outcropping verified and mapped	No	Two historic exploratory borings identified in file review
T15	M1-03	No	No	Eight historic exploratory borings identified in file review, pipe mapped, and Mesa I, Mine 13 underground workings beneath Target
T18	M5-01	Outcropping observed	No	None
T19	M5-02	Outcropping observed	No	Recent roadcut potentially exposed NORM geology
T20	M5-03	Outcropping observed	No	Recent roadcut potentially exposed NORM geology
T21	M5-05	No	Potential reclaimed soils from adjacent AUM and burial cell	17 historic exploratory borings identified in file review

Table I-ES-2. NORM/TENORM Screening Summary at Non-AUM Targets Addressed in Report (Continued)

Target ID	Target Name	NORM Observed?	TENORM Observed?	Historic Features Present?
T22	M5-06	No	Potential reclaimed soils from adjacent AUM and burial cell	19 historic exploratory borings identified in file review, Frank Jr Mine underground workings beneath Target, vertical opening mapped, 2 locations with corings observed
T24	M5-07	Outcropping observed	Potential reclaimed soils from adjacent AUM	Five historic exploratory borings identified in file review; historic haul roads up and down slope
T25	M5-08	Outcropping observed	No	Four historic exploratory borings identified in file review
T26	M5-09	Outcropping observed	No	Two historic exploratory borings identified in file review; two pipes mapped
T27	M4-02	No	No	None
T30	M1-07	Outcropping observed	No	None
T31	M1-08	Outcropping observed	No	None
T32	M2-01	No	No	None
T33	KE-01	Outcropping observed	Yes, 5- by 5-foot waste pile observed; additional inaccessible waste on bench below	None

Notes:
AUM Abandoned uranium mine
NORM Naturally occurring radioactive material
TENORM Technically enhanced naturally occurring radioactive material

Based on the information presented in the preceding tables, additional data may be required to support risk management decisions for each Target. The following data gaps were identified for the Targets:

- Additional step out gamma surveying at Targets T1, T4, T5, T10, T13, T14, T19, and T24
- Field verification of NORM using gamma survey at observed outcropping at Targets T5, T13, T19, T20, T24, T25, T26, T27, T30, T31, and T33
- Field verification of the reclamation status of the potential historic exploratory borings at Targets T14, T15, T21, T22, T24, T25, and T26

- Field verification that vents or other openings are not present along the alignment of underground mine workings at Targets T15 and T22
- Collection of sediment samples in the drainage between Target T4 and Tse Tah West drainage if elevated metals and radionuclides are documented in the Tse Tah West drainage.
- Collection of subsurface samples at Target T10 from the bottom of the plow zone to evaluate potential mixing and any residual uranium and radionuclides at depth.
- Collection of subsurface samples at Targets T21 and T22 to determine if gamma activity increases with depth or is related to reclamation grading at the adjacent burial cell and AUMs.
- Field inspection of the mapped vertical opening at Target T22 to determine the hazard status and gamma screening of observed borehole corings and debris from the mapped vertical opening.
- Collection of a sample from the waste pile at Target T33, location of the prospect or collapsed/hidden adit, and evaluation of the waste pile on the lower bench if safely accessible.

Risk screening and an NFA decision or removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

1.0 INTRODUCTION

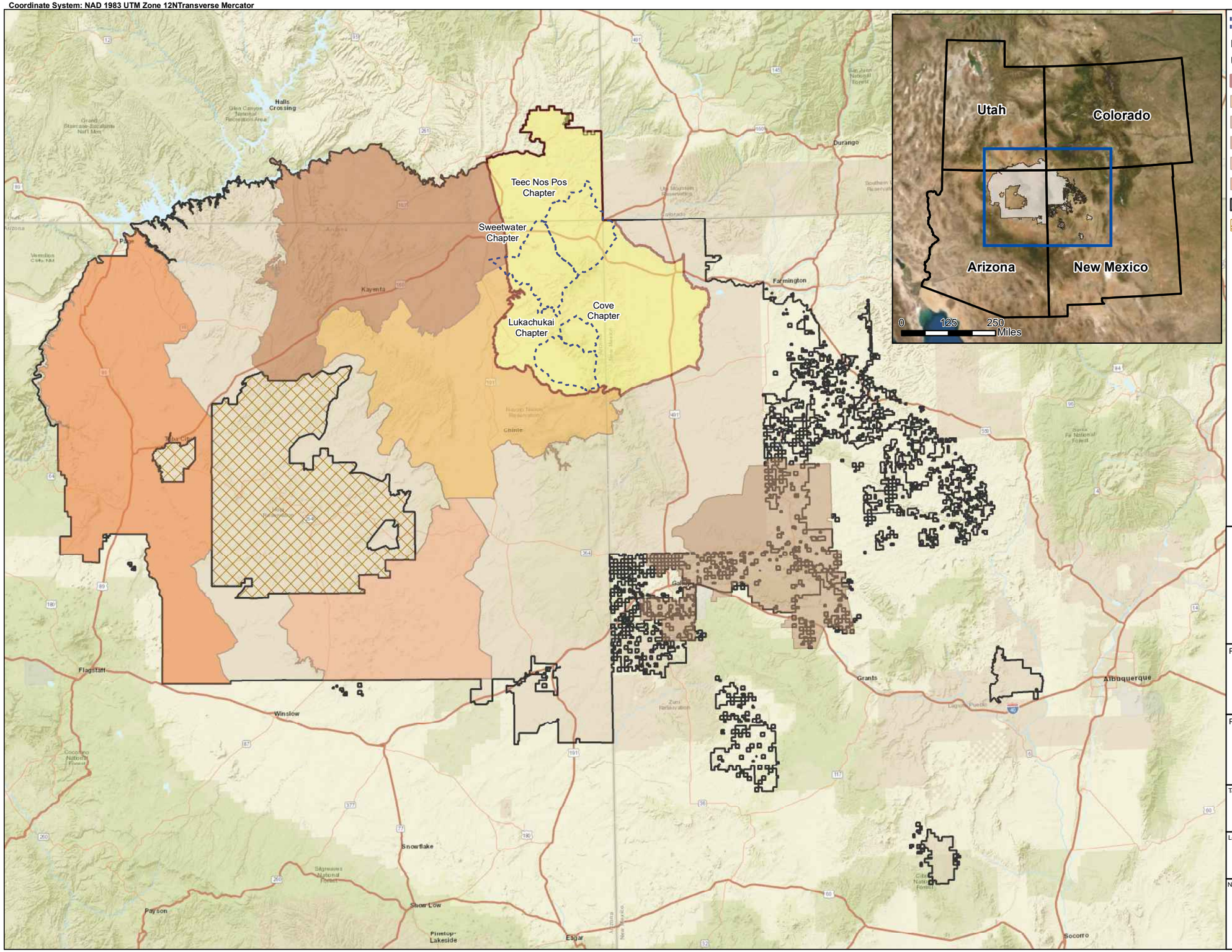
This Non-Abandoned Uranium Mine (AUM) Target Sites (Target) Data Evaluation Report is included as Appendix I of the Northern Agency Tronox Mines Removal Site Evaluation (RSE) Report (RSE Report). This report presents and documents the objectives, methodology, and results of the RSEs performed at 26 Targets not related to AUMs by Tetra Tech, Inc. (Tetra Tech) for 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 support risk screening and assist in determining the basis for no further action or additional investigation and a removal action for each non-AUM Target. Risk screening and determining the basis for further action will be documented in an engineering evaluation/cost analysis (EE/CA) for each of the Northern Agency Tronox Mines.

The Northern Agency Tronox Mines and non-AUM Targets discussed in this report are located in the Sweetwater, Teec Nos Pos, Cove, and Lukachukai Chapters of the Navajo Nation. Figure I-1 presents an overview map of the different AUM regions in the Navajo Nation and highlights the Northern AUM Region areas of interest in which the 26 non-AUM Targets are located. Under Task Order 0001, Tetra Tech conducted RSE field investigations at a number of AUMs and AUM-related Targets within the Navajo Nation that had previously been 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).

1.1 ABANDONED URANIUM MINE AND TARGETS

Because of the large number of AUM sites and Targets and limited accessibility in some areas, Tetra Tech organized the investigation areas into three primary regions and 10 subarea groups so to complete the field investigation in a cost-efficient manner and to simplify data management. The three regions were developed with geospatial and geopolitical considerations and are the (1) Tse Tah; (2) Cove Valley; and (3) Lukachukai Mountains. The 10 subareas are Subarea Group A through Subarea Group J. Table I-1 presents a summary of the regions and subareas, including the Navajo Chapters where each subarea is located. Subareas were selected based on a number of factors including accessibility, geology, existing AUM groupings, topography, and potential for grouping opportunities for future cleanup work.

Coordinate System: NAD 1983 UTM Zone 12NTransverse Mercator



Affected Chapter Boundary

Navajo Nation Abandoned 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	7/22/2019

Notes:

Figure No.: **I-1**

Table I-1. Summary of Regions and Subarea Groups

Region	Subarea Group	Navajo Chapter	AUM Sites		Targets	
			Site Boundary (acre)	Survey Area (acre)	Target Boundary (acre)	Survey Area (acre)
Tse Tah Region	Group A	Sweetwater Chapter	0.1	1.0	3.3	5.9
	Group B	Teec Nos Pos Chapter	1.4	2.1	2.2	3.6
Cove Valley Region	Group C	Cove Chapter	-	-	7.6	10.3
Lukachukai Mountains Region	Group D	Cove Chapter	24.4	40.0	14.8	22.3
	Group E	Cove Chapter	3.1	5.8	-	-
	Group F	Cove Chapter	15.7	25.6	6.4	10.5
	Group G	Cove Chapter	27.9	37.6	2.1	0.6
	Group H	Cove Chapter	17.0	28.0	1.0	1.9
	Group I	Lukachukai Chapter	0.2	3.0	1.9	2.9
	Group J	Lukachukai Chapter	4.3	12.8	-	-
Total			**94**	**156**	**39**	**58**

Notes:

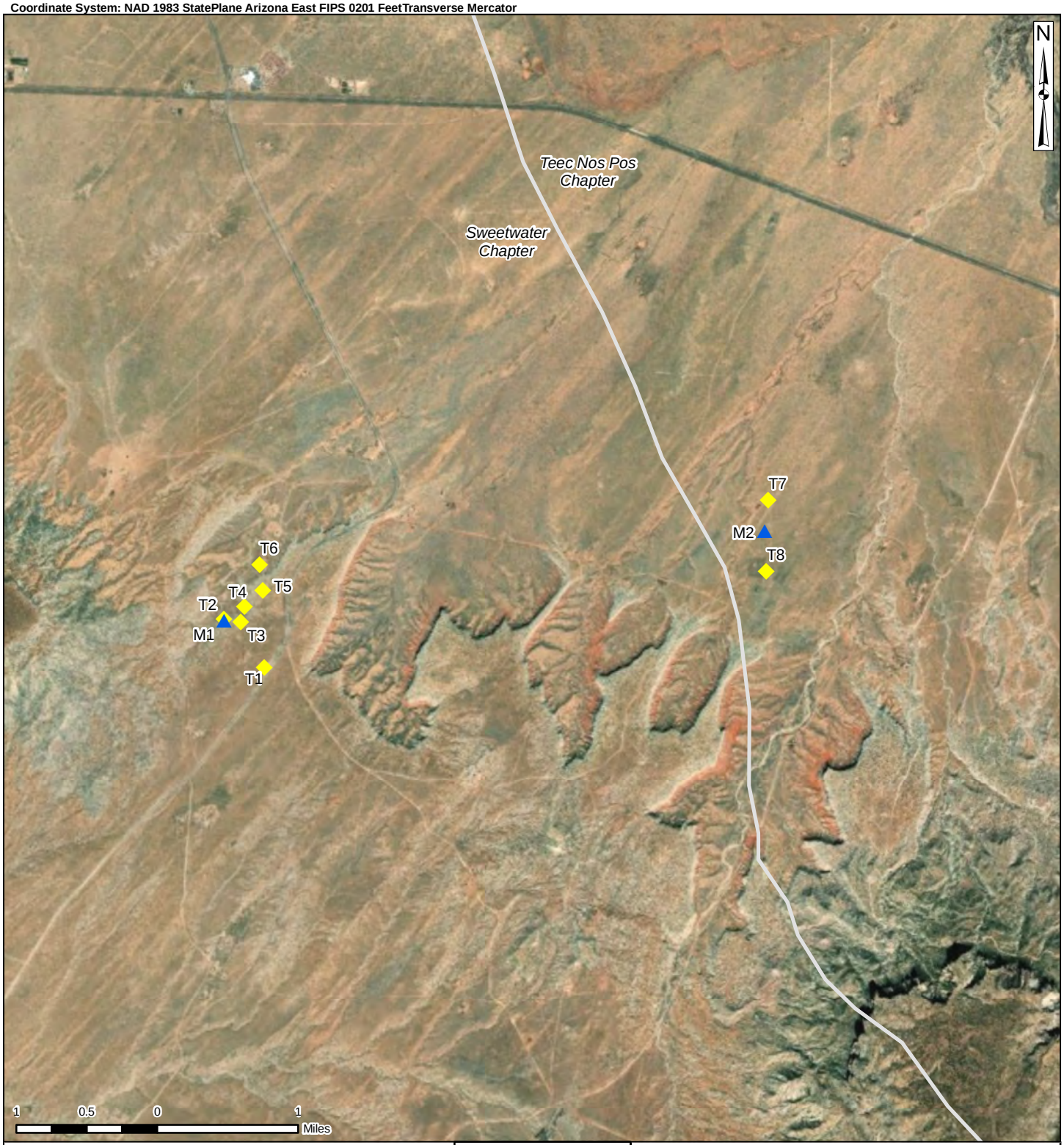
- No AUM or Target within the chapter
AUM Abandoned uranium mine

As shown in Table I-1, there are 94 acres of identified AUM site boundaries and 39 acres of Target boundaries across the three regions (133 acres total). Tetra Tech developed survey area boundaries that extend farther outside of the Target boundary provided in the USEPA geodatabase (Neptune and Company, Inc [Neptune] and TerraSpectra Geomatics [TSG] 2018). The survey area boundaries were developed on a site-by-site basis using multiple lines of evidence: aerial imagery, topography, location of known or inferred waste piles, previous gamma data, and migration pathways. These survey areas were used to focus the initial Baseline Study field surveys (X-ray fluorescence [XRF] and gamma). Subarea Group A and Subarea Group B are within the Tse Tah Region as shown in Figure I-2, Subarea Group C is within the Cove Valley Region as shown in Figure I-3 as shown in Figure I-3, and Subarea Group D through Subarea Group J are within with Lukachukai Mountains Region as shown in Figure I-3.

Table I-2 presents a summary of mines and Targets located with Subarea Group A through Subarea Group J. Four Targets are contained in part of or entirely within an AUM boundary (T2, T16, T28, and T29), five Targets are AUM-related (T9, T17, T23, T37, and T38), two Targets are located within a drainage (T35 and T36), and one Target is inaccessible because of extreme terrain and health and safety concerns (T34). Of these Targets, 26 non-AUM Targets are addressed in this report.

The following subsection presents the primary purpose and objectives of the RSE investigation at the 26 non-AUM Targets evaluated in this report.

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



Abandoned Uranium Mine Site
Non-AUM Target Site
Navajo Nation Chapter Boundary

Prepared for: U.S. EPA Region 9

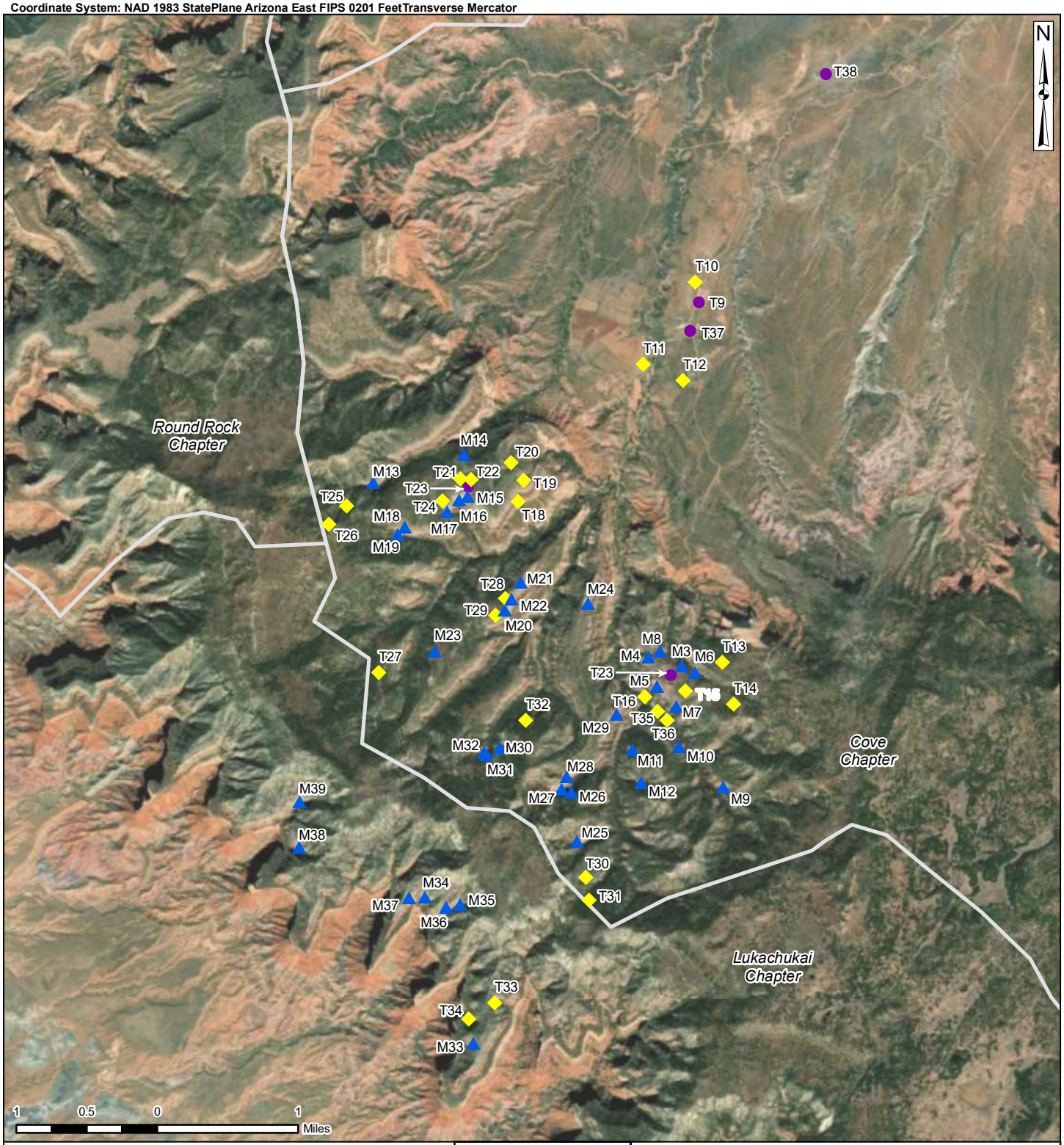
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TSE TAH REGION AUM AND TARGET MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-2
Location: NAVAJO NATION	Date: 7/9/2019	

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



- Abandoned Uranium Mine Site
- Non-AUM Target Site
- AUM Related Site
- Navajo Nation Chapter Boundary

Prepared for: U.S. EPA Region 9

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COVE VALLEY AND LUKACHUKAI MOUNTAINS REGIONS AUM AND TARGET MAP

Task Order No.:	Contract No.:	Figure No.:
TO 001	EP-S9-17-03	I-3
Location: NAVAJO NATION	Date: 7/22/2019	

Table I-2. Subgroup AUMs and Targets

Site ID	Subarea	Investigation Area Name	Site Type	Burial Cell	Site Boundary (Acres)
Sweetwater Chapter					
M1	Group A	Brodie 1	AUM Site	Burial Cell 41	0.1
T1		BR-01	Non-AUM Target	NA	1.2
T2		BR-02 (M1)	Non-AUM Target		0.6
T3		BR-03	Non-AUM Target		0.3
T4		BR-04	Non-AUM Target		0.5
T5		BR-05	Non-AUM Target		0.3
T6		BR-06	Non-AUM Target		0.5
Teec Nos Pos Chapter					
M2	Group B	Block K	AUM Site	NA	1.4
T7		BK-01	Non-AUM Target		1.4
T8		BK-02	Non-AUM Target		0.8
Cove Chapter					
T9	Group C	Cove Transfer Station	AUM-Related Boundary	NA	4.5
T10		CT-01	Non-AUM Target		1.9
T11		CT-02	Non-AUM Target		1.0
T12		CT-03	Non-AUM Target		0.2
T37		Cove Transfer Station South (T9)	AUM-Related Boundary		-
T38		Cove Transfer Station 2 (T9)	AUM-Related Boundary		-
M3	Group D	Mesa I Mine 10	AUM Site	NA	0.2
M4		Mesa I Mine 11	AUM Site	Burial Cell 9	4.8
M5		Mesa I Mine 12	AUM Site	NA	6.9
M6		Mesa I Mine 13	AUM Site		5.3
M7		Mesa I Mine 14	AUM Site		4.9
M8		Mesa I Mine 15	AUM Site	Burial Cells 6a, 6b, 7	2.5
T13		M1-01	Non-AUM Target	N/A	0.7
T14		M1-02	Non-AUM Target		0.6
T15		M1-03	Non-AUM Target		0.9
T16		M1-04 (M5)	Non-AUM Target	N/A	0.4
T35		M1-05	Non-AUM Target		?
T36		M1-06	Non-AUM Target		?
T17		Mesa I Camp	AUM-Related Boundary	Burial Cell 310AB	12

Table I-2. Subgroup AUMs and Targets (Continued)

Site ID	Subarea	Investigation Area Name	Site Type	Burial Cell	Site Boundary (Acres)
Cove Chapter (Continued)					
M9	Group E	Mesa I 1/4 Mine	AUM Site	NA	0.8
M10		Mesa I 1/2 Mine	AUM Site		1.2
M11		Henry Phillips Mine	AUM Site		0.7
M12		Mesa I 1/2, West Mine	AUM Site		0.4
M13	Group F	Mesa VI Mine	AUM Site	NA	5.2
M14		Frank Jr. Mine	AUM Site		1.5
M15		Mesa V Incline	AUM Site		0.9
M16		Mesa V Adit	AUM Site	Burial Cells 91, 92 & 93	3.6
M17		Mesa V Mine - 103	AUM Site	NA	1.0
M18		Mesa V Mine - 508	AUM Site	Burial Cell 87a	2.8
M19		Mesa IV 1/2 Mine and Simpson 181	AUM Site	Burial Cell 86b	0.8
T18		M5-01	Non-AUM Target	NA	0.3
T19		M5-02	Non-AUM Target		0.3
T20		M5-03	Non-AUM Target		0.2
T21		M5-05	Non-AUM Target		1.0
T22		M5-06	Non-AUM Target		1.7
T23		NA-0344B	Lone Burial Cell	Burial Cell 344B	1.0
T24		M5-07	Non-AUM Target	NA	0.9
T25		M5-08	Non-AUM Target		0.4
T26		M5-09	Non-AUM Target		0.5
M20	Group G	Mesa IV, Mine No. 1	AUM Site	Burial Cell 56	7.6
M21		Mesa IV, Mine No. 2	AUM Site	Burial Cell 63	14
M22		Mesa IV, Mine No. 3	AUM Site	NA	1.6
M23		Mesa IV, West Mine	AUM Site	Burial Cell 70b	2.6
M24		Mesa II Pit	AUM Site	Burial Cell 44	2.1
T27		M4-02	Non-AUM Target	NA	0.3
T28		M4-03 (M22)	Non-AUM Target		0.7
T29		M4-04 (M20)	Non-AUM Target		1.0

Table I-2. Subgroup AUMs and Targets (Continued)

Site ID	Subarea	Investigation Area Name	Site Type	Burial Cell	Site Boundary (Acres)
Cove Chapter (Continued)					
M25	Group H	Mesa I 3/4 Incline	AUM Site	Burial Cell 31a	1.2
M26		Mesa I 3/4, Mine No. 2, P150	AUM Site	NA	1.2
M27		Mesa II, Mine No. 1 & 2, P-21	AUM Site	Burial Cell 39	5.9
M28		Mesa II, Mine No. 1, P-150	AUM Site	NA	2.9
M29		Mesa II, Mine 4	AUM Site	Burial Cell 43	0.9
M30		Mesa II 1/2 Mine	AUM Site	Burial Cell 48	3.6
M31		Mesa II 1/2, Mine 4	AUM Site	NA	0.2
M32		Mesa III Mine	AUM Site		1.1
T30		M1-07	Non-AUM Target		0.4
T31		M1-08	Non-AUM Target		0.4
T32		M2-01	Non-AUM Target		0.2
Lukachukai Chapter					
M33	Group I	Knife Edge Mesa Mine	AUM Site	NA	0.2
T33		KE-01	Non-AUM Target		0.9
T34		KE-02	Non-AUM Target		1.0
M34	Group J	Black No. 1 Mine	AUM Site	NA	0.5
M35		Black No. 2 Mine	AUM Site		1.0
M36		Black No. 2 Mine (West)	AUM Site		0.2
M37		Flag No. 1 Mine	AUM Site		1.5
M38		Step Mesa Mine	AUM Site		0.6
M39		Tommy James Mine	AUM Site		0.4

Notes:

Orange shading indicates that a Target is addressed in the indicated AUM site-specific RSE report in Appendix H.

Green shading indicates that a Target is AUM-related and is addressed in the indicated AUM site-specific RSE report in Appendix H.

Purple shading indicates that a Target is addressed in the Drainage Investigation Report in Appendix J.

Red shading indicates that an AUM or Target was not accessible during the RSE investigation.

- Acreage not defined
AUM Abandoned uranium mine
NA Not applicable
RSE Removal site evaluation

1.2 PURPOSE

In 2018, Tetra Tech conducted a data gap analysis as part of a historical site assessment for all of the Northern Agency Tronox Mine AUMs and Targets. Based on the results, Tetra Tech concluded that there was not sufficient data for USEPA to make risk management or cleanup decisions for AUMs and Targets. Therefore, Tetra Tech (2018) developed several data quality objectives (DQO) as part of the RSE Work Plan, and the survey design and planning processes were integrated into the RSE investigations performed at 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 is presented in Appendix C of the RSE Work Plan (Tetra Tech 2018). The objectives of the RSE investigation for non-AUM Targets were as follows:

- Identify the contaminants of potential concern (COPC) that exceed established background levels
- Evaluate potential mining-related sources of gamma radiation identified in USEPA's Airborne Spectral and Photometric Environmental Collection Technology (ASPECT) surveys
- Define the lateral and vertical extent of contamination related to any identified technologically enhanced naturally occurring radioactive material (TENORM)

The field sampling activities conducted at the 26 non-AUM Targets were performed in accordance with the Field Sampling Plan (FSP) included as Appendix F of the RSE Work Plan and as part of the Sampling Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) included as Appendix C of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech used a phased sampling approach, which included a Baseline Study and Goback sampling to step out from elevated gamma and XRF measurement locations and to address missed transects or survey units. Both phases were completed during the 2018 field season. The Baseline Study was performed in April through June 2018, and the Goback sampling was performed in July through September 2018. The RSE investigations for non-AUM Targets presented in this report were conducted to collect sufficient information to assist USEPA in determining the basis for no further action or additional investigation and a removal action at each non-AUM Target. This report only addresses non-AUM Targets and does not address nearby AUMs and AUM-related Targets, which are addressed in Appendix H of the RSE Report. Non-AUM Targets located in drainages are discussed in Appendix J of the RSE Report. The RSE Work Plan (Tetra Tech 2018) identified a need for a assessing non-AUM Targets to satisfy Baseline Study DQOs via gamma radiation surveys, XRF field surveys, and surface soil sampling and to establish the lateral extent of radionuclides and chemical constituents at the Northern Agency non-AUM Targets.

The RSE Work Plan discusses the DQOs in detail; however, the following subsection presents a subset of the DQOs relevant to non-AUM Targets, explains how each of the DQOs were addressed as part of this RSE investigation, and provides a roadmap for where the results of each DQO are found.

1.3 DATA QUALITY OBJECTIVES

A primary objective of the non-AUM Targets RSE investigation is to address the DQOs established for the Baseline Study. DQOs for the non-AUM Targets are limited to the Baseline Study because mining activity and associated mine waste was not expected at non-AUM Targets and limited information is known about activities at the non-AUM Targets. Therefore, in consultation with the USEPA RPM, it was decided that a Site Characterization Study would not be required at this time. The DQOs for the Baseline Study at non-AUM Targets have been modified slightly to focus on the non-mining aspects of the RSE. A roadmap for how the Baseline Study DQOs are addressed is presented in Table I-3. Baseline Study Question No. 4 regarding groundwater impacts was not addressed based on technical direction from USEPA; this is discussed in the main RSE Report in more detail.

Table I-3. Baseline Study Data Quality Objective Roadmap

Phase of the RSE	Question No.	Principal Study Question	Activity Performed to Address DQO	Report Section[1]
Baseline Study	1	What are the background levels of gamma radiation and what are the background concentrations of radionuclides and metals in soils and sediment that are representative of conditions at each non-AUM Target?	Background sampling	Sections 3.3, 3.4, and X.X.3
	2	What is the lateral extent of non-mine and any mine-related surficial contamination at each non-AUM Target?	Site Mapping	Sections X.X.1
			Gamma Radiation Survey	Sections X.X.5
			XRF Field Survey	Sections X.X.6 and X.X.7
			Surface Soil Samples	Sections X.X.6 and X.X.7
	3	Is there potential for contaminants to migrate offsite via surface water pathways at each non-AUM Target?	Drainage Survey	Sections X.X.1 and X.X.8
	4	Is there potential for contaminants to migrate offsite via the groundwater pathway?	NA	Main RSE Report
	5	What is the spatial extent, locations, and types of NORM and any TENORM at the non-AUM Target?	Site Mapping	Sections X.X.1 and X.X.5
	6	Have the Tronox NAUM risk prioritization factors been evaluated adequately (such as accessibility, reclamation status, land use, and waste material characteristics)?[1]	Site Mapping	Sections X.X.1 and X.X.6

Notes:

[1] "X" in the section callout refers to each non-AUM Target section presented in this report.

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

DQO Data quality objective
NAUM Navajo Area Uranium Mine
NA Not applicable because no activity was performed
NORM Naturally occurring radioactive material
RSE Removal site evaluation
TENORM Technologically enhanced naturally occurring radioactive material
XRF X-ray fluorescence

1.4 REPORT ORGANIZATION

This report presents the objectives, methodology, and results of the RSE activities performed at the 26 non-AUM Targets within the Tse Tah, Cove Valley, and Lukachukai Mountains Regions of the Northern Agency. Targets encompassed within an AUM are addressed in the associated AUM site-specific RSE report in Appendix H of the RSE Report while Targets contained within drainages are addressed in Appendix J of the RSE Report. This report is organized as follows:

- Section 1.0 provides the introduction, including identification of AUMs and Targets, the purpose and objectives of the RSE investigation pertaining to non-AUM Targets, and the DQOs evaluated during the RSE investigation of the non-AUM Targets.
- Section 2.0 summarizes field mapping, gamma radiation survey, gamma correlation, XRF field surveys, and soil sampling and analytical methodology. Data interpretation methods are also described, including quality assurance/quality control (QA/QC), culturally and biologically sensitive areas, accessibility issues, site classification, and identification of COPCs.
- Section 3.0 identifies the locations of non-AUM Targets addressed in this report, summarizes previous investigations at these non-AUM Targets, identifies non-AUM Target-specific geology and soils, and identifies established background study areas (BSA) for non-AUM Targets based on Target and regional geology and soils. Background threshold values (BTV) were developed in Appendix A of the RSE report for each BSA and are identified in Section 4.0 through Section 11.0 for each non-AUM Target.
- Section 4.0 presents the Target setting; field activities conducted; field sampling results, including gamma radiation survey, XRF field survey, soil sampling, and geochemical results; BTVs; background comparison analysis for all analytes; mapping of the geospatial extent of primary analytes; and conclusions for Group A non-AUM Targets T1 (BR-01), T3 (BR-03), T4 (BR-04), T5 (BR-05), and T6 (BR-06).
- Section 5.0 presents the Target setting; field activities conducted; field sampling results, including gamma radiation survey, XRF field survey, soil sampling, and geochemical results; BTVs; background comparison analysis for all analytes; mapping of the geospatial extent of primary analytes; and conclusions for Group B non-AUM Targets T7 (BK-01) and T8 (BK-02).
- Section 6.0 presents the Target setting; field activities conducted; field sampling results, including gamma radiation survey, XRF field survey, soil sampling, and geochemical results; BTVs; background comparison analysis for all analytes; mapping of the geospatial extent of primary analytes; and conclusions for Group C non-AUM Targets T10 (CT-01), T11 (CT-02), and T12 (CT-03).
- Section 7.0 presents the Target setting; field activities conducted; field sampling results, including gamma radiation survey, XRF field survey, soil sampling, and geochemical results; BTVs; background comparison analysis for all analytes; mapping of the geospatial extent of primary analytes; and conclusions for Group D non-AUM Targets T13 (M1-01), T14 (M1-02), and T15 (M1-03).

- Section 8.0 presents the Target setting; field activities conducted; field sampling results, including gamma radiation survey, XRF field survey, soil sampling, and geochemical results; BTVs; background comparison analysis for all analytes; mapping of the geospatial extent of primary analytes; and conclusions for Group F non-AUM Targets T18 (M5-01), T19 (M5-02), T20 (M5-03), T21 (M5-05), T22 (M5-06), T24 (M5-07), T25 (M5-08), and T26 (M5-09).
- Section 9.0 presents the Target setting; field activities conducted; field sampling results, including gamma radiation survey, XRF field survey, soil sampling, and geochemical results; BTVs; background comparison analysis for all analytes; mapping of the geospatial extent of primary analytes; and conclusions for Group G non-AUM Target T27 (M4-02).
- Section 10.0 presents the Target setting; field activities conducted; field sampling results, including gamma radiation survey, XRF field survey, soil sampling, and geochemical results; BTVs; background comparison analysis for all analytes; mapping of the geospatial extent of primary analytes; and conclusions for Group H non-AUM Targets T30 (M1-07), T31 (M1-08), and T32 (M2-01).
- Section 11.0 presents the Target setting; field activities conducted; field sampling results, including gamma radiation survey, XRF field survey, soil sampling, and geochemical results; BTVs; background comparison analysis for all analytes; mapping of the geospatial extent of primary analytes; and conclusions for Group I non-AUM Target T33 (KE-01).
- Section 12.0 presents the references for the works cited in this report.

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

- Attachment I1 presents the photographic log of the RSE field investigation activities at the non-AUM Targets.
- Attachment I2 presents the field documentation completed in support of the RSE investigation at the non-AUM Targets.
- Attachment I3 presents validated XRF results tables for the non-AUM Targets.

Appendix I is intended to be used in conjunction with other appendices in the RSE Report that provide results and interpretation. These appendices are:

- Appendix A Radiological and Chemical Background Investigation Report
- Appendix B XRF Correlation Report
- Appendix C Gamma Correlation Report
- Appendix D Uranium Equilibrium Report
- Appendix F Geochemical Evaluation Report
- Appendix G Data Quality Assurance/Quality Control and Validation Report

- Appendix H Site-Specific Removal Site Evaluation Report
- Appendix J Drainage Investigation Report
- Appendix K Access Road Investigation Report
- Appendix L Laboratory Reports
- Appendix M Data Validation Reports

2.0 METHODS

This section presents the field mapping, field measurements, and sampling and analytical methods for the RSE investigation at the 26 non-AUM Targets. Data interpretation methods are also described, including QA/QC, culturally and biologically sensitive areas, accessibility issues, site classification, and identification of COPCs.

2.1 NON-AUM TARGET MAPPING

Mapping was performed at each non-AUM Target in a similar fashion to that which was performed at the AUM sites during the field investigation. Mapping was completed to gain a better understanding of the conditions at each non-AUM Target in accordance with the methodology identified in the FSP for individual non-AUM Targets in Appendix F of the RSE Work Plan (Tetra Tech 2018). The objectives for conducting mapping at the Northern Agency Tronox Mines included the following:

- Identifying any immediate physical hazards at the non-AUM Target
- Locating access routes, including foot pathways and roads
- Differentiating naturally occurring radioactive material (NORM) from TENORM through geological assessment and visual observation
- Mapping all drainages and potential surface water pathways at the non-AUM Target
- Identifying any exploration borings or historic haul roads
- Confirming any known non-AUM Target features and identifying any unknown mine-related features relevant to the RSE investigation process
- Verifying soil types and geological formations at each non-AUM Target
- Conducting physical measurements and visual estimates of any identified mine waste at a non-AUM Target

Mapping consisted of recording the geospatial location of key non-AUM Target features 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 obstacles, hazards, and features discovered during field work. All mapping activities were documented by the field crew using GPS units or tablets and entered into the project geodatabase on a daily occurrence following field work.

2.2 GAMMA RADIATION SURVEY

Tetra Tech performed GPS-based gamma radiation surveys of 26 non-AUM Targets as part of the Baseline Study from April through July 2018. Additional Goback gamma radiation surveys were also conducted at 16 non-AUM Targets in August and September 2018. The purpose of performing GPS-based gamma surveys was to (1) define the areal extent of NORM and any TENORM for a given non-AUM Target; (2) establish a basis from which subsurface soils can be further investigated if required; and (3) establish a basis that can be used to predict Radium-226 (Ra-226) concentrations.

Gamma radiation surveys were performed at each non-AUM Target following the methods outlined in Appendix C to the RSE Work Plan (Tetra Tech 2018). Field staff used mobile scanning systems with Ludlum Model 44-10s (2- by 2-inch) sodium iodide (NaI) gamma scintillation detector coupled to a Ludlum Model 2221 ratemeter/scaler set in ratemeter mode. The detectors were coupled to an Environmental Restoration Group, Inc. (ERG) Model 105 GPS. The ERG Model 105 GPS consists of a Juniper Mesa 2 field computer and geode GPS receiver. The gamma radiation surveys were performed using a maximum spacing of 2-meter transect width within each non-AUM Target survey area. Detector height was 1 meter above ground surface as prescribed in the RSE Work Plan (Tetra Tech 2018). The "field of view" of the NaI detector in this configuration (2-meter transects and 1-meter height) provides 100 percent coverage of land areas. Gamma count rate measurements and associated geospatial coordinates were made and recorded every 1 second. Table I-4 provides a summary of which detection systems were used and when they were used during the gamma radiation surveys at each non-AUM Target.

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 Procedures (SOP) 002: Calibration of a Radiological Survey Meter and 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 calibrated. 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 I-5 provides a summary of the detection equipment and calibration information.

Table I-4. Detection Systems Used in the Non-AUM Target Gamma Radiation Surveys

Survey Area	Ludlum Model 44-10	Ludlum Model 2221 Ratemeter/Scaler[1]	Date Used
BR-01 (T1)	PR321856	271429	8/19/2018
	PR355769	282966	5/13/2018
	PR355810	271438	5/13/2018
BR-03 (T3)	PR320678	176947	8/19/2018
	PR355810	271438	8/19/2018
	PR355769	282966	5/13/2018
BR-04 (T4)	PR320678	176947	8/19/2018
	PR321856	271429	8/19/2018
	PR355810	271438	8/19/2018
	PR355769	282966	5/13/2018
	PR355810	271438	5/13/2018
BR-05 (T5)	PR320678	176947	8/19/2018
	PR321856	271429	5/12/2018
	PR355781	271424	9/30/2018
	PR355810	271438	5/12/2018
BR-06 (T6)	PR355763	271435	8/19/2018
	PR321856	271429	5/12/2018
	PR355810	271438	5/12/2018
BK-01 (T7)	PR355763	271435	4/24/2018 5/14/2018
	PR355769	282966	4/24/2018 5/14/2018
	PR303716	149940	4/24/2018
BK-02 (T8)	PR321856	271429	8/19/2018
	PR355810	271438	8/19/2018
	PR355769	282966	4/24/2018 5/14/2018
CT-01 (T10)	PR320678	176947	5/14/2018 8/18/2018
	PR321856	271429	4/25/2018 5/14/2018
	PR355769	282966	4/25/2018
	PR303716	149940	8/18/2018
CT-02 (T11)	PR303716	149940	4/25/2018
CT-03 (T12)	PR321856	271429	5/14/2018
M1-01 (T13)	PR320678	176947	8/16/2018
	PR321856	271429	8/16/2018
	PR355810	271438	5/8/2018
	PR303716	149940	5/8/2018 5/9/2018

Table I-4. Detection Systems Used in the Non-AUM Target Gamma Radiation Surveys (Continued)

Survey Area	Ludlum Model 44-10	Ludlum Model 2221 Ratemeter/Scaler[1]	Date Used
M1-02 (T14)	PR355810	271438	5/8/2018
	PR303716	149940	5/8/2018
M1-03 (T15)	PR355763	271435	5/8/2018
	PR320678	176947	8/15/2018
	PR321856	271429	5/8/2018 8/16/2018
	PR355781	271424	8/15/2018
M5-01 (T18)	PR355763	271435	5/22/2018 5/24/2018
	PR320678	176947	5/26/2018
	PR355781	271424	5/22/2018 5/24/2018
	PR303716	149940	5/24/2018 5/26/2018
M5-02 (T19)	PR355763	271435	5/25/2018 9/11/2018
	PR320678	176947	5/26/2018
	PR355781	271424	5/25/2018 9/11/2018
	PR355810	271438	5/22/2018
	PR303716	149940	5/26/2018
M5-03 (T20)	PR355763	271435	5/25/2018 9/11/2018
	PR321856	271429	5/22/2018
	PR355781	271424	5/25/2018 9/11/2018
	PR355763	271435	5/25/2018 9/11/2018
M5-05 (T21)	PR355763	271435	5/21/2018
	PR321856	271429	5/22/2018 8/21/2018
	PR355781	271424	5/21/2018
	PR355810	271438	5/22/2018
M5-06 (T22)	PR355763	271435	8/21/2018 9/11/2018
	PR320678	176947	6/24/2018 8/20/2018
	PR321856	271429	8/20/2018
	PR355781	271424	6/24/2018
	PR355810	271438	5/21/2018
	PR303716	149940	5/21/2018

Table I-4. Detection Systems Used in the Non-AUM Target Gamma Radiation Surveys (Continued)

Survey Area	Ludlum Model 44-10	Ludlum Model 2221 Ratemeter/Scaler[1]	Date Used
M5-07 (T24)	PR355763	271435	9/11/2018
	PR320678	176947	5/24/2018 8/20/2018
	PR321856	271429	8/20/2018
	PR355781	271424	9/11/2018
	PR355810	271438	5/24/2018
M5-08 (T25)	PR320678	176947	5/25/2018
	PR355810	271438	5/25/2018
	PR303716	149940	5/25/2018
M5-09 (T26)	PR355763	271435	9/11/2018
	PR320678	176947	7/15/2018
	PR355781	271424	6/9/2018 9/11/2018
	PR355810	271438	7/15/2018
	PR355810	271438	6/9/2018 6/10/2018
M4-02 (T27)	PR355763	271435	6/10/2018
	PR320678	176947	6/10/2018
M1-07 (T30)	PR355810	271438	7/17/2018
M1-08 (T31)	PR320678	176947	7/17/2018
	PR295015	282973	9/25/2018
M2-01 (T32)	PR320678	176947	8/20/2018
	PR321856	271429	6/19/2018 8/13/2018 8/20/2018
	PR355810	271438	6/19/2018
KE-01 (T33)	PR355763	271435	7/12/2018
	PR303716	149940	7/12/2018

Notes:

[1] Serial numbers for radiation instrument used.

AUM Abandoned uranium mine

Table I-5. 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 105G and were 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 project computer. Only one computer was used for all 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 file name.

The following steps taken to validate and verify the gamma survey data were conducted in accordance with SOP 006: Validation and Verification of Gamma Survey Data (in 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 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 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 that were taken to analyze the gamma survey data were as follows:

- A total of 100 square meter (m^2) survey units were applied to the Target-wide (and areas extending outward) measurements. The survey unit averages were analyzed statistically using ArcGIS software. These results were then compared to the results obtained in the background studies (Appendix A of the RSE Report).
- The gamma survey measurements were retained as count per minute (cpm) and converted to predicted exposure rates based on the regression analysis presented in Section 2.3. The data were interpreted only in terms of cpm. However, exposure rate maps are provided in the main project-wide RSE Report.
- 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 in intervals established as multiples of the applicable BTVs. At this stage, the measurements were assessed visually for comparisons to the results obtained in the background studies and spatial trends and to discern areas of NORM and TENORM.

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 QA/QC Summary Report as Appendix G of the RSE Report. That report presents the daily calibration checks for the gamma radiation surveys at each non-AUM Target.

2.3 GAMMA CORRELATION

The following subsections describe the activities of two types of correlation studies performed at AUMs and Targets as a part of the larger RSE investigation of the Northern Agency Tronox Mines. Section 2.3.1 discusses gamma-radium correlation and the relationship between Ra-226 concentrations in surface soils and gamma count rates. Section 2.3.2 presents the NaI/high pressure ionization chamber (HPIC) correlation and the relationship between exposure rates and gamma count rates.

2.3.1 Gamma-Radium Correlation

Tetra Tech performed GPS-based gamma radiation surveys and collected nine-point composite samples of surface soils in correlation plots within verifying geologies during the Baseline Study. The sample plot locations were distributed across many different AUMs, Targets, and background areas to obtain a representative distribution of the response between observed Ra-226 and gamma measurements. These areas were selected using criteria established in the RSE Work Plan and are discussed in more detail in Appendix C of the RSE Report.

The 2- by 2-inch NaI detectors used in this investigation are sensitive to surface Ra-226 decay products and other gamma emitting radionuclides. The purpose of the gamma correlation was to estimate Ra-226 concentrations in the upper 6 inches of soil. Tetra Tech and ERG field personnel selected correlation plots based on the range of gamma radiation levels observed. If surface soil concentrations of gamma emitting radionuclides were variable between correlation locations, the variability would be included in the regression model.

Because the variability of gamma emitting radionuclides was low for the vast majority of non-AUM Targets, correlation plots were not selected, and gamma-radium correlation was not conducted at most of the non-AUM Targets. However, Ra-226 was analyzed in all surface soil and XRF confirmation samples and has been plotted with grid averaged gamma survey results as shown in the field sampling findings for each non-AUM Target.

2.3.2 Gamma-Exposure Rate Correlation

The purpose of the gamma-exposure rate correlation study and predicted energy-independent exposure rates is to translate the relatively high-density gamma measurements to more meaningful energy-independent measures of direct human exposure. This translation allows for the evaluation of human exposure across the entire area surveyed. The NaI/HPIC responds to ionizing radiation by collecting charges created by direct ionization within the detector gas through the application of an electric field. It measures interactions of gamma, X-rays, and cosmic radiation without discrimination.

The specific number and location of HPIC measurements were selected in the field by a certified health physicist, and the final analysis and results of the gamma exposure rate correlation are included in Appendix C of the RSE Report. HPIC measurements were strategically collected to span a large range of gamma survey results to allow for a robust correlation. Tetra Tech performed HPIC measurements at all types of sites, including AUM sites, Targets, roads, drainages, and BSAs.

HPIC measurements were collected in accordance with SOP 003: Marking Exposure Rate Measurements Using a HPIC in Appendix C of the RSE Work Plan (Tetra Tech 2018). A summary of instrument-specific calibration and functional checks is provided in Table I-6.

Table I-6. High Pressurized Ionization Chamber Equipment Usage Summary

Equipment	Use/Calibration Summary	Relevant SOP No.
GE-Energy Model RSS-131 HPIC or similar	**Use:** HPIC instrumentation was used to collect energy-independent measurements of gamma exposure rates. At each measurement location, gamma exposure rate measurements were collected at 5-second intervals for a duration of 10 minutes. **Calibration:** The HPIC used was calibrated within the last year. Calibration was also performed after any maintenance or repair that could affect functionality. **Functional Checks:** NA	SOP 003

Notes:
HPIC High pressure ionization chamber
NA Not applicable
SOP Standard operating procedure

The final correlation is shown in Figure I-4. The following equation can be used to convert a gamma level to an equivalent gamma exposure rate:

Equation 1: $$\gamma\left(\frac{\mu R}{hour}\right) = 8.476 + 0.000545 * (\gamma[cpm])$$

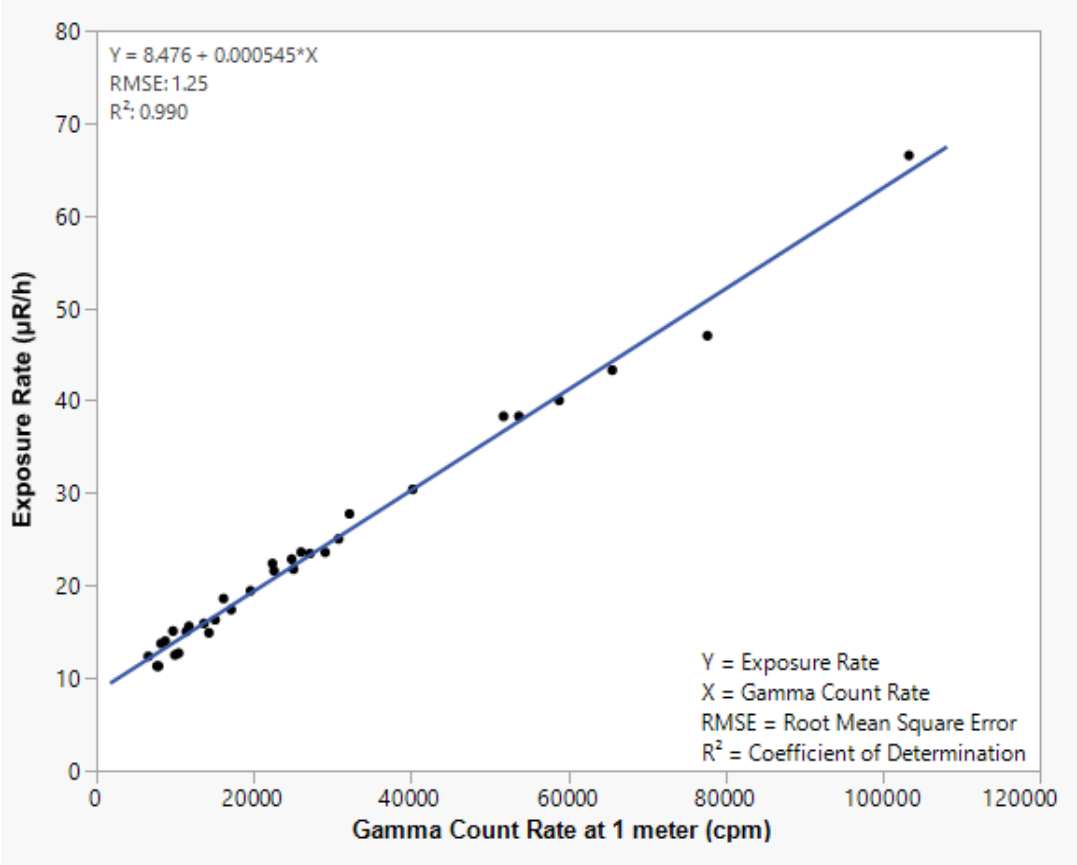


Figure I-4. Gamma Count Rate Versus Exposure Rate

2.4 XRF FIELD SURVEY

Tetra Tech performed an XRF field survey at each non-AUM Target that involved the collection of in situ XRF measurements within the centroid of each 100 m^2 survey unit. 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 Northern Agency Tronox Mines).

Tetra Tech collected surface soil confirmation samples for laboratory analysis at a depth of 0 to 3 inches below ground surface (bgs) at a minimum of 5 percent of XRF measurement locations and minimized the impact of measurement error introduced by factors, including soil moisture conditions, effects of particle size, and homogenization on comparability (USEPA 2007). See Appendix B of the RSE Report for further details on the procedures for the XRF field survey. Samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. The analytical results from these intrusive samples represented the definitive data set in the paired sampling approach. A correlation study was performed to analyze the mathematical relationship between the XRF data set and the analytical data set. The field protocol for this adjusted in situ approach is described below:

1. At each in situ XRF measurement location, the soil from 0 to 3 inches bgs in an approximatey 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 was then placed directly against the homogenized soil for measurement. A single in situ XRF measurement was collected 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 Fluorescence Analyzer Measurement in Appendix C of the RSE Work Plan (Tetra Tech 2018).
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 was placed into a resealable plastic bag. The samples were dried, sieved, and homogenized in the lab. When the sample was prepped, it was measured in the field office in Farmington, New Mexico, a minimum of six times with an XRF analyzer and then be submitted for laboratory analysis. This is referred to as the ex situ bulk sample. The ex situ bulk samples were used for a correlation study comparing the XRF data set with the analytical data set.

Appendix B of the RSE Report provides a detailed summary of the correlation study.
Nine analytes were found to correlate well between XRF and laboratory reported concentrations.

The in situ XRF measurements were converted into laboratory equivalent values by using the individual regression coefficients developed from the correlation analysis. The following analytes were found to have definitive-level relationships: arsenic, iron, lead, molybdenum, manganese, thorium, uranium, vanadium, and zinc. However, iron, molybdenum, manganese, and zinc were not typically associated with AUM mining at the Northern Agency Tronox Mines. All QA/QC results, including daily calibration checks and field replicate checks, are provided in the XRF Correlation Report in Appendix B of the RSE Report.

2.5 SOIL SAMPLING

This subsection presents the three different soil sampling techniques used at non-AUM Targets for collecting laboratory samples, which are (1) XRF confirmation soil sampling, (2) surface soil sampling, and (3) subsurface soil sampling.

2.5.1 XRF Confirmation Soil Sampling (0 to 3 Inches)

The first type of analytical soil sample collected at non-AUM Targets was the XRF confirmation soil sample collected from 0 to 3 inches bgs following the XRF field protocol described in Section 2.4. These samples were collected during the XRF field surveys. XRF confirmation samples collected at non-AUM Targets were submitted for laboratory analysis of metals by USEPA Method 6020B and Potassium-40 (K-40), Ra-226, and Radium-228 (Ra-228) by USEPA Method 901.1. A subset of XRF confirmation samples were also submitted for select mercury analysis by USEPA Method 7471A, lead-210 by Eichrom, and isotopic thorium and uranium by ASTM International (ASTM) D3972 Modified. An evaluation of the in situ XRF measurements, ex situ bulk sample XRF measurements, and laboratory analytical results of the XRF confirmation soil samples is provided as the XRF Correlation Report in Appendix B of the RSE Report. The locations of XRF field survey soil samples, results of the XRF field survey, and overall summary statistics are provided in the field sampling results for each non-AUM Target. Validated and correlation XRF field measurements for each non-AUM Target are provided in Attachment I3. In addition, the locations of and analytical results for XRF confirmation soil samples are provided in the field sampling results for each non-AUM Target.

2.5.2 Surface Soil Sampling (0 to 6 Inches)

The second type of analytical soil sample collected at non-AUM Targets T1 and T12 involved the sampling of the upper 6 inches of soil to evaluate other analytes and to provide definitive data adjacent to residential housing. Soil sampling was performed following methods outlined in Appendix C of the RSE Work Plan (Tetra Tech 2018) and following the same sampling procedures as the background investigation (Appendix A of the RSE Report). Surface soil samples were collected using a stainless-steel trowel and bowl.

Surface soil samples were submitted for laboratory analysis of metals by USEPA Method 6020B and K-40, Ra-226, and Ra-228 by USEPA Method 901.1. A subset of surface soil samples were also submitted for select mercury analysis by USEPA Method 7471A, lead-210 by Eichrom, and isotopic thorium and uranium by ASTM D3972 Modified. The locations of and analytical results for surface soil samples are provided in the field sampling results for non-AUM Targets T1 and T12 (Section 4.1 and Section 6.3, respectively).

2.5.3 Shallow Subsurface Soil Sampling (6 to 12 Inches)

The third type of analytical soil sample collected at non-AUM Targets T1 and T12 involved soil sampling from 6 to 12 inches below grade to evaluate other analytes and to provide definitive data adjacent to residential housing. Subsurface sampling activities were performed using hand tools following Appendix C of the RSE Work Plan (Tetra Tech 2018). A shovel was used to collect subsurface soil samples by creating a small test pit and measuring the depth. Discrete soil samples were collected based on soil conditions in 6-inch intervals and placed into dedicated plastic bags for laboratory analyses. Given the shallow nature of the subsurface sampling downhole, gamma readings were not collected. Borings were backfilled using the surrounding soil.

Subsurface soil samples were submitted for laboratory analysis of metals by USEPA Method 6020B and K-40, Ra-226, and Ra-228 by USEPA Method 901.1. A subset of subsurface soil samples were also submitted for toxicity characteristic leaching procedure (TCLP) leachable metals, synthetic precipitation leaching procedure (SPLP) leachable metals and radionuclides, and acid-base accounting (ABA). TCLP leachate was analyzed by USEPA Method 6020B and SPLP leachate was analyzed by USEPA 6020B for metals. Subsurface soil samples were submitted for laboratory analysis of K-40, Ra-226, and Ra-228 by USEPA 901.1, lead-210 by Eichrom, and isotopic thorium and uranium by ASTM D3972 Modified. The locations of and analytical results for subsurface soil samples are provided in the field sampling results for non-AUM Targets T1 and T12 (Section 4.1 and Section 6.3, respectively).

2.6 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/QA procedures were designed to consider relevant guidance from USEPA, as well as from *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) and the *Multi-Agency Radiological Laboratory Analytical Protocols Manual* (MARLAP) (USEPA 2004).

All project QA/QC data are included in appendices to the RSE Report 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 water sampling QA/QC results are in Appendix G. All factory field equipment calibration documentation is provided in the relevant appendices. Laboratory reports are in Appendix L, and all 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 the USEPA's Remedial Project Manager (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).

2.7 CULTURAL AND BIOLOGICAL SURVEYS

Dinetahdoo Cultural Resources Management LLC conducted cultural resource surveys under a separate contract with USEPA. The survey areas included the survey boundary of both AUMs and non-AUM Targets. The cultural survey personnel conducted monitoring during ground-disturbing activities of the project and were present during the gamma radiation surveys, XRF field surveys, and soil sampling. Two survey units at Target T4 (BR-04) were identified as containing culturally sensitive features and were not sampled. No other Targets contained culturally sensitive features. Additionally, 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 inclusive of the Tse Tah Northwest Carrizo Mountain Region and Lukachukai Mountain Region where non-AUM Targets are located is presented in the main RSE Report.

2.8 STATEMENT ON ACCESSIBILITY

The terrain within the survey areas of some non-AUM Targets sometimes posed a risk to the health and safety of the project team. An attempt was made to collect in situ XRF measurements and gamma radiation survey units within every 100 m^2 survey unit within every non-AUM Target survey area. However, given the Target-specific limitations encountered mostly because of the extreme terrain and health and safety concerns, it is possible that some survey units may not have contained an in situ XRF measurement, soil sample, or gamma radiation survey measurement data. In some cases, the XRF field survey team or the gamma radiation survey team, but not both, could not physically access an area because of differences in field measurement instrumentation, differences in the personal judgement of field staff, direction from the onsite USEPA RPM, or direction from the Tetra Tech health and safety management. Inaccessible survey units for either the XRF field survey or the gamma radiation survey are shown as gray squares on non-AUM Target figures.

2.9 SITE CLASSIFICATION

Tetra Tech followed guidance from MARSSIM (USEPA 2000) to classify AUMs. The RSE Work Plan (Tetra Tech 2018) describes the radiation survey and site investigation (RSSI) process followed by Tetra Tech. The RSSI process is a graded approach for assessing sites potentially contaminated with radiation that starts with the site identification and historical site assessment and is followed by other surveys, including scoping and characterization surveys, eventually leading to the final status survey. The non-AUM Targets are at the site discovery and site identification stage; therefore, the non-AUM Targets will not be classified until TENORM has been documented and further characterization has been completed that indicates elevated gamma activity with respect to background.

2.10 IDENTIFICATION OF CONTAMINANTS OF POTENTIAL CONCERN

Tetra Tech developed a process for the identification of COPCs for the non-AUM Targets. The soil concentrations at each non-AUM Target were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples, as well as through laboratory chemical and radiological analysis of surface and subsurface soil samples. Each of these methods are referred to as a sample type and are described in further detail in the discussion of field sampling results for each non-AUM Target. At most non-AUM Targets, 28 metals and radionuclides are evaluated. In some cases, 29 metals are evaluated instead of 28 because mercury was included in the evaluation of subsurface samples at a select number of Target. An applied BTV has been selected to represent background conditions at each non-AUM Target. The estimated BTVs are the 95 percent upper tolerance limit (UTL 95-95) or the 95 percent upper simultaneous limit (USL 95) for a given population; it is possible for a sample to have a result exceeding the BTV and still be part of the background population (that is, a false positive) and to have not been impacted by mining.

A criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. If TENORM is present, site classification and reevaluation of COPCs will be conducted in the EE/CA in accordance with the methodology developed for AUMs.

Following the background comparison analysis, the COPCs for a non-AUM Target will be evaluated, in conjunction with the presence or absence of TENORM, to determine if no further action, risk screening, or removal action is warranted. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

3.0 NON-AUM TARGET GROUPINGS AND SETTING

This section identifies the locations of the non-AUM Targets addressed in this report, summarizes the previous investigations at these non-AUM Targets, describes the non-AUM Target-specific geology and soils, and discusses the established BSAs for the non-AUM Targets. BTVs developed for each BSA are identified in Section 4.0 through Section 11.0 for each non-AUM Target.

3.1 NON-AUM TARGET GROUPINGS AND LOCATIONS

Of the 39 Targets identified in the Mine Category Assessment Protocol (MCAP) report (Weston Solutions, Inc [Weston] 2016), only 26 non-AUM Targets are addressed in this report. Four Targets are contained in part or entirely within an AUM boundary (T2, T16, T28, and T29), five Targets are AUM-related (T9, T17, T23, T37, and T38), two Targets are located within a drainage (T35 and T36), and one Target is inaccessible because of extreme terrain and health and safety concerns (T34). Table I-7 presents a summary of non-AUM Targets and associated AUMs located within Subarea Group A through Subarea Group I addressed in this report. Non-AUM Targets are not located in Subarea Group E and Subarea Group J.

The Tse Tah Region, north of the Lukachukai Mountain range at the base of the Carrizo Mountains southeast of Red Mesa, Arizona, includes Subarea Group A and Subarea Group B. The elevation of AUMs and Targets within this region ranges from approximately 5,500 to over 5,900 feet above mean sea level (amsl). Subarea Group A is within the Sweetwater Chapter and contains one AUM and six Targets. Group B is within the Teec Nos Pos Chapter and contains one AUM and two Targets. Figure I-5 and Figure I-6 present the AUM and Target locations within Subarea Group A and Subarea Group B.

The Cove Valley Region encompasses Targets only within the Cove Chapter of the Navajo Nation. The Lukachukai Mountains Region encompasses AUMs and Targets within the Cove Chapter and AUMs and Targets within the Lukachukai Chapter of the Navajo Nation. The Cove Valley is at the base of the Lukachukai Mountains, and includes the population center of Cove, Arizona. Three AUM Targets and three non-AUM Targets are located in the Cove Valley; however, no AUMs are located in the valley. The elevation of the Targets ranges from approximately 6,400 feet to 6,600 feet amsl at the Cove Transfer Station and Targets in the Cove Valley. The Cove Region includes Subarea Group C only. Figure I-8 presents the Target locations within Subarea Group C.

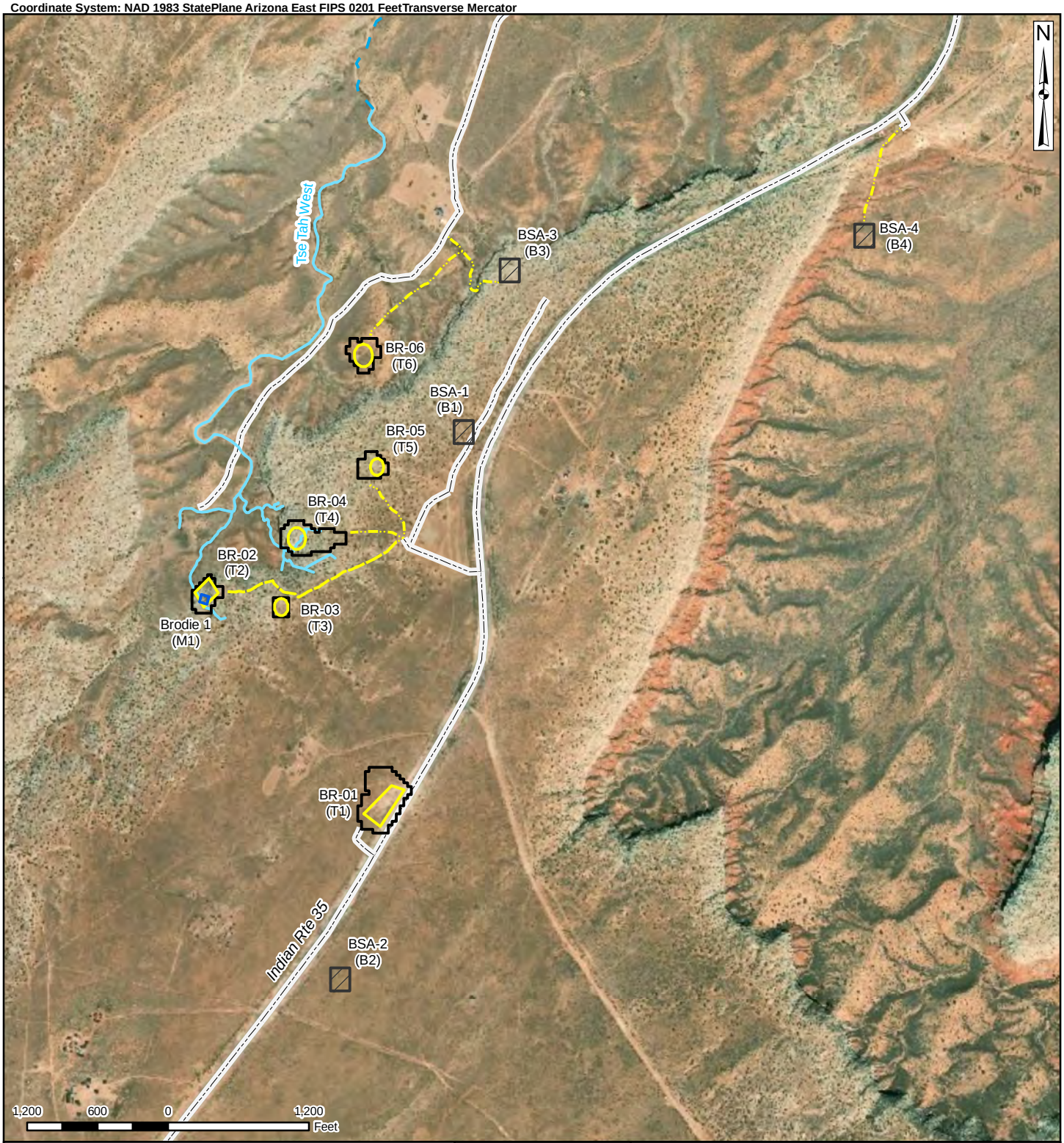
The Lukachukai Mountains Region is the largest of the three regions and encompasses more than 31 square miles of high peaks and mesas of the Lukachukai Mountains south of Cove, Arizona. The elevation of AUMs and Targets ranges from approximately 6,900 to 8,100 feet amsl. This region contains the highest density and number of AUMs and Targets. The region includes 37 AUMs and 2 AUM-related and 22 non-AUM Targets. Six of the non-AUM Targets are encompassed by AUMs, are located in drainages, or were not accessible; a total of 16 non-AUM Targets are addressed in this report. The Lukachukai Mountains Region includes Subarea Group D through Subarea Group H, which are all within the Cove Chapter of the Navajo Nation. Figure I-8 through Figure I-12 present the AUM and Target locations within Subarea Groups D, F, G, H, and I.

Table I-7. Non-AUM Targets Addressed in Report

Site ID	Subarea	Investigation Area Name	Site Type	Associated Mine or Mine Related Feature	Site Boundary (Acres)
Sweetwater Chapter					
T1	Group A	BR-01	Non-AUM Target	NA	1.2
T3		BR-03	Non-AUM Target	Brodie 1 (M1)	0.3
T4		BR-04	Non-AUM Target		0.5
T5		BR-05	Non-AUM Target		0.3
T6		BR-06	Non-AUM Target		0.5
Teec Nos Pos Chapter					
T7	Group B	BK-01	Non-AUM Target	Block K	1.4
T8		BK-02	Non-AUM Target		0.8
Cove Chapter					
T10	Group C	CT-01	Non-AUM Target	Cove Transfer Station (T9)	1.9
T11		CT-02	Non-AUM Target		1.0
T12		CT-03	Non-AUM Target		0.2
T13	Group D	M1-01	Non-AUM Target	Mesa I, Mine 13 (M6)	0.7
T14		M1-02	Non-AUM Target		0.6
T15		M1-03	Non-AUM Target		0.9
T18	Group F	M5-01	Non-AUM Target	NA	0.3
T19		M5-02	Non-AUM Target		0.3
T20		M5-03	Non-AUM Target		0.2
T21		M5-05	Non-AUM Target	Burial Cell NA-0344B (T23)	1.0
T22		M5-06	Non-AUM Target		1.7
T24		M5-07	Non-AUM Target	Mesa V 103 (M17)	0.9
T25		M5-08	Non-AUM Target	NA	0.4
T26		M5-09	Non-AUM Target		0.5
T27	Group G	M4-02	Non-AUM Target	NA	0.3
T30	Group H	M1-07	Non-AUM Target	NA	0.4
T31		M1-08	Non-AUM Target		0.4
T32		M2-01	Non-AUM Target		0.2
Lukachukai Chapter					
T33	Group I	KE-01	Non-AUM Target	Knife Edge (M33)	0.9

Notes:
AUM Abandoned uranium mine
NA Not applicable

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



Non-AUM Target Site Boundary
AUM Site Boundary
Survey Area Boundary
Background Study Area
Access Route (Foot)
Access Route (Vehicular)
Drainage*
Drainage (Field Mapped)

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

Prepared for: USEPA Region 9

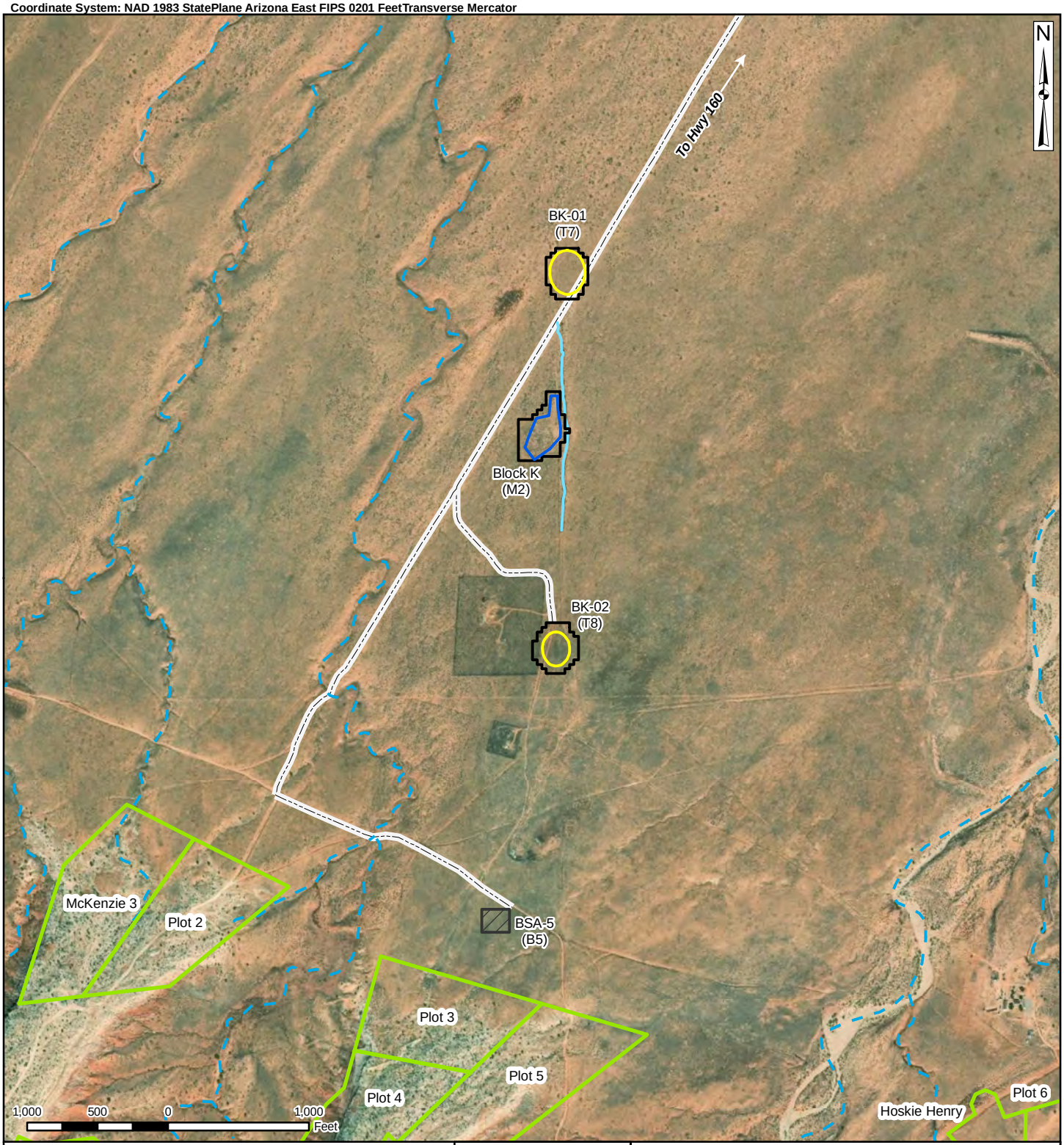
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GROUP A AUM AND NON-AUM TARGETS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-5
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 7/9/2019	

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



- Non-AUM Target Site Boundary
- AUM Site Boundary
- Survey Area Boundary
- Background Study Area
- Non-Tronox AUM Site
- Access Route (Foot)
- Access Route (Vehicular)
- Drainage*
- Drainage (Field Mapped)

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

Prepared for: USEPA Region 9

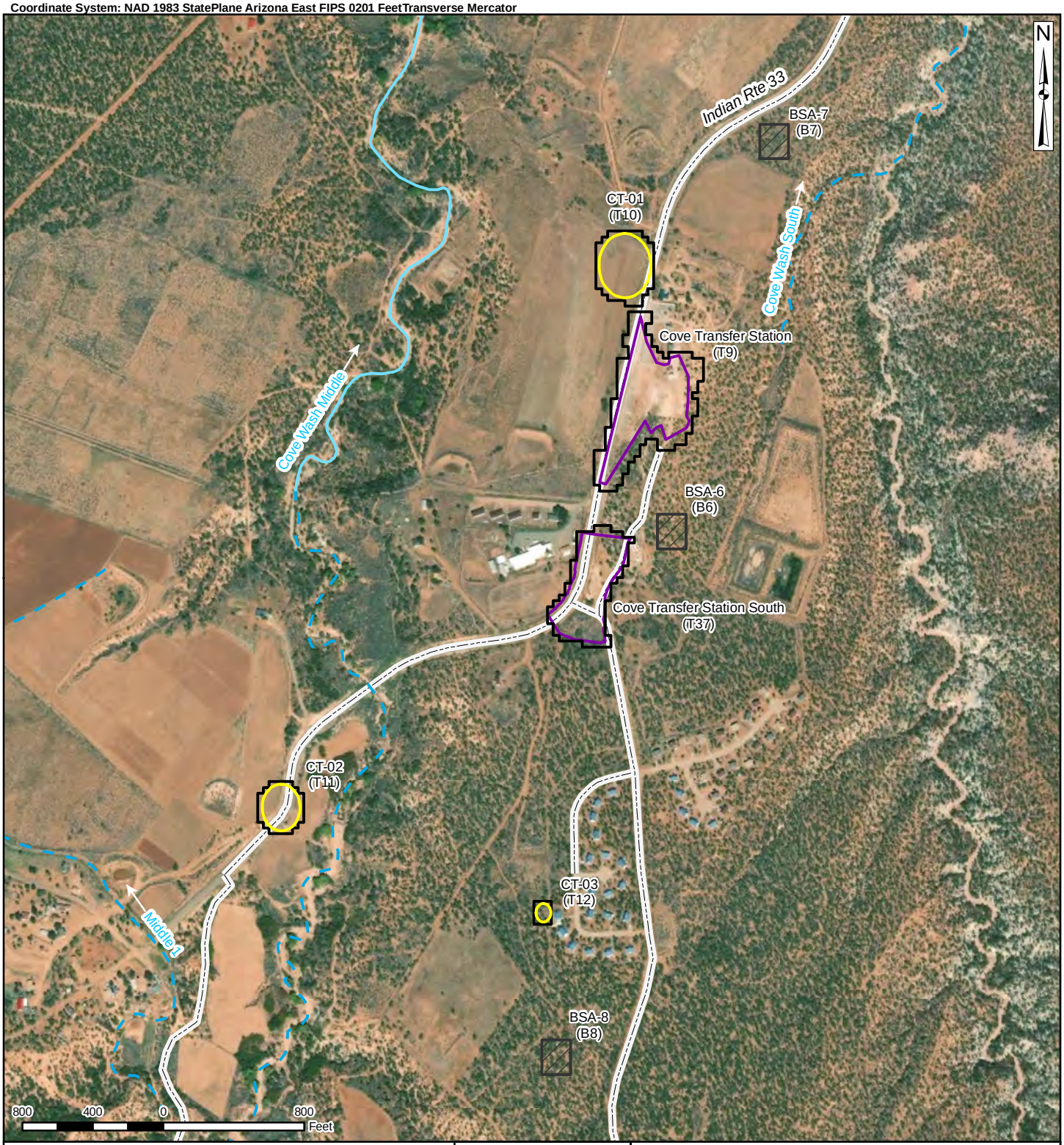
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GROUP B AUM AND NON-AUM TARGETS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-6
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 7/9/2019	

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



Non-AUM Target Site Boundary
AUM Site Boundary
AUM Related Boundary
Survey Area Boundary
Background Study Area
Access Route (Foot)
Access Route (Vehicular)

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

Prepared for: USEPA Region 9

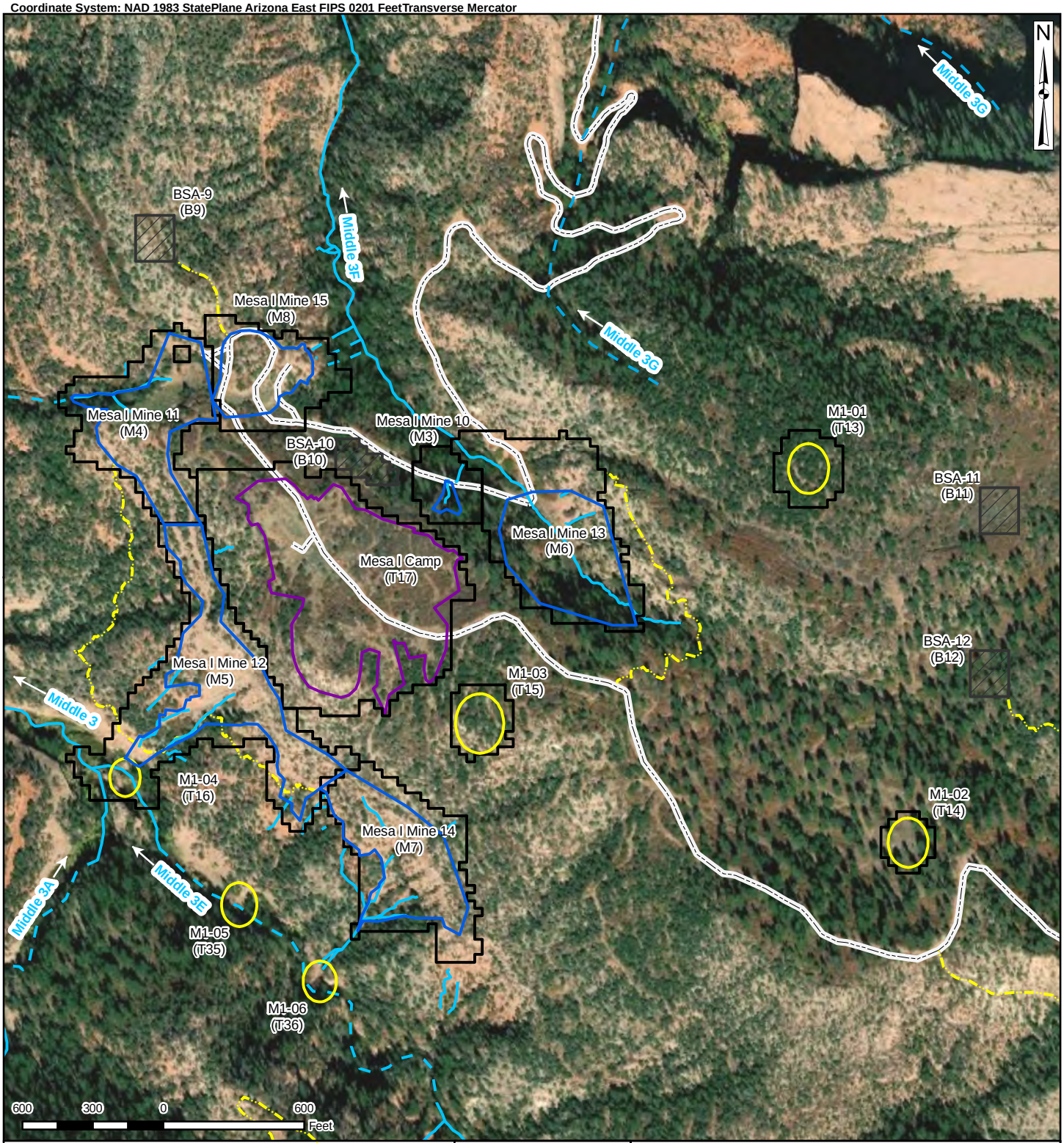
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GROUP C AUM RELATED AND NON-AUM TARGETS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-7
Location: COVE CHAPTER NAVAJO NATION	Date: 7/9/2019	

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



- Non-AUM Target Site Boundary
- AUM Site Boundary
- AUM Related Boundary
- Survey Area Boundary
- Background Study Area
- Access Route - Foot
- Access Route - Vehicular
- Drainage*
- Drainage (Estimated Path)
- Drainage (Field Mapped)

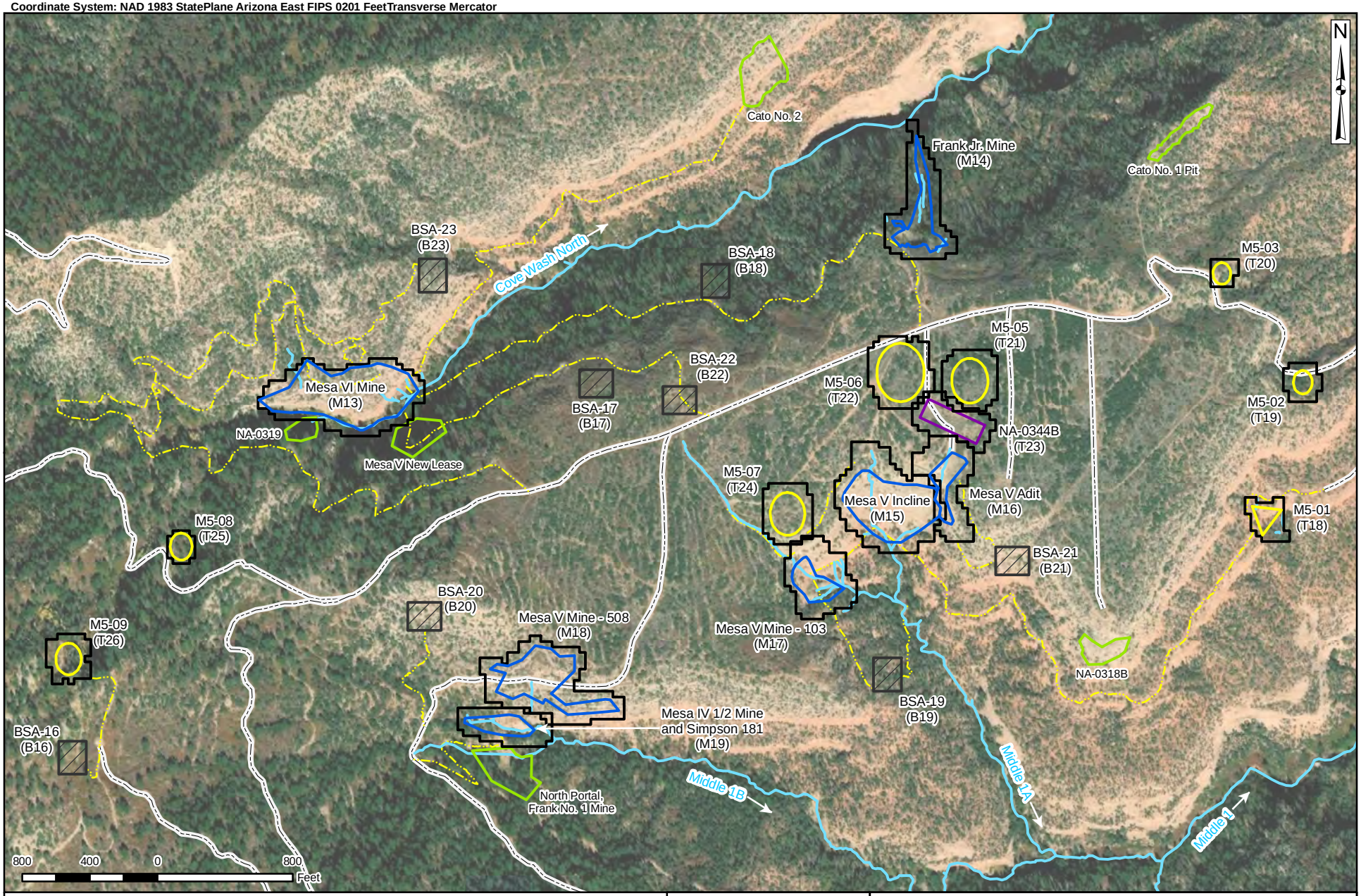
*U.S Environmental Protection Agency, Region 9, Superfund Program, *Abandoned Uranium Mines and the Navajo Nation Part II Atlas With Geospatial Data. NN_Drainage_HR_AUM.shp.* July, 2007.

Prepared for: U.S. EPA Region 9

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

GROUP D AUMS AND NON-AUM TARGETS

Task Order No.:	Contract No.:	I-8
TO0001	EP-S9-17-03	I-8
Location: COVE CHAPTER NAVAJO NATION	Date: 7/9/2019	



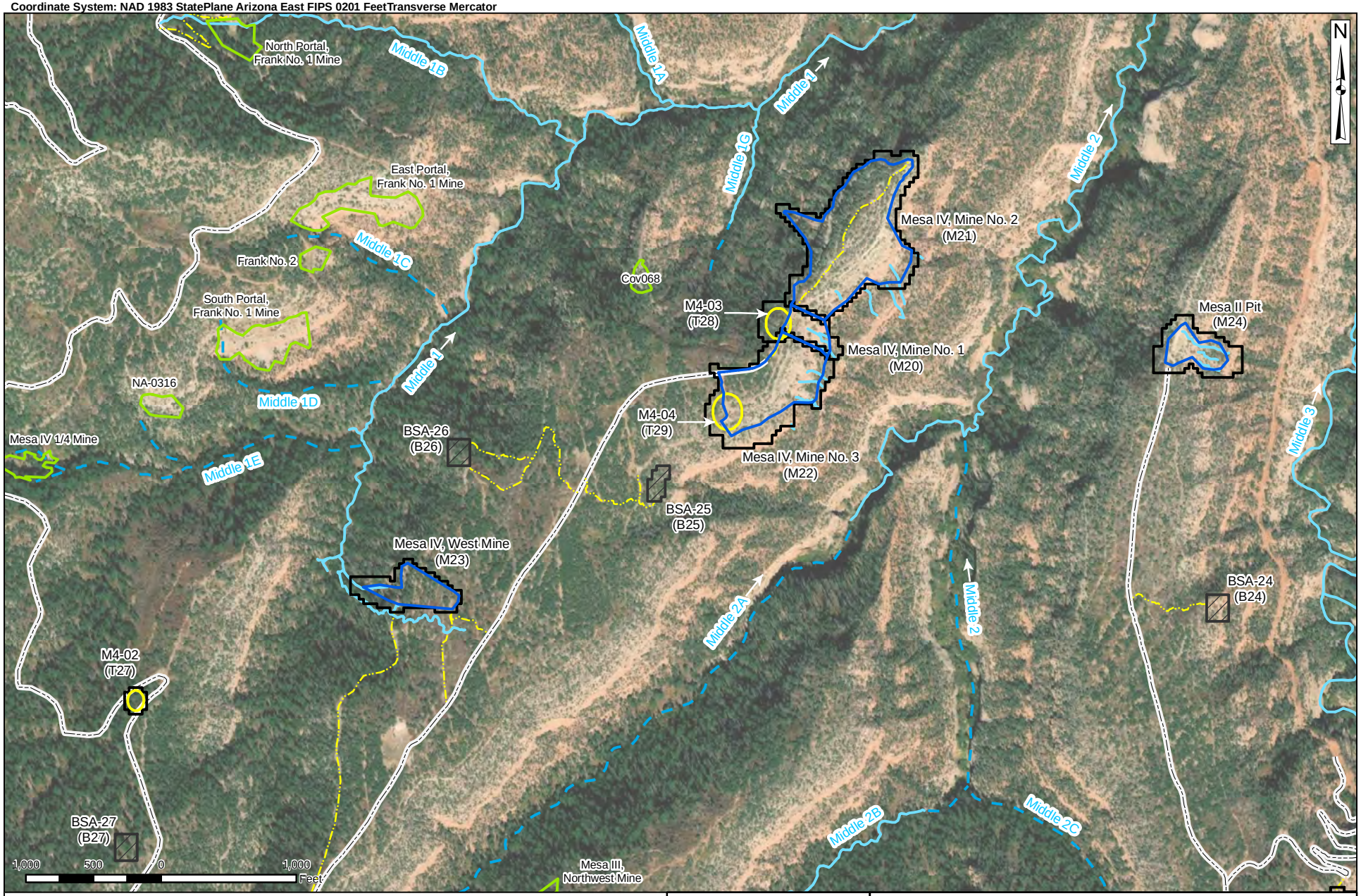
Non-AUM Target Site Boundary
AUM Site Boundary
AUM Related Boundary
Survey Area Boundary
Background Study Area
Non-Tronox AUM Site
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped

Prepared for:

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GROUP F AUMS AND NON-AUM TARGETS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-9
Location: COVE CHAPTER NAVAJO NATION	Date: 7/9/2019	



Non-AUM Target Site Boundary
AUM Site Boundary
Survey Area Boundary
Background Study Area
Non-Tronox AUM Site

Access Route (Foot)
Access Route (Vehicular)
Drainage*
Drainage (Field Mapped)

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

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GROUP G AUMS AND NON-AUM TARGETS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-10
Location: COVE CHAPTER NAVAJO NATION	Date: 7/9/2019	

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



Non-AUM Target Site Boundary
AUM Site Boundary
Survey Area Boundary
Background Study Area
Non-Tronox AUM Site
Access Route (Foot)
Access Route (Vehicular)
Drainage*
Drainage (Field Mapped)

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

Prepared for: U.S. EPA Region 9

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GROUP H AUMS AND NON-AUM TARGETS

Task Order No.:	Contract No.:	I-11
TO0001	EP-S9-17-03	I-11
Location: COVE CHAPTER NAVAJO NATION	Date: 7/9/2019	

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



Non-AUM Target Site Boundary
Non-AUM Target Site Boundary - *Inaccessible*
AUM Site Boundary
Survey Area Boundary
Background Study Area

Access Route (Foot)
Access Route (Vehicular)
Drainage*
Drainage (Field Mapped)

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

Prepared for: U.S. EPA Region 9

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GROUP I AUM AND NON-AUM TARGETS

Task Order No.:	Contract No.:	I-12
TO0001	EP-S9-17-03	I-12
Location: LUKACHUKAI CHAPTER NAVAJO NATION	Date: 7/9/2019	

3.2 PREVIOUS INVESTIGATIONS

In 2014 and 2015, the USEPA's ASPECT aircraft conducted flyovers within the Tse Tah, Cove, and Lukachukai Mountains Regions. The ASPECT surveys covered nearly 180 square miles of land. In May 2015, a ground-based characterization effort was organized to collect in situ gamma spectroscopy measurements at select locations and to ground truth the ASPECT survey (USEPA 2015). Based on the results of the ASPECT survey, USEPA identified AUMs and areas of concern requiring additional characterization.

Weston (2016) developed the MCAP under contract with USEPA in support of the Tronox settlement. The MCAP project concentrated on assessing 26 Tronox mines, as well as 6 potential Tronox mines referred to as "other Tronox mines" located within the Northern Agency of the Navajo Nation. The MCAP effort was applied to any additional mines within a 0.5-mile radius of the Tronox mines and other non-mine areas of concern (non-AUM Targets) (Weston 2016). Non-AUM Targets identified included locations determined by an analysis of the ASPECT flyover gamma survey data set. Data anomalies and elevated outliers revealed during the analysis of the ASPECT gamma spectrometry results within a 0.5-mile radius of a Tronox AUM were evaluated. A review of historical documentation and historical aerial photographs was also conducted by Weston to identify additional areas of concern. A portion of the non-AUM Target locations were visited by Weston in April and September 2016 during the MCAP reconnaissance survey to confirm ASPECT flyover survey data and non-AUM Target identification.

Prior to the RSE field investigations conducted by Tetra Tech, no soil, sediment, surface water, or groundwater samples had been collected from the non-AUM Targets addressed in this report; however, gamma measurements had been collected within most non-AUM Target boundaries during the MCAP investigation (Weston 2016). No gamma measurements were conducted by the Navajo Abandoned Mine Lands Reclamation Program (NAMLRP) at non-AUM Targets. Based on the review of historical information by Weston (2016), mine workings associated with Frank Jr. Mine (M14) and Mesa I, Mine 13 (M5) were found to be located beneath non-AUM Targets M5-06 (T22) and M1-03 (T15), respectively. Further, exploratory borings identified in historical records were found to correlate with several non-AUM Targets. Table I-8 summarizes the previous investigations conducted at the non-AUM Targets included in this report.

Table I-8. Previous Investigations at Non-AUM Targets Addressed in Report

Site ID	Subarea	Investigation Area Name	ASPECT Gamma Survey	MCAP Gamma Site Screening	Mine Workings Extended Below	Historic Exploratory Boreholes
T1	Group A	BR-01	✓	✓		
T3		BR-03	✓	✓		
T4		BR-04	✓	✓		
T5		BR-05	✓	✓		
T6		BR-06	✓	✓		
T7	Group B	BK-01	✓	✓		
T8		BK-02	✓	✓		
T10	Group C	CT-01	✓	✓		
T11		CT-02	✓	✓		
T12		CT-03	✓	✓		
T13	Group D	M1-01	✓	✓		
T14		M1-02	✓	✓		✓
T15		M1-03	✓	✓	✓	✓
T18	Group F	M5-01	✓	✓		
T19		M5-02	✓	✓		
T20		M5-03	✓	✓		
T21		M5-05	✓	✓		✓
T22		M5-06	✓	✓	✓	✓
T24		M5-07	✓	✓		✓
T25		M5-08	✓	✓		✓
T26		M5-09	✓	✓		✓
T27	Group G	M4-02	✓	✓		
T30	Group H	M1-07	✓			
T31		M1-08	✓			
T32		M2-01	✓			
T33	Group I	KE-01	✓			

Notes:
ASPECT Airborne Spectral Photometric Environmental Collection Technology (USEPA 2015)
AUM Abandoned uranium mine
MCAP Mine Category Assessment Protocol (Weston 2016)

3.3 GEOLOGY AND SOILS

Nine different geological formations found to underlie the AUMs and Targets were evaluated as part of the overall RSE investigation. Descriptors of each mapped geologic unit are listed in Table I-9 (modified from O'Sullivan and Beikman 1963 and Arizona Department of Water Resources 2009). In addition to the geological evaluation, soils data from the areas of interest were downloaded from the online Web Soil Survey system produced by the U.S. Department of Agriculture (USDA) and U.S. Natural Resource Conservation Service (NRCS) (USDA 2018). Fourteen unique soil types were identified using the soil maps from NRCS. Further information regarding the geologic and soil formations evaluated are provided in Appendix A of the RSE Report.

The following subsections present an overview of the physical setting and discuss localized geological formations within each of the three regional investigation areas identified in Section 1.1.

Table I-9. Summary of Geological Formations

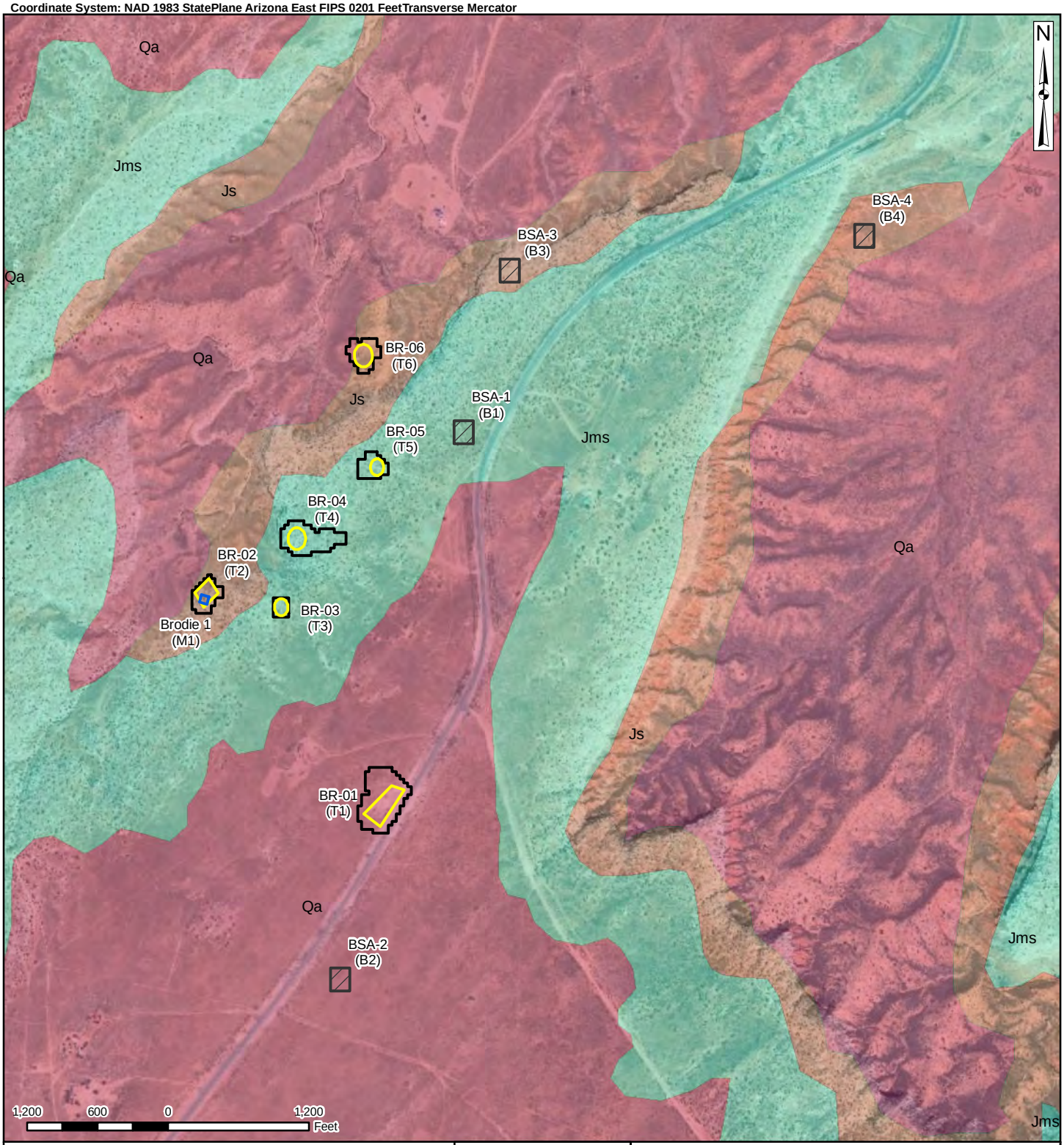
Symbol	Formation	Description
Qa	Quaternary Alluvium	Unconsolidated surficial deposits of valley fill: mainly stream-deposited silt, sand, and gravel, but also includes some wind-blown sand and silt, colluvial material, and locally, low-level terrace gravels.
Tc	Chuska Sandstone	White to gray medium to fine-grained, moderately sorted sandstone.
Jml	Lower Morrison Formation	Recapture member (Jmr): White and brown fine-to-medium grained sandstone, siltstone, and dark reddish-brown shale. Also includes Salt Wash Member (Jms): White and moderate orange very fine- to medium-grained sandstone, and grayish red shale.
Js	Summerville Formation	Moderate reddish-brown, fine- to medium-grained sandstone and argillaceous siltstone.
Jse	Summerville and Entrada Formations Undifferentiated	Alternating thin beds of gray, green, and red siltstone; gray, greenish-gray, and reddish brown, fine grained sandstone; and red and greenish gray shale. Entrada is buff, white and pink medium grained, massive cross-bedded sandstone.
Jste	Summerville, Todilto, and Entrada Formations Undifferentiated	Undifferentiated green and red siltstone; gray, greenish-gray, and reddish brown, fine-grained sandstone; and red and greenish gray shale. Buff, white, and pink medium-grained, massive cross-bedded sandstone. Red claystone interbedded with reddish orange sandstone.
Jc	Carmel Formation	Claystone, grayish red, shaly, silty, and sandy; interbeds of sandstone, moderate reddish orange, fine-grained.
Trc	Chinle Formation	Claystone, moderate red, calcareous, silty, interbedded with siltstone, moderate reddish orange, argillaceous; and with limestone, nodular, cherty; and with conglomerate, pale red, pebbles of limestone and chert. Some Sandstone, olive gray, course grained, micaceous, friable.

3.3.1 Tse Tah Region

The Tse Tah Region is located at the base of the Carrizo Mountains, approximately 20 miles northwest of Cove Chapter. The Tse Tah Region occupies portions of both the Sweetwater (in Subarea Group A) and Teec Nos Pos Chapters (in Subarea Group B) in the RSE investigation area.

The surface geology within the Tse Tah Region includes three primary surface geological formations: Quaternary alluvium (Qa), Salt Wash Member (Jms) of the Morrison Formation, and Summerville Formation (Js). Qa 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). Figure I-13 and Figure I-15 show the regional geological formations within Subarea Group A and Subarea Group B of the Tse Tah Region. Figure I-14 and Figure I-16 show the soil types within the Subarea Group A and Subarea Group B of the Tse Tah Region. BSAs identified during the background investigation (Appendix A of the RSE Report) are also shown on each map. Each BSA was selected based on geographic location within a geology and soil type that matched a specific AUM or group of AUMs.

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



Geologic Units*

- Alluvium - Qa
- Morrison Formation Salt Wash Member - Jms
- Summerville Formation - Js

- Non-AUM Target Site Boundary
- AUM Site Boundary
- Survey Area Boundary
- Background Study Area

*O'Sullivan, R.B., and Beikman, H.M. (1963). Geology, structure, and uranium deposits of the Shiprock quadrangle, New Mexico and Arizona . From the USGS/AASG National Geologic Map Database. Accessed 01/10/2018.

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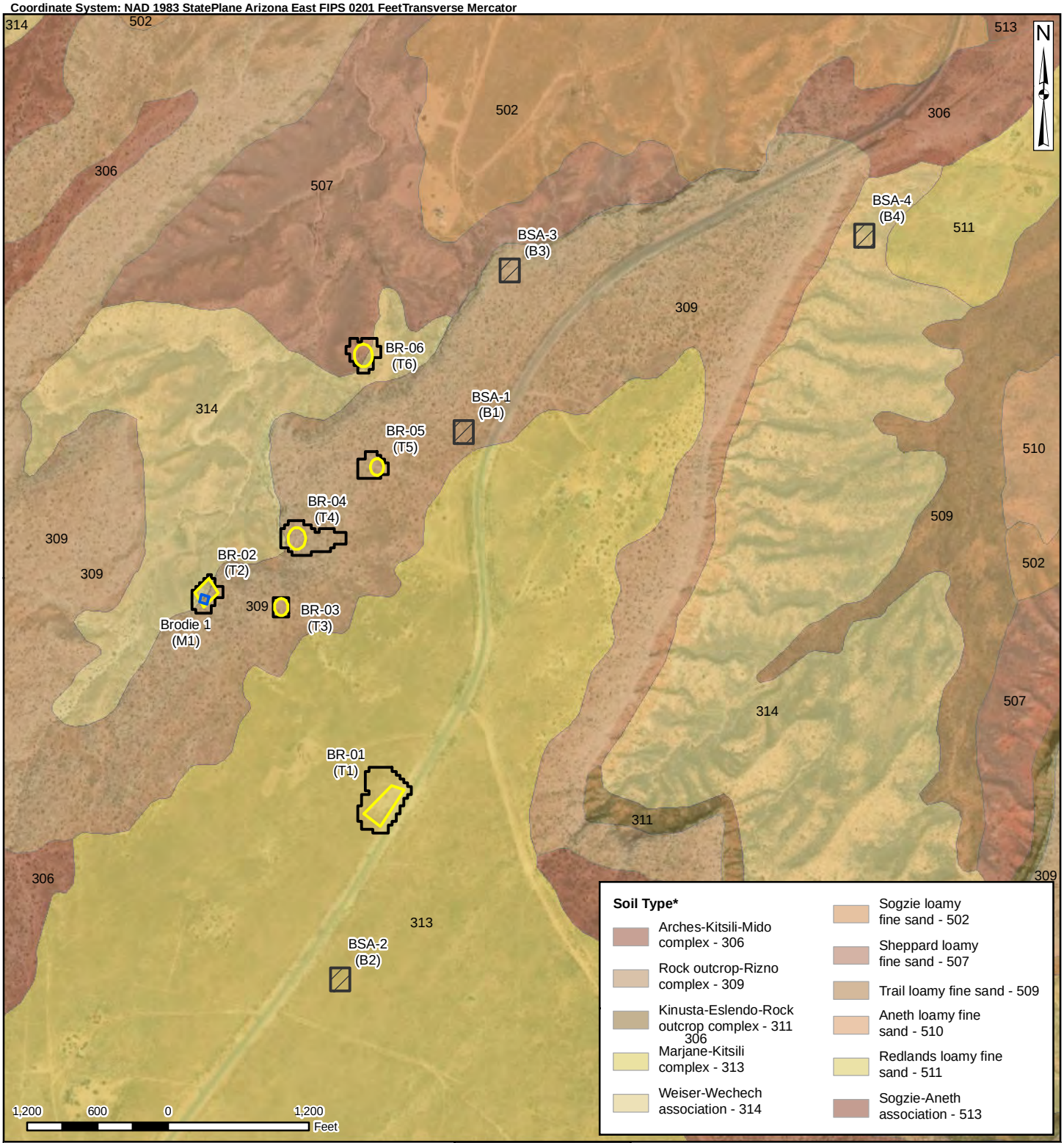
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GEOLOGIC MAP FOR GROUP A NON-AUM TARGETS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-13
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/18/2019	

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



Non-AUM Target Site Boundary
AUM Site Boundary
Survey Area Boundary
Background Study Area

*Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic SSURGO) Database for Arizona. Available online. Accessed 1/10/2018.

Prepared for: USEPA Region 9

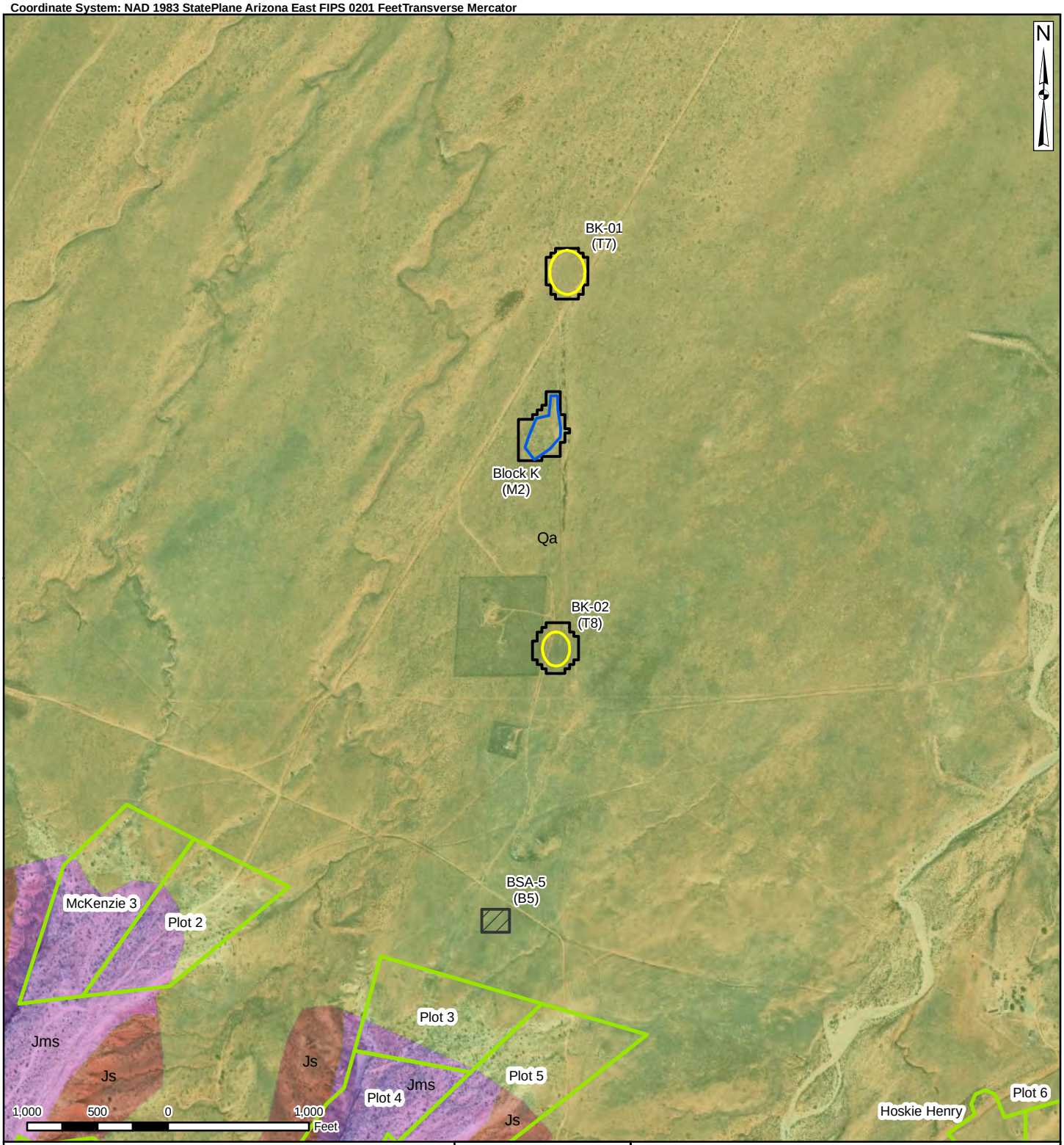
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Oakland, CA 94612

SOILS MAP FOR GROUP A NON-AUM TARGETS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-14
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/18/2019	

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



Geologic Units*

- Alluvium - Qa
- Morrison Formation Salt Wash Member - Jms
- Summerville Formation - Js

- Non-AUM Target Site Boundary
- AUM Site Boundary
- Survey Area Boundary
- Background Study Area
- Non-Tronox AUM Site

*O'Sullivan, R.B., and Beikman, H.M. (1963). Geology, structure, and uranium deposits of the Shiprock quadrangle, New Mexico and Arizona . From the USGS/AASG National Geologic Map Database. Accessed 01/10/2018.

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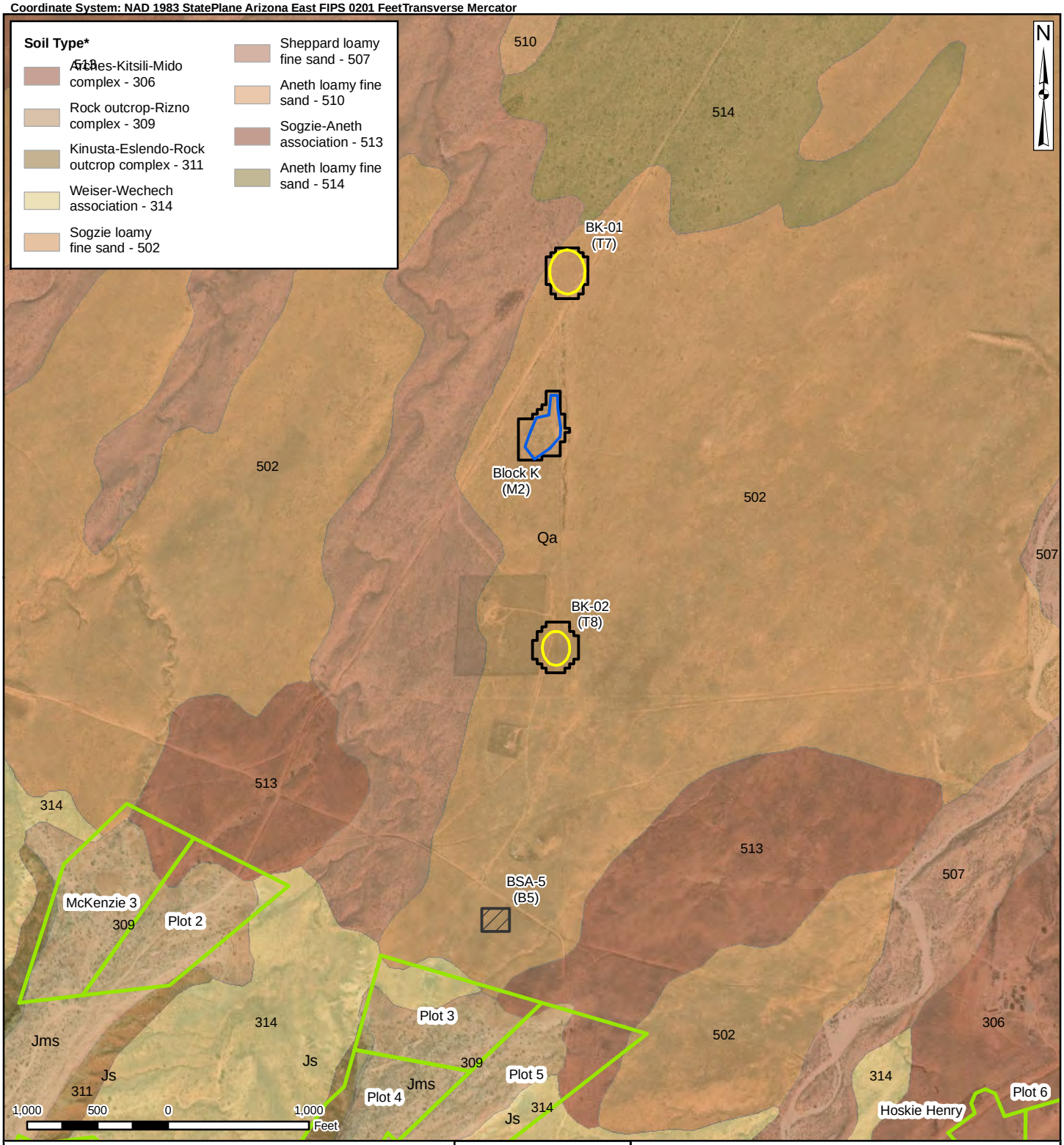
Prepared By:

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Oakland, CA 94612

GEOLOGIC MAP FOR GROUP B NON-AUM TARGETS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-15
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/18/2019	

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



Non-AUM Target Site Boundary
AUM Site Boundary
Survey Area Boundary
Background Study Area
Non-Tronox AUM Site

*Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic SSURGO) Database for Arizona. Available online. Accessed 1/10/2018.

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Prepared By:

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SOILS MAP FOR GROUP B NON-AUM TARGETS

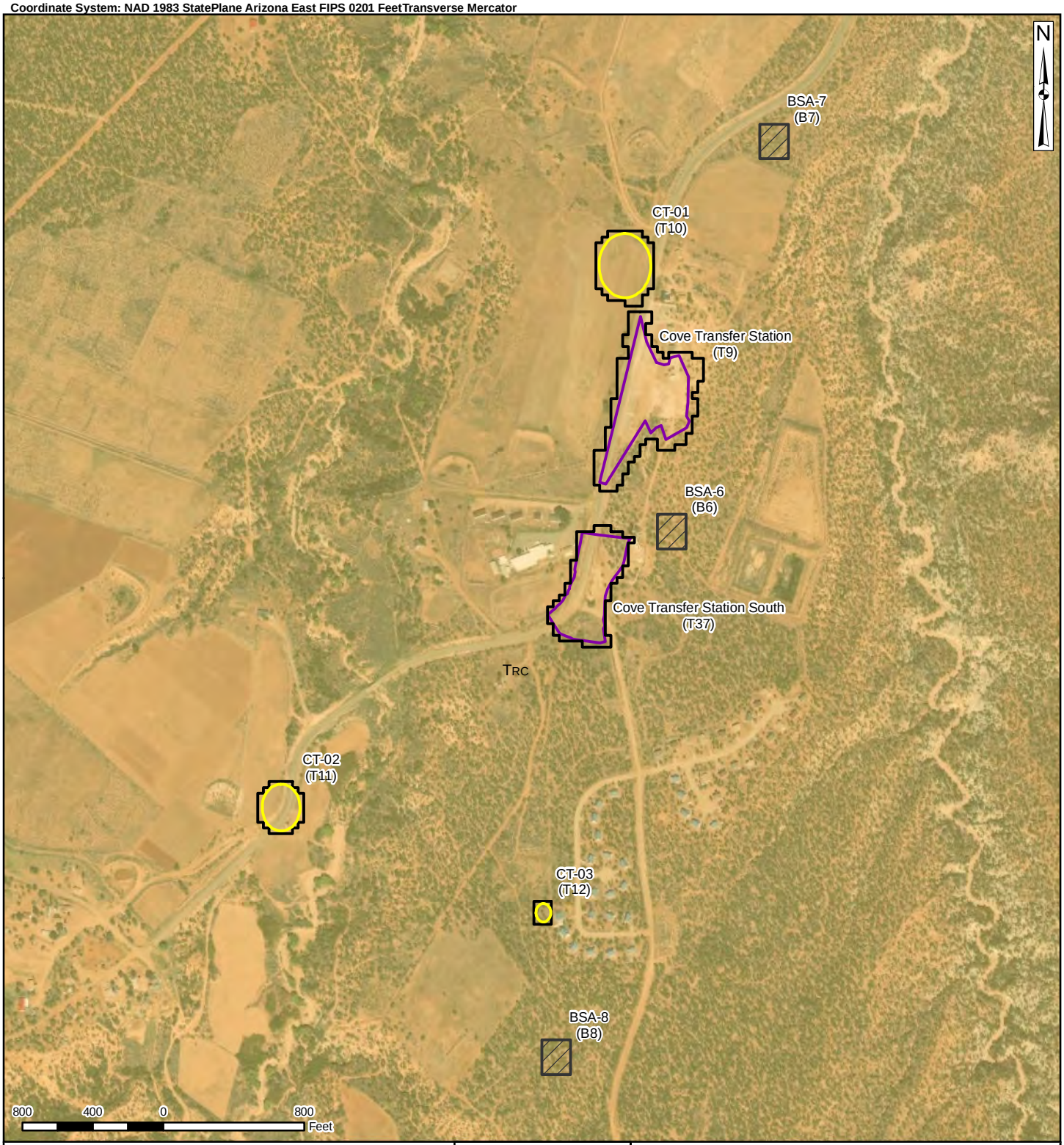
Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-16
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/18/2019	

3.3.2 Cove Valley

The Cove Valley is at the base of the Lukachukai Mountains and includes the population center of Cove, Arizona. The Cove Valley encompasses Subarea Area Group C of the RSE investigation area.

Surface geology within the vicinity of the Cove Valley is marked by occurrence of the Chinle Formation (Trc), a fluvial and lacustrine formation exposed in the broad valleys around the mountains. According to Nestler and Chenowith (1958), fluvial and lacustrine Trc is exposed in broad valleys around the mountains. Uranium minerals have been found in bleached parts of the lower Chinle sandstones where carbon trash is present (Chenoweth 1967). Figure I-17 shows the regional geological formations within the Cove Valley. Figure I-18 shows the soil types within the Cove Valley. BSAs identified during the background investigation (Appendix A of the RSE Report) are also shown on each map. Each BSA was selected based on geographic location within a geology and soil type that matched a specific AUM or group of AUMs.

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



Geologic Units*

Chinle Formation - T_{RC}

Non-AUM Target Site Boundary

AUM Site Boundary

AUM Related Boundary

Survey Area Boundary

Background Study Area

*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

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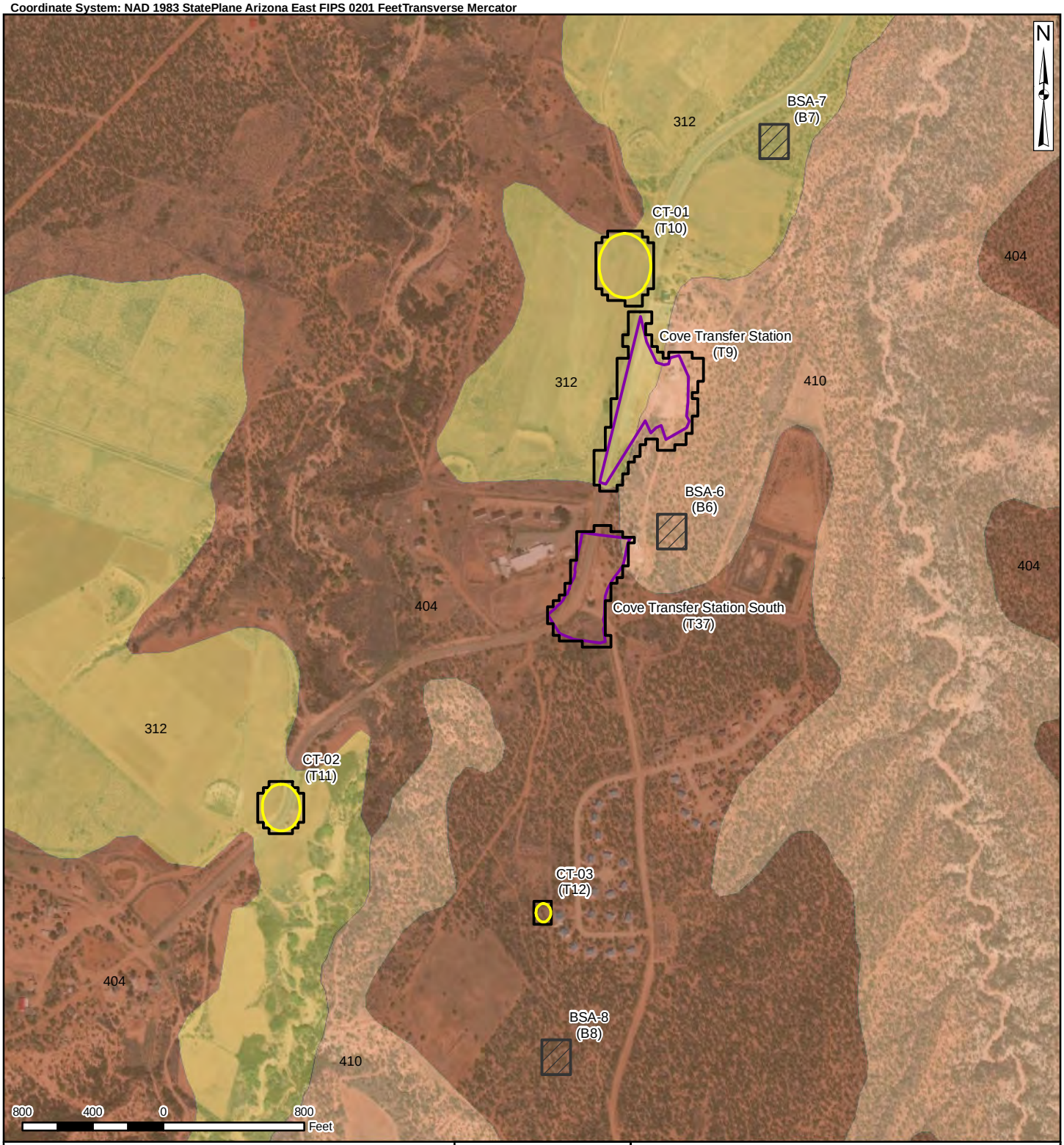
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GEOLOGIC MAP FOR GROUP C NON-AUM TARGETS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	

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



Soil Type*

- Blanding very fine sandy loam - 312
- Wetherill-Tsezhin association - 404
- Wetherill very fine sandy loam - 410

- Non-AUM Target Site Boundary
- AUM Site Boundary
- AUM Related Boundary
- Survey Area Boundary
- Background Study Area

*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

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SOILS MAP FOR GROUP C NON-AUM TARGETS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-18
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	

3.3.3 Lukachukai Mountains

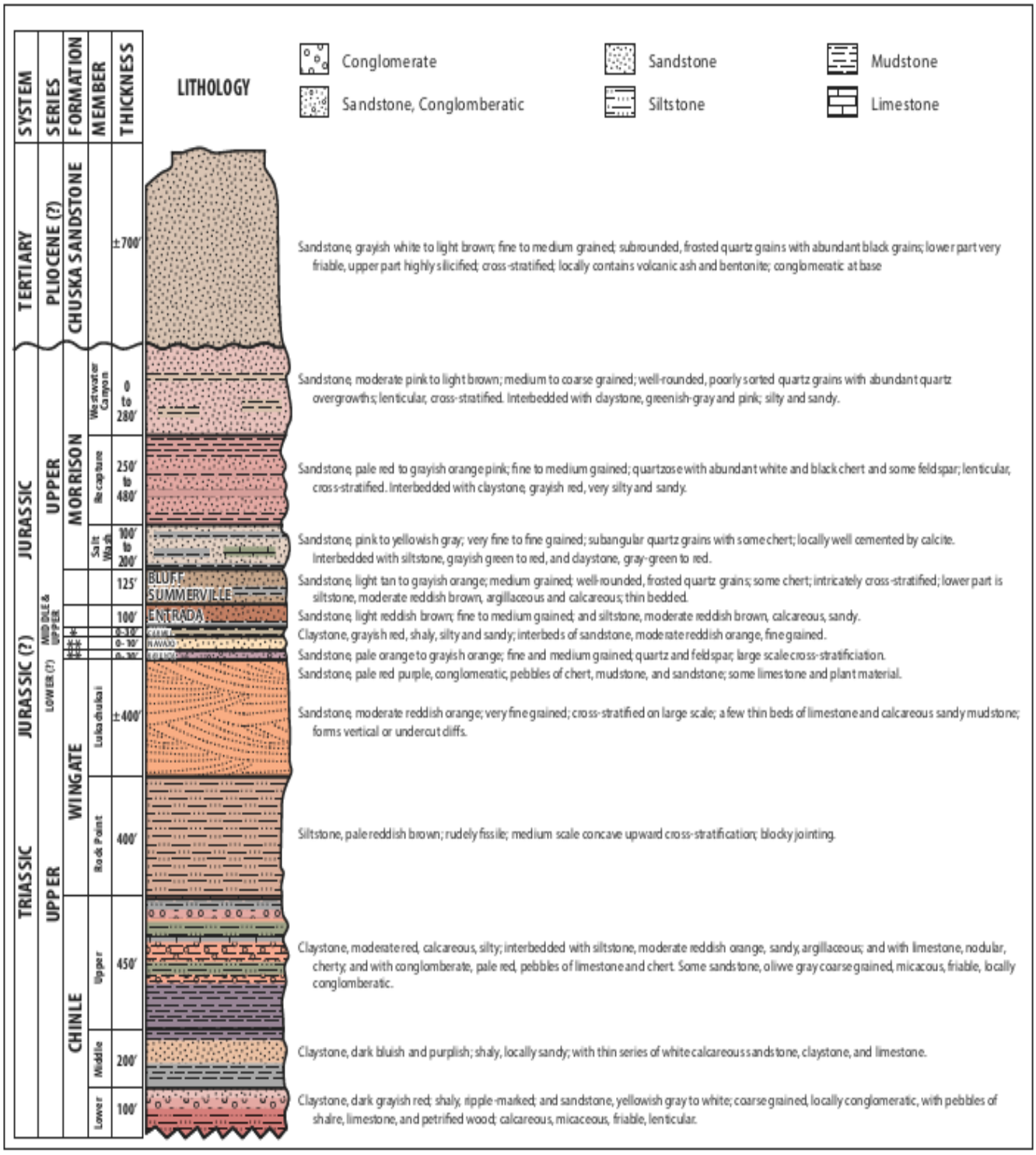
The Lukachukai Mountains are the northwestern spur of the Chuska Mountains, which span across the Cove and Lukachukai Chapters of the Navajo Nation. The Lukachukai Mountains RSE investigation area encompasses Subarea Area Group D through Subarea Group J. The majority of the Northern Agency Tronox AUMs and Targets are within the Lukachukai Mountains RSE investigation area.

In contrast to the Cove Valley, which lies primarily in a valley, the Lukachukai Mountains RSE investigation area is characterized by broad, flat mesas with steep canyons. The Lukachukai Mountains trend northwestward and except for where they join the Chaska Mountains, terminate as precipitous cliffs. Elevations at the Subarea Group D through Subarea Group J mines range from 7,200 to 7,700 feet amsl. 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.

Uranium ore in the region was mined at the exposed ground surface primarily at mesa tops, rims, and canyon walls from the late 1940s through early 1968. In addition, some mines in the Lukachukai Mountains had extensive underground mine networks (Roux Associates [Roux] 2011). Uranium associated with the AUM sites was mined from deposits within the Salt Wash Member (Jms) of the Jurassic Morrison Formation (Jm). The ore-bearing Jms is approximately 100 to 180 feet thick with most deposits confined to a nearly north-south trending belt across the southeastern end of the Lukachukai Mountains.

The Lukachukai Mountains are capped by the Tertiary Chuska Sandstone (Tc) and rimmed by the cliff-forming, uranium ore-bearing Jms. Primary surface geology within the region is characterized by undifferentiated deposits of the Summerville, Todilto, and Entrada Sandstone (Jste) and undifferentiated Summerville and Entrada (Jse), as well as undifferentiated deposits of the Morrison Formation. A secondary component of the surface geology includes the Wingate Formation (Trw), which is characterized by aeolian sandstones and siltstones that are exposed around the foot of the mountains in steep slopes and vertical cliffs (Chenoweth 1988). The Jurassic Carmel Formation (Jc) consists of marginal marine siltstone and mudstones that thin southeastward and pinch out in the Lukachukai Mountains area as well.

Mesa tops, flanks, and drainages are characterized primarily by members of the Morrison Formation (Jm). O'Sullivan and Beikman subdivided the Jm into an upper and lower portion, which were further subdivided into two members each. The Upper Morrison Formation (Jmu) consists of the Brushy Basin Member (Jmb) and the Westwater Canyon Member (Jmw). The Lower Morrison Formation (Jml) is composed of the Recapture Member (Jmr) and the Jms. For the purposes of this RSE background investigation, the Jmr and Jms units have been mapped together as Jml. Occurrence of Jml geology and predominance of the Jms of the Morrison Formation coincide with the prevalence of AUMs in the Lukachukai Mountains Region. The Summerville Formation (Js) consists of moderate reddish-brown fine- to medium-grained sandstone and argillaceous siltstone. Figure I-19 is an idealized stratigraphic profile of subsurface geology in the Lukachukai Mountains in Apache County, Arizona.



*Absent in southeast one-third of area. ** Present only in extreme northwest portion of area. Modified after Strobell. (1956)

Kosataka,R. F. 1956. Summary of Uranium Exploration in the Lukachukai Mountains, Apache County, Arizona 1950-1955. United States Atomic Energy Commission. Grand Junction Operations Office Exploration Division. Grand Junction, Colorado. March.

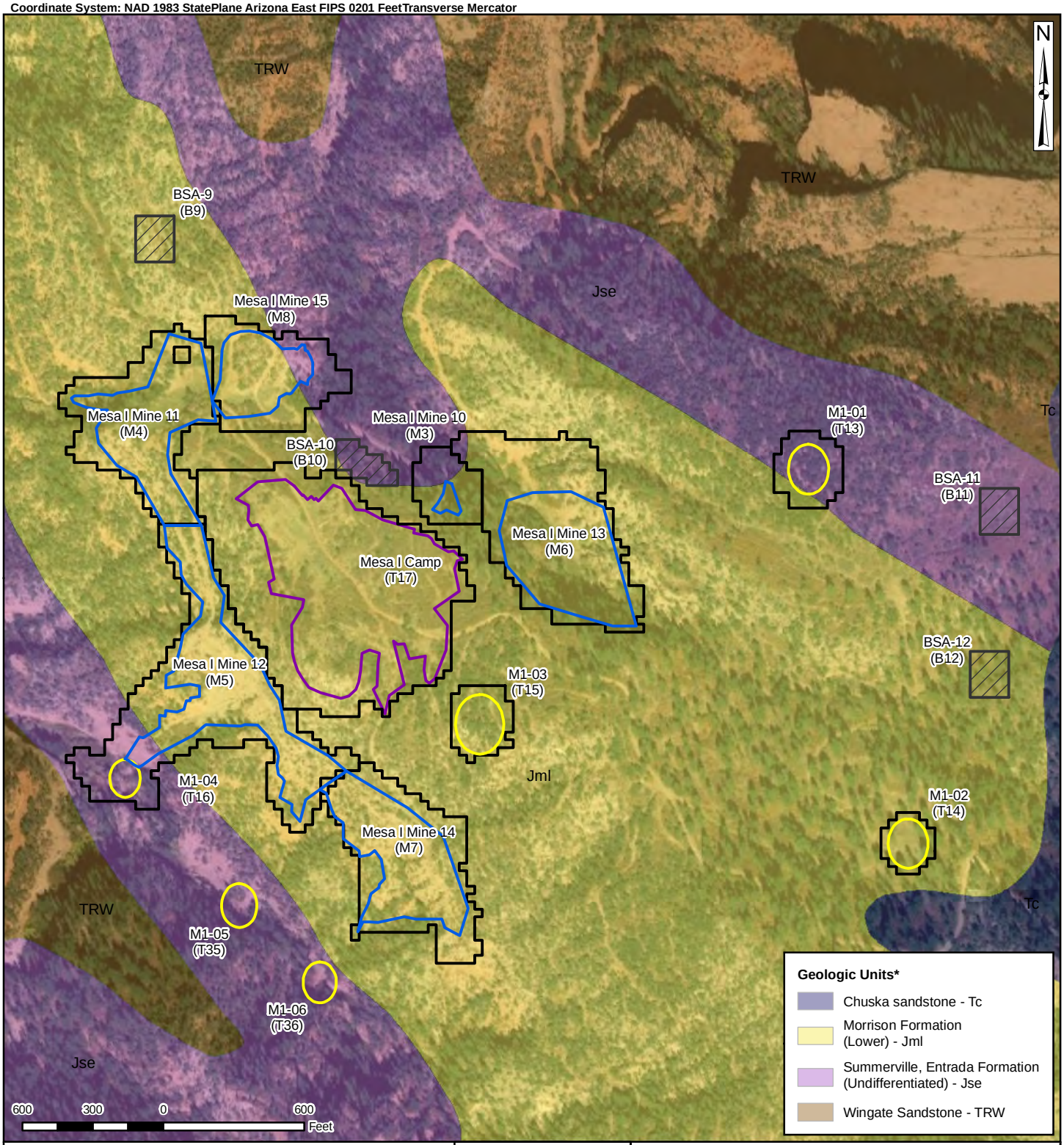
Figure I-19. Idealized Stratigraphic Profile of the Lukachukai Mountains

Uranium ore bodies are clustered and typically found at heads of canyons or near back ends of mesas 30 to 80 feet above the base of the Jms. Uranium ore bodies have the following characteristics (Neptune and TSG 2018):

- Elongated, horizontally lenticular orebodies that occur parallel to paleochannel trends and consist of one or more pods or shoots separated by proto-ore
- Many ore shoots within ore bodies that deviate from paleochannel trends and parallel a joint set, suggesting ore redistribution
- Composite ore bodies that may be as long as 1,100 feet with individual ore shoots of 350-foot length; their widths are typically at least one-third of their lengths and range to as much as 22 feet thick.
- Nearly all ore bodies are found in trough-type, cross-stratified sandstones that fill scours and channels in the underlying claystone and/or siltstone units.

Figure I-20, I-22, I-24, I-26, and I-28 show the regional geological formations within Subarea Groups D, F, G, H, and I of the Lukachukai Mountains. Figure I-21, I-23, I-25, I-27, and I-29 show the soil types within Subarea Groups D, F, G, H, and I of the Lukachukai Mountains. BSAs identified during the background investigation (Appendix A of the RSE Report) are also shown on each map. Each BSA was selected based on geographic location within a geology and soil type that matched a specific AUM or group of AUMs.

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



Non-AUM Target Site Boundary
AUM Site Boundary
AUM Related Boundary
Survey Area Boundary
Background Study Area

*O'Sullivan, R.B., and Beikman, H.M. (1963). *Geology, structure, and uranium deposits of the Shiprock quadrangle, New Mexico and Arizona* . From the USGS/AASG National Geologic Map Database. Accessed 01/10/2018.

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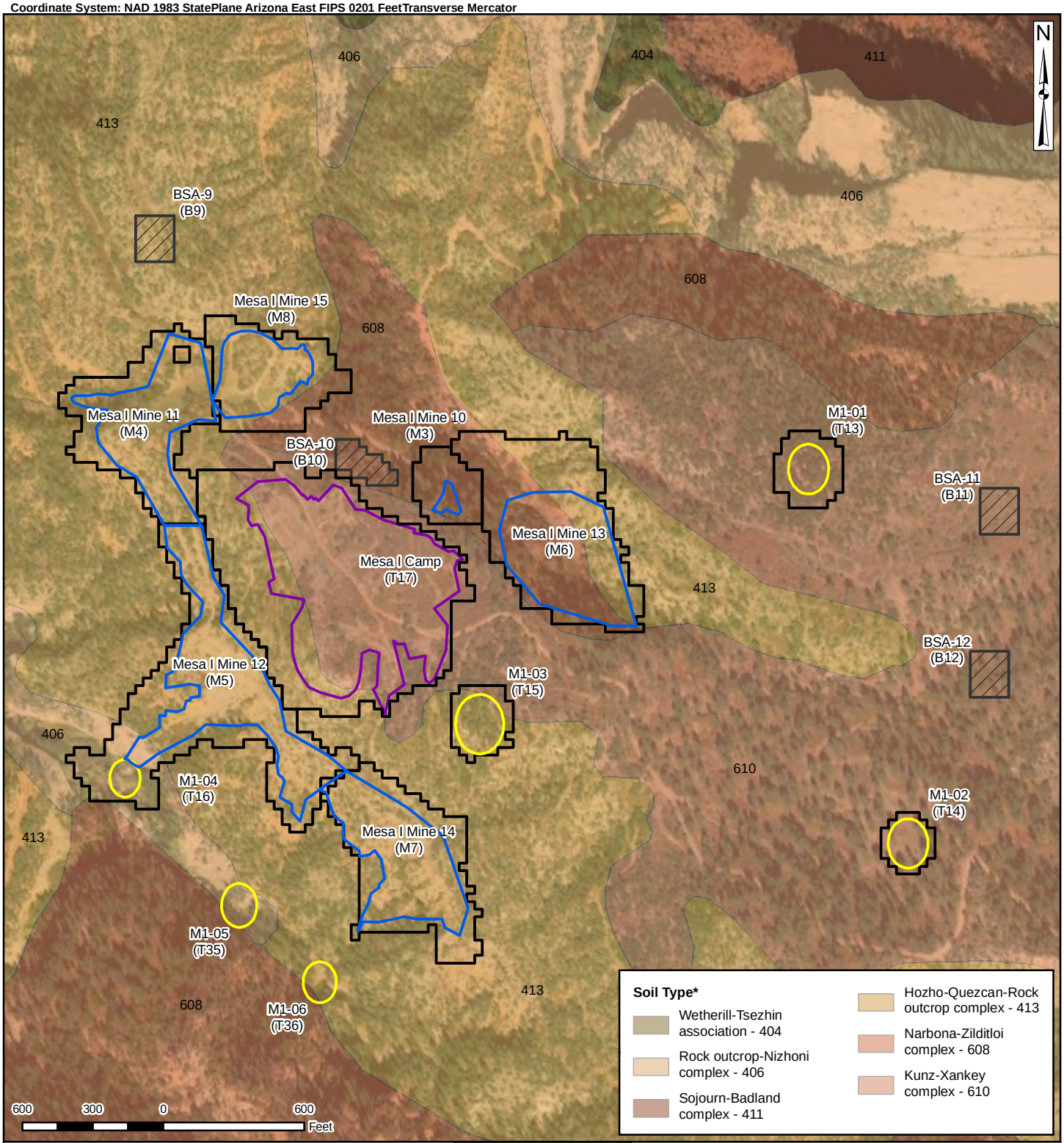
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GEOLOGIC MAP FOR GROUP D NON-AUM TARGETS

Task Order No.:	Contract No.:	I-20
TO0001	EP-S9-17-03	I-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	

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



Non-AUM Target Site Boundary
AUM Site Boundary
AUM Related Boundary
Survey Area Boundary
Background Study Area

*Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic SSURGO) Database for Arizona. Available online. Accessed 1/10/2018.

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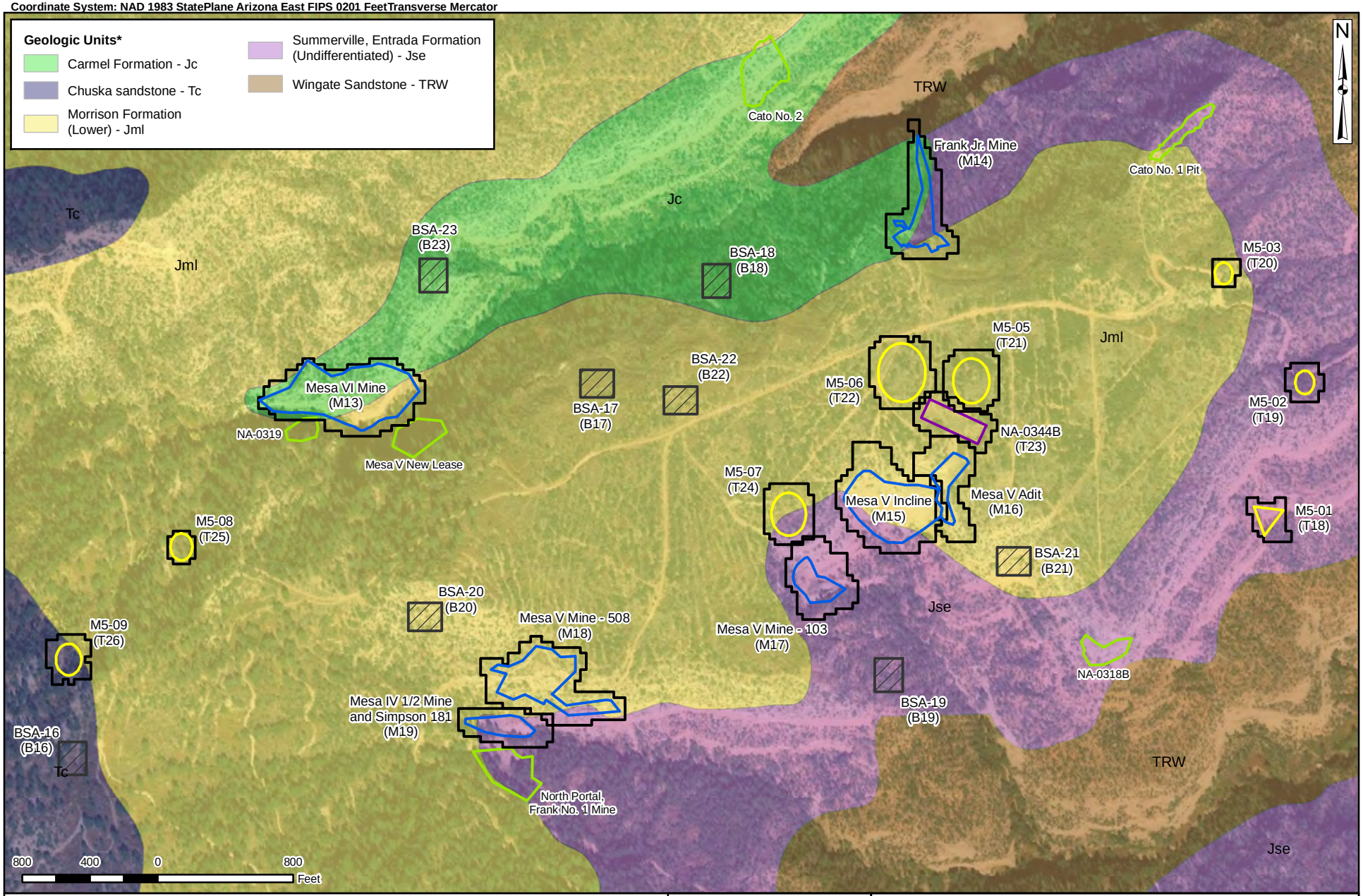
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SOILS MAP FOR GROUP D NON-AUM TARGETS

Task Order No.:	Contract No.:	I-21
TO0001	EP-S9-17-03	I-21
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	

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



Non-AUM Target Site Boundary
AUM Site Boundary
AUM Related Boundary
Survey Area Boundary
Background Study Area
Non-Tronox AUM Site

*O'Sullivan, R.B., and Beikman, H.M. (1963). Geology, structure, and uranium deposits of the Shiprock quadrangle, New Mexico and Arizona . From the USGS/AASG National Geologic Map Database. Accessed 01/10/2018.

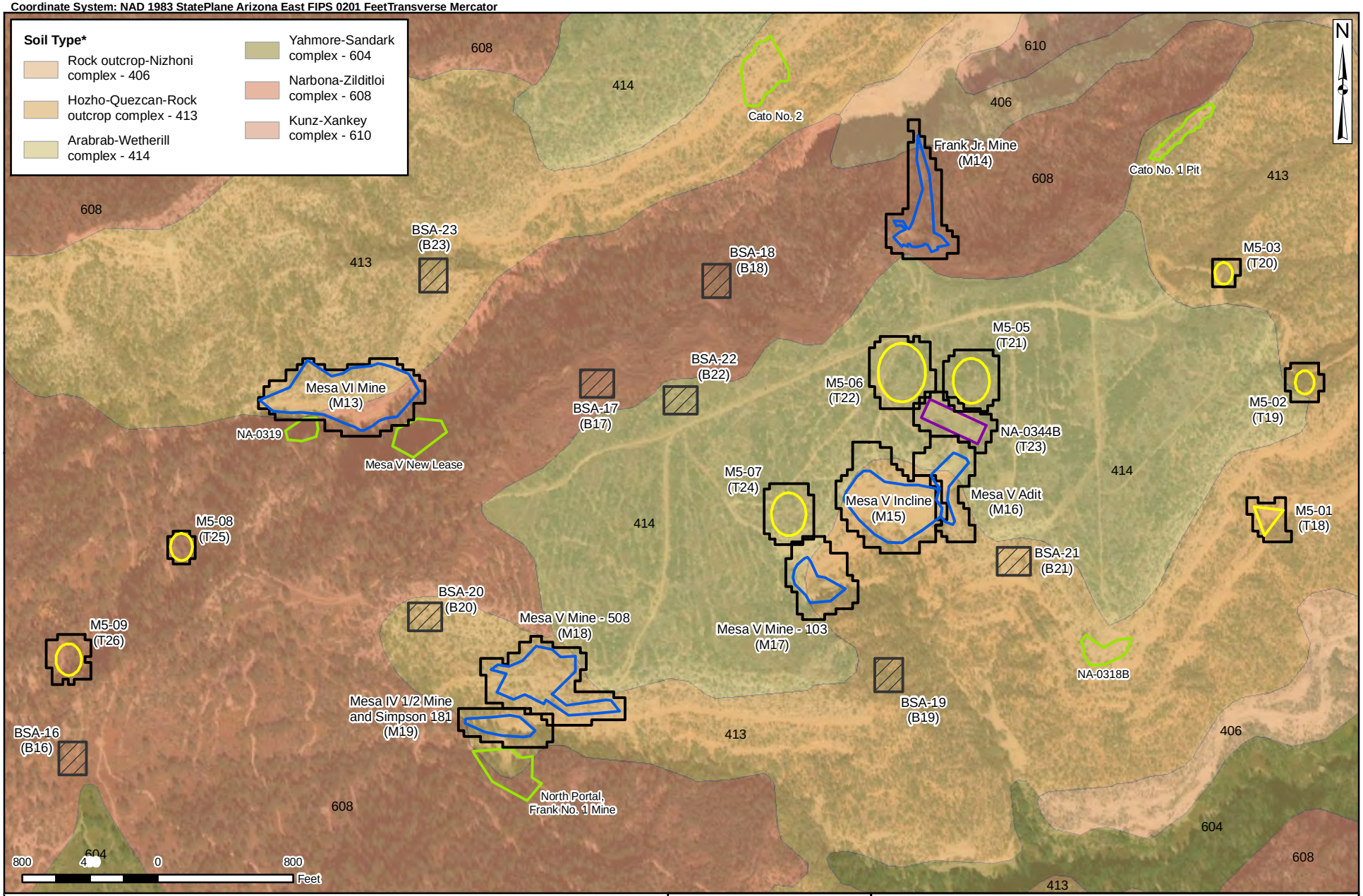
Prepared for:

Prepared By:
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Oakland, CA 94612

GEOLOGIC MAP FOR GROUP F NON-AUM TARGETS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-22
Location: COVE CHAPTER NAVAJO NATION	Date: 7/9/2019	

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



Non-AUM Target Site Boundary
AUM Site Boundary
AUM Related Boundary
Survey Area Boundary
Background Study Area
Non-Tronox AUM Site

*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

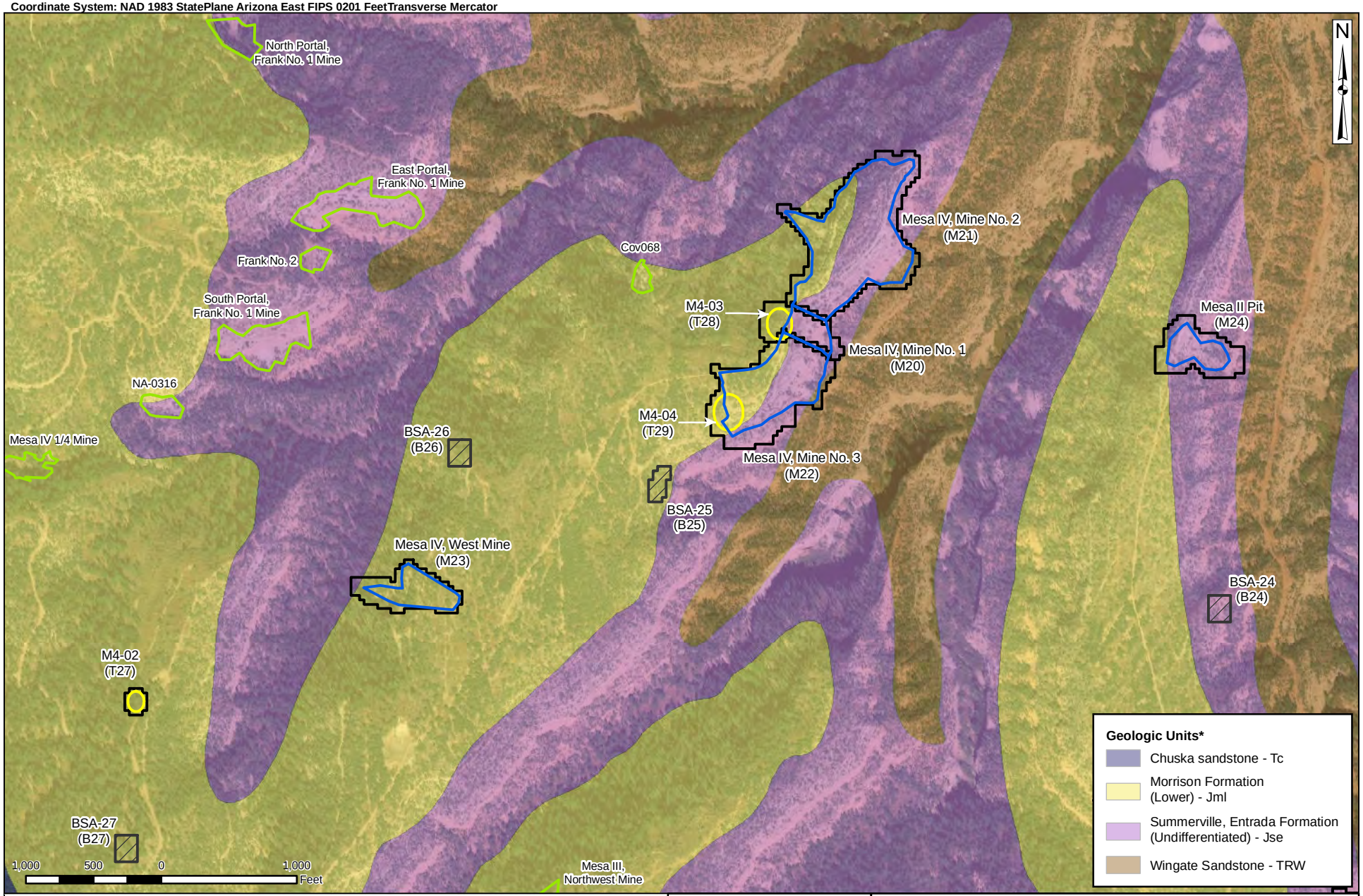
Prepared for:

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SOILS MAP FOR GROUP F NON-AUM TARGETS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	

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



Non-AUM Target Site Boundary
AUM Site Boundary
Survey Area Boundary
Background Study Area
Non-Tronox AUM Site

*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

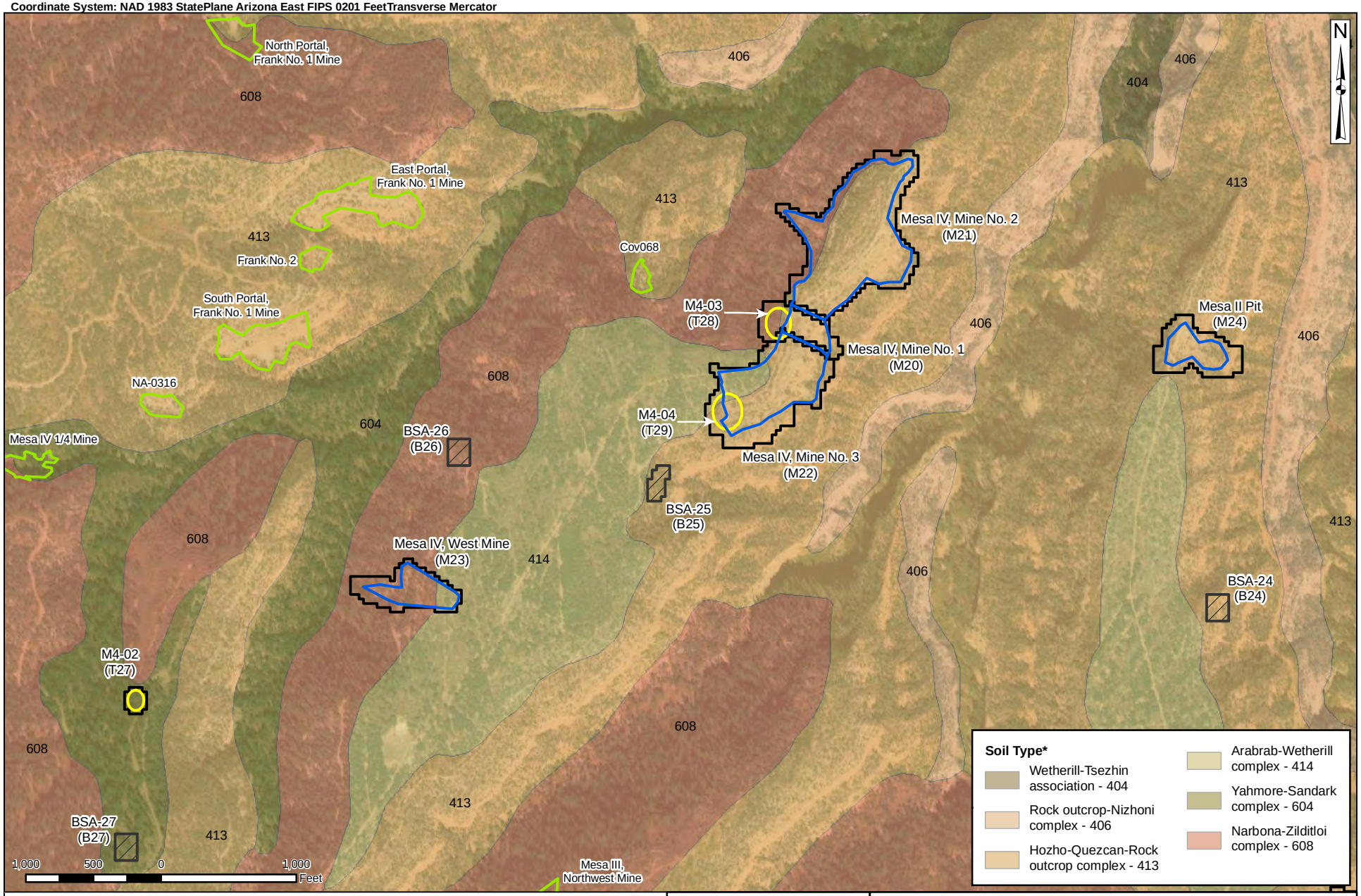
Prepared for:

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GEOLOGIC MAP FOR GROUP G NON-AUM TARGETS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-24
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	

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



Non-AUM Target Site Boundary
AUM Site Boundary
Survey Area Boundary
Background Study Area
Non-Tronox AUM Site

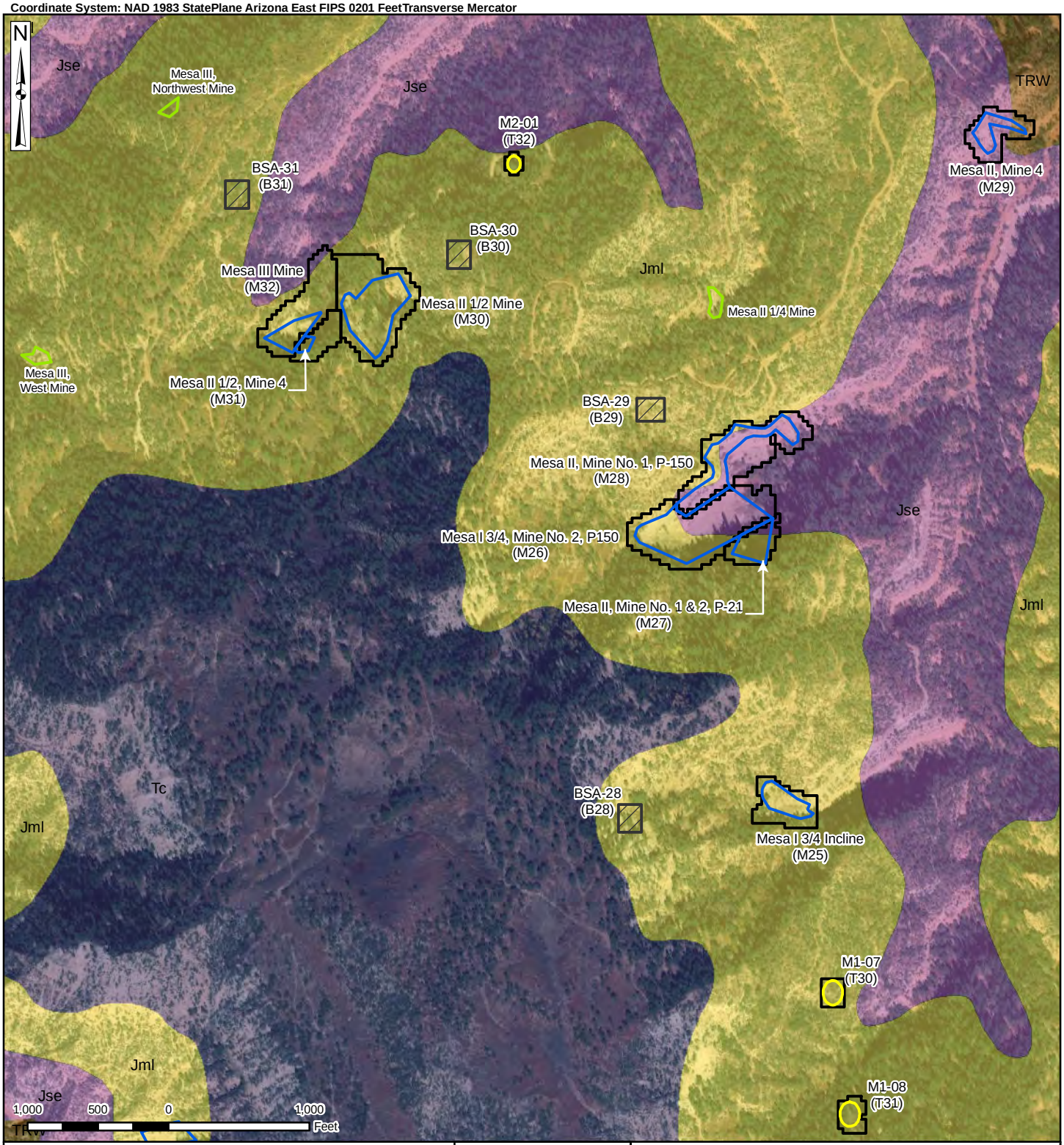
*Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. *Soil Survey Geographic (SSURGO) Database for Arizona*. Accessed 1/10/2018. https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Prepared for:

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

SOILS MAP FOR GROUP G NON-AUM TARGETS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I-25
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	



Geologic Units*

- Chuska sandstone - Tc
- Morrison Formation (Lower) - Jml
- Summerville, Entrada Formation (Undifferentiated) - Jse
- Wingate Sandstone - TRW

- Non-AUM Target Site Boundary
- AUM Site Boundary
- Survey Area Boundary
- Background Study Area
- Non-Tronox AUM Site

*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

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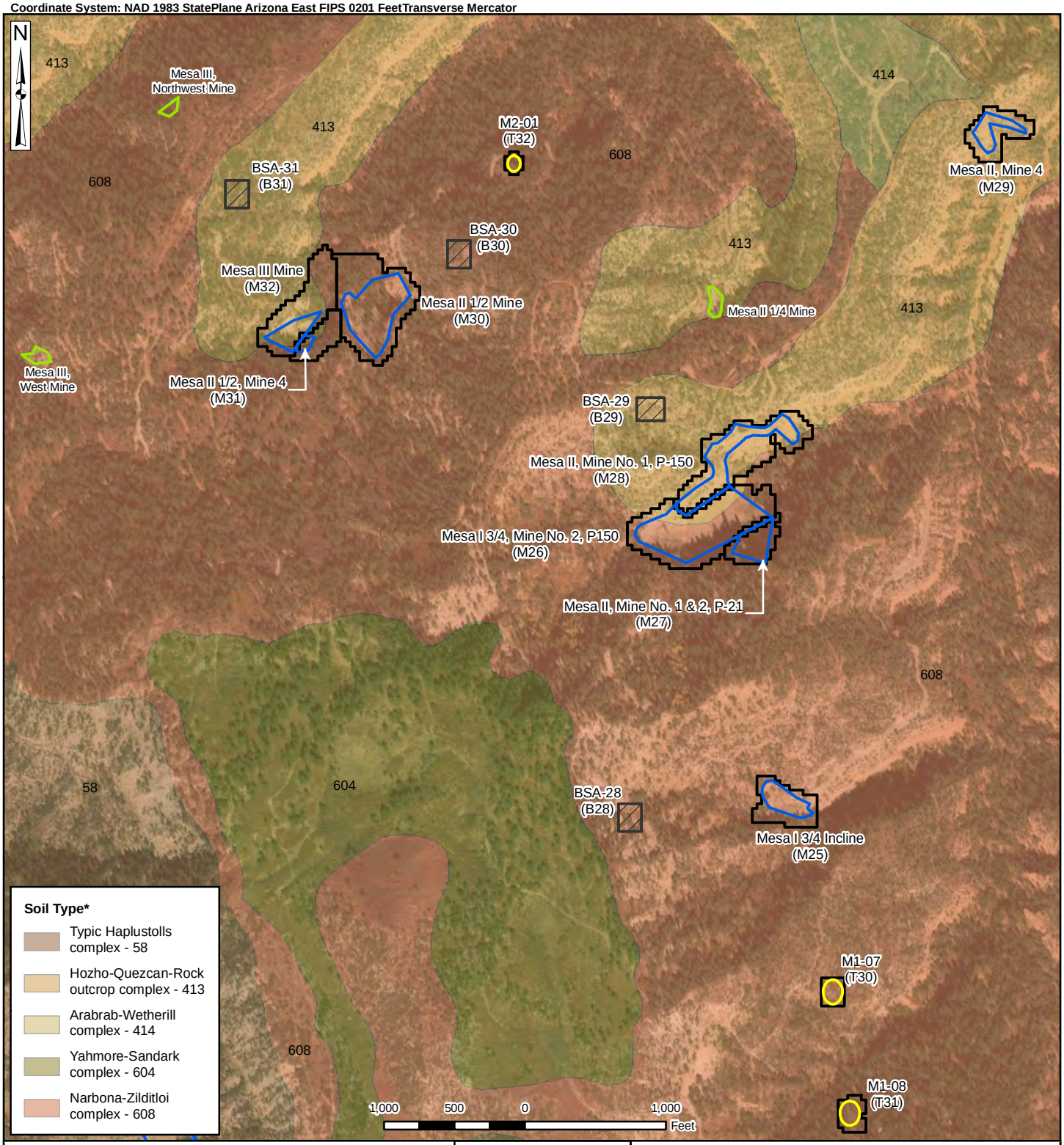
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GEOLGOIC MAP FOR GROUP H NON-AUM TARGETS

Task Order No.:	Contract No.:	I-26
TO0001	EP-S9-17-03	I-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	

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



Non-AUM Target Site Boundary
AUM Site Boundary
Survey Area Boundary
Background Study Area
Non-Tronox AUM Site

*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

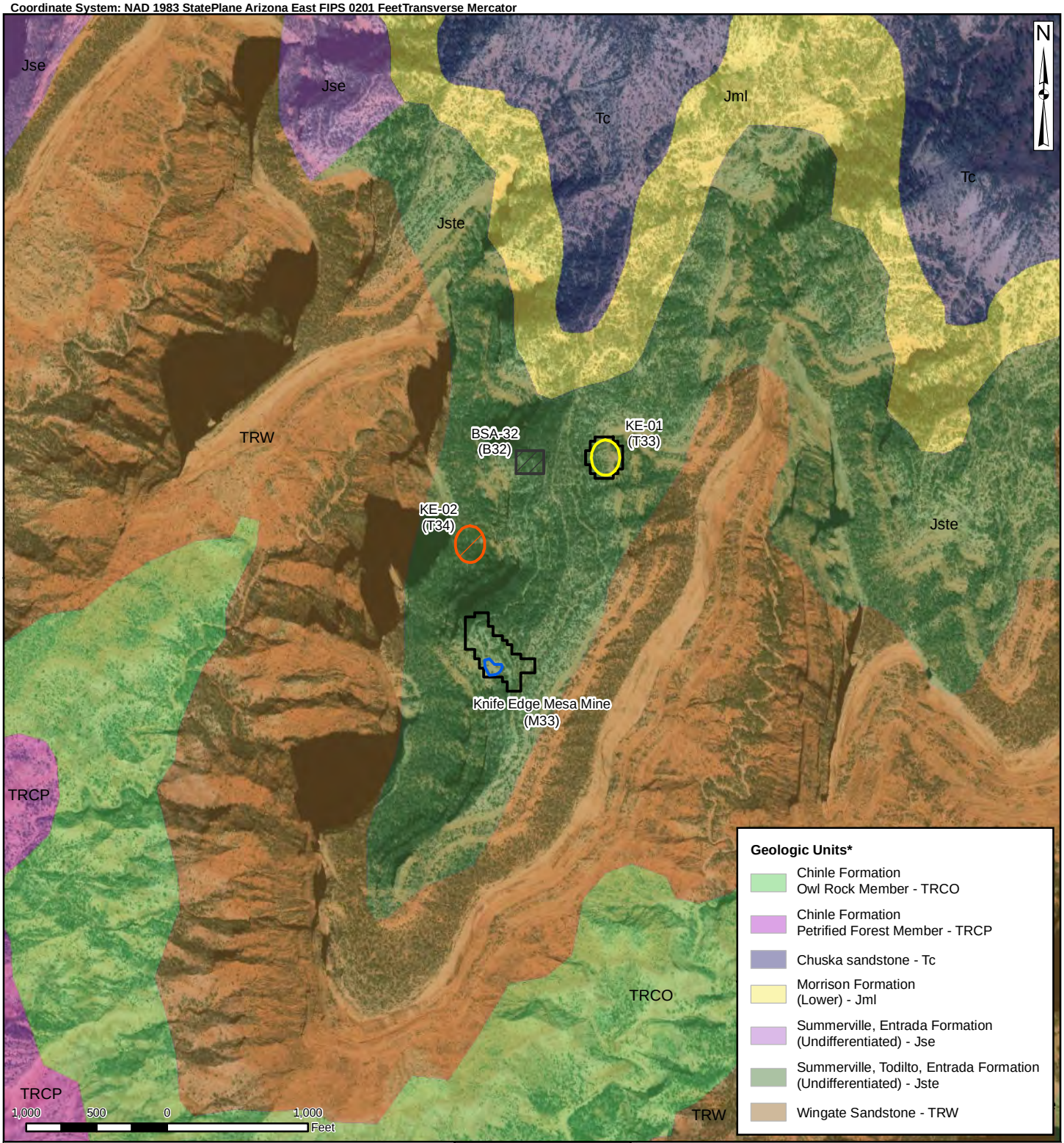
Prepared for: U.S. EPA Region 9

Prepared By:

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SOILS MAP FOR GROUP H NON-AUM TARGETS

Task Order No.:	Contract No.:	I-27
TO0001	EP-S9-17-03	I-27
Location: COVE CHAPTER NAVAJO NATION	Date: 6/26/2019	



Non-AUM Target Site Boundary

Non-AUM Target Site Boundary - *Inaccessible*

AUM Site Boundary

Survey Area Boundary

Background Study Area

*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

Prepared for: U.S. EPA Region 9

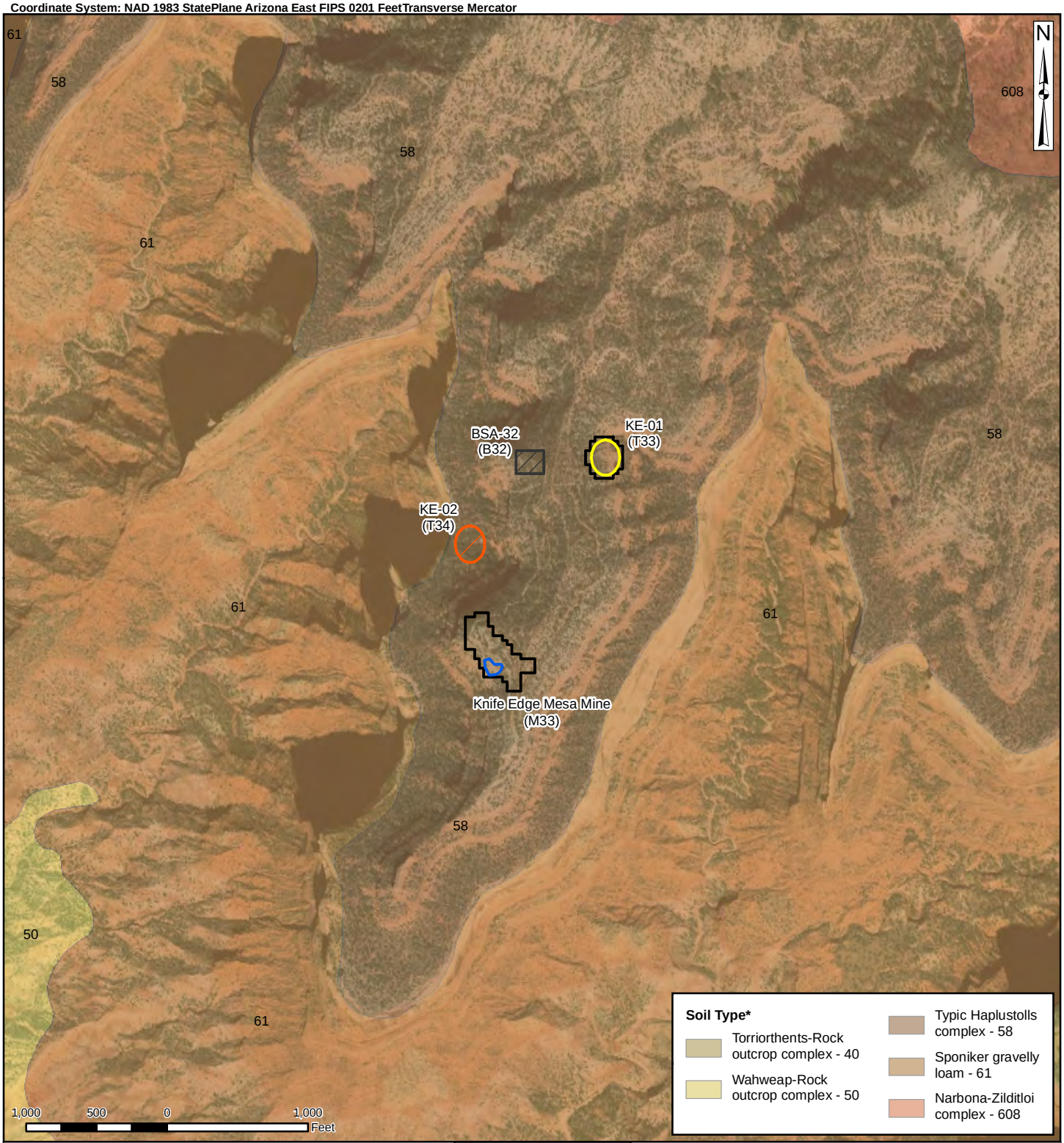
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GEOLOGIC MAP FOR GROUP I NON-AUM TARGETS

Task Order No.:	Contract No.:	I-28
TO0001	EP-S9-17-03	I-28
Location: LUKACHUKAI CHAPTER NAVAJO NATION	Date: 6/18/2019	

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



Non-AUM Target Site Boundary

Non-AUM Target Site Boundary - *Inaccessible*

AUM Site Boundary

Survey Area Boundary

Background Study Area

*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

Prepared for: U.S. EPA Region 9

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SOILS MAP FOR GROUP I NON-AUM TARGETS

Task Order No.:	Contract No.:	I-29
TO0001	EP-S9-17-03	I-29
Location: LUKACHUKAI CHAPTER NAVAJO NATION	Date: 6/26/2019	

3.4 DEVELOPMENT OF 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 Target-specific background investigation and a regional background investigation. Based on geospatial analysis, the underlying soils of each non-AUM Target was determined based on the geological formation and soil type. Local geology and soils for non-AUM Targets are identified in Section 3.3. A Target-specific BSA was then evaluated for each particular combination of geology and soil type. Additionally, a regional geological background was developed for each geologic formation.

Appendix A of the RSE Report presents the Target-specific and regional geological BTVs. The BTVs were estimated based on soil sampling and gamma radiation survey results. The BTVs calculated were typically based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at each non-AUM Target. Table I-10 identifies the primary and secondary geologies, regional BTV applied, Target-specific BTV applied, and applied gamma BTV for each non-AUM Target. Target-specific analytes and gamma radiation levels for applied BTVs are presented in Section 4.0 through Section 11.0.

Table I-10. Applied Background Threshold Value Summary Table

Tetra Tech ID	Non-AUM Target Name	Site Group	Survey Area (acres)	Primary Geology			Secondary Geology			Regional BTV(s) Applied	Site Specific BTV(s) Applied	Applied Gamma BTV Selection	Applied Gamma BTV
				Symbol	Acres	% Contained	Symbol	Acres	% Contained				
T1	BR-01	A	4.00	Qa	4.0	100%	-	-	-	None	BSA-2	BSA-2	9,660
T3	BR-03		0.49	Jms	0.5	100%	-	-	-	None	BSA-1	BSA-1	10,287
T4	BR-04		2.59	Jms	2.6	100%	-	-	-	None	BSA-1	BSA-1	10,287
T5	BR-05		1.09	Jms	1.1	100%	-	-	-	None	BSA-1	BSA-1	10,287
T6	BR-06		1.41	Js	1.1	81%	Qa	0.3	19%	None	BSA-4	BSA-4	8,673
T7	BK-01	B	2.10	Qa	2.1	100%	-	-	-	None	BSA-5	BSA-5	11,010
T8	BK-02		2.13	Qa	2.1	100%	-	-	-	None	BSA-5	BSA-5	11,010
T10	CT-01	C	2.74	Trc	2.7	100%	-	-	-	Trc	BSA-7	Trc	11,019
T11	CT-02		1.48	Trc	1.5	100%	-	-	-	Trc	BSA-7	Trc	11,019
T12	CT-03		0.30	Trc	0.3	100%	-	-	-	Trc	BSA-8	Trc	11,019
T13	M1-01	D	1.85	Jse	1.5	82%	Jml	0.3	18%	Jse	BSA-11	BSA-11	10,611
T14	M1-02		1.09	Jml	1.1	100%	-	-	-	Jml	BSA-12	Jml	14,566
T15	M1-03		1.63	Jml	1.6	100%	-	-	-	Jml	BSA-9	Jml	14,566
T18	M5-01	F	1.16	Jse	1.2	100%	-	-	-	Jse	BSA-19	BSA-19	11,319
T19	M5-02		1.04	Jse	1.0	100%	-	-	-	Jse	BSA-19	BSA-19	11,319
T20	M5-03		0.57	Jml	0.6	98%	Jse	0.01	2%	Jml	BSA-21	Jml	14,566
T21	M5-05		2.47	Jml	2.5	100%	-	-	-	Jml	BSA-22	BSA-22	11,907
T22	M5-06		3.26	Jml	3.3	100%	-	-	-	Jml	BSA-22	BSA-22	11,907
T24	M5-07		2.25	Jml	1.2	55%	Jse	1.0	45%	Jml and Jse	BSA-22	BSA-22	11,907
T25	M5-08		0.64	Jml	0.6	100%	-	-	-	Jml	BSA-17	BSA-17	11,528
T26	M5-09		1.51	Tc	1.1	73%	Jml	0.4	27%	None	BSA-16	BSA-16	12,473
T27	M4-02	G	0.64	Jml	0.6	100%	-	-	-	Jml	BSA-27	BSA-27	12,303
T30	M1-07	H	0.74	Jml	0.7	100%	-	-	-	Jml	BSA-30	BSA-30	11,378
T31	M1-08		1.06	Jml	1.1	100%	-	-	-	Jml	BSA-30	BSA-30	11,378
T32	M2-01		0.40	Jml	0.4	100%	-	-	-	Jml	BSA-30	BSA-30	11,378
T33	KE-01	I	1.43	Jste	1.4	100%	-	-	-	Jste	BSA-32	BSA-32	20,165

Notes:

-	No data
BSA	Background Study Area
BTV	background threshold value
cpm	counts per minute
Jml	Jurassic Lower Morrison Formation
Jms	Jurassic Salt Wash Member of the Lower Morrison Formation
Js	Jurassic Summerville Formation
Jse	Jurassic Undifferentiated Summerville and Entrada
Jste	Jurassic Undifferentiated Summerville, Todilto, and Entrada Sandstone
mg/kg	milligrams per kilogram
Qa	Quaternary alluvium
pCi/g	picocuries per gram
Tc	Triassic Chuska Formation
Trc	Triassic Chinle Formation

4.0 GROUP A FIELD SAMPLING RESULTS

This section presents the field sampling results for Group A Targets T1 (BR-01), T3 (BR-03), T4 (BR-04), T5 (BR-05), and T6 (BR-06). Non-AUM Target T2 (BR-02) is included in the Site-Specific Removal Site Evaluation (SSRSE) Report for Brodie 1 Mine (M1) in Appendix H1 of the RSE Report.

4.1 NON-AUM TARGET T1 (BR-01)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs at non-AUM Target T1 (BR-01).

4.1.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T1 (BR-01) is associated with the Brodie 1 Mine (M1), a former underground mine in the Tse Tah Region in Subarea Group A. Five other non-AUM Targets are associated with Brodie 1 Mine. Target T1 is administered by the Red Mesa and Sweetwater Chapters of the Navajo Nation and is accessible by vehicle via Highway 160, which is located immediately southeast. Target T1 is identified in the MCAP report (Weston 2016), but no known historical information is associated with the Target. A residence is located 800 feet to the northwest. A Target location and access map for Target T1 is shown in Figure I1-1.

A topographical relief map of the Brodie 1 Mine area and associated non-AUM Targets is provided in Figure I1-2. Target T1 appears to be a soil borrow area for the highway department. The elevation at Target T1 ranges from 5,862 to 5,865 feet amsl with an average of 5,863 feet amsl, and the slope ranges from 3 to 7 percent with an average of 4.5 percent. An ephemeral drainage channel is located approximately 0.5 mile northwest of Target T1. The Brodie 1 Mine is located entirely within the Js and the rock outcrop-Rizno complex soils unit, and Target T1 is located entirely within Qa and Marjane-Kitsili complex soils unit (map unit symbol [MUSYM] 313) (Figure I-13 and Figure I-14). The soils are thin and overly the Jms, which is exposed at the bottom of the soil borrow area comprising Target T1.

Tetra Tech performed a geospatial analysis of the 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T1. Weston did not conduct a background study for Target T1. As part of the RSE for the Brodie 1 Mine, Tetra Tech also evaluated the associated non-AUM Targets, such as T1. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T1:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T1 is accessed directly from Highway 160 to the southeast. A fence line must be crossed. Alternate access is from a residential access road to the northwest.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM was observed at the bottom of the soils borrow area. NORM was uncovered by the highway road department. TENORM was not identified.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  No drainages were located on or adjacent to the Target; the Tse Tah West drainage was located approximately 0.5 mile to the northwest (Figure I1-1) and is evaluated in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

  No exploratory borings or haul roads were identified. The Target was a former soil borrow area.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  The Target is a soil borrow area that has exposed underlying Salt Wash Member of the Morrison Formation, which contains NORM.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

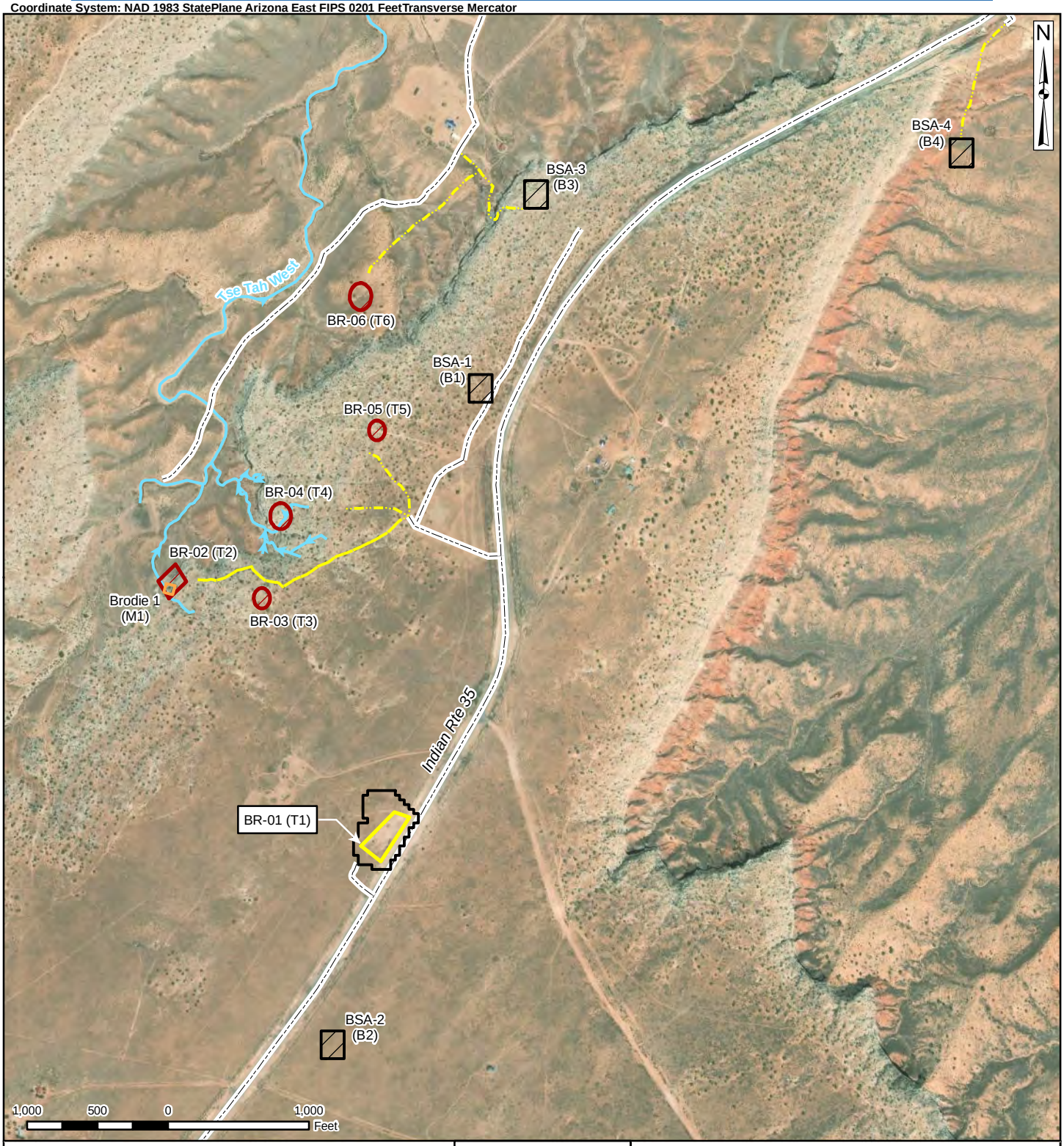
  No mine waste was identified. The soils borrow area covers 0.8 acre with a depth ranging from 2 to 5 feet.

The Baseline Study field survey, measurement, and sampling activities at Target T1 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Section 2.3 and Section 4.1.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 4.1.3 with results presented in Section 4.1.6 and Section 4.1.7)
- Collecting surface soil samples to six inches and subsurface soil samples to six to twelve inches bgs (described in Section 4.1.3 with results presented in Section 4.1.6)
- Conducting a gamma radiation survey (results presented in Section 4.1.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



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

Prepared for: USEPA Region 9

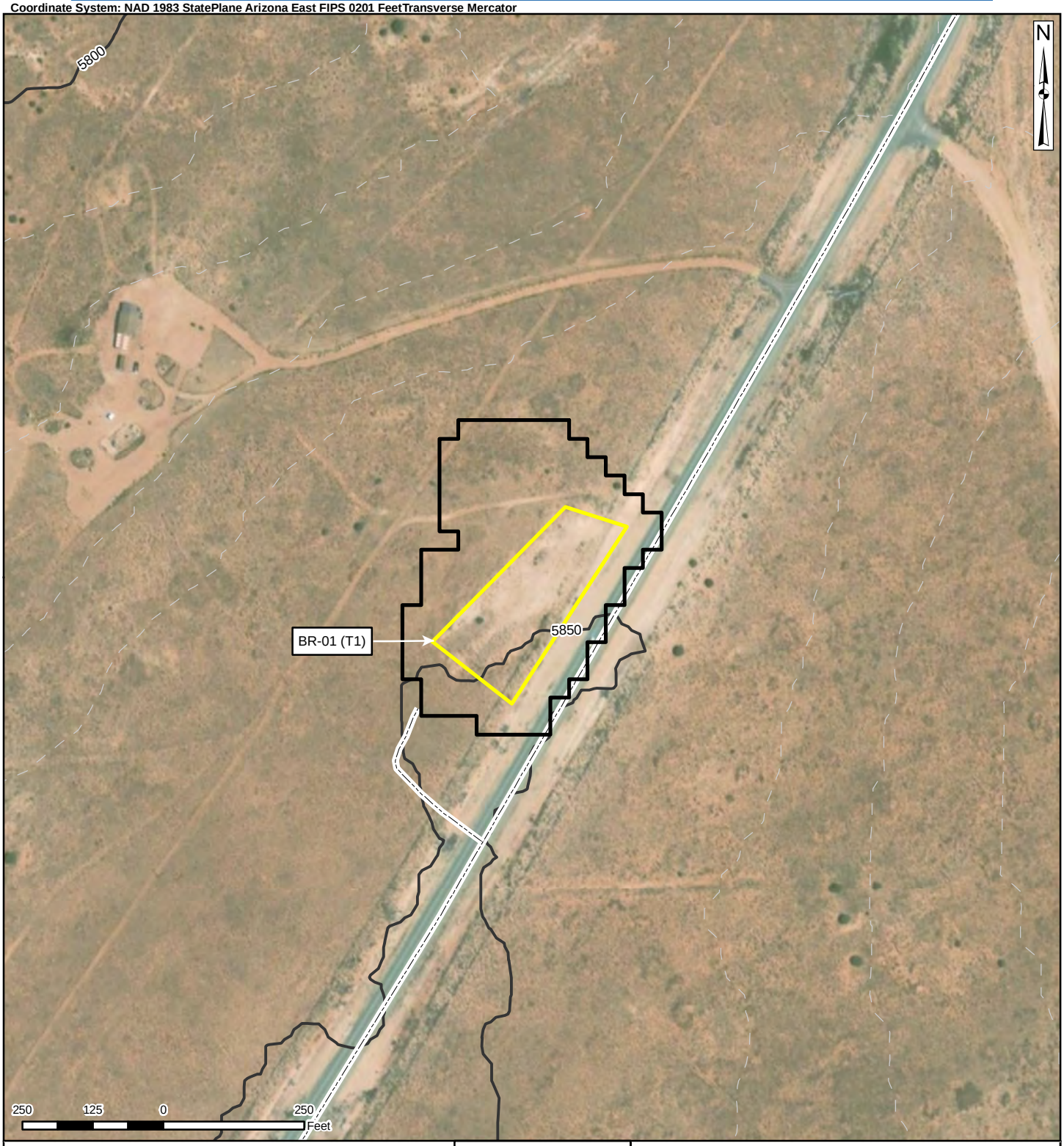
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NON-AUM TARGET BR-01 (T1) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I1-1
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

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



Non-AUM Target Site Boundary
Related Survey Area
Access Route - Vehicular
50 ft Contour*
10 ft Contour*

* 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.

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NON-AUM TARGET BR-01 (T1) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I1-2
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.1.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I1-3) within the survey area of the non-AUM Target T1 as part of the Baseline Study in May 2018. Additional Goback gamma radiation surveys were performed in August 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T1 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I1-4). The initial gamma survey area and XRF survey units are identified in Appendix F, FSP 1, of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at 58 survey units. All gamma survey and XRF survey units were evaluated.

4.1.3 XRF Confirmation and Soils Sampling Overview

Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T1. Eight XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from seven locations (Table I1-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figure I1-4 identifies the locations of in situ XRF measurements and XRF confirmation soil samples. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I1-2. A subset of XRF confirmation samples were also submitted for analysis of mercury and select additional radionuclides. The results of XRF confirmation sample analysis are provided in Section 4.1.6 and XRF field survey summary statistics in Section 4.1.7. Correlated XRF field measurements are provided in Attachment I3.

Tetra Tech also collected five surface and one shallow subsurface soil samples at five locations (as show in Table I1-3 and Table I1-4) at non-AUM Target T1 following the field protocol described in Sections 2.5.2 and Section 2.5.3. Figure I1-5 shows the locations of surface and subsurface soil samples. Surface soil and subsurface samples were submitted for laboratory analysis of metals (Table I1-5). One surface sample was also submitted for extended analysis of select radionuclides (Table I1-6), SPLP and TCLP metals (Table I1-7), SPLP radionuclides (Table I1-8), and geochemical parameters (Table I1-7). The results of soil sample analysis are provided in Section 4.1.6.

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

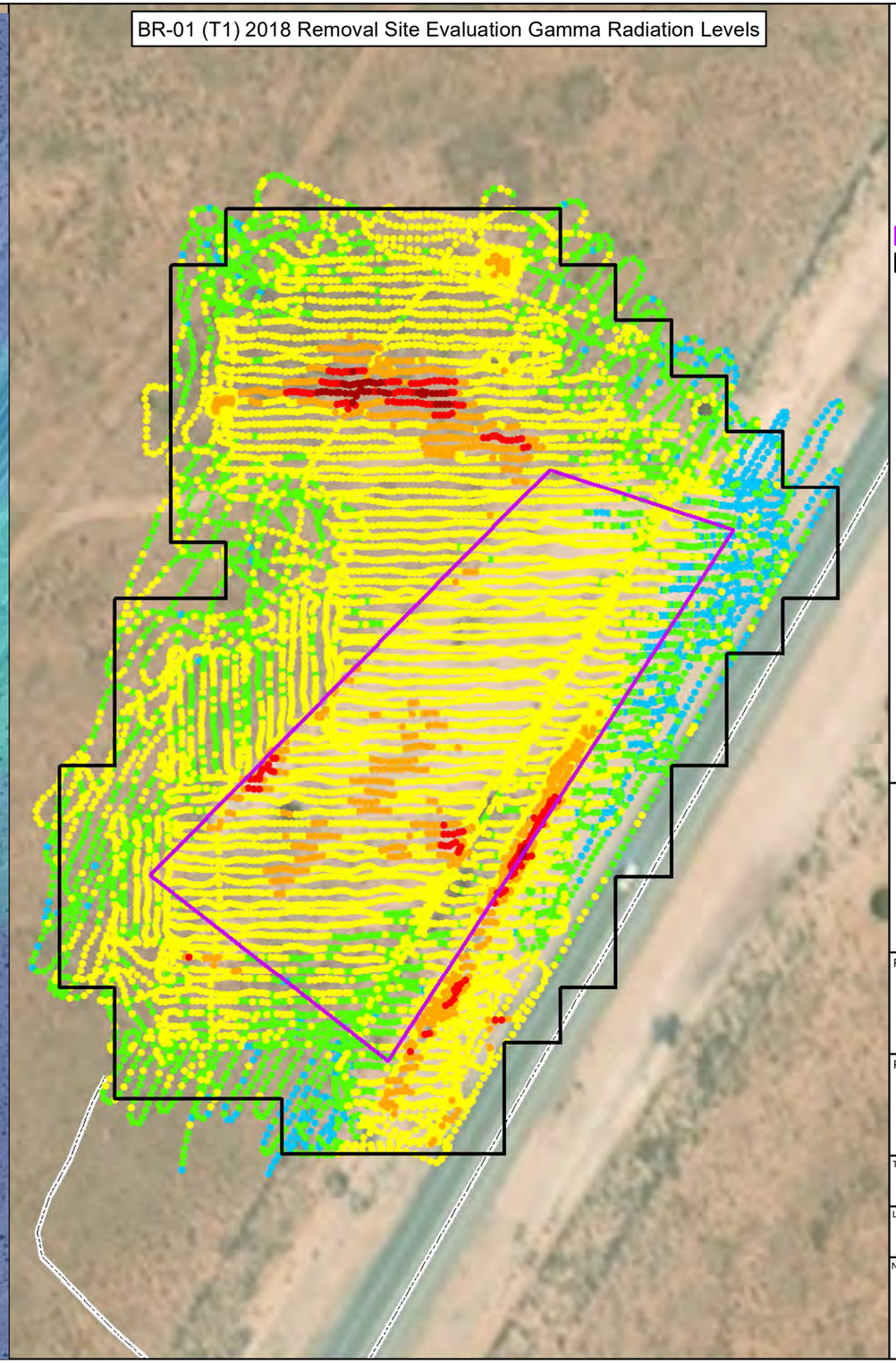
BR-01 (T1) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F6Z6bK1-37r



BR-01 (T1) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)[1]

≤ 7,954	≤ Avg. BG
7,954 - 9,660	Avg. BG - 1 x BTV
9,660 - 19,320	1 x BTV - 2 x BTV
19,320 - 28,980	2 x BTV - 3 x BTV
28,980 - 38,640	3 x BTV - 4 x BTV
38,640 - 96,660	4 x BTV - 10 x BTV
≥ 96,660	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Vehicular

[1]The applied gamma background threshold value (BTV) for BR-01 (T1) Non-AUM Target is 9,660 cpm derived from BSA-2 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 80 ft

1:960

N W E S

0 40 80 160 Feet

NON-AUM TARGET BR-01 (T1) 2018 REMOVAL SITE EVALUATION AND ASPECT GAMMA RADIATION LEVELS SURVEY MAP

Prepared For:

Prepared By:

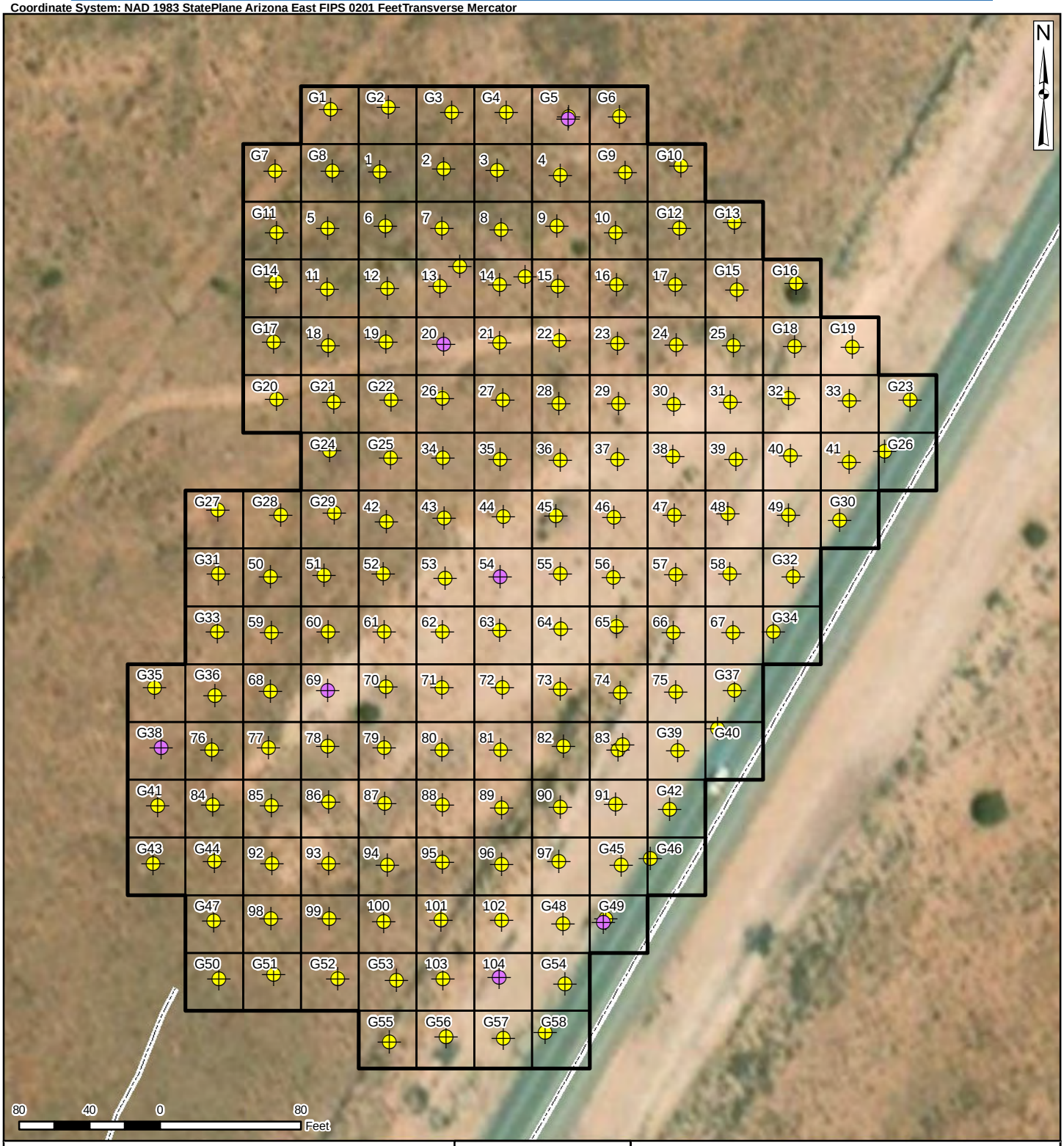
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborn Spectral Photometric Environmental Collection Technology.

Figure No.: **I1-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

Prepared for: USEPA Region 9

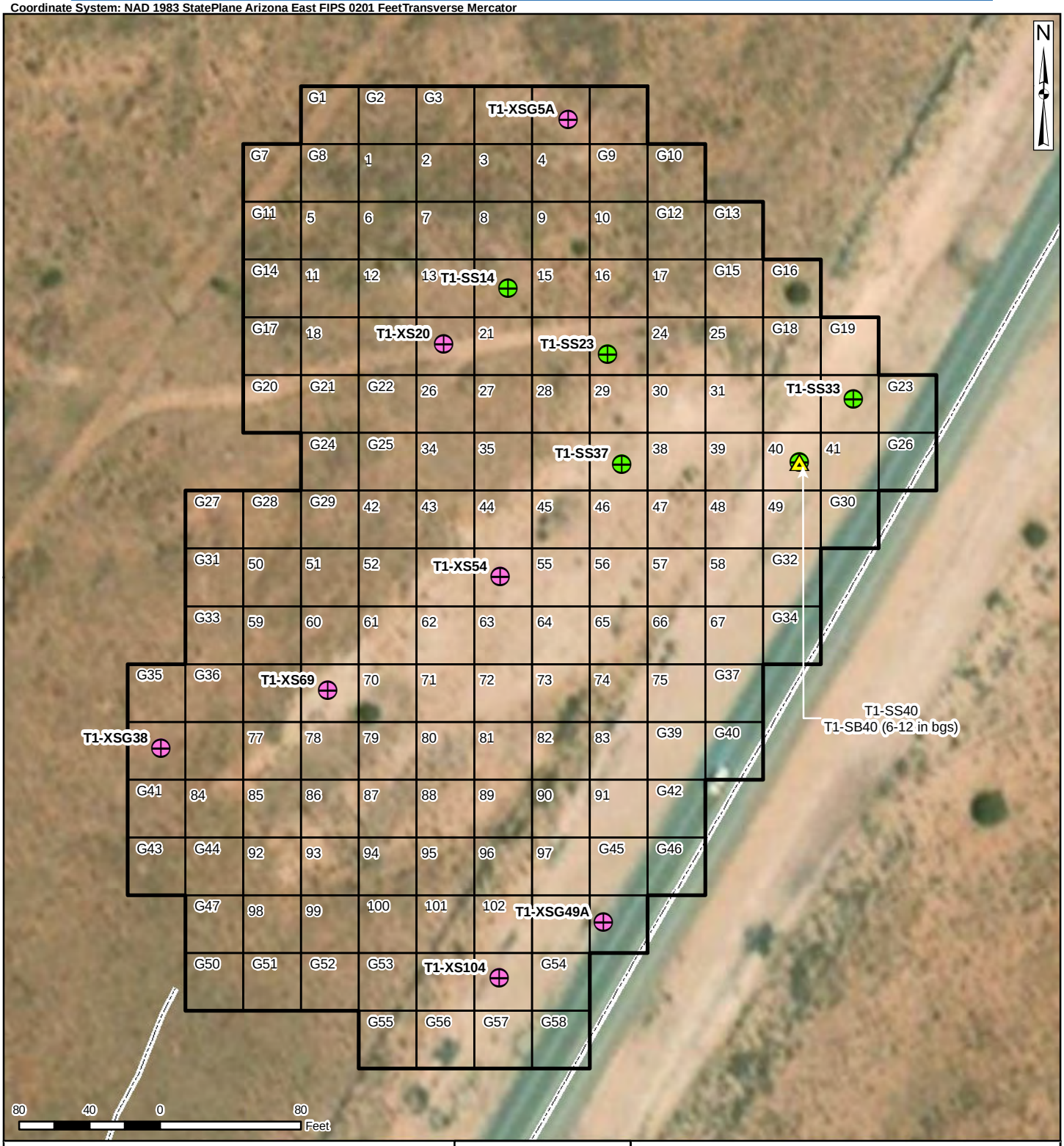
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NON-AUM TARGET BR-01 (T1)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I1-4
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

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



XRF Confirmation Soil Sample[1] (0 - 3 inches bgs)

Surface Soil Sample[2] (0 - 6 inches bgs)

Borehole Location

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

[1]T1-XS20 = site T1 XRF confirmation soil sample collected at survey unit 20. 0 - 3 in bgs = 0 to 3 inches below ground surface.
[2]T1-SS14 = site T1 surface soil sample collected at survey unit 14%. 0 - 6 in bgs = 0 to 6 inches below ground surface.

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NON-AUM TARGET BR-01 (T1) SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I1-5
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/13/2019	

Table I1-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target BR-01 (T1)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T1-XS20-01-051318	20	0-3	XRF Confirmation	Primary	5/13/2018	36.901523	-109.3476019	1805327-11, 1805328-11
T1-XS54-01-051318	54	0-3	XRF Confirmation	Primary	5/13/2018	36.901159	-109.3474960	1805327-12, 1805328-12
T1-XS54-02-051318	54	0-3	XRF Confirmation	Duplicate	5/13/2018	36.901159	-109.3474960	1805327-13, 1805328-13
T1-XS69-01-051318	69	0-3	XRF Confirmation	Primary	5/13/2018	36.900985	-109.3478326	1805327-14, 1805328-14
T1-XS104-01-051318	104	0-3	XRF Confirmation	Primary	5/13/2018	36.900534	-109.3475043	1805327-10, 1805328-10
T1-XSG5A-01-081918	G5A	0-3	XRF Confirmation	Primary	8/19/2018	36.901872	-109.3473561	1808483-15, 1808484-15
T1-XSG38-01-081918	G38	0-3	XRF Confirmation	Primary	8/19/2018	36.900897	-109.3481575	1808483-13, 1808484-13
T1-XSG49A-01-081918	G49A	0-3	XRF Confirmation	Primary	8/19/2018	36.900619	-109.3473014	1808483-14, 1808484-14

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I1-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BR-01 (T1)

Analyte	Type	CAS Number	Analytical Method	Number of Samples by Standard Analyses	Number of Samples by Extended Analyses
Aluminum	Metals	7429-90-5	USEPA SW-846 6020B	6	2
Antimony	Metals	7440-36-0	USEPA SW-846 6020B	6	2
Arsenic	Metals	7440-38-2	USEPA SW-846 6020B	6	2
Barium	Metals	7440-39-3	USEPA SW-846 6020B	6	2
Beryllium	Metals	7440-41-7	USEPA SW-846 6020B	6	2
Cadmium	Metals	7440-43-9	USEPA SW-846 6020B	6	2
Calcium	Metals	7440-70-2	USEPA SW-846 6020B	6	2
Chromium	Metals	7440-47-3	USEPA SW-846 6020B	6	2
Cobalt	Metals	7440-48-4	USEPA SW-846 6020B	6	2
Copper	Metals	7440-50-8	USEPA SW-846 6020B	6	2
Iron	Metals	7439-89-6	USEPA SW-846 6020B	6	2
Lead	Metals	7439-92-1	USEPA SW-846 6020B	6	2
Lead-210	Radionuclides	14255-04-0	Eichrom method	0	2
Lithium	Metals	7439-93-2	USEPA SW-846 6020B	6	2
Magnesium	Metals	7439-95-4	USEPA SW-846 6020B	6	2
Manganese	Metals	7439-96-5	USEPA SW-846 6020B	6	2
Mercury	Metals	7439-97-6	USEPA SW-846 7471A	0	2
Molybdenum	Metals	7439-98-7	USEPA SW-846 6020B	6	2
Nickel	Metals	7440-02-0	USEPA SW-846 6020B	6	2
Potassium-40	Radionuclides	13966-00-2	USEPA 901.1	6	2
Radium-226	Radionuclides	13982-63-3	USEPA 901.1	6	2
Radium-228	Radionuclides	15262-20-1	USEPA 901.1	6	2
Selenium	Metals	7782-49-2	USEPA SW-846 6020B	6	2
Silver	Metals	7440-22-4	USEPA SW-846 6020B	6	2
Sodium	Metals	7440-23-5	USEPA SW-846 6020B	6	2
Thallium	Metals	7440-28-0	USEPA SW-846 6020B	6	2
Vanadium	Metals	7440-62-2	USEPA SW-846 6020B	6	2
Zinc	Metals	7440-66-6	USEPA SW-846 6020B	6	2
Thorium	Metals	-	USEPA SW-846 6020B	6	2
Thorium-228	Radionuclides	14274-82-9	ASTM D3972 Modified	0	2
Thorium-230	Radionuclides	14269-63-7	ASTM D3972 Modified	0	2
Thorium-232[1]	Radionuclides	7440-29-1	ASTM D3972 Modified	0	2
Uranium	Metals	-	USEPA SW-846 6020B	6	2
Uranium-234	Radionuclides	13966-29-5	ASTM D3972 Modified	0	2
Uranium-235	Radionuclides	15117-96-1	ASTM D3972 Modified	0	2
Uranium-238[1]	Radionuclides	7440-61-1	ASTM D3972 Modified	0	2

Table I1-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BR-01 (T1) (Continued)

Notes:

[1] Measured via alpha spectroscopy

Green Shading identifies Extended Analyses

- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

Table I1-3. Summary of Surface Soil Sample Locations at Non-AUM Target BR-01 (T1)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T1-SS14-01-091618	14	0-6	Soil Sampling	Primary	9/16/2018	36.9016093	-109.3474763	1809453-15, 1809453-30, 1809453-31, 1809453-32, 1809454-15, 1809454-23
T1-SS23-01-091618	23	0-6	Soil Sampling	Primary	9/16/2018	36.9015049	-109.3472838	1809453-16, 1809454-16
T1-SS33-01-091618	33	0-6	Soil Sampling	Primary	9/16/2018	36.9014312	-109.3468073	1809453-17, 1809454-17
T1-SS37-01-091618	37	0-6	Soil Sampling	Primary	9/16/2018	36.9013336	-109.3472579	1809453-18, 1809454-18
T1-SS40-01-091618	40	0-6	Soil Sampling	Primary	9/16/2018	36.9013341	-109.3469136	1809453-19, 1809454-19

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I1-4. Summary of Subsurface Soil Sample Locations at Non-AUM Target BR-01 (T1)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T1-SB40-0612-01-091618	40	6-12	Soil Sampling	Primary	9/16/2018	36.9013341	-109.3469136	1809453-14, 1809454-14

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I1-5. Summary of Analytical Methods for Metals in Surface and Subsurface Soil Samples at Non-AUM Target BR-01 (T1)

Analyte	Type	CAS Number	Analytical Method	Number of Surface Soil Samples Analyzed	Number of Subsurface Soil Samples Analyzed
Aluminum	Metals	7429-90-5	USEPA SW-846 6020B	5	1
Antimony	Metals	7440-36-0	USEPA SW-846 6020B	5	1
Arsenic	Metals	7440-38-2	USEPA SW-846 6020B	5	1
Barium	Metals	7440-39-3	USEPA SW-846 6020B	5	1
Beryllium	Metals	7440-41-7	USEPA SW-846 6020B	5	1
Cadmium	Metals	7440-43-9	USEPA SW-846 6020B	5	1
Calcium	Metals	7440-70-2	USEPA SW-846 6020B	5	1
Chromium	Metals	7440-47-3	USEPA SW-846 6020B	5	1
Cobalt	Metals	7440-48-4	USEPA SW-846 6020B	5	1
Copper	Metals	7440-50-8	USEPA SW-846 6020B	5	1
Iron	Metals	7439-89-6	USEPA SW-846 6020B	5	1
Lead	Metals	7439-92-1	USEPA SW-846 6020B	5	1
Lithium	Metals	7439-93-2	USEPA SW-846 6020B	5	1
Magnesium	Metals	7439-95-4	USEPA SW-846 6020B	5	1
Manganese	Metals	7439-96-5	USEPA SW-846 6020B	5	1
Mercury	Metals	7439-97-6	USEPA SW-846 7471A	0	0
Molybdenum	Metals	7439-98-7	USEPA SW-846 6020B	5	1
Nickel	Metals	7440-02-0	USEPA SW-846 6020B	5	1
Selenium	Metals	7782-49-2	USEPA SW-846 6020B	5	1
Silver	Metals	7440-22-4	USEPA SW-846 6020B	5	1
Sodium	Metals	7440-23-5	USEPA SW-846 6020B	5	1
Thallium	Metals	7440-28-0	USEPA SW-846 6020B	5	1
Vanadium	Metals	7440-62-2	USEPA SW-846 6020B	5	1
Zinc	Metals	7440-66-6	USEPA SW-846 6020B	5	1
Thorium	Metals	-	USEPA SW-846 6020B	5	1
Uranium	Metals	-	USEPA SW-846 6020B	5	1

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

Table I1-6. Summary of Analytical Methods for Select Radionuclides in Surface and Subsurface Soil Samples at Non-AUM Target BR-01 (T1)

Analyte	Type	CAS Number	Analytical Method	Number of Surface Soil Samples Analyzed	Number of Subsurface Soil Samples Analyzed
Lead-210	Radionuclides	14255-04-0	Eichrom method	1	0
Potassium-40	Radionuclides	13966-00-2	USEPA 901.1	1	0
Radium-226	Radionuclides	13982-63-3	USEPA 901.1	1	0
Radium-228	Radionuclides	15262-20-1	USEPA 901.1	1	0
Thorium-228	Radionuclides	14274-82-9	ASTM D3972 Modified	1	0
Thorium-230	Radionuclides	14269-63-7	ASTM D3972 Modified	1	0
Thorium-232[1]	Radionuclides	7440-29-1	ASTM D3972 Modified	1	0
Uranium-234	Radionuclides	13966-29-5	ASTM D3972 Modified	1	0
Uranium-235	Radionuclides	15117-96-1	ASTM D3972 Modified	1	0
Uranium-238[1]	Radionuclides	7440-61-1	ASTM D3972 Modified	1	0

Notes:
[1] Measured via alpha spectroscopy

ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency

Table I1-7. Summary of Geochemical Analytical Methods for Metals in Surface and Subsurface Soil Samples at Non-AUM Target BR-01 (T1)

Analyte	Geochemical Parameter	CAS Number	Analytical Method	Number of Surface Soil Samples Analyzed	Number of Subsurface Soil Samples Analyzed
Aluminum	SPLP	7429-90-5	USEPA SW-846 6020B	1	0
Antimony	SPLP	7440-36-0	USEPA SW-846 6020B	1	0
Arsenic	SPLP, TCLP	7440-38-2	USEPA SW-846 6020B	1	0
Barium	SPLP, TCLP	7440-39-3	USEPA SW-846 6020B	1	0
Beryllium	SPLP	7440-41-7	USEPA SW-846 6020B	1	0
Cadmium	SPLP, TCLP	7440-43-9	USEPA SW-846 6020B	1	0
Calcium	SPLP	7440-70-2	USEPA SW-846 6020B	1	0
Chromium	SPLP, TCLP	7440-47-3	USEPA SW-846 6020B	1	0
Cobalt	SPLP	7440-48-4	USEPA SW-846 6020B	1	0
Copper	SPLP	7440-50-8	USEPA SW-846 6020B	1	0
Iron	SPLP	7439-89-6	USEPA SW-846 6020B	1	0
Lead	SPLP, TCLP	7439-92-1	USEPA SW-846 6020B	1	0
Lithium	SPLP	7439-93-2	USEPA SW-846 6020B	1	0
Magnesium	SPLP	7439-95-4	USEPA SW-846 6020B	1	0
Manganese	SPLP	7439-96-5	USEPA SW-846 6020B	1	0
Mercury	SPLP	7439-97-6	USEPA SW-846 7471A	1	0
Molybdenum	SPLP	7439-98-7	USEPA SW-846 6020B	1	0
Nickel	SPLP	7440-02-0	USEPA SW-846 6020B	1	0
Selenium	SPLP, TCLP	7782-49-2	USEPA SW-846 6020B	1	0
Silver	SPLP, TCLP	7440-22-4	USEPA SW-846 6020B	1	0
Sodium	SPLP	7440-23-5	USEPA SW-846 6020B	1	0
Thallium	SPLP	7440-28-0	USEPA SW-846 6020B	1	0
Vanadium	SPLP	7440-62-2	USEPA SW-846 6020B	1	0
Zinc	SPLP	7440-66-6	USEPA SW-846 6020B	1	0
Thorium	SPLP	NA	USEPA SW-846 6020B	1	0
Uranium	SPLP	NA	USEPA SW-846 6020B	1	0
Paste pH	pH	NA	USDA60	1	0
Acid-Base Accounting	AG, NNP, Total Sulfur	NA	Modified Sobek Method	1	0

Notes:
AGP Acid Generation Potential
ASTM ASTM International
CAS Chemical abstracts service
NA Not applicable
NNP Net Neutralization Potential
SPLP Synthetic precipitation leaching procedure
TCLP Toxicity characteristic leaching procedure
USEPA U.S. Environmental Protection Agency

Table I1-8. Summary of Geochemical Analytical Methods for Radionuclides in Surface and Subsurface Soil Samples at Non-AUM Target BR-01 (T1)

Analyte	Geochemical Parameter	CAS Number	Analytical Method	Number of Surface Soil Samples Analyzed	Number of Subsurface Soil Samples Analyzed
Lead-210	SPLP	14255-04-0	Eichrom method	1	0
Polonium-210	SPLP	15117-96-1	ASTM D3972 Modified	1	0
Radium-226	SPLP	13982-63-3	USEPA 901.1	1	0
Radium-228	SPLP	14274-82-9	ASTM D3972 Modified	1	0
Thorium-228	SPLP	13966-00-2	USEPA 901.1	1	0
Thorium-230	SPLP	14269-63-7	ASTM D3972 Modified	1	0
Thorium-232[1]	SPLP	15262-20-1	USEPA 901.1	1	0
Uranium-238[1]	SPLP	7440-61-1	ASTM D3972 Modified	1	0
Uranium-234	SPLP	13966-29-5	ASTM D3972 Modified	1	0
Uranium-235	SPLP	7440-29-1	ASTM D3972 Modified	1	0

Notes:
[1] Measured via alpha spectroscopy
ASTM ASTM International
CAS Chemical abstracts service
SPLP Synthetic precipitation leaching procedure
USEPA U.S. Environmental Protection Agency

4.1.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 4.1.1, Target T1 surface geology is entirely within Qa and soils within the Marjane-Kitsili complex (MUSYM 313) (Figure I-13 and Figure I-14). As a result, Background Study Area 2 (BSA-2) was selected for that combination of geology and soil type. Table I1-9 presents the Target-specific BTVs for 29 analytes and gamma radiation levels for Target T1. No regional BTVs were established for Target T1. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T1. The "Applied BTV" for each analyte is the Target-specific BTV.

Table I1-9. Applied Background Threshold Values for Non-AUM Target BR-01 (T1)

Analyte	Units	Site-Specific BTV (BSA-2)	Regional BTV (Qa)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	3,800	None	3,800	Site-Specific BTV
Antimony	mg/kg	0.075	None	0.075	Site-Specific BTV
Arsenic	mg/kg	1.5	None	1.5	Site-Specific BTV
Barium	mg/kg	75	None	75	Site-Specific BTV
Beryllium	mg/kg	0.24	None	0.24	Site-Specific BTV
Cadmium	mg/kg	0.057	None	0.057	Site-Specific BTV
Calcium	mg/kg	13,500	None	13,500	Site-Specific BTV
Chromium	mg/kg	3.7	None	3.7	Site-Specific BTV
Cobalt	mg/kg	1.7	None	1.7	Site-Specific BTV
Copper	mg/kg	3.2	None	3.2	Site-Specific BTV
Iron	mg/kg	4,390	None	4,390	Site-Specific BTV
Lead	mg/kg	3.9	None	3.9	Site-Specific BTV
Lithium	mg/kg	4.6	None	4.6	Site-Specific BTV
Magnesium	mg/kg	2,300	None	2,300	Site-Specific BTV
Manganese	mg/kg	140	None	140	Site-Specific BTV
Mercury	mg/kg	0.0075	None	0.0075	Site-Specific BTV
Molybdenum	mg/kg	0.26	None	0.26	Site-Specific BTV
Nickel	mg/kg	3.7	None	3.7	Site-Specific BTV
Potassium-40	pCi/g	16.0	None	16.0	Site-Specific BTV
Radium-226	pCi/g	0.89	None	0.89	Site-Specific BTV
Radium-228	pCi/g	0.65	None	0.65	Site-Specific BTV
Selenium	mg/kg	0.51	None	0.51	Site-Specific BTV
Silver	mg/kg	0.010	None	0.010	Site-Specific BTV
Sodium	mg/kg	19	None	19	Site-Specific BTV
Thallium	mg/kg	0.039	None	0.039	Site-Specific BTV
Thorium	mg/kg	1.7	None	1.7	Site-Specific BTV
Uranium	mg/kg	0.35	None	0.35	Site-Specific BTV
Vanadium	mg/kg	6.9	None	6.9	Site-Specific BTV
Zinc	mg/kg	12	None	12	Site-Specific BTV
Gamma Radiation	cpm	9,660	None	9,660	Site-Specific BTV

Notes:
BSA-2 Background Study Area 2
BTV background threshold value
cpm counts per minute
mg/kg milligrams per kilogram
pCi/g picocuries per gram
Qa Quaternary Alluvium

4.1.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T1 and the raw gamma radiation and grid averaged gamma radiation survey results.

4.1.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T1 in May 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in August 2018 to collect data within the Goback survey units. A gamma radiation survey was also performed in the Tse Tah West drainage within the area in conjunction with the RSE for the Brodie 1 Mine; results are presented in Appendix J of the RSE Report. The applied gamma BTV for non-AUM Target T1 is 9,660 cpm. A total of 11,080 measurements were collected as part of the gamma radiation survey at non-AUM Target T1 across 162 survey units. An average scan density of 68 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I1-10.

Table I1-10. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target BR-01 (T1)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	9,660	
# of Measurements	#	11,080	162
Minimum	cpm	5,752	7,564
Maximum	cpm	50,756	31,654
Average	cpm	12,797	12,440
Median	cpm	11,123	11,154
Standard Deviation	cpm	5,256	3,992
90th Percentile	cpm	19,086	17,412
95th Percentile	cpm	22,966	19,913
99th Percentile	cpm	33,754	26,547
Measurements per Survey Unit	#/grid	68	
Measurements Above Gamma BTV	#	8,029	121
Measurements Above Gamma BTV	%	72.5	74.7

Notes:
BTV background threshold value
cpm counts per minute

4.1.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 72.5 percent of the measurements within the Target boundaries, in some cases exceeding greater than five times the applied gamma BTV (9,660 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-2 (Qa) gamma survey results is provided on Figure I1-6. This graph shows that the spread of radiation data at Target T1 (on left) begins within the lower range of BSA-2 (Qa) gamma levels (on right) and then rises to more than five times background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T1 is slightly higher than the data cloud from the BSA-2 (Qa) data set. A box plot showing the quartiles of the data sets is provided in Figure I1-7. The box plot shows that the median of Target T1 radiation levels is higher than the median of the BSA-2 (Qa) data set and higher than the applied gamma BTV.

A map showing the results of the gamma radiation survey is provided in Figure I1-8. No uranium mining activity was observed within the survey area of Target T1. However, the Target is a former highway department soils borrow area, and up to 5 feet of soil previously covered the underlying uranium-bearing Salt Wash Member of the Jms. The underlying geology was exposed, resulting in elevated gamma readings. A soils stockpile area may have been located near the northwest corner of the borrow area based on elevated gamma readings.

In general, Target T1 has surficial gamma radiation levels above BSA-2 (Qa) levels across the majority of the Target except for the outside edges of the survey boundary, indicating that the survey encompassed the area of elevated gamma activity identified by the ASPECT and Weston MCAP gamma surveys. No TENORM or mining-related activities were observed.
Section 4.1.5.3 presents the grid averaged results of the gamma radiation survey.

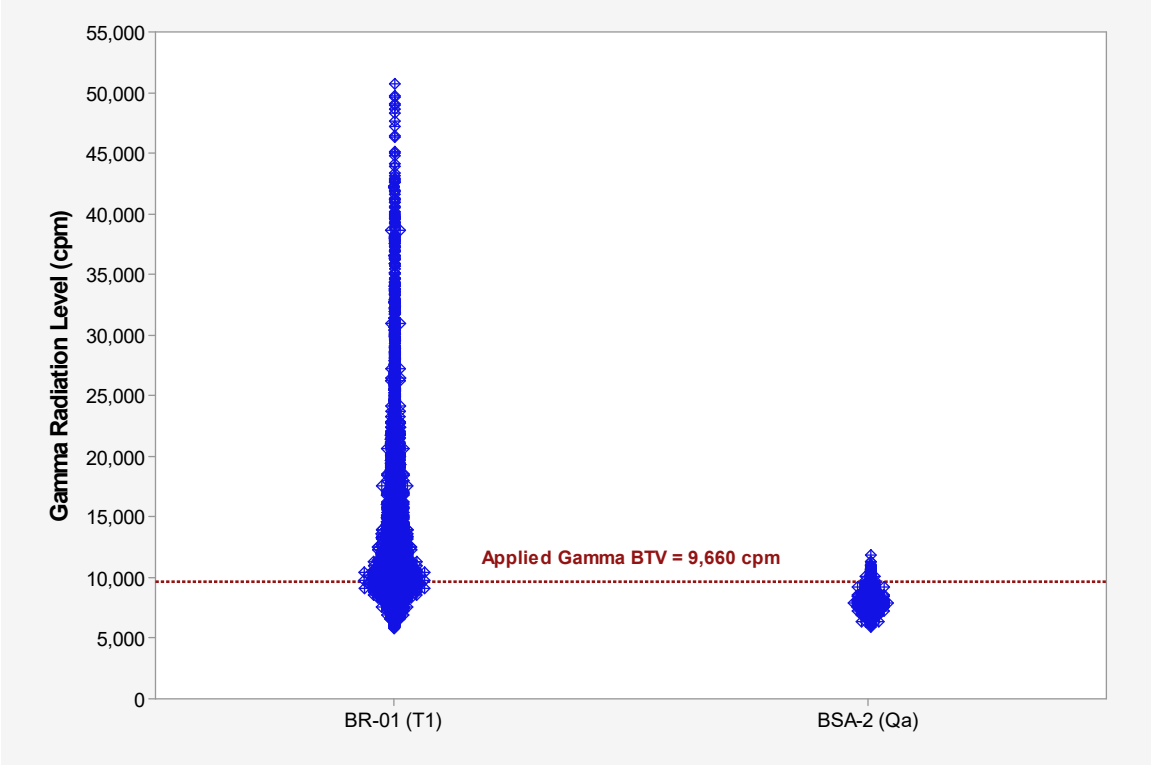


Figure I1-6. Individual Value Plot of Raw Gamma Radiation Levels at Target BR-01 (T1) and BSA-2 (Qa)

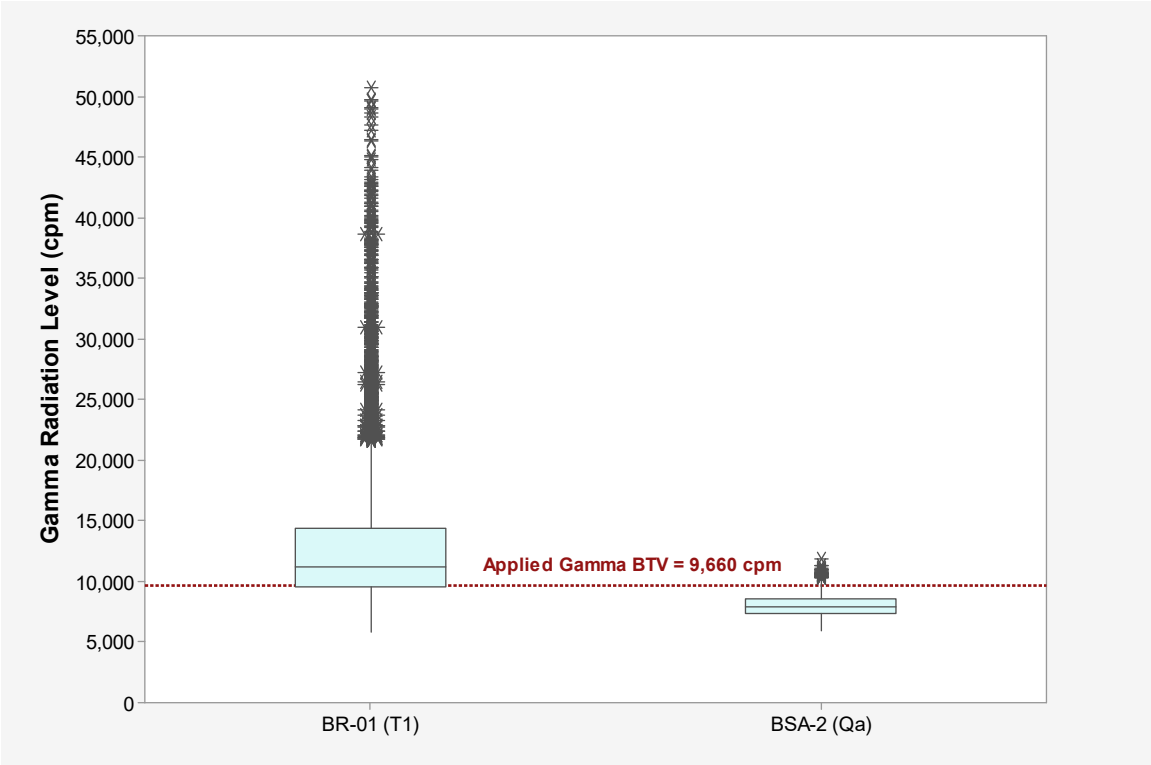
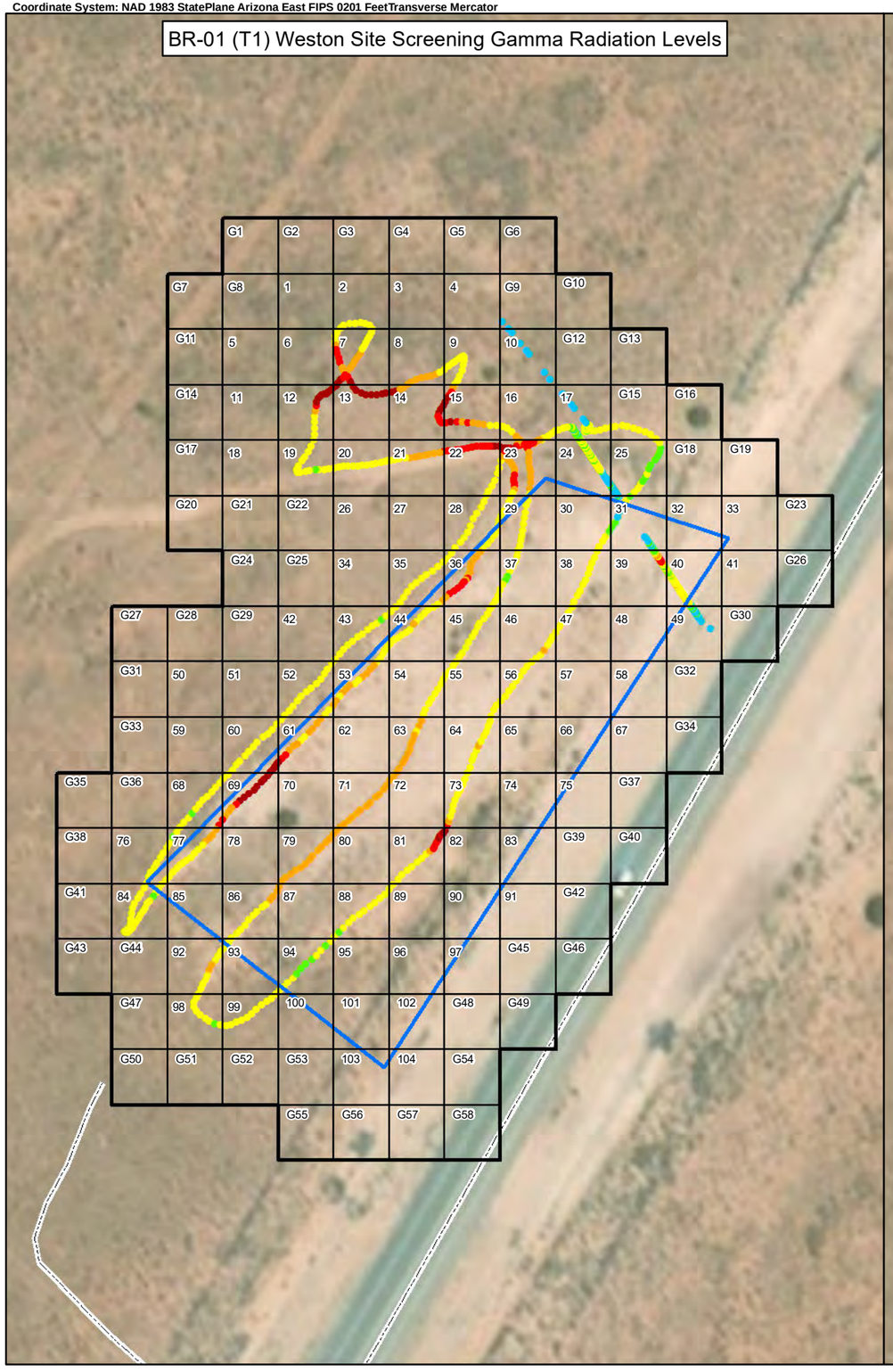


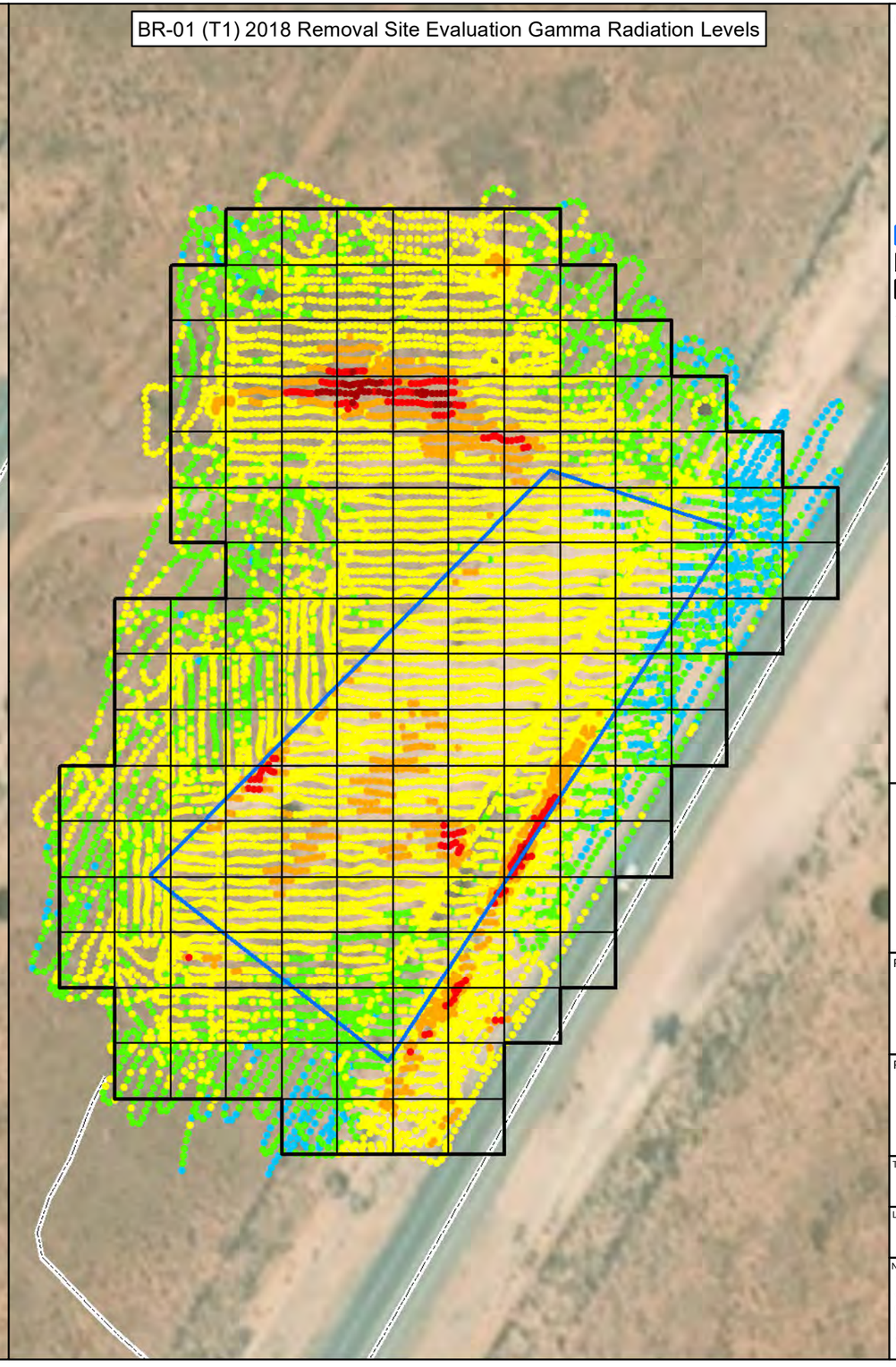
Figure I1-7. Box Plot of Raw Gamma Radiation Levels at Target BR-01 (T1) and BSA-2 (Qa)

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

BR-01 (T1) Weston Site Screening Gamma Radiation Levels



BR-01 (T1) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)*

≤ 7,954	≤ Avg. BG
7,954 - 9,660	Avg. BG - 1 x BTV
9,660 - 19,320	1 x BTV - 2 x BTV
19,320 - 28,980	2 x BTV - 3 x BTV
28,980 - 38,640	3 x BTV - 4 x BTV
38,640 - 96,660	4 x BTV - 10 x BTV
≥ 96,660	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Access Route - Vehicular

1 in = 80 ft

1:960

N W E S

0 40 80 160 Feet

NON-AUM TARGET BR-01 (T1)
2018 REMOVAL SITE EVALUATION
VS WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

Prepared For:

Prepared By:

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019

Notes:
*The applied gamma background threshold value (BTV) for BR-01 Non-AUM Target is 9,660 cpm derived from BSA-2 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I1-8**

4.1.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 4.1.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 4.1.5.1. Figure I1-9 and Figure I1-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-2 (Qa) data set (shown on right). A total of 74.7 percent of the survey units (121 of 162) within the survey area of Target T1 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I1-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I1-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. The elevated regions of the Target correspond with the borrow area and potential soils stockpile area to the northwest.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface and subsurface soil samples were collected at the Target across the survey units and are presented in Section 4.1.6.

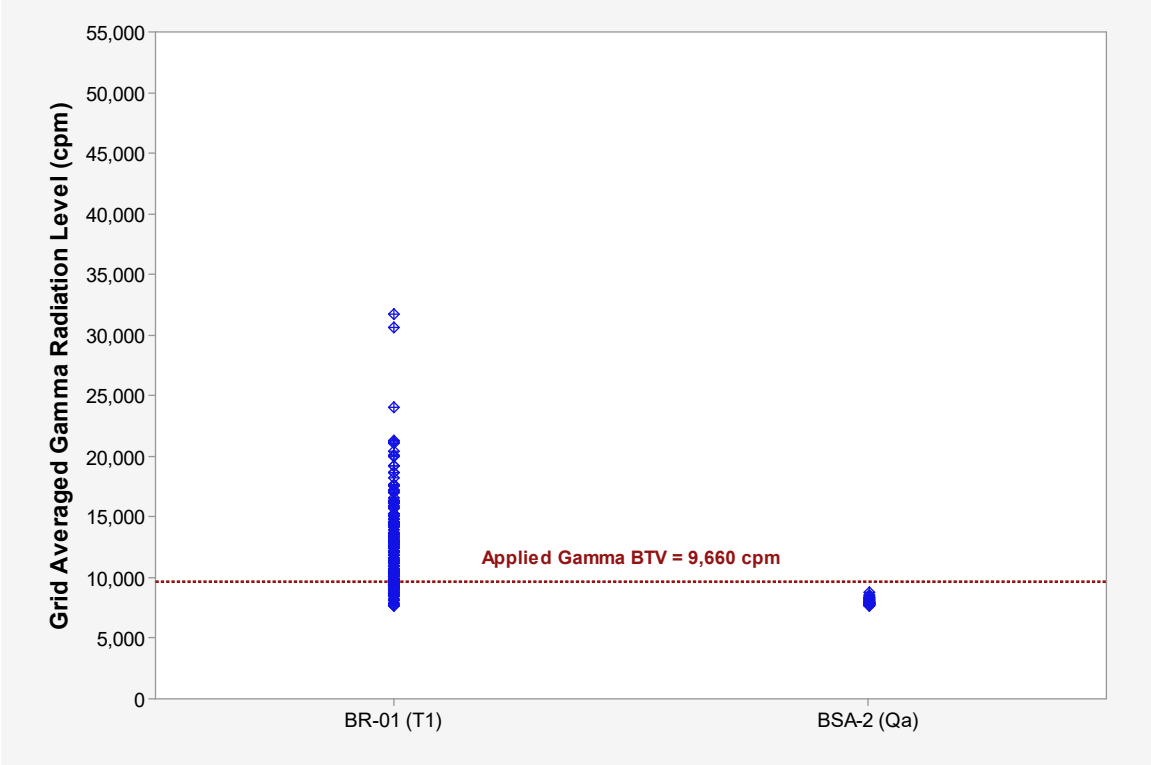


Figure I1-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target BR-01 (T1) and BSA-2 (Qa)

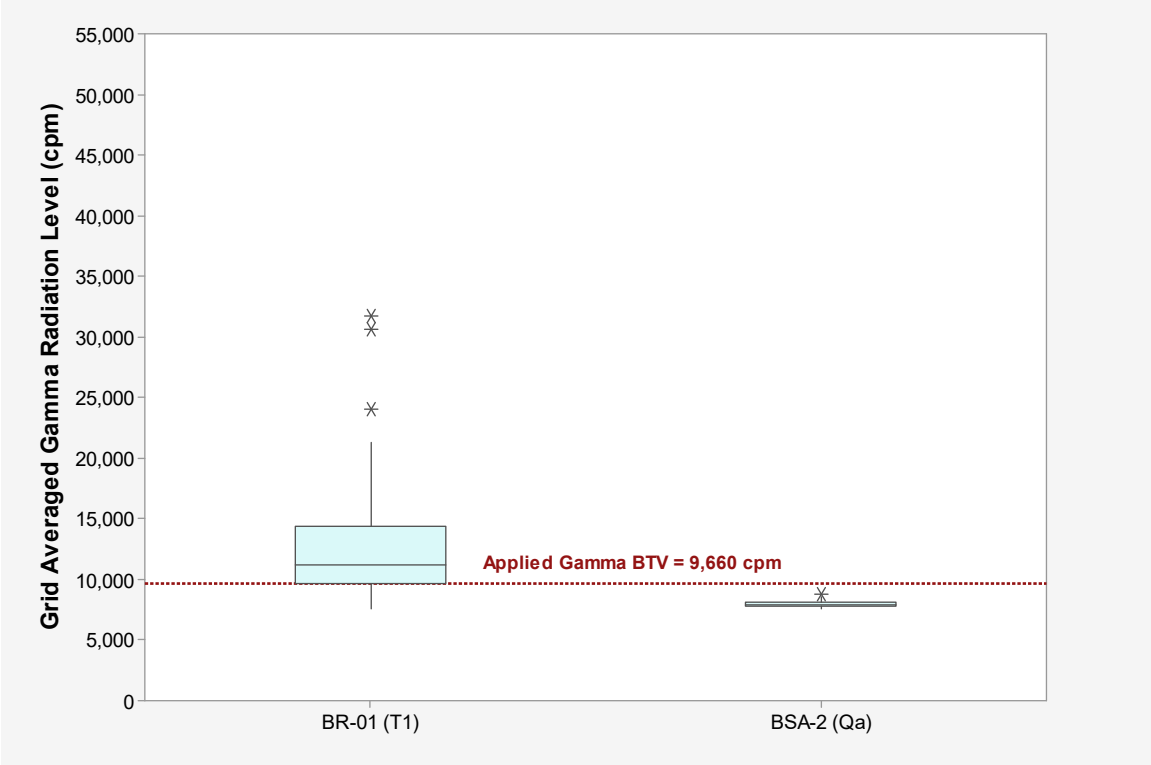
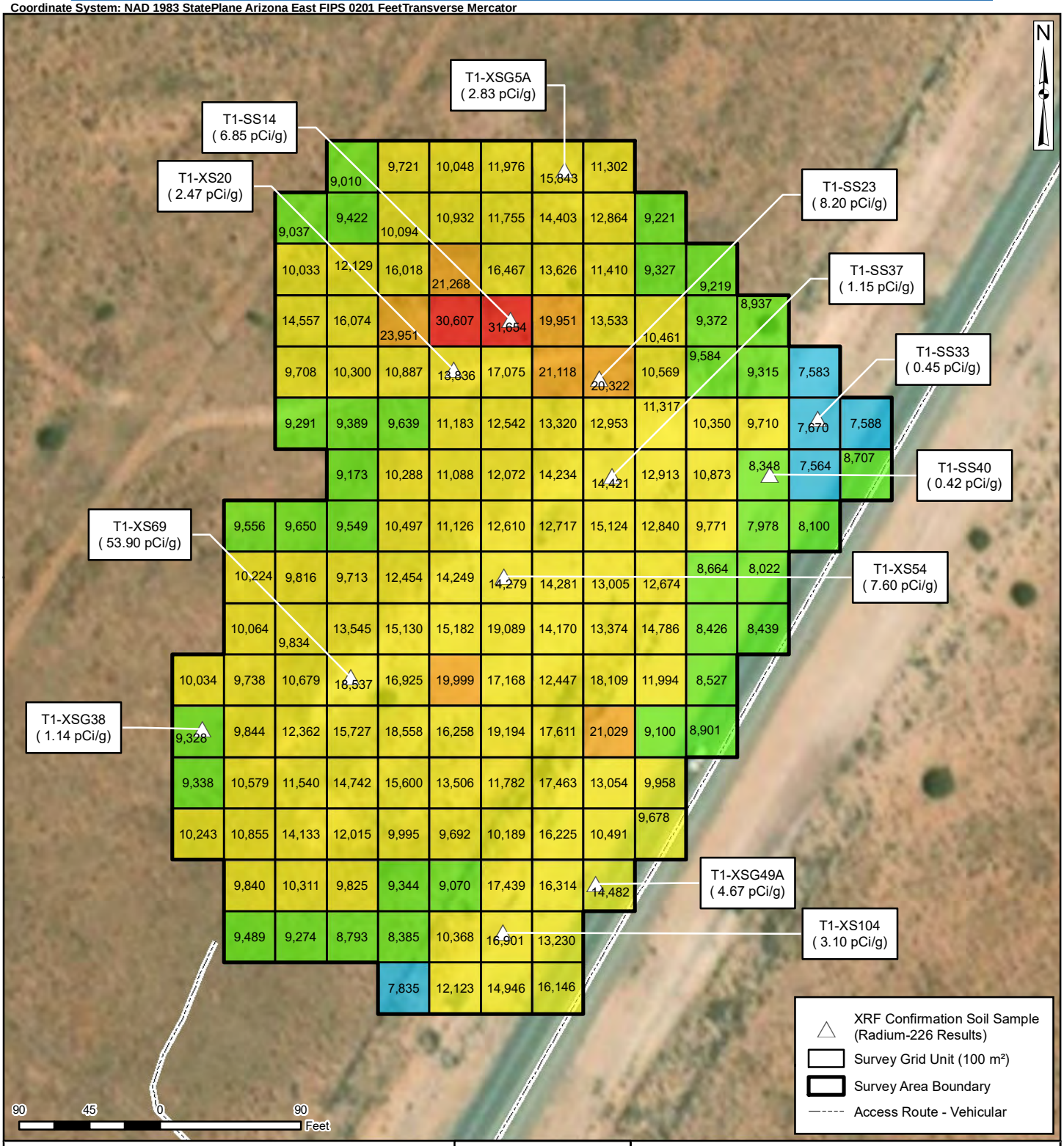


Figure I1-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target BR-01 (T1) and BSA-2 (Qa)



Grid Averaged Gamma Reading (cpm)*

≤ 7,954	≤ Avg. BG
7,954 - 9,660	Avg. BG - 1 x BTV
9,660 - 19,320	1 x BTV - 2 x BTV
19,320 - 28,980	2 x BTV - 3 x BTV
28,980 - 38,640	3 x BTV - 4 x BTV
38,640 - 96,600	4 x BTV - 10 x BTV
≥ 96,600	≥ 10 x BTV

*The applied gamma background threshold value (BTV) for BR-01 Non-AUM Target is 9,660 cpm derived from BSA-2 as presented in Appendix A. Avg. BG: Average value of the background data set.

Prepared for: USEPA Region 9

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NON-AUM TARGET BR-01 (T1)
GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I1-11
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.1.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T1. Radionuclide and metal concentrations within the surface environment (top 6 inches) and the subsurface environment (greater than 6 inches bgs) were investigated following the methods described in Section 2.5. Surface soils were evaluated using three sample types: (1) in situ XRF measurements; (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs; and (3) surface soil samples collected at a depth of 0 to 6 inches bgs. The results from these three sample types are presented in Section 4.1.6.1. A shallow subsurface soil investigation was conducted by hand as described in Section 2.5.3. The results of the subsurface sampling are presented in Section 4.1.6.2. The results of the geochemical sampling are presented in Section 4.1.6.3. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 4.1.6.4.

4.1.6.1 Surface Sampling

As described above, there are three primary surface sample types for Target T1: (1) in situ XRF measurements; (2) XRF confirmation soil samples; and (3) surface soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Table I1-1, I1-3, and I1-4. All results of the XRF confirmation soil samples and surface soil samples are presented in Table I1-11 and Table I1-12. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T1 following the methods outlined in Section 2.4 and shown in Figure I1-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 167 measurements were collected across 167 survey units from the survey area of Target T1 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I1-13.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T1 at a depth of 0 to 3 inches bgs. Eight XRF confirmation soil samples were collected at seven locations during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I1-11.

The last surface sample type was the surface soil samples collected at a depth of 0 to 6 inches bgs. A total of five surface soil samples were collected, one of which was collocated with the shallow subsurface boring locations discussed in Section 4.1.6.2. The laboratory analytical results for the surface soil samples are presented in Table I1-12.

Summary statistics for the XRF confirmation soil and surface soil samples were not prepared because of the small number of samples collected. The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 4.1.7. The following section presents the results of the subsurface soil sampling.

Table I1-11. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BR-01 (T1) Analyte

Analyte	Units	Applied BTV	T1-XS104-01-051318		T1-XS20-01-051318		T1-XS54-01-051318		T1-XS69-01-051318		T1-XSG38-01-081918		T1-XSG49A-01-081918		T1-XSG5A-01-081918	
			Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Survey Unit			X104		X20		X54		X69		XG38		XG49A		XG5A	
Aluminum	mg/kg	3,800	5,900		5,300		4,200		6,000		4,500		3,400		3,400	
Antimony	mg/kg	0.075	0.22		0.07	J	0.072	J	0.06	J	0.077	J	0.079	J	0.051	J
Arsenic	mg/kg	1.5	3.5		2.8		3.1		7.9		1.4		11		1.2	
Barium	mg/kg	75	150		140		170		310		83		140		88	
Beryllium	mg/kg	0.24	0.61		0.37		0.34		0.47		0.29		0.26		0.21	
Cadmium	mg/kg	0.057	0.062	J	0.056	J	0.091	J	0.18	J	0.076	J	0.066	J	0.049	J
Calcium	mg/kg	13,500	21,000		51,000		51,000		110,000		11,000		35,000		18,000	
Chromium	mg/kg	3.7	4.9		4.2		3.5		3.8		3.7		2.9		3	
Cobalt	mg/kg	1.7	3.5		4.5		2.8		3.7		2.2		2.6		1.6	
Copper	mg/kg	3.2	7.2		6.2		5.7		11		4.4		4.2		3.2	
Iron	mg/kg	4,390	11,000		5,400		4,100		4,800		5,000		4,500		3,800	
Lead	mg/kg	3.9	7.6		5		6.2		13		5.6		4.2		4.2	
Lead-210	pCi/g	NV	NA		NA		NA		NA		NA		3.43		1.42	
Lithium	mg/kg	4.6	14		7.4		7.3		20		5.8		6.7		4.6	
Magnesium	mg/kg	2,300	4,900		4,200		3,400		6,100		3,000		3,000		2,500	
Manganese	mg/kg	140	120		210		200		520		170		160		120	
Mercury	mg/kg	0.0075	NA		NA		NA		NA		NA		<0.033	U	<0.033	U
Molybdenum	mg/kg	0.26	0.15	J	0.19	J	0.14	J	0.14	J	0.25		3.5		0.21	
Nickel	mg/kg	3.7	6.2		5.4		4.4		4.7		4.3		3.8		3.3	
Potassium-40	pCi/g	16	23.2		12.5		13.9		11.2		13.6		11.6		11.4	
Radium-226	pCi/g	0.89	3.1		2.47		7.6		53.9	M3	1.14		4.67		2.83	
Radium-228	pCi/g	0.65	<0.71	U	0.48	LT	<0.38	U	<1.2	UJ	<0.68	UJ	<0.56	UJ	<0.24	U
Selenium	mg/kg	0.51	0.9	J	0.74	J	0.65	J	1.3		0.46	J	0.46	J	0.33	J
Silver	mg/kg	0.01	0.023	J	0.024	J	0.032	J	0.031	J	0.022	J	0.017	J	0.01	J
Sodium	mg/kg	19	130		27	J-	23	J-	88	J-	21	J	33	J	19	J
Thallium	mg/kg	0.039	0.079		0.054		0.049		0.091		0.045		0.15		0.033	
Thorium	mg/kg	1.7	4.5		2.3		2.1		3.1		2.5		1.8		1.9	
Thorium-228	pCi/g	NV	NA		NA		NA		NA		NA		0.35	M3	0.48	J
Thorium-230	pCi/g	NV	NA		NA		NA		NA		NA		4.33	M3	1.73	J
Thorium-232	pCi/g	NV	NA		NA		NA		NA		NA		0.45		0.35	J
Uranium	mg/kg	0.35	4.6		2.2		9.5		80		0.58		6		0.69	
Uranium-234	pCi/g	NV	NA		NA		NA		NA		NA		3.3		0.58	
Uranium-235	pCi/g	NV	NA		NA		NA		NA		NA		0.16	M3	<0.044	U
Uranium-238	pCi/g	NV	NA		NA		NA		NA		NA		2.78	M3	0.71	
Vanadium	mg/kg	6.9	15		9.7		10		25		6.8		11		5.8	
Zinc	mg/kg	12	24		15		13		17		14		11		9.9	

Table I1-11. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BR-01 (T1) Analyte (Continued)

Notes:

BTV	Background threshold value
J	Estimated value
J-	Estimated value, may be biased low
LT	Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
M3	The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg	Milligrams per kilogram
NA	Not applicable
NV	No Value
pCi/g	Picocuries per gram
Q	Qualification
U	Not considered detected. The associated value is the method detection limit (MDL).
UJ	Not considered detected. The associated value is the reported concentration, which is estimated.

Table I1-12. Laboratory Analytical Results for Surface and Subsurface Soil Samples at Non-AUM Target BR-01 (T1)

Analyte	Units	Applied BTV	T1-SS14-01-091618		T1-SS23-01-091618		T1-SS33-01-091618		T1-SS37-01-091618		T1-SS40-01-091618		T1-SB40-0612-01-091618	
			Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Depth (inches)			0-6		0-6		0-6		0-6		0-6		6-12	
Aluminum	mg/kg	3,800	4,300		4,000		2,300		2,000		1,700		1,700	
Antimony	mg/kg	0.075	<0.1	U	<0.091	U	<0.096	U	<0.095	U	<0.095	U	<0.1	U
Arsenic	mg/kg	1.5	2.3		2.2		1.5		2.3		1.2		0.94	
Barium	mg/kg	75	93		87		250		72		280		280	
Beryllium	mg/kg	0.24	0.27		0.25		0.15		0.11		0.095		0.09	
Cadmium	mg/kg	0.057	0.086	J	0.063	J	<0.19	U	0.069	J	<0.19	U	<0.2	U
Calcium	mg/kg	13,500	27,000		25,000		21,000		54,000		12,000		10,000	
Chromium	mg/kg	3.7	3.6		3.4		1.8		1.2		1.1		1.1	
Cobalt	mg/kg	1.7	2.2		2		1.2		0.96		0.86		0.8	
Copper	mg/kg	3.2	4.9		5.2		2.9		2.1		2.3		2.2	
Iron	mg/kg	4,390	4,700		4,400		2,700		2,100		2,000		1,900	
Lead	mg/kg	3.9	5.9		4.9		2.6		2.1		2		1.9	
Lead-210	pCi/g	NV	3.6		NA		NA		NA		NA		NA	
Lithium	mg/kg	4.6	5.8		5.4		4.4		3.3		3.3		2.8	
Magnesium	mg/kg	2,300	3,000		2,600		1,700		1,500		1,300		1,100	
Manganese	mg/kg	140	200		160		140		390		86		71	
Molybdenum	mg/kg	0.26	0.27		0.88		0.11	J	<0.19	U	0.056	J	<0.2	U
Nickel	mg/kg	3.7	4.1		3.6		2		1.5	J	1.3	J	<2	U
Potassium-40	pCi/g	16	12		13.1		10.1		9.9	LT	10.1		11.1	
Radium-226	pCi/g	0.89	6.85		8.2		<0.79	UJ	1.15		0.42	LT	<0.47	UJ
Radium-228	pCi/g	0.65	<0.38	U	<0.34	U	<0.52	U	<0.34	U	<0.28	U	<0.21	U
Selenium	mg/kg	0.51	0.76	J	0.71	J	0.52	J	0.67	J	0.33	J	0.38	J
Silver	mg/kg	0.01	0.017	J	0.015	J	0.0096	J	<0.047	U	<0.047	U	<0.051	U
Sodium	mg/kg	19	<100	U	<91	U	<96	U	<95	U	100		100	
Thallium	mg/kg	0.039	0.049		0.044		0.022		0.018		0.015		0.013	
Thorium	mg/kg	1.7	2.2		2		1.4		1.2		1.1		1.1	
Thorium-228	pCi/g	NV	0.42	M3	NA		NA		NA		NA		NA	
Thorium-230	pCi/g	NV	4.32	M3	NA		NA		NA		NA		NA	
Thorium-232	pCi/g	NV	0.48		NA		NA		NA		NA		NA	
Uranium	mg/kg	0.35	5.4		2		0.89		0.84		0.51		0.39	
Uranium-234	pCi/g	NV	2.95		NA		NA		NA		NA		NA	
Uranium-235	pCi/g	NV	0.18		NA		NA		NA		NA		NA	
Uranium-238	pCi/g	NV	3.1		NA		NA		NA		NA		NA	
Vanadium	mg/kg	6.9	8.6		8.1		6		4.6		5.9		5.6	
Zinc	mg/kg	12	12		11		7.3	J	5	J	10		<10	U

Table I1-12. Laboratory Analytical Results for Surface and Subsurface Soil Samples at Non-AUM Target BR-01 (T1) (Continued)

Notes:

BTV	Background threshold value
J	Estimated value
J-	Estimated value, may be biased low
LT	Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
M3	The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg	Milligrams per kilogram
NA	Not applicable
NV	Not value
pCi/g	Picocuries per gram
Q	Qualification
U	Not considered detected. The associated value is the method detection limit (MDL).
UJ	Not considered detected. The associated value is the reported concentration, which is estimated.

Table I1-13. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target BR-01 (T1)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	1.5	4,390	3.9	140	0.26	1.7	0.35	6.9	12
Measurements	#	167	167	167	167	167	167	167	167	167
Detects	#	81	167	166	166	78	164	137	6	166
Nondetects	#	86	0	1	1	89	3	30	161	1
Minimum	mg/kg	1.85	2,247	0.45	82	0.045	1.0	0.11	16	8.0
Maximum	mg/kg	10.8	17,288	14	363	4.7	4.9	72	60	35
Standard Deviation	mg/kg	1.7	2,091	1.9	49	1.0	0.6	7.5	16	4.0
Average	mg/kg	3.3	5,511	5.0	198	1.3	2.0	3.5	30	16
Median	mg/kg	2.7	5,000	5.2	198	1.0	2.0	1.6	24	16
Relative Standard Deviation	mg/kg	51	38	38	25	77	31	212	53	25
90th Percentile	mg/kg	4.9	8,420	7.2	261	2.7	2.8	6.9	47	21
95th Percentile	mg/kg	5.7	9,161	8.1	280	3.4	3.2	9.9	54	22
99th Percentile	mg/kg	11	11,317	9.2	333	3.8	4.2	31.8	59	30
Measurements Above Applied BTV	#	81	115	123	142	72	112	133	6	141
Measurements Above Applied BTV	%	49	69	74	85	43	67	80	4	84

Notes:
[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.
BTV Background threshold value
mg/kg Milligrams per kilogram
XRF X-ray fluorescence

4.1.6.2 Subsurface Soil Sampling

The methodology for conducting subsurface soil sampling at Target T1 is provided in Section 2.5.2. One subsurface sample was collected from one boring to a maximum depth of 12 inches. The sample depth ranges and number of samples varied per boring and are provided in Table I1-4 and Figure I1-5. The borings were selected to delineate and confirm the existence of potential areas of radiological or metals contamination at depth. The surface level results for the one boring was presented in the previous section. The laboratory analytical results for the sample collected at 6 to 12 inches bgs are provided in Table I1-12. Summary statistics for the subsurface soil samples were not prepared because of the small number of samples collected.

4.1.6.3 Geochemical Results

One surface soil sample collected at T1-SS14 at a depth of 0 to 6 inches was submitted for geochemical analyses from survey unit 14 within Target 1. The geochemical analyses included ABA, TCLP, and SPLP. The laboratory analytical results for the geochemical soil sample is presented in Table I1-14. A summary of the sample results is provided in this section, and a complete analysis of the results is provided in Appendix F of the RSE Report.

The majority of the TCLP results were nondetects. Arsenic, cadmium, chromium, lead, selenium, and silver were not detected in any of the samples. Barium was detected, but the results were below the RCRA limit. The results indicate that soils would meet the TCLP requirements for disposal at a permitted landfill or a low-level radioactive waste disposal facility.

The majority of the SPLP results for the eight primary analytes (arsenic, lead, molybdenum, Ra-226, selenium, thorium, uranium, and vanadium) were nondetects. A discussion on primary analytes is provided in Section 4.1.7. Molybdenum, selenium, thorium, and uranium were not detected in any of the leachate samples. The SPLP results for arsenic, lead, and vanadium were within or below the range of observed background concentrations reported for surface water and groundwater within the Cove Wash Watershed (Weston 2018). The results indicate that leachate from soils would not pose a threat to water quality.

The net neutralization potential (NNP) for soils was 102 tons of calcium carbonate equivalent per 1,000 tons of material (ppt $CaCO_3$). Samples with low NNP values (less than negative 20 ppt $CaCO_3$) are considered acid producing while samples with high NNP values (greater than 20 ppt $CaCO_3$) are considered non-acid producing. The results indicate that the soils from Target T1 are not acid producing. Wetted soil pH was measured at 7.8, just above neutral.

Table I1-14. Laboratory Analytical Results for Surface Soil Geochemical Parameters at Non-AUM Target BR-01 (T1)

			Sample ID	
			T1-SS14-01-091618	
Depth (inches)			0-6	
SPLP Analyte	Range of Background Concentrations for Primary Analytes in Surface Water	Units	Result	Q
Aluminum	-	mg/L	0.56	J
Antimony	-	mg/L	<0.01	U
Arsenic	<0.003 to 0.018	mg/L	0.002	J
Barium	-	mg/L	0.044	J
Beryllium	-	mg/L	<0.005	U
Cadmium	-	mg/L	<0.02	U
Calcium	-	mg/L	12	
Chromium	-	mg/L	<0.1	U
Cobalt	-	mg/L	<0.05	U
Copper	-	mg/L	<0.2	UJ
Iron	-	mg/L	<1	U
Lead	< 0.0022 to 0.0074	mg/L	0.0009	J
Lead-210	-	pCi/L	<0.23	UJ
Lithium	-	mg/L	<0.2	U
Magnesium	-	mg/L	0.91	J
Manganese	-	mg/L	<0.05	U
Molybdenum	< 0.00038 to 0.0016	mg/L	<0.02	U
Nickel	-	mg/L	<0.2	U
Polonium-210	-	pCi/L	<0.2	U
Radium-226	-	pCi/L	<0.12	U
Radium-228	-	pCi/L	<0.22	U
Selenium	<0.0045 to 0.015	mg/L	<0.1	U
Silver	-	mg/L	<0.005	U
Sodium	-	mg/L	<10	U
Thallium	-	mg/L	<0.001	U
Thorium	-	mg/L	<0.002	U
Thorium-228	-	pCi/L	<0.053	U
Thorium-230	-	pCi/L	0.107	
Thorium-232	-	pCi/L	<0.01	U
Uranium	0.0015 to 0.18	mg/L	<0.001	U
Uranium-234	-	pCi/L	<0.068	UJ
Uranium-235	-	pCi/L	<-0.032	UJ
Uranium-238	-	pCi/L	<0.14	UJ
Vanadium	0.0027 to 0.13	mg/L	0.01	J-
Zinc	-	mg/L	<1	U

Table I1-14. Laboratory Analytical Results for Surface Soil Geochemical Parameters at Non-AUM Target BR-01 (T1) (Continued)

			Sample ID	
			T1-SS14-01-091618	
Depth (inches)			0-6	
TCLP Analyte	**TCLP Permissible Limit**	**Units**	**Result**	**Q**
Arsenic	5	mg/L	<0.1	U
Barium	100	mg/L	1.4	
Cadmium	1	mg/L	<0.05	UJ
Chromium	5	mg/L	<0.1	UJ
Lead	5	mg/L	<0.04	UJ
Selenium	1	mg/L	<0.06	U
Silver	5	mg/L	<0.1	U
Analyte	**Basis**	**Units**	**Result**	**Q**
Paste pH	Standard Unit	pH	7.8	
Total Moisture	Weight	%	0.71	
Total Sulfur	Weight	%	0	U
Acid Generation Potential	$CaCO_3$	ppt	0	U
Neutralization Potential	$CaCO_3$	ppt	102	
Acid-Base Accounting	$CaCO_3$	ppt	102	

Notes:

[1] The range of primary analyte concentrations observed in surface water as reported in the Cove Wash Watershed Assessment (Weston 2018). No background concentrations were reported for thorium.

- Not applicable
$CaCO_3$ Calcium carbonate
J Estimated value
J- Estimated value, may be biased low
mg/L Milligrams per liter
pCi/L Picocuries per liter
ppt Tons of calcium carbonate equivalent per 1,000 tons of material
Q Qualifier
SPLP Synthetic precipitation leaching procedure
TCLP Toxicity characteristic leaching procedure
U Not considered detected. The associated value is the reporting limit.
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

References:

Weston Solutions, Inc. (Weston). 2018. “Cove Wash Watershed Assessment.” DCN 0100-08-AAYN. April.

4.1.6.4 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T1 to identify the radionuclide and metal COPCs in surface and subsurface soils. Soil concentrations at Target T1 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples, as well as through laboratory chemical and radiological analysis of surface and subsurface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T1. The estimated BTVs are identified in Section 4.1.4 and Table I1-9.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I1-15 presents a summary of the background comparison for different measurements and soil depths at Target T1. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T1. However, gamma radiation screening indicated that gamma levels at Target T1 are elevated in comparison to those at the BSA and appear to be associated with exposure of the Jms. Therefore, while multiple COPCs have been identified at Target T1 based on a conservative comparison to background, risk screening will be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I1-15. All Analytes Greater Than Background Threshold Values at Non-AUM Target BR-01 (T1)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Surface and Subsurface Soils	Final COPC Determination
Aluminum	✓		✓	✓
Antimony	✓			✓
Arsenic	✓	✓	✓	✓
Barium	✓		✓	✓
Beryllium	✓		✓	✓
Cadmium	✓		✓	✓
Calcium	✓		✓	✓
Chromium	✓			✓
Cobalt	✓		✓	✓
Copper	✓		✓	✓
Iron	✓	✓	✓	✓
Lead	✓	✓	✓	✓
Lithium	✓		✓	✓
Magnesium	✓		✓	✓
Manganese	✓	✓	✓	✓
Mercury				
Molybdenum	✓	✓	✓	✓
Nickel	✓		✓	✓
Potassium-40	✓			✓
Radium-226	✓		✓	✓
Radium-228				
Selenium	✓		✓	✓
Silver	✓		✓	✓
Sodium	✓		✓	✓
Thallium	✓		✓	✓
Thorium	✓	✓	✓	✓
Uranium	✓	✓	✓	✓
Vanadium	✓	✓	✓	✓
Zinc	✓	✓		✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

4.1.7 Primary Contaminant Mapping

4.1.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation (see Section 4.1.4). Section 4.1.6.4 identified the COPCs at Target T1. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, and these analytes are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 4.1.5. Surface soil and XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I1-15. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T1 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented in Section 4.1.7.2 through Section 4.1.7.6 regardless of whether the concentrations exceed applied BTVs.

This section presents a summary of the occurrence and distribution of five primary analytes in surface soils, regardless of whether the concentrations exceeded the applied BTVs. A discussion and map of individual surface measurements are presented for each primary analyte in Section 4.1.7.2 through Section 4.1.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T1. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy,

or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

4.1.7.2 Arsenic

Arsenic was identified as a COPC in both surface and subsurface environments as shown in Table I1-15. Arsenic exceeded the applied BTV in 49 percent of in situ XRF measurements and in five of the seven XRF confirmation samples. The applied BTV for arsenic is 1.5 mg/kg for Target T1 as presented in Section 4.1.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I1-11 and Attachment I3, respectively. Figure I1-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T1 and BSA-2 (Qa) samples. Figure I1-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T1 and BSA-2 (Qa) samples. Summary statistics for XRF measurements are provided in Section 4.1.6. Arsenic XRF concentrations measured in surface soils at Target T1 ranged between 1.85 and 10.8 milligrams per kilogram (mg/kg) with an average and standard deviation of 3.3 mg/kg and 1.7 mg/kg, respectively. The average arsenic XRF concentration is above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T1 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I1-14. Overall, the majority of detectable arsenic XRF results in surface soils were above the applied BTV. However, the maximum XRF value was 7.2 times higher than the applied BTV and is likely associated with the exposed uranium-bearing geology at Target T1.

For subsurface samples, arsenic did not exceed the applied BTV. The maximum arsenic concentration in the subsurface soil sample was 0.94 mg/kg.

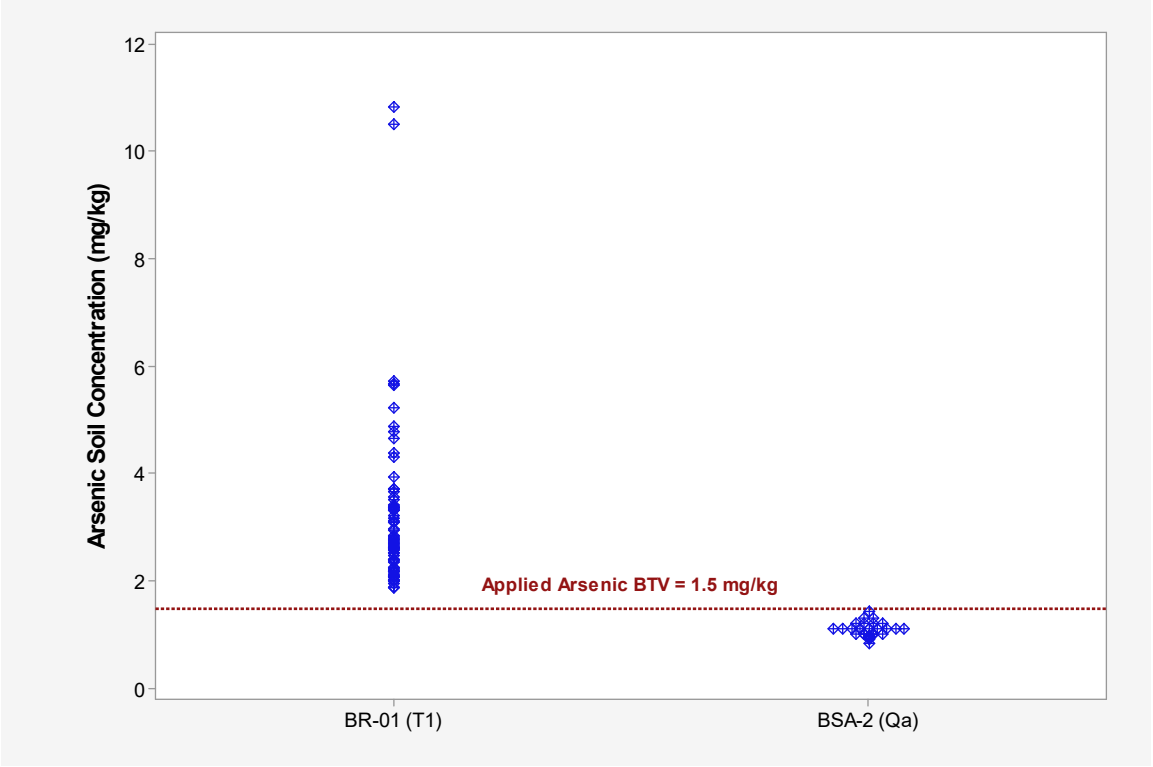


Figure I1-12. Individual Value Plot for Target BR-01 (T1) and BSA-2 (Qa) Arsenic Soil Concentrations

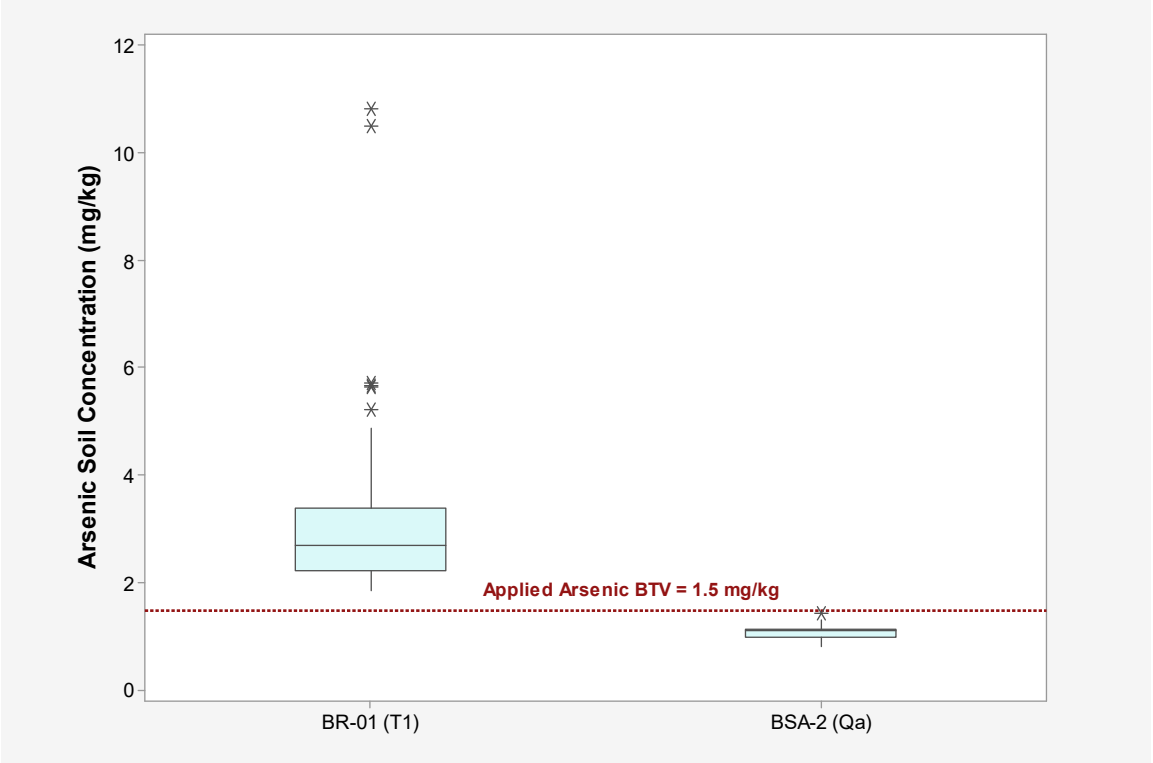
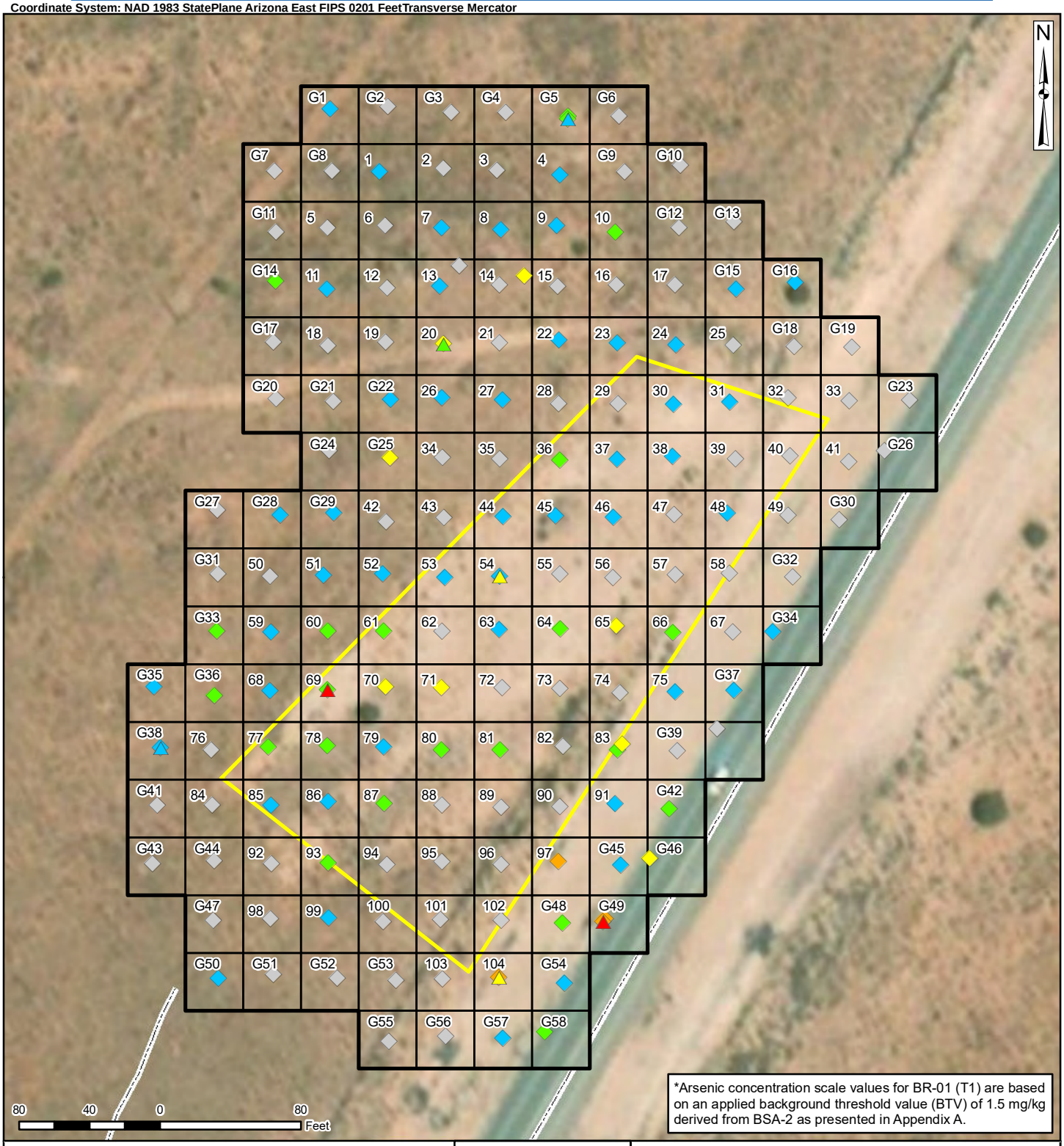


Figure I1-13. Box Plot for Target BR-01 (T1) and BSA-2 (Qa) Arsenic Soil Concentrations



Arsenic Concentration Scale (mg/kg)*

- ≤ 1.1
- 1.1 - 1.5
- 1.5 - 3.0
- 3.0 - 4.5
- 4.5 - 6.0
- 6.0 - 15
- ≥ 15
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET BR-01 (T1) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I1-14
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.1.7.3 Lead

Lead was identified as a COPC in both the surface and subsurface soil environments as shown in Table I1-15. Lead exceeded the applied BTV in 74 percent of in situ XRF measurements and in all seven XRF confirmation samples. The applied BTV for lead is 3.9 mg/kg for Target T1 as presented in Section 4.1.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I1-11 and Attachment I3, respectively. Figure I1-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T1 and BSA-2 (Qa) samples. Figure I1-16 presents a box plot of detectable lead XRF soil concentrations for Target T1 and BSA-2 (Qa) samples. Summary statistics for XRF measurements are provided in Section 4.1.6. Lead XRF concentrations measured in surface soils at Target T1 ranged between 0.45 and 14 mg/kg with an average and standard deviation of 5.0 mg/kg and 1.9 mg/kg, respectively. The average lead XRF concentration is above the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T1 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I1-17. Overall, the majority of detectable lead XRF results in surface soils were above the applied BTV. However, the maximum XRF value was 3.6 times higher than the applied BTV and is likely associated with the exposed uranium-bearing geology at Target T1.

For subsurface samples, lead did not exceed the applied BTV. The maximum lead concentration in the subsurface soil sample was 1.9 mg/kg.

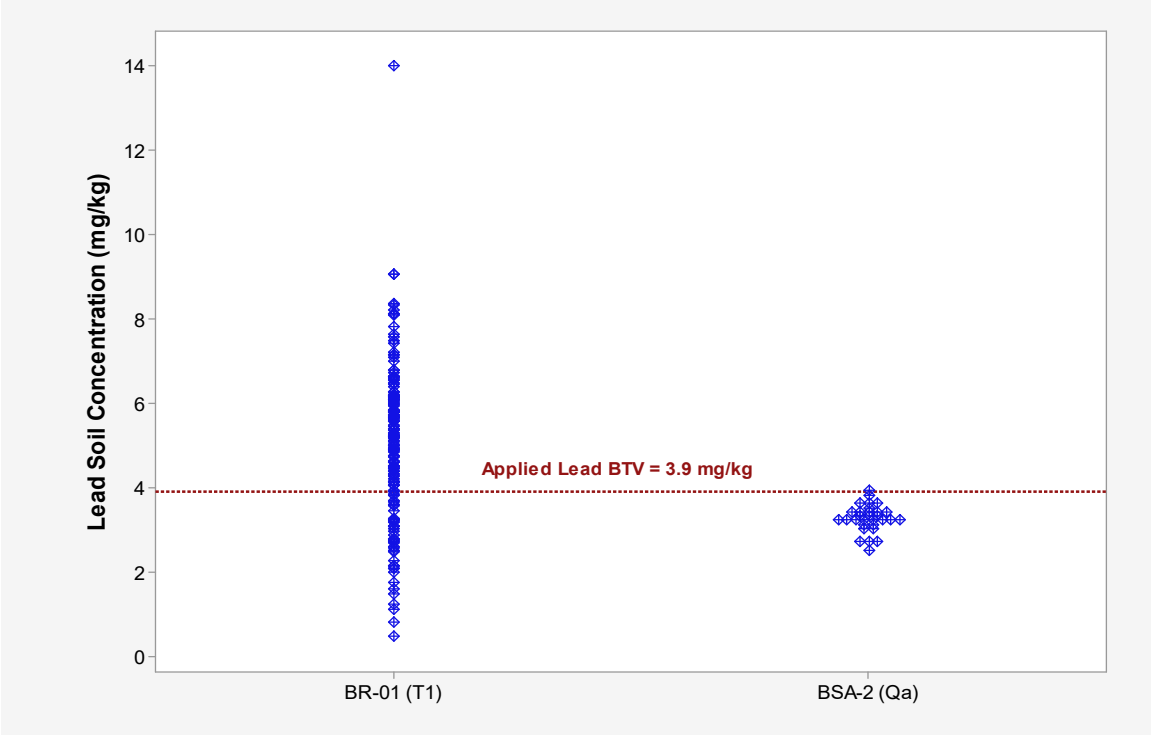


Figure I1-15. Individual Value Plot for Target BR-01 (T1) and BSA-2 (Qa) Lead Soil Concentrations

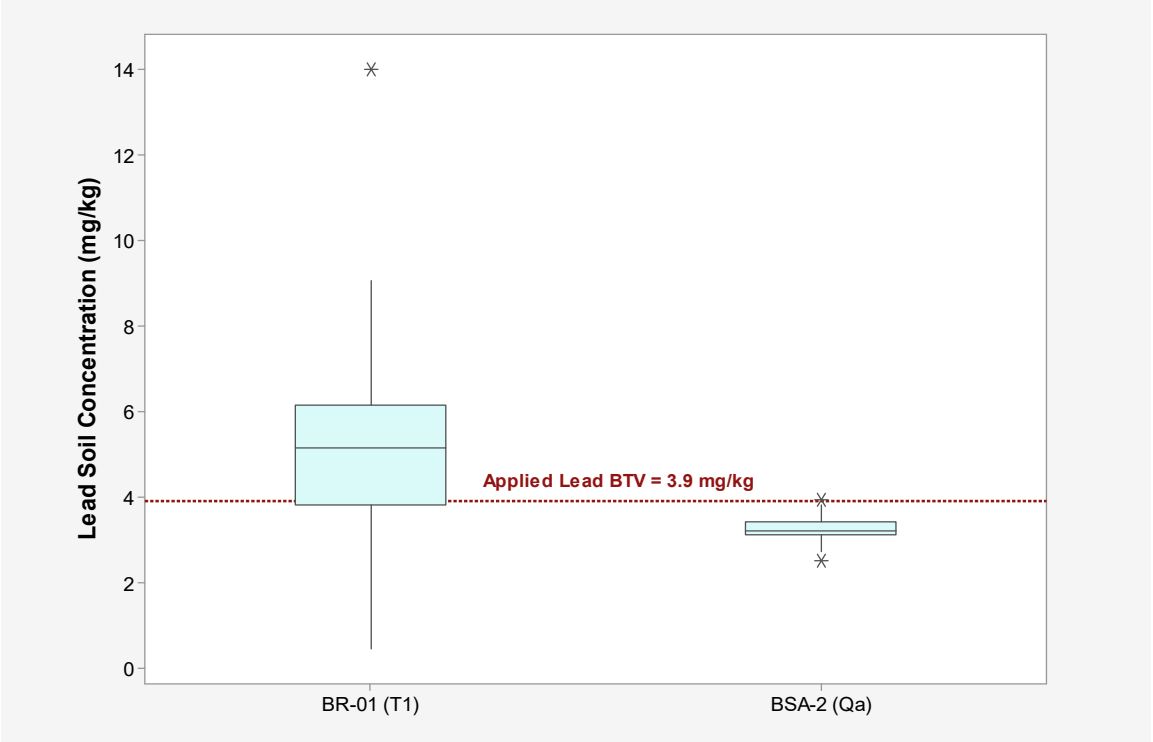
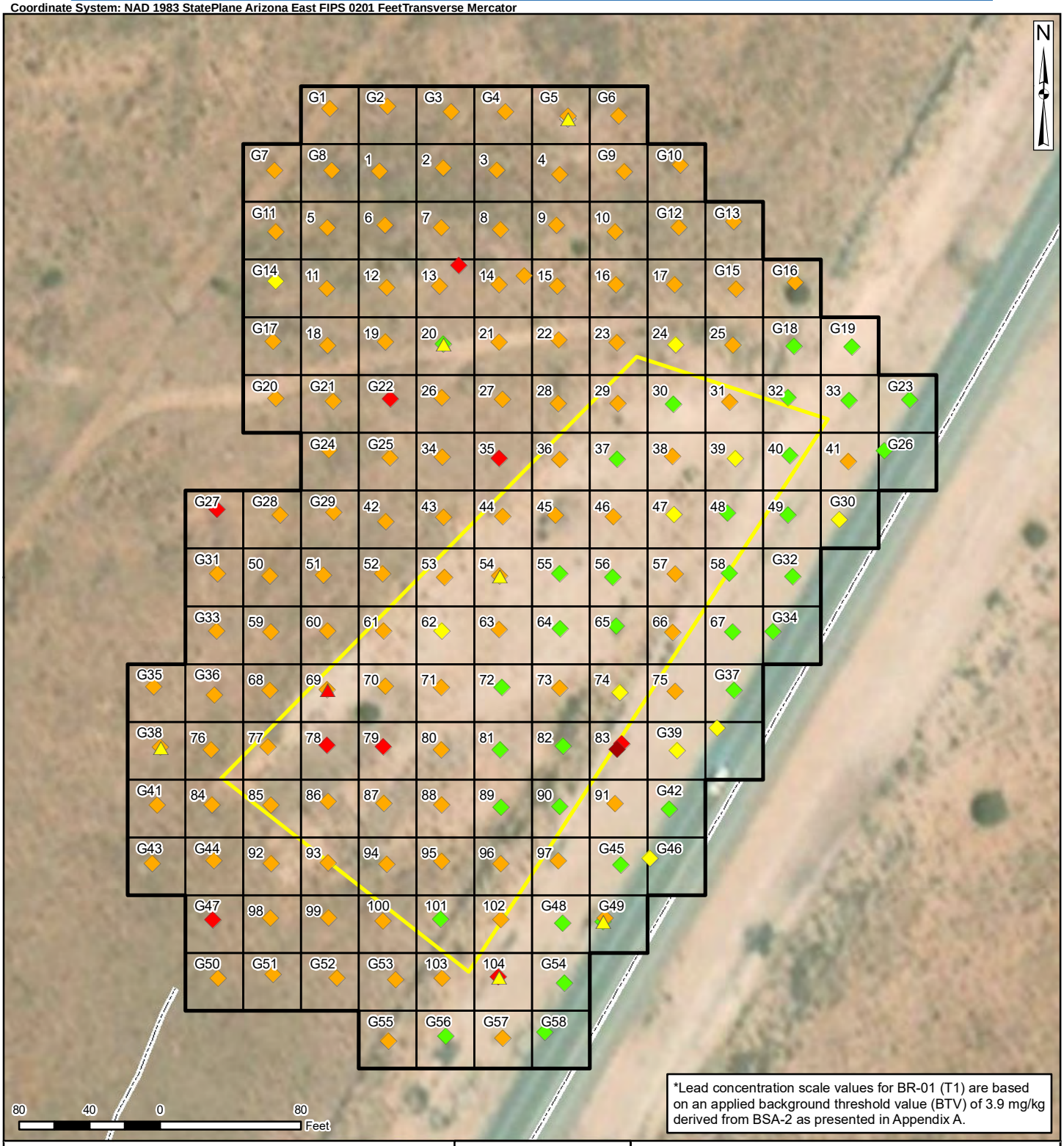


Figure I1-16. Box Plot for Target BR-01 (T1) and BSA-2 (Qa) Lead Soil Concentrations



Lead Concentration Scale (mg/kg)*

- ≤ 3.2
- 3.2 - 3.9
- 3.9 - 7.8
- 7.8 - 12
- 12 - 16
- 16 - 39
- ≥ 39
- Non-Detect - Less Than Limit of Detection

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET BR-01 (T1) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I1-17
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.1.7.4 Thorium

Thorium was identified as a COPC in the surface and subsurface soil environments as shown in Table I-25. Thorium exceeded the applied BTV in 67 percent of in situ XRF measurements and in all seven XRF confirmation samples. The applied BTV for thorium is 1.7 mg/kg for Target T1 as presented in Section 4.1.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I1-11 and Attachment I3, respectively. Figure I1-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T1 and BSA-2 (Qa) samples. Figure I1-19 presents a box plot of detectable thorium XRF soil concentrations for Target T1 and BSA-2 (Qa) samples. Summary statistics for XRF measurements are provided in Section 4.1.6. Thorium XRF concentrations measured in surface soils at Target T1 ranged between 1.0 and 4.9 mg/kg with an average and standard deviation of 2.0 mg/kg and 0.6 mg/kg, respectively. The average thorium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T1 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I1-20. Overall, the majority of detectable thorium XRF results in surface soils was above the applied BTV. However, the exceedances were not significantly higher than the applied BTV and is likely associated with the exposed uranium-bearing geology at Target T1.

For subsurface samples, thorium did not exceed the applied BTV. The maximum thorium concentration in the subsurface soil sample was 1.1 mg/kg.

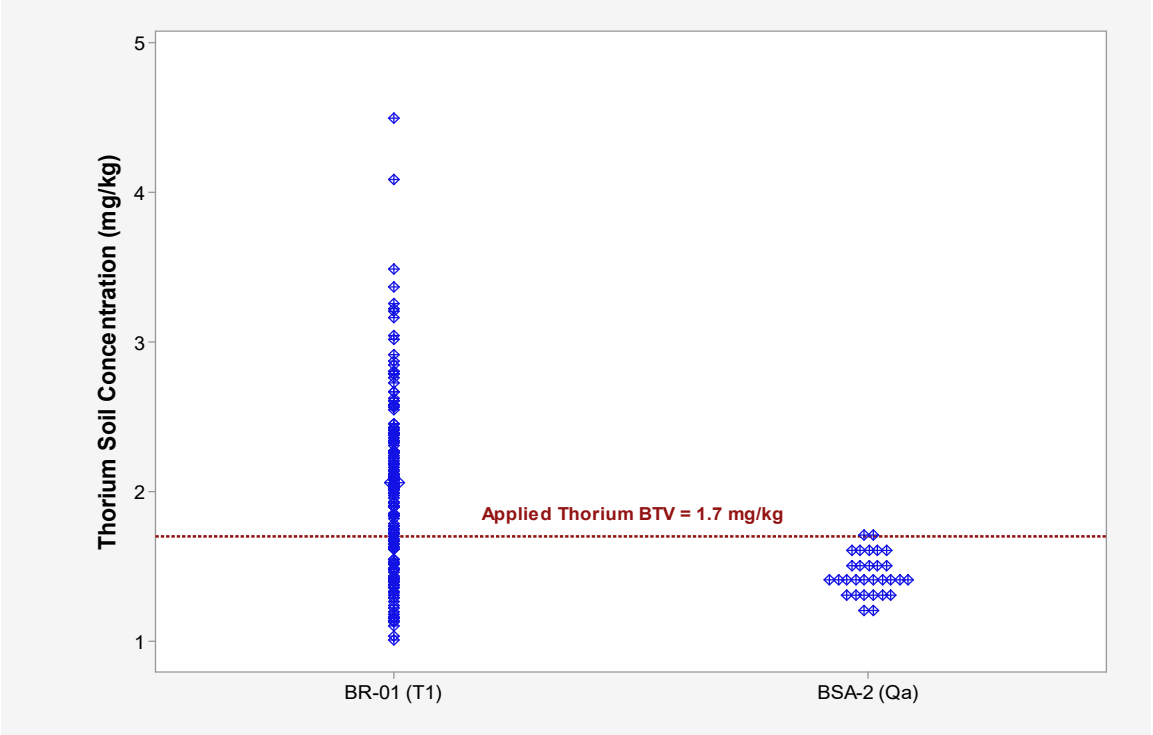


Figure I1-18. Individual Value Plot for Target BR-01 (T1) and BSA-2 (Qa) Thorium Soil Concentrations

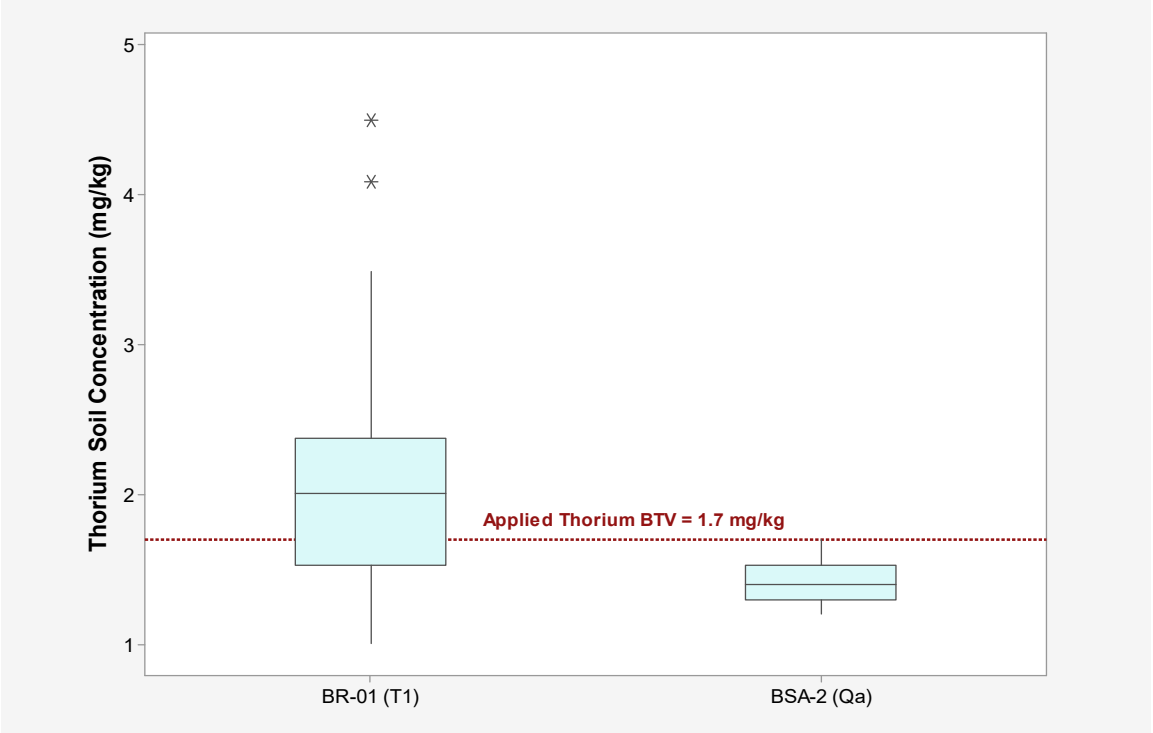
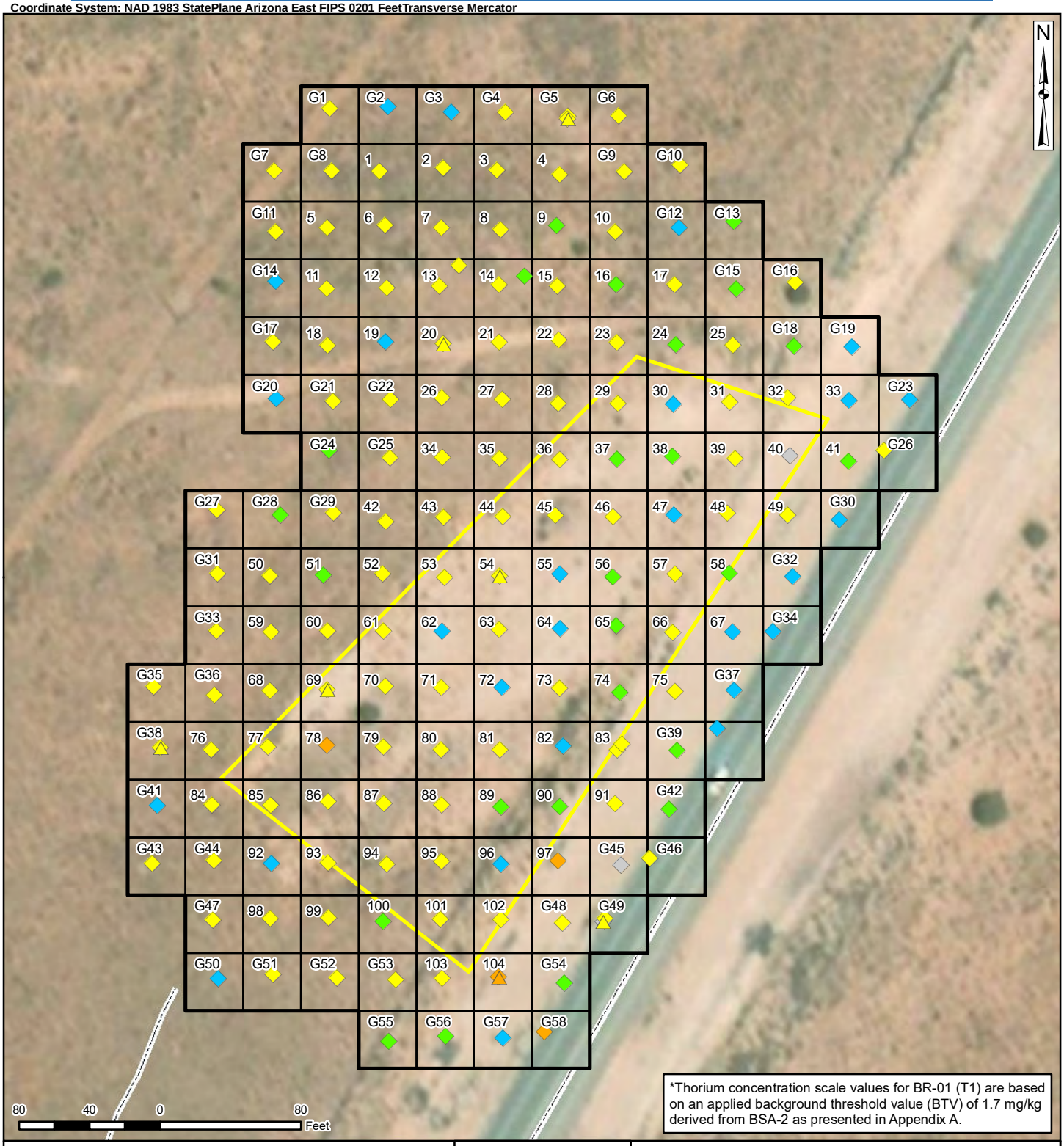


Figure I1-19. Box Plot for Target BR-01 (T1) and BSA-2 (Qa) Thorium Soil Concentrations



Thorium Concentration Scale (mg/kg)*

- ≤ 1.4
- 1.4 - 1.7
- 1.7 - 3.4
- 3.4 - 5.1
- 5.1 - 6.8
- 6.8 - 17
- ≥ 17
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET BR-01 (T1) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I1-20
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.1.7.5 Uranium

Uranium was identified as a COPC in both the surface and subsurface soil environments as shown in Table I1-15. Uranium exceeded the applied BTV in 80 percent of in situ XRF measurements and in all seven XRF confirmation samples. The applied BTV for uranium is 0.35 mg/kg for Target T1 as presented in Section 4.1.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I1-11 and Attachment I3, respectively. Figure 1-21 an individual value plot of detectable uranium XRF soil concentrations for Target T1 and BSA-2 (Qa) samples. Figure I1-22 presents a box plot of detectable uranium XRF soil concentrations for Target T1 and BSA-2 (Qa) samples. Summary statistics for XRF measurements are provided in Section 4.1.6. Uranium XRF concentrations measured in surface soils at Target T1 ranged between 0.11 and 72 mg/kg with an average and standard deviation of 3.5 mg/kg and 7.5 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T1 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I1-23. Overall, the majority of detectable uranium XRF results in surface soils were above the applied BTV. The maximum XRF value was 205 times higher than the applied BTV and is likely associated with the exposed uranium-bearing geology at Target T1.

For subsurface samples, uranium exceeded the applied BTV. The maximum uranium concentration in the subsurface soil sample was 0.39 mg/kg.

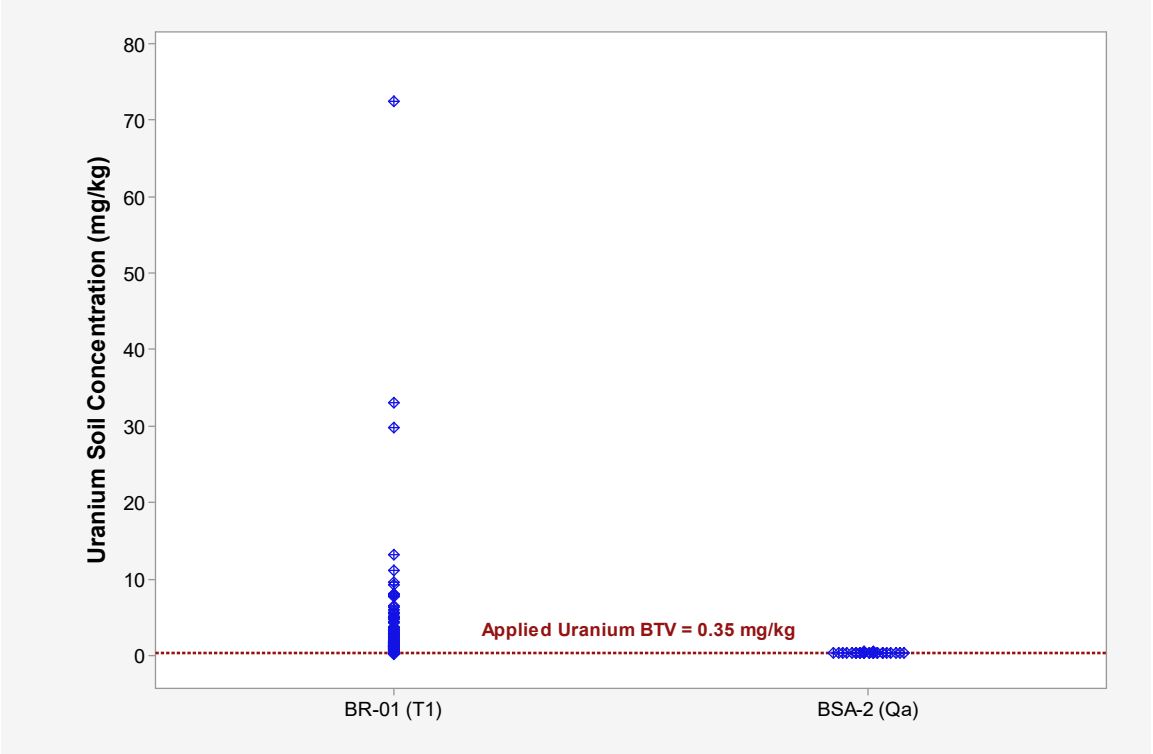


Figure I1-21. Individual Value Plot for Target BR-01 (T1) and BSA-2 (Qa) Uranium Soil Concentrations

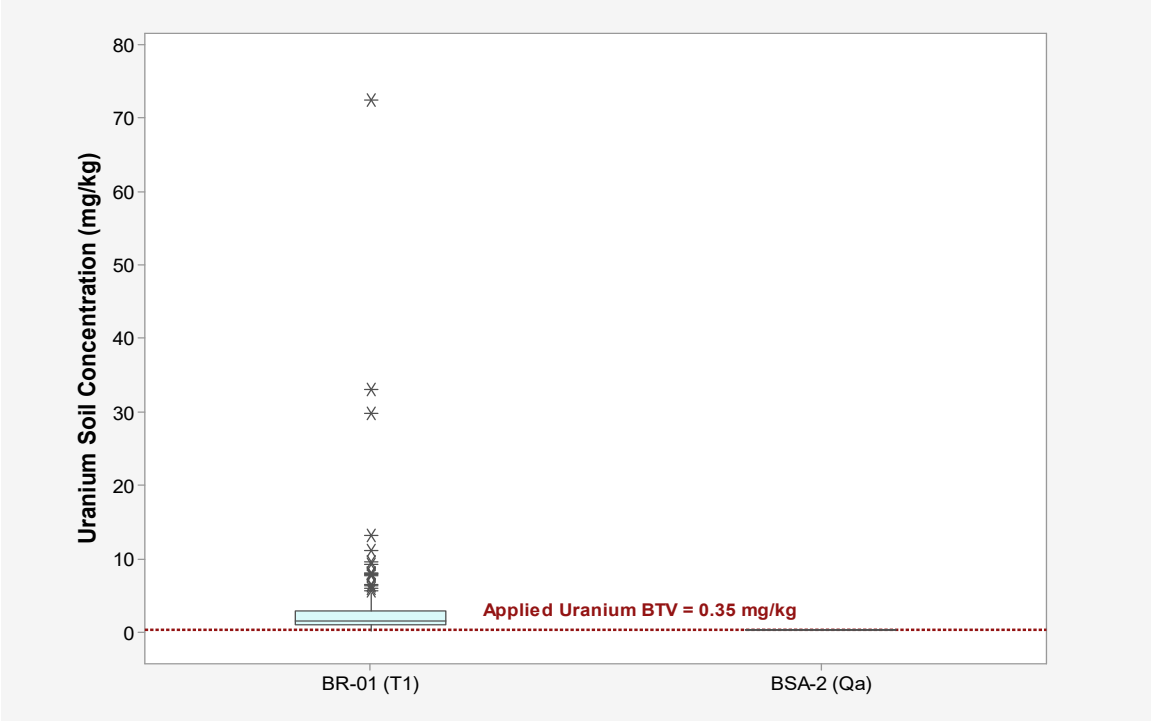
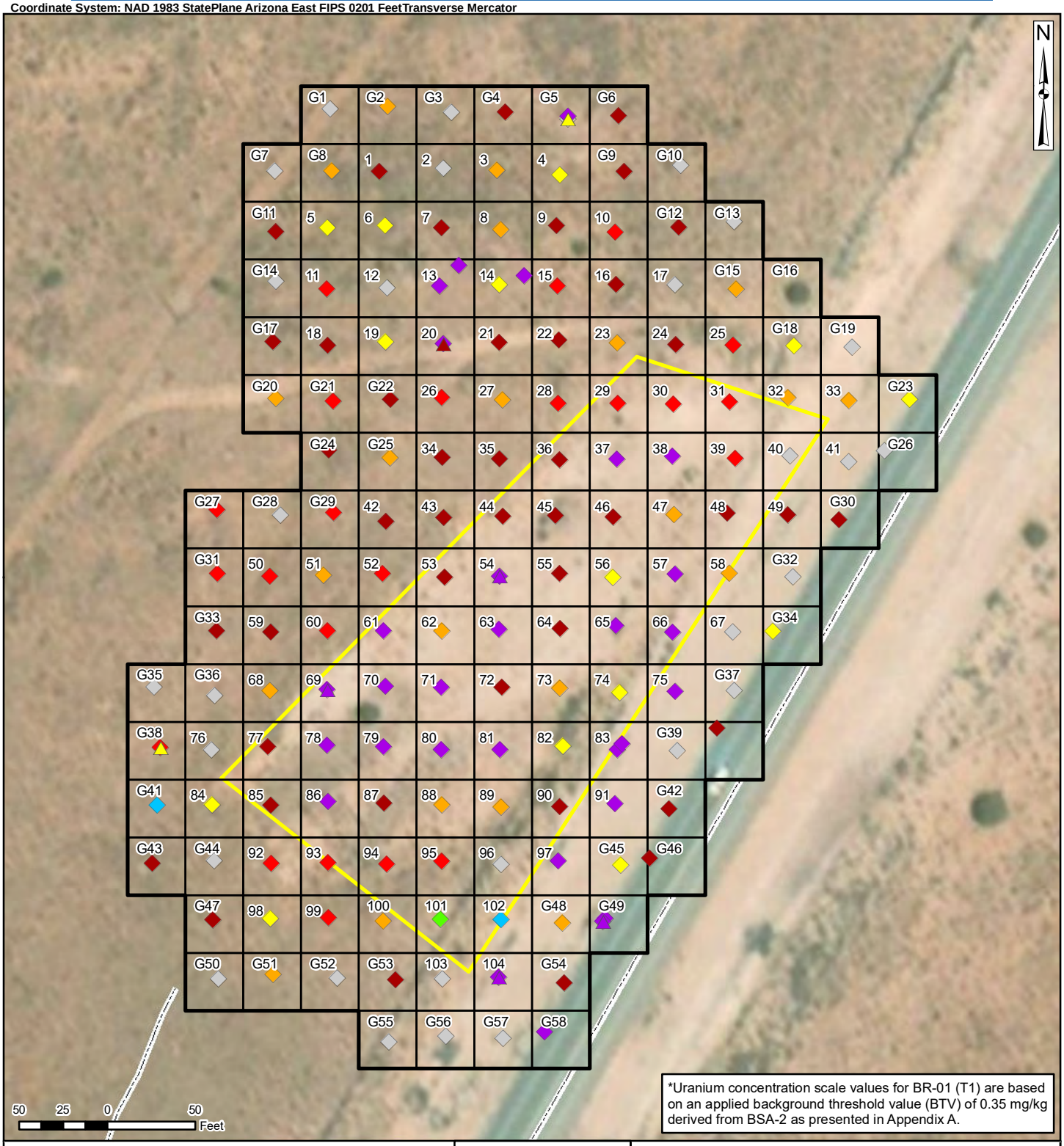


Figure I1-22. Box Plot for Target BR-01 (T1) and BSA-2 (Qa) Uranium Soil Concentrations



Uranium Concentration Scale (mg/kg)*

- ≤ 0.30
- 0.30 - 0.35
- 0.35 - 0.70
- 0.70 - 1.1
- 1.1 - 1.4
- 1.4 - 3.5
- ≥ 3.5
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET BR-01 (T1) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I1-23
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.1.7.6 Vanadium

Vanadium was identified as a COPC in both the surface and subsurface soil environments as shown in Table I1-15. Vanadium exceeded the applied BTV in 4 percent of in situ XRF measurements and in five of the seven XRF confirmation samples. The applied BTV for vanadium is 6.9 mg/kg for Target T1 as presented in Section 4.1.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I1-11 and Attachment , respectively. Figure I1-24 an individual value plot of detectable vanadium XRF soil concentrations for Target T1 and BSA-2 (Qa) samples. Figure I1-25 presents a box plot of detectable vanadium soil XRF concentrations for Target T1 and BSA-2 (Qa) samples. Summary statistics for XRF measurements are provided in Section 4.1.6. Vanadium XRF concentrations measured in surface soils at Target T1 ranged between 16 and 60 mg/kg with an average and standard deviation of 30 mg/kg and 16 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T1 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I1-26. Overall, the majority of detectable vanadium XRF results in surface soils were above the applied BTV. However, the maximum XRF value was 8.7 times higher than the applied BTV and is likely associated with the exposed uranium-bearing geology at Target T1.

For subsurface samples, vanadium did not exceed the applied BTV. The maximum vanadium concentration in the subsurface soil sample was 5.6 mg/kg.

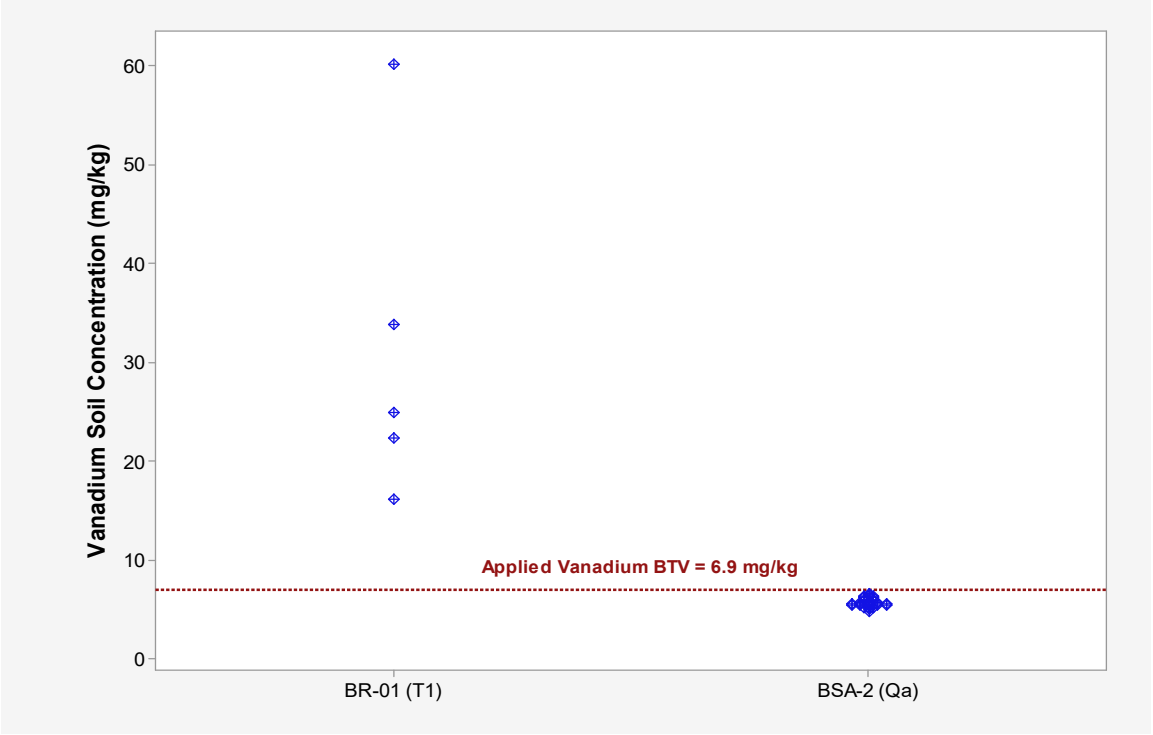


Figure I1-24. Individual Value Plot for Target BR-01 (T1) and BSA-2(Qa) Vanadium Soil Concentrations

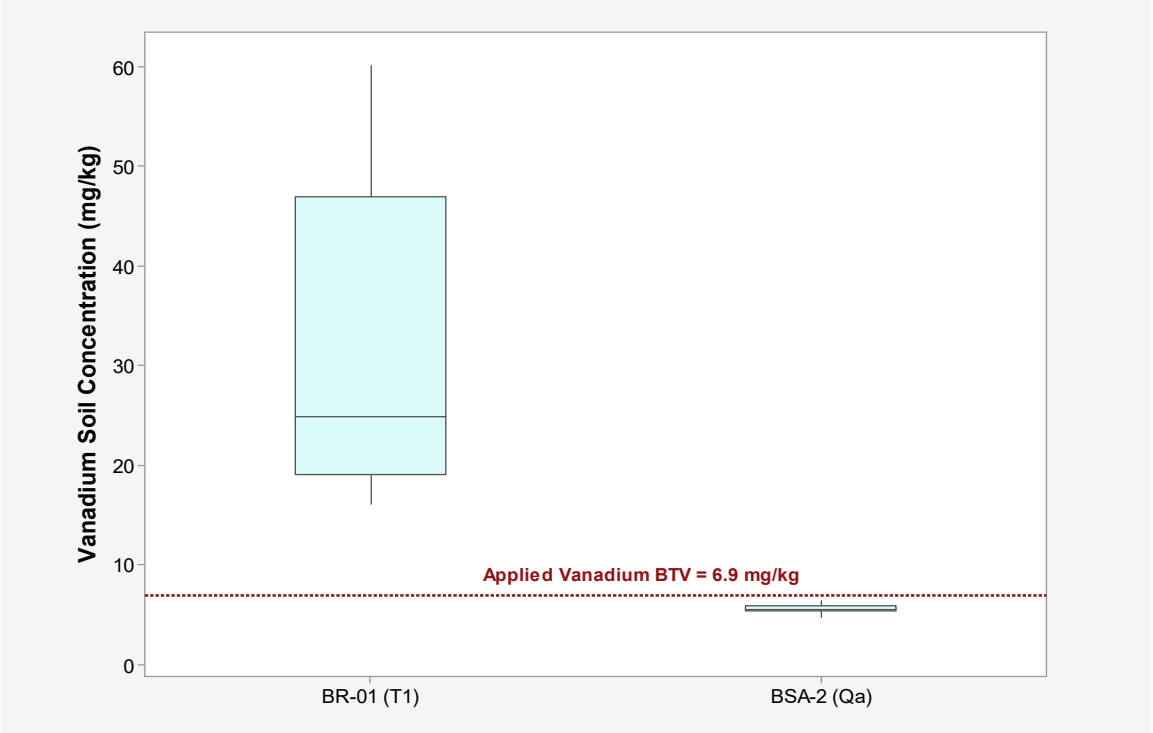
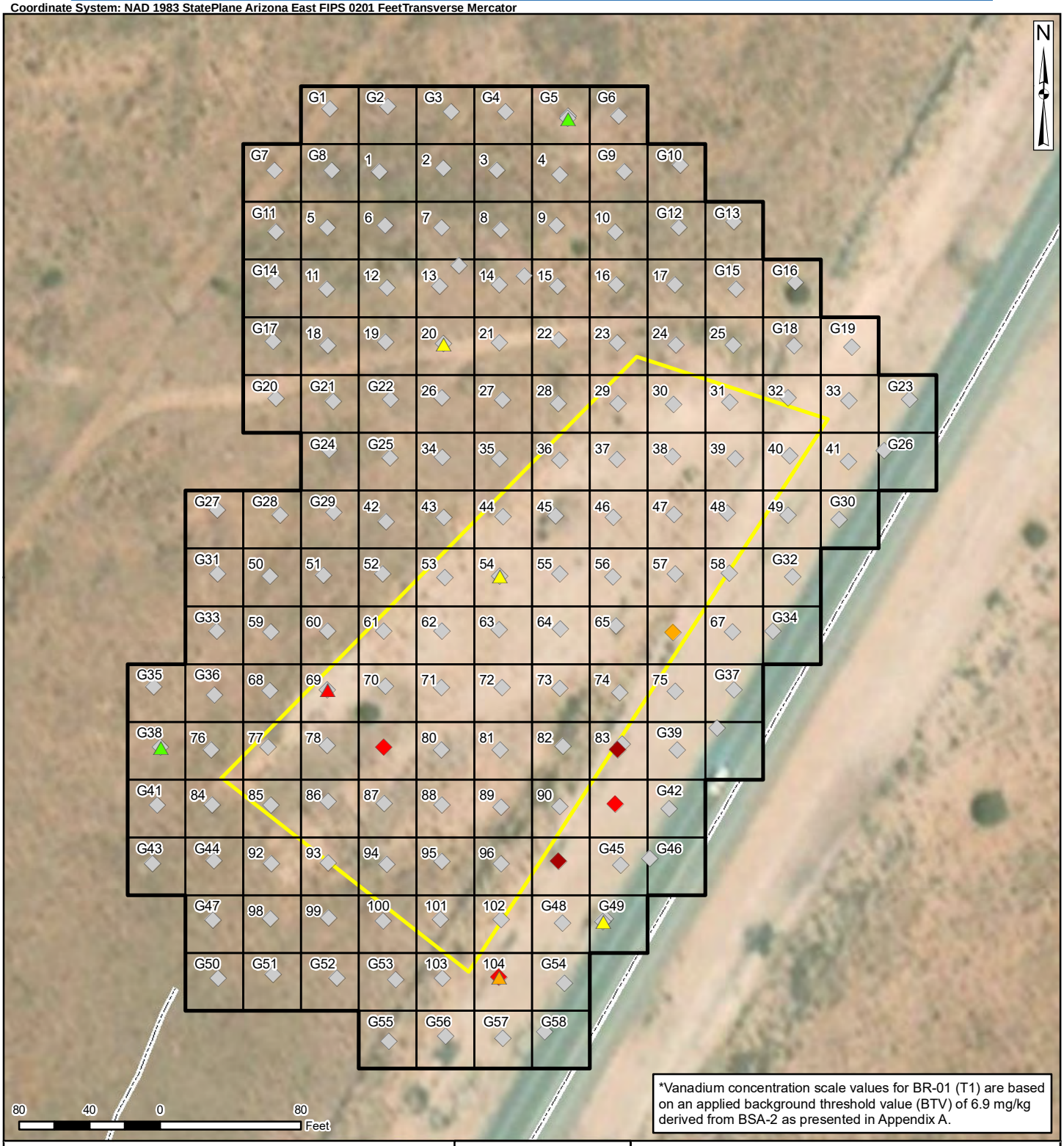


Figure I1-25. Box Plot for Target BR-01 (T1) and BSA-2(Qa) Vanadium Soil Concentrations



Vanadium Concentration Scale (mg/kg)*

- ≤ 5.6
- 5.6 - 6.9
- 6.9 - 14
- 14 - 21
- 21 - 28
- 28 - 69
- ≥ 69
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET BR-01 (T1) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I1-26
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.1.8 Conclusions

Target T1 (BR-01) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T1. Similarly, many soil samples were collected from both the surface and subsurface soil environments and analyzed for metals, radionuclides, and geochemical parameters. The conclusions from the RSE investigation at Target T1 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T1. ASPECT gamma survey results generally correlated with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE. A soil borrow area was identified that exposed underlying uranium-bearing geology.
- The lateral extent of elevated radiological activity at Target T1 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized except within the highway alignment. Ra-226 in one XRF confirmation sample from survey unit X69 (highest grid averaged gamma reading) exceeded the applied BTV by a factor of 60.6. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Mean raw gamma measurements did exceeded the applied BTV by a factor of up to 1.32. In addition, grid averaged gamma measurements exceeded the applied BTV in 121 of 162 survey units by a factor of up to 3.28.
- Site-specific and regional BTVs for Target T1 geology and soil types were established through a background study.
- A total of 36 analytes were identified as occurring within the surface soils, and 20 analytes were identified as occurring within the subsurface soils. Of these analytes, 27 were found to be above background in surface and 3 in subsurface soils. Arsenic, lead, thorium, uranium, and vanadium exceeded the applied BTV by a factor greater than two.
- Target T1 does not contain TENORM from uranium mining. However, a former soil borrow area associated with road construction has exposed the underlying uranium-bearing geology. While the soils removal is not associated with mining activities, the exposed geology may require further evaluation.
- There are no immediate significant physical hazards present at Target T1.
- Access is by a dirt road from an adjacent paved highway.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No groundwater wells are documented within the vicinity of Target T1. Rural residences are located nearby; however, it is not known if water is provided by utility or private well. No seeps or springs were observed during the RSE investigation.

- The majority of the SPLP results were nondetects, indicating that limited leaching of metals would occur in an acidic environment. ABA and paste pH results indicate that the soils are not acid generating and are slightly basic, which would further limit potential metals leachability.
- The majority of the TCLP results were nondetects, indicating that metals concentrations in soils meet the TCLP requirements for disposal at a permitted landfill or a low-level radioactive waste disposal facility.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; however, one data gap remains for Target T1. The data gap is to investigate the lateral extent of elevated gamma activity along the western side of the highway because the road cut may have exposed NORM along the highway alignment.

4.2 NON-AUM TARGET T3 (BR-03)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T3 (BR-03).

4.2.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T3 (BR-03) is associated with the Brodie 1 Mine (M1), a former underground mine in the Tse Tah Region in Subarea Group A. Five other non-AUM Targets are associated with the Brodie 1 Mine. Target T3 is administered by the Red Mesa and Sweetwater Chapters of the Navajo Nation and is accessible by vehicle via Highway 160, which is located immediately southeast. Target T3 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. A residence is located approximately 1,000 feet to the southeast. A Target location and access map for Target T3 is shown in Figure I3-1.

A topographical relief map of the Brodie 1 Mine area and associated non-AUM Targets is provided in Figure I3-2. The elevation at Target T3 ranges from 5,783 to 5,794 feet amsl with an average of 5,788 feet amsl, and the slope ranges from 2 to 8 percent with an average of 5 percent. An ephemeral drainage channel is located approximately 350 feet north of Target T3. The Brodie 1 Mine is located entirely within the Js and the rock outcrop-Rizno complex soils unit, and Target T3 is located within the Jms. The soil type of the western portion of Target T3 is within the Weiser-Wechech association (MUSYM 314) while soil type of the eastern portion is within the rock outcrop-Rizno complex (MUSYM 309) (Figure I1-3 and Figure I1-4).

Tetra Tech performed a geospatial analysis of the 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T3. Weston did not conduct a background study for Target T3. As a part of the RSE for the Brodie 1 Mine, Tetra Tech also evaluated the associated non-AUM Targets, such as T3. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 1 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T3:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T3 is accessed by taking Highway 160 to Indian Route 35 and then via a four-wheel-drive off-road access route to the northwest for approximately 0.5 miles.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM and TENORM was not observed at the Target.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  No drainages were located on or adjacent to the Target; an ephemeral drainage was located approximately 0.5 mile to the northwest and is evaluated in Appendix H1 (Figure I3-1).

- Identified any exploration borings or historic haul roads:

  No exploratory borings or haul roads were identified.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  No non-AUM Target features were identified.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target

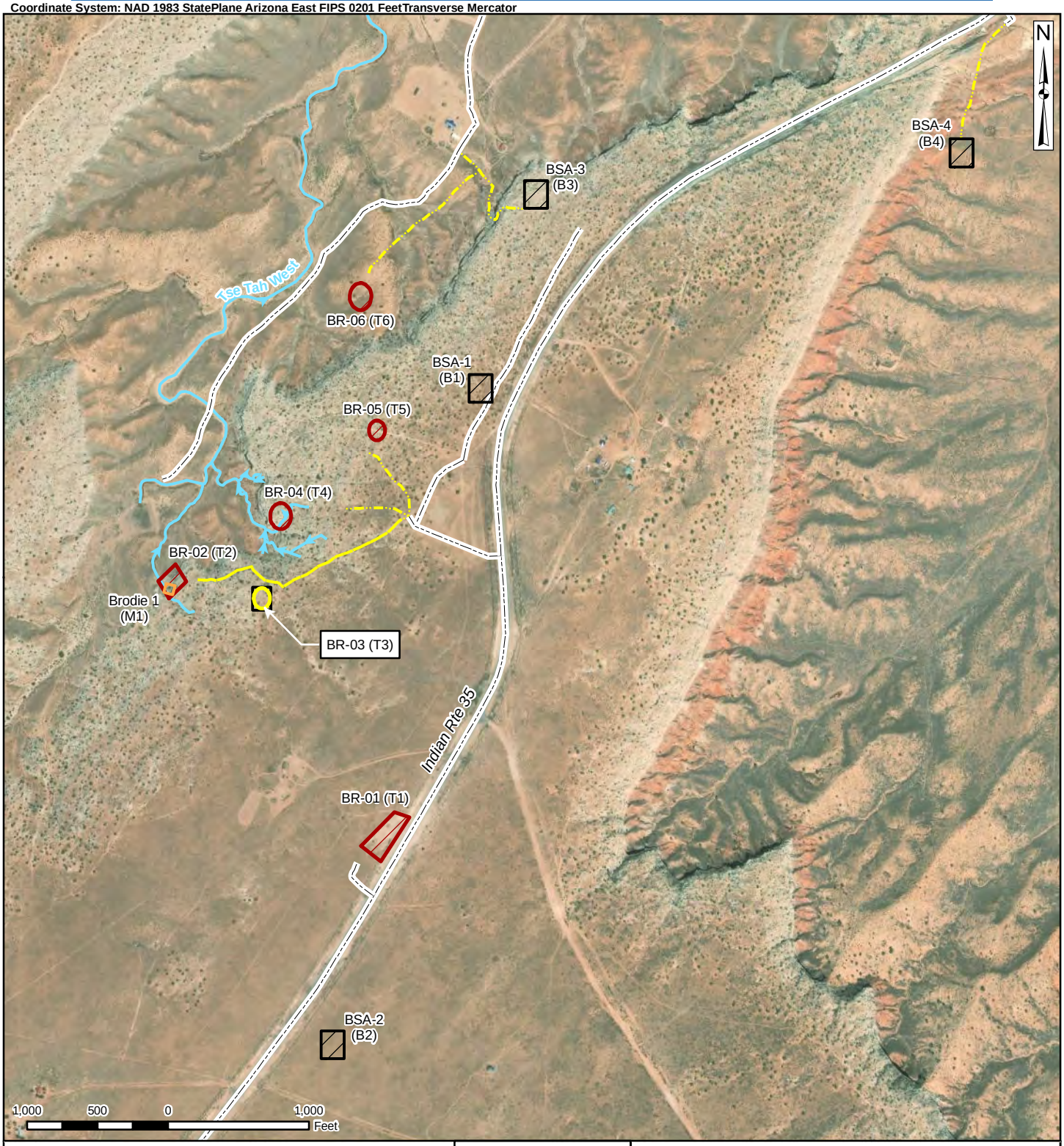
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T3 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Section 2.3 and Section 4.2.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 4.2.3 with results presented in Section 4.2.6 and Section 4.2.7)
- Conducting a gamma radiation survey (results presented in Section 4.2.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



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

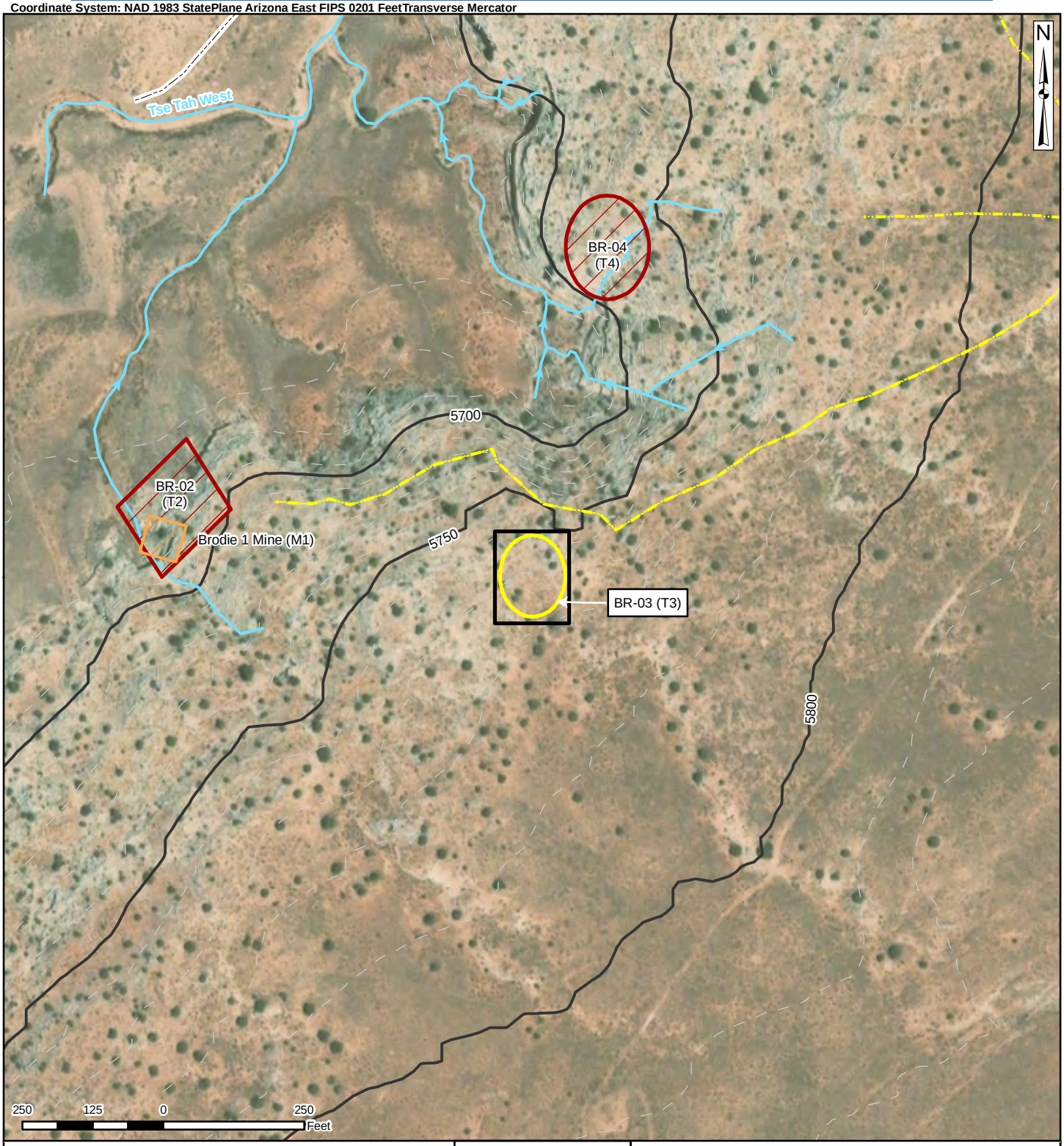
Prepared for: USEPA Region 9

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NON-AUM TARGET BR-03 (T3) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I3-1
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site Boundary
Tronox AUM Site Boundary
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped
50 ft Contour*
10 ft Contour*

* 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.

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NON-AUM TARGET BR-03 (T3) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I3-2
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

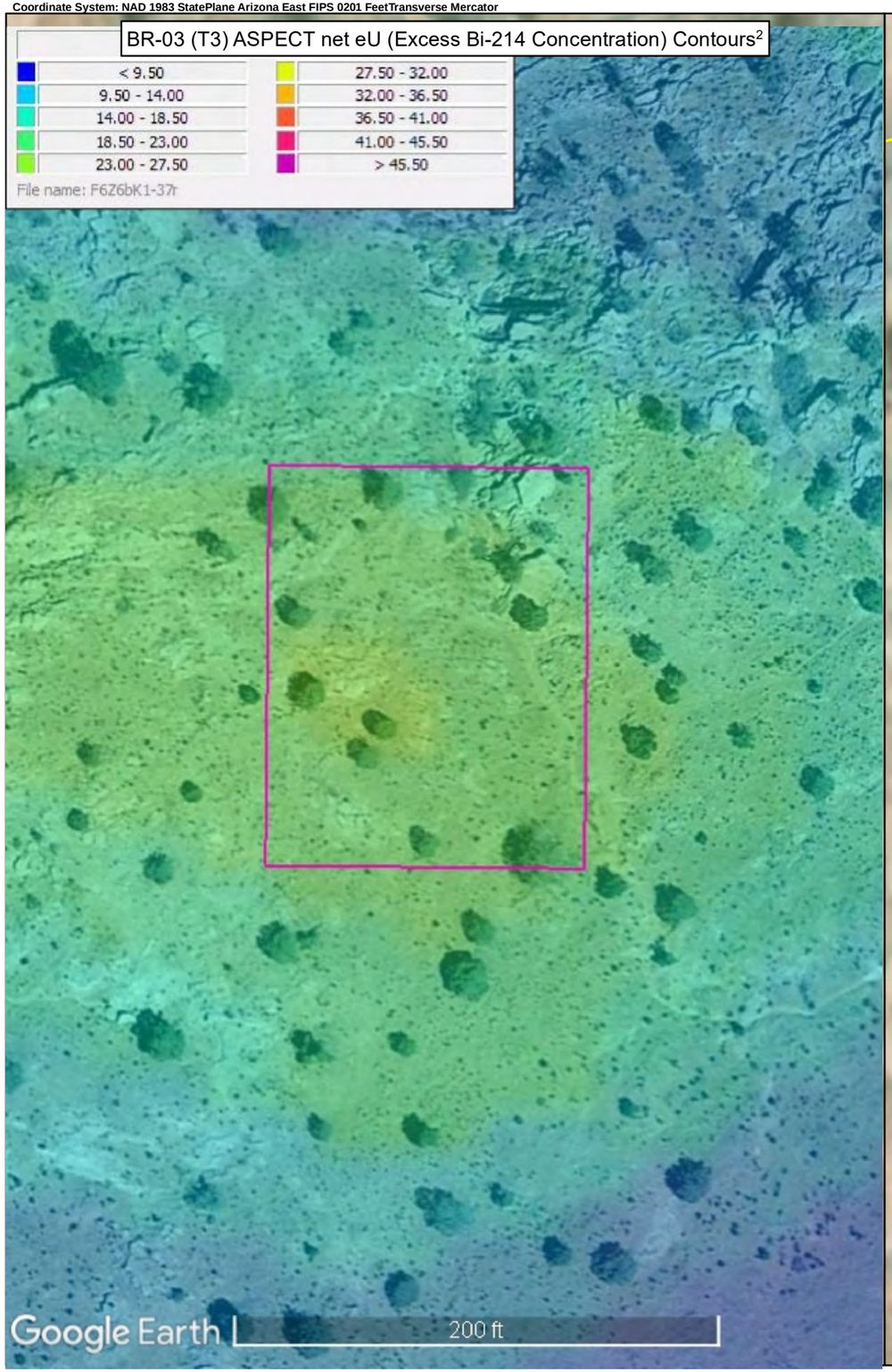
4.2.2 Gamma Radiation Survey and Field XRF Measurements

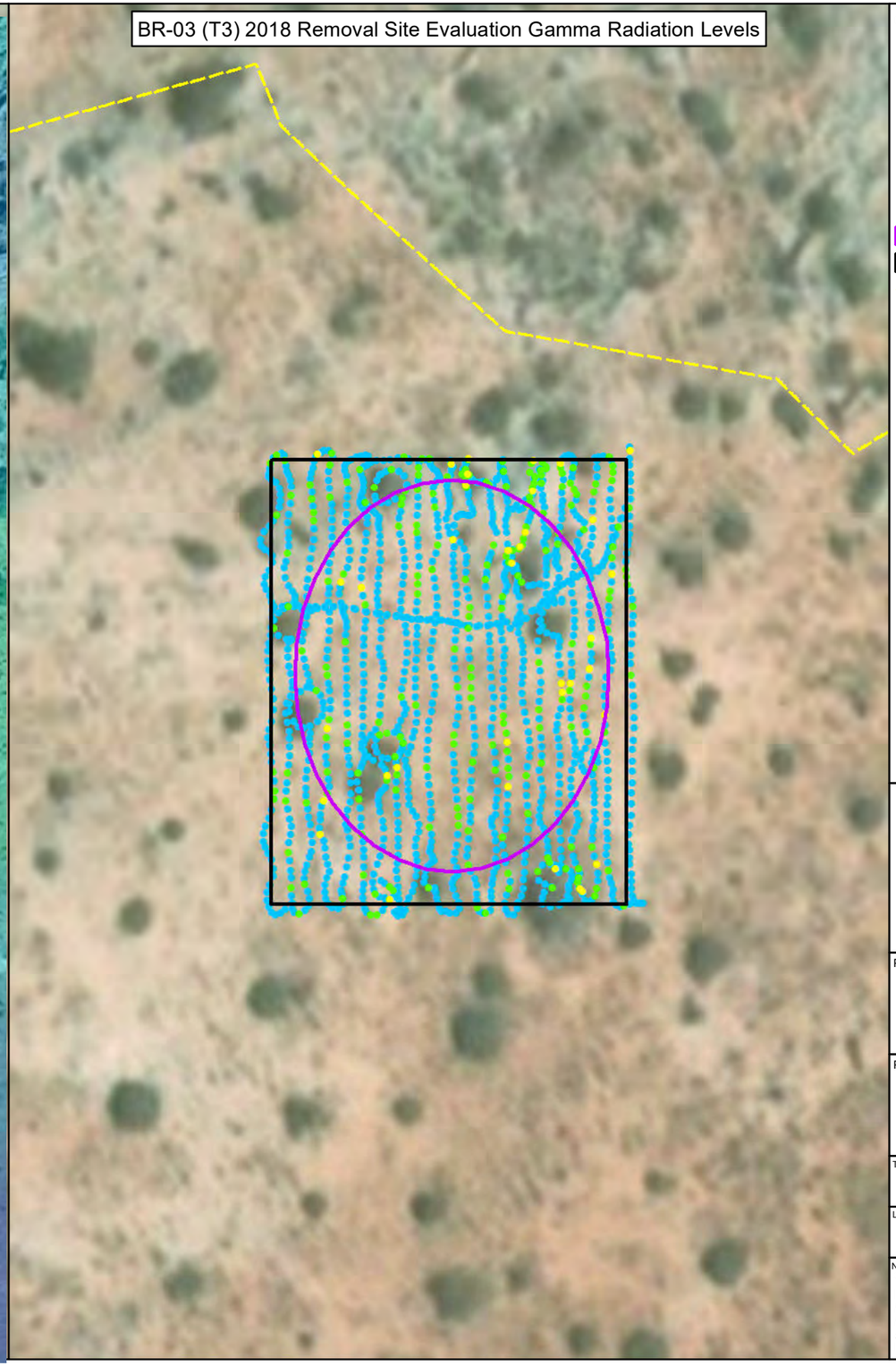
Tetra Tech performed GPS-based gamma radiation surveys (Figure I3-3) within the survey area of the non-AUM Target T3 as part of the Baseline Study in May 2018. Additional Goback gamma radiation surveys were not performed. Tetra Tech also performed an XRF field survey at non-AUM Target T3 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I3-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 1, of the RSE Workplan (Tetra Tech 2018). All gamma survey and XRF survey units were evaluated.

4.2.3 XRF Confirmation Sampling Overview

Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T3. Two XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from two locations (as shown in Table I3-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figure I3-4 and Figure I3-5 show the locations of in situ XRF measurements and XRF confirmation soil samples. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I3-2. The results of XRF confirmation sample analysis are provided in Section 4.2.6.1. Correlated XRF field measurements are provided in Attachment I3.

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





Gamma Reading (cpm)[1]

≤ 8,760	≤ Avg. BG
8,760 - 10,287	Avg. BG - 1 x BTV
10,287 - 20,574	1 x BTV - 2 x BTV
20,574 - 30,861	2 x BTV - 3 x BTV
30,861 - 41,148	3 x BTV - 4 x BTV
41,148 - 102,870	4 x BTV - 10 x BTV
≥ 102,870	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Foot

[1]The applied gamma background threshold value (BTV) for BR-03 (T3) Non-AUM Target is 10,287 cpm derived from BSA-1 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 50 ft

1:600

N W E S

0 25 50 100 Feet

NON-AUM TARGET BR-03 (T3)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

Prepared By:

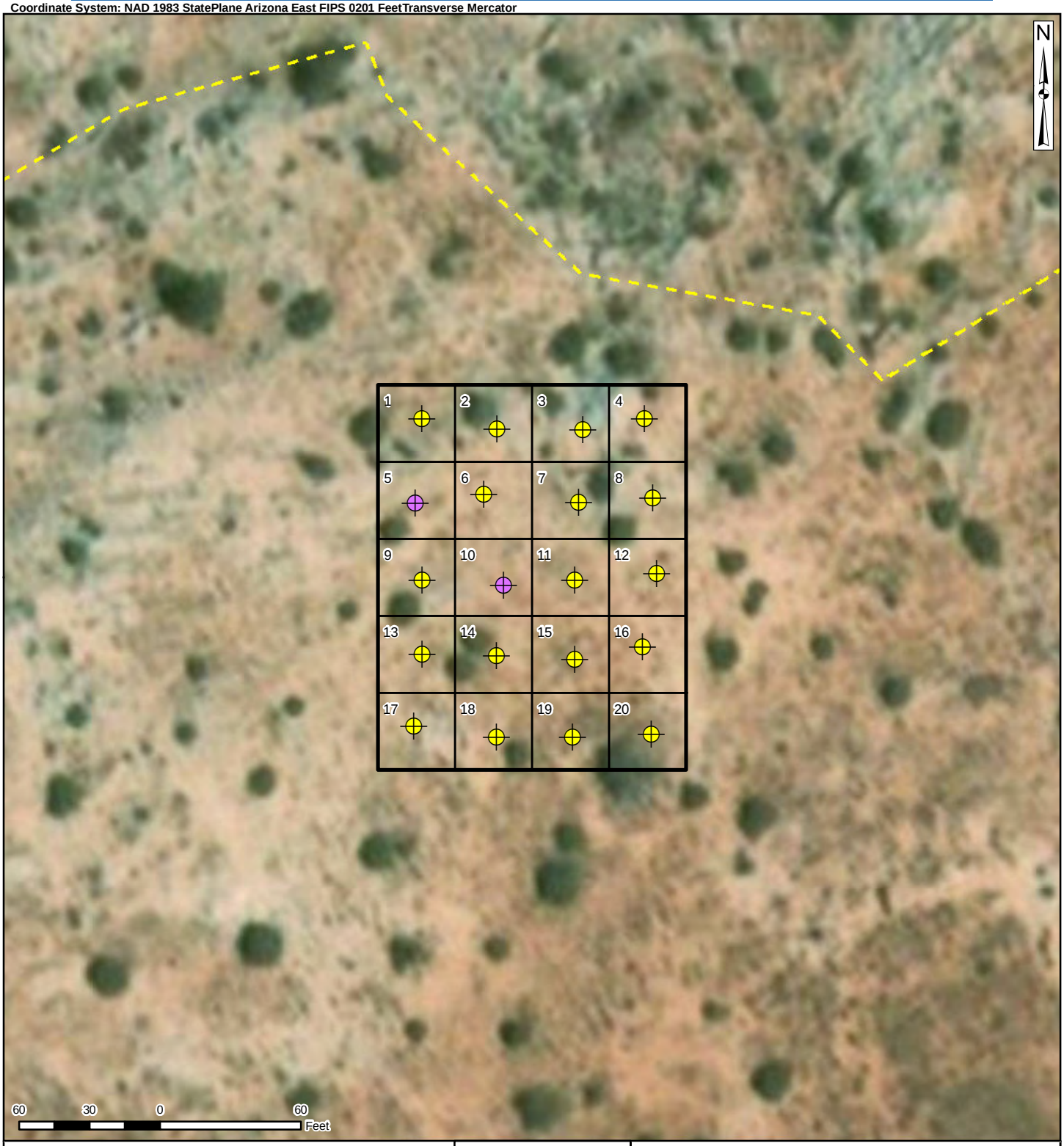
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborn Spectral Photometric Environmental Collection Technology.

Figure No.: **I3-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route - Foot

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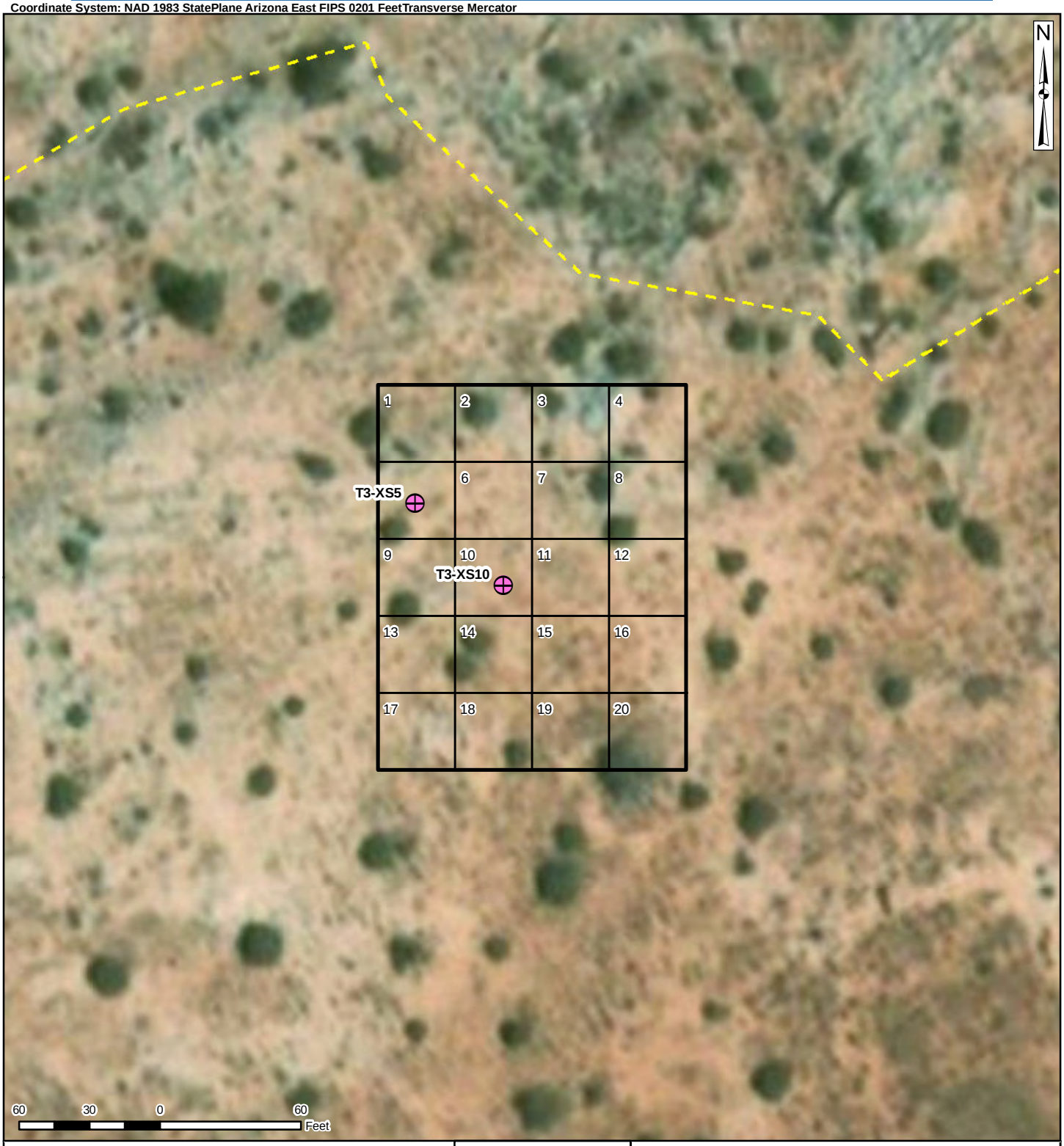
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NON-AUM TARGET BR-03 (T3) XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I3-4
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

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



XRF Confirmation Soil Sample[1] (0 - 3 inches bgs)

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route - Foot

*T3-XS5 = site T3 XRF confirmation soil sample collected at survey unit 5. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET BR-03 (T3)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I3-5
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

Table I3-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target BR-03 (T3)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T3-XS5-01-051218	5	0-3	XRF Confirmation	Primary	5/12/2018	36.9057760	-109.3505692	1805327-16, 1805328-16
T3-XS10-01-051218	X10	0-3	XRF Confirmation	Primary	5/12/2018	36.9056797	-109.3504411	1805327-15, 1805328-15

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I3-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BR-03 (T3)

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

Notes:
[1] Measured via alpha spectroscopy.
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

4.2.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 4.2.1, Target T3 surface geology is entirely within the Jms and soils within the rock outcrop-Rizno complex (MUSYM 309) (Figure I-13 and Figure I-14). As a result, Background Study Area 1 (BSA-1) was selected for that combination of geology and soil type. Table I3-3 presents the Target-specific BTVs for 29 analytes and gamma radiation levels for Target T3. No regional BTVs were established for Target T3. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T3. The "Applied BTV" for each analyte is the Target-specific BTV.

Table I3-3. Applied Background Threshold Values for Non-AUM Target BR-03 (T3)

Analyte	Units	Site-Specific BTV (BSA-1)	Regional BTV (Jms)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	5,900	None	5,900	Site-Specific BTV
Antimony	mg/kg	0.128	None	0.128	Site-Specific BTV
Arsenic	mg/kg	5.8	None	5.8	Site-Specific BTV
Barium	mg/kg	190	None	190	Site-Specific BTV
Beryllium	mg/kg	0.40	None	0.40	Site-Specific BTV
Cadmium	mg/kg	0.098	None	0.098	Site-Specific BTV
Calcium	mg/kg	90,200	None	90,200	Site-Specific BTV
Chromium	mg/kg	4.6	None	4.6	Site-Specific BTV
Cobalt	mg/kg	3.7	None	3.7	Site-Specific BTV
Copper	mg/kg	11	None	11	Site-Specific BTV
Iron	mg/kg	7,800	None	7,800	Site-Specific BTV
Lead	mg/kg	6.7	None	6.7	Site-Specific BTV
Lithium	mg/kg	14	None	14	Site-Specific BTV
Magnesium	mg/kg	5,070	None	5,070	Site-Specific BTV
Manganese	mg/kg	270	None	270	Site-Specific BTV
Mercury	mg/kg	0.0168	None	0.0168	Site-Specific BTV
Molybdenum	mg/kg	0.58	None	0.58	Site-Specific BTV
Nickel	mg/kg	5.9	None	5.9	Site-Specific BTV
Potassium-40	pCi/g	15.6	None	15.6	Site-Specific BTV
Radium-226	pCi/g	2.59	None	2.59	Site-Specific BTV
Radium-228	pCi/g	0.60	None	0.60	Site-Specific BTV
Selenium	mg/kg	0.88	None	0.88	Site-Specific BTV
Silver	mg/kg	0.037	None	0.037	Site-Specific BTV
Sodium	mg/kg	40	None	40	Site-Specific BTV
Thallium	mg/kg	0.062	None	0.062	Site-Specific BTV
Thorium	mg/kg	2.1	None	2.1	Site-Specific BTV
Uranium	mg/kg	3.9	None	3.9	Site-Specific BTV
Vanadium	mg/kg	13	None	13	Site-Specific BTV
Zinc	mg/kg	19	None	19	Site-Specific BTV
Gamma Radiation	cpm	10,287	None	10,287	Site-Specific BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
Jms Morrison Formation, Salt Wash Member
mg/kg milligrams per kilogram
pCi/g picocuries per gram

4.2.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T3 and the raw gamma radiation and grid averaged gamma radiation survey results.

4.2.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T3 in May 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine if any additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. No additional scanning, measurements, or sampling were required. A gamma radiation survey was also performed in the Tse Tah West drainage within the area in conjunction with the RSE for the Brodie 1 Mine; results are presented in Appendix J of the RSE Report. The applied gamma BTV for non-AUM Target T3 is 10,287 cpm. A total of 1,414 measurements were collected as part of the gamma radiation survey at non-AUM Target T3 across 20 survey units. An average scan density of 71 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I3-4.

Table I3-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target BR-03 (T3)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	10,287	
Measurements	#	1,414	20
Minimum	cpm	5,493	7,355
Maximum	cpm	11,778	8,474
Average	cpm	7,871	7,857
Median	cpm	7,769	7,843
Standard Deviation	cpm	989	317
90th Percentile	cpm	9,175	8,276
95th Percentile	cpm	9,772	8,375
99th Percentile	cpm	10,659	8,454
Measurements per Survey Unit	#/grid	71	
Measurements Above Gamma BTV	#	33	0
Measurements Above Gamma BTV	%	2.3	0.0

Notes:
BTV background threshold value
cpm counts per minute

4.2.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 2.3 percent of the measurements within the Target boundaries; readings did not exceed greater than two times the applied gamma BTV (10,287 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-1 (Jms) gamma survey results is provided in Figure I3-6. This graph shows that the spread of radiation data at Target T3 (on left) begins below the lower range of BSA-1 (Jms) gamma levels (on right) and then rises to less than twice the background radiation at a few locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T3 is slightly lower than the data cloud from the BSA-1 (Jms) data set. A box plot showing the quartiles of the data sets is provided in Figure I3-7. The box plot shows that the median of Target T3 radiation levels is lower than the median of the BSA-1 (Jms) data set and lower than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I3-8. No mining activity was observed within the survey area of Target T3, and no distinct elevated areas or hot spots were identified, confirming the Weston MCAP survey findings as shown in Figure I3-8.

In general, Target T3 has surficial gamma radiation levels below BSA-1 (Jms) levels across the Target and surrounding area, indicating that the survey did not identify the area of potential elevated gamma activity identified by the ASPECT gamma survey (Figures I3-3). No TENORM or mining-related activities were observed within the Target T3 survey and surrounding area. Section 4.2.5.3 presents the grid averaged results of the gamma radiation survey.

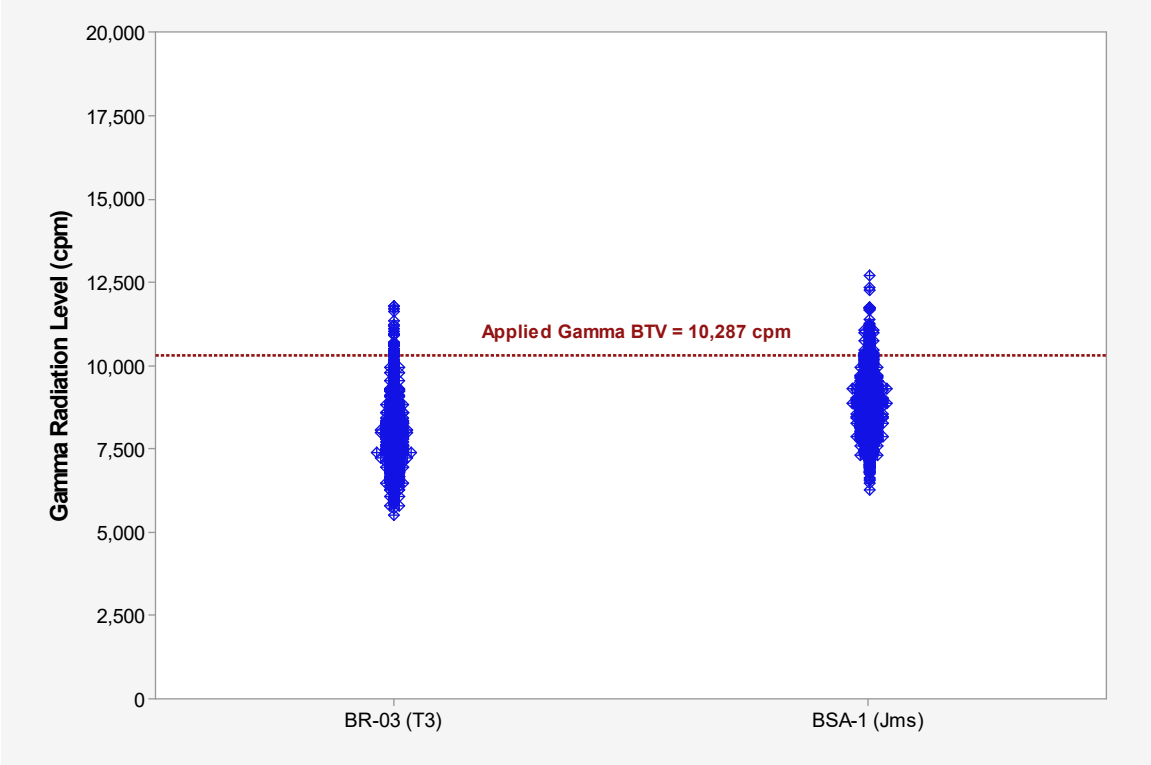


Figure I3-6. Individual Value Plot of Raw Gamma Radiation Levels at Target BR-03 (T3) and BSA-1 (Jms)

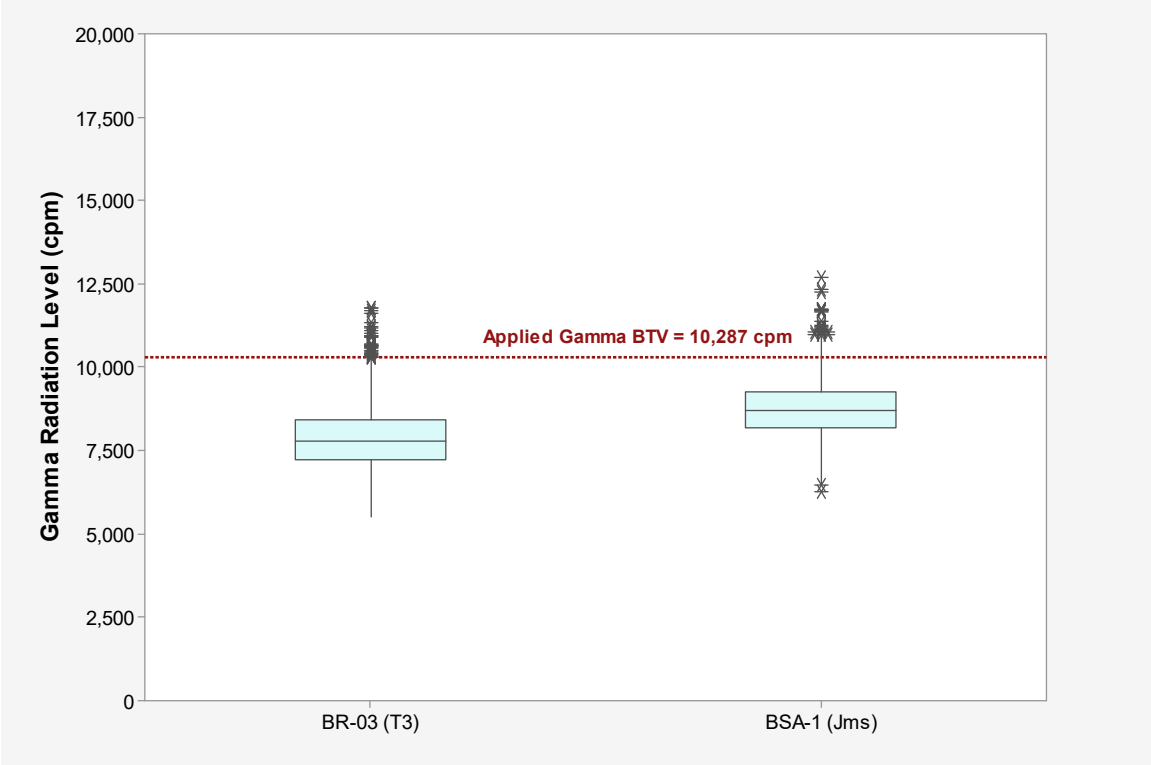
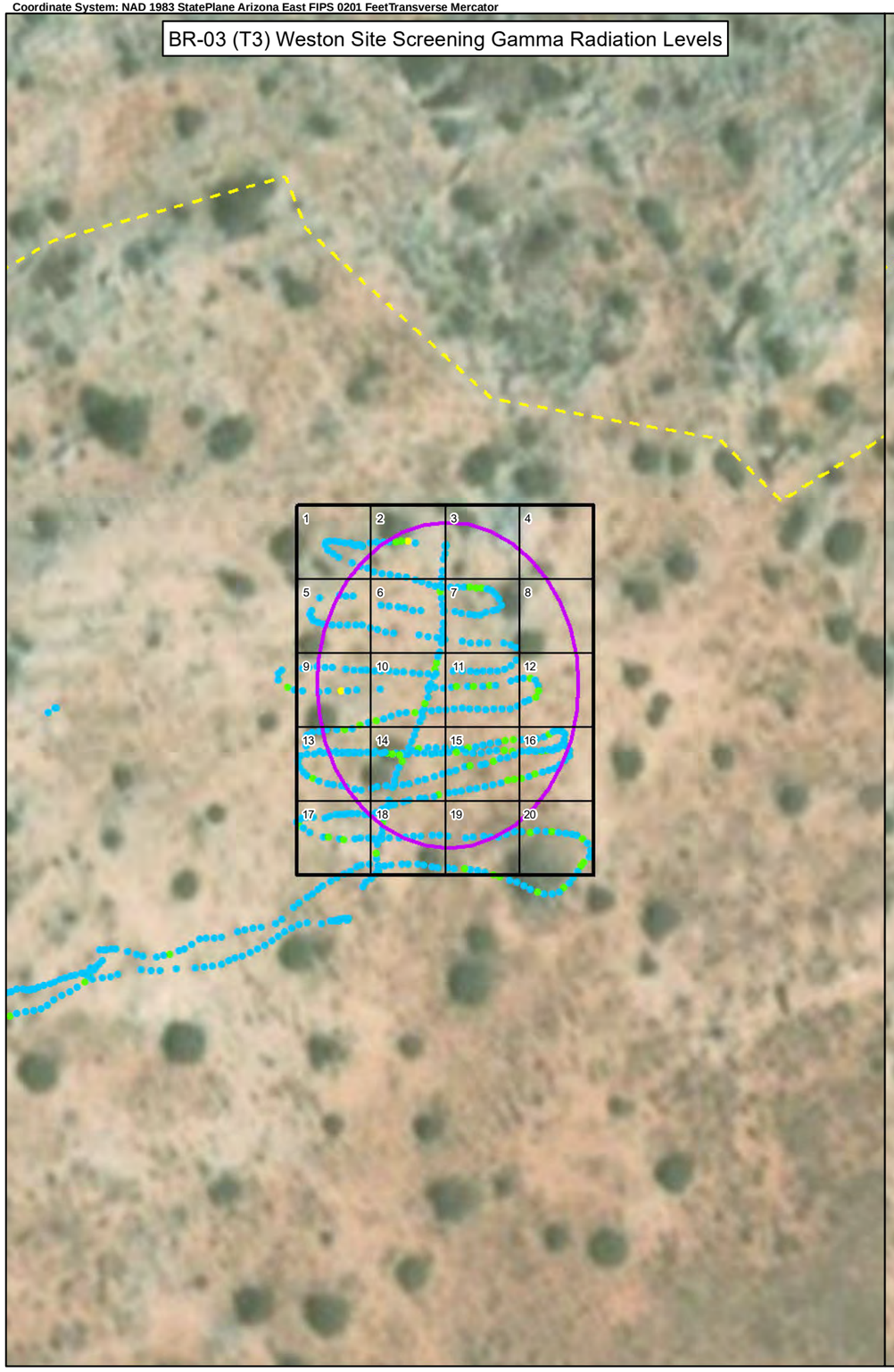


Figure I3-7. Box Plot of Raw Gamma Radiation Levels at Target BR-03 (T3) and BSA-1 (Jms)

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





Gamma Reading (cpm)*

≤ 8,760	≤ Avg. BG
8,760 - 10,287	Avg. BG - 1 x BTV
10,287 - 20,574	1 x BTV - 2 x BTV
20,574 - 30,861	2 x BTV - 3 x BTV
30,861 - 41,148	3 x BTV - 4 x BTV
41,148 - 102,870	4 x BTV - 10 x BTV
≥ 102,870	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Access Route - Foot

1 in = 60 ft

1:720

N
W E
S

0 30 60 120 Feet

NON-AUM TARGET BR-03 (T3)
2018 REMOVAL SITE EVALUATION
VS WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019

Notes:
*The applied gamma background threshold value (BTV) for BR-03 (T3) is 10,287 cpm derived from BSA-1 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I3-8**

4.2.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 4.2.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 4.2.5.1. Figure I3-9 and Figure I3-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-1 (Jms) data set (shown on right). None of the survey units within the survey area of Target T3 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I3-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I3-11 as discussed further in Section 2.8. No survey units exceeded the gamma BTV.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 4.2.6.

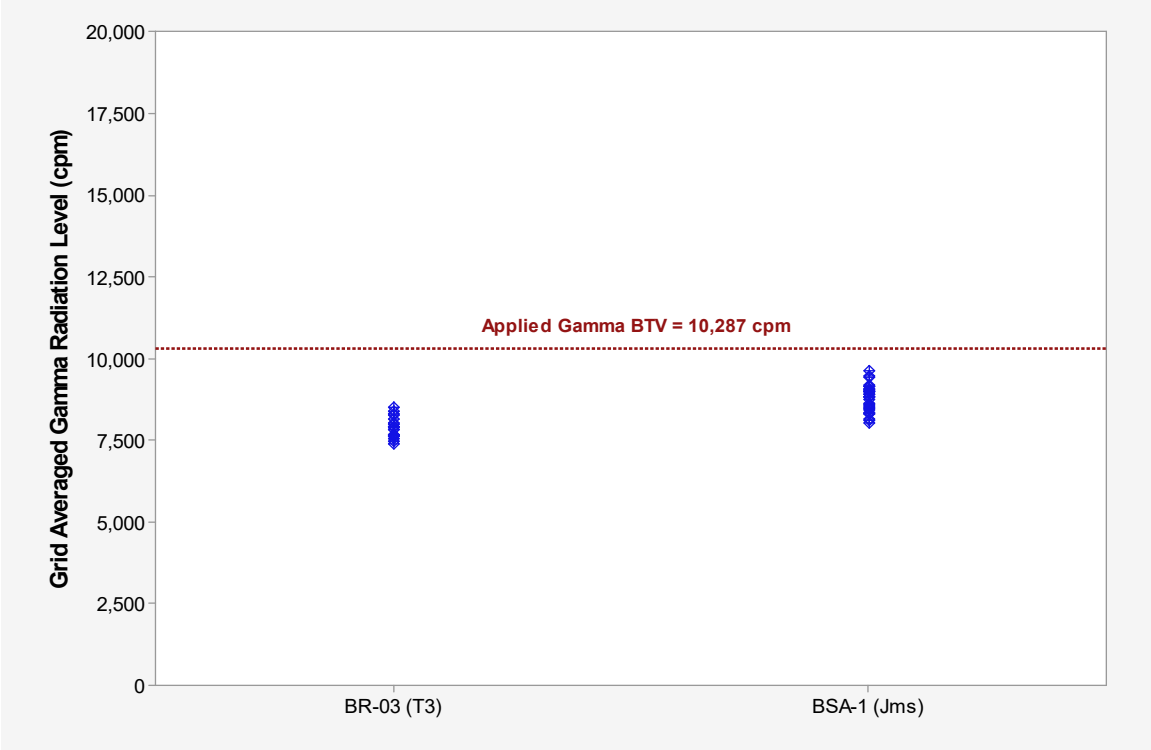


Figure I3-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target BR-03 (T3) and BSA-1 (Jms)

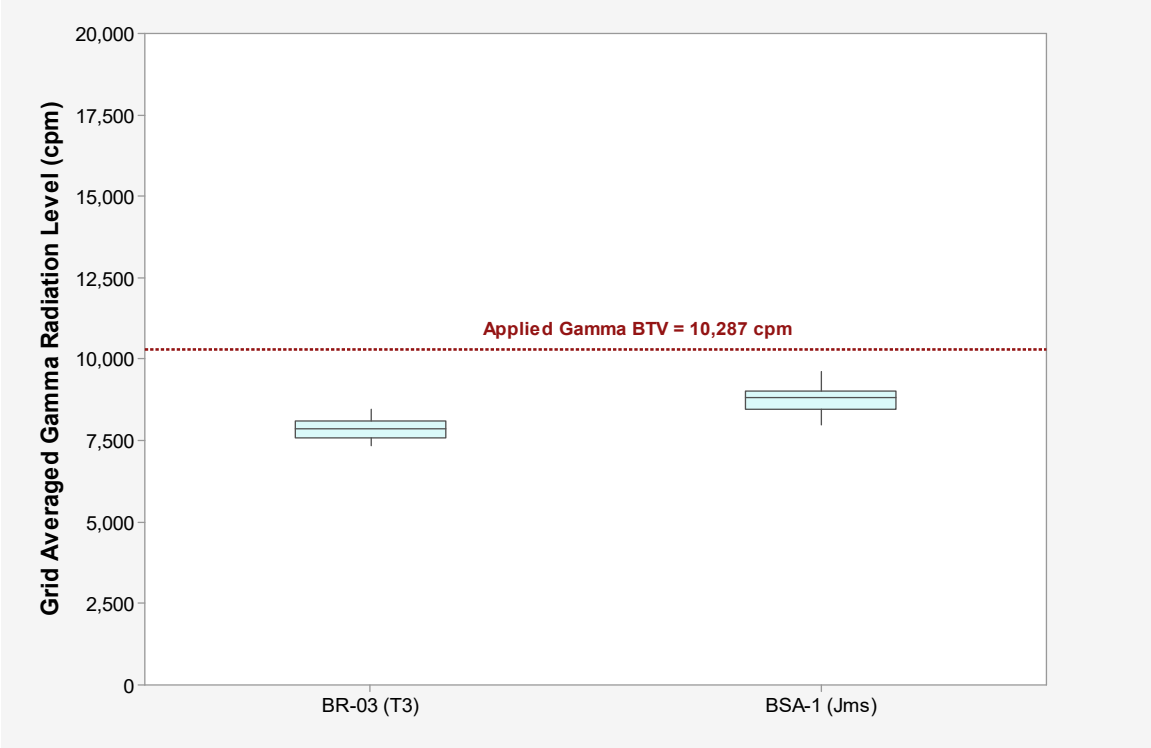
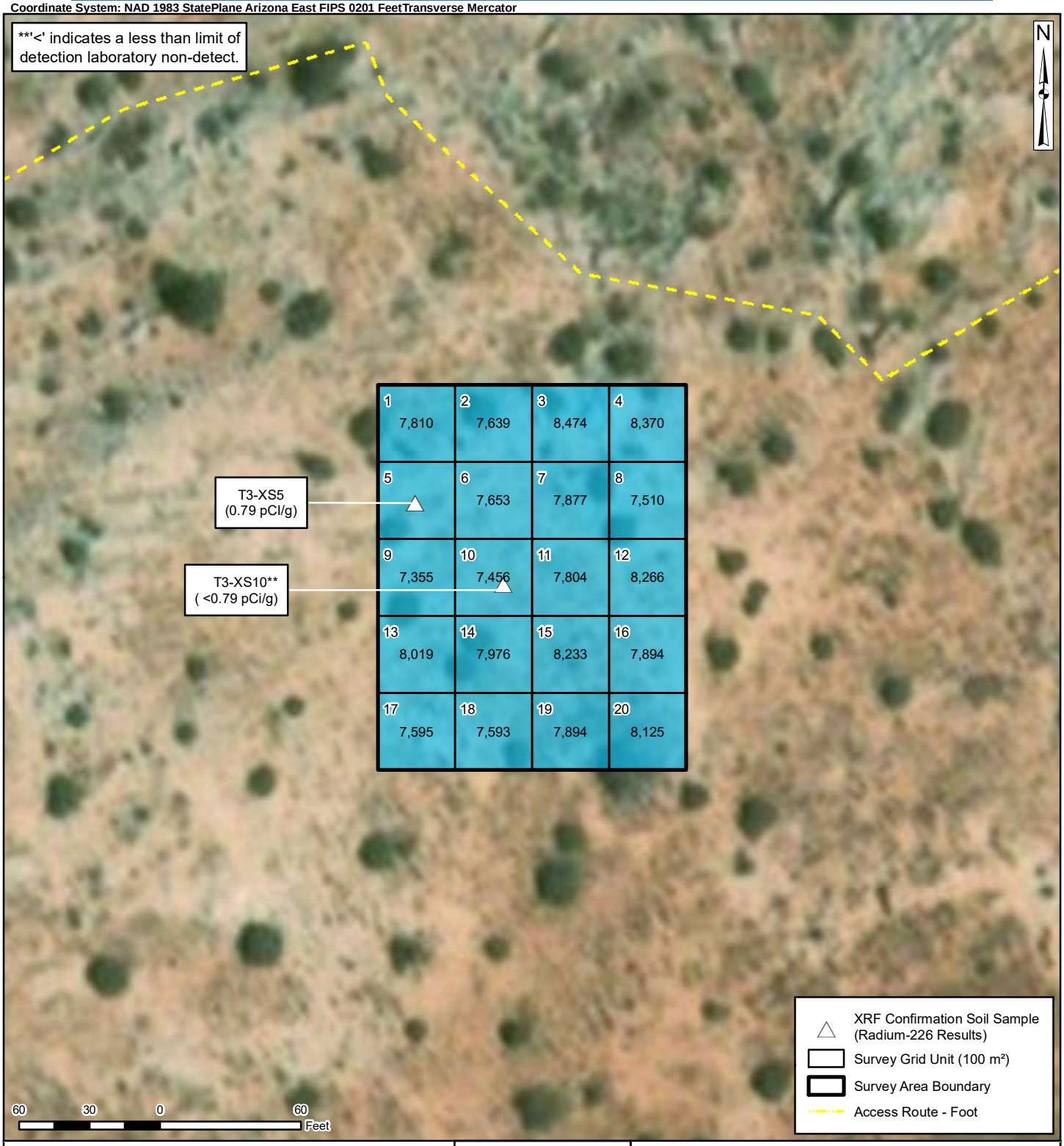


Figure I3-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target BR-03 (T3) and BSA-1 (Jms)

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



Grid Averaged Gamma Reading (cpm)*

≤ 8,760	≤ Avg. BG
8,760 - 10,287	Avg. BG - 1 x BTV
10,287 - 20,574	1 x BTV - 2 x BTV
20,574 - 30,861	2 x BTV - 3 x BTV
30,861 - 41,148	3 x BTV - 4 x BTV
41,148 - 102,870	4 x BTV - 10 x BTV
≥ 102,870	≥ 10 x BTV

*The applied gamma background threshold value (BTV) for BR-03 (T3) is 10,287 cpm derived from BSA-1 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET BR-03 (T3) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I3-11
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/12/2019	

4.2.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T3. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 4.2.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 4.2.6.2.

4.2.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T3: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Table I3-1 and Table I3-2. The results of the XRF confirmation soil samples are presented in Table I3-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T3 following the methods outlined in Section 2.4 and shown in Figure I3-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final corrected measurement for the nine elements. A total of 20 measurements were collected across 20 survey units from the Target T3 survey area during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I3-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T3 at a depth of 0 to 3 inches bgs. Two XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I3-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 4.2.7.

Table I3-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BR-03 (T3)

Analyte	Units	Applied BTV	T3-XS10-01-051218		T3-XS5-01-051218	
			Result	Q	Result	Q
Survey Unit			X10		X5	
Aluminum	mg/kg	5,900	3,300		3,000	
Antimony	mg/kg	0.128	0.067	J	0.055	J
Arsenic	mg/kg	5.8	1.7		1.1	
Barium	mg/kg	190	84		57	
Beryllium	mg/kg	0.4	0.2		0.18	
Cadmium	mg/kg	0.098	0.07	J	0.076	J
Calcium	mg/kg	90,200	36,000		18,000	
Chromium	mg/kg	4.6	3		2.8	
Cobalt	mg/kg	3.7	2.5		1.7	
Copper	mg/kg	11	5		4.4	
Iron	mg/kg	7,800	3,200		3,200	
Lead	mg/kg	6.7	3.8		3.8	
Lithium	mg/kg	14	5.1		4.5	
Magnesium	mg/kg	5,070	2,600		2,300	J
Manganese	mg/kg	270	130		120	
Molybdenum	mg/kg	0.58	0.16	J	0.13	J
Nickel	mg/kg	5.9	3.7		3	
Potassium-40	pCi/g	15.6	9.6	LT	11.7	
Radium-226	pCi/g	2.59	<0.79	UJ	0.79	LT
Radium-228	pCi/g	0.60	<0.26	U	<0.35	U
Selenium	mg/kg	0.88	0.48	J	0.4	J
Silver	mg/kg	0.037	0.013	J	0.012	J
Sodium	mg/kg	40	<100	UJ	<97	UJ
Thallium	mg/kg	0.062	0.045		0.032	
Thorium	mg/kg	2.1	1.5		1.4	
Uranium	mg/kg	3.9	0.79		0.51	
Vanadium	mg/kg	13	10		6.6	
Zinc	mg/kg	19	11		10	

Notes:

BTV Background threshold value
ID Identification
J Estimated value
J- Estimated value, may be biased low
LT Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
M3 The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg Milligrams per kilogram
NA Not applicable
NV Not value
pCi/g Picocuries per gram
Q Qualification
U Not considered detected. The associated value is the method detection limit (MDL).
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

Table I3-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target BR-03 (T3)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	5.8	7,800	6.7	270	0.58	2.1	3.9	13	19
Measurements	#	20	20	20	20	20	20	20	20	20
Detects	#	5	20	20	20	2	19	17	1	20
Nondetects	#	15	0	0	0	18	1	3	19	0
Minimum	mg/kg	1.92	3,035	2.43	129	0.39	1.1	0.11	30.7	10.1
Maximum	mg/kg	3	5,898	6.67	214	0.8	2.5	1.6	30.7	18.7
Standard Deviation	mg/kg	0.6	588	1.2	27	0.26	0.4	0.4	-	2.0
Average	mg/kg	2.7	4,072	4.9	169	0.58	1.7	0.8	-	13.4
Median	mg/kg	2.6	4,043	5.0	166	0.58	1.6	0.8	-	13.5
Relative Standard Deviation	%	23	14	24	16	45	24	54	-	14.7
90th Percentile	mg/kg	3.4	4,487	6.1	208	0.7	2.2	1.3	-	15.1
95th Percentile	mg/kg	3.4	4,664	6.4	213	0.7	2.3	1.5	-	16.4
99th Percentile	mg/kg	3.5	5,651	6.6	214	0.8	2.5	1.6	-	18.2
Measurements Above Applied BTV	#	0	0	0	0	1	4	0	1	0
Measurements Above Applied BTV	%	0.0	0.0	0.0	0.0	5.0	20	0.0	5.0	0.0

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value

mg/kg Milligram per kilogram

XRF X-ray fluorescence

4.2.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T3 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T3 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T3. The estimated BTVs are identified in Section 4.2.4 and Table I3-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I3-7 presents a summary of the background comparison for different measurement and soil depths at Target T3. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T3. Further gamma radiation screening indicated that gamma levels at Target T3 are similar to those at the BSA. Therefore, while thorium has been identified as a COPC at Target T3 based on a conservative comparison to background, risk screening may be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I3-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target BR-03 (T3)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic			
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron			
Lead			
Lithium			
Magnesium			
Manganese			
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium			
Silver			
Sodium			
Thallium			
Thorium		✓	✓
Uranium			
Vanadium		✓	✓
Zinc			

Notes:

[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).

COPC Contaminant of potential concern
XRF X-ray fluorescence

4.2.7 Primary Contaminant Mapping

4.2.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 4.2.6.2 identified the COPCs at Target T3. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 4.2.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I3-7. The primary reason for differentiating between primary and secondary analytes is for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T3 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 4.2.7.1 through Section 4.2.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T3. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

4.2.7.2 Arsenic

Arsenic was not identified as a COPC in surface soils as shown in Table I3-7. Arsenic did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for arsenic is 5.8 mg/kg for Target T3 as presented in Section 4.2.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I3-5 and Attachment I3, respectively. Figure I3-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T3 and BSA-1 (Jms) samples. Figure I3-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T3 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Table I3-6. Arsenic XRF concentrations measured in surface soils at Target T3 ranged between 1.92 and 3 mg/kg with an average and standard deviation of 2.7 mg/kg and 0.6 mg/kg, respectively. The average XRF arsenic concentration is below the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T3 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I3-14. All arsenic XRF results in surface soils were less than the applied BTV.

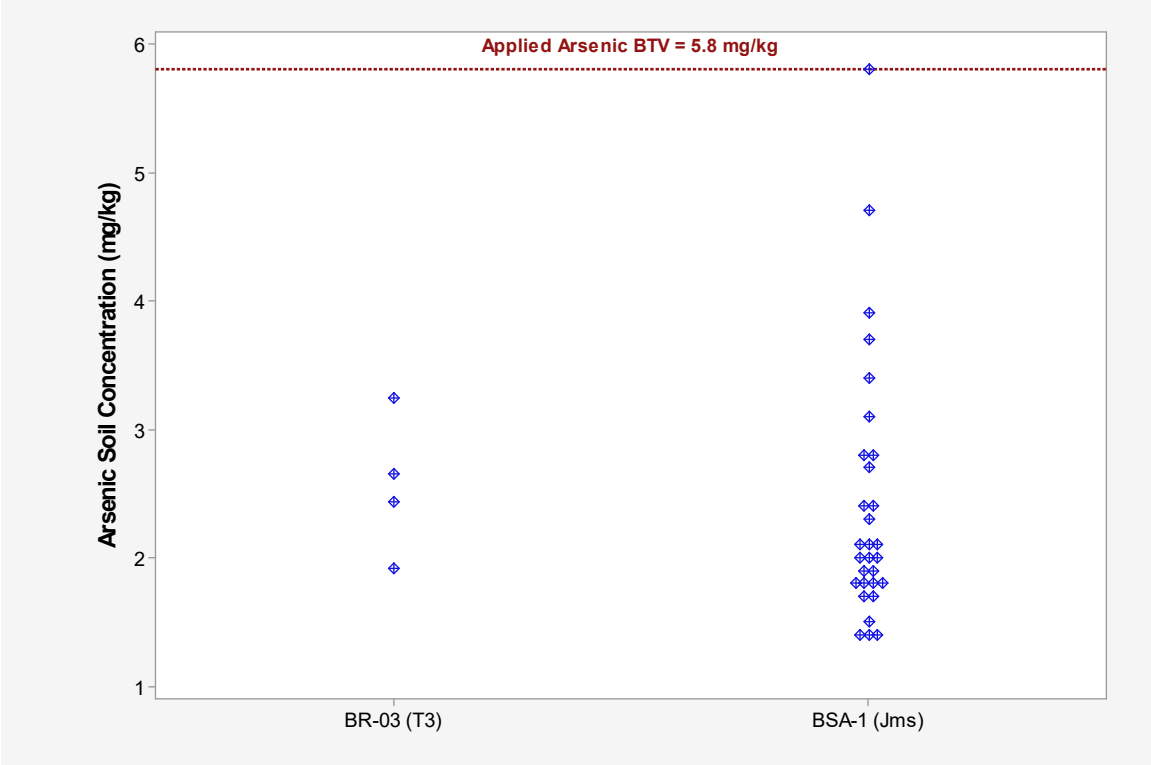


Figure I3-12. Individual Value Plot for Target BR-03 (T3) and BSA-1 (Jms) Arsenic Soil Concentrations

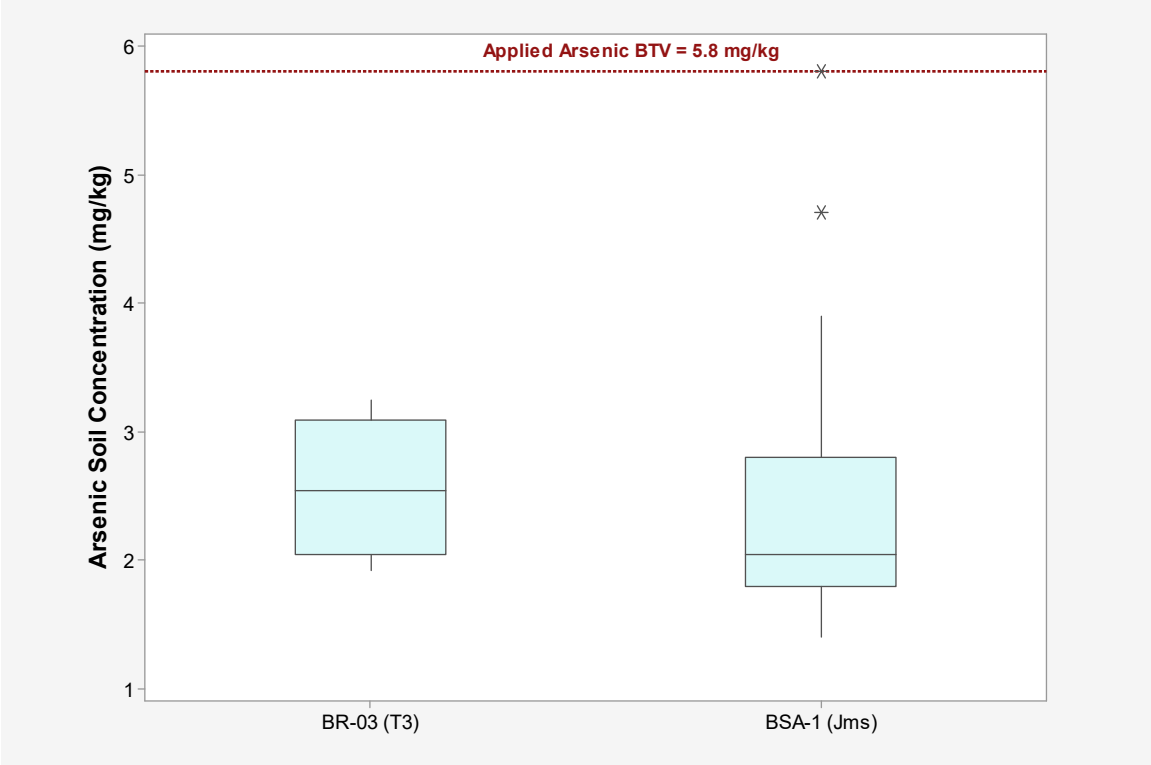
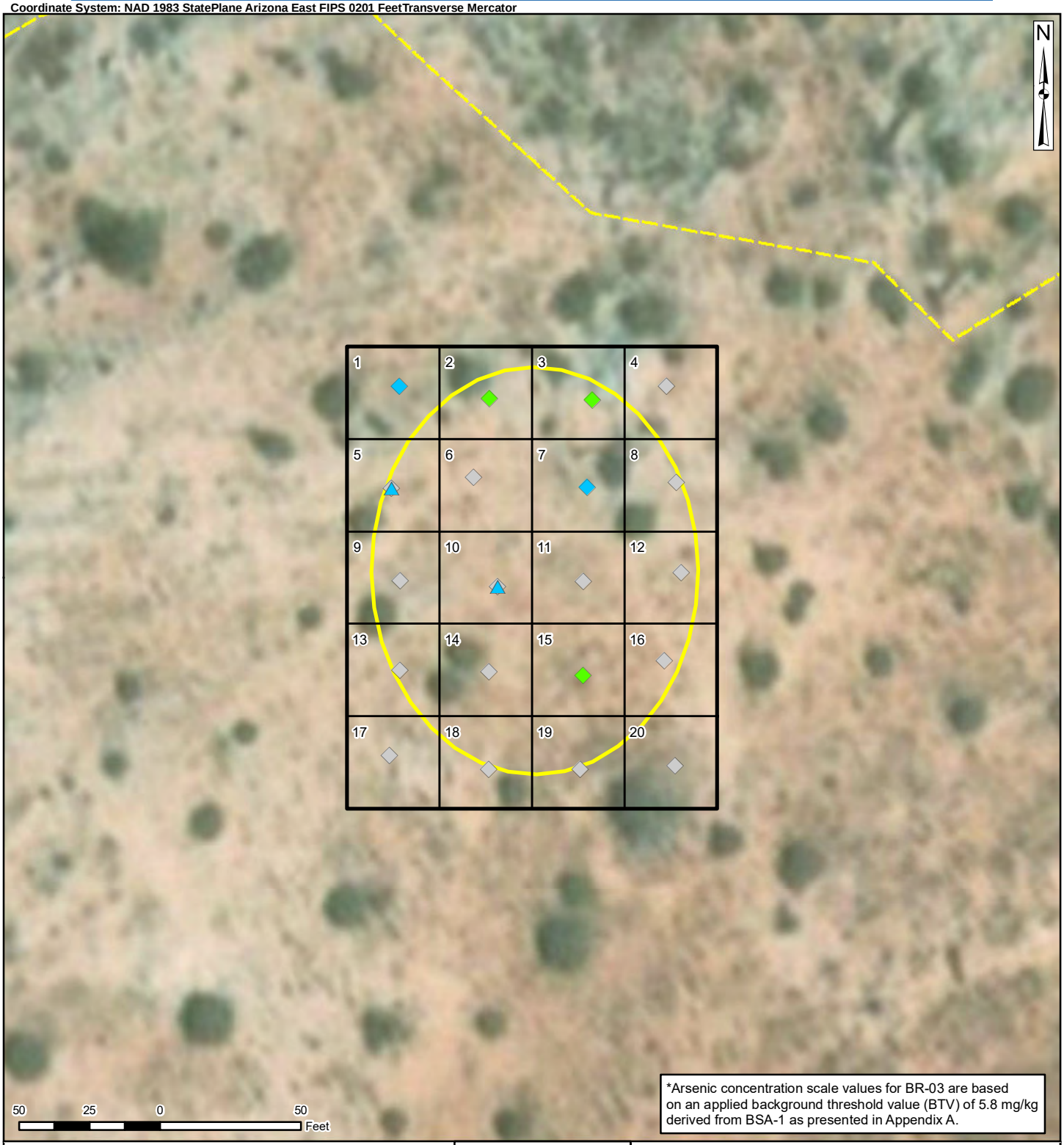


Figure I3-13. Box Plot for Target BR-03 (T3) and BSA-1 (Jms) Arsenic Soil Concentrations

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



Arsenic Concentration Scale (mg/kg)*

- ≤ 2.4
- 2.4 - 5.8
- 5.8 - 12
- 12 - 17
- 17 - 23
- 23 - 58
- ≥ 58
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET BR-03 (T3) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I3-14
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/26/2019	

4.2.7.3 Lead

Lead was not identified as a COPC in surface soil as shown in Table I3-7. Lead did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for lead is 6.7 mg/kg for Target T3 as presented in Section 4.2.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I3-5 and Attachment I3, respectively. Figure I3-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T3 and BSA-1 (Jms) samples. Figure I3-16 presents a box plot of detectable lead XRF soil concentrations for Target T3 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Table I3-6. Lead XRF concentrations measured in surface soils at Target T3 ranged between 2.43 and 6.67 mg/kg with an average and standard deviation of 4.9 mg/kg and 1.2 mg/kg, respectively. The average XRF lead concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T3 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I3-17. All lead XRF results in surface soils were less than the applied BTV.

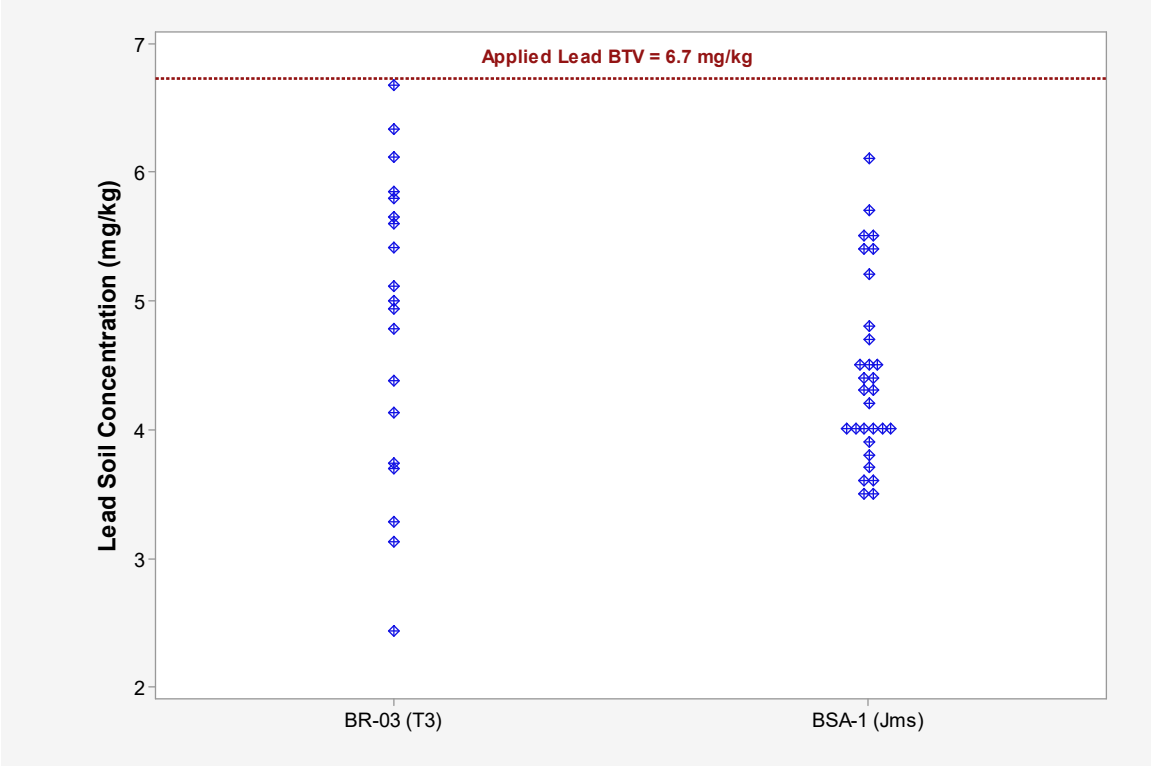


Figure I3-15. Individual Value Plot for Target BR-03 (T3) and BSA-1 (Jms) Lead Soil Concentrations

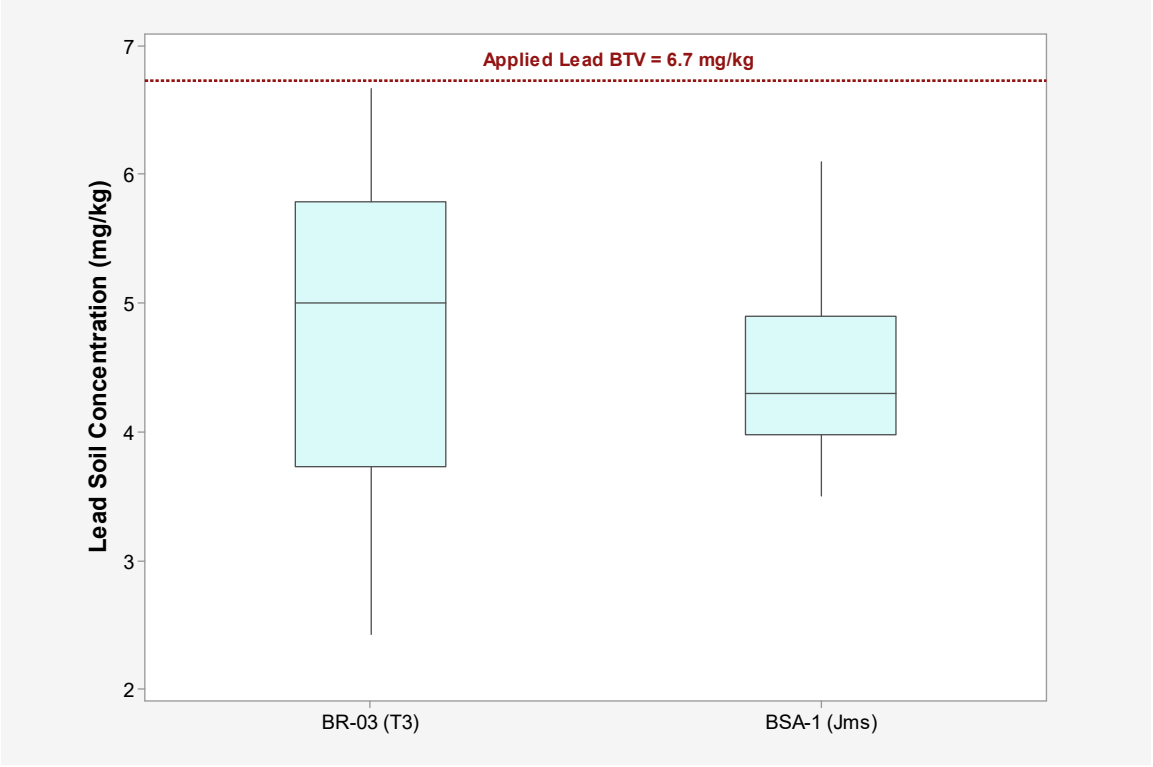
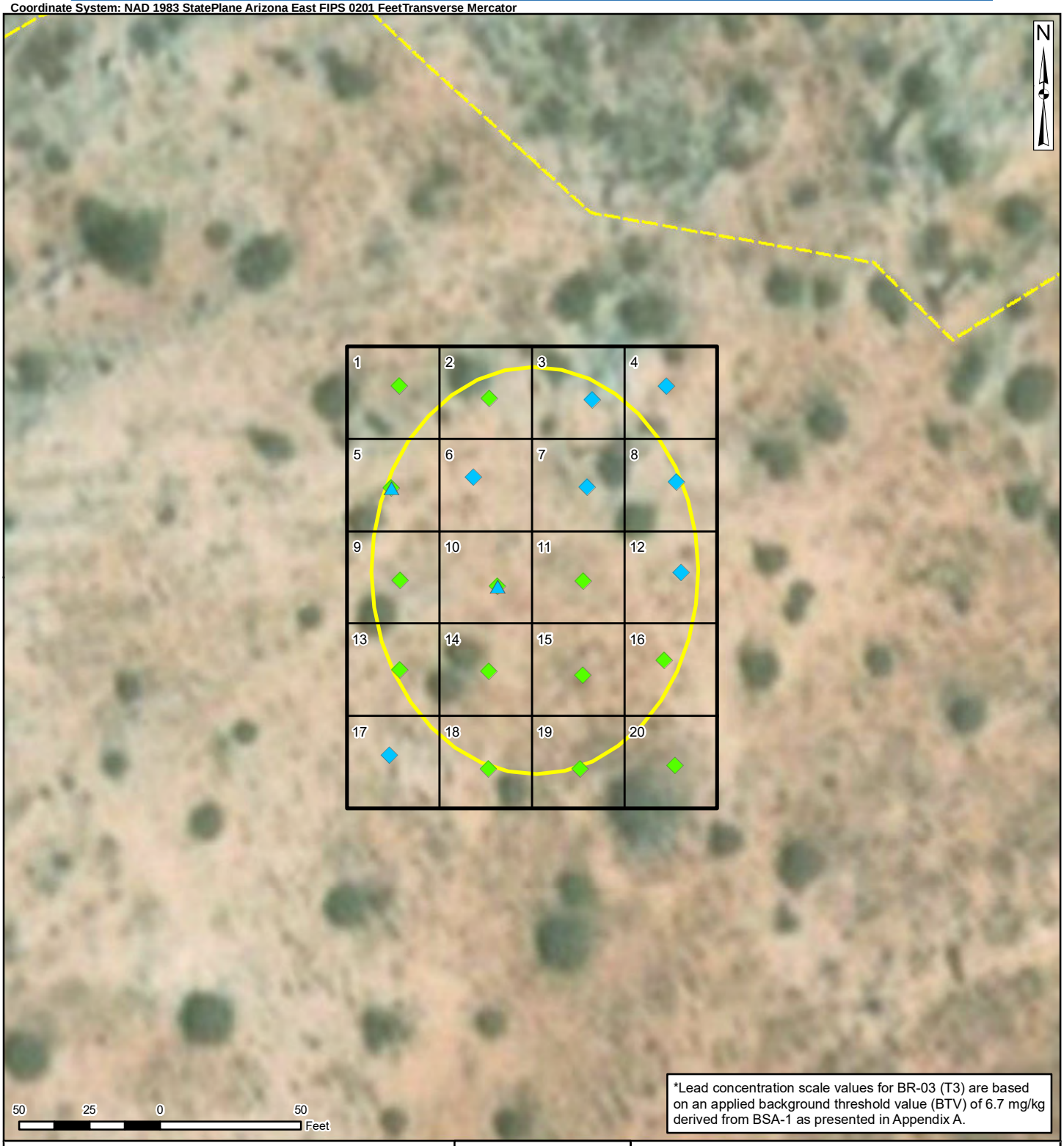


Figure I3-16. Box Plot for Target BR-03 (T3) and BSA-1 (Jms) Lead Soil Concentrations



*Lead concentration scale values for BR-03 (T3) are based on an applied background threshold value (BTV) of 6.7 mg/kg derived from BSA-1 as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 4.4
- 4.4 - 6.7
- 6.7 - 13
- 13 - 20
- 20 - 27
- 27 - 67
- ≥ 67

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET BR-03 (T3) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I3-17
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.2.7.4 Thorium

Thorium was identified as a COPC in surface soil as shown in Table I3-7. Thorium exceeded the applied BTV in 20 percent of in situ XRF measurements. The applied BTV for thorium is 2.1 mg/kg for Target T3 as presented in Section 4.2.4. The analytical results for XRF confirmation and in situ field XRF measurements are provided in Table I3-5 and Attachment I3, respectively. Figure I3-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T3 and BSA-1 (Jms) samples. Figure I3-19 presents a box plot of detectable thorium XRF soil concentrations for Target T3 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Table I3-6. Thorium XRF concentrations measured in surface soils at Target T3 ranged between 1.1 and 2.5 mg/kg with an average and standard deviation of 1.7 mg/kg and 0.4 mg/kg, respectively. The average XRF thorium concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T3 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I3-20. Overall, the majority of detectable thorium XRF results in surface soils were less than the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T3.

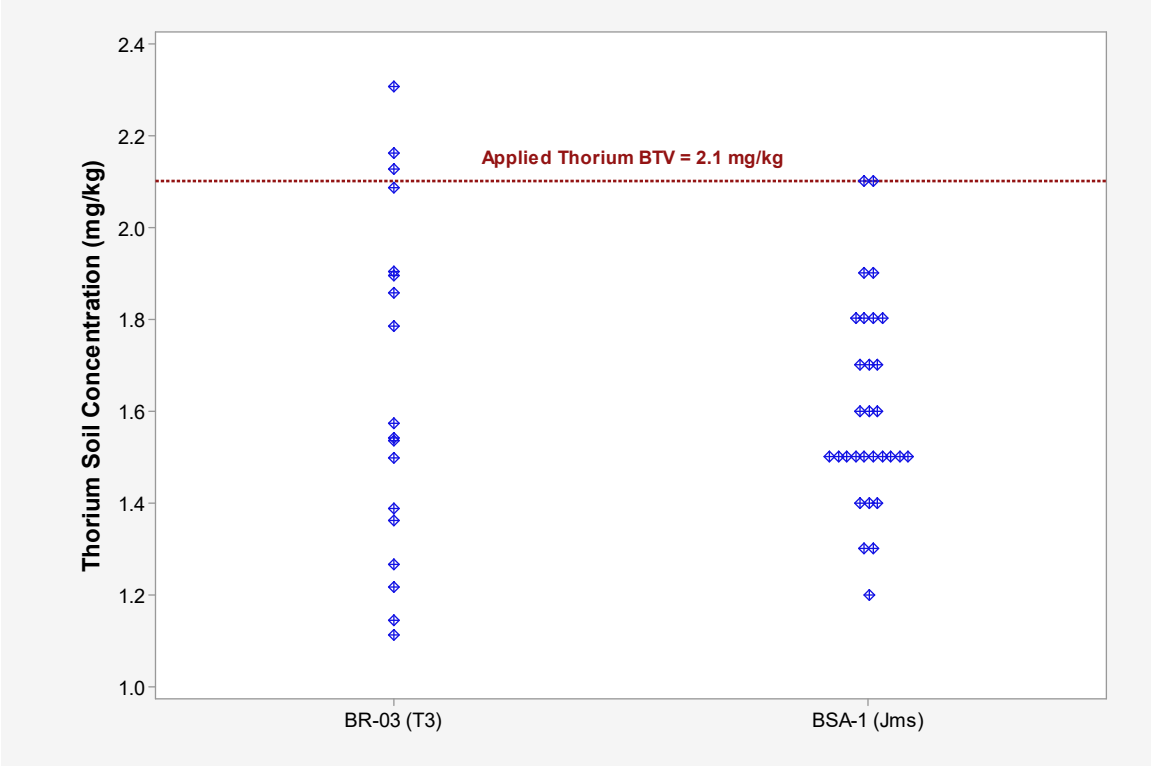


Figure I3-18. Individual Value Plot for Target BR-03 (T3) and BSA-1 (Jms) Thorium Soil Concentrations

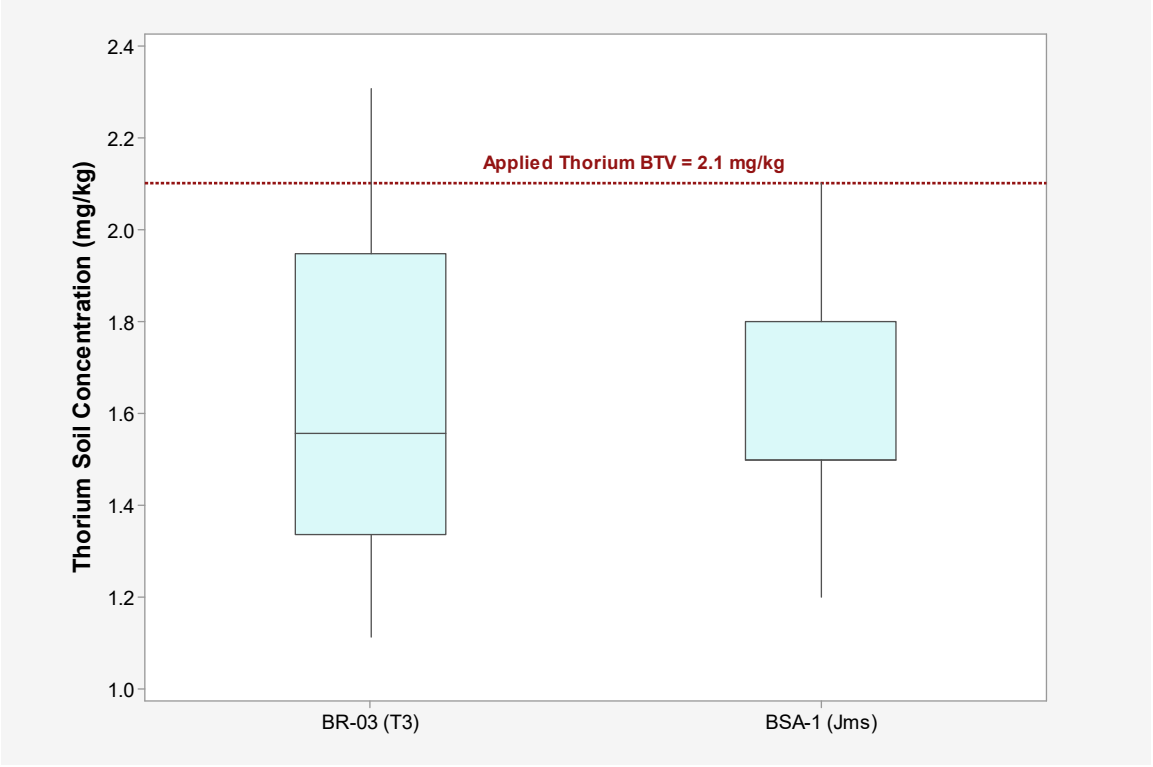
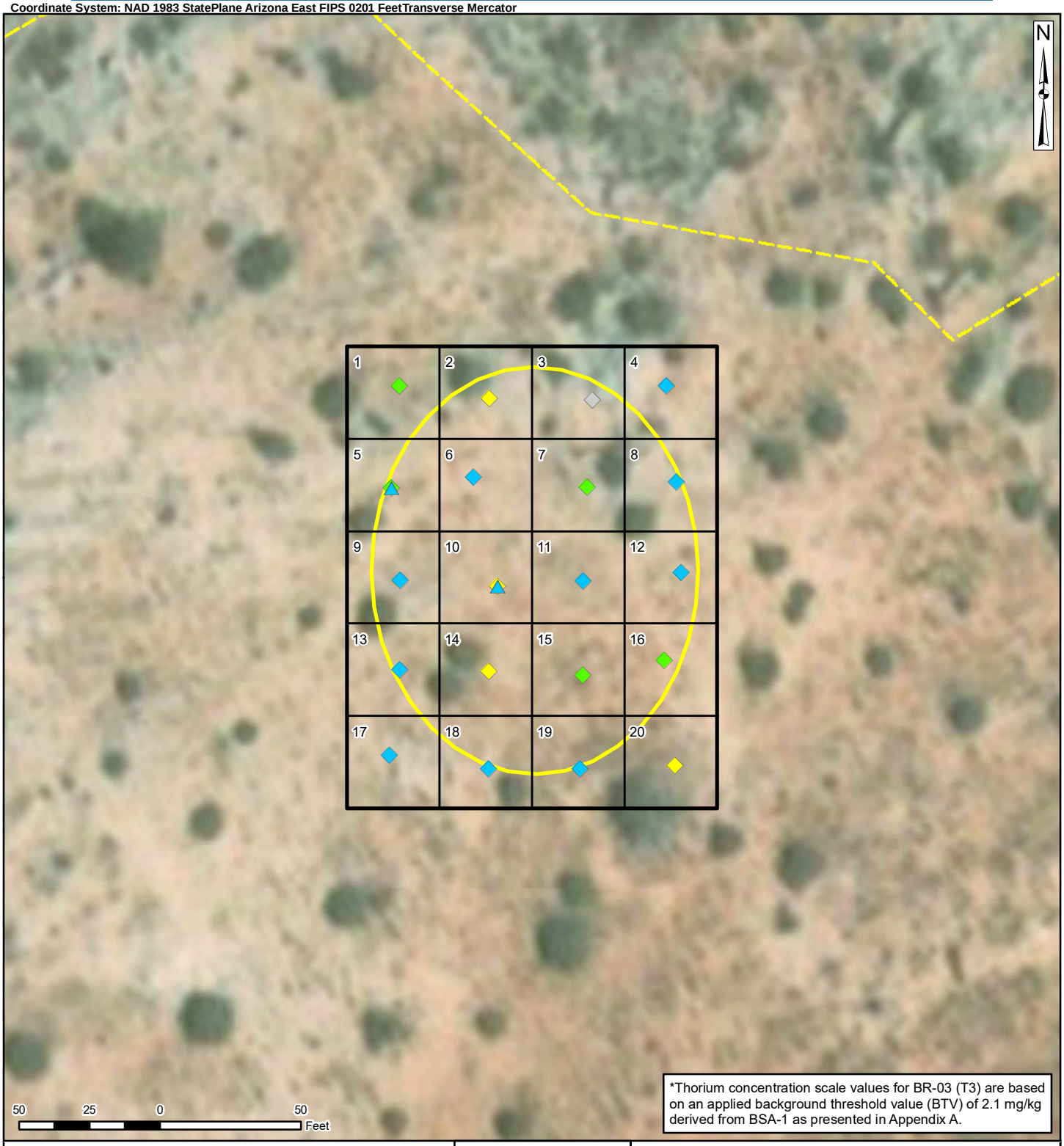


Figure I3-19. Box Plot for Target BR-03 (T3) and BSA-1 (Jms) Thorium Soil Concentrations

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



Thorium Concentration Scale (mg/kg)*

- ≤ 1.6
- 1.6 - 2.1
- 2.1 - 4.2
- 4.2 - 6.3
- 6.3 - 8.4
- 8.4 - 21
- ≥ 21
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET BR-03 (T3) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I3-20
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.2.7.5 Uranium

Uranium was not identified as a COPC in surface soil as shown in Table I3-7. Uranium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for uranium is 3.9 mg/kg for Target T3 as presented in Section 4.2.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I3-5 and Attachment I3, respectively. Figure I3-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T3 and BSA-1 (Jms) samples. Figure I3-22 presents a box plot of detectable uranium XRF soil concentrations for Target T3 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Table I3-6. Uranium XRF concentrations measured in surface soils at Target T3 ranged between 0.11 and 1.6 mg/kg with an average and standard deviation of 0.8 mg/kg and 0.4 mg/kg, respectively. The average uranium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T3 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I3-23. All uranium XRF results in surface soils were less than the applied BTV.

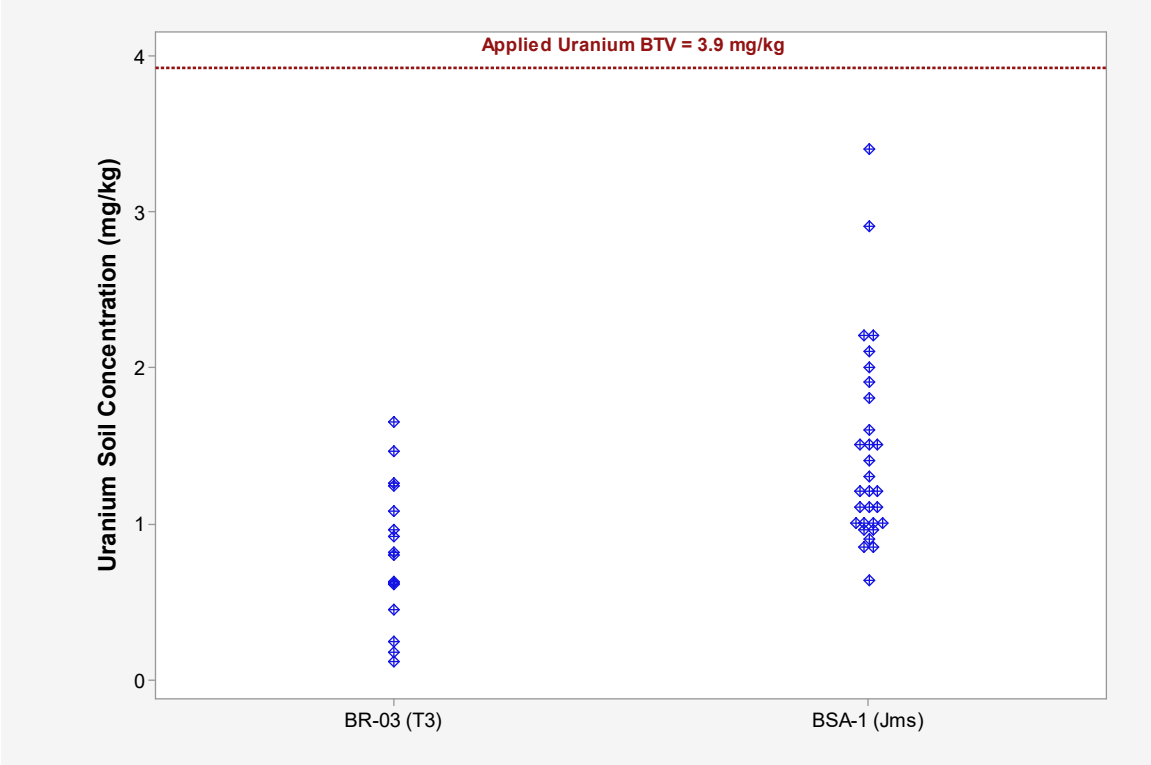


Figure I3-21. Individual Value Plot for Target BR-03 (T3) and BSA-1 (Jms) Uranium Soil Concentrations

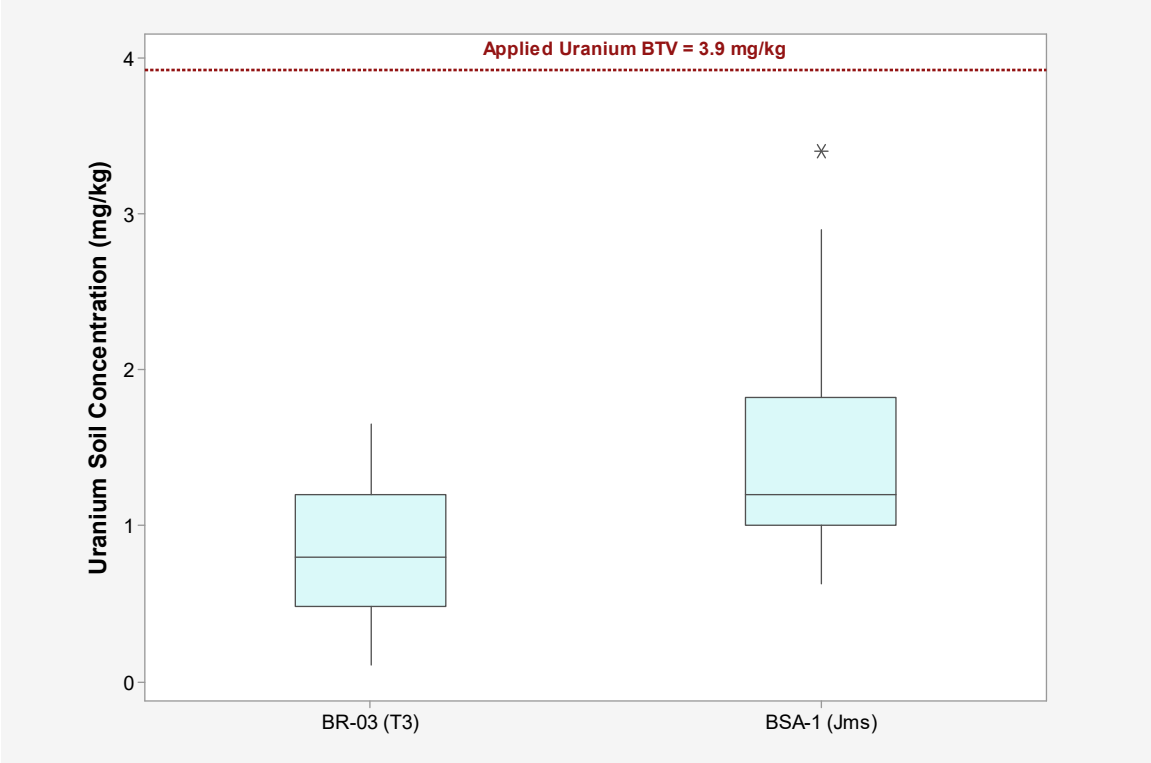
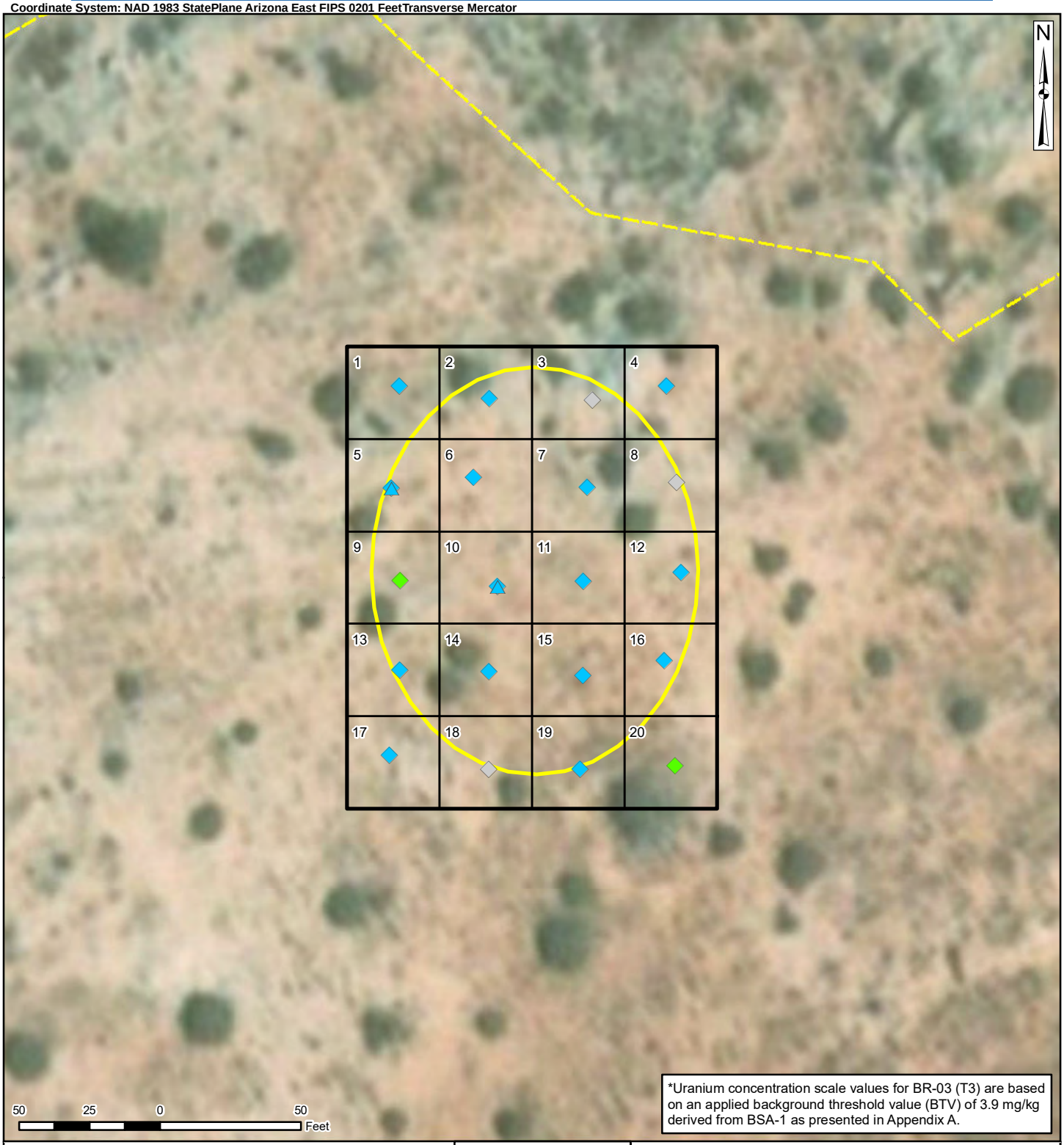


Figure I3-22. Box Plot for Target BR-03 (T3) and BSA-1 (Jms) Uranium Soil Concentrations



*Uranium concentration scale values for BR-03 (T3) are based on an applied background threshold value (BTV) of 3.9 mg/kg derived from BSA-1 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 1.4
- 1.4 - 3.9
- 3.9 - 7.8
- 7.8 - 12
- 12 - 16
- 16 - 39
- ≥ 39
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

Prepared for: USEPA Region 9

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NON-AUM TARGET BR-03 (T3) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I3-23
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.2.7.6 Vanadium

Vanadium was not identified as a COPC in surface soils as shown in Table I3-7. Vanadium exceeded the applied BTV for one in situ XRF measurement. The applied BTV for vanadium is 13 mg/kg for Target T3 as presented in Section 4.2.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I3-5 and Attachment I3, respectively. Figure I3-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T3 and BSA-1 (Jms) samples. Figure I3-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T3 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Table I3-6. Vanadium was only measured in one XRF surface soil sample at Target T3 at a concentration of 30.7 mg/kg.

A soil contaminant map showing the individual vanadium concentrations observed at Target T3 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I3-26. Overall, all but one vanadium result in surface soils were less than the detection limit of 16 mg/kg. One XRF sample exceeded the applied BTV by a factor of 2.

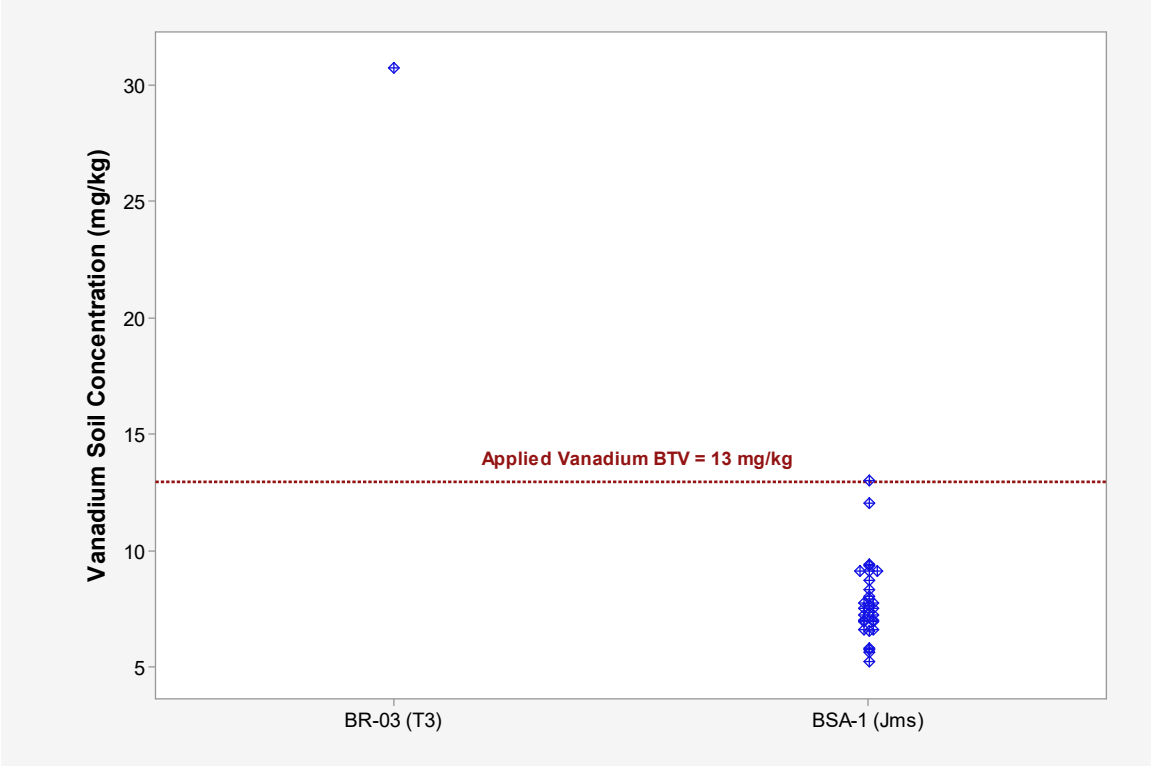


Figure I3-24. Individual Value Plot for Target BR-03 (T3) and BSA-1 (Jms) Vanadium Soil Concentrations

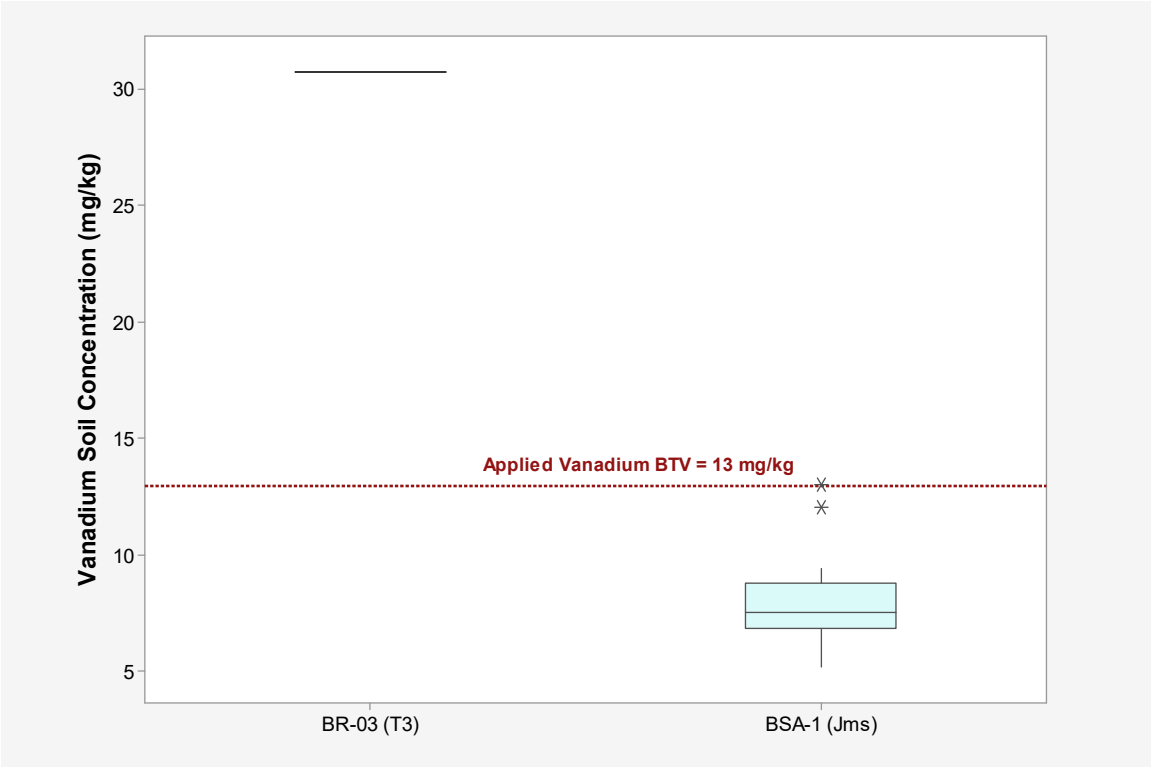
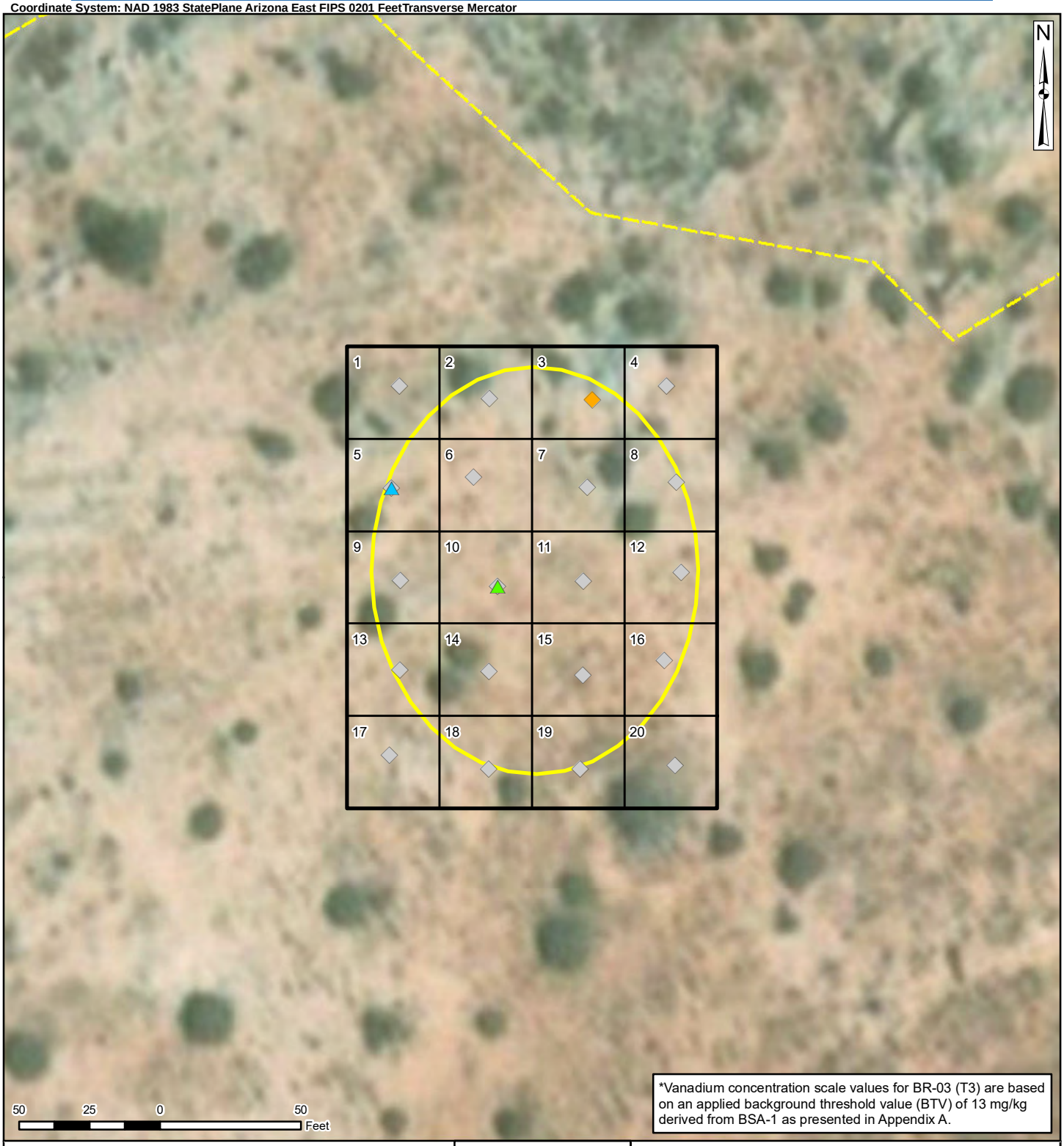


Figure I3-25. Box Plot for Target BR-03 (T3) and BSA-1 (Jms) Vanadium Soil Concentrations

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



Vanadium Concentration Scale (mg/kg)*

- ≤ 7.7
- 7.7 - 13
- 13 - 26
- 26 - 39
- 39 - 52
- 52 - 130
- ≥ 130
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET BR-03 (T3) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I3-26
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.2.8 Conclusions

Target T3 (BR-03) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T3. Similarly, soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T3 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T3. ASPECT gamma survey results generally did not correlate with 2018 RSE investigation gamma survey results. No mining related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T3 was well documented through gamma radiation surveys, and the lateral extent of thorium above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Mean raw gamma measurements did not exceed the applied BTV. No grid averaged gamma measurements exceeded the applied BTV.
- Site-specific BTVs for Target T3 geology and soil types were established through a background study.
- A total of 26 analytes were identified as occurring within the surface environment. Of these analytes, only one was identified as a COPC. Only one measurement of vanadium exceeded the applied BTV by a factor greater than two.
- Based on Tetra Tech's observations, Target T3 does not contain TENORM. No mining-related activities or features were observed in the field. No historical exploratory borings, vents, or other mine openings were noted in the file review or during field observations. NORM was not identified visually or by gamma survey.
- There are no immediate significant physical hazards present at Target T3.
- Access is by a dirt road from an adjacent paved highway.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No groundwater wells are documented within the vicinity of Target T3. Rural residences are located nearby; however, it is not known if water is provided by utility or private well. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T3. Therefore, evaluation of the leachability of metals and radionuclides is not required.

- No mine waste was observed at Target T3; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; no data gaps remain for Target T3.

4.3 NON-AUM TARGET T4 (BR-04)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T4 (BR-04).

4.3.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T4 (BR-04) is associated with the Brodie 1 Mine (M1), a former underground mine in the Tse Tah Region in Subarea Group A. Five other non-AUM Targets are associated with the Brodie 1 Mine. Target T4 is administered by the Red Mesa and Sweetwater Chapters of the Navajo Nation and is accessible by vehicle via Indian Route 35 from Highway 160, which is located immediately southeast of Red Mesa. Target T4 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. A residence is located a 1/4 mile to the south. A Target location and access map for Target T4 is shown in Figure I4-1.

A topographical relief map of the Brodie 1 Mine area and associated non-AUM Targets is provided in Figure I4-2. The elevation at Target T4 ranges from 5,705 to 5,753 feet amsl with an average of 5,729 feet amsl. The slope at Target T4 ranges from 14 to 29 percent with an average of 21 percent. An ephemeral drainage channel is located on Target T4 and joins the Tse Tah West drainage located 575 feet to the northwest. The Brodie 1 Mine is located entirely within the Js and rock outcrop-Rizno complex soils unit, and Target T4 is located entirely within the Jms. The soil type at the Target is primarily rock outcrop-Rizno soils (MUSYM 309), but the western edge of the Target includes soils of the Weiser-Wechech association (MUSYM 314) (Figures I-13 and I-14).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T4. Weston did not conduct a background study for Target T4. As a part of the RSE for the Brodie 1 Mine, Tetra Tech also evaluated the associated non-AUM Targets, such as T4. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 1 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T4:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified at Target T4 other than the naturally occurring cliff.

- Located access routes, including foot pathways and roads:

  Target T4 is accessed by taking Highway 160 to Indian Route 35 and then via a four-wheel-drive off-road access route to the northwest. A short hike via footpath and off-trail trek is required to get to the Target.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM was observed throughout the Target and was verified by gamma survey in the field. No TENORM was observed.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

An ephemeral drainage was located within the Target that drops over the cliff and joins the Tse Tah West drainage to the northwest. The Tse Tah West drainage was evaluated under the RSE for the Brodie 1 Mine.

- Identified any exploration borings or historic haul roads:

  No exploratory borings or haul roads were identified.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  A cultural structure was identified within survey units 41 and 49. No mine related features were identified. In the absence of any mining related features, outcropping of the Jms are likely contributing to elevated gamma readings. NORM was observed and verified in the field.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

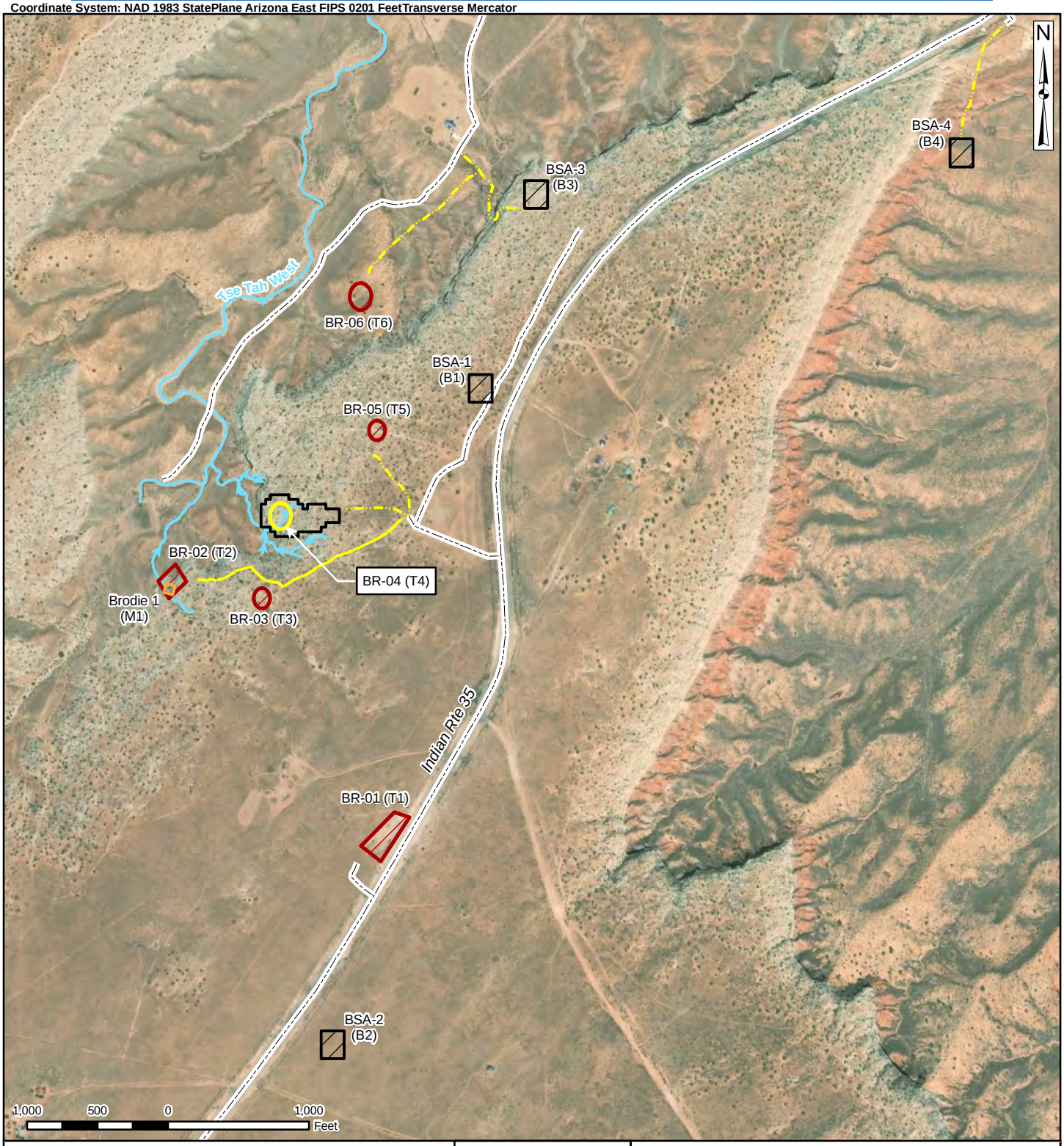
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T4 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Section 2.3 and 4.3.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 4.3.3 with results presented in Sections 4.3.6 and 4.3.7)
- Conducting a gamma radiation survey (results presented in Section 4.3.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



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

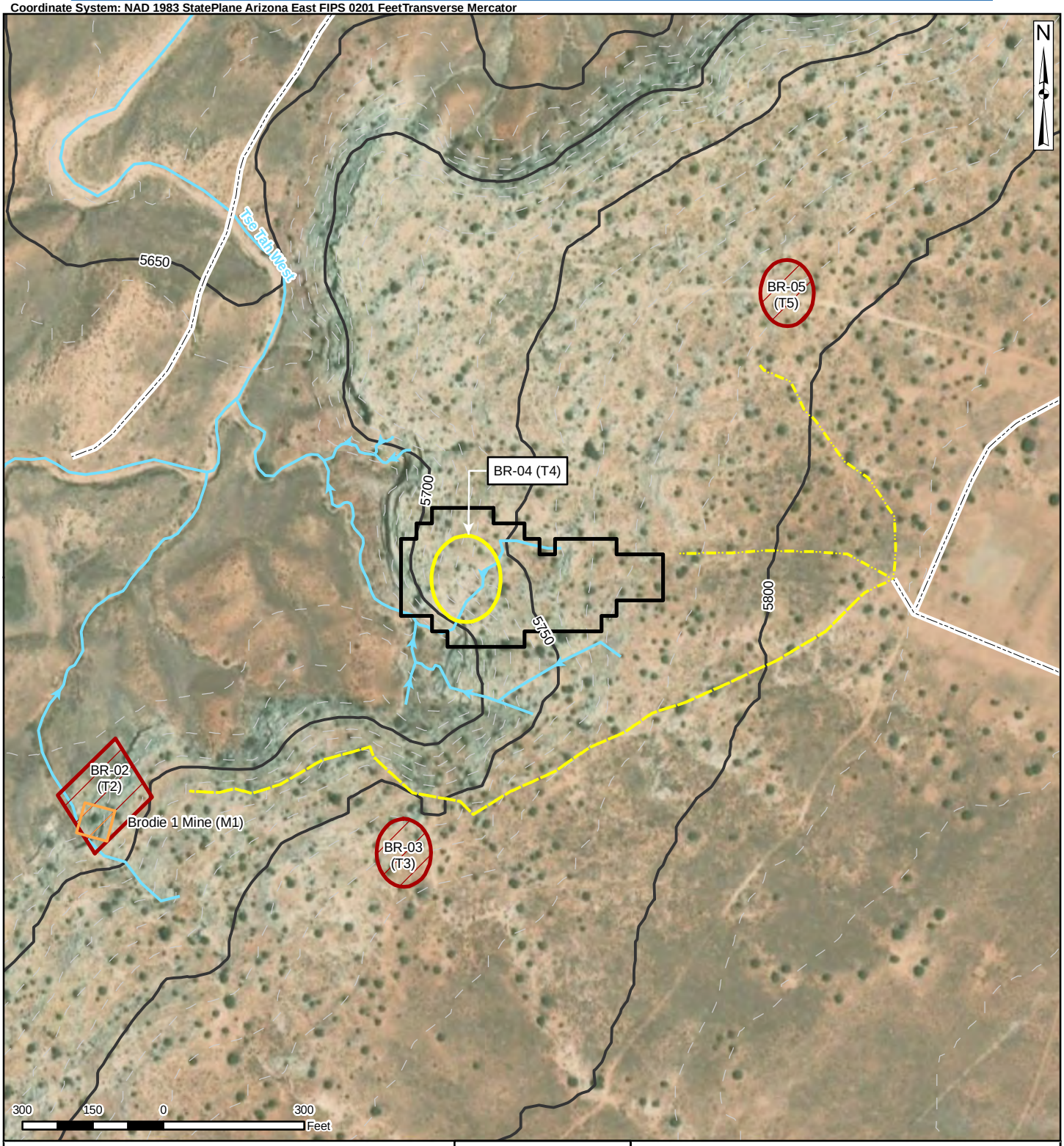
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NON-AUM TARGET BR-04 (T4) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I4-1
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site Boundary
Tronox AUM Site Boundary
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped
50 ft Contour*
10 ft Contour*

* 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.

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NON-AUM TARGET BR-04 (T4) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I4-2
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.3.2 Gamma Radiation Survey and Field XRF Measurements

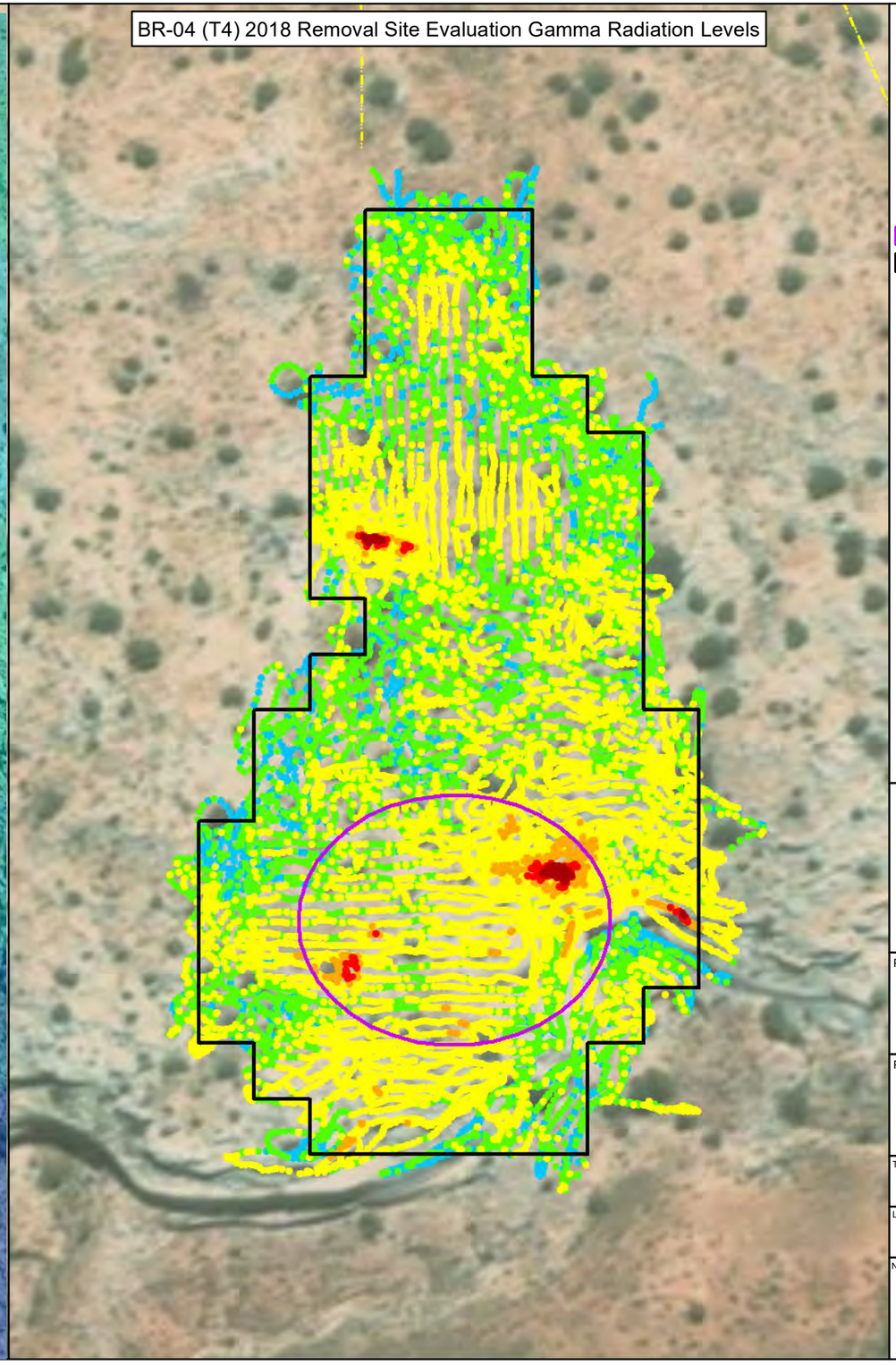
Tetra Tech performed GPS-based gamma radiation surveys (Figure I4-3) within the survey area of the non-AUM Target T4 as part of the Baseline Study in May 2018. Additional Goback gamma radiation surveys were performed in August 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T4 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I4-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 1, of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at 53 survey units. All gamma survey and XRF survey units were evaluated.

4.3.3 XRF Confirmation Sampling Overview

Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T4. Seven XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from seven locations (Table I4-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I4-4 and I4-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I4-2. A subset of XRF confirmation samples were also submitted for analysis of mercury and select additional radionuclides. The results of XRF confirmation sample analysis are provided in Section 4.3.6.1. Correlated XRF field measurements are provided in Attachment I3.

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





Gamma Reading (cpm)[1]

≤ 8,760	≤ Avg. BG
8,760 - 10,287	Avg. BG - 1 x BTV
10,287 - 20,574	1 x BTV - 2 x BTV
20,574 - 30,861	2 x BTV - 3 x BTV
30,861 - 41,148	3 x BTV - 4 x BTV
41,148 - 102,870	4 x BTV - 10 x BTV
≥ 102,870	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Foot

[1]The applied gamma background threshold value (BTV) for BR-04 (T4) Non-AUM Target is 10,287 cpm derived from BSA-1 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 80 ft

1:960

0 40 80 160 Feet

N E S W

NON-AUM TARGET BR-04 (T4)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

Prepared By:

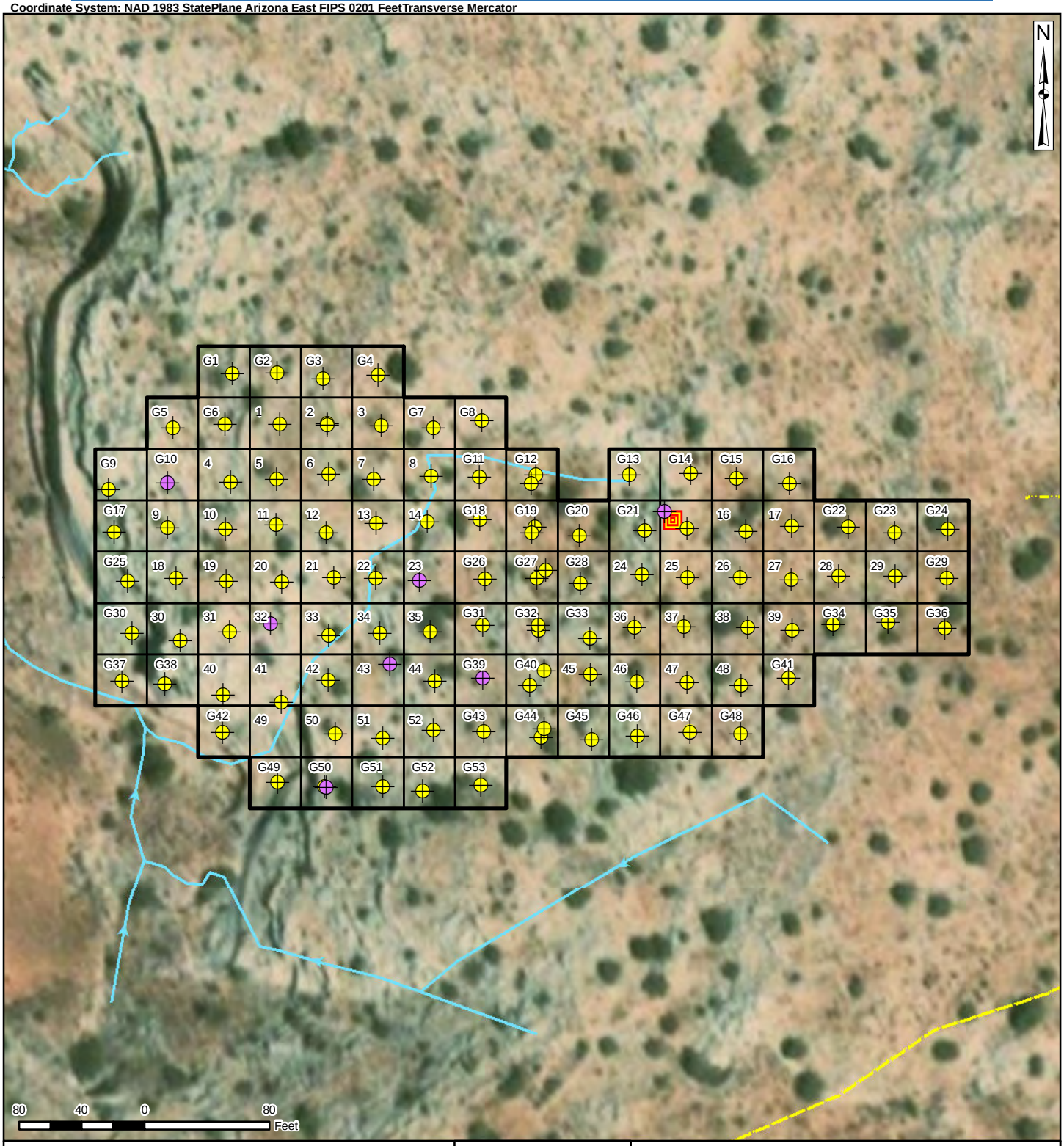
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborn Spectral Photometric Environmental Collection Technology.

Figure No.: **I4-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

NORM - Field Mappped

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route - Foot

Drainage - Field Mapped

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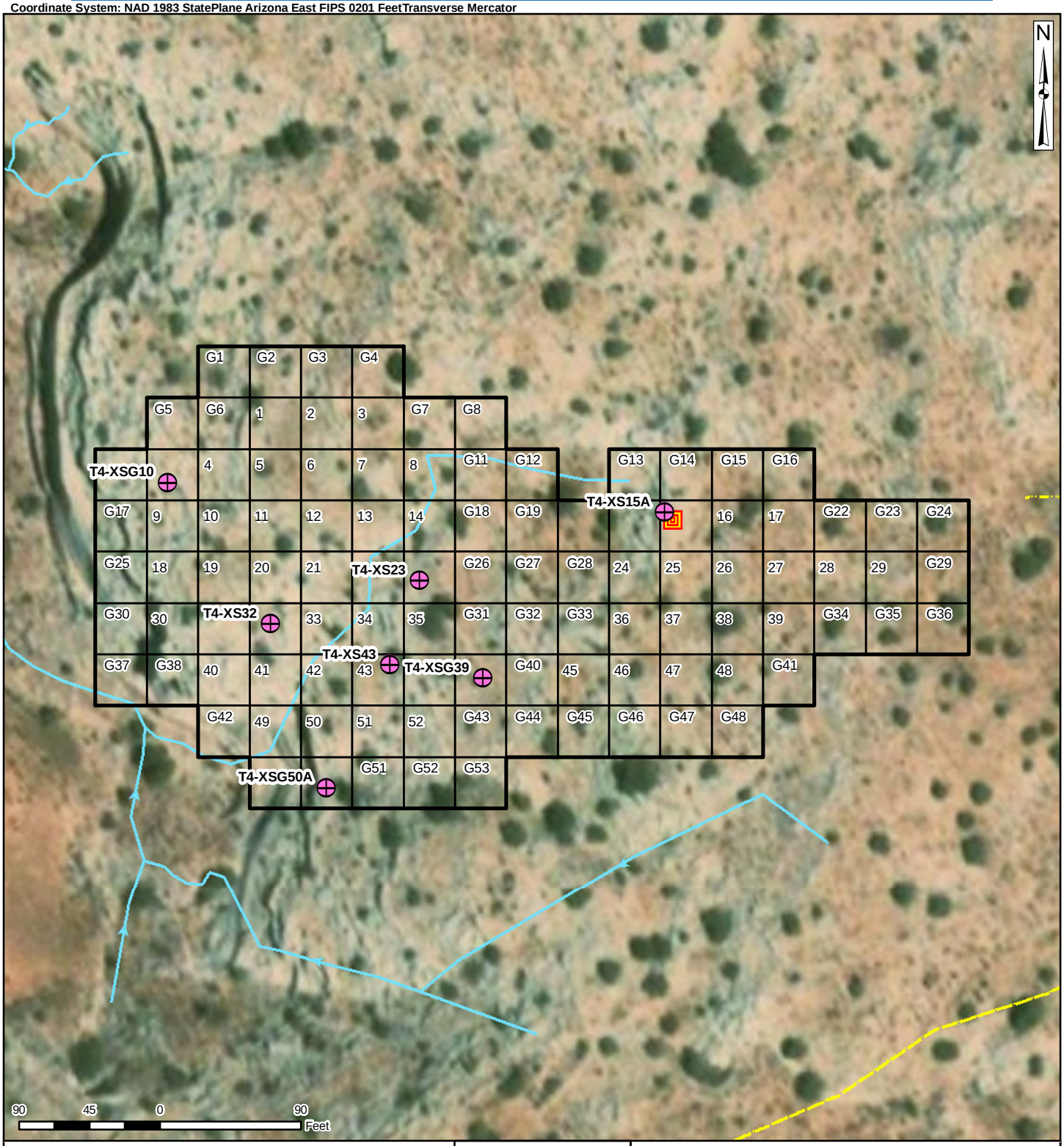
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NON-AUM TARGET BR-04 (T4) XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I4-4
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

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



XRF Confirmation Soil Sample[1] (0 - 3 inches bgs)

NORM - Field Mappped

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route - Foot

Drainage - Field Mapped

*T4-XSG10 = site T4 XRF confirmation soil sample collected at survey unit G10. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET BR-04 (T4)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I4-5
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/12/2019	

Table I4-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target BR-04 (T4)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T4-XS15A-01-081918	15A	0-3	XRF Confirmation	Primary	8/19/2018	36.9074126	-109.3491545	1808486-9, 1808487-9
T4-XS23-01-051218	23	0-3	XRF Confirmation	Primary	5/12/2018	36.9072960	-109.3496907	1805327-17, 1805328-17
T4-XS32-01-051218	X32	0-3	XRF Confirmation	Primary	5/12/2018	36.9072222	-109.3500167	1805327-18, 1805328-18
T4-XS43-01-051218	43	0-3	XRF Confirmation	Primary	5/12/2018	36.9071489	-109.3497572	1805327-19, 1805328-19
T4-XSG10-01-081918	G10	0-3	XRF Confirmation	Primary	8/19/2018	36.9074715	-109.3502394	1808483-16, 1808484-16
T4-XSG39-01-081918	G39	0-3	XRF Confirmation	Primary	8/19/2018	36.9071238	-109.3495539	1808483-17, 1808484-17
T4-XSG50A-01-081918	G50A	0-3	XRF Confirmation	Primary	8/19/2018	36.9069343	-109.3498975	1808483-18, 1808484-18

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I4-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BR-04 (T4)

Analyte	Type	CAS Number	Analytical Method	Number of Samples by Standard Analyses	Number of Samples by Extended Analyses
Aluminum	Metals	7429-90-5	USEPA SW-846 6020B	5	2
Antimony	Metals	7440-36-0	USEPA SW-846 6020B	5	2
Arsenic	Metals	7440-38-2	USEPA SW-846 6020B	5	2
Barium	Metals	7440-39-3	USEPA SW-846 6020B	5	2
Beryllium	Metals	7440-41-7	USEPA SW-846 6020B	5	2
Cadmium	Metals	7440-43-9	USEPA SW-846 6020B	5	2
Calcium	Metals	7440-70-2	USEPA SW-846 6020B	5	2
Chromium	Metals	7440-47-3	USEPA SW-846 6020B	5	2
Cobalt	Metals	7440-48-4	USEPA SW-846 6020B	5	2
Copper	Metals	7440-50-8	USEPA SW-846 6020B	5	2
Iron	Metals	7439-89-6	USEPA SW-846 6020B	5	2
Lead	Metals	7439-92-1	USEPA SW-846 6020B	5	2
Lead-210	Radionuclides	14255-04-0	Eichrom method	0	2
Lithium	Metals	7439-93-2	USEPA SW-846 6020B	5	2
Magnesium	Metals	7439-95-4	USEPA SW-846 6020B	5	2
Manganese	Metals	7439-96-5	USEPA SW-846 6020B	5	2
Mercury	Metals	7439-97-6	USEPA SW-846 7471A	0	2
Molybdenum	Metals	7439-98-7	USEPA SW-846 6020B	5	2
Nickel	Metals	7440-02-0	USEPA SW-846 6020B	5	2
Potassium-40	Radionuclides	13966-00-2	USEPA 901.1	5	2
Radium-226	Radionuclides	13982-63-3	USEPA 901.1	5	2
Radium-228	Radionuclides	15262-20-1	USEPA 901.1	5	2
Selenium	Metals	7782-49-2	USEPA SW-846 6020B	5	2
Silver	Metals	7440-22-4	USEPA SW-846 6020B	5	2
Sodium	Metals	7440-23-5	USEPA SW-846 6020B	5	2
Thallium	Metals	7440-28-0	USEPA SW-846 6020B	5	2
Vanadium	Metals	7440-62-2	USEPA SW-846 6020B	5	2
Zinc	Metals	7440-66-6	USEPA SW-846 6020B	5	2
Thorium	Metals	-	USEPA SW-846 6020B	5	2
Thorium-228	Radionuclides	14274-82-9	ASTM D3972 Modified	0	2
Thorium-230	Radionuclides	14269-63-7	ASTM D3972 Modified	0	2
Thorium-232[1]	Radionuclides	7440-29-1	ASTM D3972 Modified	0	2
Uranium	Metals	-	USEPA SW-846 6020B	5	2
Uranium-234	Radionuclides	13966-29-5	ASTM D3972 Modified	0	2
Uranium-235	Radionuclides	15117-96-1	ASTM D3972 Modified	0	2
Uranium-238[1]	Radionuclides	7440-61-1	ASTM D3972 Modified	0	2

Table I4-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BR-04 (T4) (Continued)

Notes:

Green Shading identifies Extended Analyses

[1] Measured via alpha spectroscopy.

- Not applicable

ASTM ASTM International

CAS Chemical abstracts service

USEPA U.S. Environmental Protection Agency

XRF X-ray fluorescence

4.3.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 4.3.1, Target T4 surface geology is entirely within the Jms and soils within the rock outcrop-Rizno complex (MUSYM 309) for most of the Target except for the western edge in the Weiser-Wechech association (MUSYM 314) (Figures I-13 and I-14). As a result, BSA-1 was selected for that combination of geology and soil type. Table I4-3 presents the Target-specific BTVs for 29 analytes and gamma radiation levels for Target T4. No regional BTVs were established for Target T4. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T4. The "Applied BTV" for each analyte is the Target-specific BTV.

Table I4-3. Applied Background Threshold Values for Non-AUM Target BR-04 (T4)

Analyte	Units	Site-Specific BTV (BSA-1)	Regional BTV (Jms)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	5,900	None	5,900	Site-Specific BTV
Antimony	mg/kg	0.128	None	0.128	Site-Specific BTV
Arsenic	mg/kg	5.8	None	5.8	Site-Specific BTV
Barium	mg/kg	190	None	190	Site-Specific BTV
Beryllium	mg/kg	0.40	None	0.40	Site-Specific BTV
Cadmium	mg/kg	0.098	None	0.098	Site-Specific BTV
Calcium	mg/kg	90,200	None	90,200	Site-Specific BTV
Chromium	mg/kg	4.6	None	4.6	Site-Specific BTV
Cobalt	mg/kg	3.7	None	3.7	Site-Specific BTV
Copper	mg/kg	11	None	11	Site-Specific BTV
Iron	mg/kg	7,800	None	7,800	Site-Specific BTV
Lead	mg/kg	6.7	None	6.7	Site-Specific BTV
Lithium	mg/kg	14	None	14	Site-Specific BTV
Magnesium	mg/kg	5,070	None	5,070	Site-Specific BTV
Manganese	mg/kg	270	None	270	Site-Specific BTV
Mercury	mg/kg	0.0168	None	0.0168	Site-Specific BTV
Molybdenum	mg/kg	0.58	None	0.58	Site-Specific BTV
Nickel	mg/kg	5.9	None	5.9	Site-Specific BTV
Potassium-40	pCi/g	15.6	None	15.6	Site-Specific BTV
Radium-226	pCi/g	2.59	None	2.59	Site-Specific BTV
Radium-228	pCi/g	0.60	None	0.60	Site-Specific BTV
Selenium	mg/kg	0.88	None	0.88	Site-Specific BTV
Silver	mg/kg	0.037	None	0.037	Site-Specific BTV
Sodium	mg/kg	40	None	40	Site-Specific BTV
Thallium	mg/kg	0.062	None	0.062	Site-Specific BTV
Thorium	mg/kg	2.1	None	2.1	Site-Specific BTV
Uranium	mg/kg	3.9	None	3.9	Site-Specific BTV
Vanadium	mg/kg	13	None	13	Site-Specific BTV
Zinc	mg/kg	19	None	19	Site-Specific BTV
Gamma Radiation	cpm	10,287	None	10,287	Site-Specific BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
Jms Morrison Formation, Salt Wash Member
mg/kg milligrams per kilogram
pCi/g picocuries per gram

4.3.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T4 and the raw gamma radiation and grid averaged gamma radiation survey results.

4.3.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T4 in May 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in August 2018 to collect data within the Goback survey units. A gamma radiation survey was also performed in the Tse Tah West drainage in conjunction with the RSE for the Brodie 1 Mine; results are presented in Appendix J of the RSE Report. The applied gamma BTV for non-AUM Target T4 is 10,287 cpm. A total of 15,322 measurements were collected as part of the gamma radiation survey at non-AUM Target T4 across 105 survey units. An average scan density of 146 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I4-4.

Table I4-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target BR-04 (T4)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	10,287	
Measurements	#	15,322	105
Minimum	cpm	4,931	8,659
Maximum	cpm	70,871	28,185
Average	cpm	11,974	11,302
Median	cpm	10,506	10,572
Standard Deviation	cpm	5,253	2,790
90th Percentile	cpm	16,706	14,028
95th Percentile	cpm	19,967	15,796
99th Percentile	cpm	35,100	19,586
Measurements per Survey Unit	#/grid	146	
Measurements Above Gamma BTV	#	8,366	59
Measurements Above Gamma BTV	%	54.6	56.2

Notes:
BTV background threshold value
cpm counts per minute

4.3.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 56.2 percent of the measurements within the Target boundaries, in some cases exceeding greater than four times the applied gamma BTV (10,287 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-1 (Jms) gamma survey results is provided on Figure I4-6. This graph shows that the spread of radiation data at Target T4 (on left) begins below the range of BSA-1 (Jms) gamma levels (on right) and then rises to more than four times background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T4 is slightly higher than the data cloud from the BSA-1 (Jms) data set. A box plot showing the quartiles of the data sets is provided in Figure I4-7. The box plot shows that the median of Target T4 radiation levels is higher than the median of the BSA-1 (Jms) data set and higher than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I4-8. No mining activity was observed within the survey area of Target T4. However, a large portion of the survey area contains the exposed surface of the Salt Wash Member of the Jms. The Target boundary ends at a vertical cliff with loose material susceptible to erosion to the Tse Tah West drainage below.

In general, Target T4 has surficial gamma radiation levels above BSA-1 (Jms) levels across the majority of the Target area, decreasing toward the outside edges of the survey boundary, indicating that the survey encompassed the area of elevated gamma activity identified by the ASPECT and Weston MCAP gamma surveys (Figures I4-3 and I4-8). No TENORM or mining-related activities were observed within the Target T4 survey and surrounding area. Section 4.3.5.3 presents the grid averaged results of the gamma radiation survey.

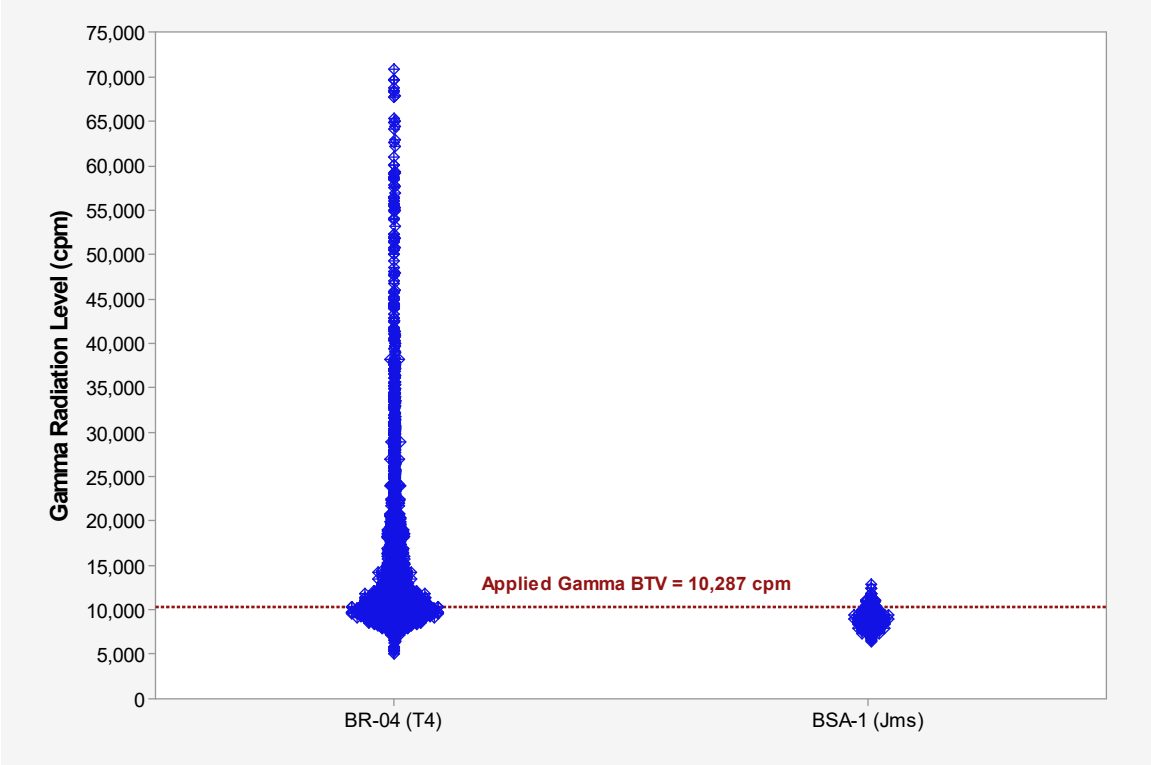


Figure I4-6. Individual Value Plot of Raw Gamma Radiation Levels at Target BR-04 (T4) and BSA-1 (Jms)

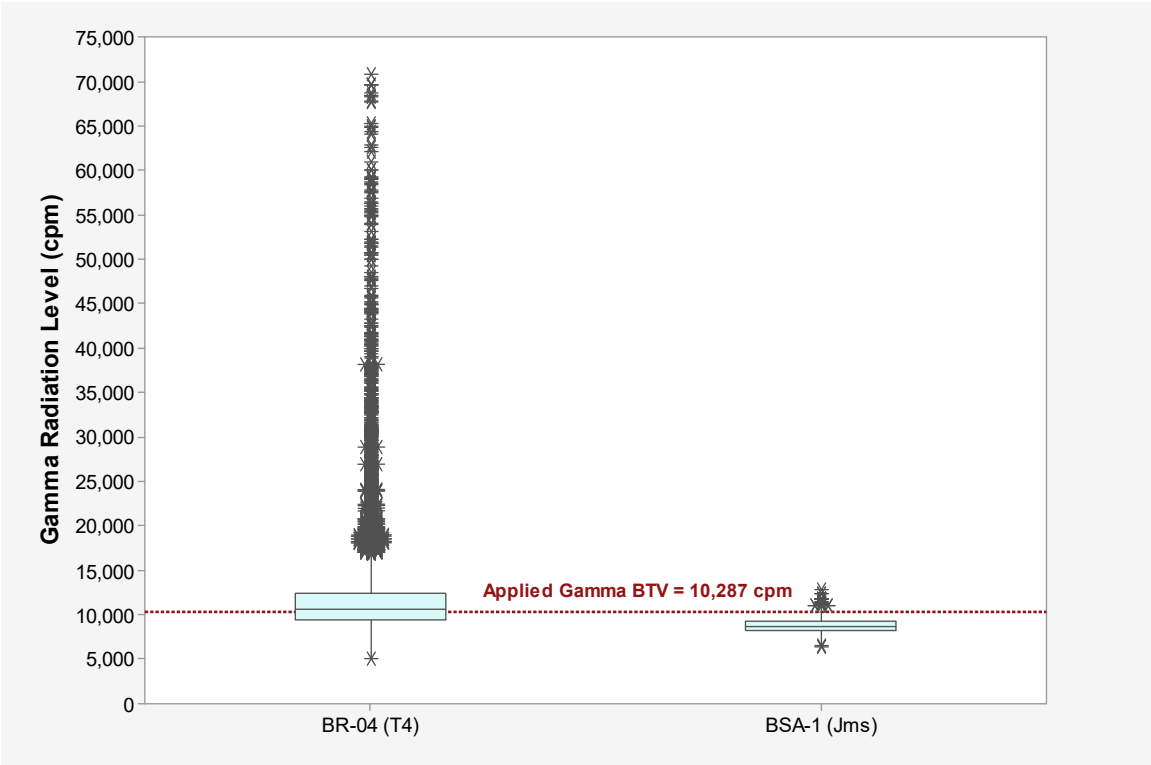
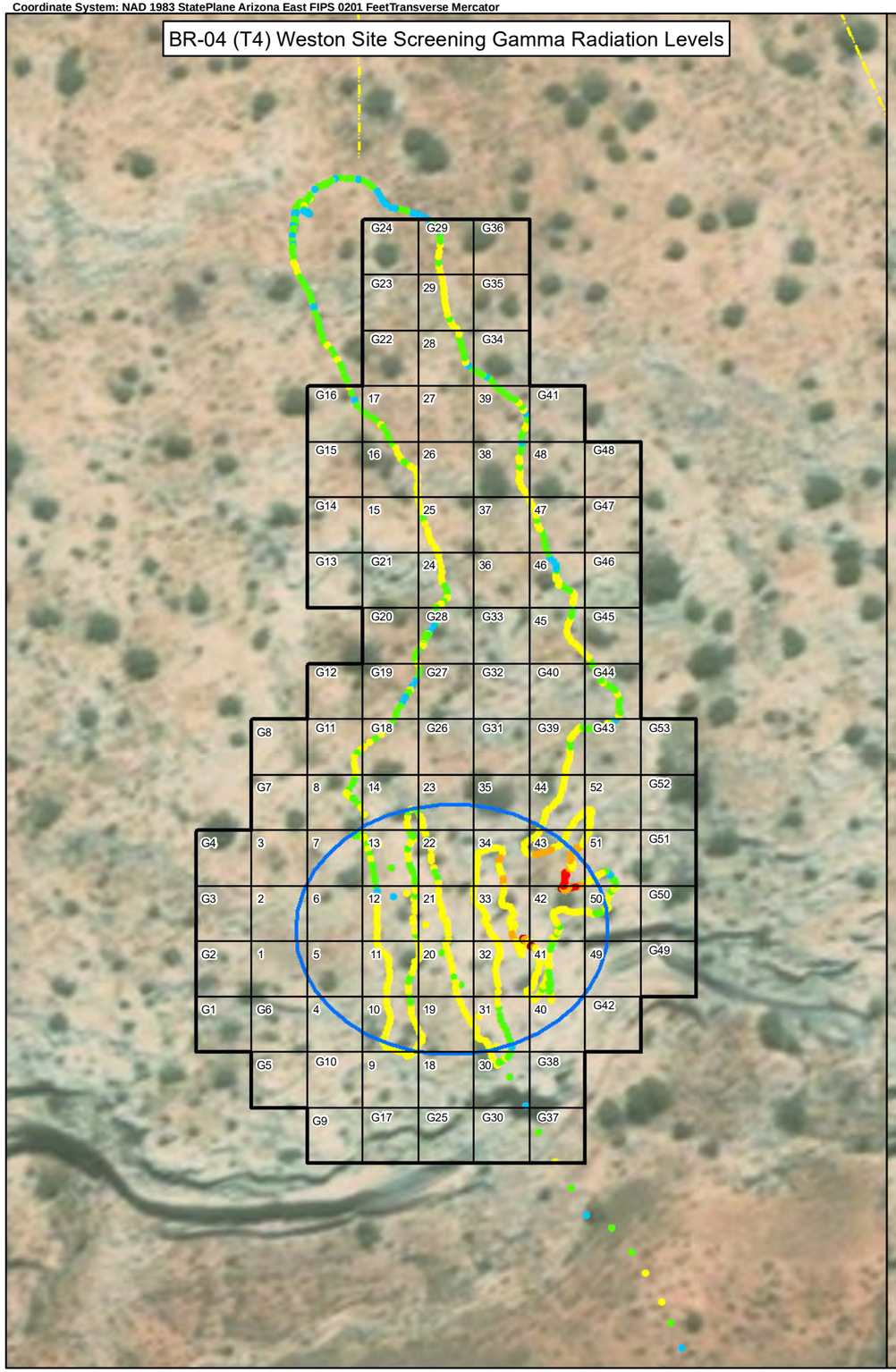


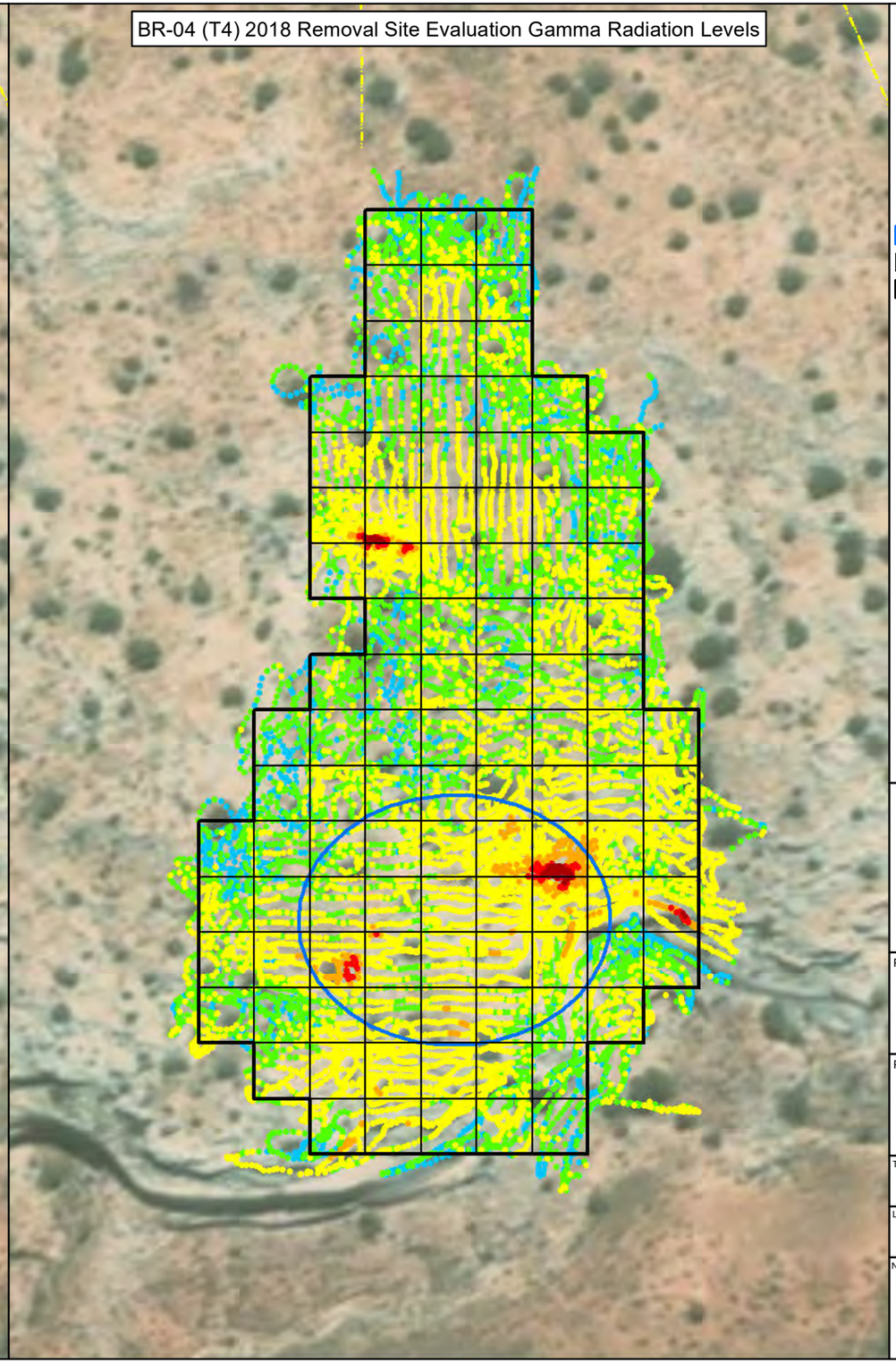
Figure I4-7. Box Plot of Raw Gamma Radiation Level at Target BR-04 (T4) and BSA-1 (Jms)

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

BR-04 (T4) Weston Site Screening Gamma Radiation Levels



BR-04 (T4) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)*

≤ 8,760	≤ Avg. BG
8,760 - 10,287	Avg. BG - 1 x BTV
10,287 - 20,574	1 x BTV - 2 x BTV
20,574 - 30,861	2 x BTV - 3 x BTV
30,861 - 41,148	3 x BTV - 4 x BTV
41,148 - 102,870	4 x BTV - 10 x BTV
≥ 102,870	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Access Route - Foot

1 in = 80 ft

1:960

0 40 80 160 Feet

N E S W

NON-AUM TARGET BR-04 (T4) 2018 REMOVAL SITE EVALUATION VS WESTON SITE SCREENING GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: SWEETWATER CHAPTER NAVAJO NATION	**Date:** 6/11/2019

Notes:
*The applied gamma background threshold value (BTV) for BR-04 Non-AUM Target is 10,287 cpm derived from BSA-1 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I4-8**

4.3.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 4.3.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 4.3.5.1. Figure I4-9 and Figure I4-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-1 (Jms) data set (shown on right). A total of 56.2 percent of the survey units (59 of 105) within the survey area of Target T4 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I4-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I4-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. The elevated regions correspond with surface exposure of the Salt Wash Member of the Jms.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 4.3.6.

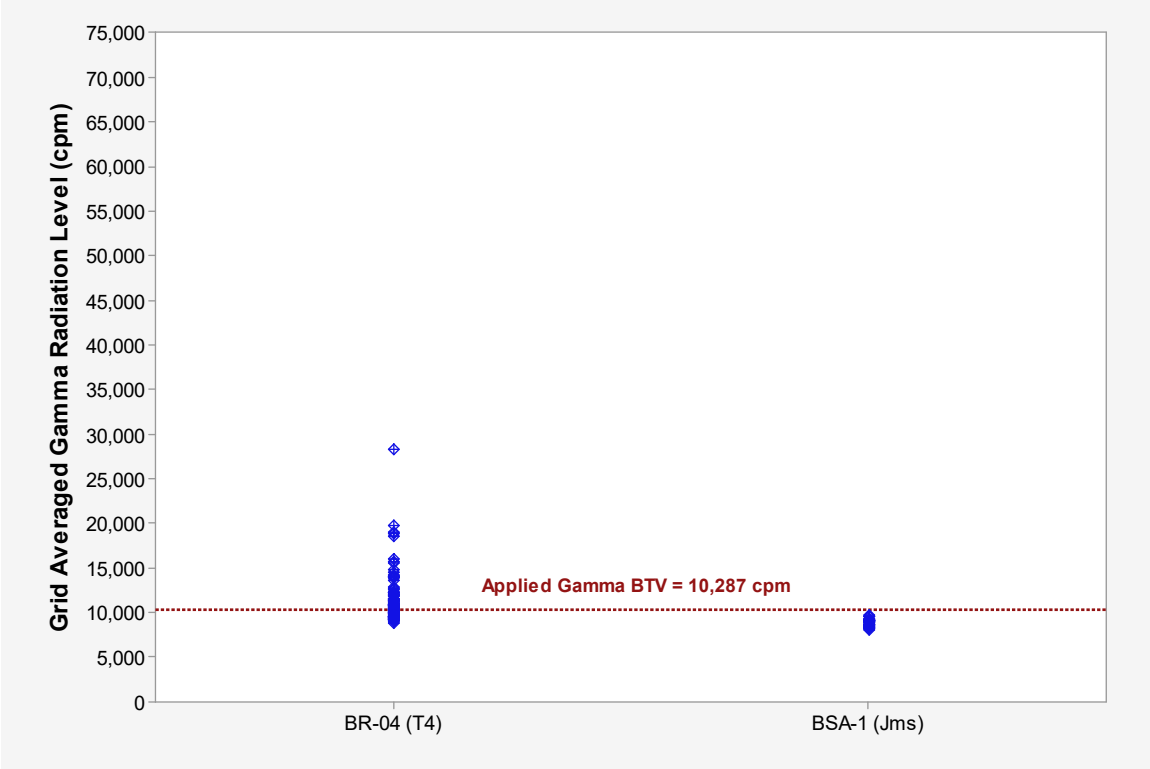


Figure I4-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target BR-04 (T4) and BSA-1 (Jms)

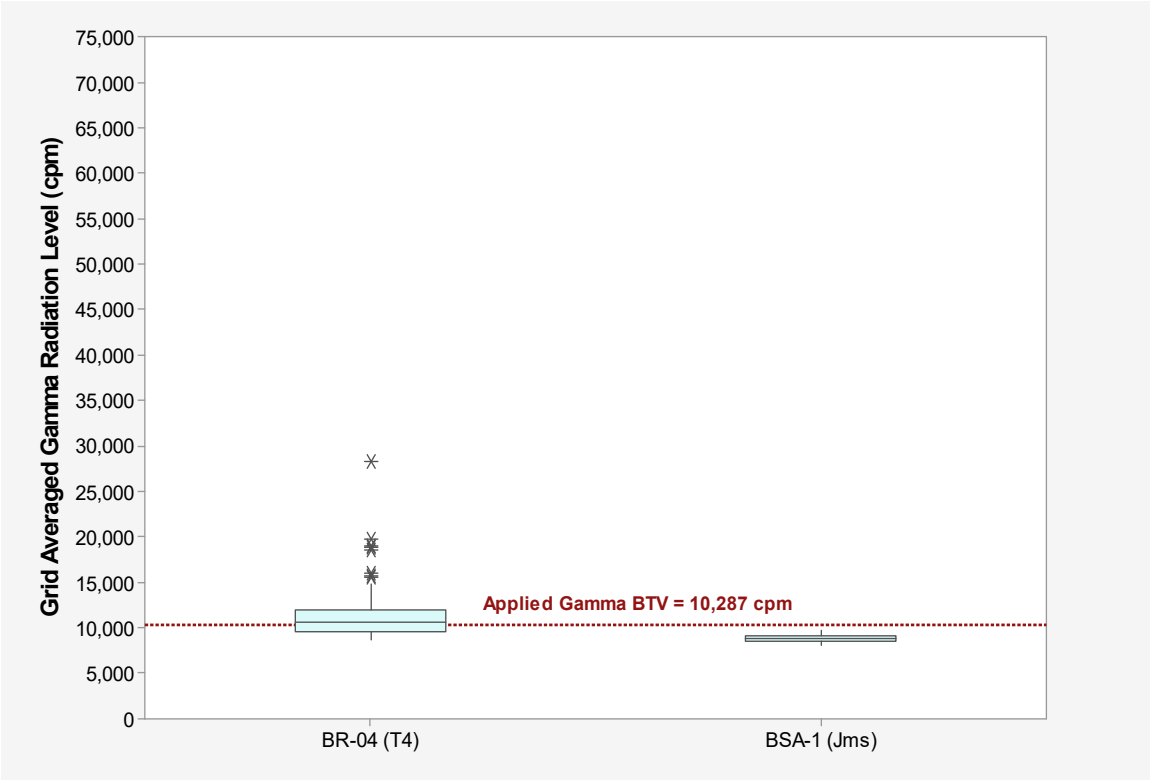
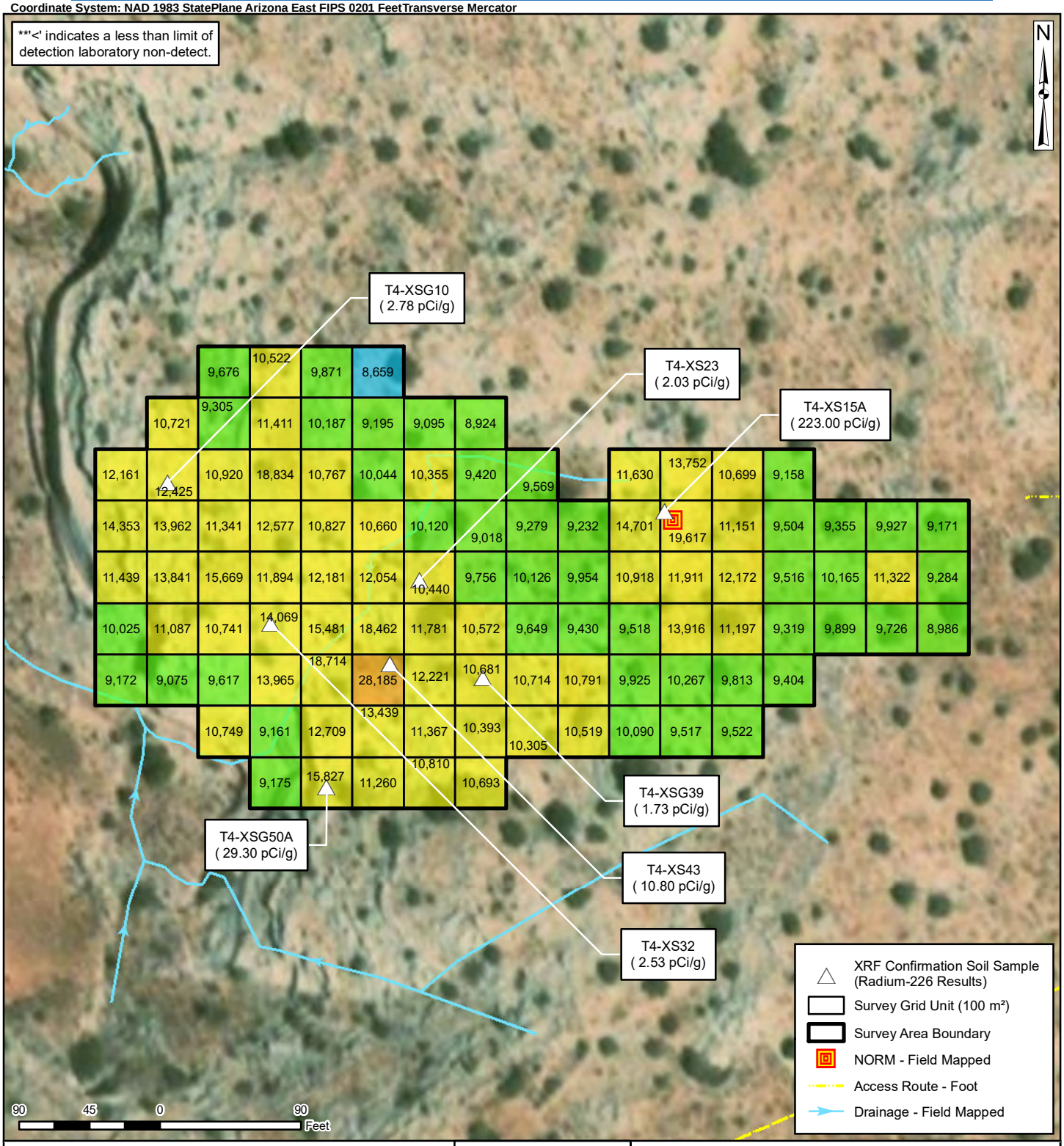


Figure I4-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target BR-04 (T4) and BSA-1 (Jms)

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



Grid Averaged Gamma Reading (cpm)*

≤ 8,760	≤ Avg. BG
8,760 - 10,287	Avg. BG - 1 x BTV
10,287 - 20,574	1 x BTV - 2 x BTV
20,574 - 30,861	2 x BTV - 3 x BTV
30,861 - 41,148	3 x BTV - 4 x BTV
41,148 - 102,870	4 x BTV - 10 x BTV
≥ 102,870	≥ 10 x BTV

*The applied gamma background threshold value (BTV) for BR-04 Non-AUM Target is 10,287 cpm derived from BSA-1 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET BR-04 (T4) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I4-11
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/12/2019	

4.3.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T4. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 4.3.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 4.3.6.2.

4.3.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T4: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I4-1 and I4-2. All the results of the XRF confirmation soil samples are presented in Table I4-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T4 following the methods outlined in Section 2.4 and shown in Figure I4-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Data Evaluation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 113 measurements were collected across 105 survey units from the survey area of Target T4 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I4-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T4 at a depth of 0 to 3 inches bgs. Seven XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I4-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 4.3.7.

Table I4-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BR-04 (T4)

Analyte	Units	Applied BTV	T4-XS15A-01-081918		T4-XS23-01-051218		T4-XS32-01-051218		T4-XS43-01-051218		T4-XSG10-01-081918		T4-XSG39-01-081918		T4-XSG50A-01-081918	
			Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Survey Unit			X15A		X23		X32		X43		XG10		XG39		XG50A	
Aluminum	mg/kg	5,900	14,000		2,900		3,200		3,200		3,200		2,700		12,000	
Antimony	mg/kg	0.128	0.42		0.03	J	0.029	J	0.36		0.034	J	<0.093	U	0.2	
Arsenic	mg/kg	5.8	42		1.2		0.94		44		1.6		0.96		2.1	
Barium	mg/kg	190	310		39		41		42		37		26		85	
Beryllium	mg/kg	0.4	1		0.13		0.15		0.17		0.16		0.11		0.91	
Cadmium	mg/kg	0.098	0.27		0.057	J	0.051	J	1		0.098	J	0.034	J	0.036	J
Calcium	mg/kg	90,200	21,000		16,000		14,000		15,000		14,000		21,000		18,000	
Chromium	mg/kg	4.6	11		2.2		2.4		2.6		2.6		1.9		9.8	
Cobalt	mg/kg	3.7	15		1.3		1.3		5.7		1.5		0.96		8.2	
Copper	mg/kg	11	24		2.9		3.5		8.3		3.9		2.4		16	
Iron	mg/kg	7,800	15,000		2,800		2,800		5,000		3,400		2,600		12,000	
Lead	mg/kg	6.7	22		4		3.5		11		4.3		2.6		7	
Lead -210	pCi/g	NV	86		NA		NA		NA		NA		NA		11.9	
Lithium	mg/kg	14	36		5		5.4		5.7		5.9		4.9		28	
Magnesium	mg/kg	5,070	11,000		2,400		2,400		2,300		2,800		2,100		12,000	
Manganese	mg/kg	270	200		120		110		120		130		130		230	
Mercury	mg/kg	0.0168	<0.031	U	NA		NA		NA		NA		NA		<0.033	U
Molybdenum	mg/kg	0.58	2.2		0.097	J	0.083	J	3.3		0.14	J	0.077	J	0.1	J
Nickel	mg/kg	5.9	19		2.3		2.6		5.3		2.9		2		16	
Potassium-40	pCi/g	15.6	19.6		12.4		9.8	LT	10	LT	7.6	LT	12.3		23.1	
Radium-226	pCi/g	2.59	223	M3	2.03		2.53		10.8		2.78		1.73		29.3	
Radium-228	pCi/g	0.60	<0.6	UJ	<-0.02	U	<0.26	U	<0.84	UJ	<0.12	U	<0.19	U	<1.23	UJ
Selenium	mg/kg	0.88	2.1		0.35	J	0.35	J	0.8	J	0.4	J	0.3	J	0.92	J
Silver	mg/kg	0.037	0.061		<0.05	U	<0.048	U	0.11		0.015	J	<0.047	U	0.036	J
Sodium	mg/kg	40	77	J	<100	UJ	<96	UJ	<100	UJ	<94	U	<93	U	140	
Thallium	mg/kg	0.062	0.72		0.027		0.036		0.24		0.036		0.017		0.091	
Thorium	mg/kg	2.1	6.6		1.3		1.3		1.6		1.4		1.3		6.5	
Thorium-228	pCi/g	NV	1.26	M3	NA		NA		NA		NA		NA		0.97	M3
Thorium-230	pCi/g	NV	112	M3	NA		NA		NA		NA		NA		14	M3
Thorium-232	pCi/g	NV	1.38		NA		NA		NA		NA		NA		0.91	
Uranium	mg/kg	3.9	52		3.1		4.5		20		5.3		2.5		25	
Uranium-234	pCi/g	NV	32		NA		NA		NA		NA		NA		7.2	
Uranium-235	pCi/g	NV	1.35		NA		NA		NA		NA		NA		0.28	
Uranium-238	pCi/g	NV	29.9		NA		NA		NA		NA		NA		7.4	
Vanadium	mg/kg	13	18		6.3		29		14		9.9		4.7		59	
Zinc	mg/kg	19	67		9.2	J	9.5	J	9.9	J	9.9		7.5	J	44	

Table I4-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BR-04 (T4) (Continued)

Notes:

BTV	Background threshold value
ID	Identification
J	Estimated value
J-	Estimated value, may be biased low
LT	Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
M3	The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg	Milligrams per kilogram
NA	Not applicable
NV	No Value
pCi/g	Picocuries per gram
Q	Qualification
U	Not considered detected. The associated value is the method detection limit (MDL).
UJ	Not considered detected. The associated value is the reported concentration, which is estimated.

Table I4-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target BR-04 (T4)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	5.8	7,800	6.7	270	0.58	2.1	3.9	13	19
Measurements	#	113	113	113	113	113	113	113	113	113
Detects	#	68	113	111	110	17	107	107	35	112
Nondetects	#	45	0	2	3	96	6	6	78	1
Minimum	mg/kg	1.85	1,934	1.43	96	0.04	1.03	0.54	16.3	7.9
Maximum	mg/kg	42.6	18,586	16.1	326	3.5	8.0	52.1	109	51
Standard Deviation	mg/kg	6.2	2,842	2.0	44	0.99	0.97	6.1	24	7.1
Average	mg/kg	5.1	5,448	5.1	188	1.03	2.2	4.8	34.5	17.2
Median	mg/kg	3.3	4,736	5.0	177	0.69	2.0	3.3	24.6	15.6
Relative Standard Deviation	%	123	52	38	24	96	45	127	68	41
90th Percentile	mg/kg	7.8	7,567	6.9	250	2.3	2.8	9.7	63	22
95th Percentile	mg/kg	15.9	12,290	8.4	269	3.4	3.6	12.9	87	31
99th Percentile	mg/kg	32.0	17,946	10.4	300	3.5	5.8	20.8	107	44
Measurements Above Applied BTV	#	9	10	14	6	12	44	42	35	25
Measurements Above Applied BTV	%	8.0	8.8	12.4	5.3	10.	38.9	37.2	31.0	22.1

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value
mg/kg Milligram per kilogram
XRF X-ray fluorescence

4.3.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T4 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T4 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T4. The estimated BTVs are identified in Section 4.3.4 and Table I4-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I4-7 presents a summary of the background comparison for different measurement and soil depths at Target T4. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T4. However, gamma radiation screening indicated that gamma levels at Target T4 are elevated in comparison to the BSA and appear to be associated with outcropping of the Salt Wash Member of the Jms. Therefore, while multiple COPCs have been identified at Target T4 based on a conservative comparison to background, risk screening will be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I4-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target BR-04 (T4)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum	✓		✓
Antimony	✓		✓
Arsenic	✓	✓	✓
Barium	✓		✓
Beryllium	✓		✓
Cadmium	✓		✓
Calcium			
Chromium	✓		✓
Cobalt	✓		✓
Copper	✓		✓
Iron		✓	✓
Lead	✓	✓	✓
Lithium	✓		✓
Magnesium	✓		✓
Manganese		✓	✓
Mercury			
Molybdenum	✓	✓	✓
Nickel	✓		✓
Potassium-40	✓		✓
Radium-226	✓		✓
Radium-228			
Selenium	✓		✓
Silver	✓		✓
Sodium	✓		✓
Thallium	✓		✓
Thorium	✓	✓	✓
Uranium	✓	✓	✓
Vanadium	✓	✓	✓
Zinc	✓	✓	✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

4.3.7 Primary Contaminant Mapping

4.3.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 4.3.6.2 identified the COPCs at Target T4. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 4.3.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I4-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T4 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 4.3.7.1 through Section 4.3.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T4. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

4.3.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I4-7. Arsenic exceeded the applied BTV in 8 percent of in situ XRF measurements and in two of the seven XRF confirmation samples. The applied BTV for arsenic is 5.8 mg/kg for Target T4 as presented in Section 4.3.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I4-5 and Attachment I3, respectively. Figure I4-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T4 and BSA-1 (Jms) samples. Figure I4-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T4 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Section 4.3.6.1. Arsenic XRF concentrations measured in surface soils at Target T4 ranged between 1.85 and 42.6 mg/kg with an average and standard deviation of 5.1 mg/kg and 6.2 mg/kg, respectively. The average arsenic XRF concentration is below the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T4 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I4-14. Overall, the majority of detectable arsenic XRF results in surface soils were lower than the applied BTV. However, the maximum XRF value was 7.3 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T4.

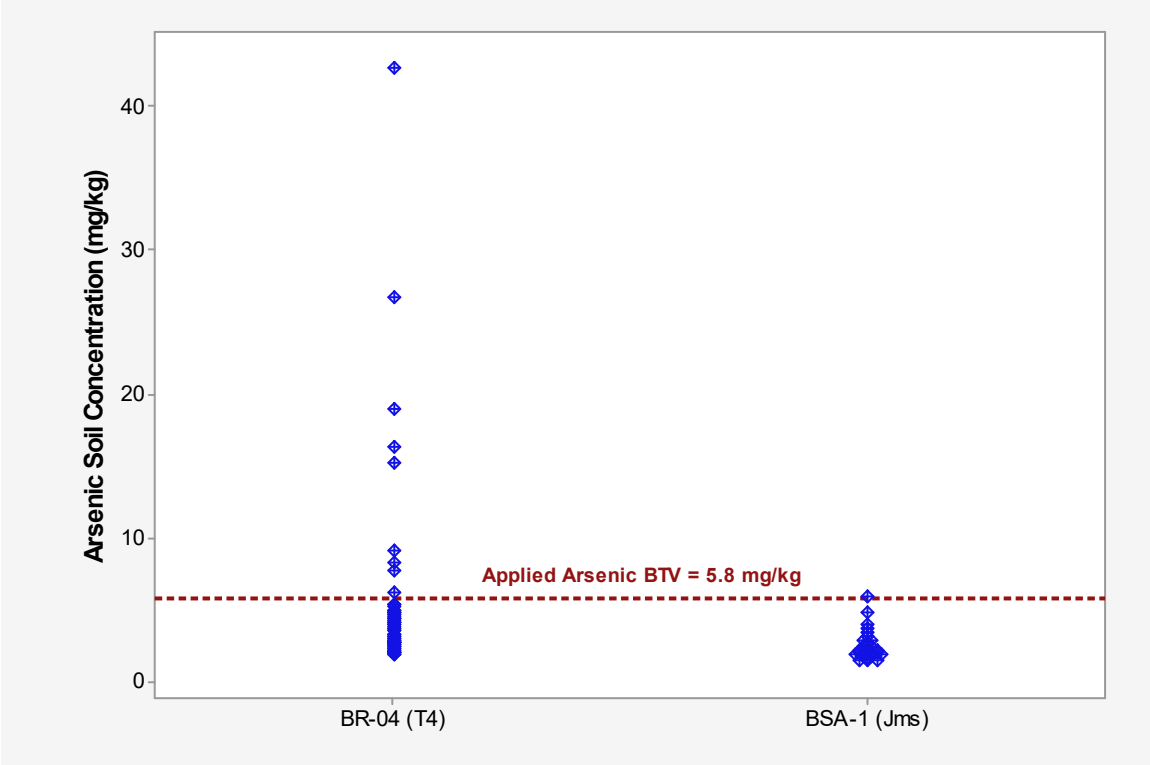


Figure I4-12. Individual Value Plot for Target BR-04 (T4) and BSA-1 (Jms) Arsenic Soil Concentrations

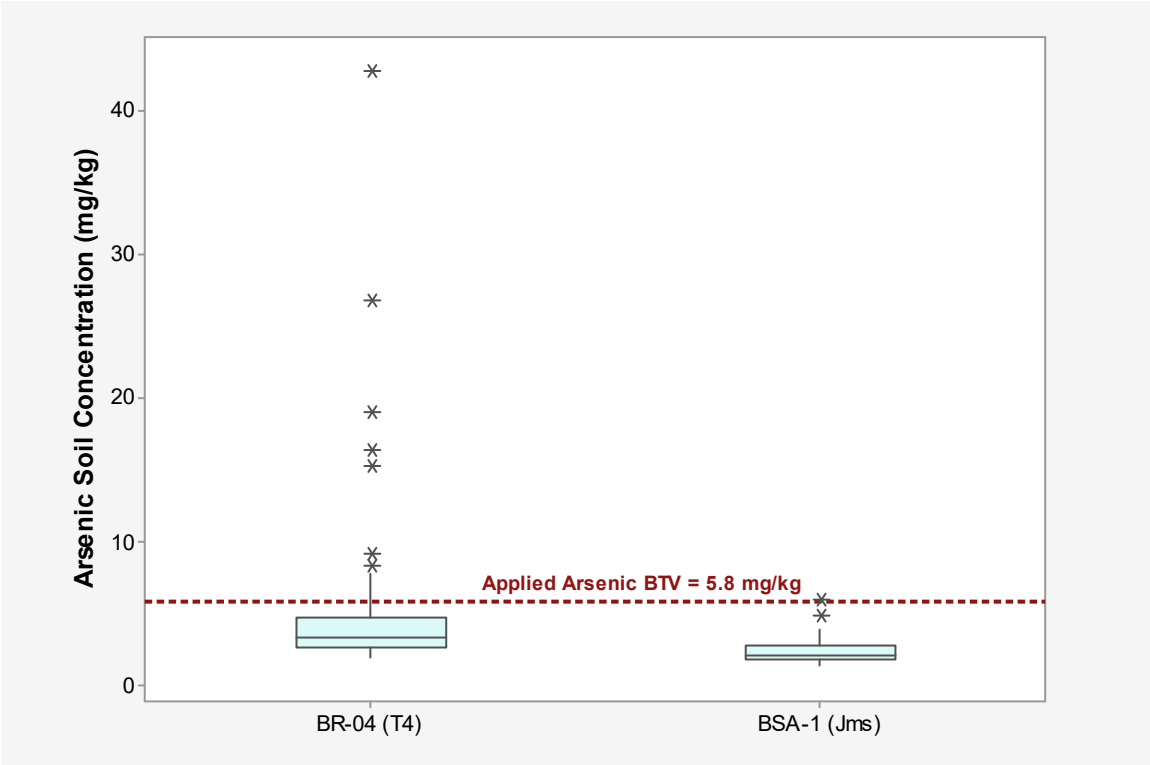
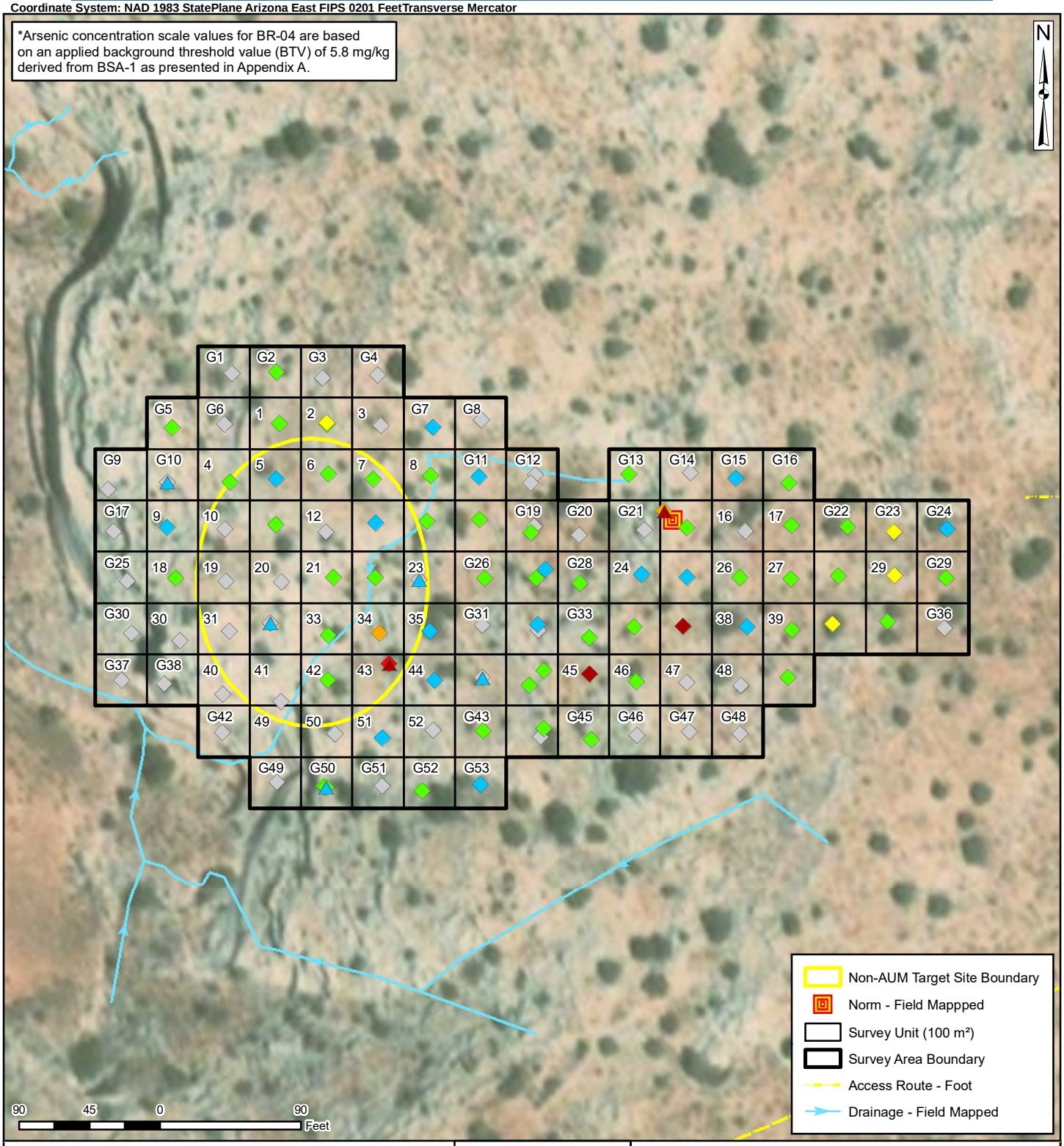


Figure I4-13. Box Plot for Target BR-04 (T4) and BSA-1 (Jms) Arsenic Soil Concentrations

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



Arsenic Concentration Scale (mg/kg)*

- ≤ 2.4
- 2.4 - 5.8
- 5.8 - 12
- 12 - 17
- 17 - 23
- 23 - 58
- ≥ 58
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

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NON-AUM TARGET BR-04 (T4) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I4-14
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/26/2019	

4.3.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I4-7. Lead exceeded the applied BTV in 12.4 percent of in situ XRF measurements and in three of the seven XRF confirmation samples. The applied BTV for lead is 6.7 mg/kg for Target T4 as presented in Section 4.3.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I4-5 and Attachment I3, respectively. Figure I4-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T4 and BSA-1 (Jms) samples. Figure I4-16 presents a box plot of detectable lead XRF soil concentrations for Target T4 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Section 4.3.6.1. Lead XRF concentrations measured in surface soils at Target T4 ranged between 0.32 and 16.1 mg/kg with an average and standard deviation of 5.0 mg/kg and 2.0 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T4 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I4-17. Overall, the majority of detectable lead XRF results in surface soils were less than the applied BTV. However, the maximum XRF value was 2.4 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T4.

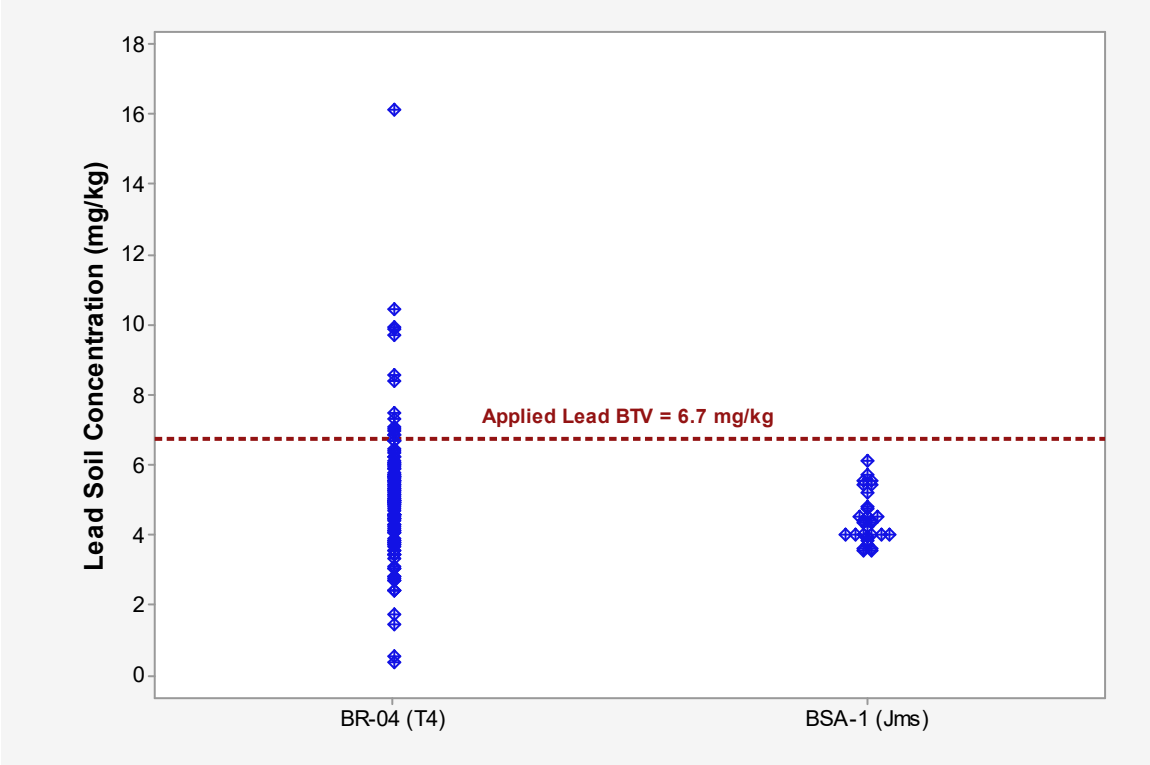


Figure I4-15. Individual Value Plot for Target BR-04 (T4) and BSA-1 (Jms) Lead Soil Concentrations

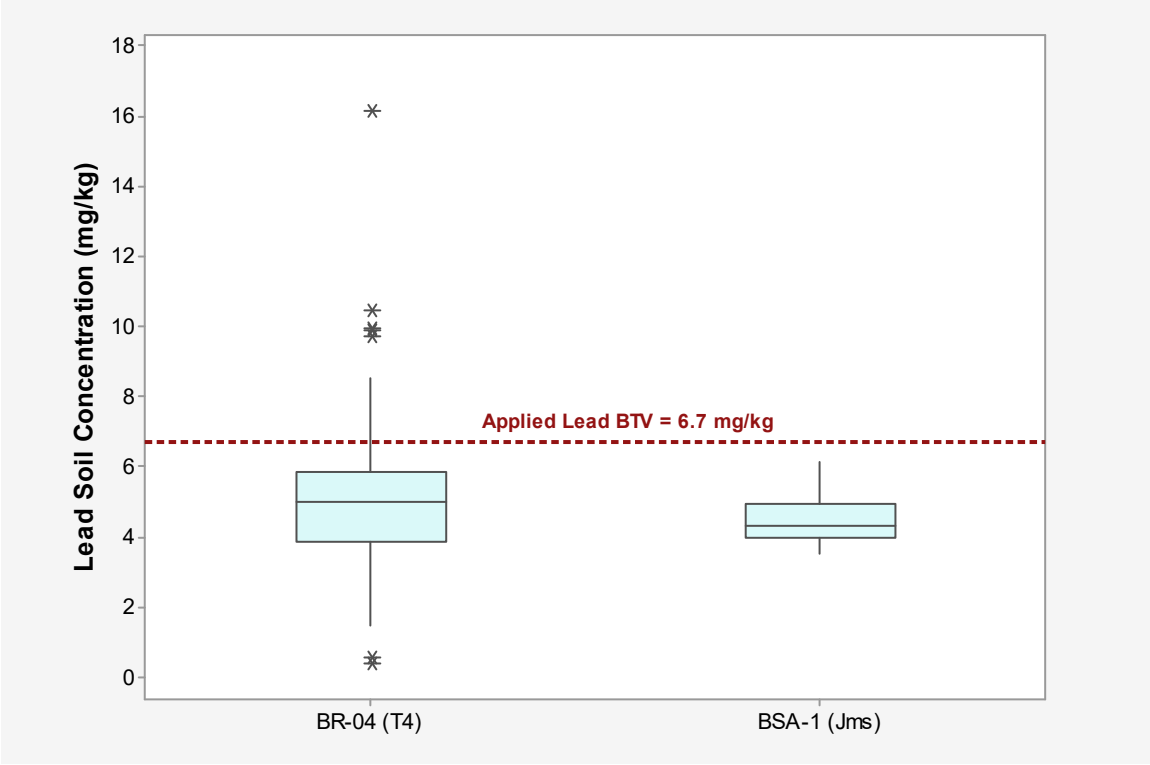
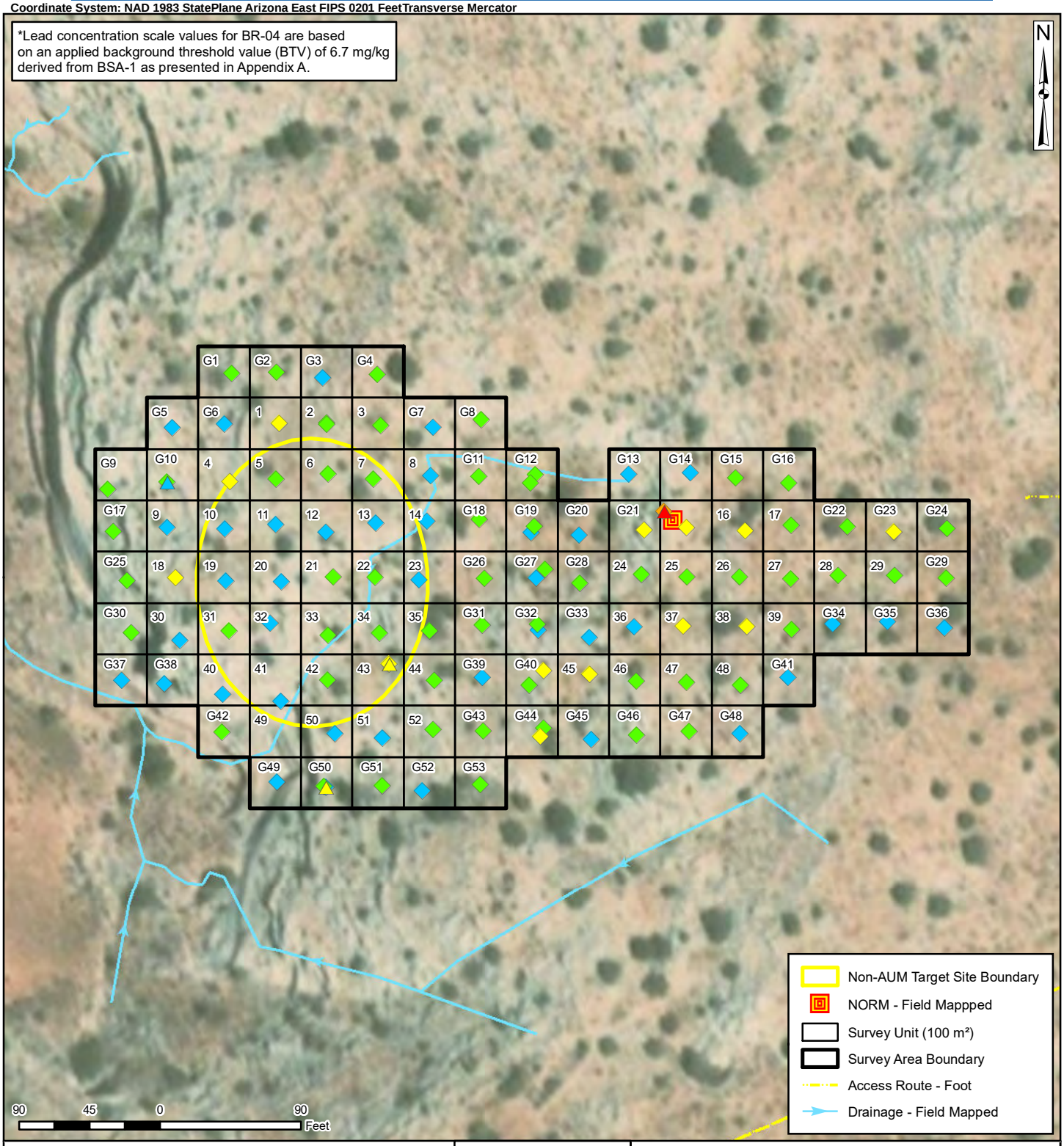


Figure I4-16. Box Plot for Target BR-04 (T4) and BSA-1 (Jms) Lead Soil Concentrations

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

*Lead concentration scale values for BR-04 are based on an applied background threshold value (BTV) of 6.7 mg/kg derived from BSA-1 as presented in Appendix A.



Lead Concentration Scale (mg/kg)*

- ≤ 4.4
- 4.4 - 6.7
- 6.7 - 13
- 13 - 20
- 20 - 27
- 27 - 67
- ≥ 67

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

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NON-AUM TARGET BR-04 (T4) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I4-17
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/26/2019	

4.3.7.4 Thorium

Thorium was identified as a COPC in surface soil as shown in Table I4-7. Thorium exceeded the applied BTV in 38 percent of in situ XRF measurements and in two of the seven XRF confirmation samples. The applied BTV for thorium is 2.1 mg/kg for Target T4 as presented in Section 4.3.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I4-5 and Attachment I3, respectively. Figure I4-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T4 and BSA-1 (Jms) samples. Figure I4-19 presents a box plot of detectable thorium XRF soil concentrations for Target T4 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Section 4.3.6.1. Thorium XRF concentrations measured in surface soils at Target T4 ranged between 1.03 and 8.0 mg/kg with an average and standard deviation of 2.2 mg/kg and 0.97 mg/kg, respectively. The average thorium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T4 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I4-20. Overall, the majority of detectable thorium XRF results in surface soils were less than the applied BTV. However, the maximum XRF value was 3.8 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T4.

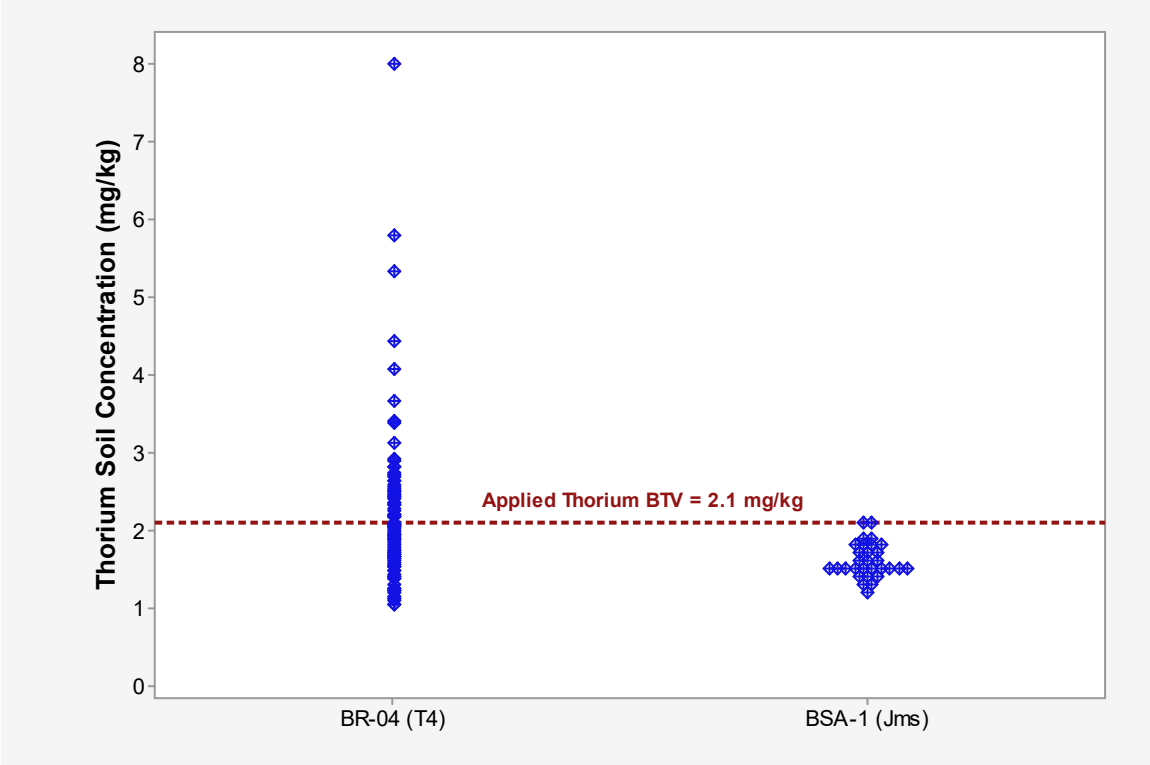


Figure I4-18. Individual Value Plot for Target BR-04 (T4) and BSA-1 (Jms) Thorium Soil Concentrations

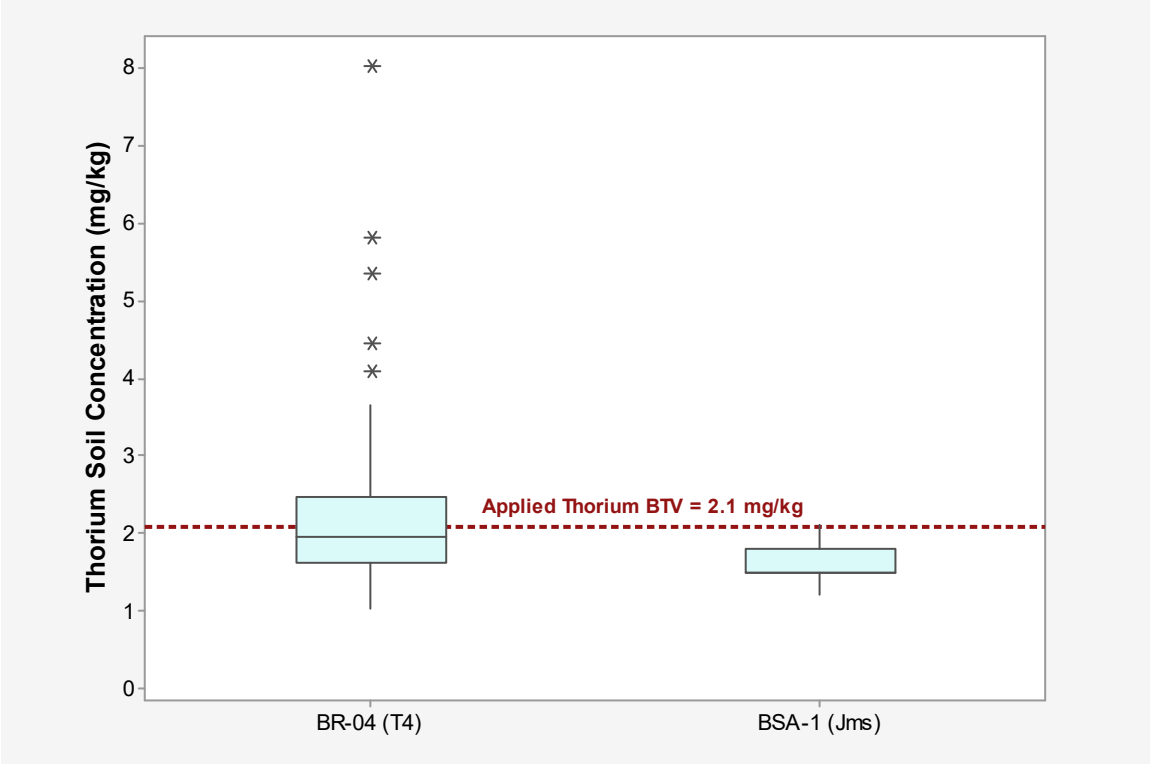
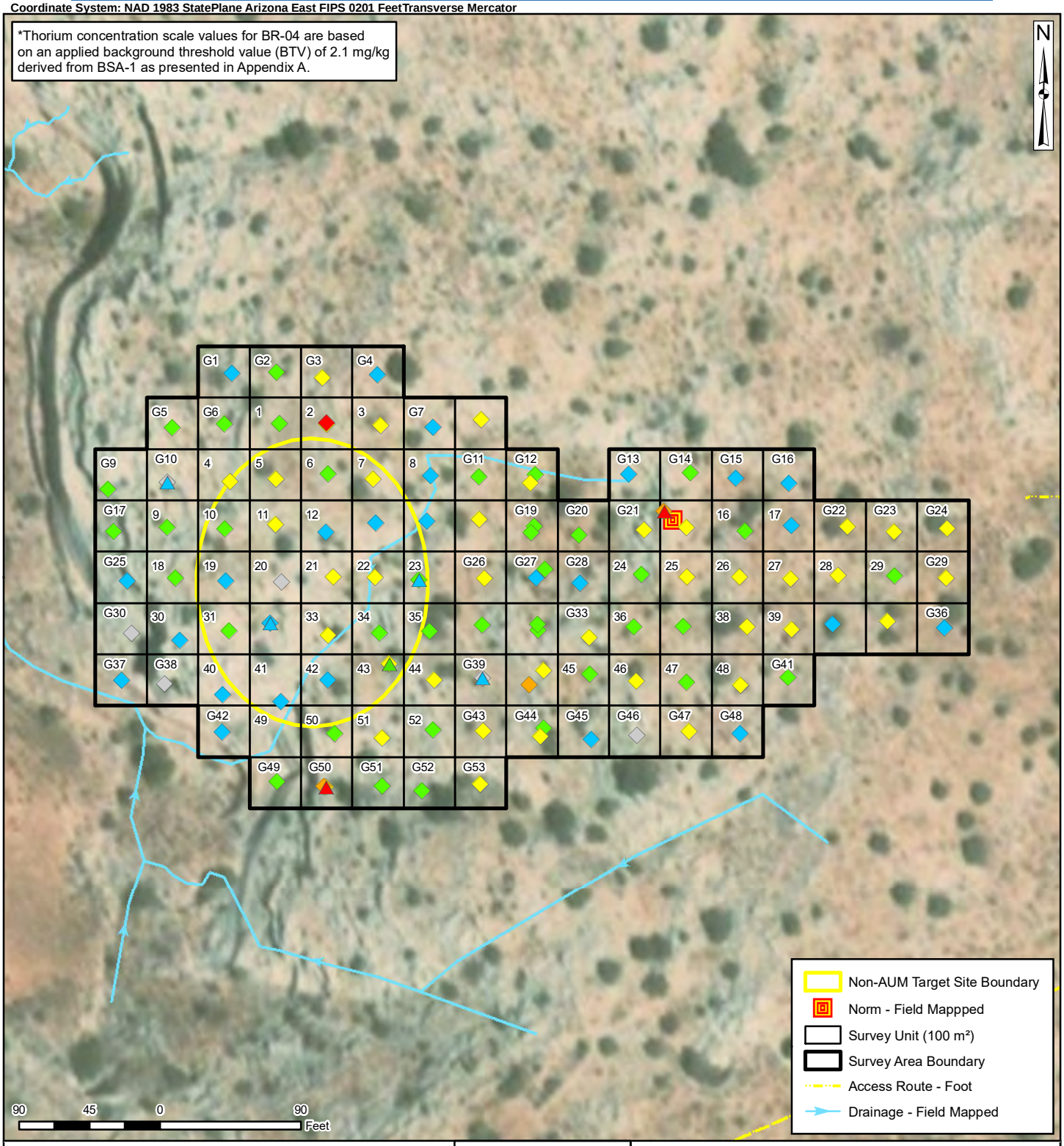


Figure I4-19. Box Plot for Target BR-04 (T4) and BSA-1 (Jms) Thorium Soil Concentrations

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



Thorium Concentration Scale (mg/kg)*

- ≤ 1.6
- 1.6 - 2.1
- 2.1 - 4.2
- 4.2 - 6.3
- 6.3 - 8.4
- 8.4 - 21
- ≥ 21
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- ◇ In Situ XRF Measurement
- △ XRF Confirmation Soil Sample

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NON-AUM TARGET BR-04 (T4) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I4-20
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/26/2019	

4.3.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I4-7. Uranium exceeded the applied BTV in 37.2 percent of in situ XRF measurements and in five of the seven XRF confirmation samples. The applied BTV for uranium is 3.9 mg/kg for Target T4 as presented in Section 4.3.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I4-5 and Attachment I3, respectively. Figure I4-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T4 and BSA-1 (Jms) samples. Figure I4-22 presents a box plot of detectable uranium XRF soil concentrations for Target T4 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Section 4.3.6.1. Uranium XRF concentrations measured in surface soils at Target T4 ranged between 0.54 and 52.1 mg/kg with an average and standard deviation of 4.8 mg/kg and 6.1 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T4 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I4-23. Overall, the majority of detectable uranium XRF results in surface soils were clustered about the applied BTV. However, the maximum XRF value was 14 times higher than the applied BTV and does not appear to be associated with mining-related materials.

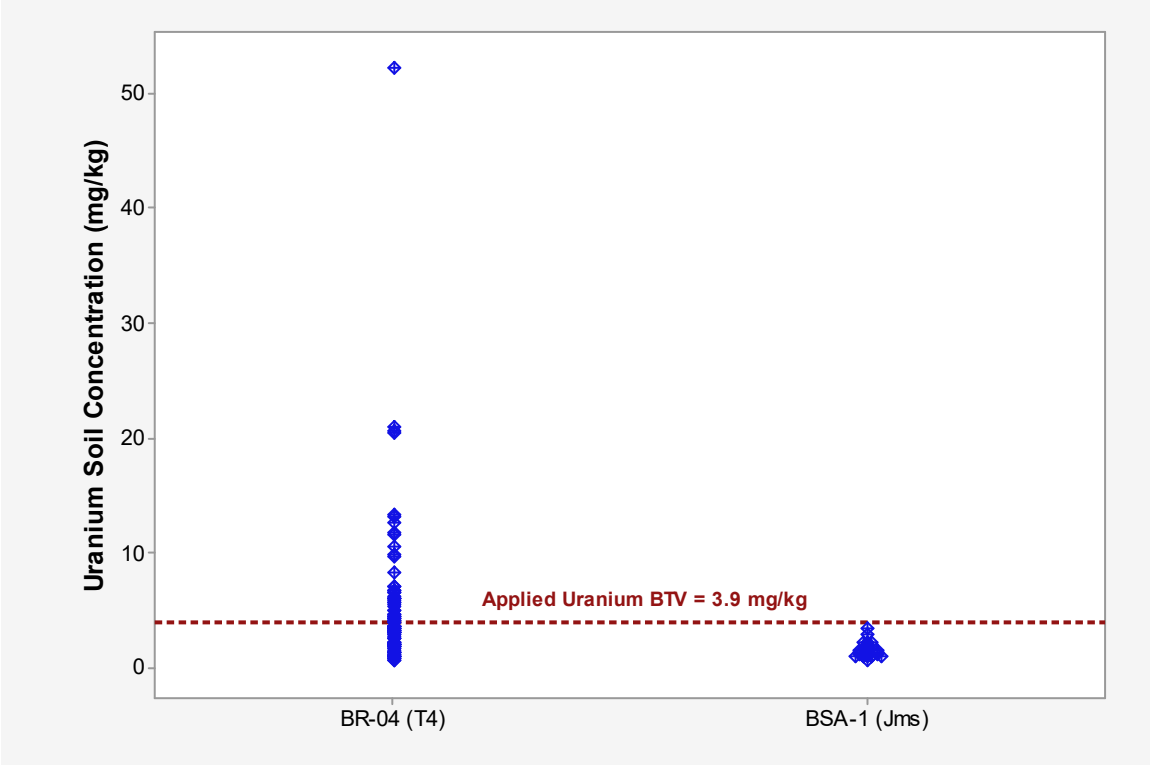


Figure I4-21. Individual Value Plot for Target BR-04 (T4) and BSA-1 (Jms) Uranium Soil Concentrations

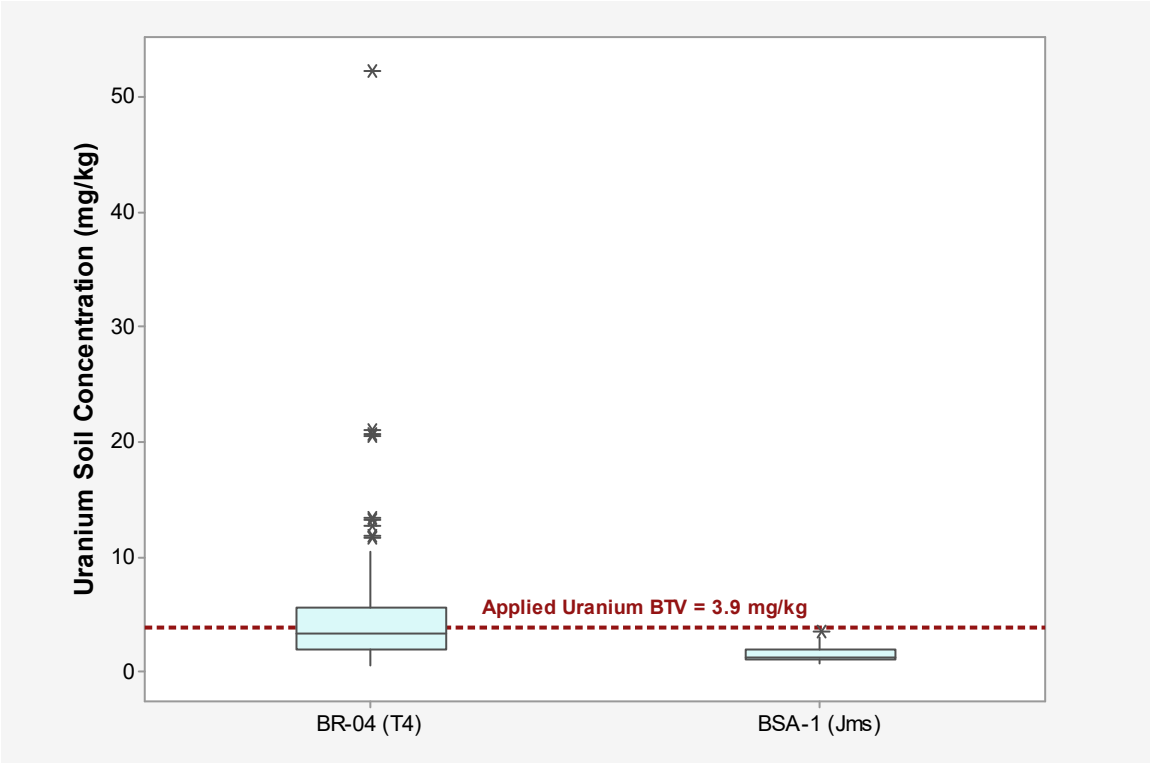
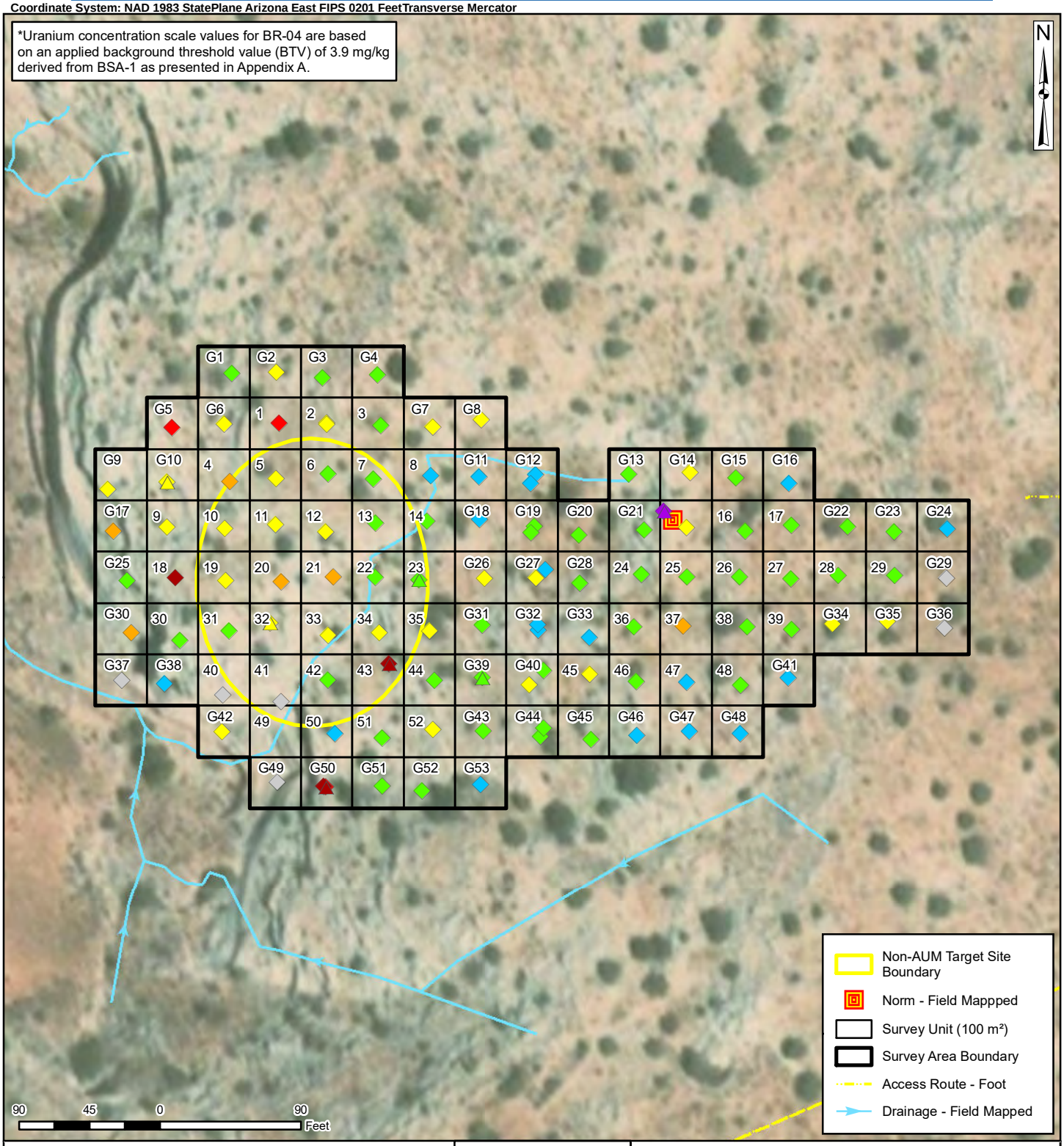


Figure I4-22. Box Plot for Target BR-04 (T4) and BSA-1 (Jms) Uranium Soil Concentrations

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



Uranium Concentration Scale (mg/kg)*

- ≤ 1.4
- 1.4 - 3.9
- 3.9 - 7.8
- 7.8 - 12
- 12 - 16
- 16 - 39
- ≥ 39
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

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NON-AUM TARGET BR-04 (T4) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I4-23
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/26/2019	

4.3.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I4-7. Vanadium exceeded the applied BTV in 31 percent of in situ XRF measurements and in four of the seven XRF confirmation samples. The applied BTV for vanadium is 13 mg/kg for Target T4 as presented in Section 4.3.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I4-5 and Attachment I3, respectively. Figure I4-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T4 and BSA-1 (Jms) samples. Figure I4-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T4 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Section 4.3.6.1. Vanadium XRF concentrations measured in surface soils at Target T4 ranged between 16.3 and 109 mg/kg with an average and standard deviation of 34.5 mg/kg and 24 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T4 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I4-26. All of the vanadium XRF results in surface soils were higher than the applied BTV. However, the maximum XRF value was 8.3 times higher than the applied BTV and does not appear to be associated with mining-related materials.

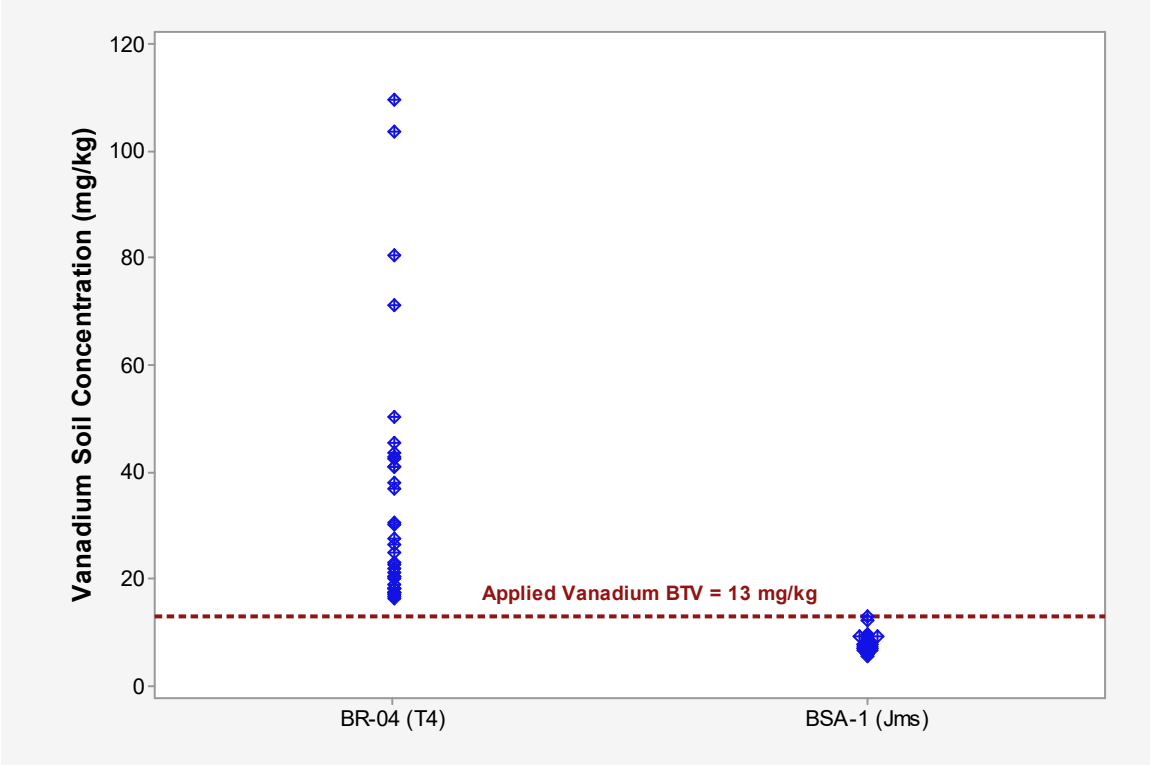


Figure I4-24. Individual Value Plot for Target BR-04 (T4) and BSA-1 (Jms) Vanadium Soil Concentrations

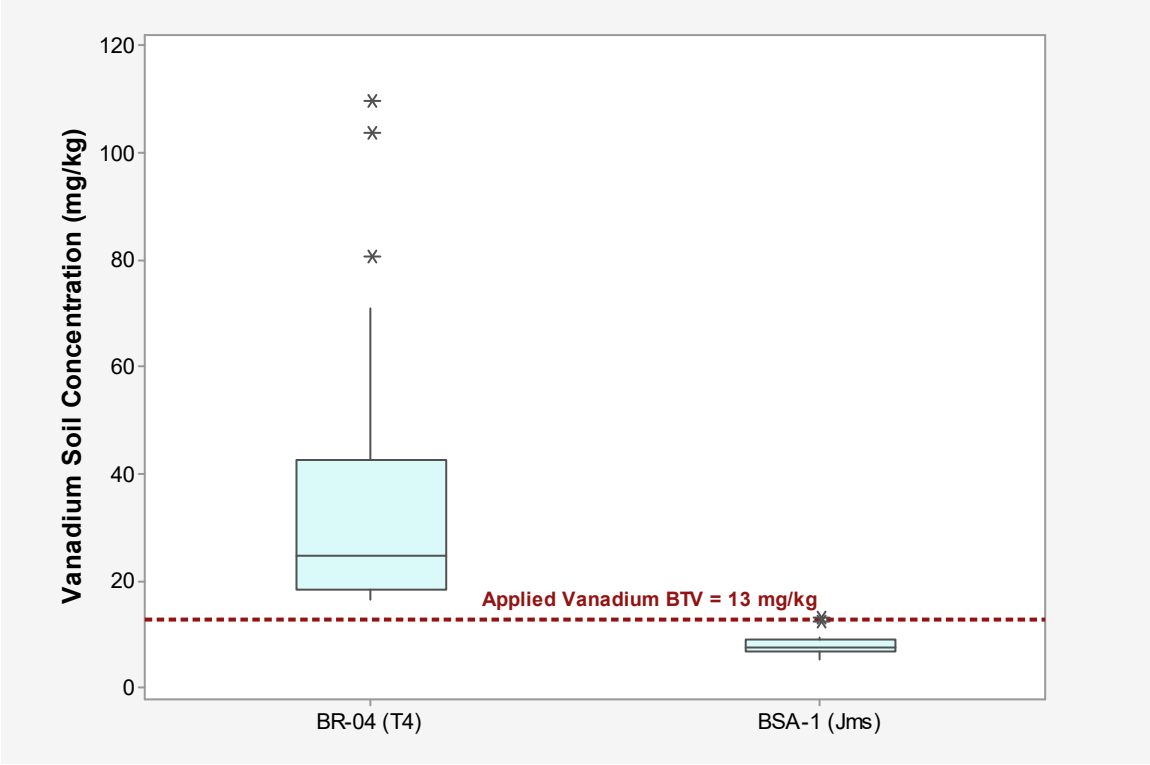
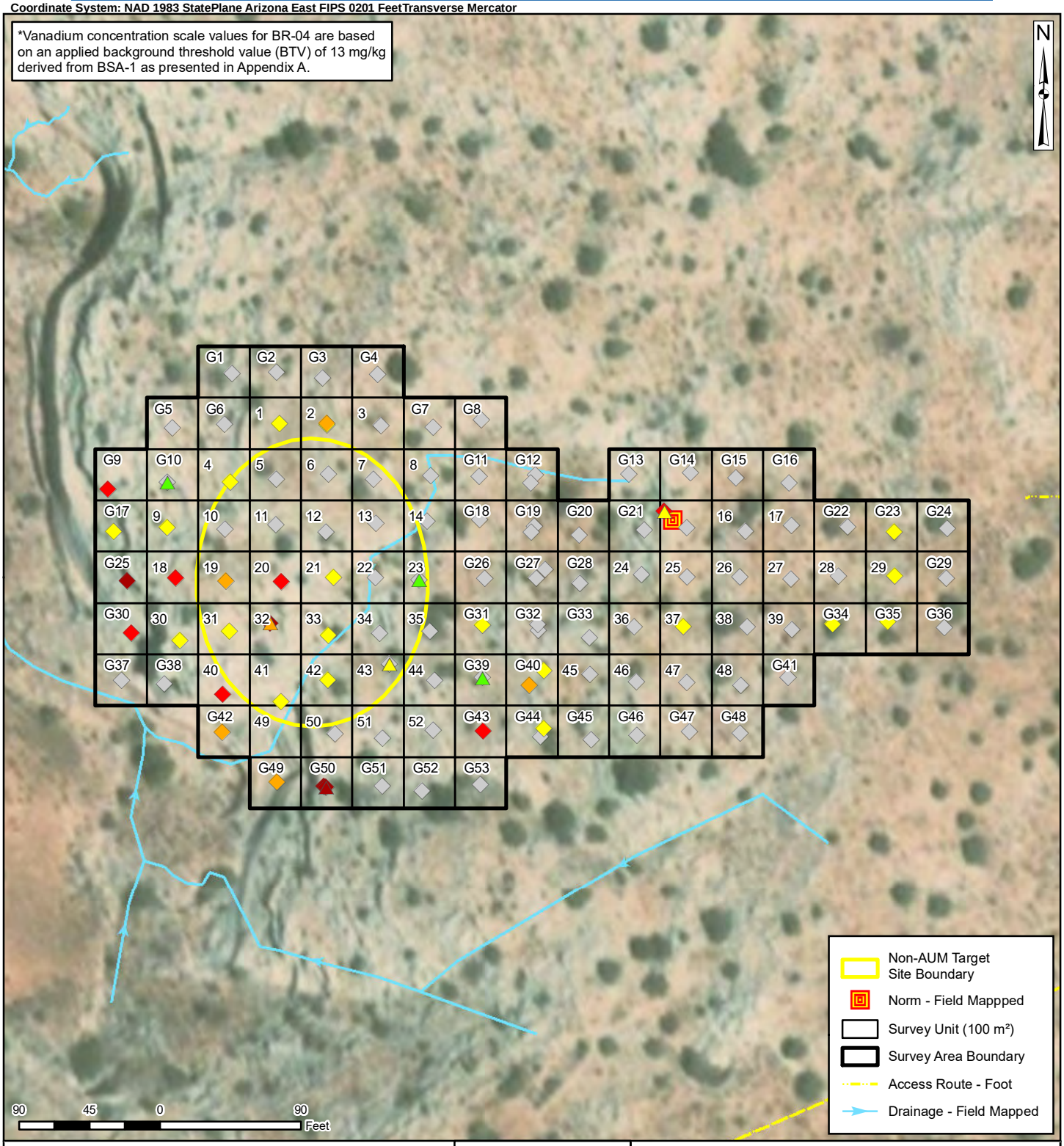


Figure I4-25. Box Plot for Target BR-04 (T4) and BSA-1 (Jms) Vanadium Soil Concentrations

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

*Vanadium concentration scale values for BR-04 are based on an applied background threshold value (BTV) of 13 mg/kg derived from BSA-1 as presented in Appendix A.



Vanadium Concentration Scale (mg/kg)*

- ≤ 7.7
- 7.7 - 13
- 13 - 26
- 26 - 39
- 39 - 52
- 52 - 130
- ≥ 130
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

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NON-AUM TARGET BR-04 (T4) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I4-26
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/26/2019	

4.3.8 Conclusions

Target T4 (BR-04) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T4. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T4 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T4. ASPECT gamma survey results generally correlated with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T4 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in one XRF confirmation sample from survey unit 15 (highest grid averaged gamma reading and field mapped NORM) exceeded the applied BTV by a factor of 86. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific BTVs for Target T4 geology and soil types were established through a background study.
- Mean raw gamma measurements exceeded the applied BTV by a factor of 1.16. In addition, grid averaged gamma measurements exceeded the applied BTV in 59 of the 105 survey units by a factor of up to 2.7.
- A total of 29 analytes were identified as occurring within the surface environment. Of these analytes, 26 were identified as COPCs. Arsenic, lead, thorium, uranium, and vanadium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's observations, Target T4 does not contain TENORM. No mining-related activities or features were observed in the field, and no historical exploratory boring, vents, or other mine openings were noted in the file review or during field observation. Outcropping of Salt Wash Member of the Morrison Formation was identified throughout the area and NORM was verified by gamma surveying.
- Natural erosion of outcroppings may increase the lateral extent of NORM to the Tse Tah West drainage below.
- There are no immediate significant physical hazards present at Target T4 other than the naturally occurring cliff.
- Access is by a dirt road from an adjacent paved highway.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.

- No groundwater wells are documented within the vicinity of Target T4. Rural residences are located nearby; however, it is not known if water is provided by utility or private well. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T4. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No mine waste was observed at Target T4; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; however, a few data gaps remain for Target T4. The remaining data gaps include potentially stepping out to north and south along the top of the cliff to further refine the extent of elevated gamma activity and sampling the ephemeral drainage at the base of the cliff and upstream of the confluence with Tse Tah West drainage. Data gaps will likely remain for extremely treacherous inaccessible areas.

4.4 NON-AUM TARGET T5 (BR-05)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T5 (BR-05).

4.4.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T5 (BR-05) is associated with the Brodie 1 Mine (M1), a former underground mine in the Tse Tah Region in Subarea Group A. Five other non-AUM Targets are associated with Brodie 1 AUM. Target T5 is administered by the Red Mesa and Sweetwater Chapters of the Navajo Nation and is accessible by foot off Indian Route 35 from Highway 160, which is located immediately southeast of Red Mesa. Target T5 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. A community of residences is located 1/4 mile to the east. A Target location and access map for Target T5 is shown in Figure I5-1.

A topographical relief map of the Brodie 1 Mine area and associated non-AUM Targets is provided in Figure I5-2. The elevation at Target T5 ranges from 5,795 to 5,804 feet amsl with an average of 5,800 feet amsl. The slope at Target T5 ranges from 1 to 7 percent with an average of 3 percent. There are no nearby drainages near the Target. The Brodie 1 Mine is located entirely within the Js and rock outcrop-Rizno complex soils unit, and Target T5 is located entirely within the Jms and rock outcrop-Rizno soils (MUSYM 309) (Figures I-13 and I-14).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston 92016) screening level gamma survey data to determine the RSE survey area for Target T5. Weston did not conduct a background study for Target T5. As a part of the RSE for the Brodie 1 Mine, Tetra Tech also evaluated the associated non-AUM Targets, such as T5. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 1 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T5:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T5 is accessed by taking Highway 160 to Indian Route 35 and then via a four-wheel-drive off-road access route to the northwest. A short hike via footpath and off-trail trek is required to get to the Target.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM was not mapped in the field at the Target; however, an outcropping of the underlying uranium-bearing Jms was observed across the hillslope in the field. No TENORM was observed by Tetra Tech during the RSE.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  There were no drainages near the Target.

- Identified any exploration borings or historic haul roads:

  No exploratory borings or haul roads were identified.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  No mine-related features were identified. In the absence of any mine-related features, outcropping of the Salt Wash Member of the Jms may be contributing to elevated gamma readings.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

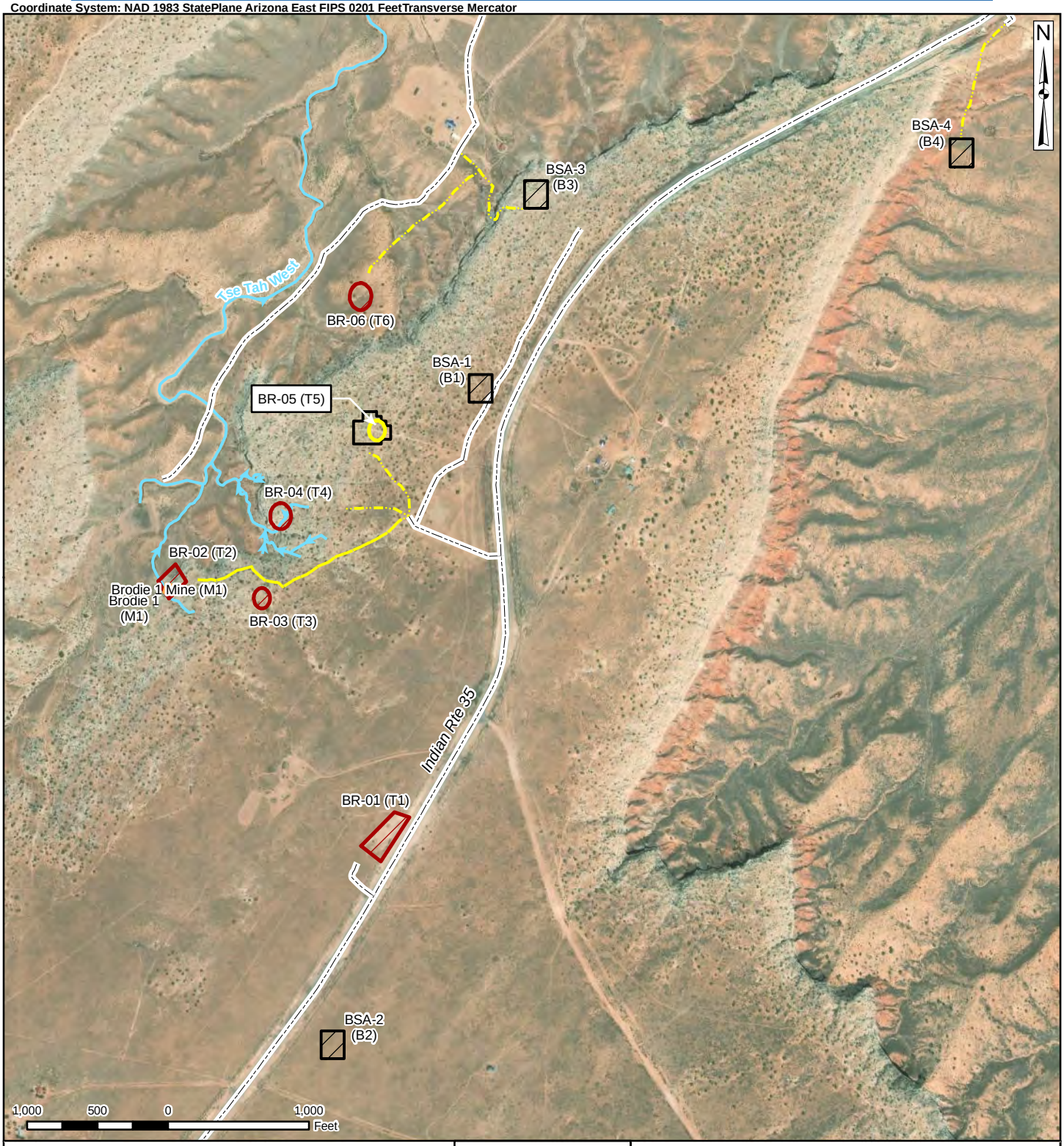
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T5 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Sections 2.3 and 4.4.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPC (described in Section 4.4.3 with results presented in Sections 4.4.6 and 4.4.7)
- Conducting a gamma radiation survey (results presented in Section 4.4.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



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

Prepared for: USEPA Region 9

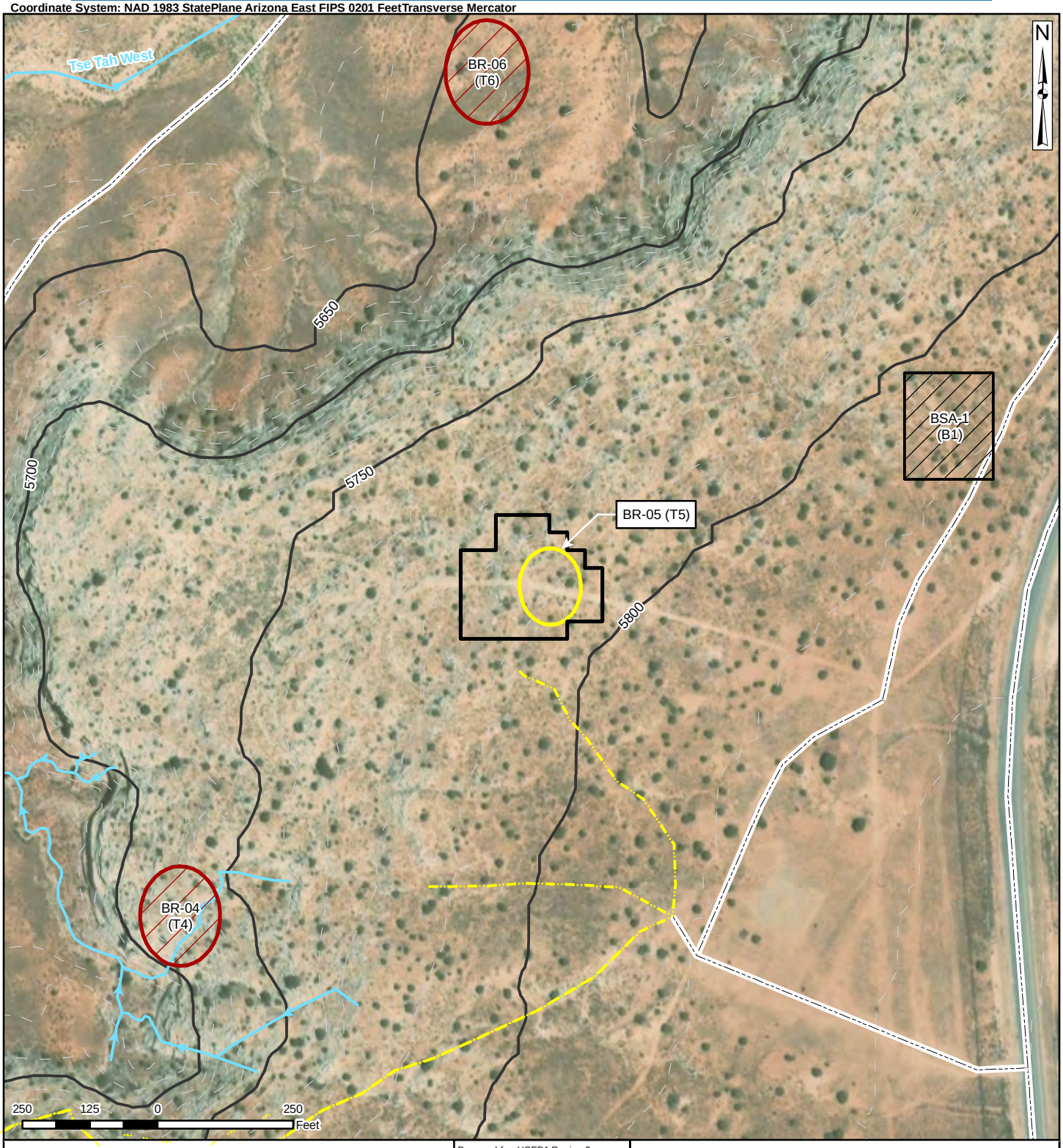
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NON-AUM TARGET BR-05 (T5) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I5-1
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site Boundary
Background Location
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped
50 ft Contour*
10 ft Contour*

* 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.

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NON-AUM TARGET BR-05 (T5) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I5-2
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.4.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I5-3) within the survey area of the non-AUM Target T5 as part of the Baseline Study in May 2018. Additional Goback gamma radiation surveys were performed in August and September 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T5 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I5-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at 17 survey units. All gamma survey and XRF survey units were evaluated.

4.4.3 XRF Confirmation Sampling Overview

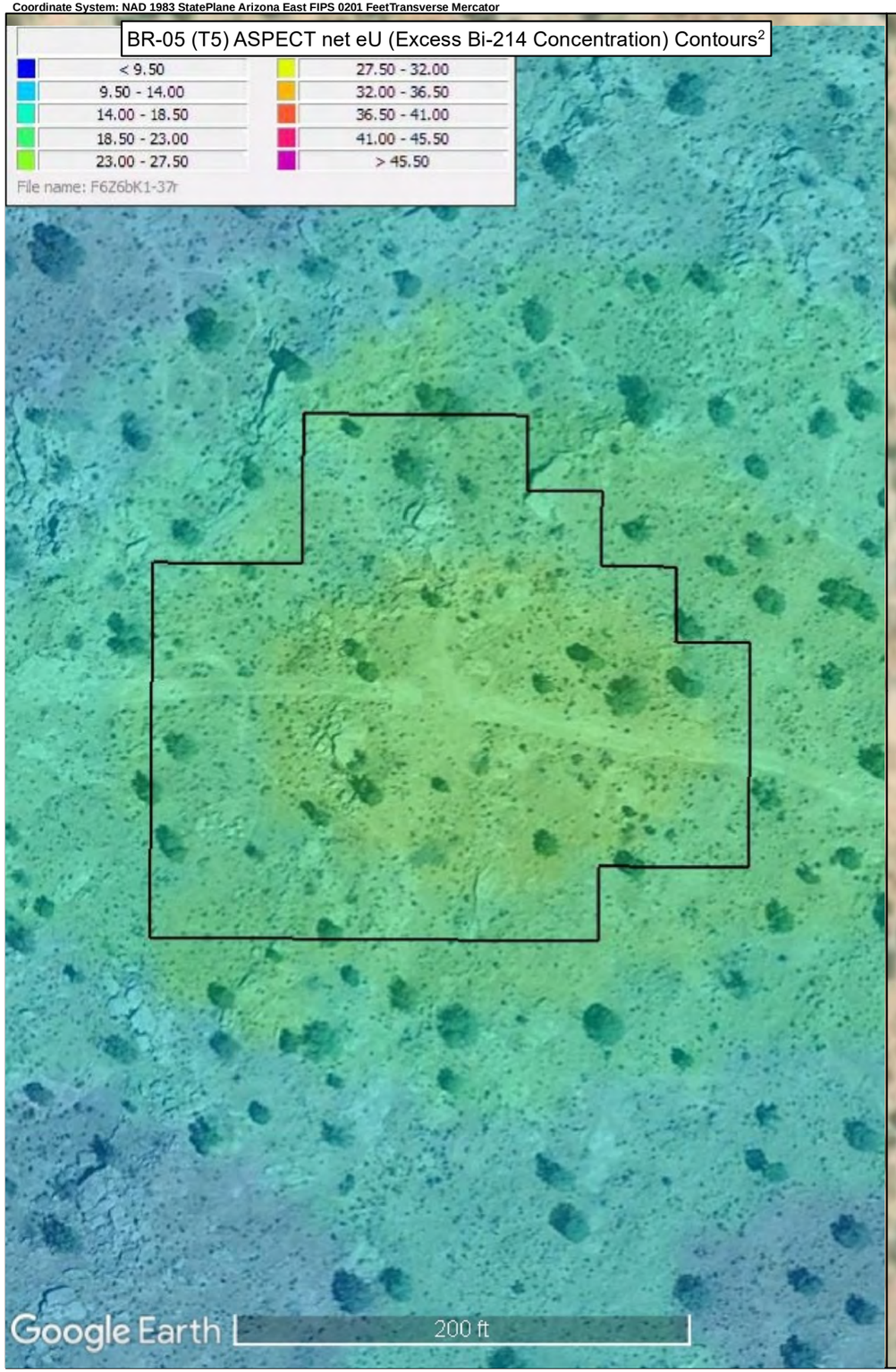
Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T5. Four XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from three locations (Table I5-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I5-4 and I5-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I5-2. The results of XRF confirmation sample analysis are provided in Section 4.4.6.1. Correlated XRF field measurements are provided in Attachment I3.

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

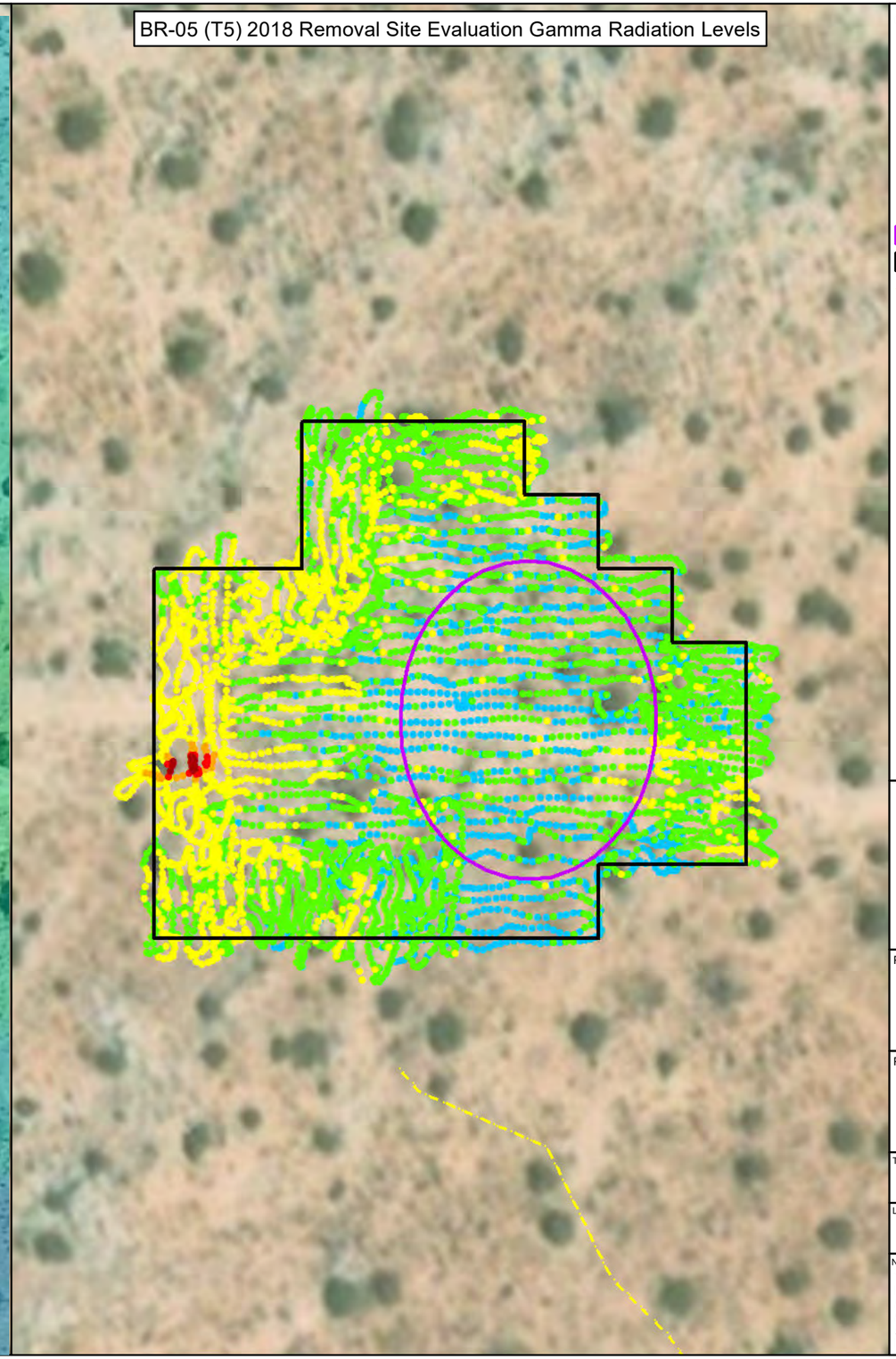
BR-05 (T5) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F6Z6bK1-37r



BR-05 (T5) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)[1]

≤ 8,760	≤ Avg. BG
8,760 - 10,287	Avg. BG - 1 x BTV
10,287 - 20,574	1 x BTV - 2 x BTV
20,574 - 30,861	2 x BTV - 3 x BTV
30,861 - 41,148	3 x BTV - 4 x BTV
41,148 - 102,870	4 x BTV - 10 x BTV
≥ 102,870	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Foot

[1]The applied gamma background threshold value (BTV) for BR-05 (T5) Non-AUM Target is 10,287 cpm derived from BSA-1 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET BR-05 (T5) 2018 REMOVAL SITE EVALUATION AND ASPECT GAMMA RADIATION LEVELS SURVEY MAP

Prepared For:

Prepared By:

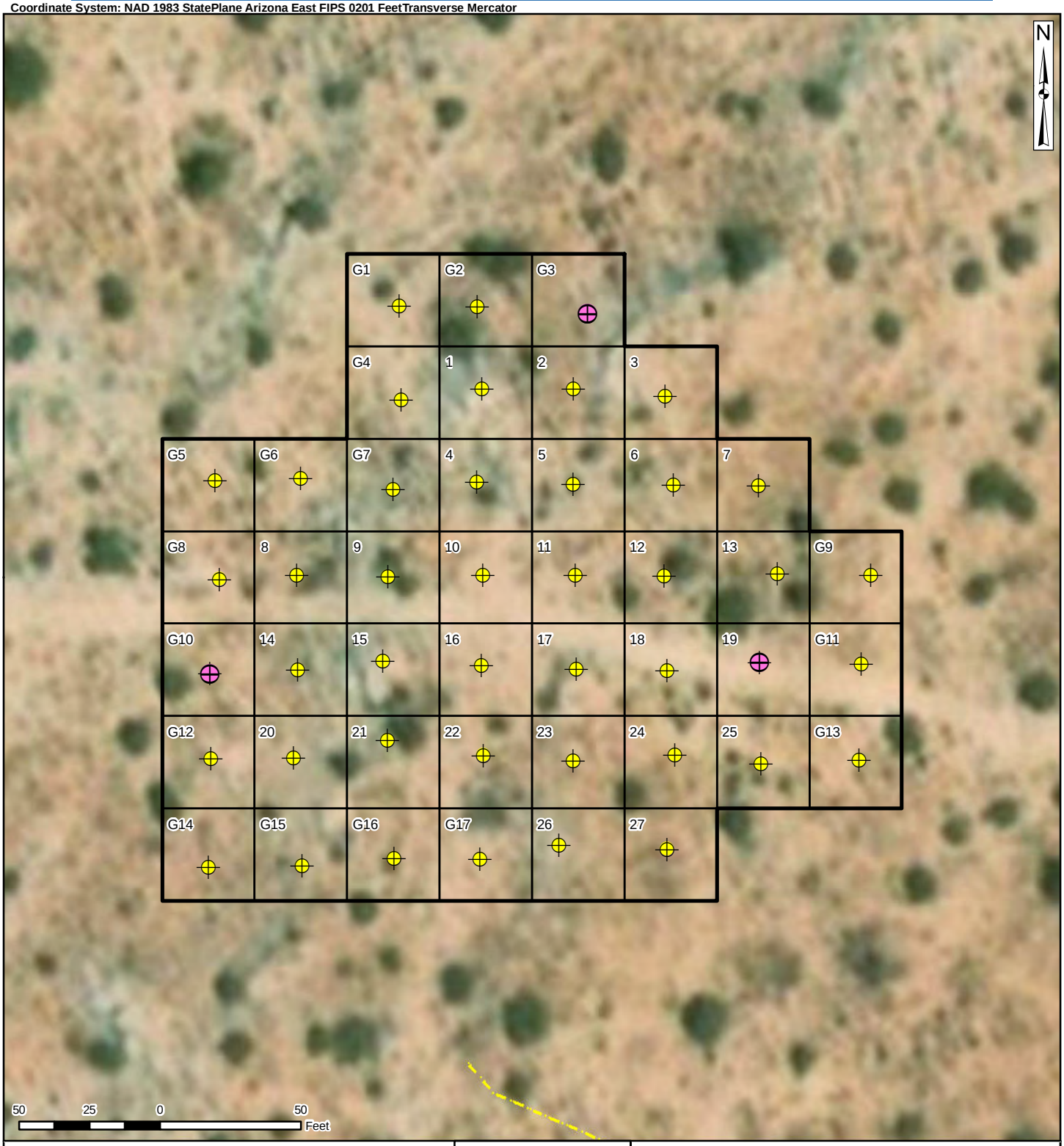
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TO0001	EP-S9-17-03
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborn Spectral Photometric Environmental Collection Technology.

Figure No.: **I5-3**

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



XRF Confirmation Soil Sample[1] (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route - Foot

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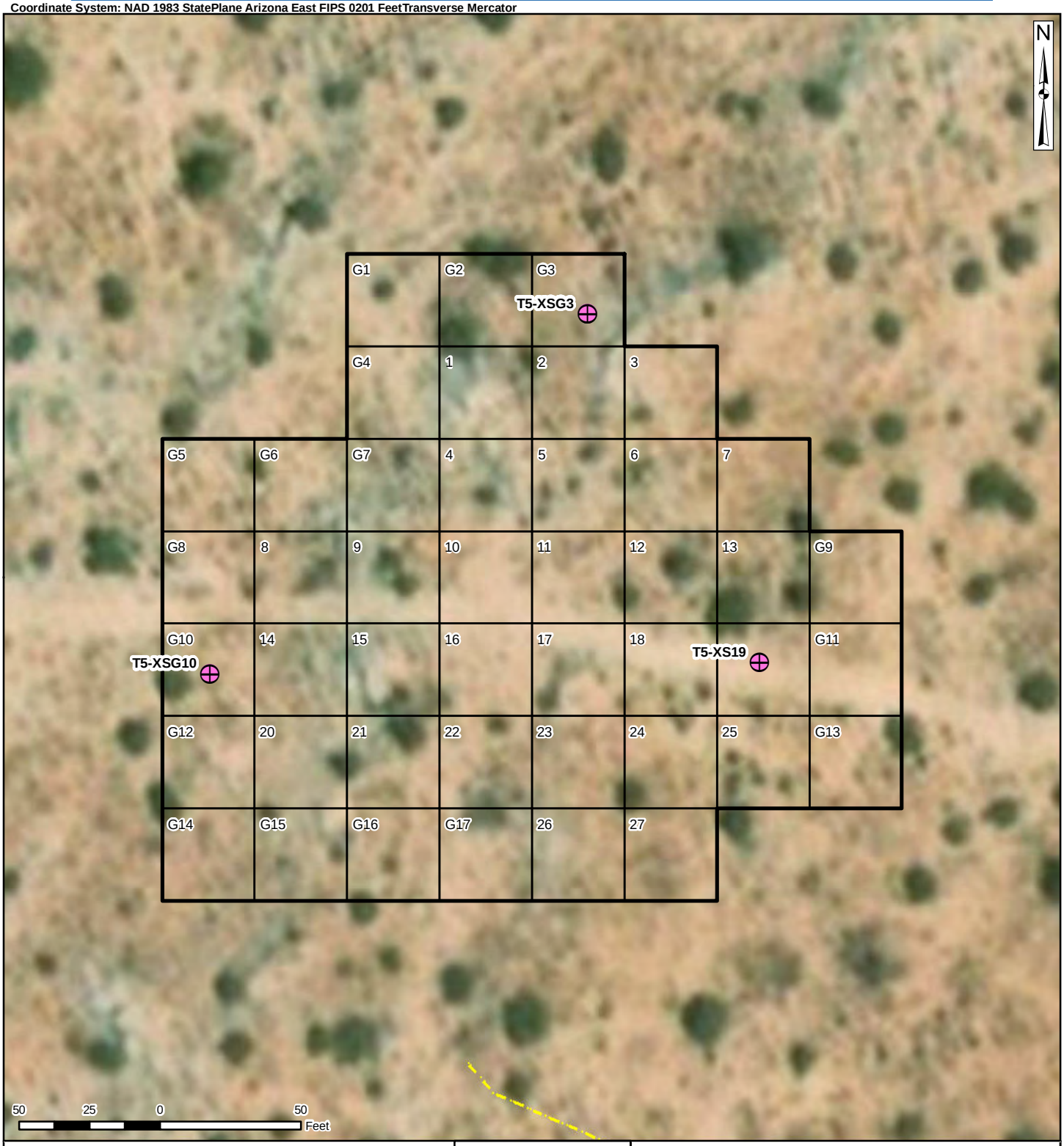
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NON-AUM TARGET BR-05 (T5)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I5-4
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/12/2019	

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



XRF Confirmation Soil Sample* (0 - 3 inches bgs)

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route - Foot

*T5-XSG3 = site T5 XRF confirmation soil sample collected at survey unit G3. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET BR-05 (T5)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I5-5
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/12/2019	

Table I5-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target BR-05 (T5)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T5-XS19-01-051418	19	0-3	XRF Confirmation	Primary	5/14/2018	36.9089076	-109.3475243	1805327-20, 1805328-20
T5-XSG3-01-092818	G3	0-3	XRF Confirmation	Primary	9/28/2018	36.9092560	-109.3476170	1810072-19, 1810073-19
T5-XSG3-02-092818	G3	0-3	XRF Confirmation	Duplicate	9/28/2018	36.9092560	-109.3476170	1810072-20, 1810073-20
T5-XSG10-01-081918	G10	0-3	XRF Confirmation	Primary	8/19/2018	36.9089082	-109.3480789	1808483-19, 1808484-19

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I5-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BR-05 (T5)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

4.4.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 4.4.1, Target T5 surface geology is entirely within the Jms and soils within the rock outcrops-Rizno complex (MUSYM 309) (Figures I-13 and I-14). As a result, BSA-1 was selected for that combination of geology and soil type. Table I5-3 presents the Target-specific BTVs for 29 analytes and gamma radiation levels for Target T5. No regional BTVs were established for Target T5. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T5. The "Applied BTV" for each analyte is the Target-specific BTV.

Table I5-3. Applied Background Threshold Values for Non-AUM Target BR-05 (T5)

Analyte	Units	Site-Specific BTV (BSA-1)	Regional BTV (Jms)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	5,900	None	5,900	Site-Specific BTV
Antimony	mg/kg	0.128	None	0.128	Site-Specific BTV
Arsenic	mg/kg	5.8	None	5.8	Site-Specific BTV
Barium	mg/kg	190	None	190	Site-Specific BTV
Beryllium	mg/kg	0.40	None	0.40	Site-Specific BTV
Cadmium	mg/kg	0.098	None	0.098	Site-Specific BTV
Calcium	mg/kg	90,200	None	90,200	Site-Specific BTV
Chromium	mg/kg	4.6	None	4.6	Site-Specific BTV
Cobalt	mg/kg	3.7	None	3.7	Site-Specific BTV
Copper	mg/kg	11	None	11	Site-Specific BTV
Iron	mg/kg	7,800	None	7,800	Site-Specific BTV
Lead	mg/kg	6.7	None	6.7	Site-Specific BTV
Lithium	mg/kg	14	None	14	Site-Specific BTV
Magnesium	mg/kg	5,070	None	5,070	Site-Specific BTV
Manganese	mg/kg	270	None	270	Site-Specific BTV
Mercury	mg/kg	0.0168	None	0.0168	Site-Specific BTV
Molybdenum	mg/kg	0.58	None	0.58	Site-Specific BTV
Nickel	mg/kg	5.9	None	5.9	Site-Specific BTV
Potassium-40	pCi/g	15.6	None	15.6	Site-Specific BTV
Radium-226	pCi/g	2.59	None	2.59	Site-Specific BTV
Radium-228	pCi/g	0.60	None	0.60	Site-Specific BTV
Selenium	mg/kg	0.88	None	0.88	Site-Specific BTV
Silver	mg/kg	0.037	None	0.037	Site-Specific BTV
Sodium	mg/kg	40	None	40	Site-Specific BTV
Thallium	mg/kg	0.062	None	0.062	Site-Specific BTV
Thorium	mg/kg	2.1	None	2.1	Site-Specific BTV
Uranium	mg/kg	3.9	None	3.9	Site-Specific BTV
Vanadium	mg/kg	13	None	13	Site-Specific BTV
Zinc	mg/kg	19	None	19	Site-Specific BTV
Gamma Radiation	cpm	10,287	None	10,287	Site-Specific BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
Jms Morrison Formation, Salt Wash Member
mg/kg milligrams per kilogram
pCi/g picocuries per gram

4.4.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T5 and the raw gamma radiation and grid averaged gamma radiation survey results.

4.4.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T5 in May 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in August and September 2018 to collect data within the Goback survey unit. A gamma radiation survey was also performed in the Tse Tah West drainage within the area in conjunction with the RSE for the Brodie 1 Mine; results are presented in Appendix J of the RSE Report. The applied gamma BTV for non-AUM Target T5 is 10,287 cpm. A total of 5,074 measurements were collected as part of the gamma radiation survey at non-AUM Target T5 across 44 survey units. An average scan density of 115 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I5-4.

Table I5-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target BR-05 (T5)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	10,287	
Measurements	#	5,074	44
Minimum	cpm	6,261	8,410
Maximum	cpm	60,853	22,588
Average	cpm	10,131	9,822
Median	cpm	9,704	9,412
Standard Deviation	cpm	3,389	2,101
90th Percentile	cpm	11,095	10,588
95th Percentile	cpm	11,817	11,070
99th Percentile	cpm	29,450	17,681
Measurements per Survey Unit	#/grid	115	
Measurements Above Gamma BTV	#	1,542	10
Measurements Above Gamma BTV	%	30.4	22.7

Notes:
BTV background threshold value
cpm counts per minute

4.4.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 30.4 percent of the measurements within the Target boundaries, in some cases exceeding greater than four times the applied gamma BTV (10,287 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-1 (Jms) gamma survey results is provided on Figure I5-6. This graph shows that the spread of radiation data at Target T5 (shown on left) begins below the lower range of BSA-1 (Jms) gamma levels (shown on right) and then rises to more than six times background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T5 is slightly higher than the data cloud from the BSA-1 (Jms) data set. A box plot showing the quartiles of the data sets is provided in Figure I5-7. The box plot shows that the median of Target T5 radiation levels is slightly higher than the median of the BSA-1 (Jms) data set and slightly lower than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I5-8. No mining activity was observed within the survey area of Target T5. However, the western portion of the survey area contains the exposed surface of the Jms.

In general, Target T5 has surficial gamma radiation levels above BSA-1 (Jms) levels increasing in the western portion of the Target with exposure of underlying geology indicating that the survey encompassed the area of elevated gamma activity identified by the ASPECT gamma survey (Figure I5-3). No TENORM or mining-related activities were observed. Section 4.4.5.3 presents the grid averaged results of the gamma radiation survey.

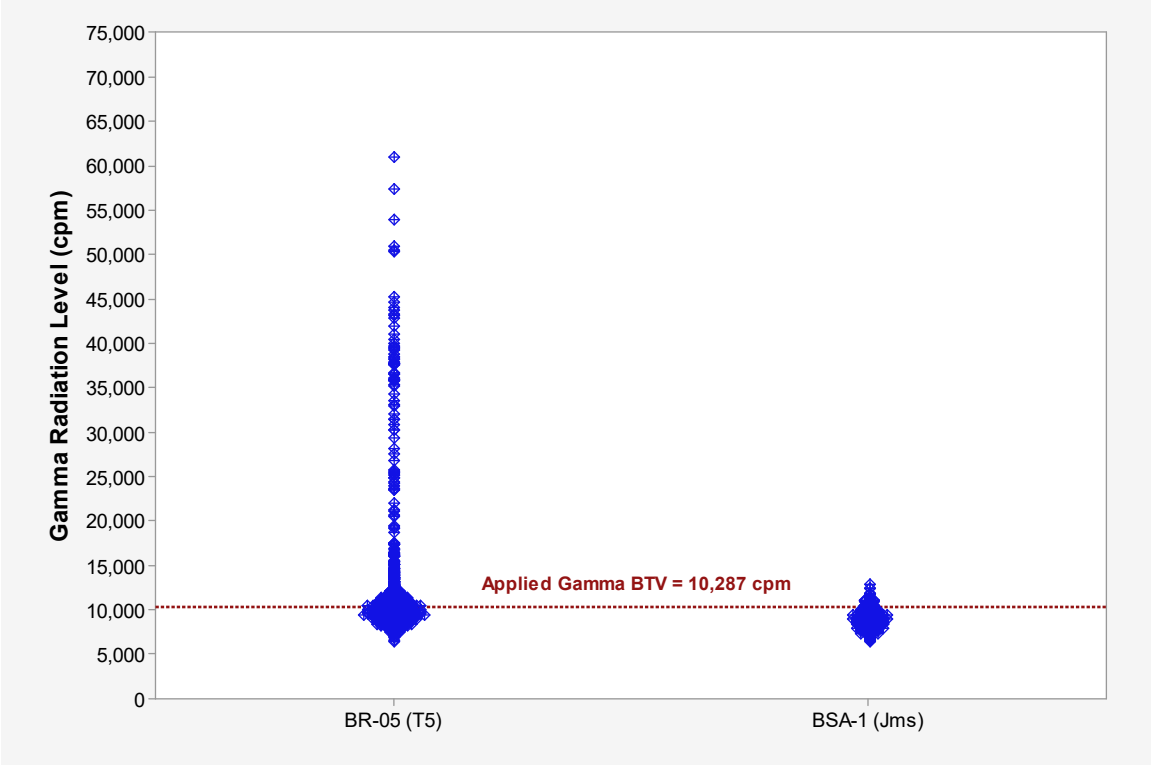


Figure I5-6. Individual Value Plot of Raw Gamma Radiation Levels at Target BR-05 (T5) and BSA-1 (Jms)

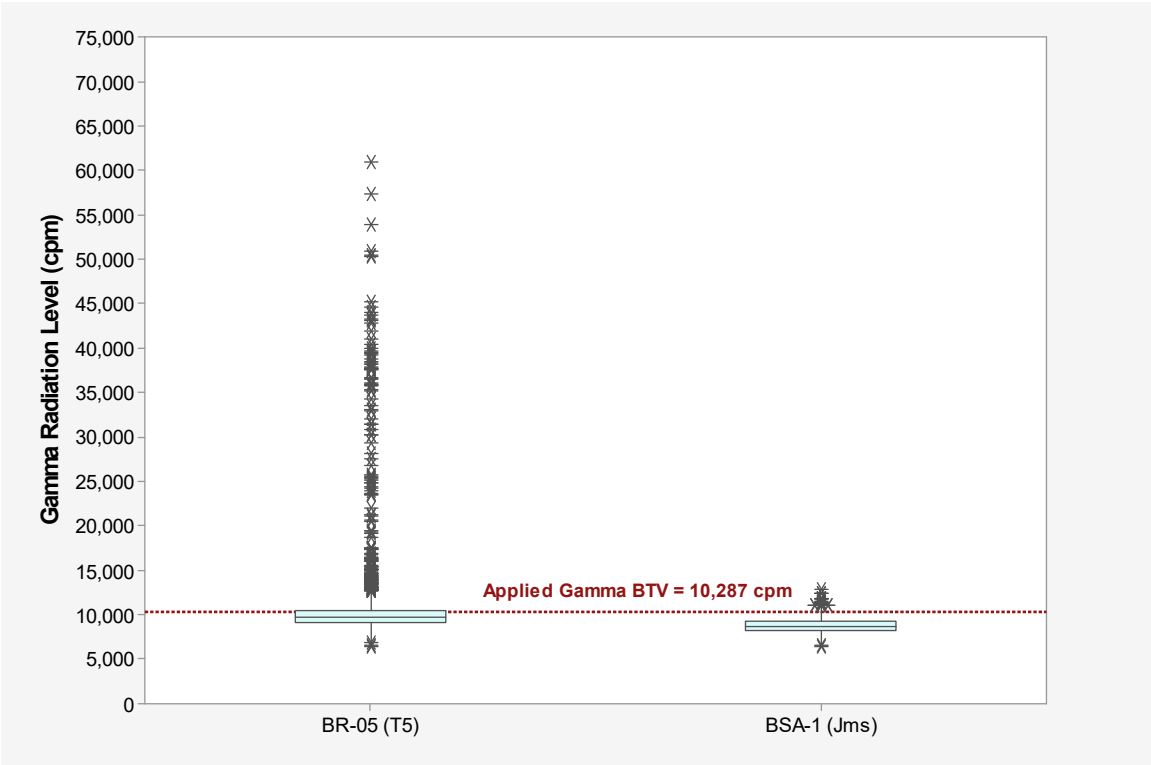
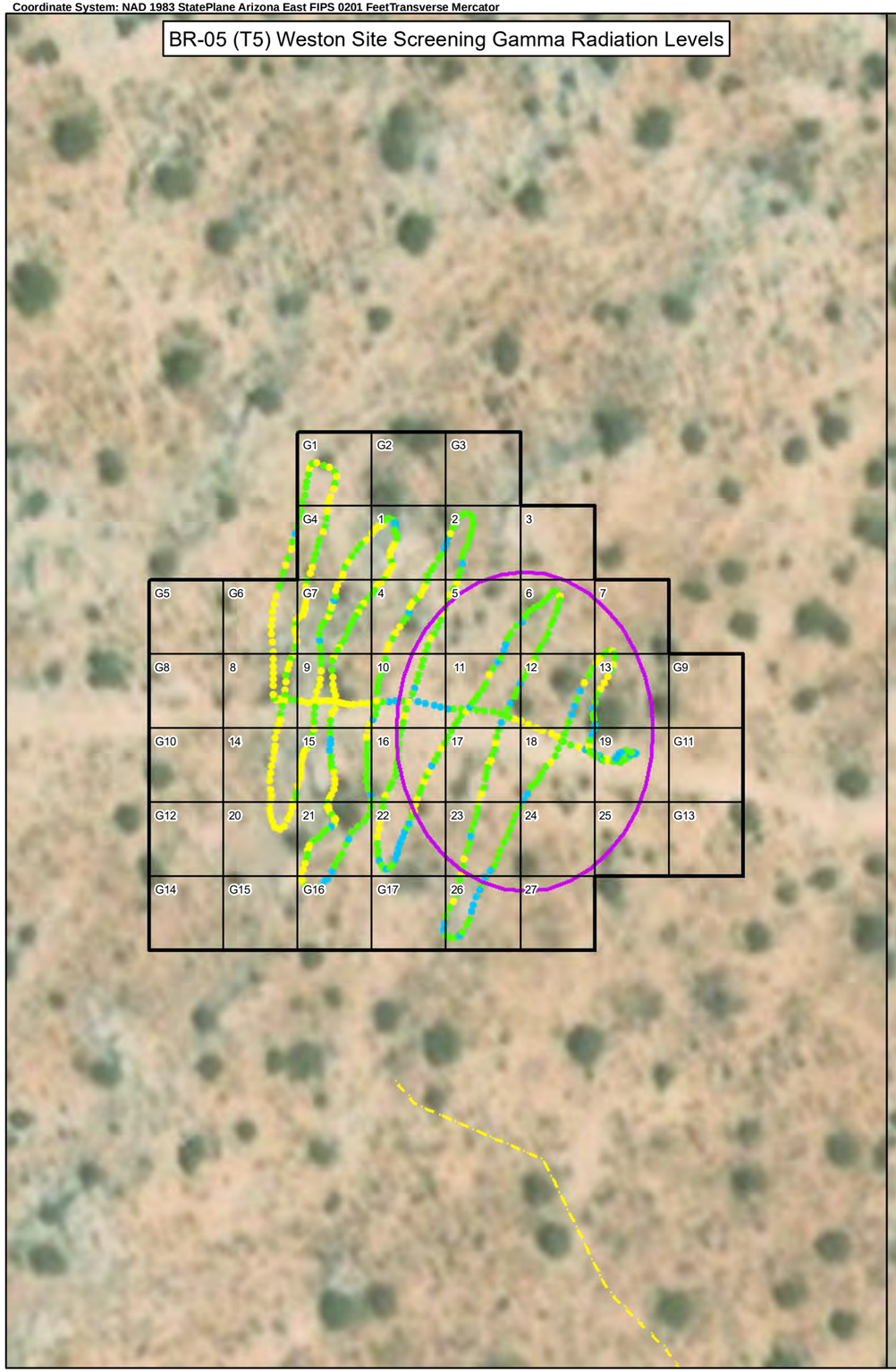


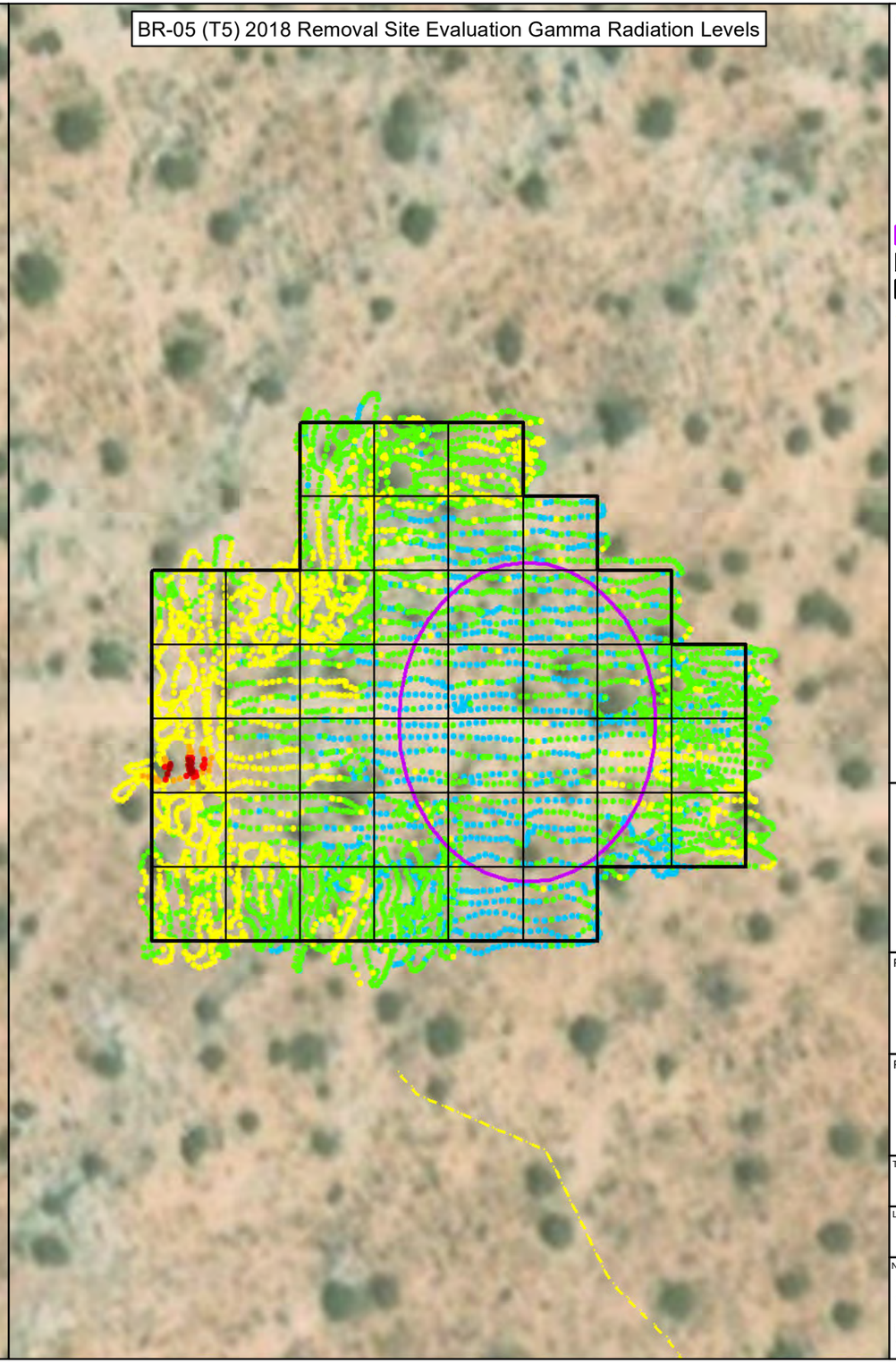
Figure I5-7. Box Plot of Raw Gamma Radiation Levels at Target BR-05 (T5) and BSA-1 (Jms)

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

BR-05 (T5) Weston Site Screening Gamma Radiation Levels



BR-05 (T5) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)*

≤ 8,760	≤ Avg. BG
8,760 - 10,287	Avg. BG - 1 x BTV
10,287 - 20,574	1 x BTV - 2 x BTV
20,574 - 30,861	2 x BTV - 3 x BTV
30,861 - 41,148	3 x BTV - 4 x BTV
41,148 - 102,870	4 x BTV - 10 x BTV
≥ 102,870	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Access Route - Foot

1 in = 60 ft

1:720

N
W E
S

0 30 60 120 Feet

NON-AUM TARGET BR-05 (T5) SITE
2018 REMOVAL SITE EVALUATION
VS WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

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Notes:
*The applied gamma background threshold value (BTV) for BR-04 Non-AUM Target is 10,287 cpm derived from BSA-1 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I5-8**

4.4.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 4.4.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 4.4.5.1. Figure I5-9 and Figure I5-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-1 (Jms) data set (shown on right). A total of 22.7 percent of the survey units (10 of 44) within the survey area of Target T5 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I5-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I5-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. The elevated regions correspond with surface exposure of the Jms.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 4.4.6.

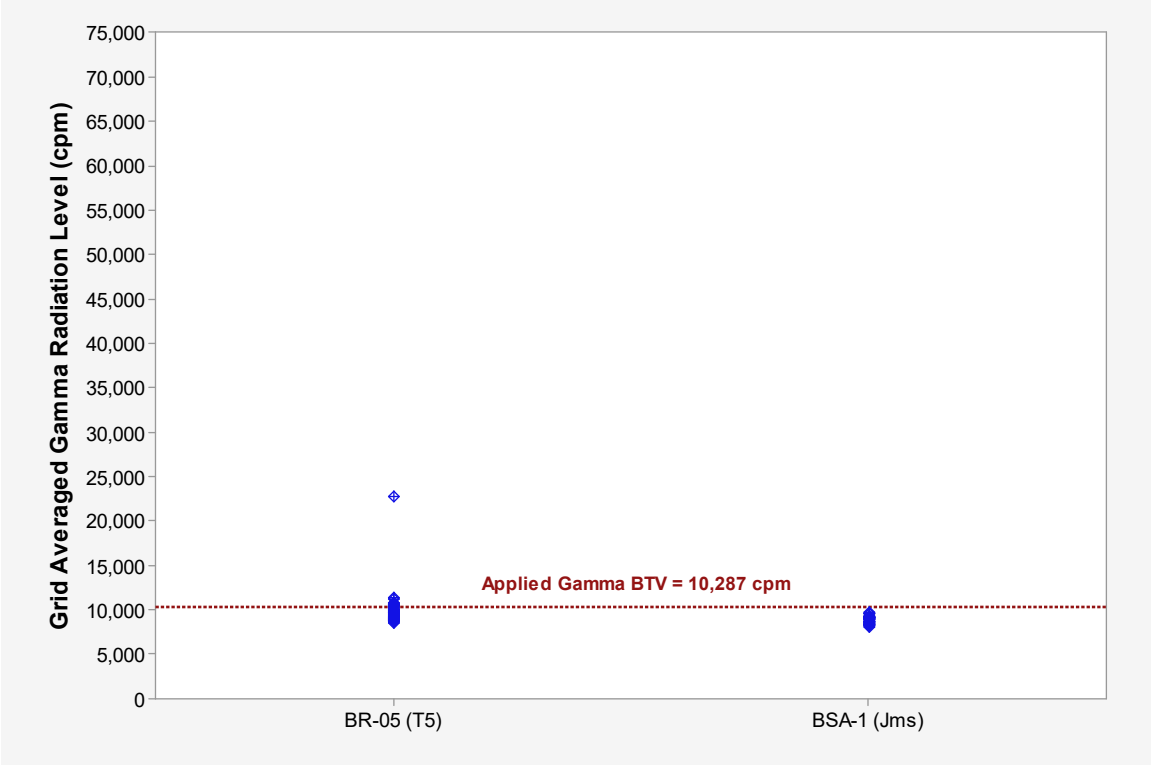


Figure I5-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target BR-05 (T5) and BSA-1 (Jms)

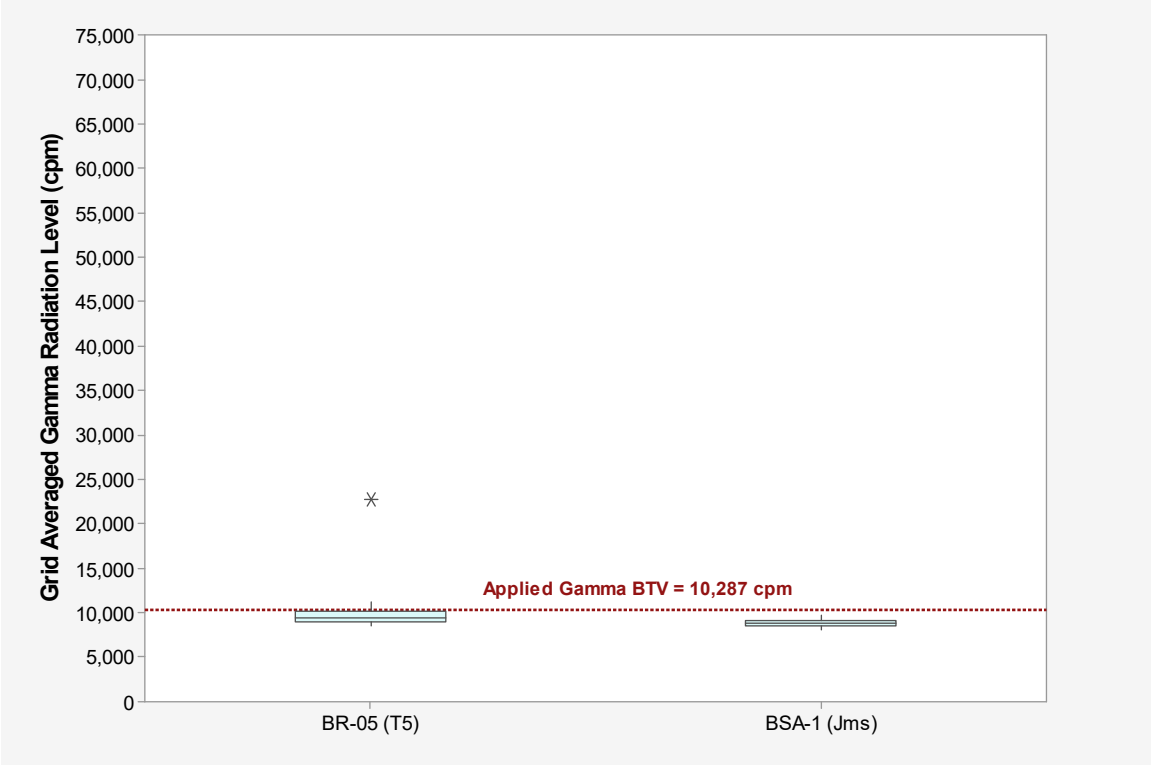
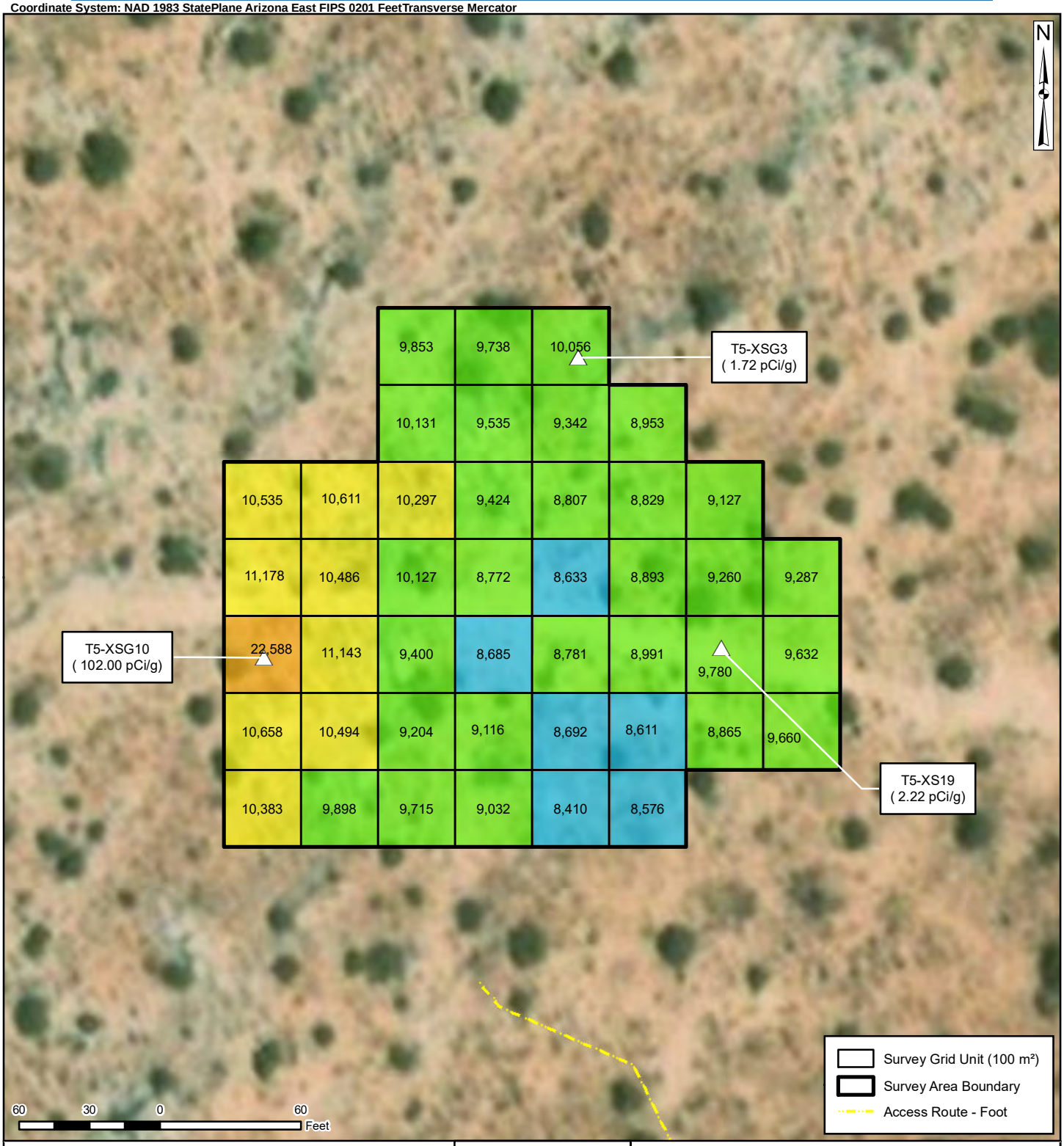


Figure I5-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target BR-05 (T5) and BSA-1 (Jms)

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



Grid Averaged Gamma Reading (cpm)*

≤ 8,760	≤ Avg. BG
8,760 - 10,287	Avg. BG - 1 x BTV
10,287 - 20,574	1 x BTV - 2 x BTV
20,574 - 30,861	2 x BTV - 3 x BTV
30,861 - 41,148	3 x BTV - 4 x BTV
41,148 - 102,870	4 x BTV - 10 x BTV
≥ 102,870	≥ 10 x BTV

*The applied gamma background threshold value (BTV) for BR-05 (T5) is 10,287 cpm derived from BSA-1 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET BR-05 (T5) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I5-11
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/12/2019	

4.4.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T5. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 4.4.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 4.4.6.2.

4.4.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T5: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I5-1 and I5-2. All the results of the XRF confirmation soil samples are presented in Table I5-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T5 following the methods outlined in Section 2.4 and shown in Figure I5-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 44 measurements were collected across 44 survey units from the survey area of Target T5 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I5-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T5 at a depth of 0 to 3 inches bgs. Four XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I5-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 4.4.7.

Table I5-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BR-05 (T5)

Analyte	Units	Applied BTV	T5-XS19-01-051418		T5-XSG10-01-081918		T5-XSG3-01-092818	
			Result	Q	Result	Q	Result	Q
Survey Unit			X19		XG10		XG3	
Aluminum	mg/kg	5,900	4,100		5,400		4,400	
Antimony	mg/kg	0.128	0.045	J	0.26		0.056	J
Arsenic	mg/kg	5.8	4.8		30		2.2	
Barium	mg/kg	190	71		110		72	
Beryllium	mg/kg	0.4	0.22		0.43		0.25	
Cadmium	mg/kg	0.098	0.051	J	0.26		0.071	J
Calcium	mg/kg	90,200	28,000		49,000		20,000	
Chromium	mg/kg	4.6	3		3.9		3.6	
Cobalt	mg/kg	3.7	1.8		9.6		2	
Copper	mg/kg	11	4.7		12		4.3	
Iron	mg/kg	7,800	3,400		7,500		5,000	
Lead	mg/kg	6.7	2.3		15		4.9	
Lithium	mg/kg	14	8.9		16		6.3	
Magnesium	mg/kg	5,070	3,200		5,100		3,200	
Manganese	mg/kg	270	93		300		170	
Molybdenum	mg/kg	0.58	0.31		2		0.24	
Nickel	mg/kg	5.9	3.7		10		4	
Potassium-40	pCi/g	15.6	10.4		13.4		11.9	
Radium-226	pCi/g	2.59	2.22		102	M3	1.72	J
Radium-228	pCi/g	0.60	<0.19	U	<0.3	UJ	<0.46	U
Selenium	mg/kg	0.88	0.37	J	1.2		0.5	J
Silver	mg/kg	0.037	0.0097	J	0.13		0.015	J
Sodium	mg/kg	40	<97	UJ	48	J	27	J
Thallium	mg/kg	0.062	0.036		0.36		0.049	
Thorium	mg/kg	2.1	1.4		3.8		2	
Uranium	mg/kg	3.9	3.1		51		1.8	
Vanadium	mg/kg	13	7.1		20		7.9	
Zinc	mg/kg	19	11		27		12	

Notes:

BTV Background threshold value
J Estimated value
J- Estimated value, may be biased low
M3 The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg Milligrams per kilogram
pCi/g Picocuries per gram
Q Qualification
U Not considered detected. The associated value is the method detection limit (MDL).
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

Table I5-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target BR-05 (T5)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	5.8	7,800	6.7	270	0.58	2.1	3.9	13	19
Measurements	#	44	44	44	44	44	44	44	44	44
Detects	#	33	44	44	44	4	41	43	3	44
Nondetects	#	11	0	0	0	40	3	1	41	0
Minimum	mg/kg	1.9	2,755	1.3	117.6	0.22	1.1	0.44	18.9	9.3
Maximum	mg/kg	24.5	9,994	10.1	238.7	0.56	3.2	14.3	26.3	27.9
Standard Deviation	mg/kg	4.0	1,286	1.7	28.1	0.14	0.5	2.2	3.8	3.2
Average	mg/kg	4.0	4,376	5.1	176.0	0.37	1.8	2.8	22.1	13.4
Median	mg/kg	2.8	4,185	4.8	174.7	0.36	1.6	2.5	21.2	13.0
Relative Standard Deviation	%	100	29	34	16	38	26	81	17	24
90th Percentile	mg/kg	6.1	5,483	7.2	214.5	0.5	2.4	4.0	25.3	16.8
95th Percentile	mg/kg	6.9	6,404	7.4	219.9	0.5	2.5	6.1	25.8	17.8
99th Percentile	mg/kg	19.0	8,909	9.1	232.4	0.6	2.9	11.1	26.2	24.1
Measurements Above Applied BTV	#	4	1	10	0	0	10	5	3	1
Measurements Above Applied BTV	%	9.1	2.3	22.7	0.0	0.0	22.7	11.4	6.8	2.3

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value
mg/kg Milligram per kilogram
XRF X-ray fluorescence

4.4.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T5 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T5 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T5. The estimated BTVs are identified in Section 4.4.4 and Table I5-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I5-7 presents a summary of the background comparison for different measurement and soil depths at Target T5. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T5. However, gamma radiation screening indicated that gamma levels at Target T5 are elevated in comparison to the BSA and appear to be associated with outcropping of the Jms. Therefore, while multiple COPCs have been identified at Target T5 based on a conservative comparison to background, risk screening will be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I5-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target BR-05 (T5)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony	✓		✓
Arsenic	✓	✓	✓
Barium			
Beryllium	✓		✓
Cadmium	✓		✓
Calcium			
Chromium			
Cobalt	✓		✓
Copper	✓		✓
Iron			
Lead	✓	✓	✓
Lithium	✓		✓
Magnesium	✓		✓
Manganese	✓		✓
Molybdenum	✓		✓
Nickel	✓		✓
Potassium-40			
Radium-226	✓		✓
Radium-228			
Selenium	✓		✓
Silver	✓		✓
Sodium	✓		✓
Thallium	✓		✓
Thorium	✓	✓	✓
Uranium	✓	✓	✓
Vanadium	✓	✓	✓
Zinc	✓		✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

4.4.7 Primary Contaminant Mapping

4.4.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 4.4.6.2 identified the COPCs at Target T5. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 4.4.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I5-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T5 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 4.4.7.1 through Section 4.4.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T5. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

4.4.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I5-7. Arsenic exceeded the applied BTV in 9.1 percent of in situ XRF measurements and in one of the three XRF confirmation samples. The applied BTV for arsenic is 5.8 mg/kg for Target T5 as presented in Section 4.4.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I5-5 and Attachment I3, respectively. Figure I5-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T5 and BSA-1 (Jms) samples. Figure I5-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T5 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Section 4.4.6.1. Arsenic XRF concentrations measured in surface soils at Target T5 ranged between 1.9 and 24.5 mg/kg with an average and standard deviation of 4.0 mg/kg and 4.0 mg/kg, respectively. The average arsenic XRF concentration is below the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T5 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I5-14. Overall, the majority of detectable arsenic XRF results in surface soils were less than the applied BTV. However, the maximum XRF value was 4.2 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T5.

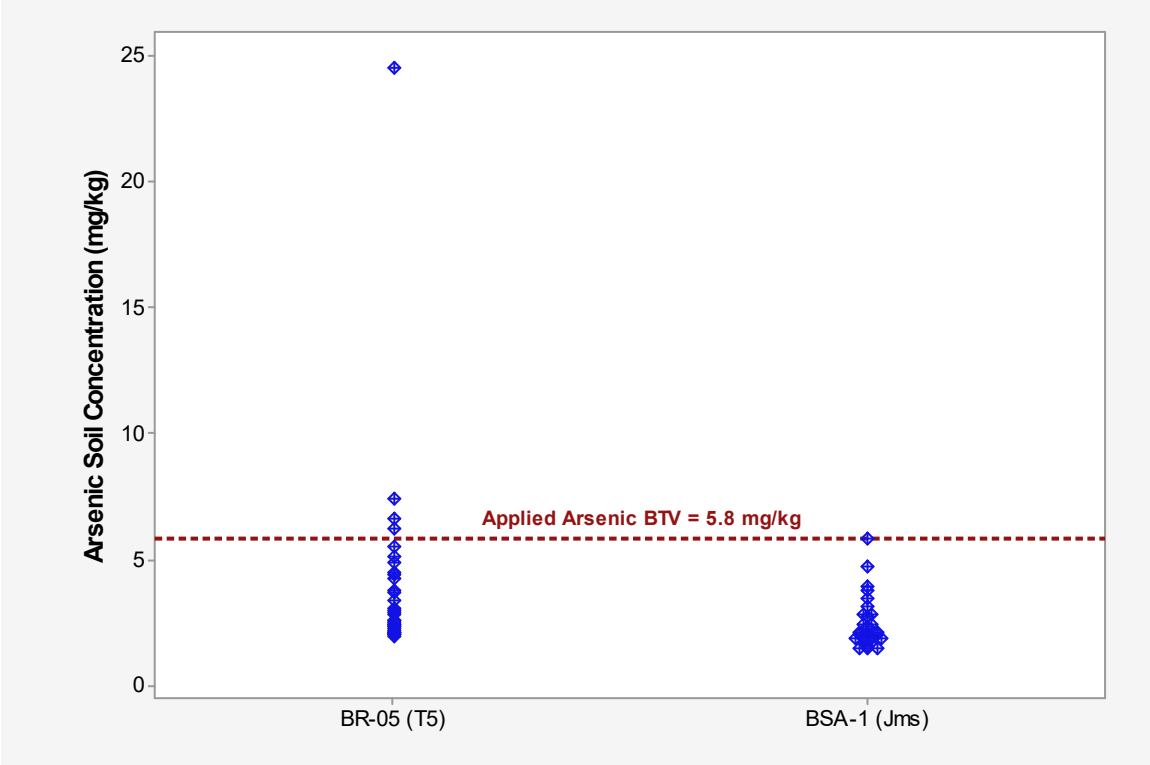


Figure I5-12. Individual Value Plot for Target BR-05 (T5) and BSA-1 (Jms) Arsenic Soil Concentrations

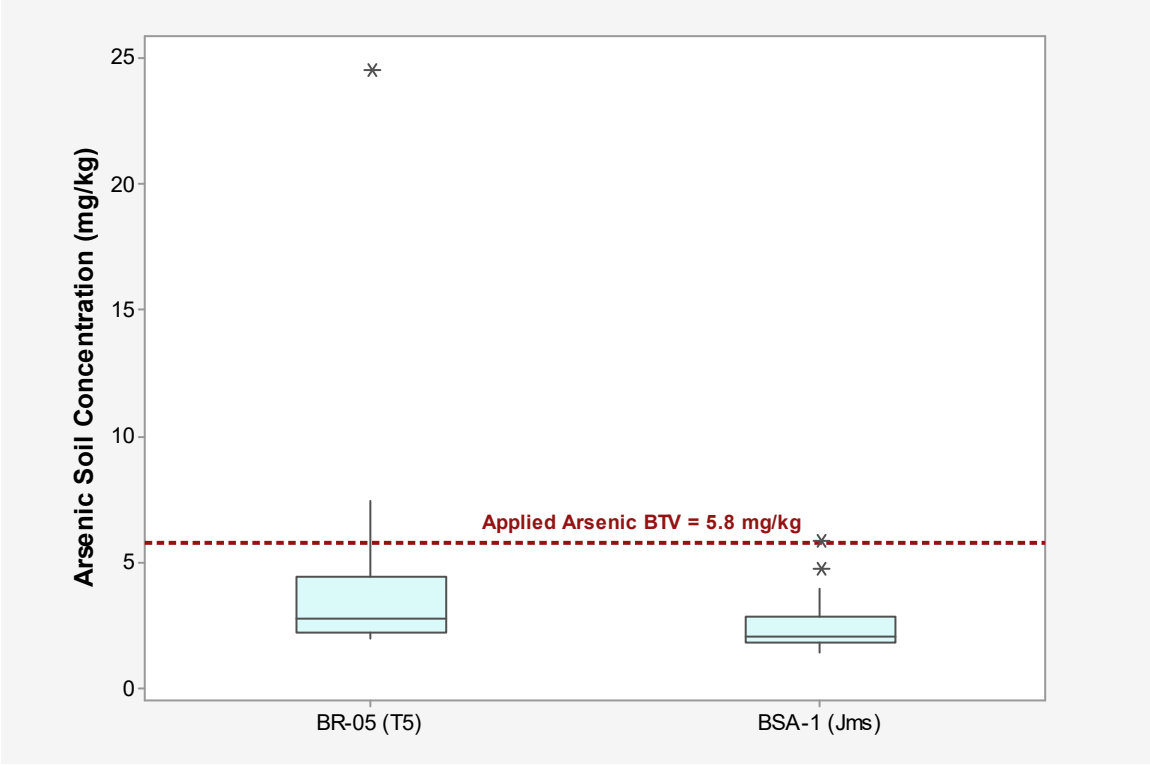
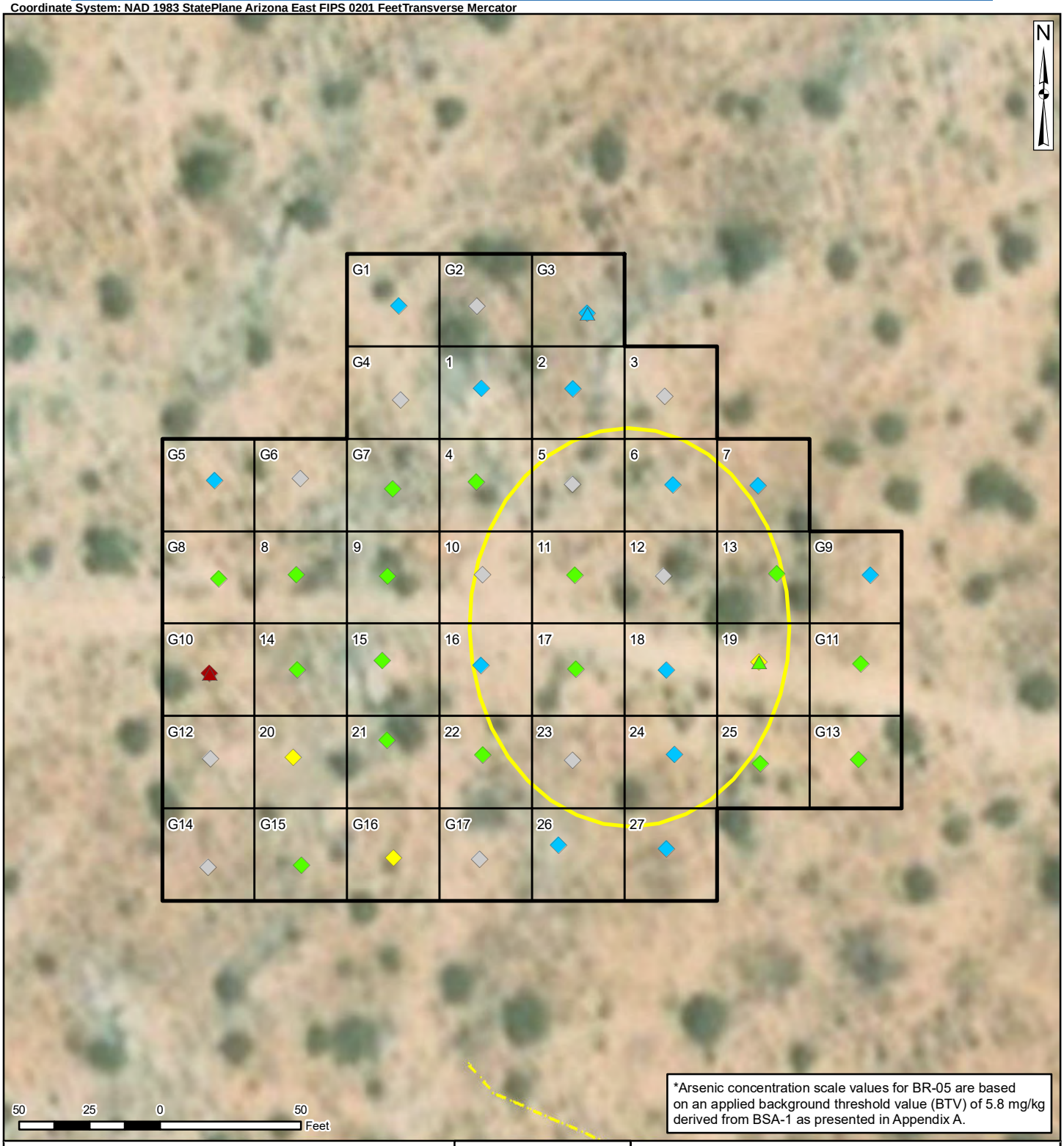


Figure I5-13. Box Plot for Target BR-05 (T5) and BSA-1 (Jms) Arsenic Soil Concentrations

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



*Arsenic concentration scale values for BR-05 are based on an applied background threshold value (BTV) of 5.8 mg/kg derived from BSA-1 as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 2.4
- 2.4 - 5.8
- 5.8 - 12
- 12 - 17
- 17 - 23
- 23 - 58
- ≥ 58
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET BR-05 (T5) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I5-14
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/26/2019	

4.4.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I5-7. Lead exceeded the applied BTV in 22.7 percent of in situ XRF measurements and in one of the three XRF confirmation samples. The applied BTV for lead is 6.7 mg/kg for Target T5 as presented in Section 4.4.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I5-5 and Attachment I3, respectively. Figure I5-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T5 and BSA-1 (Jms) samples. Figure I5-16 presents a box plot of detectable lead XRF soil concentrations for Target T5 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Section 4.4.6.1. Lead XRF concentrations measured in surface soils at Target T5 ranged between 1.3 and 10.1 mg/kg with an average and standard deviation of 5.1 mg/kg and 1.7 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T5 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I5-17. Overall, the majority of detectable lead XRF results in surface soils were lower than the applied BTV. Exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T5.

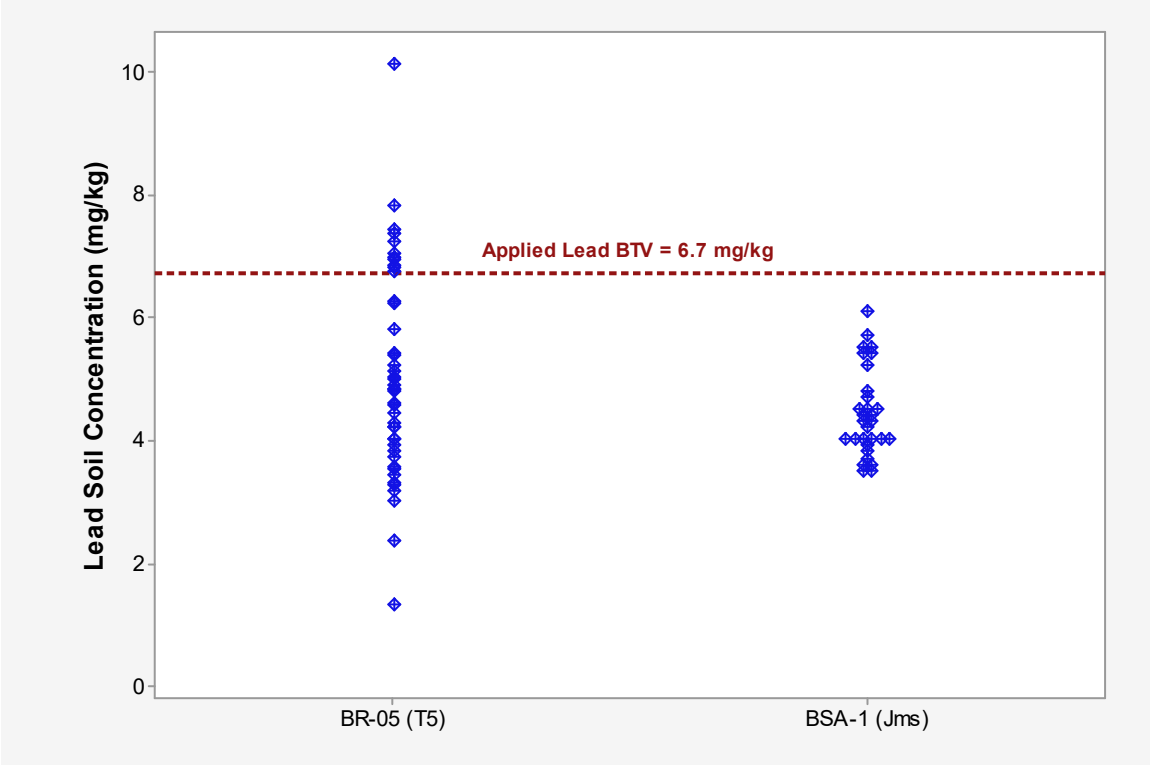


Figure I5-15. Individual Value Plot for Target BR-05 (T5) and BSA-1 (Jms) Lead Soil Concentrations

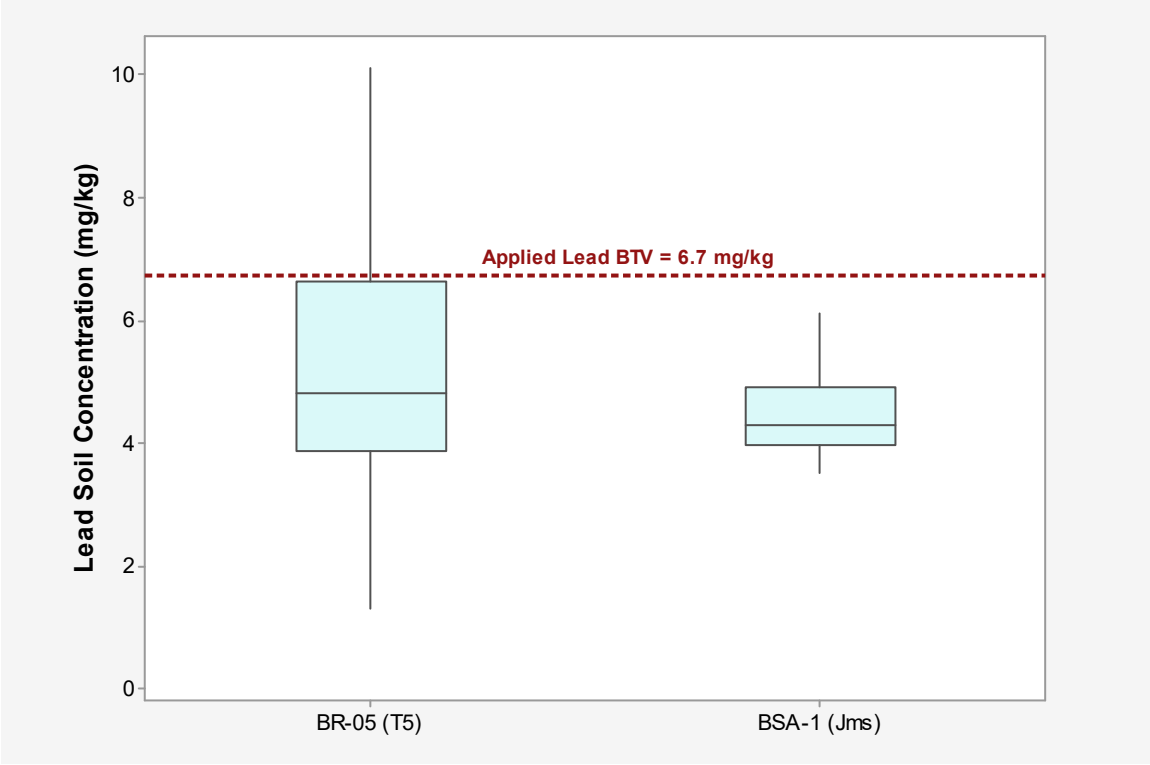
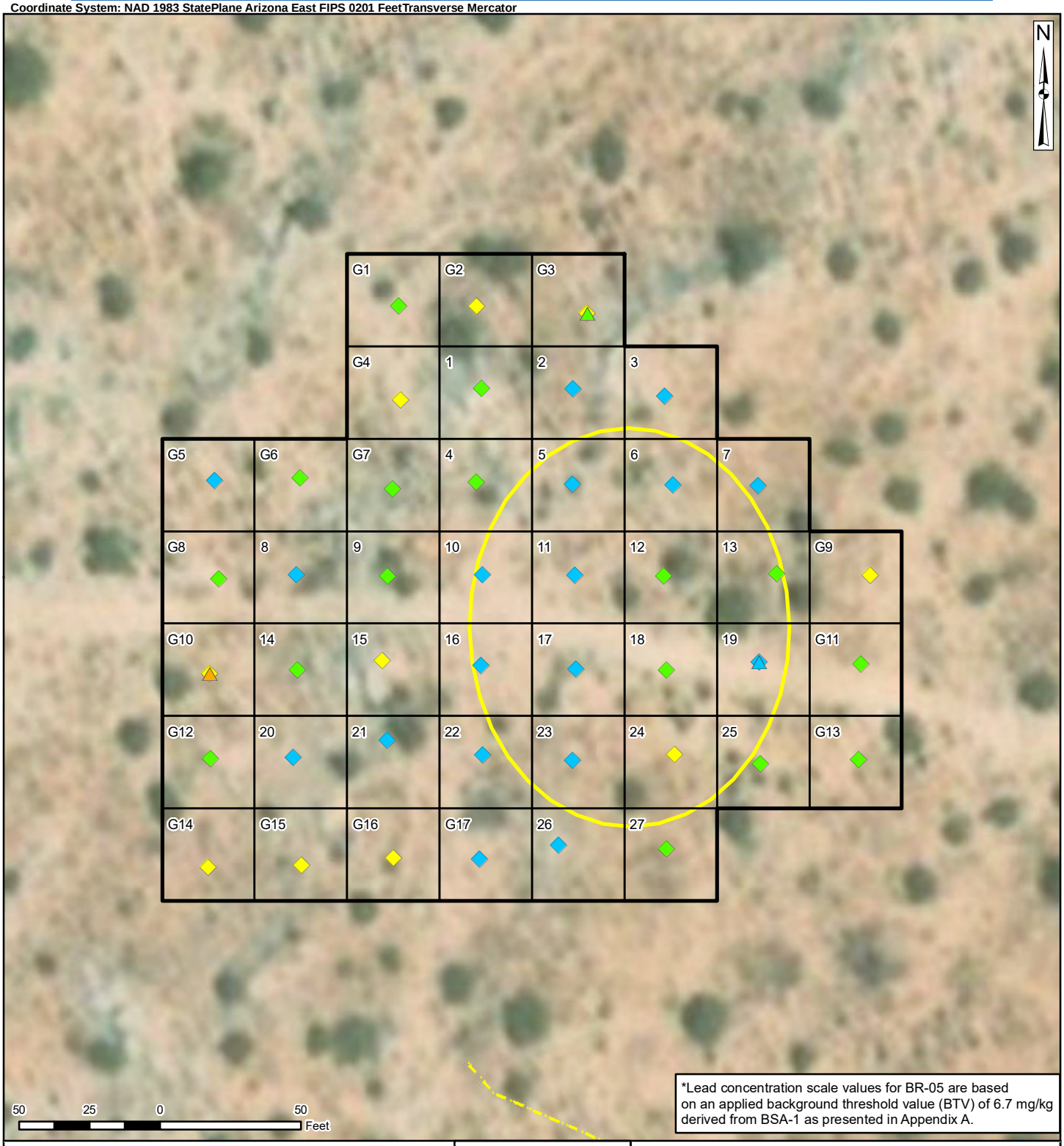


Figure I5-16. Box Plot for Target BR-05 (T5) and BSA-1 (Jms) Lead Soil Concentrations

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



*Lead concentration scale values for BR-05 are based on an applied background threshold value (BTV) of 6.7 mg/kg derived from BSA-1 as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 4.4
- 4.4 - 6.7
- 6.7 - 13
- 13 - 20
- 20 - 27
- 27 - 67
- ≥ 67

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET BR-05 (T5) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I5-17
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/26/2019	

4.4.7.4 Thorium

Thorium was identified as a COPC in surface soil as shown in Table I5-7. Thorium exceeded the applied BTV in 22.7 percent of in situ XRF measurements and in one of the three XRF confirmation samples. The applied BTV for thorium is 2.1 mg/kg for Target T5 as presented in Section 4.4.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I5-5 and Attachment I3, respectively. Figure I5-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T5 and BSA-1 (Jms) samples. Figure I5-19 presents a box plot of detectable thorium XRF soil concentrations for Target T5 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Section 4.4.6.1. Thorium XRF concentrations measured in surface soils at Target T5 ranged between 1.1 and 3.2 mg/kg with an average and standard deviation of 1.8 mg/kg and 0.5 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T5 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I5-20. Overall, the majority of detectable thorium XRF results in surface soils were lower than the applied BTV. However, exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T5.

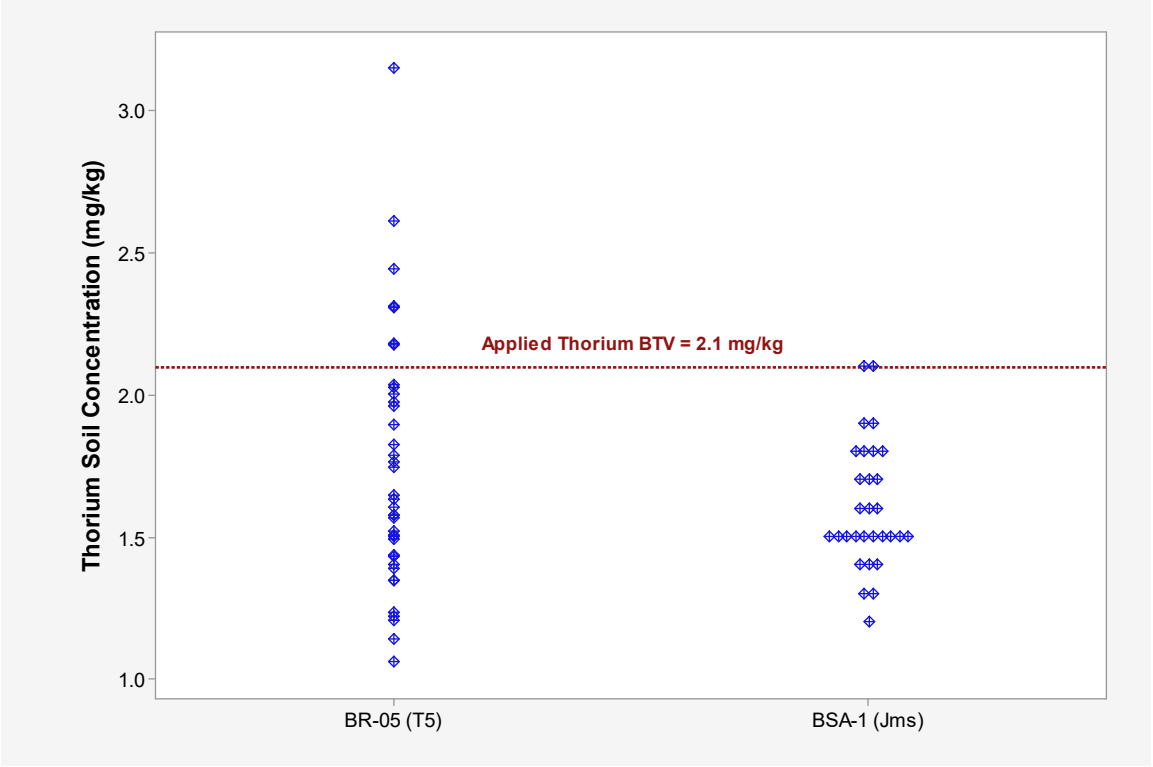


Figure I5-18. Individual Value Plot for Target BR-05 (T5) and BSA-1 (Jms) Thorium Soil Concentrations

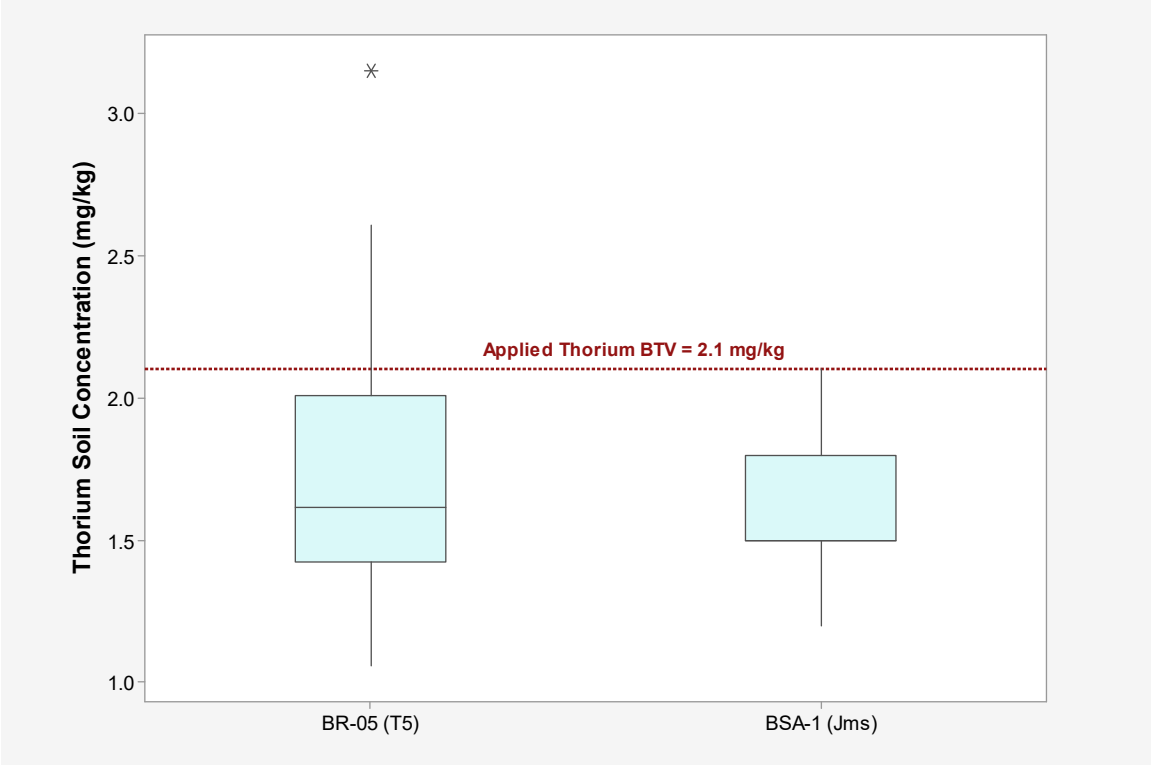
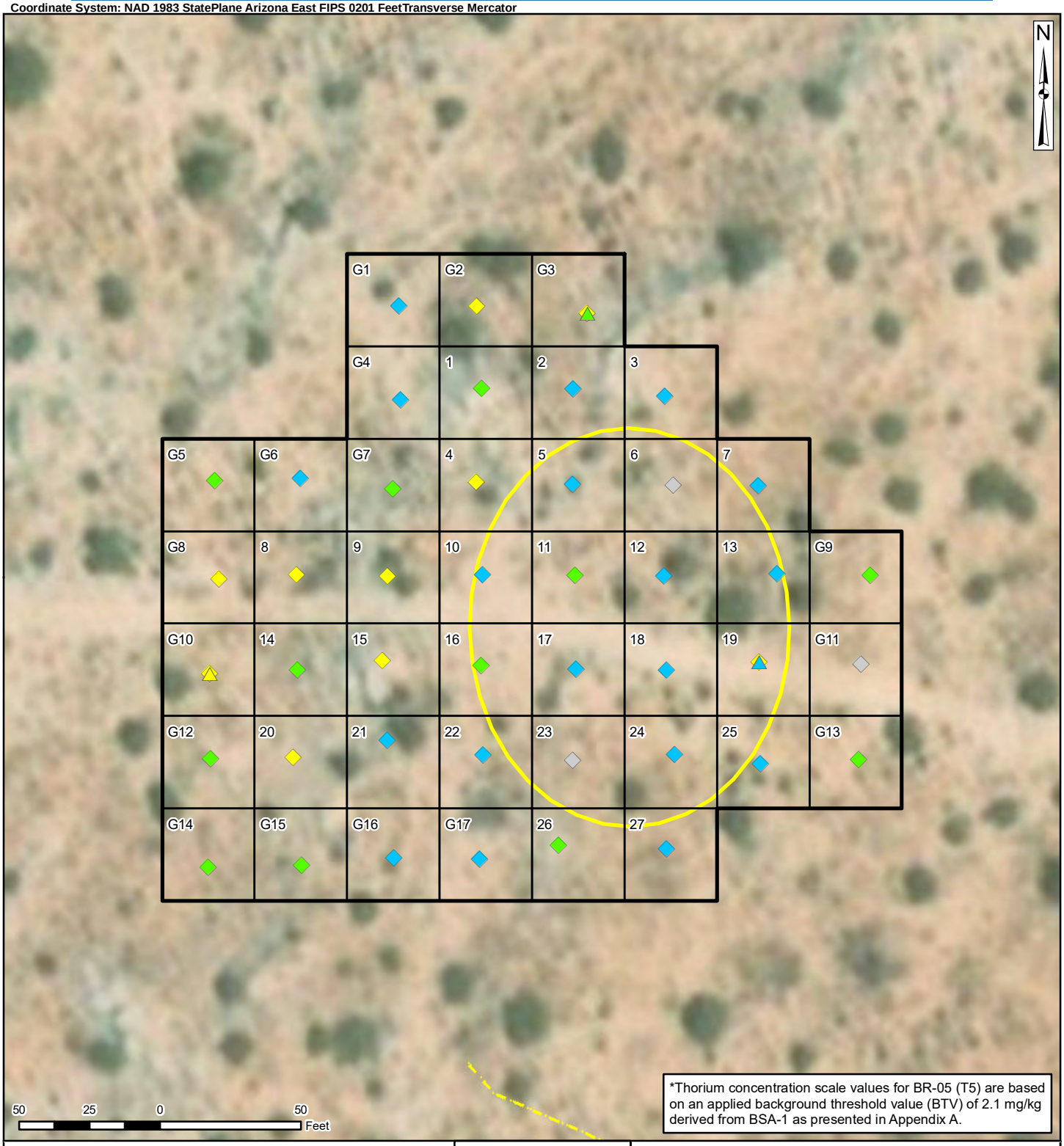


Figure I5-19. Box Plot for Target BR-05 (T5) and BSA-1 (Jms) Thorium Soil Concentrations

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



*Thorium concentration scale values for BR-05 (T5) are based on an applied background threshold value (BTV) of 2.1 mg/kg derived from BSA-1 as presented in Appendix A.

Thorium Concentration Scale (mg/kg)*

- ≤ 1.6
- 1.6 - 2.1
- 2.1 - 4.2
- 4.2 - 6.3
- 6.3 - 8.4
- 8.4 - 21
- ≥ 21
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET BR-05 (T5) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I5-20
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/12/2019	

4.4.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I5-7. Uranium exceeded the applied BTV in 11.4 percent of in situ XRF measurements and in one of the three XRF confirmation samples. The applied BTV for uranium is 3.9 mg/kg for Target T5 as presented in Section 4.4.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I5-5 and Attachment I3, respectively. Figure I5-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T5 and BSA-1 (Jms) samples. Figure I5-22 presents a box plot of detectable uranium XRF soil concentrations for Target T5 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Section 4.4.6.1. Uranium XRF concentrations measured in surface soils at Target T5 ranged between 0.44 and 14.3 mg/kg with an average and standard deviation of 2.8 mg/kg and 2.2 mg/kg, respectively. The average uranium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T5 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I5-23. Overall, the majority of detectable uranium XRF results in surface soils were lower than the applied BTV. However, the maximum XRF value was 3.7 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T5.

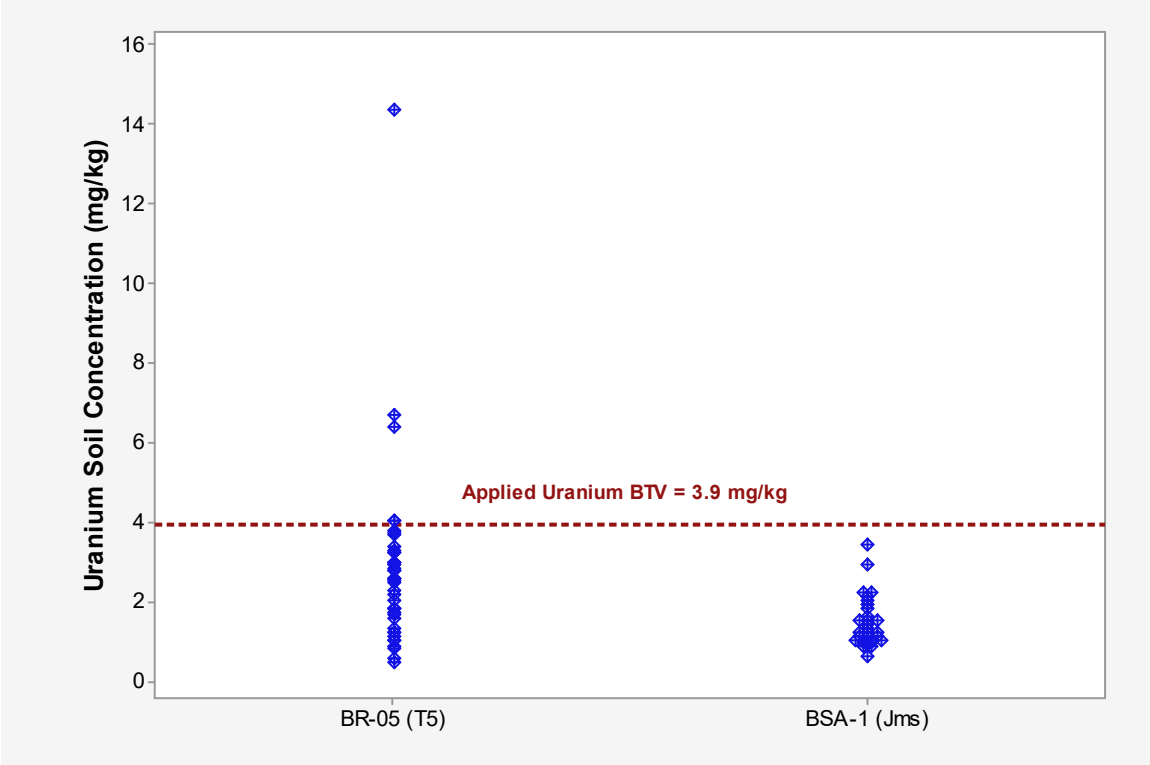


Figure I5-21. Individual Value Plot for Target BR-05 (T5) and BSA-1 (Jms) Uranium Soil Concentrations

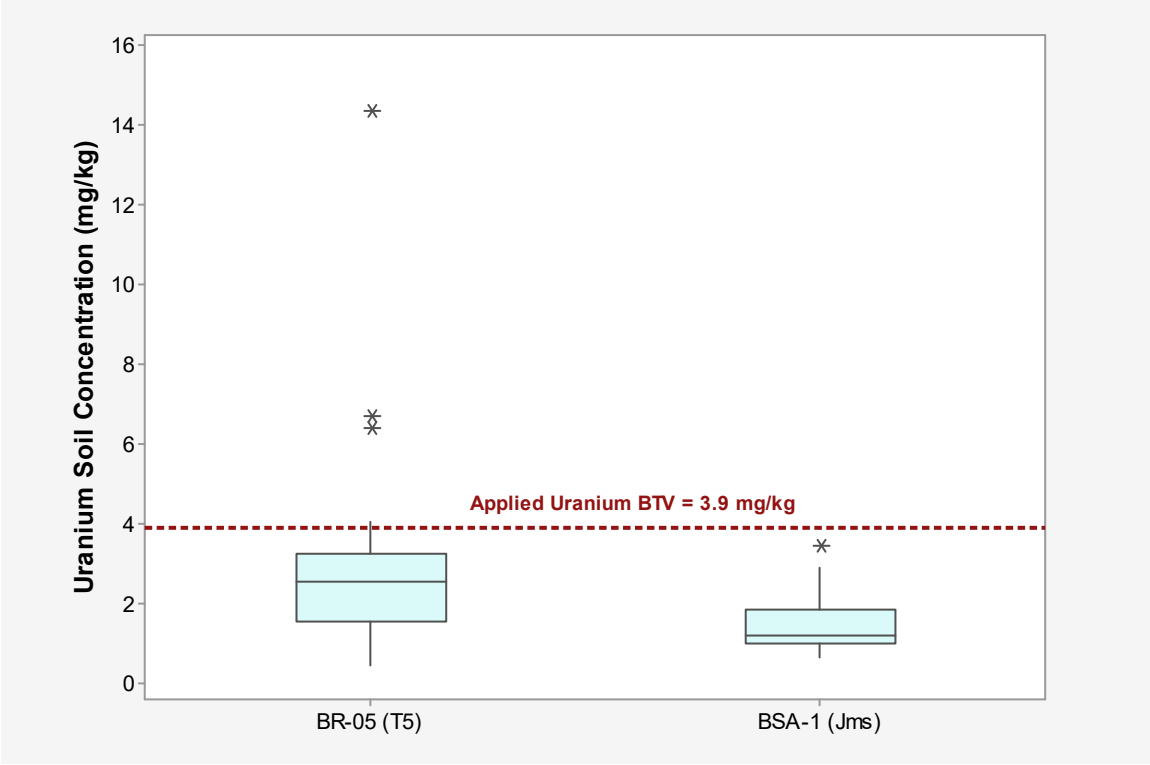
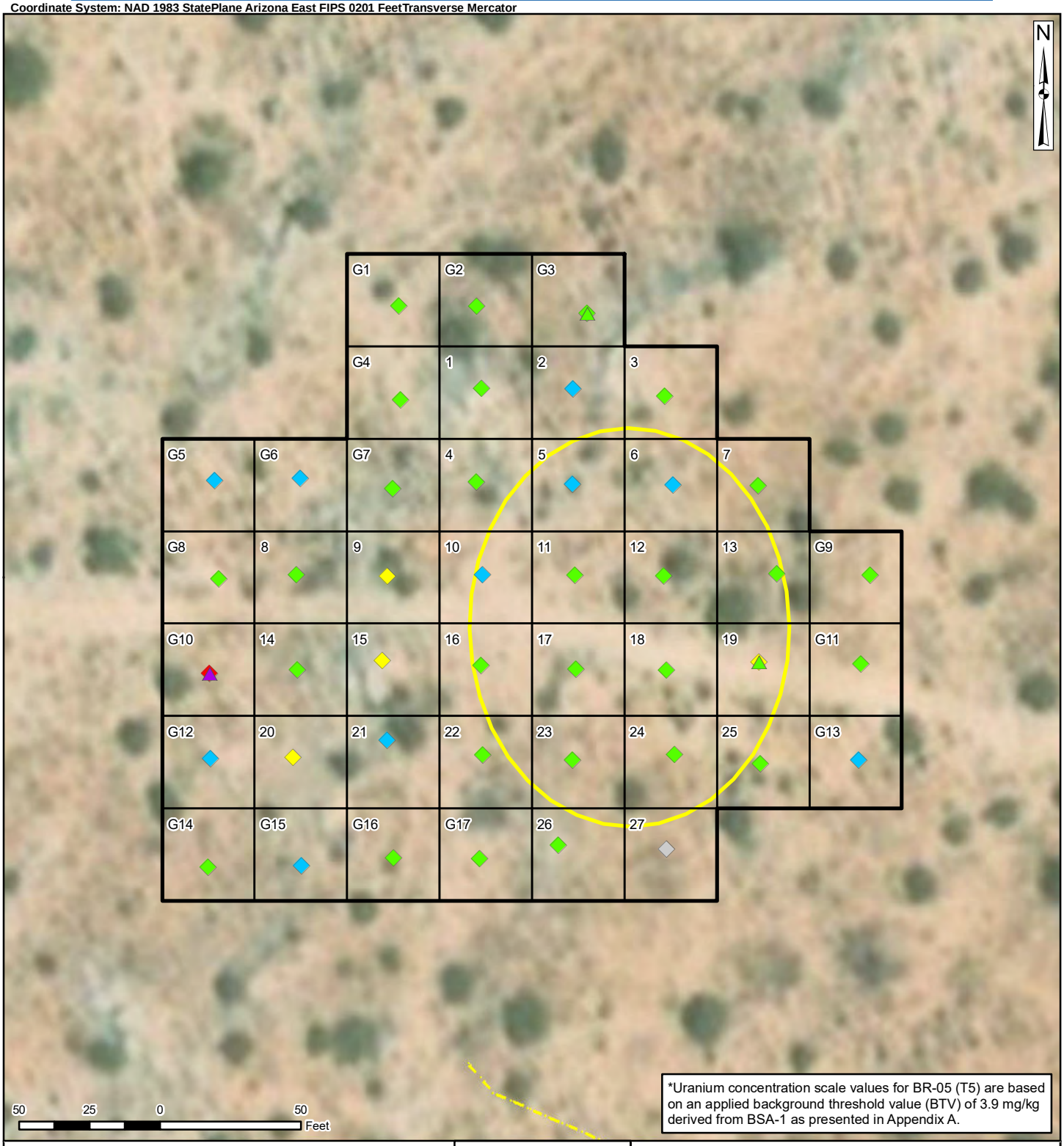


Figure I5-22. Box Plot for Target BR-05 (T5) and BSA-1 (Jms) Uranium Soil Concentrations

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



*Uranium concentration scale values for BR-05 (T5) are based on an applied background threshold value (BTV) of 3.9 mg/kg derived from BSA-1 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 1.4
- 1.4 - 3.9
- 3.9 - 7.8
- 7.8 - 12
- 12 - 16
- 16 - 39
- ≥ 39
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET BR-05 (T5) SURFACE SOIL URANIUM CONCENTRATION MAP

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TO0001	EP-S9-17-03	I5-23
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/12/2019	

4.4.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I5-7. Vanadium exceeded the applied BTV in 6.8 percent of in situ XRF measurements and in one of the three XRF confirmation samples. The applied BTV for vanadium is 13 mg/kg for Target T5 as presented in Section 4.4.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I5-5 and Attachment I3, respectively. Figure I5-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T5 and BSA-1 (Jms) samples. Figure I5-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T5 and BSA-1 (Jms) samples. Summary statistics for XRF measurements are provided in Section 4.4.6.1. Vanadium XRF concentrations measured in surface soils at Target T5 ranged between 18.9 and 26.3 mg/kg with an average and standard deviation of 22.1 mg/kg and 3.8 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T5 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I5-26. All of the vanadium XRF results in surface soils were higher than the applied BTV. However, the maximum XRF value was about two times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T5.

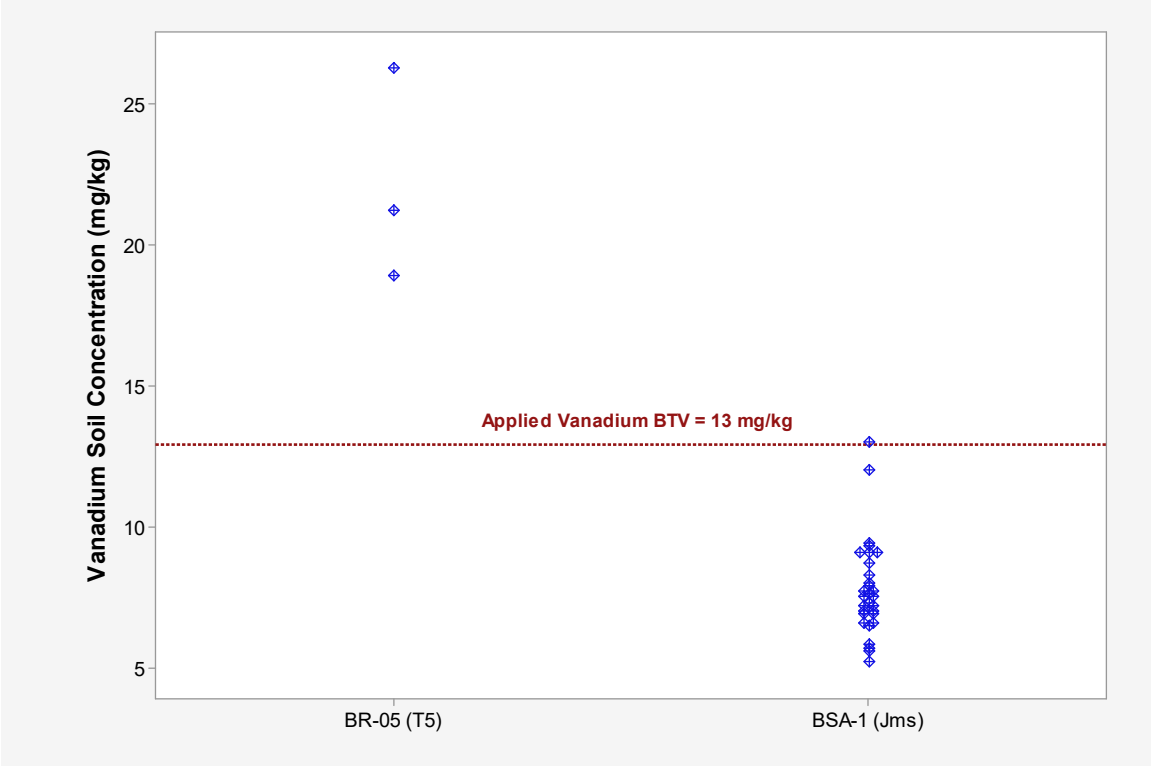


Figure I5-24. Individual Value Plot for Target BR-05 (T5) and BSA-1 (Jms) Vanadium Soil Concentrations

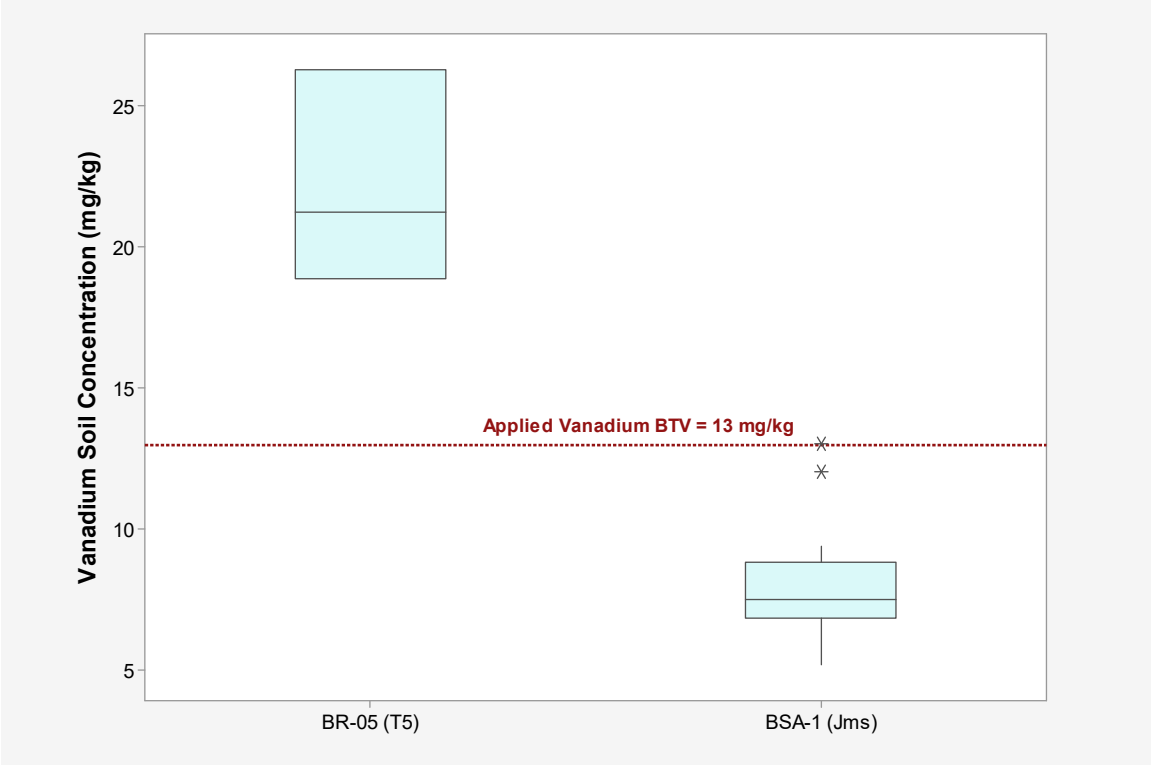
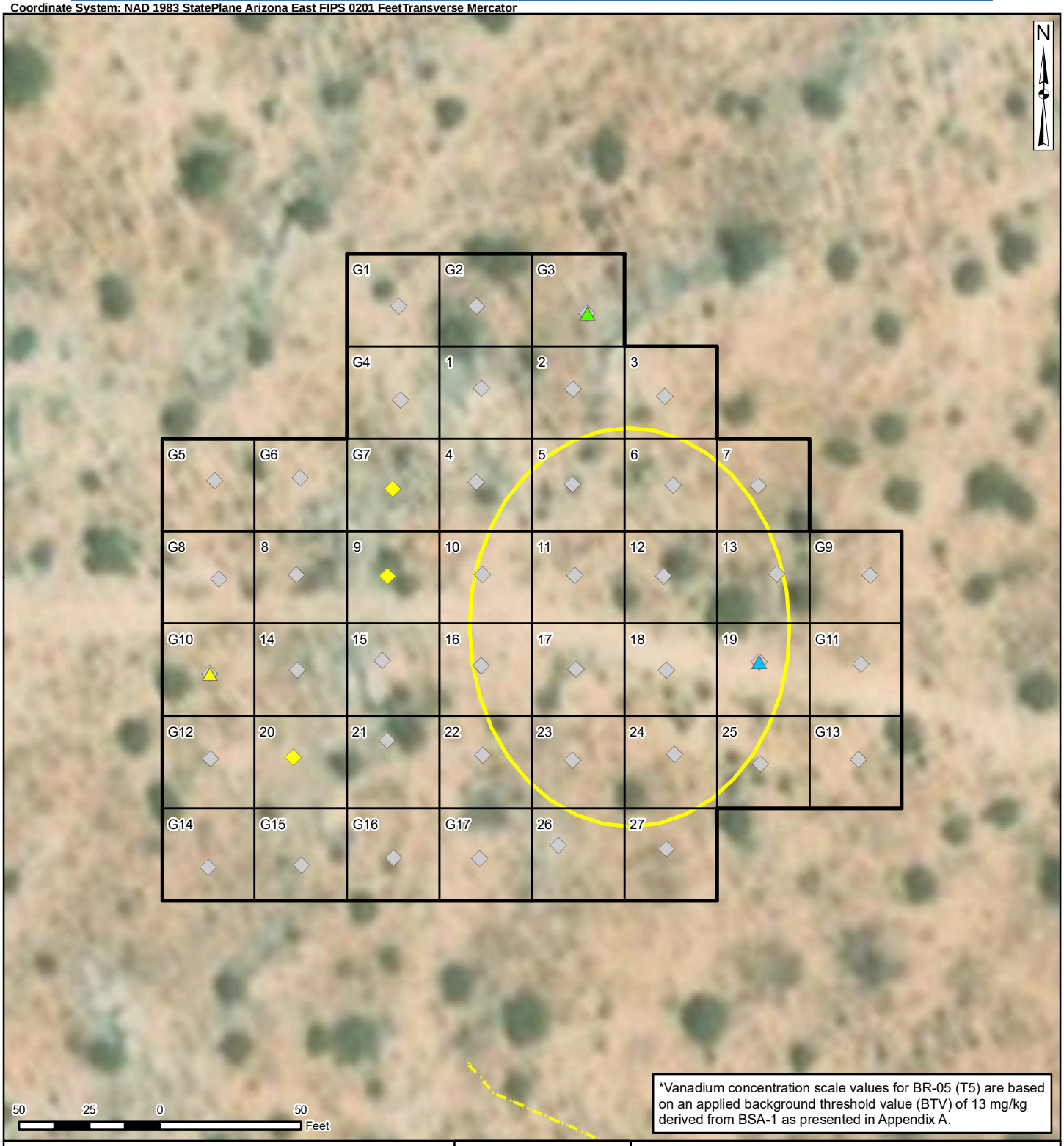


Figure I5-25. Box Plot for Target BR-05 (T5) and BSA-1 (Jms) Vanadium Soil Concentrations

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



*Vanadium concentration scale values for BR-05 (T5) are based on an applied background threshold value (BTV) of 13 mg/kg derived from BSA-1 as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 7.7
- 7.7 - 13
- 13 - 26
- 26 - 39
- 39 - 52
- 52 - 130
- ≥ 130
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET BR-05 (T5) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I5-26
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/12/2019	

4.4.8 Conclusions

Target T5 (BR-05) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T5. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T5 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T5. ASPECT gamma survey results generally correlated with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T5 was well documented through gamma radiation surveys, and the lateral extent of metals above the applied BTV levels has been characterized. Ra-226 in one XRF confirmation sample from survey unit G10 (highest grid averaged gamma reading) exceeded the applied BTV by a factor of 39. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific BTVs for Target T5 geology and soil types were established through a background study.
- A total of 29 analytes were identified as occurring within the surface environment. Of these analytes, 22 were identified as COPCs. Only arsenic and uranium exceeded the applied BTVs by a factor greater than 2.
- Mean raw gamma measurements did not exceed the applied BTV. However, grid averaged gamma measurements exceeded the applied BTV in 10 of 44 survey units by a factor of up to 2.2.
- Based on Tetra Tech's observations, Target T5 does not contain TENORM. No mining-related activities or features were observed in the field, and no historical exploratory borings, vents, or other mine openings were noted in the file review or during field observation. Outcropping of Salt Wash Member of the Morrison Formation was visually identified in the western portion of the Target but not verified by gamma surveying.
- Natural erosion of outcroppings may increase the lateral extent of NORM.
- There are no immediate significant physical hazards present at Target T5.
- Access is by a dirt road from an adjacent paved highway.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.

- No groundwater wells are documented within the vicinity of Target T5. Rural residences are located nearby; however, it is not known if water is provided by utility or private well. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T5. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No mine waste was observed at Target T5; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; however, a few data gaps remain for Target T5. The remaining data gaps include to step out to the west of survey unit G10 and to verify the presence of NORM within the western portion of the Target.

4.5 NON-AUM TARGET T6 (BR-06)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T6 (BR-06).

4.5.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T6 (BR-06) is associated with the Brodie 1 Mine (M1), a former underground mine in the Tse Tah Region in Subarea Group A. Five other non-AUM Targets are associated with the Brodie 1 Mine. Target T6 is administered by the Red Mesa and Sweetwater Chapters of the Navajo Nation and is accessible is accessible by foot off Indian Route 35 from Highway 160, which is located immediately southeast of Red Mesa. Target T6 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. A residence is located approximately 0.5 mile to the northeast. A Target location and access map for Target T6 is shown in Figure I6-1.

A topographical relief map for the Brodie 1 Mine area and associated non-AUM Targets is provided in Figure I6-2. The elevation at Target T6 ranges from 5,661 to 5,675 feet amsl with an average of 5,668 feet amsl. The slope at Target T6 ranges from 2 to 8 percent with an average of 5 percent. An ephemeral drainage channel is located approximately 400 feet west of Target T6 and a second drainage is located 500 feet east. The Brodie 1 Mine is located predominately within the Js and rock outcrop-Rizno complex soils unit. Target T6 is primarily within the Js with the western edge occupying Qa. The soil type is a combination of Sheppard loamy fine sand (MUSYM 507) and Weiser-Wechech association (MUSYM 314) (Figures I-13 and I-14).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T6. Weston did not conduct a background study for Target T6. As a part of the RSE for the Brodie 1 Mine, Tetra Tech also evaluated the associated non-AUM Targets, such as T6. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 1 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T6:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T6 is accessed by taking Highway 160 to Indian Route 35 and then via a four-wheel-drive off-road access route to the southwest. A short hike via footpath and off-trail trek is required to get to the Target.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM and TENORM were not observed at the Target.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  An ephemeral drainage was located approximately 400 feet to the west and evaluated under the RSE for the Brodie 1 Mine. A second drainage was located approximately 500 feet east of the Target.

- Identified any exploration borings or historic haul roads:

  No exploratory borings or haul roads were identified.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  Erosion of outcropping of the Jms to the southeast may contribute to elevated gamma readings.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target

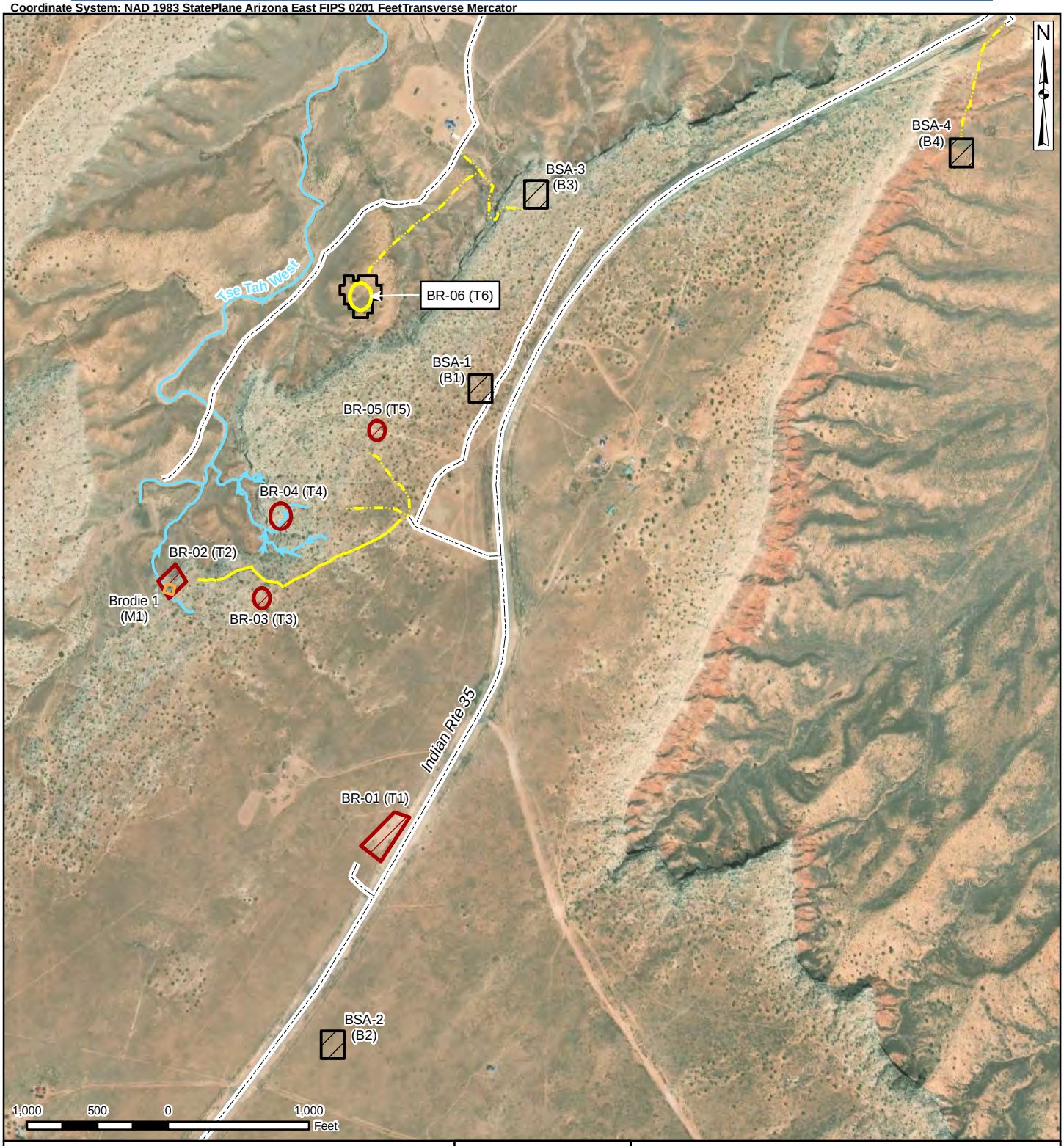
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T6 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Section 2.3 and 4.5.4)
- Conducting an XRF field survey.
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 4.5.3 with results presented in Sections 4.5.6 and 4.5.7)
- Conducting a gamma radiation survey (results presented in Section 4.5.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



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

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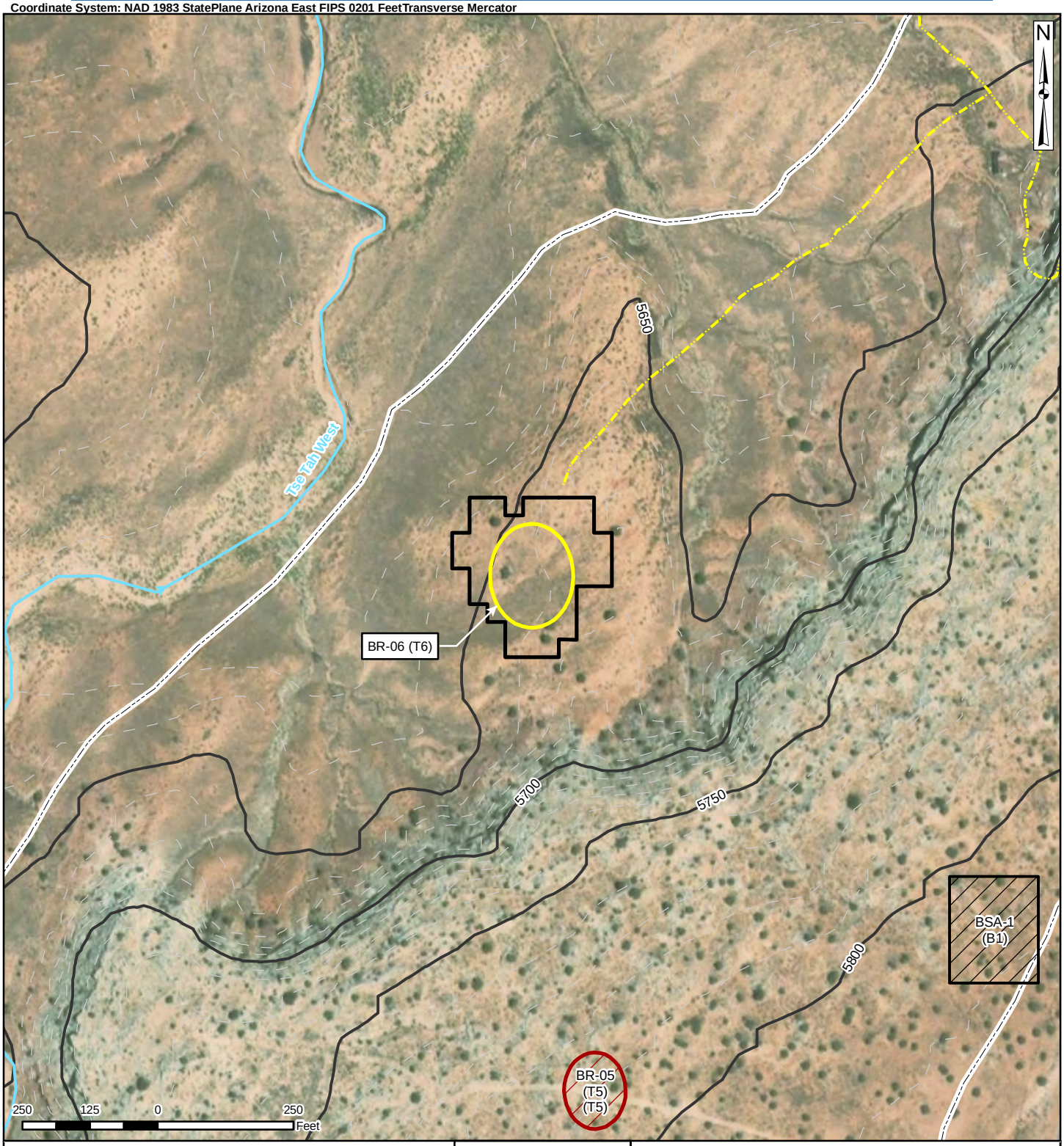
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NON-AUM TARGET BR-06 (T6) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I6-1
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site Boundary
Background Location
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped
50 ft Contour*
10 ft Contour*

* 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.

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NON-AUM TARGET BR-06 (T6) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I6-2
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

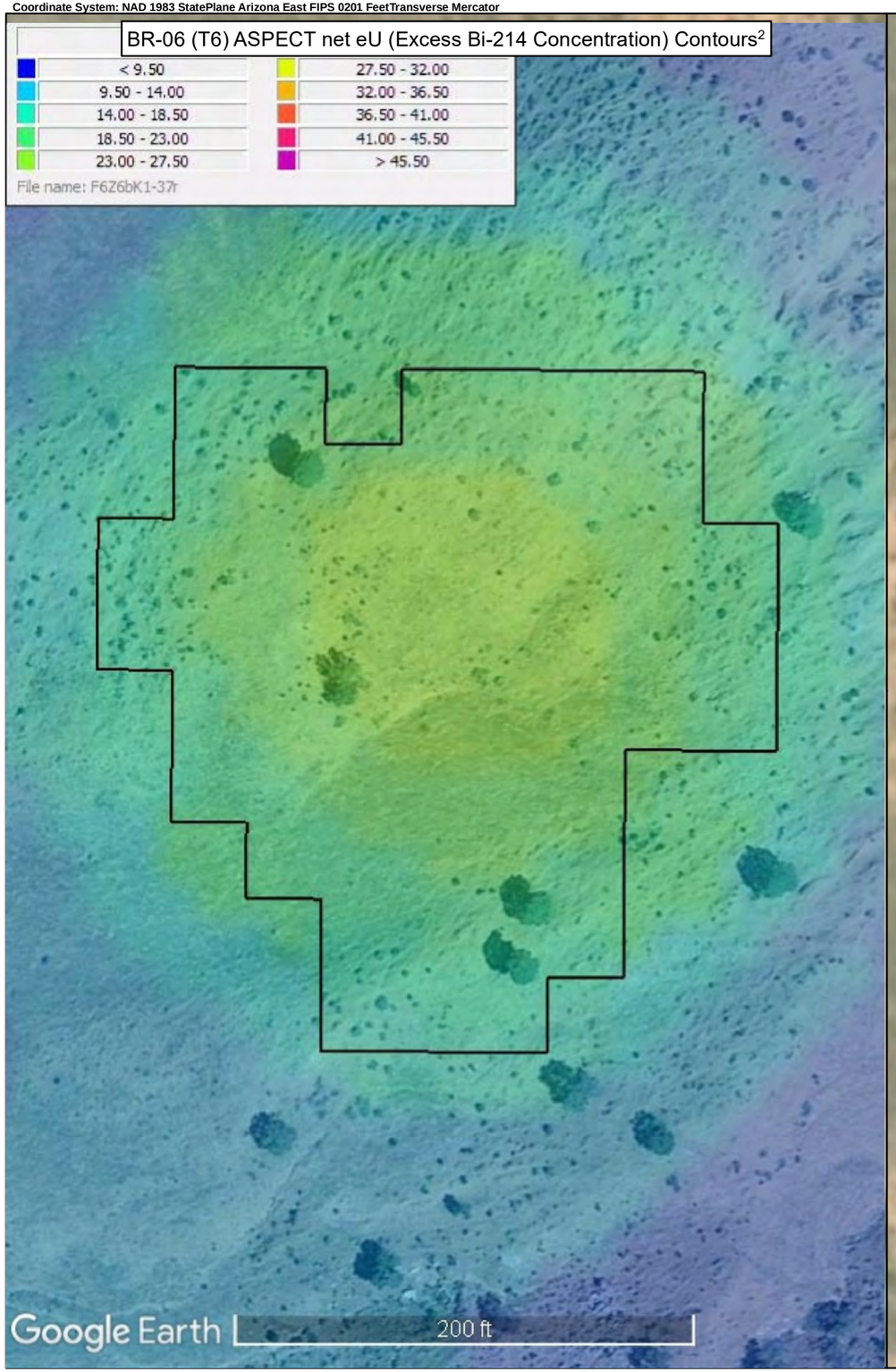
4.5.2 Gamma Radiation Survey and Field XRF Measurements

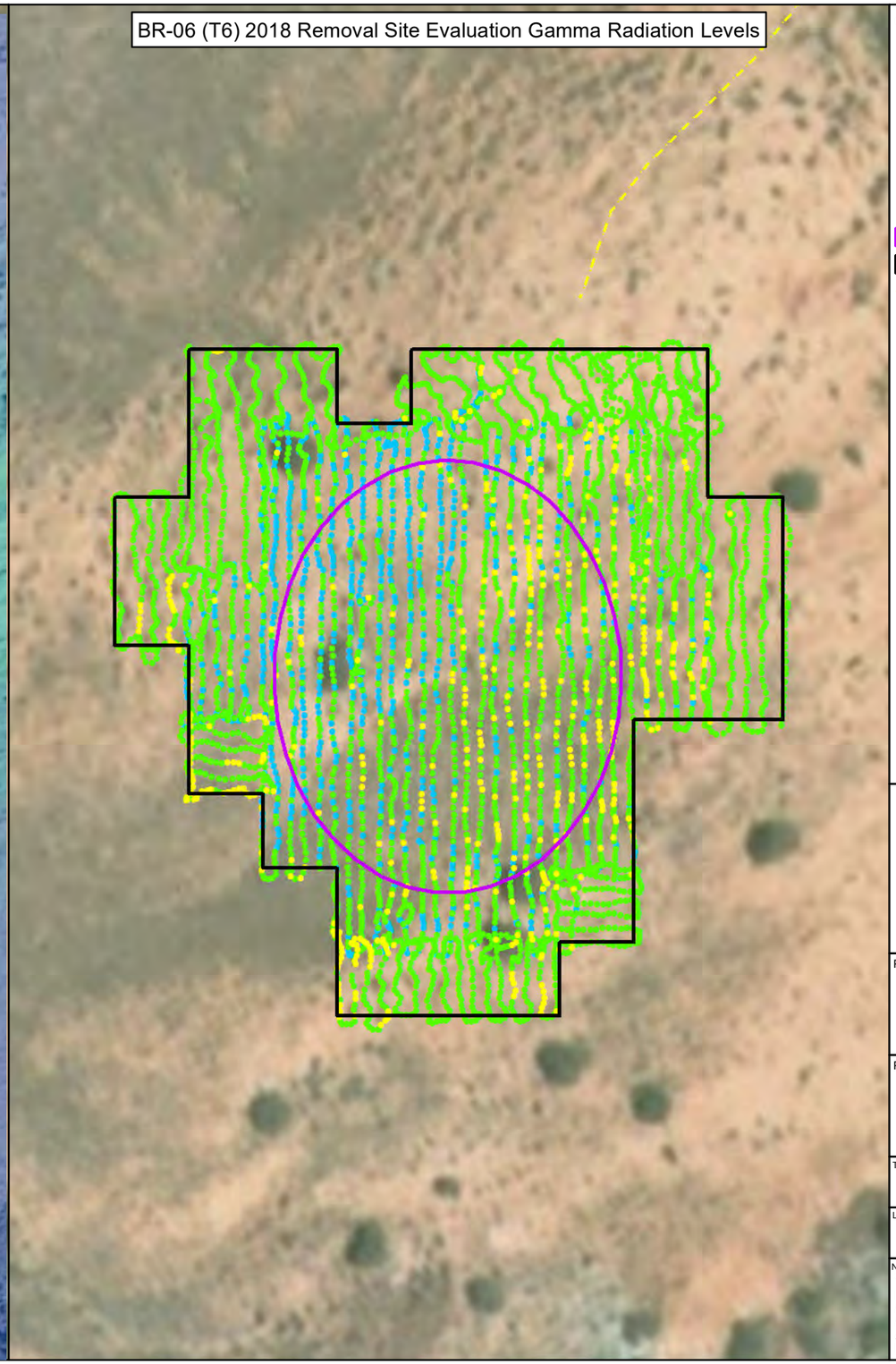
Tetra Tech performed GPS-based gamma radiation surveys (Figure I6-3) within the survey area of the non-AUM Target T6 as part of the Baseline Study in May 2018. Additional Goback gamma radiation surveys were performed in August 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T6 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I6-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 1, of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at 20 survey units. All gamma survey and XRF survey units were evaluated.

4.5.3 XRF Confirmation Sampling Overview

Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T6. Four XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from three locations (Table I6-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I6-4 and I16-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I6-2. A subset of XRF confirmation samples were also submitted for analysis of mercury and select additional radionuclides. The results of XRF confirmation sample analysis are provided in Section 4.5.6.1. Correlated XRF field measurements are provided in Attachment I3.

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





Gamma Reading (cpm)[1]

≤ 7,231	≤ Avg. BG
7,231 - 8,673	Avg. BG - 1 x BTV
8,673 - 17,346	1 x BTV - 2 x BTV
17,346 - 26,019	2 x BTV - 3 x BTV
26,019 - 34,692	3 x BTV - 4 x BTV
34,692 - 86,730	4 x BTV - 10 x BTV
≥ 86,730	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Foot

[1]The applied gamma background threshold value (BTV) for BR-06 (T6) Non-AUM Target is 8,673 cpm derived from BSA-4 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET BR-06 (T6)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

Prepared By:

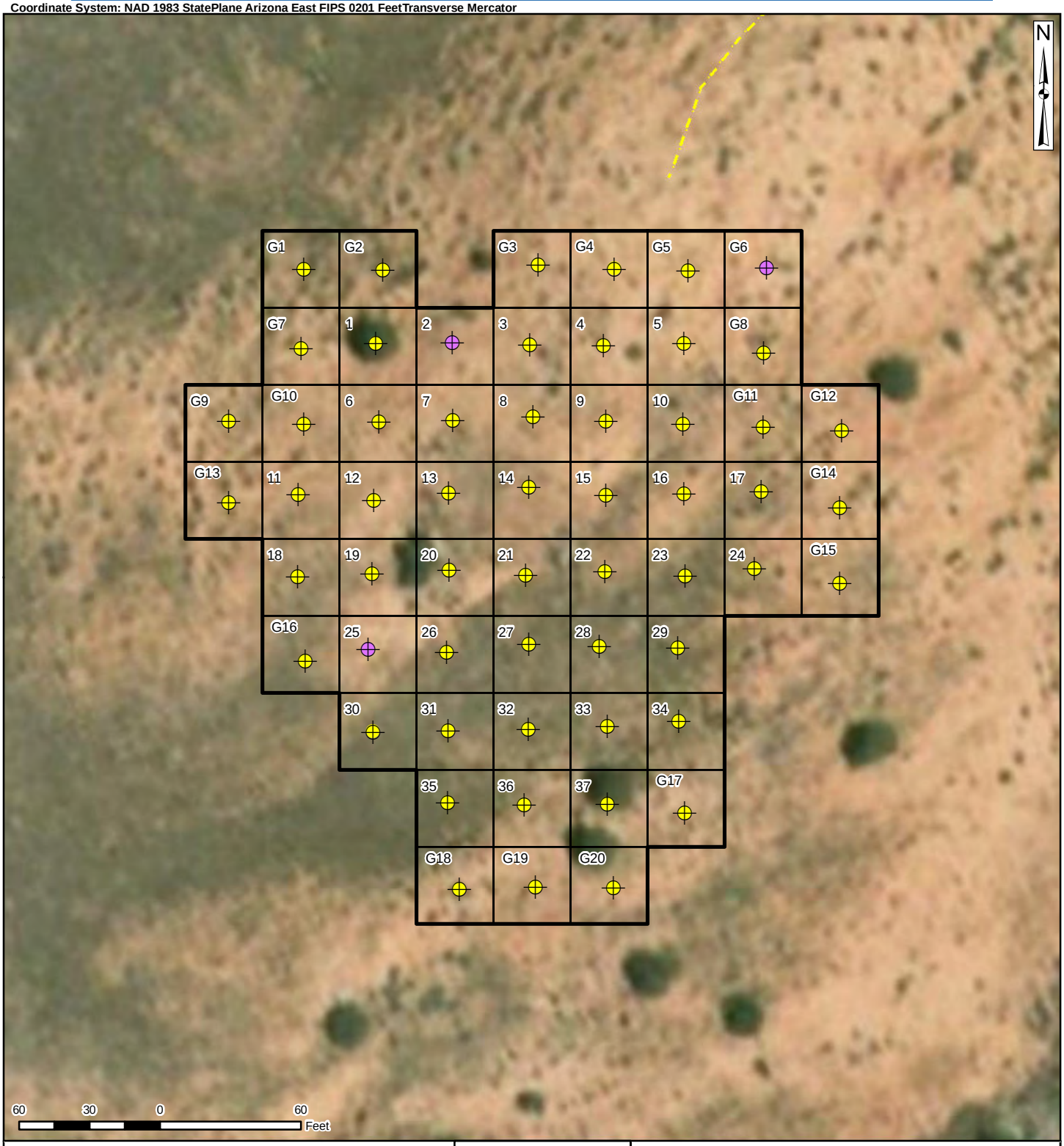
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborn Spectral Photometric Environmental Collection Technology.

Figure No.: **I6-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route - Foot

Prepared for: USEPA Region 9

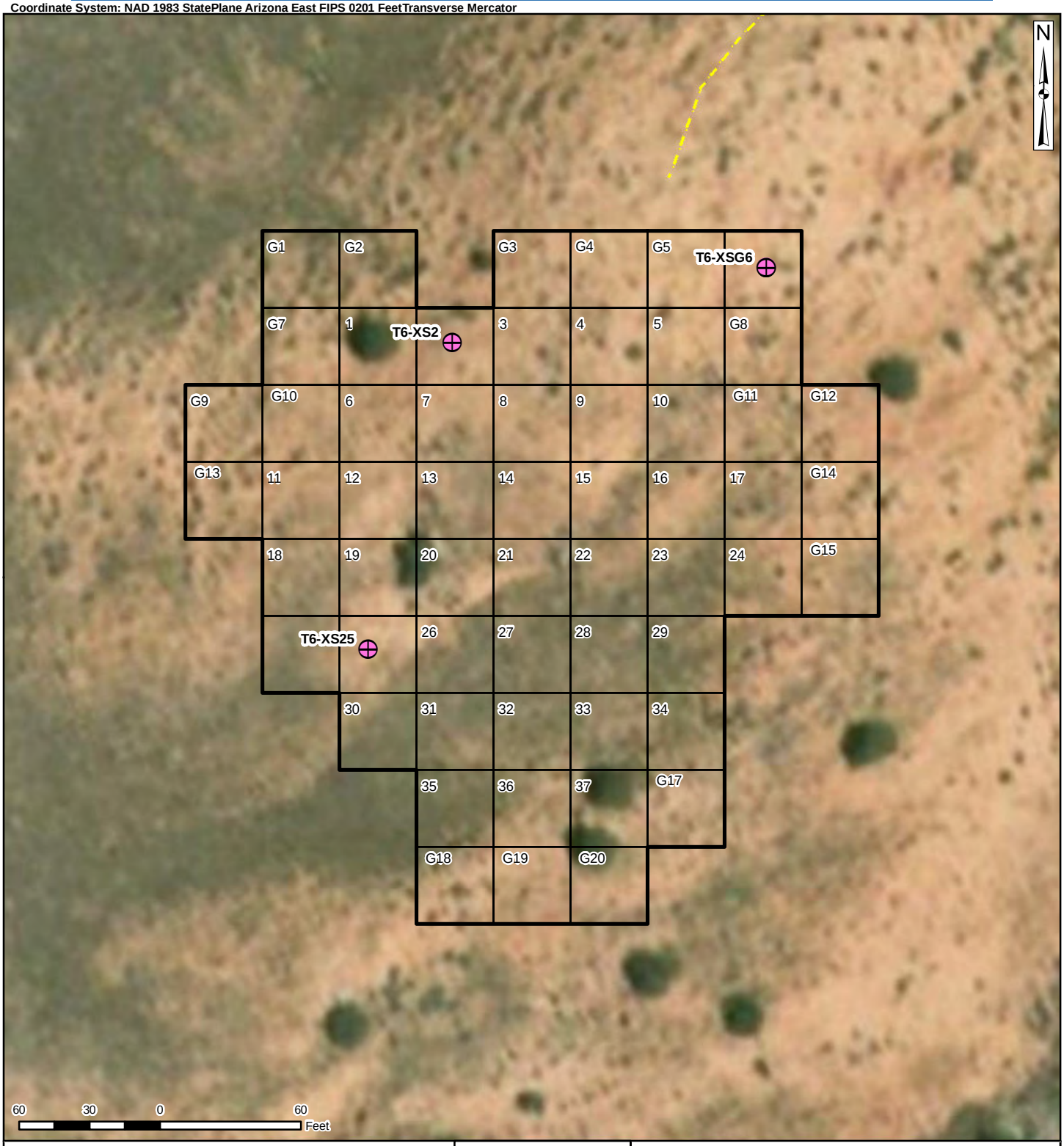
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NON-AUM TARGET BR-06 (T6) XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I6-4
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

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



XRF Confirmation Soil Sample[1] (0 - 3 inches bgs)

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route - Foot

*T6-XG6 = site T6 XRF confirmation soil sample collected at survey unit G6. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET BR-06 (T6)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I6-5
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

Table I6-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target BR-06 (T6)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T6-XS2-01-051218	2	0-3	XRF Confirmation	Primary	5/12/2018	36.9118301	-109.3480518	1805327-21, 1805328-21
T6-XS25-01-051218	25	0-3	XRF Confirmation	Primary	5/12/2018	36.9114719	-109.3481783	1805327-22, 1805328-22
T6-XSG6-01-081918	G6	0-3	XRF Confirmation	Primary	8/19/2018	36.9119144	-109.3475930	1808486-10, 1808487-10
T6-XSG6-02-081918	G6	0-3	XRF Confirmation	Duplicate	8/19/2018	36.9119144	-109.3475930	1808486-11, 1808487-11

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I6-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BR-06 (T6)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

4.5.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 4.5.1, Target T6 surface geology is predominately within the Js and soil with a combination of Sheppard loamy fine sand (MUSYM 507) and Weiser-Wechech association (MUSYM 314) (Figures I-13 and I-14). As a result, Background Study Area 4 (BSA-4) was selected for that combination of geology and soil type. Table I6-3 presents the Target-specific BTVs for 29 analytes and gamma radiation levels for Target T6. No regional BTVs were established for Target T6. The BTVs for a given analyte are calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T6. The "Applied BTV" for each analyte is the Target-specific BTV.

Table I6-3. Applied Background Threshold Values for Non-AUM Target BR-06 (T6)

Analyte	Units	Site-Specific BTV (BSA-4)	Regional BTV (Js)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	3,680	None	3,680	Site-Specific BTV
Antimony	mg/kg	-	None	-	Site-Specific BTV
Arsenic	mg/kg	1.4	None	1.4	Site-Specific BTV
Barium	mg/kg	65	None	65	Site-Specific BTV
Beryllium	mg/kg	0.21	None	0.21	Site-Specific BTV
Cadmium	mg/kg	0.073	None	0.073	Site-Specific BTV
Calcium	mg/kg	19,700	None	19,700	Site-Specific BTV
Chromium	mg/kg	4.2	None	4.2	Site-Specific BTV
Cobalt	mg/kg	1.6	None	1.6	Site-Specific BTV
Copper	mg/kg	3.1	None	3.1	Site-Specific BTV
Iron	mg/kg	3,840	None	3,840	Site-Specific BTV
Lead	mg/kg	4.0	None	4.0	Site-Specific BTV
Lithium	mg/kg	6.0	None	6.0	Site-Specific BTV
Magnesium	mg/kg	3,310	None	3,310	Site-Specific BTV
Manganese	mg/kg	180	None	180	Site-Specific BTV
Mercury	mg/kg	0.0085	None	0.0085	Site-Specific BTV
Molybdenum	mg/kg	0.30	None	0.30	Site-Specific BTV
Nickel	mg/kg	3.5	None	3.5	Site-Specific BTV
Potassium-40	pCi/g	16.0	None	16.0	Site-Specific BTV
Radium-226	pCi/g	0.97	None	0.97	Site-Specific BTV
Radium-228	pCi/g	-	None	-	Site-Specific BTV
Selenium	mg/kg	0.46	None	0.46	Site-Specific BTV
Silver	mg/kg	0.008	None	0.008	Site-Specific BTV
Sodium	mg/kg	-	None	-	Site-Specific BTV
Thallium	mg/kg	0.031	None	0.031	Site-Specific BTV
Thorium	mg/kg	1.7	None	1.7	Site-Specific BTV
Uranium	mg/kg	0.59	None	0.59	Site-Specific BTV
Vanadium	mg/kg	8.2	None	8.2	Site-Specific BTV
Zinc	mg/kg	16	None	16	Site-Specific BTV
Gamma Radiation	cpm	8,673	None	8,673	Site-Specific BTV

Notes:

-	No BTV
BSA	Background Study Area
BTV	background threshold value
cpm	counts per minute
Js	Jurassic Summerville Formation
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram

4.5.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T6 and the raw gamma radiation and grid averaged gamma radiation survey results.

4.5.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T6 in May 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in August 2018 to collect data within the Goback survey units. A gamma radiation survey was also performed in the Tse Tah West drainage within the area in conjunction with the RSE for the Brodie 1 Mine; results are presented in Appendix J of the RSE Report. The applied gamma BTV for non-AUM Target T6 is 8,673 cpm. A total of 4,474 measurements were collected as part of the gamma radiation survey at non-AUM Target T6 across 57 survey units. An average scan density of 78 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I6-4.

Table I6-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target BR-06 (T6)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	8,673	
Measurements	#	4,474	57
Minimum	cpm	5,455	7,161
Maximum	cpm	11,256	8,433
Average	cpm	7,919	7,907
Median	cpm	8,018	7,979
Standard Deviation	cpm	692	344
90th Percentile	cpm	8,671	8,298
95th Percentile	cpm	8,905	8,347
99th Percentile	cpm	9,640	8,424
Measurements per Survey Unit	#/grid	78	
Measurements Above Gamma BTV	#	444	0
Measurements Above Gamma BTV	%	9.9	0.0

Notes:
BTV background threshold value
cpm counts per minute

4.5.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 9.9 percent of the measurements within the Target boundaries, in some cases exceeding greater than two times the applied gamma BTV (8,673 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-4 (Js) gamma survey results is provided on Figure I6-6. This graph shows that the spread of radiation data at Target T6 (shown on left) begins within the lower range of BSA-4 (Js) gamma levels (shown on right) and then rises above background radiation. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T6 is slightly higher than the data cloud from the BSA-4 (Js) data set. A box plot showing the quartiles of the data sets is provided in Figure I6-7. The box plot shows that the median of Target T6 radiation levels is higher than the median of the BSA-4 (Js) data set and lower than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I6-8. No mining activity was observed within the survey area of Target T6. In general, Target T6 has surficial gamma radiation levels below BSA-4 (Js) levels across the Target and surrounding area, indicating that the survey did not identify the area of potential elevated gamma activity identified by the ASPECT gamma survey (Figure I6-3). No TENORM or mining-related activities were observed. Section 4.5.5.3 presents the grid averaged results of the gamma radiation survey.

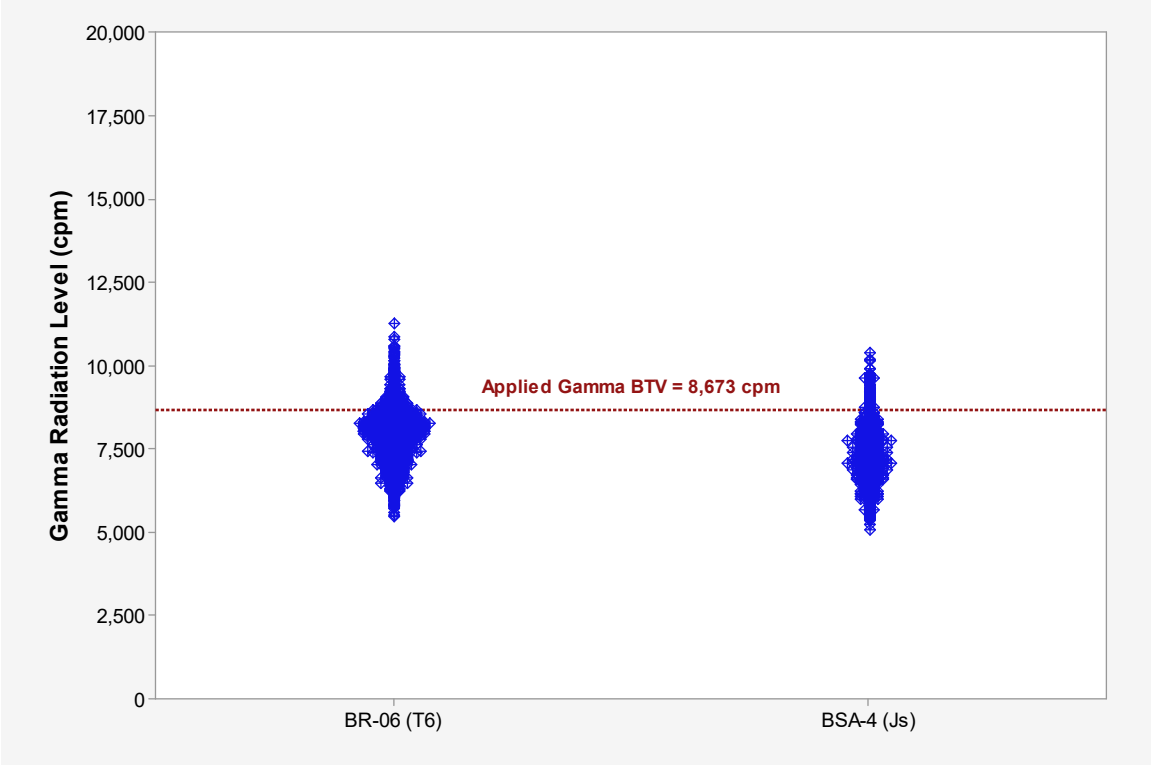


Figure I6-6. Individual Value Plot of Raw Gamma Radiation Levels at Target BR-06 (T6) and BSA-4 (Js)

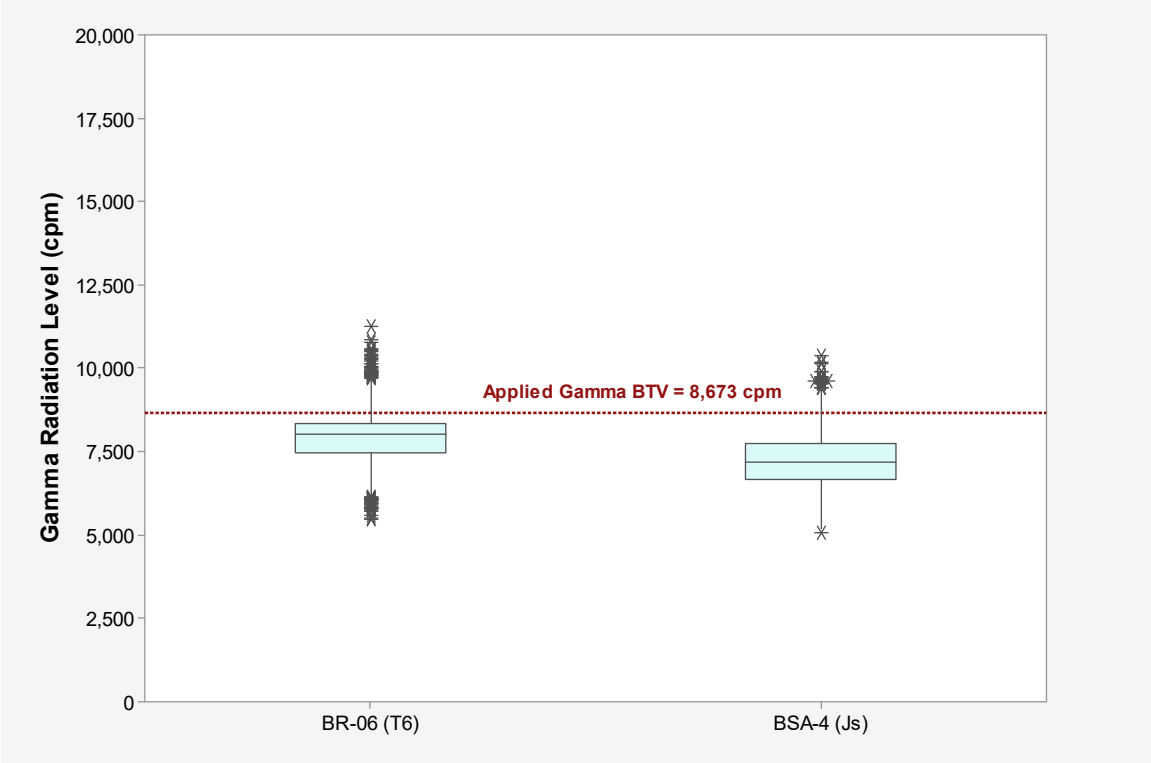
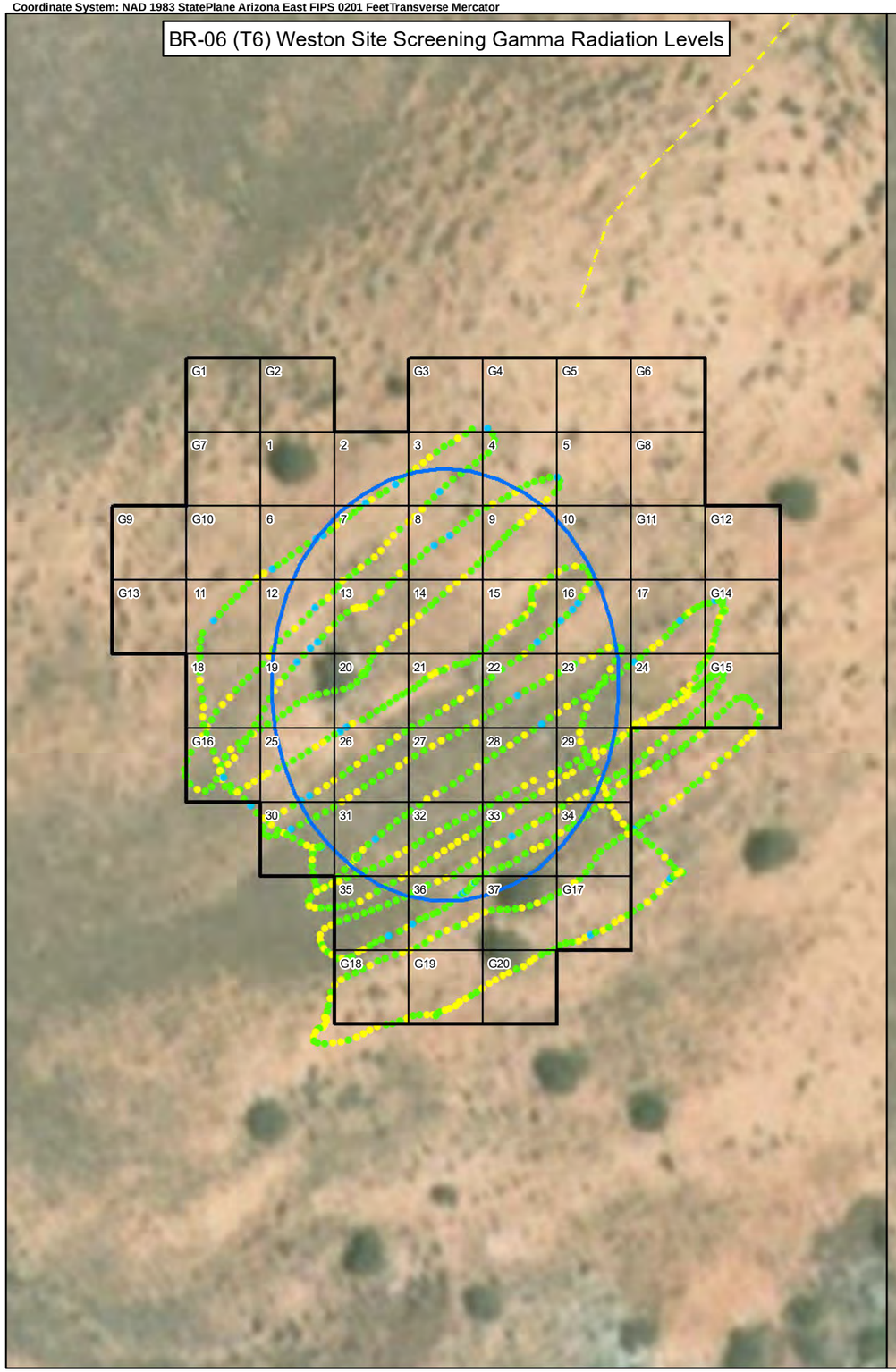
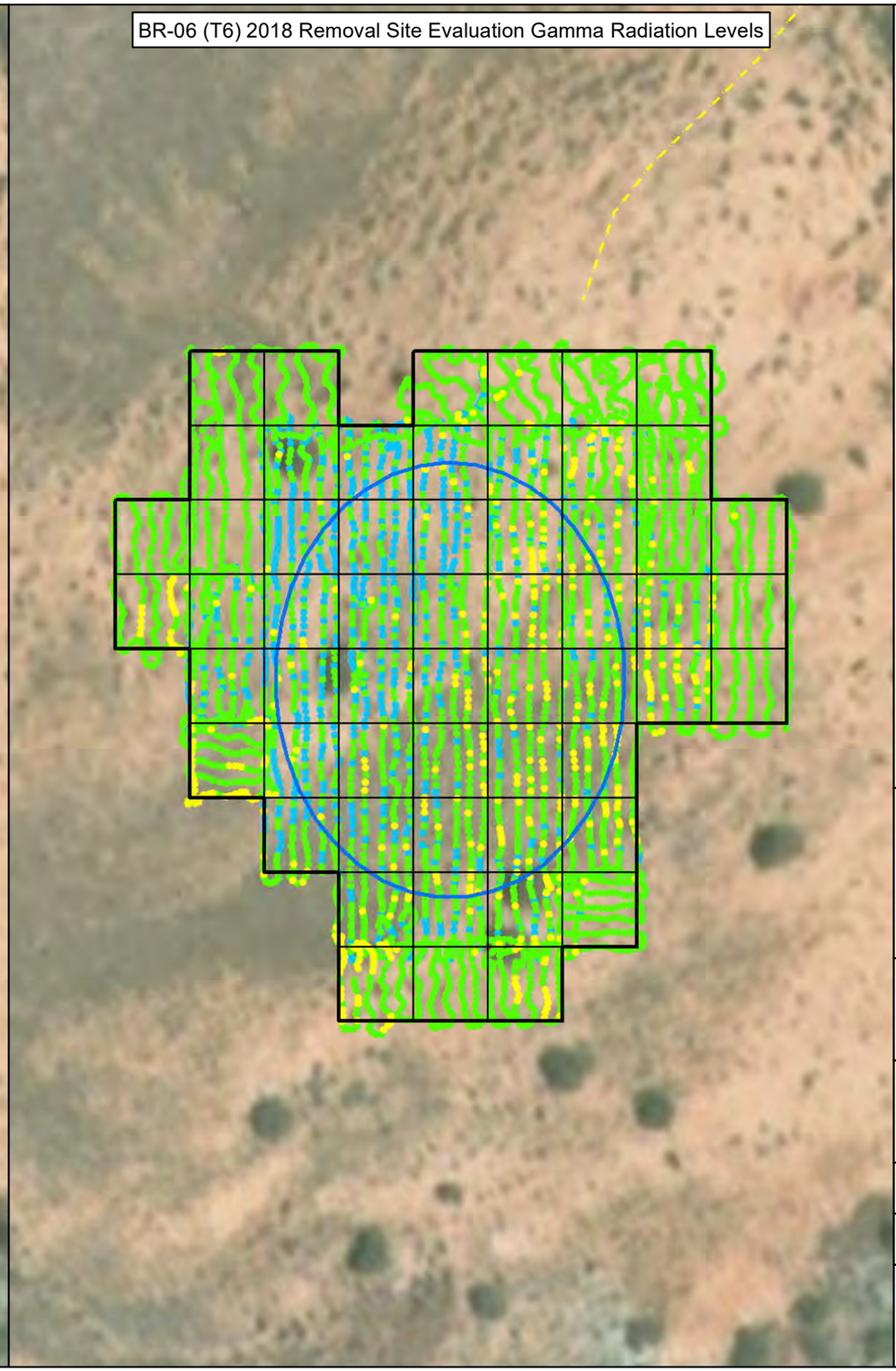


Figure I6-7. Box Plot of Raw Gamma Radiation Levels at Target BR-06 (T6) and BSA-4 (Js)

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





Gamma Reading (cpm)*

≤ 7,231	≤ Avg. BG
7,231 - 8,673	Avg. BG - 1 x BTV
8,673 - 17,346	1 x BTV - 2 x BTV
17,346 - 26,019	2 x BTV - 3 x BTV
26,019 - 34,692	3 x BTV - 4 x BTV
34,692 - 86,730	4 x BTV - 10 x BTV
≥ 86,730	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Access Route - Foot

1 in = 60 ft

1:720

N
W E
S

0 30 60 120 Feet

NON-AUM TARGET BR-06 (T6) SITE 2018 REMOVAL SITE EVALUATION VS WESTON SITE SCREENING GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019

Notes:
*The applied gamma background threshold value (BTV) for BR-04 Non-AUM Target is 8,673 cpm derived from BSA-4 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I6-8**

4.5.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 4.5.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 4.5.5.1. Figure I6-9 and Figure I6-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-4 (Js) data set (shown on right). None of the survey units within the survey area of Target T6 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I6-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I6-11 as discussed further in Section 2.8. No survey units exceeded the gamma BTV.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 4.5.6.

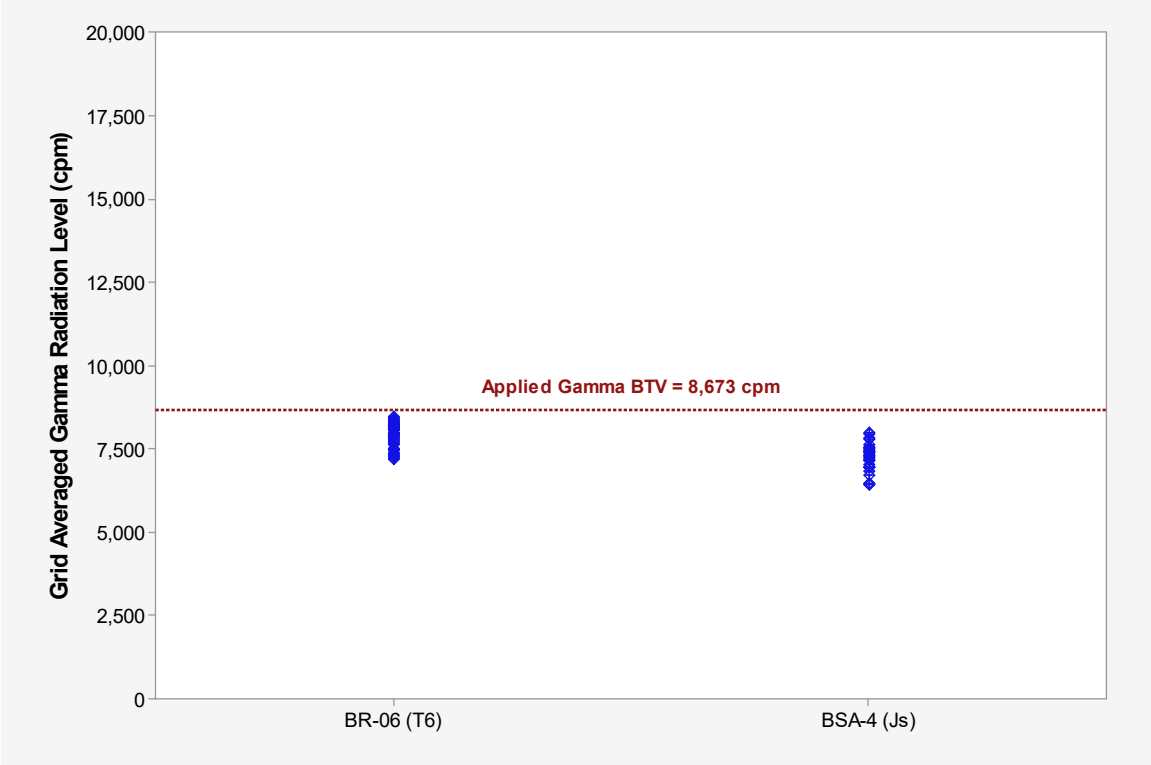


Figure I6-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target BR-06 (T6) and BSA-4 (Js)

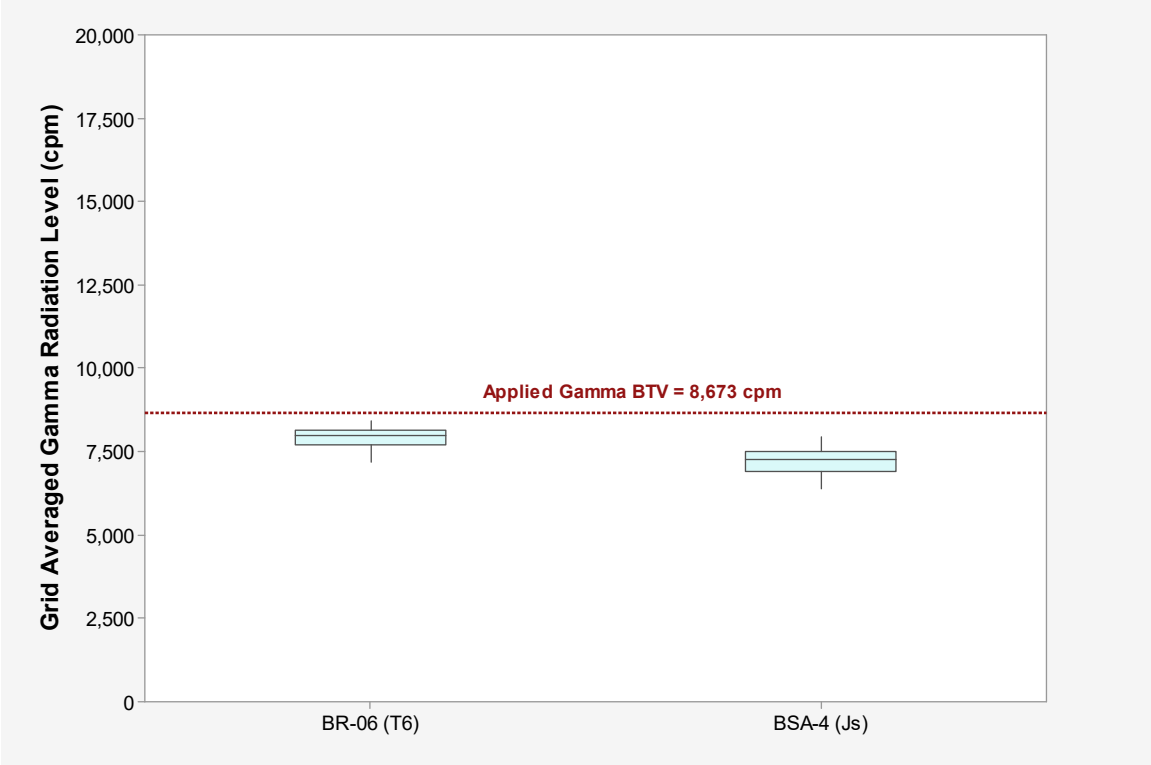
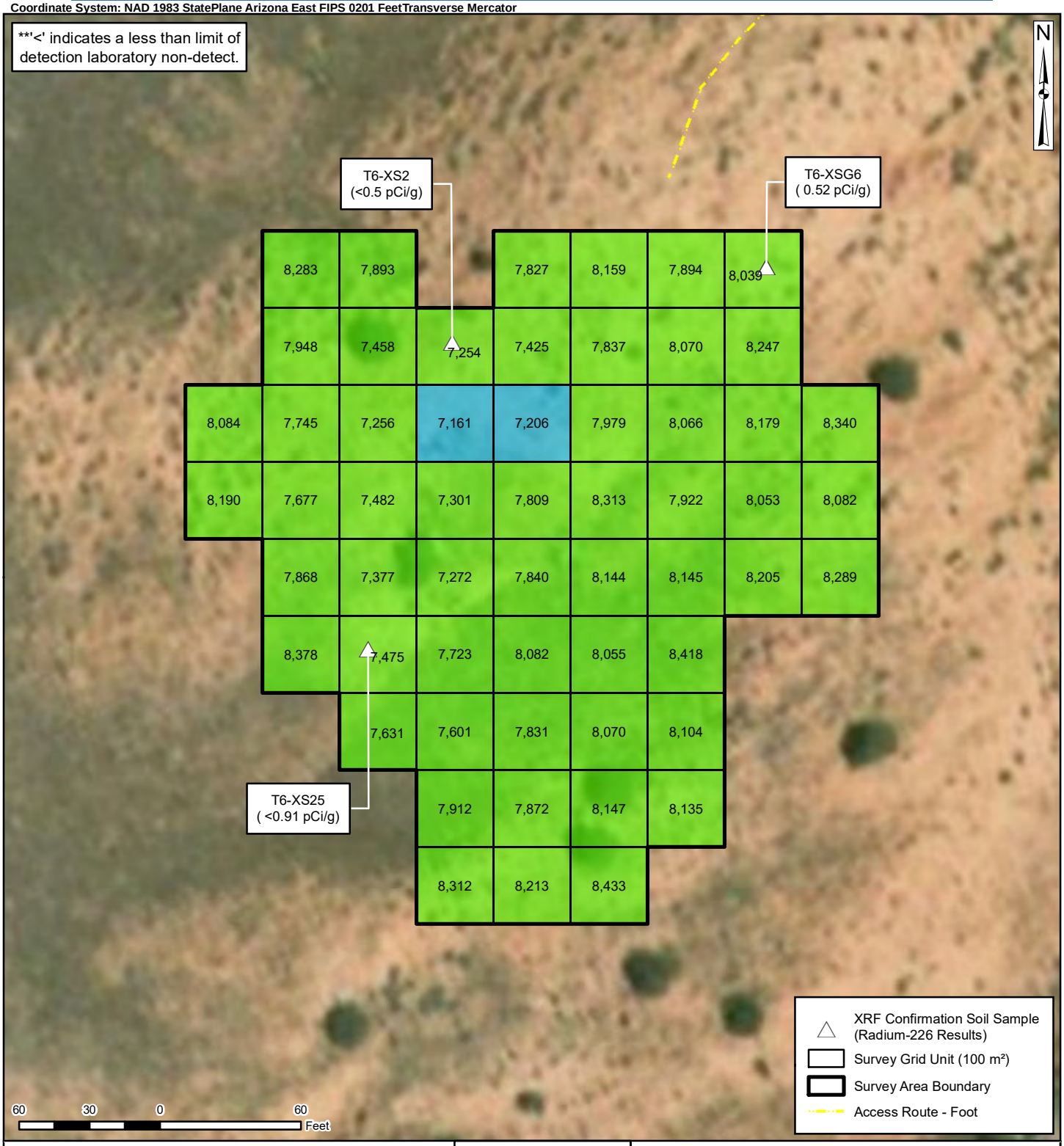


Figure I6-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target BR-06 (T6) and BSA-4 (Js)

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



Grid Averaged Gamma Reading (cpm)*

≤ 7,231	≤ Avg. BG
7,231 - 8,673	Avg. BG - 1 x BTV
8,673 - 17,346	1 x BTV - 2 x BTV
17,346 - 26,019	2 x BTV - 3 x BTV
26,019 - 34,692	3 x BTV - 4 x BTV
34,692 - 86,730	4 x BTV - 10 x BTV
≥ 86,730	≥ 10 x BTV

*The applied gamma background threshold value (BTV) for BR-06 (T6) is 8,673 cpm derived from BSA-4 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET BR-06 (T6) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
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Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/12/2019	

4.5.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T6. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 4.5.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 4.5.6.2.

4.5.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T6: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I6-1 and I6-2. All the results of the XRF confirmation soil samples are presented in Table I6-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T6 following the methods outlined in Section 2.4 and shown in Figure I6-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 57 measurements were collected across 57 survey units from the survey area of Target T6 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I6-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T6 at a depth of 0 to 3 inches bgs. Four XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I6-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 4.5.7.

Table I6-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BR-06 (T6)

Analyte	Units	Applied BTV	T6-XS2-01-051218		T6-XS25-01-051218		T6-XSG6-01-081918	
			Result	Q	Result	Q	Result	Q
Survey Unit			X2		XG25		XG6	
Aluminum	mg/kg	3,680	2,100		2,400		2,600	
Antimony	mg/kg	-	<0.099	U	<0.098	UJ	0.06	J
Arsenic	mg/kg	1.4	1.1		1.6		1.2	
Barium	mg/kg	65	51		53		48	
Beryllium	mg/kg	0.21	0.15		0.16		0.16	
Cadmium	mg/kg	0.073	<0.2	U	0.034	J	<0.2	U
Calcium	mg/kg	19,700	9,800		13,000		9,100	
Chromium	mg/kg	4.2	1.9		2.2		2.3	
Cobalt	mg/kg	1.6	1.1		1.3		1.2	
Copper	mg/kg	3.1	1.5	J	2.4		1.9	J
Iron	mg/kg	3,840	2,400		2,600		2,800	
Lead	mg/kg	4	2.1		2.5		2.1	
Lithium	mg/kg	6	3		3.4		3.8	
Magnesium	mg/kg	3,310	1,500		1,700		1,500	
Manganese	mg/kg	180	95		100		94	
Molybdenum	mg/kg	0.3	0.13	J	0.11	J	0.16	J
Nickel	mg/kg	3.5	2	J	2.4		2.2	
Potassium-40	pCi/g	16	11.1		10.7		12.3	
Radium-226	pCi/g	0.97	<0.5	UJ	<0.91	UJ	0.52	LT
Radium-228	pCi/g	-	<-0.03	U	<0.47	U	<0.24	U
Selenium	mg/kg	0.46	<0.99	U	<0.98	U	<0.98	U
Silver	mg/kg	0.008	<0.049	U	0.0088	J	<0.049	U
Sodium	mg/kg	-	<99	UJ	<98	UJ	<98	U
Thallium	mg/kg	0.031	0.022		0.027		0.023	
Thorium	mg/kg	1.7	1.1		1.2		1.3	
Uranium	mg/kg	0.59	0.53		0.92		0.64	
Vanadium	mg/kg	8.2	4.7		5.8		5.7	
Zinc	mg/kg	16	6.3	J	7.1	J	6.4	J

Notes:

-	No BTV
BTV	Background threshold value
J	Estimated value
J-	Estimated value, may be biased low
mg/kg	Milligrams per kilogram
NA	Not applicable
NV	No Value
pCi/g	Picocuries per gram
Q	Qualification
U	Not considered detected. The associated value is the method detection limit (MDL).
UJ	Not considered detected. The associated value is the reported concentration, which is estimated.

Table I6-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target BR-06 (T6)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	1.4	3,840	4	180	0.30	1.7	0.59	8.2	16
Measurements	#	57	57	57	57	57	57	57	57	57
Detects	#	2	57	57	57	6	44	13	0	45
Nondetects	#	55	0	0	0	51	13	44	57	12
Minimum	mg/kg	2.14	2,165	1.4	94.6	0.1	1.0	0.1	-	8.1
Maximum	mg/kg	2.26	5,009	6.8	221.3	0.3	2.8	4.0	-	13.5
Standard Deviation	mg/kg	0.1	619	1.1	28.6	0.1	0.4	1.0	-	1.4
Average	mg/kg	2.2	3,341	3.9	143.7	0.2	1.7	1.0	-	10.2
Median	mg/kg	2.2	3,375	3.9	139.9	0.2	1.6	0.9	-	10.2
Relative Standard Deviation	%	4	19	28	20	62	26	94	-	14
90th Percentile	mg/kg	2.24	4,007	5.4	180.2	0.3	2.2	1.4	-	12.1
95th Percentile	mg/kg	2.25	4,279	5.9	201.6	0.3	2.5	2.5	-	12.8
99th Percentile	mg/kg	2.26	4,875	6.6	219.8	0.3	2.7	3.7	-	13.3
Measurements Above Applied BTV	#	2	12	25	6	2	17	8	0	0
Measurements Above Applied BTV	%	3.5	21.1	43.9	10.5	3.5	29.8	14.0	0.0	0.0

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

- No data

BTV Background threshold value

mg/kg Milligram per kilogram

XRF X-ray fluorescence

4.5.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T6 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T6 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T6. The estimated BTVs are identified in Section 4.5.4 and Table I6-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I6-7 presents a summary of the background comparison for different measurement and soil depths at Target T6. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T6. Further gamma radiation screening indicated that gamma levels at Target T6 are similar to the BSA. Therefore, while multiple COPCs have been identified at Target T6 based on a conservative comparison to background, risk screening may be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I6-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target BR-06 (T6)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic	✓		✓
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron		✓	✓
Lead		✓	✓
Lithium			
Magnesium			
Manganese		✓	✓
Molybdenum			
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium			
Silver	✓		✓
Sodium			
Thallium			
Thorium		✓	✓
Uranium	✓	✓	✓
Vanadium			
Zinc			

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

4.5.7 Primary Contaminant Mapping

4.5.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 4.5.6.2 identified the COPCs at Target T6. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 4.5.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I6-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T6 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 4.5.7.1 through Section 4.5.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T6. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

4.5.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I6-7. Arsenic exceeded the applied BTV in 3.5 percent of in situ XRF measurements and in one of the three XRF confirmation samples. The applied BTV for arsenic is 1.4 mg/kg for Target T6 as presented in Section 4.5.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I6-5 and Attachment I3, respectively. Figure I6-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T6 and BSA-4 (Js) samples. Figure I6-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T6 and BSA-4 (Js) samples. Summary statistics for XRF measurements are provided in Section 4.5.6.1. Arsenic XRF concentrations measured in surface soils at Target T6 ranged between 2.14 and 2.26 mg/kg with an average and standard deviation of 2.2 mg/kg and 0.1 mg/kg, respectively. The average arsenic XRF concentration is above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T6 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I6-14. Overall, the majority of detectable arsenic XRF results in surface soils were higher than the applied BTV. However, exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T6.

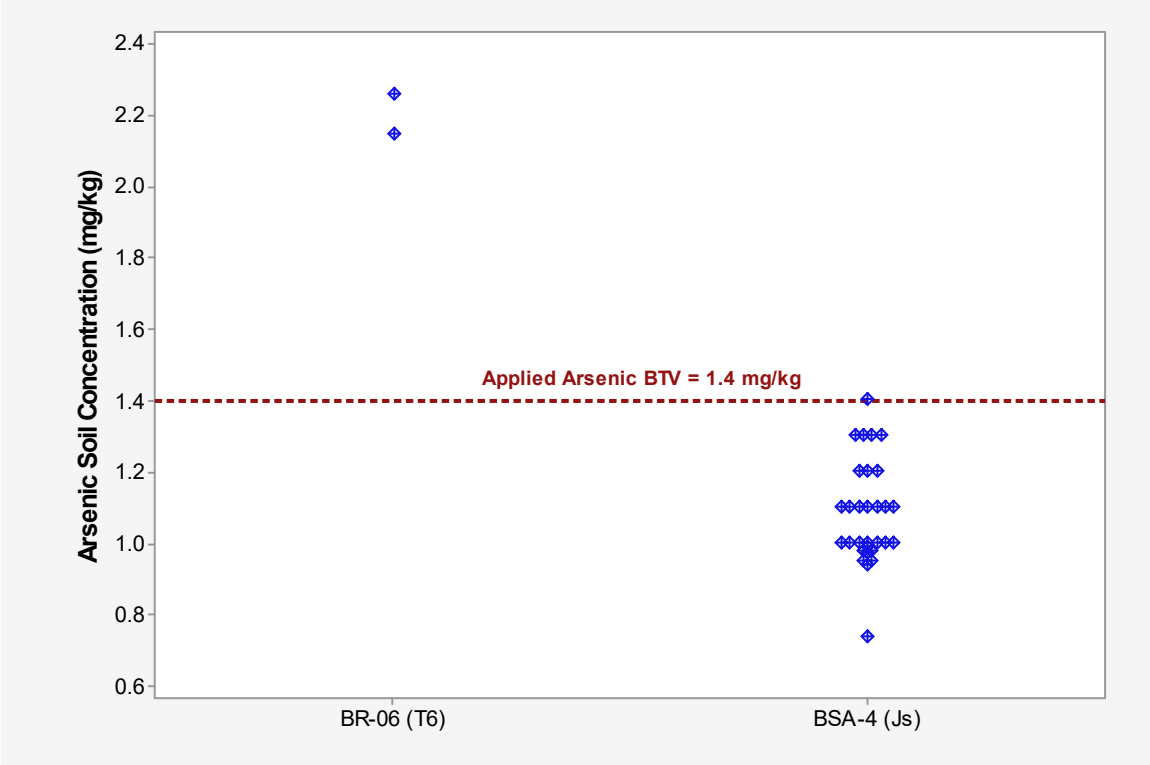


Figure I6-12. Individual Value Plot for Target BR-06 (T6) and BSA-4 (Js) Arsenic Soil Concentrations

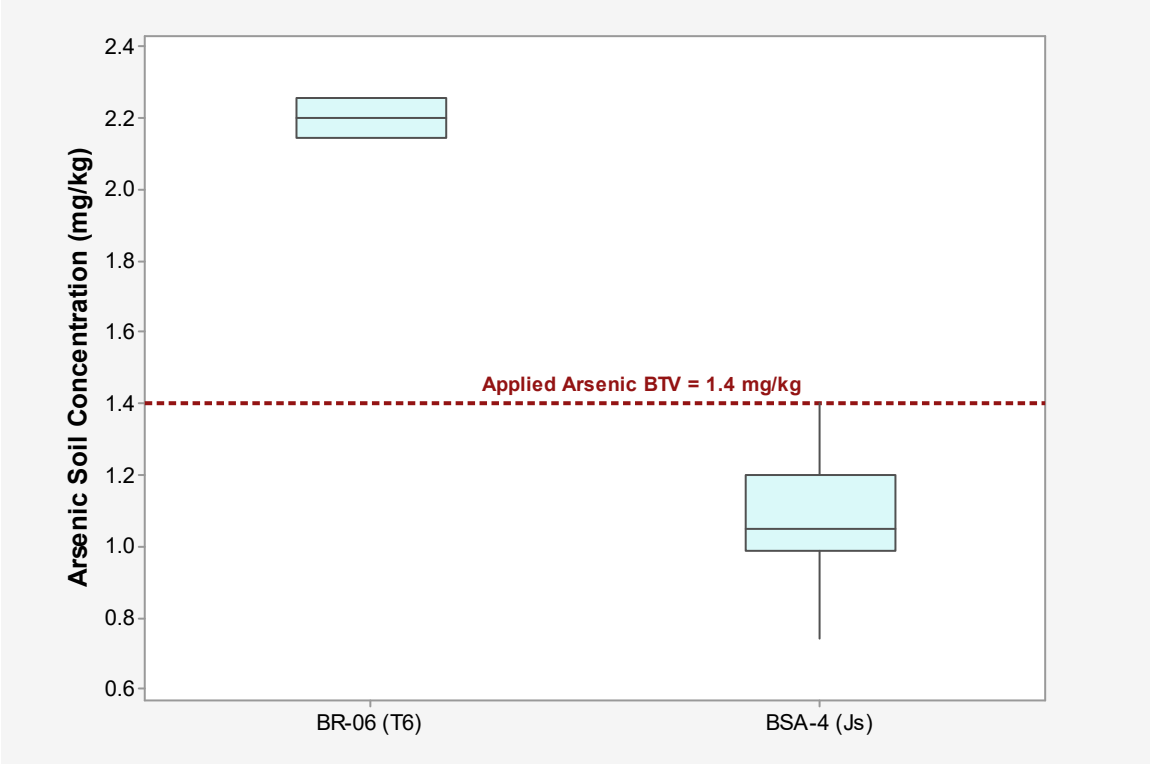
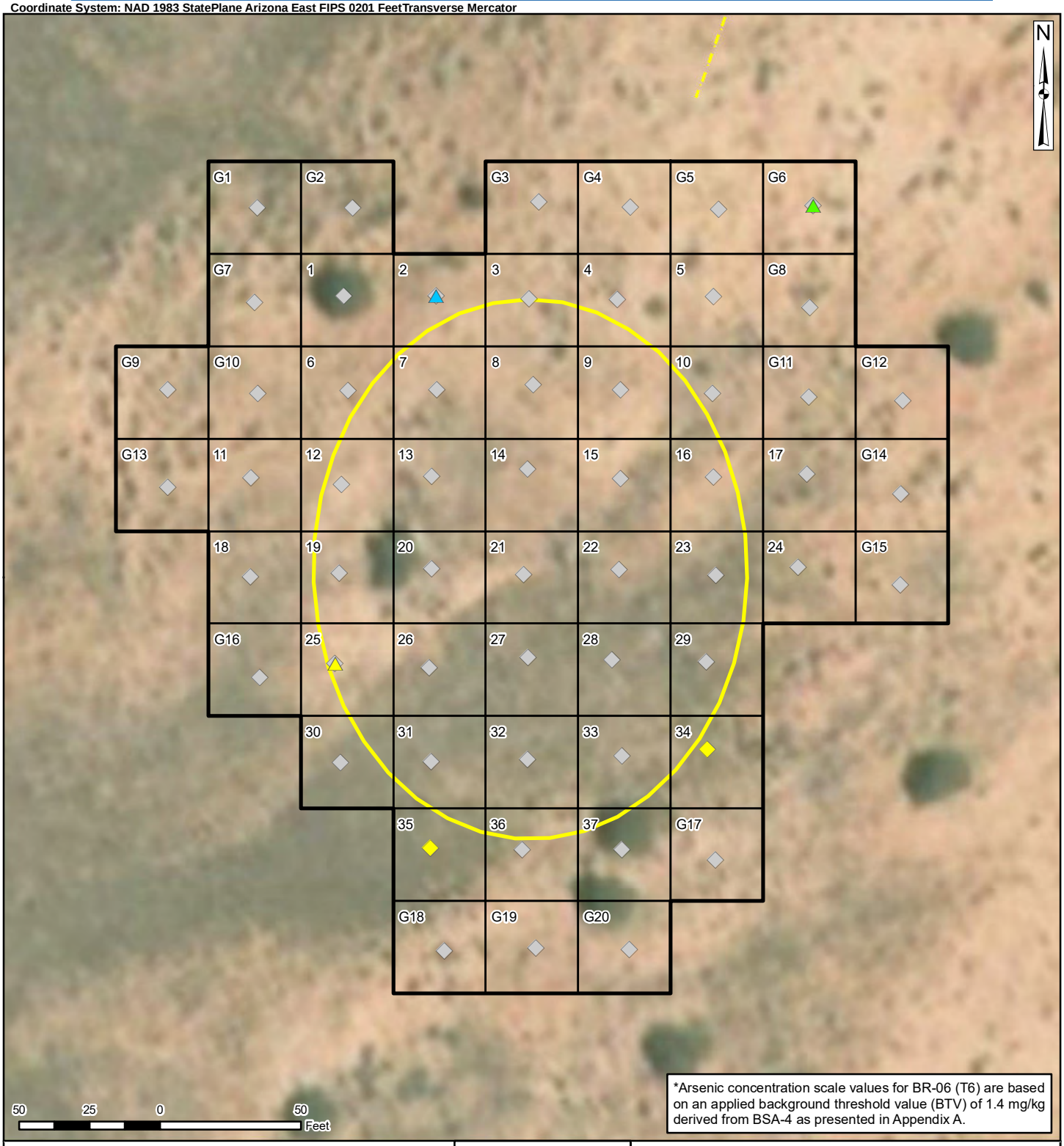


Figure I6-13. Box Plot for Target BR-06 (T6) and BSA-4 (Js) Arsenic Soil Concentrations

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



*Arsenic concentration scale values for BR-06 (T6) are based on an applied background threshold value (BTV) of 1.4 mg/kg derived from BSA-4 as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 1.1
- 1.1 - 1.4
- 1.4 - 2.8
- 2.8 - 4.2
- 4.2 - 5.6
- 5.6 - 14
- ≥ 14
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET BR-06 (T6) SURFACE SOIL ARSENIC CONCENTRATION MAP

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Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/12/2019	

4.5.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I6-7. Lead exceeded the applied BTV in 43.9 percent of in situ XRF measurements but not in the XRF confirmation samples. The applied BTV for lead is 4 mg/kg for Target T6 as presented in Section 4.5.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I6-5 and Attachment I3, respectively. Figure I6-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T6 and BSA-4 (Js) samples. Figure I6-16 presents a box plot of detectable lead XRF soil concentrations for Target T6 and BSA-4 (Js) samples. Summary statistics for XRF measurements are provided in Section 4.5.6.1. Lead XRF concentrations measured in surface soils at Target T6 ranged between 1.4 and 6.8 mg/kg with an average and standard deviation of 3.9 mg/kg and 1.1 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T6 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I6-17. Overall, the majority of detectable lead XRF results in surface soils were less than the applied BTV. However, exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T6.

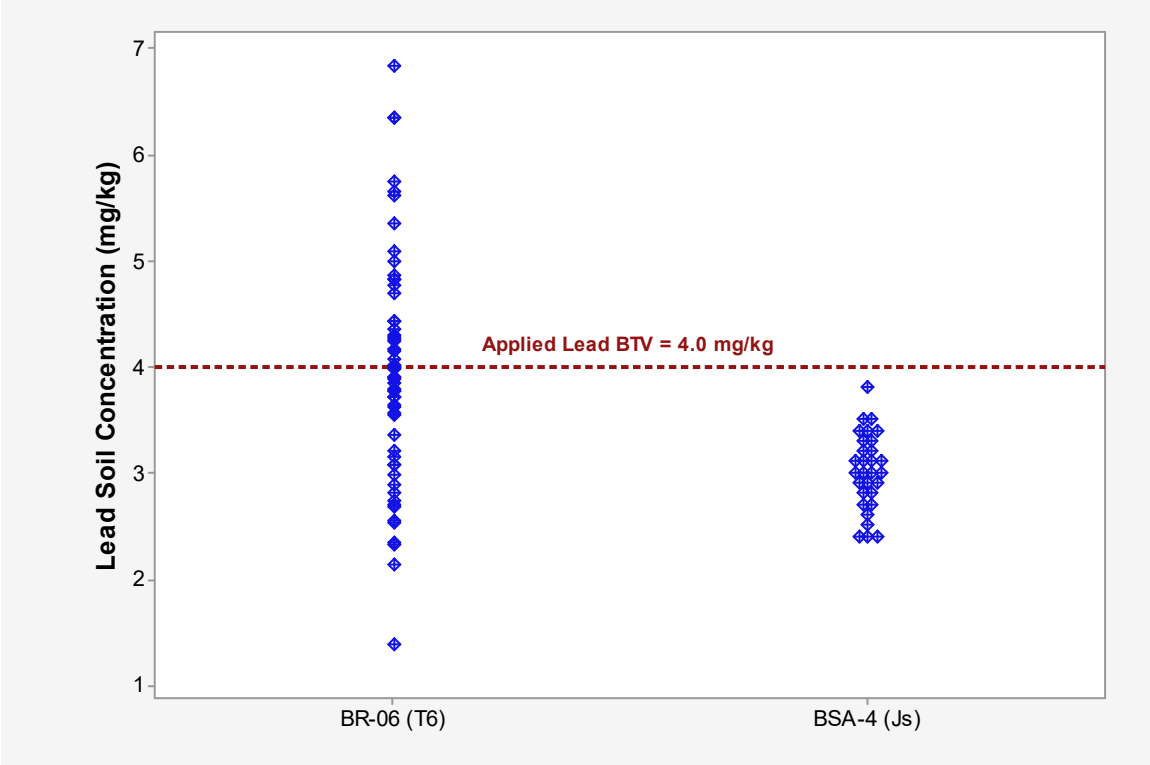


Figure I6-15. Individual Value Plot for Target BR-06 (T6) and BSA-4 (Js) Lead Soil Concentrations

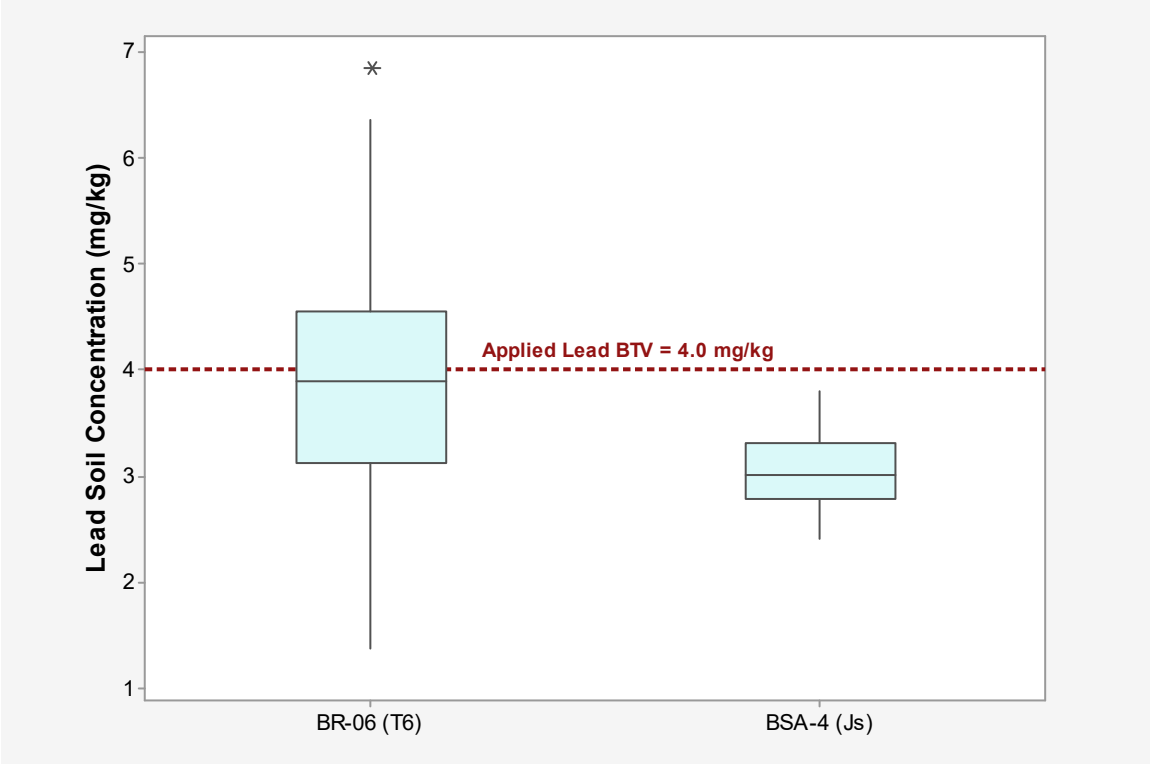
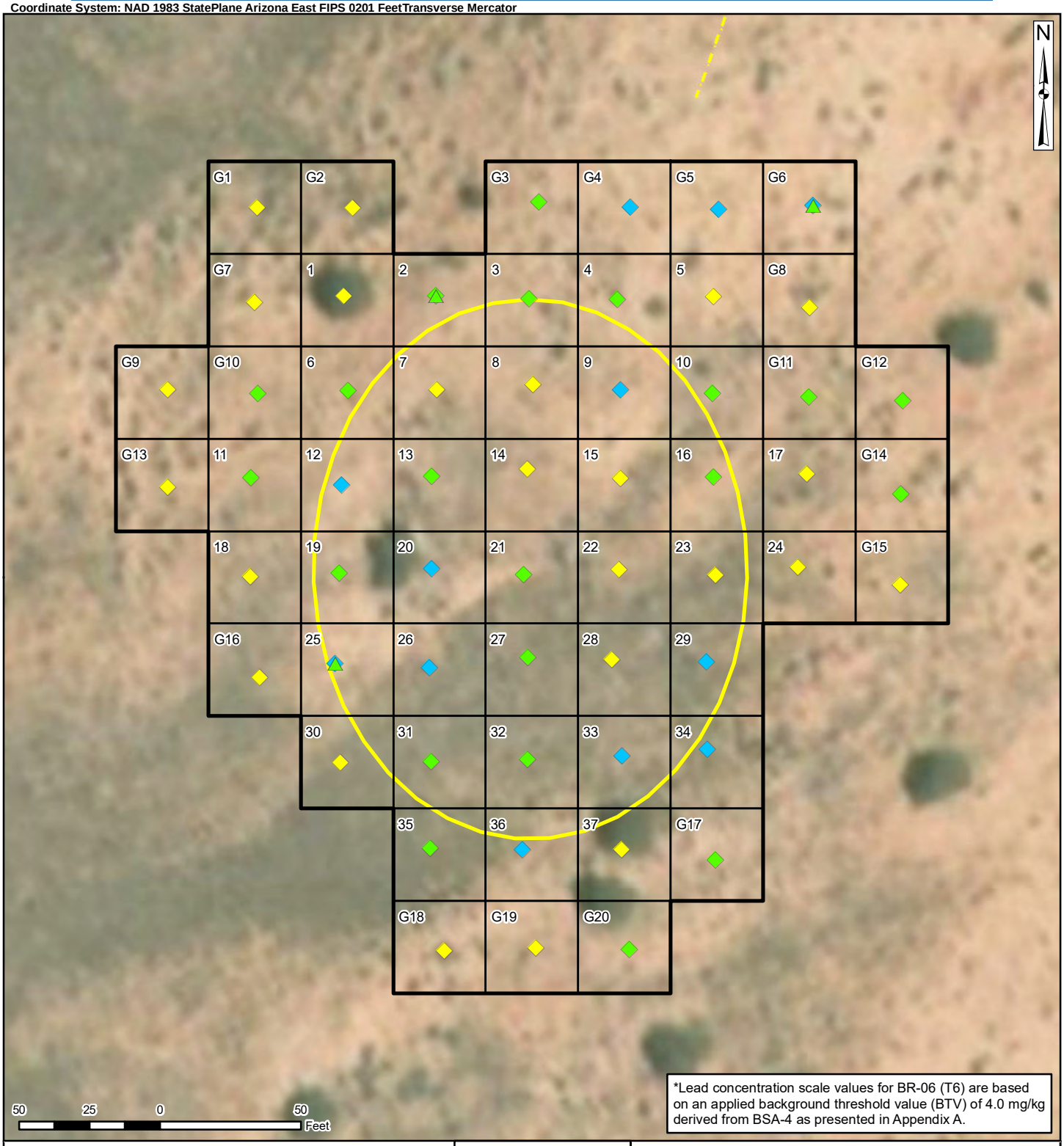


Figure I6-16. Box Plot for Target BR-06 (T6) and BSA-4 (Js) Lead Soil Concentrations



Lead Concentration Scale (mg/kg)*

- ≤ 3.0
- 3.0 - 4.0
- 4.0 - 8.0
- 8.0 - 12
- 12 - 16
- 16 - 40
- ≥ 40

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET BR-06 (T6) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I6-17
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.5.7.4 Thorium

Thorium was identified as a COPC in surface soil as shown in Table I6-7. Thorium exceeded the applied BTV in 29.8 percent of in situ XRF measurements but in none of the XRF confirmation samples. The applied BTV for thorium is 1.7 mg/kg for Target T6 as presented in Section 4.5.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I6-5 and Attachment I3, respectively. Figure I6-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T6 and BSA-4 (Js) samples. Figure I6-19 presents a box plot of detectable thorium XRF soil concentrations for Target T6 and BSA-4 (Js) samples. Summary statistics for XRF measurements are provided in Section 4.5.6.1. Thorium XRF concentrations measured in surface soils at Target T6 ranged between 1.0 and 2.8 mg/kg with an average and standard deviation of 1.7 mg/kg and 0.4 mg/kg, respectively. The average thorium XRF concentration is equal to the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T6 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I6-20. Overall, the majority of detectable thorium XRF results in surface soils were slightly below the applied BTV. Exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T6.

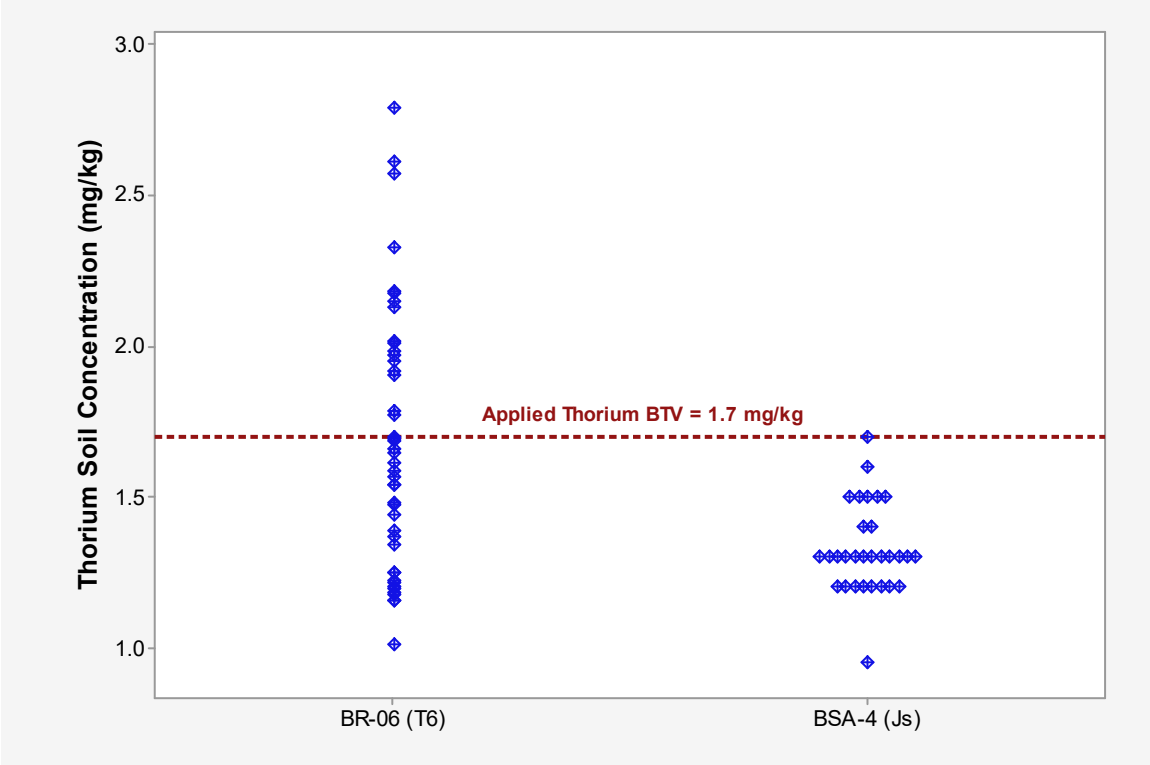


Figure I6-18. Individual Value Plot for Target BR-06 (T6) and BSA-4 (Js) Thorium Soil Concentrations

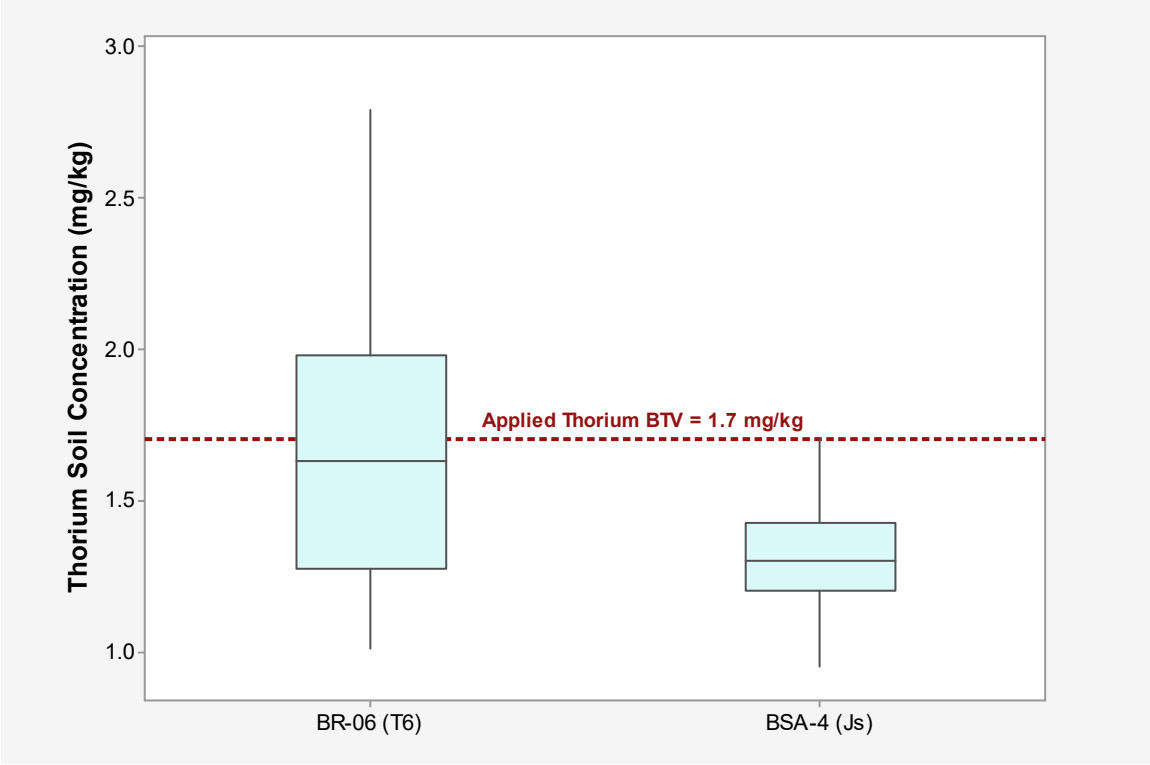
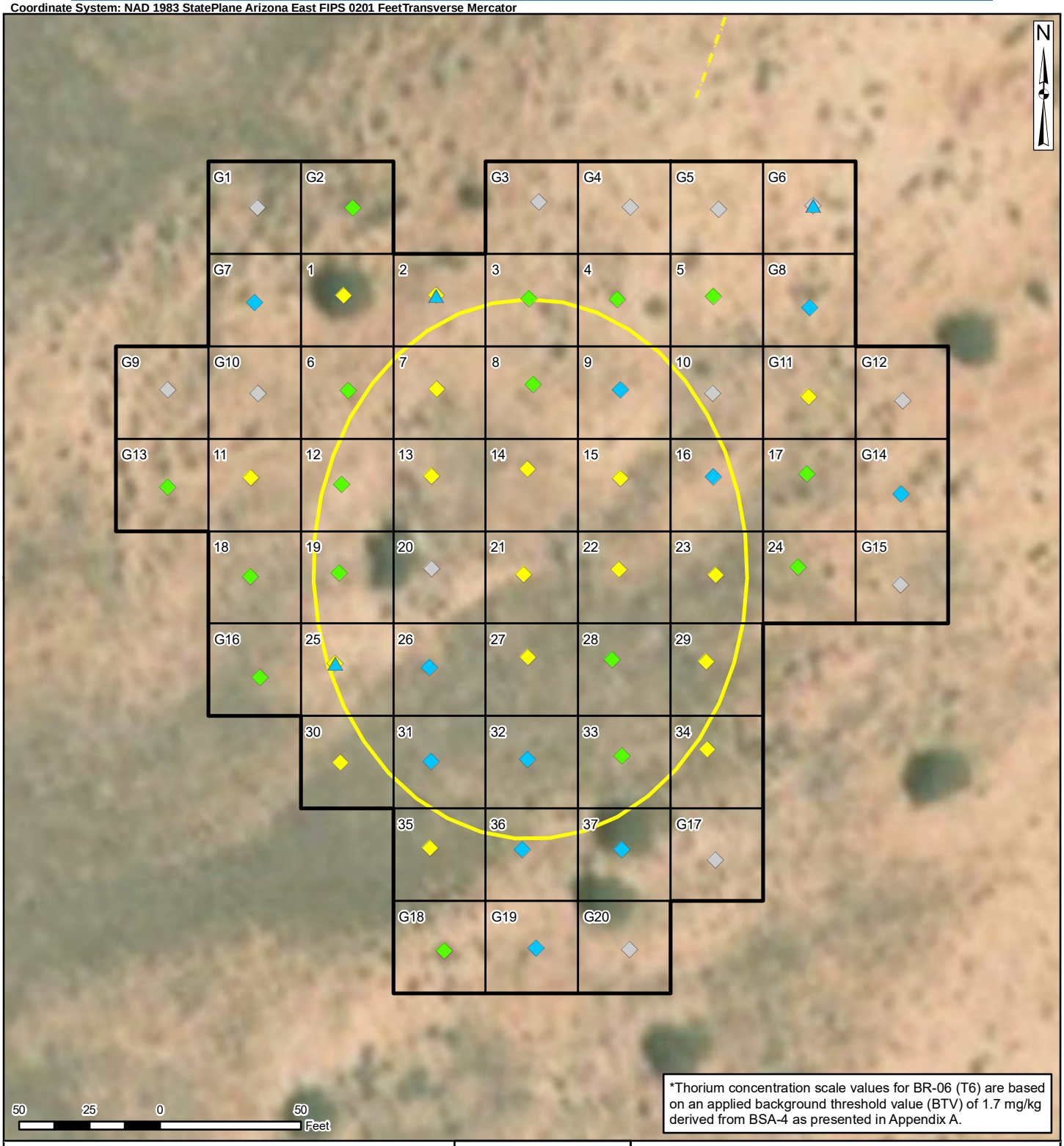


Figure I6-19. Box Plot for Target BR-06 (T6) and BSA-4 (Js) Thorium Soil Concentrations

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



*Thorium concentration scale values for BR-06 (T6) are based on an applied background threshold value (BTV) of 1.7 mg/kg derived from BSA-4 as presented in Appendix A.

Thorium Concentration Scale (mg/kg)*

- ≤ 1.3
- 1.3 - 1.7
- 1.7 - 3.4
- 3.4 - 5.1
- 5.1 - 6.8
- 6.8 - 17
- ≥ 17
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET BR-06 (T6) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I6-20
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.5.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I6-7. Uranium exceeded the applied BTV in 14 percent of in situ XRF measurements and in two of the three XRF confirmation samples. The applied BTV for uranium is 0.59 mg/kg for Target T6 as presented in Section 4.5.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I6-5 and Attachment I3, respectively. Figure I6-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T6 and BSA-4 (Js) samples. Figure I6-22 presents a box plot of detectable uranium XRF soil concentrations for Target T6 and BSA-4 (Js) samples. Summary statistics for XRF measurements are provided in Section 4.5.6.1. Uranium XRF concentrations measured in surface soils at Target T6 ranged between 0.1 and 4.0 mg/kg with an average and standard deviation of 1.0 mg/kg and 1.0 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T6 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I6-23. Overall, the majority of detectable uranium results in surface soils were above the applied BTV. However, the maximum XRF value was about 6.8 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T6.

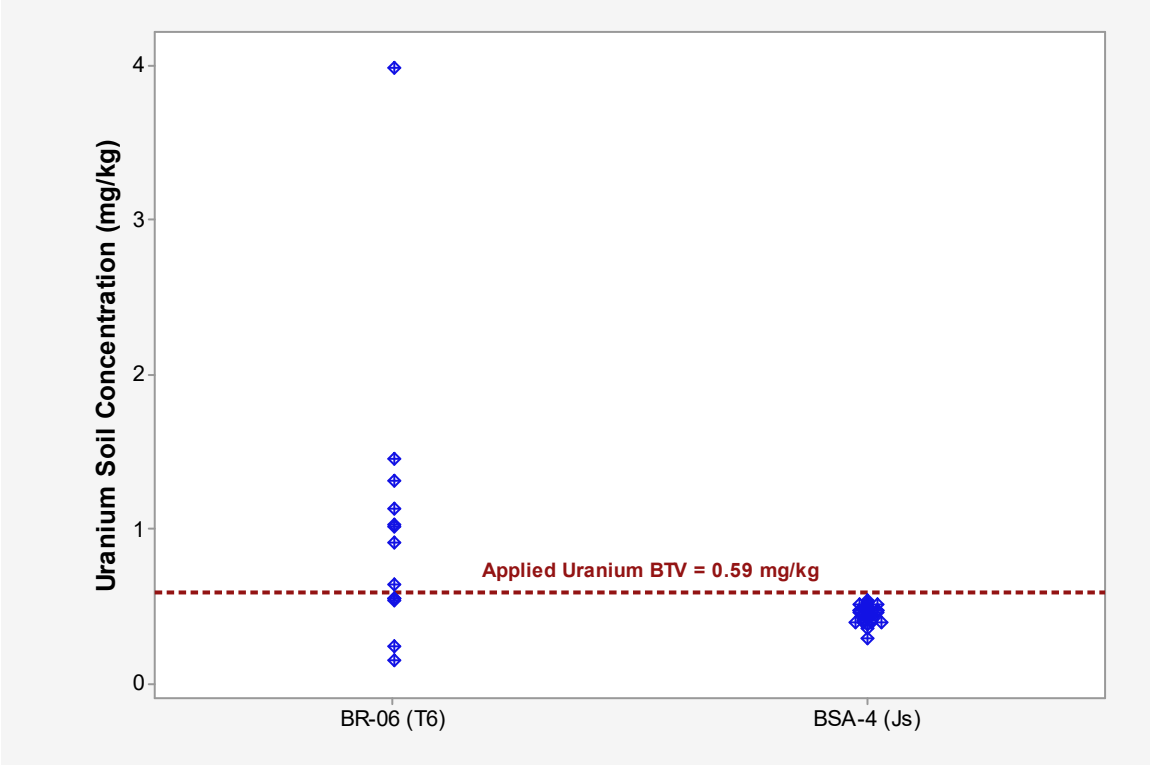


Figure I6-21. Individual Value Plot for Target BR-06 (T6) and BSA-4 (Js) Uranium Soil Concentrations

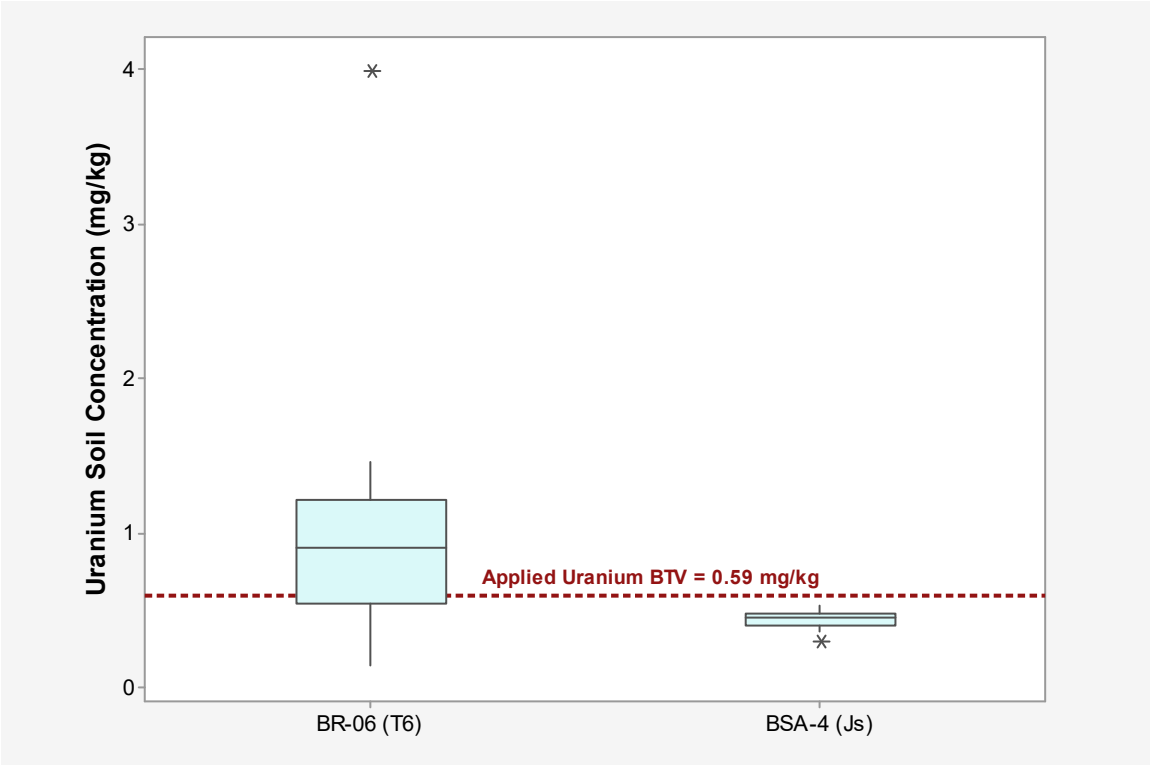
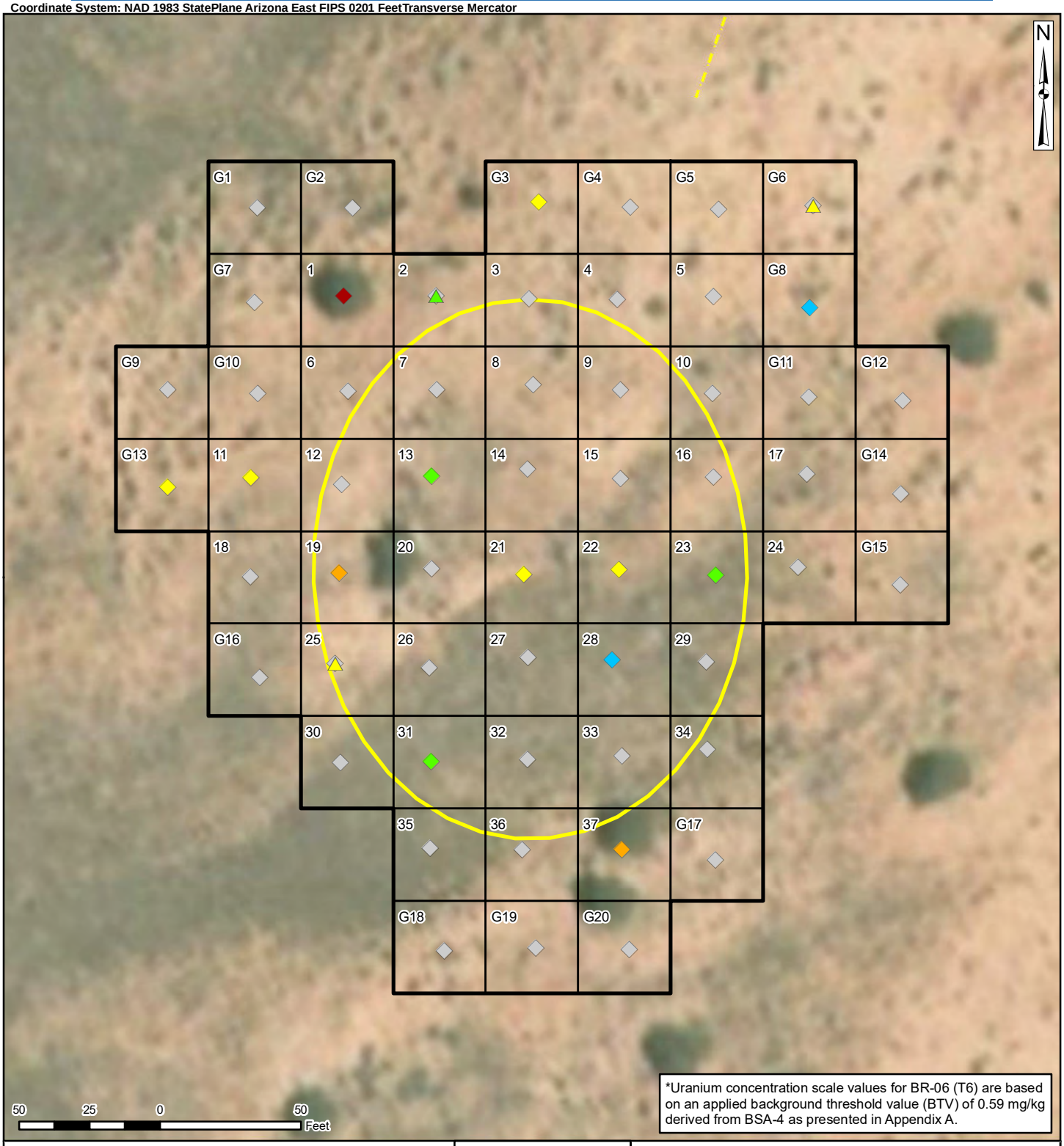


Figure I6-22. Box Plot for Target BR-06 (T6) and BSA-4 (Js) Uranium Soil Concentrations

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



*Uranium concentration scale values for BR-06 (T6) are based on an applied background threshold value (BTV) of 0.59 mg/kg derived from BSA-4 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 0.44
- 0.44 - 0.59
- 0.59 - 1.2
- 1.2 - 1.8
- 1.8 - 2.4
- 2.4 - 5.9
- ≥ 5.9
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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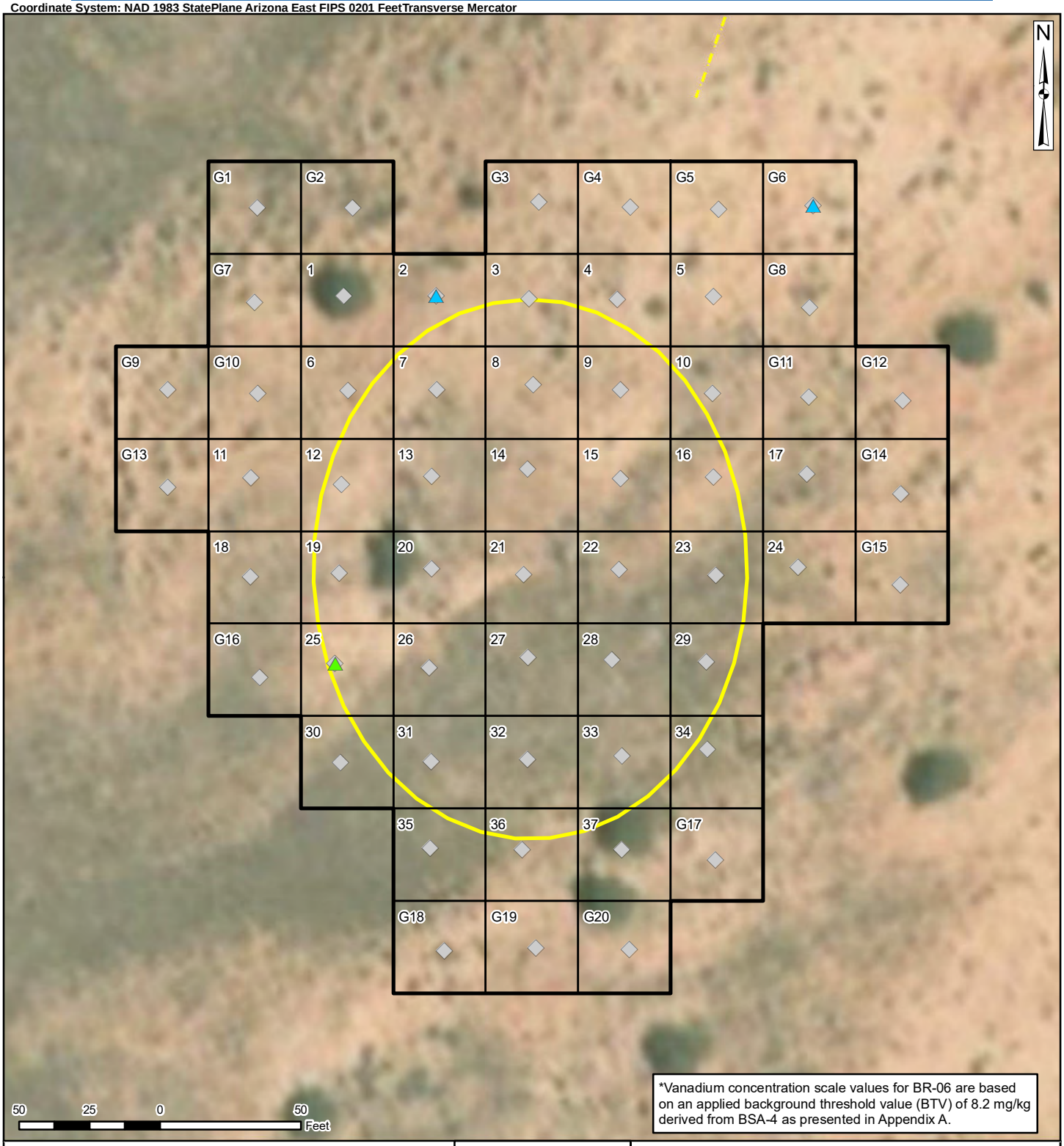
NON-AUM TARGET BR-06 (T6) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I6-23
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/11/2019	

4.5.7.6 Vanadium

Vanadium was not identified as a COPC in surface soils as shown in Table I6-7. Vanadium was not detected in surface soils at Target T6 above XRF analyzer detection limit of 16 mg/kg. The applied BTV for vanadium is 8.2 mg/kg for Target T6 as presented in Section 4.5.4. Vanadium concentrations in XRF confirmation samples ranged from 4.7 to 5.8 mg/kg, which are also below the applied BTV. The analytical results for vanadium for XRF confirmation samples are provided in Table I6-5. Summary statistics for XRF measurements are provided in Section 4.5.6.1. A soil contaminant map showing the individual vanadium concentrations observed at Target T6 from XRF confirmation samples is provided in Figure I6-26.

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



*Vanadium concentration scale values for BR-06 are based on an applied background threshold value (BTV) of 8.2 mg/kg derived from BSA-4 as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 5.7
- 5.7 - 8.2
- 8.2 - 16
- 16 - 25
- 25 - 33
- 33 - 82
- ≥ 82
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET BR-06 (T6) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I6-24
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 6/23/2019	

4.5.8 Conclusions

Target T6 (BR-06) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T6. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T6 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T6. ASPECT gamma survey results generally did not correlate with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T6 was well documented through gamma radiation surveys, and the lateral extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific BTVs for Target T6 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. No grid averaged gamma measurements exceeded the applied BTV.
- A total of 25 analytes were identified as occurring within the surface environment. Of these analytes, 7 were identified as COPCs. Only uranium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's observations, Target T6 does not contain TENORM. No mining-related activities or features were observed in the field, and no historical exploratory borings, vents, or other mine openings were noted in the file review or during field observation. TENORM and NORM were not identified visually or by gamma survey.
- There are no immediate significant physical hazards present at Target T6.
- Access is by dirt road with a small four-wheel-drive vehicle, followed by footpath.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No groundwater wells are documented within the vicinity of Target T6. Rural residences are located nearby; however, it is not known if water is provided by utility or private well. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T6. Therefore, evaluation of the leachability of metals and radionuclides is not required.

- No mine waste was observed at Target T6; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; no data gaps remain at Target T6.

5.0 GROUP B FIELD SAMPLING RESULTS

This section presents field sampling results for Group B Targets T7 (BK-01) and T8 (BK-02). No other non-AUM Targets are associated with Group B.

5.1 NON-AUM TARGET T7 (BK-01)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T7 (BK-01).

5.1.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T7 (BK-01) is associated with the Block K mine (M2), a former surface mine in the Tse Tah Region in Subarea Group B. Target T7 is administered by the Red Mesa and Sweetwater Chapters of the Navajo Nation and is accessible by vehicle via Highway 160, which is located to the northeast. Two Targets (T7 and T8) are affiliated with the Block K mine and included in the MCAP (Weston 2016) as BK-01 and BK-02, respectively. No known historical information is associated with Target T7. Three residences are within 1 mile of the Target with the closest located 0.5 mile to the south. A Target location and access map for Target T7 is shown in Figure I7-1.

A topographical relief map for the Block K mine area and associated non-AUM Targets is provided in Figure I7-2. The elevation at Target T7 ranges from 5,535 to 5,541 feet amsl with an average of 5,538 feet amsl. The slope at Target T7 ranges from 1 to 3 percent with an average of 2 percent. There is an ephemeral drainage channel 750 feet north of Target T7. The Block K mine and Target T7 are located entirely within Qa, and the soil type for the mine and Target is Sogzie loamy fine sand (MUSYM 502) (Figures I-15 and I-16).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T7. Weston did not conduct a background study for Target T7. As a part of the RSE for the Block K mine, Tetra Tech also evaluated the associated non-AUM Targets, such as T7. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 2 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T7:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.
- Located access routes, including foot pathways and roads:

  Target T7 is accessed from a dirt road off of Highway 160 to the southwest.
- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM and TENORM were not observed at the Target.
- Mapped all drainages and potential surface water pathways at the non-AUM Target:

No drainages were present at the Target.

- Identified any exploration borings or historic haul roads:

  No exploratory borings or haul roads were identified. However, a dirt road intersects the Target boundary.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  No non-AUM Target features were identified.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

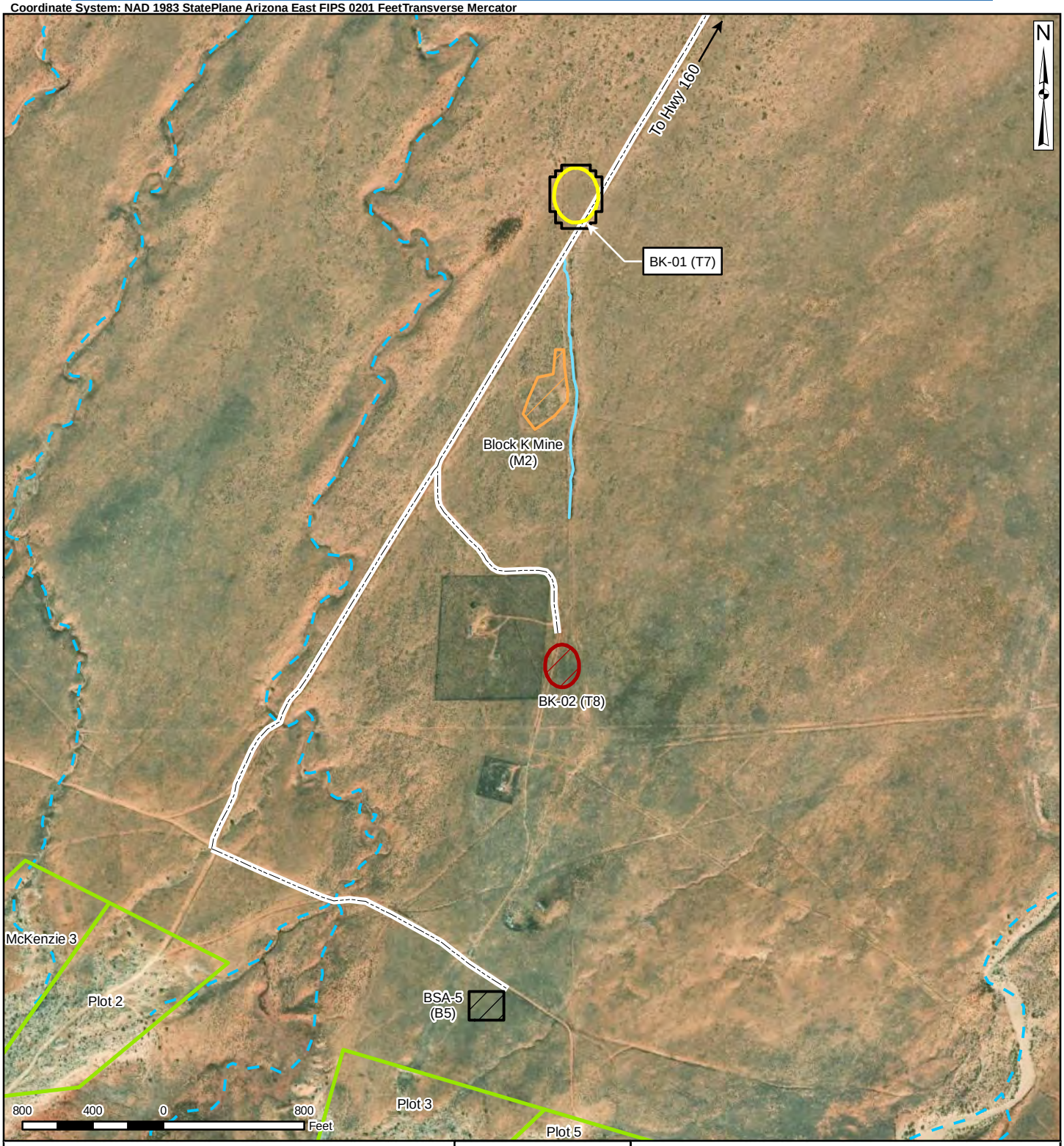
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T7 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Section 2.3 and 5.1.4)
- Conducting gamma and XRF field surveys
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 5.1.3 with results presented in Sections 5.1.6 and 5.1.7)
- Conducting a gamma radiation survey (results presented in Section 5.1.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site Boundary
Tronox AUM Site Boundary
Background Location

Non-Tronox AUM Site
Access Route - Vehicular
Drainage*
Drainage - Field Mapped

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

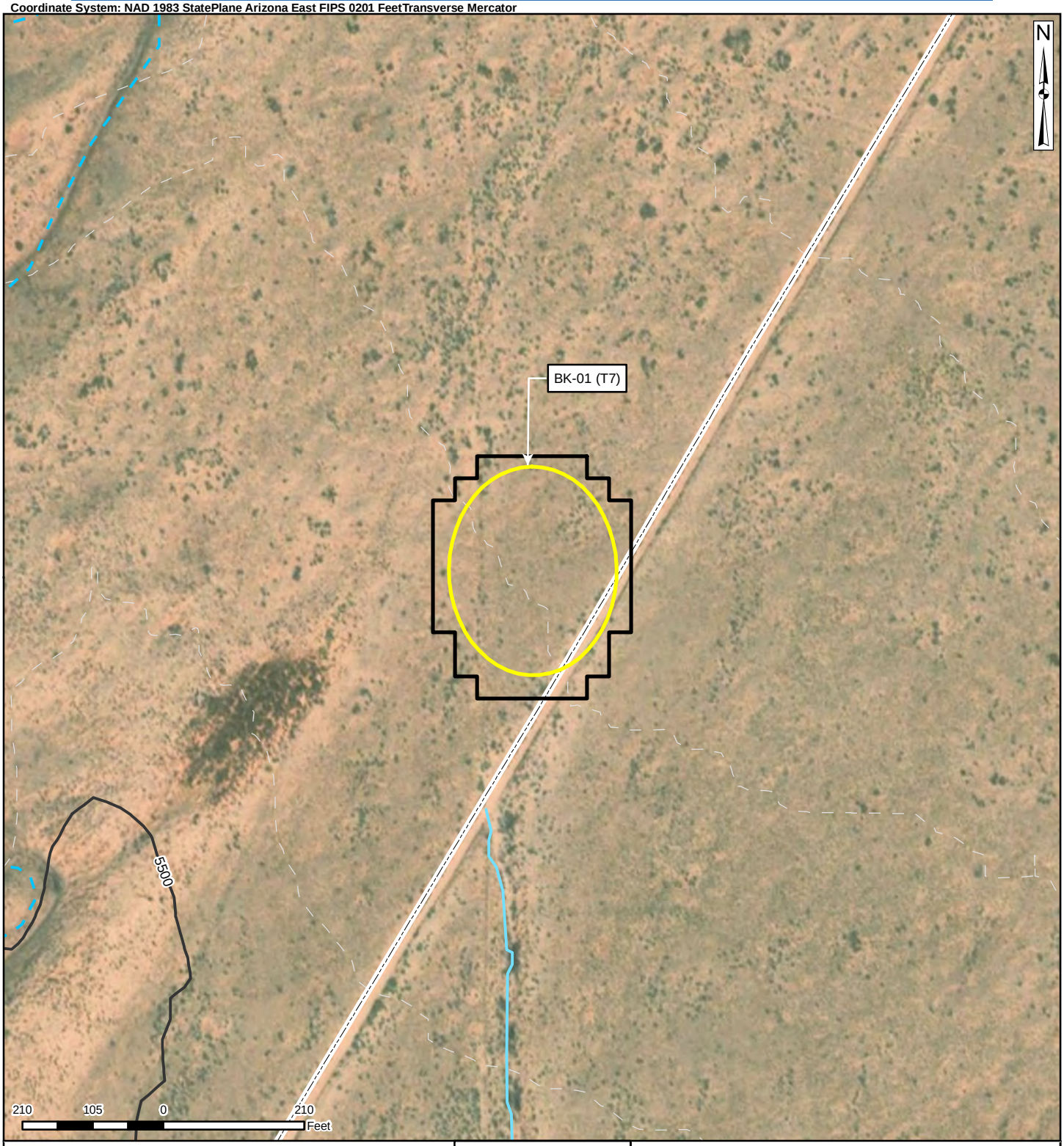
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BK-01 NON-AUM TARGET SITE LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I7-1
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	



Non-AUM Target Site Boundary
Related Survey Area
Access Route - Vehicular
Drainage*
Drainage - Field Mapped
50 ft Contour**
20 ft Contour**

*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.
**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.

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NON-AUM TARGET BK-01 (T7) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I7-2
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

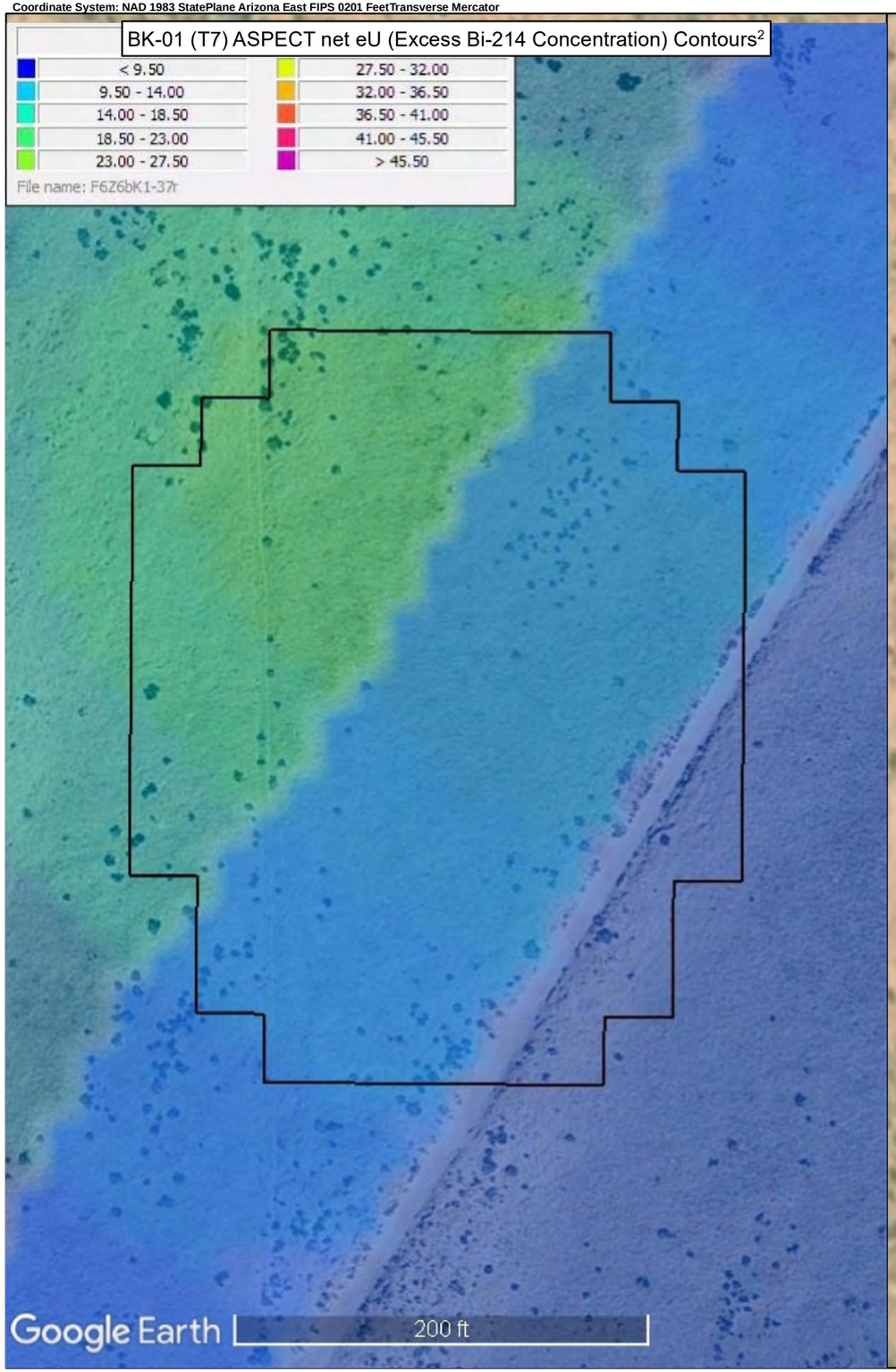
5.1.2 Gamma Radiation Survey and Field XRF Measurements

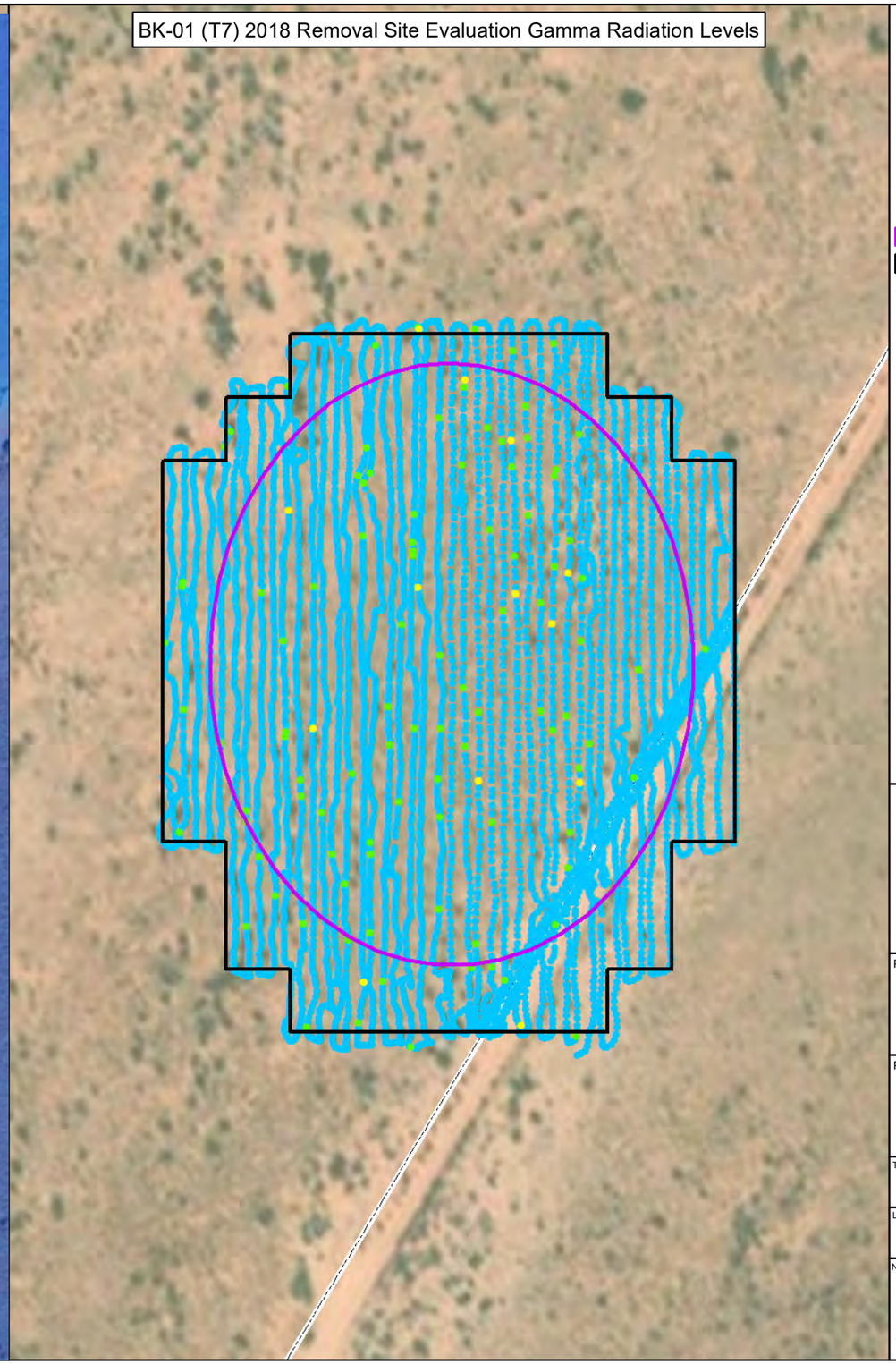
Tetra Tech performed GPS-based gamma radiation surveys (Figure I7-3) within the survey area of the non-AUM Target T7 as part of the Baseline Study in April 2018. Additional Goback gamma radiation surveys were not performed at Target T7. Tetra Tech also performed an XRF field survey at non-AUM Target T7 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I7-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 2, of the RSE Work Plan (Tetra Tech 2018). All gamma survey and XRF survey units were evaluated.

5.1.3 XRF Confirmation Sampling Overview

Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T7. Five XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from five locations (Table I7-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I7-4 and I7-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I7-2. The results of XRF confirmation sample analysis are provided in Section 5.1.6.1. Correlated XRF field measurements are provided in Attachment I3.

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





Gamma Reading (cpm)[1]

≤ 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

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Vehicular

[1]The applied gamma background threshold value (BTV) for BK-01 (T7) Non-AUM Target is 11,010 cpm derived from BSA-5 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 70 ft

1:840

N W E S

0 35 70 140 Feet

NON-AUM TARGET BK-01 (T7)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

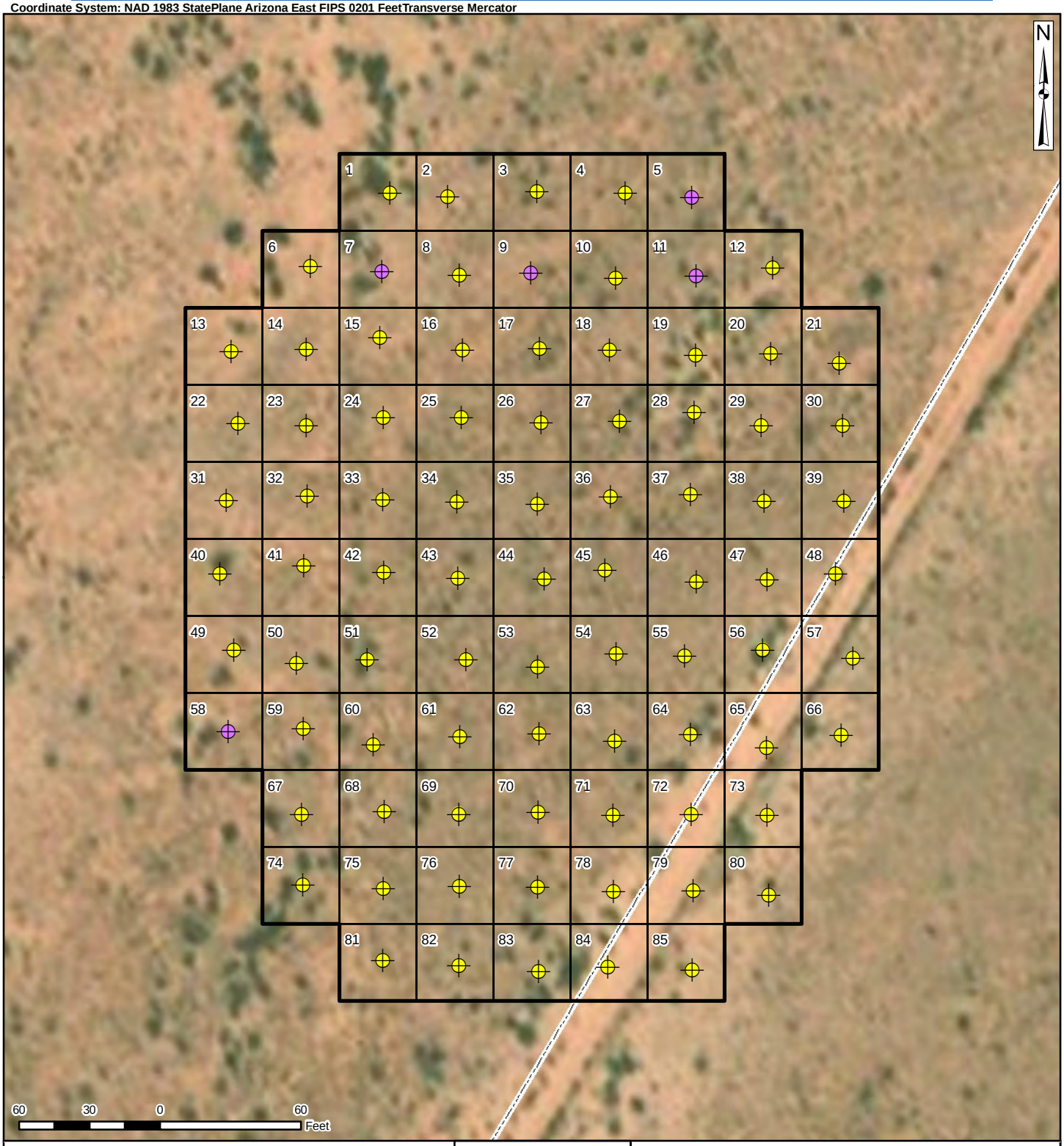
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborn Spectral Photometric Environmental Collection Technology.

Figure No.: **I7-3**



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

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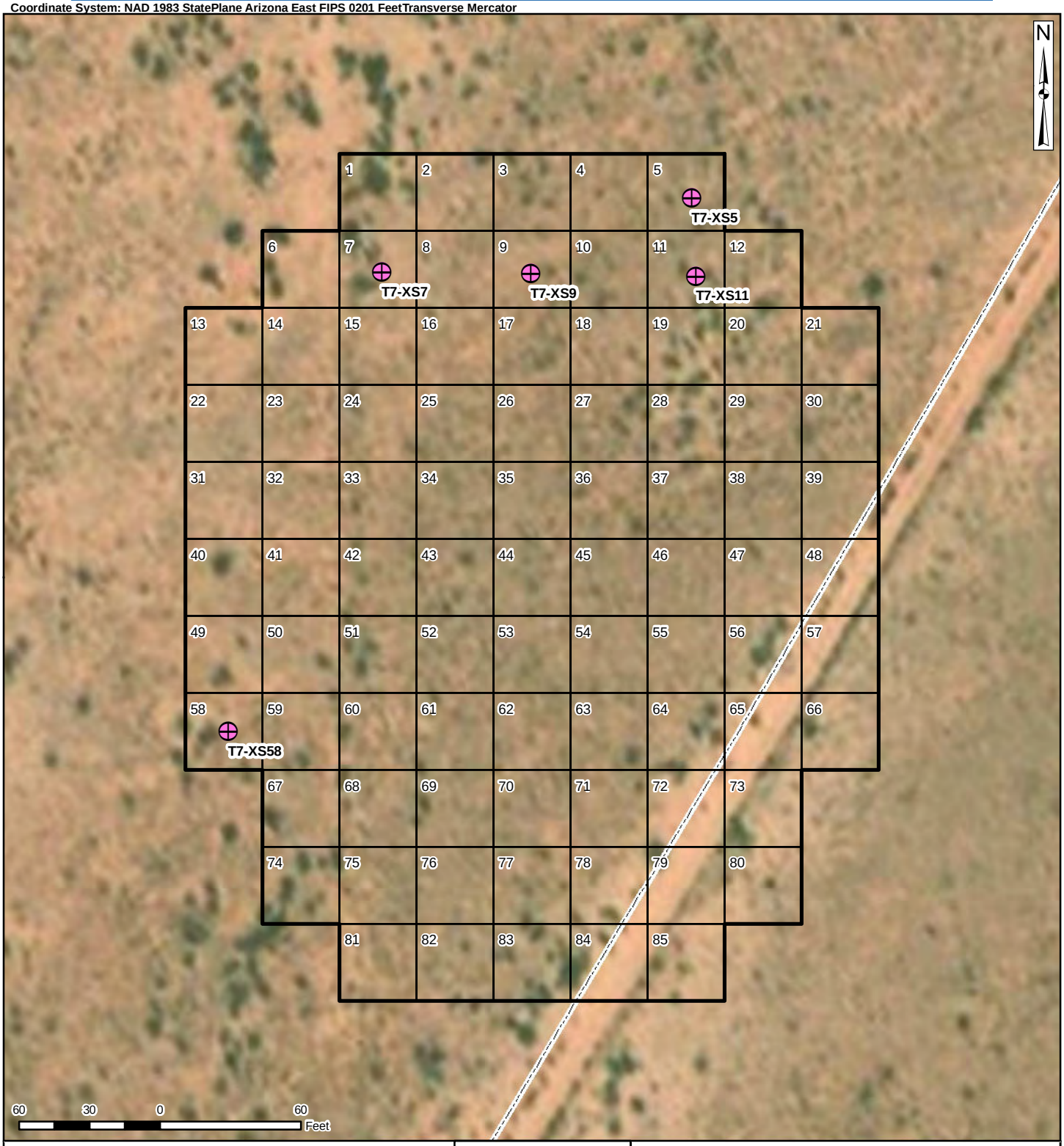
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NON-AUM TARGET BK-01 (T7) XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I7-4
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

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



XRF Confirmation Soil Sample*
(0 - 3 inches bgs)

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route
(Vehicular)

*T7-XS5 = site T7 XRF confirmation soil sample collected at survey unit 5. 0 - 3 in bgs = 0 to 3 inches below ground surface.

Prepared for: USEPA Region 9

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NON-AUM TARGET BK-01 (T7)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I7-5
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

Table I7-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target BK-01 (T7)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T7-XS5-01-042418	5	0-3	XRF Confirmation	Primary	4/24/2018	36.9181679	-109.2824300	1805035-10, 1805036-10
T7-XS7-01-042418	7	0-3	XRF Confirmation	Primary	4/24/2018	36.9180843	-109.2828822	1805035-12, 1805036-12
T7-XS9-01-042418	9	0-3	XRF Confirmation	Primary	4/24/2018	36.9180813	-109.2826656	1805035-13, 1805036-13
T7-XS11-01-042418	11	0-3	XRF Confirmation	Primary	4/24/2018	36.9180761	-109.2824248	1805035-9, 1805036-9
T7-XS58-01-042418	58	0-3	XRF Confirmation	Primary	4/24/2018	36.9175484	-109.2831126	1805035-11, 1805036-11

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I7-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BK-01 (T7)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

5.1.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 5.1.1, Target T7 surface geology is entirely within Qa with soils within the Sogzie loamy fine sands (MUSYM 502) (Figures I-15 and I-16). As a result, Background Study Area 5 (BSA-5) was selected for that combination of geology and soil type. Table I7-3 presents the Target-specific BTVs for 29 analytes and gamma radiation levels for Target T7. No regional BTVs were established for Target 7. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T7. The "Applied BTV" for each analyte is the Target-specific BTV.

Table I7-3. Applied Background Threshold Values for Non-AUM Target BK-01 (T7)

Analyte	Units	Site-Specific BTV (BSA-5)	Regional BTV (Qa)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	4,220	None	4,220	Site-Specific BTV
Antimony	mg/kg	0.160	None	0.160	Site-Specific BTV
Arsenic	mg/kg	3.9	None	3.9	Site-Specific BTV
Barium	mg/kg	68	None	68	Site-Specific BTV
Beryllium	mg/kg	0.25	None	0.25	Site-Specific BTV
Cadmium	mg/kg	0.091	None	0.091	Site-Specific BTV
Calcium	mg/kg	21,000	None	21,000	Site-Specific BTV
Chromium	mg/kg	3.6	None	3.6	Site-Specific BTV
Cobalt	mg/kg	2.0	None	2.0	Site-Specific BTV
Copper	mg/kg	4.7	None	4.7	Site-Specific BTV
Iron	mg/kg	4,500	None	4,500	Site-Specific BTV
Lead	mg/kg	5.0	None	5.0	Site-Specific BTV
Lithium	mg/kg	6.8	None	6.8	Site-Specific BTV
Magnesium	mg/kg	3,640	None	3,640	Site-Specific BTV
Manganese	mg/kg	210	None	210	Site-Specific BTV
Mercury	mg/kg	0.0100	None	0.0100	Site-Specific BTV
Molybdenum	mg/kg	0.34	None	0.34	Site-Specific BTV
Nickel	mg/kg	4.1	None	4.1	Site-Specific BTV
Potassium-40	pCi/g	16.8	None	16.8	Site-Specific BTV
Radium-226	pCi/g	2.38	None	2.38	Site-Specific BTV
Radium-228	pCi/g	-	None	-	Site-Specific BTV
Selenium	mg/kg	0.47	None	0.47	Site-Specific BTV
Silver	mg/kg	0.017	None	0.017	Site-Specific BTV
Sodium	mg/kg	53	None	53	Site-Specific BTV
Thallium	mg/kg	0.045	None	0.045	Site-Specific BTV
Thorium	mg/kg	1.9	None	1.9	Site-Specific BTV
Uranium	mg/kg	1.5	None	1.5	Site-Specific BTV
Vanadium	mg/kg	11	None	11	Site-Specific BTV
Zinc	mg/kg	22	None	22	Site-Specific BTV
Gamma Radiation	cpm	11,010	None	11,010	Site-Specific BTV

Notes:
- No BTV
BSA Background Study Area
BTV background threshold value
cpm counts per minute
mg/kg milligrams per kilogram
pCi/g picocuries per gram
Qa Quaternary Alluvium

5.1.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T7 and the raw gamma radiation and grid averaged gamma radiation survey results.

5.1.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T7 in April 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine if any additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. No additional scanning, measurements, or sampling were required. The applied gamma BTV for non-AUM Target T7 is 11,010 cpm. A total of 5,235 measurements were collected as part of the gamma radiation survey at non-AUM Target T7 across 85 survey units. An average scan density of 62 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I7-4.

Table I7-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target BK-01 (T7)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,010	
Measurements	#	5,235	85
Minimum	cpm	5,152	6,798
Maximum	cpm	12,786	8,173
Average	cpm	7,453	7,478
Median	cpm	7,353	7,512
Standard Deviation	cpm	915	300
90th Percentile	cpm	8,651	7,835
95th Percentile	cpm	9,126	7,863
99th Percentile	cpm	10,068	8,000
Measurements per Survey Unit	#/grid	62	
Measurements Above Gamma BTV	#	12	0
Measurements Above Gamma BTV	%	0.2	0.0

Notes:
BTV background threshold value
cpm counts per minute

5.1.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 0.2 percent of the measurements within the Target boundaries, in some cases exceeding greater than two times the applied gamma BTV (11,010 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-5 (Qa) gamma survey results is provided on Figure I7-6. This graph shows that the spread of radiation data at Target T7 (shown on left) begins below the lower range of BSA-5 (Qa) gamma levels (shown on right) and then rises to slightly more than the background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T7 is lower than the data cloud from the BSA-5 (Qa) data set. A box plot showing the quartiles of the data sets is provided in Figure I7-7. The box plot shows that the median of Target T7 radiation levels is lower than the median of the BSA-5 (Qa) data set and lower than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I7-8. No mining activity was observed within the survey area of Target T7. There were also no distinct elevated areas or hot spots, confirming Weston MCAP survey findings as shown in Figure I7-8.

In general, Target T7 has surficial gamma radiation levels below BSA-5 (Qa) levels across the entire Target and survey boundary, indicating that the survey did not identify the area of potential elevated gamma activity identified by the ASPECT gamma survey (Figures I7-3). No TENORM or mining-related activities were observed within the Target T7 survey and surrounding area. Section 5.1.5.3 presents the grid averaged results of the gamma radiation survey.

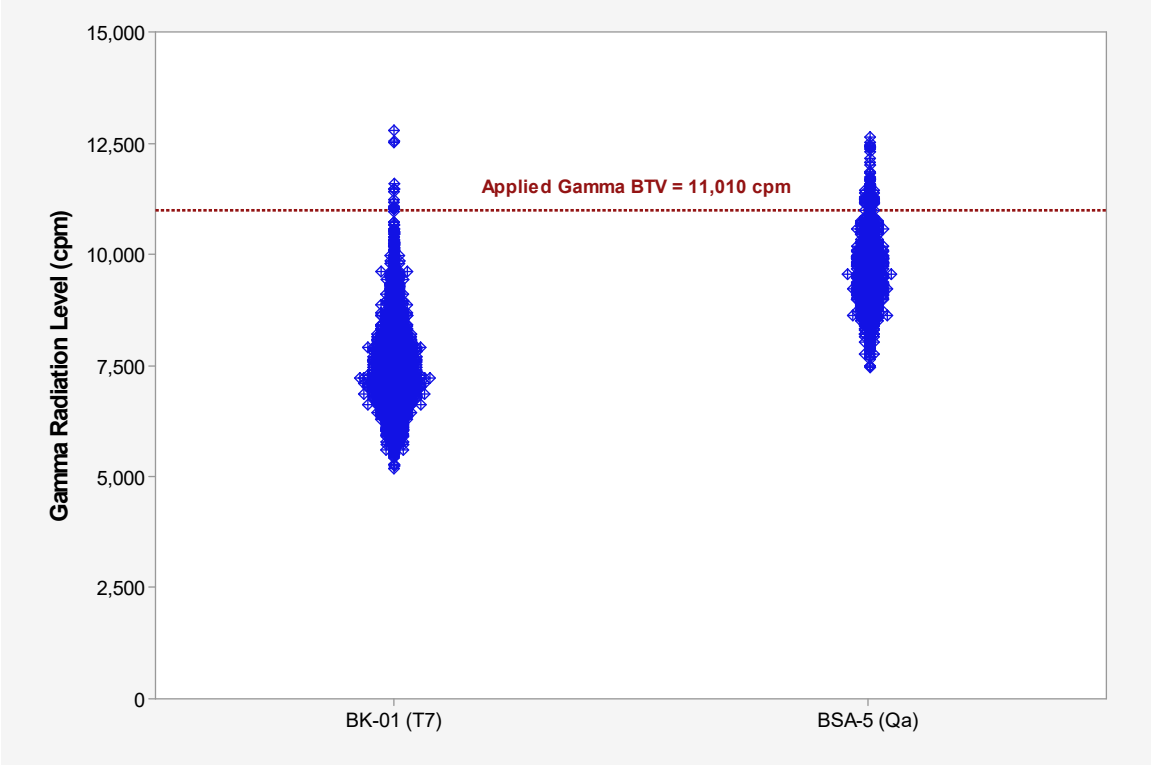


Figure I7-6. Individual Value Plot of Raw Gamma Radiation Levels at Target BK-01 (T7) and BSA-5 (Qa)

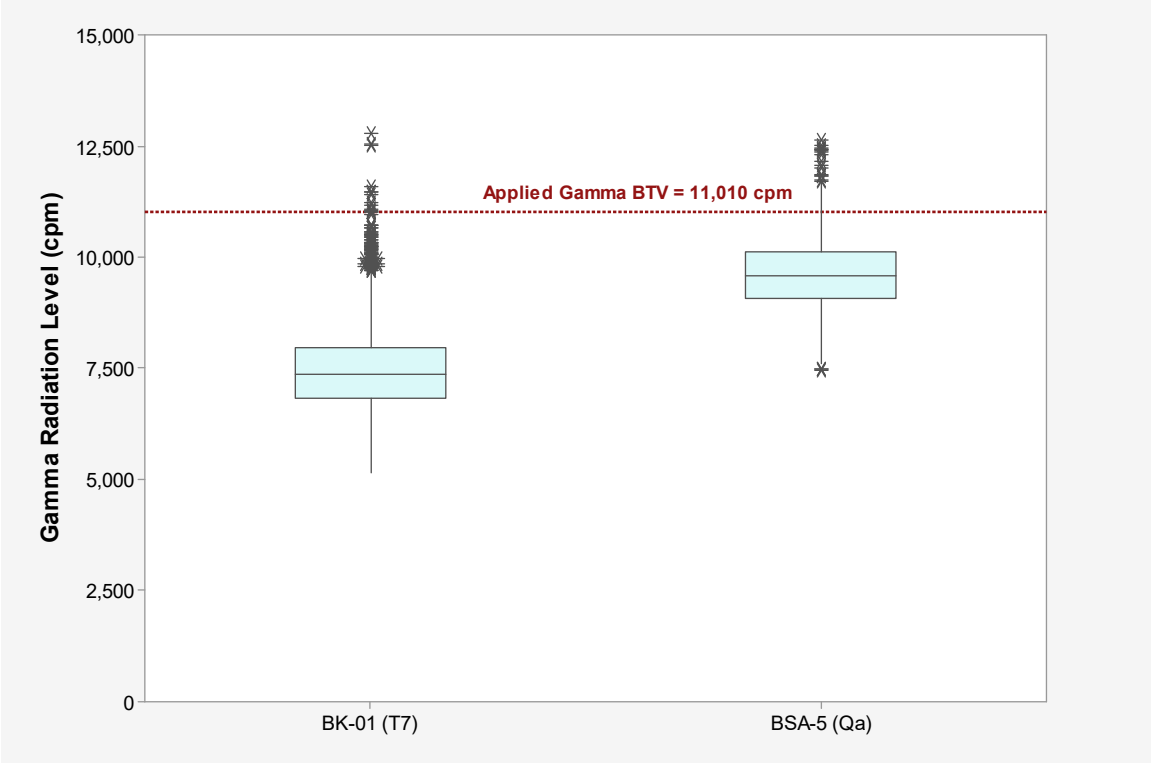


Figure I7-7. Box Plot of Raw Gamma Radiation Levels at Target BK-01 (T7) and BSA-5 (Qa)

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

BK-01 (T7) Weston Site Screening Gamma Radiation Levels

BK-01 (T7) 2018 Removal Site Evaluation Gamma Radiation Levels

Gamma Reading (cpm)*

≤ 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

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Access Route - Vehicular
Drainage - Field Mapped

1 in = 70 ft

1:840

N W E S

0 35 70 140 Feet

NON-AUM TARGET BK-01 (T7) 2018 REMOVAL SITE EVALUATION VS WESTON SITE SCREENING GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019

Notes:
*The applied gamma radiation background threshold value (BTV) for BK-01 (T7) is 11,010 cpm derived from BSA-5 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I7-8**

5.1.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 5.1.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 5.1.5.1. Figure I7-9 and Figure I7-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-5 (Qa) data set (shown on right). No survey units within the survey area of Target T7 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I7-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I7-11 as discussed further in Section 2.8. No survey units exceeded the gamma BTV.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 5.1.6.

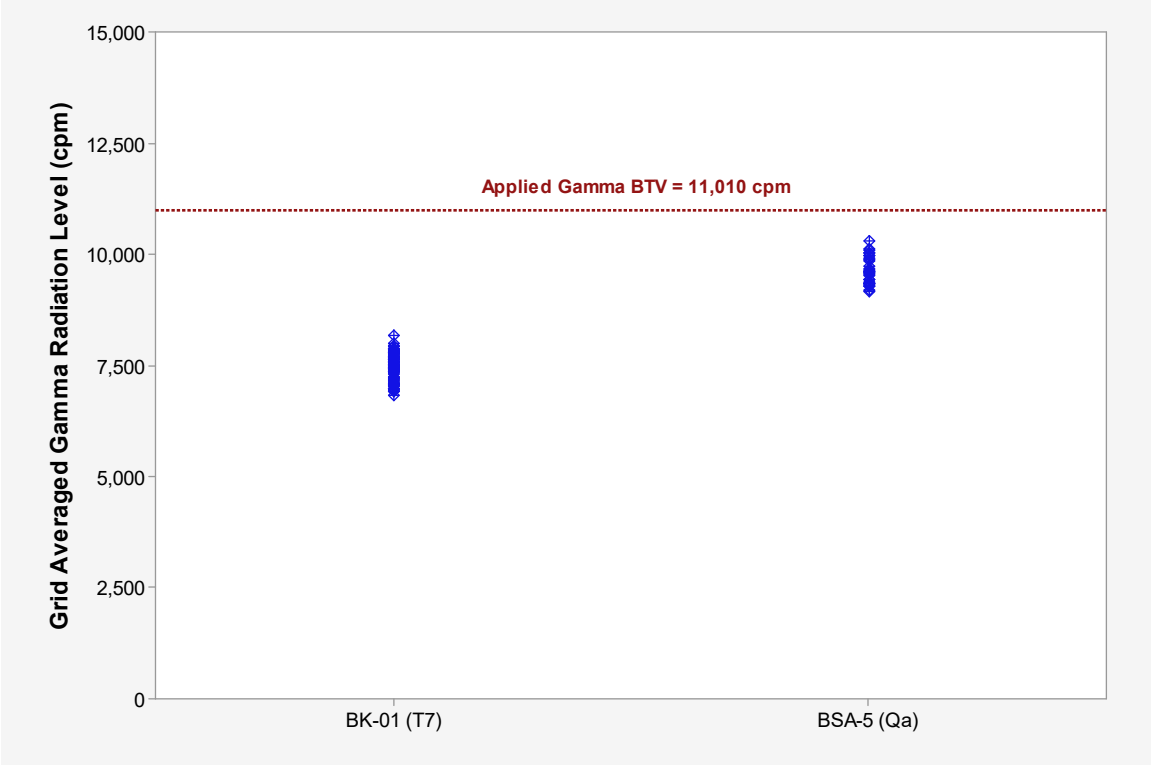


Figure I7-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target BK-01 (T7) and BSA-5 (Qa)

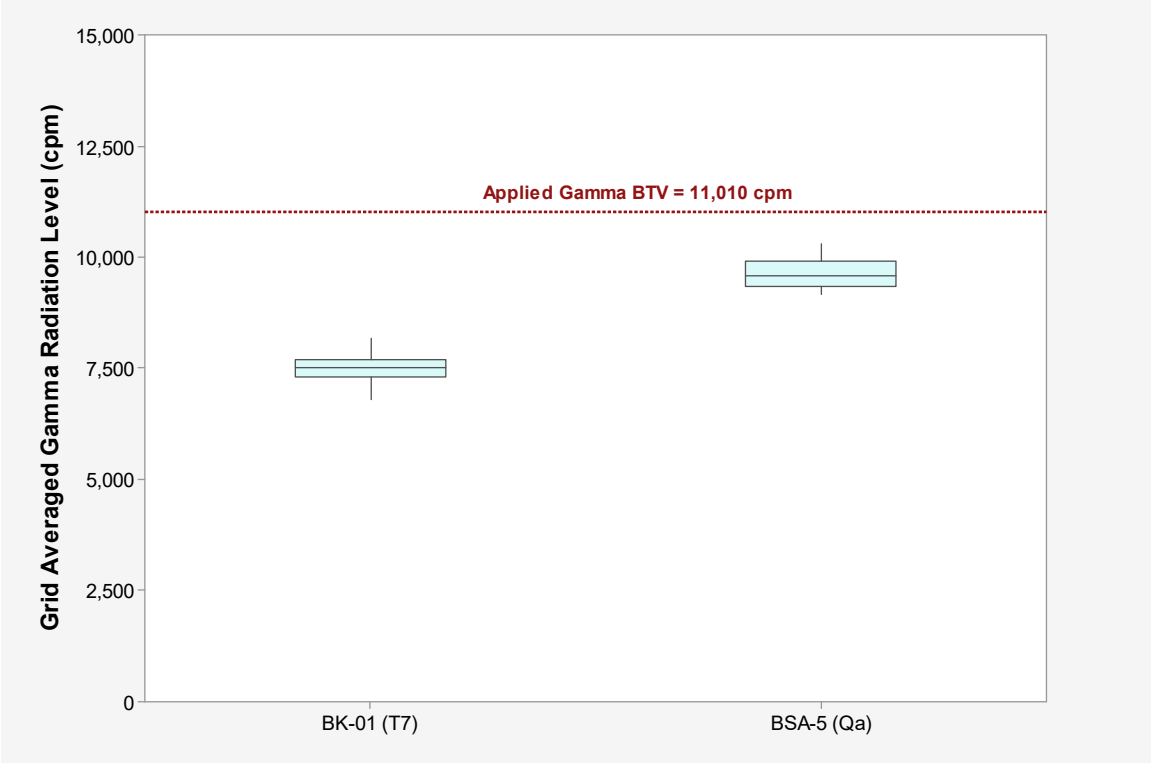
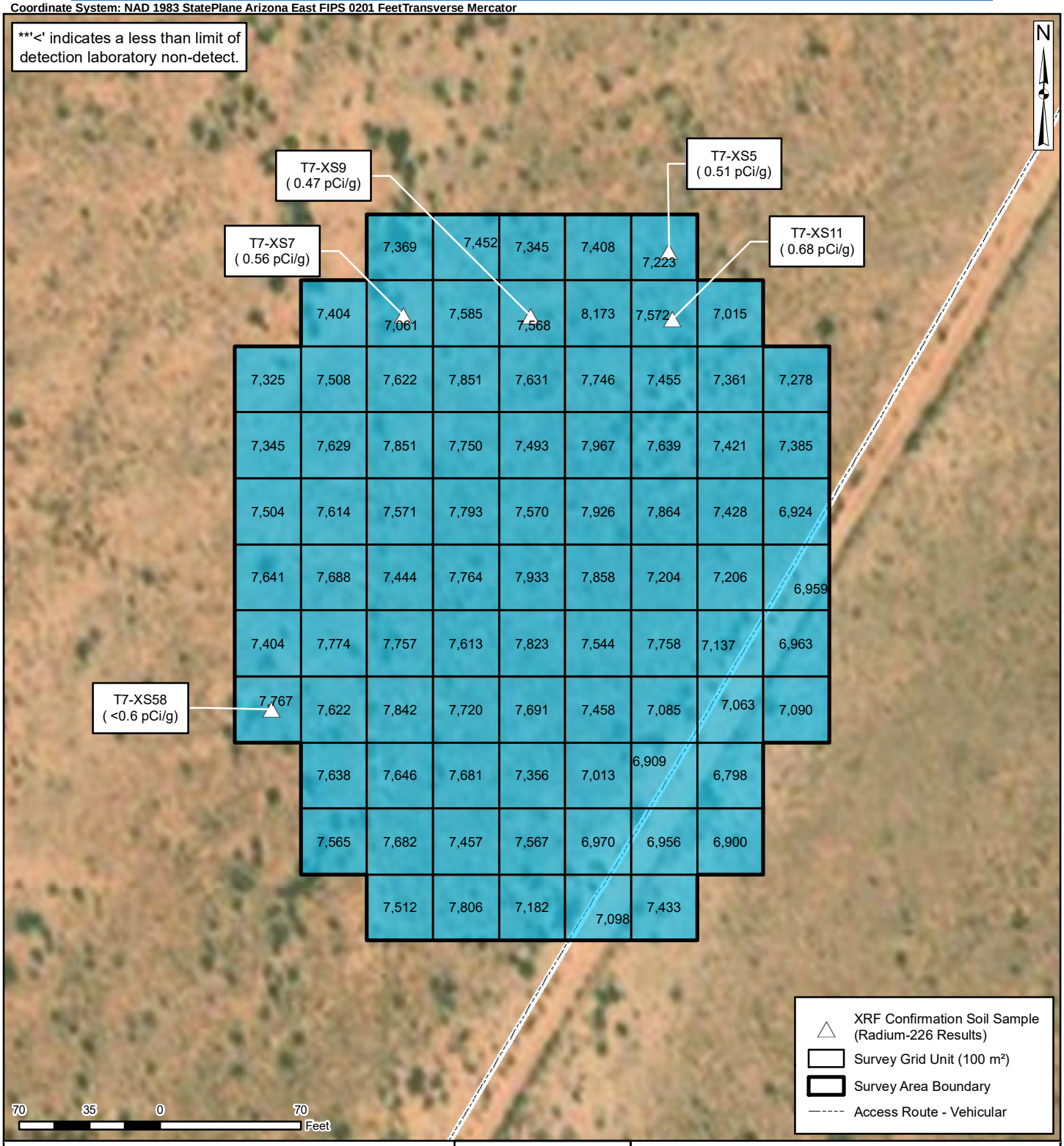


Figure I7-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target BK-01 (T7) and BSA-5 (Qa)

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



Grid Averaged Gamma Reading (cpm)*

≤ 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

*The applied gamma background threshold value (BTV) for BK-01 (T7) is 11,010 cpm derived from BSA-5 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET BK-01 (T7) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I7-11
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

5.1.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T7. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 5.1.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 5.1.6.2.

5.1.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T7: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I7-1 and I7-2. All the results of the XRF confirmation soil samples are presented in Table I7-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T7 following the methods outlined in Section 2.4 and shown in Figure I7-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 85 measurements were collected across 85 survey units from the survey area of Target T7 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I7-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T7 at a depth of 0 to 3 inches bgs. Five XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I7-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 5.1.7.

Table I7-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BK-01 (T7)

Analyte	Units	Applied BTV	T7-XS11-01-042418		T7-XS5-01-042418		T7-XS58-01-042418		T7-XS7-01-042418		T7-XS9-01-042418	
			Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Survey Unit			X11		X5		X58		X7		X9	
Aluminum	mg/kg	4,220	2,900		2,600		2,600		2,400		2,800	
Antimony	mg/kg	0.160	0.055	J	0.046	J	0.041	J	0.041	J	0.05	J
Arsenic	mg/kg	3.9	1		0.96		0.96		1		1.1	
Barium	mg/kg	68	47		42		41		37		46	
Beryllium	mg/kg	0.25	0.18		0.16		0.16		0.15		0.17	
Cadmium	mg/kg	0.091	0.038	J	0.038	J	<0.2	U	<0.2	U	0.039	J
Calcium	mg/kg	21,000	5,800		6,000		4,600		4,400		7,200	
Chromium	mg/kg	3.6	2.3		2.1		2.1		1.9		2.2	
Cobalt	mg/kg	2.0	1.3		1.2		1.2		1.1		1.3	
Copper	mg/kg	4.7	2.3		2.3		2.1		1.9	J	2.3	
Iron	mg/kg	4,500	3,000		2,900		2,700		2,400		2,900	
Lead	mg/kg	5.0	2.6		2.7		2.7		2.2		2.7	
Lithium	mg/kg	6.8	4.5		4.2		4.4		4.2		4.6	
Magnesium	mg/kg	3,640	2,200		2,100		2,100		2,000		2,200	
Manganese	mg/kg	210	110		100		97		89		100	
Molybdenum	mg/kg	0.34	0.1	J	0.13	J	0.11	J	0.098	J	0.11	J
Nickel	mg/kg	4.1	2.3		2.2		2.1		1.9	J	2.2	
Potassium-40	pCi/g	16.8	10.7		13.4		12.7		12.1		11.6	
Radium-226	pCi/g	2.38	0.68	LT	0.51	LT	<0.6	UJ	0.56	LT	0.47	LT
Radium-228	pCi/g	-	<0.31	U	<0.48	U	<0.32	U	<0.31	U	<0.25	U
Selenium	mg/kg	0.47	<0.99	U	<1	U	<0.98	U	<0.99	U	<1	U
Silver	mg/kg	0.017	<0.05	U	<0.05	U	<0.049	U	<0.05	U	<0.05	U
Sodium	mg/kg	53	<99	U	<100	U	<98	U	<99	U	<100	U
Thallium	mg/kg	0.045	0.024		0.021		0.021		0.02		0.021	
Thorium	mg/kg	1.9	1.2		1.1		1.2		1		1.2	
Uranium	mg/kg	1.5	0.39		0.4		0.39		0.38		0.43	
Vanadium	mg/kg	11	5.9		5.7		5.5		5		5.9	
Zinc	mg/kg	22	8.9	J	8.2	J	8.7	J	7.8	J	8.7	J

Notes:

-	No BTV
BTV	Background threshold value
J	Estimated value
J-	Estimated value, may be biased low
LT	Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
M3	The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg	Milligrams per kilogram
NA	Not applicable
NV	No Value
pCi/g	Picocuries per gram
Q	Qualification
U	Not considered detected. The associated value is the method detection limit (MDL).
UJ	Not considered detected. The associated value is the reported concentration, which is estimated.

Table I7-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target BK-01 (T7)

Summary Statistic	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	3.9	4,500	5	210	0.34	1.9	1.5	11	22
Measurements	#	85	85	85	85	85	85	85	85	85
Detects	#	8	85	85	85	47	80	29	0	80
Nondetects	#	77	0	0	0	38	5	56	85	5
Minimum	mg/kg	1.8	2,048	0.7	84.7	0.1	1.0	0.1	-	8.2
Maximum	mg/kg	3.86	4,769	5.8	208.4	3.0	2.5	2.6	-	15.5
Standard Deviation	mg/kg	0.6	508	1.0	22.5	0.5	0.4	0.6	-	1.4
Average	mg/kg	2.6	3,303	3.5	143.6	0.9	1.6	0.6	-	10.9
Median	mg/kg	2.6	3,329	3.7	143.1	0.8	1.5	0.4	-	11.0
Relative Standard Deviation	%	24.5	15.4	28.2	15.7	60.9	22.3	98.1	-	12.4
90th Percentile	mg/kg	3.2	3,891	4.6	170.4	1.5	2.1	1.5	-	12.4
95th Percentile	mg/kg	3.5	4,087	4.8	183.2	1.7	2.2	1.6	-	12.6
99th Percentile	mg/kg	3.8	4,429	5.4	207.1	2.5	2.3	2.3	-	13.7
Measurements Above Applied BTV	#	0	1	3	0	41	16	3	0	0
Measurements Above Applied BTV	%	0.0	1.2	3.5	0.0	48.2	18.8	3.5	0.0	0.0

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value

mg/kg Milligram per kilogram

XRF X-ray fluorescence

5.1.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T7 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T7 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T7. The estimated BTVs are identified in Section 5.1.4 and Table I7-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I7-7 presents a summary of the background comparison for different measurement and soil depths at Target T7. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T7. Further gamma radiation screening indicated that gamma levels at Target T7 are lower than the BSA. Therefore, while molybdenum and thorium have been identified as a COPC at Target T7 based on a conservative comparison to background, risk screening may be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I7-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target BK-01 (T7)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic			
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron			
Lead			
Lithium			
Magnesium			
Manganese			
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium			
Silver			
Sodium			
Thallium			
Thorium		✓	✓
Uranium			
Vanadium			
Zinc			

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

5.1.7 Primary Contaminant Mapping

5.1.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 5.1.6.2 identified the COPCs at Target T7. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 5.1.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to demonstrate contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I7-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T7 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 5.1.7.1 through Section 5.1.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T7. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

5.1.7.2 Arsenic

Arsenic was not identified as a COPC in surface soils as shown in Table I7-7. Arsenic did not exceed the applied BTV in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for arsenic is 3.9 mg/kg for Target T7 as presented in Section 5.1.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I7-5 and Attachment I3, respectively. Figure I7-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T7 and BSA-5 (Qa) samples. Figure I7-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T7 and BSA-5 (Qa) samples. Summary statistics for XRF measurements are provided in Section 5.1.6.1. Arsenic XRF concentrations measured in surface soils at Target T7 ranged between 1.8 and 3.86 mg/kg with an average and standard deviation of 2.6 mg/kg and 0.6 mg/kg, respectively. The average arsenic XRF concentration is below the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T7 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I7-14. All arsenic XRF results in surface soils were less than the applied BTV.

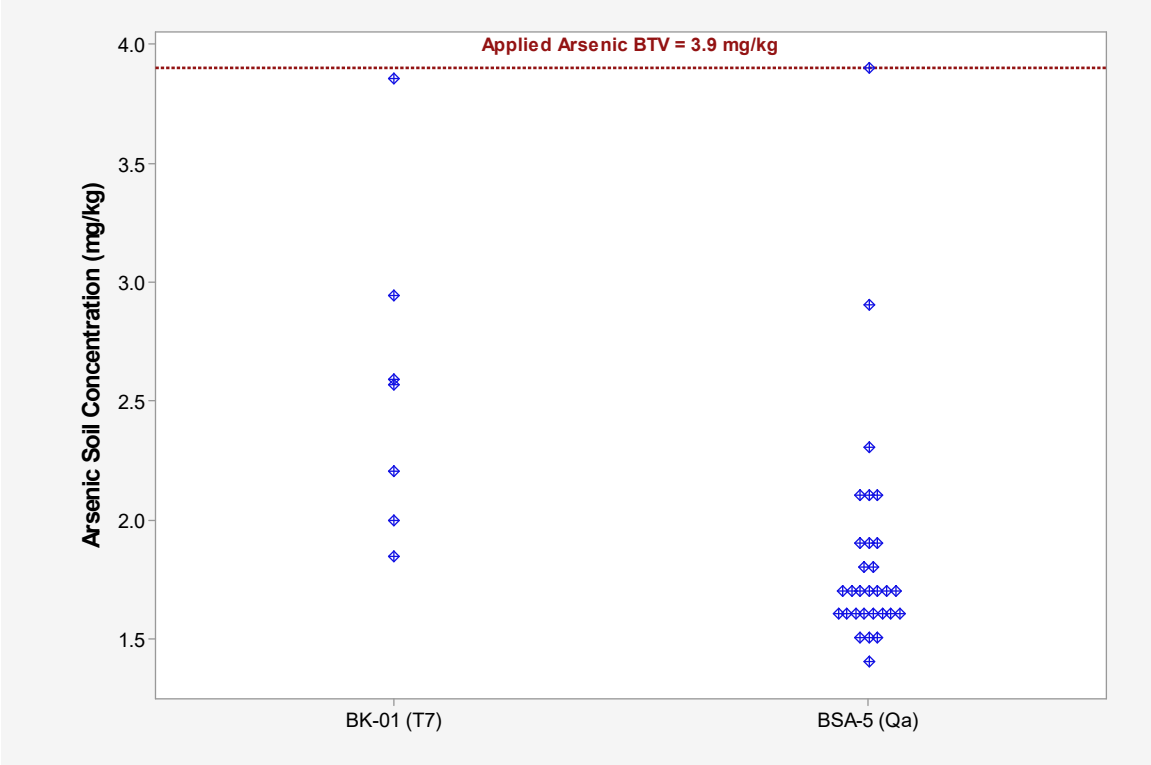


Figure I7-12. Individual Value Plot for Target BK-01 (T7) and BSA-5 (Qa) Arsenic Soils Concentrations

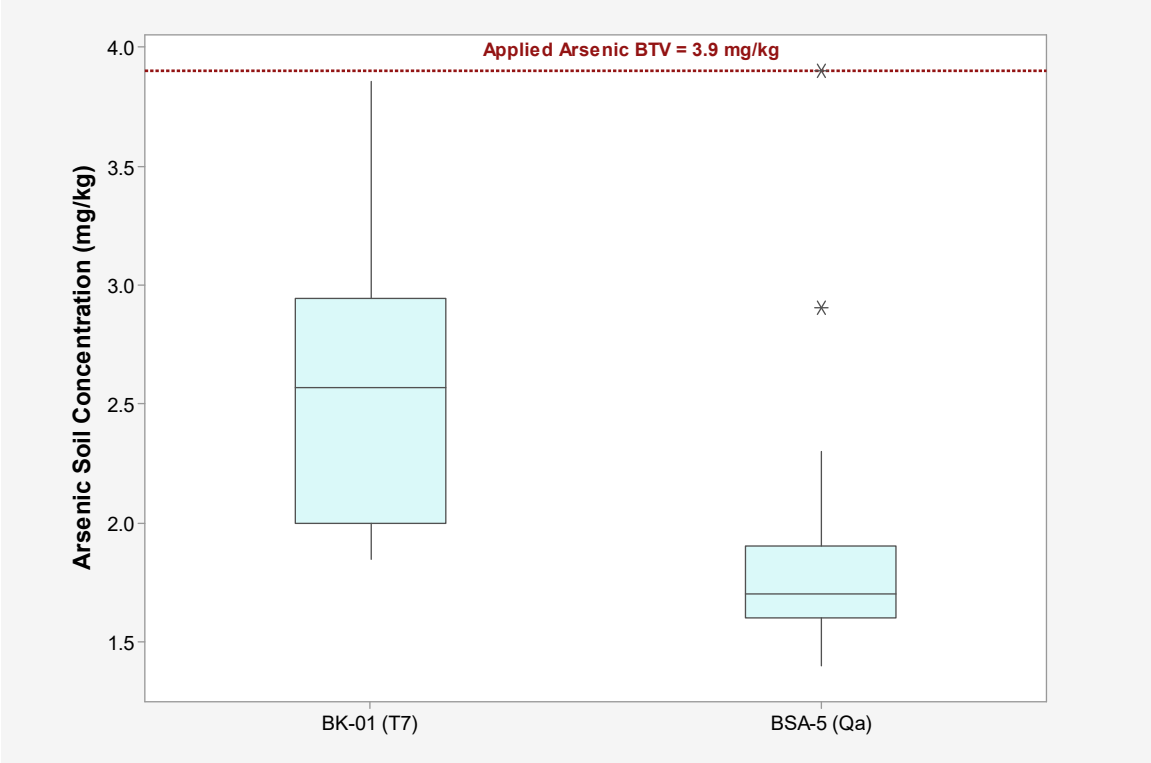
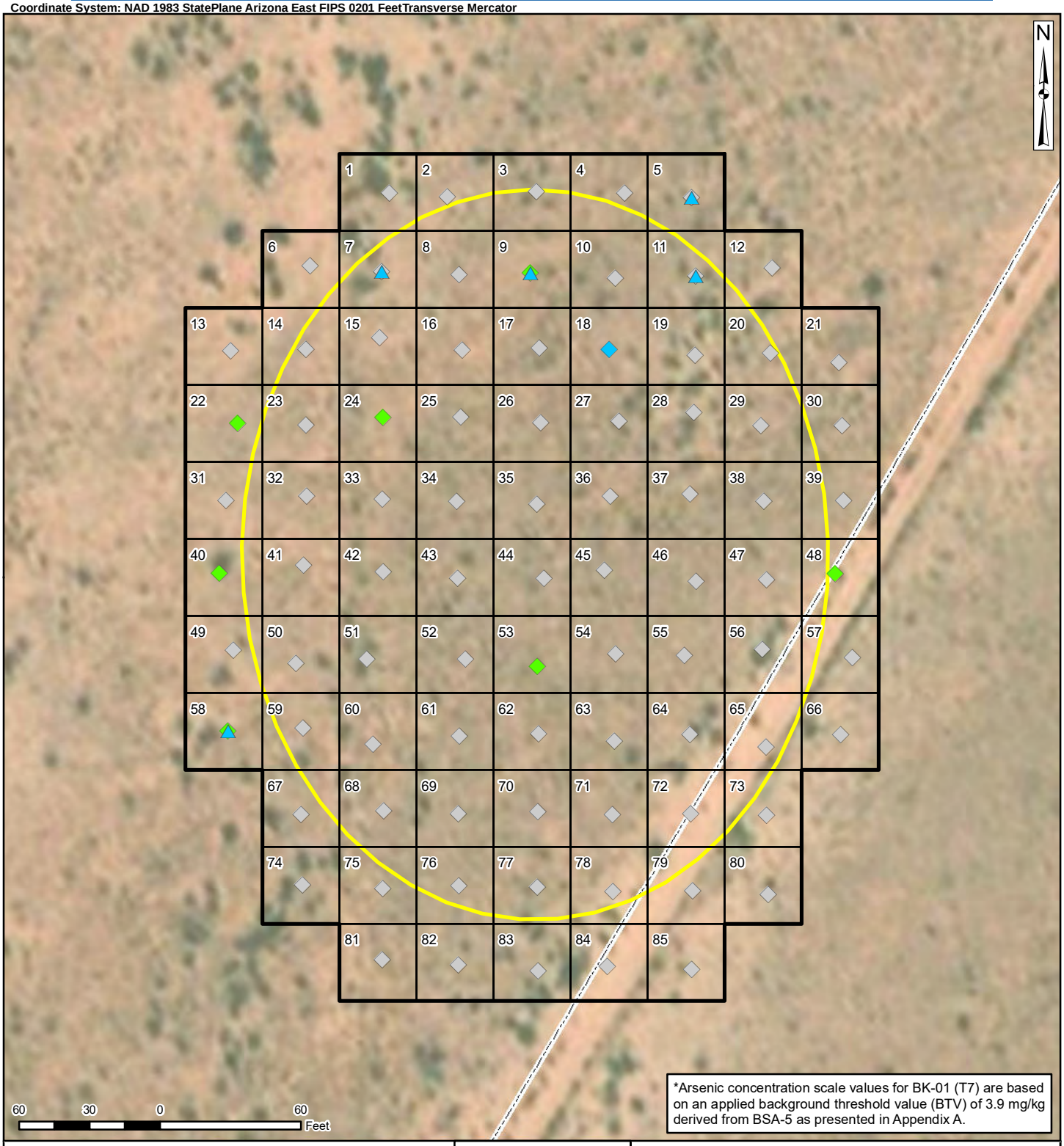


Figure I7-13. Box Plot for Target BK-01 (T7) and BSA-5 (Qa) Arsenic Soils Concentrations



*Arsenic concentration scale values for BK-01 (T7) are based on an applied background threshold value (BTV) of 3.9 mg/kg derived from BSA-5 as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 1.8
- 1.8 - 3.9
- 3.9 - 7.8
- 7.8 - 12
- 12 - 16
- 16 - 39
- ≥ 39
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET BK-01 (T7) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I7-14
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

5.1.7.3 Lead

Lead was not identified as a COPC in surface soil as shown in Table I7-7. Lead exceeded the applied BTV for in situ XRF measurements in 3.5 percent of samples and did not exceed the BTV in any XRF confirmation samples. The applied BTV for lead is 5 mg/kg for Target T7 as presented in Section 5.1.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I7-5 and Attachment I3, respectively. Figure I7-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T7 and BSA-5 (Qa) samples. Figure I7-16 presents a box plot of detectable lead XRF soil concentrations for Target T7 and BSA-5 (Qa) samples. Summary statistics for XRF measurements are provided in Section 5.1.6.1. Lead XRF concentrations measured in surface soils at Target T7 ranged between 0.7 and 5.8 mg/kg with an average and standard deviation of 3.5 mg/kg and 1.0 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T7 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I7-17. Overall, the majority of detectable lead XRF results in surface soils were less than the applied BTV. However, exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T7.

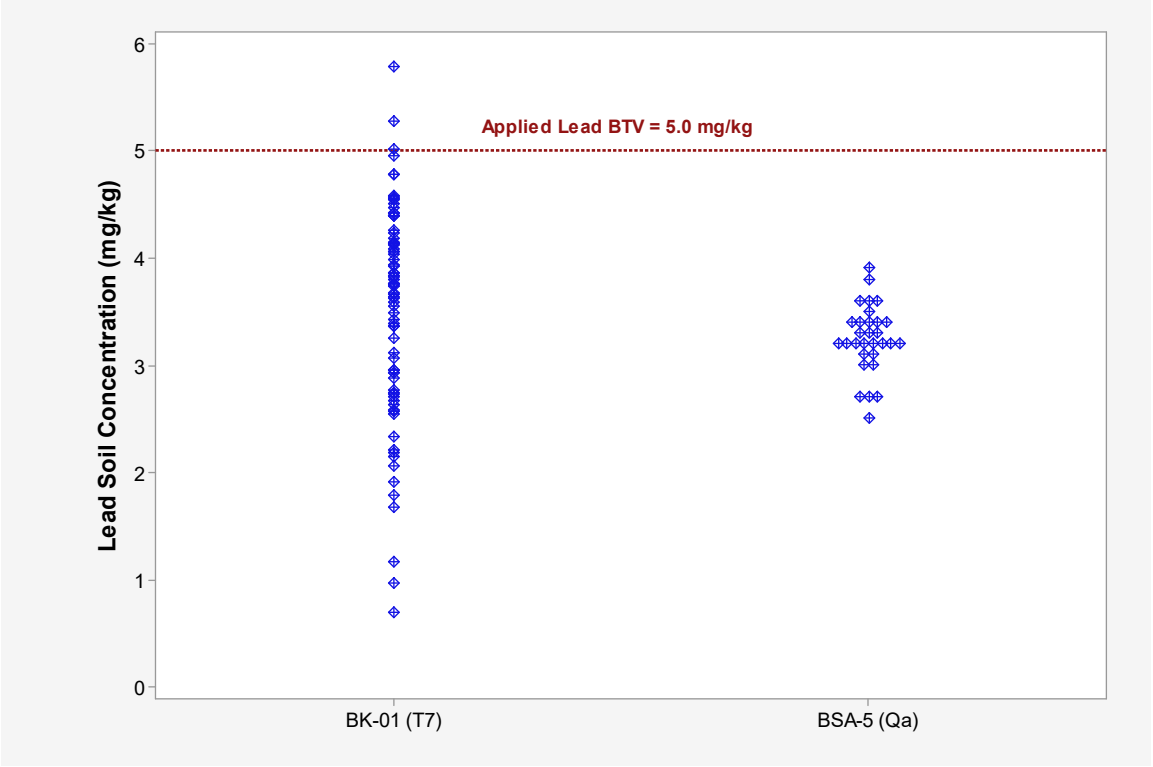


Figure I7-15. Individual Value Plot for Target BK-01 (T7) and BSA-5 (Qa) Lead Soils Concentrations

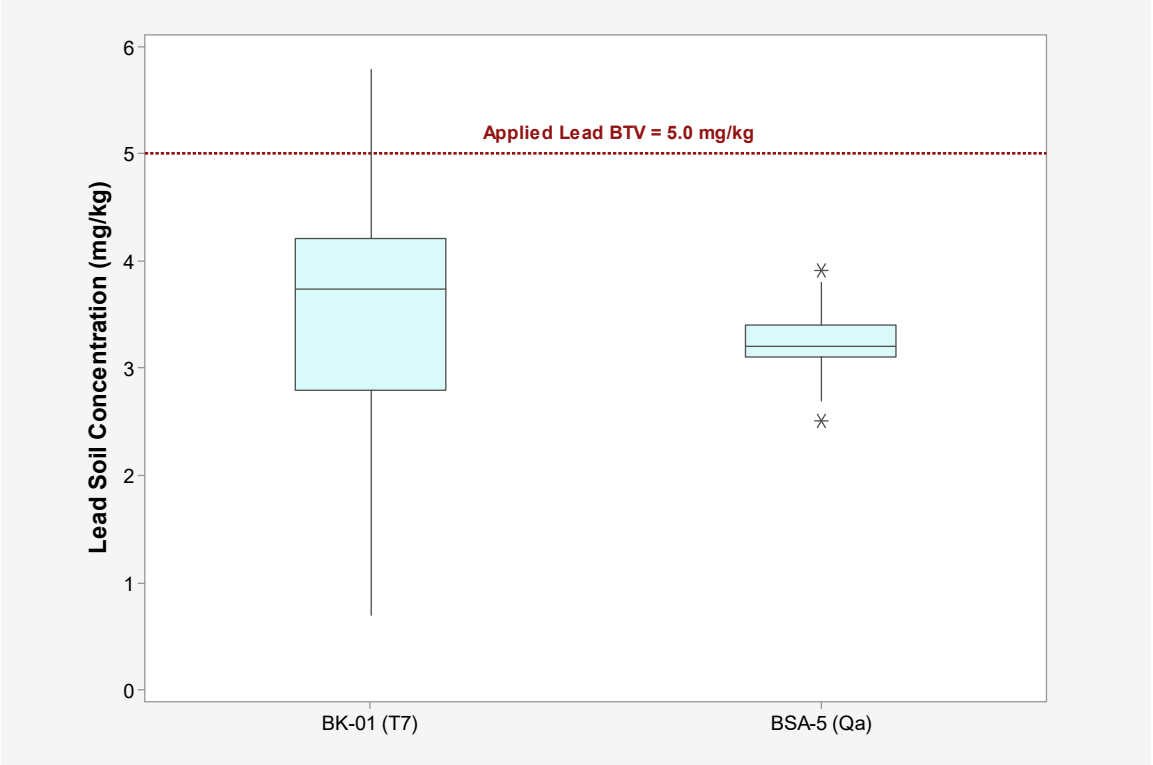
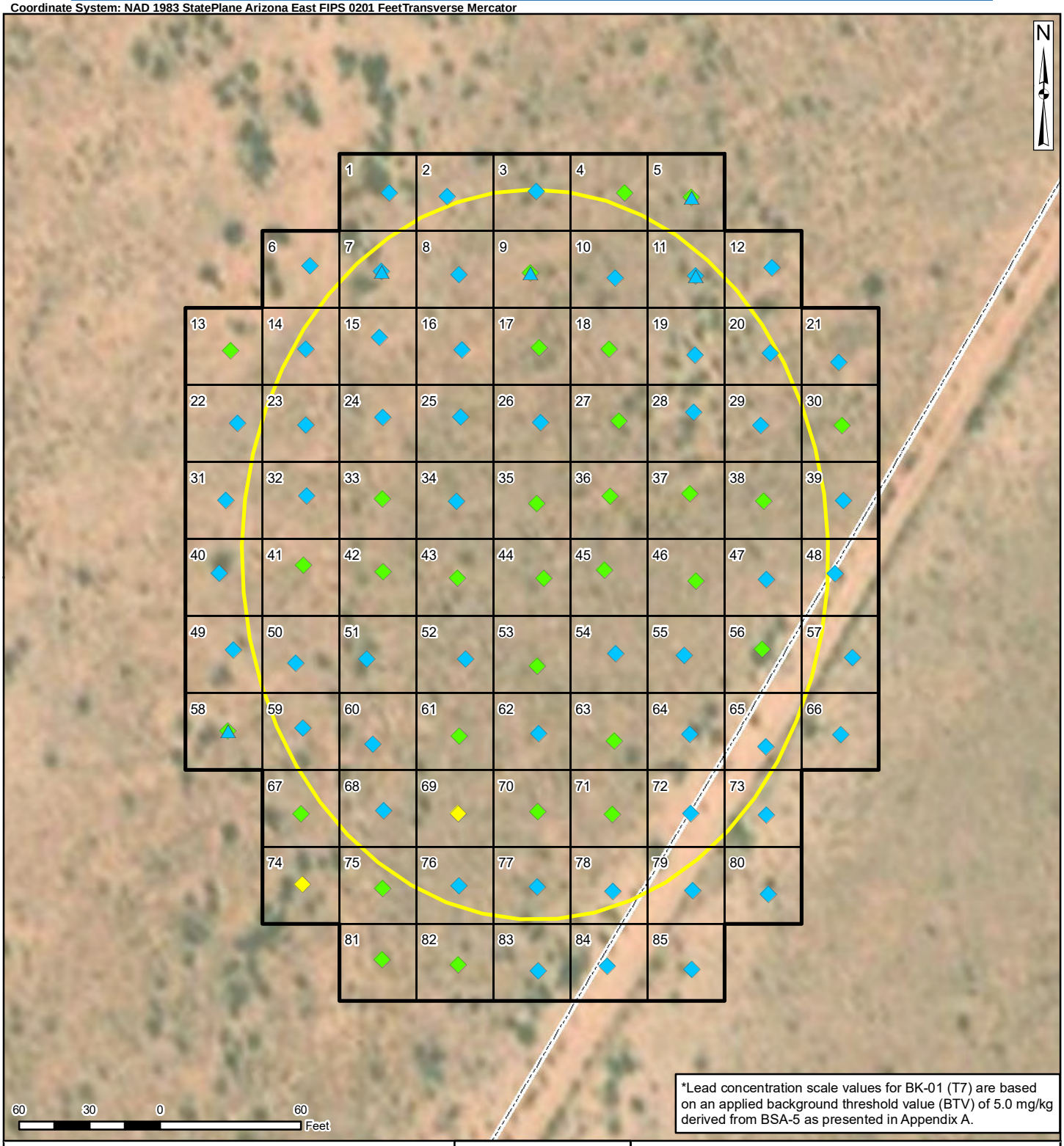


Figure I7-16. Box Plot for Target BK-01 (T7) and BSA-5 (Qa) Lead Soils Concentrations



*Lead concentration scale values for BK-01 (T7) are based on an applied background threshold value (BTV) of 5.0 mg/kg derived from BSA-5 as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 3.9
- 3.9 - 5.0
- 5.0 - 10
- 10 - 15
- 15 - 20
- 20 - 50
- ≥ 50

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET BK-01 (T7) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I7-17
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

5.1.7.4 Thorium

Thorium was identified as a COPC in surface soil as shown in Table I7-7. Thorium exceeded the applied BTV in 18.8 percent of in situ XRF measurements but in none of the XRF confirmation samples. The applied BTV for thorium is 1.9 mg/kg for Target T7 as presented in Section 5.1.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I7-5 and Attachment I3, respectively. Figure I7-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T7 and BSA-5 (Qa) samples. Figure I7-19 presents a box plot of detectable thorium XRF soil concentrations for Target T7 and BSA-5 (Qa) samples. Summary statistics for XRF measurements are provided in Section 5.1.6.1. Thorium XRF concentrations measured in surface soils at Target T7 ranged between 1.0 and 2.5 mg/kg with an average and standard deviation of 1.6 mg/kg and 0.4 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T7 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I7-20. Overall, the majority of detectable thorium XRF results in surface soils were less than the applied BTV. However, exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T7.

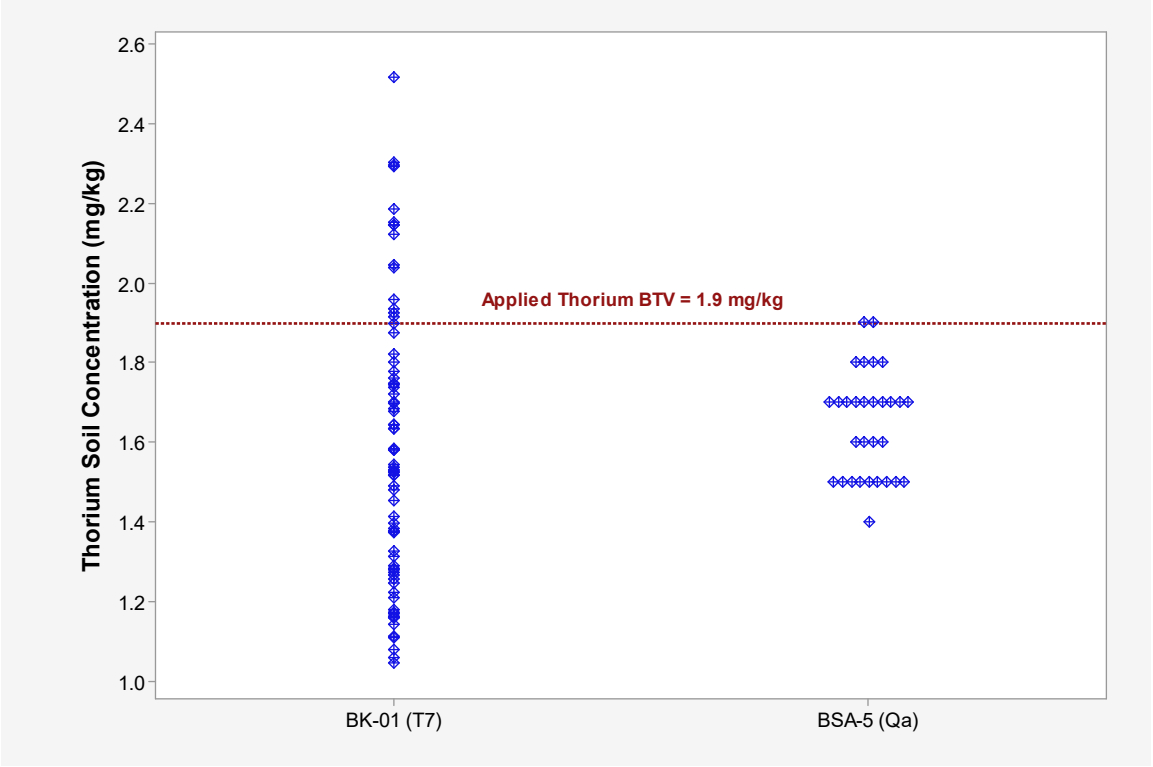


Figure I7-18. Individual Value Plot for Target BK-01 (T7) BSA-5 (Qa) Thorium Soils Concentrations

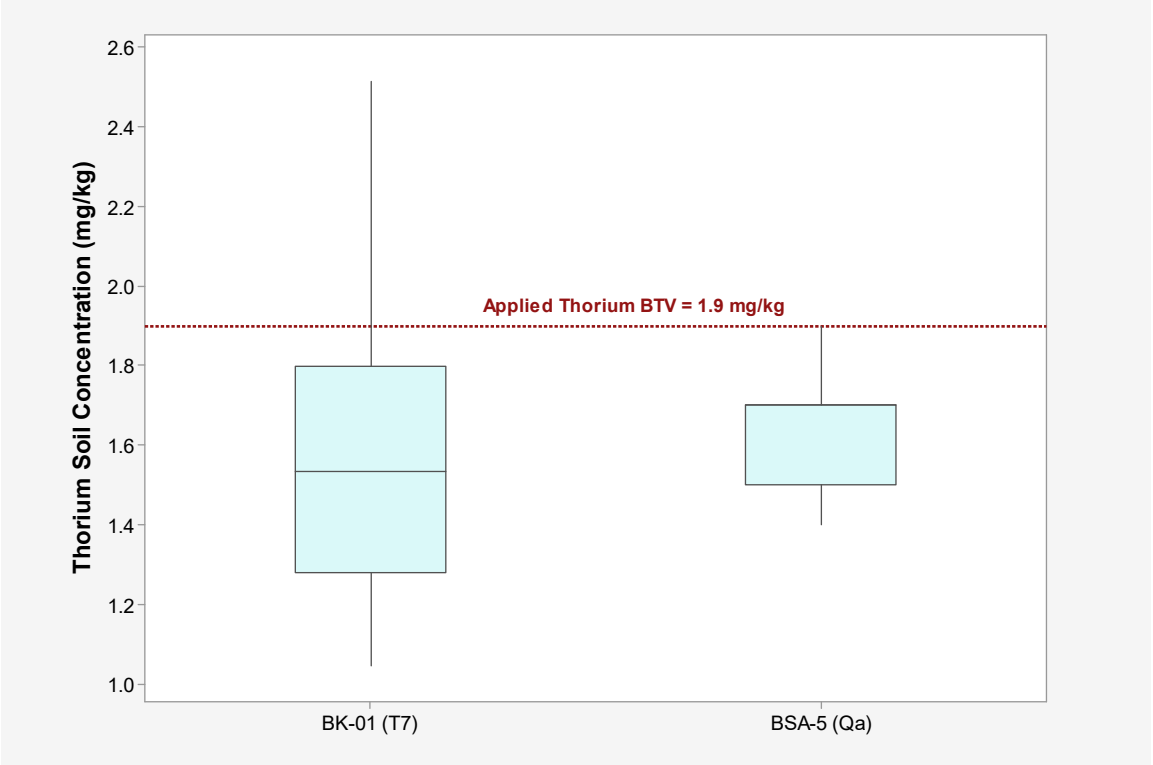
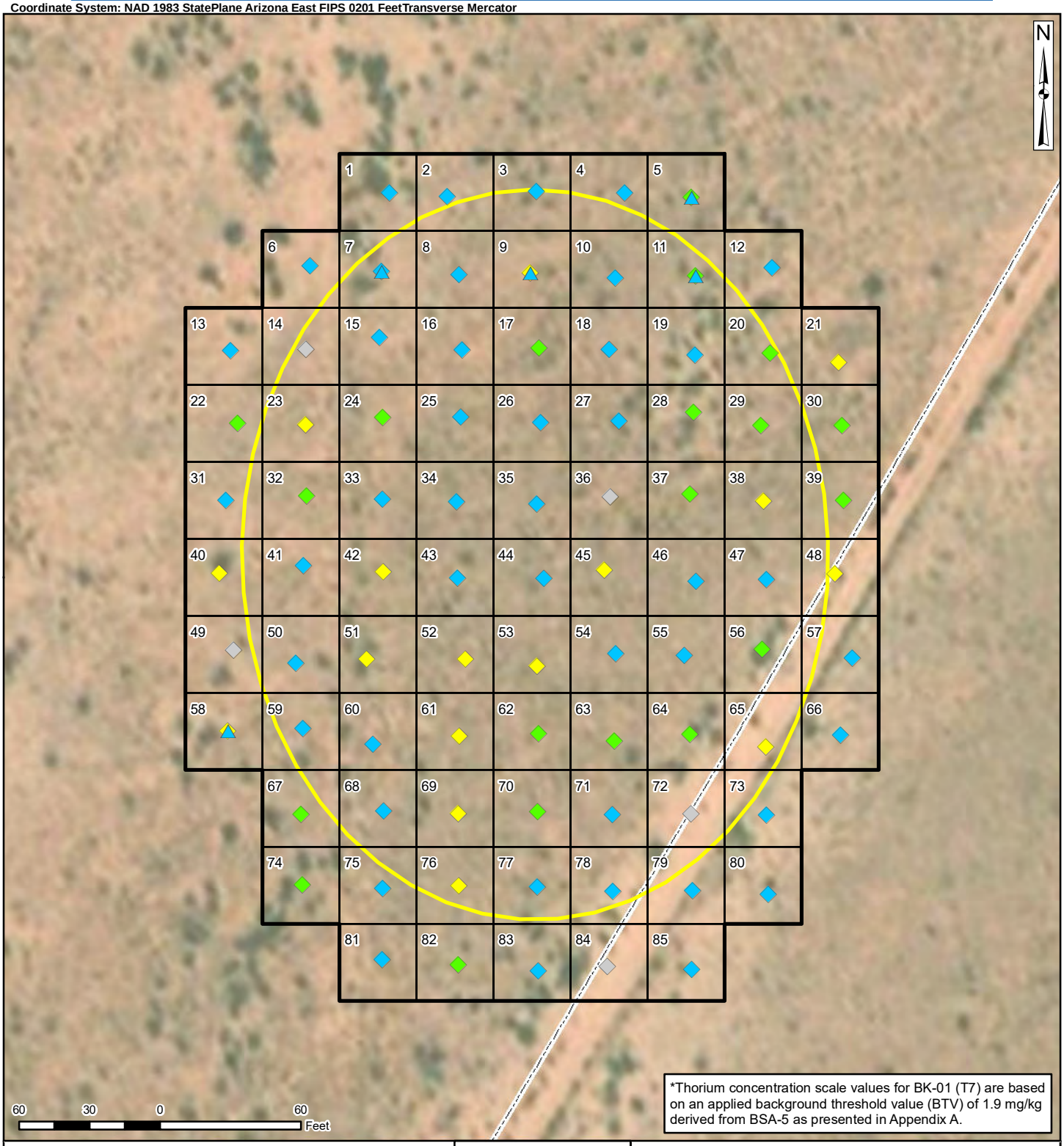


Figure I7-19. Box Plot for Target BK-01 (T7) and BSA-5 (Qa) Thorium Soils Concentrations



Thorium Concentration Scale (mg/kg)*

- ≤ 1.6
- 1.6 - 1.9
- 1.9 - 3.8
- 3.8 - 5.7
- 5.7 - 7.6
- 7.6 - 19
- ≥ 19
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET BK-01 (T7) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I7-20
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

5.1.7.5 Uranium

Uranium was not identified as a COPC in surface soil as shown in Table I7-7. Uranium exceeded the applied BTV for in situ XRF measurements in 3.5 percent of samples and did not exceed the BTV in any XRF confirmation samples. The applied BTV for uranium is 1.5 mg/kg for Target T7 as presented in Section 5.1.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I7-5 and Attachment I3, respectively. Figure I7-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T7 and BSA-5 (Qa) samples. Figure I7-22 presents a box plot of detectable uranium XRF soil concentrations for Target T7 and BSA-5 (Qa) samples. Summary statistics for XRF measurements are provided in Section 5.1.6.1. Uranium XRF concentrations measured in surface soils at Target T7 ranged between 0.1 and 2.6 mg/kg with an average and standard deviation of 0.6 mg/kg and 0.6 mg/kg, respectively. The average uranium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T7 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I7-23. Overall, the majority of detectable uranium XRF results in surface soils were less than the applied BTV. However, exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T7.

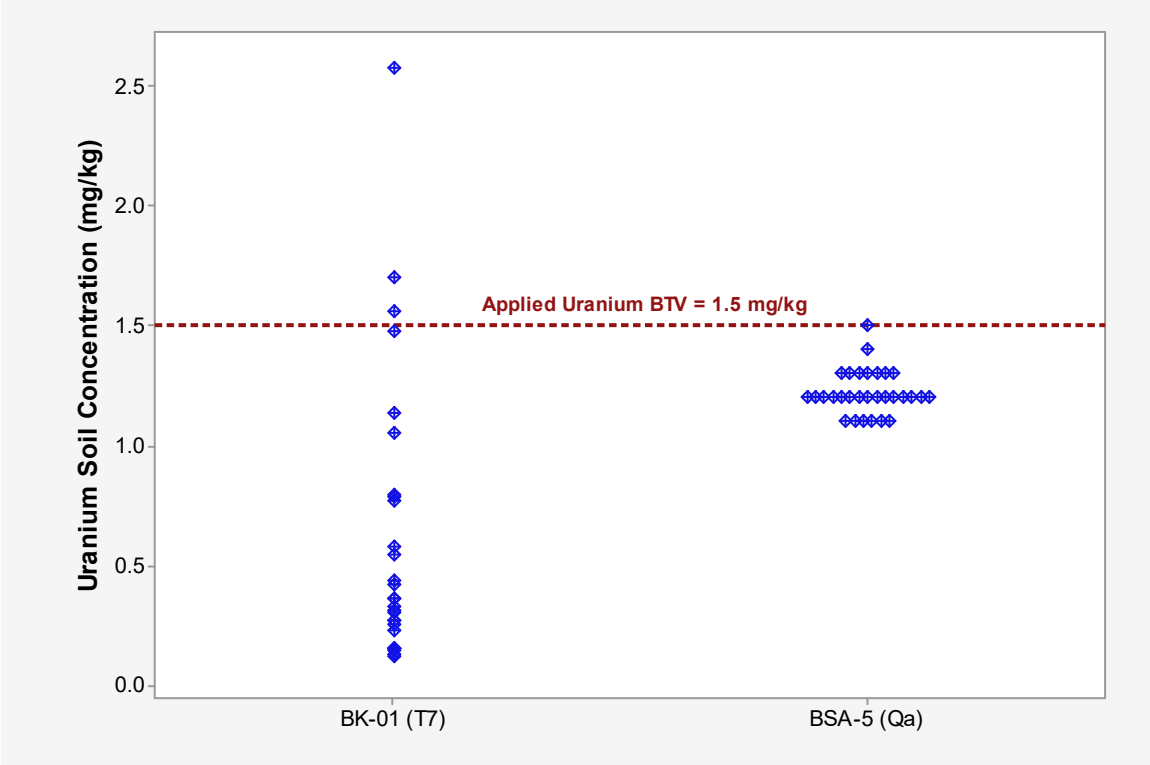


Figure I7-21. Individual Value Plot for Target BK-01 (T7) and BSA-5 (Qa) Uranium Soils Concentrations

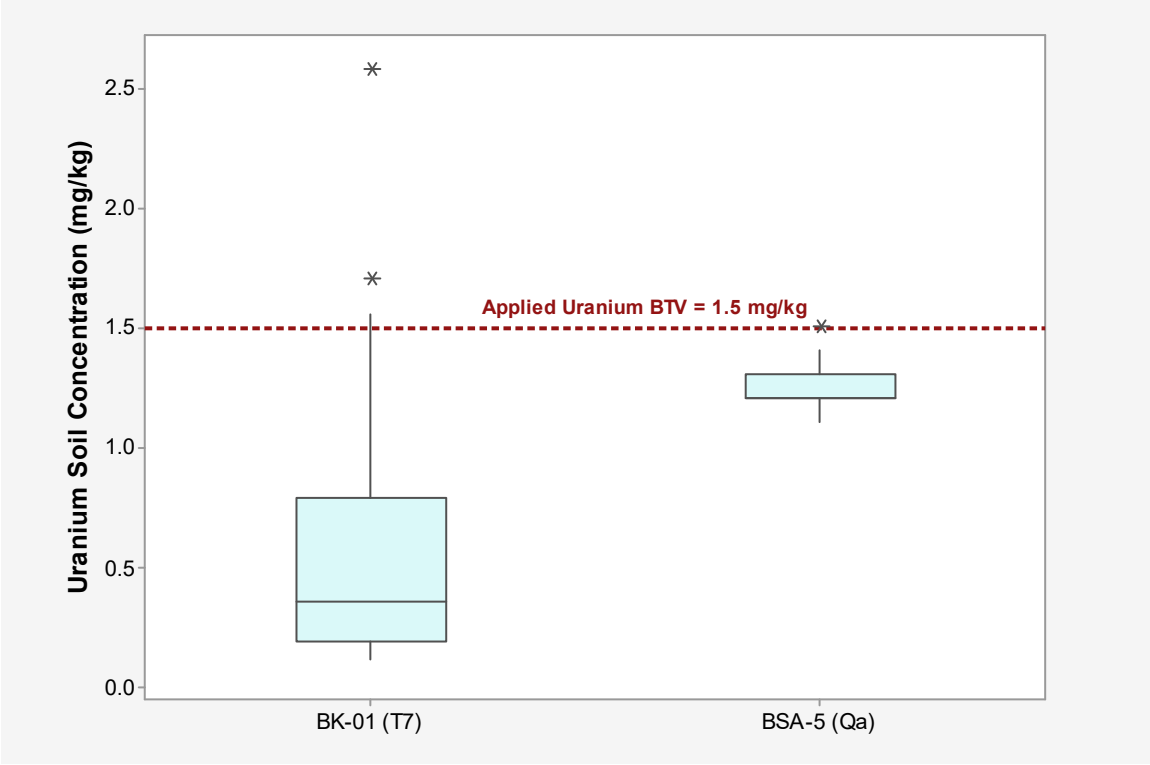
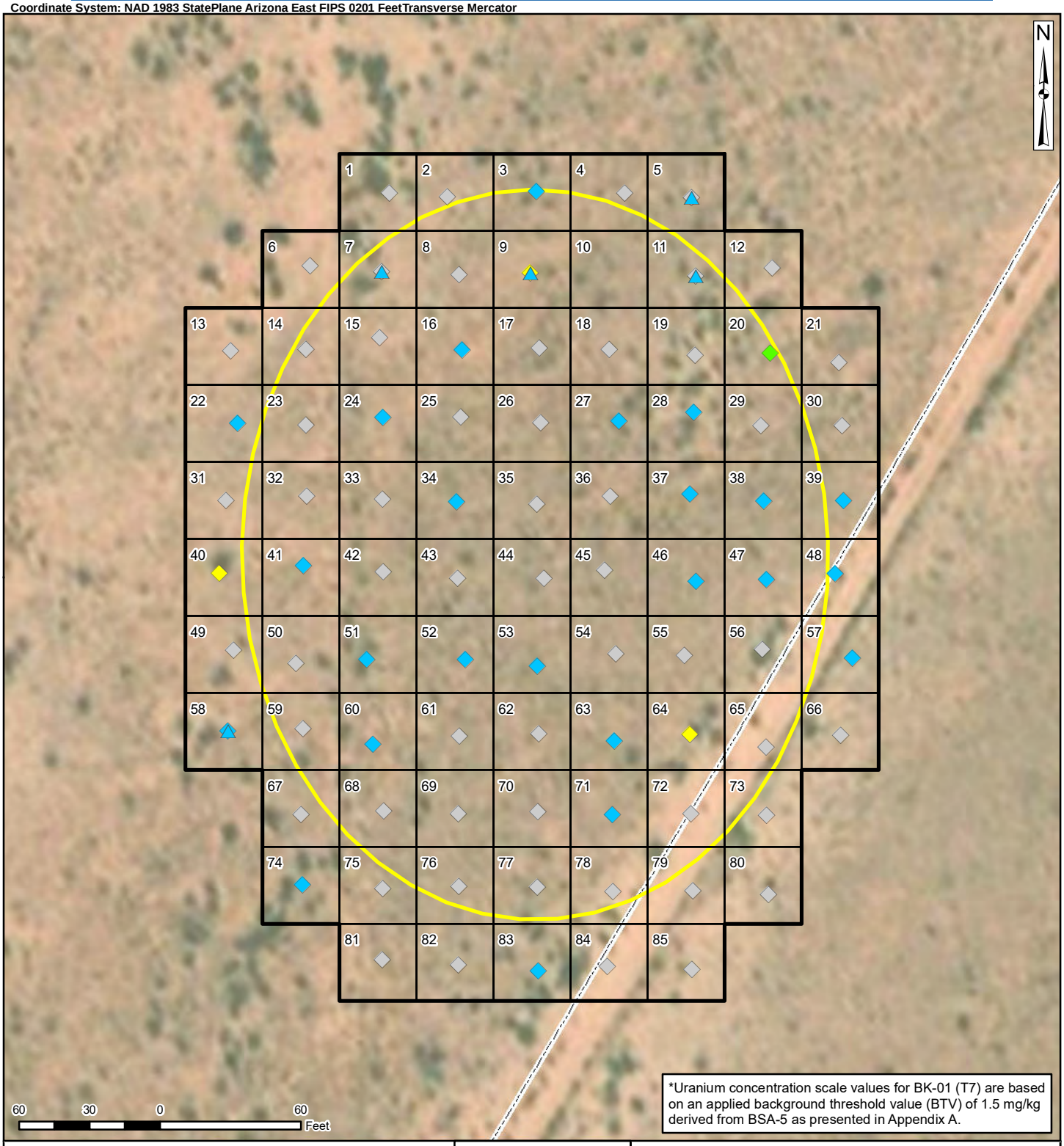


Figure I7-22. Box Plot for Target BK-01 (T7) and BSA-5 (Qa) Uranium Soils Concentrations



*Uranium concentration scale values for BK-01 (T7) are based on an applied background threshold value (BTV) of 1.5 mg/kg derived from BSA-5 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 1.2
- 1.2 - 1.5
- 1.5 - 3.0
- 3.0 - 4.5
- 4.5 - 6.0
- 6.0 - 15
- ≥ 15
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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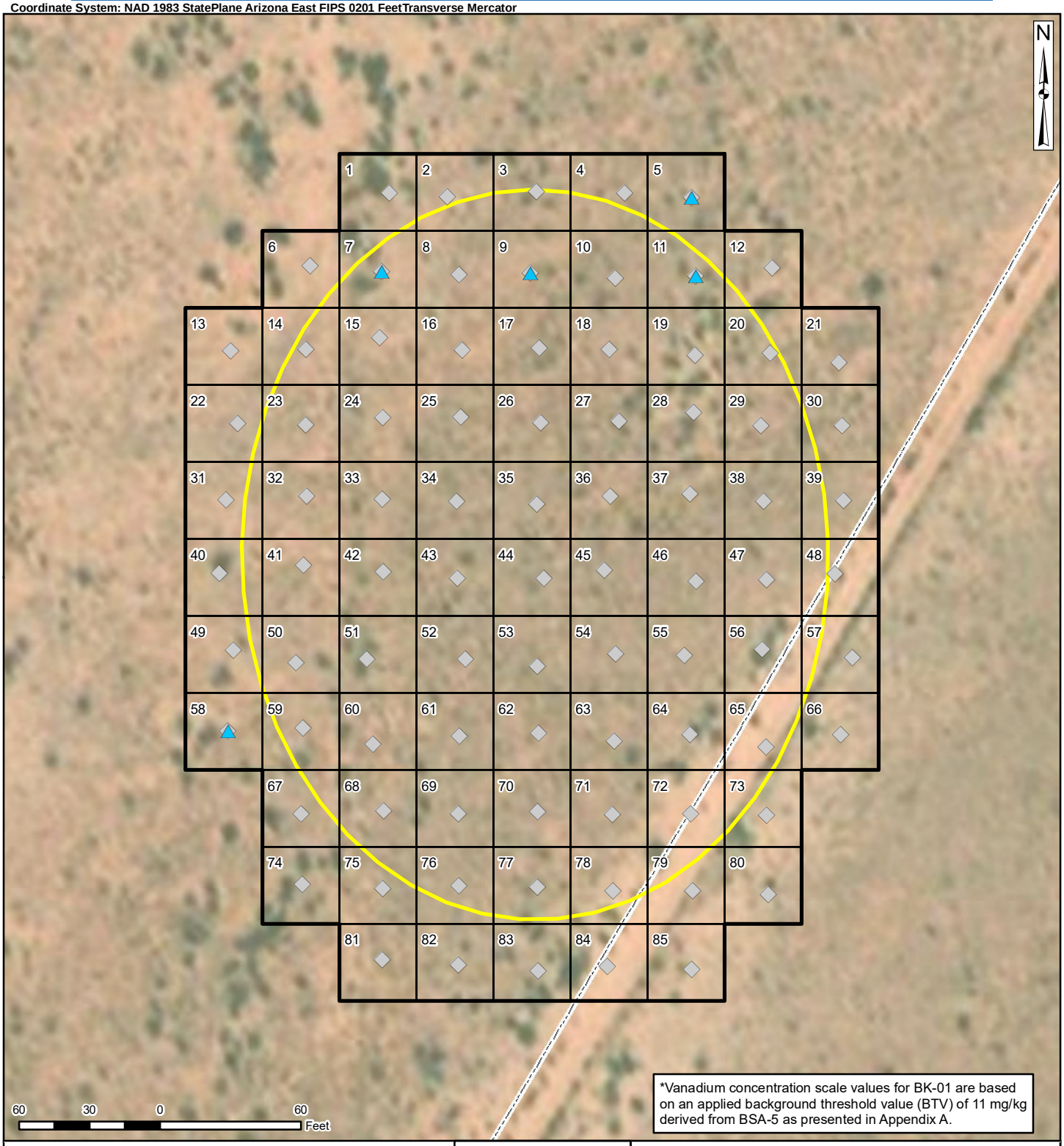
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NON-AUM TARGET BK-01 (T7) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
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Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

5.1.7.6 Vanadium

Vanadium was not identified as a COPC in surface soils as shown in Table I7-7. Vanadium was not detected in surface soils at Target T7 above XRF analyzer detection limit of 16 mg/kg. Vanadium concentrations in XRF confirmation samples ranged from 5.0 to 5.9 mg/kg, which is below the applied BTV; the applied BTV for vanadium is 11 mg/kg for Target T7 as presented in Section 5.1.4. The analytical results for vanadium for XRF confirmation samples are provided in Table I7-5. Summary statistics for XRF measurements are provided in Section 5.1.6.1. A soil contaminant map showing the individual vanadium concentrations observed at Target T7 from XRF confirmation samples is provided in Figure I7-24.



Vanadium Concentration Scale (mg/kg)*

- ≤ 8.9
- 8.9 - 11
- 11 - 22
- 22 - 33
- 33 - 44
- 44 - 110
- ≥ 110
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET BK-01 (T7) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I7-24
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/24/2019	

5.1.8 Conclusions

Target T7 (BK-01) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T7. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T7 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T7. ASPECT gamma survey results generally did not correlate with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T7 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may also be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Mean raw gamma measurements did not exceed the applied BTV. No grid averaged gamma measurements exceeded the applied BTV.
- Site-specific BTVs for Target T7 geology and soil types were established through a background study.
- A total of 24 analytes were identified as occurring within the surface environment. Of these analytes, 2 were identified as COPCs. No COPCs exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's observations, Target T7 does not contain TENORM. No mining-related activities or features were observed in the field, and no historical exploratory borings, vents, or other mine openings were noted in the file review or during field observation. NORM was not identified visually or by gamma survey.
- There are no immediate significant physical hazards present at Target T7.
- Access is via a dirt road with a small four-wheel-drive vehicle.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No groundwater wells are documented within the vicinity of Target T7. Rural residences are located nearby; however, it is not known if water is provided by utility or private well. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T7. Therefore, evaluation of the leachability of metals and radionuclides is not required.

- No mine waste was observed at Target T7; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; no data gaps remain for Target T7.

5.2 NON-AUM TARGET T8 (BK-02)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T8 (BK-02).

5.2.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T8 (BK-02) is associated with the Block K mine (M2), a former surface mine in the Tse Tah Region in Subarea Group B. Target T8 is administered by the Red Mesa and Sweetwater Chapters of the Navajo Nation and accessible by vehicle via Highway 160, which is located to the northeast. Two Targets (T7 and T8) are affiliated with the Block K mine and included in the MCAP (Weston 2016) as BK-01 and BK-02, respectively. No known historical information is associated with Target T8. There are three residences within 1 mile of the Target with the closest located 300 feet to the west. A Target location and access map for Target T8 is shown in Figure I8-1.

A topographical relief map for the Block K mine area and associated non-AUM Targets is provided in Figure I8-2. The elevation at Target T8 ranges from 5,487 to 5,493 feet amsl with an average of 5,490 feet amsl. The slope at Target T8 ranges from 1 to 3 percent with an average of 2 percent. There is a drainage channel 250 feet south of Target T8. The Block K mine and Target T8 are located entirely within Qa, and the soil type for the AUM and Target is Sogzie loamy fine sand (MUSYM 502) (Figures I-15 and I-16).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T8. Weston did not conduct a background study for Target T8. As a part of the RSE for the Block K mine, Tetra Tech also evaluated the associated non-AUM Targets, such as T8. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 2 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T8:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.
- Located access routes, including foot pathways and roads:

  Target T8 is accessed from a dirt road off of Highway 160 to the northeast.
- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM and TENORM were not observed at the Target.
- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  No drainages were present at the Target.
- Identified any exploration borings or historic haul roads:

  No exploratory borings or former haul roads were identified.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  No non-AUM Target features were identified.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

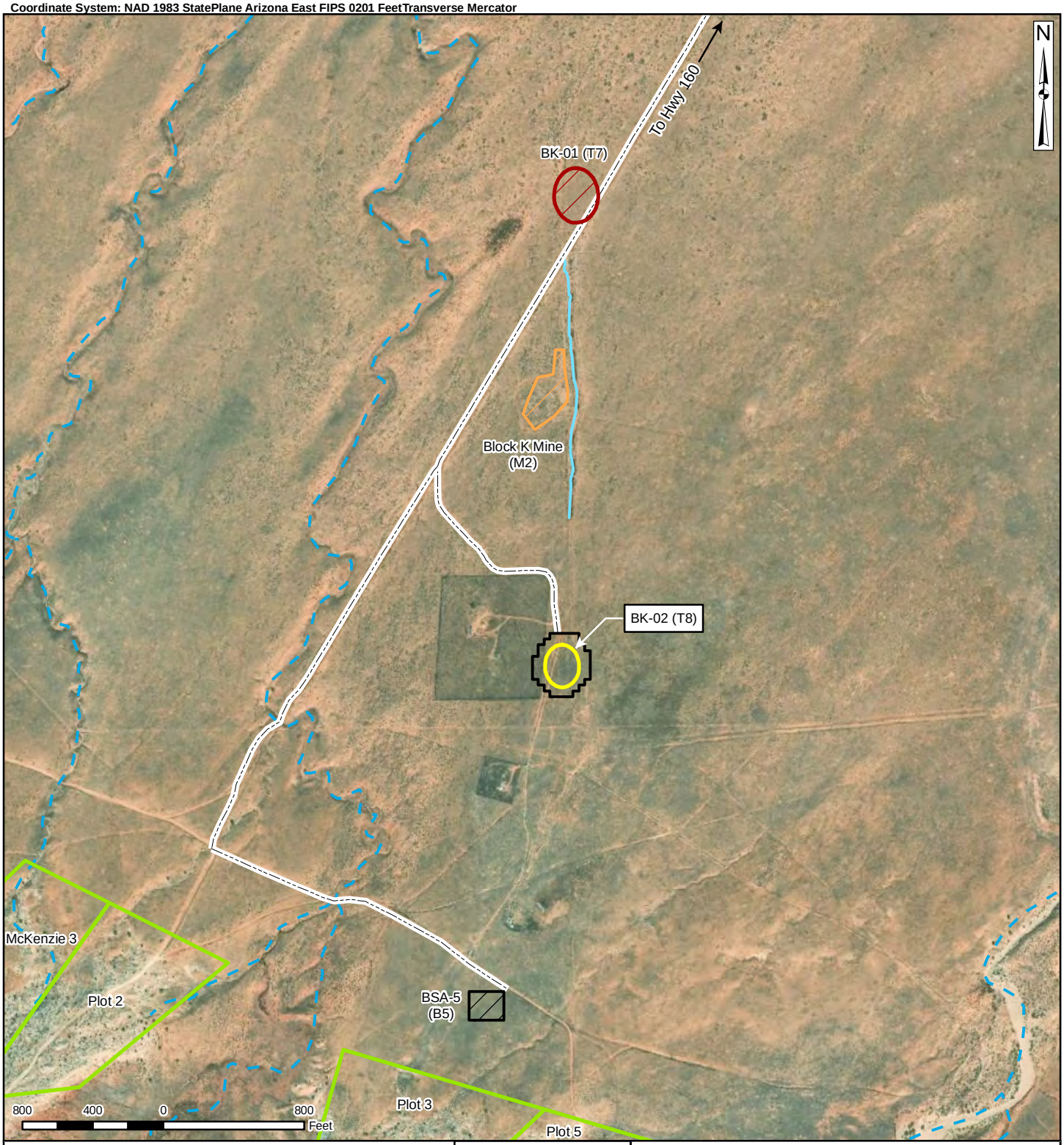
  Concrete debris was observed at the Target, but the debris did not correlate with any elevated gamma readings.

The Baseline Study field survey, measurement, and sampling activities at Target T8 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Section 2.3 and 5.2.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 5.2.3 with results presented in Sections 5.2.6 and 5.2.7)
- Conducting a gamma radiation survey (results presented in Section 5.2.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target
Tronox AUM Site Boundary
Background Location
Non-Tronox AUM Site
Access Route - Vehicular
Drainage*
Drainage - Field Mapped

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

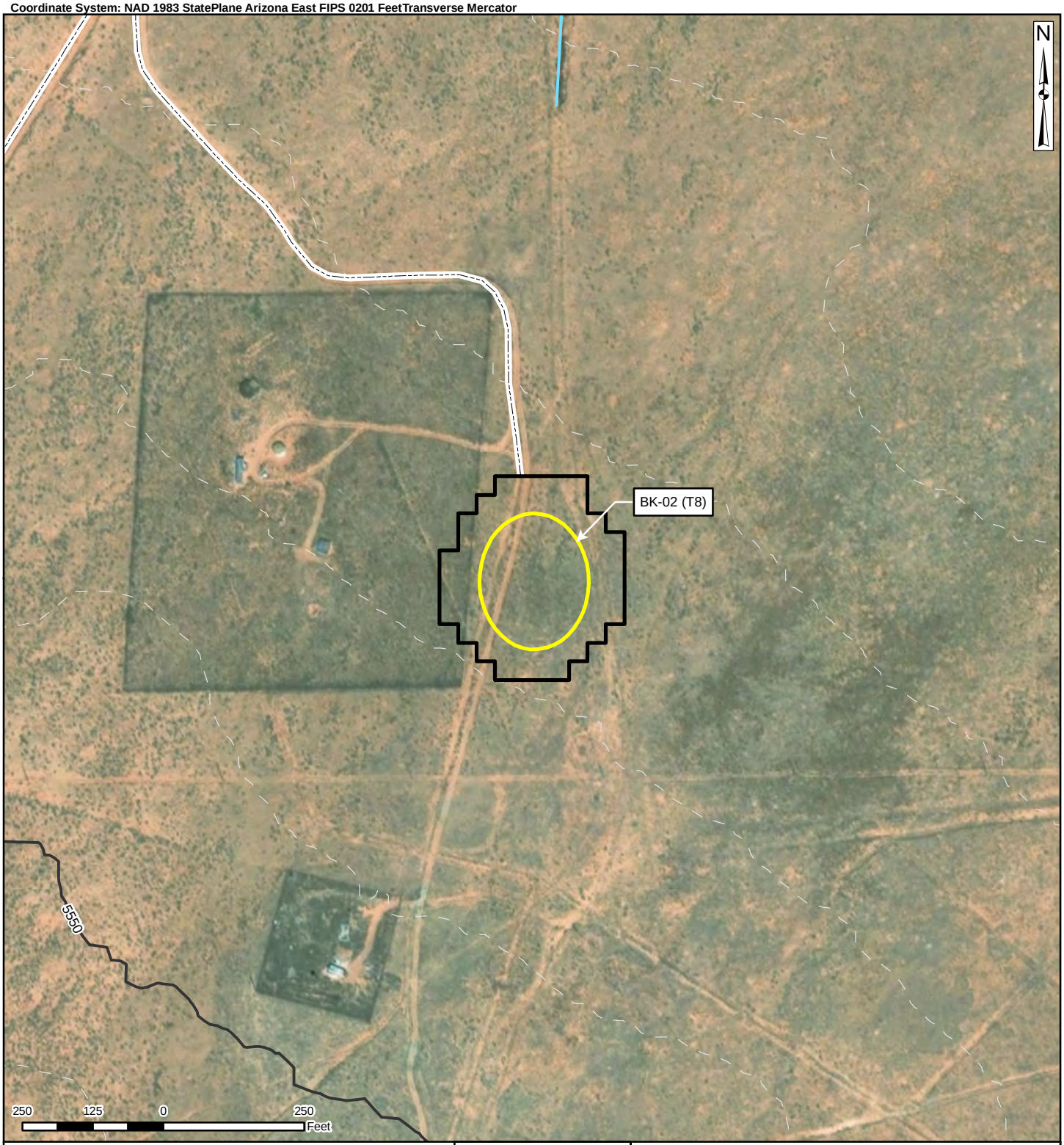
Prepared for: USEPA Region 9

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

NON-AUM TARGET BK-02 (T8) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I8-1
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

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



Non-AUM Target Site Boundary
Related Survey Area
Access Route - Vehicular
Drainage - Field Mapped
50 ft Contour*
10 ft Contour*

* 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.

Prepared for: USEPA Region 9

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NON-AUM TARGET BK-02 (T8) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I8-2
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

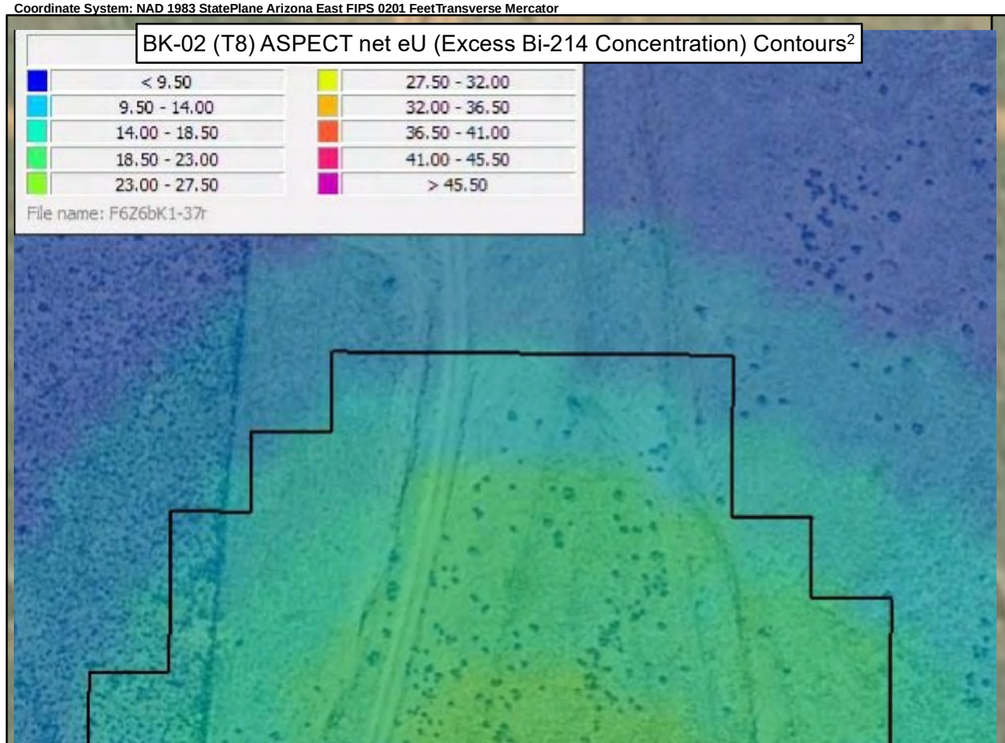
5.2.2 Gamma Radiation Survey and Field XRF Measurements

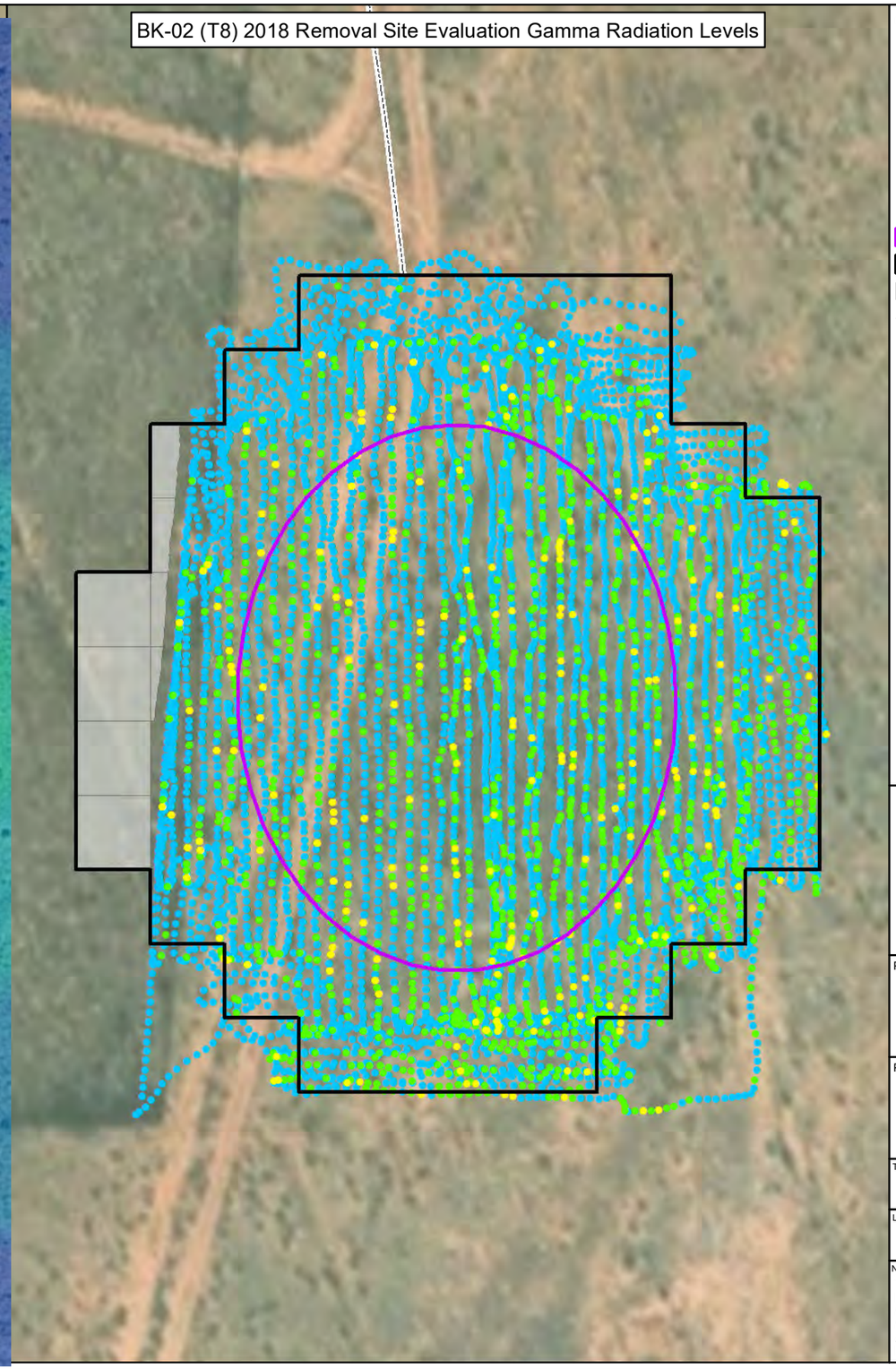
Tetra Tech performed GPS-based gamma radiation surveys (Figure I8-3) within the survey area of the non-AUM Target T8 as part of the Baseline Study in April 2018. Additional Goback gamma radiation surveys were performed in August 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T8 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I8-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at 26 survey units. Four gamma survey and four XRF survey units were not evaluated along the western edge of the survey area because of accessibility issues related to private property ownership.

5.2.3 XRF Confirmation Sampling Overview

Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T8. Three XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from three locations (Table I8-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I8-4 and I8-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I8-2. The results of XRF confirmation sample analysis are provided in Section 5.2.6.1. Correlated XRF field measurements are provided in Attachment I3.

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





Gamma Reading (cpm)[1]

≤ 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

Non-AUM Target Site Boundary

Survey Area Boundary

Inaccessible

Access Route - Vehicular

[1]The applied gamma background threshold value (BTV) for BK-02 (T8) Non-AUM Target is 11,010 cpm derived from BSA-5 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET BK-02 (T8)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

Prepared By:

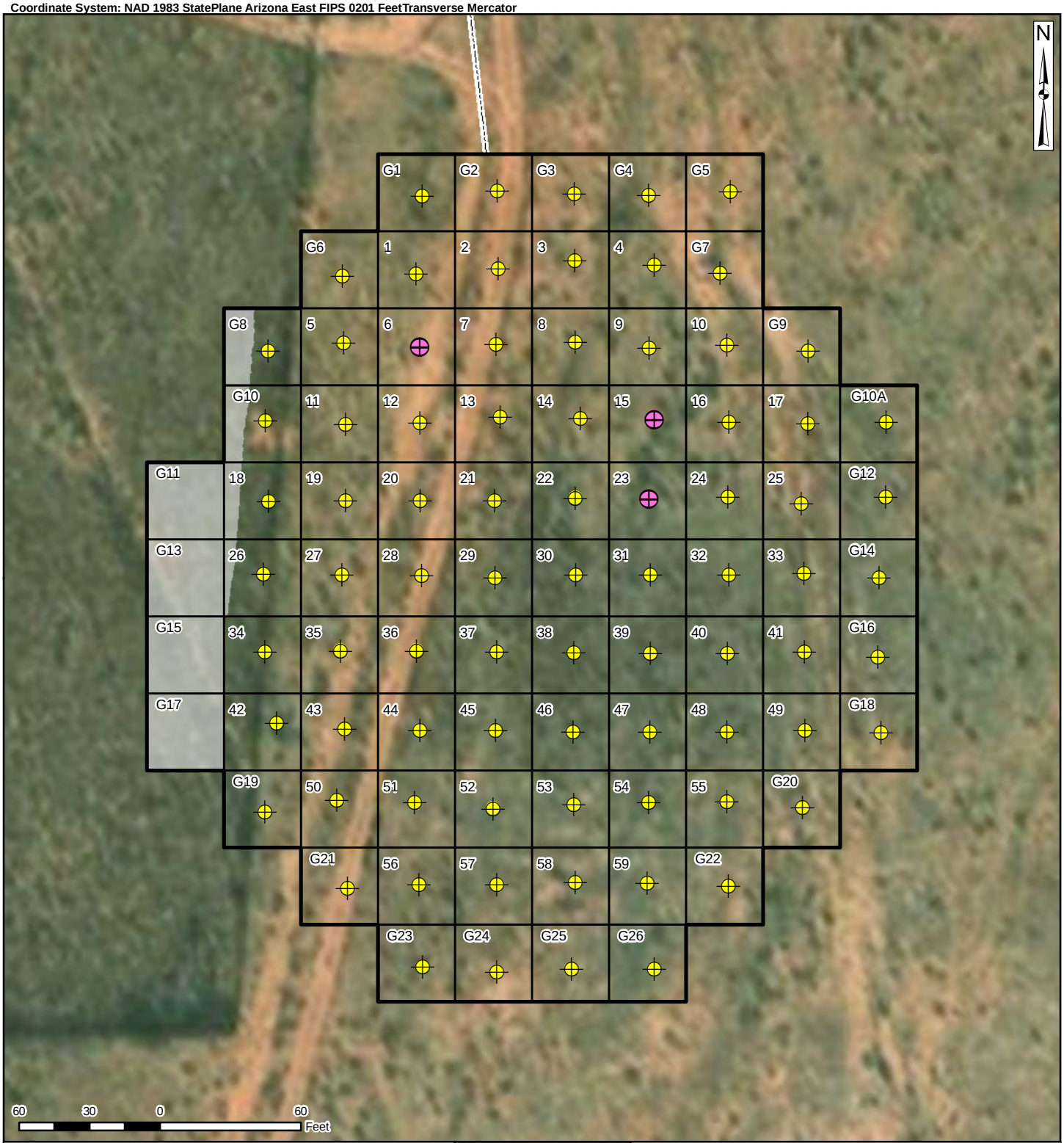
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborn Spectral Photometric Environmental Collection Technology.

Figure No.: **I8-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Grid Unit (100 m²)

Survey Area Boundary

Inaccessible

Access Route - Vehicular

Prepared for: USEPA Region 9

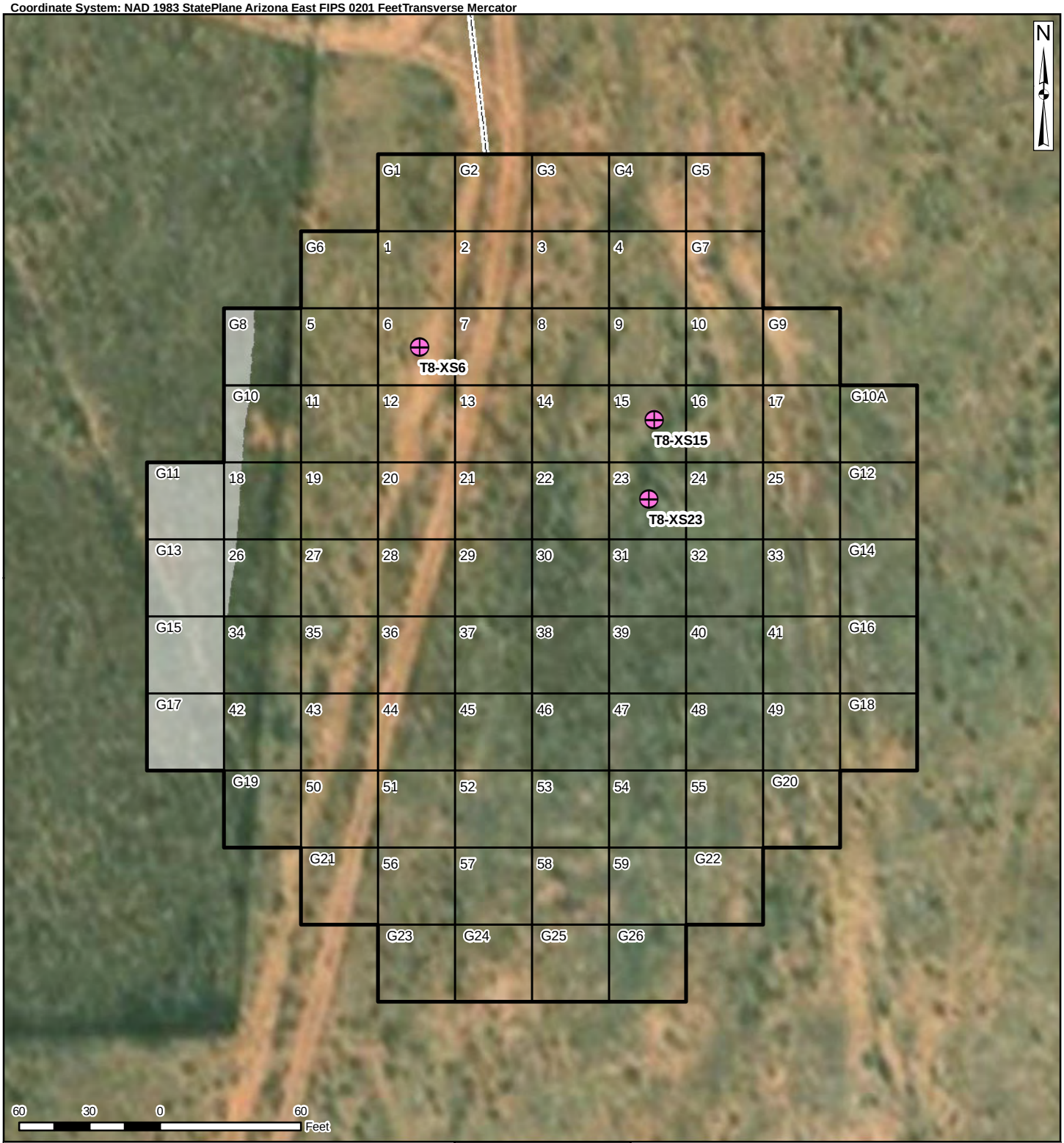
Prepared By:

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NON-AUM TARGET BK-02 (T8)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I8-4
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

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



XRF Confirmation Soil Sample* (0 - 3 inches bgs)

Survey Grid Unit (100 m²)

Survey Area Boundary

Inaccessible

Access Route - Vehicular

*T8-XS6 = site T8 XRF confirmation soil sample collected at survey unit 6. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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Prepared By:

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NON-AUM TARGET BK-02 (T8)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I8-5
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

Table I8-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target BK-02 (T8)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T8-XS6-01-042418	6	0-3	XRF Confirmation	Primary	4/24/2018	36.9106992	-109.2831928	1805035-16, 1805036-16
T8-XS15-01-042418	15	0-3	XRF Confirmation	Primary	4/24/2018	36.9106121	-109.2828523	1805035-14, 1805036-14
T8-XS23-01-042418	23	0-3	XRF Confirmation	Primary	4/24/2018	36.9105193	-109.2828608	1805035-15, 1805036-15

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I8-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BK-02 (T8)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

5.2.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 5.2.1, Target T8 surface geology is entirely within Qa and soils within the Sogzie loamy fine sands (MUSYM 502) (Figures I-15 and I-16). As a result, BSA-5 was selected for that combination of geology and soil type. Table I8-3 presents the Target-specific BTVs for 29 analytes and gamma radiation levels for Target T8. No regional BTVs were established for Target T8. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T8. The "Applied BTV" for each analyte is the Target-specific BTV.

Table I8-3. Applied Background Threshold Values for Non-AUM Target BK-02 (T8)

Analyte	Units	Site-Specific BTV (BSA-5)	Regional BTV (Qa)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	4,220	None	4,220	Site-Specific BTV
Antimony	mg/kg	0.160	None	0.160	Site-Specific BTV
Arsenic	mg/kg	3.9	None	3.9	Site-Specific BTV
Barium	mg/kg	68	None	68	Site-Specific BTV
Beryllium	mg/kg	0.25	None	0.25	Site-Specific BTV
Cadmium	mg/kg	0.091	None	0.091	Site-Specific BTV
Calcium	mg/kg	21,000	None	21,000	Site-Specific BTV
Chromium	mg/kg	3.6	None	3.6	Site-Specific BTV
Cobalt	mg/kg	2.0	None	2.0	Site-Specific BTV
Copper	mg/kg	4.7	None	4.7	Site-Specific BTV
Iron	mg/kg	4,500	None	4,500	Site-Specific BTV
Lead	mg/kg	5.0	None	5.0	Site-Specific BTV
Lithium	mg/kg	6.8	None	6.8	Site-Specific BTV
Magnesium	mg/kg	3,640	None	3,640	Site-Specific BTV
Manganese	mg/kg	210	None	210	Site-Specific BTV
Mercury	mg/kg	0.010	None	0.010	Site-Specific BTV
Molybdenum	mg/kg	0.34	None	0.34	Site-Specific BTV
Nickel	mg/kg	4.1	None	4.1	Site-Specific BTV
Potassium-40	pCi/g	16.8	None	16.8	Site-Specific BTV
Radium-226	pCi/g	2.38	None	2.38	Site-Specific BTV
Radium-228	pCi/g	-	None	-	Site-Specific BTV
Selenium	mg/kg	0.47	None	0.47	Site-Specific BTV
Silver	mg/kg	0.017	None	0.017	Site-Specific BTV
Sodium	mg/kg	53	None	53	Site-Specific BTV
Thallium	mg/kg	0.045	None	0.045	Site-Specific BTV
Thorium	mg/kg	1.9	None	1.9	Site-Specific BTV
Uranium	mg/kg	1.5	None	1.5	Site-Specific BTV
Vanadium	mg/kg	11	None	11	Site-Specific BTV
Zinc	mg/kg	22	None	22	Site-Specific BTV
Gamma Radiation	cpm	11,010	None	11,010	Site-Specific BTV

Notes:

-	No BTV
BSA	Background Study Area
BTV	background threshold value
cpm	counts per minute
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
Qa	Quaternary Alluvium

5.2.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T8 and the raw gamma radiation and grid averaged gamma radiation survey results.

5.2.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T8 in April 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in August 2018 to collect data within the Goback survey units. The applied gamma BTV for non-AUM Target T8 is 11,010 cpm. A total of 9,055 measurements were collected as part of the gamma radiation survey at non-AUM Target T8 across 82 survey units. An average scan density of 110 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I8-4.

Table I8-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target BK-02 (T8)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,010	
Measurements	#	9,055	82
Minimum	cpm	5,641	7,708
Maximum	cpm	13,922	9,591
Average	cpm	8,949	8,987
Median	cpm	8,862	9,066
Standard Deviation	cpm	1,038	432
90th Percentile	cpm	10,292	9,431
95th Percentile	cpm	10,756	9,465
99th Percentile	cpm	11,815	9,569
Measurements per Grid	#/grid	110	
Measurements Above Gamma BTV	#	339	0
Measurements Above Gamma BTV	%	3.7	0

Notes:
BTV background threshold value
cpm counts per minute

5.2.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 3.7 percent of the measurements within the Target boundaries, in some cases slightly exceeding the applied gamma BTV (11,010 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-5 (Qa) gamma survey results is provided on Figure I8-6. This graph shows that the spread of radiation data at Target T8 (shown on left) begins below the lower range of BSA-5 (Qa) gamma levels (shown on right) and then exceeds background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T8 is slightly lower than the data cloud from the BSA-5 (Qa) data set. A box plot showing the quartiles of the data sets is provided in Figure I8-7. The box plot shows that the median of Target T8 radiation levels is lower than the median of the BSA-5 (Qa) data set and lower than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I8-8. Survey units that were classified as inaccessible during the gamma radiation survey because of private property ownership are shown as gray squares on Figure I8-8 as discussed further in Section 2.8. No mining activity was observed within the survey area of Target T8. There were no distinct elevated areas or hot spots, confirming Weston MCAP survey findings as shown in Figure I8-8.

In general, Target T8 has surficial gamma radiation levels below BSA-5 (Qa) levels across the entire Target and survey boundary, indicating that the survey did not identify the area of potential elevated gamma activity identified by the ASPECT gamma survey (Figures I8-3). No TENORM or mining-related activities were observed within the Target T8 survey and surrounding area. Section 5.2.5.3 presents the grid averaged results of the gamma radiation survey.

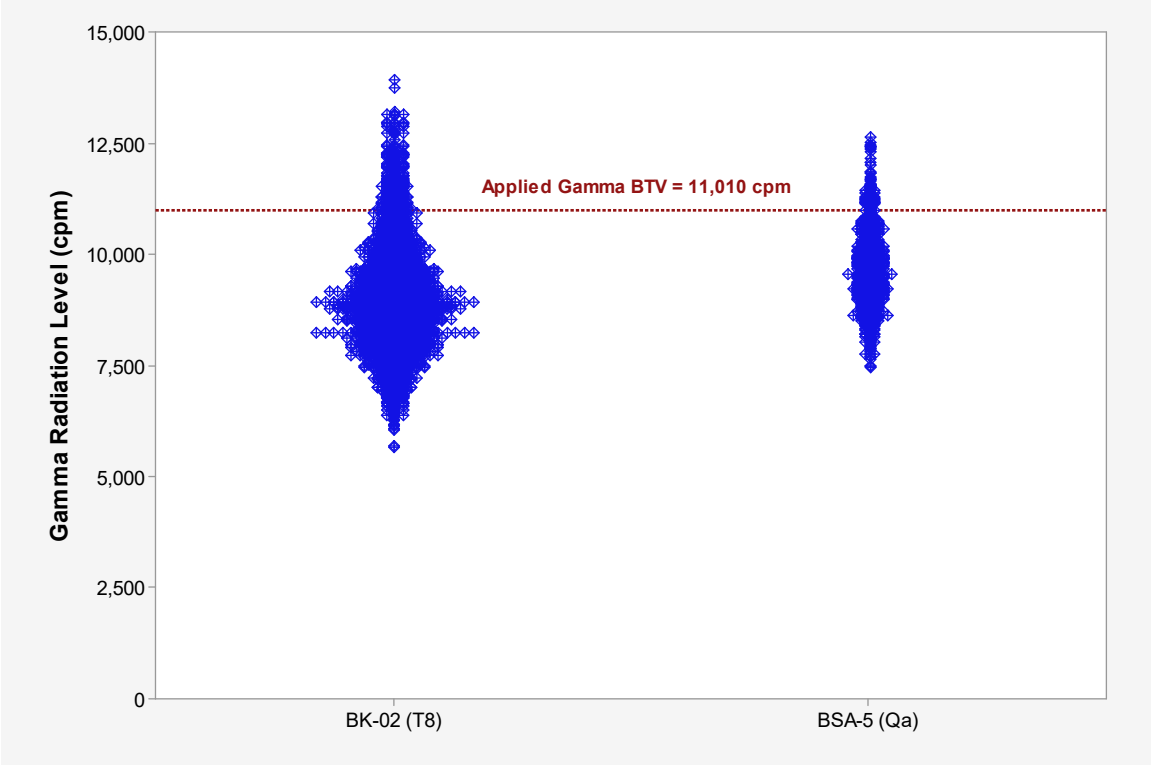


Figure I8-6. Individual Value Plot of Raw Gamma Radiation Levels at Target BK-02 (T8) and BSA-5 (Qa)

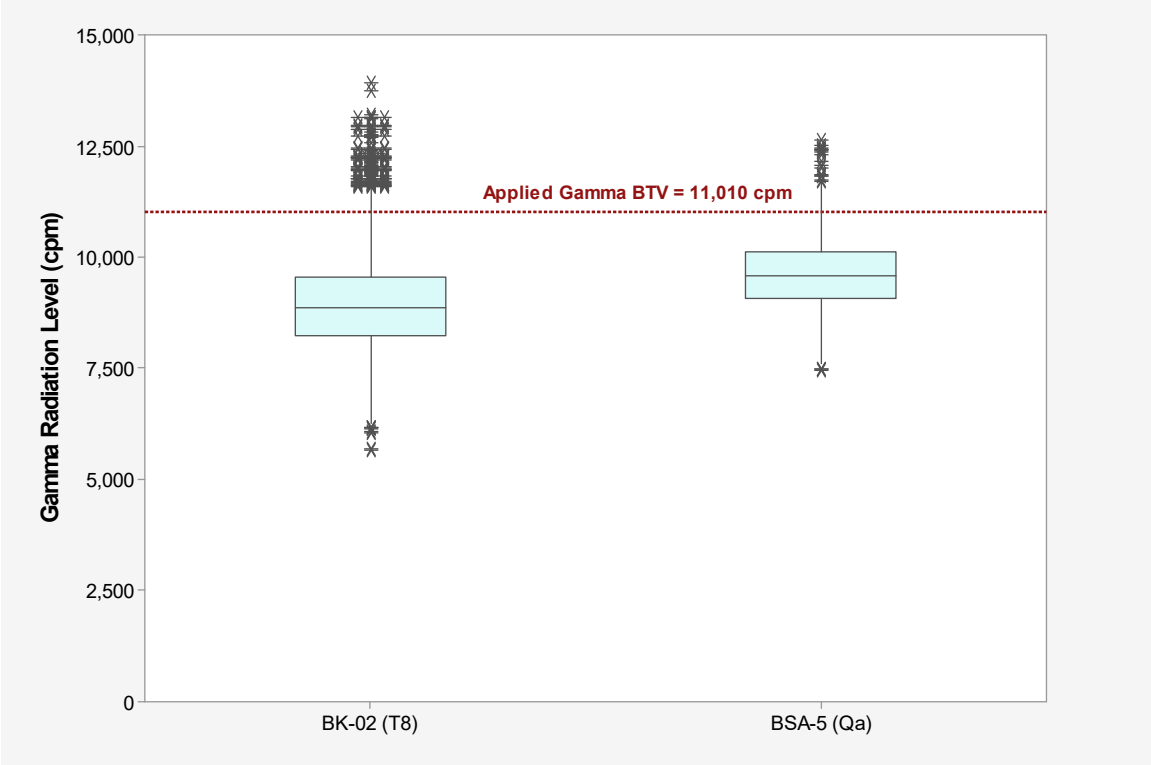
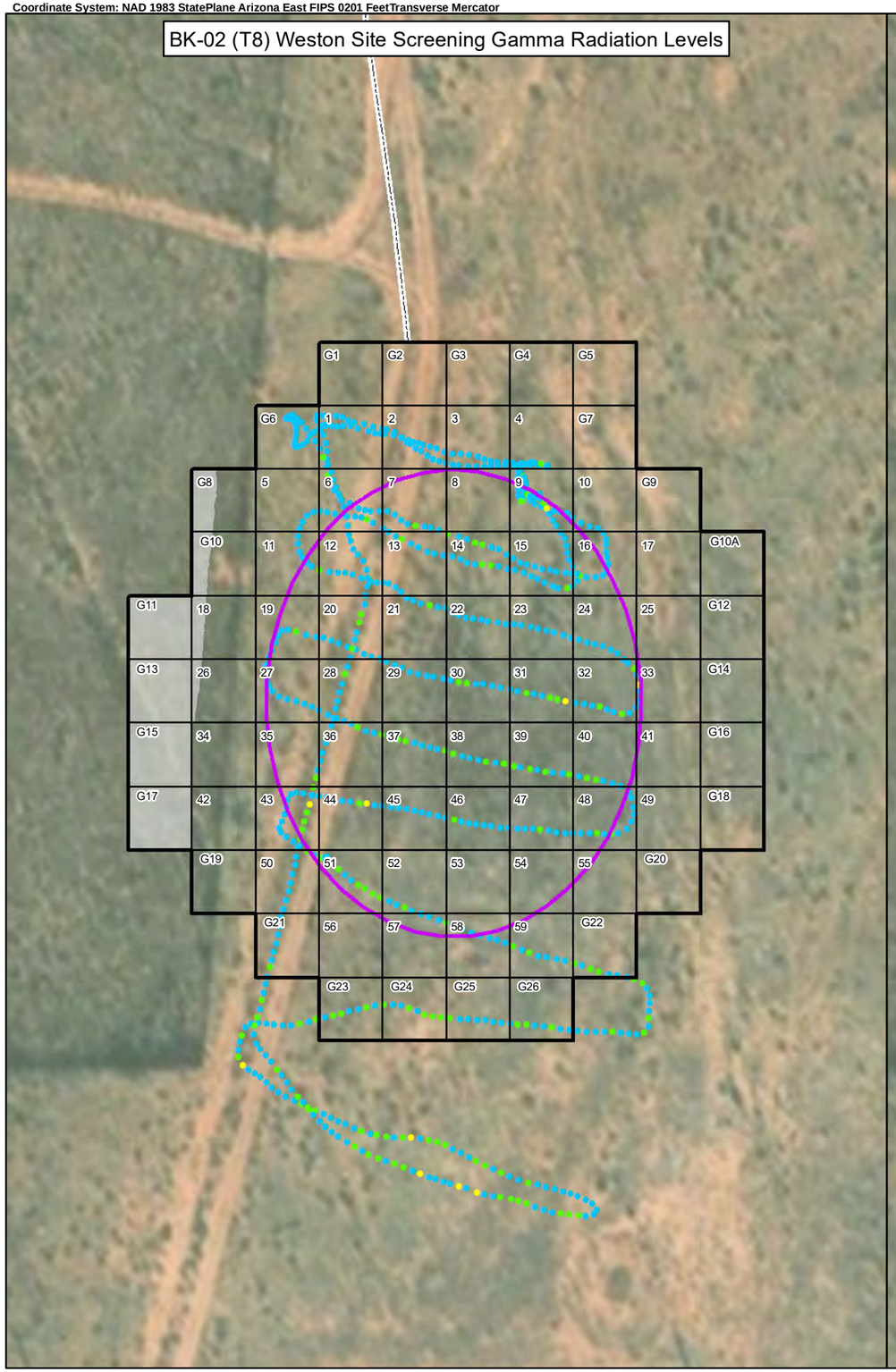
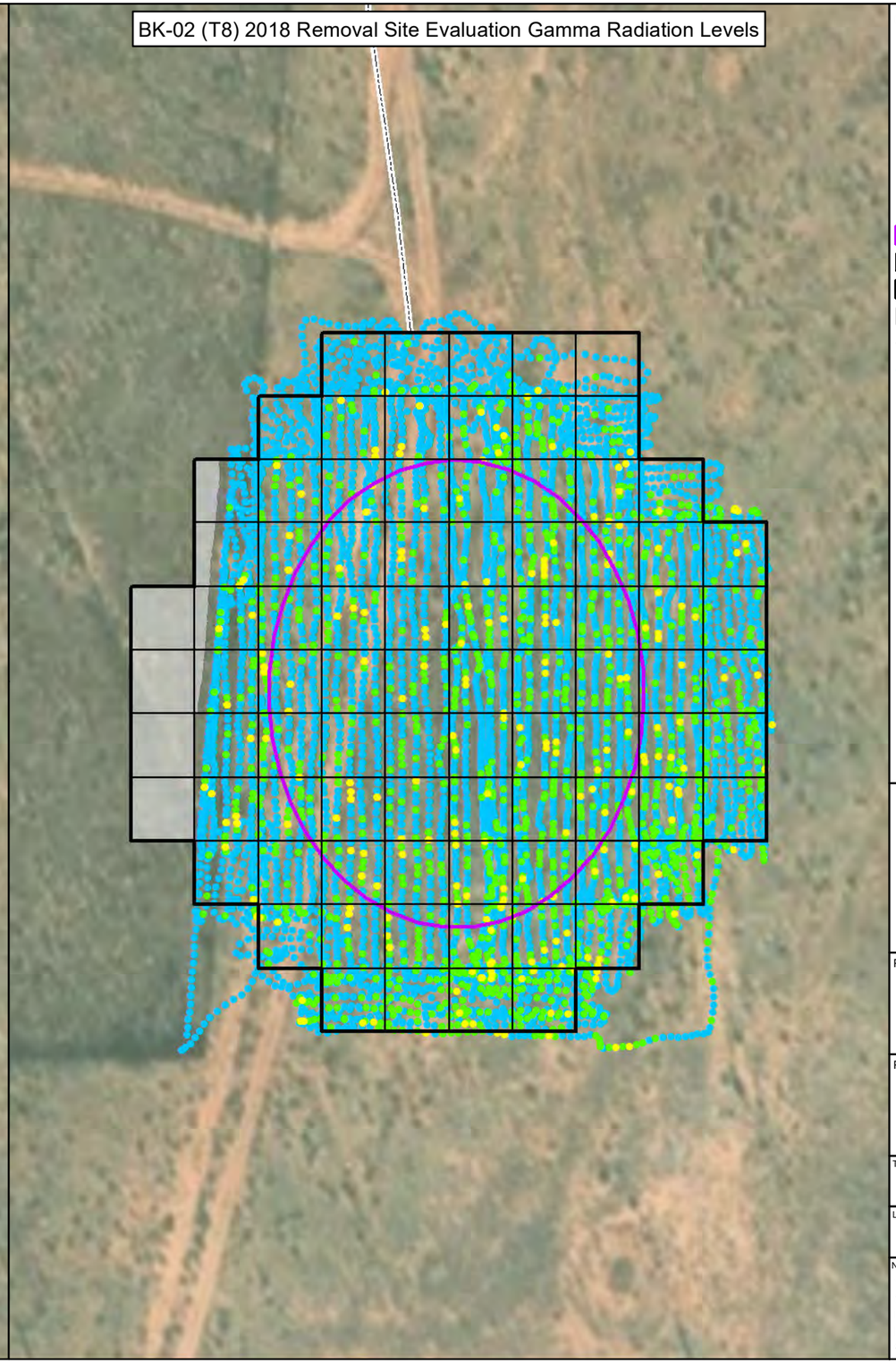


Figure I8-7. Box Plot of Raw Gamma Radiation Levels at Target BK-02 (T8) and BSA-5 (Qa)

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





Gamma Reading (cpm)*

≤ 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

- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Inaccessible
- Access Route - Vehicular
- Drainage - Field Mapped

1 in = 70 ft

1:840

N W E S

0 35 70 140 Feet

NON-AUM TARGET BK-02 (T8)
2018 REMOVAL SITE EVALUATION
VS WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019

Notes:
*The applied gamma radiation background threshold value (BTV) for BK-02 (T8) is 11,010 cpm derived from BSA-5 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I8-8**

5.2.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 5.2.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 5.2.5.1. Figure I8-9 and Figure I8-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-5 (Qa) data set (shown on right). No survey units within the survey area of Target T8 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I8-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I8-11 as discussed further in Section 2.8. No survey units exceeded the gamma BTV.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 5.2.6.

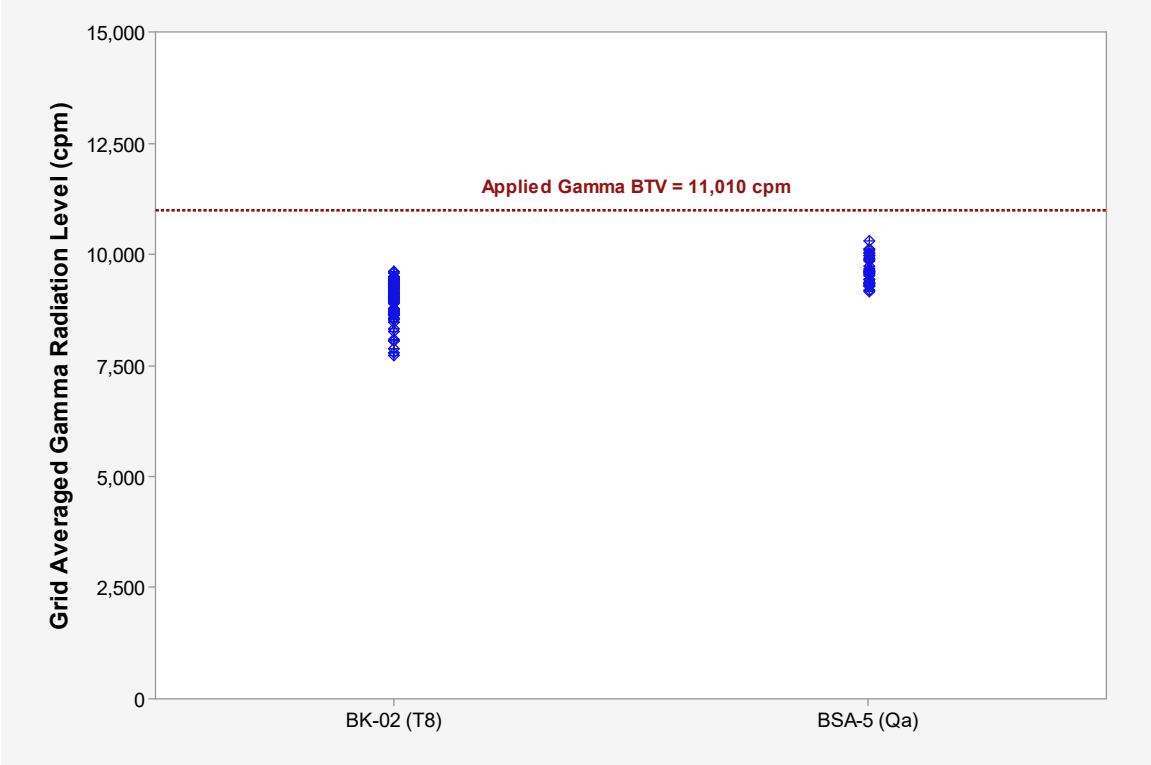


Figure I8-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target BK-02 (T8) and BSA-5 (Qa)

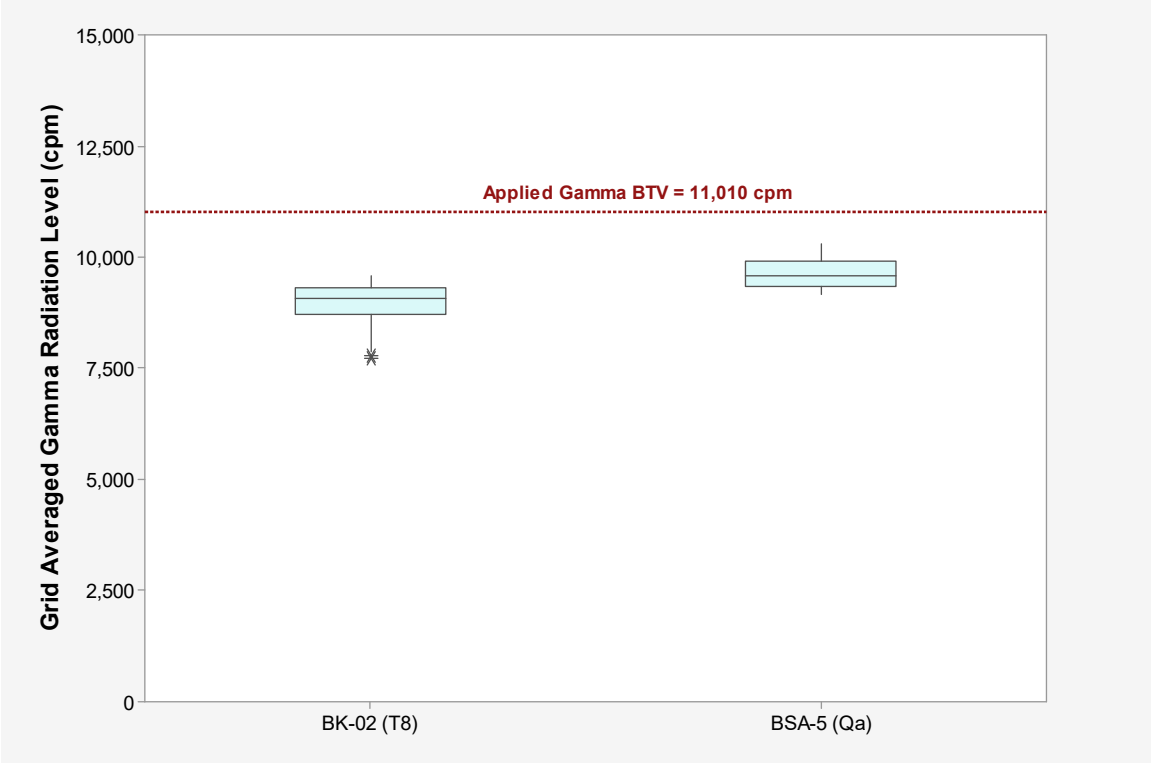
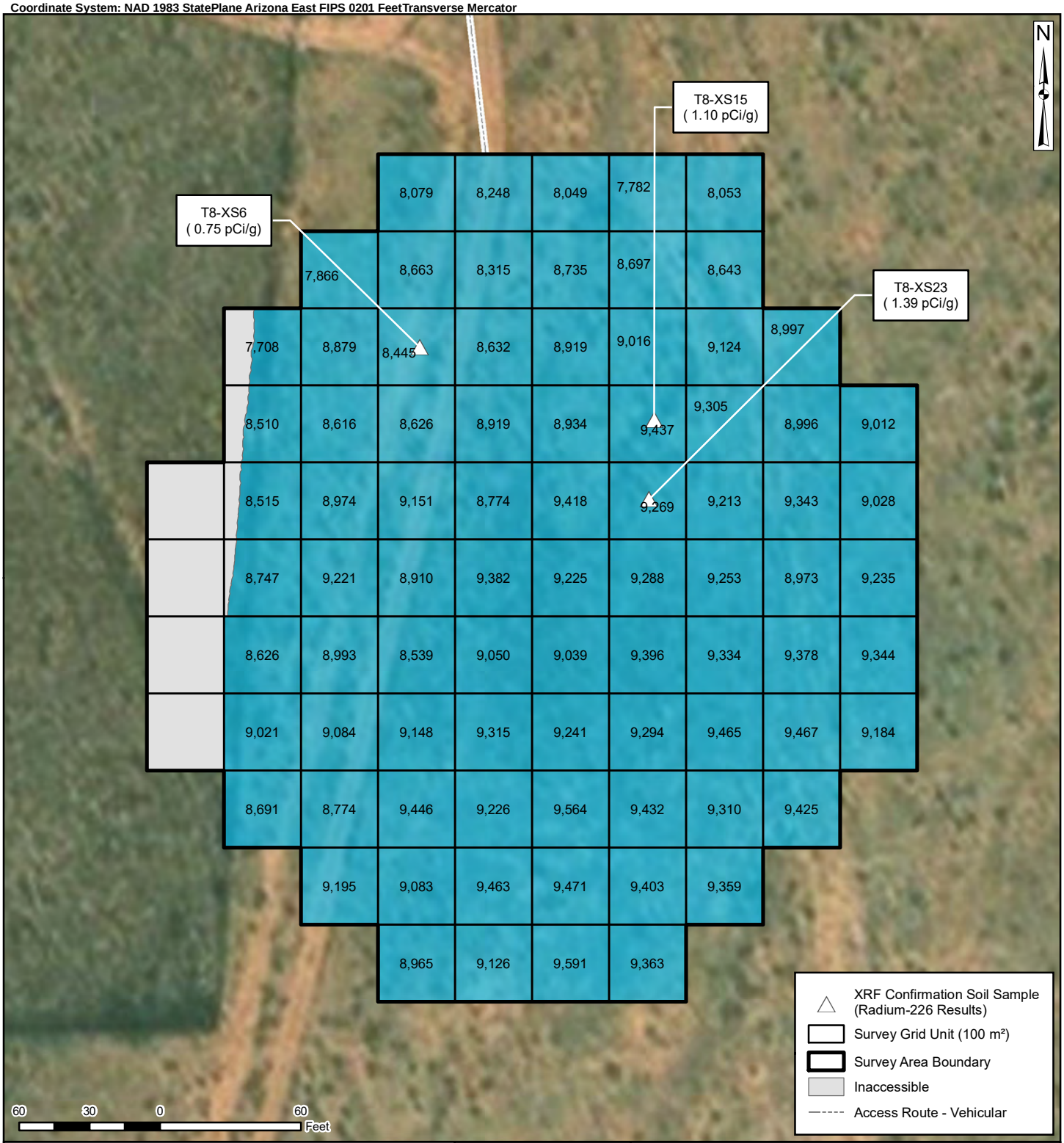


Figure I8-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target BK-02 (T8) and BSA-5 (Qa)

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



Grid Averaged Gamma Reading (cpm)*

≤ 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

*The applied gamma background threshold value (BTV) for BK-02 is 11,010 cpm derived from BSA-5 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET BK-02 (T8) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I8-11
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 7/9/2019	

5.2.6 Soil Sampling Results

This section presents the results of analyses for soil within the survey area of Target T8. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 5.2.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 5.2.6.2.

5.2.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T8: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I8-1 and I8-2. All the results of the XRF confirmation soil samples are presented in Table I8-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T8 following the methods outlined in Section 2.4 and shown in Figure I8-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 82 measurements were collected across 86 survey units from the survey area of Target T8 during the Baseline Study. Four survey units were not sampled because of private property ownership. The summary statistics of the XRF field survey results are provided in Table I8-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T8 at a depth of 0 to 3 inches bgs. Three XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I8-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 5.2.7.

Table I8-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BK-02 (T8)

Analyte	Units	Applied BTV	T8-XS15-01-042418		T8-XS23-01-042418		T8-XS6-01-042418	
			Result	Q	Result	Q	Result	Q
Survey Unit			X15		X23		X6	
Aluminum	mg/kg	4,220	3,300		3,700		3,000	
Antimony	mg/kg	0.160	0.056	J	0.068	J	0.049	J
Arsenic	mg/kg	3.9	1.3		1.4		1.2	
Barium	mg/kg	68	47		52		54	
Beryllium	mg/kg	0.25	0.21		0.24		0.2	
Cadmium	mg/kg	0.091	0.057	J	0.059	J	<0.19	U
Calcium	mg/kg	21,000	5,800		5,600		8,800	
Chromium	mg/kg	3.6	2.7		3.1		2.5	
Cobalt	mg/kg	2.0	1.6		1.8		1.5	
Copper	mg/kg	4.7	3.1		3.5		2.6	
Iron	mg/kg	4,500	3,600		4,000		3,200	
Lead	mg/kg	5.0	3.6		3.8		2.7	
Lithium	mg/kg	6.8	5.1		5.7		4.3	
Magnesium	mg/kg	3,640	2,700		3,100		2,100	
Manganese	mg/kg	210	130		150		110	
Molybdenum	mg/kg	0.34	0.18	J	0.19	J	0.1	J
Nickel	mg/kg	4.1	3		3.5		2.6	
Potassium-40	pCi/g	16.8	14.4		13.7		11.6	
Radium-226	pCi/g	2.38	1.1		1.39		0.75	LT
Radium-228	pCi/g	-	<0.25	U	<0.45	U	<0.29	U
Selenium	mg/kg	0.47	0.37	J	0.38	J	0.33	J
Silver	mg/kg	0.017	0.0095	J	0.0098	J	0.0084	J
Sodium	mg/kg	53	<95	U	<98	U	<93	U
Thallium	mg/kg	0.045	0.028		0.033		0.027	
Thorium	mg/kg	1.9	1.5		1.6		1.3	
Uranium	mg/kg	1.5	0.71		0.71		0.43	
Vanadium	mg/kg	11	7.3		7.9		6.6	
Zinc	mg/kg	22	11		14		9.1	J

Notes:

-	No BTV
BTV	Background threshold value
J	Estimated value
J-	Estimated value, may be biased low
LT	Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
M3	The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg	Milligrams per kilogram
NA	Not applicable
NV	No Value
pCi/g	Picocuries per gram
Q	Qualification
U	Not considered detected. The associated value is the method detection limit (MDL).
UJ	Not considered detected. The associated value is the reported concentration, which is estimated.

Table I8-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target BK-02 (T8)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	3.9	4,500	5	210	0.34	1.9	1.5	11	22
Measurements	#	82	82	82	82	82	82	82	82	82
Detects	#	23	82	82	82	10	70	47	0	82
Nondetects	#	59	0	0	0	72	12	35	82	0
Minimum	mg/kg	1.9	3,277	2.7	126.3	0.4	1.0	0.1	-	11.2
Maximum	mg/kg	2.9	8,333	6.9	222.3	2.1	2.3	3.2	-	20.3
Standard Deviation	mg/kg	0.3	1,237	0.9	19.5	0.6	0.3	0.6	-	1.9
Average	mg/kg	2.2	4,633	4.9	177.2	1.0	1.5	0.8	-	15.1
Median	mg/kg	2.1	4,320	4.9	181.1	0.9	1.5	0.6	-	14.7
Relative Standard Deviation	%	12	27	19	11	57	23	78	-	13
90th Percentile	mg/kg	2.5	7,221	6.2	199.2	1.5	2.0	1.7	-	17.9
95th Percentile	mg/kg	2.5	7,726	6.5	205.9	1.8	2.1	1.8	-	18.6
99th Percentile	mg/kg	2.8	8,035	6.9	217.0	2.1	2.2	2.6	-	19.5
Measurements Above Applied BTV	#	0	28	38	3	10	15	8	0	0
Measurements Above Applied BTV	%	0.0	34.1	46.3	3.7	12.2	18.3	9.8	0.0	0.0

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value

mg/kg Milligram per kilogram

XRF X-ray fluorescence

5.2.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T8 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T8 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T8. The estimated BTVs are identified in Section 5.2.4 and Table I8-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I8-7 presents a summary of the background comparison for different measurement and soil depths at Target T8. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T8. Further gamma radiation screening indicated that, in general, gamma levels at Target T8 were lower than the BSA. Therefore, while iron, lead, molybdenum, thorium, and uranium have been identified as COPCs at Target T8 based on a conservative comparison to background, risk screening may be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I8-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target BK-02 (T8)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic			
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron		✓	✓
Lead		✓	✓
Lithium			
Magnesium			
Manganese			
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium			
Silver			
Sodium			
Thallium			
Thorium		✓	✓
Uranium		✓	✓
Vanadium			
Zinc			

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

5.2.7 Primary Contaminant Mapping

5.2.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 5.2.6.2 identified the COPCs at Target T8. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 5.2.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I8-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T8 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 5.2.7.1 through Section 5.2.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T8. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

5.2.7.2 Arsenic

Arsenic was not identified as a COPC in surface soils as shown in Table I8-7. Arsenic did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for arsenic is 3.9 mg/kg for Target T8 as presented in Section 5.2.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I8-5 and Attachment I3, respectively. Figure I8-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T8 and BSA-5 (Qa) samples. Figure I8-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T8 and BSA-5 (Qa) samples. Summary statistics for XRF measurements are provided in Section 5.2.6.1. Arsenic XRF concentrations measured in surface soils at Target T8 ranged between 1.9 and 2.9 mg/kg with an average and standard deviation of 2.2 mg/kg and 0.3 mg/kg, respectively. The average arsenic concentration is below the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T8 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I8-14. All arsenic results in surface soils were less than the applied BTV.

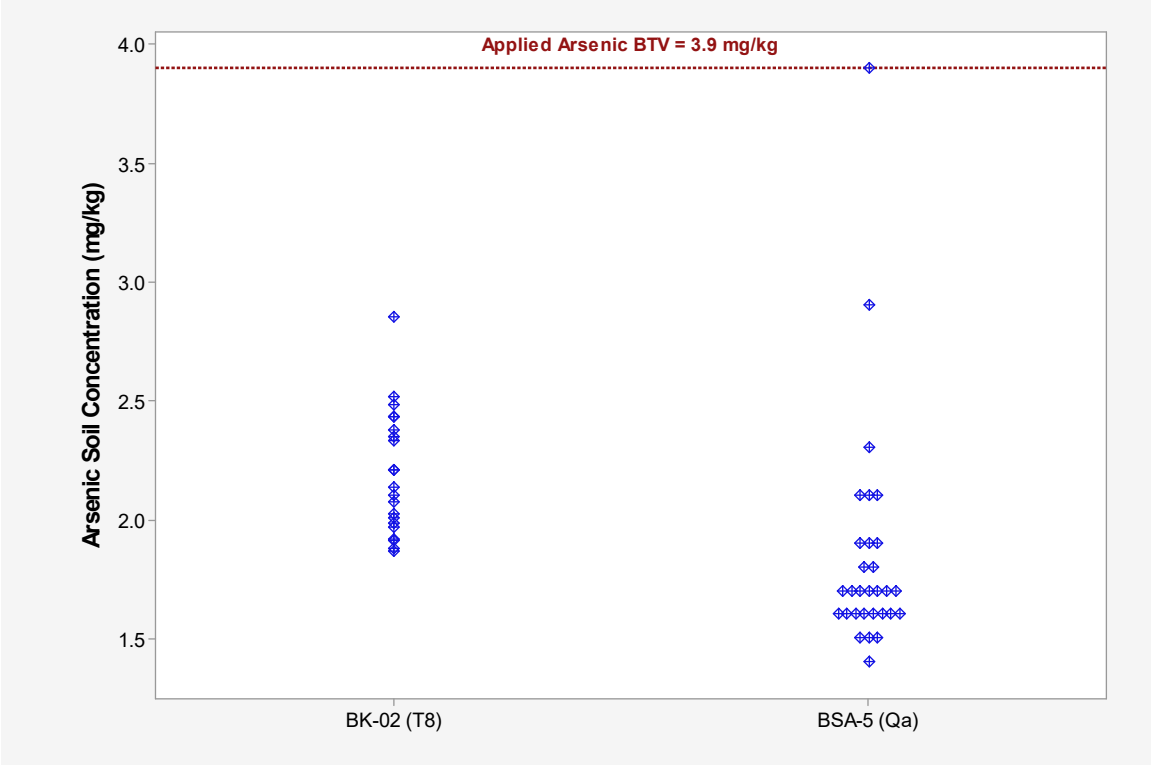


Figure I8-12. Individual Value Plot for Target BK-02 (T8) and BSA-5 (Qa) Arsenic Soil Concentrations

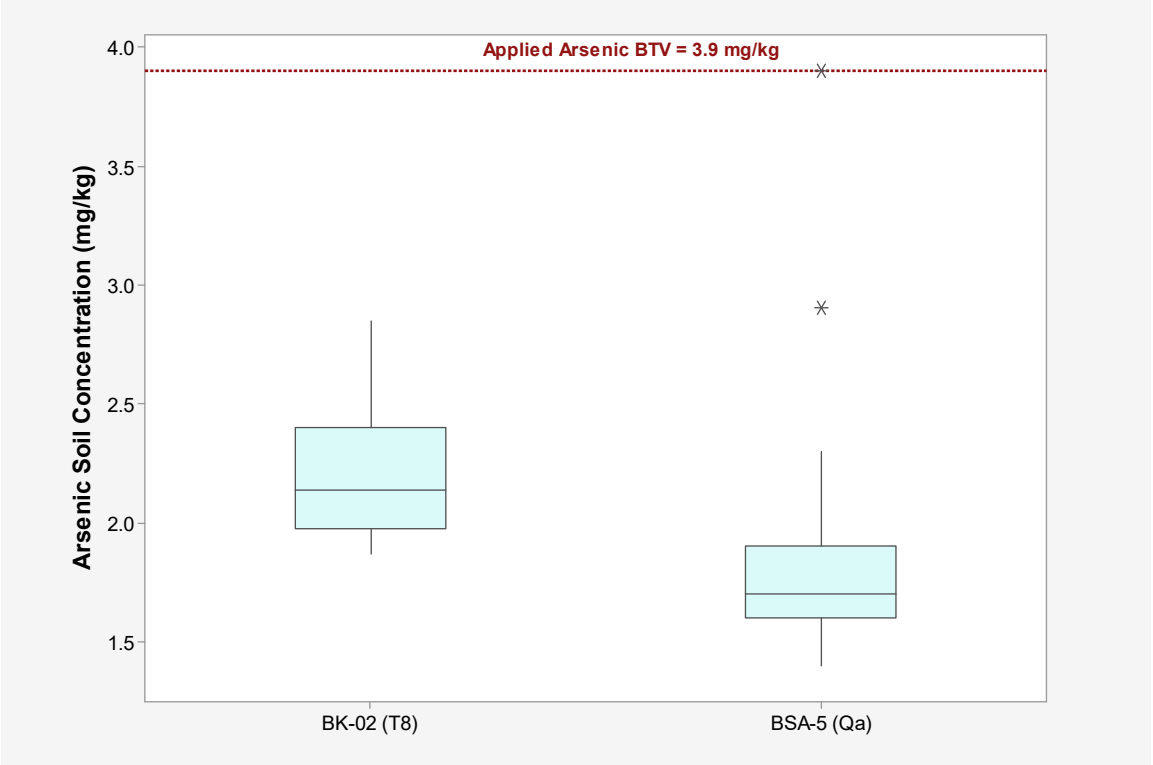
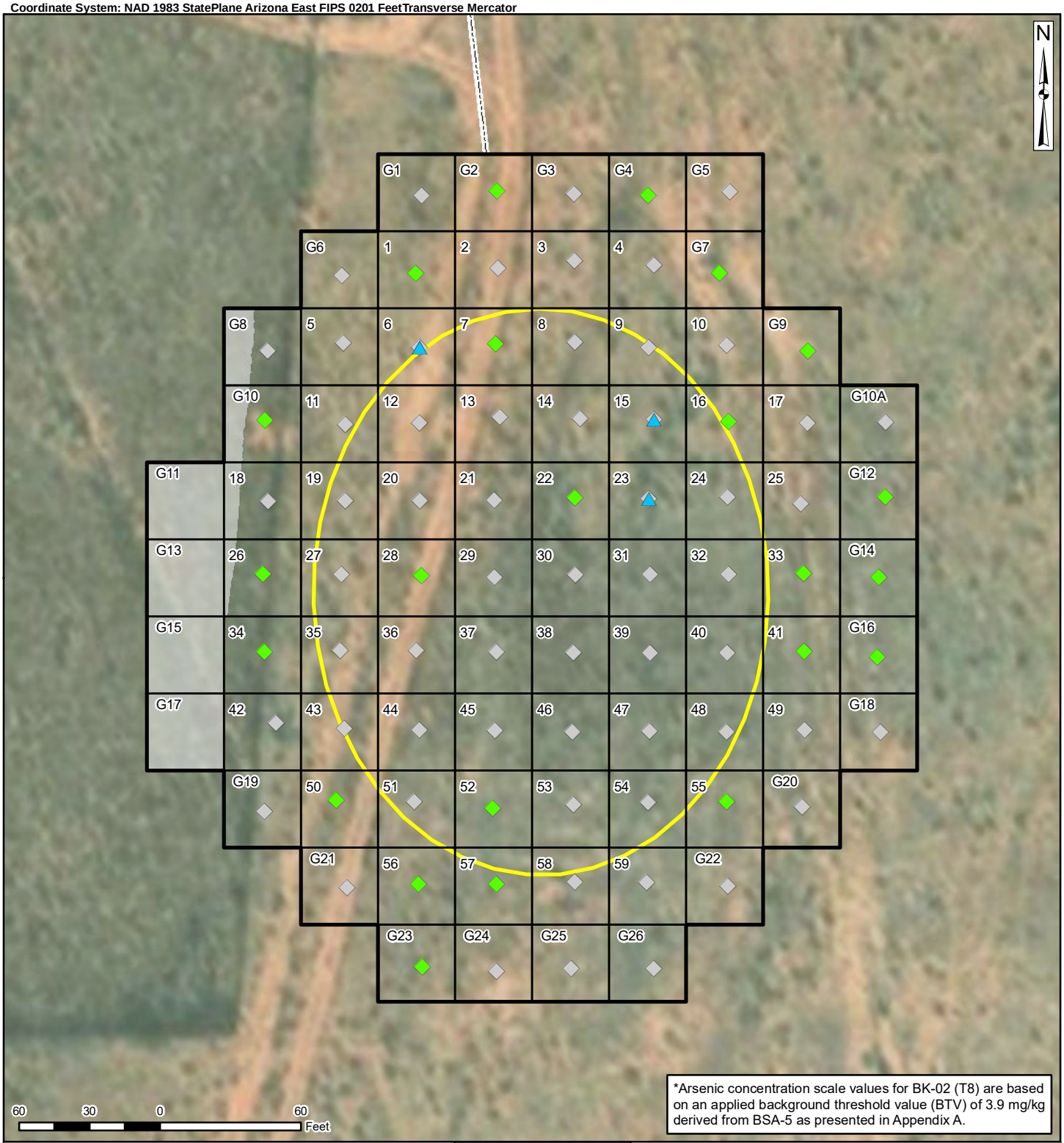


Figure I8-13. Box Plot for Target BK-02 (T8) and BSA-5 (Qa) Arsenic Soil Concentrations

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



*Arsenic concentration scale values for BK-02 (T8) are based on an applied background threshold value (BTV) of 3.9 mg/kg derived from BSA-5 as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 1.8
- 1.8 - 3.9
- 3.9 - 7.8
- 7.8 - 12
- 12 - 16
- 16 - 39
- ≥ 39
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Inaccessible
- Access Route - Vehicular

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NON-AUM TARGET BK-02 (T8) SURFACE SOIL ARSENIC CONCENTRATION MAP

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TO0001	EP-S9-17-03	I8-14
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

5.2.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I8-7. Lead exceeded the applied BTV in 46.3 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for lead is 5 mg/kg for Target T8 as presented in Section 5.2.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I8-5 and Attachment I3, respectively. Figure I8-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T8 and BSA-5 (Qa) samples. Figure I8-16 presents a box plot of detectable lead XRF soil concentrations for Target T8 and BSA-5 (Qa) samples. Summary statistics for XRF measurements are provided in Section 5.2.6.1. Lead XRF concentrations measured in surface soils at Target T8 ranged between 2.7 and 6.9 mg/kg with an average and standard deviation of 4.9 mg/kg and 0.9 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T8 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I8-17. Overall, the majority of detectable lead XRF results in surface soils were less than the applied BTV. However, exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T8.

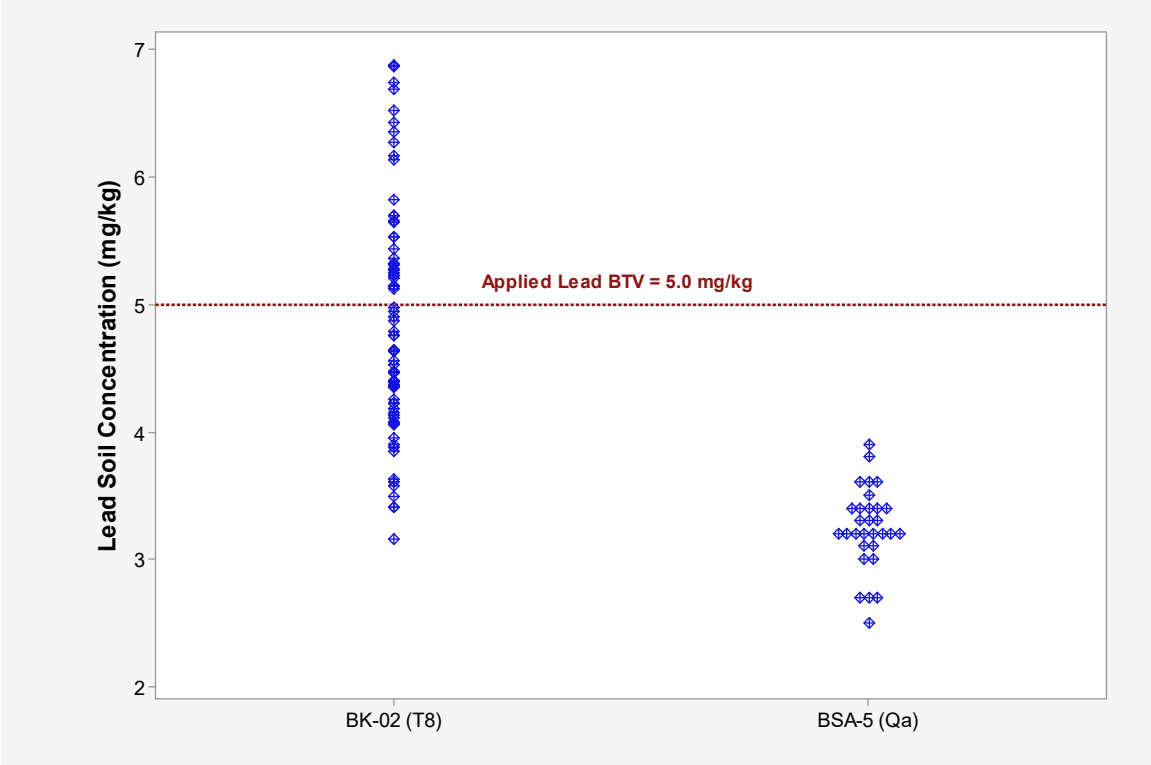


Figure I8-15. Individual Value Plot for Target BK-02 (T8) and BSA-5 (Qa) Lead Soil Concentrations

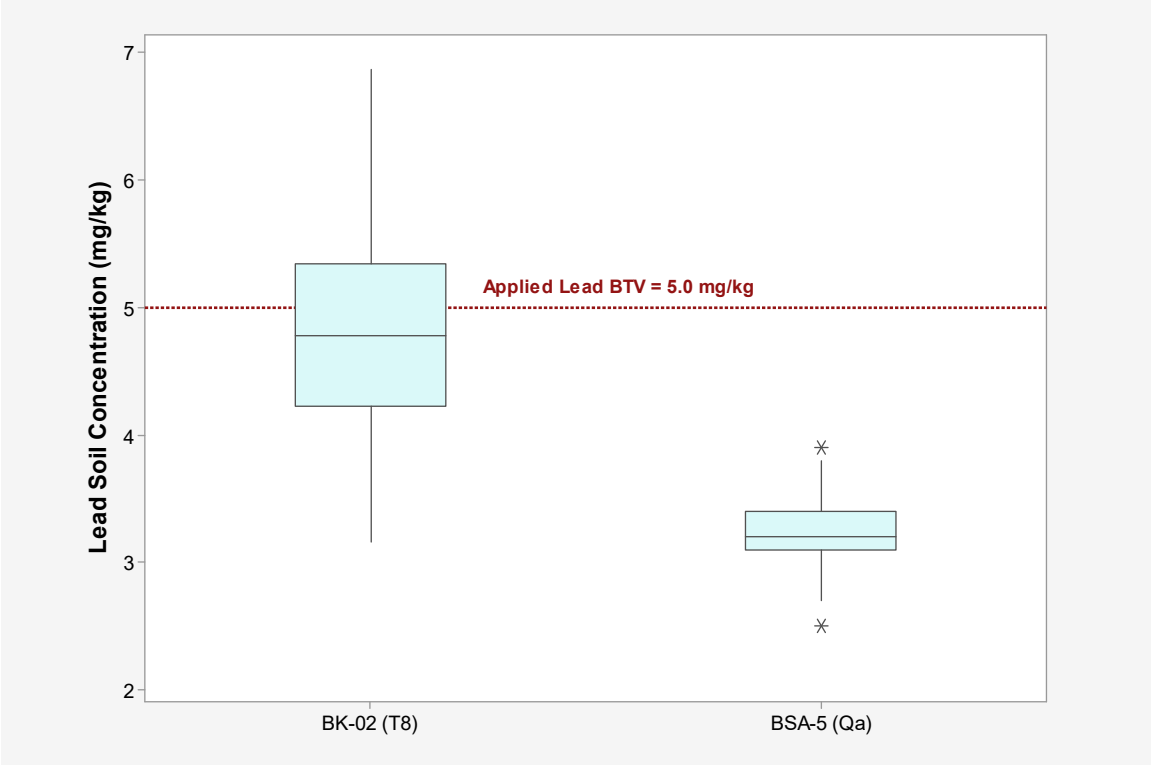
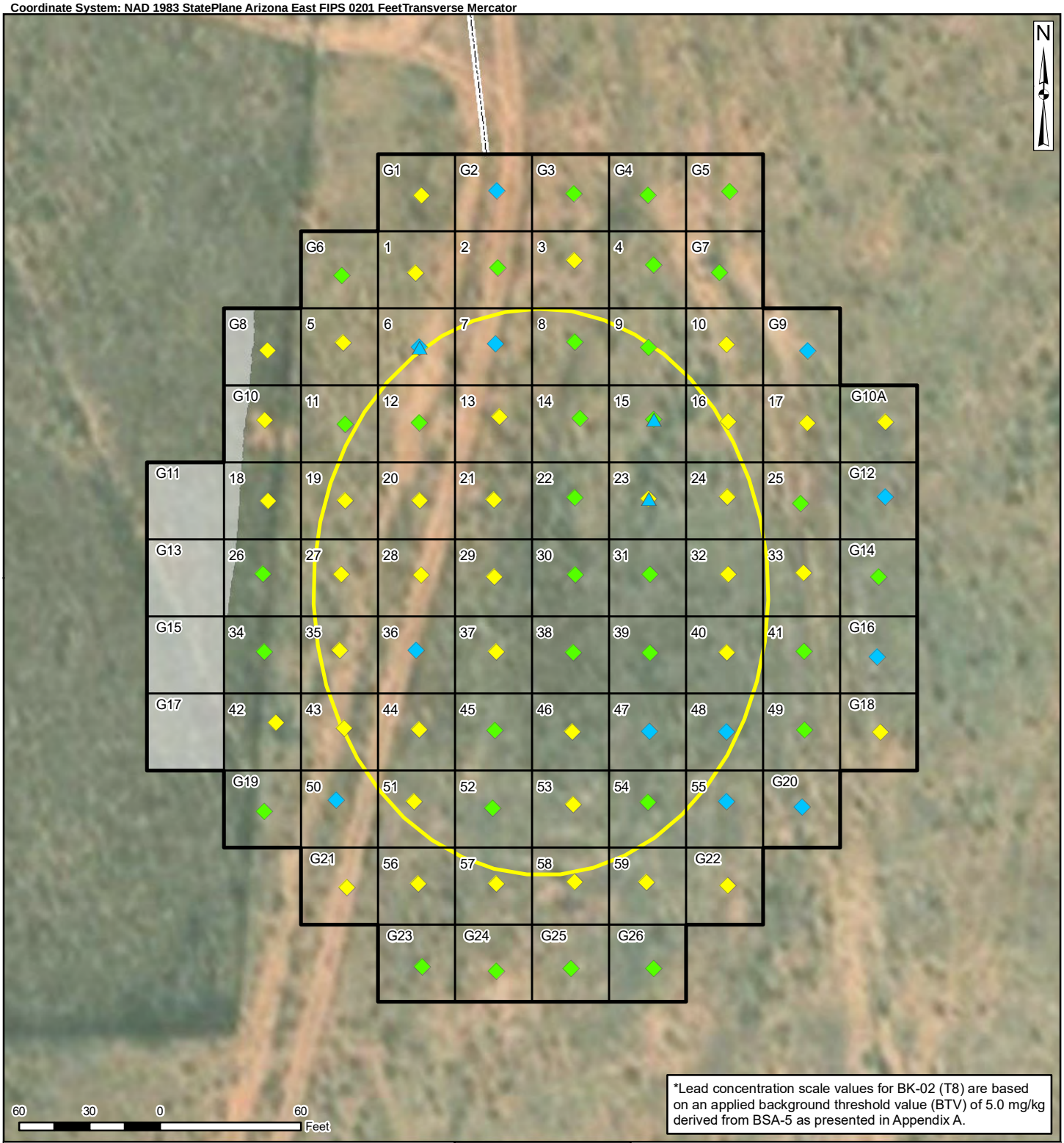


Figure I8-16. Box Plot for Target BK-02 (T8) and BSA-5 (Qa) Lead Soil Concentrations



*Lead concentration scale values for BK-02 (T8) are based on an applied background threshold value (BTV) of 5.0 mg/kg derived from BSA-5 as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 3.9
- 3.9 - 5.0
- 5.0 - 10
- 10 - 15
- 15 - 20
- 20 - 50
- ≥ 50

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Inaccessible
- Access Route - Vehicular

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NON-AUM TARGET BK-02 (T8) SURFACE SOIL LEAD CONCENTRATION MAP

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TO0001	EP-S9-17-03	I8-17
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

5.2.7.4 Thorium

Thorium was identified as a COPC in surface soil as shown in Table I8-7. Thorium exceeded the applied BTV in 18.3 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for thorium is 1.9 mg/kg for Target T8 as presented in Section 5.2.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I8-5 and Attachment I3, respectively. Figure I8-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T8 and BSA-5 (Qa) samples. Figure I8-19 presents a box plot of detectable thorium XRF soil concentrations for Target T8 and BSA-5 (Qa) samples. Summary statistics for XRF measurements are provided in Section 5.2.6.1. Thorium XRF concentrations measured in surface soils at Target T8 ranged between 1.0 and 2.3 mg/kg with an average and standard deviation of 1.5 mg/kg and 0.3 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T8 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I8-20. Overall, the majority of detectable thorium XRF results in surface soils were less than the applied BTV. However, exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T8.

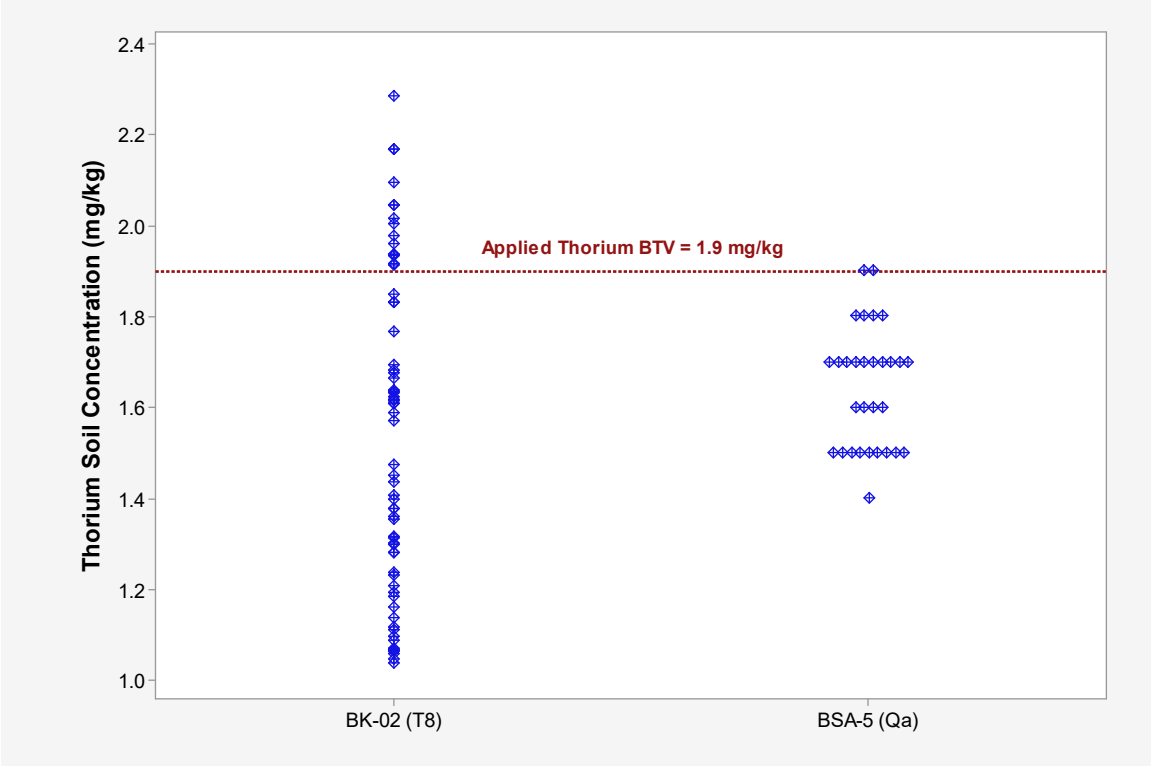


Figure I8-18. Individual Value Plot for Target BK-02 (T8) and BSA-5 (Qa) Thorium Soil Concentrations

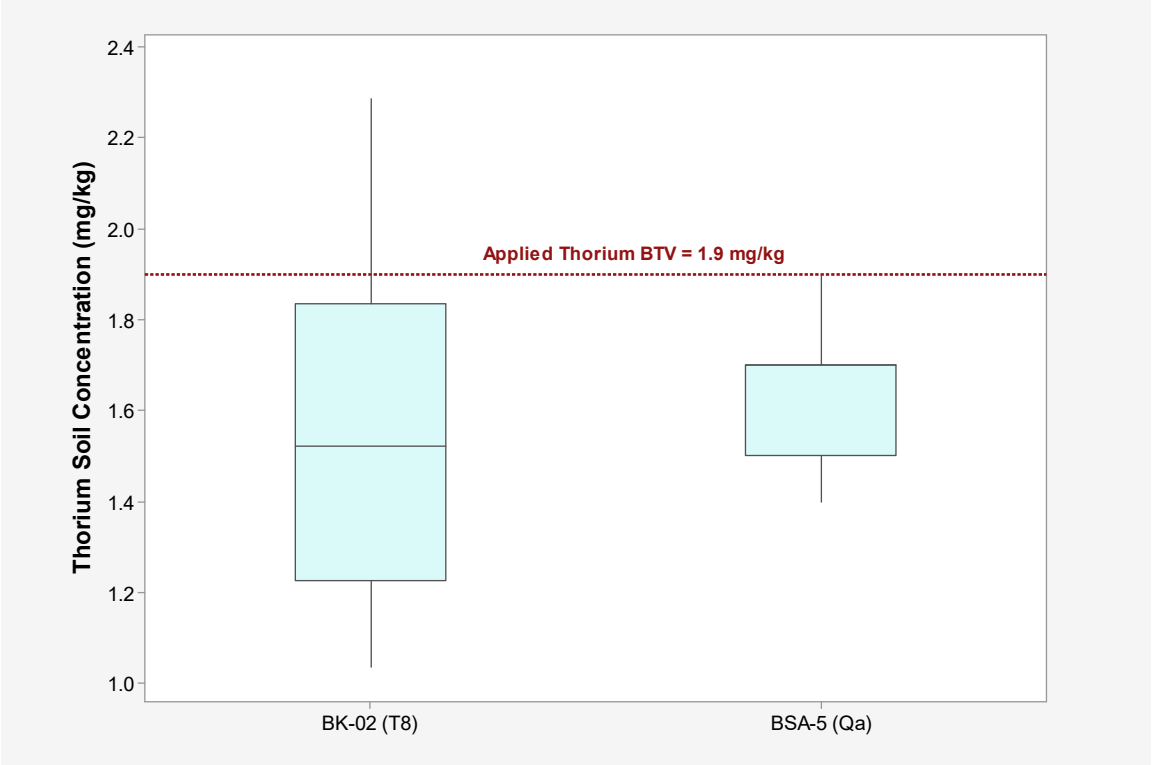
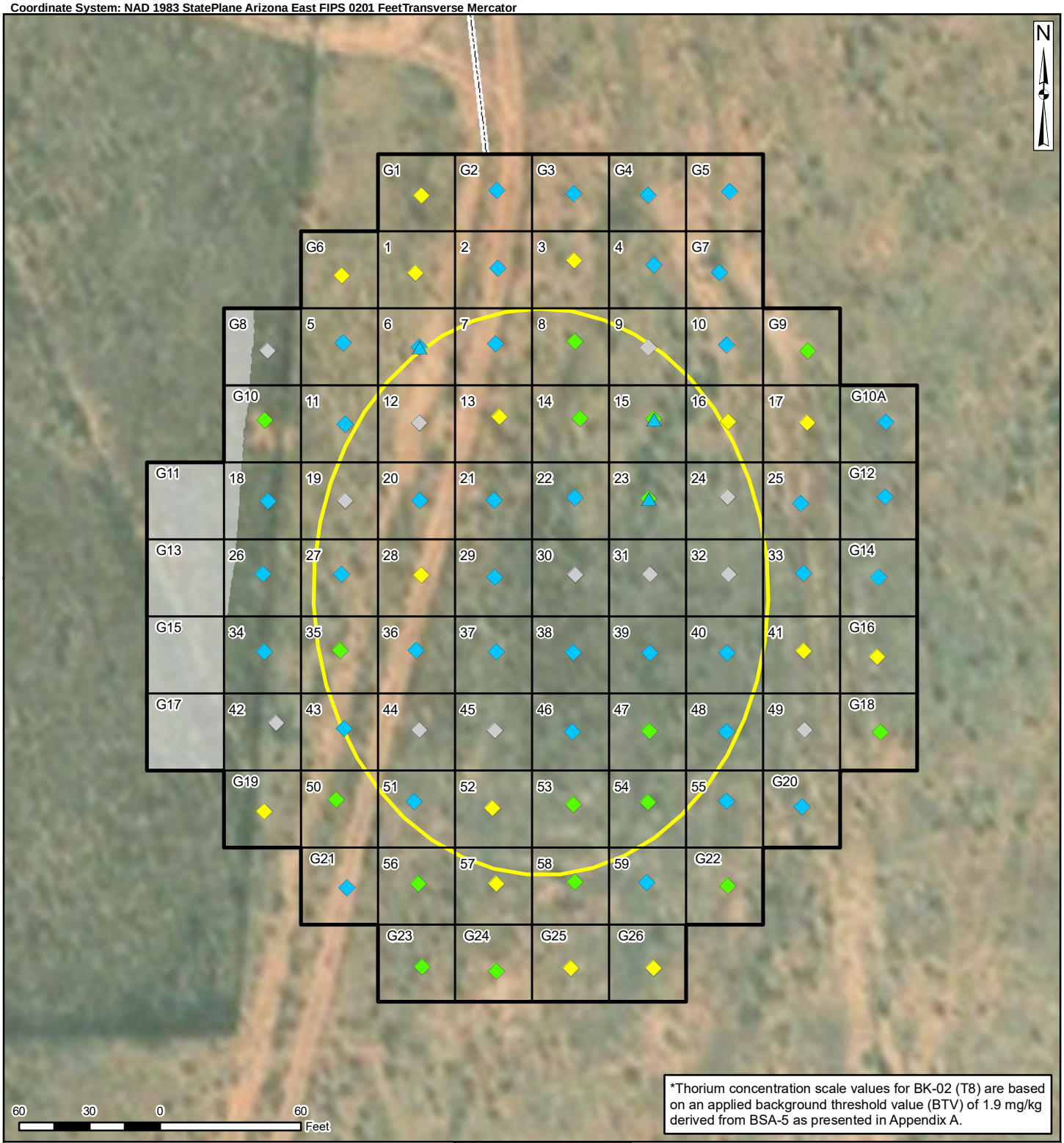


Figure I8-19. Box Plot for Target BK-02 (T8) and BSA-5 (Qa) Thorium Soil Concentrations

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



*Thorium concentration scale values for BK-02 (T8) are based on an applied background threshold value (BTV) of 1.9 mg/kg derived from BSA-5 as presented in Appendix A.

Thorium Concentration Scale (mg/kg)*

- ≤ 1.6
- 1.6 - 1.9
- 1.9 - 3.8
- 3.8 - 5.7
- 5.7 - 7.6
- 7.6 - 19
- ≥ 19
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Inaccessible
- Access Route - Vehicular

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NON-AUM TARGET BK-02 (T8) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
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Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

5.2.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I8-7. Uranium exceeded the applied BTV in 9.8 percent of in situ XRF measurements but not in any XRF confirmation samples. The applied BTV for uranium is 1.5 mg/kg for Target T8 as presented in Section 5.2.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I8-5 and Attachment I3, respectively. Figure I8-21 presents an individual value plot of detectable uranium soil XRF concentrations for Target T8 and BSA-5 (Qa) samples. Figure I8-22 presents a box plot of detectable uranium XRF soil concentrations for Target T8 and BSA-5 (Qa) samples. Summary statistics for XRF measurements are provided in Section 5.2.6.1. Uranium XRF concentrations measured in surface soils at Target T8 ranged between 0.1 and 3.2 mg/kg with an average and standard deviation of 0.8 mg/kg and 0.6 mg/kg, respectively. The average uranium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T8 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I8-23. Overall, the majority of detectable uranium XRF results in surface soils were less than the applied BTV. However, the maximum value was 2.1 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T8.

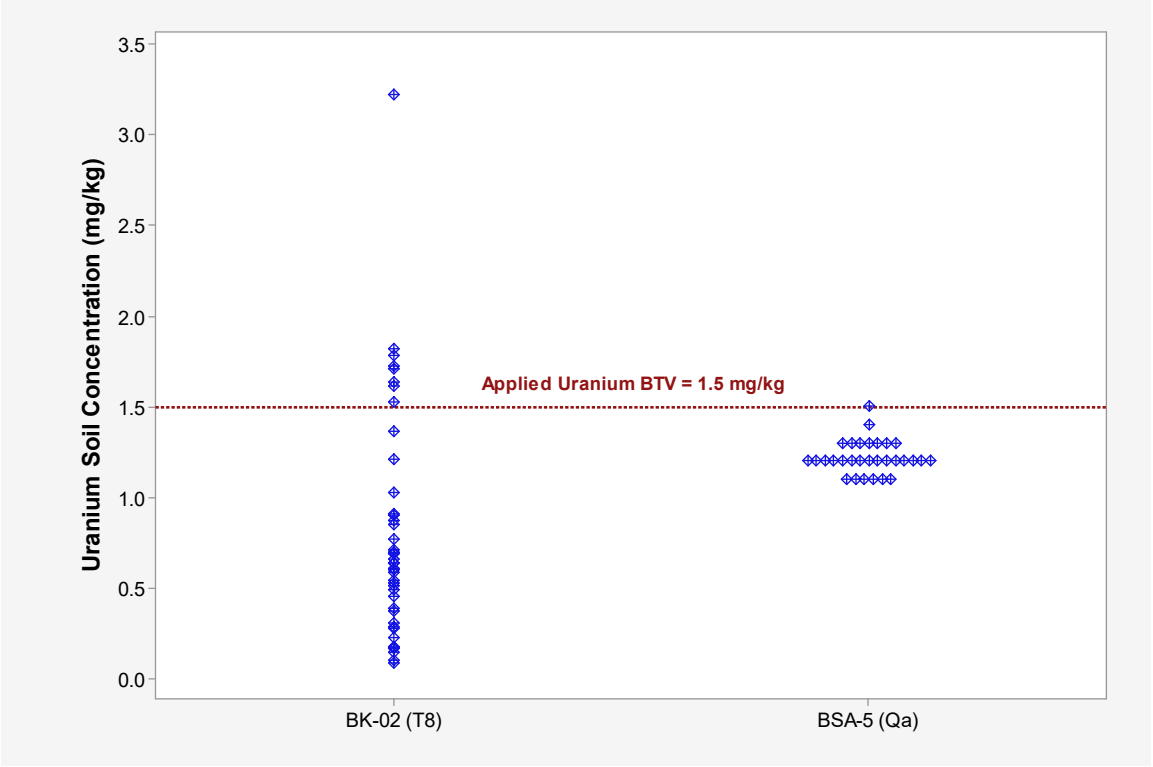


Figure I8-21. Individual Value Plot for Target BK-02 (T8) and BSA-5 (Qa) Uranium Soil Concentrations

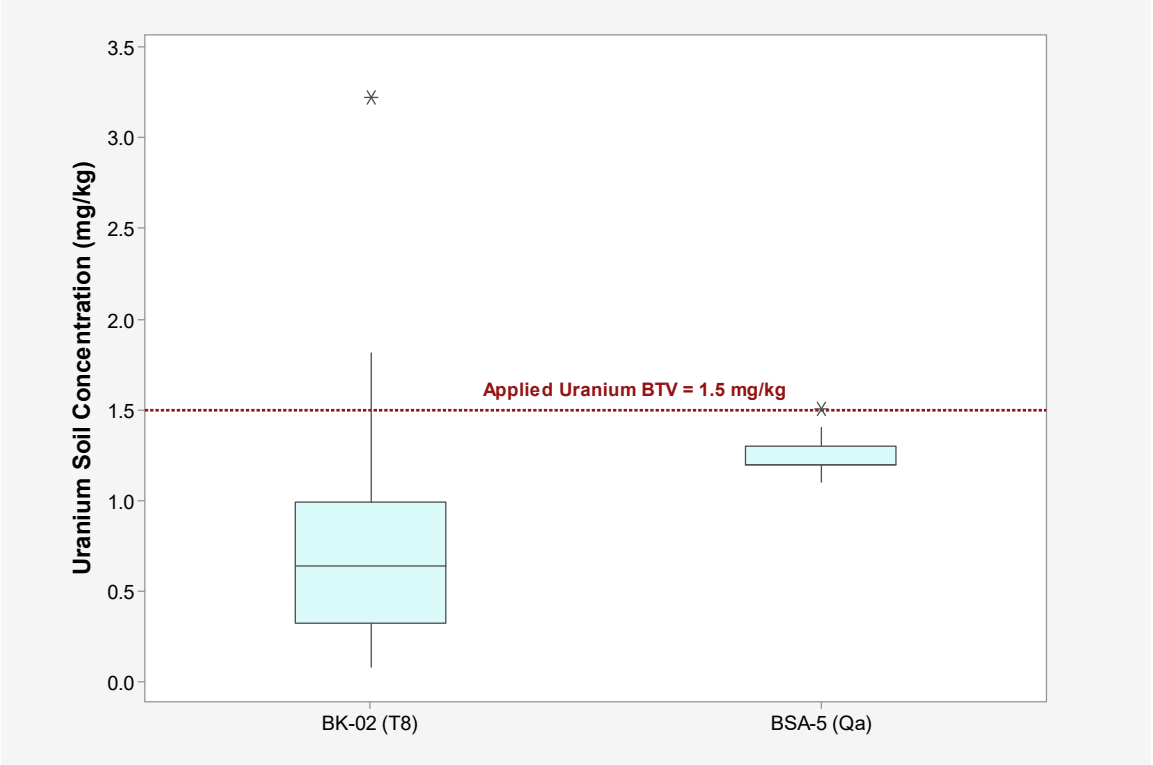
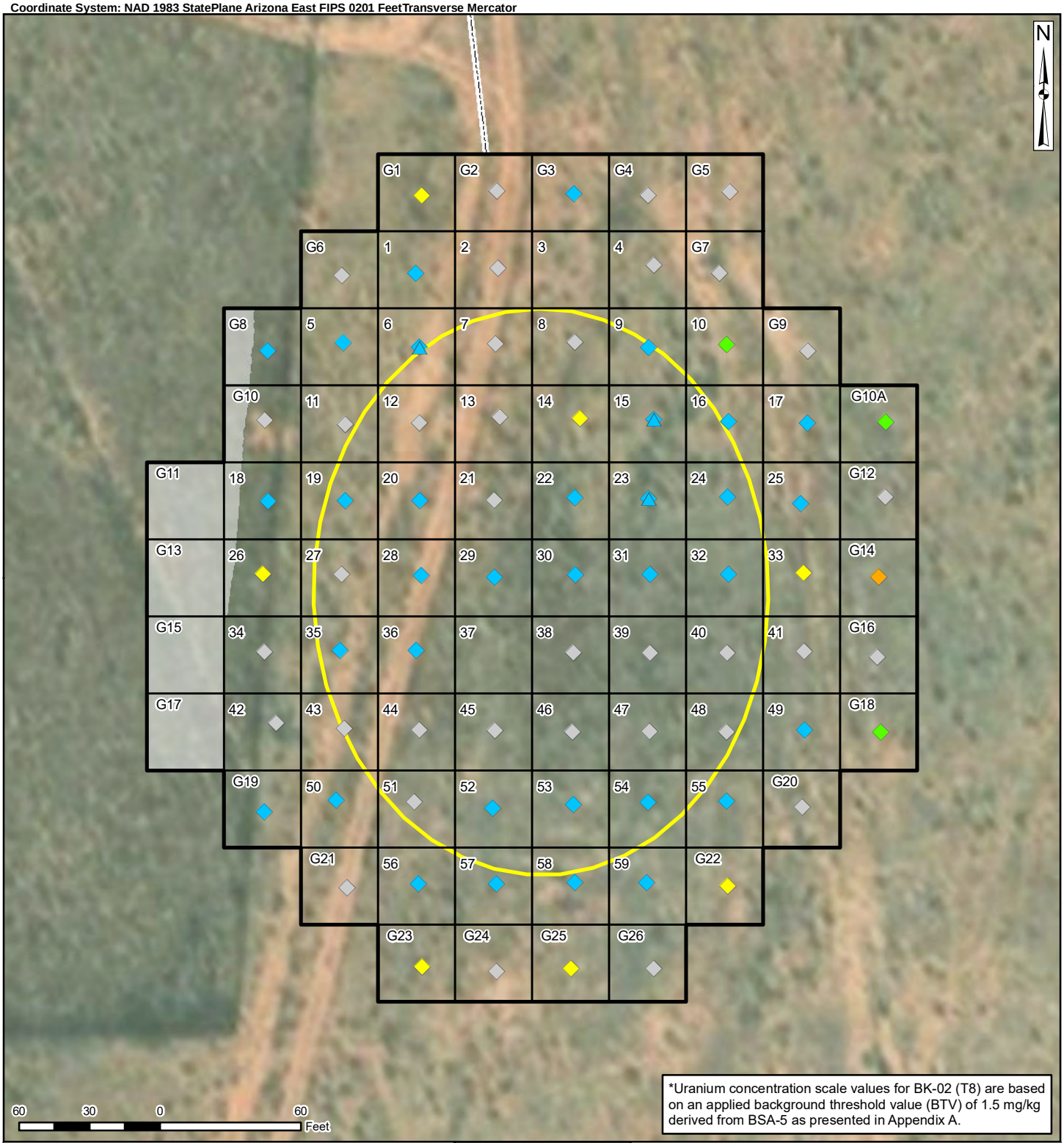


Figure I8-22. Box Plot for Target BK-02 (T8) and BSA-5 (Qa) Uranium Soil Concentrations

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



*Uranium concentration scale values for BK-02 (T8) are based on an applied background threshold value (BTV) of 1.5 mg/kg derived from BSA-5 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 1.2
- 1.2 - 1.5
- 1.5 - 3.0
- 3.0 - 4.5
- 4.5 - 6.0
- 6.0 - 15
- ≥ 15
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Inaccessible
- Access Route - Vehicular

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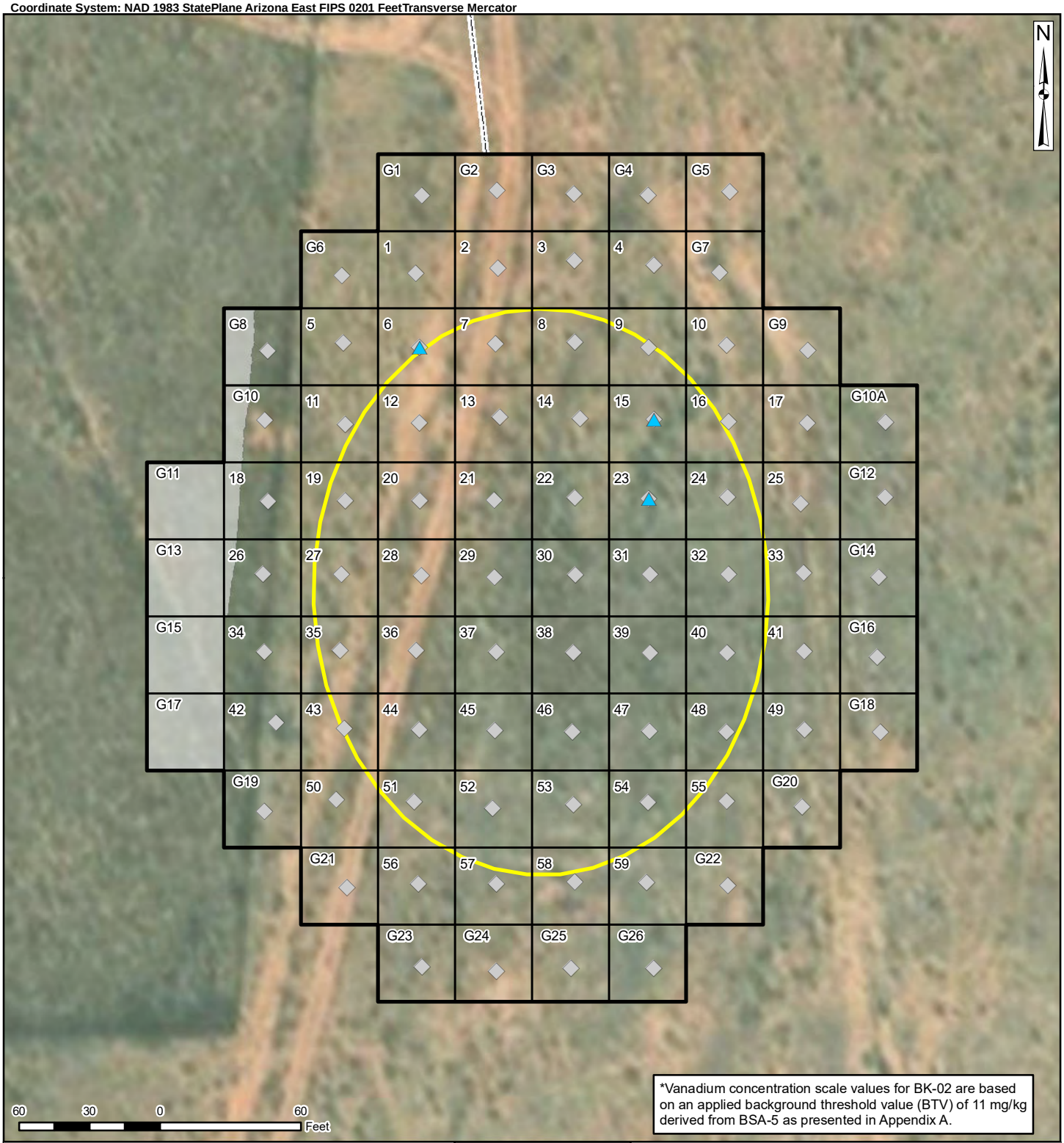
NON-AUM TARGET BK-02 (T8) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I8-23
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/12/2019	

5.2.7.6 Vanadium

Vanadium was not identified as a COPC in surface soils as shown in Table I8-7. Vanadium was not detected in surface soils at Target T8 above XRF analyzer detection limit of 16 mg/kg. Vanadium concentrations in XRF confirmation samples ranged from 6.6 to 7.9 mg/kg, which is below the applied BTV; the applied BTV for vanadium is 11 mg/kg for Target T7 as presented in Section 5.2.4. The analytical results for vanadium for XRF confirmation samples are provided in Table I8-5. Summary statistics for XRF measurements are provided in Section 5.2.6.1. A soil contaminant map showing the individual vanadium concentrations observed at Target T8 from XRF confirmation samples is provided in Figure I8-24. All vanadium results in surface soils were less than the applied BTV.

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



*Vanadium concentration scale values for BK-02 are based on an applied background threshold value (BTV) of 11 mg/kg derived from BSA-5 as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 8.9
- 8.9 - 11
- 11 - 22
- 22 - 33
- 33 - 44
- 44 - 110
- ≥ 110
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Inaccessible
- Access Route - Vehicular

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NON-AUM TARGET BK-02 (T8) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I8-24
Location: TEEC NOS POS CHAPTER NAVAJO NATION	Date: 6/24/2019	

5.2.8 Conclusions

Target T8 (BK-02) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T8. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T8 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T8. ASPECT gamma survey results generally did not correlate with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T8 was well documented through gamma radiation surveys, and the lateral extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Mean raw gamma measurements did not exceed the applied BTV. No grid averaged gamma measurements exceeded the applied BTV.
- Site-specific BTVs for Target T8 geology and soil types were established through a background study.
- A total of 26 analytes were identified as occurring within the surface environment. Of these analytes, 5 were identified as COPCs. Only uranium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's observations, Target T8 does not contain TENORM. No mining-related activities or features were observed in the field, and no historical exploratory borings, vents, or other mine openings were noted in the file review or during field observation. NORM was not identified visually or by gamma survey.
- There are no immediate significant physical hazards present at Target T8.
- Access is via a dirt road with a small four-wheel-drive vehicle.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No groundwater wells are documented within the vicinity of Target T8. Rural residences are located nearby; however, it is not known if water is provided by utility or private well. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T8. Therefore, evaluation of the leachability of metals and radionuclides is not required.

- No mine waste was observed at Target T8; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3. Several survey units along the western margin of the survey area were inaccessible because of private property ownership; however, gamma survey measurements did not indicate an increasing trend to the west or along the fence line. No data gaps remain for Target T8.

6.0 GROUP C FIELD SAMPLING RESULTS

This section presents field sampling results for Group C Targets T10 (CT-01), T11 (CT-02), and T12 (CT-03). Non-AUM Targets T37 (CTS South) and T38 (CTS 2) are included in the Cove Transfer Station (AUM-related Target T9) SSRSE Report.

6.1 NON-AUM TARGET T10 (CT-01)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T10 (CT-01).

6.1.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T10 (CT-01) is associated with the Cove Transfer Station (T9), a former mining operations field camp and uranium ore storage and transfer facility in the Cove Valley Region in Subarea Group C within the Cove Chapter of the Navajo Nation. Two other non-AUM Targets are associated with the Cove Transfer Station, which is within the residential area of Cove, Arizona, and is accessible by vehicle via Indian Route 33. Target T10 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. There are several residences located nearby with the closest located 150 feet to the east. A Target location and access map for Target T10 is shown in Figure I10-1.

A topographical relief map for the Cove Transfer Station area and associated non-AUM Targets is provided in Figure I10-2. The elevation at Target T10 ranges from 6,404 to 6,423 feet amsl with an average of 6,413 feet amsl. The slope at Target T10 ranges from 1 to 6 percent with an average of 4 percent. There are two ephemeral drainage channels nearby the Target; one is located 900 feet to the west and the other is 900 feet to the east. Cove Transfer Station and Target T10 are located within Trc, and Target T10 is located within Blanding very fine sandy loam soils (MUSYM 312) (Figures I-17 and I-18).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T10. Weston did not conduct a background study for Target T10. As a part of the RSE for the Cove Transfer Station, Tetra Tech also evaluated the associated non-AUM Targets, such as T10. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 3 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T10:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T10 is accessed by vehicle from Indian Route 33. The road intersects the Target.

- Differentiated NORM/TENORM through geological assessment and visual observation:

NORM and TENORM were not observed at the Target.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  No drainages were present on the Target, but two were observed nearby. One ephemeral drainage (Cove Wash South) is located 900 feet east of the Target, and the other ephemeral drainage (Cove Wash Middle) is located 900 feet to the west. Cove Wash Middle was evaluated under the RSE for the Cove Transfer Station.

- Identified any exploration borings or historic haul roads:

  No exploratory borings or haul roads were identified. However, Indian Route 33 intersects the Target, which connects to the Cove Transfer Station.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  No AUM or non-AUM Target features were present at the Target.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target

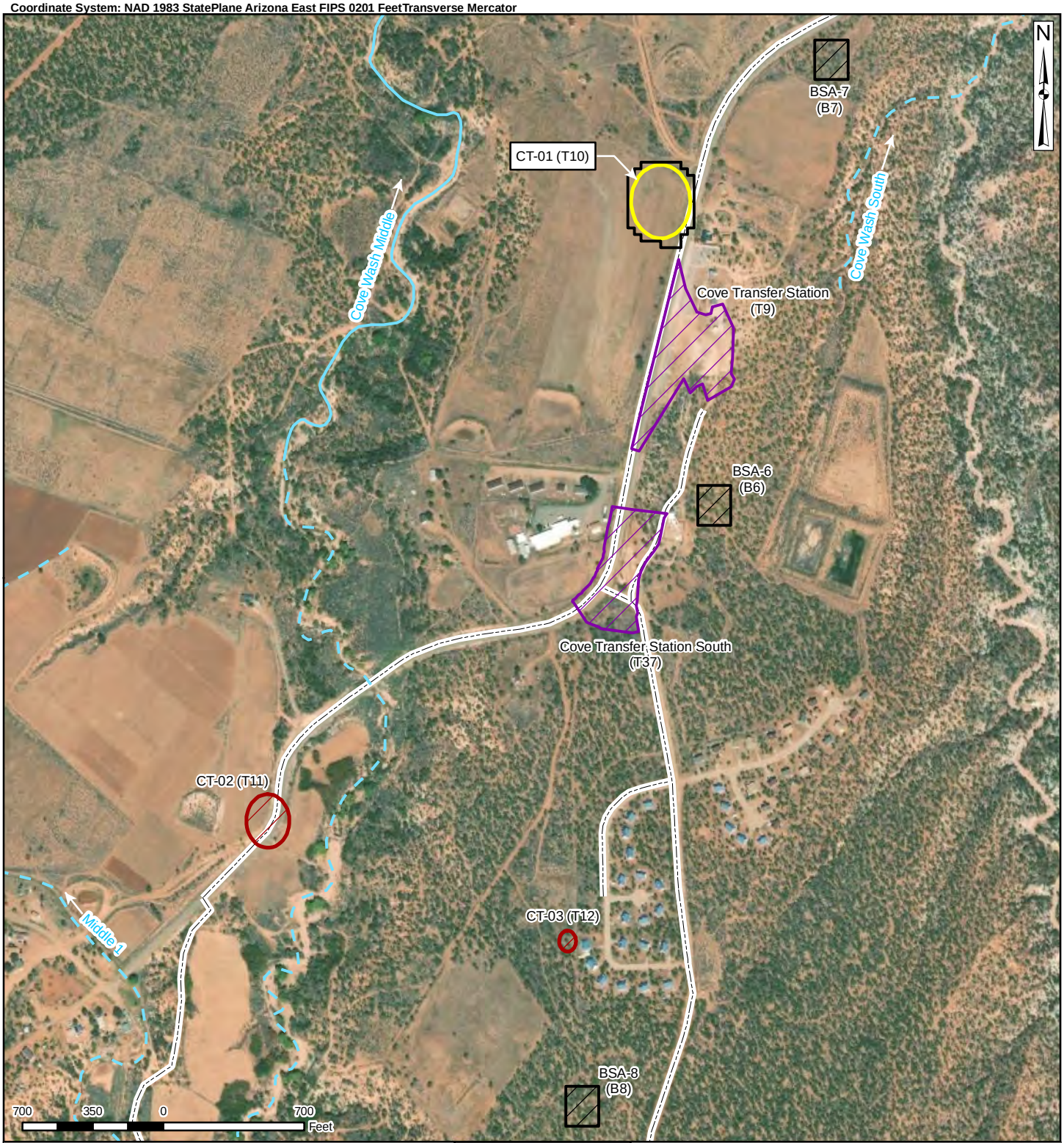
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T10 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Section 2.3 and 6.1.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 6.1.3 with results presented in Sections 6.1.6 and 6.1.7)
- Conducting a gamma radiation survey (results presented in Section 6.1.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target
AUM Related Site Boundary
Background Location
Access Route - Vehicular
Drainage*
Drainage - Field Mapped

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

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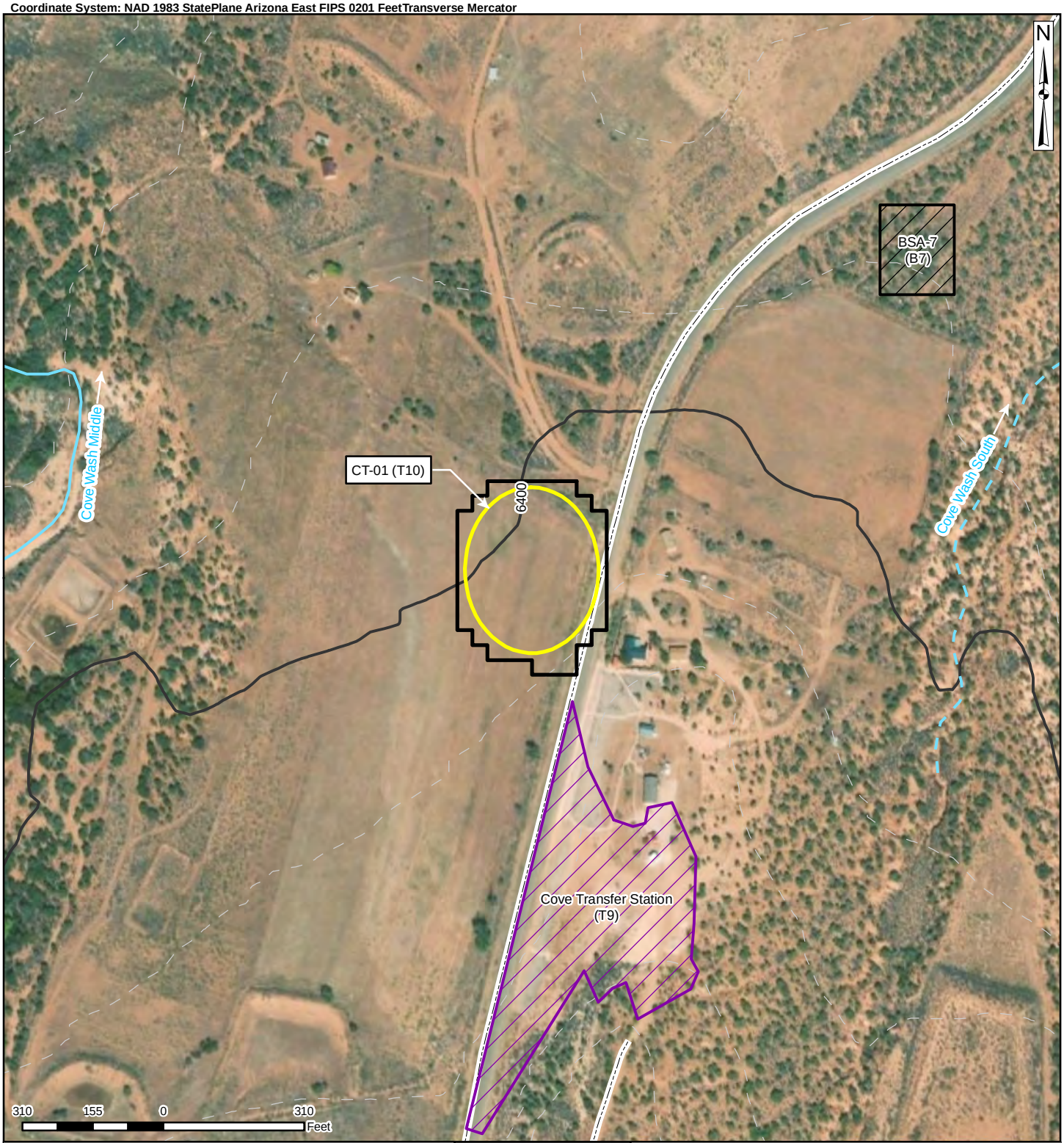
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NON-AUM TARGET CT-01 (T10) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I10-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

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



Non-AUM Target Site Boundary
Related Survey Area
AUM Related Site Boundary
Background Location
Access Route - Vehicular
Drainage*
Drainage - Field Mapped
100 ft Contour**
20 ft Contour**

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

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NON-AUM TARGET CT-01 (T10) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I10-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

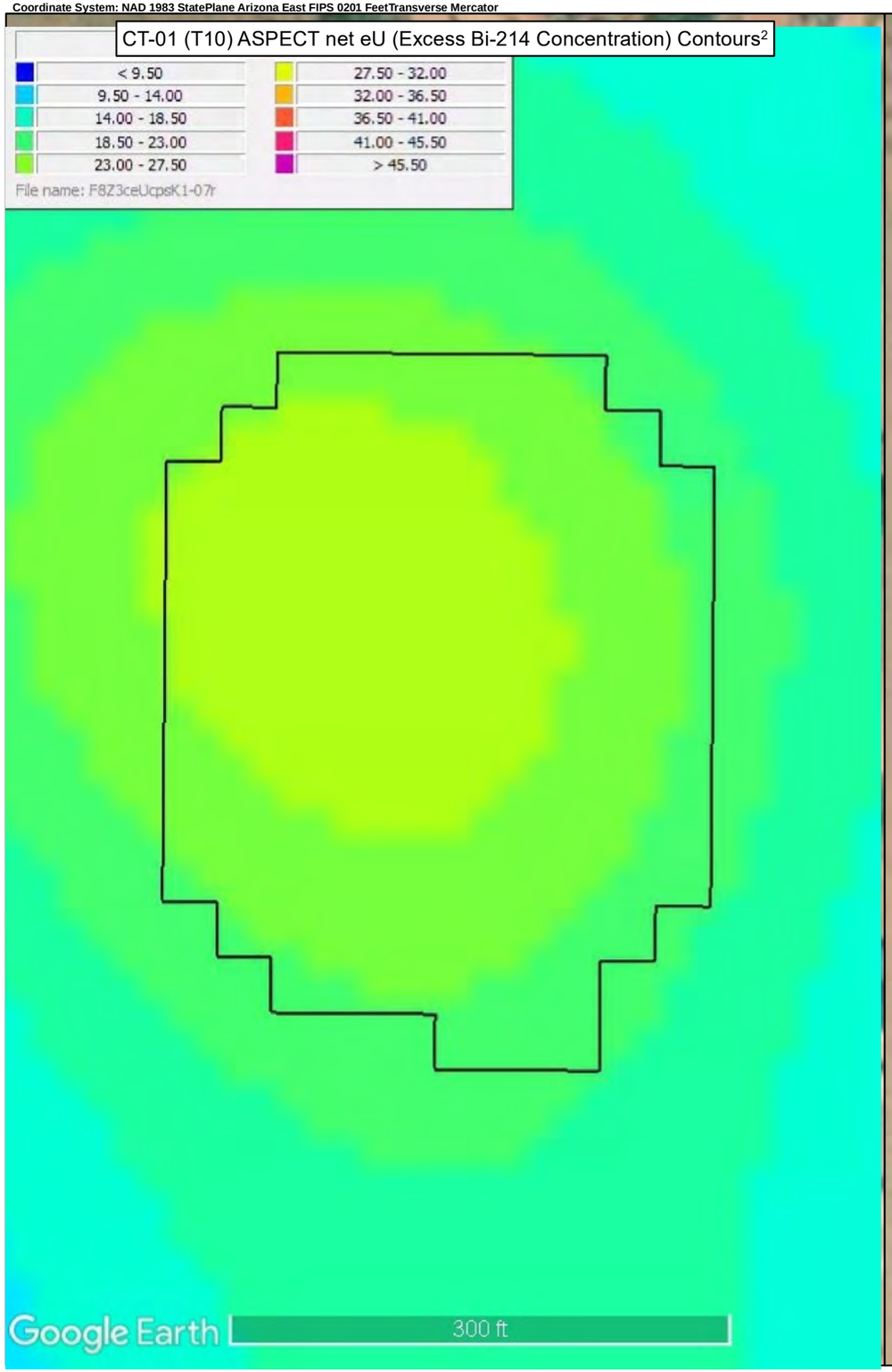
6.1.2 Gamma Radiation Survey and Field XRF Measurements

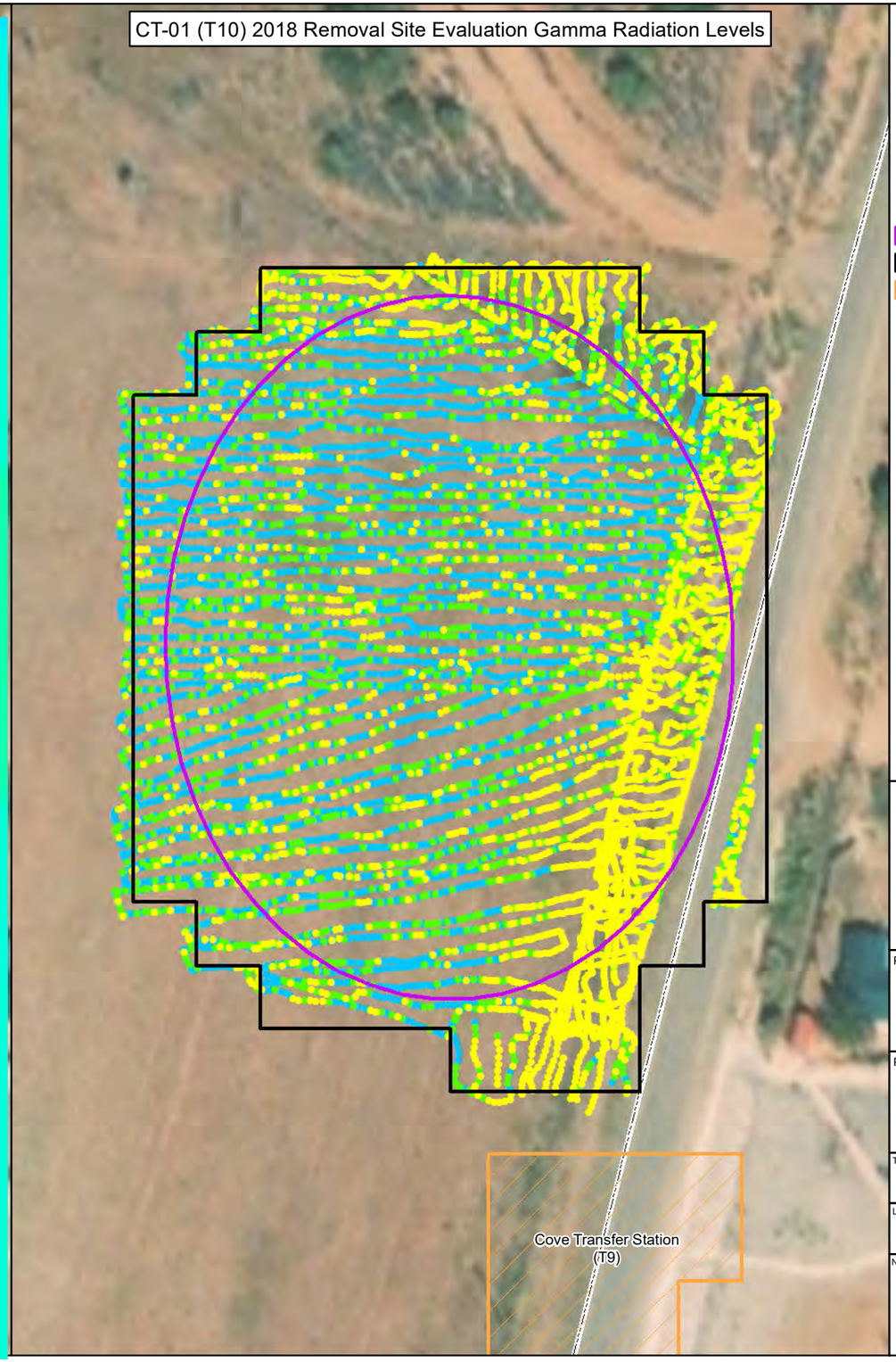
Tetra Tech performed GPS-based gamma radiation surveys (Figure I10-3) within the survey area of the non-AUM Target T10 as part of the Baseline Study in April 2018. Additional Goback gamma radiation surveys were performed in August 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T10 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I10-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at three survey units. All gamma survey and XRF survey units were evaluated.

6.1.3 XRF Confirmation Sampling Overview

Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T10. Six XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from six locations (Table I10-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I10-4 and I10-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I10-2. A subset of XRF confirmation samples were also submitted for analysis of mercury and select additional radionuclides. The results of XRF confirmation sample analysis are provided in Section 6.1.6.1. Correlated XRF field measurements are provided in Attachment I3.

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





Gamma Reading (cpm)[1]

≤ 10,289	≤ Avg. BG
10,289 - 11,019	Avg. BG - 1 x BTV
11,019 - 22,038	1 x BTV - 2 x BTV
22,038 - 33,057	2 x BTV - 3 x BTV
33,057 - 44,076	3 x BTV - 4 x BTV
44,076 - 110,190	4 x BTV - 10 x BTV
≥ 110,190	≥ 10 x BTV

- Non-AUM Target Site Boundary
- Survey Area Boundary
- Other Survey Area
- Access Route - Vehicular

[1]The applied gamma background threshold value (BTV) for CT-01 (T10) Non-AUM Target is 11,019 cpm derived from BSAs within the T_{RC} formation as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 70 ft

1:840

N W E S

0 35 70 140 Feet

NON-AUM TARGET CT-01 (T10)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

Prepared By:

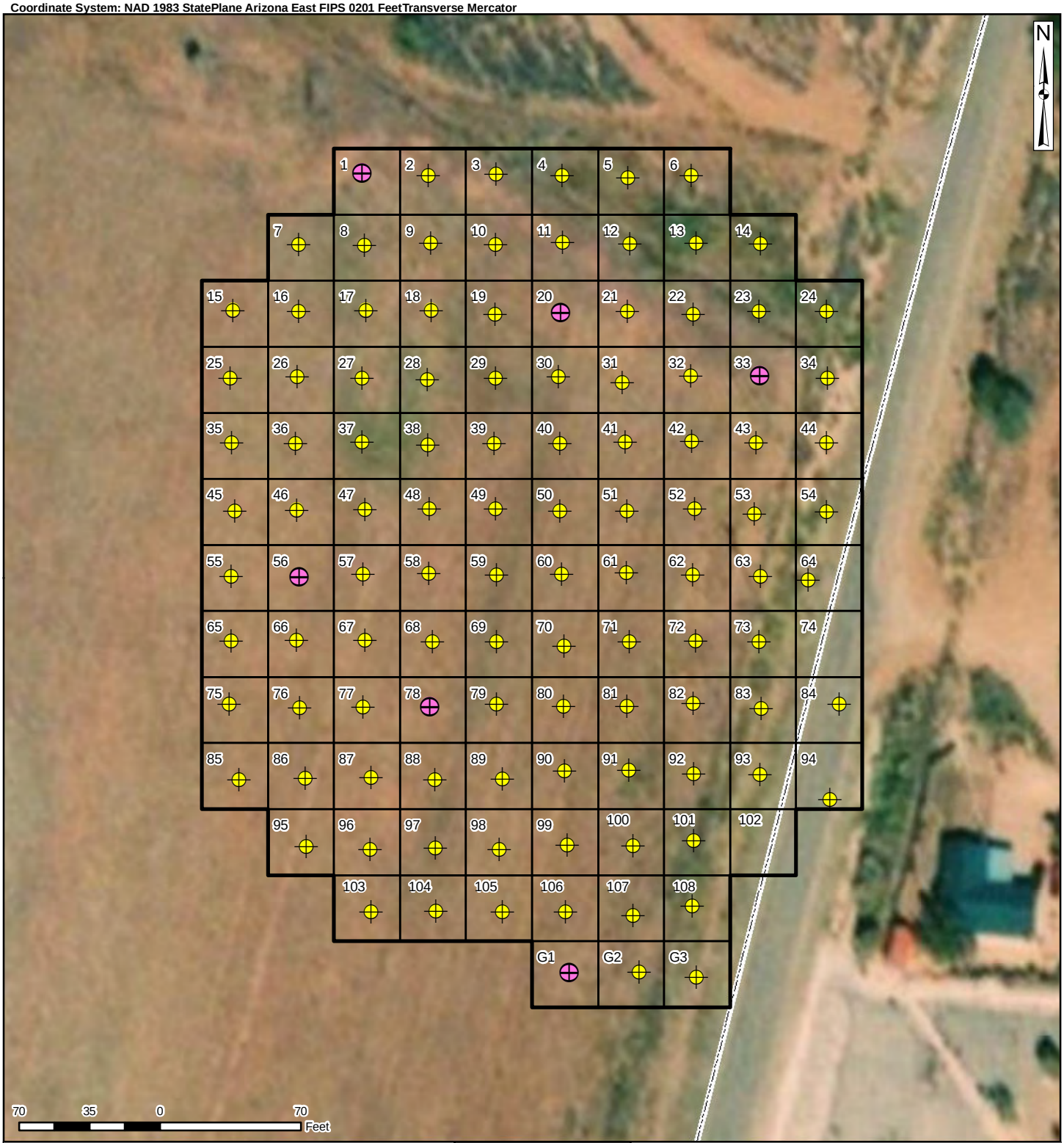
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/12/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborn Spectral Photometric Environmental Collection Technology.

Figure No.: **I10-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

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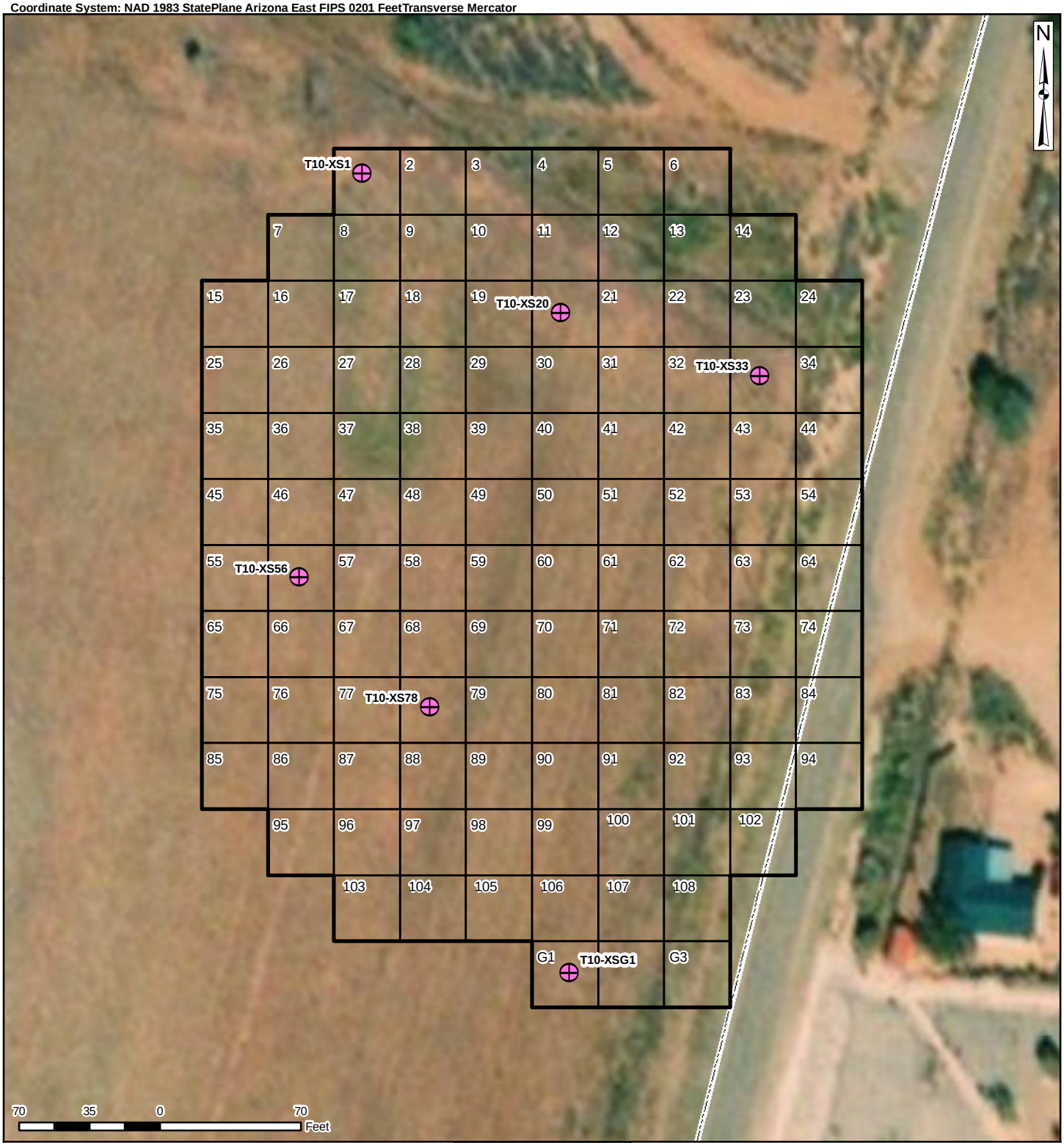
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NON-AUM TARGET CT-01 (T10)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I10-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

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



XRF Confirmation Soil Sample* (0 - 3 inches bgs)

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

*T10-XS1 = site T10 XRF confirmation soil sample collected at survey unit 1. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET CT-01 (T10)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I10-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

Table I10-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target CT-01 (T10)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T10-XS1-01-042518	1	0-3	XRF Confirmation	Primary	4/25/2018	36.5636863	-109.2173943	1805035-1, 1805036-1
T10-XS20-01-042518	20	0-3	XRF Confirmation	Primary	4/25/2018	36.5634933	-109.2170611	1805035-2, 1805036-2
T10-XS33-01-042518	33	0-3	XRF Confirmation	Primary	4/25/2018	36.5634046	-109.2167249	1805035-3, 1805036-3
T10-XS56-01-042518	56	0-3	XRF Confirmation	Primary	4/25/2018	36.5631355	-109.2175079	1805035-4, 1805036-4
T10-XS78-01-042518	78	0-3	XRF Confirmation	Primary	4/25/2018	36.5629574	-109.2172896	1805035-5, 1805036-5
T10-XSG1-01-081818	G1	0-3	XRF Confirmation	Primary	8/18/2018	36.5625926	-109.2170575	1808483-10, 1808484-10

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I10-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target CT-01 (T10)

Analyte	Type	CAS Number	Analytical Method	Number of Samples by Standard Analyses	Number of Samples by Extended Analyses
Aluminum	Metals	7429-90-5	USEPA SW-846 6020B	6	1
Antimony	Metals	7440-36-0	USEPA SW-846 6020B	6	1
Arsenic	Metals	7440-38-2	USEPA SW-846 6020B	6	1
Barium	Metals	7440-39-3	USEPA SW-846 6020B	6	1
Beryllium	Metals	7440-41-7	USEPA SW-846 6020B	6	1
Cadmium	Metals	7440-43-9	USEPA SW-846 6020B	6	1
Calcium	Metals	7440-70-2	USEPA SW-846 6020B	6	1
Chromium	Metals	7440-47-3	USEPA SW-846 6020B	6	1
Cobalt	Metals	7440-48-4	USEPA SW-846 6020B	6	1
Copper	Metals	7440-50-8	USEPA SW-846 6020B	6	1
Iron	Metals	7439-89-6	USEPA SW-846 6020B	6	1
Lead	Metals	7439-92-1	USEPA SW-846 6020B	6	1
Lead-210	Radionuclides	14255-04-0	Eichrom method	0	1
Lithium	Metals	7439-93-2	USEPA SW-846 6020B	6	1
Magnesium	Metals	7439-95-4	USEPA SW-846 6020B	6	1
Manganese	Metals	7439-96-5	USEPA SW-846 6020B	6	1
Mercury	Metals	7439-97-6	USEPA SW-846 7471A	0	1
Molybdenum	Metals	7439-98-7	USEPA SW-846 6020B	6	1
Nickel	Metals	7440-02-0	USEPA SW-846 6020B	6	1
Potassium-40	Radionuclides	13966-00-2	USEPA 901.1	6	1
Radium-226	Radionuclides	13982-63-3	USEPA 901.1	6	1
Radium-228	Radionuclides	15262-20-1	USEPA 901.1	6	1
Selenium	Metals	7782-49-2	USEPA SW-846 6020B	6	1
Silver	Metals	7440-22-4	USEPA SW-846 6020B	6	1
Sodium	Metals	7440-23-5	USEPA SW-846 6020B	6	1
Thallium	Metals	7440-28-0	USEPA SW-846 6020B	6	1
Vanadium	Metals	7440-62-2	USEPA SW-846 6020B	6	1
Zinc	Metals	7440-66-6	USEPA SW-846 6020B	6	1
Thorium	Metals	-	USEPA SW-846 6020B	6	1
Thorium-228	Radionuclides	14274-82-9	ASTM D3972 Modified	0	1
Thorium-230	Radionuclides	14269-63-7	ASTM D3972 Modified	0	1
Thorium-232[1]	Radionuclides	7440-29-1	ASTM D3972 Modified	0	1
Uranium	Metals	-	USEPA SW-846 6020B	6	1
Uranium-234	Radionuclides	13966-29-5	ASTM D3972 Modified	0	1
Uranium-235	Radionuclides	15117-96-1	ASTM D3972 Modified	0	1
Uranium-238[1]	Radionuclides	7440-61-1	ASTM D3972 Modified	0	1

Notes:
Green Shading identifies Extended Analyses
[1] Measured via alpha spectroscopy.
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

6.1.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 6.1.1, Target T10 surface geology is entirely within Trc with soils within the Blanding very fine sandy loams (MUSYM 312) (Figures I-17 and I-18). As a result, Background Study Area 7 (BSA-7) was selected for that combination of geology and soil type. Additionally, the Trc regional geological background would also be applicable for this Target. Table I10-4 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T10. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T10. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T10. The “Applied BTV” for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I10-3. Applied Background Threshold Values for Non-AUM Target CT-01 (T10)

Analyte	Units	Site-Specific BTV (BSA-7)	Regional BTV (Trc)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	8,470	9,734	8,470	Site-Specific BTV
Antimony	mg/kg	0.170	0.190	0.170	Site-Specific BTV
Arsenic	mg/kg	2.6	3.0	2.6	Site-Specific BTV
Barium	mg/kg	150	150	150	Regional BTV
Beryllium	mg/kg	0.51	0.54	0.51	Site-Specific BTV
Cadmium	mg/kg	0.160	0.257	0.160	Site-Specific BTV
Calcium	mg/kg	9,900	9,900	9,900	Regional BTV
Chromium	mg/kg	9.0	9.7	9.0	Site-Specific BTV
Cobalt	mg/kg	4.5	4.6	4.5	Site-Specific BTV
Copper	mg/kg	8.5	15	8.5	Site-Specific BTV
Iron	mg/kg	9,830	9,965	9,830	Site-Specific BTV
Lead	mg/kg	11	12	11	Site-Specific BTV
Lithium	mg/kg	8.5	9.7	8.5	Site-Specific BTV
Magnesium	mg/kg	3,600	3,600	3,600	Regional BTV
Manganese	mg/kg	396	380	380	Regional BTV
Mercury	mg/kg	0.0276	0.0260	0.0260	Regional BTV
Molybdenum	mg/kg	0.23	0.45	0.23	Site-Specific BTV
Nickel	mg/kg	8.7	9.2	8.7	Site-Specific BTV
Potassium-40	pCi/g	21.3	21.8	21.3	Site-Specific BTV
Radium-226	pCi/g	2.82	2.49	2.49	Regional BTV
Radium-228	pCi/g	0.84	0.76	0.76	Regional BTV
Selenium	mg/kg	0.95	1.0	0.95	Site-Specific BTV
Silver	mg/kg	0.029	0.039	0.029	Site-Specific BTV
Sodium	mg/kg	68	51	51	Regional BTV
Thallium	mg/kg	0.086	0.092	0.086	Site-Specific BTV
Thorium	mg/kg	4.7	4.8	4.7	Site-Specific BTV
Uranium	mg/kg	2.1	1.7	1.7	Regional BTV
Vanadium	mg/kg	20	19	19	Regional BTV
Zinc	mg/kg	33	37	33	Site-Specific BTV
Gamma Radiation	cpm	11,994	11,019	11,019	Regional BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
mg/kg milligrams per kilogram
pCi/g picocuries per gram
Trc Chinle Formation

6.1.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T10 and the raw gamma radiation and grid averaged gamma radiation survey results.

6.1.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T10 in April August 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in August 2018 to collect data within the Goback survey units. A gamma radiation survey was also performed in the Cove Wash Middle drainage within the area in conjunction with the RSE for the Cove Transfer Station; results are presented in Appendix J of the RSE Report. The applied gamma BTV for non-AUM Target T10 is 11,019 cpm. A total of 8,655 measurements were collected as part of the gamma radiation survey at non-AUM Target T10 across 111 survey units. An average scan density of 78 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I10-4.

Table I10-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target CT-01 (T10)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,019	
Measurements	#	8,655	111
Minimum	cpm	7,570	9,553
Maximum	cpm	18,144	13,730
Average	cpm	10,886	10,697
Median	cpm	10,640	10,346
Standard Deviation	cpm	1,351	836
90th Percentile	cpm	12,750	11,841
95th Percentile	cpm	13,504	12,447
99th Percentile	cpm	14,928	13,393
Measurements per Survey Unit	#/grid	78	
Measurements Above Gamma BTV	#	3,302	30
Measurements Above Gamma BTV	%	38.2	27.0

Notes:
BTV background threshold value
cpm counts per minute

6.1.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 38.2 percent of the measurements within the Target boundaries, in some cases exceeding the applied gamma BTV (11,019 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the Trc regional gamma survey results is provided on Figure I10-6. This graph shows that the spread of radiation data at Target T10 (shown on left) begins in a similar range as Trc regional gamma levels (shown on right) and then rises to less than two times background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T10 is slightly higher than the data cloud from the Trc regional data set. A box plot showing the quartiles of the data sets is provided in Figure I10-7. The box plot shows that the median of Target T10 radiation levels is slightly higher than the median of the Trc regional data set but lower than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I10-8. No mining activity was observed within the survey area of Target T10. In general, Target T10 has surficial gamma radiation levels below Trc regional levels across the majority of the Target area except for the northern and eastern edges of the survey boundary outside of the fence line. Surface gamma levels appear to have been impacted by disking or plowing of the field in the Target area; gamma levels outside of the field are elevated with respect to Trc regional levels. The survey appears to have correspond to the area of elevated gamma activity identified by the ASPECT gamma survey (Figure I10-3). No TENORM or mining-related activities were observed. Section 6.1.5.3 presents the grid averaged results of the gamma radiation survey.

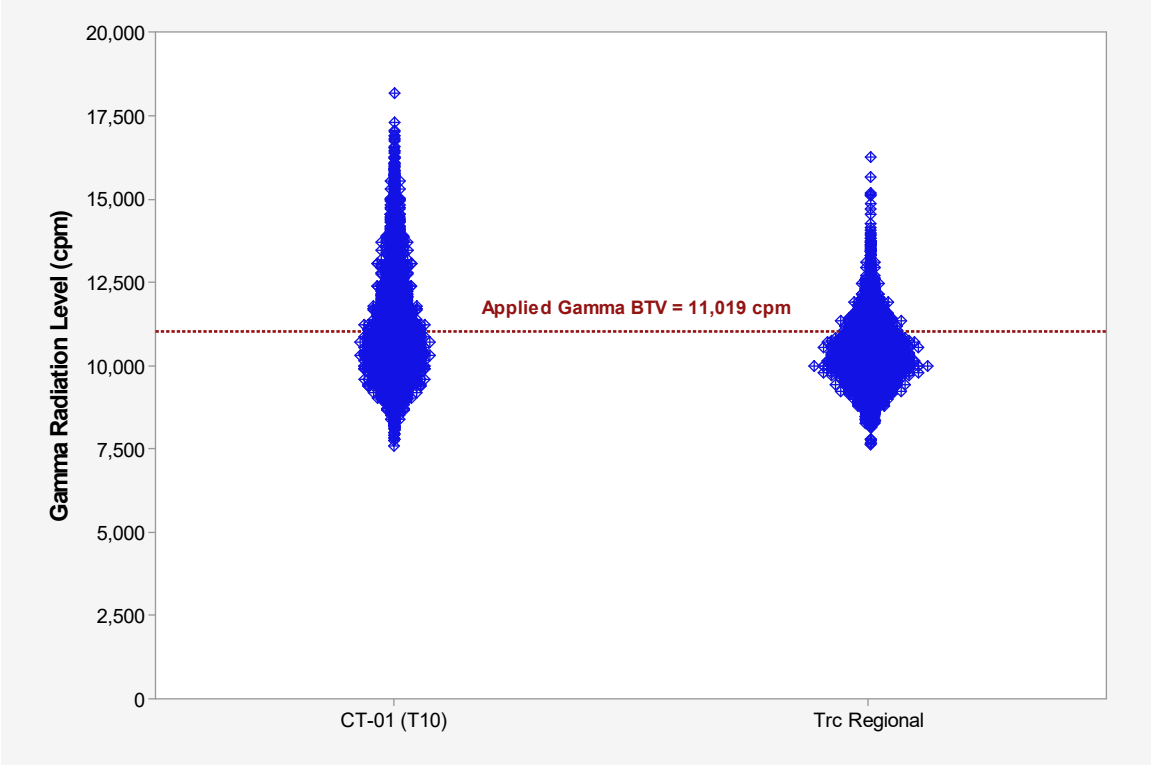


Figure I10-6. Individual Value Plot of Raw Gamma Radiation Levels at Target CT-01 (T10) and Trc Regional

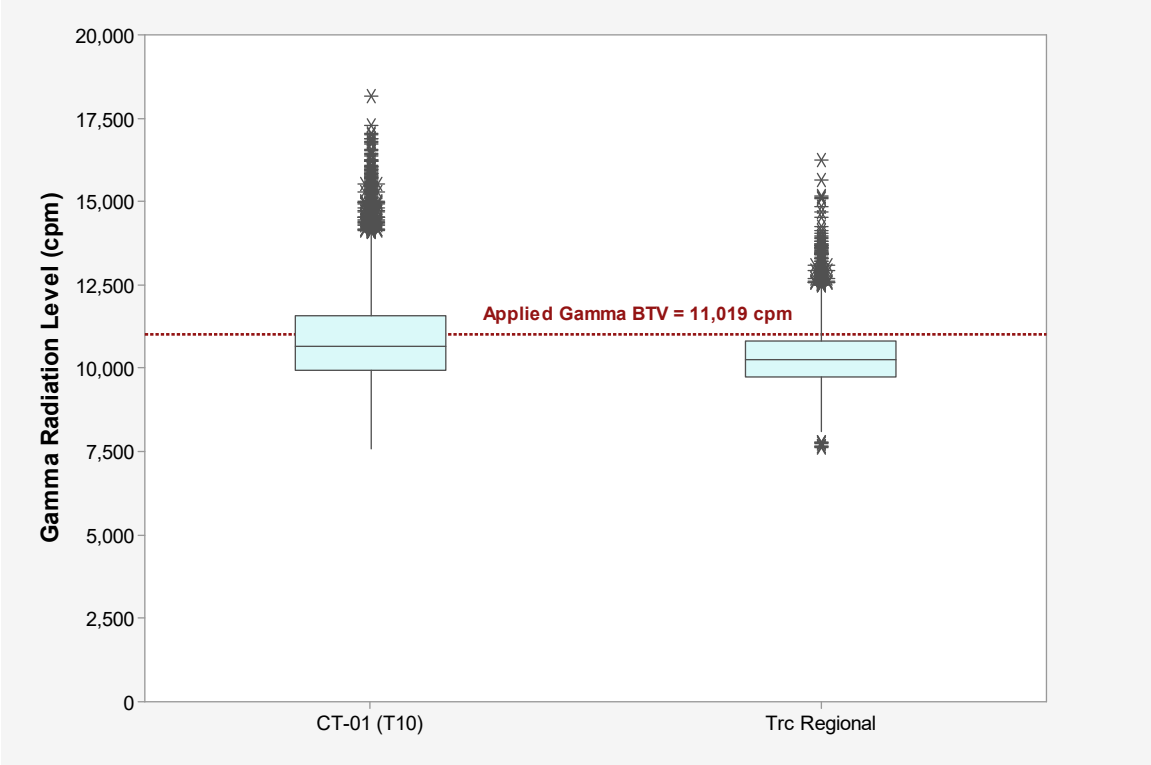


Figure I10-7. Box Plot of Raw Gamma Radiation Levels at Target CT-01 (T10) and Trc Regional

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

CT-01 (T10) Weston Site Screening Gamma Radiation Levels

CT-01 (T10) 2018 Removal Site Evaluation Gamma Radiation Levels

Cove Transfer Station (T9)

Cove Transfer Station (T9)

Gamma Reading (cpm)*

≤ 10,289	≤ Avg. BG
10,289 - 11,019	Avg. BG - 1 x BTV
11,019 - 22,038	1 x BTV - 2 x BTV
22,038 - 33,057	2 x BTV - 3 x BTV
33,057 - 44,076	3 x BTV - 4 x BTV
44,076 - 110,190	4 x BTV - 10 x BTV
≥ 110,190	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Other Survey Area
Access Route - Vehicular

1 in = 70 ft

1:840

N W E S

0 35 70 140 Feet

NON-AUM TARGET CT-01 (T10) SITE
2018 REMOVAL SITE EVALUATION
VS WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019

Notes:
*The applied gamma radiation background threshold value (BTV) for CT-01 (T10) is 11,019 cpm derived from gamma survey data for BSAs within the T_{RC} formation as presented in Appendix A.

Figure No.: **I10-8**

6.1.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 6.1.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 6.1.5.1. Figure I10-9 and Figure I10-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to Trc regional data set (shown on right). A total of 27 percent of the survey units (30 of 111) within the survey area of Target T10 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I10-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I10-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. The elevated regions of the Target correspond with the areas to the north and east of the field.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface samples were collected at the Target across the survey units and are presented in Section 6.1.6.

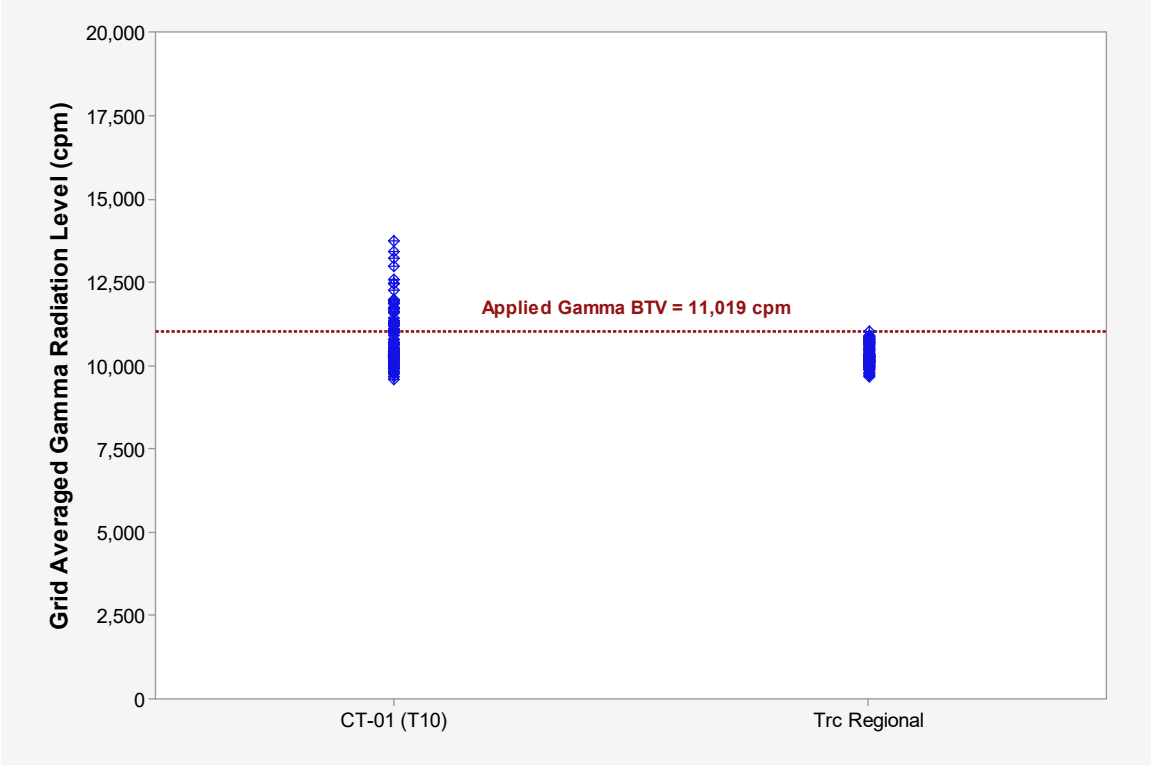


Figure I10-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target CT-01 (T10) and Trc Regional

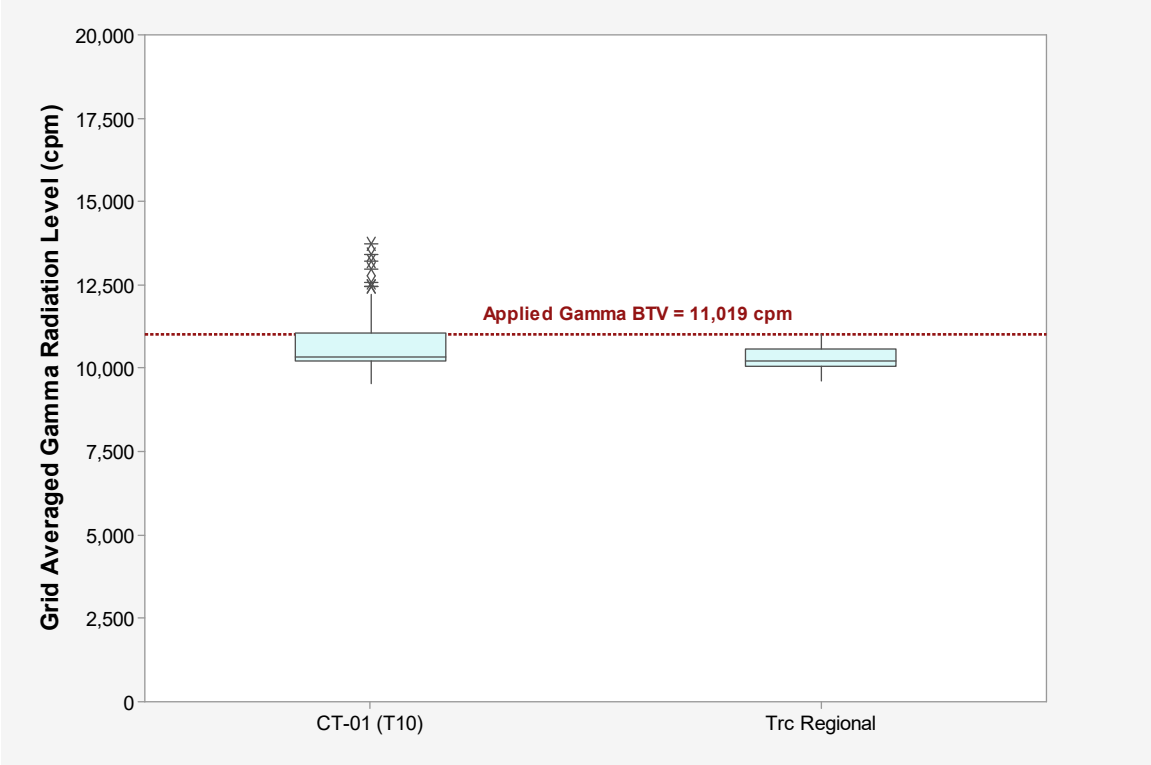
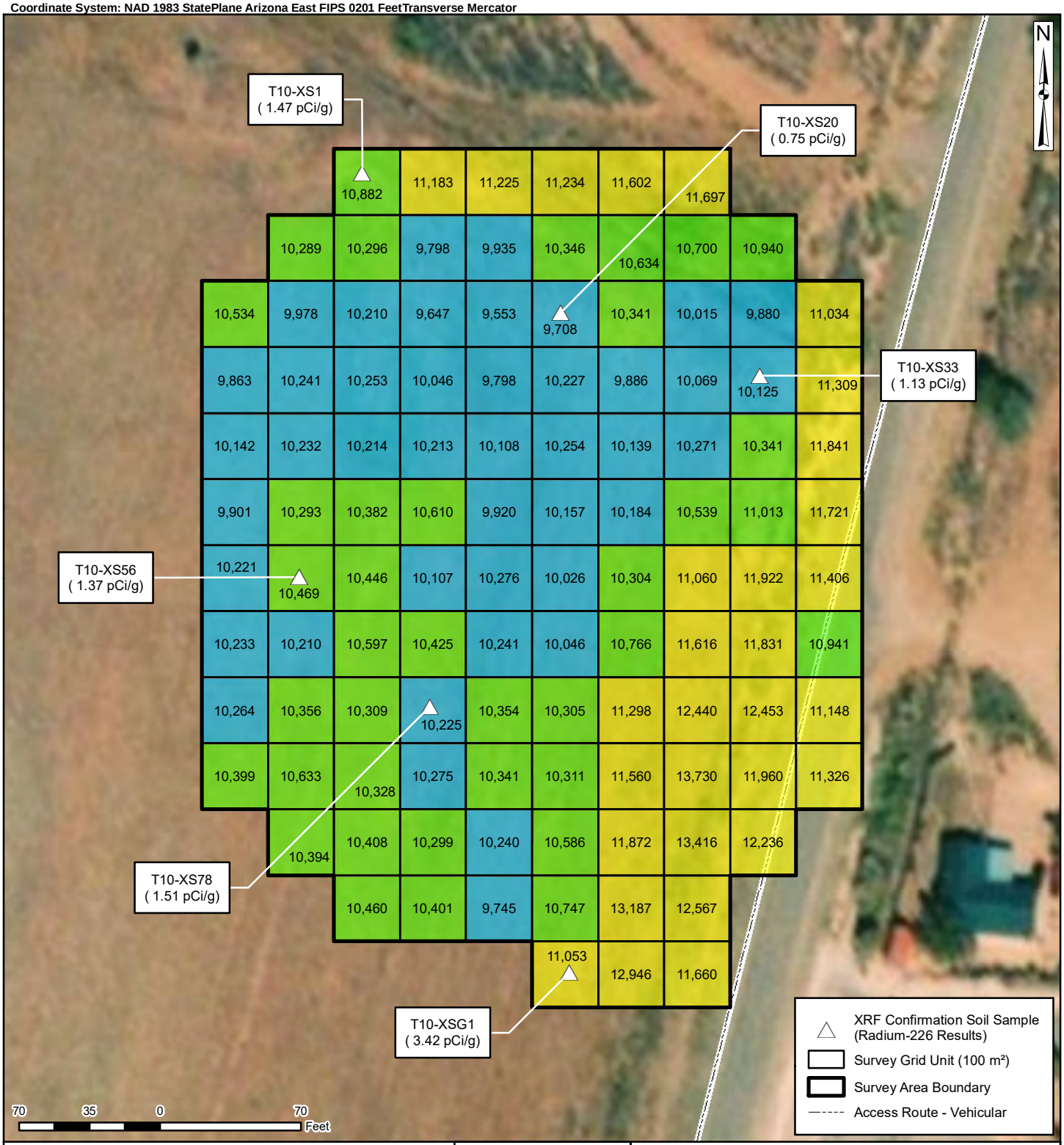


Figure I10-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target CT-01 (T10) and Trc Regional

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



Grid Averaged Gamma Reading (cpm)*

≤ 10,289	≤ Avg. BG
10,289 - 11,019	Avg. BG - 1 x BTV
11,019 - 22,038	1 x BTV - 2 x BTV
22,038 - 33,057	2 x BTV - 3 x BTV
33,057 - 44,076	3 x BTV - 4 x BTV
44,076 - 110,190	4 x BTV - 10 x BTV
≥ 110,190	≥ 10 x BTV

*The applied gamma radiation background threshold value (BTV) for CT-01 (T10) is 11,019 cpm derived from gamma survey data for BSAs within the T_{RC} formation as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET CT-01 (T10)
GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I10-11
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.1.6 Soil Sampling Results

This section presents the results of analyses for soil within the survey area of Target T10. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 6.1.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 6.1.6.2.

6.1.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T10: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I10-1 and I10-2. All the results of the XRF confirmation soil samples are presented in Table I10-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T10 following the methods outlined in Section 2.4 and shown in Figure I10-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 109 measurements were collected across 111 survey units from the survey area of Target T10 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I10-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T10 at a depth of 0 to 3 inches bgs. Six XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I10-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 6.1.7.

Table I10-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target CT-01 (T10)

Analyte	Units	Applied BTV	T10-XS1-01-042518		T10-XS20-01-042518		T10-XS33-01-042518		T10-XS56-01-042518		T10-XS78-01-042518		T10-XSG1-01-081818	
			Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Survey Unit			X1		X20		X33		X56		X78		XG1	
Aluminum	mg/kg	8,470	4,500		3,300		3,500		4,600		4,700		4,000	
Antimony	mg/kg	0.170	0.096	J	0.07	J	0.072	J	0.093	J	0.1	J	0.1	
Arsenic	mg/kg	2.6	1.6		1.3		1.3		1.8		1.8		1.5	
Barium	mg/kg	150	93		66		76		99		100		89	
Beryllium	mg/kg	0.51	0.37		0.28		0.3		0.37		0.41		0.3	
Cadmium	mg/kg	0.160	0.11	J	0.069	J	0.083	J	0.068	J	0.068	J	0.086	J
Calcium	mg/kg	9,900	3,400		2,000		2,600		4,400		3,400		4,100	
Chromium	mg/kg	9.0	4.3		3.2		3.4		4.6		4.7		4.1	
Cobalt	mg/kg	4.5	2.8		2.1		2.2		3		3.1		2.4	
Copper	mg/kg	8.5	5.6		3.9		4.4		5.4		5.5		5.2	
Iron	mg/kg	9,830	5,400		4,100		4,200		5,800		5,800		5,100	
Lead	mg/kg	11	6.6		4.4		5		6		5.7		6.8	
Lead-210	pCi/g	NV	NA		0.89	LT	NA		NA		NA		NA	
Lithium	mg/kg	8.5	5.8		4.4		4.5		6.1		6		5.3	
Magnesium	mg/kg	3,600	2,500		1,800		2,000		2,700		2,500	J	2,400	
Manganese	mg/kg	380	240		180		200		240		260		210	
Mercury	mg/kg	0.0260	NA		0.0065	J-	NA		NA		NA		NA	
Molybdenum	mg/kg	0.23	0.2		0.12	J	0.14	J	0.18	J	0.18	J	0.17	J
Nickel	mg/kg	8.7	4.8		3.6		3.8		5.3		5.5		4.4	
Potassium-40	pCi/g	21.3	12.5		14.9		14.7		14.1		18.5		15	
Radium-226	pCi/g	2.49	1.47		0.75	LT	1.13		1.37		1.51		3.42	
Radium-228	pCi/g	0.76	<0.32	U	<0.66	U	<0.37	U	<0.72	U	<0.57	U	<0.49	U
Selenium	mg/kg	0.95	0.61	J	0.5	J	0.47	J	0.57	J	0.63	J	0.53	J
Silver	mg/kg	0.029	0.016	J	0.014	J	0.013	J	0.02	J	0.02	J	0.02	J
Sodium	mg/kg	51	31	J	<98	U	<96	U	25	J	18	J	25	J
Thallium	mg/kg	0.086	0.05		0.037		0.038		0.055		0.056		0.047	
Thorium	mg/kg	4.7	2.5		1.9		1.8		2.6		2.6	J	2.6	
Thorium-228	pCi/g	NV	NA		0.66	M3	NA		NA		NA		NA	
Thorium-230	pCi/g	NV	NA		0.86	M3	NA		NA		NA		NA	
Thorium-232	pCi/g	NV	NA		0.57		NA		NA		NA		NA	
Uranium	mg/kg	1.7	0.89		0.43		0.79		0.63		0.7		2.6	
Uranium-234	pCi/g	NV	NA		0.52		NA		NA		NA		NA	
Uranium-235	pCi/g	NV	NA		0.076	LT	NA		NA		NA		NA	
Uranium-238	pCi/g	NV	NA		0.53		NA		NA		NA		NA	
Vanadium	mg/kg	19	12		8		9.2		12		13		16	
Zinc	mg/kg	33	17		15		14		16		16		17	11

Notes:
BTV Background threshold value
J Estimated value
J- Estimated value, may be biased low
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 Qualification
U Not considered detected. The associated value is the method detection limit (MDL).
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

Table I10-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target CT-01 (T10)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.6	9,830	11	380	0.23	4.7	1.7	19	33
Measurements	#	109	109	109	109	109	109	109	109	109
Detects	#	69	109	109	109	64	108	103	35	109
Nondetects	#	40	0	0	0	45	1	6	74	0
Minimum	mg/kg	1.9	3,766	3.6	185.5	0.1	1.3	0.3	16.1	13.1
Maximum	mg/kg	4.2	10,472	11.8	443.8	4.2	4.0	5.5	27.7	29.9
Standard Deviation	mg/kg	0.6	1,078	1.4	46.9	0.9	0.5	0.9	3.5	2.9
Average	mg/kg	2.7	6,333	7.4	296.4	1.5	2.8	1.8	20.5	20.0
Median	mg/kg	2.6	6,436	7.3	294.3	1.4	2.8	1.8	20.0	19.7
Relative Standard Deviation	%	21.6	17	19	16	60	20	50	17	14.5
90th Percentile	mg/kg	3.5	7,513	8.9	340.9	2.9	3.5	3.0	25.8	23.8
95th Percentile	mg/kg	3.7	7,894	9.7	365.7	3.1	3.8	3.4	27.0	24.8
99th Percentile	mg/kg	4.1	8,617	10.8	421.1	3.6	3.9	3.8	27.6	27.9
Measurements Above Applied BTV	#	38	1	1	5	62	0	58	22	0
Measurements Above Applied BTV	%	34.9	0.9	0.9	4.6	56.9	0.0	53.2	20.2	0.0

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value
mg/kg Milligram per kilogram
XRF X-ray fluorescence

6.1.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T10 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T10 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T10. The estimated BTVs are identified in Section 6.1.4 and Table I10-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I10-7 presents a summary of the background comparison for different measurement and soil depths at Target T10. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T10. However, gamma radiation screening indicated that gamma levels at Target T10 are elevated beyond the fence line. Therefore, while multiple COPCs have been identified at Target T10 based on a comparison to background, risk screening will be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I10-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target CT-01 (T10)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic		✓	✓
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron			
Lead			
Lithium			
Magnesium			
Manganese			
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226	✓		✓
Radium-228			
Selenium			
Silver			
Sodium			
Thallium			
Thorium			
Uranium	✓	✓	✓
Vanadium		✓	✓
Zinc			

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

6.1.7 Primary Contaminant Mapping

6.1.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 6.1.6.2 identified the COPCs at Target T10. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 6.1.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I10-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T10 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 6.1.7.1 through Section 6.1.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T10. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

6.1.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I10-7. Arsenic exceeded the applied BTV in 34.9 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for arsenic is 2.6 mg/kg for Target T10 as presented in Section 6.1.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I10-5 and Attachment I3, respectively. Figure I10-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T10 and Trc regional samples. Figure I10-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T10 and Trc regional samples. Summary statistics for XRF measurements are provided in Section 6.1.6.1. Arsenic XRF concentrations measured in surface soils at Target T10 ranged between 1.9 and 4.2 mg/kg with an average and standard deviation of 2.7 mg/kg and 0.6 mg/kg, respectively. The average arsenic XRF concentration is slightly above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T10 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I10-14. Overall, the majority of detectable arsenic results in surface soils were slightly below the applied BTV. However, exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T10.

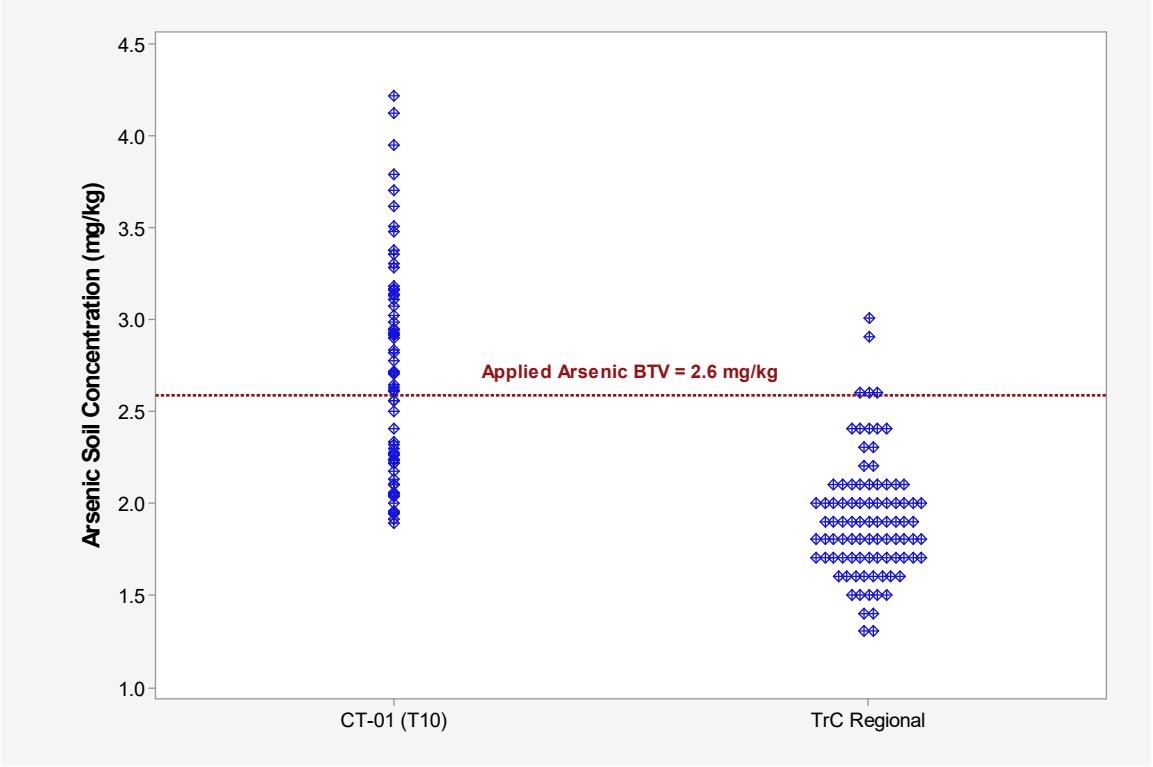


Figure I10-12. Individual Value Plot for Target CT-01 (T10) and Trc Regional Arsenic Soil Concentrations

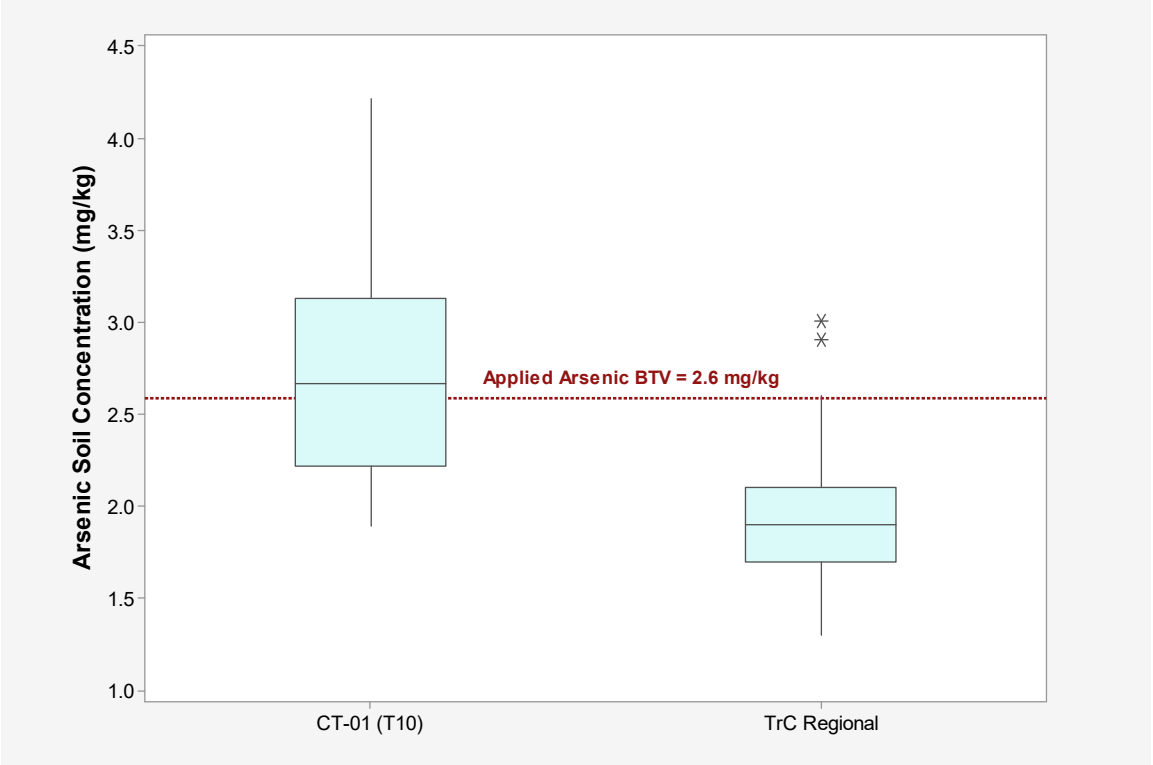
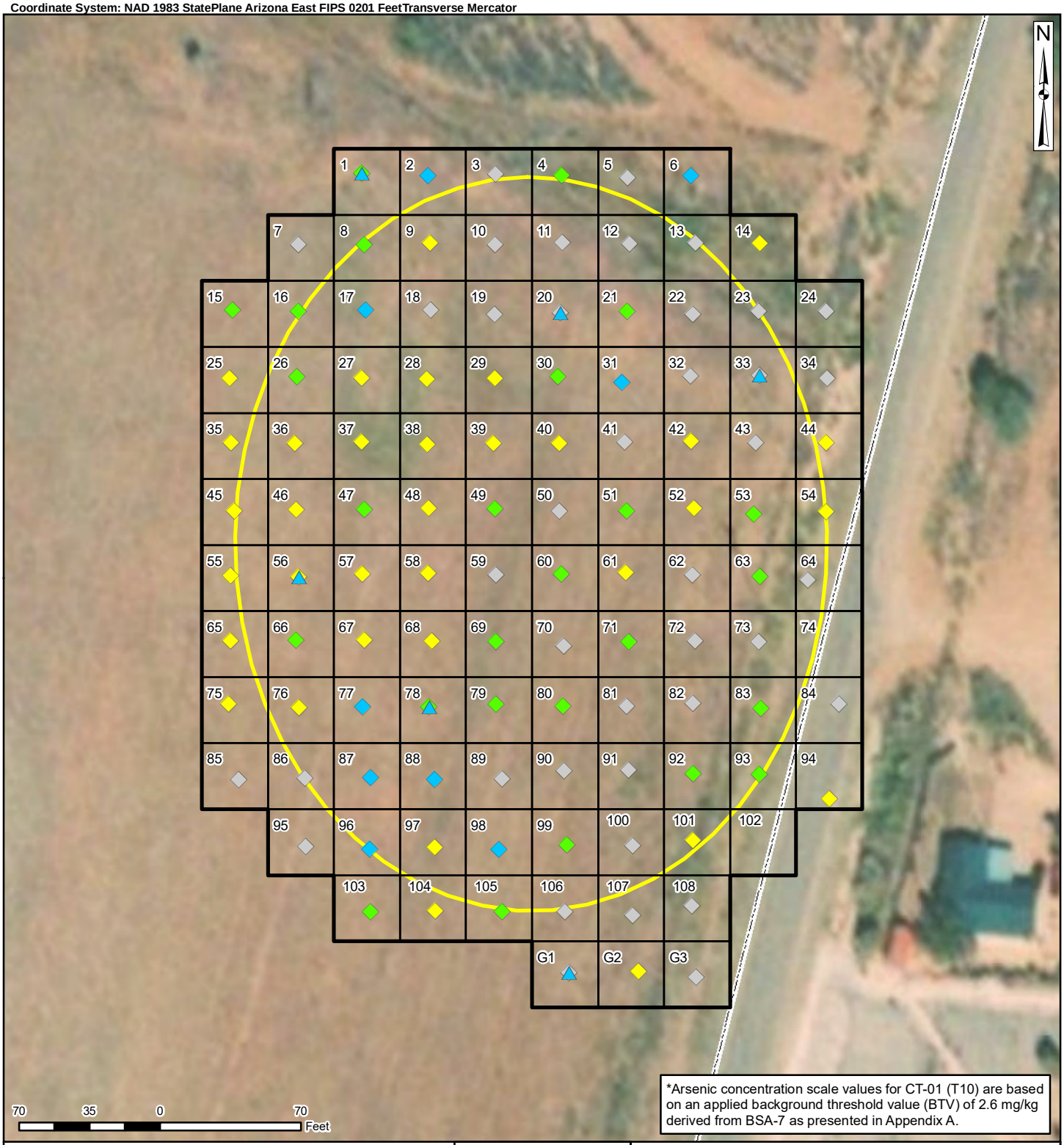


Figure I10-13. Box Plot for Target CT-01 (T10) and Trc Regional Arsenic Soil Concentrations

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



*Arsenic concentration scale values for CT-01 (T10) are based on an applied background threshold value (BTV) of 2.6 mg/kg derived from BSA-7 as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 2.0
- 2.0 - 2.6
- 2.6 - 5.2
- 5.2 - 7.8
- 7.8 - 10
- 10 - 26
- ≥ 26
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET CT-01 (T10) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I10-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.1.7.3 Lead

Lead was not identified as a COPC in surface soil as shown in Table I10-7. Lead exceeded the applied BTV for in situ XRF measurements in 0.9 percent of samples and did not exceed the BTV in any XRF confirmation samples. The applied BTV for lead is 11 mg/kg for Target T10 as presented in Section 6.1.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I10-5 and Attachment I3, respectively. Figure I10-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T10 and BSA-7 (Trc) samples. Figure I10-16 presents a box plot of detectable lead XRF soil concentrations for Target T10 and BSA-7 (Trc) samples. Summary statistics for XRF measurements are provided in Section 6.1.6.1. Lead XRF concentrations measured in surface soils at Target T10 ranged between 3.6 and 11.8 mg/kg with an average and standard deviation of 7.4 mg/kg and 1.4 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T10 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I10-17. Overall, the majority of detectable lead results in surface soils were less than the applied BTV. Exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T10.

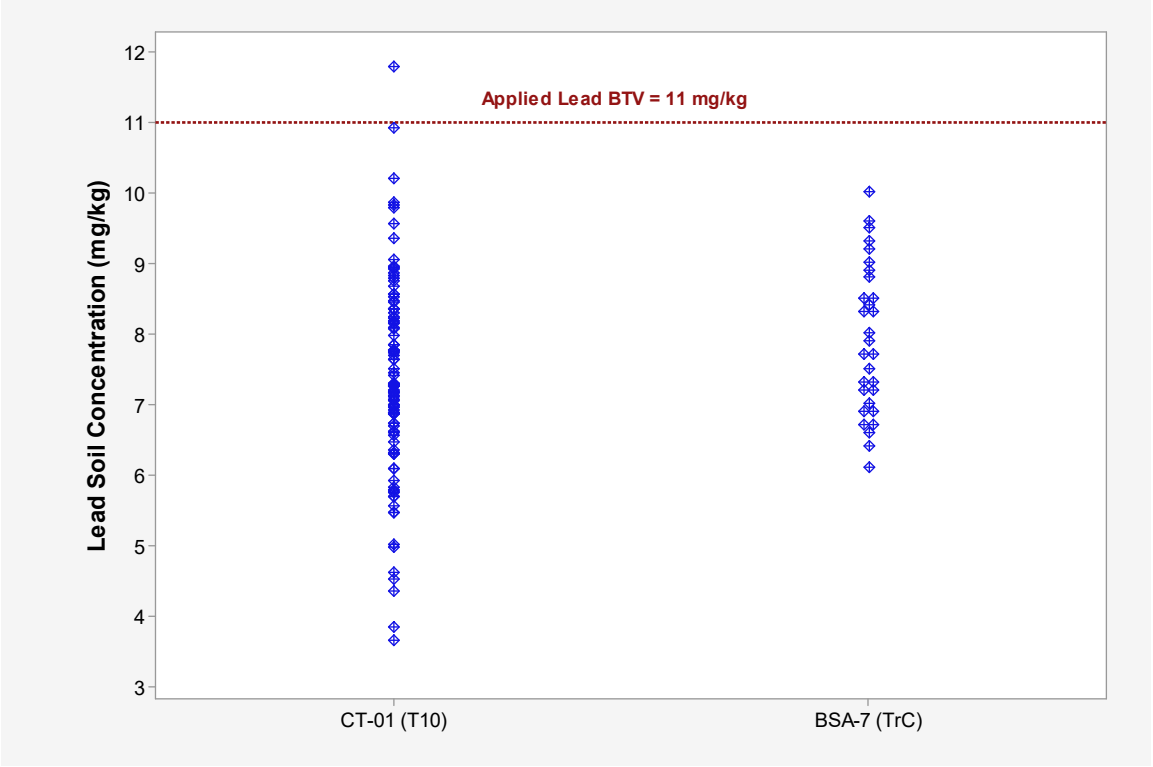


Figure I10-15. Individual Value Plot for Target CT-01 (T10) and BSA-7 (Trc) Lead Soil Concentrations

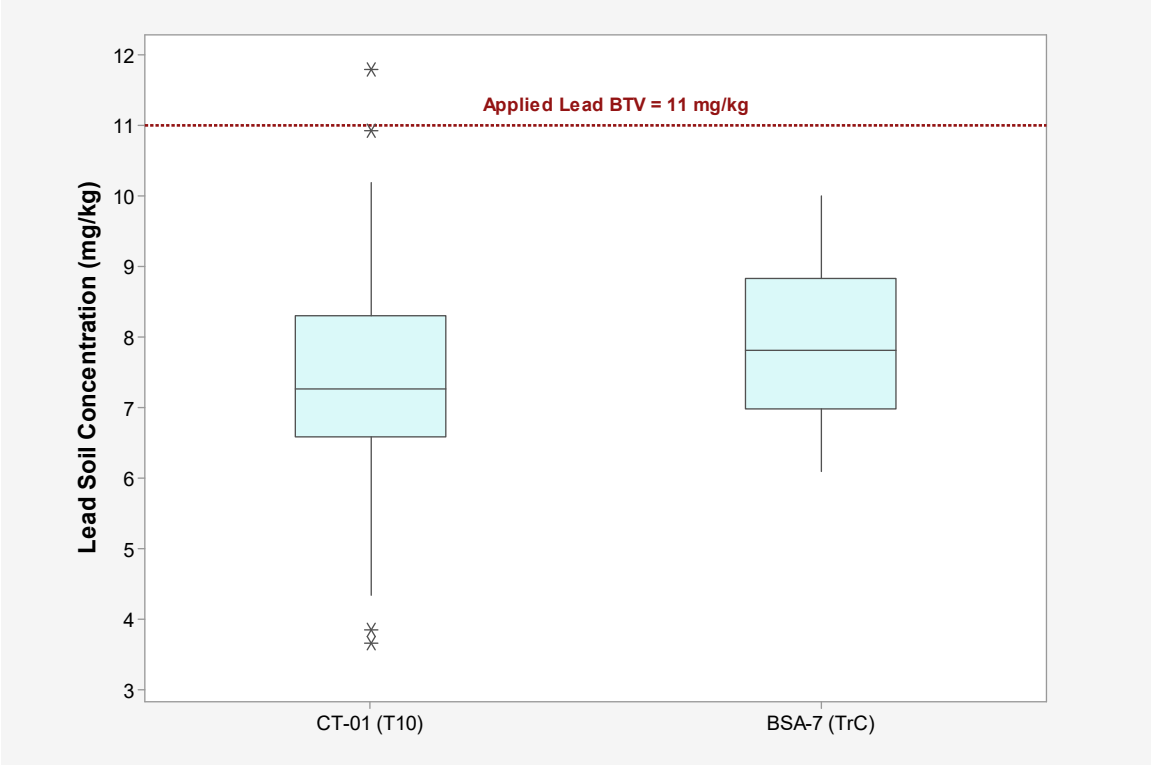
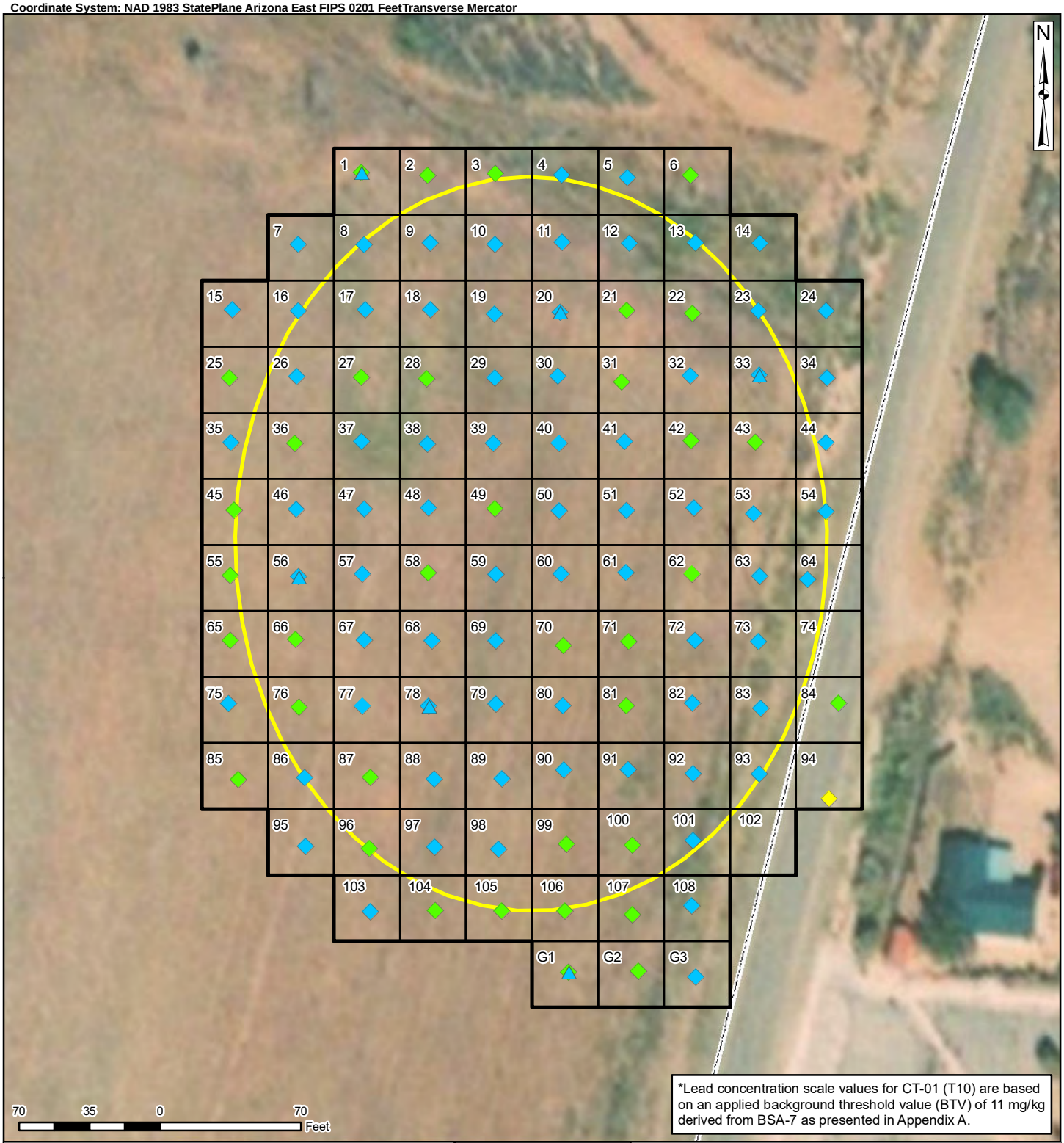


Figure I10-16. Box Plot for Target CT-01 (T10) and BSA-7 (Trc) Lead Soil Concentrations



Lead Concentration Scale (mg/kg)*

- ≤ 7.9
- 7.9 - 11
- 11 - 22
- 22 - 33
- 33 - 44
- 44 - 110
- ≥ 110

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET CT-01 (T10) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I10-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.1.7.4 Thorium

Thorium was not identified as a COPC in surface soil as shown in Table I10-7. Thorium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for thorium is 4.7 mg/kg for Target T10 as presented in Section 6.1.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I10-5 and Attachment I3, respectively. Figure I10-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T10 and BSA-7 (Trc) samples. Figure I10-19 presents a box plot of detectable thorium XRF soil concentrations for Target T10 and BSA-7 (Trc) samples. Summary statistics for XRF measurements are provided in Section 6.1.6.1. Thorium XRF concentrations measured in surface soils at Target T10 ranged between 1.3 and 4.0 mg/kg with an average and standard deviation of 2.8 mg/kg and 0.5 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T10 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I10-20. All thorium results in surface soils were less than the applied BTV.

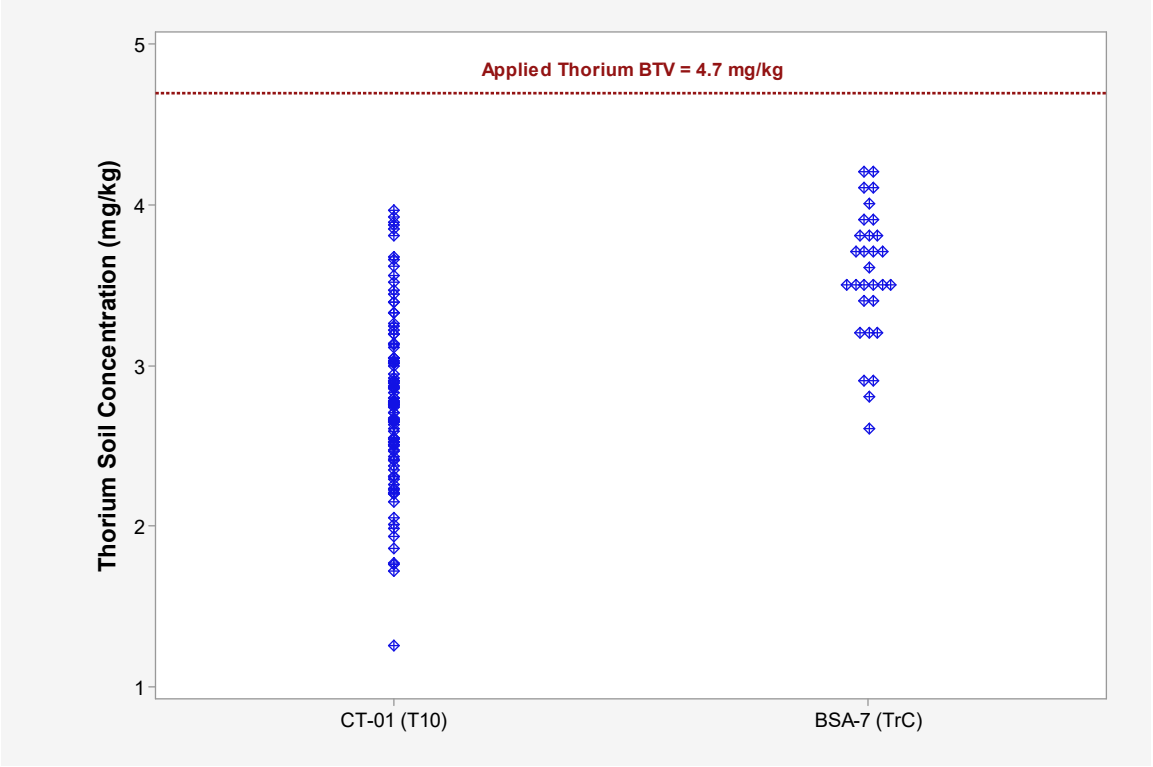


Figure I10-18. Individual Value Plot for Target CT-01 (T10) and BSA-7 (Trc) Thorium Soil Concentrations

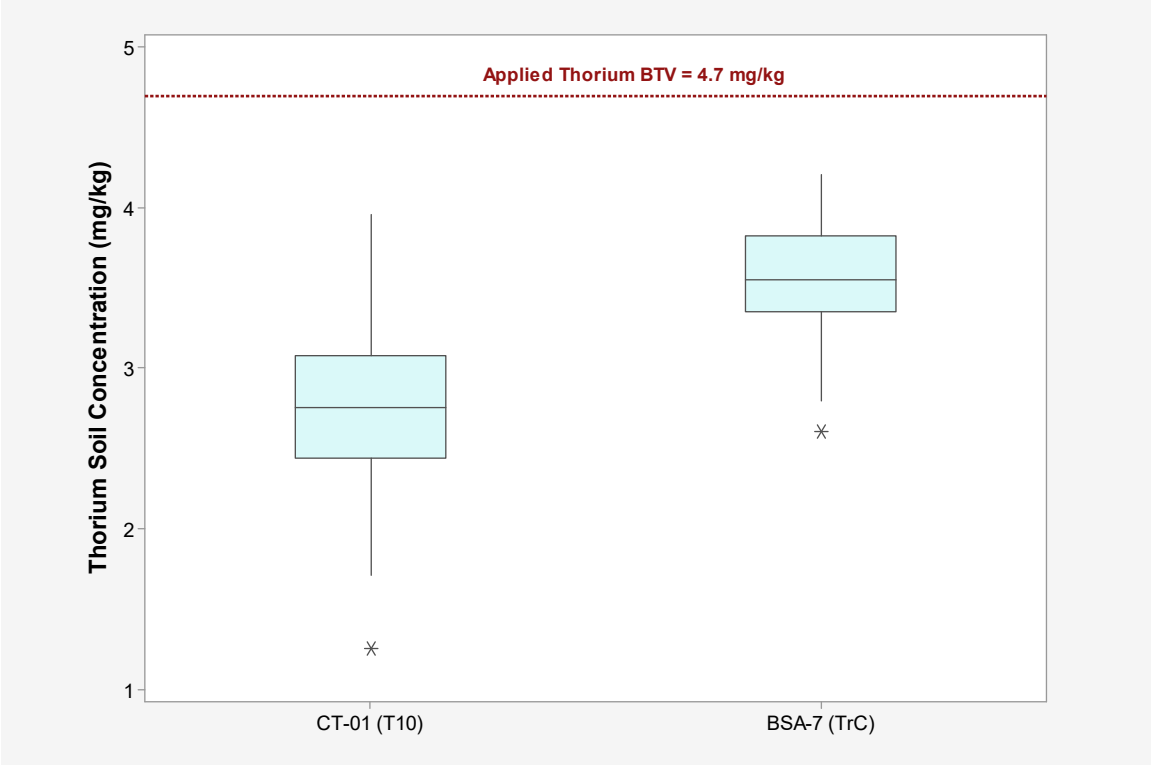
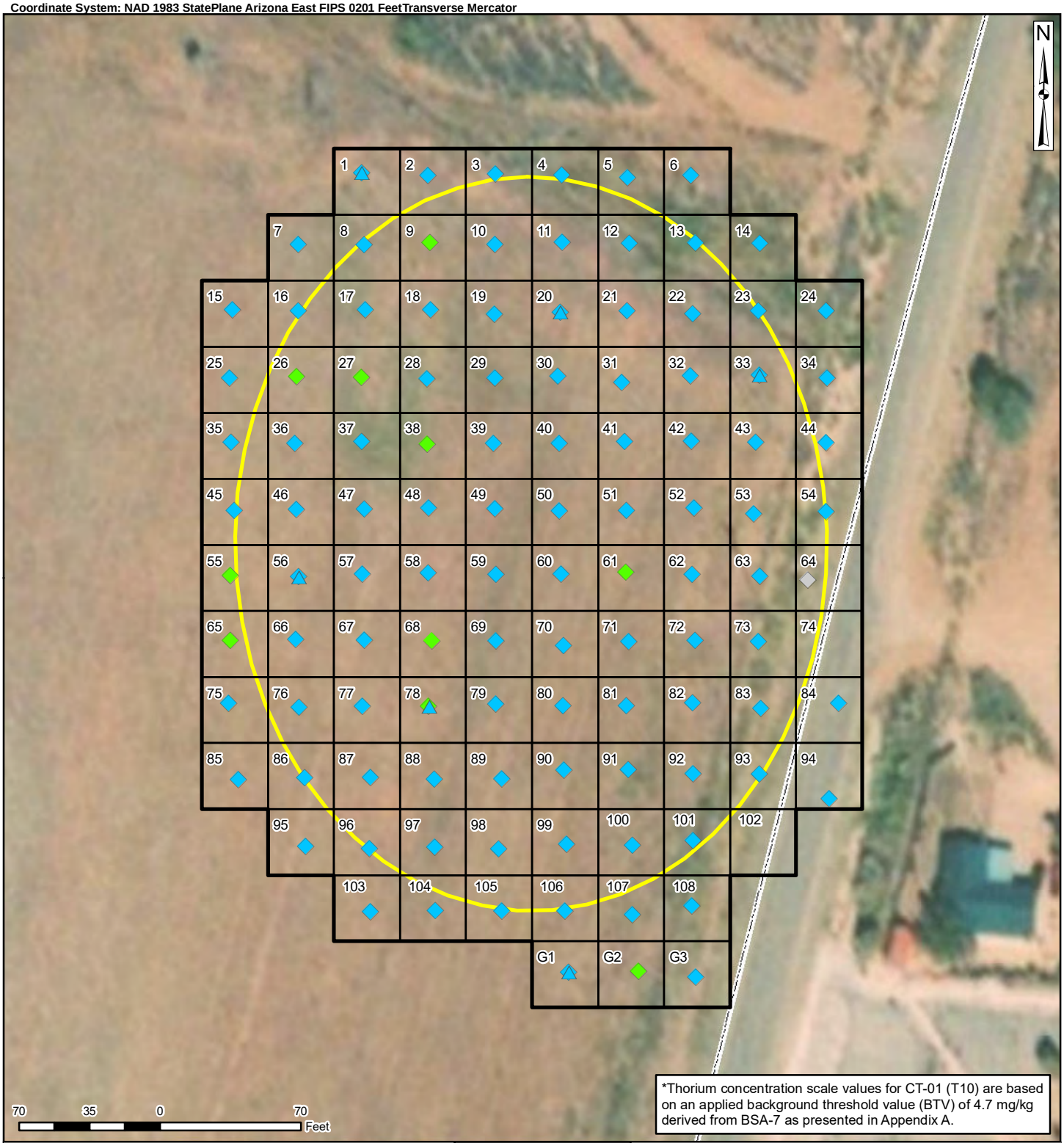


Figure I10-19. Box Plot for Target CT-01 (T10) and BSA-7 (Trc) Thorium Soil Concentrations

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



*Thorium concentration scale values for CT-01 (T10) are based on an applied background threshold value (BTV) of 4.7 mg/kg derived from BSA-7 as presented in Appendix A.

Thorium Concentration Scale (mg/kg)*

- ≤ 3.6
- 3.6 - 4.7
- 4.7 - 9.4
- 9.4 - 14
- 14 - 19
- 19 - 47
- ≥ 47
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET CT-01 (T10) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I10-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.1.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I10-7. Uranium exceeded the applied BTV in 53.2 percent of in situ XRF measurements and in one of the six XRF confirmation samples. The applied BTV for uranium is 1.7 mg/kg for Target T10 as presented in Section 6.1.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I10-5 and Attachment I3, respectively. Figure I10-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T10 and Trc regional samples. Figure I10-22 presents a box plot of detectable uranium XRF soil concentrations for Target T10 and Trc regional samples. Summary statistics for XRF measurements are provided in Section 6.1.6.1. Uranium XRF concentrations measured in surface soils at Target T10 ranged between 0.3 and 5.5 mg/kg with an average and standard deviation of 1.8 mg/kg and 0.9 mg/kg, respectively. The average uranium XRF concentration is slightly above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T10 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I10-23. Overall, the majority of detectable uranium results in surface soils were slightly above the applied BTV. However, the maximum value was 3.2 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T10.

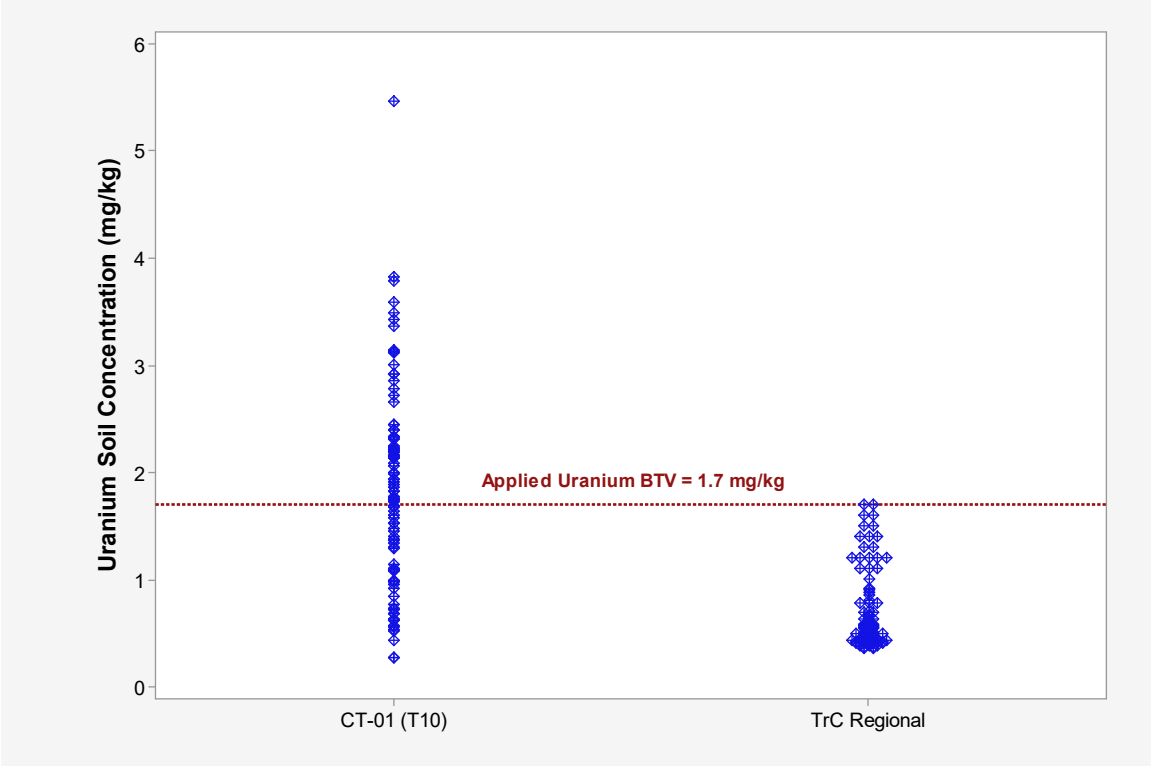


Figure I10-21. Individual Value Plot for Target CT-01 (T10) and Trc Regional Uranium Soil Concentrations

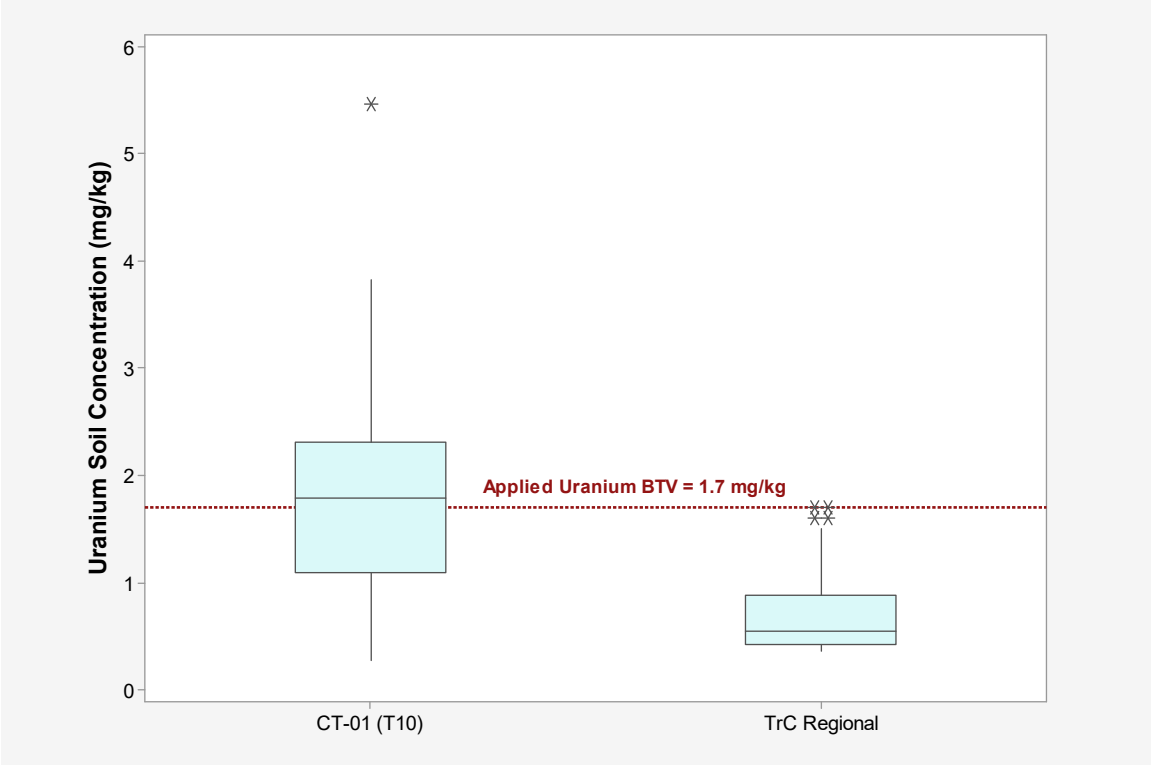
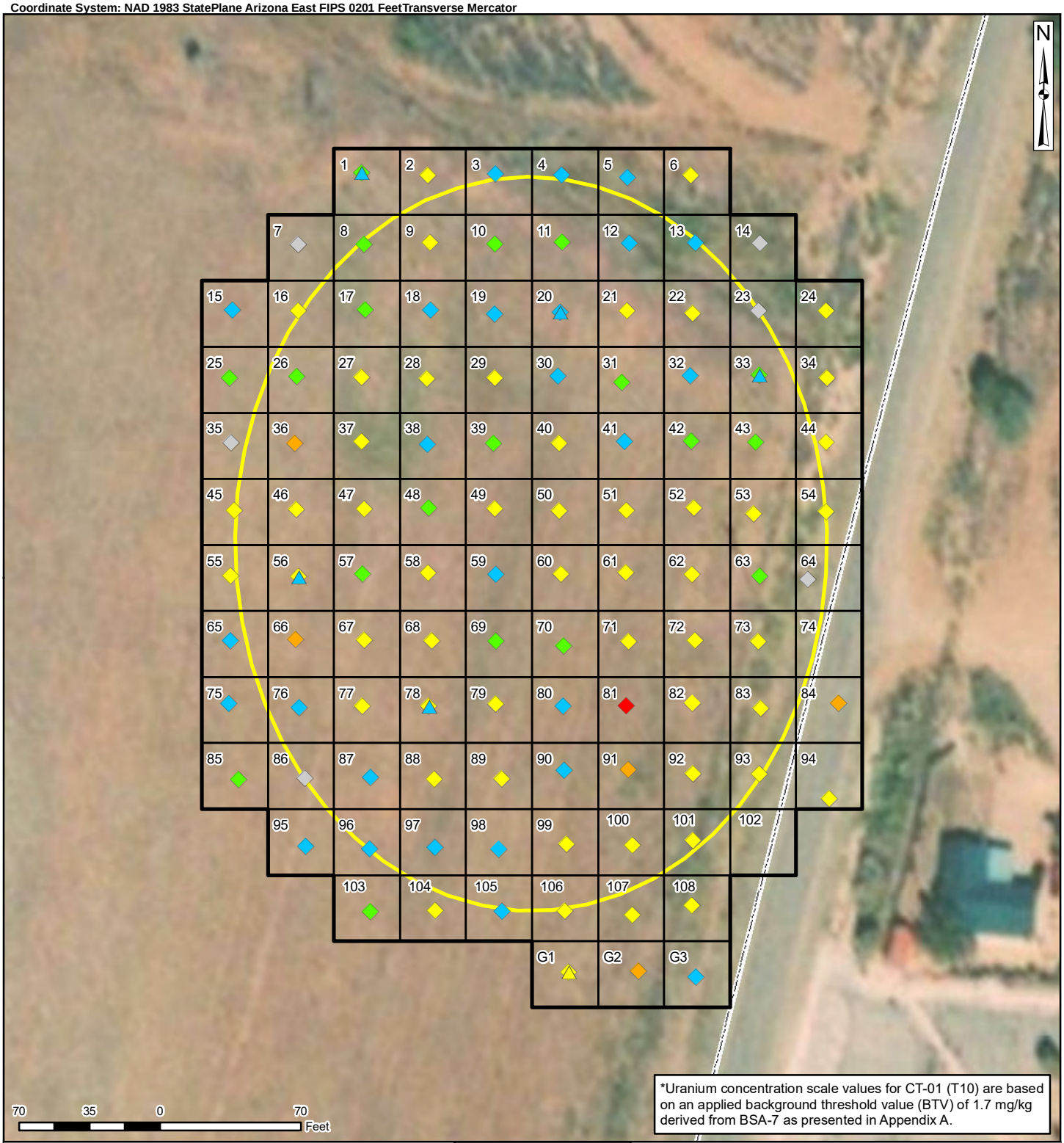


Figure I10-22. Box Plot for Target CT-01 (T10) and Trc Regional Uranium Soil Concentrations

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



*Uranium concentration scale values for CT-01 (T10) are based on an applied background threshold value (BTV) of 1.7 mg/kg derived from BSA-7 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 1.1
- 1.1 - 1.7
- 1.7 - 3.4
- 3.4 - 5.1
- 5.1 - 6.8
- 6.8 - 17
- ≥ 17
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET CT-01 (T10) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I10-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.1.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I10-7. Vanadium exceeded the applied BTV in 20.2 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for vanadium is 19 mg/kg for Target T10 as presented in Section 6.1.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I10-5 and Attachment I3, respectively. Figure I10-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T10 and Trc regional samples. Figure I10-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T10 and Trc regional samples. Summary statistics for XRF measurements are provided in Section 6.1.6.1. Vanadium XRF concentrations measured in surface soils at Target T10 ranged between 16.1 and 27.7 mg/kg with an average and standard deviation of 20.5 mg/kg and 3.5 mg/kg, respectively. The average vanadium XRF concentration is slightly above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T10 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I10-26. Overall, the majority of detectable vanadium results in surface soils were higher than the applied BTV. However, exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T10.

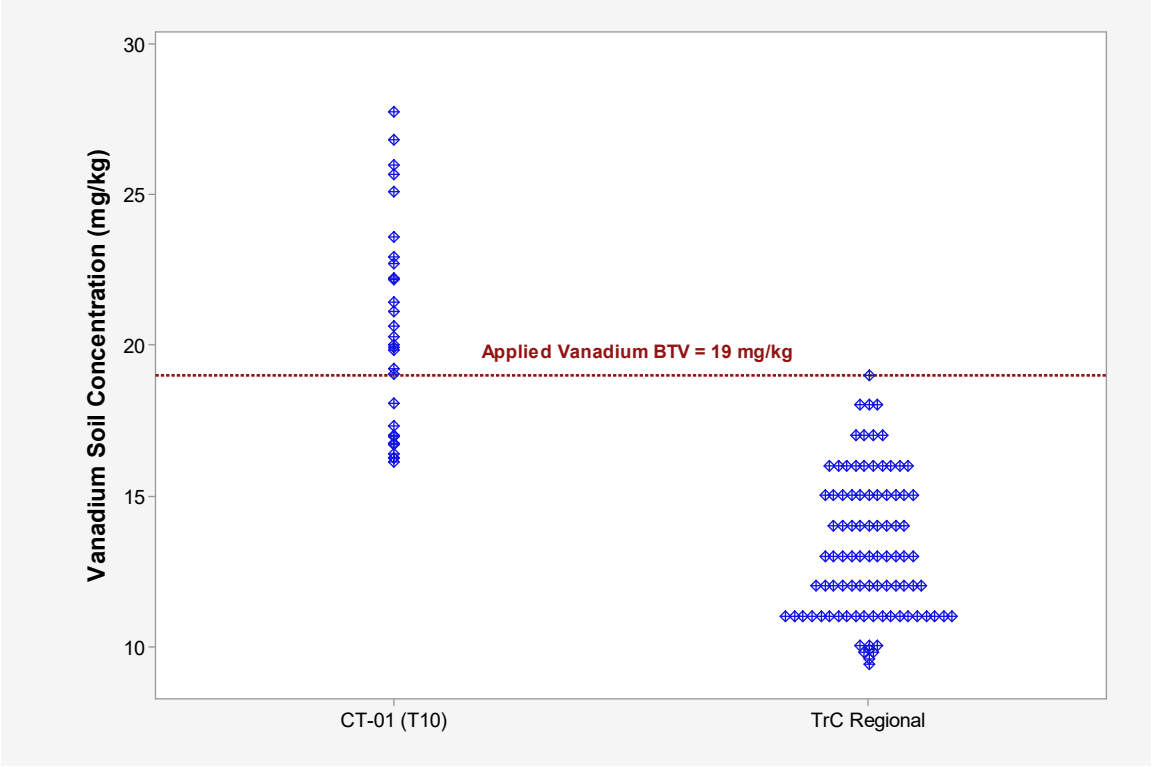


Figure I10-24. Individual Value Plot for Target CT-01 (T10) and Trc Regional Vanadium Soil Concentrations

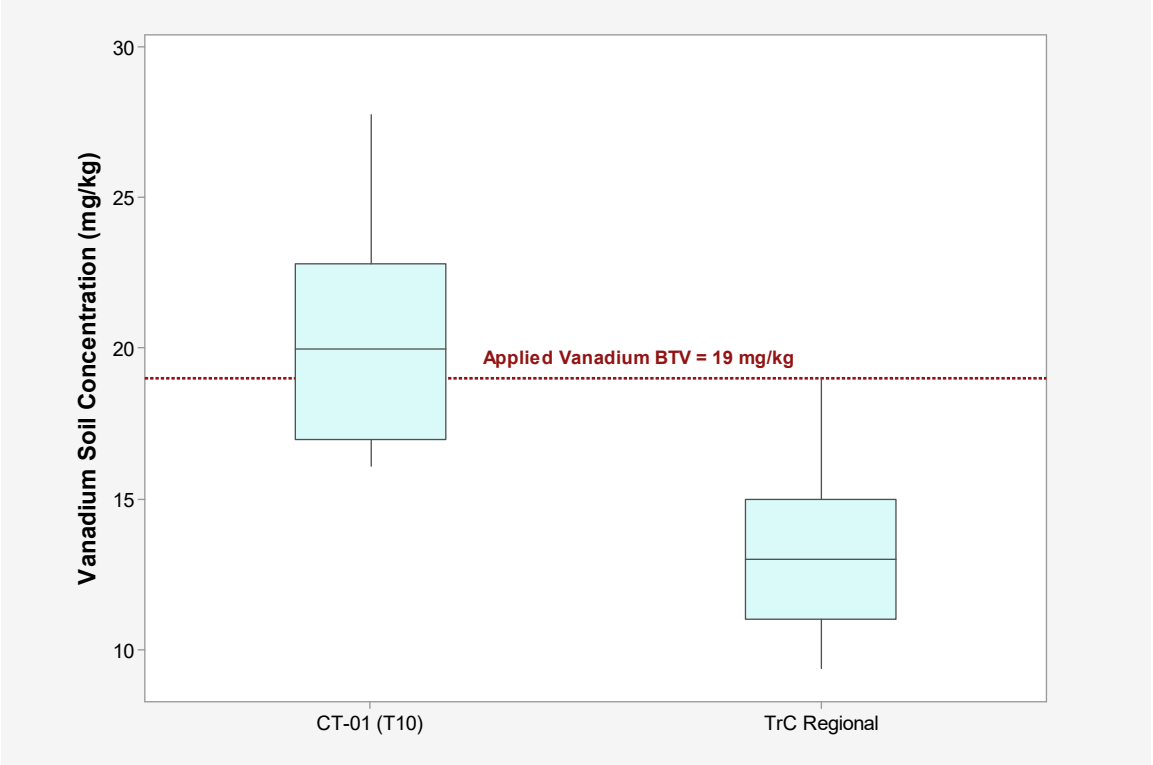
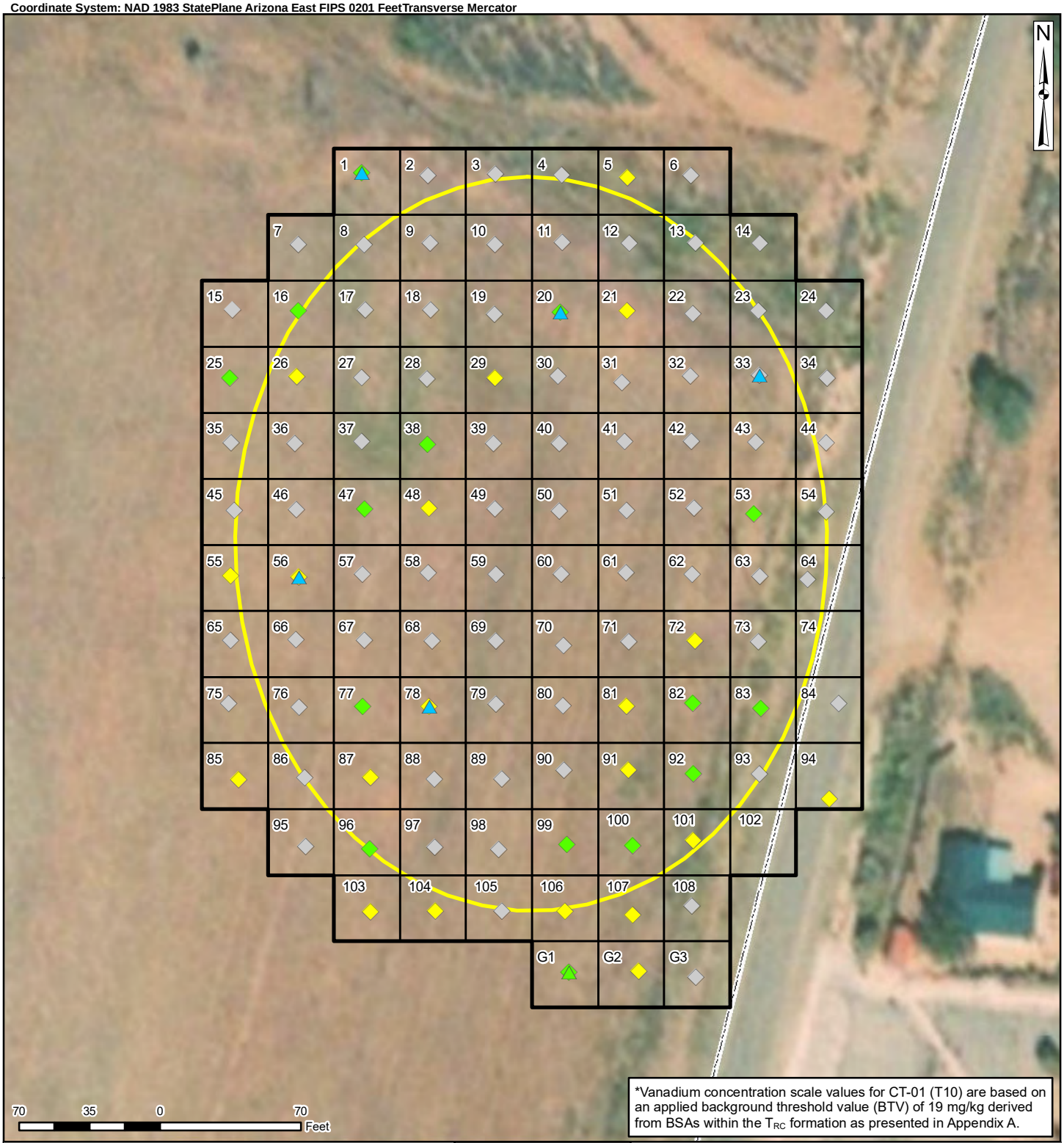


Figure I10-25. Box Plot for Target CT-01 (T10) and Trc Regional Vanadium Soil Concentrations

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



*Vanadium concentration scale values for CT-01 (T10) are based on an applied background threshold value (BTV) of 19 mg/kg derived from BSAs within the T_{RC} formation as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 13
- 13 - 19
- 19 - 38
- 38 - 57
- 57 - 76
- 76 - 190
- ≥ 190
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET CT-01 (T10) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I10-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.1.8 Conclusions

Target T10 (CT-01) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T10. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T10 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T10. ASPECT gamma survey results generally correlated with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T10 was partially documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples exceeded the applied BTV in one of the six XRF confirmation samples. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T10 geology and soil types were established through a background study.
- A total of 34 analytes were identified as occurring within the surface environment. Of these analytes, 5 were identified as COPCs. Only arsenic exceeded the applied BTV by a factor greater than 2.
- Mean raw gamma measurements did not exceed the applied BTV. However, grid averaged gamma measurements exceeded the applied BTV in 30 of 111 survey units by a factor of up to 1.2.
- Based on Tetra Tech's observations, Target T10 does not contain TENORM. No mining-related activities or features were observed in the field, and no historical exploratory borings, vents, or other mine openings were noted in the file review or during field observation. NORM was not identified visually or by gamma survey.
- There are no immediate significant physical hazards present at Target T10.
- Access is by highway.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No groundwater wells are documented within the vicinity of Target T10. Rural residences are located nearby; however, it is not known if water is provided by utility or private well. No seeps or springs were observed during the RSE investigation.

- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T10. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No mine waste was observed at Target T10; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was generally successful at fulfilling the DQOs identified in Section 1.3; however, a few data gaps remain for Target T10. The remaining data gaps are to step out to the north of the fence line and across the highway to refine the lateral extent of elevated gamma radiation and to collect subsurface samples at the bottom of the plow zone to evaluate potential mixing and any residual uranium and radionuclides at depth.

6.2 NON-AUM TARGET T11 (CT-02)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T11 (CT-02).

6.2.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T11 (CT-02) is associated with the Cove Transfer Station (T9), a former mining operations field camp and uranium ore storage and transfer facility in the Cove Valley Region in Subarea Group C within the Cove Chapter of the Navajo Nation. Two other non-AUM Targets are also associated with Cove Transfer Station, which is within the residential area of Cove, Arizona, and is accessible by vehicle via Indian Route 33. Target T11 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. One residence is located 1,000 feet north of Target T11. A Target location and access map for Target T11 is shown in Figure I11-1.

A topographical relief map for the Cove Transfer Station area and associated non-AUM Targets is provided in Figure I11-2. The elevation at Target T11 ranges from 6,481 to 6,502 feet amsl with an average of 6,491 feet amsl. The slope at Target T11 ranges from 1 to 10 percent with an average of 5 percent. One ephemeral drainage channel is located 250 feet east of Target T11. Cove Transfer Station and Target T11 are located within Trc, and Target T11 is located within Blanding very fine sandy loam soils (MUSYM 312) (Figures I-17 and I-18).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T11. Weston did not conduct a background study for Target T11. As a part of the RSE for the Cove Transfer Station, Tetra Tech also evaluated the associated non-AUM Targets, such as T11. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 3 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T11:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.
- Located access routes, including foot pathways and roads:

  Target T11 is next to Indian Route 33, which connects to Cove Transfer Station area.
- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM and TENORM were not observed at the Target.
- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  One ephemeral drainage (Cove Wash Middle) was identified 250 feet east of the Target.
- Identified any exploration borings or historic haul roads:

  No exploratory borings or haul roads were identified.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  No AUM or non-AUM Target features were identified at this Target.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

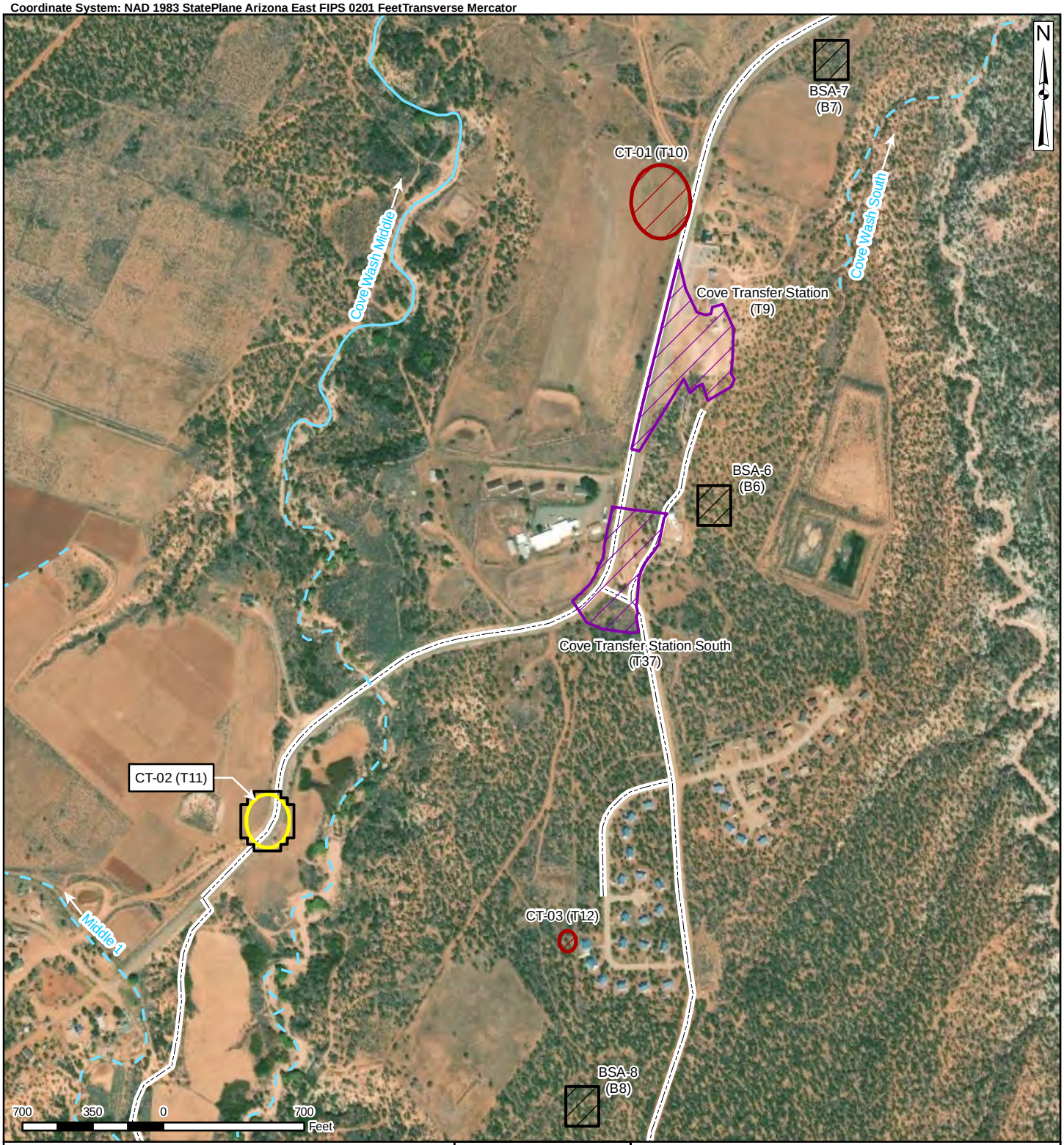
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T11 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Section 2.3 and 6.2.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 6.2.3 with results presented in Sections 6.2.6 and 6.2.7)
- Conducting a gamma radiation survey (results presented in Section 6.2.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target
AUM Related Site Boundary
Background Location
Access Route - Vehicular
Drainage*
Drainage - Field Mapped

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

Prepared for: USEPA Region 9

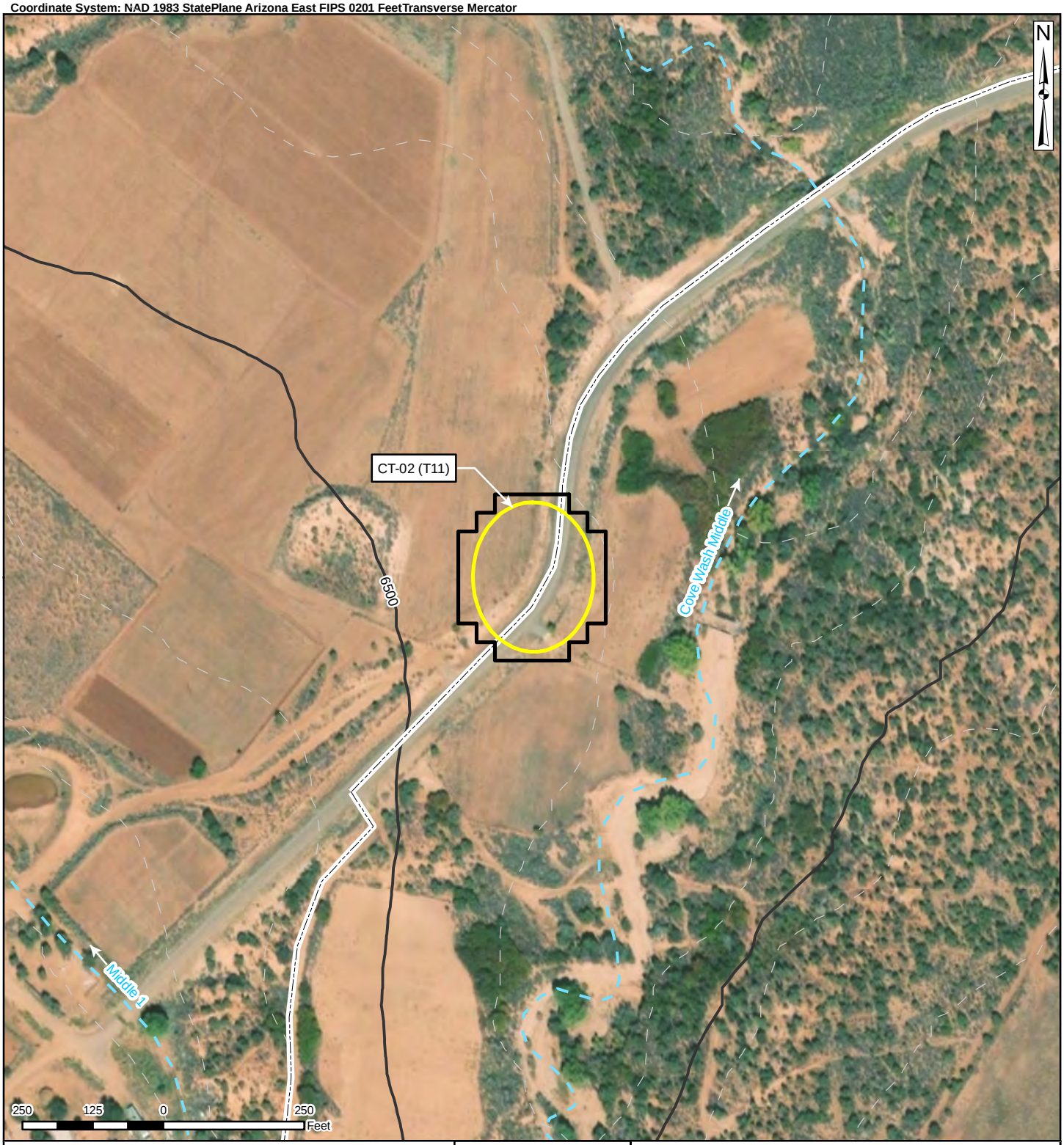
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NON-AUM TARGET CT-02 (T11) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I11-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

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



Non-AUM Target Site Boundary

Related Survey Area

Access Route - Vehicular

Drainage*

100 ft Contour**

20 ft Contour**

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

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NON-AUM TARGET CT-02 (T11) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I11-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.2.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I11-3) within the survey area of the non-AUM Target T11 as part of the Baseline Study in April 2018. No Goback gamma radiation surveys were performed at Target T11. Tetra Tech also performed an XRF field survey at non-AUM Target T11 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I11-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 3, of the RSE Work Plan (Tetra Tech 2018). Eight XRF survey units were not evaluated because of a paved road. All gamma survey units were evaluated.

6.2.3 XRF Confirmation Sampling Overview

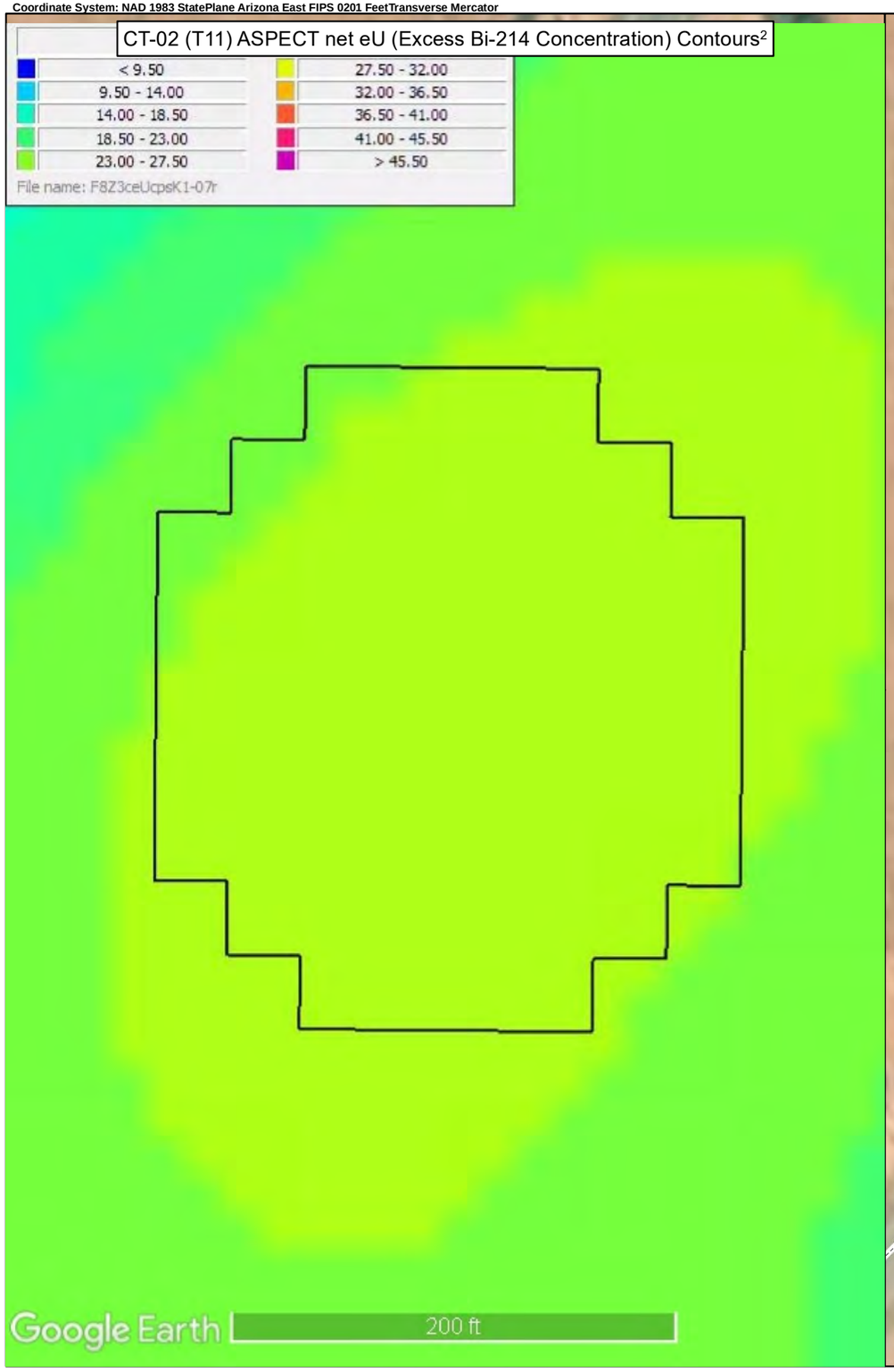
Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T11. Three XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from three locations (Table I11-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I11-4 and I11-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I11-2. The results of XRF confirmation sample analysis are provided in Section 6.2.6.1. Correlated XRF field measurements are provided in Attachment I3.

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

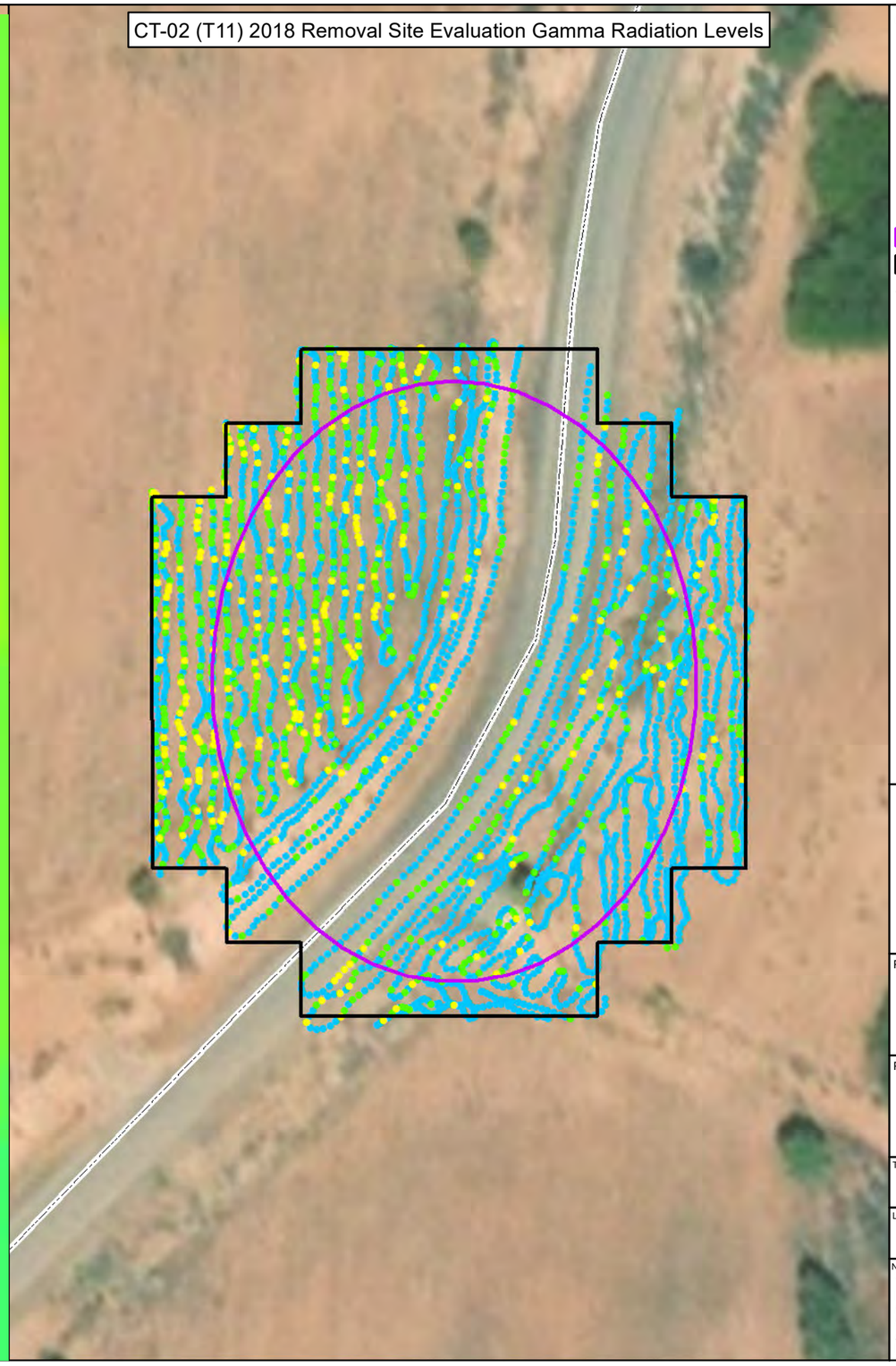
CT-02 (T11) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F8Z3ceUcpsK1-07r



CT-02 (T11) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)[1]

≤ 10,289	≤ Avg. BG
10,289 - 11,019	Avg. BG - 1 x BTV
11,019 - 22,038	1 x BTV - 2 x BTV
22,038 - 33,057	2 x BTV - 3 x BTV
33,057 - 44,076	3 x BTV - 4 x BTV
44,076 - 110,190	4 x BTV - 10 x BTV
≥ 110,190	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Vehicular

[1]The applied gamma background threshold value (BTV) for CT-02 (T11) Non-AUM Target is 11,019 cpm derived from BSAs within the T_{RC} formation as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET CT-02 (T11)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

Prepared By:

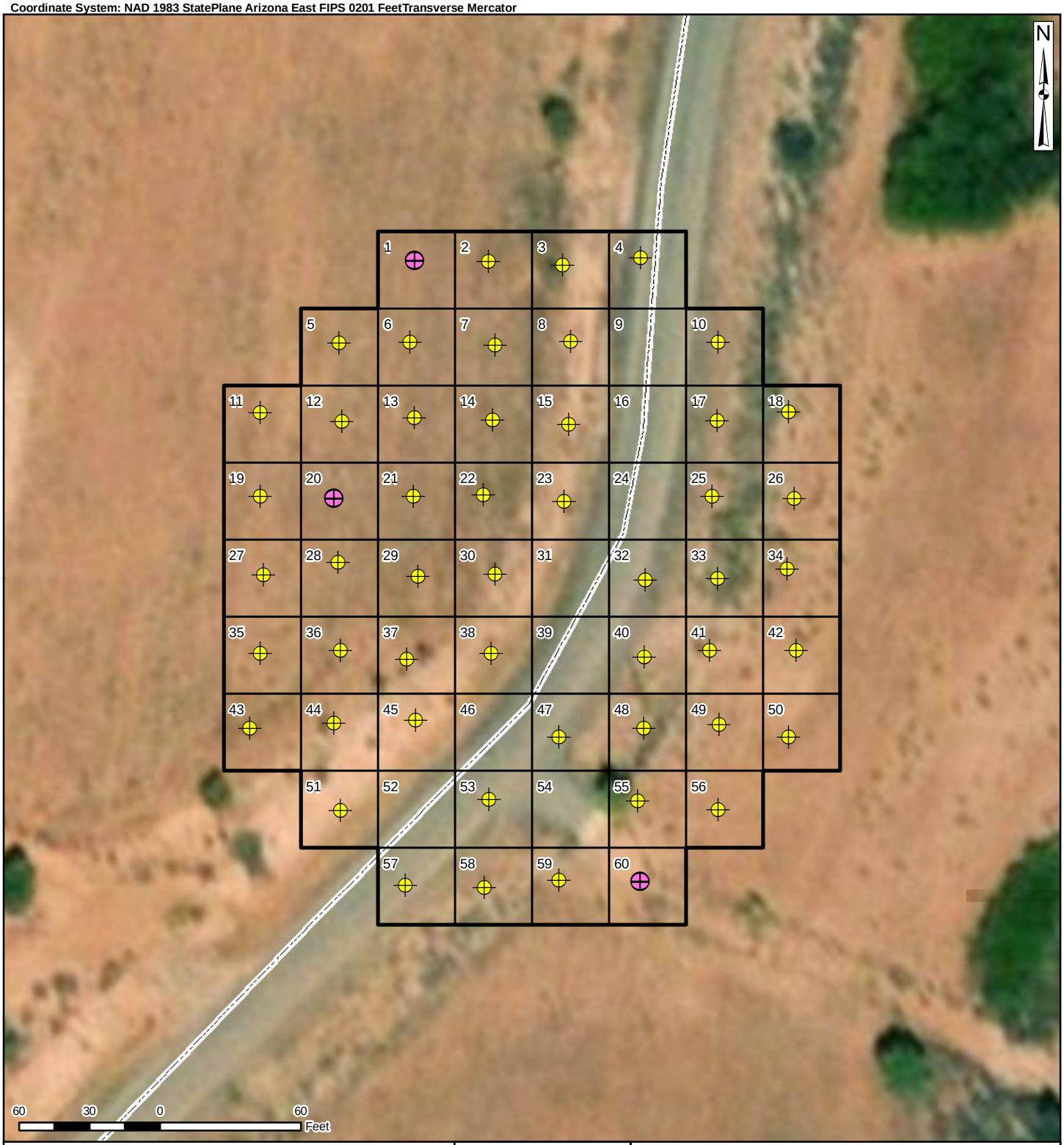
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TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/12/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborn Spectral Photometric Environmental Collection Technology.

Figure No.: **I11-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

Prepared for: USEPA Region 9

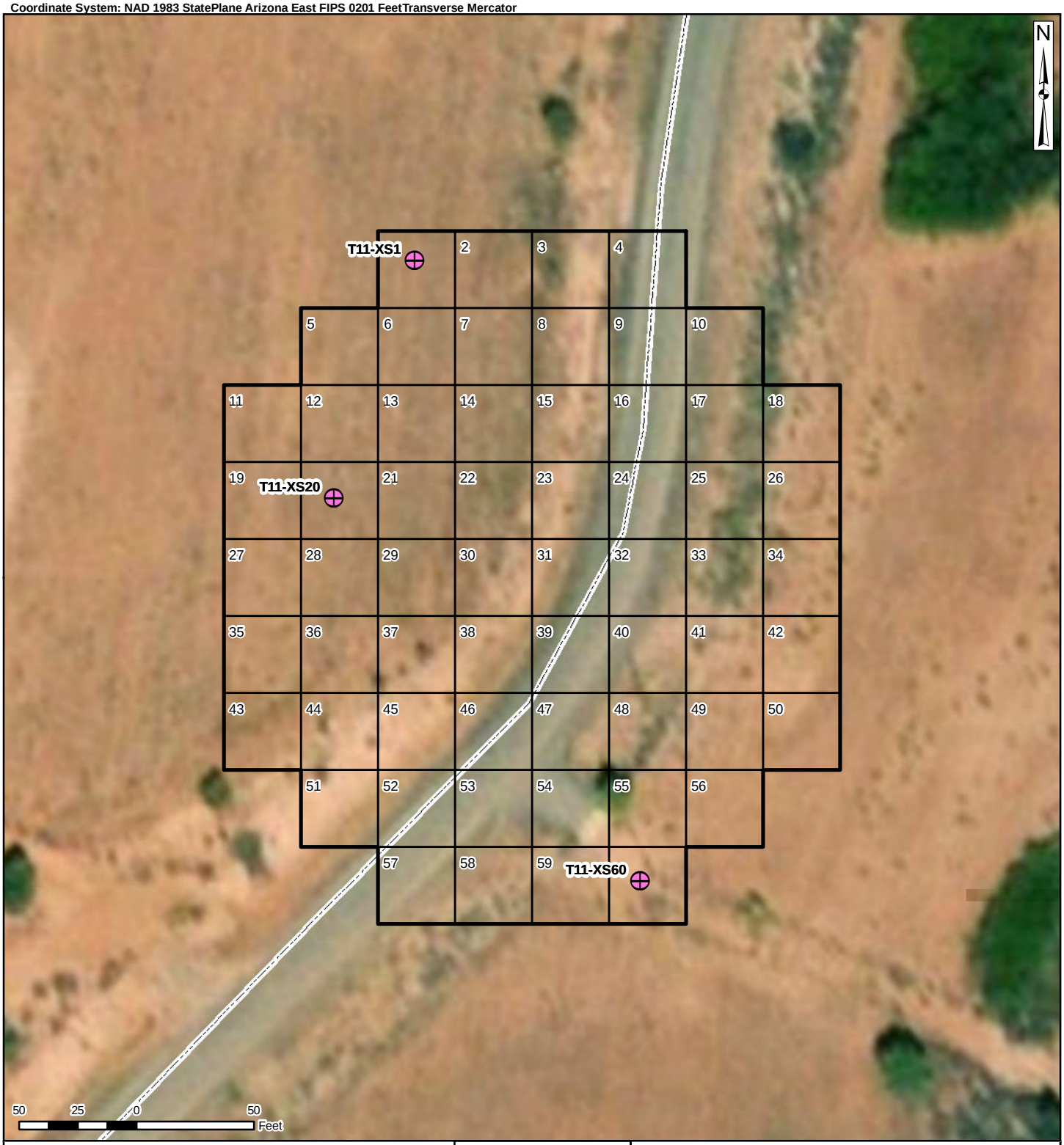
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NON-AUM TARGET CT-02 (T11)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I11-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

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



XRF Confirmation Soil Sample* (0 - 3 inches bgs)

Survey Grid Unit (100 m²)

Survey Area Boundary

Access Route (Vehicular)

*T11-XS1 = site T11 XRF confirmation soil sample collected at survey unit 1. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET CT-02 (T11)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I11-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

Table I11-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target CT-02 (T11)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T11-XS1-01-042518	1	0-3	XRF Confirmation	Primary	4/25/2018	36.5551517	-109.2240373	1805035-6, 1805036-6
T11-XS20-01-042518	20	0-3	XRF Confirmation	Primary	4/25/2018	36.5548746	-109.2241575	1805035-7, 1805036-7
T11-XS60-01-042518	60	0-3	XRF Confirmation	Primary	4/25/2018	36.5544231	-109.2237192	1805035-8, 1805036-8

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I11-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target CT-02 (T11)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

6.2.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 6.2.1, Target T11 surface geology is entirely within Trc with soils within the Blanding very fine sandy loams (MUSYM 312) (Figures I-17 and I-18). As a result, BSA-7 was selected for that combination of geology and soil type. Additionally, the Trc regional geological background would also be applicable for this Target. Table I11-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T11. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T11. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T11. The "Applied BTV" for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I11-3. Applied Background Threshold Values for Non-AUM Target CT-02 (T11)

Analyte	Units	Site-Specific BTV (BSA-7)	Regional BTV (Trc)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	8,470	9,734	8,470	Site-Specific BTV
Antimony	mg/kg	0.170	0.190	0.170	Site-Specific BTV
Arsenic	mg/kg	2.6	3.0	2.6	Site-Specific BTV
Barium	mg/kg	150	150	150	Regional BTV
Beryllium	mg/kg	0.51	0.54	0.51	Site-Specific BTV
Cadmium	mg/kg	0.160	0.257	0.160	Site-Specific BTV
Calcium	mg/kg	9,900	9,900	9,900	Regional BTV
Chromium	mg/kg	9.0	9.7	9.0	Site-Specific BTV
Cobalt	mg/kg	4.5	4.6	4.5	Site-Specific BTV
Copper	mg/kg	8.5	15	8.5	Site-Specific BTV
Iron	mg/kg	9,830	9,965	9,830	Site-Specific BTV
Lead	mg/kg	11	12	11	Site-Specific BTV
Lithium	mg/kg	8.5	9.7	8.5	Site-Specific BTV
Magnesium	mg/kg	3,600	3,600	3,600	Regional BTV
Manganese	mg/kg	396	380	380	Regional BTV
Mercury	mg/kg	0.0276	0.0260	0.0260	Regional BTV
Molybdenum	mg/kg	0.23	0.45	0.23	Site-Specific BTV
Nickel	mg/kg	8.7	9.2	8.7	Site-Specific BTV
Potassium-40	pCi/g	21.3	21.8	21.3	Site-Specific BTV
Radium-226	pCi/g	2.82	2.49	2.49	Regional BTV
Radium-228	pCi/g	0.84	0.76	0.76	Regional BTV
Selenium	mg/kg	0.95	1.0	0.95	Site-Specific BTV
Silver	mg/kg	0.029	0.039	0.029	Site-Specific BTV
Sodium	mg/kg	68	51	51	Regional BTV
Thallium	mg/kg	0.086	0.092	0.086	Site-Specific BTV
Thorium	mg/kg	4.7	4.8	4.7	Site-Specific BTV
Uranium	mg/kg	2.1	1.7	1.7	Regional BTV
Vanadium	mg/kg	20	19	19	Regional BTV
Zinc	mg/kg	33	37	33	Site-Specific BTV
Gamma Radiation	cpm	11,994	11,019	11,019	Regional BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
mg/kg milligrams per kilogram
pCi/g picocuries per gram
Trc Chinle Formation

6.2.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T11 and the raw gamma radiation and grid averaged gamma radiation survey results.

6.2.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T11 in April 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine if any additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. No additional scanning, measurements, or sampling were required. A gamma radiation survey was also performed in the Cove Wash Middle drainage within the area in conjunction with the RSE for the Cove Transfer Station; results are presented in Appendix J of the RSE Report. The applied gamma BTV for non-AUM Target T11 is 11,019 cpm. A total of 3,230 measurements were collected as part of the gamma radiation survey at non-AUM Target T11 across 60 survey units. An average scan density of 54 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I11-4.

Table I11-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target CT-02 (T11)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,019	
Measurements	#	3,230	60
Minimum	cpm	6,974	8,987
Maximum	cpm	13,815	10,531
Average	cpm	9,858	9,841
Median	cpm	9,817	9,836
Standard Deviation	cpm	834	356
90th Percentile	cpm	10,929	10,273
95th Percentile	cpm	11,265	10,353
99th Percentile	cpm	11,973	10,526
Measurements per Survey Unit	#/grid	54	
Measurements Above Gamma BTV	#	268	0
Measurements Above Gamma BTV	%	8.3	0.0

Notes:
BTV background threshold value
cpm counts per minute

6.2.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 8.3 percent of the measurements within the Target boundaries, in some cases exceeding the applied gamma BTV (11,019 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the Trc regional gamma survey results is provided on Figure I11-6. This graph shows that the spread of radiation data at Target T11 (shown on left) begins slightly below the lower range of Trc regional gamma levels (shown on right) and then rises above the BTV in some locations but remains within the range of the background data set. This individual value plot shows that the majority and largest amount of radiation data collected from Target T11 is slightly lower than the data cloud from the Trc regional data set. A box plot showing the quartiles of the data sets is provided in Figure I11-7. The box plot shows that the median of Target T11 radiation levels is lower than the median of the Trc regional data set and lower than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I11-8. No mining activity was observed within the survey area of Target T11. In general, Target T11 has surficial gamma radiation levels below Trc regional levels across the majority of the Target and surrounding area, indicating that the survey did not identify the area of potential elevated gamma activity identified by the ASPECT gamma survey (Figure I11-3). No TENORM or mining-related activities were observed. Section 6.2.5.3 presents the grid averaged results of the gamma radiation survey.

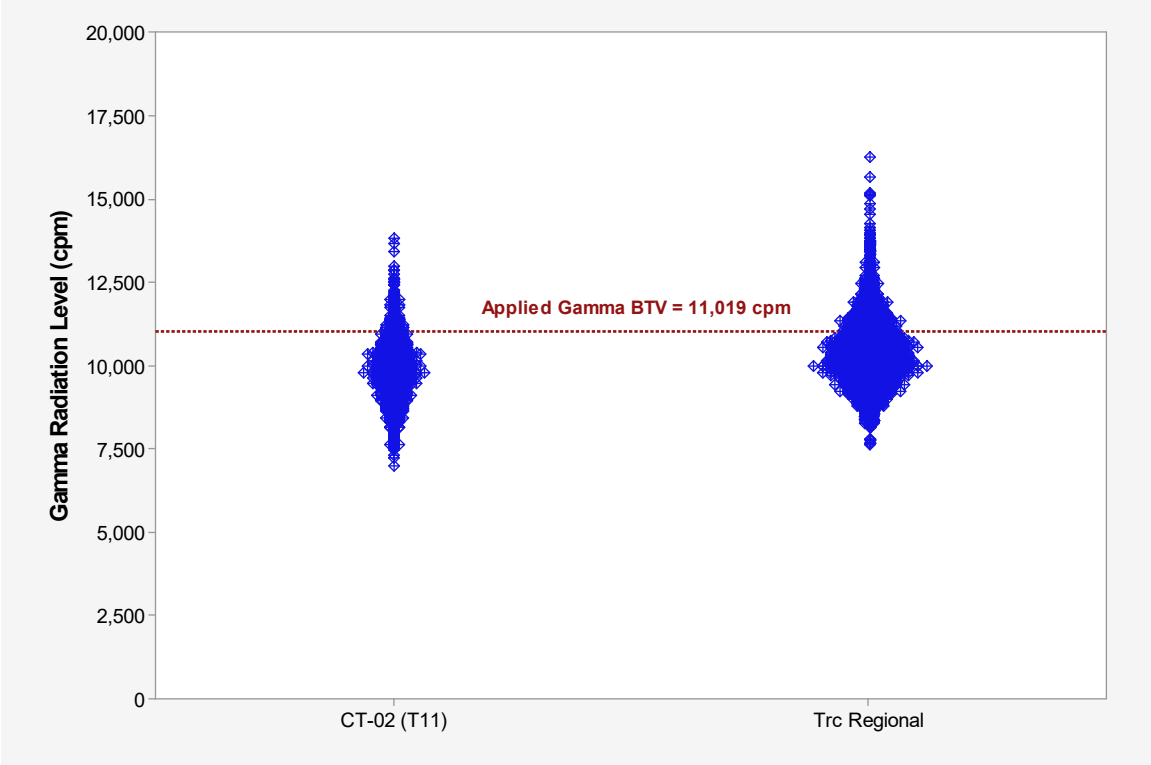


Figure I11-6. Individual Value Plot of Raw Gamma Radiation Levels at Target CT-02 (T11) and Trc Regional

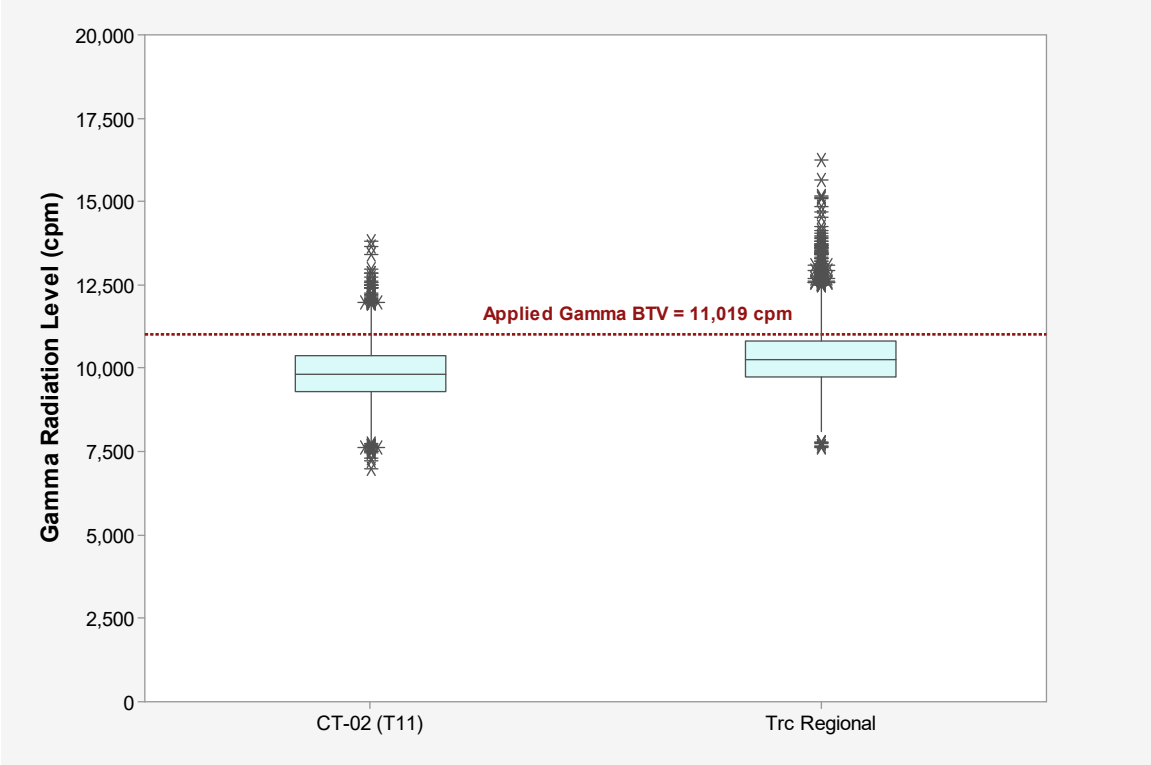
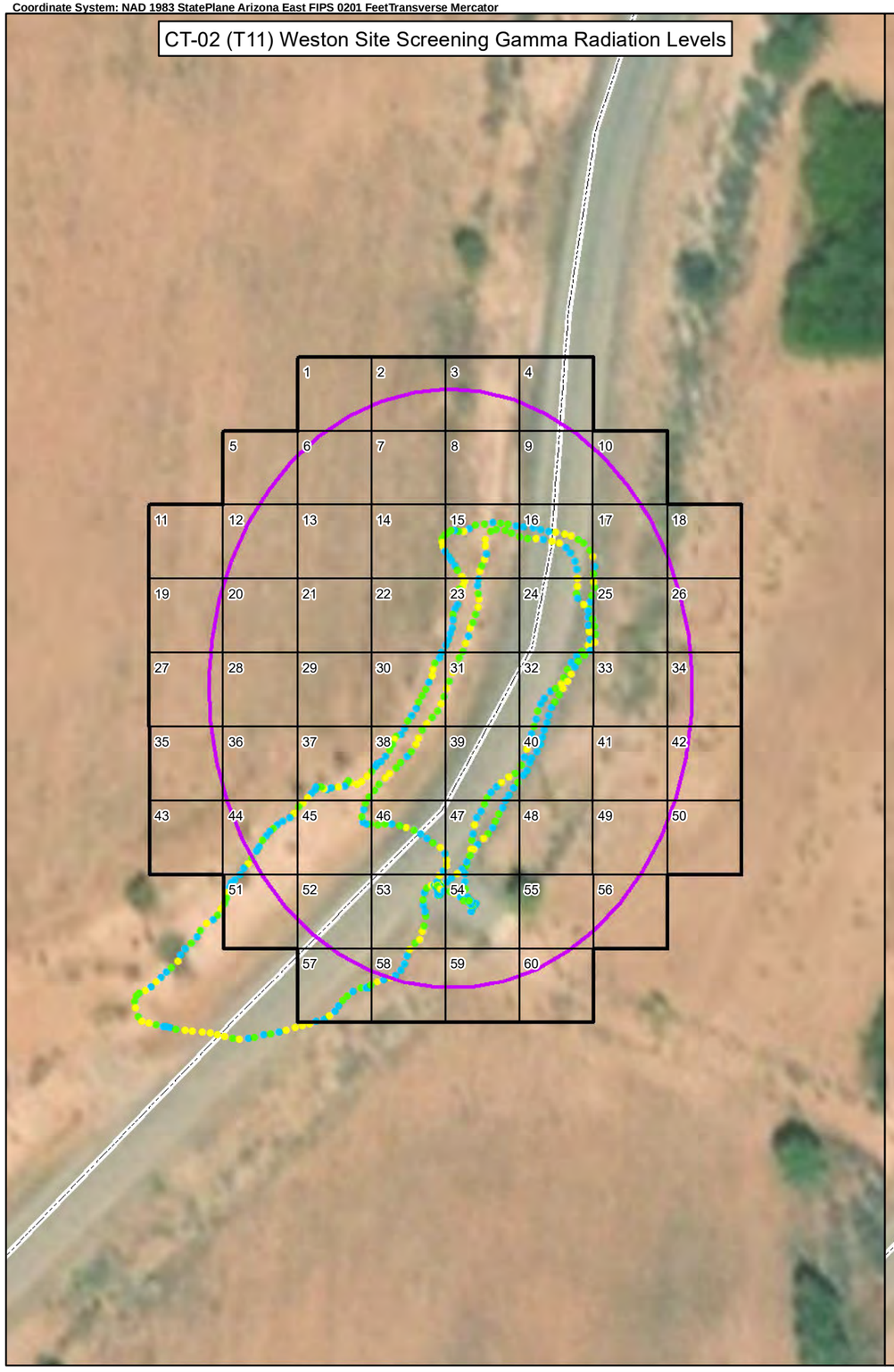
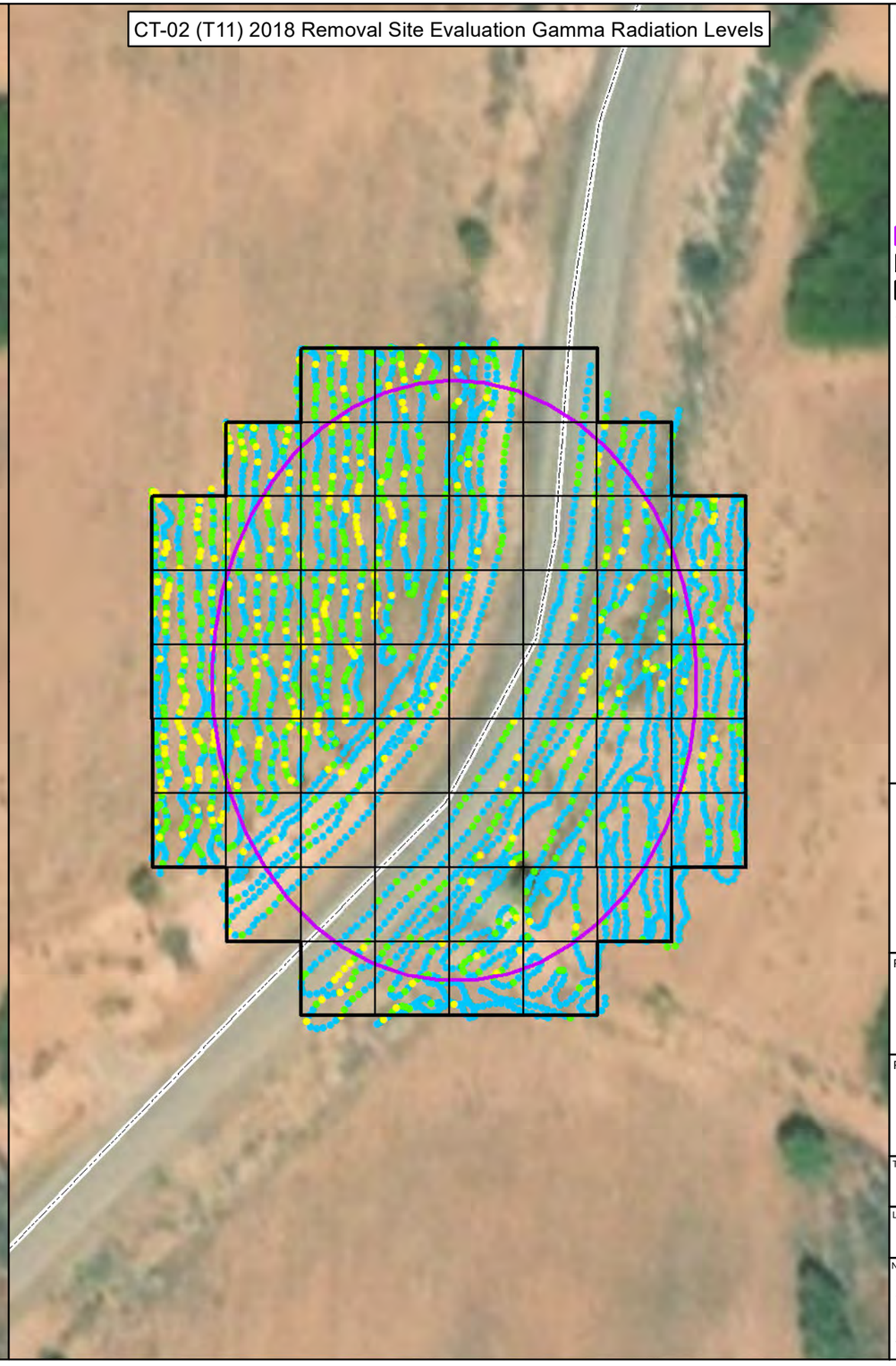


Figure I11-7. Box Plot of Raw Gamma Radiation Levels at Target CT-02 (T11) and Trc Regional

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





Gamma Reading (cpm)*

≤ 10,289	≤ Avg. BG
10,289 - 11,019	Avg. BG - 1 x BTV
11,019 - 22,038	1 x BTV - 2 x BTV
22,038 - 33,057	2 x BTV - 3 x BTV
33,057 - 44,076	3 x BTV - 4 x BTV
44,076 - 110,190	4 x BTV - 10 x BTV
≥ 110,190	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Access Route - Vehicular

1 in = 60 ft

1:720

N
W E
S

0 30 60 120 Feet

NON-AUM TARGET CT-02 (T11) SITE
2018 REMOVAL SITE EVALUATION
VS WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/12/2019

Notes:
*The applied gamma radiation background threshold value (BTV) for CT-02 (T11) is 11,019 cpm derived from gamma survey data for BSAs within the T_{RC} formation as presented in Appendix A.

Figure No.: **I11-8**

6.2.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 6.2.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 6.2.5.1. Figure I11-9 and Figure I11-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to Trc regional data set (shown on right). No survey units within the survey area of Target T11 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I11-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I11-11 as discussed further in Section 2.8. No survey units exceeded the gamma BTV.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 6.2.6.

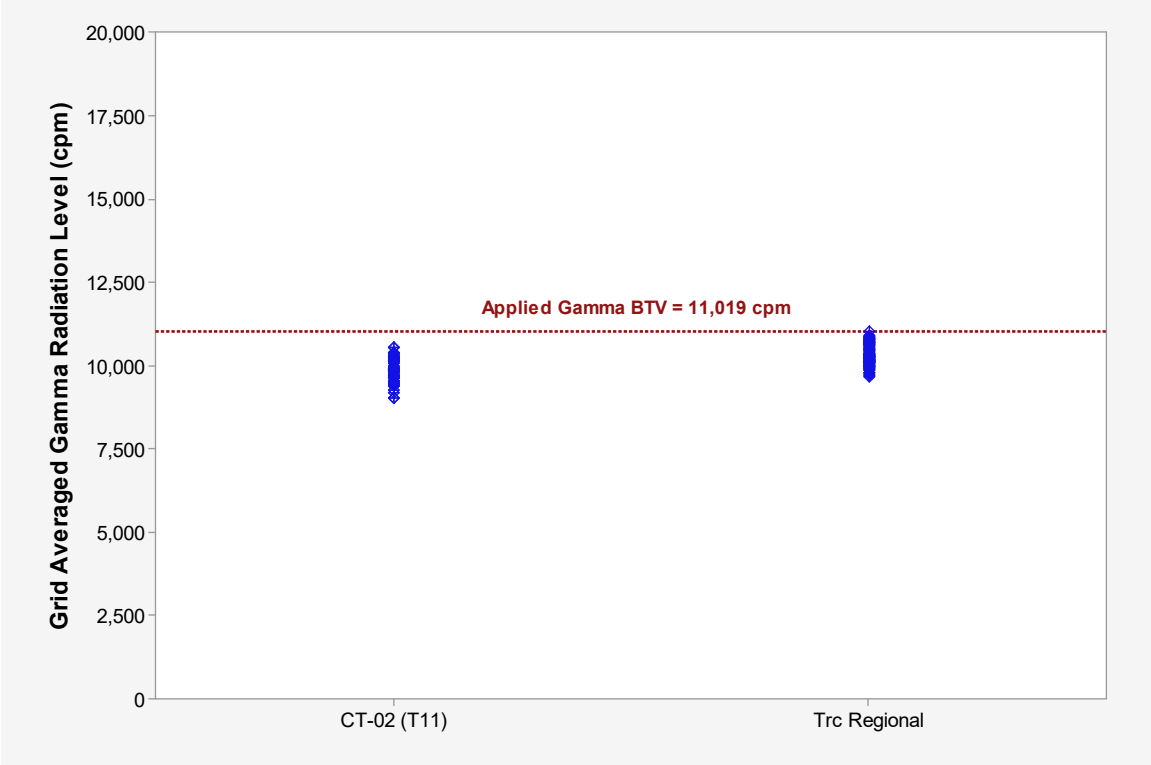


Figure I11-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target CT-02 (T11) and Trc Regional

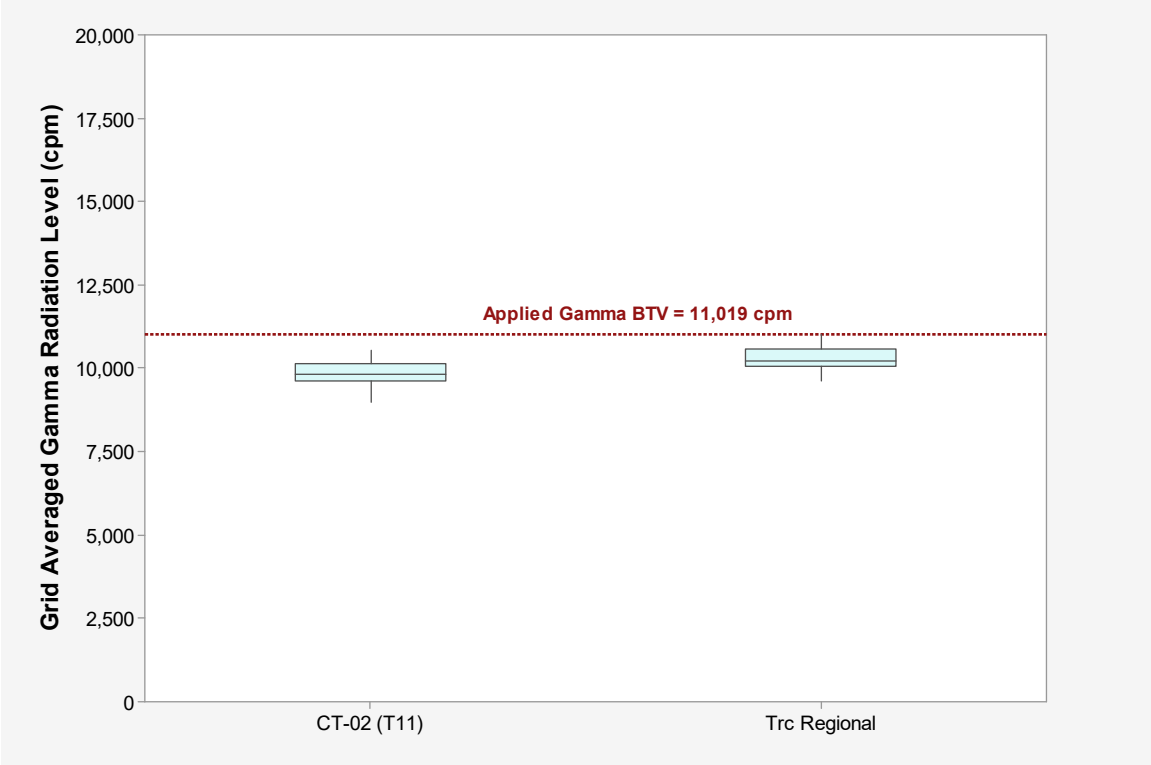
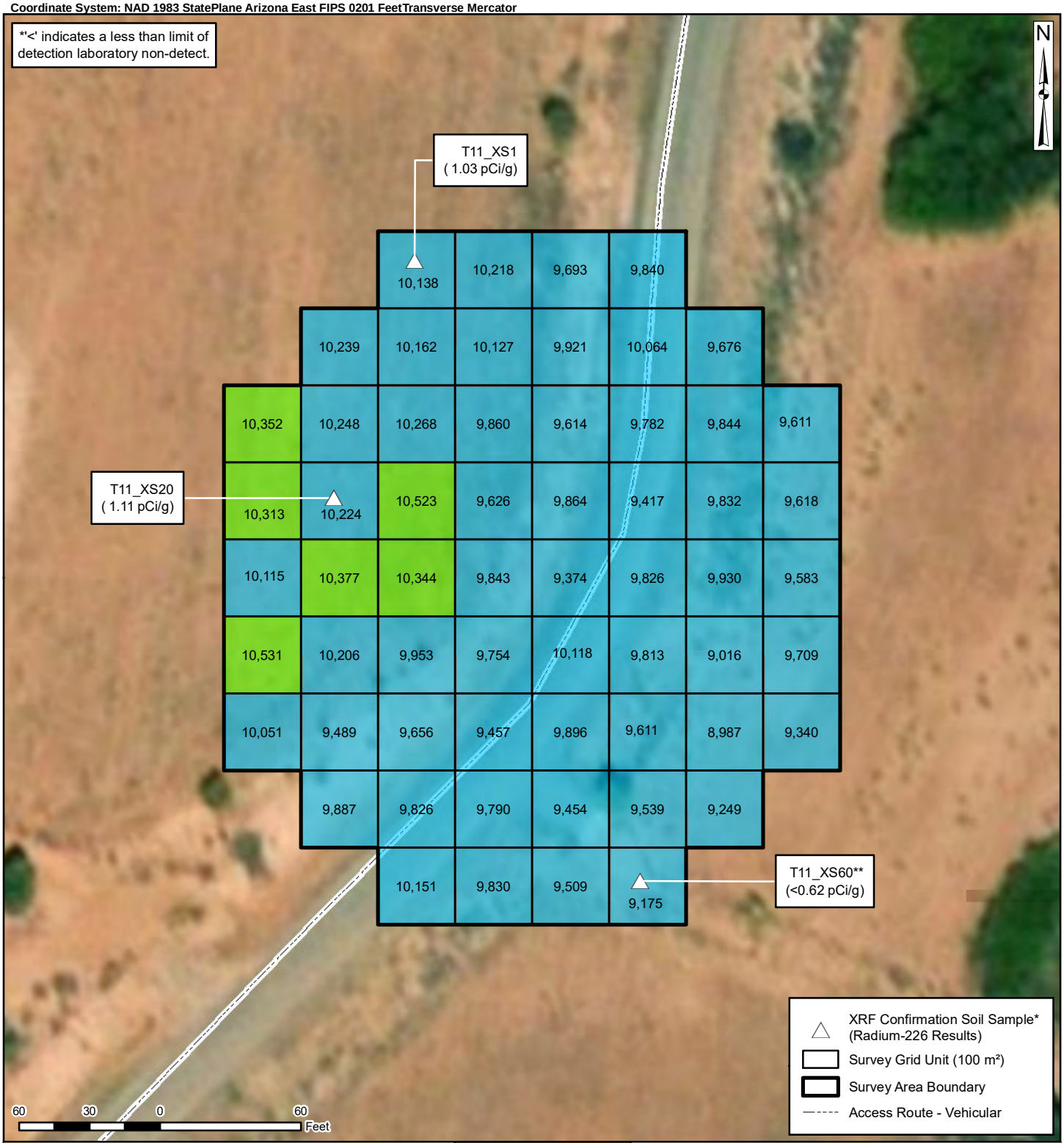


Figure I11-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target CT-02 (T11) and Trc Regional

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



Grid Averaged Gamma Reading (cpm)*

≤ 10,289	≤ Avg. BG
10,289 - 11,019	Avg. BG - 1 x BTV
11,019 - 22,038	1 x BTV - 2 x BTV
22,038 - 33,057	2 x BTV - 3 x BTV
33,057 - 44,076	3 x BTV - 4 x BTV
44,076 - 110,190	4 x BTV - 10 x BTV
≥ 110,190	≥ 10 x BTV

*The applied gamma radiation background threshold value (BTV) for CT-02 (T11) is 11,019 cpm derived from gamma survey data for BSAs within the T_{RC} formation as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET CT-02 (T11) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I11-11
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.2.6 Soil Sampling Results

This section presents the results of analyses for soil within the survey area of Target T11. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 6.2.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 6.2.6.2.

6.2.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T11: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I11-1 and I11-2. All the results of the XRF confirmation soil samples are presented in Table I11-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T11 following the methods outlined in Section 2.4 and shown in Figure I11-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 52 measurements were collected across 60 survey units from the survey area of Target T11 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I11-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T11 at a depth of 0 to 3 inches bgs. Three XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I11-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 6.2.7.

Table I11-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target CT-02 (T11)

Analyte	Units	Applied BTV	T11-XS1-01-042518		T11-XS20-01-042518		T11-XS60-01-042518	
			Result	Q	Result	Q	Result	Q
Survey Unit			X1		X20		X60	
Aluminum	mg/kg	8,470	4,900		4,800		2,900	
Antimony	mg/kg	0.170	0.11		0.11		0.055	J
Arsenic	mg/kg	2.6	1.8		1.8		1.2	
Barium	mg/kg	150	100		93		56	
Beryllium	mg/kg	0.51	0.39		0.38		0.23	
Cadmium	mg/kg	0.160	0.093	J	0.084	J	0.031	J
Calcium	mg/kg	9,900	3,200		3,700		4,700	
Chromium	mg/kg	9.0	4.9		4.8		2.8	
Cobalt	mg/kg	4.5	3.2		3		1.7	
Copper	mg/kg	8.5	6.4		6		2.6	
Iron	mg/kg	9,830	6,200		6,100		3,500	
Lead	mg/kg	11	6.3		6		3.2	
Lithium	mg/kg	8.5	6		6.1		4.1	
Magnesium	mg/kg	3,600	2,500		2,600		1,600	
Manganese	mg/kg	380	290		250		140	
Molybdenum	mg/kg	0.23	0.21		0.21		0.088	J
Nickel	mg/kg	8.7	5.6		5.4		2.9	
Potassium-40	pCi/g	21.3	14.9		16.2		12.7	
Radium-226	pCi/g	2.49	1.03		1.11		<0.62	UJ
Radium-228	pCi/g	0.76	<0.88	UJ	<0.64	UJ	<0.47	U
Selenium	mg/kg	0.95	0.66	J	0.65	J	0.42	J
Silver	mg/kg	0.029	0.019	J	0.018	J	0.026	J
Sodium	mg/kg	51	24	J	22	J	<95	U
Thallium	mg/kg	0.086	0.058		0.054		0.031	
Thorium	mg/kg	4.7	2.6		2.5		1.4	
Uranium	mg/kg	1.7	0.46		0.39		0.24	
Vanadium	mg/kg	19	11		10		7.2	
Zinc	mg/kg	33	17		16		11	

Notes:
BTV Background threshold value
ID Identification
J Estimated value
J- Estimated value, may be biased low
LT Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
M3 The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg Milligrams per kilogram
NA Not applicable
NV No Value
pCi/g Picocuries per gram
Q Qualification
U Not considered detected. The associated value is the method detection limit (MDL).
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

Table I11-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target CT-02 (T11)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.6	9,830	11	380	0.23	4.7	1.7	19	33
Measurements	#	52	52	52	52	52	52	52	52	52
Detects	#	28	52	52	51	2	52	44	5	52
Nondetects	#	24	0	0	1	50	0	8	47	0
Minimum	mg/kg	1.9	3,002	4.3	143.7	0.66	1.3	0.2	16.4	8.6
Maximum	mg/kg	6.7	7,945	13.3	409	0.78	5.5	4.5	22.2	40.0
Standard Deviation	mg/kg	0.9	1,232	1.5	60.3	0.09	0.9	0.9	2.4	5.3
Average	mg/kg	2.9	5,890	7.2	280.3	0.72	2.8	1.3	18.1	17.3
Median	mg/kg	2.7	5,623	6.9	276.5	0.72	2.9	1.3	16.8	17.4
Relative Standard Deviation	%	33.0	20.9	21.1	21.5	12.6	31.2	67.0	13.6	30.5
90th Percentile	mg/kg	3.6	7,627	9.1	366.5	0.77	3.9	2.2	20.7	22.6
95th Percentile	mg/kg	3.8	7,848	9.3	386.0	0.78	4.1	2.4	21.4	24.4
99th Percentile	mg/kg	6.0	7,936	11.3	401.9	0.78	5.2	3.8	22.0	33.0
Measurements Above Applied BTV	#	14	0	1	4	2	2	13	1	1
Measurements Above Applied BTV	%	26.9	0.0	1.9	7.7	3.8	3.8	25.0	1.9	1.9

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value
mg/kg Milligram per kilogram
XRF X-ray fluorescence

6.2.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T11 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T11 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T11. The estimated BTVs are identified in Section 6.2.4 and Table I11-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I11-7 presents a summary of the background comparison for different measurement and soil depths at Target T11. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T11. Further gamma radiation screening indicated that gamma levels at Target T11 are similar to those at BSA-7. Therefore, while arsenic, manganese, and uranium have been identified as COPCs at Target T11 based on a conservative comparison to background, risk screening may be required to support a future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

Table I11-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target CT-02 (T11)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic		✓	✓
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron			
Lead			
Lithium			
Magnesium			
Manganese		✓	✓
Molybdenum			
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium			
Silver			
Sodium			
Thallium			
Thorium			
Uranium		✓	✓
Vanadium			
Zinc			

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

6.2.7 Primary Contaminant Mapping

6.2.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 6.2.6.2 identified the COPCs at Target T11. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 6.2.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I11-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T11 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 6.2.7.1 through Section 6.2.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T11. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

6.2.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I11-7. Arsenic exceeded the applied BTV in 26.9 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for arsenic is 2.6 mg/kg for Target T11 as presented in Section 6.2.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I11-5 and Attachment I3, respectively. Figure I11-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T11 and Trc regional samples. Figure I11-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T11 and Trc regional samples. Summary statistics for XRF measurements are provided in Section 6.2.6.1. Arsenic XRF concentrations measured in surface soils at Target T11 ranged between 1.9 and 6.7 mg/kg with an average and standard deviation of 2.9 mg/kg and 0.9 mg/kg, respectively. The average arsenic XRF concentration is slightly above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T11 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I11-14. Overall, the majority of detectable arsenic results in surface soils were slightly below the applied BTV. However, the maximum value was 2.6 times higher than the applied BTV and does not appear to be associated with mining-related materials.

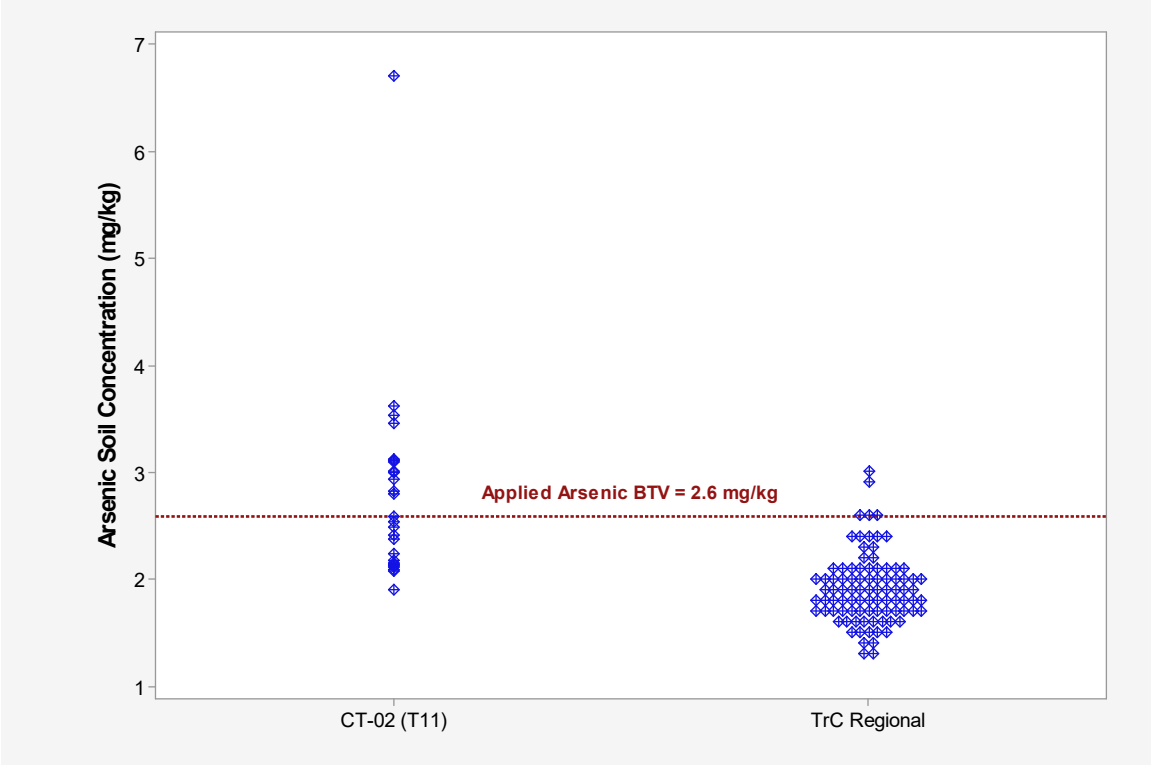


Figure I11-12. Individual Value Plot for Target CT-02 (T11) and Trc Regional Arsenic Soil Concentrations

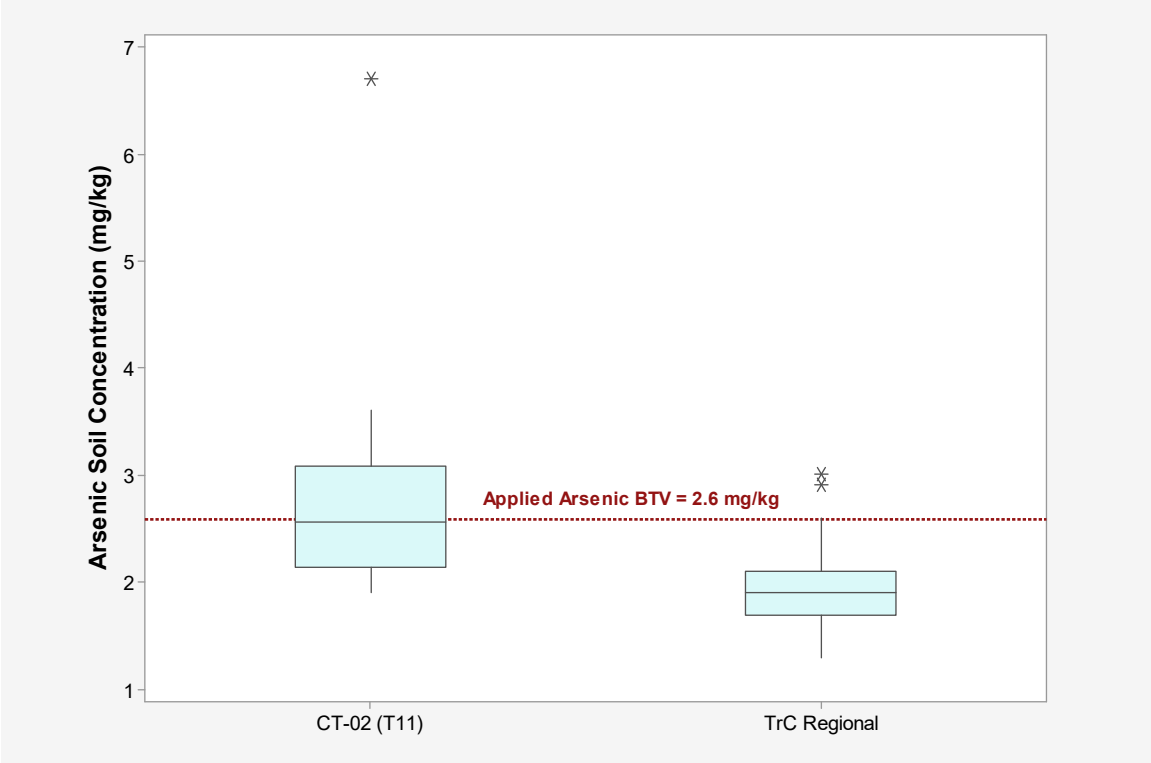
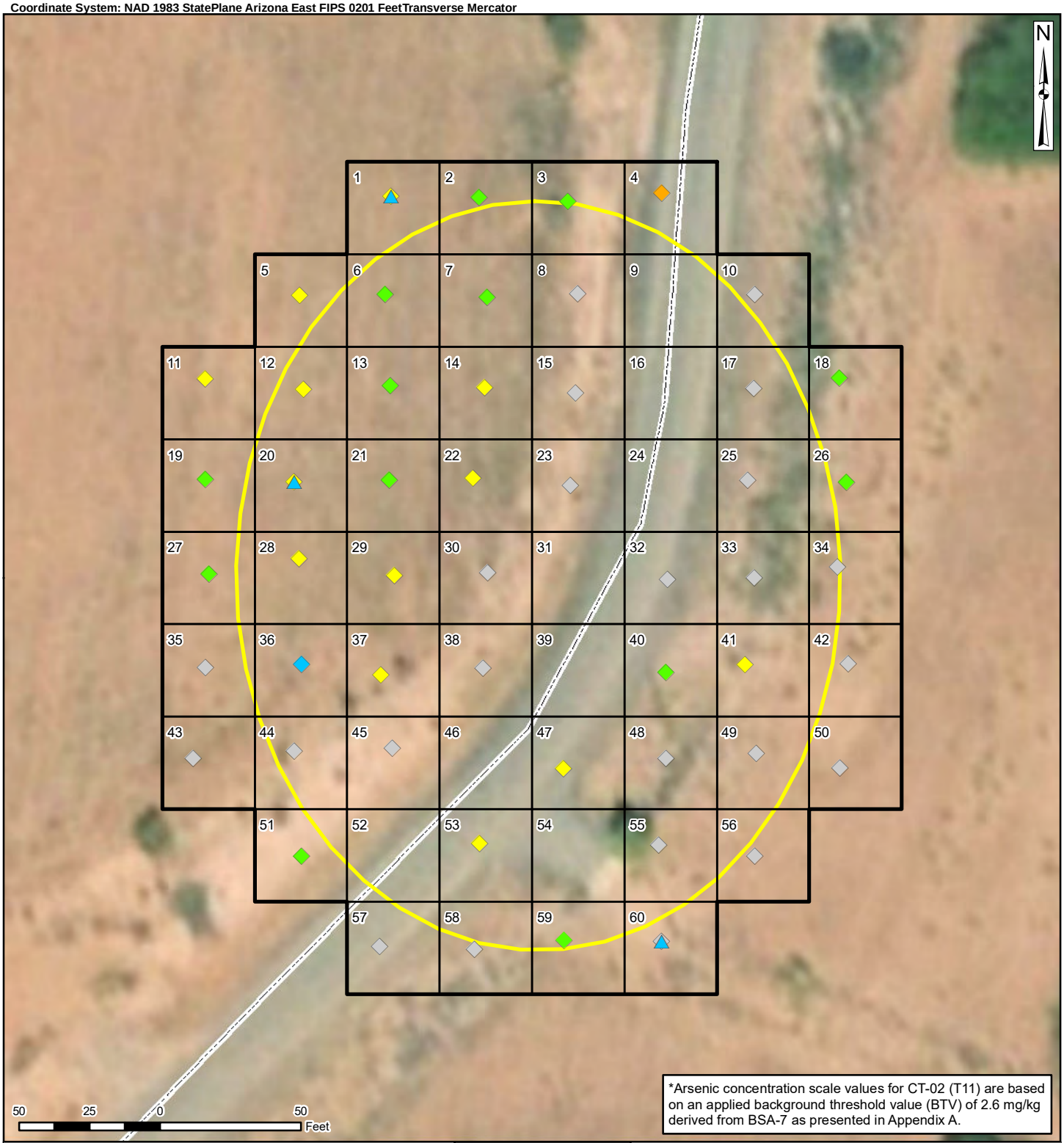


Figure I11-13. Box Plot for Target CT-02 (T11) and Trc Regional Arsenic Soil Concentrations

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



*Arsenic concentration scale values for CT-02 (T11) are based on an applied background threshold value (BTV) of 2.6 mg/kg derived from BSA-7 as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 2.0
- 2.0 - 2.6
- 2.6 - 5.2
- 5.2 - 7.8
- 7.8 - 10
- 10 - 26
- ≥ 26
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET CT-02 (T11) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I11-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.2.7.3 Lead

Lead was not identified as a COPC in surface soil as shown in Table I11-7. Lead exceeded the applied BTV in 1.9 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for lead is 11 mg/kg for Target T11 as presented in Section 6.2.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I11-5 and Attachment I3, respectively. Figure I11-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T11 and BSA-7 (Trc) samples. Figure I11-16 presents a box plot of detectable lead XRF soil concentrations for Target T11 and BSA-7 (Trc) samples. Summary statistics for XRF measurements are provided in Section 6.2.6.1. Lead XRF concentrations measured in surface soils at Target T11 ranged between 4.3 and 13.3 mg/kg with an average and standard deviation of 7.2 mg/kg and 1.5 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T11 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I11-17. Overall, the majority of detectable lead results in surface soils were less than the applied BTV. One exceedance was not significantly higher than the applied BTV and does not appear to be associated with mining-related materials at Target T11.

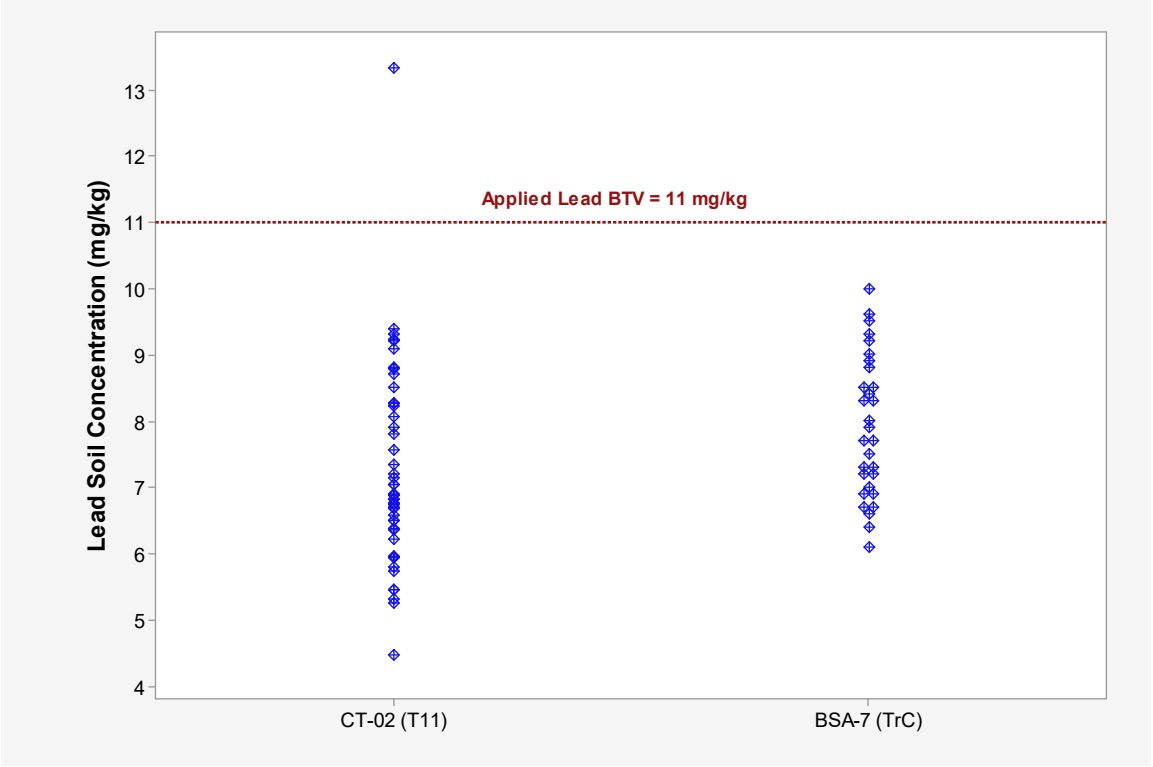


Figure I11-15. Individual Value Plot for Target CT-02 (T11) and BSA-7 (Trc) Lead Soil Concentrations

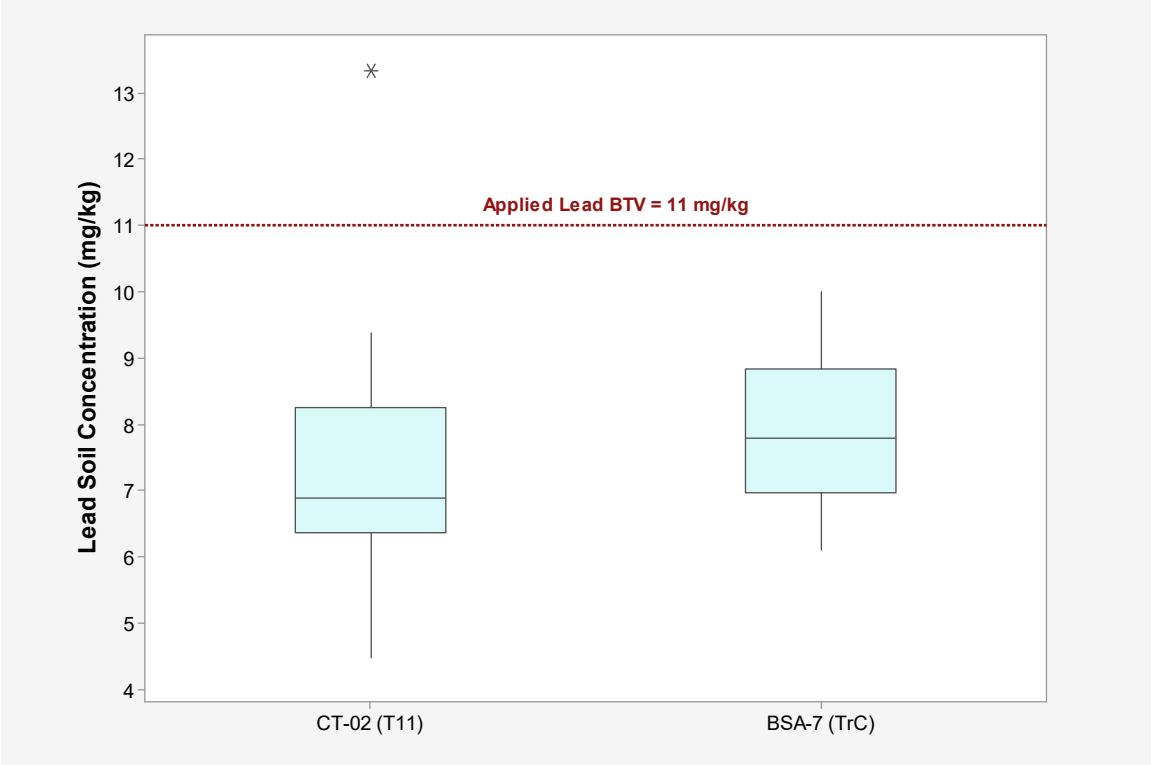
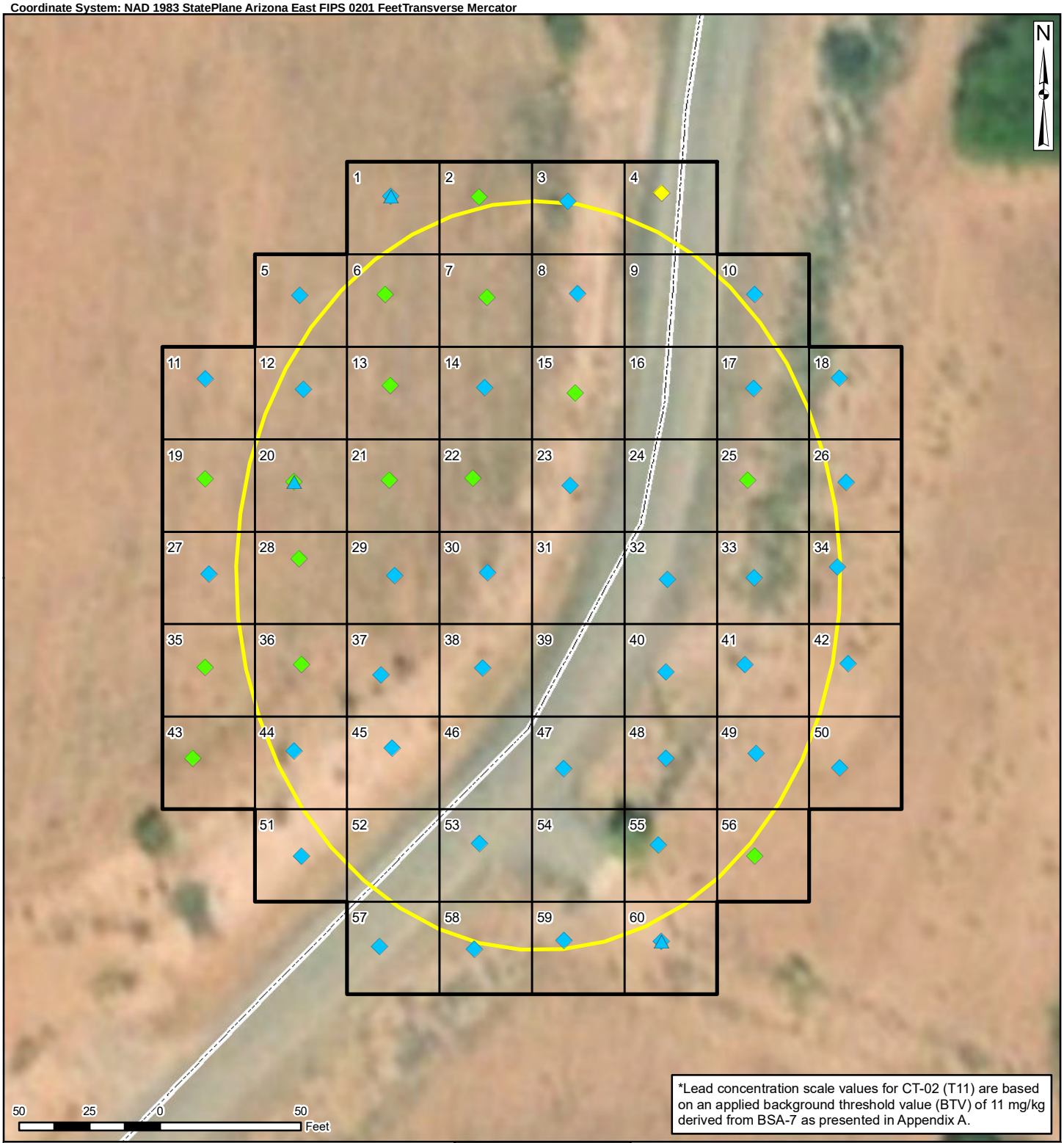


Figure I11-16. Box Plot for Target CT-02 (T11) and BSA-7 (Trc) Lead Soil Concentrations

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



*Lead concentration scale values for CT-02 (T11) are based on an applied background threshold value (BTV) of 11 mg/kg derived from BSA-7 as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 7.9
- 7.9 - 11
- 11 - 22
- 22 - 33
- 33 - 44
- 44 - 110
- ≥ 110

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET CT-02 (T11) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I11-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.2.7.4 Thorium

Thorium was not identified as a COPC in surface soil as shown in Table I11-7. Thorium exceeded the applied BTV in 3.8 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for thorium is 4.7 mg/kg for Target T11 as presented in Section 6.2.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I11-5 and Attachment I3, respectively. Figure I11-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T11 and BSA-7 (Trc) samples. Figure I11-19 presents a box plot of detectable thorium XRF soil concentrations for Target T11 and BSA-7 (Trc) samples. Summary statistics for XRF measurements are provided in Section 6.2.6.1. Thorium XRF concentrations measured in surface soils at Target T11 ranged between 1.3 and 5.5 mg/kg with an average and standard deviation of 2.8 mg/kg and 0.9 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T11 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I11-20. Overall, the majority of detectable thorium results in surface soils were less than the applied BTV. Exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T11.

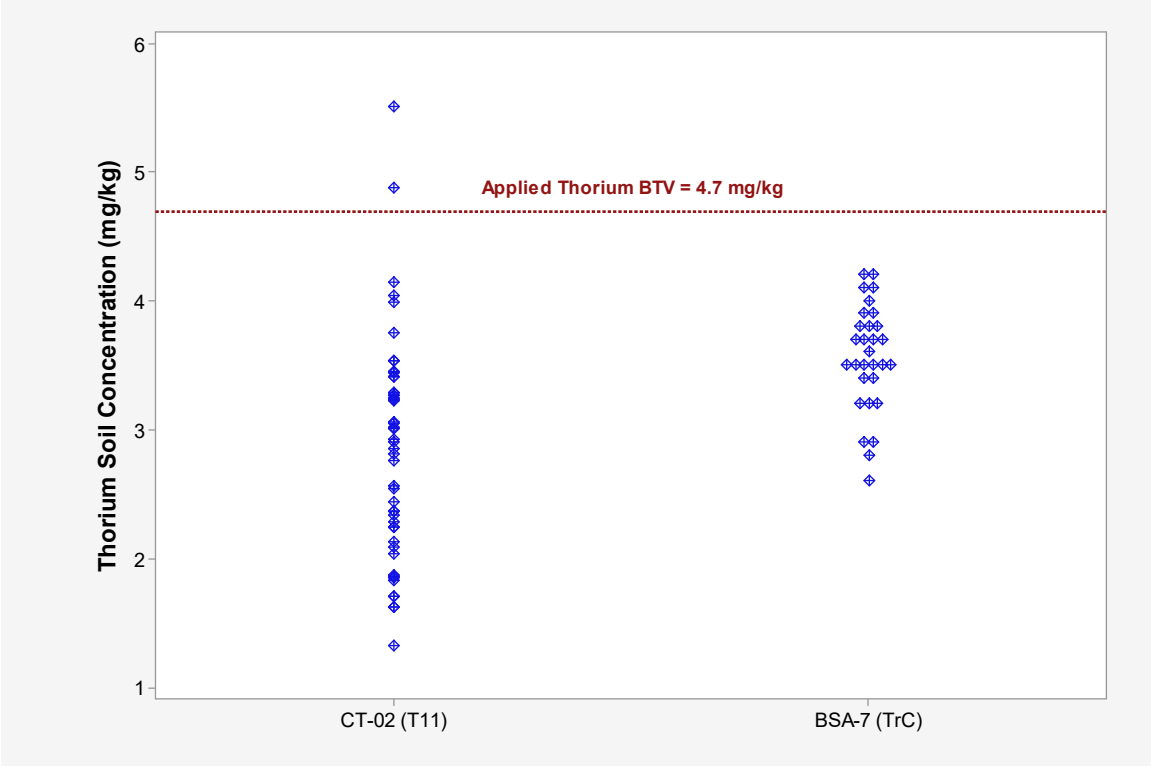


Figure I11-18. Individual Value Plot for Target CT-02 (T11) and BSA-7 (Trc) Thorium Soil Concentrations

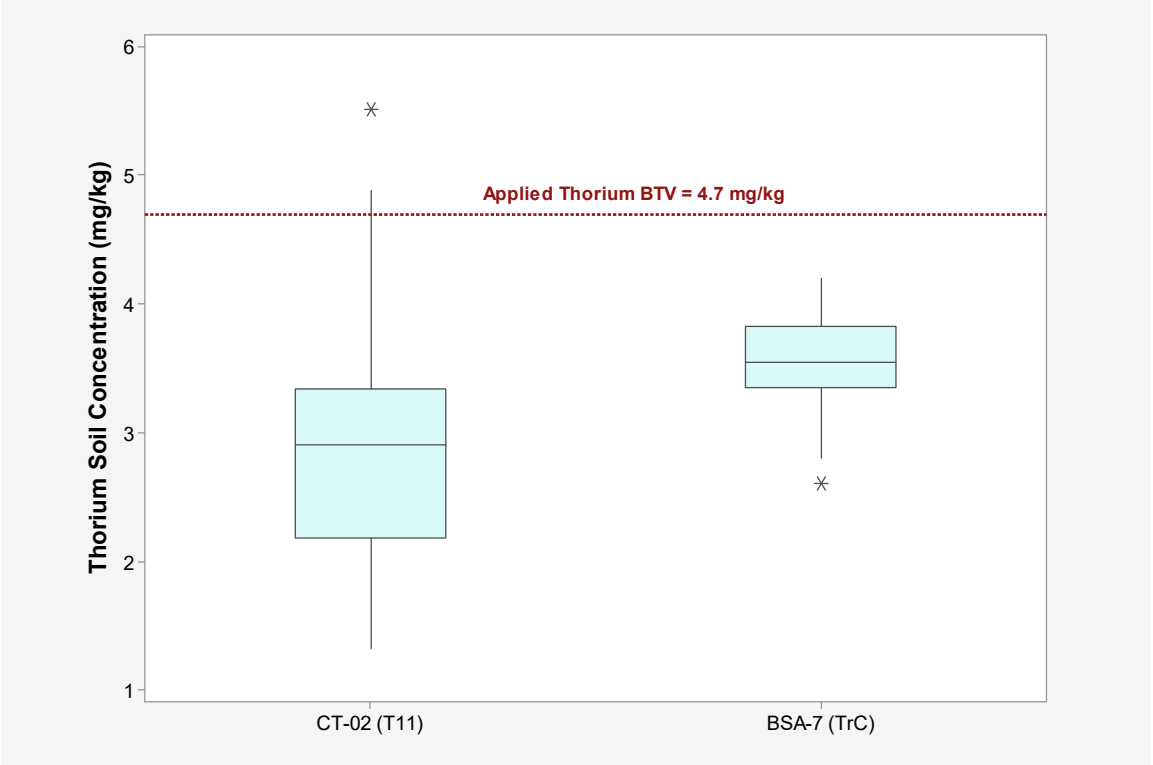
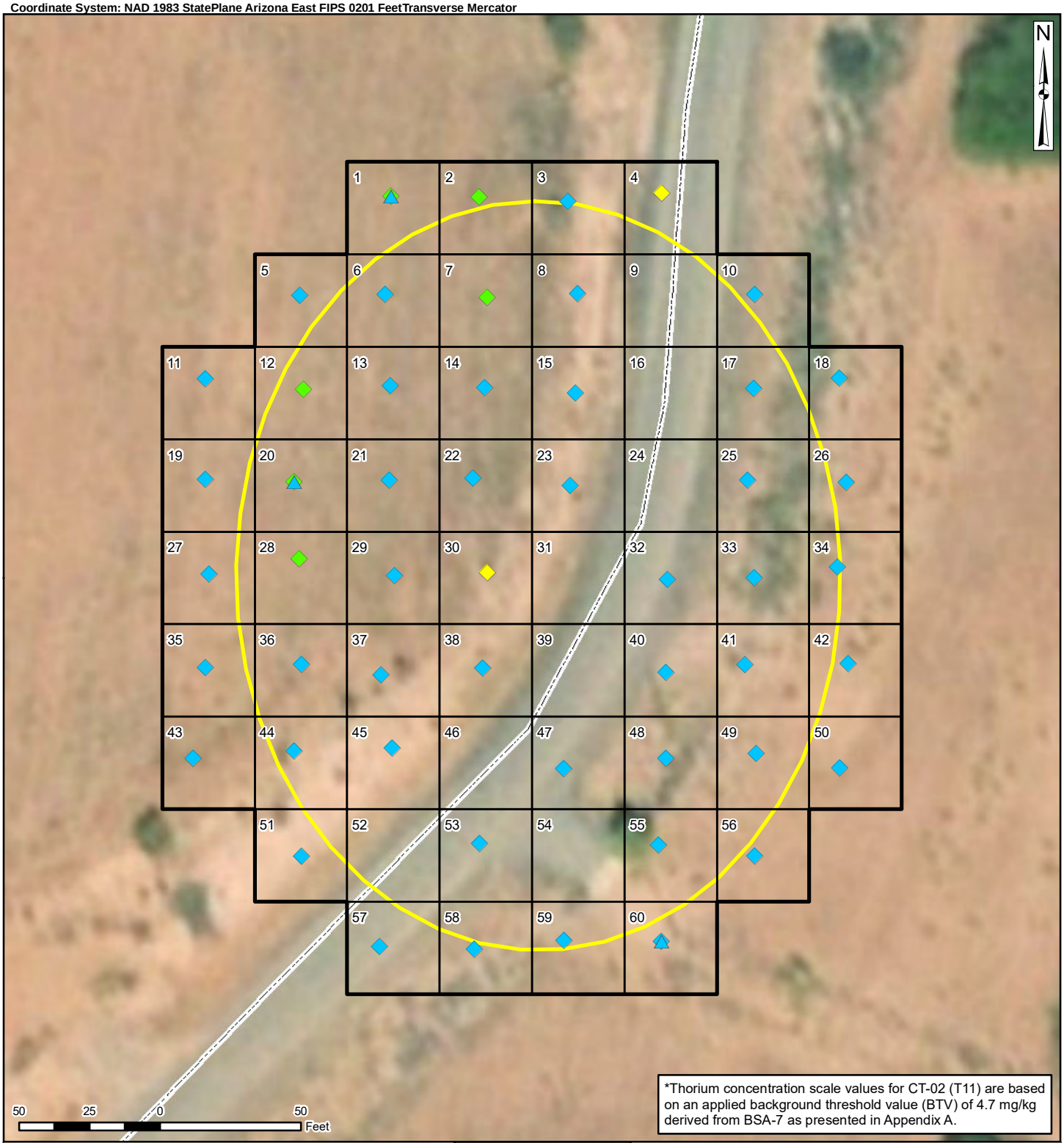


Figure I11-19. Box Plot for Target CT-02 (T11) and BSA-7 (Trc) Thorium Soil Concentrations

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



*Thorium concentration scale values for CT-02 (T11) are based on an applied background threshold value (BTV) of 4.7 mg/kg derived from BSA-7 as presented in Appendix A.

Thorium Concentration Scale (mg/kg)*

- ≤ 3.6
- 3.6 - 4.7
- 4.7 - 9.4
- 9.4 - 14
- 14 - 19
- 19 - 47
- ≥ 47

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET CT-02 (T11) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I11-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.2.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I11-7. Uranium exceeded the applied BTV in 25 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for uranium is 1.7 mg/kg for Target T11 as presented in Section 6.2.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I11-5 and Attachment I3, respectively. Figure I11-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T11 and Trc regional samples. Figure I11-22 presents a box plot of detectable uranium XRF soil concentrations for Target T11 and Trc regional samples. Summary statistics for XRF measurements are provided in Section 6.2.6.1. Uranium XRF concentrations measured in surface soils at Target T11 ranged between 0.2 and 4.5 mg/kg with an average and standard deviation of 1.3 mg/kg and 0.9 mg/kg, respectively. The average uranium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T11 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I11-23. Overall, the majority of detectable uranium results in surface soils were less than the applied BTV. However, the maximum value was 2.6 times higher than the applied BTV and does not appear to be associated with mining-related materials.

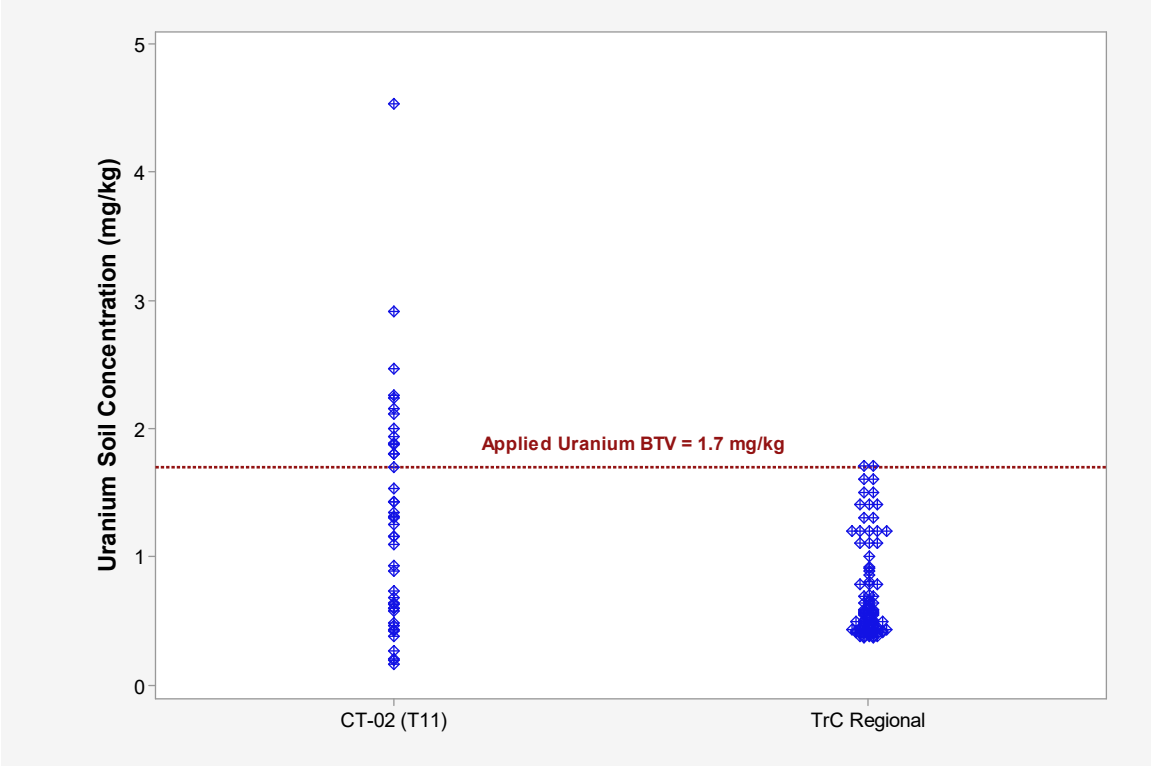


Figure I11-21. Individual Value Plot for Target CT-02 (T11) and Trc Regional Uranium Soil Concentrations

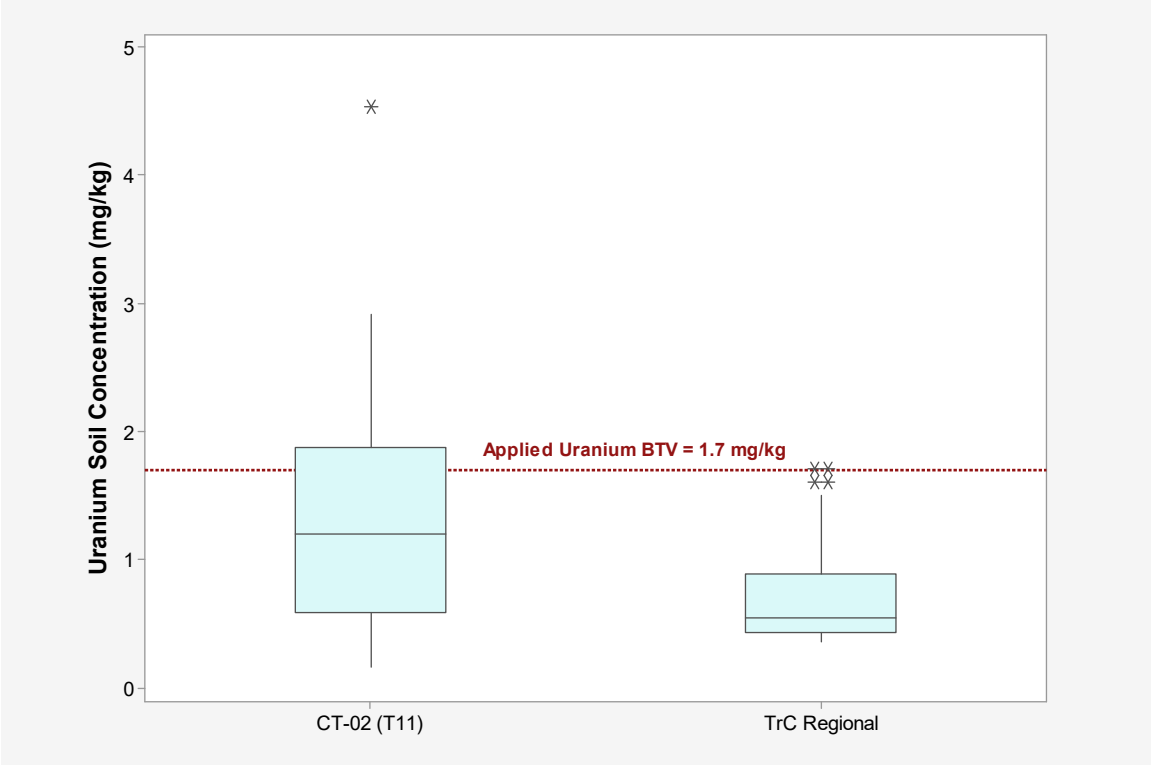
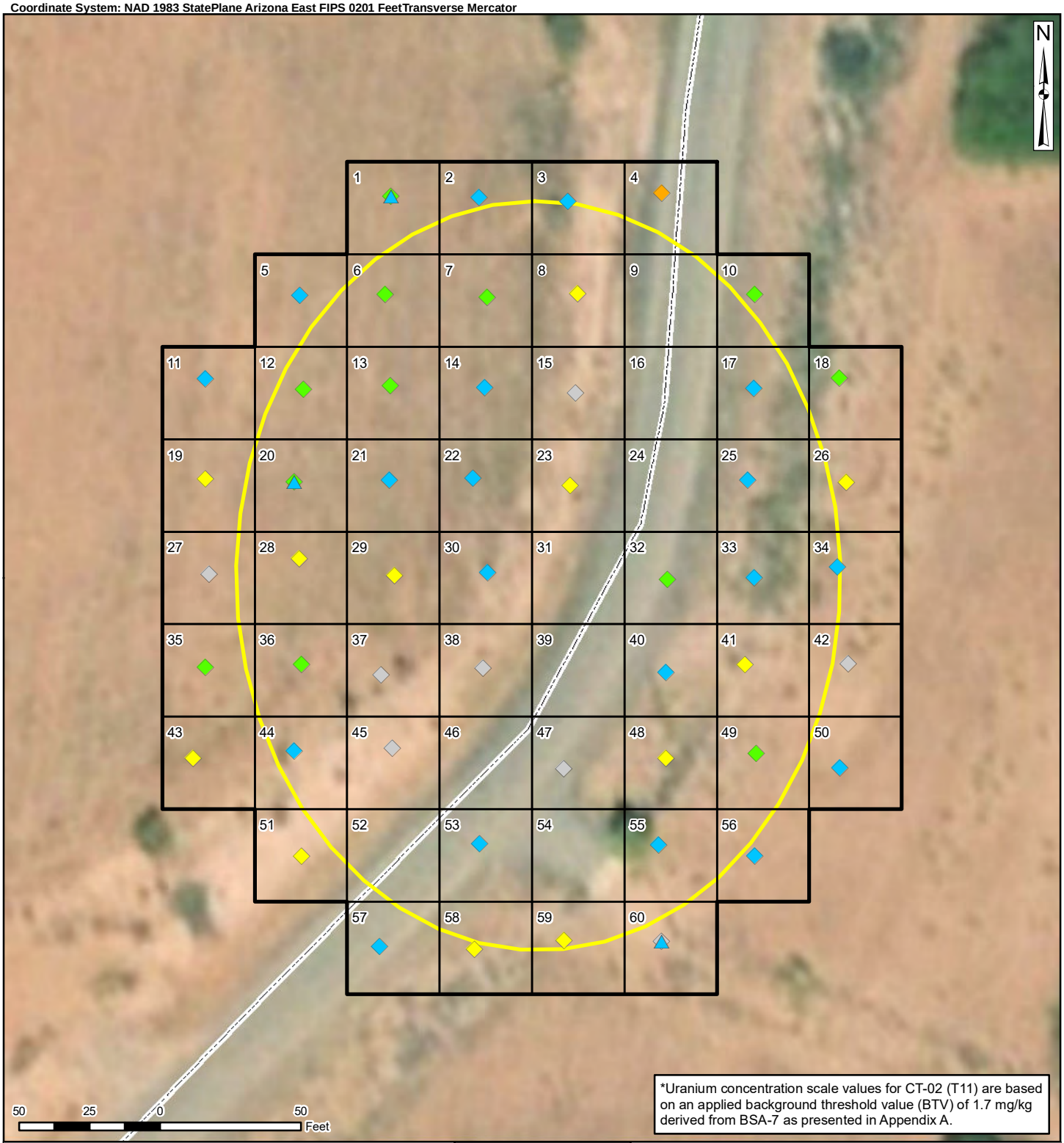


Figure I11-22. Box Plot for Target CT-02 (T11) and Trc Regional Uranium Soil Concentrations

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



*Uranium concentration scale values for CT-02 (T11) are based on an applied background threshold value (BTV) of 1.7 mg/kg derived from BSA-7 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 1.1
- 1.1 - 1.7
- 1.7 - 3.4
- 3.4 - 5.1
- 5.1 - 6.8
- 6.8 - 17
- ≥ 17
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET CT-02 (T11) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I11-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.2.7.6 Vanadium

Vanadium was not identified as a COPC in surface soils as shown in Table I11-7. Vanadium exceeded the applied BTV in 1.9 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for vanadium is 19 mg/kg for Target T11 as presented in Section 6.2.4. The analytical results for XRF confirmation and in situ field XRF measurements are provided in Table I11-5 and Attachment I3, respectively. Figure I11-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T11 and Trc regional samples. Figure I11-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T11 and Trc regional samples. Summary statistics for XRF measurements are provided in Section 6.2.6.1. Vanadium XRF concentrations measured in surface soils at Target T11 ranged between 16.4 and 22 mg/kg with an average and standard deviation of 18.1 mg/kg and 2.4 mg/kg, respectively. The average vanadium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T11 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I11-26. Overall, the majority of detectable vanadium results in surface soils were less than the applied BTV. Exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials Target at T11.

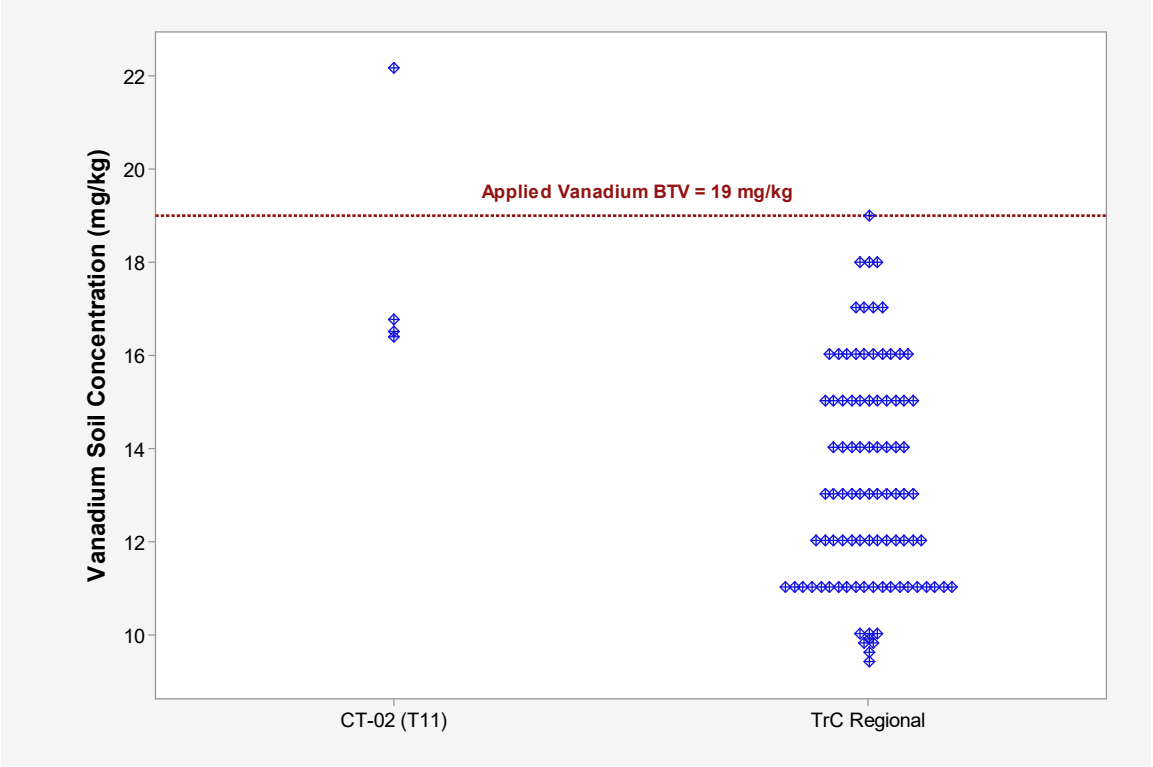


Figure I11-24. Individual Value Plot for Target CT-02 (T11) and Trc Regional Vanadium Soil Concentrations

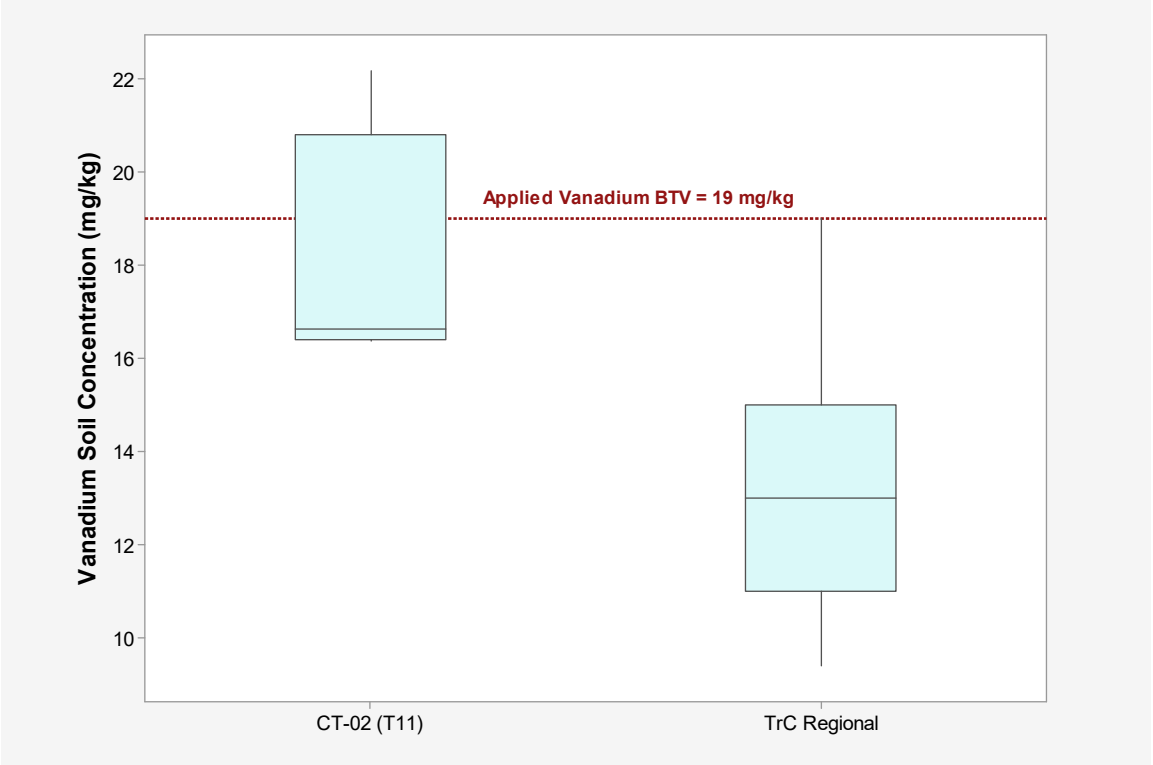
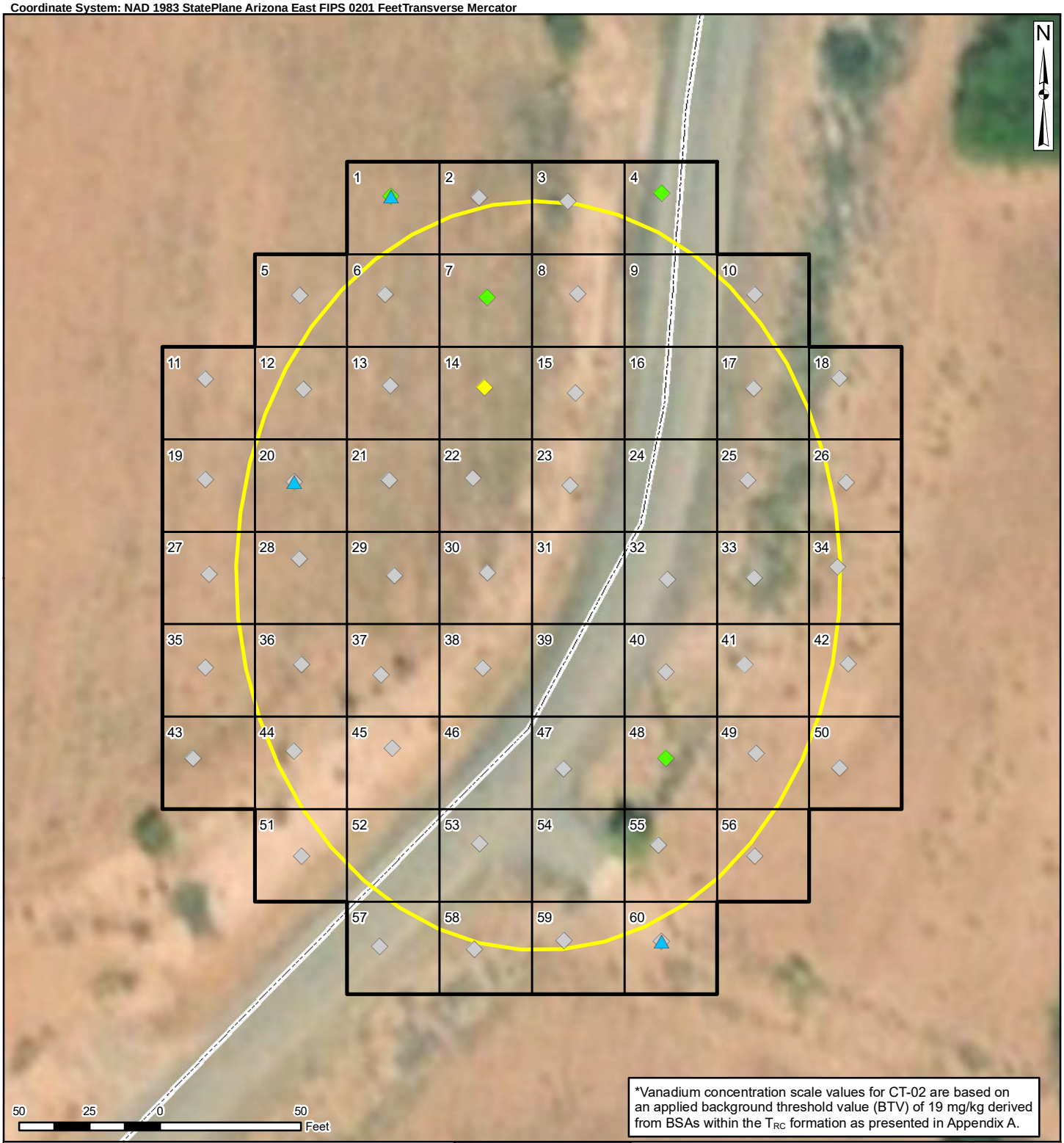


Figure I11-25. Box Plot for Target CT-02 (T11) and Trc Regional Vanadium Soil Concentrations

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



*Vanadium concentration scale values for CT-02 are based on an applied background threshold value (BTV) of 19 mg/kg derived from BSAs within the T_{RC} formation as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 13
- 13 - 19
- 19 - 38
- 38 - 57
- 57 - 76
- 76 - 190
- ≥ 190
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET CT-02 (T11) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I11-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/26/2019	

6.2.8 Conclusions

Target T11 (CT-02) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T11. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T11 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T11. ASPECT gamma survey results generally did not correlate with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T11 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T11 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. No grid averaged gamma measurements exceeded the applied BTV.
- A total of 27 analytes were identified as occurring within the surface environment. Of these analytes, 3 were identified as COPCs. Arsenic and uranium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T11 does not contain TENORM. No mining-related activities or features were observed in the field, and no historical exploratory borings, vents, or other mine openings were noted in the file review or during field observation. NORM was not identified visually or by gamma survey.
- There are no immediate significant physical hazards present at Target T11.
- Access is by highway.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No groundwater wells are documented within the vicinity of Target T11. Rural residences are located nearby; however, it is not known if water is provided by utility or private well. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T11. Therefore, evaluation of the leachability of metals and radionuclides is not required.

- No mine waste was observed at Target T11; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; no data gaps remain at Target T11.

6.3 NON-AUM TARGET T12 (CT-03)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T12 (CT-03).

6.3.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T12 (CT-03) is associated with the Cove Transfer Station (T9), a former mining operations field camp and uranium ore storage and transfer facility in the Cove Valley Region in Subarea Group C within the Cove Chapter of the Navajo Nation. Two other non-AUM Targets are associated with the Cove Transfer Station, which is within the residential area of Cove, Arizona, and is accessible by vehicle via Indian Route 33. Target T12 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. A community of about 40 residences is located nearby with the closest residence 50 feet to the east of the Target. A Target location and access map for Target T12 is shown in Figure I12-1.

A topographical relief map for the Cove Transfer Station area and associated non-AUM Targets is provided in Figure I12-2. The elevation at Target T12 ranges from 6,553 to 6,559 feet amsl with an average of 6,655 feet amsl. The slope at Target T12 ranges from 1 to 6 percent with an average of 4 percent. There is an ephemeral drainage channel 0.25 mile to the east of the Target. Cove Transfer Station and Target T12 are located within the Trc, and Target T12 is located within the Wetherill-Tsezhin association soils (MUSYM 404) (Figures I-17 and I-18).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T12. Weston did not conduct a background study for Target T12. As a part of the RSE for the Cove Transfer Station, Tetra Tech also evaluated the associated non-AUM Targets, such as T12. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 3 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T12:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T12 is accessed by a paved residential road that branches off of Indian Route 33. The Target overlaps the backyard of a residential property.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM and TENORM were not observed at the Target.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  An ephemeral drainage (Cove Wash Middle)is located 0.25 mile west of the Target.

- Identified any exploration borings or historic haul roads:

No exploratory borings or haul roads were identified.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  No AUM or non-AUM Target features were present at this Target.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

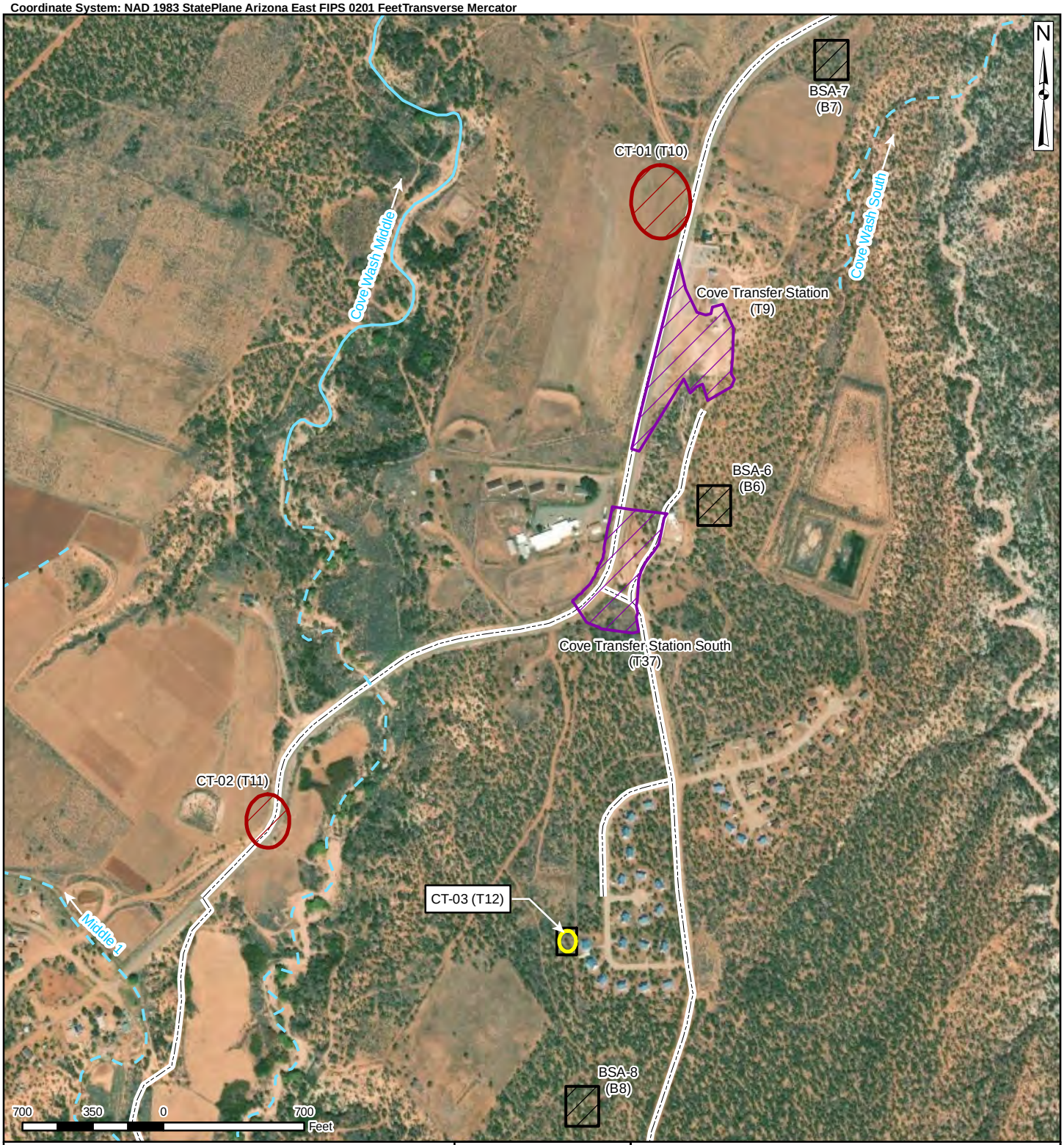
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T12 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Section 2.3 and 6.3.4)
- Conducting an XRF field survey.
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 6.3.3 with results presented in Sections 6.3.6 and 6.3.7)
- Collecting surface soil samples to six inches and subsurface soil samples to six to twelve inches (described in Section 6.3.3, results presented in Section 6.3.6)
- Conducting a gamma radiation survey (results presented in Section 6.3.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target
AUM Related Site Boundary
Background Location
Access Route - Vehicular
Drainage*
Drainage - Field Mapped

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

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NON-AUM TARGET CT-03 (T12) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I12-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

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



Non-AUM Target Site Boundary
Related Survey Area
Background Location
Access Route - Vehicular
Drainage*
100 ft Contour**
20 ft Contour**

*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.
**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.

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NON-AUM TARGET CT-03 (T12) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I12-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.3.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I12-3) within the survey area of the non-AUM Target T12 as part of the Baseline Study in May 2018. Additional Goback gamma radiation surveys were not performed at Target T12. Tetra Tech also performed an XRF field survey at non-AUM Target T12 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I12-4). Additional soil samples were collected in all survey units in September 2018. The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 3, of the RSE Work Plan (Tetra Tech 2018). All gamma survey and XRF survey units were evaluated.

6.3.3 XRF Confirmation and Soils Sampling

Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T12. Twelve XRF soil confirmation samples were collected at a depth of 0 to 6 inches bgs from twelve locations (Table I12-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I12-4 and I12-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I12-2. The results of XRF confirmation sample analysis are provided in Section 6.3.6.1. Correlated XRF field measurements are provided in Attachment I3.

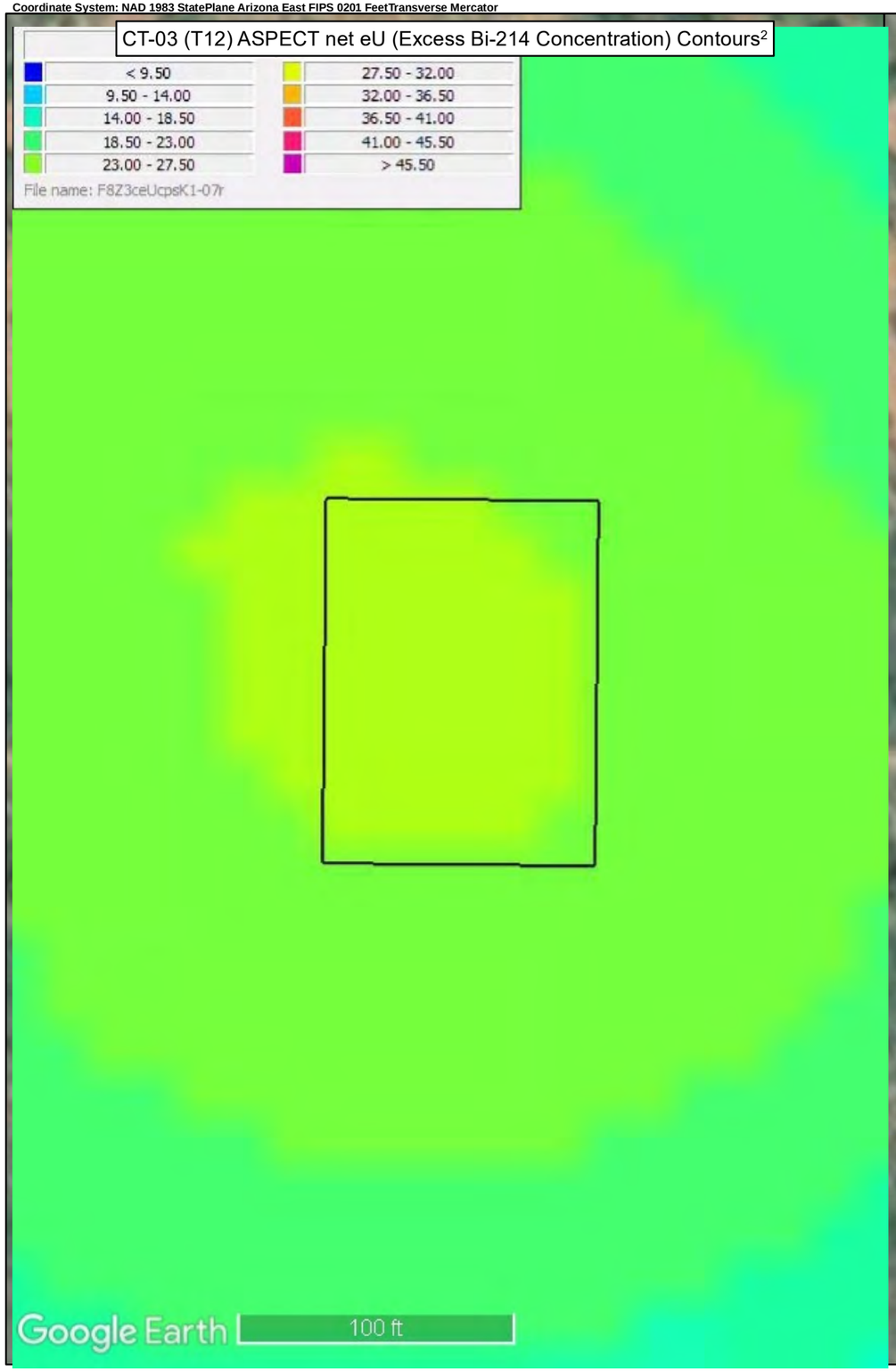
Tetra Tech also collected two shallow subsurface soil samples at two locations (Table I12-1) at non-AUM Target T12 following the field protocol described in Sections 2.5.2 and 2.5.3. Figure I12-5 identifies the locations of subsurface soil samples. Subsurface soil samples were submitted for laboratory analysis of metals (Table I12-2). The results of soil sample analysis are provided in Section 6.3.6.

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

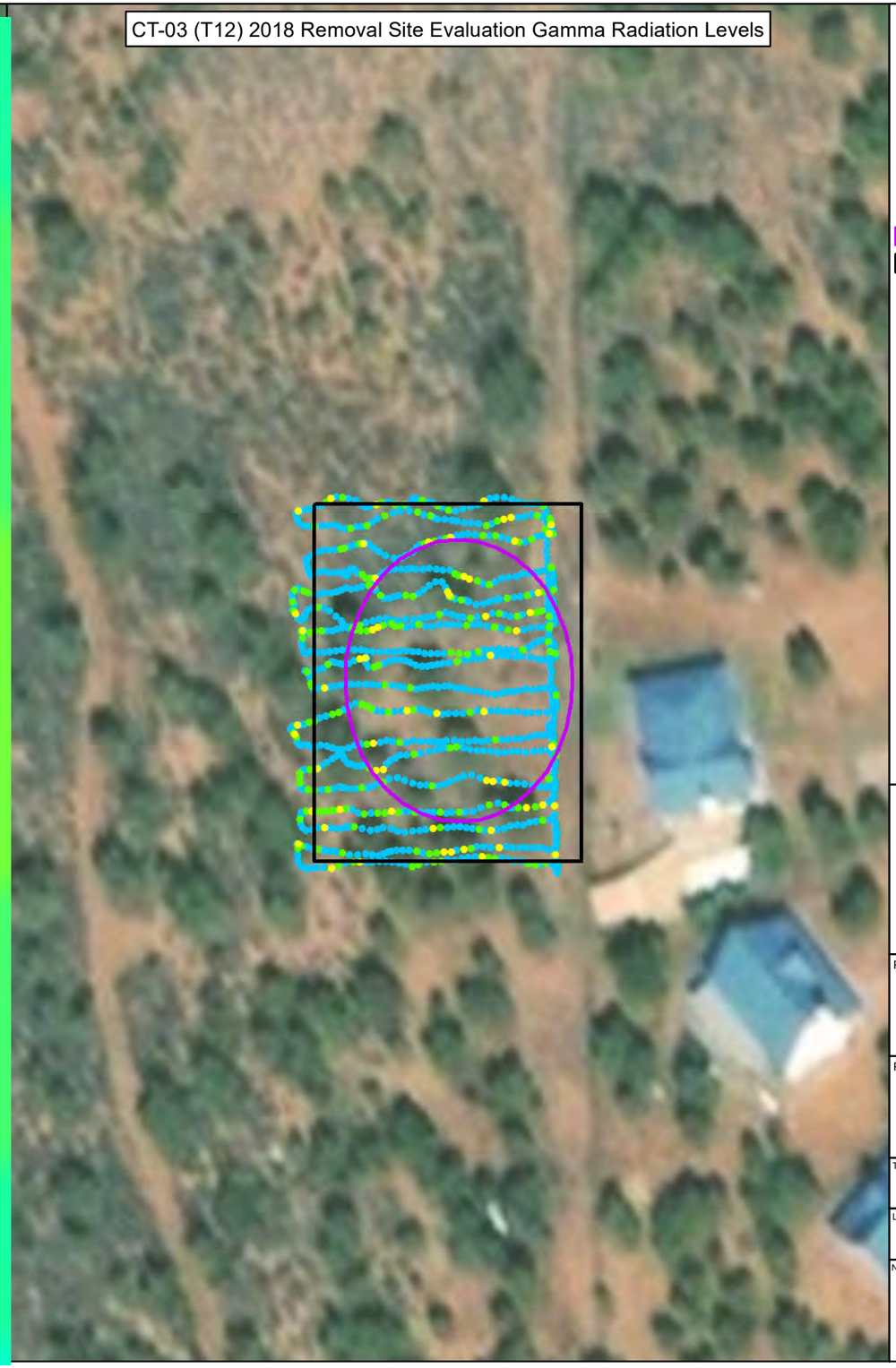
CT-03 (T12) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F8Z3ceUcpsK1-07r



CT-03 (T12) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)[1]

≤ 10,289	≤ Avg. BG
10,289 - 11,019	Avg. BG - 1 x BTV
11,019 - 22,038	1 x BTV - 2 x BTV
22,038 - 33,057	2 x BTV - 3 x BTV
33,057 - 44,076	3 x BTV - 4 x BTV
44,076 - 110,190	4 x BTV - 10 x BTV
≥ 110,190	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Area Boundary

[1]The applied gamma background threshold value (BTV) for CT-03 (T12) Non-AUM Target is 11,019 cpm derived from BSAs within the T_{RC} formation as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 50 ft

1:600

N W E S

0 25 50 100 Feet

NON-AUM TARGET CT-03 (T12)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/12/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation*. May, 2015. ASPECT - Airborn Spectral Photometric Environmental Collection Technology.

Figure No.: **I12-3**

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



In Situ XRF Measurement Location

Survey Grid Unit (100 m²)

Survey Area Boundary

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NON-AUM TARGET CT-03 (T12)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I12-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

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



Surface Soil Sample*
(0 - 6 inches bgs)

Borehole Location**

Survey Grid Unit (100 m²)

Survey Area Boundary

*T12-SS1 = site T12 surface soil sample collected at survey unit 1. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET CT-03 (T12) SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I12-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

Table I12-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target CT-03 (T12)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T12-SS1-01-091218	1	0-6	XRF Confirmation	Primary	9/12/2018	36.5532264	-109.2189294	1809285-4, 1809286-4
T12-SB1-0612-01-091218	1	6-12	XRF Confirmation	Primary	9/12/2018	36.5532264	-109.2189294	1809285-1, 1809286-1
T12-SS2-01-091218	2	0-6	XRF Confirmation	Primary	9/12/2018	36.5532262	-109.2188152	1809285-7, 1809286-7
T12-SS3-01-091218	3	0-6	XRF Confirmation	Primary	9/12/2018	36.5532184	-109.2187121	1809285-8, 1809286-8
T12-SS4-01-091218	4	0-6	XRF Confirmation	Primary	9/12/2018	36.5531397	-109.2189342	1809285-9, 1809286-9
T12-SS5-01-091218	5	0-6	XRF Confirmation	Primary	9/12/2018	36.5531353	-109.2188195	1809285-10, 1809286-10
T12-SS6-01-091218	6	0-6	XRF Confirmation	Primary	9/12/2018	36.5531410	-109.2187119	1809285-11, 1809286-11
T12-SS7-01-091218	7	0-6	XRF Confirmation	Primary	9/12/2018	36.5530445	-109.2189304	1809285-12, 1809286-12
T12-SS8-01-091218	8	0-6	XRF Confirmation	Primary	9/12/2018	36.5530515	-109.2188209	1809285-13, 1809286-13
T12-SS9-01-091218	9	0-6	XRF Confirmation	Primary	9/12/2018	36.5530449	-109.2187113	1809285-14, 1809286-14
T12-SB9-0612-01-091218	9	6-12	XRF Confirmation	Primary	9/12/2018	36.5530449	-109.2187113	1809285-2, 1809286-2
T12-SS10-01-091218	10	0-6	XRF Confirmation	Primary	9/12/2018	36.5529609	-109.2189301	1809285-3, 1809286-3
T12-SS11-01-091218	11	0-6	XRF Confirmation	Primary	9/12/2018	36.5529567	-109.2188197	1809285-5, 1809286-5
T12-SS12-01-091218	12	0-6	XRF Confirmation	Primary	9/12/2018	36.5529522	-109.2187111	1809285-6, 1809286-6

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I12-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target CT-03 (T12)

Analyte	Type	CAS Number	Analytical Method	Number of Samples by Standard Analyses
Aluminum	Metals	7429-90-5	USEPA SW-846 6020B	14
Antimony	Metals	7440-36-0	USEPA SW-846 6020B	14
Arsenic	Metals	7440-38-2	USEPA SW-846 6020B	14
Barium	Metals	7440-39-3	USEPA SW-846 6020B	14
Beryllium	Metals	7440-41-7	USEPA SW-846 6020B	14
Cadmium	Metals	7440-43-9	USEPA SW-846 6020B	14
Calcium	Metals	7440-70-2	USEPA SW-846 6020B	14
Chromium	Metals	7440-47-3	USEPA SW-846 6020B	14
Cobalt	Metals	7440-48-4	USEPA SW-846 6020B	14
Copper	Metals	7440-50-8	USEPA SW-846 6020B	14
Iron	Metals	7439-89-6	USEPA SW-846 6020B	14
Lead	Metals	7439-92-1	USEPA SW-846 6020B	14
Lithium	Metals	7439-93-2	USEPA SW-846 6020B	14
Magnesium	Metals	7439-95-4	USEPA SW-846 6020B	14
Manganese	Metals	7439-96-5	USEPA SW-846 6020B	14
Molybdenum	Metals	7439-98-7	USEPA SW-846 6020B	14
Nickel	Metals	7440-02-0	USEPA SW-846 6020B	14
Potassium-40	Radionuclides	13966-00-2	USEPA 901.1	14
Radium-226	Radionuclides	13982-63-3	USEPA 901.1	14
Radium-228	Radionuclides	15262-20-1	USEPA 901.1	14
Selenium	Metals	7782-49-2	USEPA SW-846 6020B	14
Silver	Metals	7440-22-4	USEPA SW-846 6020B	14
Sodium	Metals	7440-23-5	USEPA SW-846 6020B	14
Thallium	Metals	7440-28-0	USEPA SW-846 6020B	14
Vanadium	Metals	7440-62-2	USEPA SW-846 6020B	14
Zinc	Metals	7440-66-6	USEPA SW-846 6020B	14
Thorium	Metals	-	USEPA SW-846 6020B	14
Uranium	Metals	-	USEPA SW-846 6020B	14

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

6.3.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 6.3.1, Target T12 surface geology is entirely within Trc with soils within the Wetherill-Tsezhin association (MUSYM 404) (Figures I-17 and I-18). As a result, Background Study Area 8 (BSA-8) was selected for that combination of geology and soil type. Additionally, the Trc regional geological background would also be applicable for this Target. Table I12-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T12. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T12. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T12. The “Applied BTV” for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I12-3. Applied Background Threshold Values for Non-AUM Target CT-03 (T12)

Analyte	Units	Site-Specific BTV (BSA-8)	Regional BTV (Trc)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	7,060	9,734	7,060	Site-Specific BTV
Antimony	mg/kg	0.258	0.190	0.190	Regional BTV
Arsenic	mg/kg	2.6	3.0	2.6	Site-Specific BTV
Barium	mg/kg	140	150	140	Site-Specific BTV
Beryllium	mg/kg	0.48	0.54	0.48	Site-Specific BTV
Cadmium	mg/kg	0.243	0.257	0.243	Site-Specific BTV
Calcium	mg/kg	16,000	9,900	9,900	Regional BTV
Chromium	mg/kg	7.8	9.7	7.8	Site-Specific BTV
Cobalt	mg/kg	3.8	4.6	3.8	Site-Specific BTV
Copper	mg/kg	8.0	15	8.0	Site-Specific BTV
Iron	mg/kg	8,310	9,965	8,310	Site-Specific BTV
Lead	mg/kg	11	12	11	Site-Specific BTV
Lithium	mg/kg	8.3	9.7	8.3	Site-Specific BTV
Magnesium	mg/kg	3,250	3,600	3,250	Site-Specific BTV
Manganese	mg/kg	313	380	313	Site-Specific BTV
Mercury	mg/kg	0.0420	0.0260	0.0260	Regional BTV
Molybdenum	mg/kg	0.31	0.45	0.31	Site-Specific BTV
Nickel	mg/kg	7.7	9.2	7.7	Site-Specific BTV
Potassium-40	pCi/g	19.7	21.8	19.7	Site-Specific BTV
Radium-226	pCi/g	1.33	2.49	1.33	Site-Specific BTV
Radium-228	pCi/g	0.72	0.76	0.72	Site-Specific BTV
Selenium	mg/kg	0.89	1.0	0.89	Site-Specific BTV
Silver	mg/kg	0.042	0.039	0.039	Regional BTV
Sodium	mg/kg	53	51	51	Regional BTV
Thallium	mg/kg	0.069	0.092	0.069	Site-Specific BTV
Thorium	mg/kg	4.4	4.8	4.4	Site-Specific BTV
Uranium	mg/kg	0.55	1.7	0.55	Site-Specific BTV
Vanadium	mg/kg	15	19	15	Site-Specific BTV
Zinc	mg/kg	120	37	37	Regional BTV
Gamma Radiation	cpm	12,131	11,019	11,019	Regional BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
mg/kg milligrams per kilogram
pCi/g picocuries per gram
Trc Chinle Formation

6.3.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T12 and the raw gamma radiation and grid averaged gamma radiation survey results.

6.3.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T12 in May 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine if any additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. No additional scanning was required; however, additional soil samples were collected across all survey units in September 2018. The applied gamma BTV for non-AUM Target T12 is 11,019 cpm. A total of 823 measurements were collected as part of the gamma radiation survey at non-AUM Target T12 across 12 survey units. An average scan density of 69 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I12-4.

Table I12-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target CT-03 (T12)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,019	
Measurements	#	823	12
Minimum	cpm	7,710	9,238
Maximum	cpm	13,548	10,036
Average	cpm	9,774	9,781
Median	cpm	9,747	9,848
Standard Deviation	cpm	771	219
90th Percentile	cpm	10,772	9,994
95th Percentile	cpm	11,122	10,018
99th Percentile	cpm	11,730	10,032
Measurements per Survey Unit	#/grid	69	
Measurements Above Gamma BTV	#	49	0
Measurements Above Gamma BTV	%	6.0	0.0

Notes:
BTV background threshold value
cpm counts per minute

6.3.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 6.0 percent of the measurements within the Target boundaries, in some cases slightly exceeding the applied gamma BTV (11,019 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the Trc regional gamma survey results is provided on Figure I12-6. This graph shows that the spread of radiation data at Target T12 (shown on left) begins slightly below the lower range of Trc regional gamma levels (shown on right) and then rises above the BTV in some locations but remains within the range of the background data set. This individual value plot shows that the majority and largest amount of radiation data collected from Target T11 is slightly lower than the data cloud from the Trc regional data set. A box plot showing the quartiles of the data sets is provided in Figure I12-7. The box plot shows that the median of Target T12 radiation levels is lower than the median of the Trc regional data set and lower than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I12-8. No mining activity was observed within the survey area of Target T12.

In general, Target T12 has surficial gamma radiation levels below Trc regional levels across the majority of the Target and surrounding area, indicating that the survey did not identify the area of potential elevated gamma activity identified by the ASPECT gamma survey (Figures I12-3). No TENORM or mining-related activities were observed within the Target T12 survey and surrounding area. Section 6.3.5.3 presents the grid averaged results of the gamma radiation survey.

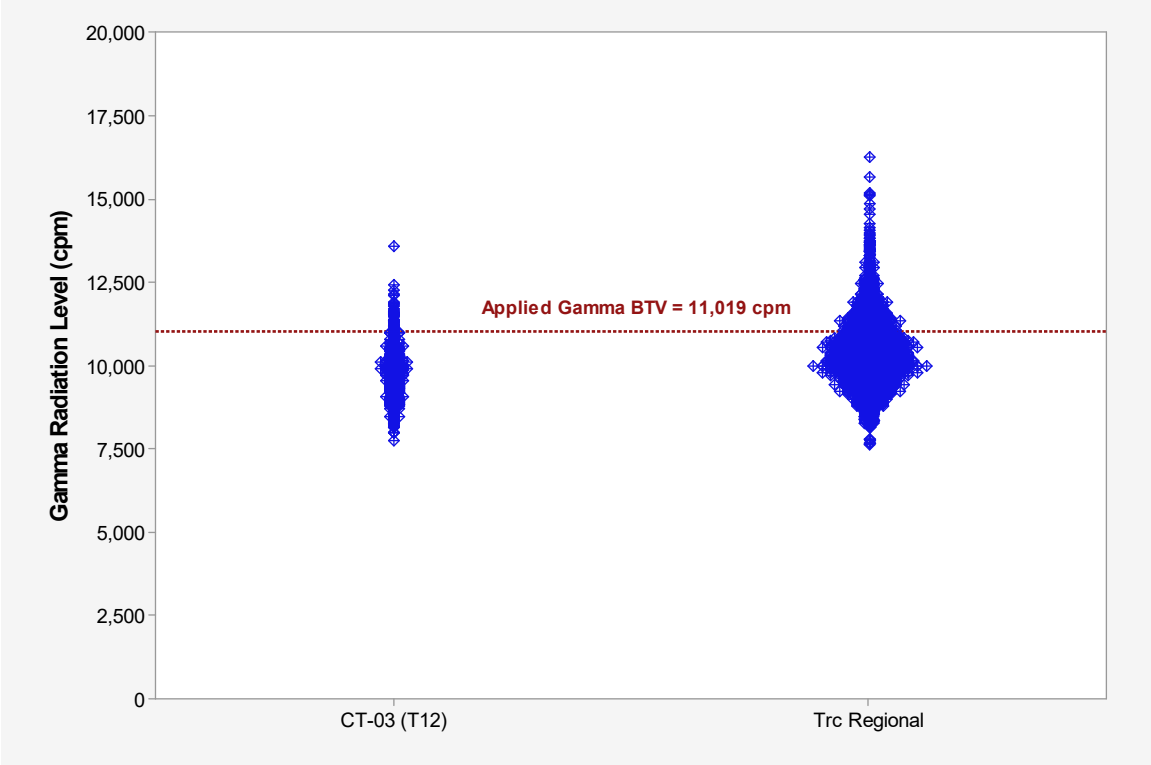


Figure I12-6. Individual Value Plot of Raw Gamma Radiation Levels at Target CT-03 (T12) and Trc Regional

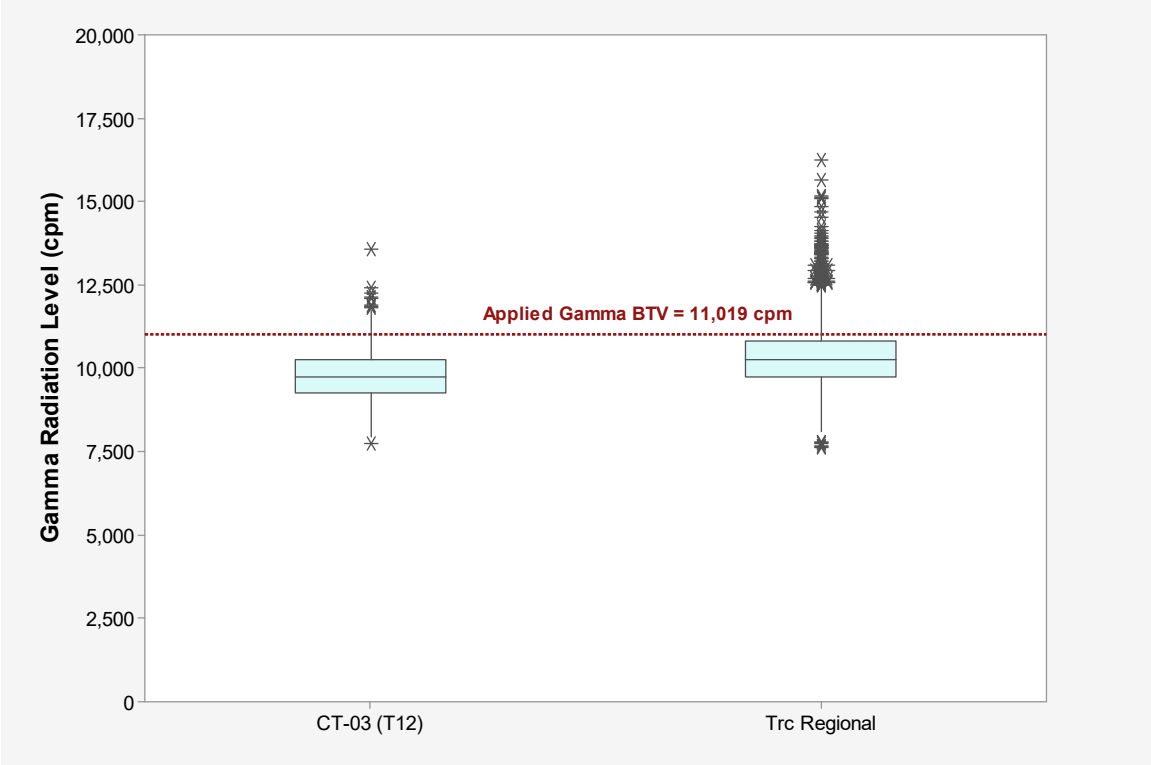
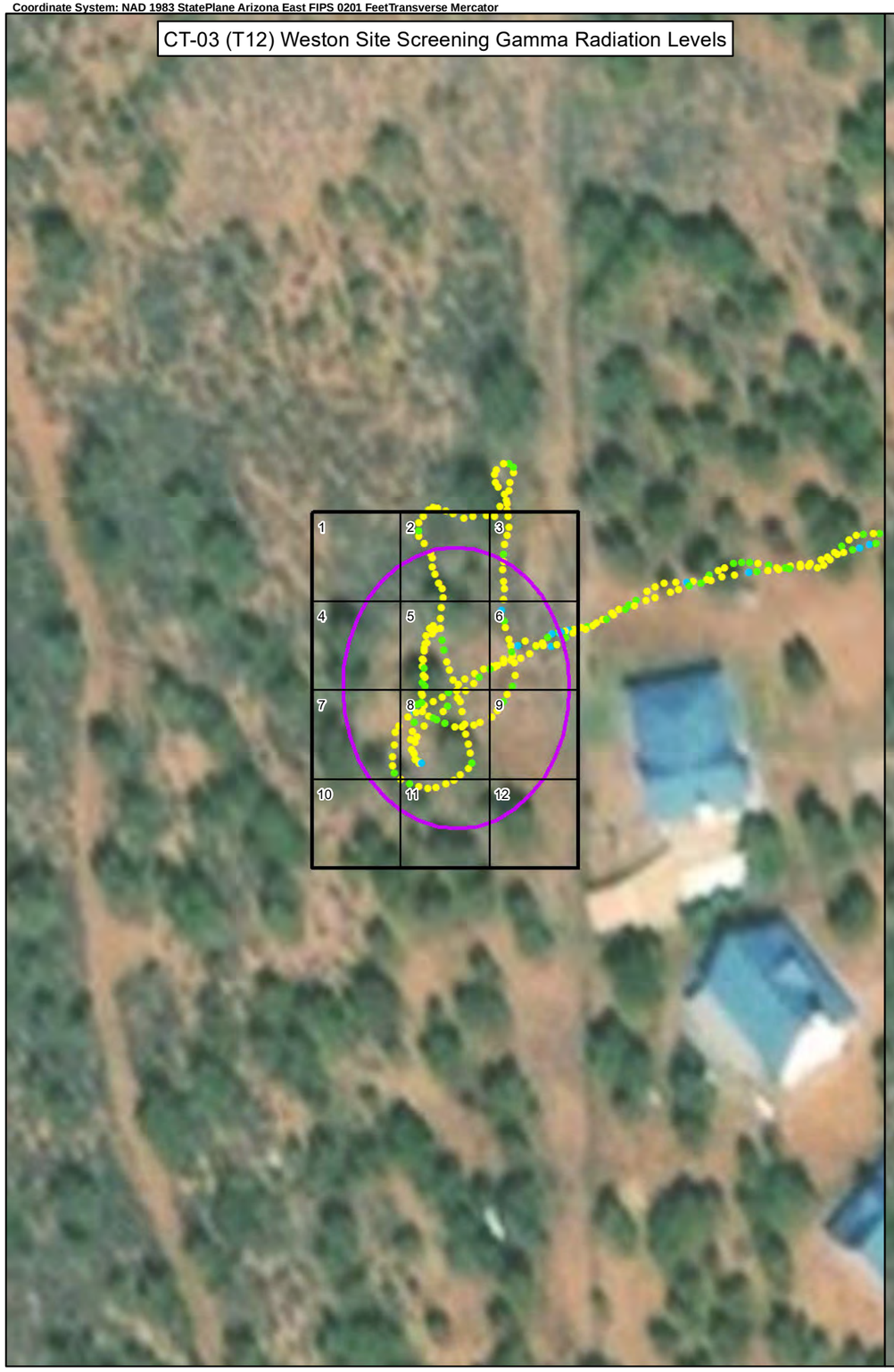
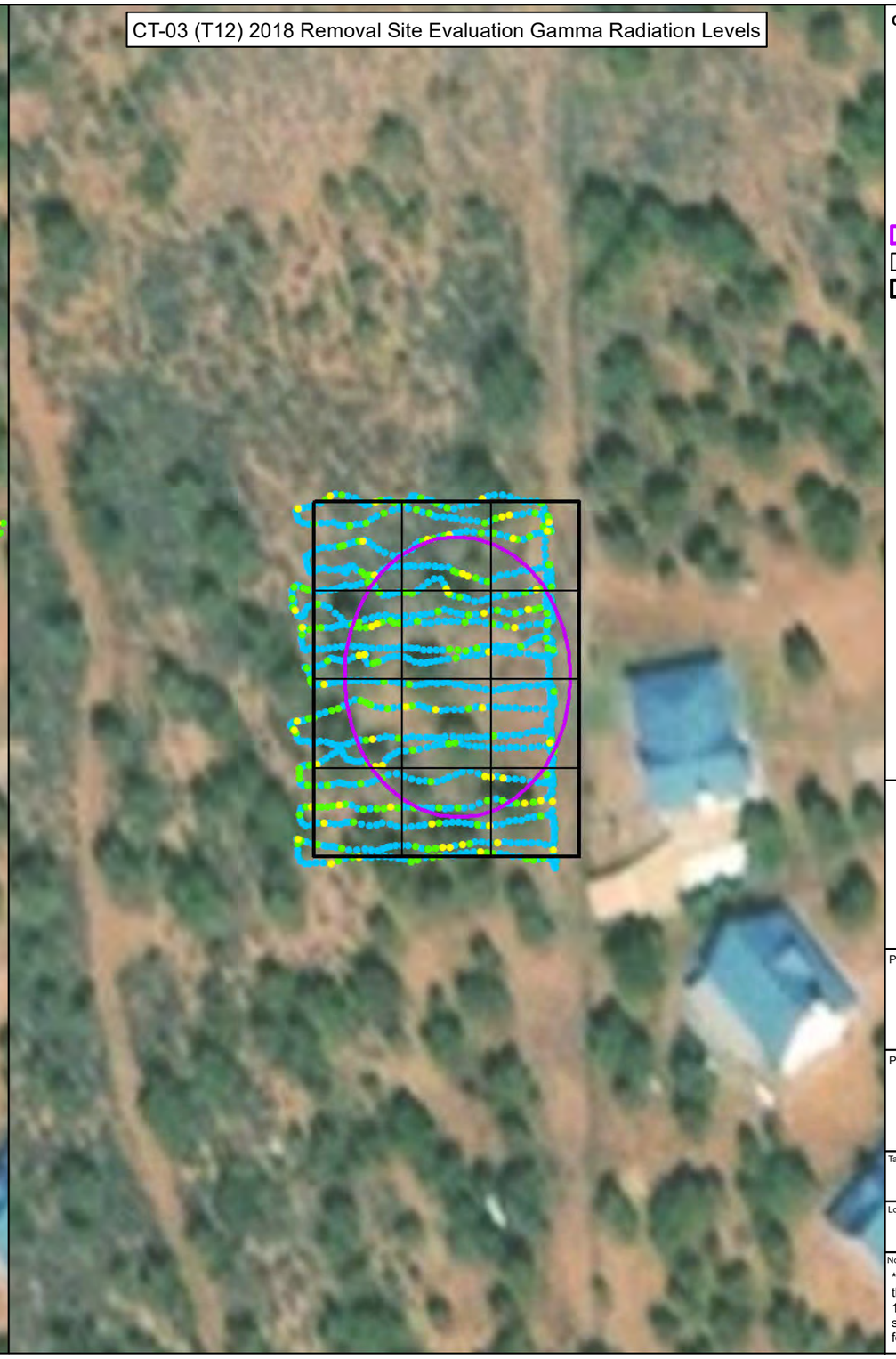


Figure I12-7. Box Plot of Raw Gamma Radiation Levels at Target CT-03 (T12) and Trc Regional

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





Gamma Reading (cpm)*

≤ 10,289	≤ Avg. BG
10,289 - 11,019	Avg. BG - 1 x BTV
11,019 - 22,038	1 x BTV - 2 x BTV
22,038 - 33,057	2 x BTV - 3 x BTV
33,057 - 44,076	3 x BTV - 4 x BTV
44,076 - 110,190	4 x BTV - 10 x BTV
≥ 110,190	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary

1 in = 50 ft

1:600

N
W E
S

0 25 50 100 Feet

NON-AUM TARGET CT-03 (T12) SITE
2018 REMOVAL SITE EVALUATION
VS WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019

Notes:
*The applied gamma radiation background threshold value (BTV) for CT-03 (T12) is 11,019 cpm derived from gamma survey data for BSAs within the T_{RC} formation as presented in Appendix A.

Figure No.: **I12-8**

6.3.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 6.3.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 6.3.5.1. Figure I12-9 and Figure I12-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to Trc regional data set (shown on right). No survey units within the survey area of Target T12 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I12-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I12-11 as discussed further in Section 2.8. No survey units exceeded the gamma BTV.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface and subsurface soil samples were collected at the Target across the survey units and are presented in Section 6.3.6.

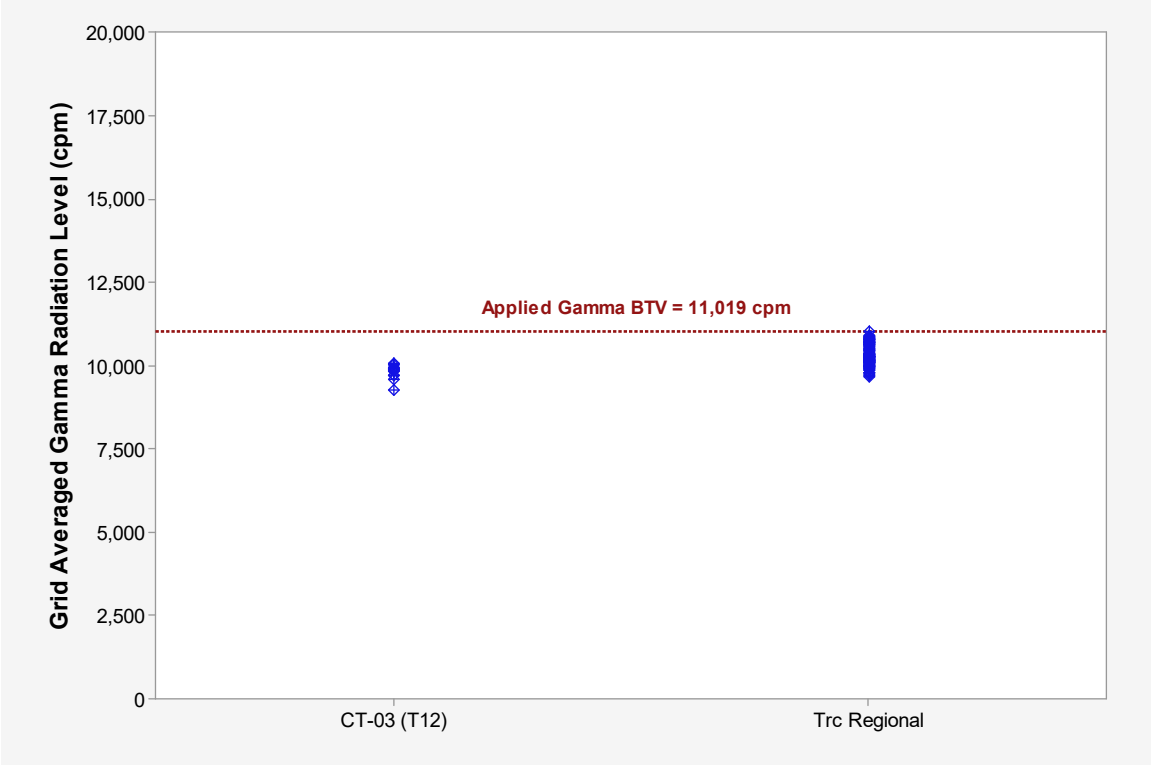


Figure I12-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target CT-03 (T12) and Trc Regional

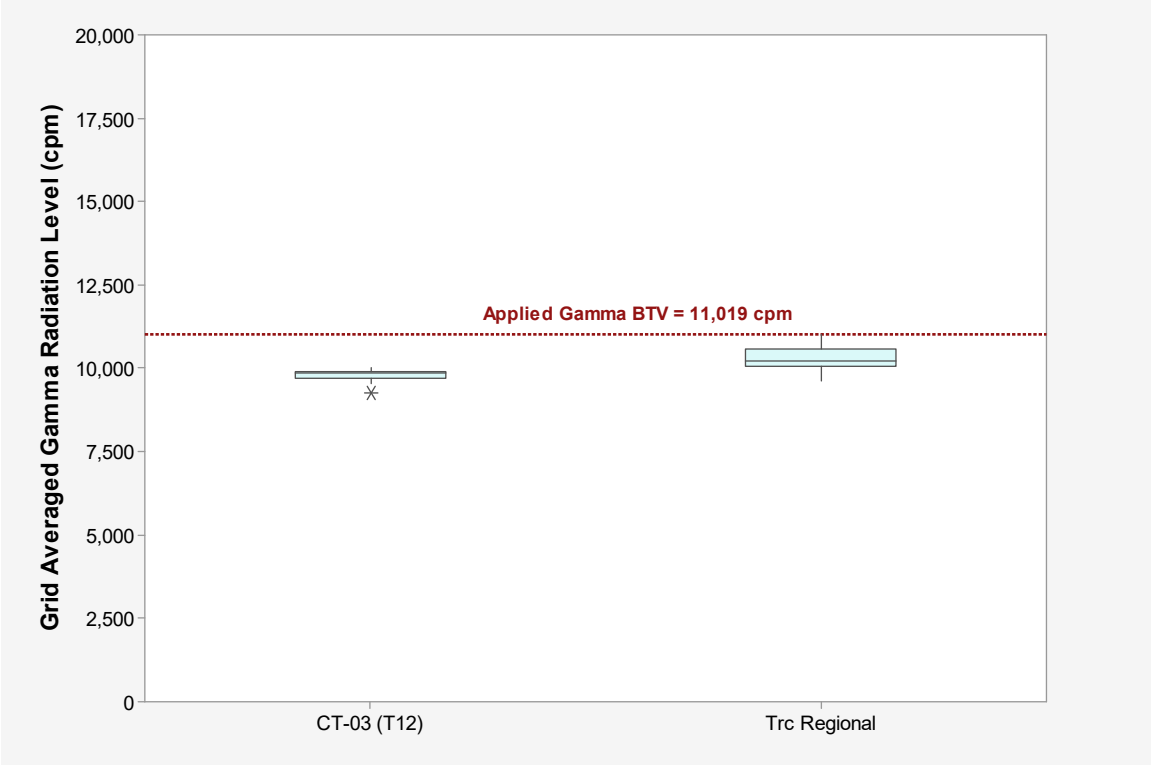
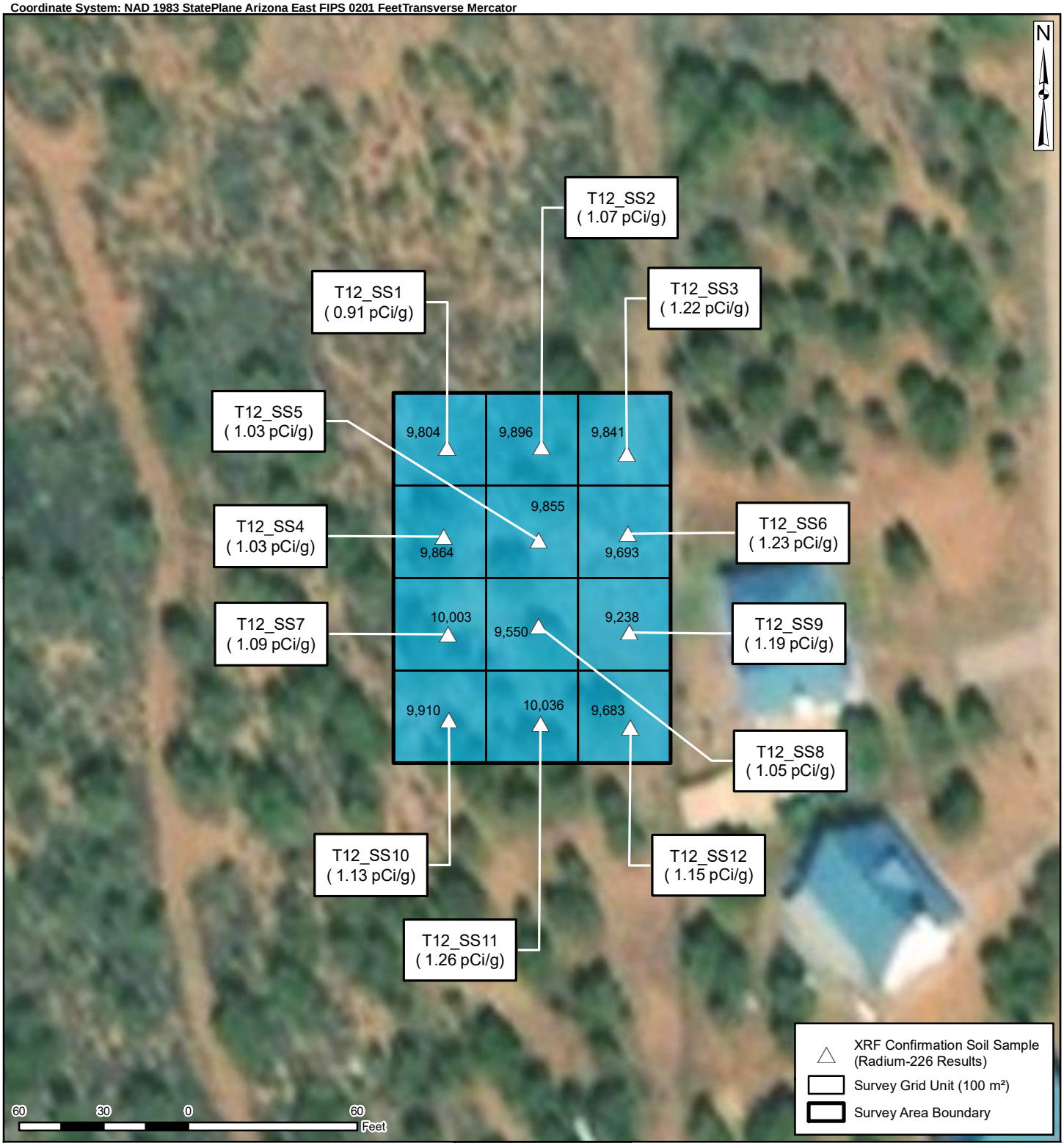


Figure I12-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target CT-03 (T12) and Trc Regional

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



Grid Averaged Gamma Reading (cpm)*

≤ 10,289	≤ Avg. BG
10,289 - 11,019	Avg. BG - 1 x BTV
11,019 - 22,038	1 x BTV - 2 x BTV
22,038 - 33,057	2 x BTV - 3 x BTV
33,057 - 44,076	3 x BTV - 4 x BTV
44,076 - 110,190	4 x BTV - 10 x BTV
≥ 110,190	≥ 10 x BTV

*The applied gamma radiation background threshold value (BTV) for CT-03 (T12) is 11,019 cpm derived from gamma survey data for BSAs within the TRC formation as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET CT-03 (T12) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I12-11
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.3.6 Soil Sampling Results

This section presents the results of analyses for soil within the survey area of Target T12. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 6.3.6.1. In addition, subsurface soil samples were collected at a depth of 6 to 12 inches bgs; the results for subsurface samples are presented in Section 6.3.6.2. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 6.3.6.3.

6.3.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T12: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I12-1 and I12-2. All the results of the XRF confirmation soil samples are presented in Table I12-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T12 following the methods outlined in Section 2.4 and shown in Figure I12-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 12 measurements were collected across 12 survey units from the survey area of Target T12 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I12-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T12 at a depth of 0 to 3 inches bgs. Twelve XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I12-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes, in the form of contaminant maps, are provided in Section 6.3.7.

6.3.6.2 Subsurface Soil Sampling

The methodology for conducting subsurface soil sampling at Target T12 is provided in Section 2.5.2. A total of two subsurface samples were collected from two borings to a maximum depth of 12 inches. The sample depth ranges and number of samples varied per boring and are provided in Table I12-2 and Figure I12-5. The borings were selected to confirm the existence of potential areas of radiological or metals contamination at depth. Surface sample results are provided in the previous section. The laboratory analytical results for each of the subsurface samples are provided in Table I12-5. Summary statistics for the subsurface soil samples were not prepared because of the small number of samples collected.

Table I12-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target CT-03 (T12) (1 of 2)

Analyte	Units	Applied BTV	T12-SS1-01-091218		T12-SB1-0612-01-091218		T12-SS2-01-091218		T12-SS3-01-091218		T12-SS4-01-091218		T12-SS5-01-091218		T12-SS6-01-091218	
			Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Survey Unit			SS1		SB1		SS2		SS3		SS4		SS5		SS6	
Aluminum	mg/kg	7,060	4,600		4,700		4,400		5,100		6,900		5,000		5,200	
Antimony	mg/kg	0.190	<0.1	U	0.078	J	0.09	J	0.079	J	0.13		<0.1	U	<0.1	U
Arsenic	mg/kg	2.6	2.2		2		2		2.4		2.6		2.6		2.3	
Barium	mg/kg	140	98		99		110		110		150		96		100	
Beryllium	mg/kg	0.48	0.34		0.33		0.29		0.38		0.44		0.35		0.37	
Cadmium	mg/kg	0.243	0.077	J	0.096	J	0.11	J	0.11	J	0.21		0.095	J	0.097	J
Calcium	mg/kg	9,900	7,300		5,900		7,100		4,600		7,600		7,700		5,500	
Chromium	mg/kg	7.8	5.3		5.4		4.8		5.7		6.1		5.6		5.8	
Cobalt	mg/kg	3.8	3.1		3.1		2.9		3.5		3.7		3.3		3.3	
Copper	mg/kg	8.0	5.6		6		5.9		6.7		11		6.4		6.6	
Iron	mg/kg	8,310	6,500		6,500		6,200		7,100		7,800		6,900		6,900	
Lead	mg/kg	11	5.9		6.2		6.1		7		11		6.5		6.5	
Lithium	mg/kg	8.3	5.5		5.6		5.3		6.4		7.6		6.5		6	
Magnesium	mg/kg	3,250	2,300		2,300		2,300		2,500	J	2,900		2,500		2,500	
Manganese	mg/kg	313	250		250		280		290		360		250		270	
Molybdenum	mg/kg	0.31	0.17	J	<0.21	U	<0.21	U	<0.2	UJ	0.25		0.17	J	0.19	J
Nickel	mg/kg	7.7	5.2		5.3		4.8		6		6.5		5.7		5.8	
Potassium-40	pCi/g	19.7	16		14.6		12.4		19.3		15.8		15.6		15.5	
Radium-226	pCi/g	1.33	0.91	LT	0.8	LT	1.07		1.22		1.03		1.03		1.23	
Radium-228	pCi/g	0.72	<0.27	U	<0.47	U	<0.77	UJ	<0.54	UJ	<0.54	U	<0.95	UJ	<0.76	U
Selenium	mg/kg	0.89	0.7	J	0.68	J	0.67	J	0.71	J	0.9	J	0.77	J	0.78	J
Silver	mg/kg	0.039	0.016	J	0.017	J	0.017	J	0.049	J	0.048	J	0.045	J	0.022	J
Sodium	mg/kg	51	<100	U	<100	U	<100	U	<98	U	<100	U	<100	U	<100	U
Thallium	mg/kg	0.069	0.056		0.06		0.052		0.063		0.073		0.057		0.063	
Thorium	mg/kg	4.4	2.2		2.2		2.3		3		3.3		2.8		2.6	
Uranium	mg/kg	0.55	0.34		0.35		0.35		0.39		0.6		0.39		0.36	
Vanadium	mg/kg	15	10		10		9.5		12		13		12		11	
Zinc	mg/kg	37	15		16		17		19		30		18		18	

Table I12-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target CT-03 (T12) (2 of 2)

Analyte	Units	Applied BTV	T12-SS7-01-091218		T12-SS8-01-091218		T12-SS9-01-091218		T12-SB9-0612-01-091218		T12-SS10-01-091218		T12-SS11-01-091218		T12-SS12-01-091218	
			Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Survey Unit			SS7		SS8		SS9		SB9		SS10		SS11		SS12	
Aluminum	mg/kg	7,060	5,100		5,900		5,100		4,600		5,600		4,800		5,400	
Antimony	mg/kg	0.190	0.12		0.11		<0.1	U	0.08	J	0.1		0.087	J	<0.1	U
Arsenic	mg/kg	2.6	2.3		2.4		2.2		2.1		2.6		2.4		2.5	
Barium	mg/kg	140	100		100		100		100		120		95		110	
Beryllium	mg/kg	0.48	0.35		0.41		0.35		0.33		0.37		0.33		0.41	
Cadmium	mg/kg	0.243	0.16	J	0.1	J	0.1	J	0.12	J	0.17	J	0.12	J	0.087	J
Calcium	mg/kg	9,900	4,000		3,400		6,700		6,800		5,900		3,800		4,400	
Chromium	mg/kg	7.8	5.4		6.1		5.6		5.1		6.2		5.4		5.7	
Cobalt	mg/kg	3.8	3.2		3.5		3.2		2.9		3.6		3.1		3.6	
Copper	mg/kg	8.0	6.6		6.4		6.6		6.2		7.5		6.6		6.9	
Iron	mg/kg	8,310	6,900		7,600		6,900		6,200		7,600		6,700		7,300	
Lead	mg/kg	11	8.9		7.3		7.1		7.3		8.6		7.1		6.7	
Lithium	mg/kg	8.3	5.8		6.6		6.1		5.6		6.5		5.5		6.3	
Magnesium	mg/kg	3,250	2,300		2,600		2,400		2,200		2,700		2,300		2,500	
Manganese	mg/kg	313	280		270		270		260		320		280		280	
Molybdenum	mg/kg	0.31	<0.2	U	0.17	J	0.19	J	<0.21	U	<0.2	U	0.2		0.17	J
Nickel	mg/kg	7.7	5.4		6.4		5.6		5.2		6		5.5		6.3	
Potassium-40	pCi/g	19.7	17.7		19.1		15		14.4		15.3		16.3		16.7	
Radium-226	pCi/g	1.33	1.09		1.05		1.19		1.03		1.13		1.26		1.15	
Radium-228	pCi/g	0.72	<0.44	U	<0.45	U	<0.47	U	<0.47	U	<0.68	U	<0.35	U	<0.33	U
Selenium	mg/kg	0.89	0.74	J	0.77	J	0.8	J	0.67	J	0.78	J	0.71	J	0.85	J
Silver	mg/kg	0.039	0.022	J	0.022	J	0.11		0.02	J	0.022	J	0.021	J	0.05	J
Sodium	mg/kg	51	<100	U	<100	U	<100	U	<100	U	<100	U	<97	U	<100	U
Thallium	mg/kg	0.069	0.061		0.068		0.063		0.058		0.071		0.059		0.066	
Thorium	mg/kg	4.4	3.1		3.3		2.9		2.7		3		2.5		2.9	
Uranium	mg/kg	0.55	0.49		0.43		0.42		0.38		0.6		0.43		0.38	
Vanadium	mg/kg	15	11		12		11		11		12		10		13	
Zinc	mg/kg	37	19		18		19		17		20		17		18	

Notes:

BTV Background threshold value
ID Identification
J Estimated value
J- Estimated value, may be biased low
LT Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration.
M3 The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg Milligrams per kilogram
NA Not applicable
NV No Value
pCi/g Picocuries per gram
Q Qualification
U Not considered detected. The associated value is the method detection limit (MDL).
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

Table I12-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target CT-03 (T12)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.6	8,310	11	313	0.31	4.4	0.55	15	37
Measurements	#	12	12	12	12	12	12	12	12	12
Detects	#	11	12	12	12	9	12	12	8	12
Nondetects	#	1	0	0	0	3	0	0	4	0
Minimum	mg/kg	1.94	6,001	5.93	292.4	0.15	2.17	0.3	16.1	19.8
Maximum	mg/kg	4.46	8,934	13.4	516.7	1.87	4.30	1.95	29.3	34.8
Standard Deviation	mg/kg	0.8	981	1.8	57	0.55	0.6	0.6	5	4.4
Average	mg/kg	2.8	7,602	9.6	377	0.93	2.9	1.2	19.6	26.3
Median	mg/kg	2.6	7,934	9.4	372	0.93	2.8	1.2	17.6	26.0
Relative Standard Deviation	%	29.4	12.9	18.7	15.0	59.8	20.1	53.5	23.0	16.7
90th Percentile	mg/kg	3.6	8,629	11.0	416	1.5	3.4	1.9	25	31
95th Percentile	mg/kg	4.0	8,779	12.1	462	1.7	3.8	1.9	27	33
99th Percentile	mg/kg	4.4	8,903	13.1	506	1.8	4.2	1.9	29	34
Measurements Above Applied BTV	#	6	3	1	11	7	0	9	8	0
Measurements Above Applied BTV	%	50.0	25.0	8.3	91.7	58.3	0.0	75.0	66.7	0.0

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value

mg/kg Milligram per kilogram

XRF X-ray fluorescence

6.3.6.3 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T12 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T12 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T12. The estimated BTVs are identified in Section 6.3.4 and Table I12-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I12-7 presents a summary of the background comparison for different measurement and soil depths at Target T12. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T12. Further gamma radiation screening indicated that gamma levels at Target T12 are similar to those at BSA-8. Therefore, while multiple COPCs have been identified at Target T12 based on a conservative comparison to background, risk screening may be required to support a future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I12-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target CT-03 (T12)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic		✓	✓
Barium	✓		✓
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper	✓		✓
Iron		✓	✓
Lead		✓	✓
Lithium			
Magnesium			
Manganese	✓	✓	✓
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium	✓		✓
Silver	✓		✓
Sodium			
Thallium	✓		✓
Thorium			
Uranium	✓	✓	✓
Vanadium		✓	✓
Zinc			

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

6.3.7 Primary Contaminant Mapping

6.3.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 6.3.6.3 identified the COPCs at Target T12. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 6.3.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I12-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T12 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 6.3.7.1 through Section 6.3.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T12. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

6.3.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I12-7. Arsenic exceeded the applied BTV in 50 percent of in situ XRF measurements and 3 of the 12 XRF confirmation samples. The applied BTV for arsenic is 2.6 mg/kg for Target T12 as presented in Section 6.3.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I12-5 and Attachment I3, respectively. Figure I12-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T12 and BSA-8 (Trc) samples. Figure I12-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T12 and BSA-8 (Trc) samples. Summary statistics for XRF measurements are provided in Section 6.3.6.1. Arsenic XRF concentrations measured in surface soils at Target T12 ranged between 1.94 and 4.46 mg/kg with an average and standard deviation of 2.8 mg/kg and 0.8 mg/kg, respectively. The average arsenic XRF concentration is slightly above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T12 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I12-14. Overall, the majority of detectable arsenic XRF results in surface soils were slightly above the applied BTV. However, exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials.

For subsurface samples, arsenic did not exceed the applied BTV. The maximum arsenic concentration in the subsurface soil samples was 2.1 mg/kg.

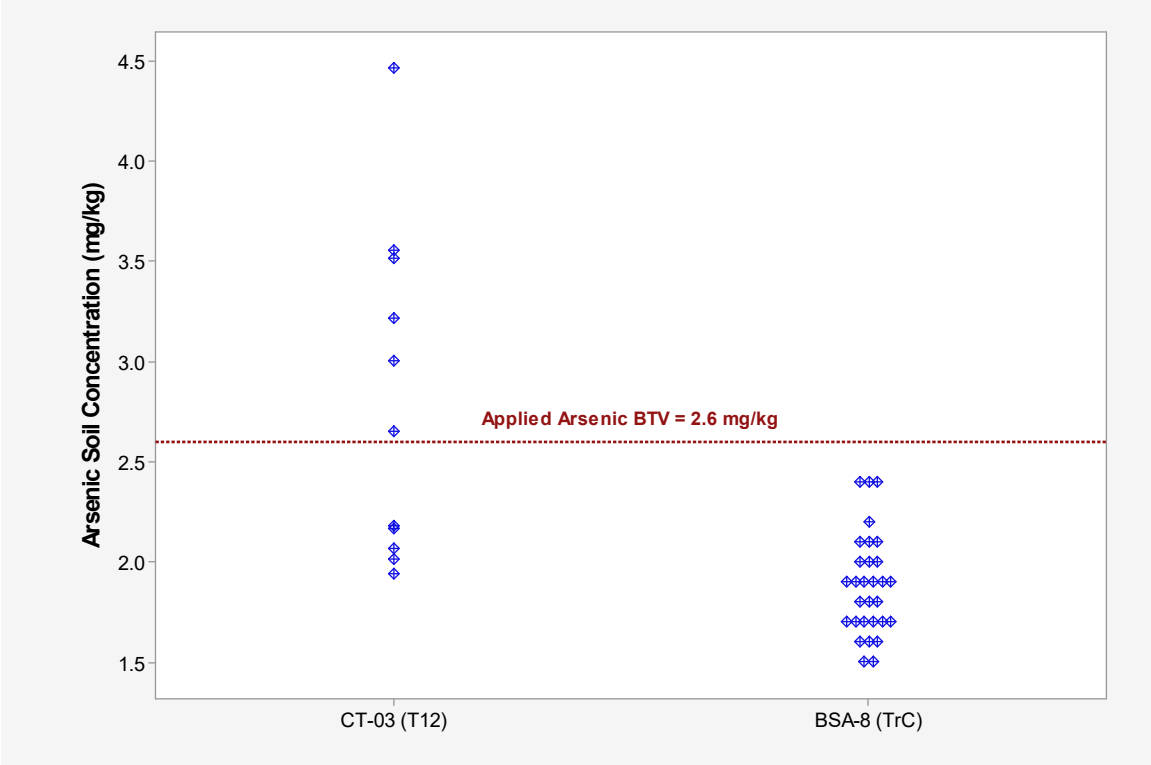


Figure I12-12. Individual Value Plot for Target CT-03 (T12) and BSA-8 (Trc) Arsenic Soil Concentrations

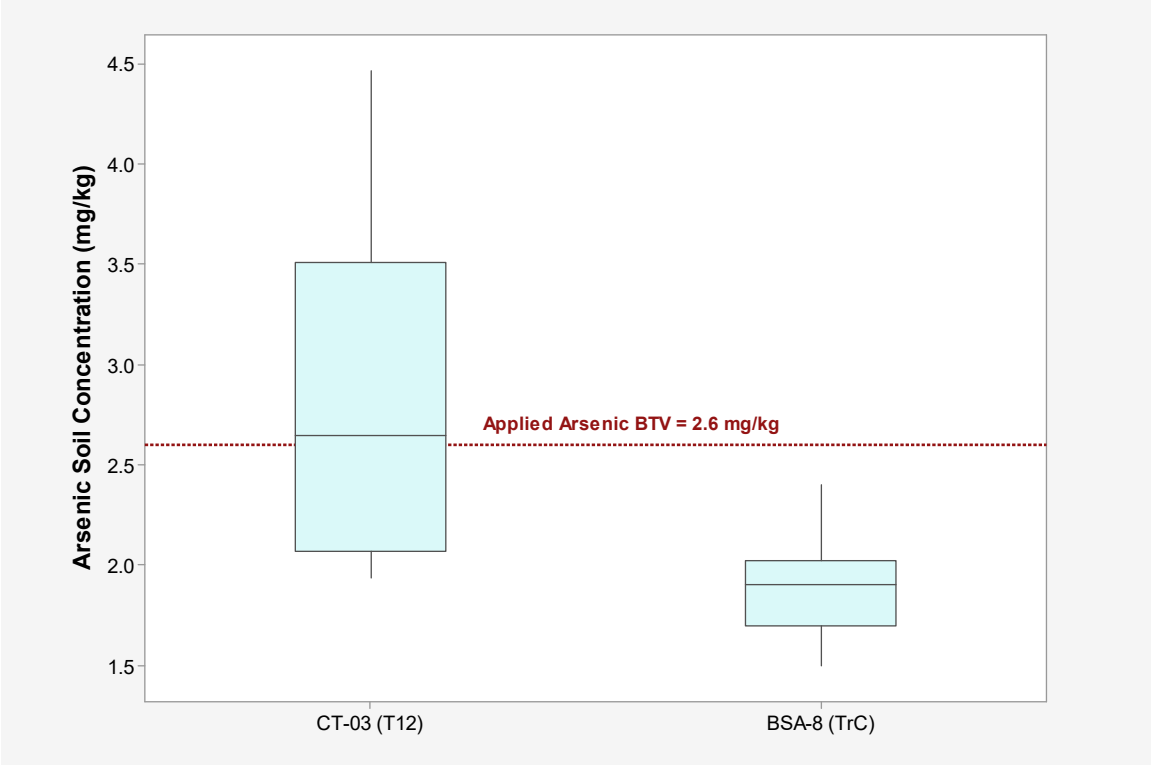
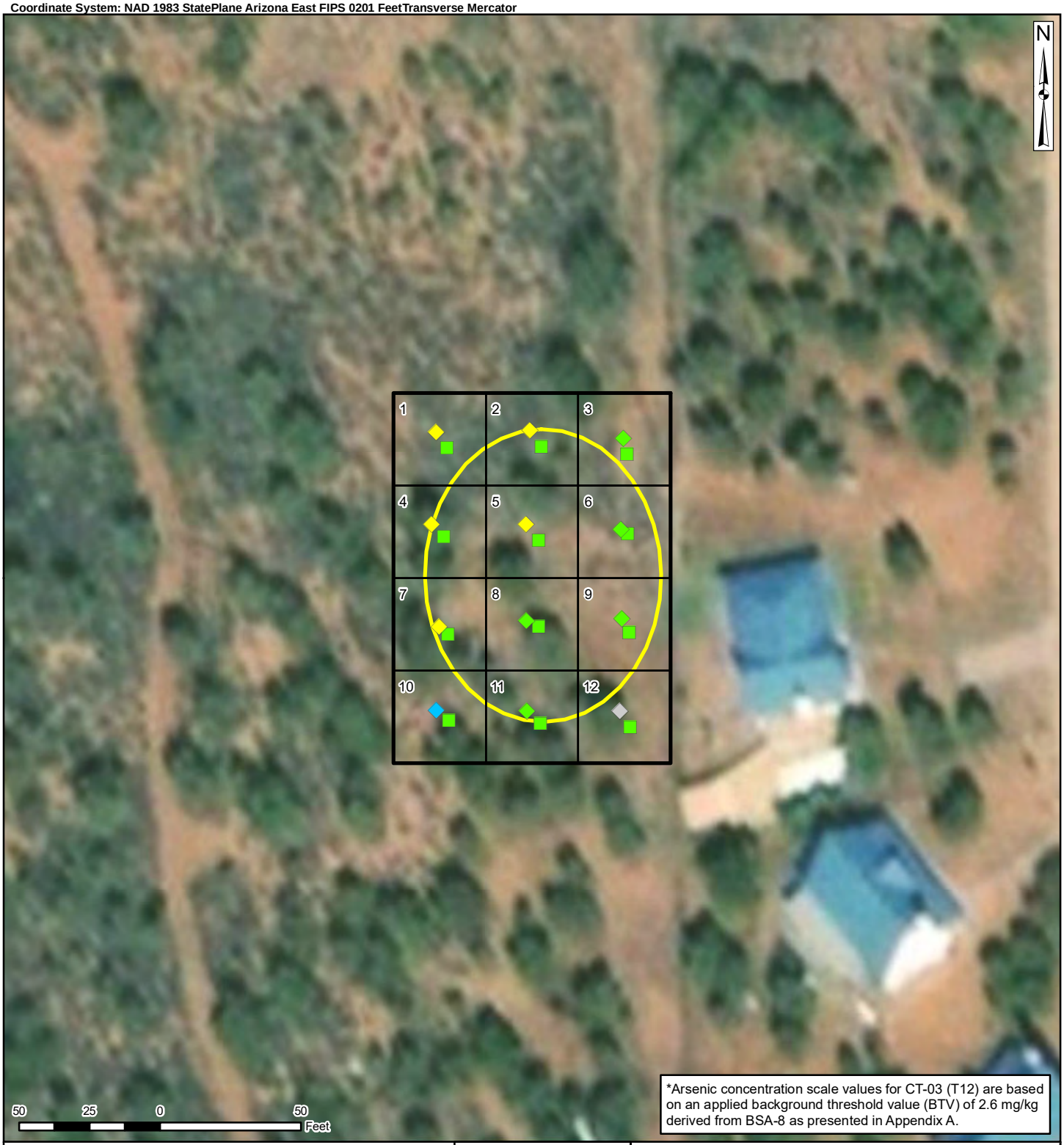


Figure I12-13. Box Plot for Target CT-03 (T12) and BSA-8 (Trc) Arsenic Soil Concentrations

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



*Arsenic concentration scale values for CT-03 (T12) are based on an applied background threshold value (BTV) of 2.6 mg/kg derived from BSA-8 as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 1.9
- 1.9 - 2.6
- 2.6 - 5.2
- 5.2 - 7.8
- 7.8 - 10
- 10 - 26
- ≥ 26
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- Surface Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET CT-03 (T12) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I12-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.3.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I12-7. Lead exceeded the applied BTV in 8.3 percent of in situ XRF measurements and 1 of the 12 XRF confirmation samples. The applied BTV for lead is 11 mg/kg for Target T12 as presented in Section 6.3.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I12-5 and Attachment I3, respectively. Figure I12-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T12 and BSA-8 (Trc) samples. Figure I12-16 presents a box plot of detectable lead XRF soil concentrations for Target T12 and BSA-8 (Trc) samples. Summary statistics for XRF measurements are provided in Section 6.3.6.1. Lead XRF concentrations measured in surface soils at Target T12 ranged between 5.93 and 13.4 mg/kg with an average and standard deviation of 9.6 mg/kg and 1.8 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T12 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I12-17. Overall, the majority of detectable lead results in surface soils were less than the applied BTV. Exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials.

For subsurface samples, lead did not exceed the applied BTV. The maximum lead concentration in the subsurface soil samples was 7.3 mg/kg.

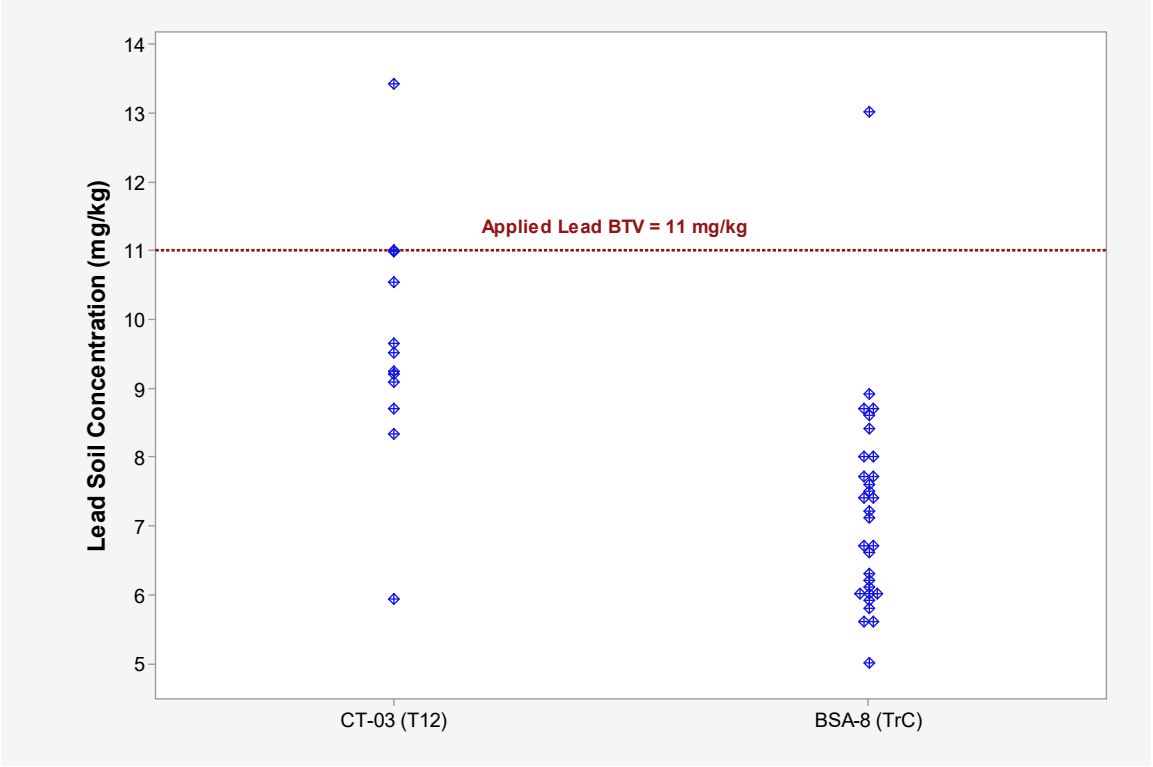


Figure I12-15. Individual Value Plot for Target CT-03 (T12) and BSA-8 (Trc) Lead Soil Concentrations

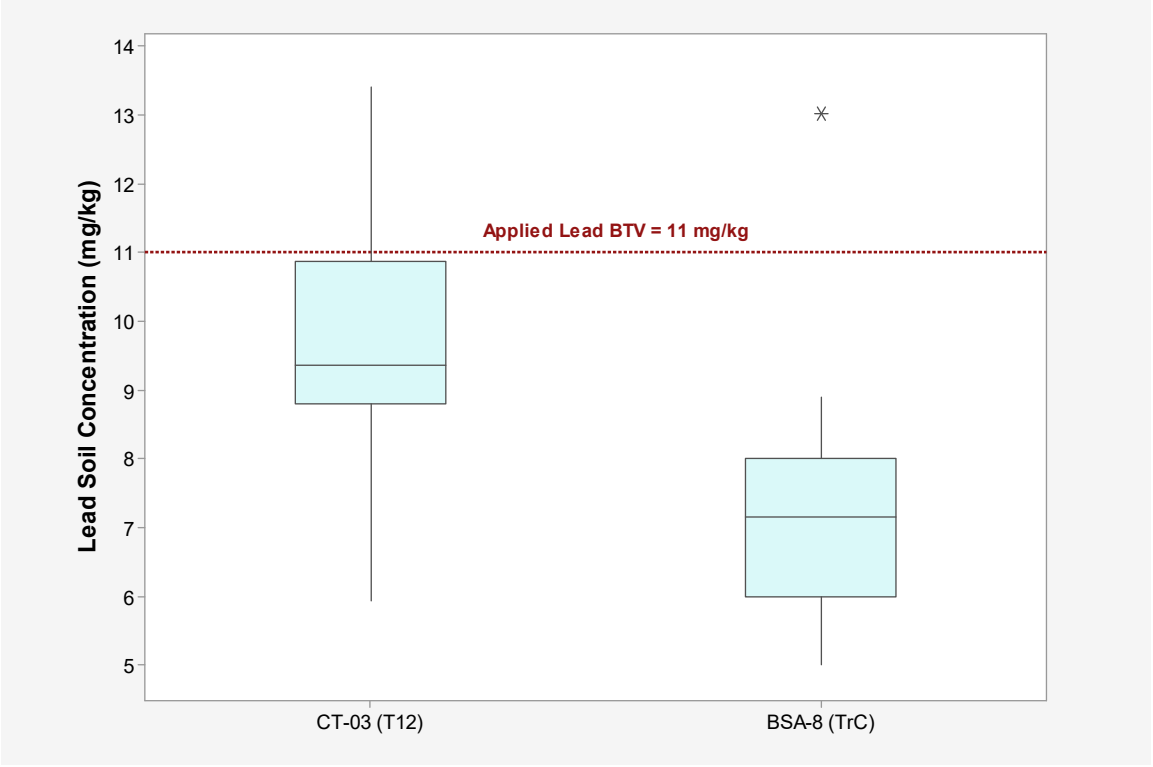
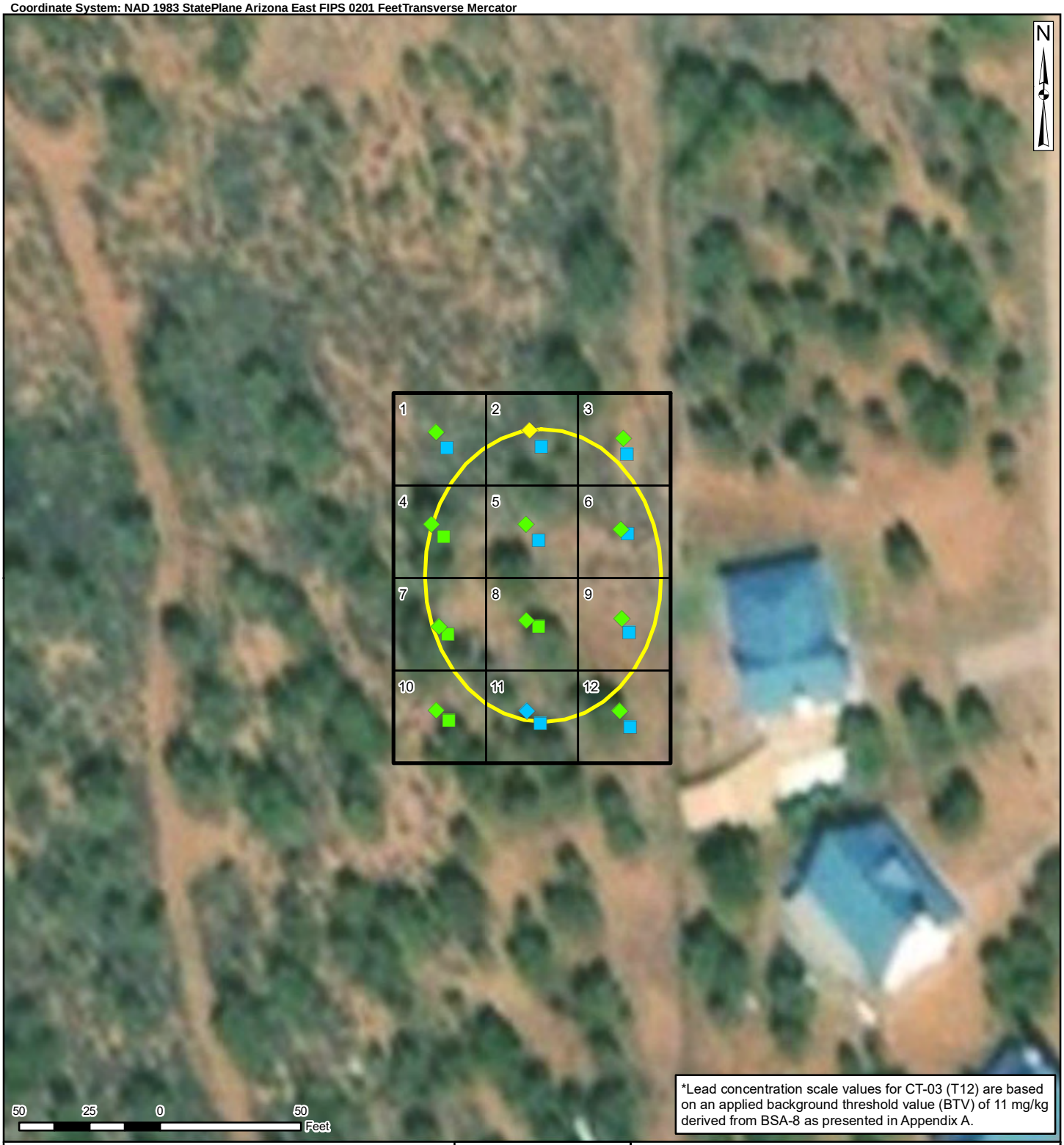


Figure I12-16. Box Plot for Target CT-03 (T12) and BSA-8 (Trc) Lead Soil Concentrations

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



*Lead concentration scale values for CT-03 (T12) are based on an applied background threshold value (BTV) of 11 mg/kg derived from BSA-8 as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 7.2
- 7.2 - 11
- 11 - 22
- 22 - 33
- 33 - 44
- 44 - 110
- ≥ 110

Lead Concentration Value Source

- In Situ XRF Measurement
- Surface Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET CT-03 (T12) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I12-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.3.7.4 Thorium

Thorium was not identified as a COPC in surface soil as shown in Table I12-7. Thorium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for thorium is 4.4 mg/kg for Target T12 as presented in Section 6.3.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I12-5 and Attachment I3, respectively. Figure I12-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T12 and BSA-8 (Trc) samples. Figure I12-19 presents a box plot of detectable thorium soil concentrations for Target T12 and BSA-8 (Trc) samples. Summary statistics for XRF measurements are provided in Section 6.3.6.1. Thorium XRF concentrations measured in surface soils at Target T12 ranged between 2.17 and 4.33 mg/kg with an average and standard deviation of 2.9 mg/kg and 0.6 mg/kg, respectively. The average thorium concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T12 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I12-20. All thorium results in surface soils were less than the applied BTV.

Thorium did not exceed the applied BTV in the subsurface soil samples collected. The maximum thorium concentration in the subsurface soil samples was 2.7 mg/kg.

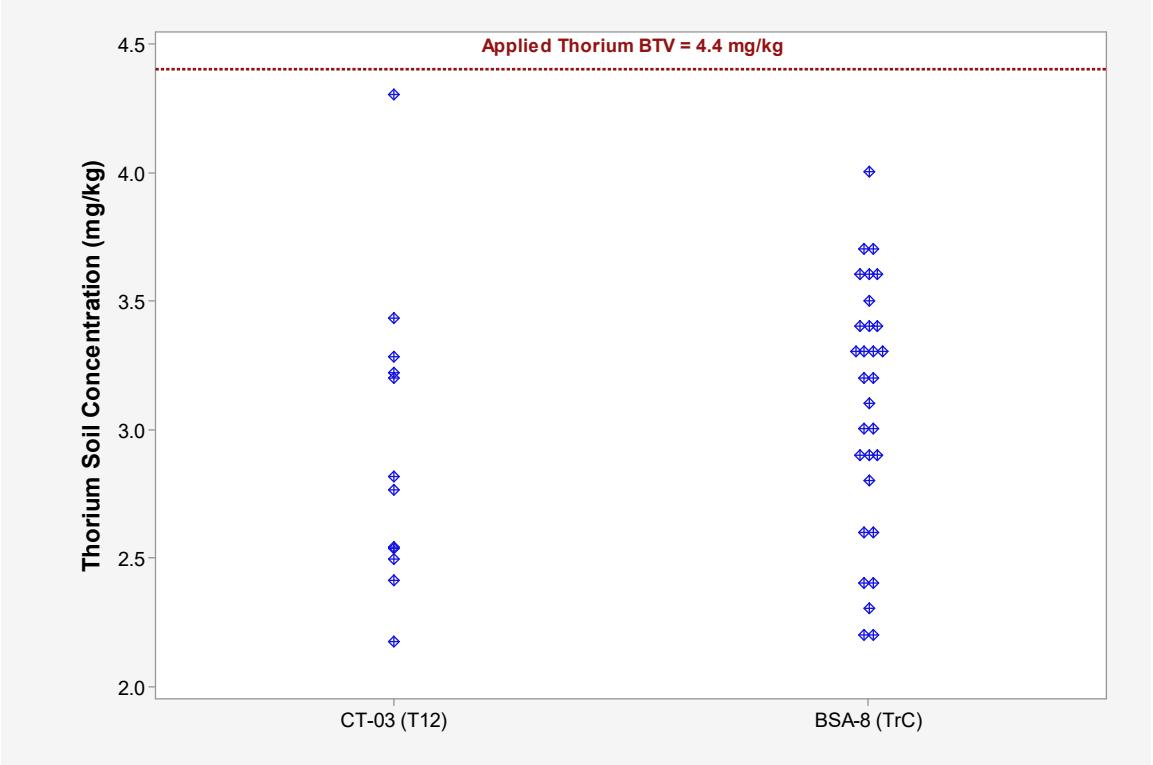


Figure I12-18. Individual Value Plot for Target CT-03 (T12) and BSA-8 (Trc) Thorium Soil Concentrations

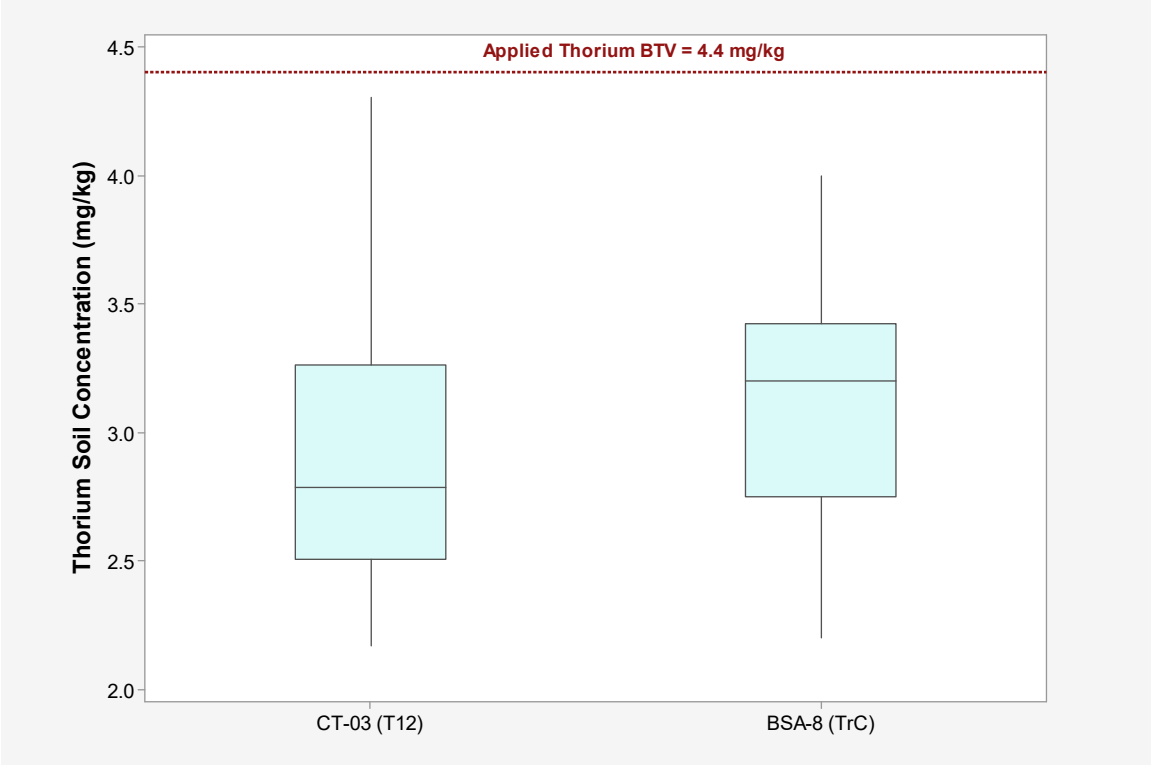
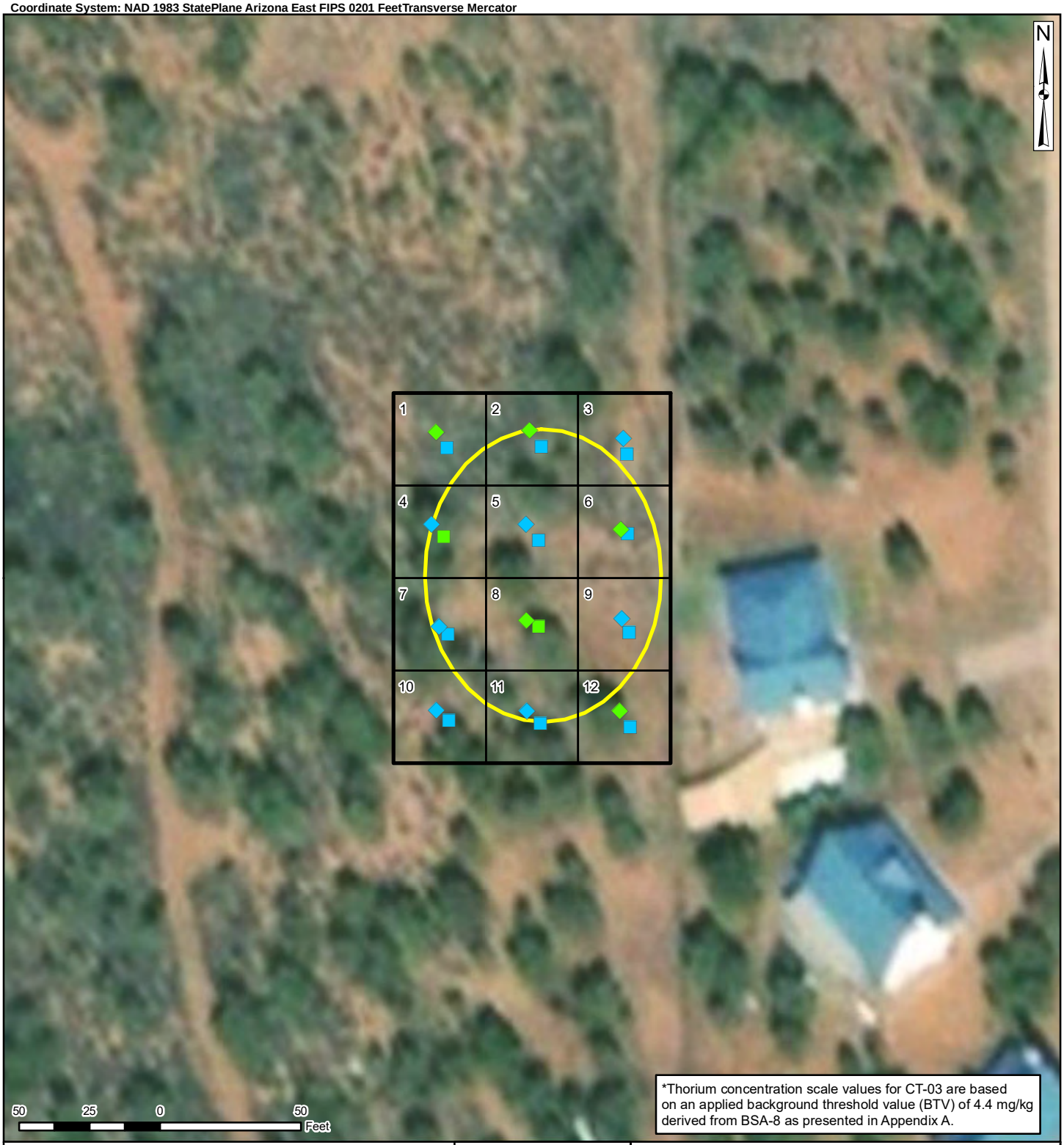


Figure I12-19. Box Plot for Target CT-03 (T12) and BSA-8 (Trc) Thorium Soil Concentrations

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



Thorium Concentration Scale (mg/kg)*

- ≤ 3.1
- 3.1 - 4.4
- 4.4 - 8.8
- 8.8 - 13
- 13 - 18
- 18 - 44
- ≥ 44

Thorium Concentration Value Source

- In Situ XRF Measurement
- Surface Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET CT-03 (T12) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I12-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/25/2019	

6.3.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I12-7. Uranium exceeded the applied BTV in 75 percent of in situ XRF measurements and 2 of the 12 XRF confirmation samples. The applied BTV for uranium is 0.55 mg/kg for Target T12 as presented in Section 6.3.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I12-5 and Attachment I3, respectively. Figure I12-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T12 and BSA-8 (Trc) samples. Figure I12-22 presents a box plot of detectable uranium XRF soil concentrations for Target T12 and BSA-8 (Trc) samples. Summary statistics for XRF measurements are provided in Section 6.3.6.1. Uranium XRF concentrations measured in surface soils at Target T12 ranged between 0.3 and 1.95 mg/kg with an average and standard deviation of 1.2 mg/kg and 0.6 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T12 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I12-23. Overall, the detectable uranium results in surface soils were slightly above the applied BTV. However, the maximum value was 3.5 times higher than the applied BTV and does not appear to be associated with mining-related materials.

For subsurface samples, uranium did not exceed the applied BTV. The maximum uranium concentration in the subsurface soil samples was 0.38 mg/kg.

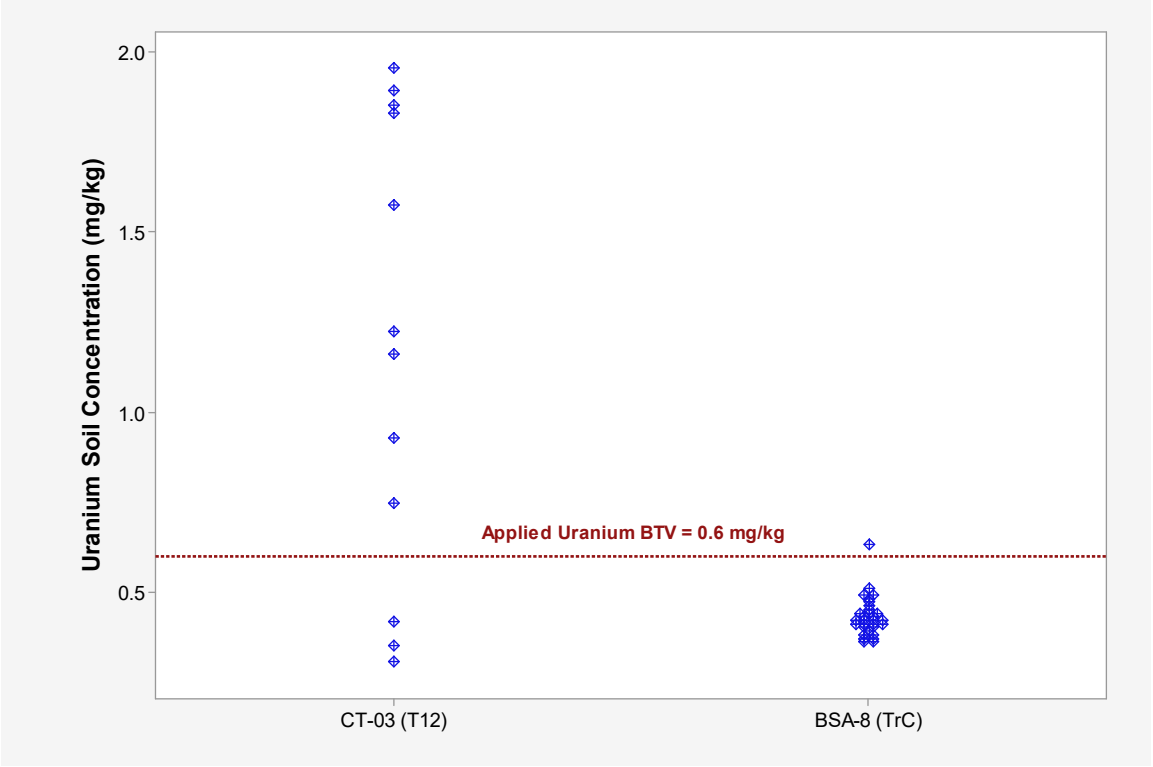


Figure I12-21. Individual Value Plot for Target CT-03 (T12) and BSA-8 (Trc) Uranium Soil Concentrations

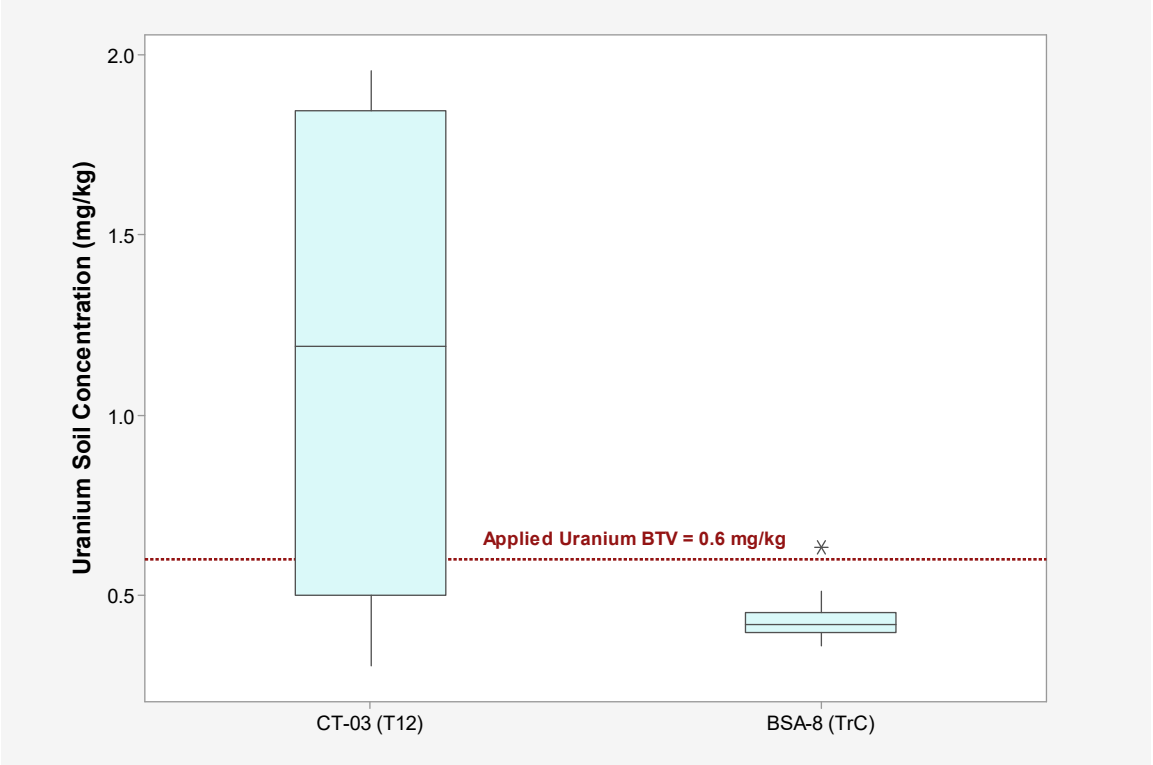
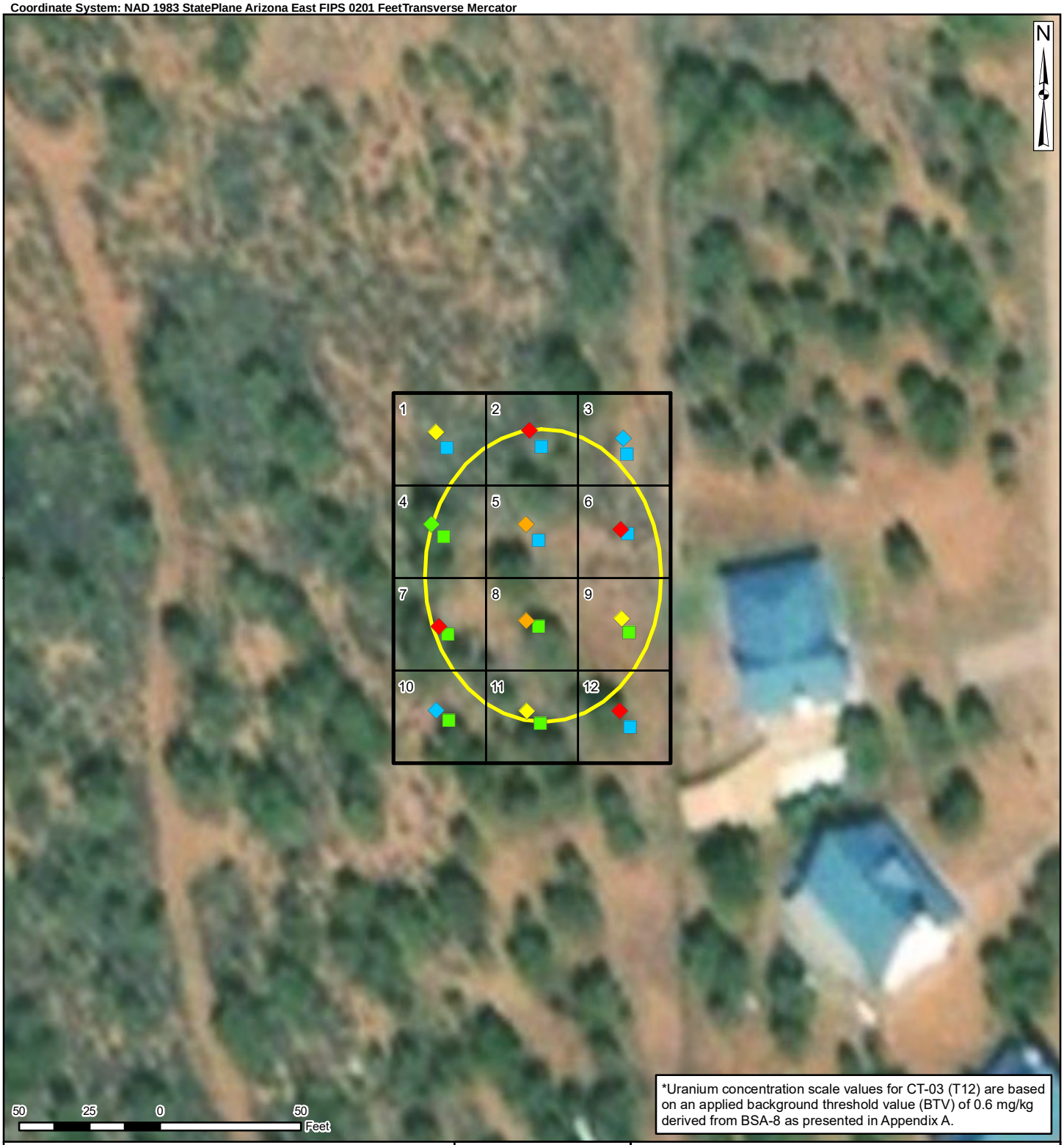


Figure I12-22. Box Plot for Target CT-03 (T12) and BSA-8 (Trc) Uranium Soil Concentrations

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



*Uranium concentration scale values for CT-03 (T12) are based on an applied background threshold value (BTV) of 0.6 mg/kg derived from BSA-8 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 0.4
- 0.4 - 0.6
- 0.6 - 1.2
- 1.2 - 1.8
- 1.8 - 2.4
- 2.4 - 6.0
- ≥ 6.0

Uranium Concentration Value Source

- In Situ XRF Measurement
- Surface Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET CT-03 (T12) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I12-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.3.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I12-7. Vanadium exceeded the applied BTV in 66.7 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for vanadium is 15 mg/kg for Target T12 as presented in Section 6.3.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I12-5 and Attachment I3, respectively. Figure I12-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T12 and BSA-8 (Trc) samples. Figure I12-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T12 and BSA-8 (Trc) samples. Summary statistics for XRF measurements are provided in Section 6.3.6.1. Vanadium XRF concentrations measured in surface soils at Target T12 ranged between 16.1 and 29.3 mg/kg with an average and standard deviation of 19.6 mg/kg and 5.0 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T12 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I12-26. Overall, the majority of detectable vanadium results in surface soils were above the applied BTV. However, exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials.

For subsurface samples, vanadium did not exceed the applied BTV. The maximum vanadium concentration in the subsurface soil samples was 11 mg/kg.

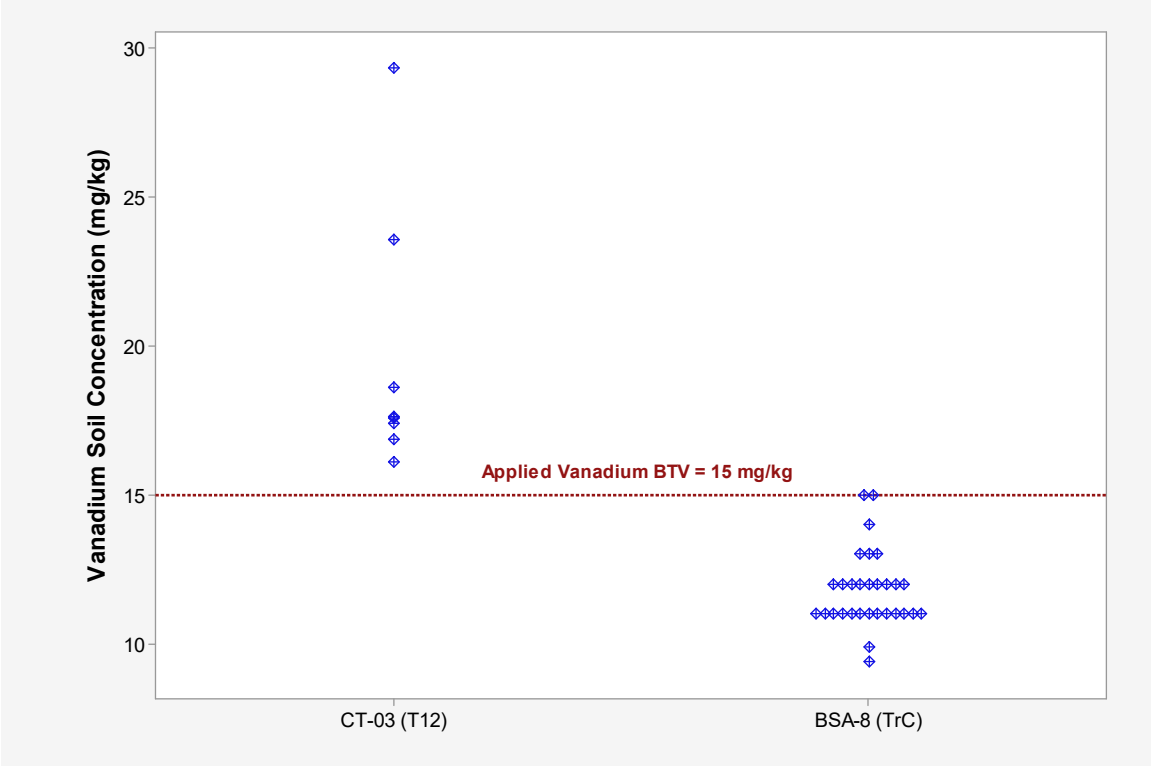


Figure I12-24. Individual Value Plot for Target CT-03 (T12) and BSA-8 (Trc) Vanadium Soil Concentrations

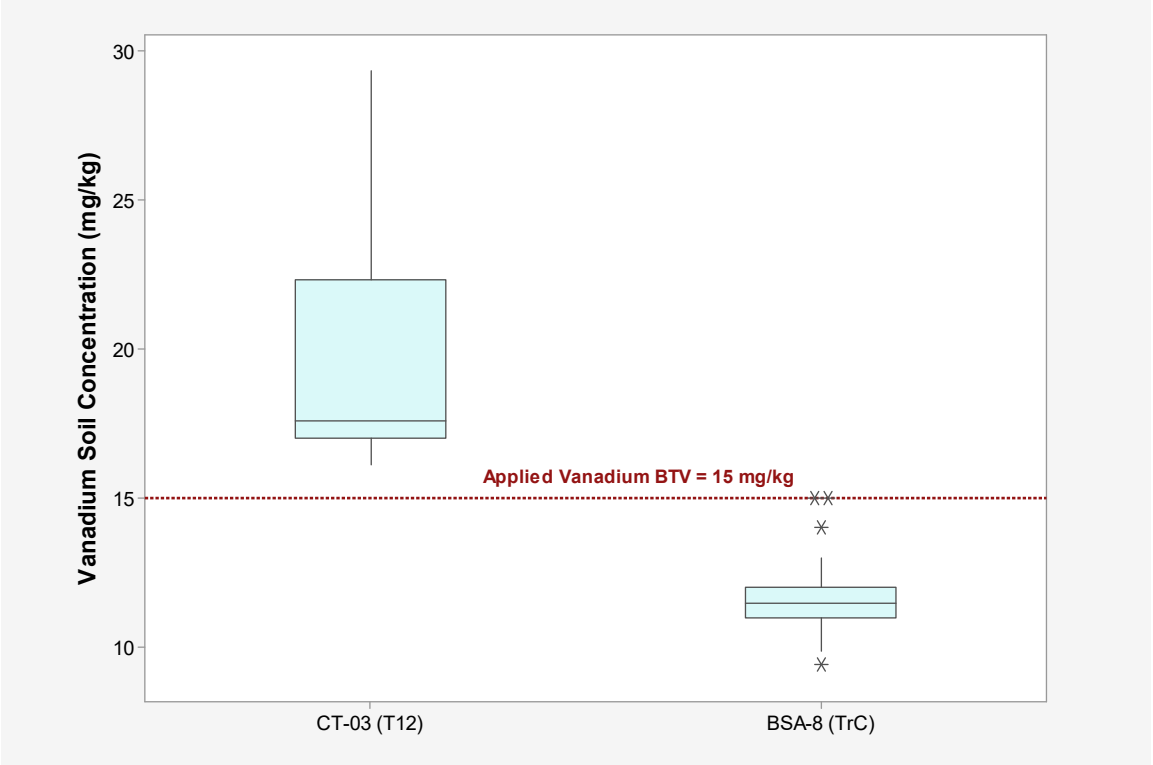
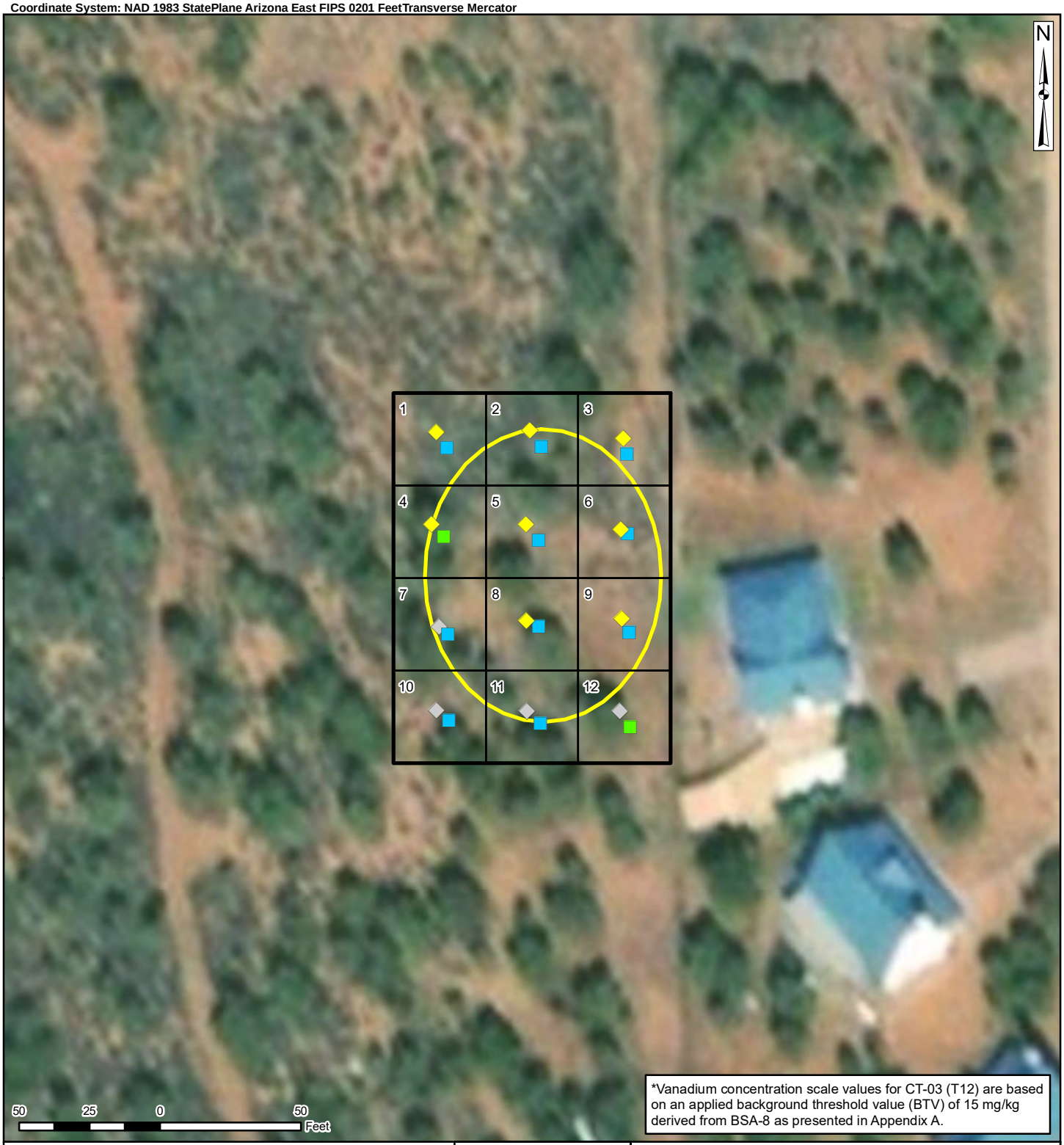


Figure I12-25. Box Plot for Target CT-03 (T12) and BSA-8 (Trc) Vanadium Soil Concentrations

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



*Vanadium concentration scale values for CT-03 (T12) are based on an applied background threshold value (BTV) of 15 mg/kg derived from BSA-8 as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 12
- 12 - 15
- 15 - 30
- 30 - 45
- 45 - 60
- 60 - 150
- ≥ 150
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- Surface Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET CT-03 (T12) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I12-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

6.3.8 Conclusions

Target T12 (CT-03) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T12. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T12 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T12. ASPECT gamma survey results generally did not correlate with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T12 was well documented through gamma radiation surveys, and the lateral extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T12 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. No grid averaged gamma measurements exceeded the applied BTV.
- A total of 26 analytes were identified as occurring within the surface environment. Of these analytes, 12 were identified as COPCs. Only uranium exceeded the applied BTV by a factor greater than 2 based on correlated XRF measurement; however, all XRF confirmation samples were at or below the applied BTV. Sample results at 6 to 12 inches bgs were similar to surface sample results.
- Based on Tetra Tech's RSE observations, Target T12 does not contain TENORM. No mining-related activities or features were observed in the field, and no historical exploratory borings, vents, or other mine openings were noted in the file review or during field observation. NORM was not identified visually or by gamma survey.
- There are no immediate significant physical hazards present at Target T12.
- Access is by footpath only and with permission from the property owner.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No groundwater wells are documented within the vicinity of Target T12. Residences are located nearby; however, it is not known if water is provided by utility or private well. No seeps or springs were observed during the RSE investigation.

- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T12. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No mine waste was observed at Target T12; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; no data gaps remain for Target T12.

7.0 GROUP D FIELD SAMPLING RESULTS

This section presents the field sampling results for Group D Targets T13 (M1-01), T14 (M1-02), and T15 (M1-03). Non-AUM Target T16 (M1-04) is encompassed by and discussed in the Mesa I, Mine 12 (M5) SSRSE Report, and AUM-related Target T17 is addressed in the Mesa I Camp SSRSE Report; both reports are included in Appendix H of the RSE Report. Non-AUM Targets T35 (M1-05) and T36 (M1-06) are discussed in Appendix J of the RSE Report.

7.1 NON-AUM TARGET T13 (M1-01)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T13 (M1-01).

7.1.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T13 (M1-01) is associated with two other non-AUM Targets: T14 (M1-02) and T15 (M1-03). Target T13 is in the Lukachukai Mountains Region in Subarea Group D within the Cove Chapter of the Navajo Nation and accessible by foot off of Indian Route 33. Target T13 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. No residential structures are near the Target. A Target location and access map for Target T13 is shown in Figure I13-1.

A topographical relief map for Target T13 is provided in Figure I13-2. The elevation at Target T13 ranges from 7,588 to 7,614 feet amsl with an average of 7,603 feet amsl. The slope at Target T13 ranges from 1 to 10 percent with an average of 7 percent. There are no drainages at the Target. Target T13 is primarily within the Jse except for a portion of the Target within the Jml, which comprises the Recapture and Salt Wash Members. Target T13 is within the Kunz-Xankey complex soil type (MUSYM 610) (Figures I-20 and I-21).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T13. Weston did not conduct a background study for Target T13. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 11 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T13:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T13 is accessed by taking Indian Route 33 to Mesa I road and then hiking 0.25 mile southeast off-trail.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM and TENORM were not observed at the Target.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  No drainages were observed at the Target. The closest drainage is Middle 3F, which is 800 feet southwest of the Target and discussed in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

  No exploratory borings or haul roads were identified at the Target.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  No AUM or non-AUM Target features were present at the Target. However, the underlying geology is the NORM-bearing Jml and Jse, which may contribute to elevated gamma readings.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target

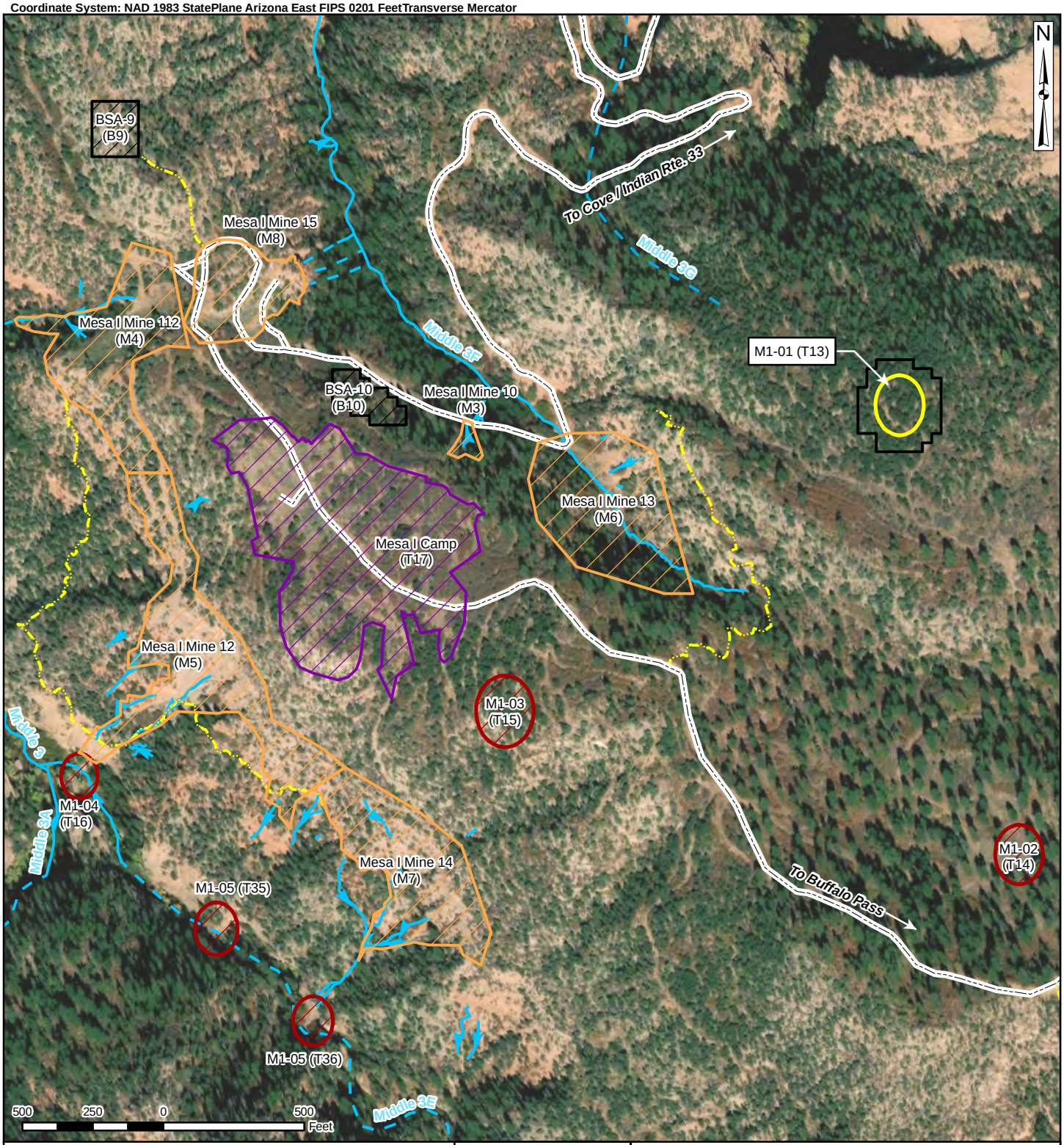
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T13 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Section 2.3 and 7.1.4)
- Conducting an XRF field survey.
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 7.1.3 with results presented in Sections 7.1.6 and 7.1.7)
- Conducting a gamma radiation survey (results presented in Section 7.1.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



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

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

Prepared for: USEPA Region 9

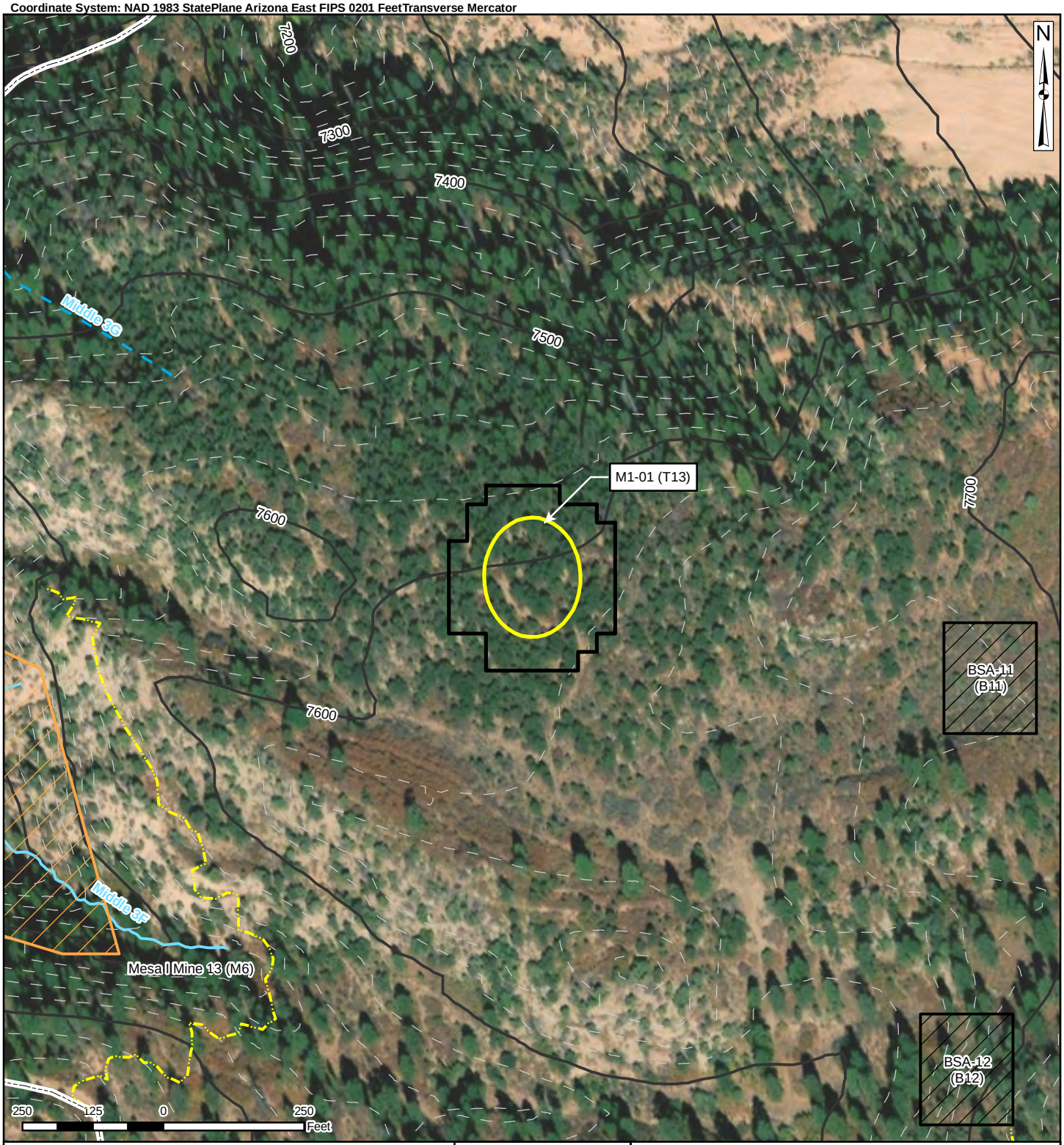
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NON-AUM TARGET M1-01 (T13) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I13-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

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



Non-AUM Target Site Boundary
Related Survey Area
Tronox AUM Site Boundary
Background Location
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped
Drainage*
Drainage - Field Mapped
100 ft Contour**
20 ft Contour**

*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.
**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.

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NON-AUM TARGET M1-01 (T13) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I13-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

7.1.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I13-3) within the survey area of the non-AUM Target T13 as part of the Baseline Study in May 2018. Additional Goback gamma radiation surveys were performed in August 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T13 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I13-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 11, of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at 31 survey units. All gamma survey and XRF survey units were evaluated.

7.1.3 XRF Confirmation Sampling Overview

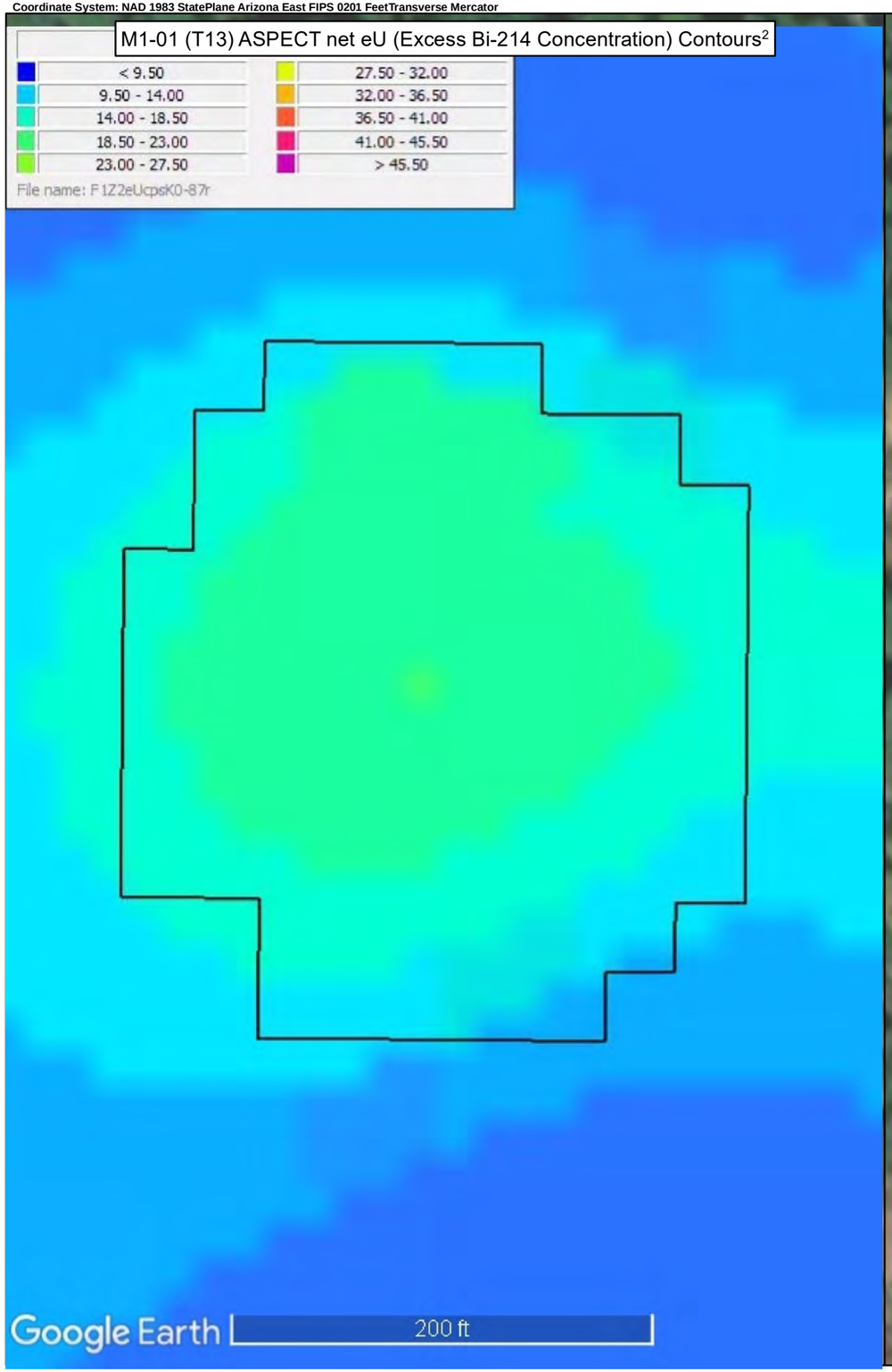
Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T13. Five XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from five locations (Table I13-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I13-4 and I13-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I13-2. The results of XRF confirmation sample analysis are provided in Section 7.1.6.1. Correlated XRF field measurements are provided in Attachment I3.

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

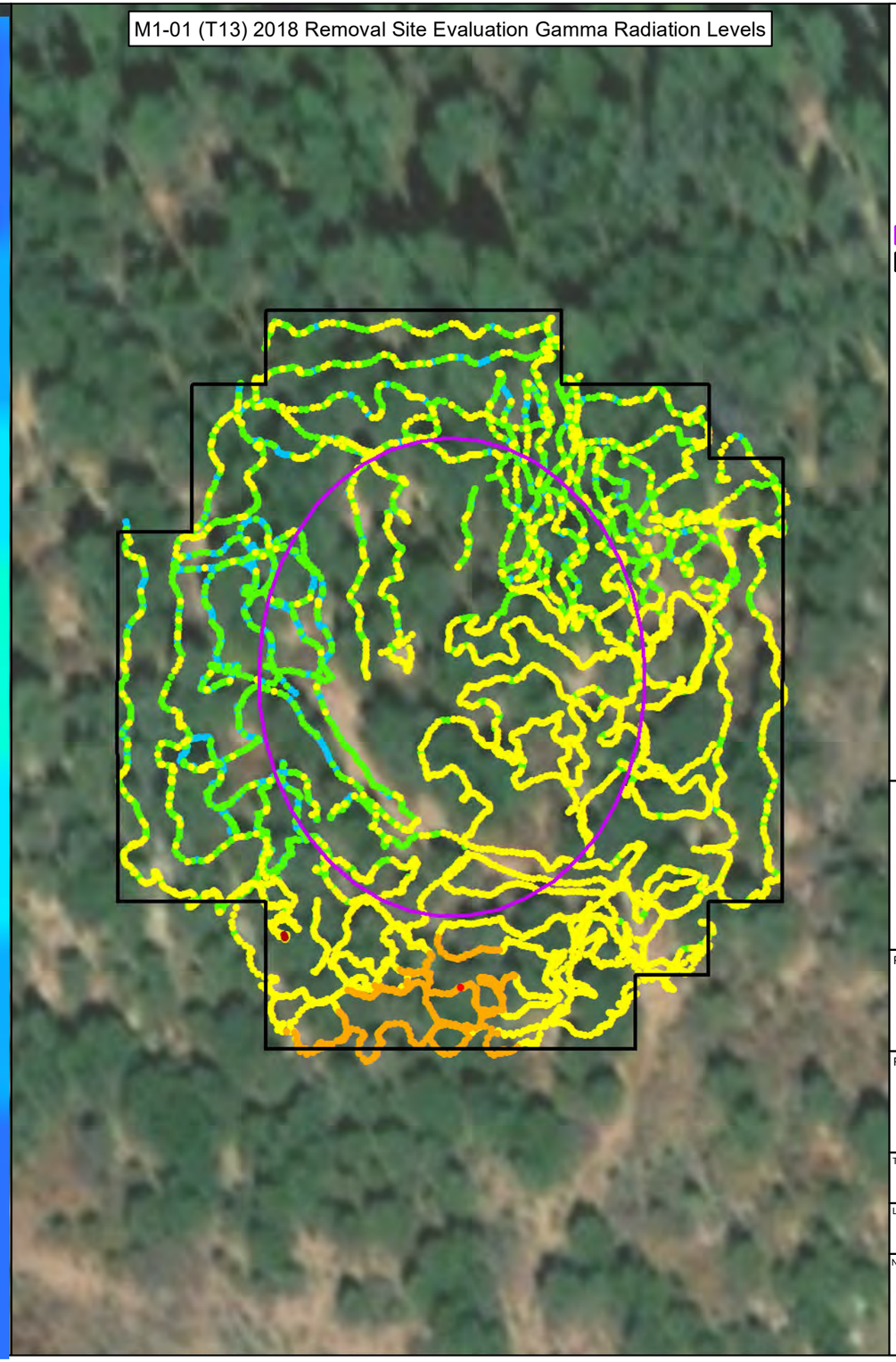
M1-01 (T13) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F1Z2eUcpsK0-87r



M1-01 (T13) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)[1]

≤ 9,283	≤ Avg. BG
9,283 - 10,611	Avg. BG - 1 x BTV
10,611 - 21,222	1 x BTV - 2 x BTV
21,222 - 34,833	2 x BTV - 3 x BTV
34,833 - 42,444	3 x BTV - 4 x BTV
42,444 - 106,110	4 x BTV - 10 x BTV
≥ 106,110	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Area Boundary

[1]The applied gamma background threshold value (BTV) for M1-01 (T13) Non-AUM Target is 10,611 cpm derived from BSA-11 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET M1-01 (T13)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

Prepared By:

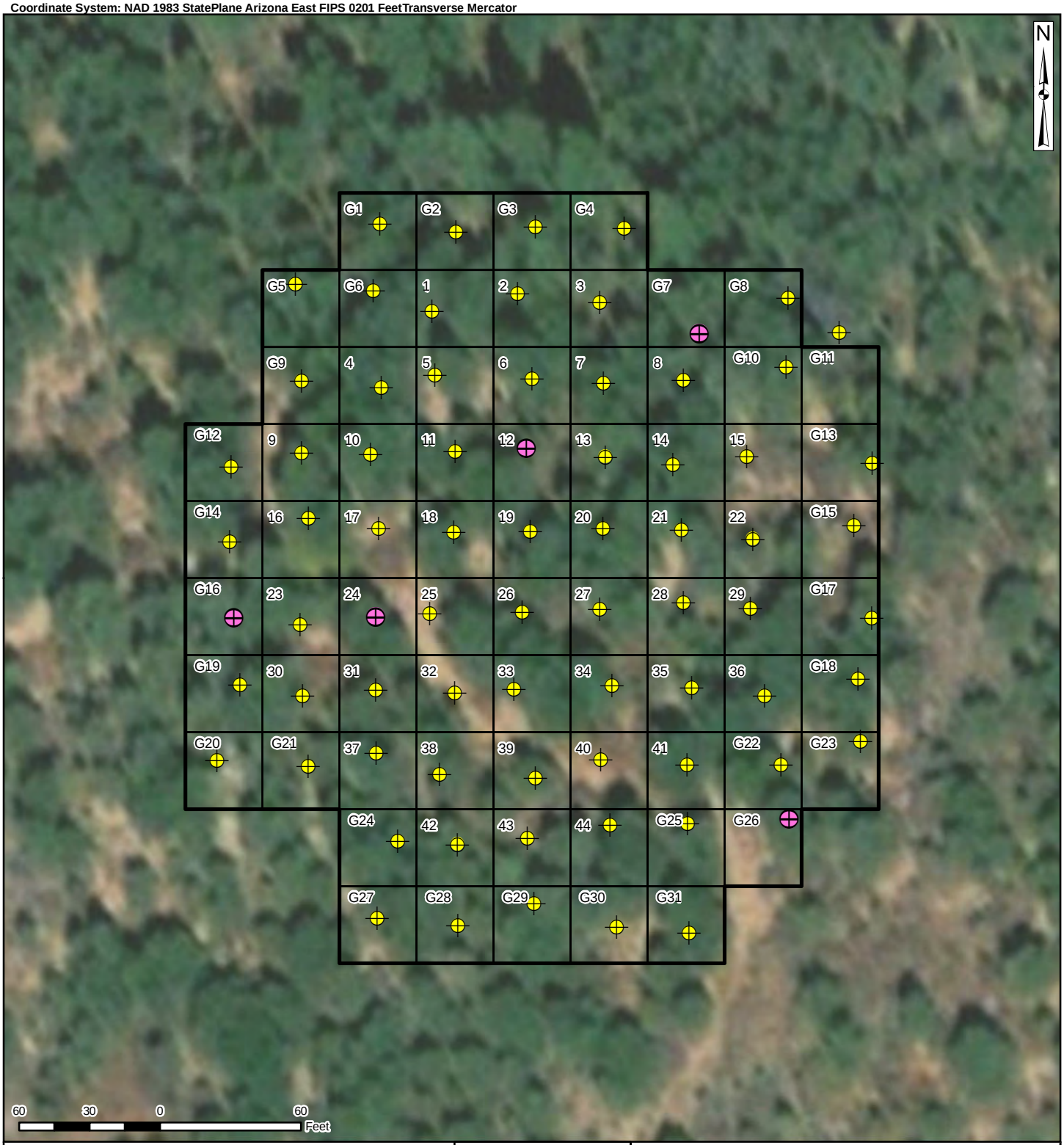
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/12/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborn Spectral Photometric Environmental Collection Technology.

Figure No.: **I13-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Unit (100 m²)

Survey Area Boundary

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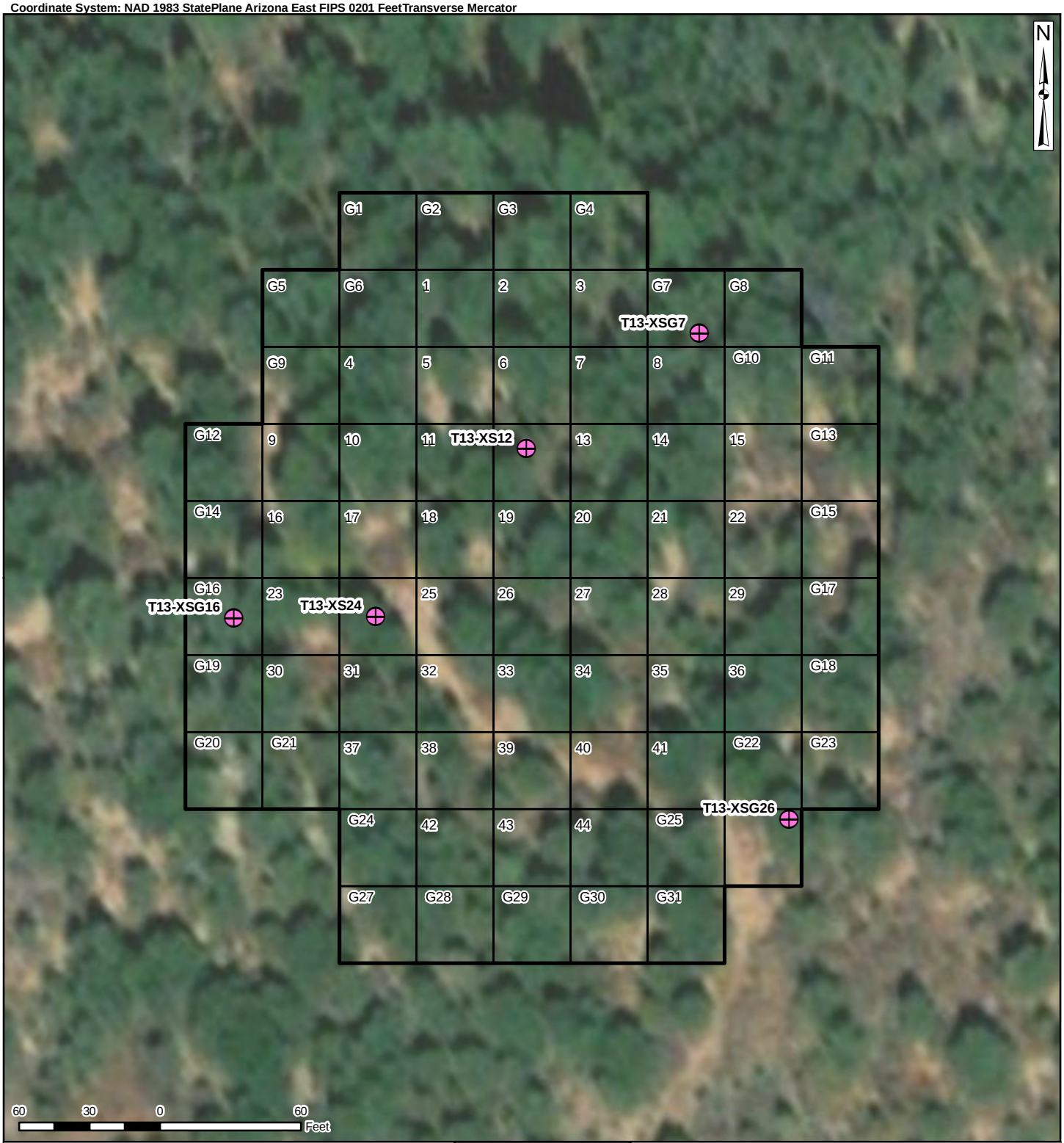
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NON-AUM TARGET M1-01 (T13)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I13-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

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



XRF Confirmation Soil Sample* (0 - 3 inches bgs)

Survey Unit (100 m²)

Survey Area Boundary

*T13-XSG7 = site T13 XRF confirmation soil sample collected at survey unit G7. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET M1-01 (T13)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I13-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

Table I13-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M1-01 (T13)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T13-XS12-01-050818	12	0-3	XRF Confirmation	Primary	5/8/2018	36.5242104	-109.2141431	1805321-21, 1805322-21
T13-XS24-01-050818	24	0-3	XRF Confirmation	Primary	5/8/2018	36.5240155	-109.2143640	1805321-22, 1805322-22
T13-XSG7-01-081618	G7	0-3	XRF Confirmation	Primary	8/16/2018	36.5243429	-109.2138906	1808475-15, 1808476-15
T13-XSG16-01-081618	G16	0-3	XRF Confirmation	Primary	8/16/2018	36.5240154	-109.2145693	1808475-13, 1808476-13
T13-XSG26-01-081618	G26	0-3	XRF Confirmation	Primary	8/16/2018	36.5237739	-109.2137680	1808475-14, 1808476-14

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I13-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M1-01 (T13)

Analyte	Type	CAS Number	Analytical Method	Number of Samples by Standard Analyses
Aluminum	Metals	7429-90-5	USEPA SW-846 6020B	5
Antimony	Metals	7440-36-0	USEPA SW-846 6020B	5
Arsenic	Metals	7440-38-2	USEPA SW-846 6020B	5
Barium	Metals	7440-39-3	USEPA SW-846 6020B	5
Beryllium	Metals	7440-41-7	USEPA SW-846 6020B	5
Cadmium	Metals	7440-43-9	USEPA SW-846 6020B	5
Calcium	Metals	7440-70-2	USEPA SW-846 6020B	5
Chromium	Metals	7440-47-3	USEPA SW-846 6020B	5
Cobalt	Metals	7440-48-4	USEPA SW-846 6020B	5
Copper	Metals	7440-50-8	USEPA SW-846 6020B	5
Iron	Metals	7439-89-6	USEPA SW-846 6020B	5
Lead	Metals	7439-92-1	USEPA SW-846 6020B	5
Lead-210	Radionuclides	14255-04-0	Eichrom method	5
Lithium	Metals	7439-93-2	USEPA SW-846 6020B	5
Magnesium	Metals	7439-95-4	USEPA SW-846 6020B	5
Manganese	Metals	7439-96-5	USEPA SW-846 6020B	0
Molybdenum	Metals	7439-98-7	USEPA SW-846 6020B	5
Nickel	Metals	7440-02-0	USEPA SW-846 6020B	5
Potassium-40	Radionuclides	13966-00-2	USEPA 901.1	5
Radium-226	Radionuclides	13982-63-3	USEPA 901.1	5
Radium-228	Radionuclides	15262-20-1	USEPA 901.1	5
Selenium	Metals	7782-49-2	USEPA SW-846 6020B	5
Silver	Metals	7440-22-4	USEPA SW-846 6020B	5
Sodium	Metals	7440-23-5	USEPA SW-846 6020B	5
Thallium	Metals	7440-28-0	USEPA SW-846 6020B	5
Vanadium	Metals	7440-62-2	USEPA SW-846 6020B	5
Zinc	Metals	7440-66-6	USEPA SW-846 6020B	5
Thorium	Metals	-	USEPA SW-846 6020B	5
Thorium-228	Radionuclides	14274-82-9	ASTM D3972 Modified	5
Thorium-230	Radionuclides	14269-63-7	ASTM D3972 Modified	5
Thorium-232[1]	Radionuclides	7440-29-1	ASTM D3972 Modified	5
Uranium	Metals	-	USEPA SW-846 6020B	5
Uranium-234	Radionuclides	13966-29-5	ASTM D3972 Modified	5
Uranium-235	Radionuclides	15117-96-1	ASTM D3972 Modified	5
Uranium-238[1]	Radionuclides	7440-61-1	ASTM D3972 Modified	5

Notes:
[1] Measured via alpha spectroscopy
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

7.1.4 Applied Background Threshold Value

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 7.1.1, Target T13 surface geology is predominately within Jse with soils within the Kunz-Xankey complex (MUSYM 610) (Figures I-20 and I-21). As a result, Background Study Area 11 (BSA-11) was selected for that combination of geology and soil type. Additionally, the Jse regional geological background would also be applicable for this Target. Table I13-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T13. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T13. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T13. The “Applied BTV” for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I13-3. Applied Background Threshold Values for Non-AUM Target M1-01 (T13)

Analyte	Units	Site-Specific BTV (BSA-11)	Regional BTV (Jse)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	5,010	7,400	5,010	Site-Specific BTV
Antimony	mg/kg	0.158	0.163	0.158	Site-Specific BTV
Arsenic	mg/kg	2.4	4.8	2.4	Site-Specific BTV
Barium	mg/kg	150	166	150	Site-Specific BTV
Beryllium	mg/kg	0.47	0.51	0.47	Site-Specific BTV
Cadmium	mg/kg	0.134	0.160	0.134	Site-Specific BTV
Calcium	mg/kg	18,800	36,000	18,800	Site-Specific BTV
Chromium	mg/kg	12	11.0	11.0	Regional BTV
Cobalt	mg/kg	3.2	4.4	3.2	Site-Specific BTV
Copper	mg/kg	10	11	10	Site-Specific BTV
Iron	mg/kg	6,510	8,000	6,510	Site-Specific BTV
Lead	mg/kg	10	12	10	Site-Specific BTV
Lithium	mg/kg	8.4	13	8.4	Site-Specific BTV
Magnesium	mg/kg	3,380	7,000	3,380	Site-Specific BTV
Manganese	mg/kg	460	500	460	Site-Specific BTV
Mercury	mg/kg	0.0291	0.0298	0.0291	Site-Specific BTV
Molybdenum	mg/kg	0.30	0.34	0.30	Site-Specific BTV
Nickel	mg/kg	13.0	11.0	11.0	Regional BTV
Potassium-40	pCi/g	21.2	23.7	21.2	Site-Specific BTV
Radium-226	pCi/g	1.32	4.15	1.32	Site-Specific BTV
Radium-228	pCi/g	0.50	0.84	0.50	Site-Specific BTV
Selenium	mg/kg	0.82	0.98	0.82	Site-Specific BTV
Silver	mg/kg	0.020	0.055	0.020	Site-Specific BTV
Sodium	mg/kg	30	36	30	Site-Specific BTV
Thallium	mg/kg	0.063	0.091	0.063	Site-Specific BTV
Thorium	mg/kg	4.1	3.6	3.6	Regional BTV
Uranium	mg/kg	0.63	3.4	0.63	Site-Specific BTV
Vanadium	mg/kg	11	31	11	Site-Specific BTV
Zinc	mg/kg	39	28	28	Regional
Gamma Radiation	cpm	10,611	15,781	10,611	Site-Specific BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
Jse Summerville, Entrada Formation (Undifferentiated)
mg/kg milligrams per kilogram
pCi/g picocuries per gram

7.1.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T13 and the raw gamma radiation and grid averaged gamma radiation survey results.

7.1.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T13 in May 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in August 2018 to collect data within the Goback survey units. The applied gamma BTV for non-AUM Target T13 is 10,611 cpm. A total of 6,254 measurements were collected as part of the gamma radiation survey at non-AUM Target T13 across 75 survey units. An average scan density of 83 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I13-4.

Table I13-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M1-01 (T13)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	10,611	
Measurements	#	6,254	75
Minimum	cpm	7,589	9,384
Maximum	cpm	73,751	25,317
Average	cpm	11,968	11,512
Median	cpm	10,945	10,618
Standard Deviation	cpm	3,928	2,824
90th Percentile	cpm	14,865	13,853
95th Percentile	cpm	21,826	17,878
99th Percentile	cpm	26,707	23,354
Measurements per Grid	#/grid	83	
Measurements Above Gamma BTV	#	3,857	38
Measurements Above Gamma BTV	%	61.7	50.7

Notes:
BTV background threshold value
cpm counts per minute

7.1.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 61.7 percent of the measurements within the Target boundaries, in some cases exceeding greater than three times the applied gamma BTV (10,611 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-11 (Jse) gamma survey results is provided in Figure I13-6. This graph shows that the spread of radiation data at Target T13 (shown on left) begins within the lower range of BSA-11 (Jse) gamma levels (shown on right) and then rises to more than three times background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T13 is slightly higher than the data cloud from the BSA-11 (Jse) data set. A box plot showing the quartiles of the data sets is provided in Figure I13-7. The box plot shows that the median of Target T13 radiation levels is higher than the median of the BSA-11 (Jse) data set and slightly higher than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I13-8. No mining activity was observed within the survey area of Target T13. However, the southern portion of the survey area contains outcroppings of Jml.

In general, Target T13 has surficial gamma radiation levels above BSA-11 (Jse) levels that increase along with exposure of underlying geology in the southern portion of the Target, indicating that the survey encompassed the area of elevated gamma activity identified by the ASPECT gamma survey (Figure I13-3). No TENORM or mining-related activities were observed. Section 7.1.5.3 presents the grid averaged results of the gamma radiation survey.

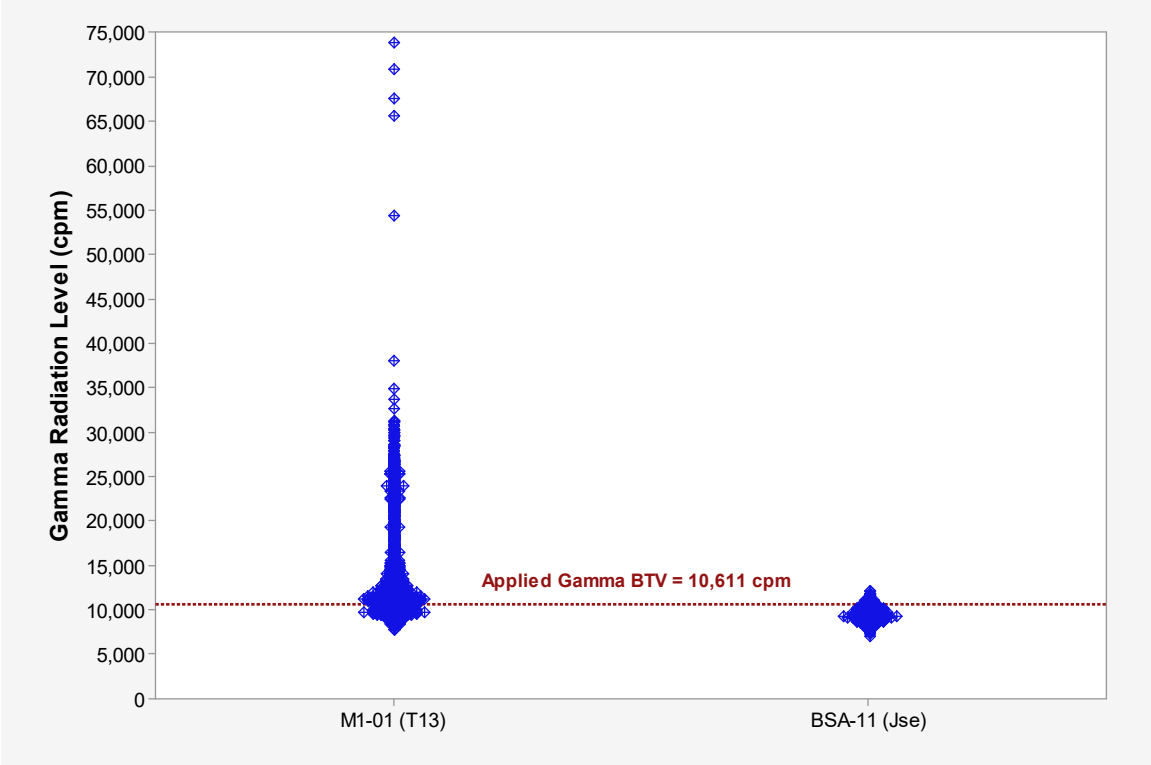


Figure I13-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M1-01 (T13) and BSA-11 (Jse)

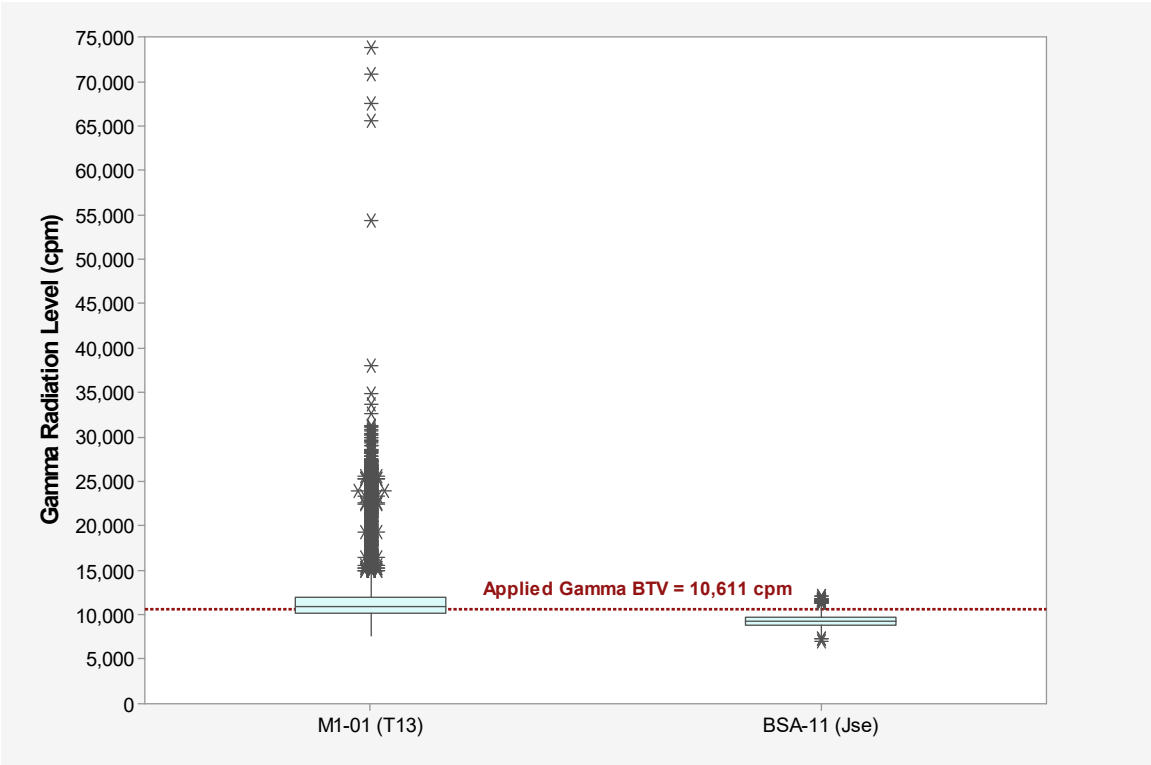
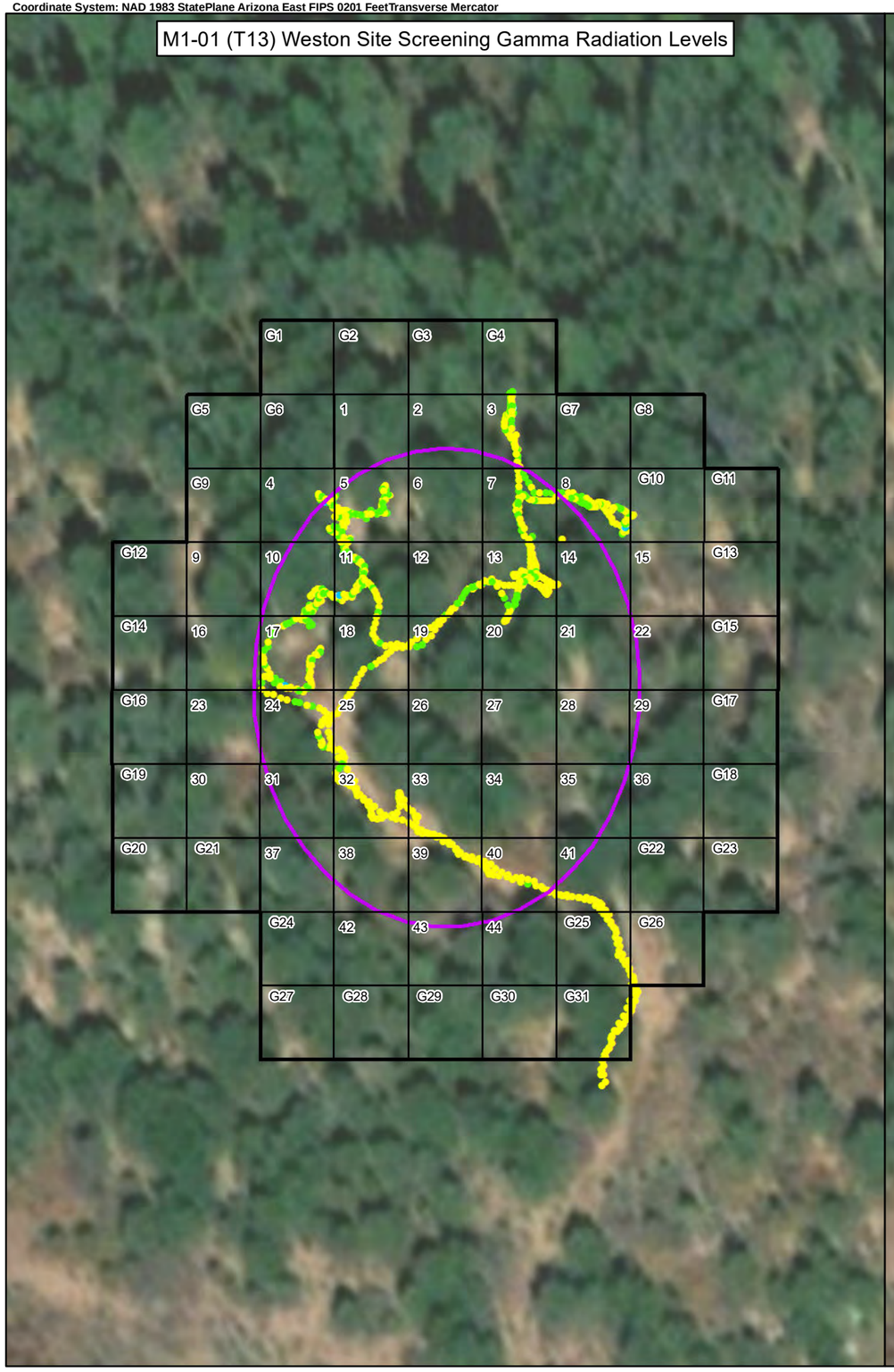
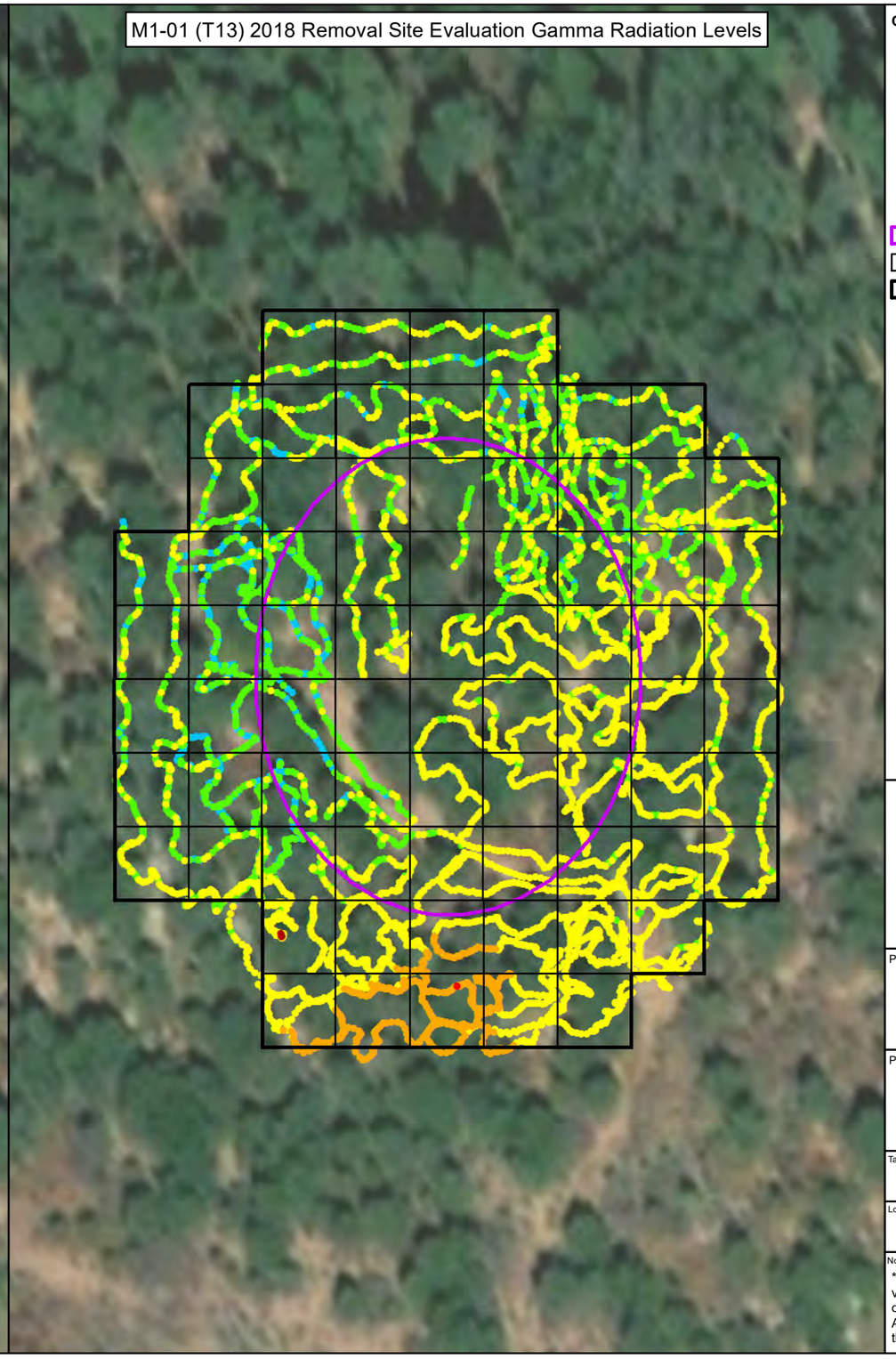


Figure I13-7. Box Plot of Raw Gamma Radiation Levels at Target M1-01 (T13) and BSA-11 (Jse)

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





Gamma Reading (cpm)*

≤ 9,283	≤ Avg. BG
9,283 - 10,611	Avg. BG - 1 x BTV
10,611 - 21,222	1 x BTV - 2 x BTV
21,222 - 34,833	2 x BTV - 3 x BTV
34,833 - 42,444	3 x BTV - 4 x BTV
42,444 - 106,110	4 x BTV - 10 x BTV
≥ 106,110	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary

1 in = 60 ft

1:720

N
W E
S

0 30 60 120 Feet

NON-AUM TARGET M1-01 (T13) 2018 REMOVAL SITE EVALUATION VS WESTON SITE SCREENING GAMMA RADIATION LEVELS SURVEY MAP

Prepared For:

Prepared By:

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/13/2019

Notes:
*The applied gamma background threshold value (BTV) for M1-01 (T13) is 10,611 cpm derived from BSA-11 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I13-8**

7.1.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 7.1.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 7.1.5.1. Figure I13-9 and Figure I13-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-11 (Jse) data set (shown on right). A total of 50.7 percent of the survey units (38 of 75) within the survey area of Target T13 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I13-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I13-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. The elevated regions correspond with surface exposure of the Jml.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 7.1.6.

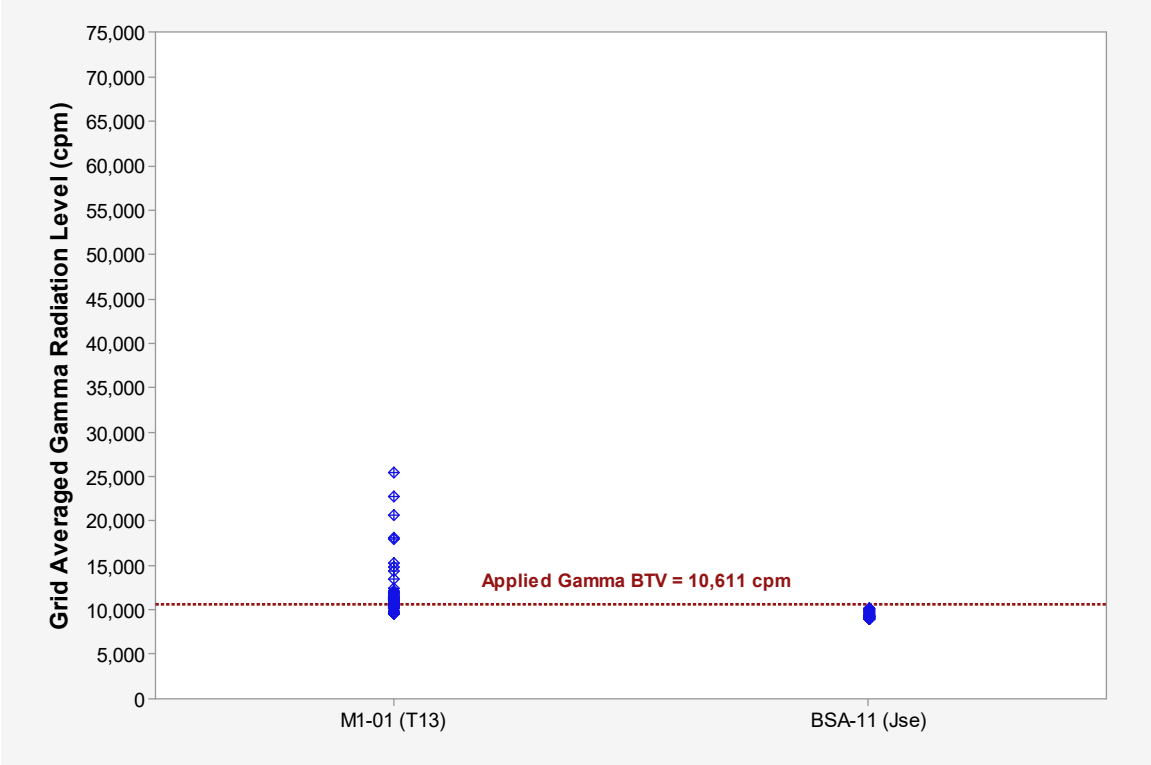


Figure I13-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M1-01 (T13) and BSA-11 (Jse)

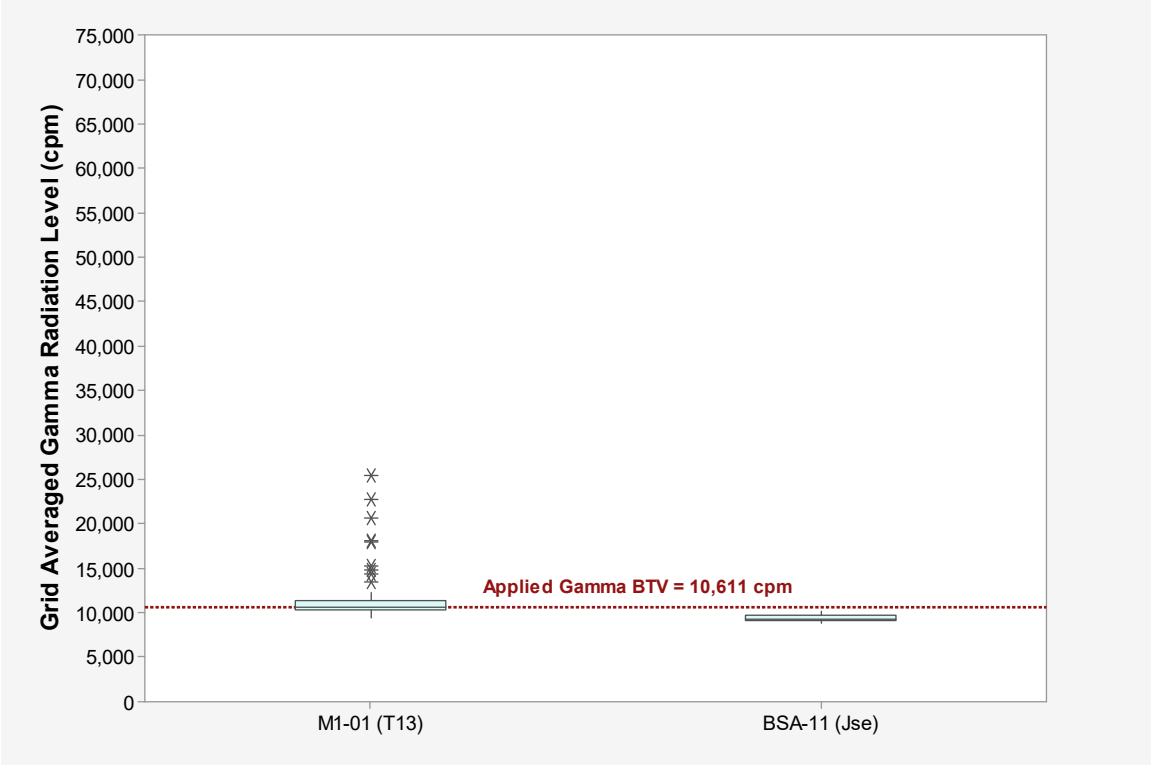
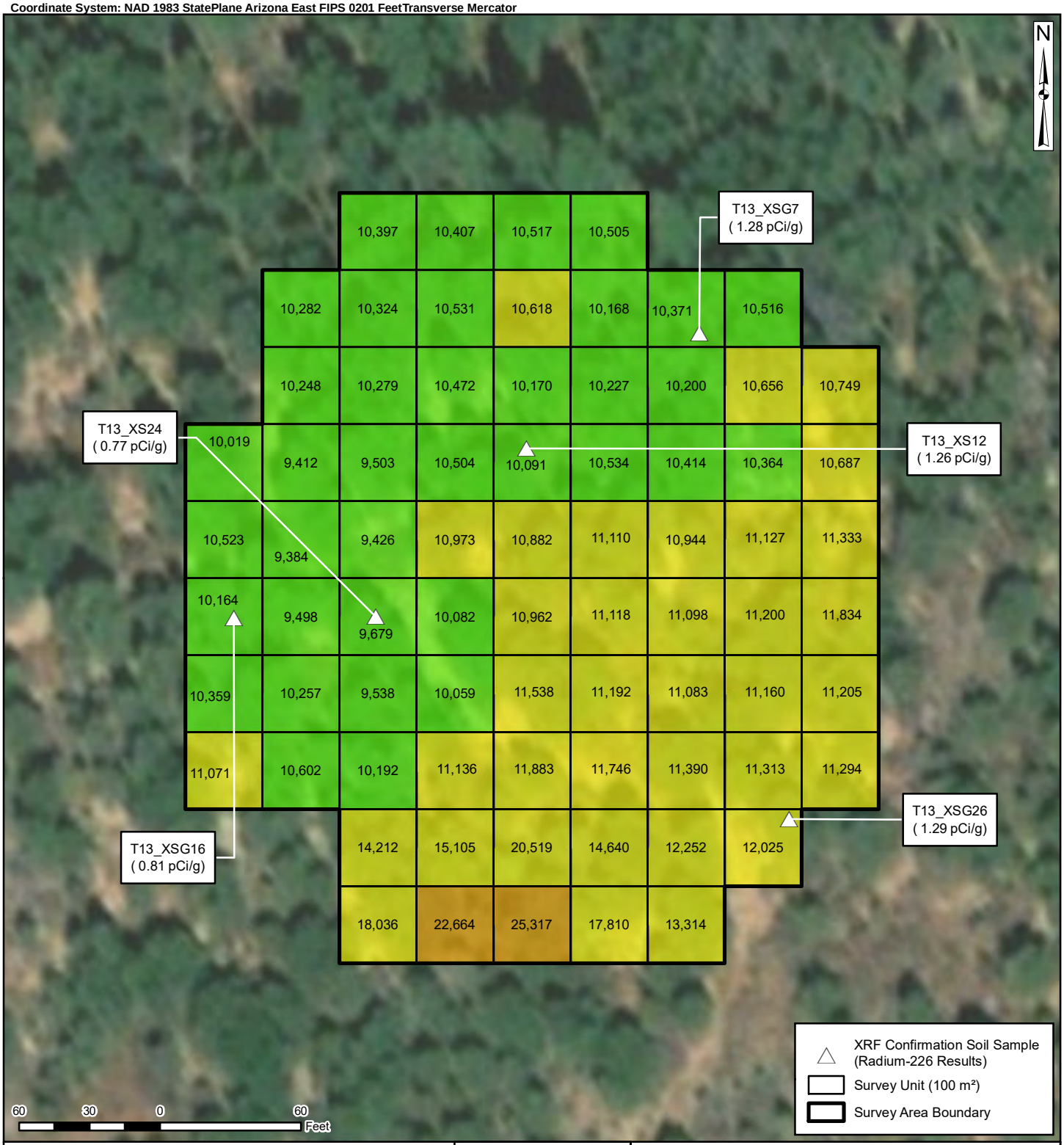


Figure I13-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M1-01 (T13) and BSA-11 (Jse)

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



Grid Averaged Gamma Reading (cpm)*

≤ 9,283	≤ Avg. BG
9,283 - 10,611	Avg. BG - 1 x BTV
10,611 - 21,222	1 x BTV - 2 x BTV
21,222 - 31,833	2 x BTV - 3 x BTV
31,833 - 42,444	3 x BTV - 4 x BTV
42,444 - 106,110	4 x BTV - 10 x BTV
≥ 106,110	≥ 10 x BTV

*The applied gamma background threshold value (BTV) for M1-01 (T13) is 10,611 cpm derived from BSA-11 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M1-01 (T13) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
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Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

7.1.6 Soil Sampling Results

This section presents the results of analyses for soil within the survey area of Target T13. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 7.1.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 7.1.6.2.

7.1.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T13: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I13-1 and I13-2. All the results of the XRF confirmation soil samples are presented in Table I13-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T13 following the methods outlined in Section 2.4 and shown in Figure I13-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 75 measurements were collected across 75 survey units from the survey area of Target T13 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I13-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T13 at a depth of 0 to 3 inches bgs. Five XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I13-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 7.1.7.

Table I13-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M1-01 (T13)

Analyte	Units	Applied BTV	T13-XS12-01-050818		T13-XS24-01-05081		T13-XSG16-01-081618		T13-XSG26-01-081618		T13-XSG7-01-081618	
			Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Survey Unit			X12		X24		G16		G26		G7	
Aluminum	mg/kg	5,010	5,100		2,100		3,600		4,700		3,700	
Antimony	mg/kg	0.158	0.14		0.068	J	0.11		0.15		0.13	
Arsenic	mg/kg	2.4	2		0.92		1.7		2.2		1.6	
Barium	mg/kg	150	130		44		79		140		100	
Beryllium	mg/kg	0.47	0.4		0.18		0.24		0.36		0.28	
Cadmium	mg/kg	0.134	0.18	J	0.072	J	0.14	J	0.19	J	0.12	J
Calcium	mg/kg	18,800	4,200		4,500		4,200		4,300		4,000	
Chromium	mg/kg	11.0	8.3		4.3		4		7.6		5.5	
Cobalt	mg/kg	3.2	4		1.6		2.3		3.4		2.5	
Copper	mg/kg	10	8.6		3.6		5.2		7.2		5.7	
Iron	mg/kg	6,510	7,300		3,300		5,400		7,200		5,800	
Lead	mg/kg	10	9.7		3.2		9.2		14		8.3	
Lithium	mg/kg	8.4	5.3		2.2		4.4		5.6		4.5	
Magnesium	mg/kg	3,380	2,300		1,100		1,800		2,500		1,900	
Manganese	mg/kg	460	510		130		210		390		330	
Molybdenum	mg/kg	0.3	0.28		0.14	J	0.19	J	0.21		0.21	J
Nickel	mg/kg	11.0	9.5		4.1		4.2		9		5.9	
Potassium-40	pCi/g	21.2	15.6	J+	15.5	J+	16.6	J+	19.5	J+	18.6	J+
Radium-226	pCi/g	1.32	1.26	J+	0.77	J+	0.81	J+	1.29	J+	1.28	J+
Radium-228	pCi/g	0.50	<0.88	UJ	<0.61	UJ	<0.24	UJ	<1.01	UJ	<0.76	UJ
Selenium	mg/kg	0.82	0.71	J	<1.1	U	0.5	J	0.71	J	0.55	J
Silver	mg/kg	0.020	0.021	J	0.012	J	0.018	J	0.02	J	0.023	J
Sodium	mg/kg	30	28	J	<110	U	25	J	33	J	20	J
Thallium	mg/kg	0.063	0.077		0.034		0.046		0.075		0.053	
Thorium	mg/kg	3.6	3.5		2		2		3.3		2.3	
Uranium	mg/kg	0.63	0.74		0.28		0.97		0.99		0.58	
Vanadium	mg/kg	11	13		6.7		9.7		12		9.1	
Zinc	mg/kg	28	88		16		17		19		16	

Notes:
BTV Background threshold value
ID Identification
J Estimated value
J- Estimated value, may be biased low
LT Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration.
M3 The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg Milligrams per kilogram
NA Not applicable
NV No Value
pCi/g Picocuries per gram
Q Qualification
U Not considered detected. The associated value is the method detection limit (MDL).
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

Table I13-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M1-01 (T13)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.4	6,510	10	460	0.30	3.6	0.63	11	28
Measurements	#	75	75	75	75	75	75	75	75	75
Detects	#	43	75	75	75	23	75	71	20	72
Nondetects	#	32	0	0	0	52	0	4	55	0
Minimum	mg/kg	1.9	3,751	3.1	205.5	0.1	1.5	0.1	16.3	11.2
Maximum	mg/kg	5.9	11,449	28.4	661.7	5.2	12.5	7.5	41.8	64.7
Standard Deviation	mg/kg	0.9	1,249	4.5	107	1.30	1.4	1.3	6	8.2
Average	mg/kg	3.0	6,337	11.4	378	1.44	3.3	2.1	23.9	22.1
Median	mg/kg	2.7	6,170	9.7	366	1.02	3.0	1.9	22.6	21.8
Relative Standard Deviation	%	31.5	19.7	39.2	28.2	90.2	42.4	61.7	24.3	37.2
90th Percentile	mg/kg	4.1	7,787	17.0	520	3.0	4.2	3.7	29	29
95th Percentile	mg/kg	5.2	8,279	18.9	580	4.4	4.9	4.0	33	31
99th Percentile	mg/kg	5.7	10,272	23.9	632	5.0	9.3	6.0	40	54
Measurements Above Applied BTV	#	29	30	35	16	21	17	65	20	9
Measurements Above Applied BTV	%	38.7	40.0	46.7	21.3	28.0	22.7	86.7	26.7	12.0

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value

mg/kg Milligram per kilogram

XRF X-ray fluorescence

7.1.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T13 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T13 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T13. The estimated BTVs are identified in Section 7.1.4 and Table I13-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I13-7 presents a summary of the background comparison for different measurement and soil depths at Target T13. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T13. However, gamma radiation screening indicated that gamma levels at Target T13 are elevated in comparison to the BSA and appear to be associated with outcropping of Jml in the southern portion of the Target. Therefore, while multiple COPCs have been identified at Target T13 based on a conservative comparison to background, risk screening will be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I13-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M1-01 (T13)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum	✓		✓
Antimony			
Arsenic		✓	✓
Barium			
Beryllium			
Cadmium	✓		✓
Calcium			
Chromium			
Cobalt	✓		✓
Copper			
Iron	✓	✓	✓
Lead	✓	✓	✓
Lithium			
Magnesium			
Manganese	✓	✓	✓
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium			
Silver	✓		✓
Sodium	✓		✓
Thallium	✓		✓
Thorium		✓	✓
Uranium	✓	✓	✓
Vanadium	✓	✓	✓
Zinc	✓	✓	✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

7.1.7 Primary Contaminant Mapping

7.1.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 7.1.6.2 identified the COPCs at Target T13. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 7.1.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I13-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T13 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 7.1.7.1 through Section 7.1.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T13. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

7.1.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I13-7. Arsenic exceeded the applied BTV in 38.7 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for arsenic is 2.4 mg/kg for Target T13 as presented in Section 7.1.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I13-5 and Attachment I3, respectively. Figure I13-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T13 and BSA-11 (Jse) samples. Figure I13-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T13 and BSA-11 (Jse) samples. Summary statistics for XRF measurements are provided in Section 7.1.6.1. Arsenic XRF concentrations measured in surface soils at Target T13 ranged between 1.9 and 5.9 mg/kg with an average and standard deviation of 3.0 mg/kg and 0.9 mg/kg, respectively. The average arsenic XRF concentration is above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T13 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I13-14. Overall, the majority of detectable arsenic results in surface soils were slightly above the applied BTV. However, the maximum XRF value was 2.5 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T13.

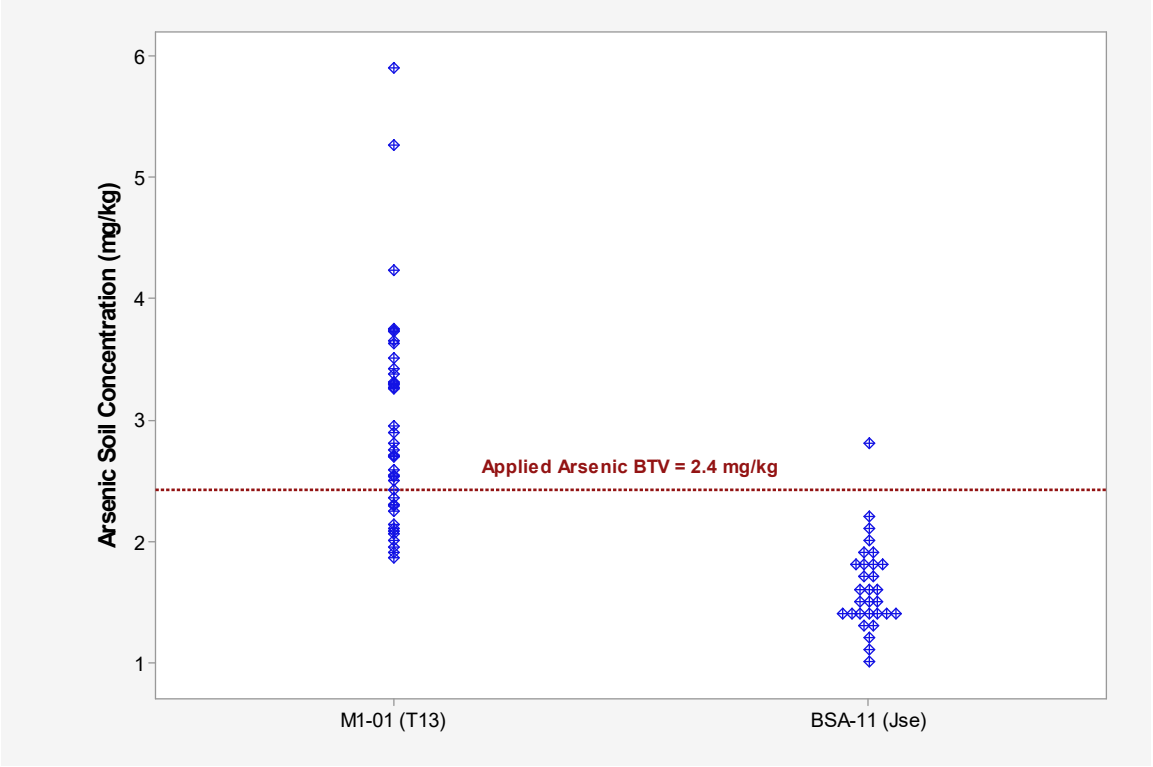


Figure I13-12. Individual Value Plot for Target M1-01 (T13) and BSA-11 (Jse) Arsenic Soil Concentrations

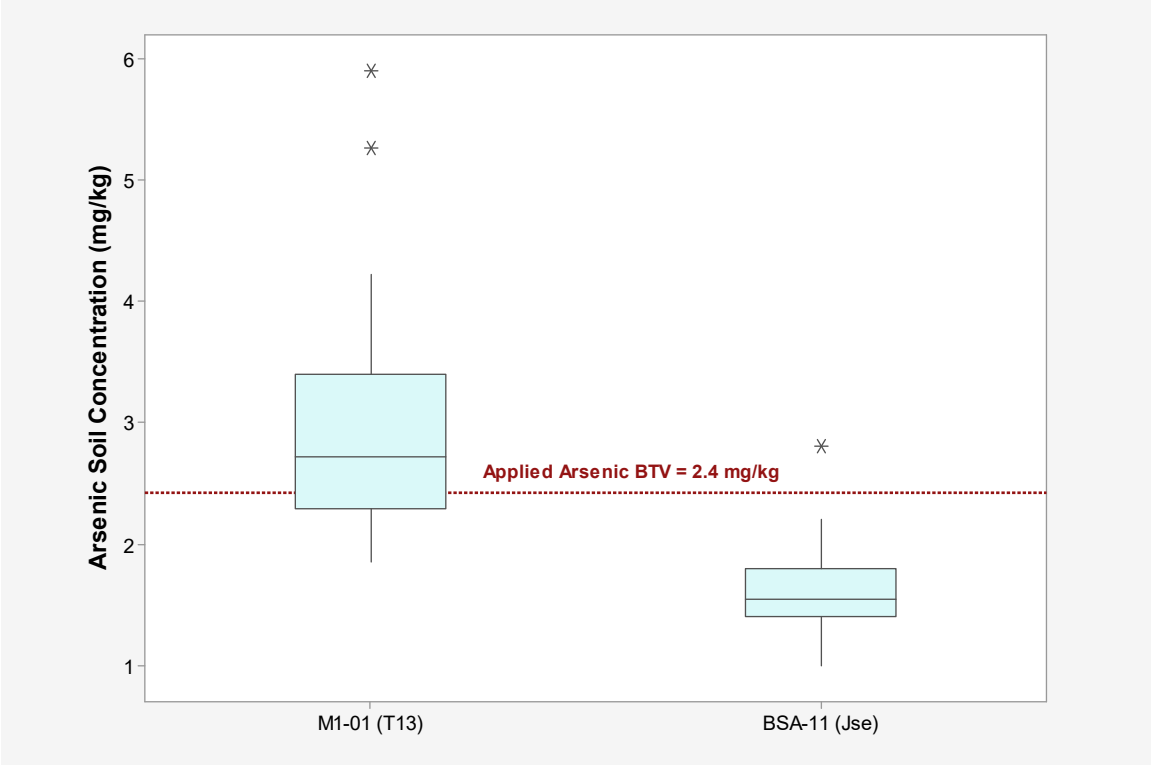
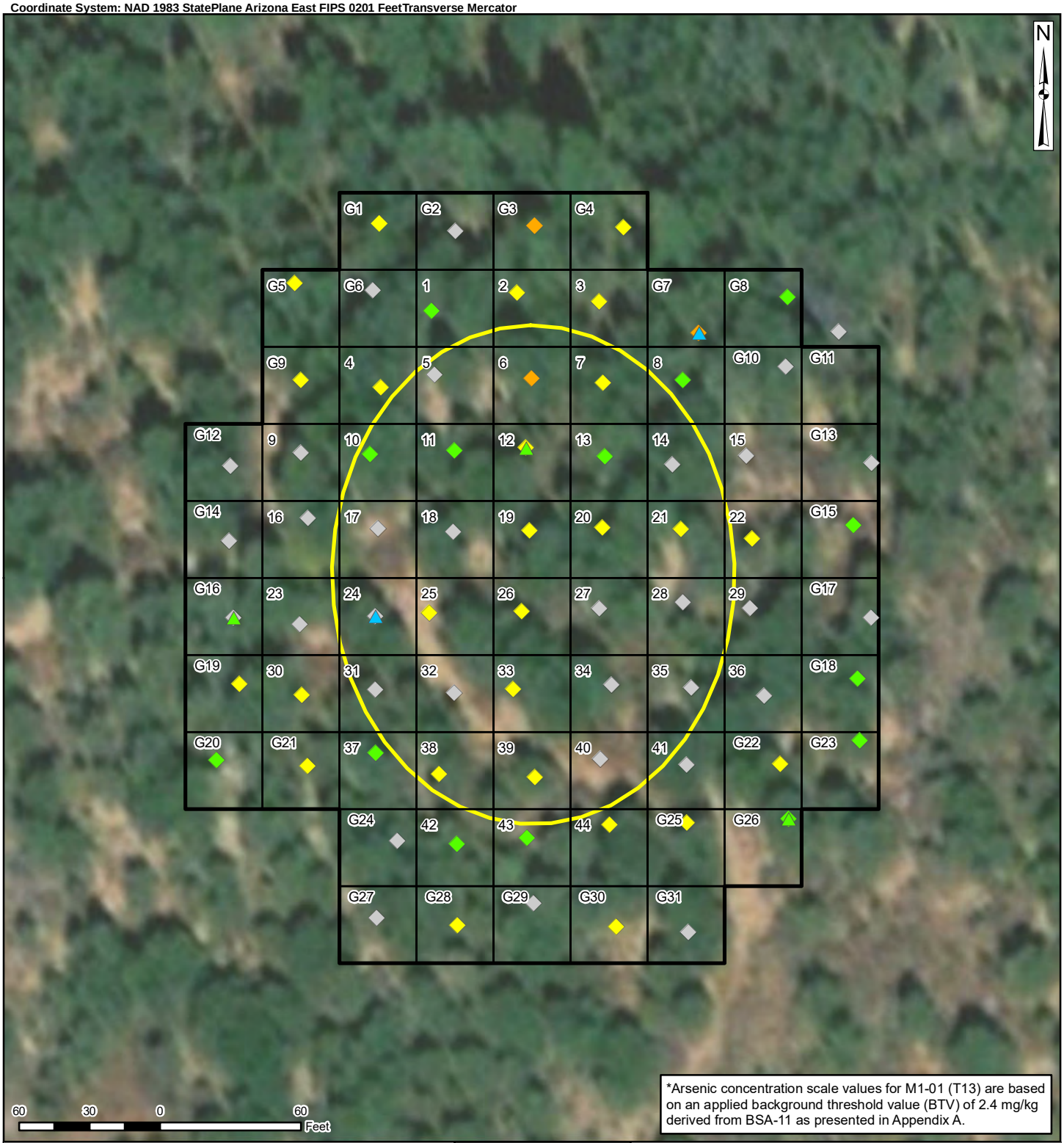


Figure I13-13. Box Plot for Target M1-01 (T13) and BSA-11 (Jse) Arsenic Soil Concentrations

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



*Arsenic concentration scale values for M1-01 (T13) are based on an applied background threshold value (BTV) of 2.4 mg/kg derived from BSA-11 as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 1.6
- 1.6 - 2.4
- 2.4 - 4.8
- 4.8 - 7.2
- 7.2 - 9.6
- 9.6 - 24
- ≥ 24
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET M1-01 (T13) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I13-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

7.1.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I13-7. Lead exceeded the applied BTV in 46.7 percent of in situ XRF measurements and in one of the five XRF confirmation samples. The applied BTV for lead is 10 mg/kg for Target T13 as presented in Section 7.1.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I13-5 and Attachment I3, respectively. Figure I13-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T13 and BSA-11 (Jse) sample types. Figure I13-16 presents a box plot of detectable lead XRF soil concentrations for Target T13 and BSA-11 (Jse) samples. Summary statistics for XRF measurements are provided in Section 7.1.6.1. Lead XRF concentrations measured in surface soils at Target T13 ranged between 3.1 and 28.4 mg/kg with an average and standard deviation of 11.4 mg/kg and 4.5 mg/kg, respectively. The average lead XRF concentration is above the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T13 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I13-17. Overall, the majority of detectable lead results in surface soils were slightly above the applied BTV. However, the maximum XRF value was 2.8 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T13.

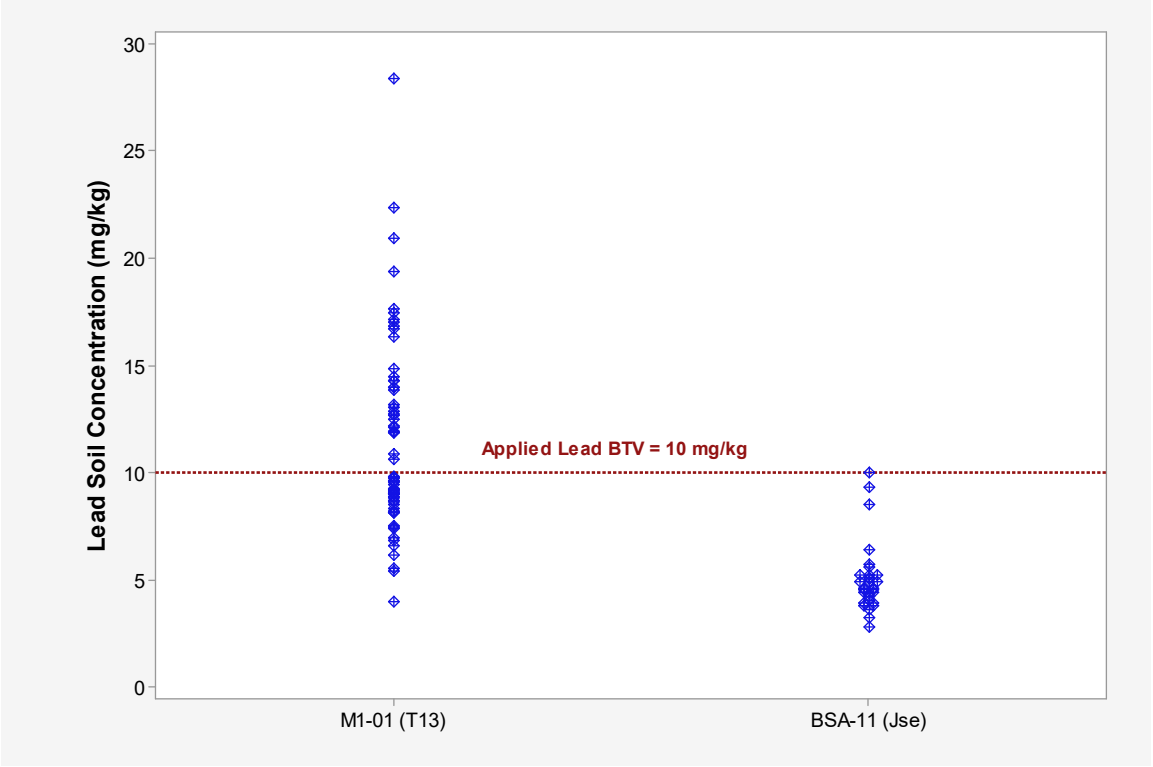


Figure I13-15. Individual Value Plot for Target M1-01 (T13) and BSA-11 (Jse) Lead Soil Concentrations

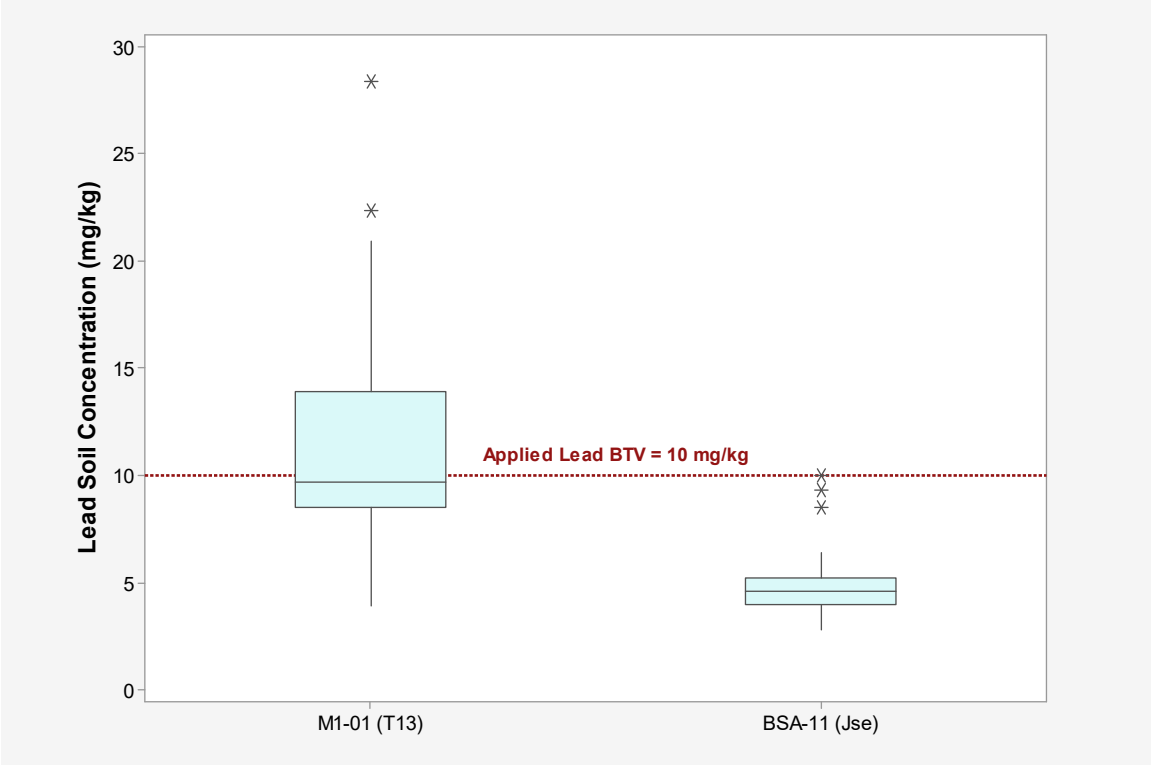
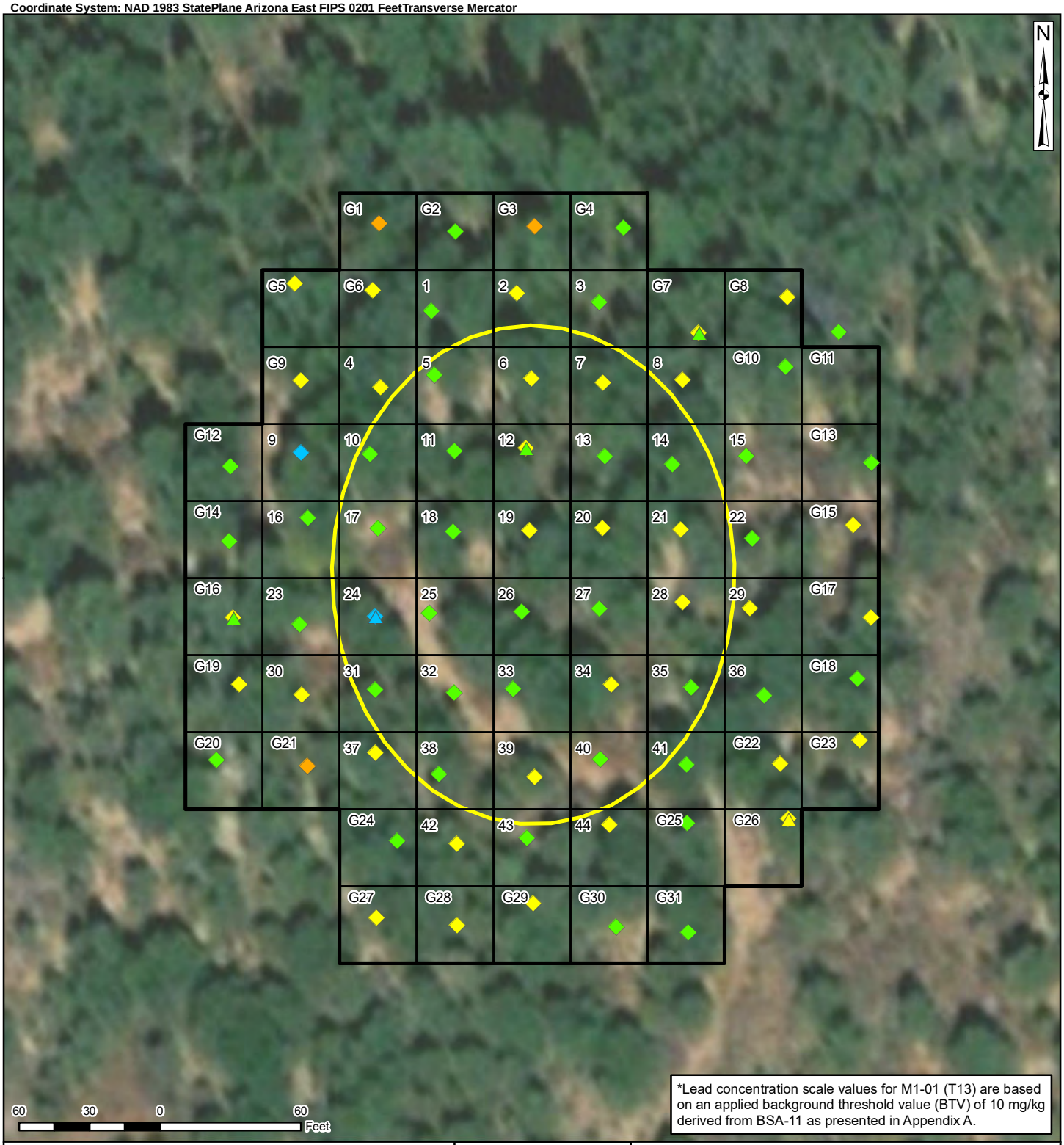


Figure I13-16. Box Plot for Target M1-01 (T13) and BSA-11 (Jse) Lead Soil Concentrations



*Lead concentration scale values for M1-01 (T13) are based on an applied background threshold value (BTV) of 10 mg/kg derived from BSA-11 as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 5
- 5 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 100
- ≥ 100

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET M1-01 (T13) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I13-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

7.1.7.4 Thorium

Thorium was identified as a COPC in surface soil as shown in Table I13-7. Thorium exceeded the applied BTV in 22.7 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for thorium is 3.6 mg/kg for Target T13 as presented in Section 7.1.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I13-5 and Attachment I3, respectively. Figure I13-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T13 and Jse regional samples. Figure I13-19 presents a box plot of detectable thorium XRF soil concentrations for Target T13 and Jse regional samples. Summary statistics for XRF measurements are provided in Section 7.1.6.1. Thorium XRF concentrations measured in surface soils at Target T13 ranged between 1.5 and 12.5 mg/kg with an average and standard deviation of 3.3 mg/kg and 1.4 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T13 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I13-20. Overall, the majority of detectable thorium results in surface soils were less than the applied BTV. However, the maximum XRF value was 3.5 times higher than the applied BTV and does not appear to be associated with mining-related materials Target T13.

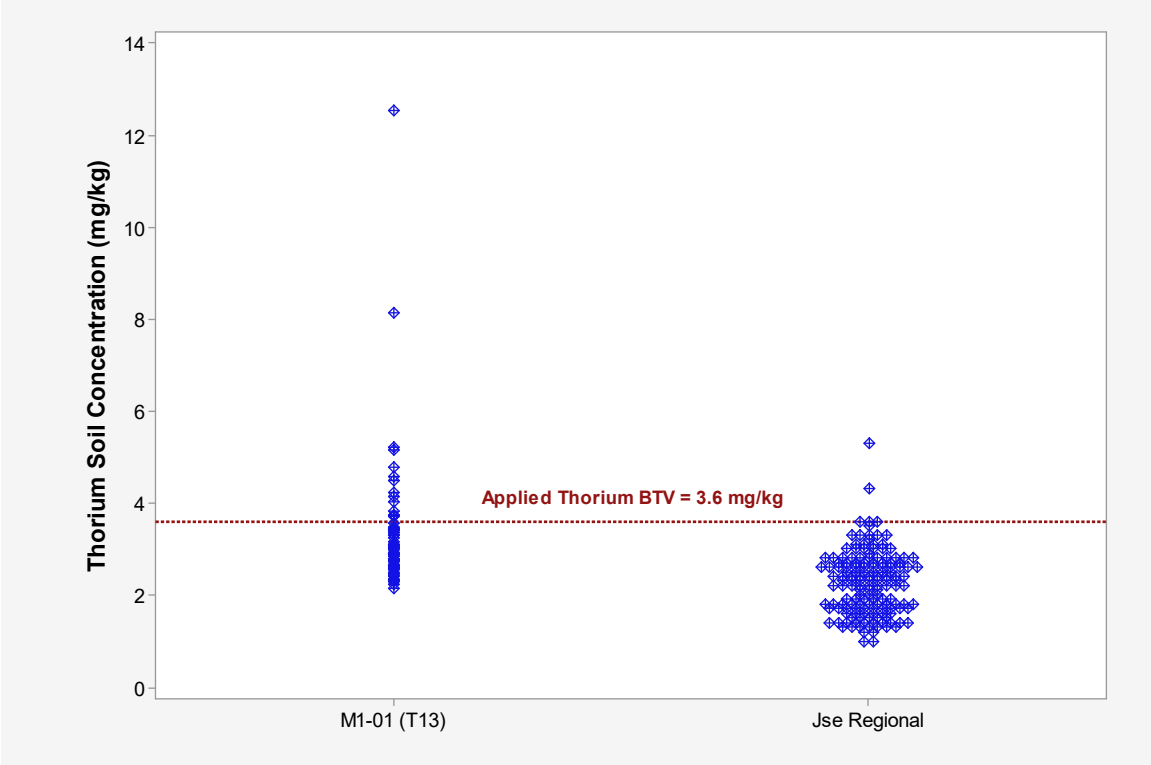


Figure I13-18. Individual Value Plot for Target M1-01 (T13) and Jse Regional Thorium Soil Concentrations

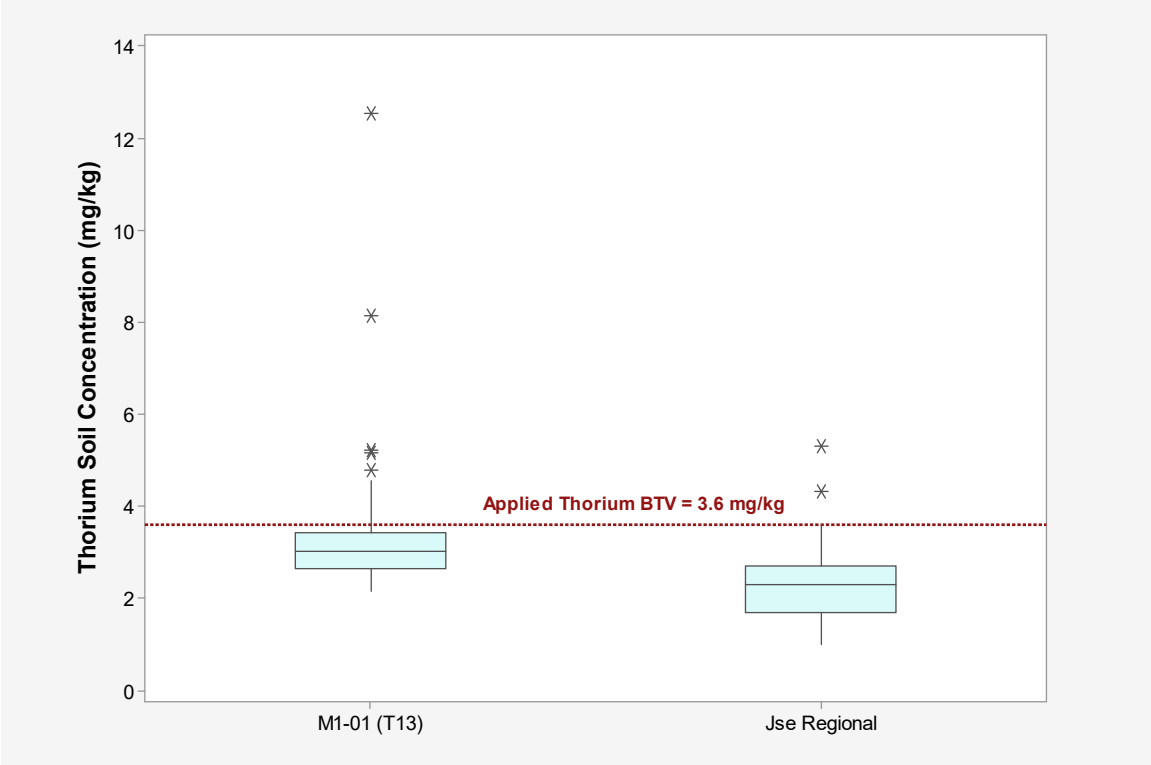
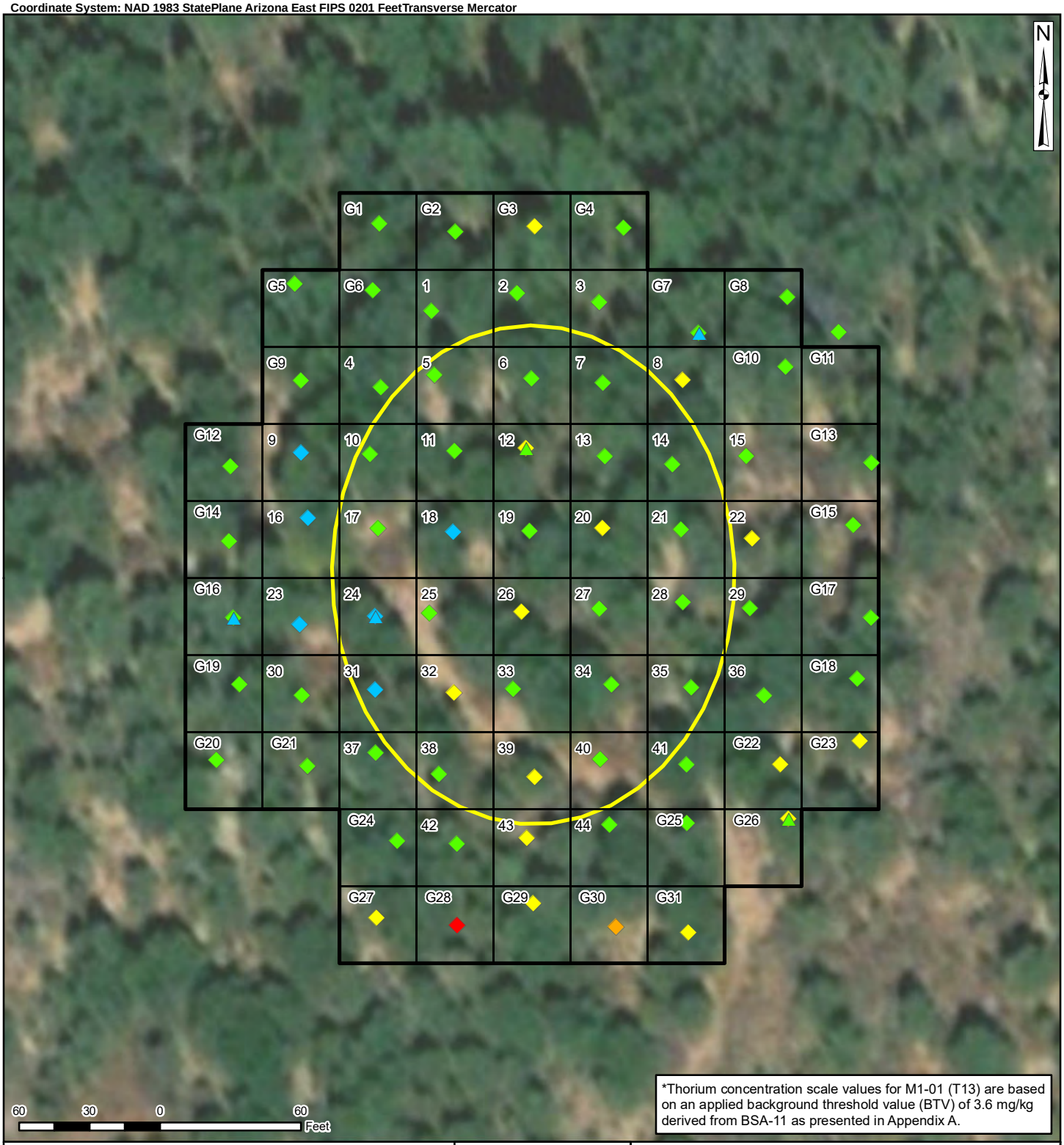


Figure I13-19. Box Plot for Target M1-01 (T13) and Jse Regional Thorium Soil Concentrations

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



*Thorium concentration scale values for M1-01 (T13) are based on an applied background threshold value (BTV) of 3.6 mg/kg derived from BSA-11 as presented in Appendix A.

Thorium Concentration Scale (mg/kg)*

- ≤ 2.3
- 2.3 - 3.6
- 3.6 - 7.2
- 7.2 - 11
- 11 - 14
- 14 - 36
- ≥ 36

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary

Prepared for: USEPA Region 9

Prepared By:

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NON-AUM TARGET M1-01 (T13) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I13-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

7.1.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I13-7. Uranium exceeded the applied BTV in 86.7 percent of in situ XRF measurements and in three of the five XRF confirmation samples. The applied BTV for uranium is 0.63 mg/kg for Target T13 as presented in Section 7.1.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I13-5 and Attachment I3, respectively. Figure I13-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T13 and BSA-11 (Jse) samples. Figure I13-22 presents a box plot of detectable uranium soil XRF concentrations for Target T13 and BSA-11 (Jse) samples. Summary statistics for XRF measurements are provided in Section 7.1.6.1. Uranium XRF concentrations measured in surface soils at Target T13 ranged between 0.1 and 7.5 mg/kg with an average and standard deviation of 2.1 mg/kg and 1.3 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T13 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I13-23. Overall, the majority of detectable uranium results in surface soils were above the applied BTV. However, the maximum XRF value was about 12 times higher than the applied BTV and does not appear to be associated with mining-related materials Target T13.

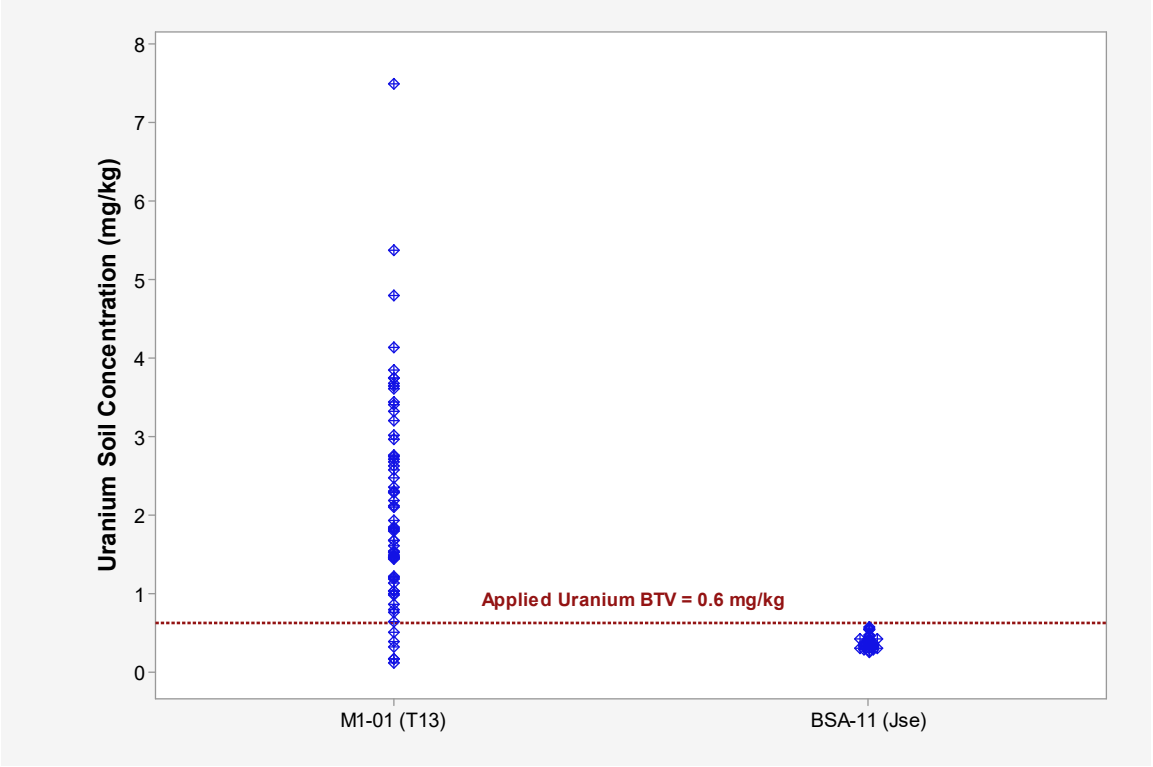


Figure I13-21. Individual Value Plot for Target M1-01 (T13) and BSA-11 (Jse) Uranium Soil Concentrations

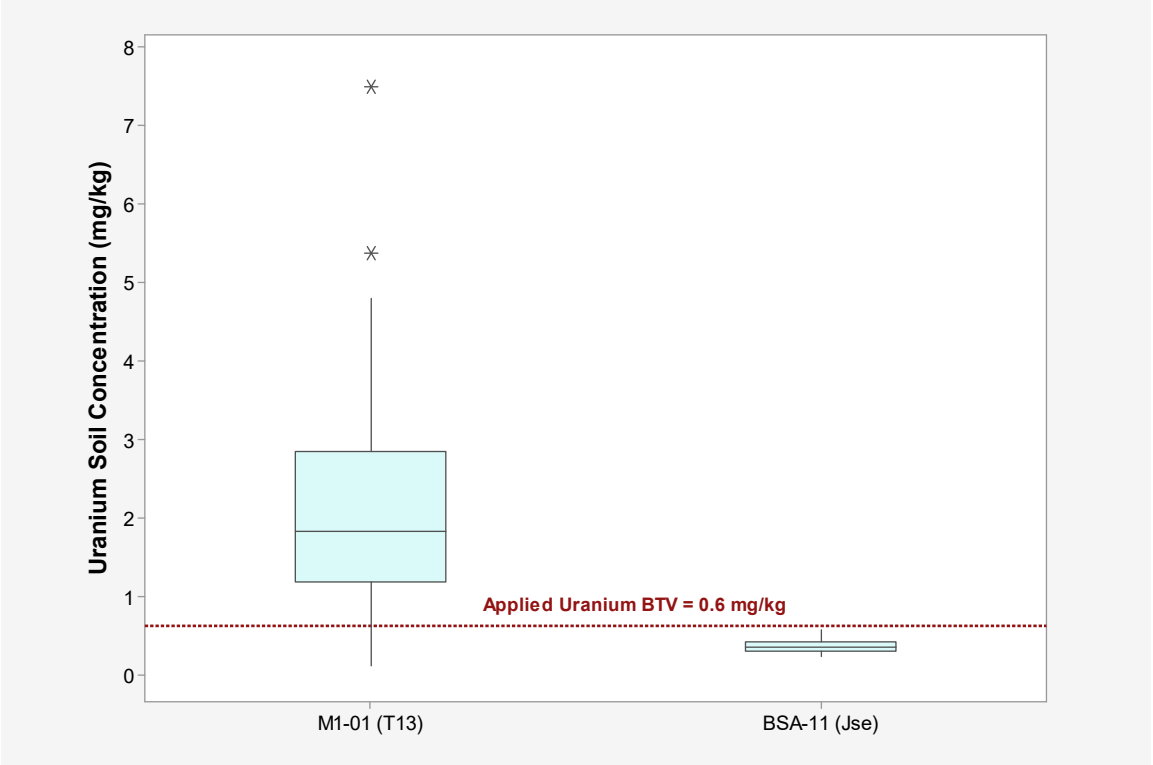
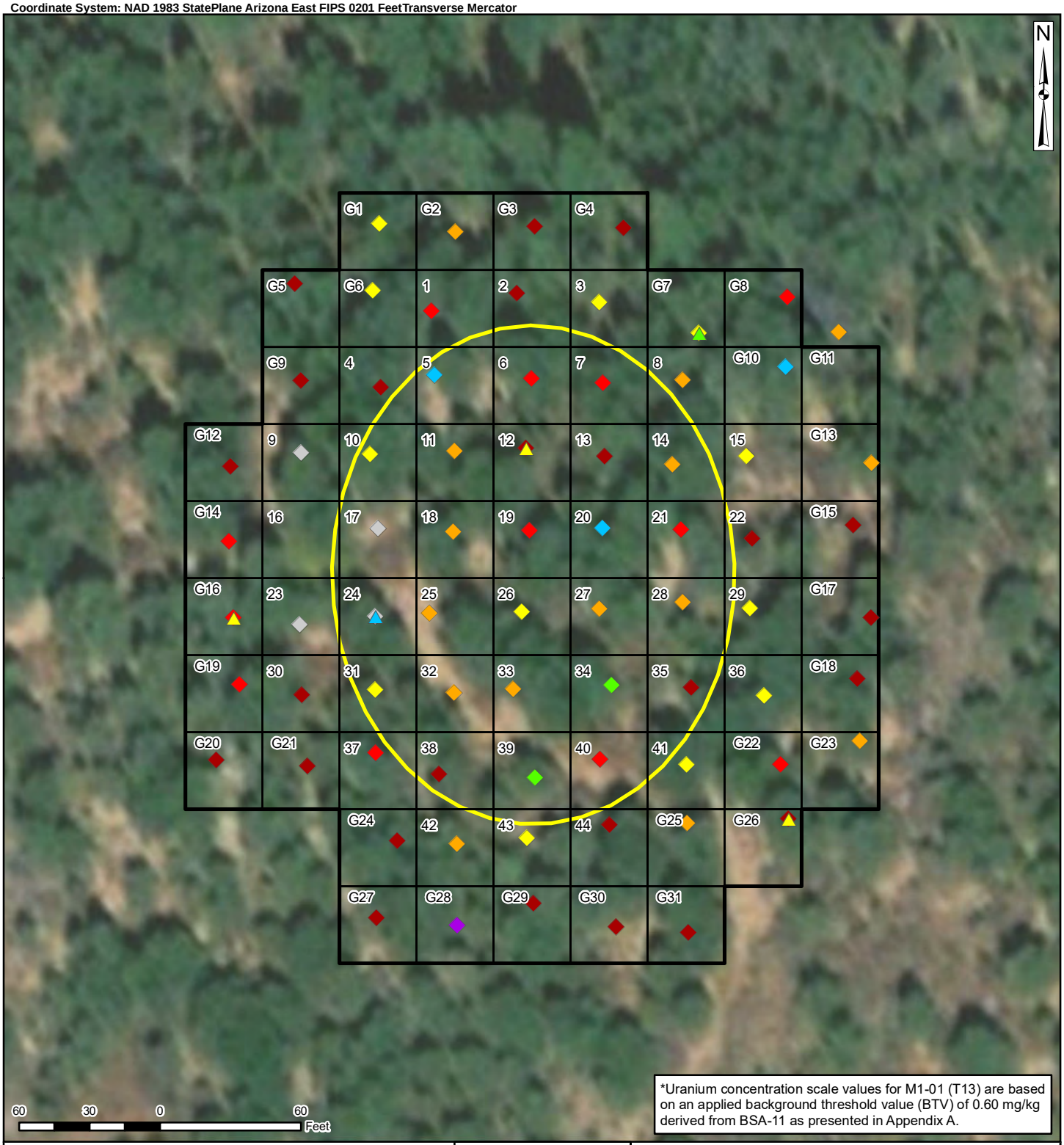


Figure I13-22. Box Plot for Target M1-01 (T13) and BSA-11 (Jse) Uranium Soil Concentrations

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



*Uranium concentration scale values for M1-01 (T13) are based on an applied background threshold value (BTV) of 0.60 mg/kg derived from BSA-11 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 0.38
- 0.38 - 0.60
- 0.60 - 1.2
- 1.2 - 1.8
- 1.8 - 2.4
- 2.4 - 6.0
- ≥ 6.0
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET M1-01 (T13) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I13-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

7.1.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I13-7. Vanadium exceeded the applied BTV in 26.7 percent of in situ XRF measurements and in two of the five XRF confirmation samples. The applied BTV for vanadium is 11 mg/kg for Target T13 as presented in Section 7.1.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I13-5 and Attachment I3, respectively. Figure I13-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T13 and BSA-11 (Jse) samples. Figure I13-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T13 and BSA-11 (Jse) samples. Summary statistics for XRF measurements are provided in Section 7.1.6.1. Vanadium XRF concentrations measured in surface soils at Target T13 ranged between 16.3 and 41.8 mg/kg with an average and standard deviation of 23.9 mg/kg and 6.0 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T13 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I13-26. Overall, the majority of detectable vanadium results in surface soils were above the applied BTV. However, the maximum XRF value was 3.8 times higher than the applied BTV and does not appear to be associated with mining-related materials Target T13.

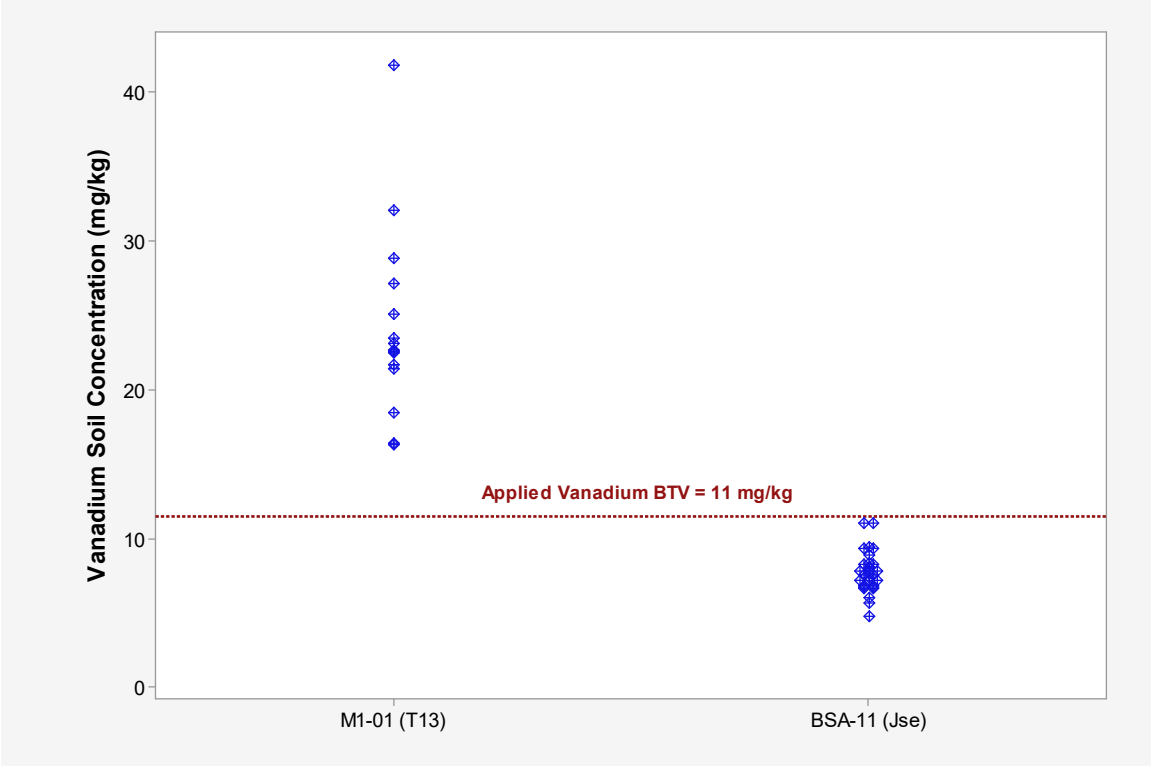


Figure I13-24. Individual Value Plot for Target M1-01 (T13) and BSA-11 (Jse) Vanadium Soil Concentrations

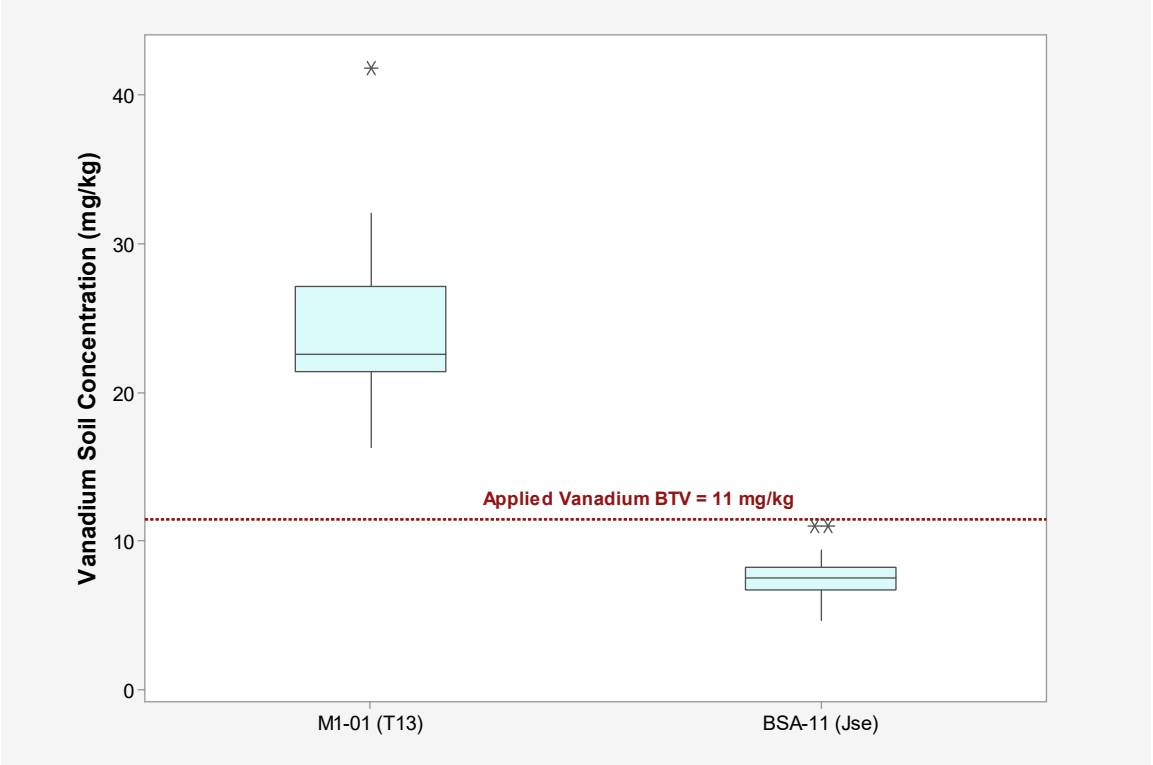
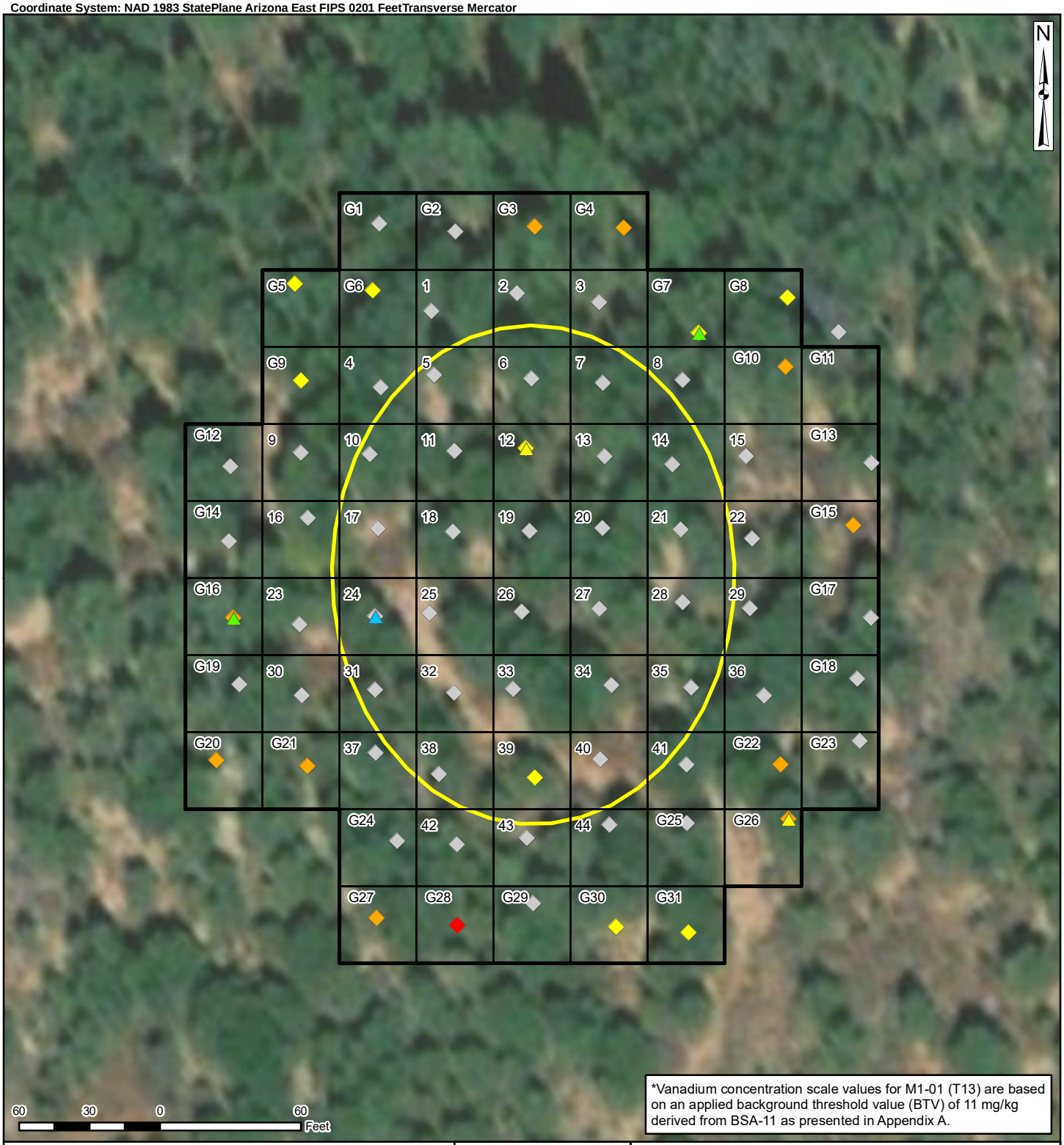


Figure I13-25. Box Plot for Target M1-01 (T13) and BSA-11 (Jse) Vanadium Soil Concentrations

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



*Vanadium concentration scale values for M1-01 (T13) are based on an applied background threshold value (BTV) of 11 mg/kg derived from BSA-11 as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 7.7
- 7.7 - 11
- 11 - 22
- 22 - 33
- 33 - 44
- 44 - 110
- ≥ 110
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET M1-01 (T13) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I13-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

7.1.8 Conclusions

Target T13 (M1-01) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T13. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T13 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T13. ASPECT gamma survey results generally correlated with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T13 was well documented through gamma radiation surveys, and the lateral extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T13 geology and soil types were established through a background study.
- Mean raw gamma measurements exceeded the applied BTV by a factor of 1.13. In addition, grid averaged gamma measurements exceeded the applied BTV in 38 of 75 survey units by a factor of up to 2.4.
- A total of 28 analytes were identified as occurring within the surface environment. Of these analytes, 15 were identified as COPCs. Arsenic, lead, thorium, uranium, and vanadium exceeded the applied BTVs by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T13 does not contain TENORM. No mining-related activities or features were observed in the field, and no historical exploratory borings, vents, or other mine openings were noted in the file review or during field observation. Outcropping of Jml was identified on the southern portion of the Target; however, NORM was not identified visually or by gamma survey.
- Natural erosion of outcroppings may have increased the lateral extent of NORM.
- There are no immediate significant physical hazards present at Target T13.
- Access is by dirt road with a small four-wheel-drive vehicle followed by footpath.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No existing groundwater wells are documented within the vicinity of Target T13. No seeps or springs were observed during the RSE investigation.

- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T13. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No mine waste was observed at Target T13; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; however, a few data gaps remain for Target T13. The remaining data gaps include potentially stepping out to the south and east to further refine the extent of elevated gamma activity and field mapping and verification of NORM in Jml outcroppings.

7.2 NON-AUM TARGET T14 (M1-02)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T14 (M1-02).

7.2.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T14 (M1-02) is not associated with a former mine but is associated with two non-AUM Targets: T13 (M1-01) and T15 (M1-03). Target T14 is in the Lukachukai Mountains Region in Subarea Group D within the Cove Chapter of the Navajo Nation and accessible by foot off of Indian Route 33. Target T14 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. No residential structures are near the Target. A Target location and access map for Target T14 is shown in Figure I14-1.

A topographical relief map for Target T14 and associated AUM areas is provided in Figure I14-2. The elevation at Target T14 ranges from 7,396 to 7,723 feet amsl with an average of 7,706 feet amsl. The slope at Target T14 ranges from 7 to 15 percent with an average of 10 percent. There are no drainages at the Target. Target T14 is entirely within Jml, which comprises the Recapture and Salt Wash Members, and within the Kunz-Xankey complex soil type (MUSYM 610) (Figures I-20 and I-21).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T14. Weston did not conduct a background study for Target T14. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 11 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T14:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T14 is accessed by taking Indian Route 33 and then hiking 200 feet northwest off-trail.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM was observed and recorded in the field at outcroppings with elevated gamma readings. The underlying Jml geology is known to bear NORM. TENORM may be associated with exploratory borings.

- Mapped all drainages and potential surface water pathways at the non-AUM Target

  No drainages were identified at the Target. The closest drainage is Middle 3F, which is located approximately 1,300 feet northwest of the Target and discussed in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

  Two historic exploratory borings in the northern and southern areas of the Target were potentially identified based on literature review. However, the potential locations of the borings do not correspond to elevated gamma activity.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  No AUM or non-AUM Target features were present at the Target.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

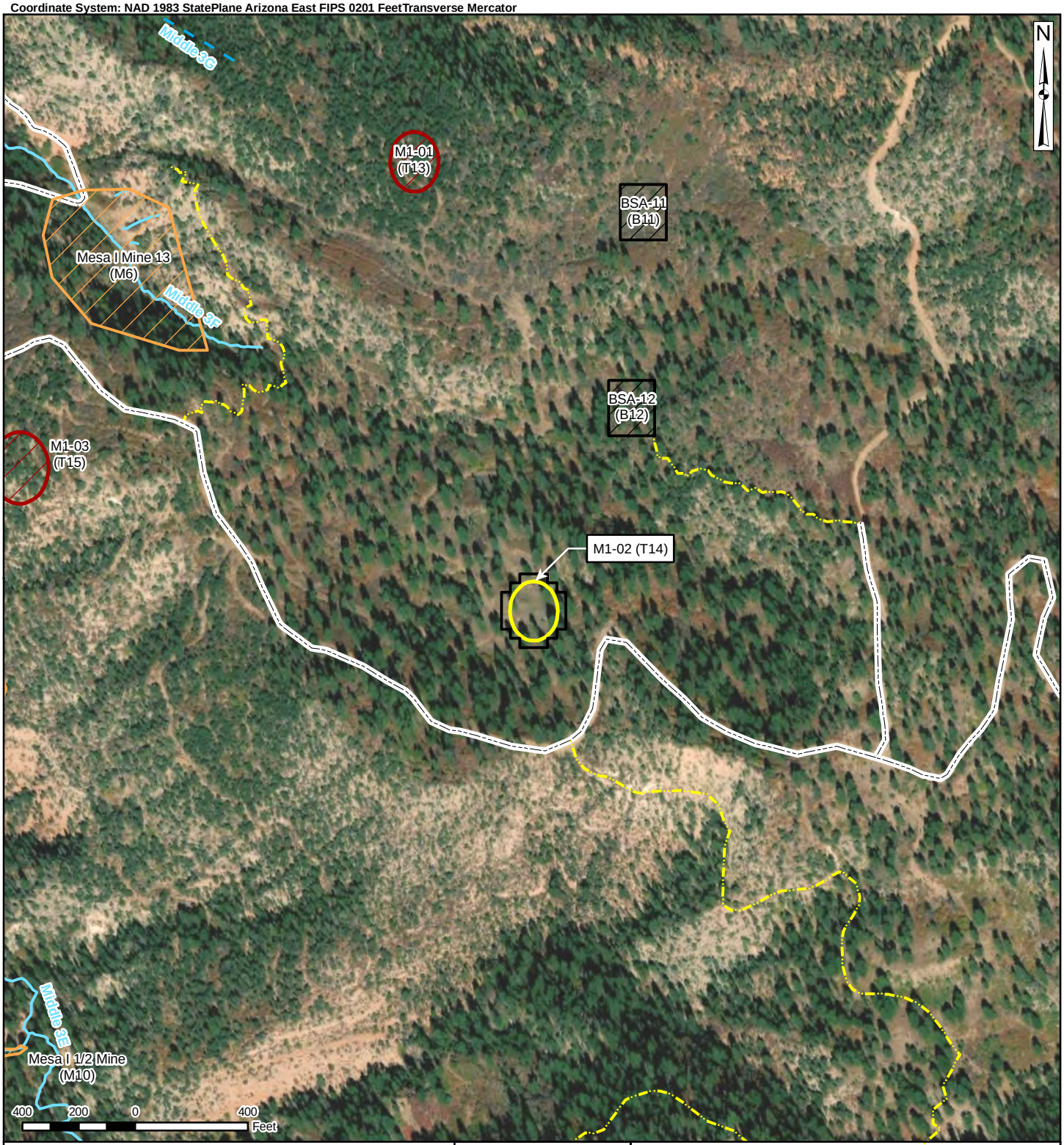
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T14 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Section 2.3 and 7.2.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 7.2.3 with results presented in Sections 7.2.6 and 7.2.7)
- Conducting a gamma radiation survey (results presented in Section 7.2.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Tronox AUM Site Boundary
Background Location
Access Route - Foot
Access Route - Vehicular
Drainage*
Drainage - Field Mapped

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

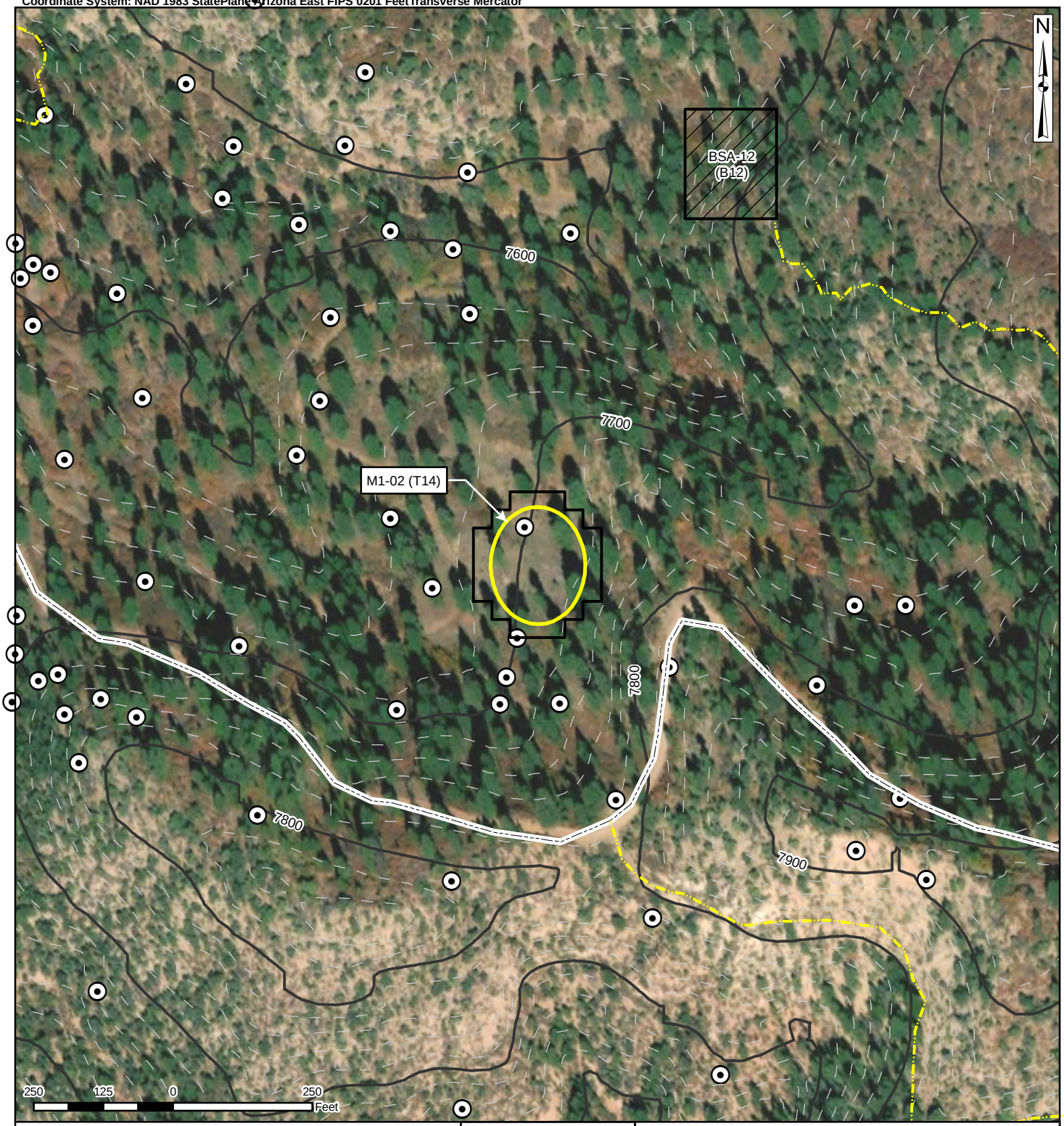
Prepared for: USEPA Region 9

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NON-AUM TARGET M1-02 (T14) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I14-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	



Non-AUM Target Site Boundary
Related Survey Area
Background Location
Exploratory Bore Hole
Access Route (Foot)
Access Route (Vehicular)
100 ft Contour**
20 ft Contour**

*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.
**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.

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NON-AUM TARGET M1-02 (T14) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I14-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	

7.2.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I14-3) within the survey area of the non-AUM Target T14 as part of the Baseline Study in May 2018. Additional Goback gamma radiation surveys were not performed at Target T14. Tetra Tech also performed an XRF field survey at non-AUM Target T14 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I14-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 11, of the RSE Work Plan (Tetra Tech 2018). All gamma survey and XRF survey units were evaluated.

7.2.3 XRF Confirmation Sampling Overview

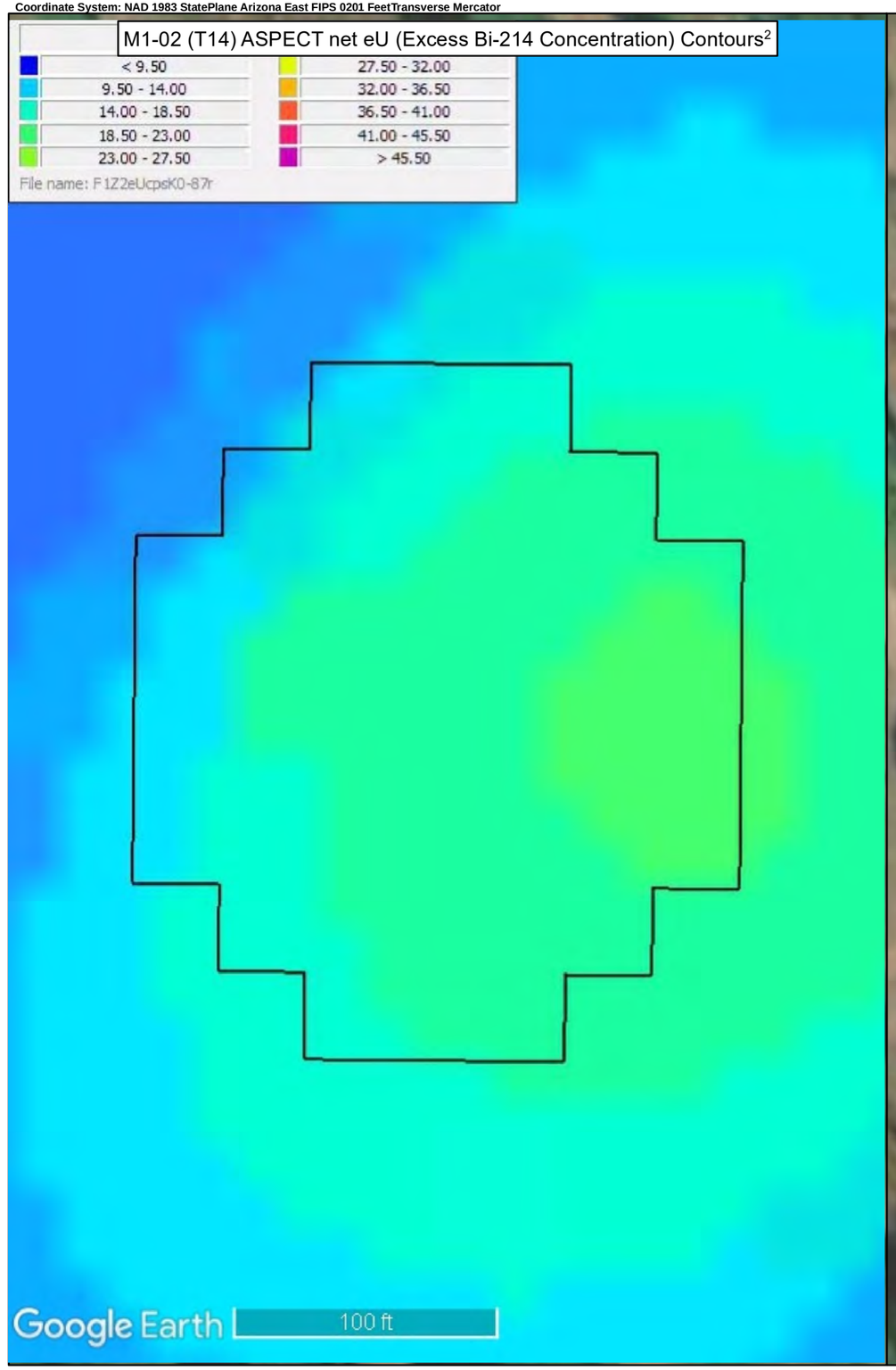
Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T14. Two XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from two locations (Table I14-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I14-4 and I14-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I14-2. A subset of XRF confirmation samples were also submitted for analysis of mercury and select additional radionuclides. The results of XRF confirmation sample analysis are provided in Section 7.2.6.1. Correlated XRF field measurements are provided in Attachment I3.

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

M1-02 (T14) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F1Z2eUcpsK0-87r



M1-02 (T14) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)[1]

≤ 9,712	≤ Avg. BG
9,712 - 14,566	Avg. BG - 1 x BTV
14,566 - 29,132	1 x BTV - 2 x BTV
29,132 - 43,698	2 x BTV - 3 x BTV
43,698 - 58,264	3 x BTV - 4 x BTV
58,264 - 145,660	4 x BTV - 10 x BTV
≥ 145,660	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Area Boundary

[1]The applied gamma background threshold value (BTV) for M1-02 (T14) Non-AUM Target is 14,566 cpm from gamma survey data for BSAs within the JmI as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 50 ft

1:600

N W E S

0 25 50 100 Feet

NON-AUM TARGET M1-02 (T14)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

Prepared By:

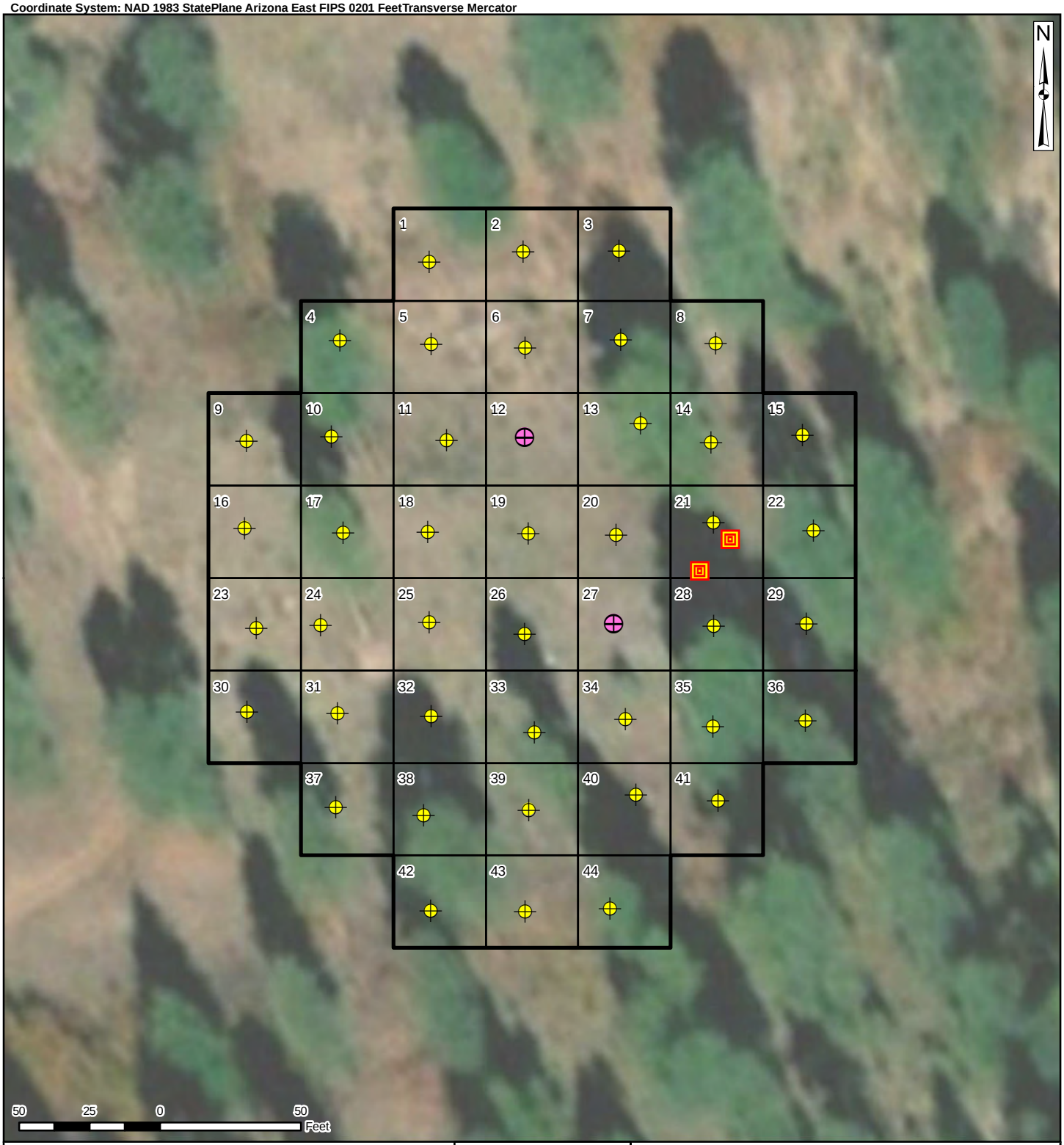
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborn Spectral Photometric Environmental Collection Technology.

Figure No.: **I14-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

NORM - Field Mapped

Survey Unit (100 m²)

Survey Area Boundary

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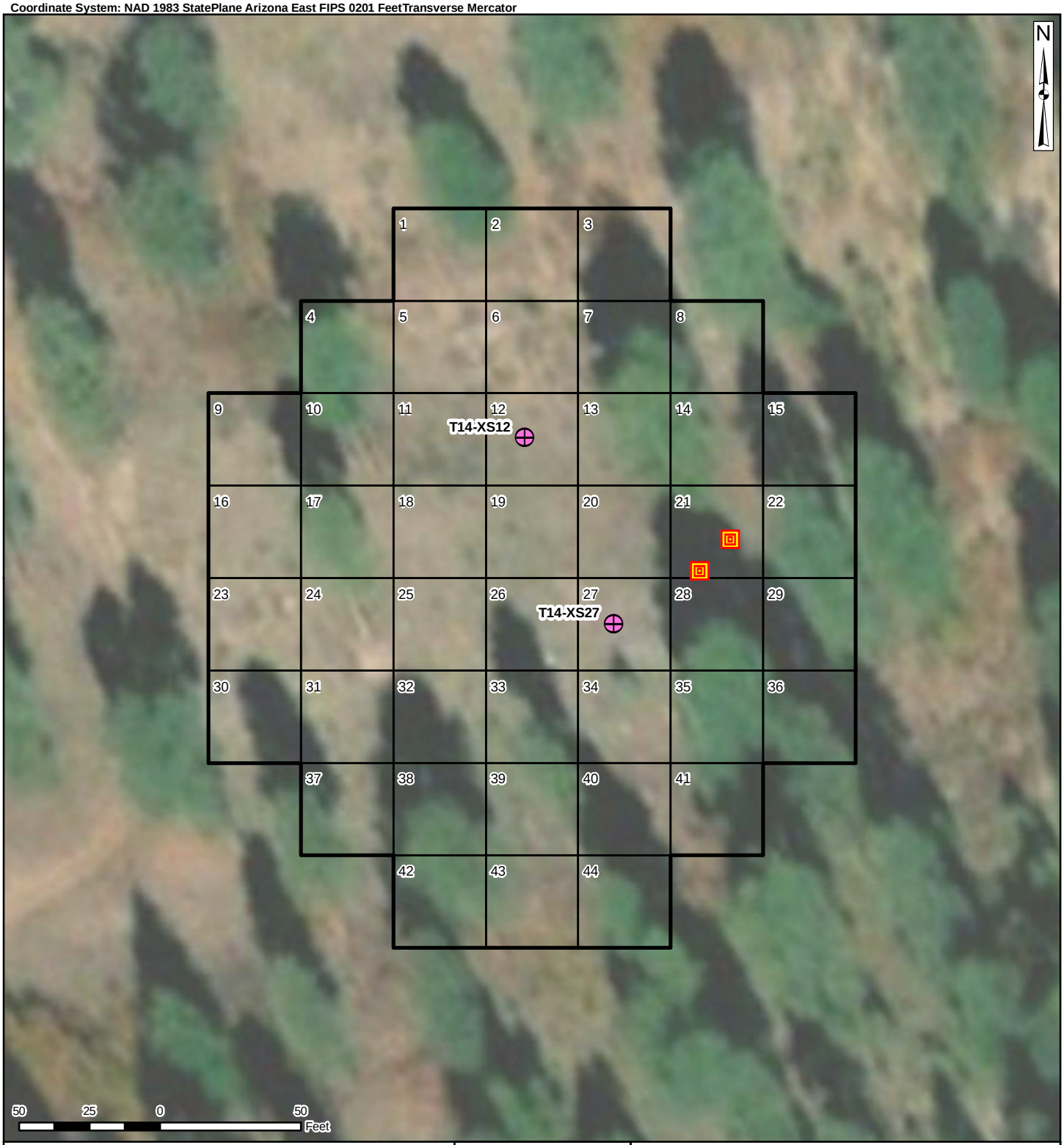
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NON-AUM TARGET M1-02 (T14)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I14-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

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



XRF Confirmation Soil Sample*
(0 - 3 inches bgs)

NORM - Field Mapped

Survey Unit (100 m²)

Survey Area Boundary

Prepared for: USEPA Region 9

Prepared By:

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NON-AUM TARGET M1-02 (T14)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I14-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

Table I14-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M1-02 (T14)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T14-XS12-01-050818	12	0-3	XRF Confirmation	Primary	5/8/2018	36.5198144	-109.2127550	1805321-23, 1805322-23
T14-XS27-01-050818	27	0-3	XRF Confirmation	Primary	5/8/2018	36.5196322	-109.2126495	1805321-24, 1805322-24

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I14-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M1-02 (T14)

Analyte	Type	CAS Number	Analytical Method	Number of Samples by Standard Analyses	Number of Samples by Extended Analyses
Aluminum	Metals	7429-90-5	USEPA SW-846 6020B	1	1
Antimony	Metals	7440-36-0	USEPA SW-846 6020B	1	1
Arsenic	Metals	7440-38-2	USEPA SW-846 6020B	1	1
Barium	Metals	7440-39-3	USEPA SW-846 6020B	1	1
Beryllium	Metals	7440-41-7	USEPA SW-846 6020B	1	1
Cadmium	Metals	7440-43-9	USEPA SW-846 6020B	1	1
Calcium	Metals	7440-70-2	USEPA SW-846 6020B	1	1
Chromium	Metals	7440-47-3	USEPA SW-846 6020B	1	1
Cobalt	Metals	7440-48-4	USEPA SW-846 6020B	1	1
Copper	Metals	7440-50-8	USEPA SW-846 6020B	1	1
Iron	Metals	7439-89-6	USEPA SW-846 6020B	1	1
Lead	Metals	7439-92-1	USEPA SW-846 6020B	1	1
Lead-210	Radionuclides	14255-04-0	Eichrom method	0	1
Lithium	Metals	7439-93-2	USEPA SW-846 6020B	1	1
Magnesium	Metals	7439-95-4	USEPA SW-846 6020B	1	1
Manganese	Metals	7439-96-5	USEPA SW-846 6020B	1	1
Mercury	Metals	7439-97-6	USEPA SW-846 7471A	0	1
Molybdenum	Metals	7439-98-7	USEPA SW-846 6020B	1	1
Nickel	Metals	7440-02-0	USEPA SW-846 6020B	1	1
Potassium-40	Radionuclides	13966-00-2	USEPA 901.1	1	1
Radium-226	Radionuclides	13982-63-3	USEPA 901.1	1	1
Radium-228	Radionuclides	15262-20-1	USEPA 901.1	1	1
Selenium	Metals	7782-49-2	USEPA SW-846 6020B	1	1
Silver	Metals	7440-22-4	USEPA SW-846 6020B	1	1
Sodium	Metals	7440-23-5	USEPA SW-846 6020B	1	1
Thallium	Metals	7440-28-0	USEPA SW-846 6020B	1	1
Vanadium	Metals	7440-62-2	USEPA SW-846 6020B	1	1
Zinc	Metals	7440-66-6	USEPA SW-846 6020B	1	1
Thorium	Metals	-	USEPA SW-846 6020B	1	1
Thorium-228	Radionuclides	14274-82-9	ASTM D3972 Modified	0	1
Thorium-230	Radionuclides	14269-63-7	ASTM D3972 Modified	0	1
Thorium-232[1]	Radionuclides	7440-29-1	ASTM D3972 Modified	0	1
Uranium	Metals	-	USEPA SW-846 6020B	1	1
Uranium-234	Radionuclides	13966-29-5	ASTM D3972 Modified	0	1
Uranium-235	Radionuclides	15117-96-1	ASTM D3972 Modified	0	1
Uranium-238[1]	Radionuclides	7440-61-1	ASTM D3972 Modified	0	1

Notes:

Green Shading identifies Extended Analyses

[1] Measured via alpha spectroscopy

- Not applicable

ASTM ASTM International

CAS Chemical abstracts service

USEPA U.S. Environmental Protection Agency

XRF X-ray fluorescence

7.2.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 7.2.1, Target T14 surface geology is entirely within Jml with soils within the Kunz-Xankey complex (MUSYM 610) (Figures I-20 and I-21). As a result, Background Study Area 12 (BSA-12) was selected for that combination of geology and soil type. Additionally, the Jml regional geological background would also be applicable for this Target. Table I14-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T14. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T14. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T14. The “Applied BTV” for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I14-3. Applied Background Threshold Values for Non-AUM Target M1-02 (T14)

Analyte	Units	Site-Specific BTV (BSA-12)	Regional BTV (Jml)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	8,390	7,000	7,000	Regional BTV
Antimony	mg/kg	0.128	0.140	0.128	Site-Specific BTV
Arsenic	mg/kg	6.4	3.5	3.5	Regional BTV
Barium	mg/kg	334	270	270	Regional BTV
Beryllium	mg/kg	2.2	0.57	0.57	Regional BTV
Cadmium	mg/kg	0.191	0.160	0.160	Regional BTV
Calcium	mg/kg	8,250	32,000	8,250	Site-Specific BTV
Chromium	mg/kg	58	5.2	5.2	Regional BTV
Cobalt	mg/kg	9.5	4.4	4.4	Regional BTV
Copper	mg/kg	16	12	12	Regional BTV
Iron	mg/kg	13,300	8,897	8,897	Regional BTV
Lead	mg/kg	19	11	11	Regional BTV
Lithium	mg/kg	19	8.8	8.8	Regional BTV
Magnesium	mg/kg	9,110	3,900	3,900	Regional BTV
Manganese	mg/kg	384	440	384	Site-Specific BTV
Mercury	mg/kg	0.0510	0.0378	0.0378	Regional BTV
Molybdenum	mg/kg	0.23	0.29	0.23	Site-Specific BTV
Nickel	mg/kg	92	6.2	6.2	Regional BTV
Potassium-40	pCi/g	33.3	26.9	26.9	Regional BTV
Radium-226	pCi/g	2.58	2.23	2.23	Regional BTV
Radium-228	pCi/g	3.66	0.75	0.75	Regional BTV
Selenium	mg/kg	3.2	0.99	0.99	Regional BTV
Silver	mg/kg	0.027	0.037	0.027	Site-Specific BTV
Sodium	mg/kg	141	45	45	Regional BTV
Thallium	mg/kg	0.350	0.075	0.075	Regional BTV
Thorium	mg/kg	28	4.7	4.7	Regional BTV
Uranium	mg/kg	3.3	1.5	1.5	Regional BTV
Vanadium	mg/kg	27	24	24	Regional BTV
Zinc	mg/kg	36	27	27	Regional BTV
Gamma Radiation	cpm	24,891	14,566	14,566	Regional BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
Jml Morrison Formation (Lower)
mg/kg milligrams per kilogram
pCi/g picocuries per gram

7.2.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T14 and the raw gamma radiation and grid averaged gamma radiation survey results.

7.2.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T14 in May 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine if any additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. No additional scanning, measurements, or sampling were required. The applied gamma BTV for non-AUM Target T14 is 14,566 cpm. A total of 3,847 measurements were collected as part of the gamma radiation survey at non-AUM Target T14 across 44 survey units. An average scan density of 87 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I14-4.

Table I14-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M1-02 (T14)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	14,566	
Measurements	#	3,847	44
Minimum	cpm	7,788	9,984
Maximum	cpm	31,731	15,731
Average	cpm	11,889	11,710
Median	cpm	11,354	11,260
Standard Deviation	cpm	2,041	1,452
90th Percentile	cpm	14,777	14,090
95th Percentile	cpm	15,580	14,972
99th Percentile	cpm	17,681	15,555
Measurements per Grid	#/grid	87	
Measurements Above Gamma BTV	#	435	3
Measurements Above Gamma BTV	%	11.3	6.8

Notes:
BTV background threshold value
cpm counts per minute

7.2.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 11.3 percent of the measurements within the Target boundaries, in some cases exceeding greater than twice the applied gamma BTV (14,556 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the Jml regional gamma survey results is provided on Figure I14-6. This graph shows that the spread of radiation data at Target T14 (shown on left) begins within the middle range of Jml regional gamma levels (shown on right) and then rises approximately the same as background radiation. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T14 is slightly higher than the data cloud from the Jml regional data set. A box plot showing the quartiles of the data sets is provided in Figure I14-7. The box plot shows that the median of Target T14 radiation levels is slightly higher than the median of the Jml regional data set but lower than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I14-8. No mining activity was observed within the survey area of Target T14. However, there were a few distinct elevated areas located near outcropping of the Jml and NORM was visually documented in the field (Figure I14-4). Historic exploratory borings may also be present in the Target area.

In general, Target T14 has surficial gamma radiation levels below Jml regional levels across the majority of the Target except for the NORM identified on the eastern edge of the survey area, which correlated with the area of elevated gamma activity identified by the ASPECT and Weston MCAP gamma surveys (Figures I14-3 and I14-8). No TENORM or mining-related activities were observed. Section 7.2.5.3 presents the grid averaged results of the gamma radiation survey.

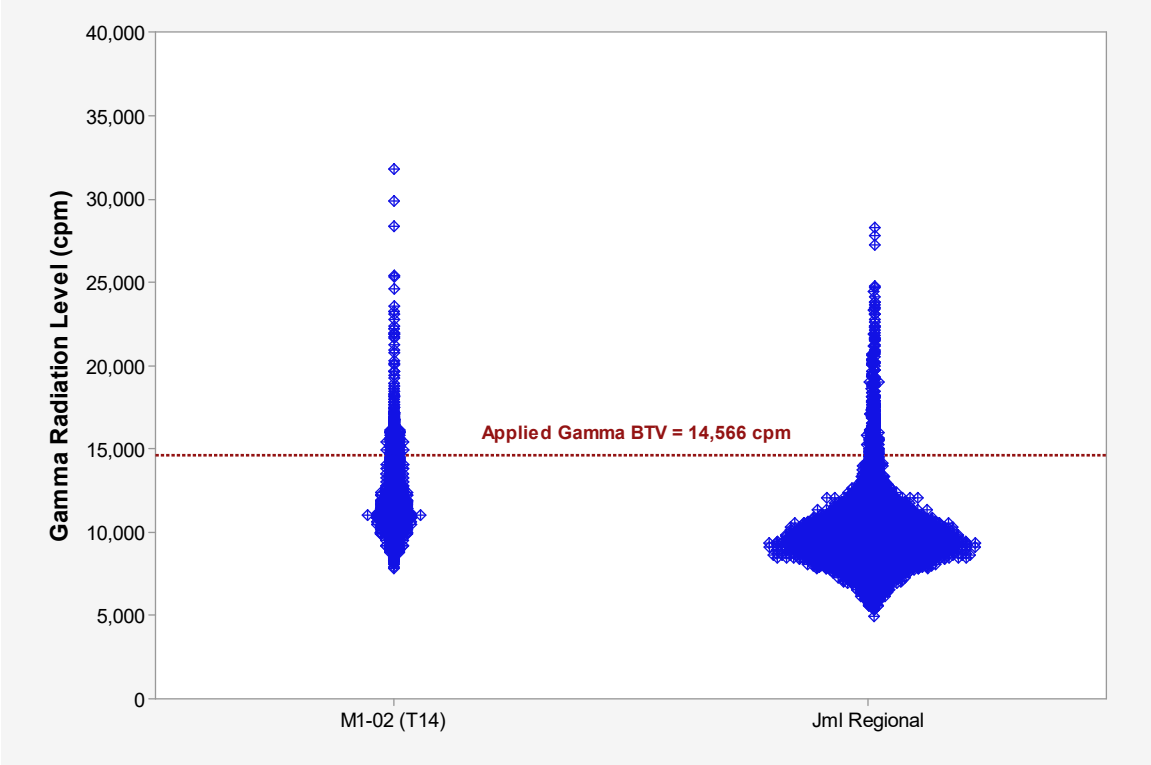


Figure I14-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M1-02 (T14) and Jml Regional

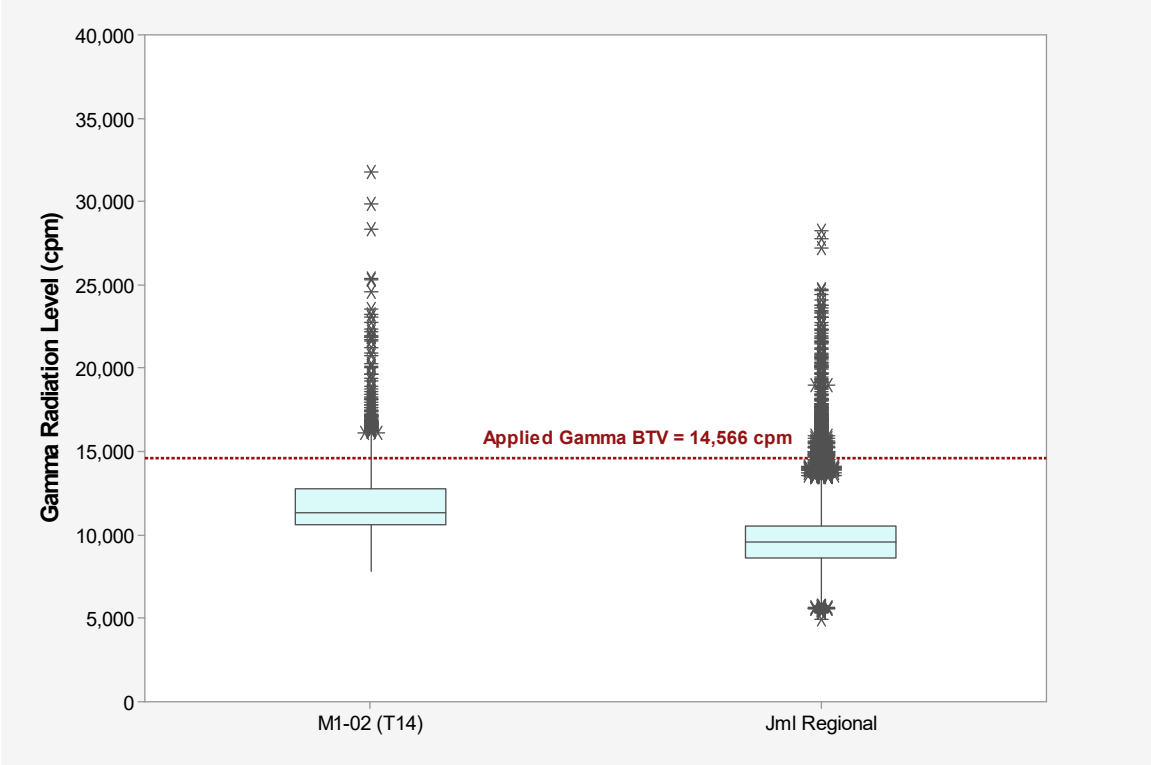
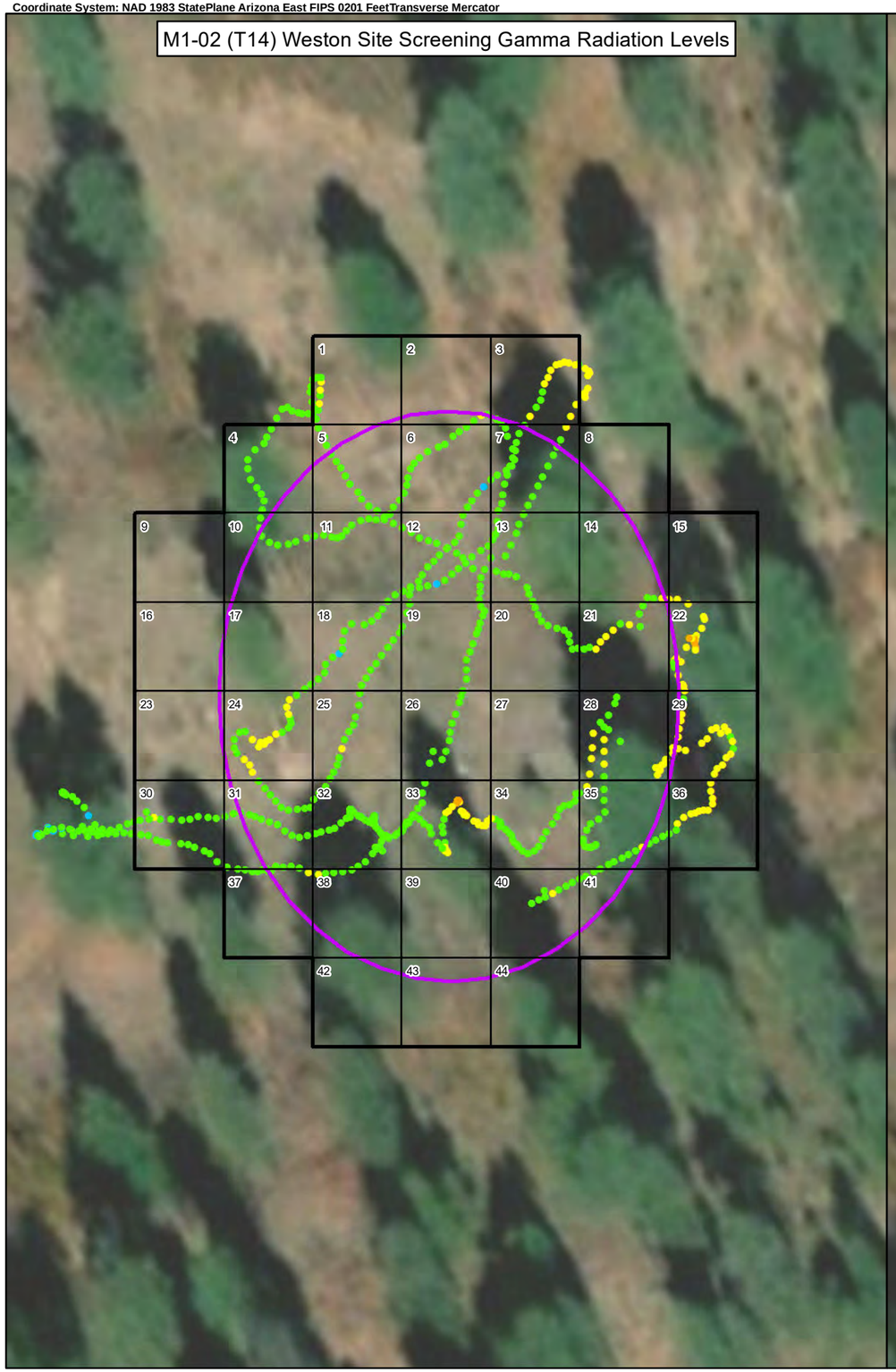


Figure I14-7. Box Plot of Raw Gamma Radiation Levels at Target M1-02 (T14) and Jml Regional

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

M1-02 (T14) Weston Site Screening Gamma Radiation Levels



M1-02 (T14) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)*

≤ 9,712	≤ Avg. BG
9,712 - 14,566	Avg. BG - 1 x BTV
14,566 - 29,132	1 x BTV - 2 x BTV
29,132 - 43,698	2 x BTV - 3 x BTV
43,698 - 58,264	3 x BTV - 4 x BTV
58,264 - 145,660	4 x BTV - 10 x BTV
≥ 145,660	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Unit (100 m²)

Survey Area Boundary

1 in = 50 ft

1:600

N W E S

0 25 50 100 Feet

NON-AUM TARGET M1-02 (T14) 2018 REMOVAL SITE EVALUATION VS WESTON SITE SCREENING GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/13/2019

Notes:

*The applied gamma radiation background threshold value (BTV) for M1-02 Non-AUM Target is 14,566 cpm derived from gamma survey data for BSAs within the Jml formation as presented in Appendix A.

Figure No.: **I14-8**

7.2.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 7.2.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 7.2.5.1. Figure I14-9 and Figure I14-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to the Jml regional data set (shown on right). A total of 6.8 percent of the survey units (3 of 44) within the survey area of Target T14 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I14-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I14-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. The elevated regions of the Target correspond with the observed NORM associated with outcropping of the Jml.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 7.2.6.

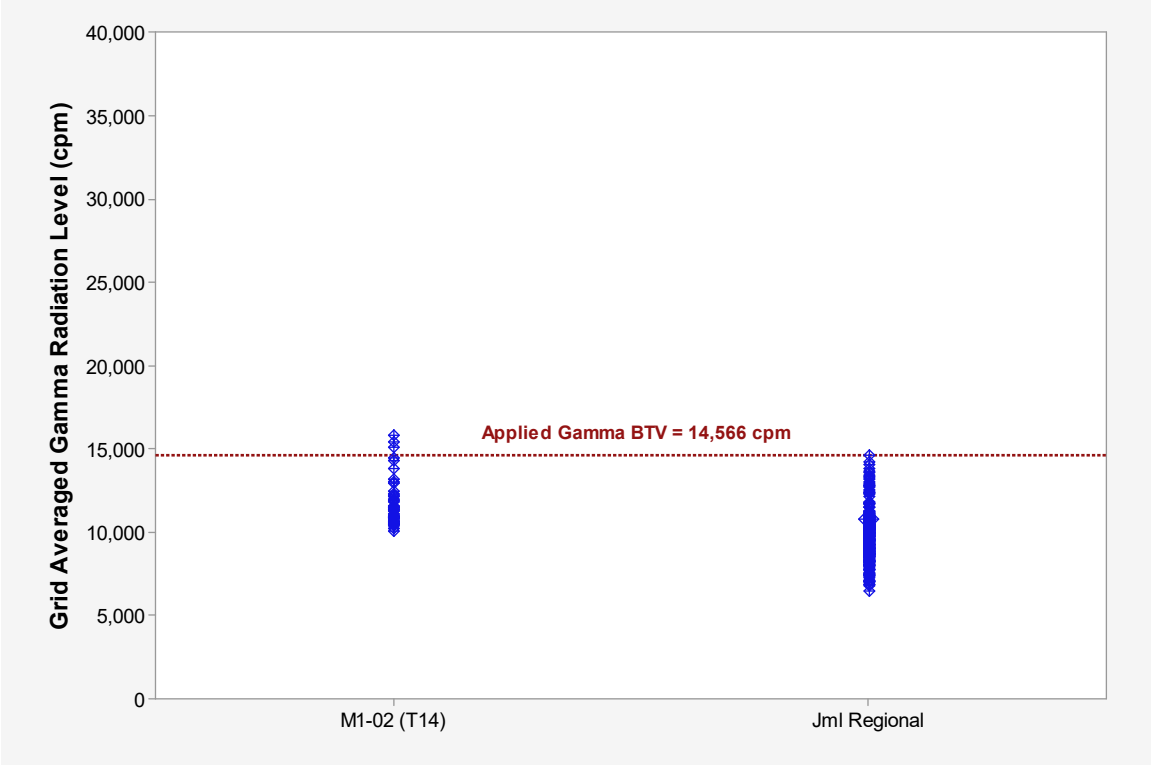


Figure I14-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M1-02 (T14) and Jml Regional

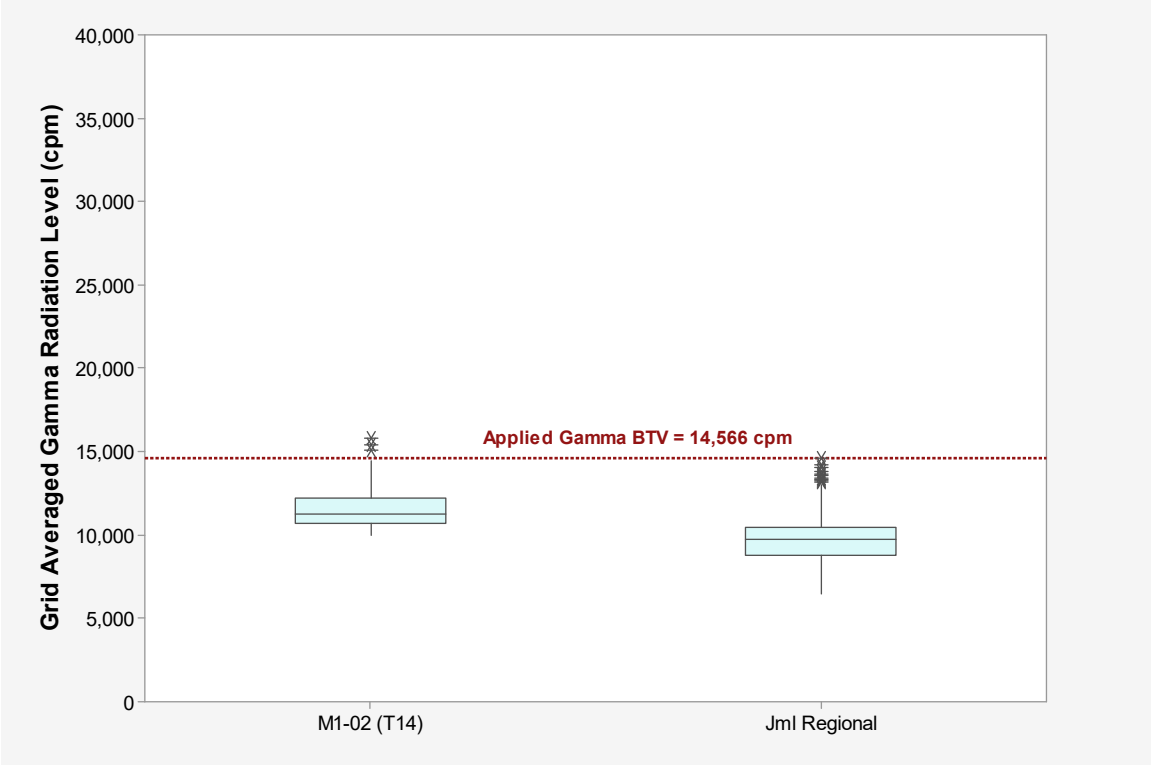
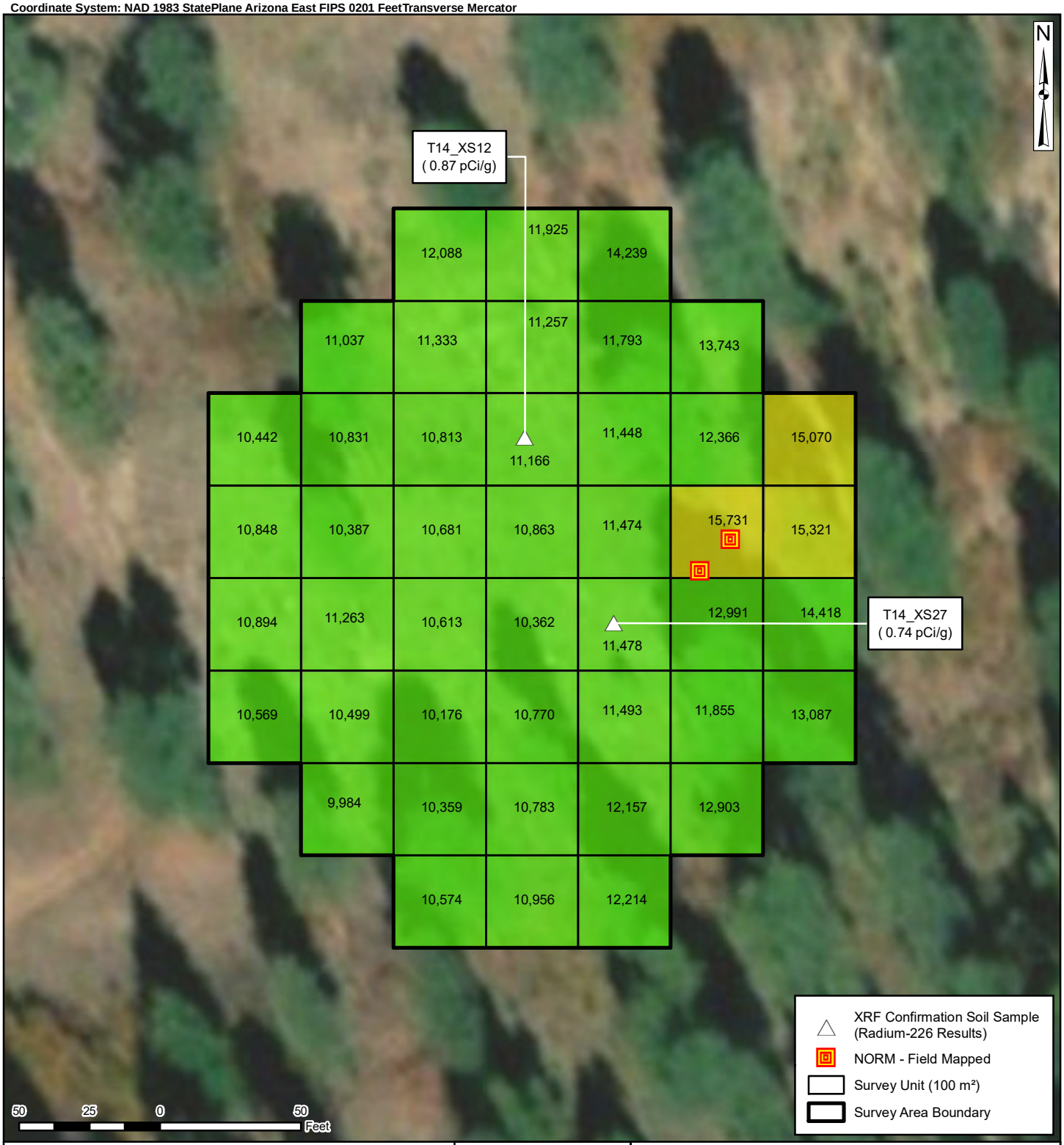


Figure I14-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M1-02 (T14) and Jml Regional

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



Grid Averaged Gamma Reading (cpm)*

≤ 9,712	≤ Avg. BG
9,712 - 14,566	Avg. BG - 1 x BTV
14,566 - 29,132	1 x BTV - 2 x BTV
29,132 - 43,698	2 x BTV - 3 x BTV
43,698 - 58,264	3 x BTV - 4 x BTV
58,264 - 145,660	4 x BTV - 10 x BTV
≥ 145,660	≥ 10 x BTV

*The applied gamma radiation background threshold value (BTV) for M1-02 (T14) is 14,566 cpm derived from gamma survey data for BSAs within the Jml formation as presented in Appendix A.

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NON-AUM TARGET M1-02 (T14) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I14-11
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

7.2.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T14. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 7.2.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 7.2.6.2.

7.2.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T14: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I14-1 and I14-2. All the results of the XRF confirmation soil samples are presented in Table I14-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T14 following the methods outlined in Section 2.4 and shown in Figure I14-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 44 measurements were collected across 44 survey units from the survey area of Target T14 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I14-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T14 at a depth of 0 to 3 inches bgs. Two XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I14-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 7.2.7.

Table I14-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M1-02 (T14)

Analyte	Units	Applied BTV	T14-XS12-01-050818		T14-XS27-01-050818	
			Result	Q	Result	Q
Survey Unit			X12		X27	
Aluminum	mg/kg	7,000	4,200		3,700	
Antimony	mg/kg	0.128	0.33		0.089	J
Arsenic	mg/kg	3.5	3.5		1.5	
Barium	mg/kg	270	100		74	
Beryllium	mg/kg	0.57	0.33		0.28	
Cadmium	mg/kg	0.160	0.094	J	0.046	J
Calcium	mg/kg	8,250	3,900		2,700	
Chromium	mg/kg	5.2	4.2		3.6	
Cobalt	mg/kg	4.4	2.8		2.3	
Copper	mg/kg	12	5		3.2	
Iron	mg/kg	8,897	6,200		5,300	
Lead	mg/kg	11	7		4.3	
Lead-210	pCi/g	NV	NA		0.81	LT
Lithium	mg/kg	8.8	3.8		3.5	
Magnesium	mg/kg	3,900	1,700		1,400	
Manganese	mg/kg	384	340		220	
Mercury	mg/kg	0.0378	NA		0.0081	J-
Molybdenum	mg/kg	0.23	0.21		0.16	J
Nickel	mg/kg	6.2	5		4	
Potassium-40	pCi/g	26.9	13.7		14.9	
Radium-226	pCi/g	2.23	0.87	LT	0.74	LT
Radium-228	pCi/g	0.75	0.79	LT	<0.64	U
Selenium	mg/kg	0.99	0.75	J	0.53	J
Silver	mg/kg	0.027	0.0094	J	<0.052	U
Sodium	mg/kg	45	<100	U	21	J
Thallium	mg/kg	0.075	0.05		0.036	
Thorium	mg/kg	4.7	2.7		2.6	
Thorium-228	pCi/g	NV	NA		0.61	
Thorium-230	pCi/g	NV	NA		0.85	M3
Thorium-232	pCi/g	NV	NA		0.61	
Uranium	mg/kg	1.5	0.46		0.46	
Uranium-234	pCi/g	NV	NA		0.49	
Uranium-235	pCi/g	NV	NA		<0.017	U
Uranium-238	pCi/g	NV	NA		0.64	
Vanadium	mg/kg	24	11		9.4	
Zinc	mg/kg	27	13		11	

Notes:

BTV	Background threshold value
J	Estimated value
J-	Estimated value, may be biased low
LT	Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
M3	The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg	Milligrams per kilogram
NA	Not applicable
NV	No Value
pCi/g	Picocuries per gram
Q	Qualification
U	Not considered detected. The associated value is the method detection limit (MDL).
UJ	Not considered detected. The associated value is the reported concentration, which is estimated.

Table I14-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M1-02 (T14)

Summary Statistic	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	3.5	8,897	11	384	0.23	4.7	1.5	24	27
Measurements	#	44	44	44	44	44	44	44	44	44
Detects	#	22	44	44	44	16	44	35	1	44
Nondetects	#	22	0	0	0	28	0	9	43	0
Minimum	mg/kg	1.9	4,104	3.8	213.1	0.09	1.5	0.23	16.4	12.5
Maximum	mg/kg	3.7	7,303	14.5	553.1	4.9	4.1	5.6	16.4	33.9
Standard Deviation	mg/kg	0.6	747	2.1	69	1.32	0.5	1.0	-	5.0
Average	mg/kg	2.5	5,831	8.5	312	1.36	2.6	1.3	16.4	18.5
Median	mg/kg	2.3	5,810	8.4	308	1.01	2.6	1.3	16.4	17.4
Relative Standard Deviation	%	22.7	12.8	24.4	22.3	96.7	20.6	77.0	-	27.1
90th Percentile	mg/kg	3.2	6,792	11.2	390	2.9	3.2	2.0	16.4	25
95th Percentile	mg/kg	3.4	6,961	11.8	403	4.0	3.4	2.5	16.4	29
99th Percentile	mg/kg	3.6	7,215	13.4	517	4.7	3.9	4.7	16.4	34
Measurements Above Applied BTV	#	1	0	7	6	13	0	12	0	3
Measurements Above Applied BTV	%	2.3	0.0	15.9	13.6	29.5	0.0	27.3	0.0	6.8

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value

mg/kg Milligram per kilogram

XRF X-ray fluorescence

7.2.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T14 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T14 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T14. The estimated BTVs are identified in Section 7.2.4 and Table I14-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I14-7 presents a summary of the background comparison for different measurement and soil depths at Target T14. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T14. Further gamma radiation screening indicated that gamma levels at Target T14 are similar to those of BSA-12 except for the area of NORM. Therefore, while multiple COPCs have been identified at Target T15 based on a conservative comparison to background, risk screening may be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

Table I14-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M1-02 (T14)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony	✓		✓
Arsenic			
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron			
Lead		✓	✓
Lithium			
Magnesium			
Manganese		✓	✓
Mercury			
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226	✓		✓
Radium-228			
Selenium			
Silver			
Sodium			
Thallium			
Thorium			
Uranium		✓	✓
Vanadium			
Zinc		✓	✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

7.2.7 Primary Contaminant Mapping

7.2.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 7.2.6.2 identified the COPCs at Target T14. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 7.2.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I14-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T14 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 7.2.7.1 through Section 7.2.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T14. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

7.2.7.2 Arsenic

Arsenic was not identified as a COPC in surface soils as shown in Table I14-7. Arsenic exceeded the applied BTV in 2.3 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for arsenic is 3.5 mg/kg for Target T14 as presented in Section 7.2.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I14-5 and Attachment I3, respectively. Figure I14-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T14 and Jml regional samples. Figure I14-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T14 and Jml regional samples. Summary statistics for XRF measurements are provided in Section 7.2.6.1. Arsenic XRF concentrations measured in surface soils at Target T14 ranged between 1.9 and 3.7 mg/kg with an average and standard deviation of 2.5 mg/kg and 0.6 mg/kg, respectively. The average arsenic XRF concentration is below the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T14 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I14-14. Overall, the majority of detectable arsenic results in surface soils were below the applied BTV. Only one measurement slightly exceeded the applied BTV and does not appear to be associated with mining-related materials at Target T14.

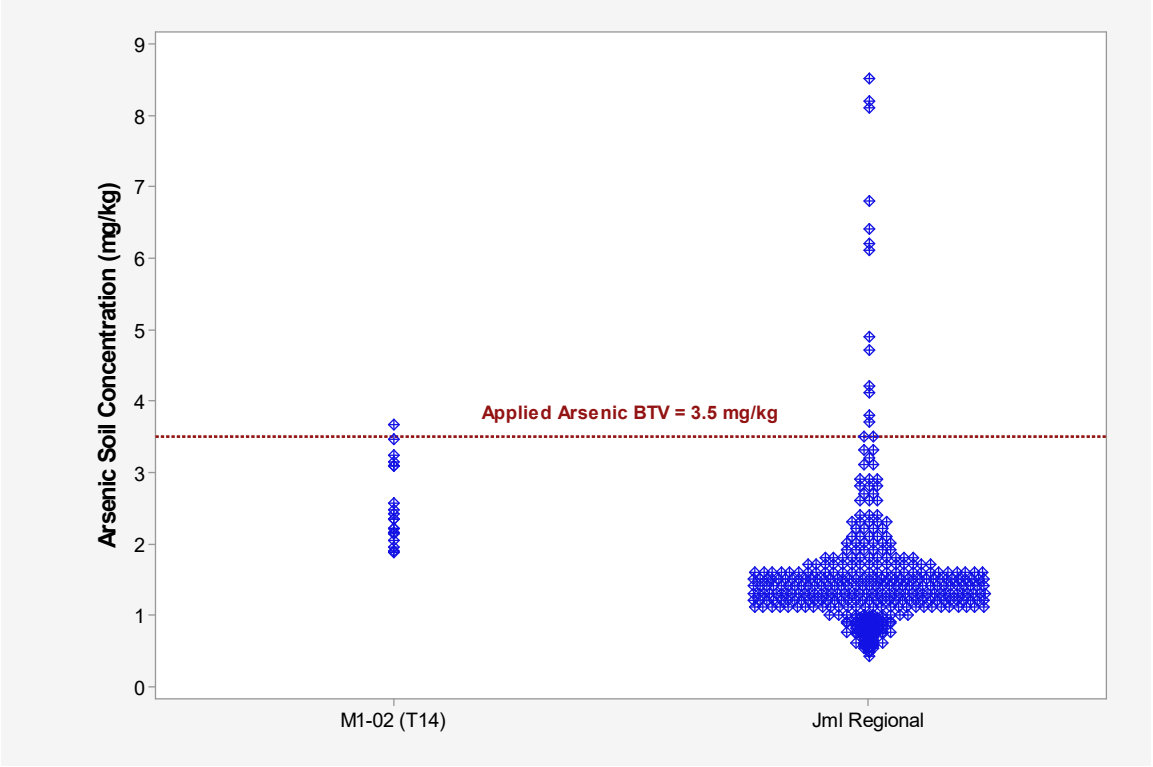


Figure I14-12. Individual Value Plot for Target M1-02 (T14) and Jml Regional Arsenic Soil Concentrations

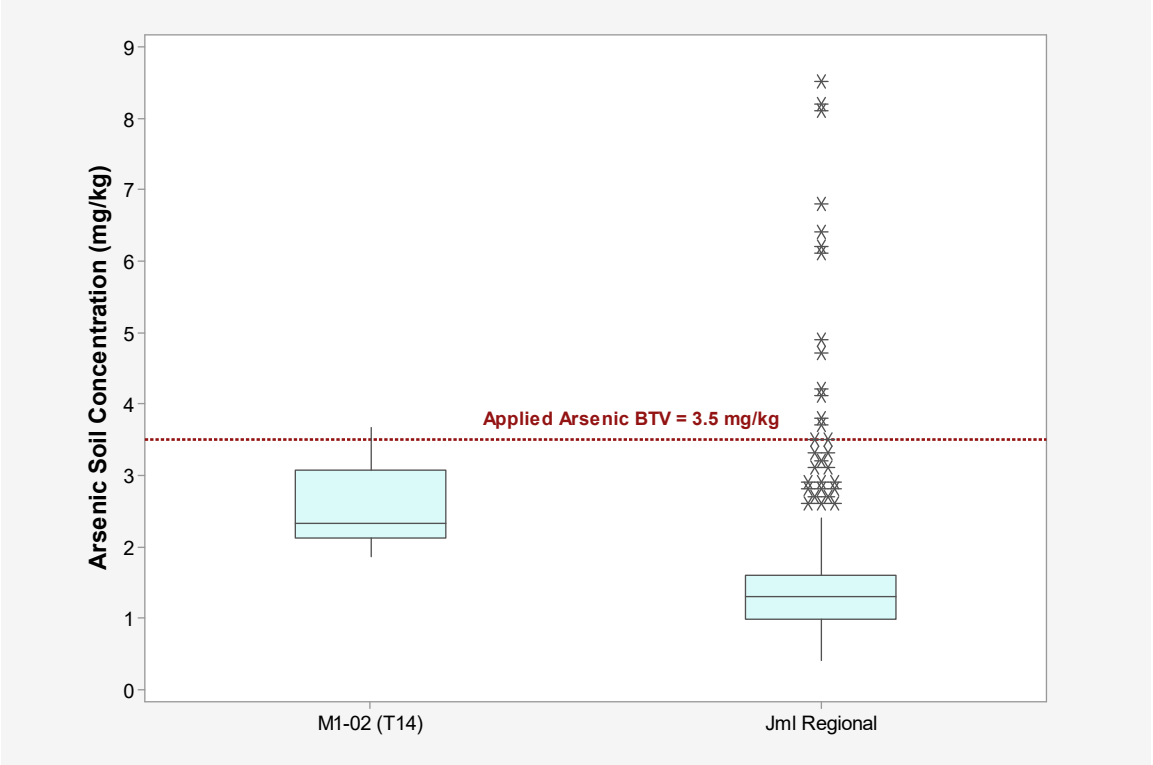
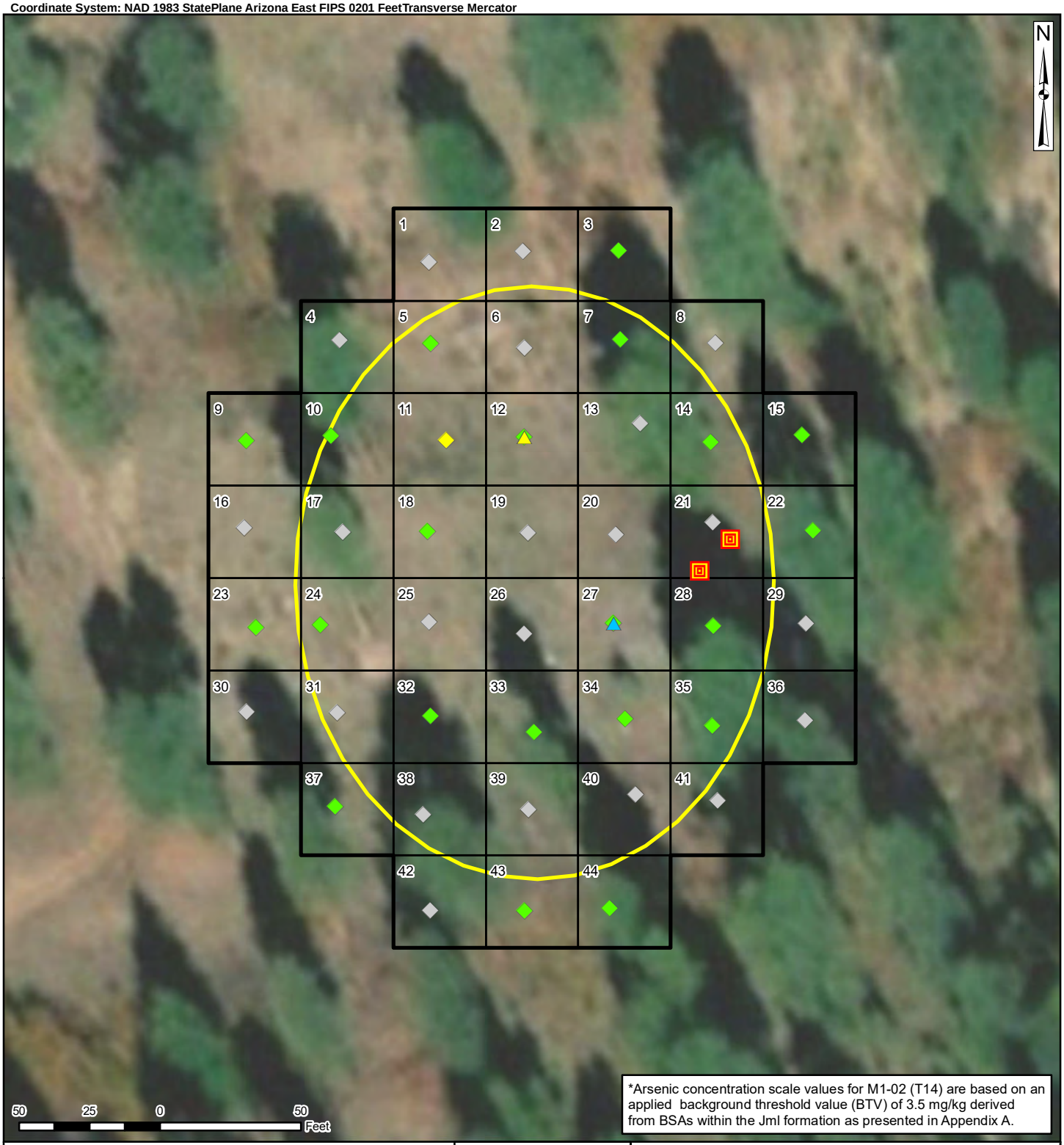


Figure I14-13. Box Plot for Target M1-02 (T14) and Jml Regional Arsenic Soil Concentrations

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



*Arsenic concentration scale values for M1-02 (T14) are based on an applied background threshold value (BTV) of 3.5 mg/kg derived from BSAs within the Jml formation as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 1.5
- 1.5 - 3.5
- 3.5 - 7.0
- 7.0 - 11
- 11 - 14
- 14 - 35
- ≥ 35
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- NORM - Field Mappped
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET M1-02 (T14) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I14-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

7.2.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I14-7. Lead exceeded the applied BTV in 15.9 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for lead is 11 mg/kg for Target T14 as presented in Section 7.2.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I14-5 and Attachment I3, respectively. Figure I14-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T14 and Jml regional samples. Figure I14-16 presents a box plot of detectable lead XRF soil concentrations for Target T14 and Jml regional samples. Summary statistics for XRF measurements are provided in Section 7.2.6.1. Lead XRF concentrations measured in surface soils at Target T14 ranged between 3.8 and 14.5 mg/kg with an average and standard deviation of 8.5 mg/kg and 2.1 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T14 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I14-17. Overall, the majority of detectable lead results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T14.

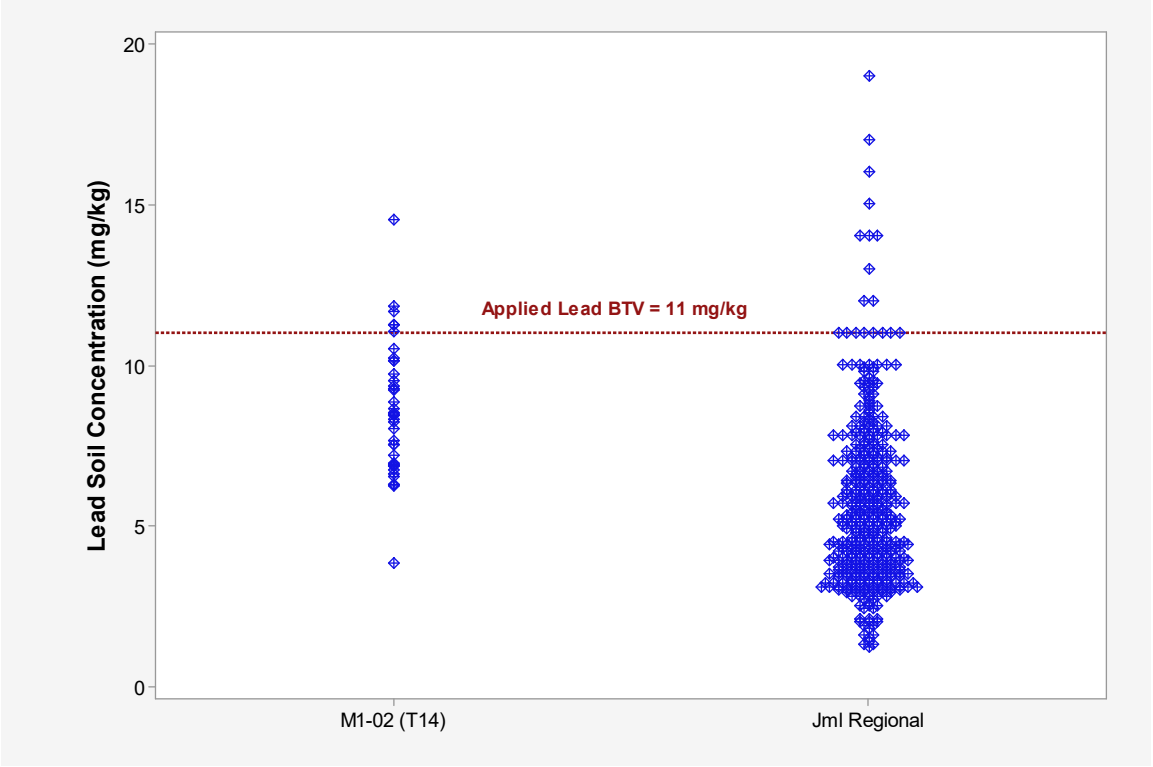


Figure I14-15. Individual Value Plot for Target M1-02 (T14) and Jml Regional Lead Soil Concentrations

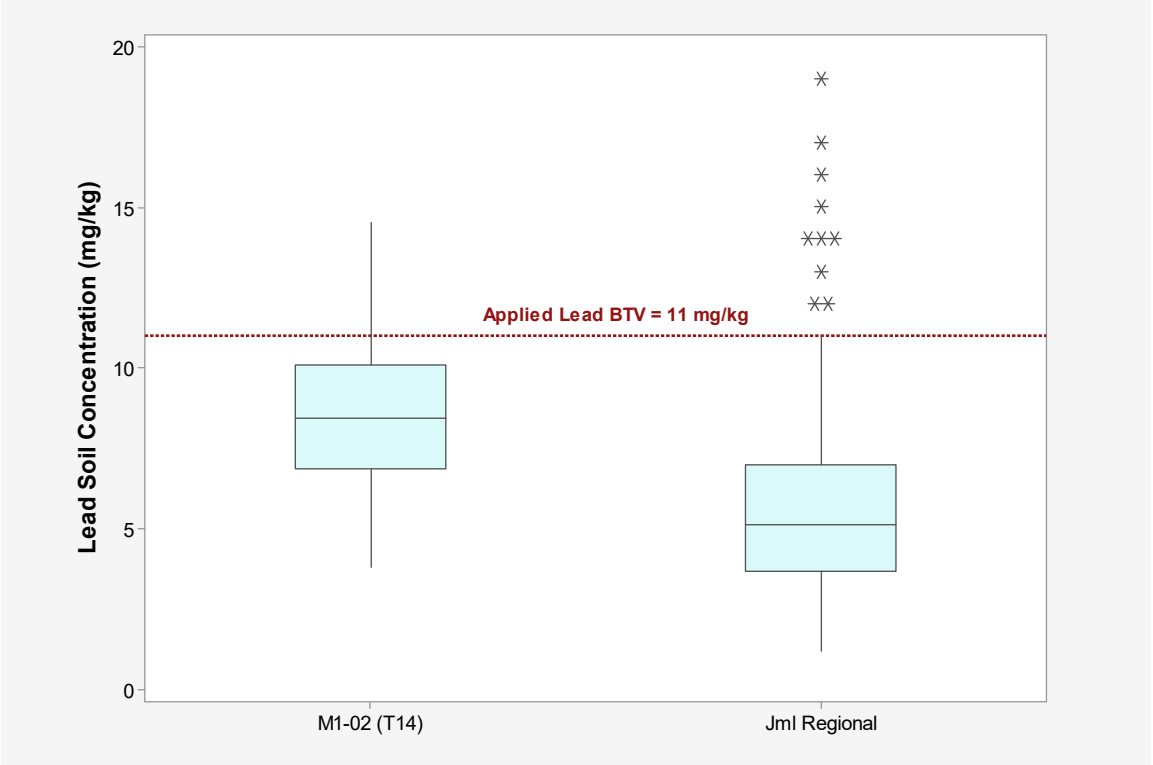
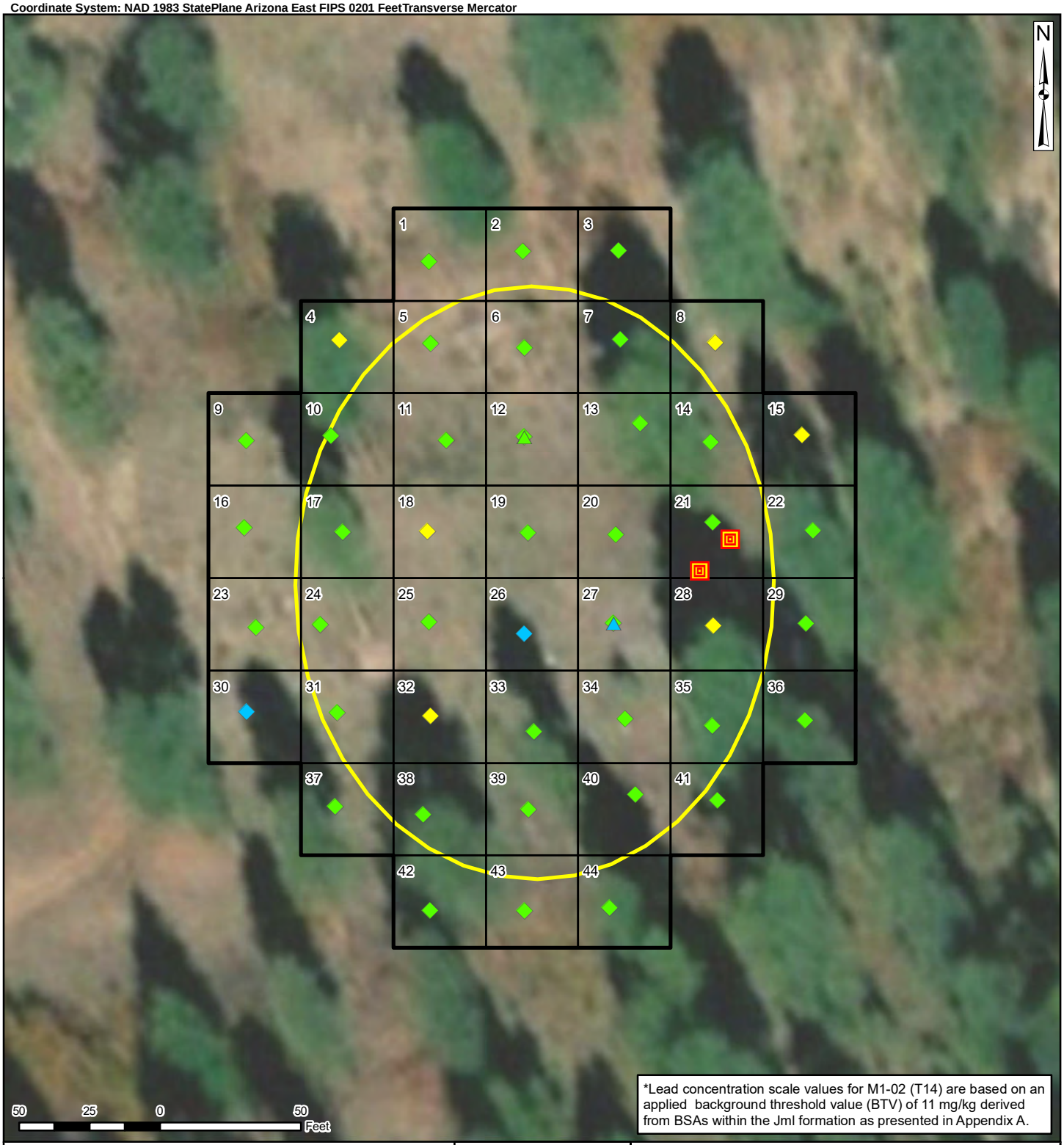


Figure I14-16. Box Plot for Target M1-02 (T14) and Jml Regional Lead Soil Concentrations

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



*Lead concentration scale values for M1-02 (T14) are based on an applied background threshold value (BTV) of 11 mg/kg derived from BSAs within the Jml formation as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 5.6
- 5.6 - 11
- 11 - 22
- 22 - 33
- 33 - 44
- 44 - 110
- ≥ 110

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- NORM - Field Mappped
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET M1-02 (T14) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I14-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

7.2.7.4 Thorium

Thorium was not identified as a COPC in surface soil as shown in Table I14-7. Thorium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for thorium is 4.7 mg/kg for Target T14 as presented in Section 7.2.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I14-5 and Attachment I3, respectively. Figure I14-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T14 and Jml regional samples. Figure I14-19 presents a box plot of detectable thorium XRF soil concentrations for Target T14 and Jml regional samples. Summary statistics for XRF measurements are provided in Section 7.2.6.1. Thorium XRF concentrations measured in surface soils at Target T14 ranged between 1.5 and 4.1 mg/kg with an average and standard deviation of 2.6 mg/kg and 0.5 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T14 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I14-20. All thorium results in surface soils were less than the applied BTV.

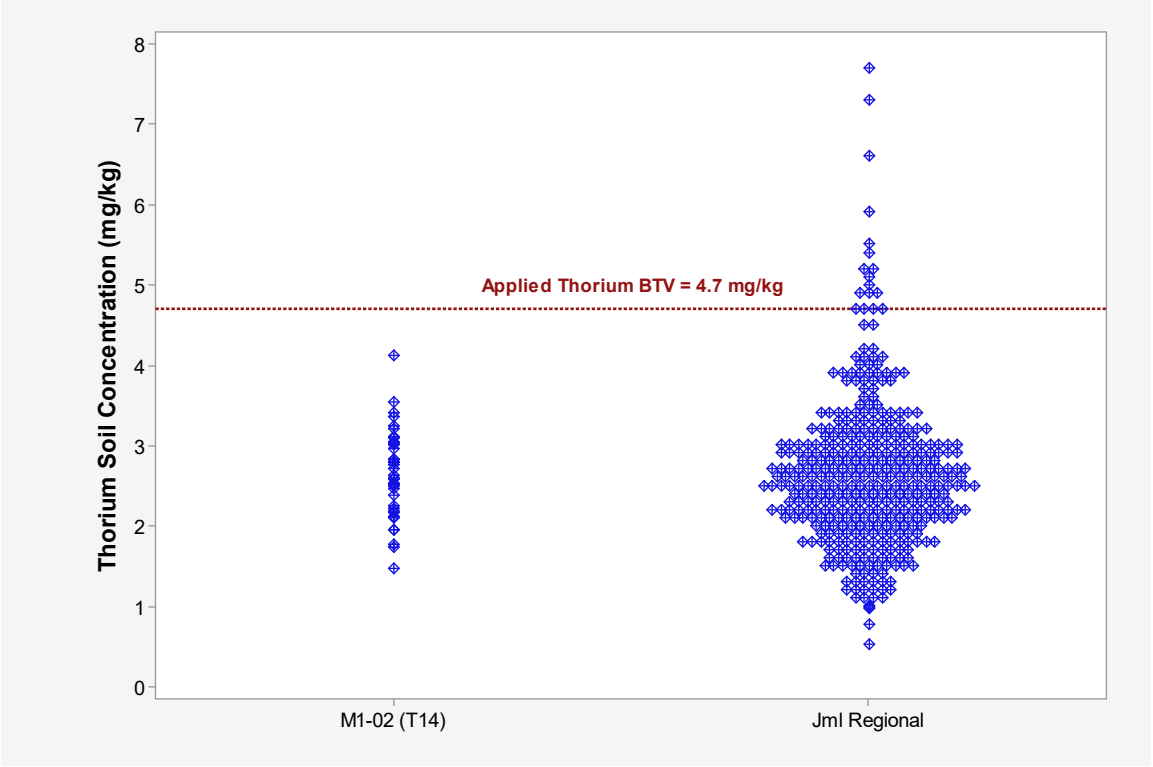


Figure I14-18. Individual Value Plot for Target M1-02 (T14) and Jml Regional Thorium Soil Concentrations

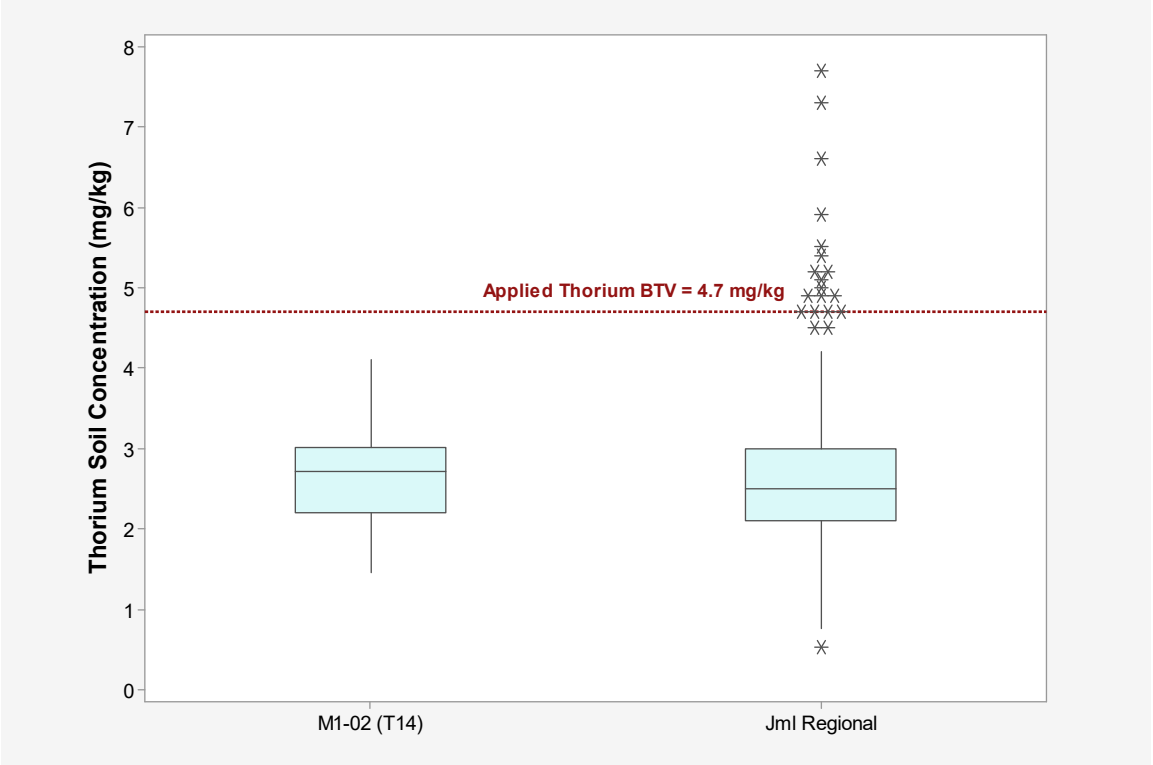
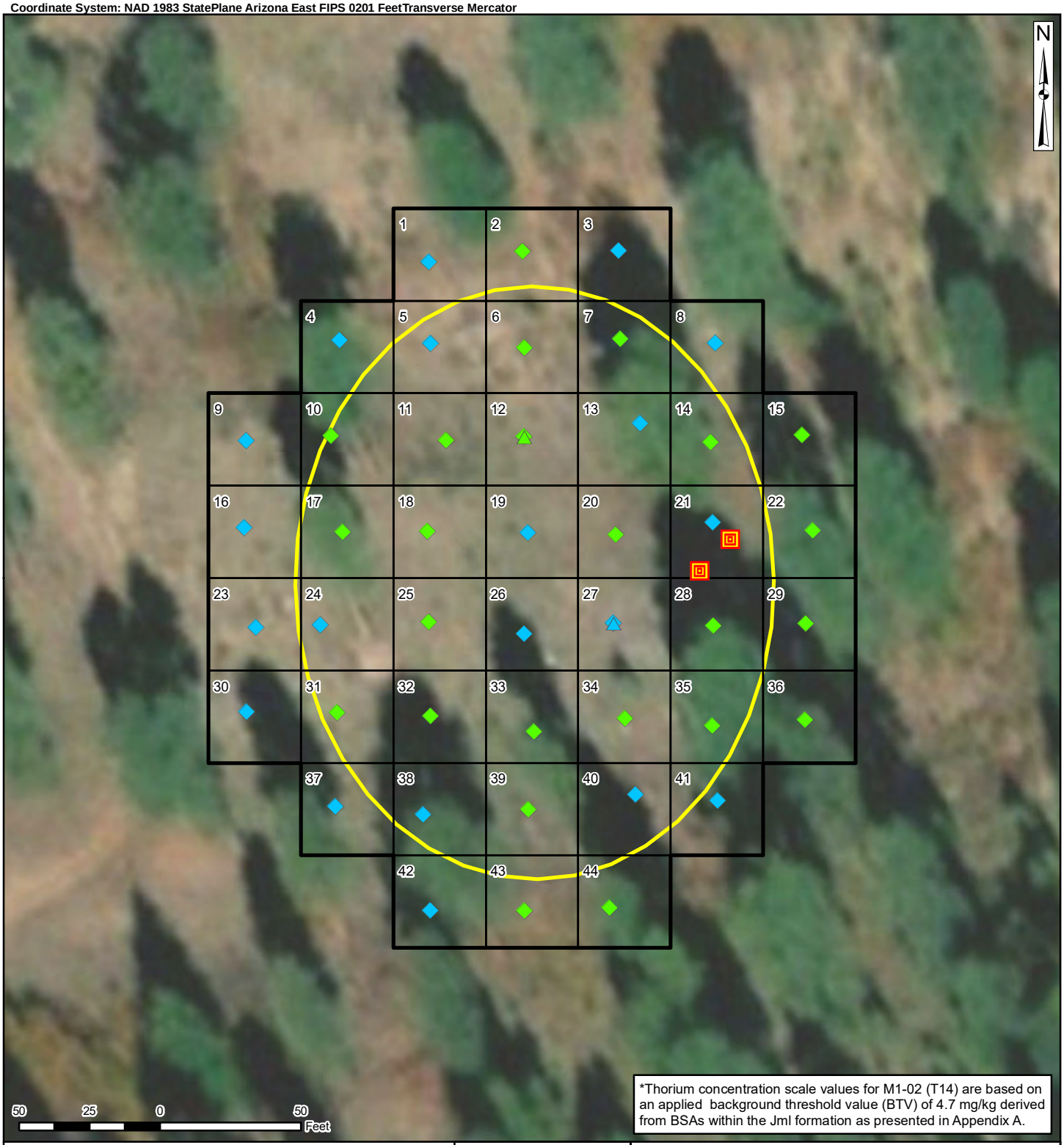


Figure I14-19. Box Plot for Target M1-02 (T14) and Jml Regional Thorium Soil Concentrations

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



*Thorium concentration scale values for M1-02 (T14) are based on an applied background threshold value (BTV) of 4.7 mg/kg derived from BSAs within the Jml formation as presented in Appendix A.

Thorium Concentration Scale (mg/kg)*

- ≤ 2.6
- 2.6 - 4.7
- 4.7 - 9.4
- 9.4 - 14
- 14 - 19
- 19 - 47
- ≥ 47

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- NORM - Field Mappped
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET M1-02 (T14) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I14-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

7.2.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I14-7. Uranium exceeded the applied BTV in 27.3 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for uranium is 1.5 mg/kg for Target T14 as presented in Section 7.2.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I14-5 and Attachment I3, respectively. Figure I14-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T14 and Jml regional samples. Figure I14-22 presents a box plot of detectable uranium XRF soil concentrations for Target T14 and Jml regional samples. Summary statistics for XRF measurements are provided in Section 7.2.6.1. Uranium XRF concentrations measured in surface soils at Target T14 ranged between 0.23 and 5.6 mg/kg with an average and standard deviation of 1.3 mg/kg and 1.0 mg/kg, respectively. The average uranium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T14 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I14-23. Overall, the majority of detectable uranium results in surface soils were below the applied BTV. However, the maximum XRF value was 3.7 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T14.

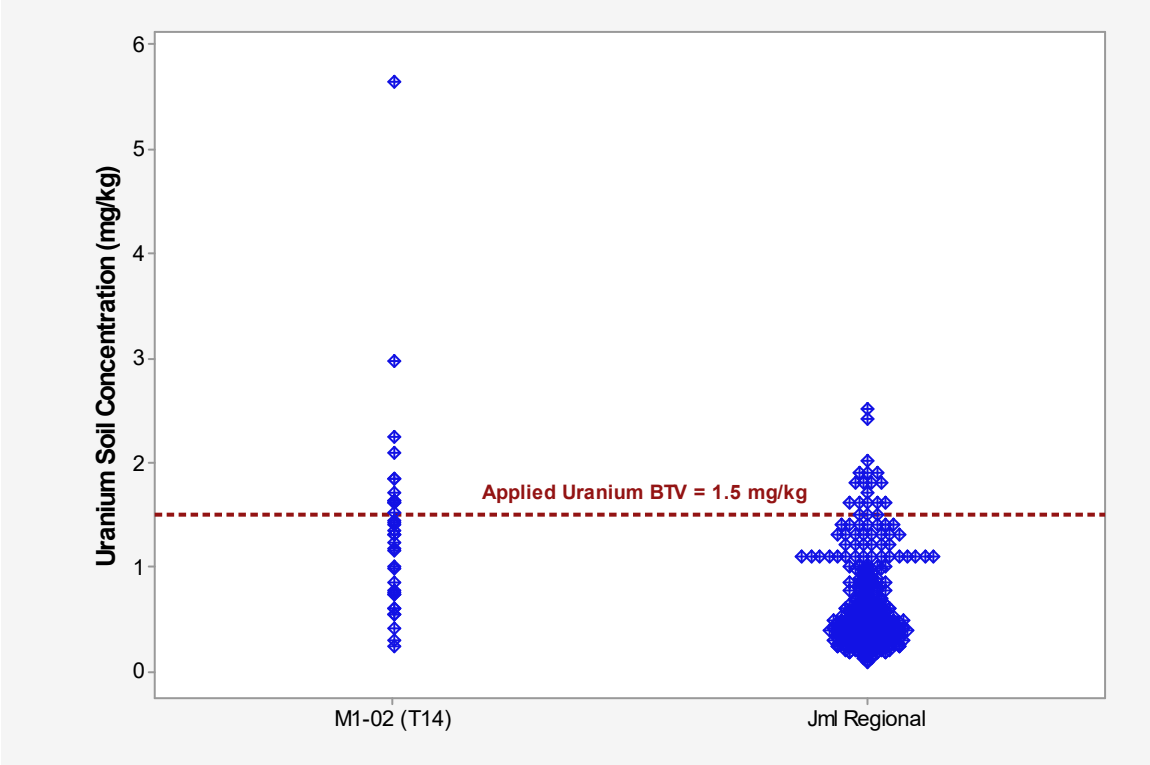


Figure I14-21. Individual Value Plot for Target M1-02 (T14) and Jml Regional Uranium Soil Concentrations

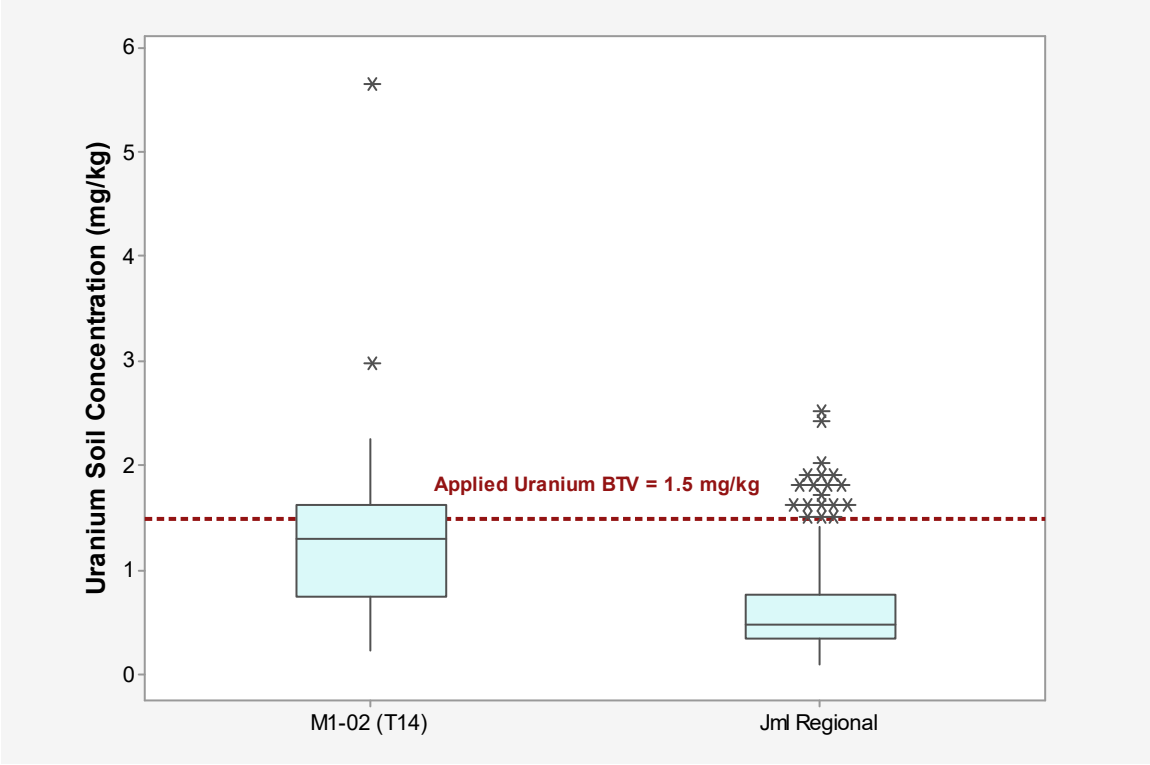
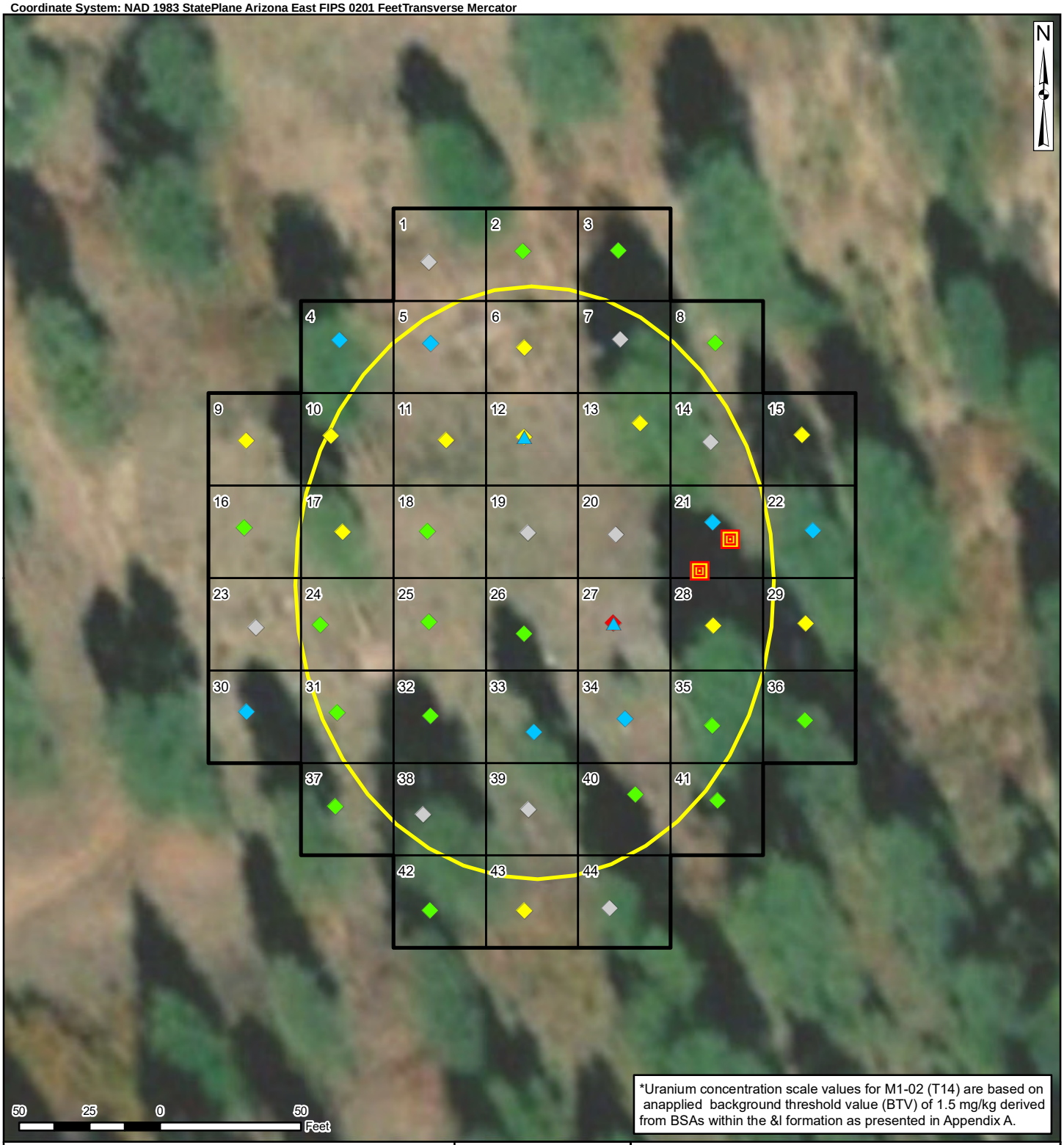


Figure I14-22. Box Plot for Target M1-02 (T14) and Jml Regional Uranium Soil Concentrations

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



*Uranium concentration scale values for M1-02 (T14) are based on anapplied background threshold value (BTV) of 1.5 mg/kg derived from BSAs within the &I formation as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 0.61
- 0.61 - 1.5
- 1.5 - 3.0
- 3.0 - 4.5
- 4.5 - 6.0
- 6.0 - 15
- ≥ 15
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- NORM - Field Mappped
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET M1-02 (T14) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I14-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

7.2.7.6 Vanadium

Vanadium was not identified as a COPC in surface soils as shown in Table I14-7. Vanadium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for vanadium is 24 mg/kg for Target T14 as presented in Section 7.2.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I14-5 and Attachment I3, respectively. Figure I14-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T14 and Jml regional samples. Figure I14-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T14 and Jml regional samples. Summary statistics for XRF measurements are provided in Section 7.2.6.1. Vanadium was only measured once in surface soils at Target T14 at a concentration of 16.4 mg/kg. This vanadium concentration is below the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T14 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I14-26. All vanadium results in surface soils were less than the applied BTV.

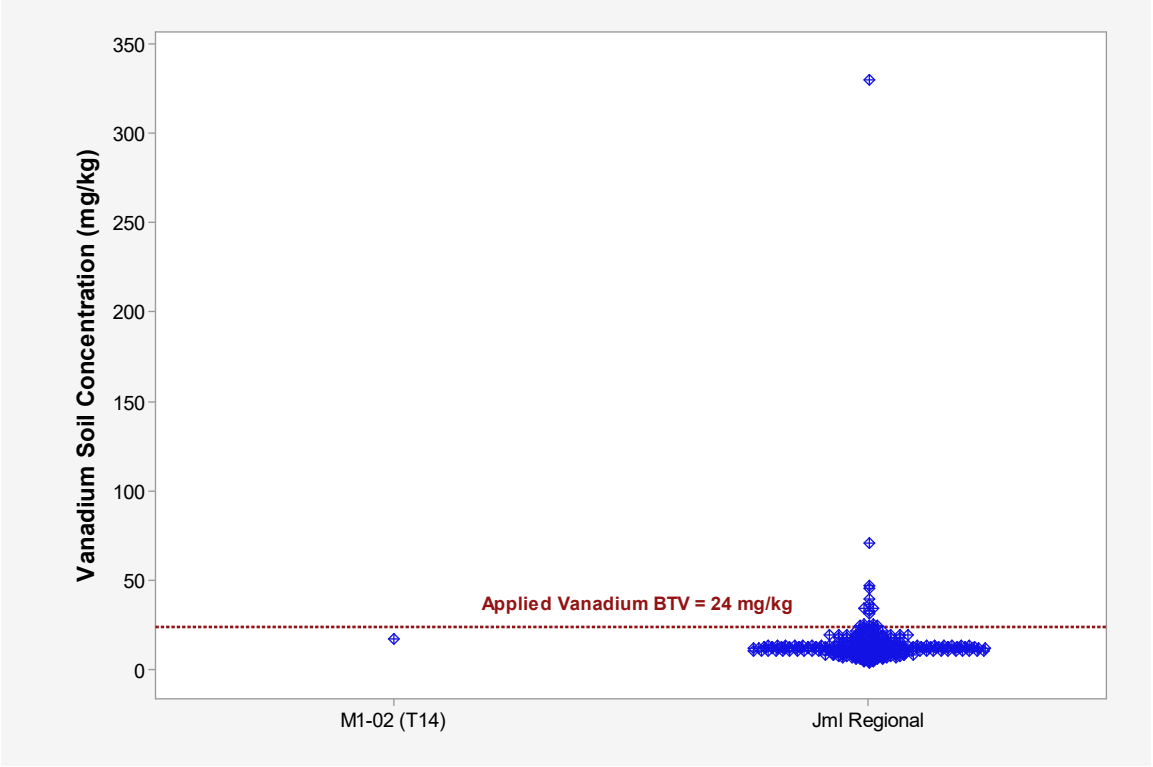


Figure I14-24. Individual Value Plot for Target M1-02 (T14) and Jml Regional Vanadium Soil Concentrations

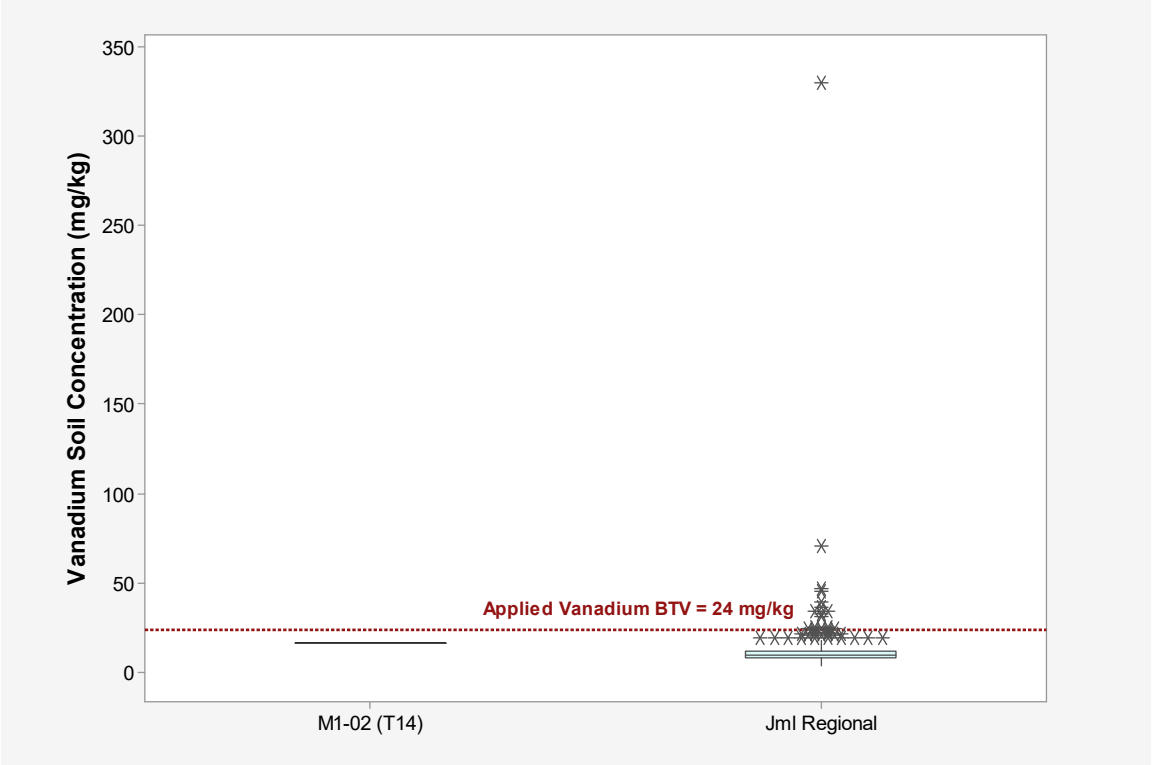
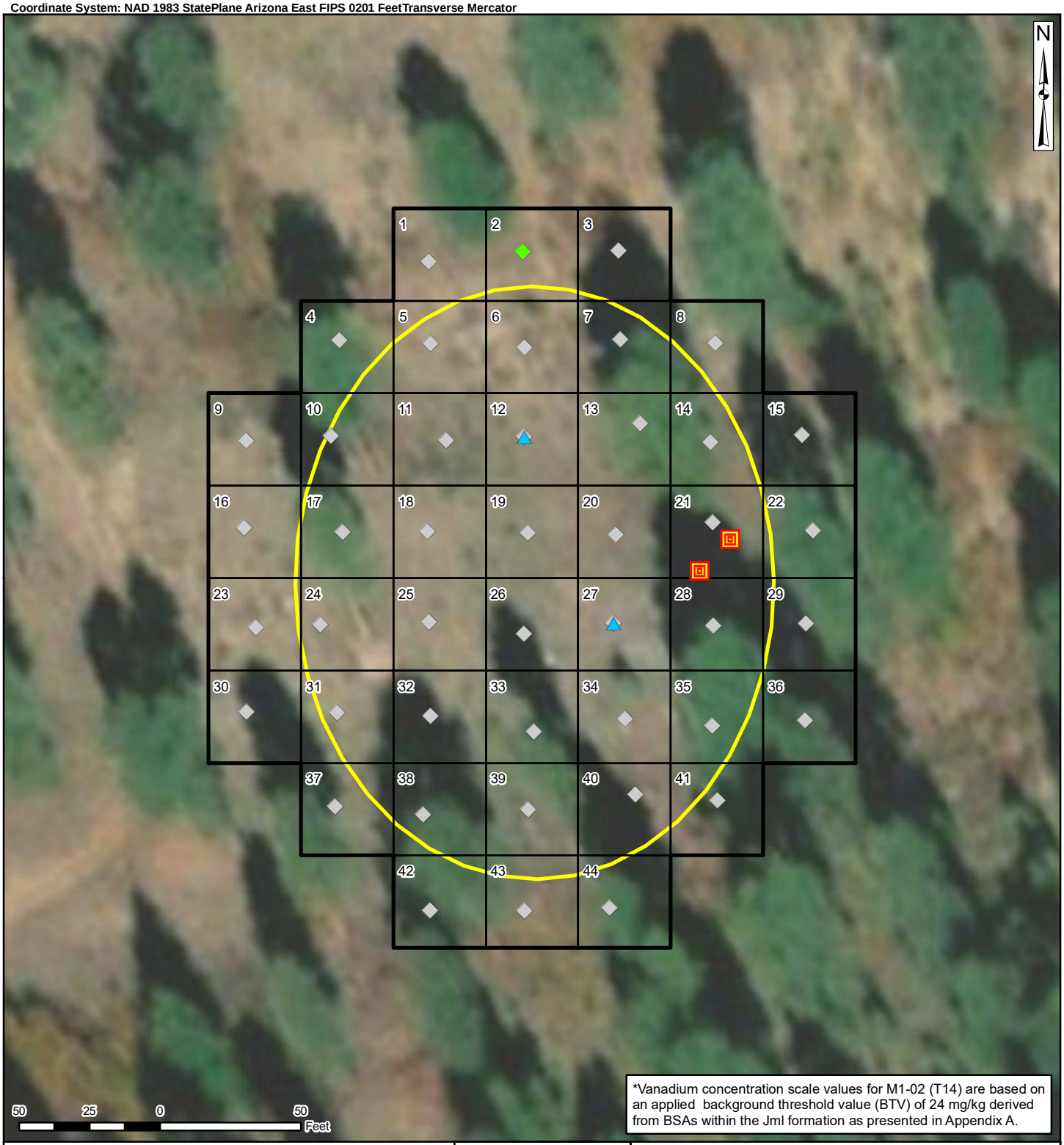


Figure I14-25. Box Plot for Target M1-02 (T14) and Jml Regional Vanadium Soil Concentrations

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



*Vanadium concentration scale values for M1-02 (T14) are based on an applied background threshold value (BTV) of 24 mg/kg derived from BSAs within the Jml formation as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 12
- 12 - 24
- 24 - 48
- 48 - 72
- 72 - 96
- 96 - 240
- ≥ 240
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- NORM - Field Mappped
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET M1-02 (T14) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I14-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

7.2.8 Conclusions

Target T14 (M1-02) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T14. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T14 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T14. ASPECT gamma survey results generally correlated with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T14 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T14 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. However, grid averaged gamma measurements exceeded the applied BTV in 3 of 44 survey units by a factor of up to 1.08.
- A total of 35 analytes were identified as occurring within the surface environment. Of these analytes, 7 were identified as COPCs. Only uranium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T14 does not contain TENORM. No mining-related activities or features were observed in the field. Two historical exploratory borings were noted in the file review; TENORM may be associated with these borings. Outcropping of Jml was identified in the eastern portion of the area, and NORM was verified visually and by gamma surveying.
- Natural erosion of outcroppings may have increased the lateral extent of NORM.
- There are no immediate significant physical hazards present at Target T14.
- Access is by dirt road with a small four-wheel-drive vehicle followed by footpath.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No existing groundwater wells are documented within the vicinity of Target T14. No seeps or springs were observed during the RSE investigation.

- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T14. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No mine waste was observed at Target T14; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; however, a few data gaps remain for Target T14. The remaining data gaps include stepping out to the northeast and east to further refine the extent of elevated gamma activity and field verification of the reclamation status of the potential historic exploratory borings.

7.3 NON-AUM TARGET T15 (M1-03)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T15 (M1-03).

7.3.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T15 (M1-03) is grouped with two non-AUM Targets: T13 (M1-01) and T14 (M1-02). Target T15 is in the Lukachukai Mountains Region in Subarea Group D within the Cove Chapter of the Navajo Nation and accessible by foot off of Indian Route 33. Target T15 is identified in the MCAP (Weston 2016). Target T15 overlies a portion of the underground mine workings for Mesa I Mine 13 (M6), but no known historical information is associated with the Target. No residential structures are near the Target. A Target location and access map for Target T15 is shown in Figure I15-1.

A topographical relief map for Target T15 and associated AUM areas is provided in Figure I15-2. The elevation at Target T15 ranges from 7,597 to 7,658 feet amsl with an average of 7,630 feet amsl. The slope at Target T15 ranges from 7 to 32 percent with an average of 18 percent. No drainages are present at the Target. Target T15 is entirely within the Jml, which comprises the Recapture and Salt Wash Members. The Target T15 soil type is primarily within the Hozho-Quezcan-Rock outcrop complex (MUSYM 413) and partly within the Kunz-Xankey complex (MUSYM 610) (Figures I-20 and I-21).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T15. Weston did not conduct a background study for Target T15. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 11 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T15:

- Identified any immediate physical hazards at the non-AUM Target:

  Mine workings were mapped beneath the Target. One historic exploratory boring may be located above the mine workings, and the reclamation status of this boring is unknown.

- Located access routes, including foot pathways and roads:

  Target T15 is accessed by taking Indian Route 33 and then hiking 300 feet southwest off-trail.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM was not observed at the Target. TENORM may be associated with exploratory borings.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

No drainages were present on the Target. The closest drainage is Middle 3E, which is located approximately 1,100 feet southwest and discussed in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

  Eight historic exploratory borings were potentially identified in the northern and western areas of the Target based on file review. One boring may have penetrated underground mine workings for Mesa I Mine 13. The reclamation status of the borings is not known. The potential locations of the borings do not correspond to elevated gamma activity.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  A pipe was mapped in the northeastern portion of the Target. Eight historic exploratory borings may be located on the Target.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

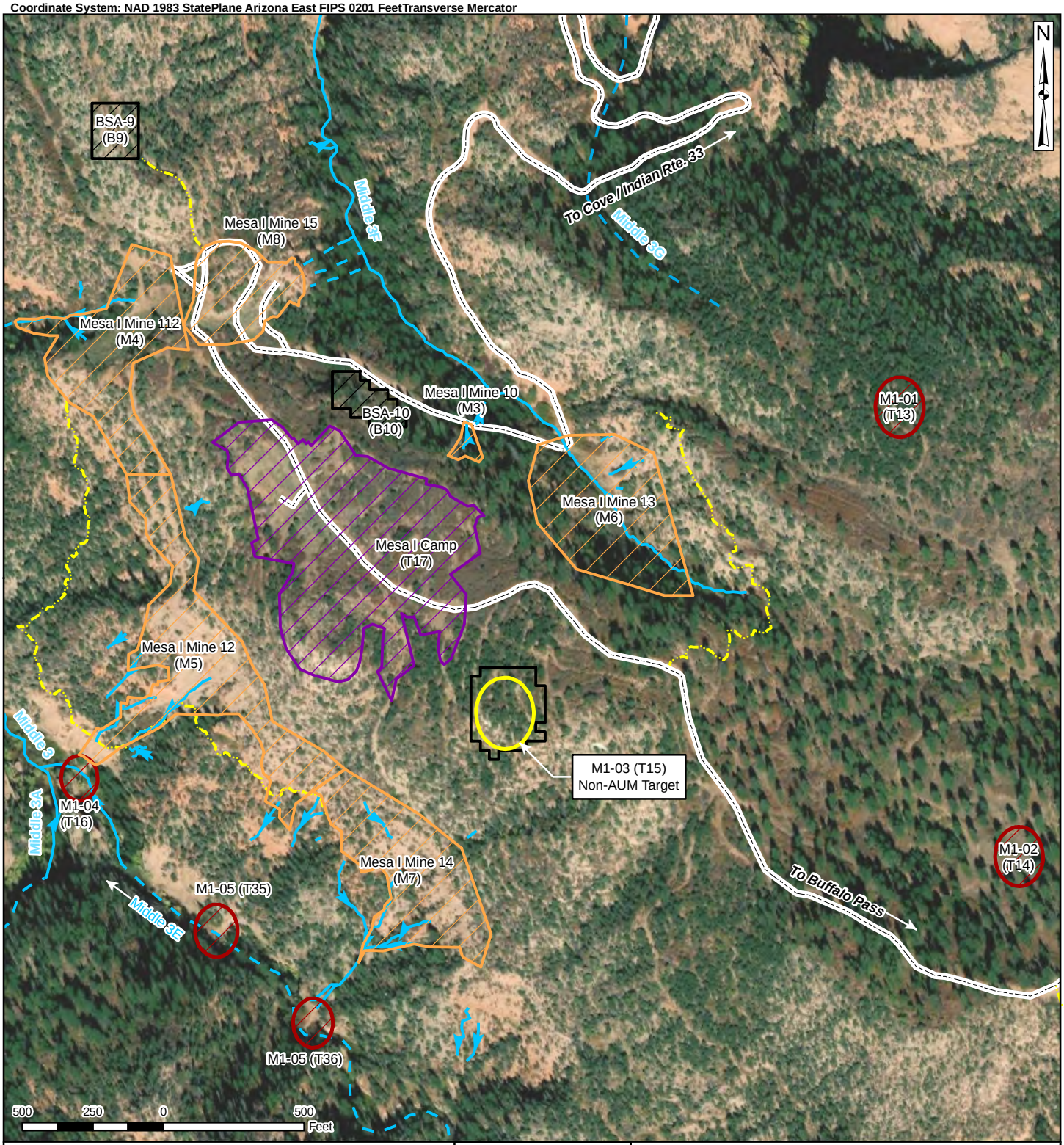
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T15 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Section 2.3 and 7.3.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 7.3.3 with results presented in Sections 7.3.6 and 7.3.7)
- Conducting a gamma radiation survey (results presented in Section 7.3.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



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

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

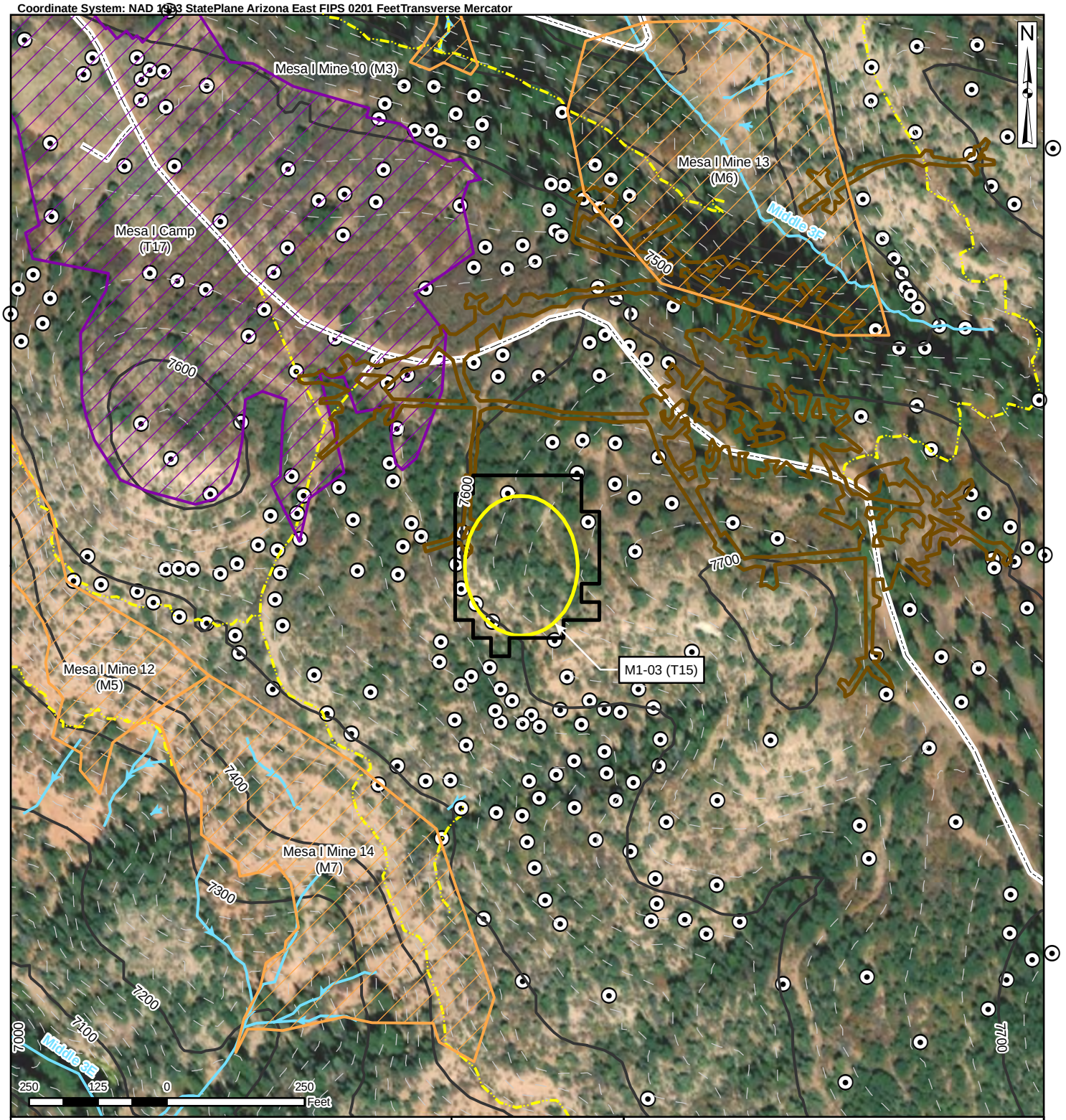
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NON-AUM TARGET M1-03 (T15) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I15-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	



Non-AUM Target Site Boundary
Related Survey Area
Tronox AUM Site Boundary
AUM Related Site Boundary
Underground Workings

Exploratory Bore Hole
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped
100 ft Contour*
20 ft Contour*

* 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.

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NON-AUM TARGET M1-03 (T15) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I15-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	

7.3.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I15-3) within the survey area of the non-AUM Target T15 as part of the Baseline Study in May 2018. Additional Goback gamma radiation surveys were performed in August 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T15 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I15-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 11, of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at 14 survey units. All gamma survey and XRF survey units were evaluated.

7.3.3 XRF Confirmation Sampling Overview

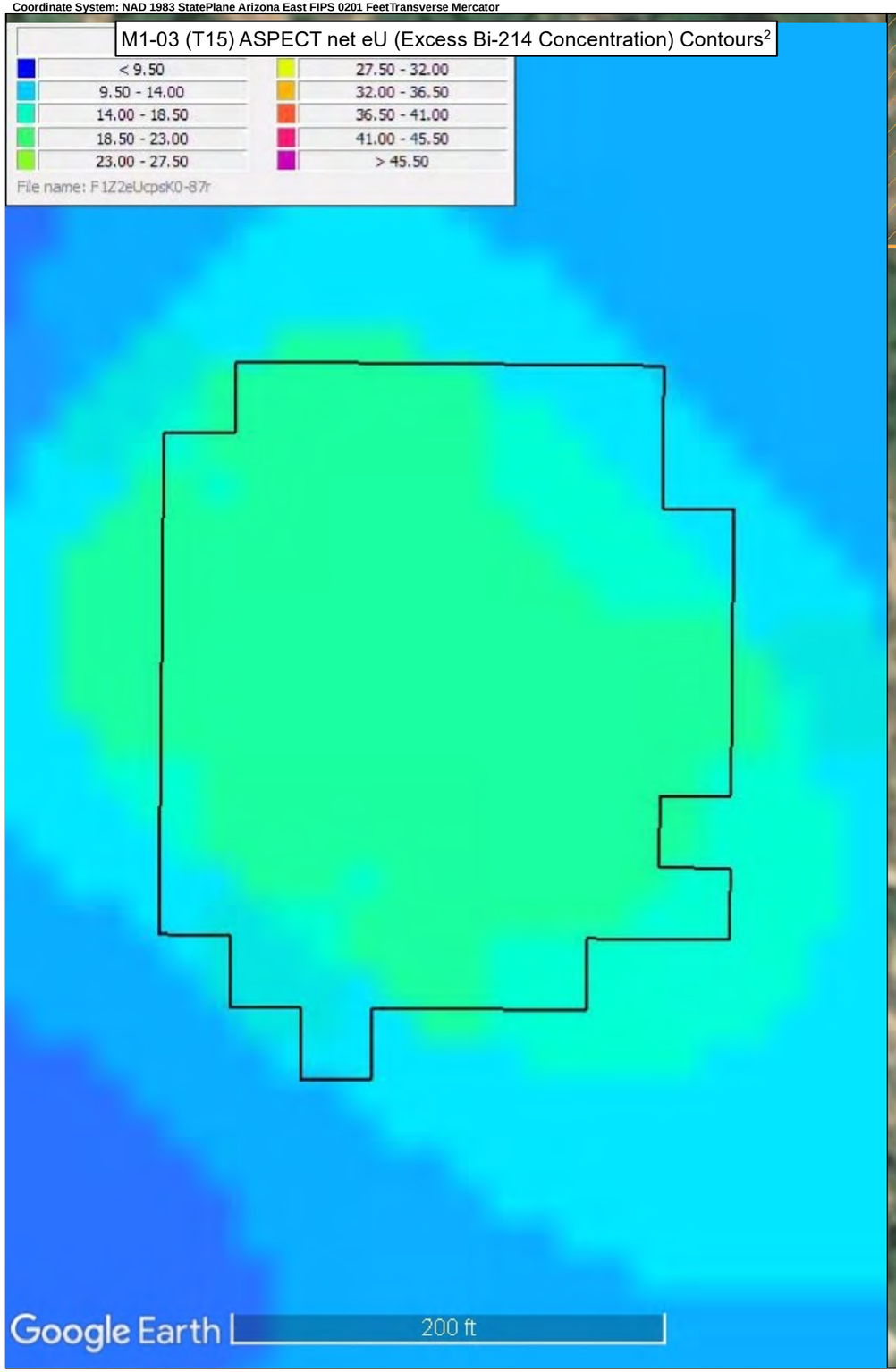
Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T15. Four XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from four locations (Table I15-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I15-4 and I15-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I15-2. The results of XRF confirmation sample analysis are provided in Section 7.3.6.1. Correlated XRF field measurements are provided in Attachment I3.

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

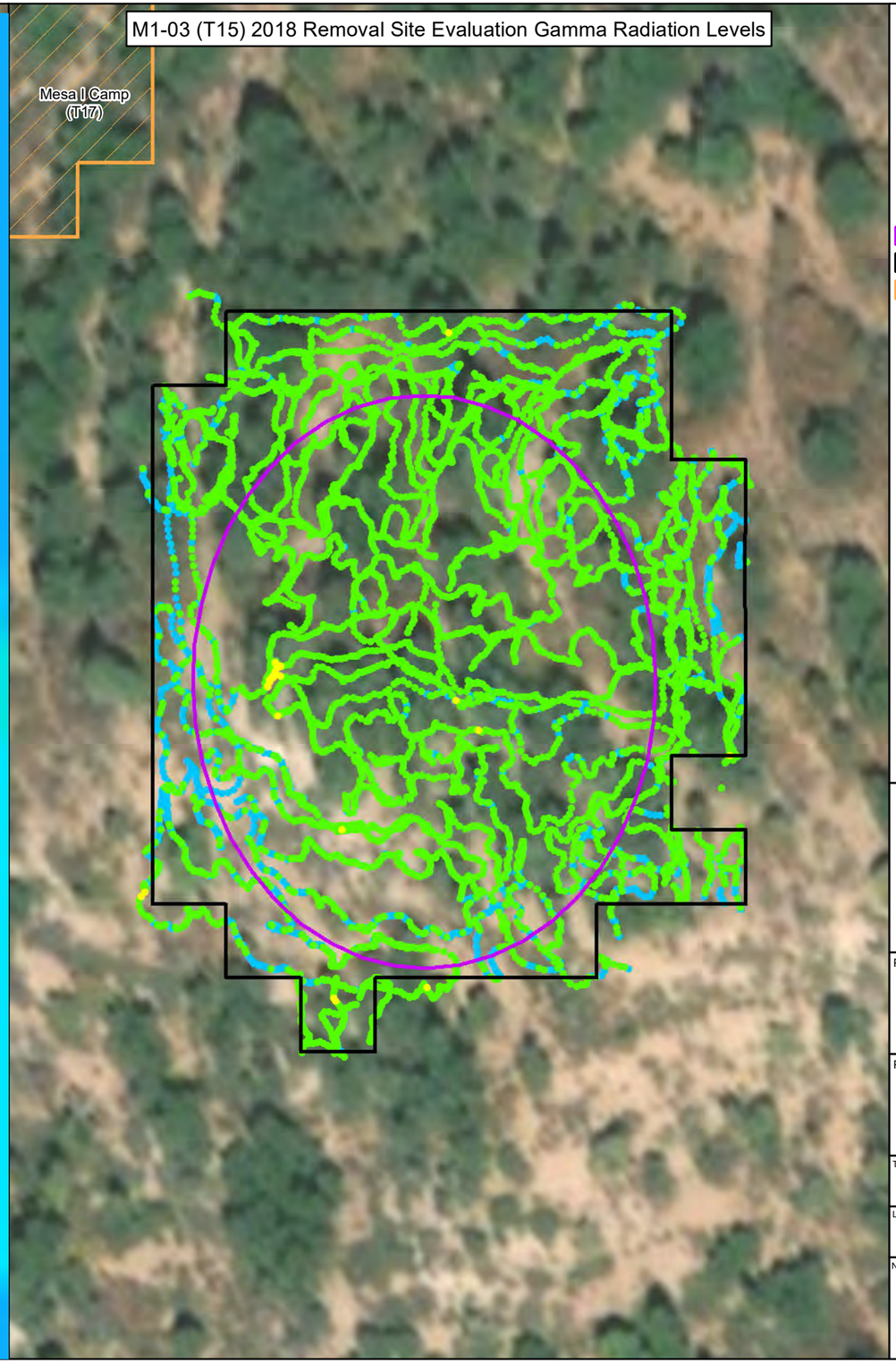
M1-03 (T15) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F1Z2eUcpsK0-87r



M1-03 (T15) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)[1]

≤ 9,712	≤ Avg. BG
9,712 - 14,566	Avg. BG - 1 x BTV
14,566 - 29,132	1 x BTV - 2 x BTV
29,132 - 43,698	2 x BTV - 3 x BTV
43,698 - 58,264	3 x BTV - 4 x BTV
58,264 - 145,660	4 x BTV - 10 x BTV
≥ 145,660	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Area Boundary

Other Survey Area

[1]The applied gamma background threshold value (BTV) for M1-03 (T15) Non-AUM Target is 14,566 cpm derived from gamma survey data from BSAs within the Jml formation as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET M1-03 (T15)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

Prepared By:

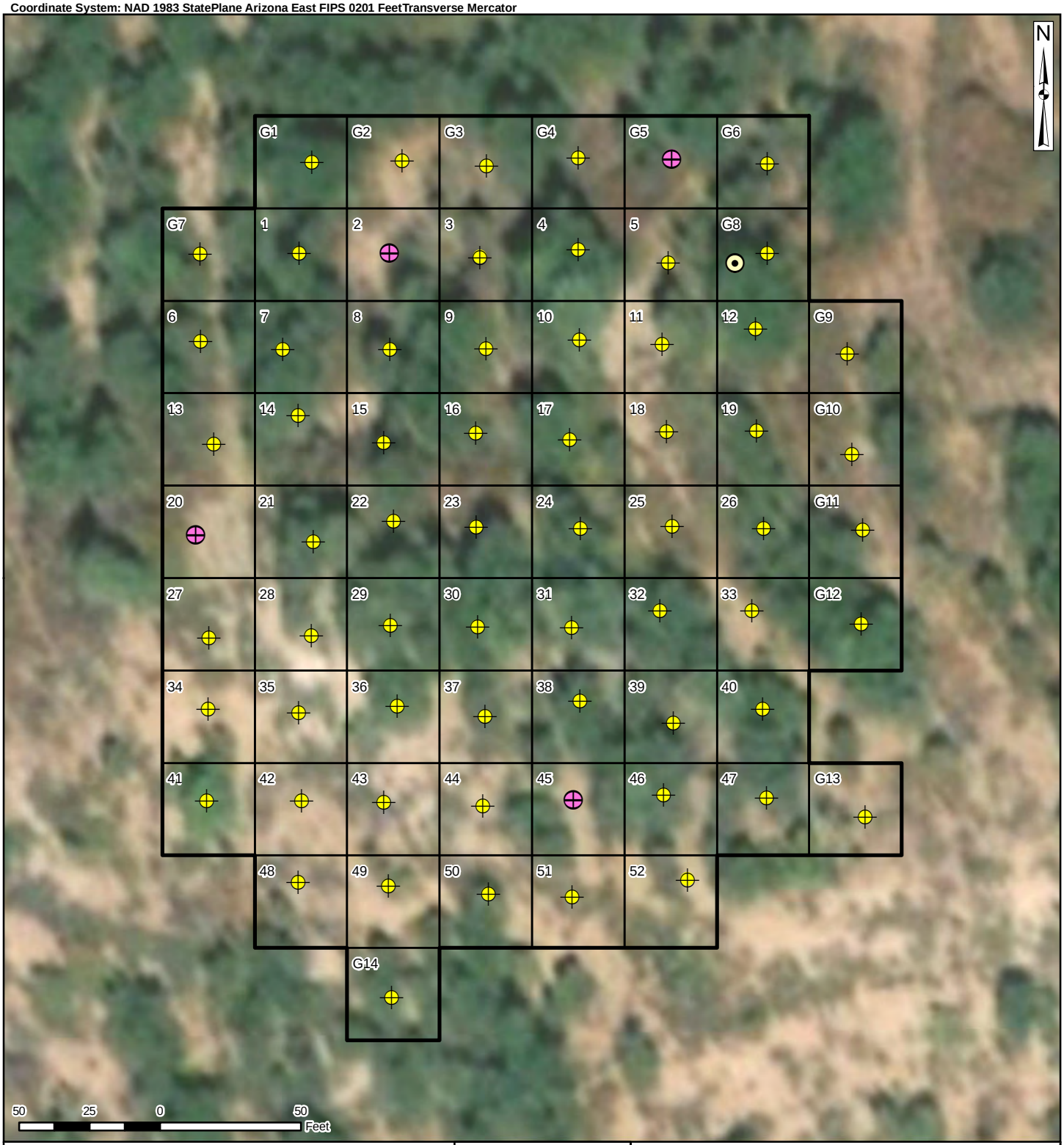
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborn Spectral Photometric Environmental Collection Technology.

Figure No.: **I15-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Pipe - Field Mapped

Survey Unit (100 m²)

Survey Area Boundary

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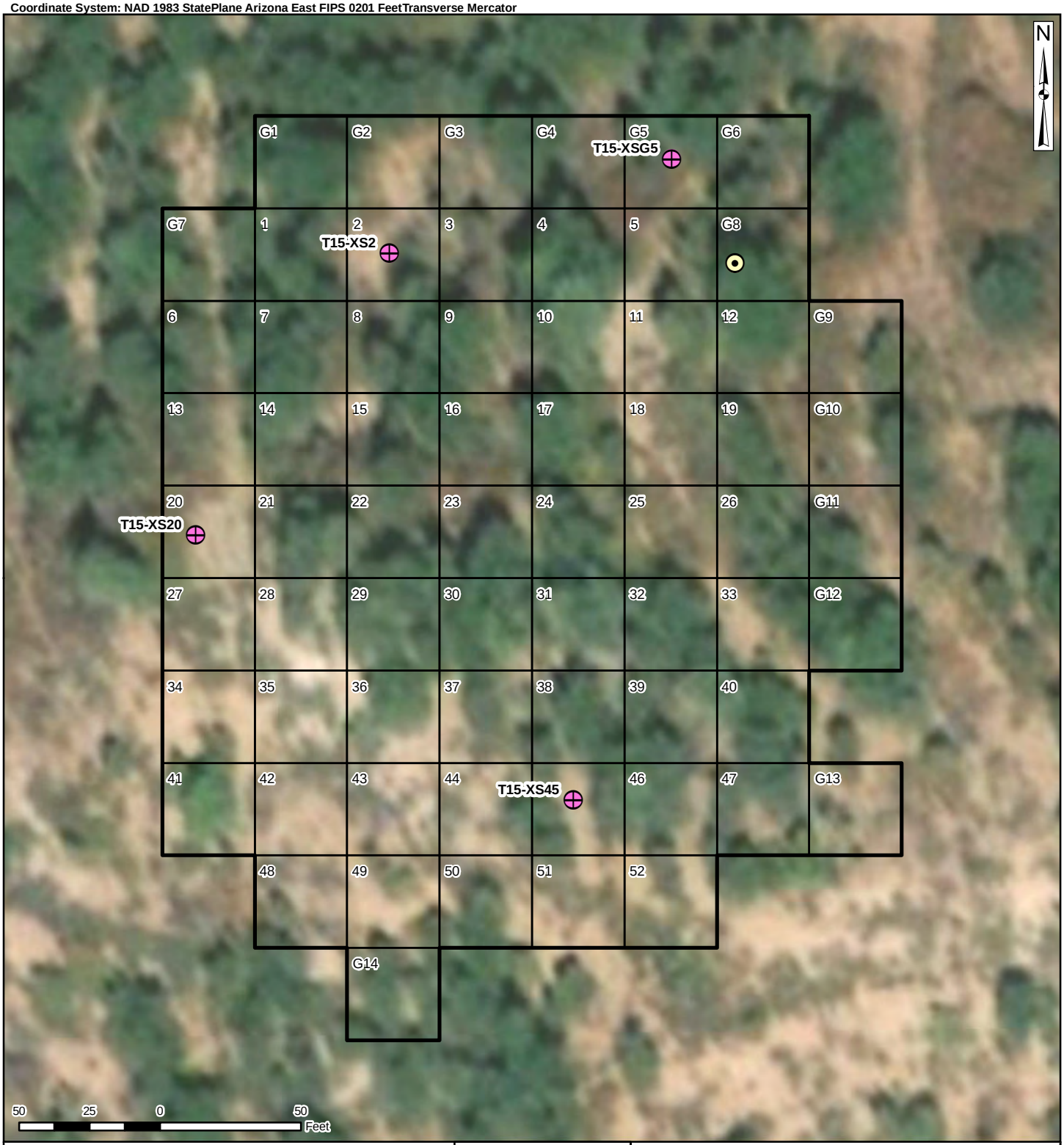
Prepared By:

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NON-AUM TARGET M1-03 (T15)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I15-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

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



XRF Confirmation Soil Sample*
(0 - 3 inches bgs)

Pipe - Field Mapped

Survey Unit (100 m²)

Survey Area Boundary

*T15-XSG5 = site T15 XRF confirmation soil sample collected at survey unit G5. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET M1-03 (T15)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I15-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

Table I15-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M1-03 (T15)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T15-XS2-01-050818	2	0-3	XRF Confirmation	Primary	5/8/2018	36.5214345	-109.2190684	1805321-25, 1805322-25
T15-XS20-01-081718	20	0-3	XRF Confirmation	Primary	8/17/2018	36.5211618	-109.2193058	1808483-11, 1808484-11
T15-XS45-01-050818	45	0-3	XRF Confirmation	Primary	5/8/2018	36.5208999	-109.2188529	1805321-26, 1805322-26
T15-XSG5-01-081718	G5	0-3	XRF Confirmation	Primary	8/17/2018	36.5215239	-109.2187266	1808483-12, 1808484-12

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I15-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M1-03 (T15)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

7.3.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 7.3.1, Target T15 surface geology is entirely within Jml with soils primarily within the Hozho-Quezcan-Rock outcrop complex (MUSYM 413) (Figures I-20 and I-21). As a result, Background Study Area 9 (BSA-9) was selected for that combination of geology and soil type. Additionally, the Jml regional geological background would also be applicable for this Target. Table I15-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T15. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T15. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T15. The "Applied BTV" for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I15-3. Applied Background Threshold Values for Non-AUM Target M1-03 (T15)

Analyte	Units	Site-Specific BTV (BSA-9)	Regional BTV (Jml)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	4,980	7,000	4,980	Site-Specific BTV
Antimony	mg/kg	0.138	0.140	0.138	Site-Specific BTV
Arsenic	mg/kg	2.5	3.5	2.5	Site-Specific BTV
Barium	mg/kg	170	270	170	Site-Specific BTV
Beryllium	mg/kg	0.62	0.57	0.57	Regional BTV
Cadmium	mg/kg	0.094	0.160	0.094	Site-Specific BTV
Calcium	mg/kg	8,080	32,000	8,080	Site-Specific BTV
Chromium	mg/kg	10	5.2	5.2	Regional BTV
Cobalt	mg/kg	3.5	4.4	3.5	Site-Specific BTV
Copper	mg/kg	5.1	12	5.1	Site-Specific BTV
Iron	mg/kg	5,830	8,897	5,830	Site-Specific BTV
Lead	mg/kg	7.0	11	7.0	Site-Specific BTV
Lithium	mg/kg	7.8	8.8	7.8	Site-Specific BTV
Magnesium	mg/kg	2,400	3,900	2,400	Site-Specific BTV
Manganese	mg/kg	261	440	261	Site-Specific BTV
Mercury	mg/kg	0.0435	0.0378	0.0378	Regional BTV
Molybdenum	mg/kg	0.16	0.29	0.16	Site-Specific BTV
Nickel	mg/kg	11	6.2	6.2	Regional BTV
Potassium-40	pCi/g	21.7	26.9	21.7	Site-Specific BTV
Radium-226	pCi/g	2.24	2.23	2.23	Regional BTV
Radium-228	pCi/g	0.87	0.75	0.75	Regional BTV
Selenium	mg/kg	0.77	0.99	0.77	Site-Specific BTV
Silver	mg/kg	0.025	0.037	0.025	Site-Specific BTV
Sodium	mg/kg	28	45	28	Site-Specific BTV
Thallium	mg/kg	0.054	0.075	0.054	Site-Specific BTV
Thorium	mg/kg	5.0	4.7	4.7	Regional BTV
Uranium	mg/kg	2.0	1.5	1.5	Regional BTV
Vanadium	mg/kg	15	24	15	Site-Specific BTV
Zinc	mg/kg	21	27	21	Site-Specific BTV
Gamma Radiation	cpm	17,699	14,566	14,566	Regional BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
Jml Morrison Formation (Lower)
mg/kg milligrams per kilogram
pCi/g picocuries per gram

7.3.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T15 and the raw gamma radiation and grid averaged gamma radiation survey results.

7.3.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T15 in May 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in August 2018 to collect data within the Goback survey units. The applied gamma BTV for non-AUM Target T15 is 14,566 cpm. A total of 6,237 measurements were collected as part of the gamma radiation survey at non-AUM Target T15 across 66 survey units. An average scan density of 95 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I15-4.

Table I15-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M1-03 (T15)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	14,566	
Measurements	#	6,237	66
Minimum	cpm	7,383	9,248
Maximum	cpm	15,792	13,073
Average	cpm	10,775	10,775
Median	cpm	10,736	10,770
Standard Deviation	cpm	1,077	664
90th Percentile	cpm	12,110	11,510
95th Percentile	cpm	12,540	11,583
99th Percentile	cpm	13,700	12,233
Measurements per Survey Unit	#/grid	95	
Measurements Above Gamma BTV	#	24	0
Measurements Above Gamma BTV	%	0.4	0.0

Notes:
BTV background threshold value
cpm counts per minute

7.3.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 0.4 percent of the measurements within the Target boundaries, just slightly exceeding the applied gamma BTV (14,566 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the Jml regional gamma survey results is provided on Figure I15-6. This graph shows that the spread of radiation data at Target T15 (shown on left) begins within the middle range of Jml regional gamma levels (shown on right) and then rises to just above middle range of background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T15 is within the same range as the data cloud from the Jml regional data set. A box plot showing the quartiles of the data sets is provided in Figure I15-7. The box plot shows that the median of Target T15 radiation levels is slightly higher than the median of the Jml regional data set but lower than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I15-8. No mining activity was observed within the survey area of Target T15. However, historic exploratory borings and underground mine workings were identified in the file review.

In general, Target T15 has surficial gamma radiation levels below Jml regional levels across the Target and surrounding area, indicating little correlation with the area of elevated gamma activity identified by the ASPECT gamma survey (Figure I15-3). No TENORM or mining-related activities were observed. Section 7.3.5.3 presents the grid averaged results of the gamma radiation survey.

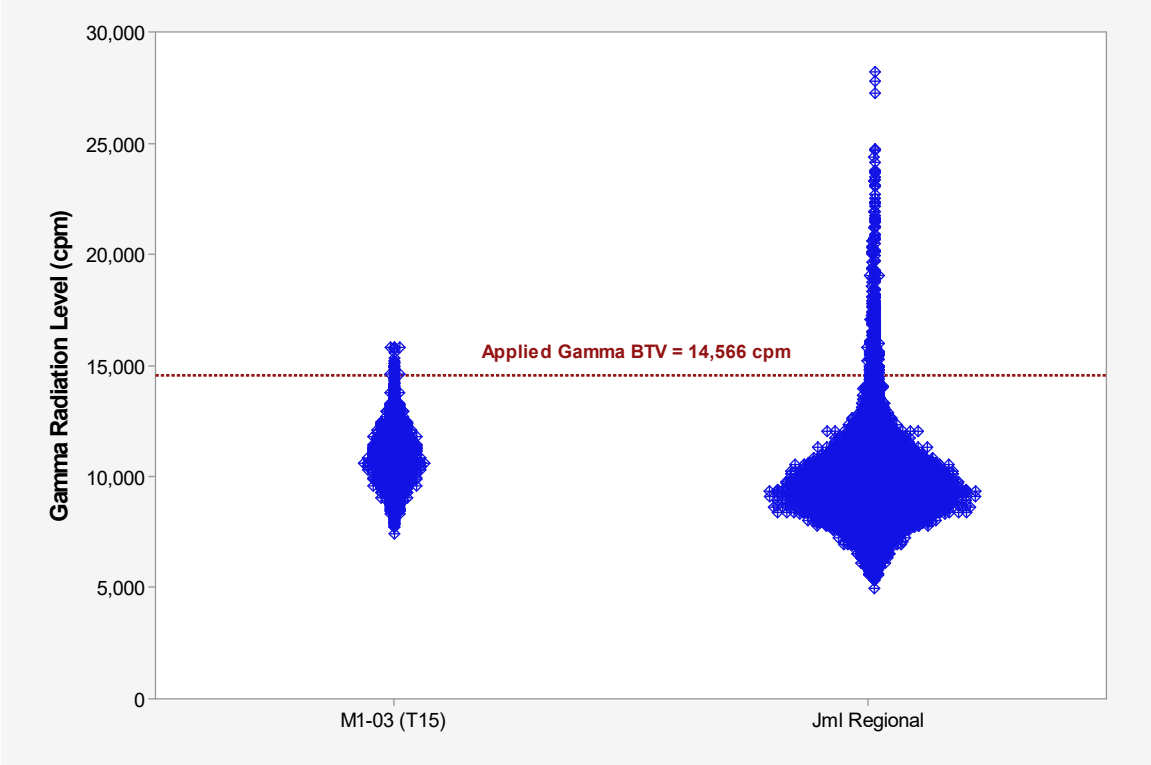


Figure I15-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M1-03 (T15) and Jml Regional

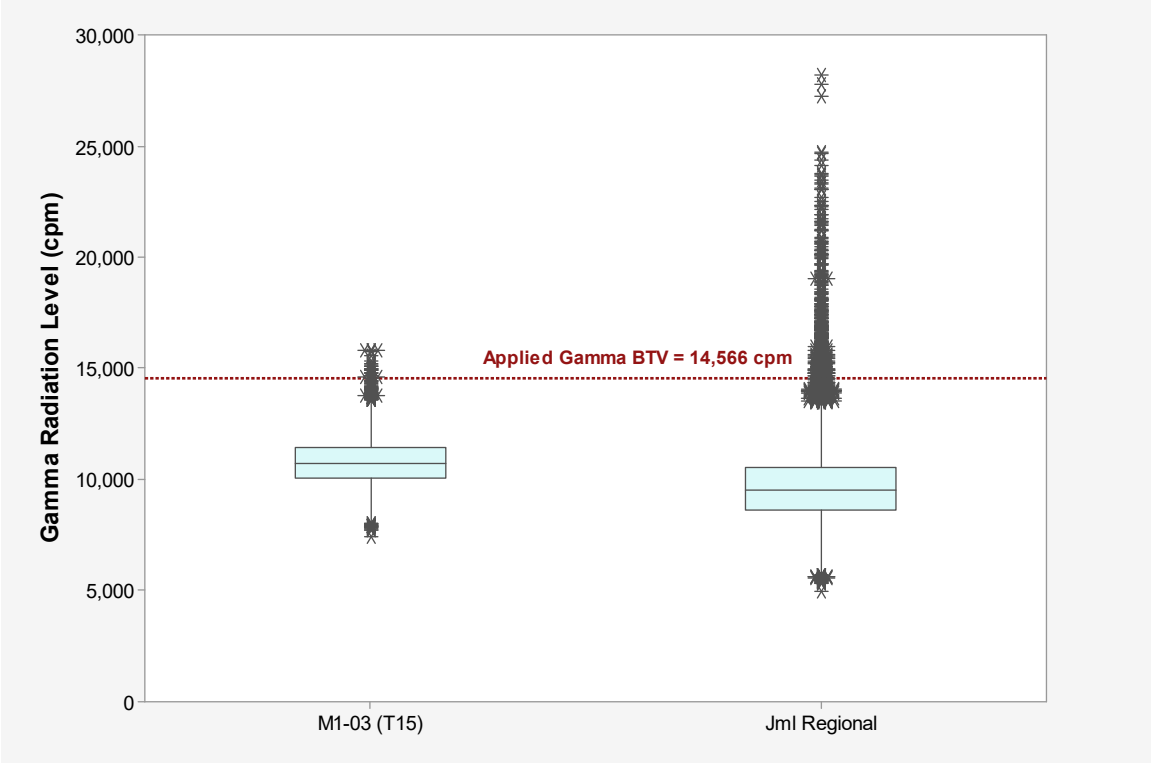
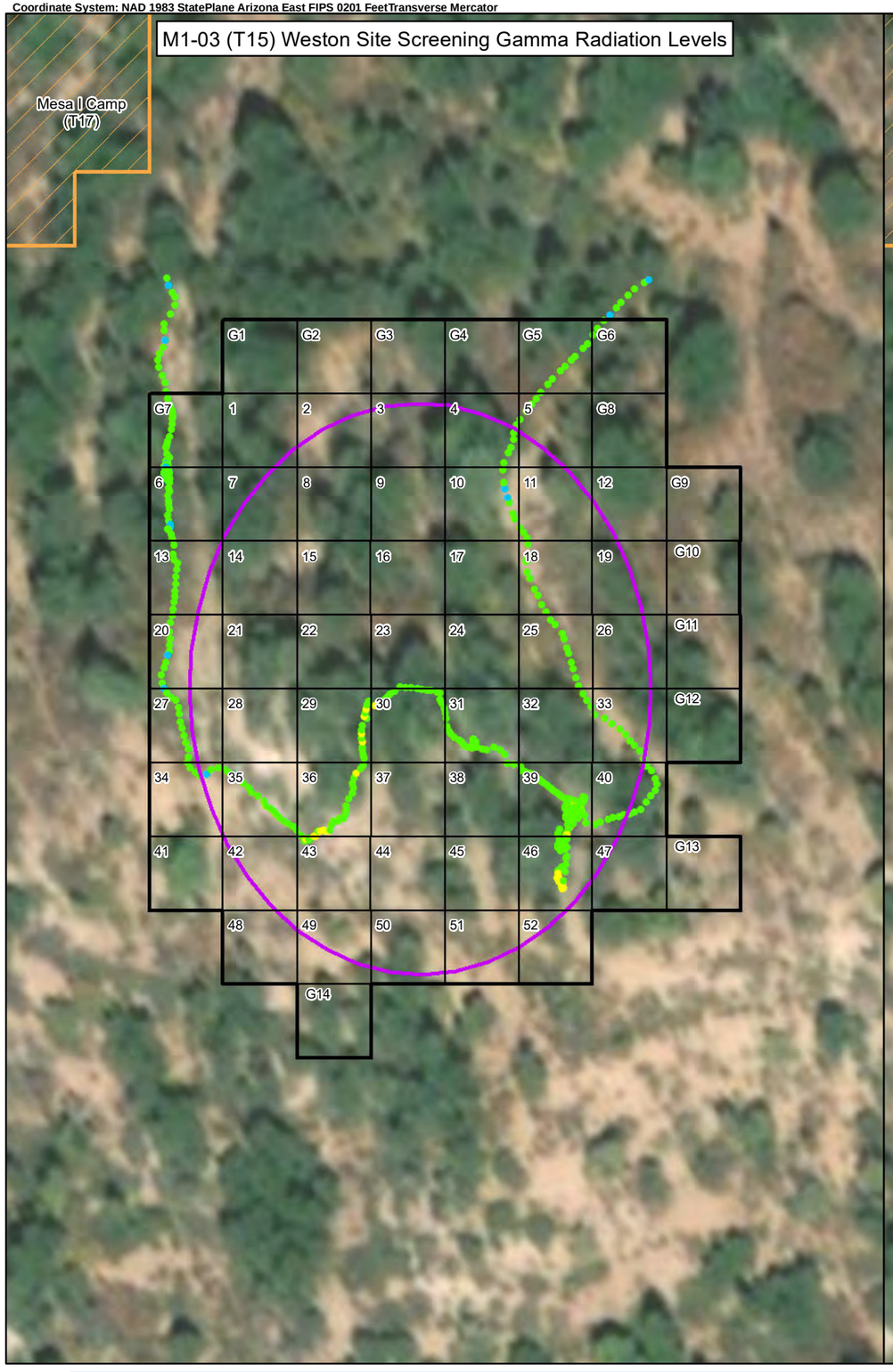


Figure I15-7. Box Plot of Raw Gamma Radiation Levels at Target M1-03 (T15) and Jml Regional

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





Gamma Reading (cpm)*

≤ 9,712	≤ Avg. BG
9,712 - 14,566	Avg. BG - 1 x BTV
14,566 - 29,132	1 x BTV - 2 x BTV
29,132 - 43,698	2 x BTV - 3 x BTV
43,698 - 58,264	3 x BTV - 4 x BTV
58,264 - 145,660	4 x BTV - 10 x BTV
≥ 145,660	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Other Survey Area

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET M1-03 (T15)
2018 REMOVAL SITE EVALUATION
AND WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

Prepared For:

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019

Notes:
*The applied gamma radiation background threshold value (BTV) for M1-03 (T15) is 14,566 cpm derived from gamma survey data for BSAs within the Jml formation as presented in Appendix A.

Figure No.: **I15-8**

7.3.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 7.3.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 7.3.5.1. Figure I15-9 and Figure I15-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to Jml regional data set (shown on right). No survey units within the survey area of Target T15 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I15-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I15-11 as discussed further in Section 2.8. No survey units exceeded the gamma BTV.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 7.3.6.

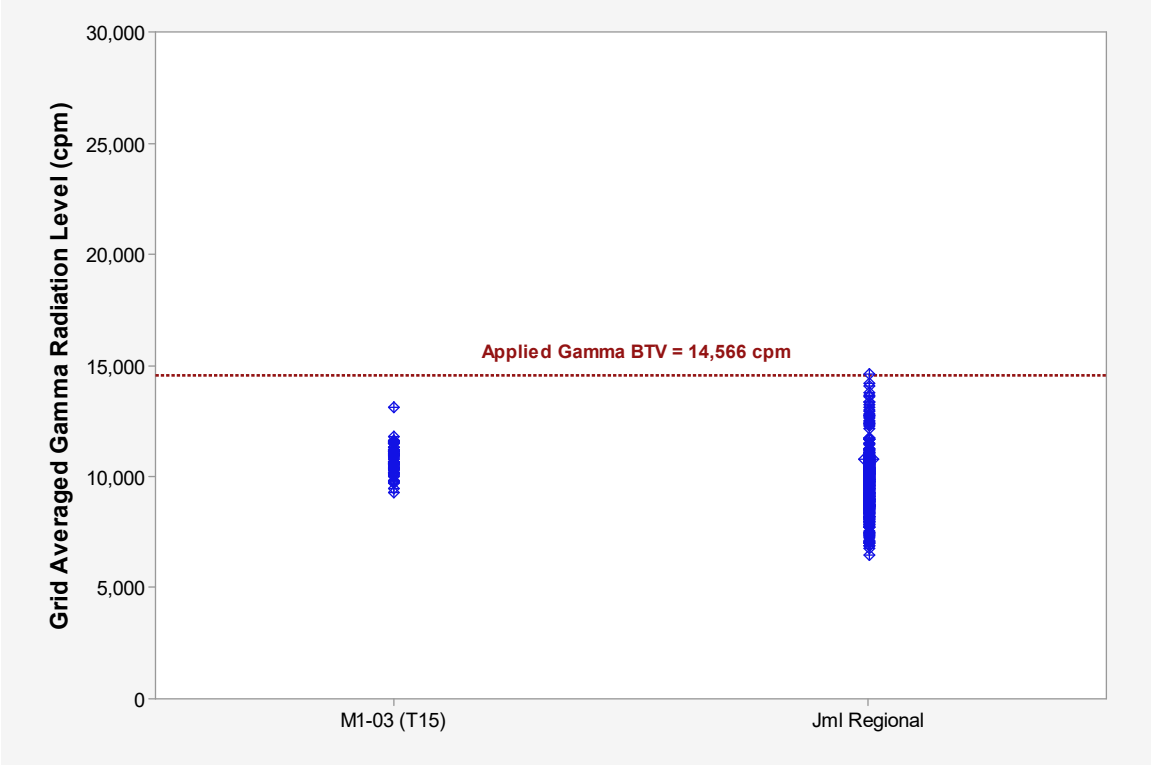


Figure I15-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M1-03 (T15) and Jml Regional

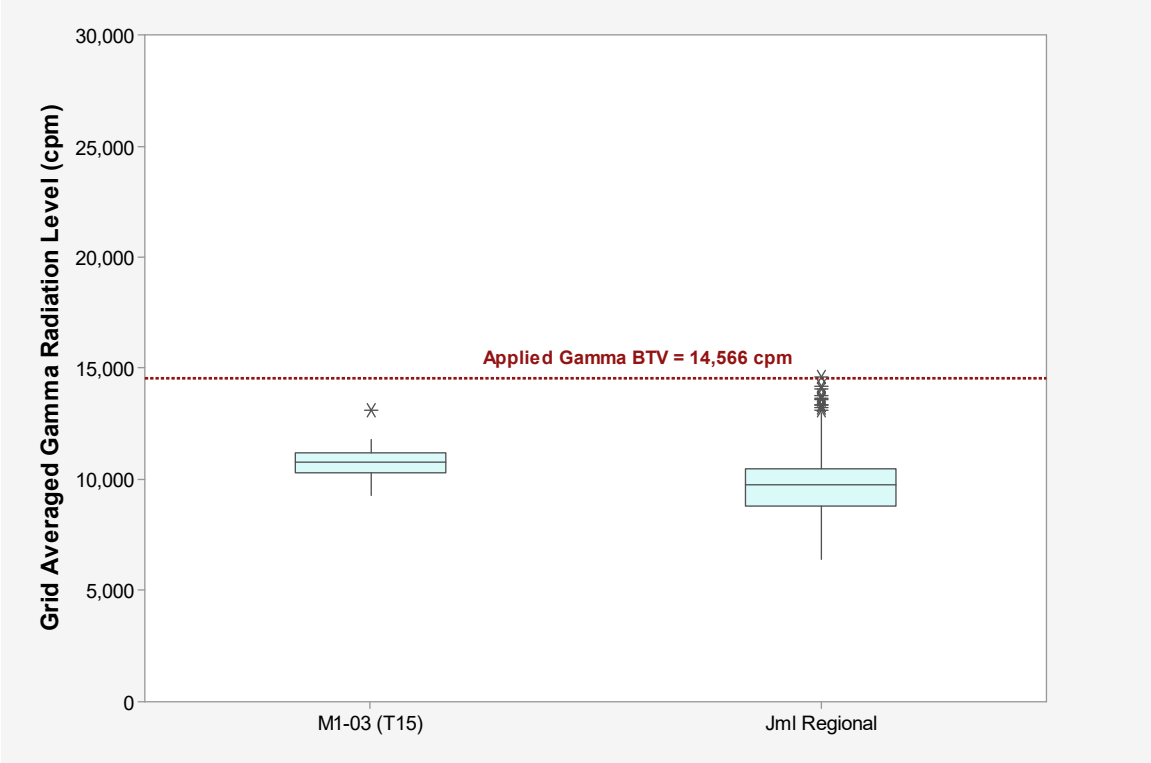
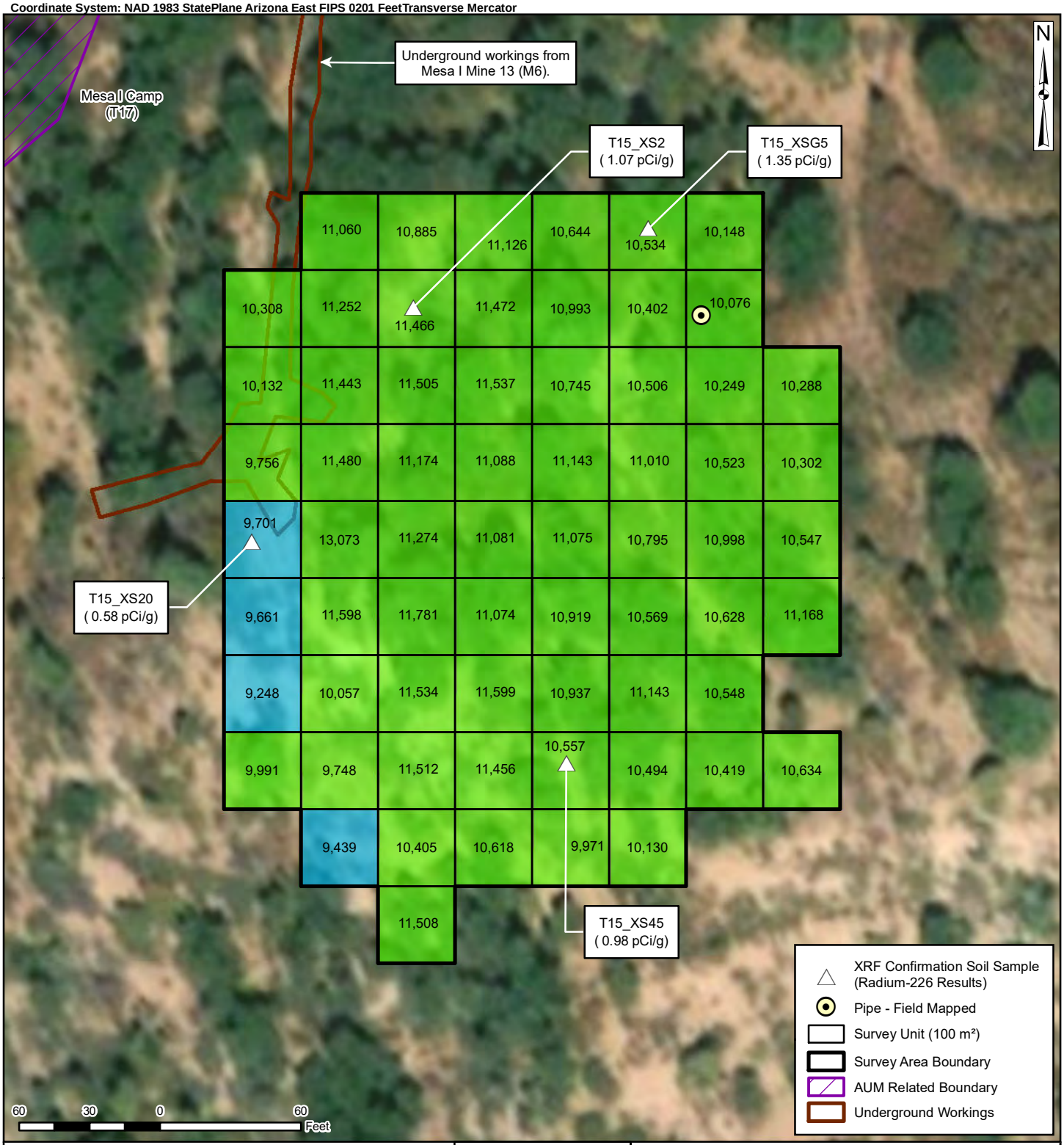


Figure I15-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M1-03 (T15) and Jml Regional



Grid Averaged Gamma Reading (cpm)*

≤ 9,712	≤ Avg. BG
9,712 - 14,566	Avg. BG - 1 x BTV
14,566 - 29,132	1 x BTV - 2 x BTV
29,132 - 43,698	2 x BTV - 3 x BTV
43,698 - 58,264	3 x BTV - 4 x BTV
58,264 - 145,660	4 x BTV - 10 x BTV
≥ 145,660	≥ 10 x BTV

*The applied gamma radiation background threshold value (BTV) for M1-03 (T15) is 14,566 cpm derived from gamma survey data for BSAs within the Jml formation as presented in Appendix A.

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NON-AUM TARGET M1-03 (T15) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I15-11
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

7.3.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T15. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 7.3.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 7.3.6.2.

7.3.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T15: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I15-1 and I15-2. All the results of the XRF confirmation soil samples are presented in Table I15-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T15 following the methods outlined in Section 2.4 and shown in Figure I15-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 66 measurements were collected across 66 survey units from the survey area of Target T15 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I15-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T15 at a depth of 0 to 3 inches bgs. Four XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I15-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 7.3.7.

Table I15-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M1-03 (T15)

Analyte	Units	Applied BTV	T15-XS20-01-081718		T15-XS2-01-050818		T15-XS45-01-050818		T15-XSG5-01-081718	
			Result	Q	Result	Q	Result	Q	Result	Q
Survey Unit			X20		X2		X45		G5	
Aluminum	mg/kg	4,980	2,300		4,400		3,400		3,900	
Antimony	mg/kg	0.138	0.095	J	0.13		0.11	J	0.082	J
Arsenic	mg/kg	2.5	4.5	J	1.7		3.1	J	1.7	
Barium	mg/kg	170	37	J	72		56		70	
Beryllium	mg/kg	0.57	0.26		0.31		0.29		0.29	
Cadmium	mg/kg	0.094	0.033	J	0.076	J	0.058	J	0.075	J
Calcium	mg/kg	8,080	1,600		2,800		3,000	J	2,100	
Chromium	mg/kg	5.2	2.1		4.5		3.1		3.6	
Cobalt	mg/kg	3.5	1.6		2.6		2.1		2.3	
Copper	mg/kg	5.1	3		4.1		4.1		3.4	
Iron	mg/kg	5,830	3,600		6,000		5,000		5,300	
Lead	mg/kg	7.0	4.3		6		4.7		6.1	
Lithium	mg/kg	7.8	4.6		4.6		4.3		4.8	
Magnesium	mg/kg	2,400	1,000	J	1,800		1,500		1,500	
Manganese	mg/kg	261	99		170		160		160	
Molybdenum	mg/kg	0.16	0.32		0.2	J	0.24		0.16	J
Nickel	mg/kg	6.2	3.1		4.2		3.5		3.9	
Potassium-40	pCi/g	21.7	18.8		19.1		16.5		16.8	
Radium-226	pCi/g	2.23	0.58	LT	1.07		0.98	LT	1.35	
Radium-228	pCi/g	0.75	<0.51	U	<0.76	UJ	<0.56	U	<0.79	UJ
Selenium	mg/kg	0.77	0.4	J	0.48	J	0.47	J	0.43	J
Silver	mg/kg	0.025	<0.048	U	0.016	J	0.015	J	0.012	J
Sodium	mg/kg	28	<95	U	<110	U	<110	U	18	J
Thallium	mg/kg	0.054	0.027		0.045		0.033		0.037	
Thorium	mg/kg	4.7	3.1		3		2.6		3.3	
Uranium	mg/kg	1.5	0.28		0.69		0.44		0.74	
Vanadium	mg/kg	15	8.4		11		11		9.5	
Zinc	mg/kg	21	8.1	J	14		14		11	

Notes:
BTV Background threshold value
J Estimated value
J- Estimated value, may be biased low
LT Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
M3 The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg Milligrams per kilogram
NA Not applicable
NV No Value
pCi/g Picocuries per gram
Q Qualification
U Not considered detected. The associated value is the method detection limit (MDL).
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

Table I15-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M1-03 (T15)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.5	5,830	7	261	0.16	4.7	1.5	15	21
Measurements	#	66	66	66	66	66	66	66	66	66
Detects	#	53	66	66	66	22	66	54	7	66
Nondetects	#	13	0	0	0	44	0	12	59	0
Minimum	mg/kg	1.9	3,563	4.1	148.1	0.1	1.3	0.3	17.5	9.7
Maximum	mg/kg	7.6	10,807	16.9	653.1	3.3	5.0	7.1	27.8	39.5
Standard Deviation	mg/kg	0.9	1,215	2.1	105	0.89	0.7	1.3	4	5.3
Average	mg/kg	3.1	6,000	8.5	286	0.97	2.9	1.9	21.7	18.9
Median	mg/kg	3.1	5,862	8.5	261	0.80	2.8	1.8	19.5	18.5
Relative Standard Deviation	%	30.0	20.2	25.1	36.8	92.2	24.7	66.0	18.6	27.9
90th Percentile	mg/kg	4.0	7,111	10.6	401	2.1	3.8	3.4	27	26
95th Percentile	mg/kg	4.1	7,637	11.8	442	2.9	4.0	4.0	27	28
99th Percentile	mg/kg	6.0	9,460	14.8	644	3.3	4.8	6.1	28	33
Measurements Above Applied BTV	#	39	35	51	33	19	1	32	7	17
Measurements Above Applied BTV	%	59.1	53.0	77.3	50.0	28.8	1.5	48.5	10.6	25.8

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value

mg/kg Milligram per kilogram

XRF X-ray fluorescence

7.3.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T15 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T15 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T15. The estimated BTVs are identified in Section 7.3.4 and Table I15-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I15-7 presents a summary of the background comparison for different measurement and soil depths at Target T15. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T15. Further gamma radiation screening indicated that gamma levels at Target T15 are similar to those of BSA-9. Therefore, while multiple COPCs have been identified at Target T15 based on a conservative comparison to background, risk screening may be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I15-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M1-03 (T15)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic	✓	✓	✓
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron	✓	✓	✓
Lead		✓	✓
Lithium			
Magnesium			
Manganese		✓	✓
Molybdenum	✓	✓	✓
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium			✓
Silver			
Sodium			
Thallium			
Thorium			
Uranium		✓	✓
Vanadium		✓	✓
Zinc		✓	✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

7.3.7 Primary Contaminant Mapping

7.3.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 7.3.6.2 identified the COPCs at Target T15. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 7.3.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I15-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T15 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 7.3.7.1 through Section 7.3.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T15. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

7.3.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I15-7. Arsenic exceeded the applied BTV in 59.1 percent of in situ XRF measurements and in two of the four XRF confirmation samples. The applied BTV for arsenic is 2.5 mg/kg for Target T15 as presented in Section 7.3.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I15-5 and Attachment I3, respectively. Figure I15-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T15 and BSA-9 (Jml) samples. Figure I15-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T15 and BSA-9 (Jml) samples. Summary statistics for XRF measurements are provided in Section 7.3.6.1. Arsenic XRF concentrations measured in surface soils at Target T15 ranged between 1.9 and 7.6 mg/kg with an average and standard deviation of 3.1 mg/kg and 0.9 mg/kg, respectively. The average arsenic XRF concentration is above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T15 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I15-14. Overall, the majority of detectable arsenic results in surface soils were above the applied BTV. However, the maximum value was about 3 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T15.

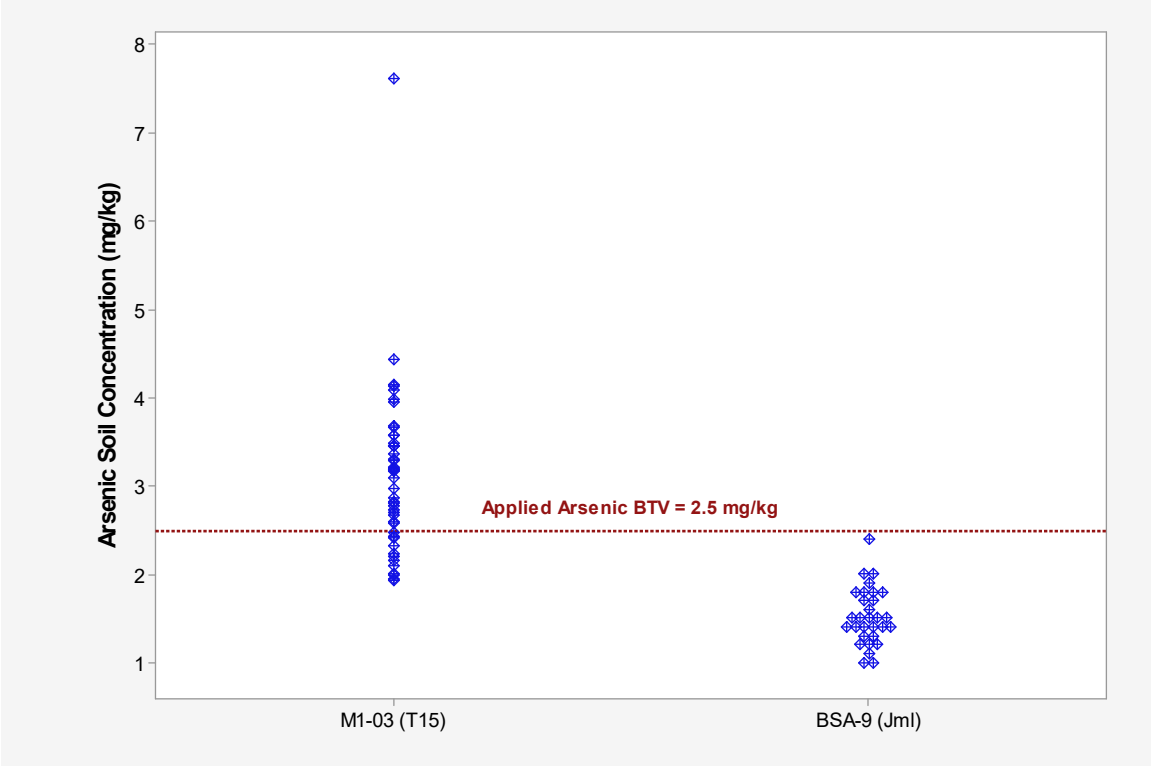


Figure I15-12. Individual Value Plot for Target M1-03 (T15) and BSA-9 (Jml) Arsenic Soil Concentrations

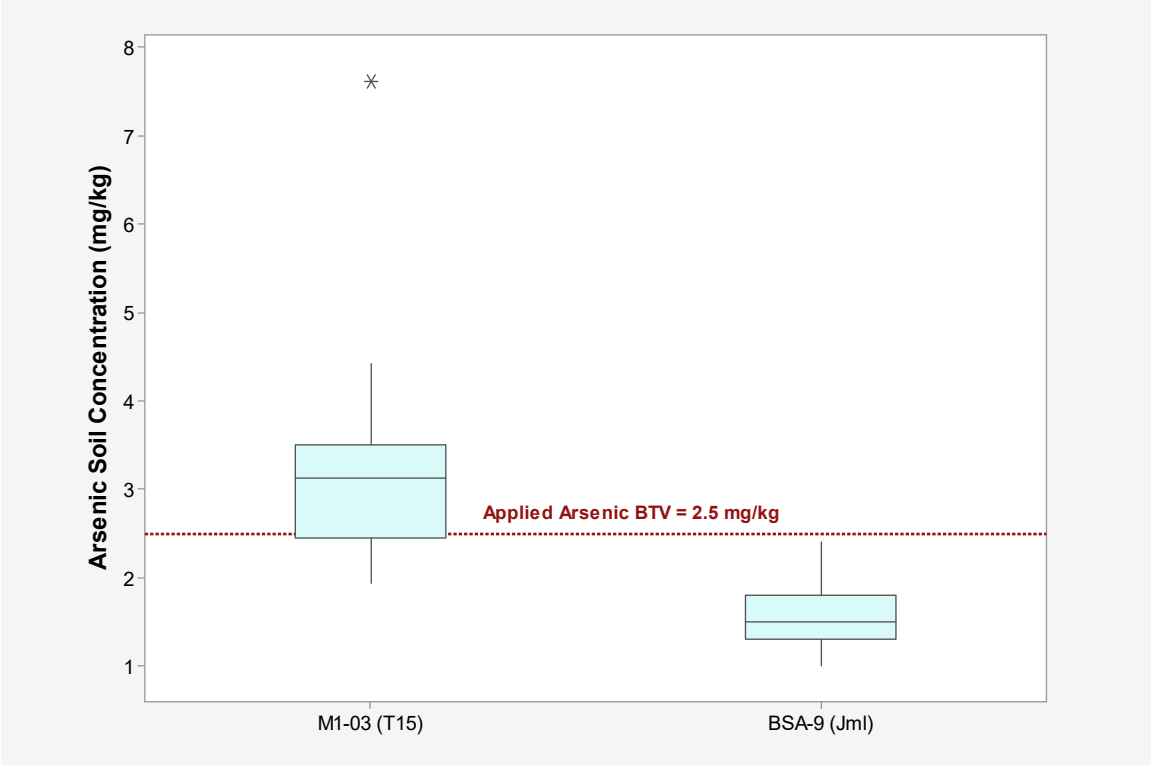
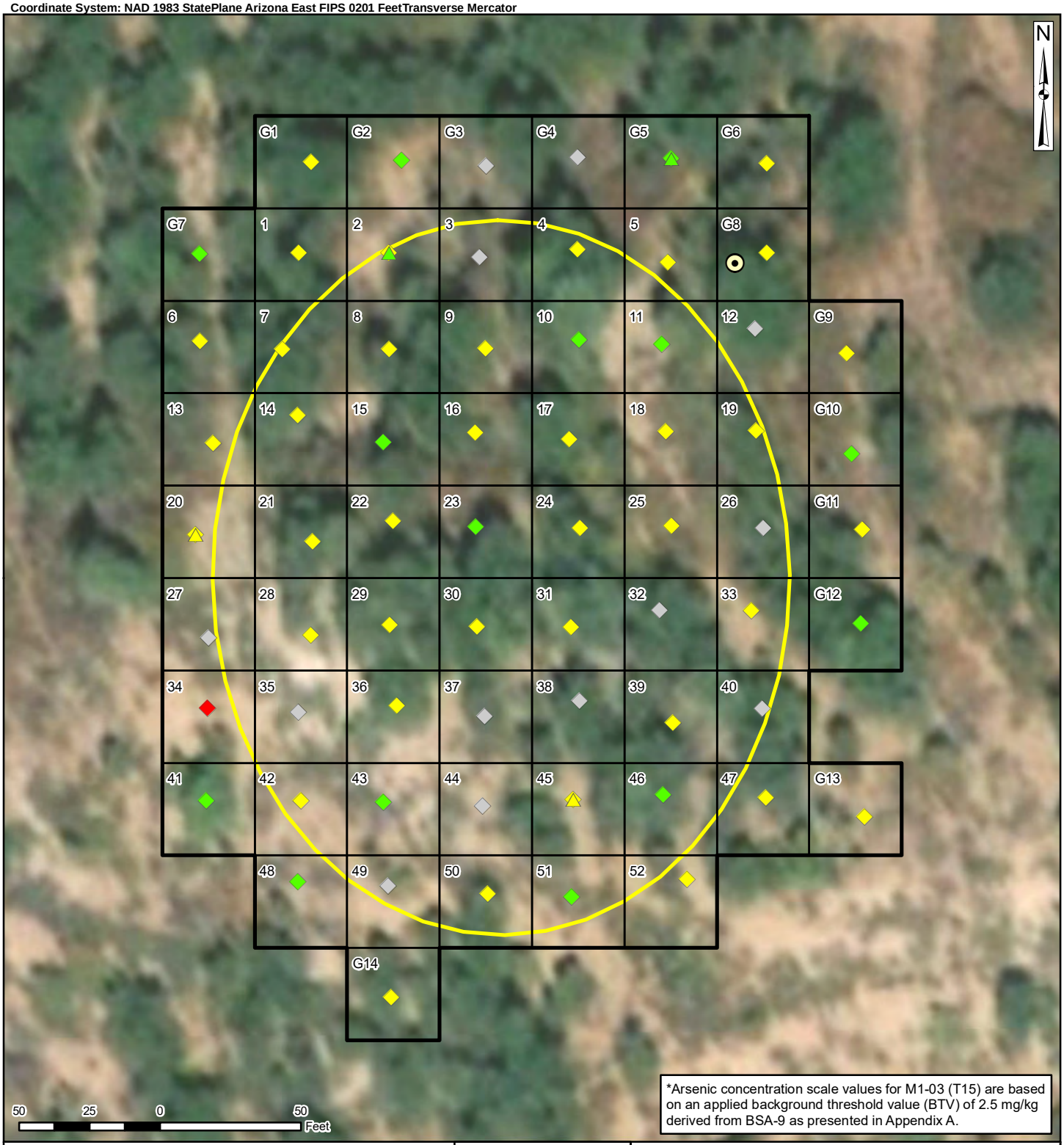


Figure I15-13. Box Plot for Target M1-03 (T15) and BSA-9 (Jml) Arsenic Soil Concentrations

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



*Arsenic concentration scale values for M1-03 (T15) are based on an applied background threshold value (BTV) of 2.5 mg/kg derived from BSA-9 as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 1.5
- 1.5 - 2.5
- 2.5 - 5.0
- 5.0 - 7.5
- 7.5 - 10
- 10 - 25
- ≥ 25
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Pipe - Field Mapped
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET M1-03 (T15) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
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Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

7.3.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I15-7. Lead exceeded the applied BTV in 77.3 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for lead is 7 mg/kg for Target T15 as presented in Section 7.3.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I15-5 and Attachment I3, respectively. Figure I15-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T15 and BSA-9 (Jml) samples. Figure I15-16 presents a box plot of detectable lead XRF soil concentrations for Target T15 and BSA-9 (Jml) samples. Summary statistics for XRF measurements are provided in Section 7.3.6.1. Lead XRF concentrations measured in surface soils at Target T15 ranged between 4.1 and 16.9 mg/kg with an average and standard deviation of 8.5 mg/kg and 2.1 mg/kg, respectively. The average lead XRF concentration is above the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T15 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I15-17. Overall, the majority of detectable lead results in surface soils were above the applied BTV. However, the maximum XRF value was 2.4 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T15.

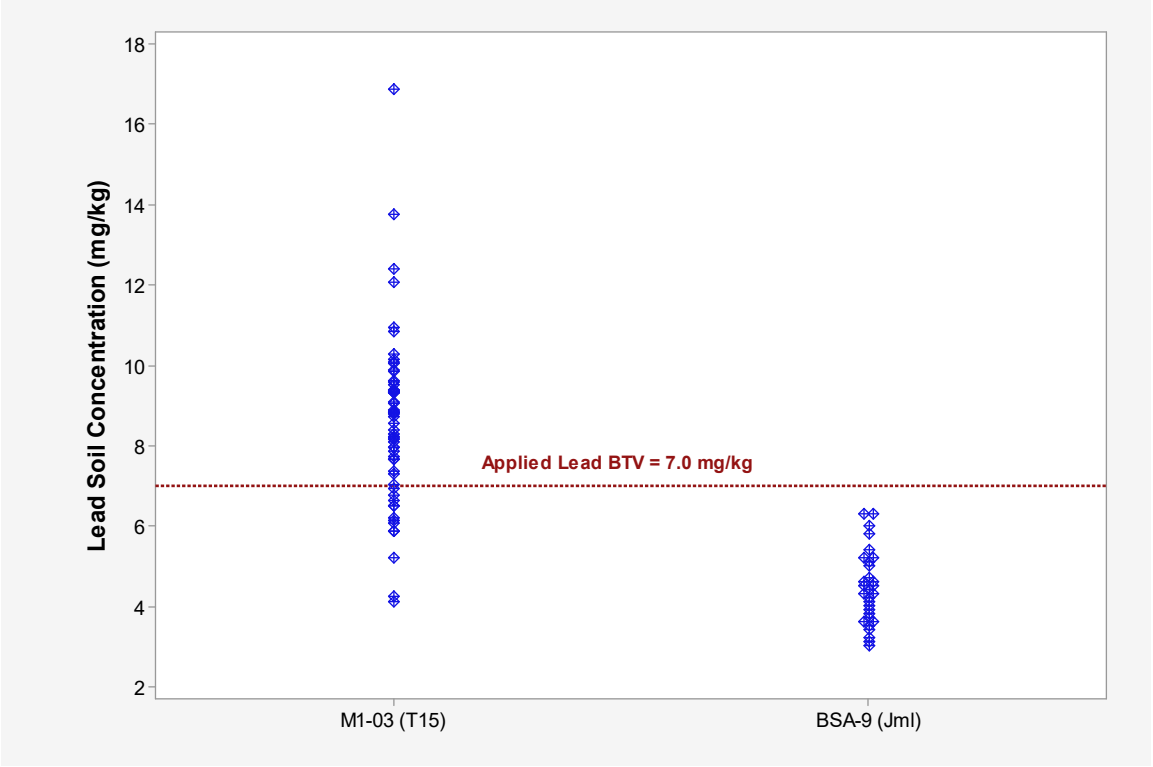


Figure I15-15. Individual Value Plot for Target M1-03 (T15) and BSA-9 (Jml) Lead Soil Concentrations

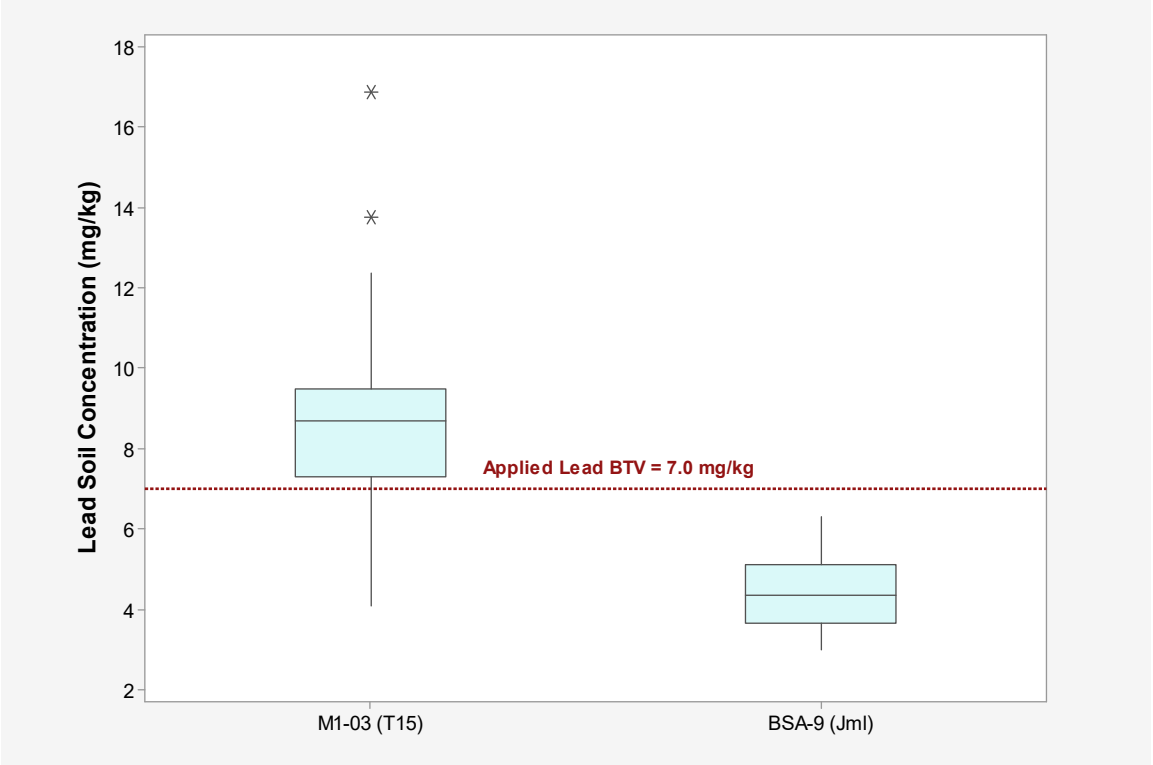
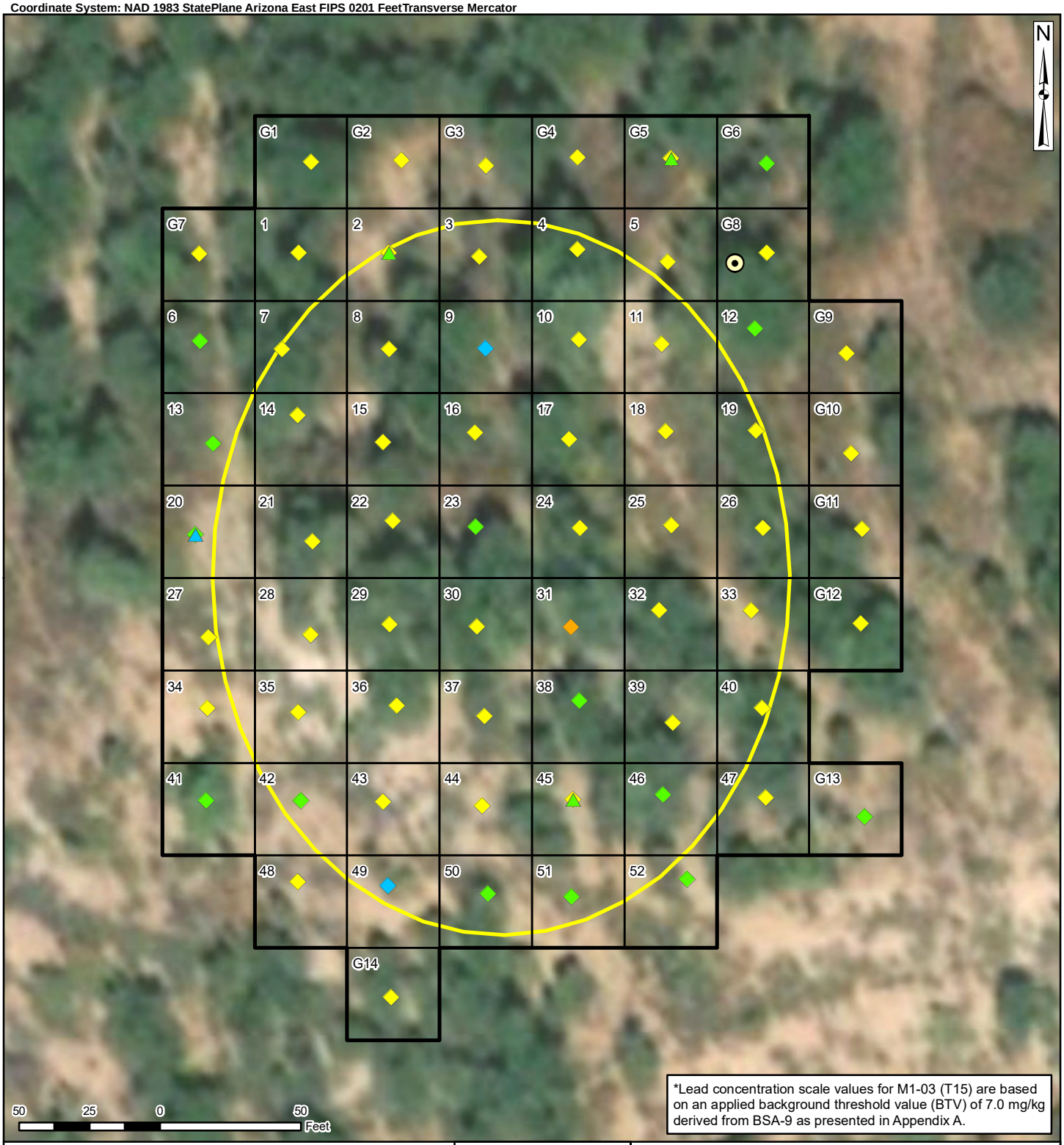


Figure I15-16. Box Plot for Target M1-03 (T15) and BSA-9 (Jml) Lead Soil Concentrations

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



*Lead concentration scale values for M1-03 (T15) are based on an applied background threshold value (BTV) of 7.0 mg/kg derived from BSA-9 as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 4.4
- 4.4 - 7.0
- 7.0 - 14
- 14 - 21
- 21 - 28
- 28 - 70
- ≥ 70

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Pipe - Field Mapped
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET M1-03 (T15) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I15-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

7.3.7.4 Thorium

Thorium was not identified as a COPC in surface soil as shown in Table I15-7. Thorium exceeded the applied BTV in 1.5 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for thorium is 4.7 mg/kg for Target T15 as presented in Section 7.3.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I15-5 and Attachment I3, respectively. Figure I15-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T15 and Jml regional samples. Figure I15-19 presents a box plot of detectable thorium XRF soil concentrations for Target T15 and Jml regional samples. Summary statistics for XRF measurements are provided in Section 7.3.6.1. Thorium XRF concentrations measured in surface soils at Target T15 ranged between 1.3 and 5.0 mg/kg with an average and standard deviation of 2.9 mg/kg and 0.7 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T15 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I15-20. Overall, the majority of detectable thorium results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T15.

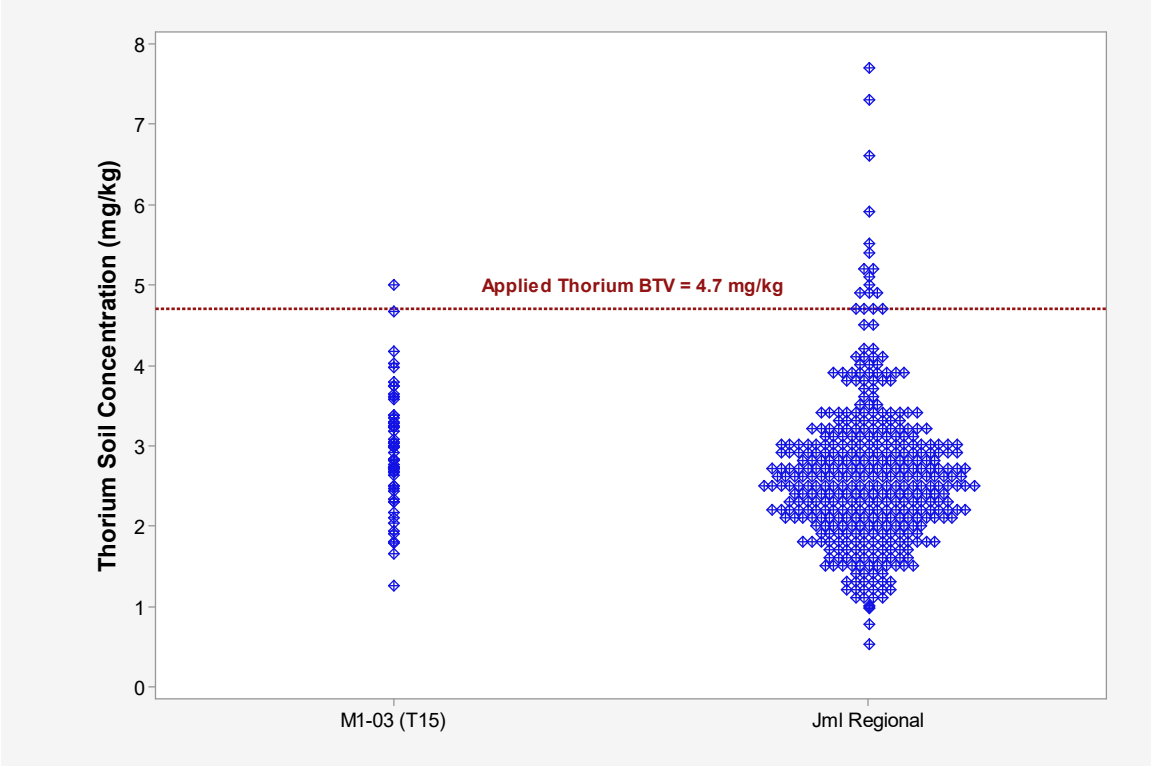


Figure I15-18. Individual Value Plot for Target M1-03 (T15) and Jml Regional Thorium Soil Concentrations

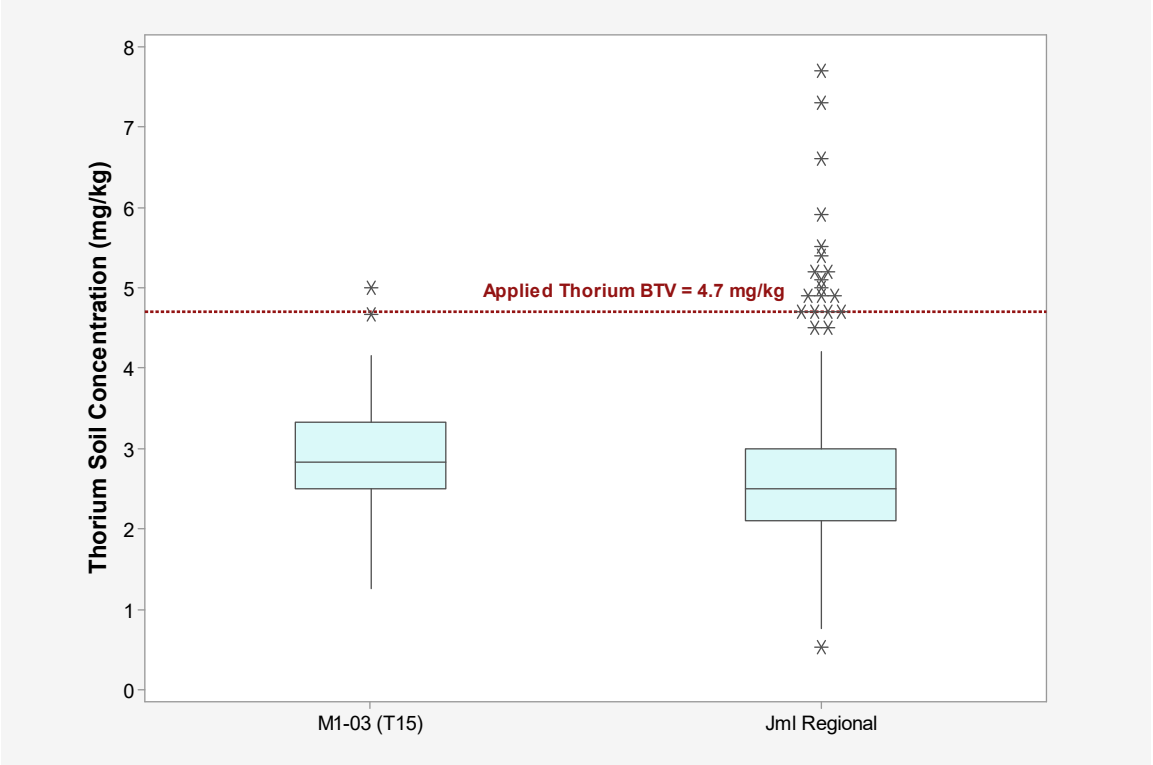
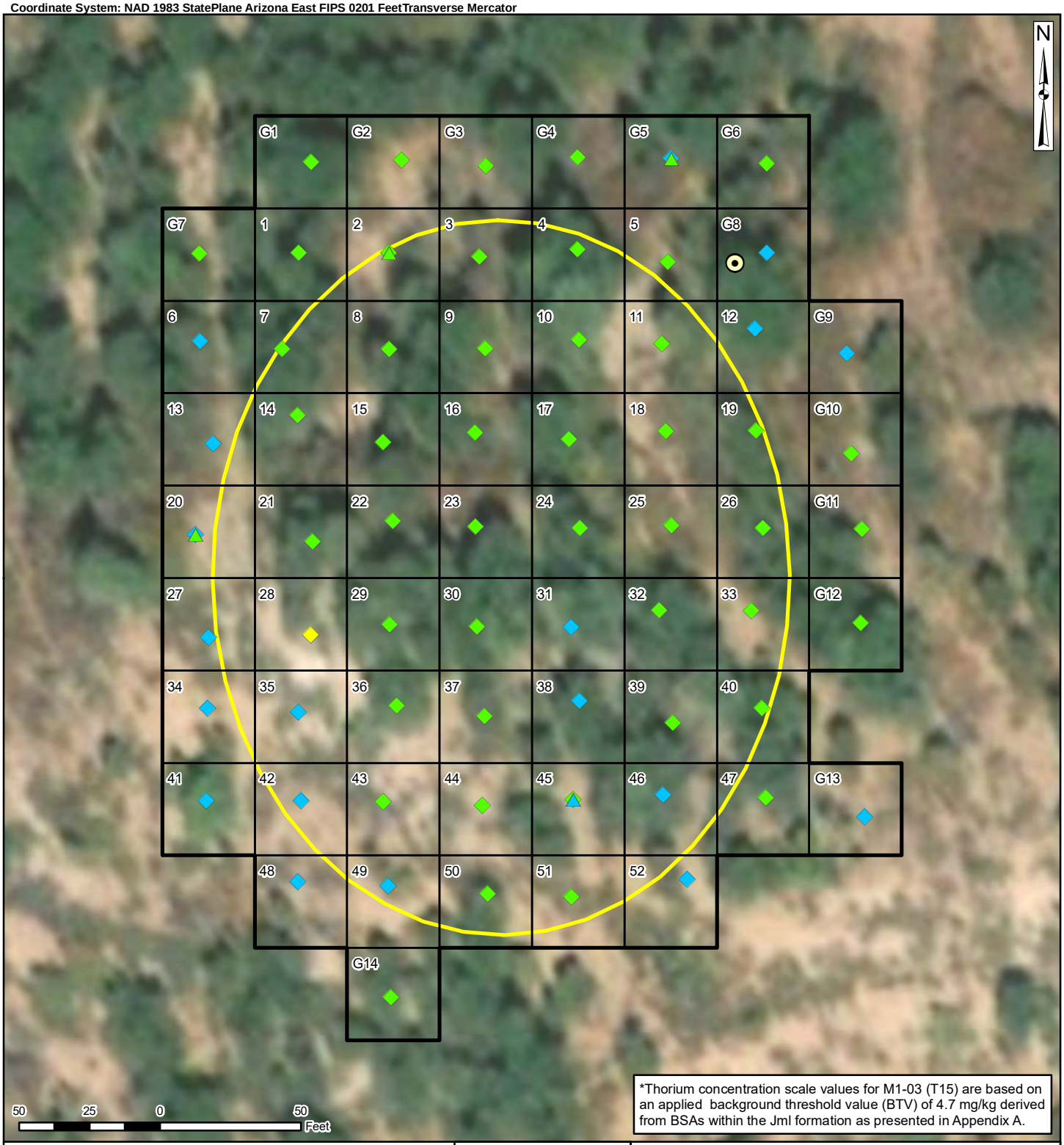


Figure I15-19. Box Plot for Target M1-03 (T15) and Jml Regional Thorium Soil Concentrations



*Thorium concentration scale values for M1-03 (T15) are based on an applied background threshold value (BTV) of 4.7 mg/kg derived from BSAs within the Jml formation as presented in Appendix A.

Thorium Concentration Scale (mg/kg)*

- ≤ 2.6
- 2.6 - 4.7
- 4.7 - 9.4
- 9.4 - 14
- 14 - 19
- 19 - 47
- ≥ 47

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Pipe - Field Mapped
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET M1-03 (T15) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I15-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

7.3.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I15-7. Uranium exceeded the applied BTV in 48.5 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for uranium is 1.5 mg/kg for Target T15 as presented in Section 7.3.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I15-5 and Attachment I3, respectively. Figure I15-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T15 and Jml regional samples. Figure I15-22 presents a box plot of detectable uranium XRF soil concentrations for Target T15 and Jml regional samples. Summary statistics for XRF measurements are provided in Section 7.3.6.1. Uranium XRF concentrations measured in surface soils at Target T15 ranged between 0.3 and 7.1 mg/kg with an average and standard deviation of 1.9 mg/kg and 1.3 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T15 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I15-23. Overall, the majority of detectable uranium results in surface soils were above the applied BTV. However, the maximum XRF value was 4.7 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T15.

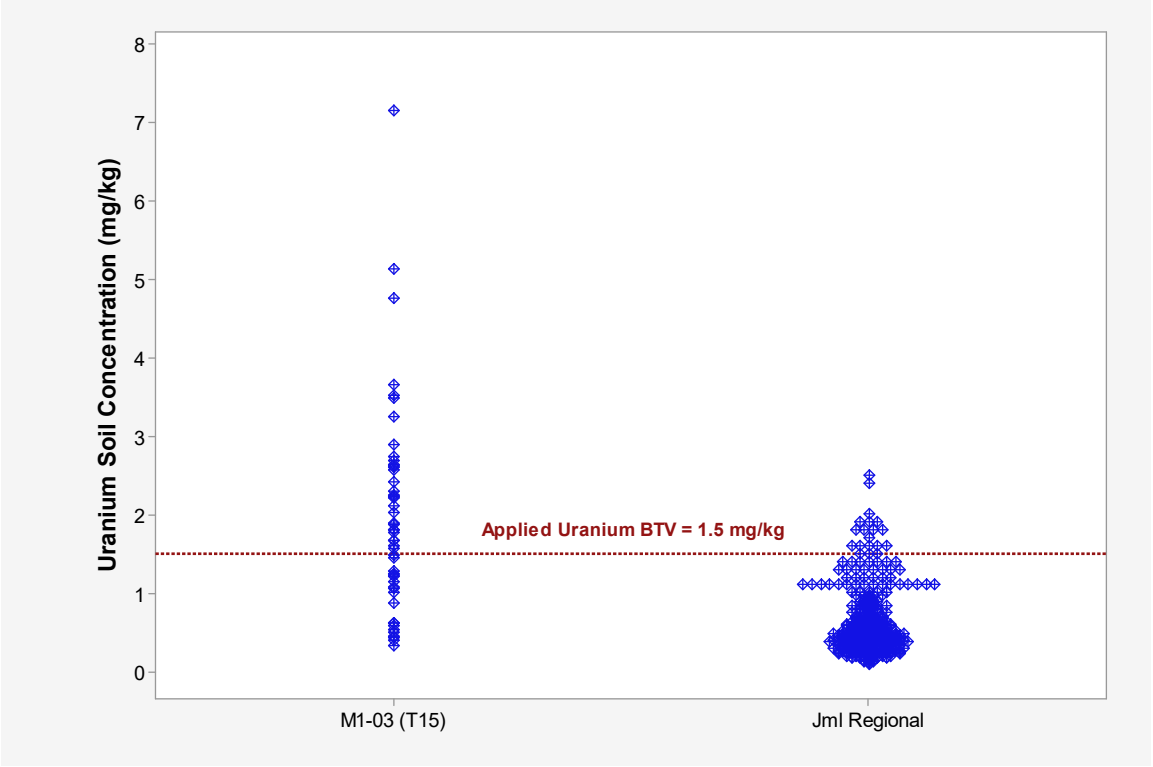


Figure I15-21. Individual Value Plot for Target M1-03 (T15) and Jml Regional Uranium Soil Concentrations

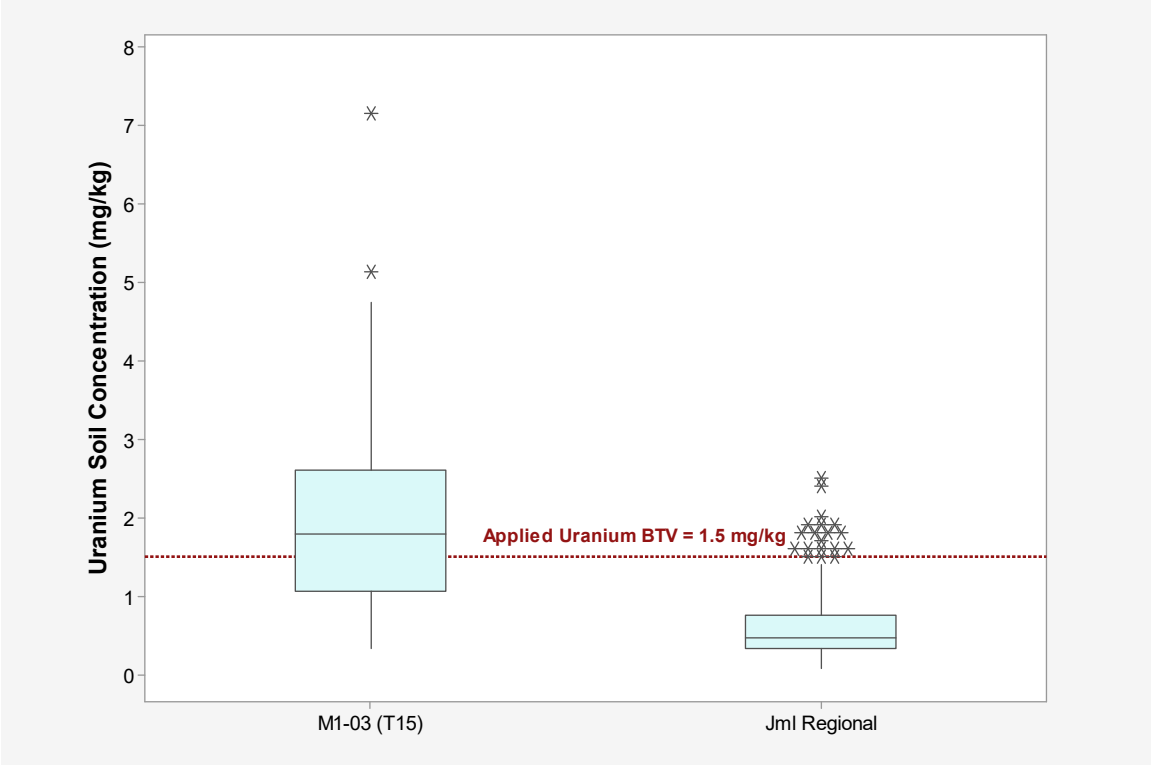
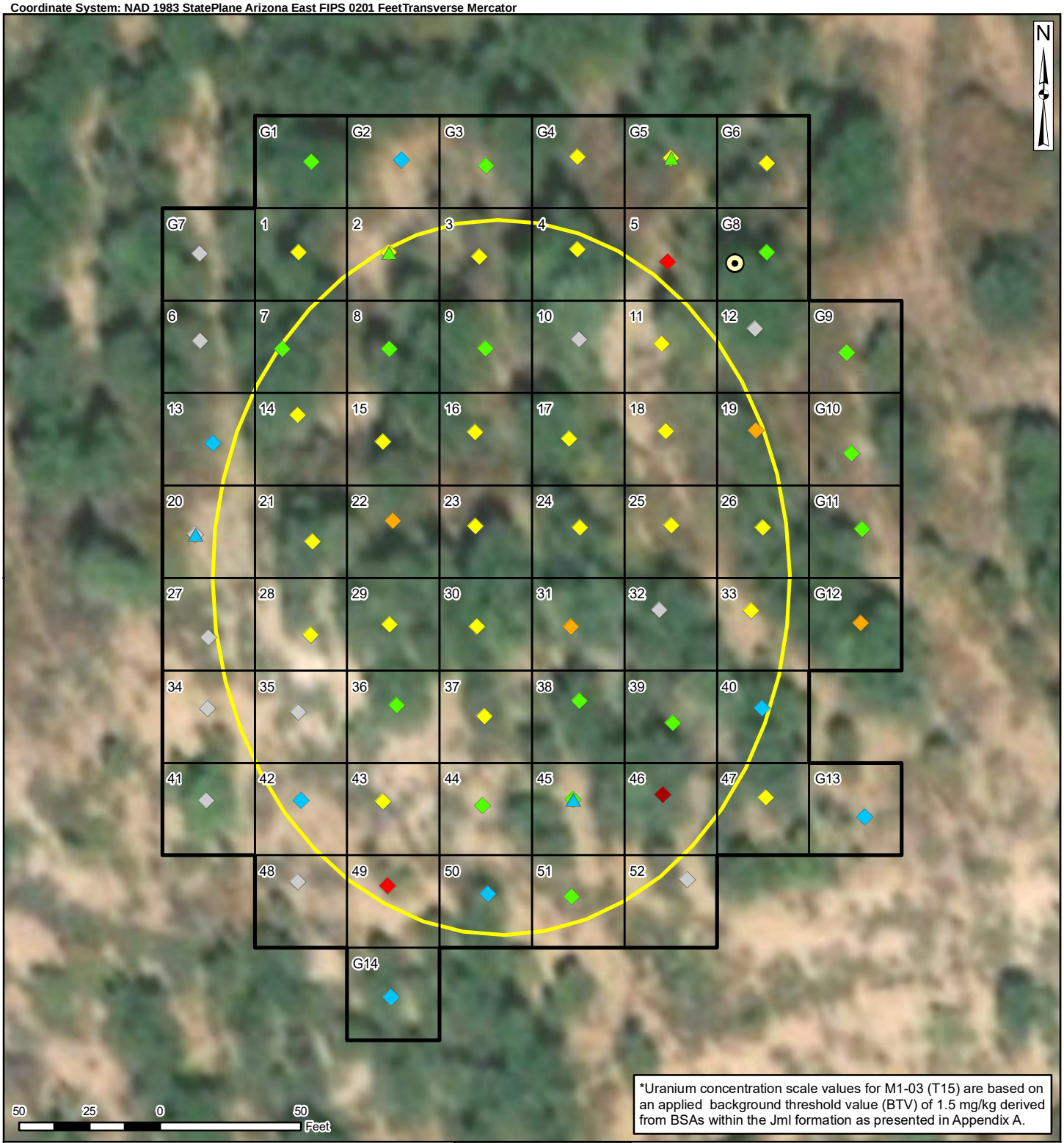


Figure I15-22. Box Plot for Target M1-03 (T15) and Jml Regional Uranium Soil Concentrations

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



*Uranium concentration scale values for M1-03 (T15) are based on an applied background threshold value (BTV) of 1.5 mg/kg derived from BSAs within the Jml formation as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 0.61
- 0.61 - 1.5
- 1.5 - 3.0
- 3.0 - 4.5
- 4.5 - 6.0
- 6.0 - 15
- ≥ 15
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Pipe - Field Mapped
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET M1-03 (T15) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I15-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

7.3.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I15-7. Vanadium exceeded the applied BTV in 10.6 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for vanadium is 15 mg/kg for Target T15 as presented in Section 7.3.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I15-5 and Attachment I3, respectively. Figure I15-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T15 and BSA-9 (Jml) samples. Figure I15-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T15 and BSA-9 (Jml) samples. Summary statistics for XRF measurements are provided in Section 7.3.6.1. Vanadium XRF concentrations measured in surface soils at Target T15 ranged between 17.5 and 27.8 mg/kg with an average and standard deviation of 21.7 mg/kg and 4.0 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T15 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I15-26. Overall, the majority of detectable vanadium results in surface soils were above the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T15.

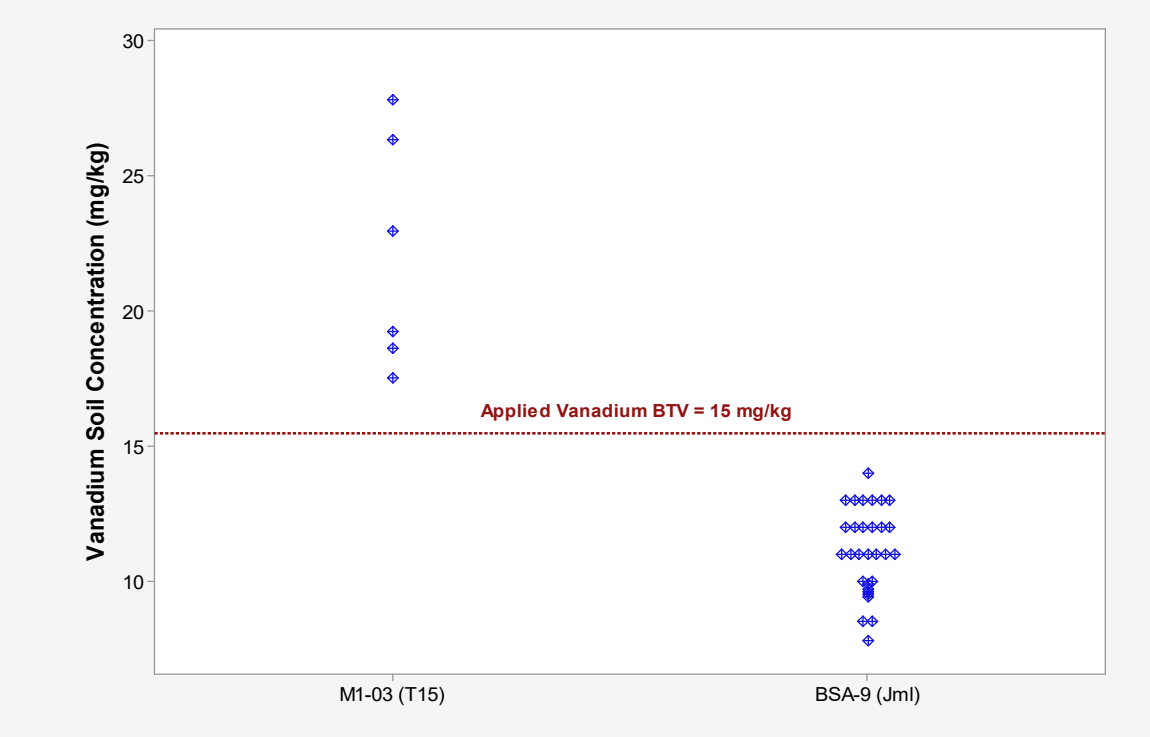


Figure I15-24. Individual Value Plot for Target M1-03 (T15) and BSA-9 (Jml) Vanadium Soil Concentrations

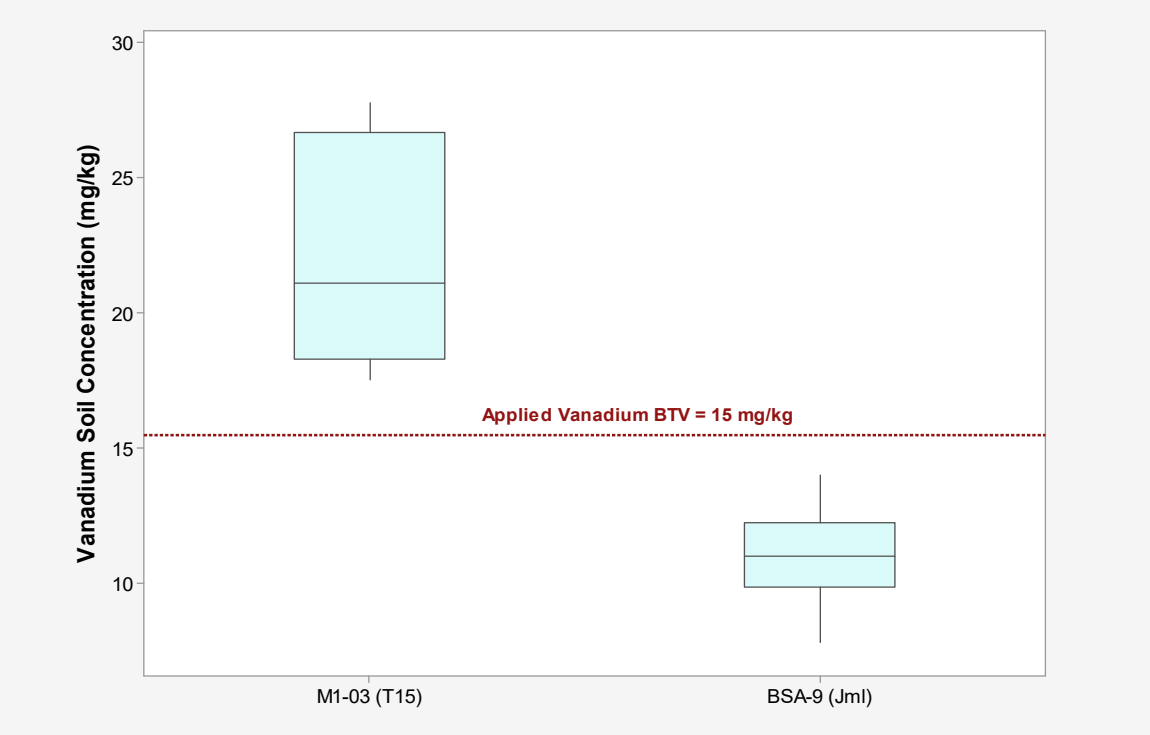
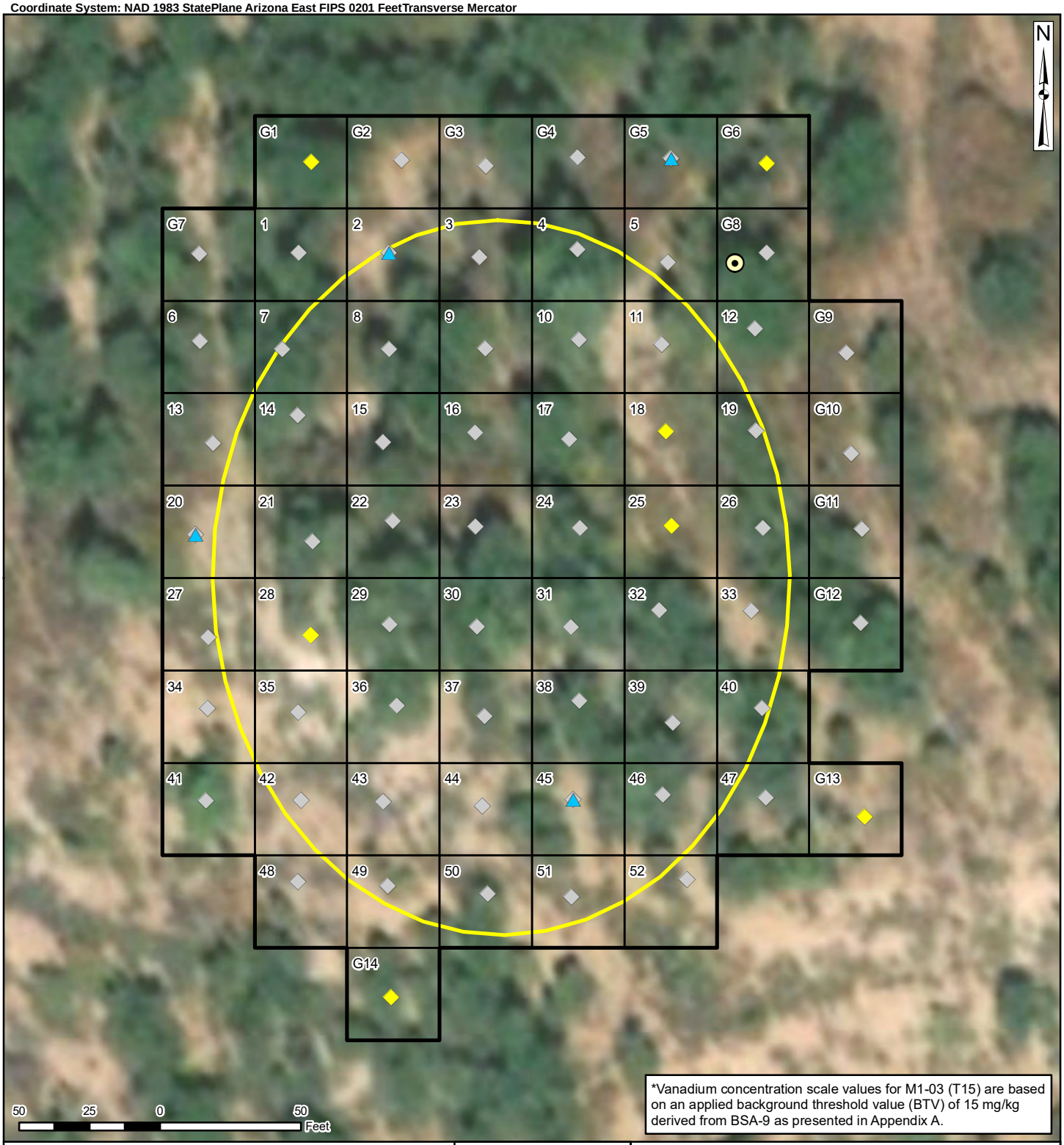


Figure I15-25. Box Plot for Target M1-03 (T15) and BSA-9 (Jml) Vanadium Soil Concentrations

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



*Vanadium concentration scale values for M1-03 (T15) are based on an applied background threshold value (BTV) of 15 mg/kg derived from BSA-9 as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 11
- 11 - 15
- 15 - 30
- 30 - 45
- 45 - 60
- 60 -150
- ≥ 150
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Pipe - Field Mapped
- Survey Unit (100 m²)
- Survey Area Boundary

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NON-AUM TARGET M1-03 (T15) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I15-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/12/2019	

7.3.8 Conclusions

Target T15 (M1-03) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T15. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T15 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T15. ASPECT gamma survey results generally did not correlate with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE; however, historic exploratory borings and underground mine workings were identified in the file review.
- The lateral extent of elevated radiological activity at Target T15 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T15 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. No grid averaged gamma measurements exceeded the applied BTV.
- A total of 27 analytes were identified as occurring within the surface environment. Of these analytes, 9 were identified as COPCs. Arsenic, lead, and uranium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observation, Target T15 does not contain TENORM. Underground mine workings associated with an adjacent mine and eight historical exploratory borings were noted in the file review, and a pipe was observed in the northeast corner of the Target. TENORM may be associated with the exploratory borings. NORM was not identified visually or by gamma survey.
- There are no immediate significant physical hazards present at Target T15.
- Access is by dirt road with a small four-wheel-drive vehicle followed by footpath.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No existing groundwater wells are documented within the vicinity of Target T15. No seeps or springs were observed during the RSE investigation.

- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T15. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No mine waste was observed at Target T15; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; however, a few data gaps remain for Target T15. The remaining data gaps include field verification of the reclamation status of the potential historic exploratory and if a vent is not present along the alignment of the underground mine workings.

8.0 GROUP F FIELD SAMPLING RESULTS

This section presents field sampling results for Group F Targets T18 (M5-01), T19 (M5-02), T20 (M5-03), T21 (M5-05), T22 (M5-06), T24 (M5-07), T25 (M5-08), and T26 (M5-09). AUM-related Target T23 is addressed in the Mesa V, Burial Cell 344B SSRSE Report in Appendix H of the RSE Report.

8.1 NON-AUM TARGET T18 (M5-01)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T18 (M5-01).

8.1.1 Access, Physical Conditions, and Field Observations

Target T18 (M5-01) is grouped with two other non-AUM Targets: T18 (M5-02) and T20 (M5-03). Target T18 is in the Lukachukai Mountains Region in Subarea Group F within the Cove Chapter of the Navajo Nation and accessed by foot off of Indian Route 33. Target T18 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. No residential structures are near the Target. A Target location and access map for Target T18 is shown in Figure I18-1.

A topographical relief map for Target T18 and associated AUM areas is provided in Figure I18-2. The elevation at Target T18 ranges from 7,069 to 7,123 feet amsl with an average of 7,087 feet amsl. The slope at Target T18 ranges from 4 to 36 percent with an average of 22 percent. Target T18 is entirely within the Jse and the Hozho-Quezcan-Rock outcrop complex soil type (MUSYM 413) (Figures I-22 and I-23).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T18. Weston did not conduct a background study for Target T18. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 23 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T18:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards other than steep cliffs were identified.

- Located access routes, including foot pathways and roads:

  Target T18 is accessible directly from a utility vehicle (UTV) trail off of Indian Route 33.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  Cliffs exposing outcrops of Jse, which contain NORM, were identified. No TENORM was observed.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  Three small ephemeral drainages were identified at the Target. The Middle 1 drainage is located 0.25 mile southeast of the Target and discussed in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

  No exploratory borings or haul roads were identified.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  No AUM or non-AUM Target features were present at the Target. The Target partially overlies Jse, which contains NORM.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T18 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Section 2.3 and 8.1.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPC (described in Section 8.1.3 with results presented in Sections 8.1.6 and 8.1.7)
- Conducting a gamma radiation survey (results presented in Section 8.1.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped

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NON-AUM TARGET M5-01 (T18) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I18-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Non-Tronox AUM Site
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped
100 ft Contour*
20 ft Contour*

* 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.

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NON-AUM TARGET M5-01 (T18) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I18-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.1.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I18-3) within the survey area of the non-AUM Target T18 as part of the Baseline Study in June 2018. Additional Goback gamma radiation surveys were performed in September 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T18 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I18-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 23, of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at 14 survey units. Three XRF survey units were inaccessible because of extreme terrain and health and safety concerns and were not evaluated.

8.1.3 XRF Confirmation Sampling Overview

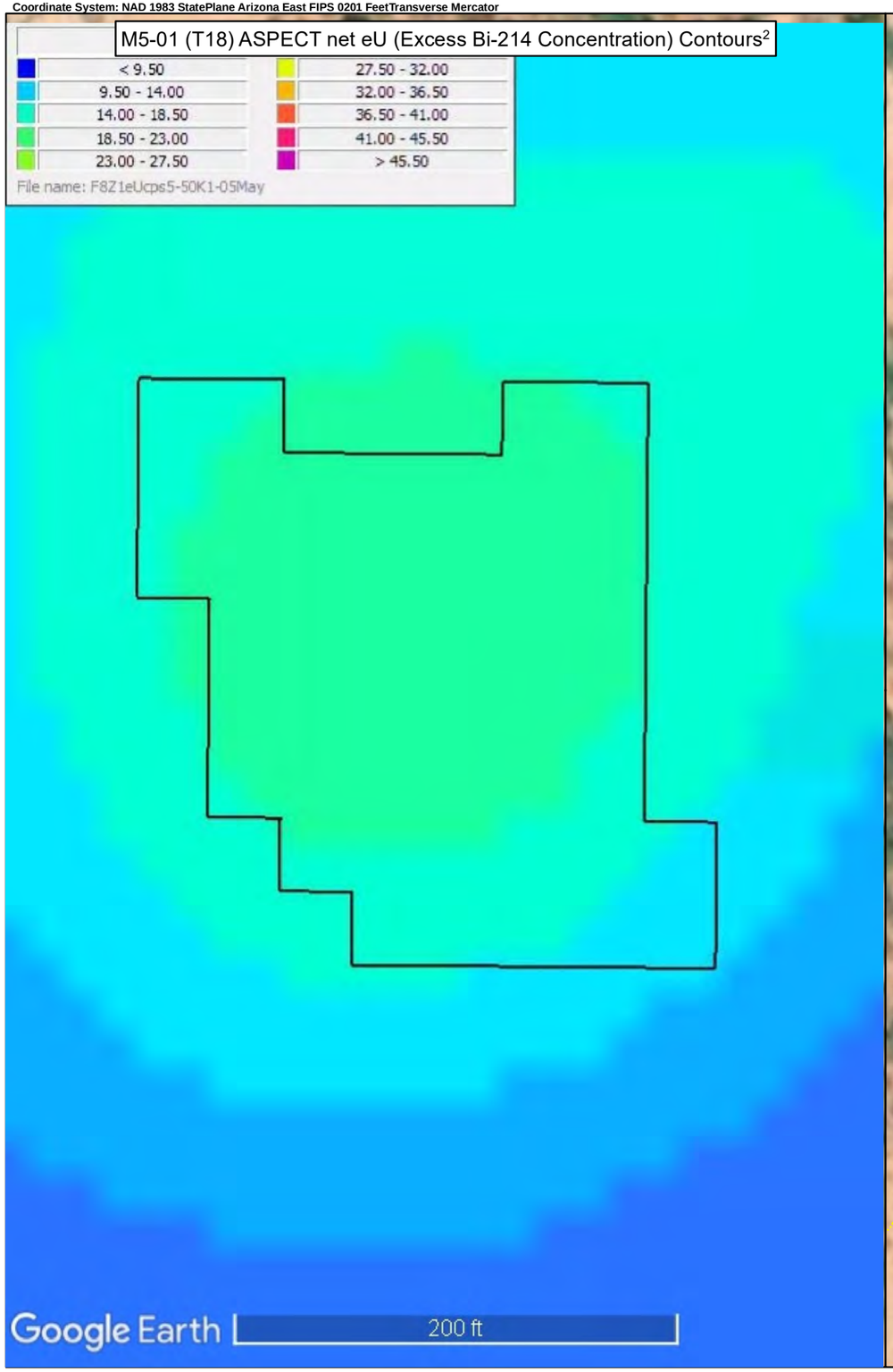
Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T18. Three XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from three locations (Table I18-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I18-4 and I8-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I18-2. The results of XRF confirmation sample analysis are provided in Section 8.1.6.1. Correlated XRF field measurements are provided in Attachment I3.

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

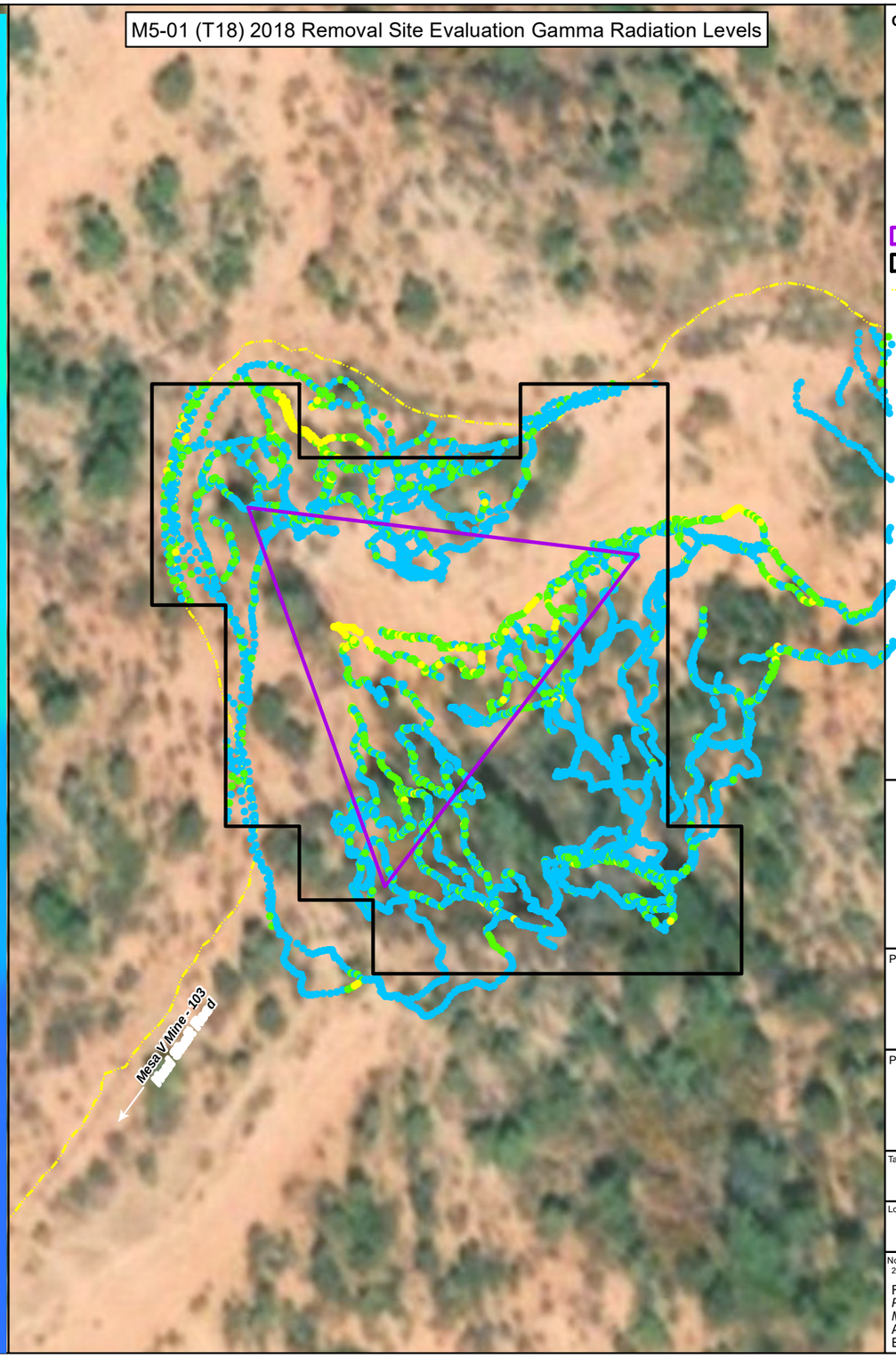
M5-01 (T18) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F8Z1eUcps5-50K1-05May



M5-01 (T18) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)[1]

≤ 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

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Foot

[1]The applied gamma background threshold value (BTV) for M5-01 (T18) Non-AUM Target is 11,319 cpm derived from BSA-19 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET M5-01 (T18)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

Prepared By:

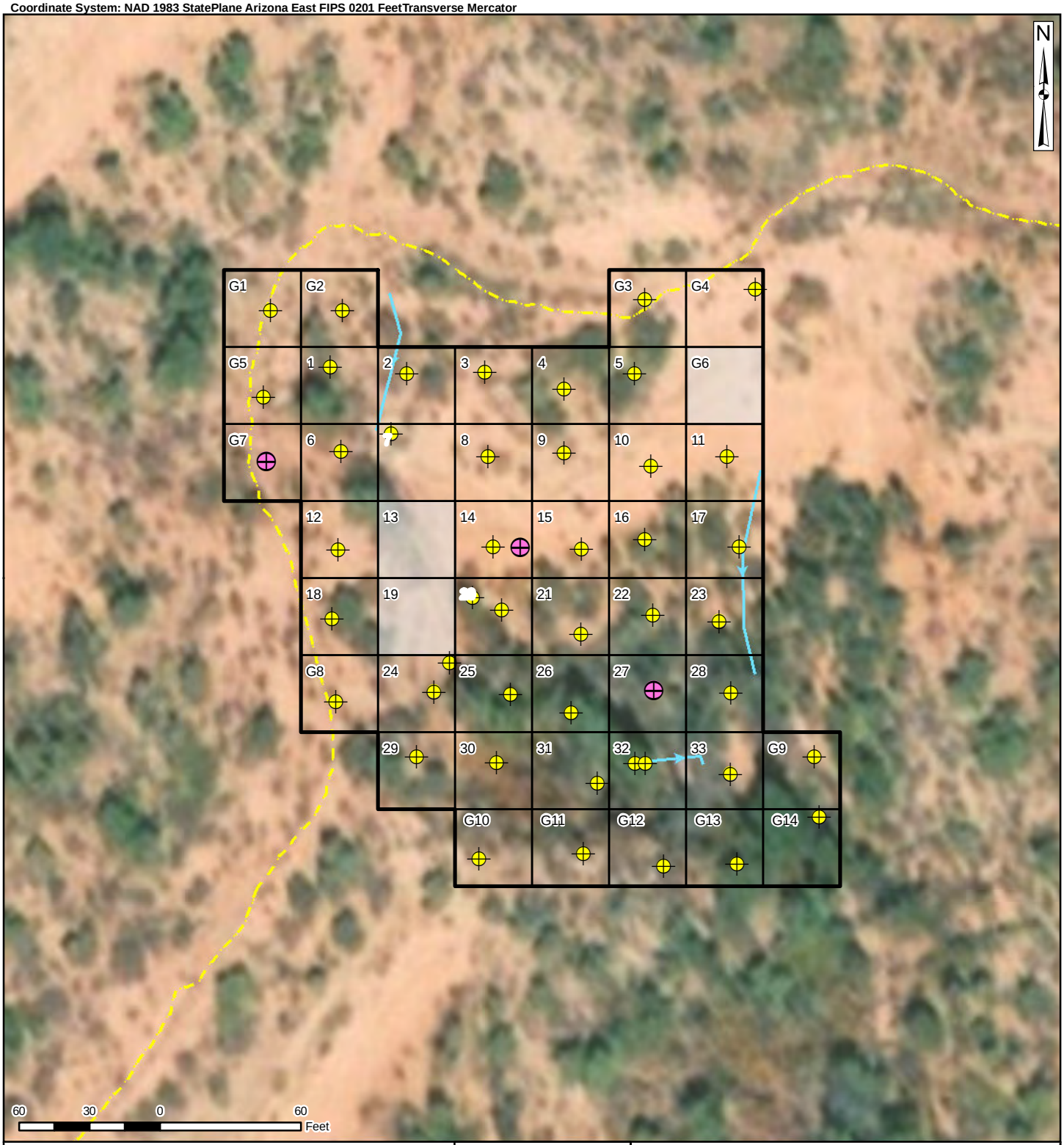
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborne Spectral Photometric Environmental Collection Technology.

Figure No.: **I18-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Unit (100 m²)

Survey Area Boundary

Inaccessible to XRF Survey

Access Route - Foot

Prepared for: USEPA Region 9

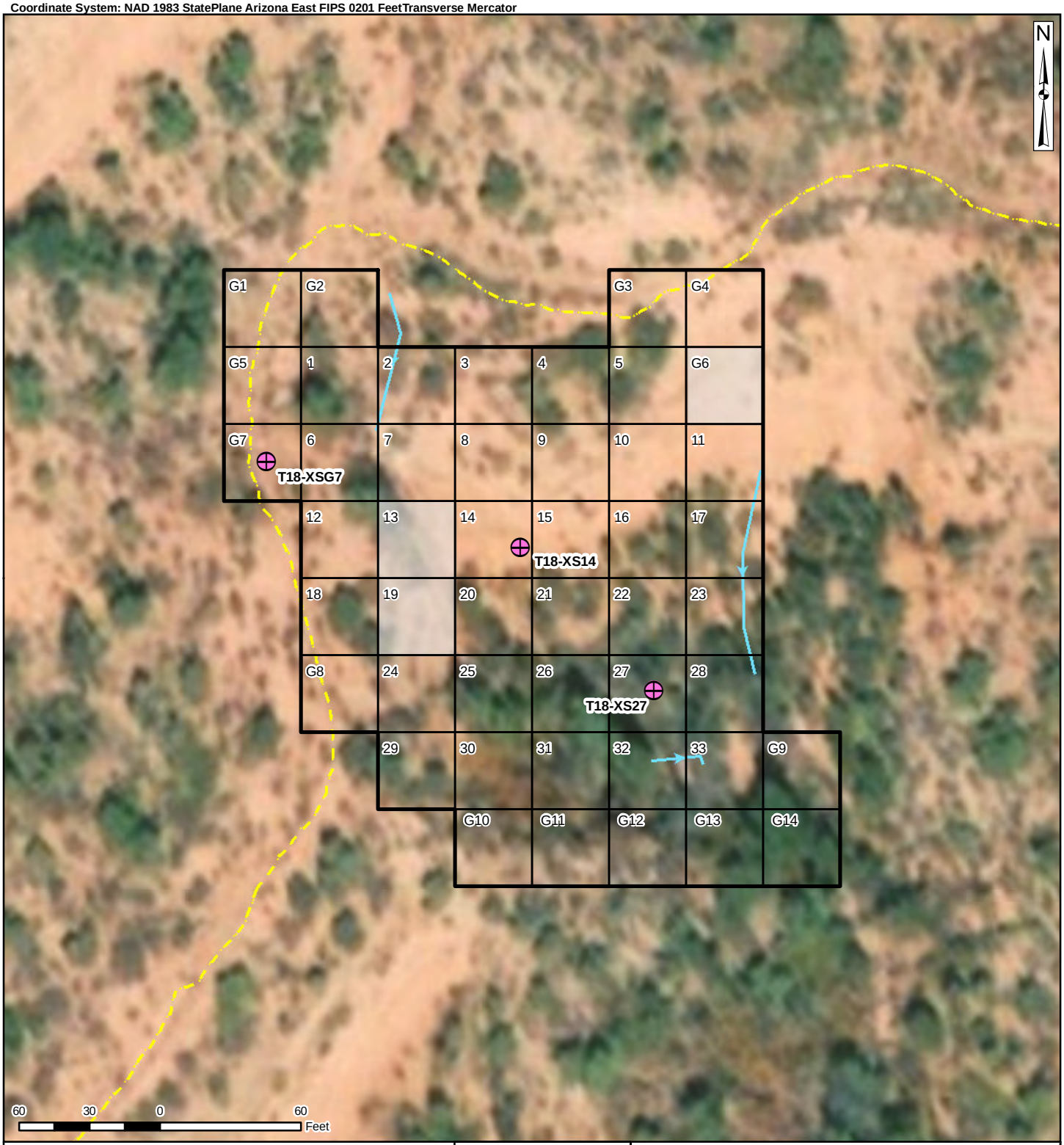
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NON-AUM TARGET M5-01 (T18)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I18-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

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



XRF Confirmation Soil Sample* (0 - 3 inches bgs)

Survey Unit (100 m²)

Survey Area Boundary

Inaccessible to XRF Survey

Access Route - Foot

*T18-XS14 = site T18 XRF confirmation soil sample collected at survey unit 14. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET M5-01 (T18) SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I18-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

Table I18-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-01 (T18)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T18-XS14-01-061118	14	0-3	XRF Confirmation	Primary	6/11/2018	36.5407792	-109.2400029	1806311-5, 1806312-5
T18-XS27-01-061118	27	0-3	XRF Confirmation	Primary	6/11/2018	36.5406107	-109.2398121	1806311-6, 1806312-6
T18-XSG7-01-091518	G7	0-3	XRF Confirmation	Primary	9/15/2018	36.5408829	-109.2403700	1809475-42, 1809476-42

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I18-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-01 (T18)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

8.1.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 8.1.1, Target T18 surface geology is entirely within Jse with soils within the Hozho-Quezcan-Rock outcrop complex (MUSYM 413) (Figures I-22 and I-23). As a result, Background Study Area 19 (BSA-19) was selected for that combination of geology and soil type. Additionally, the Jse regional geological background would also be applicable for this Target. Table I18-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T18. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T18. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T18. The “Applied BTV” for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I18-3. Applied Background Threshold Values for Non-AUM Target M5-01 (T18)

Analyte	Units	Site-Specific BTV (BSA-19)	Regional BTV (Jse)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	6,410	7,400	6,410	Site-Specific BTV
Antimony	mg/kg	0.138	0.163	0.138	Site-Specific BTV
Arsenic	mg/kg	2.4	4.8	2.4	Site-Specific BTV
Barium	mg/kg	241	166	166	Regional BTV
Beryllium	mg/kg	0.46	0.51	0.46	Site-Specific BTV
Cadmium	mg/kg	0.150	0.160	0.150	Site-Specific BTV
Calcium	mg/kg	25,300	36,000	25,300	Site-Specific BTV
Chromium	mg/kg	7.4	11	7.4	Site-Specific BTV
Cobalt	mg/kg	3.2	4.4	3.2	Site-Specific BTV
Copper	mg/kg	13	11	11	Regional BTV
Iron	mg/kg	5,830	8,000	5,830	Site-Specific BTV
Lead	mg/kg	9.3	12	9.3	Site-Specific BTV
Lithium	mg/kg	18	13	13	Regional BTV
Magnesium	mg/kg	7,240	7,000	7,000	Regional BTV
Manganese	mg/kg	264	500	264	Site-Specific BTV
Mercury	mg/kg	0.0407	0.0298	0.0298	Regional BTV
Molybdenum	mg/kg	0.20	0.34	0.20	Site-Specific BTV
Nickel	mg/kg	4.9	11	4.9	Site-Specific BTV
Potassium-40	pCi/g	20.2	23.7	20.2	Site-Specific BTV
Radium-226	pCi/g	1.57	4.15	1.57	Site-Specific BTV
Radium-228	pCi/g	-	0.84	0.84	Regional BTV
Selenium	mg/kg	0.84	0.98	0.84	Site-Specific BTV
Silver	mg/kg	0.019	0.055	0.019	Site-Specific BTV
Sodium	mg/kg	43	36	36	Regional BTV
Thallium	mg/kg	0.046	0.091	0.046	Site-Specific BTV
Thorium	mg/kg	2.4	3.6	2.4	Site-Specific BTV
Uranium	mg/kg	1.3	3.4	1.3	Site-Specific BTV
Vanadium	mg/kg	22	31	22	Site-Specific BTV
Zinc	mg/kg	28	28	28	Regional BTV
Gamma Radiation	cpm	11,319	15,781	11,319	Site-Specific BTV

Notes:

-	No BTV
BSA	Background Study Area
BTV	background threshold value
cpm	counts per minute
Jse	Summerville, Entrada Formation (Undifferentiated)
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram

8.1.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T18 and the raw gamma radiation and grid averaged gamma radiation survey results.

8.1.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T18 in June 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in September 2018 to collect data within the Goback survey units. The applied gamma BTV for non-AUM Target T18 is 11,319 cpm. A total of 5,967 measurements were collected as part of the gamma radiation survey at non-AUM Target T18 across 47 survey units. Because of the cliffs and steep topography, not all survey units were scanned or scanned at 100 percent density. An average scan density of 127 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I18-4.

Table I18-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-01 (T18)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,319	
Measurements	#	5,967	47
Minimum	cpm	5,516	7,491
Maximum	cpm	16,408	11,952
Average	cpm	8,790	8,898
Median	cpm	8,704	8,848
Standard Deviation	cpm	1,162	810
90th Percentile	cpm	10,243	9,920
95th Percentile	cpm	10,759	10,221
99th Percentile	cpm	12,221	11,259
Measurements per Grid	#/grid	127	
Measurements Above Gamma BTV	#	151	1
Measurements Above Gamma BTV	%	2.5	2.1

Notes:
BTV background threshold value
cpm counts per minute

8.1.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 2.5 percent of the measurements within the Target boundaries, in some cases exceeding greater than 1.4 times the applied gamma BTV (11,319 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-19 (Jse) gamma survey results is provided on Figure I18-6. This graph shows that the spread of radiation data at Target T18 (shown on left) begins within the lower range of BSA-19 (Jse) gamma levels (shown on right) and then rises to the upper range of background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T18 is slightly lower than the data cloud from the BSA-19 (Jse) data set. A box plot showing the quartiles of the data sets is provided in Figure I18-7. The box plot shows that the median of Target T18 radiation levels is lower than the median of the BSA-19 (Jse) data set and lower than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I18-8. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I18-8 as discussed further in Section 2.8. No mining activity was observed within the survey area of Target T18. In general, Target T18 has surficial gamma radiation levels below BSA-19 (Jse) levels across the majority of the Target and surrounding area. The ASPECT gamma survey (Figure I18-3) may have measured elevated gamma activity associated with the NORM on the inaccessible cliff face. No TENORM or mining-related activities were observed. Section 8.1.5.3 presents the grid averaged results of the gamma radiation survey.

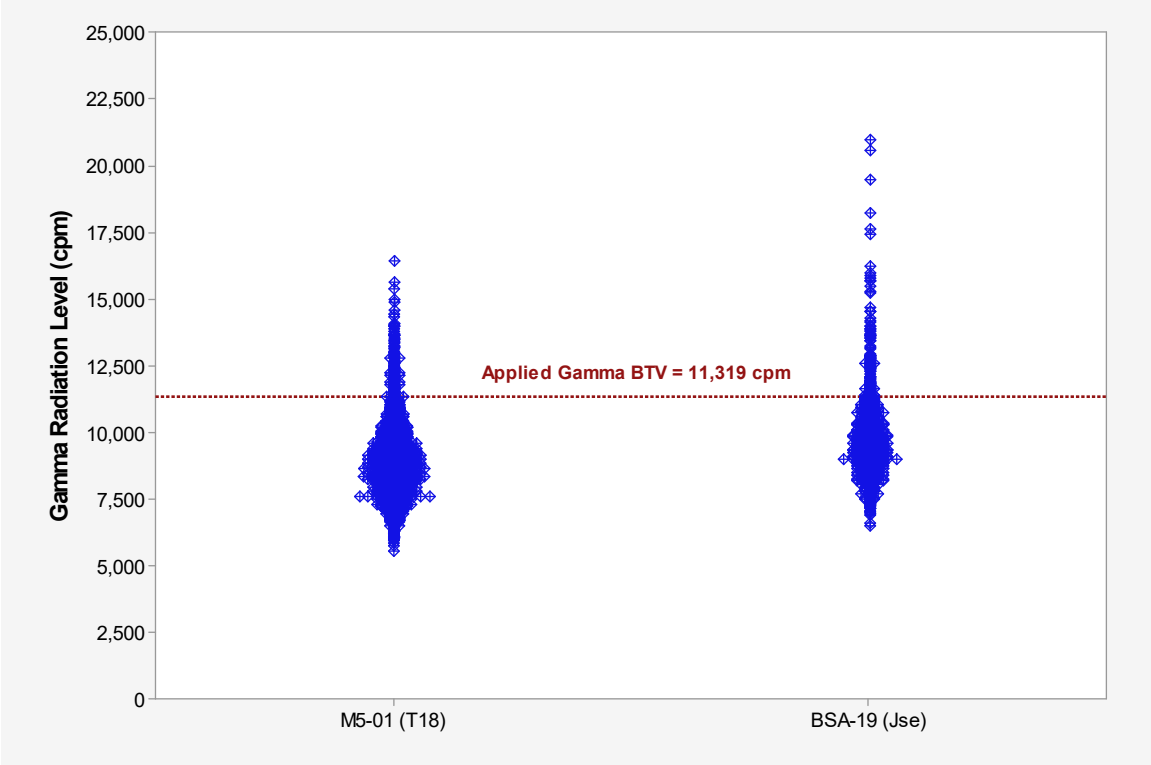


Figure I18-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M5-01 (T18) and BSA-19 (Jse)

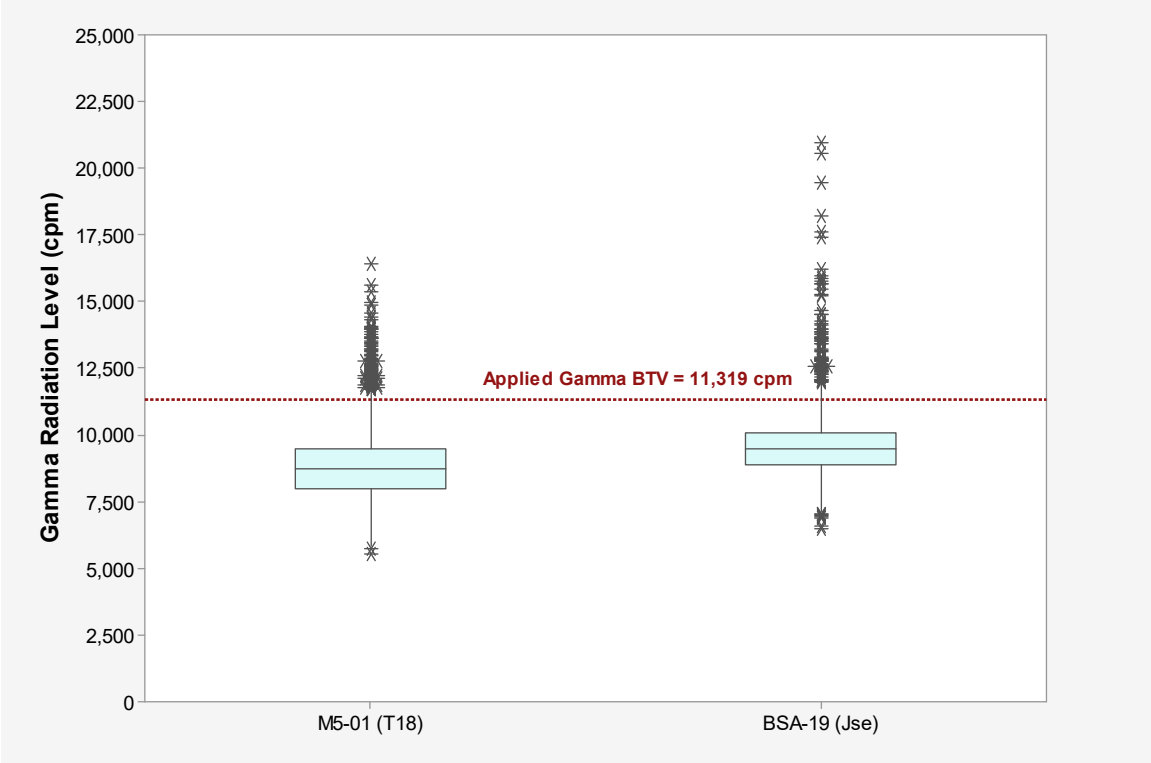
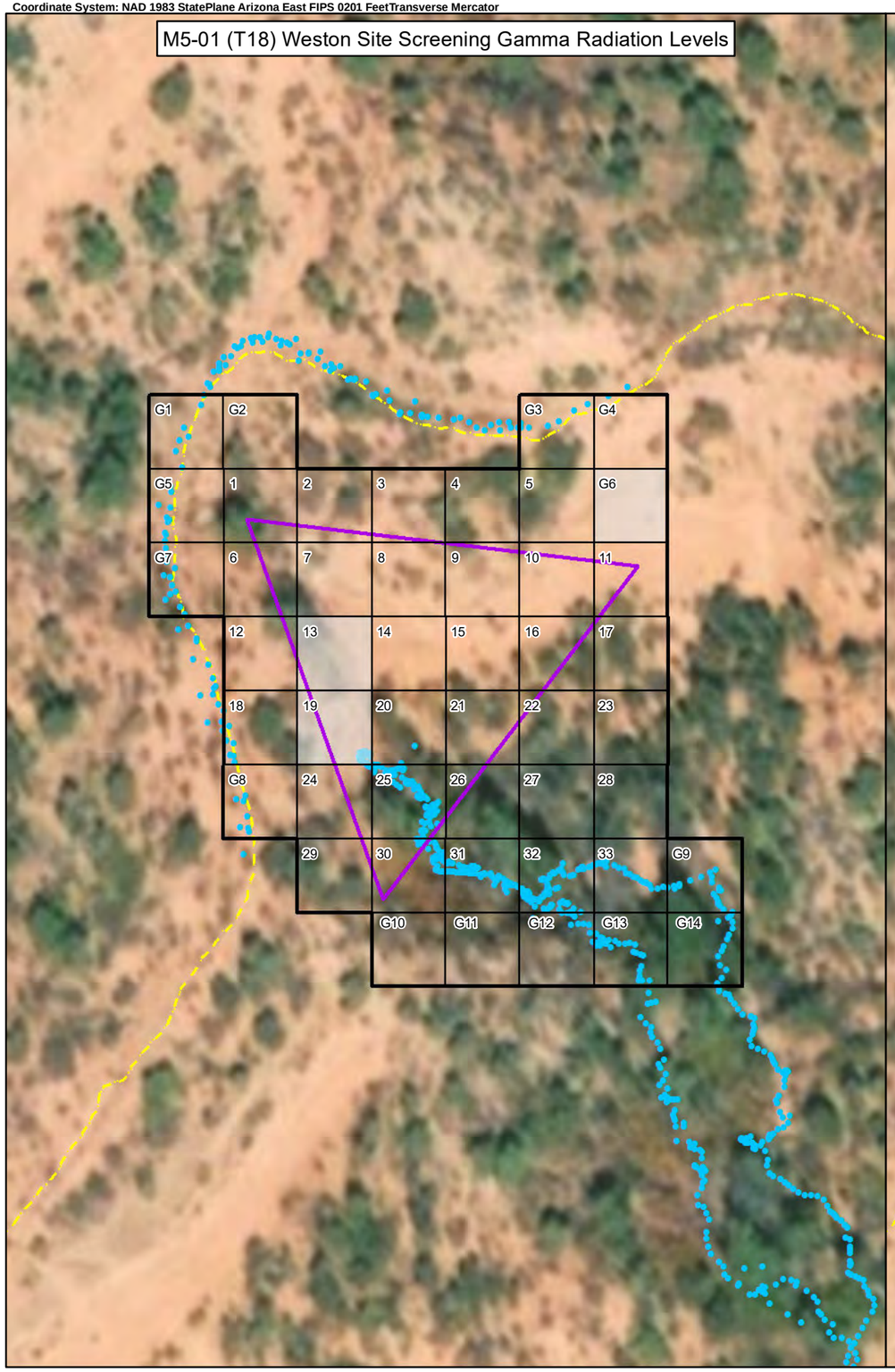
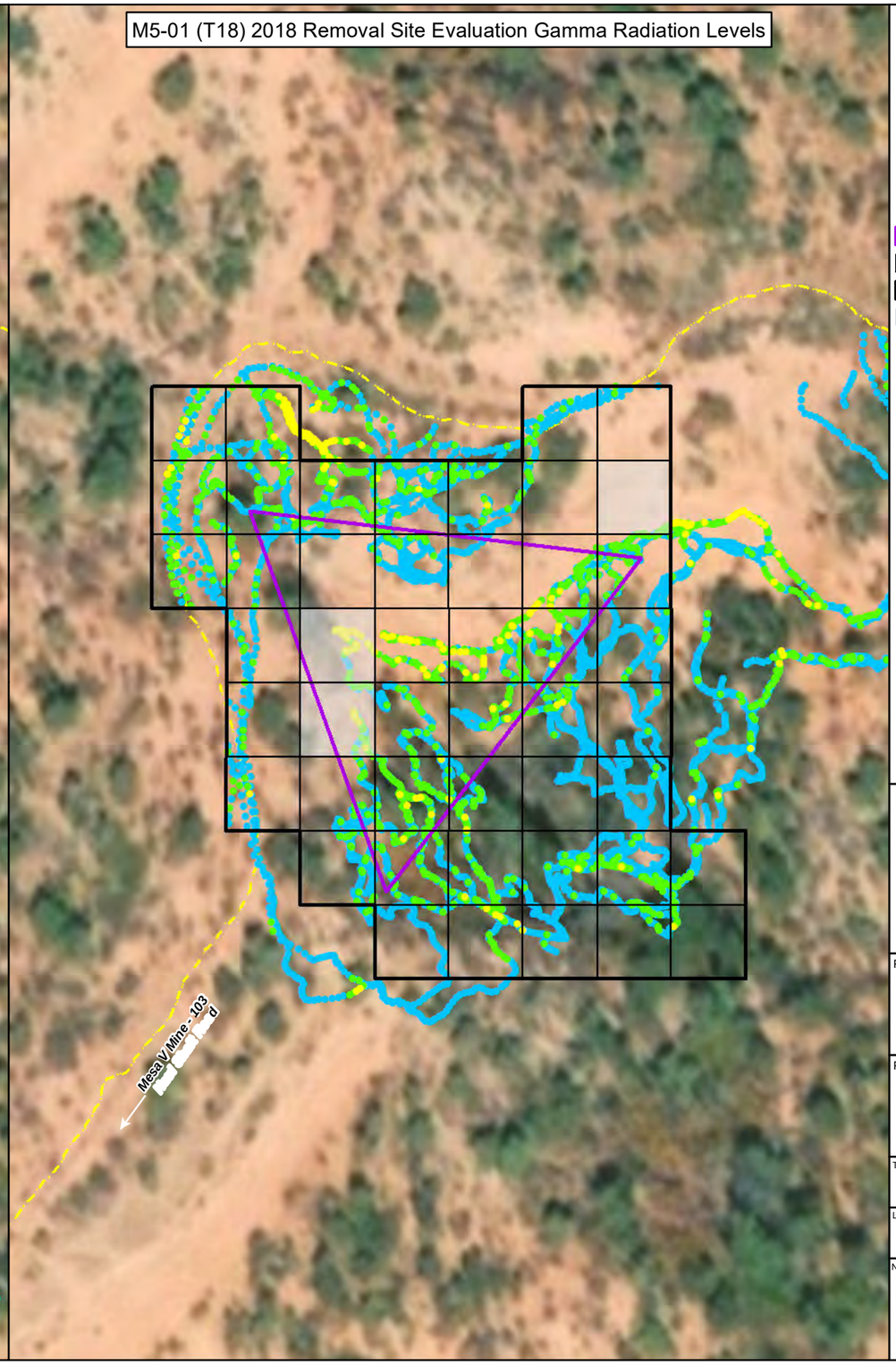


Figure I18-7. Box Plot of Raw Gamma Radiation Levels at Target M5-01 (T18) and BSA-19 (Jse)

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





Gamma Reading (cpm)*

≤ 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

- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Inaccessible
- Access Route - Foot

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET M5-01 (T18)
2018 REMOVAL SITE EVALUATION
VS WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/14/2019

Notes:
*The applied gamma background threshold value (BTV) for M5-01 (T18) is 11,319 cpm derived from BSA-19 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I18-8**

8.1.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 8.1.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 8.1.5.1. Figure I18-9 and Figure I18-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-19 (Jse) data set (shown on right). A total of 2.1 percent of the survey units (1 of 47) within the survey area of Target T18 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I18-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I18-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. The elevated regions of the Target correspond with the exposed cliff face area within survey unit 13, which is likely NORM.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface and subsurface soil samples were collected at the Target across the survey units and are presented in Section 8.1.6.

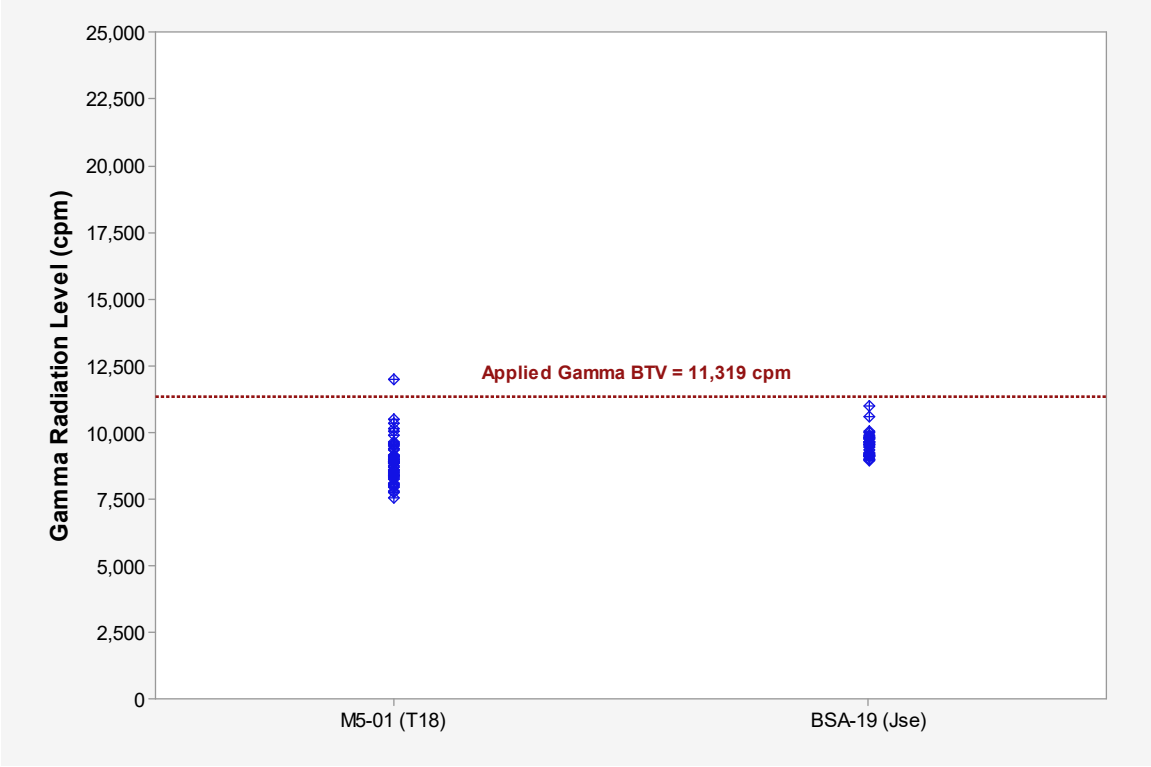


Figure I18-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-01 (T18) and BSA-19 (Jse)

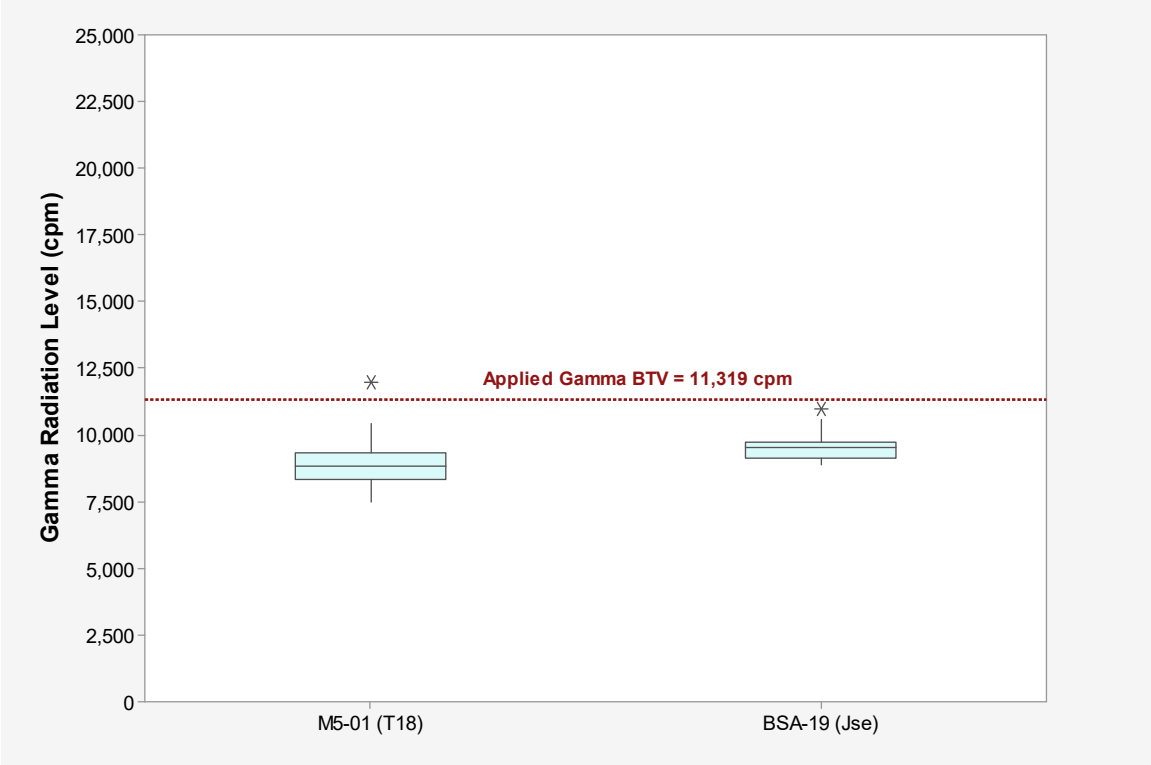
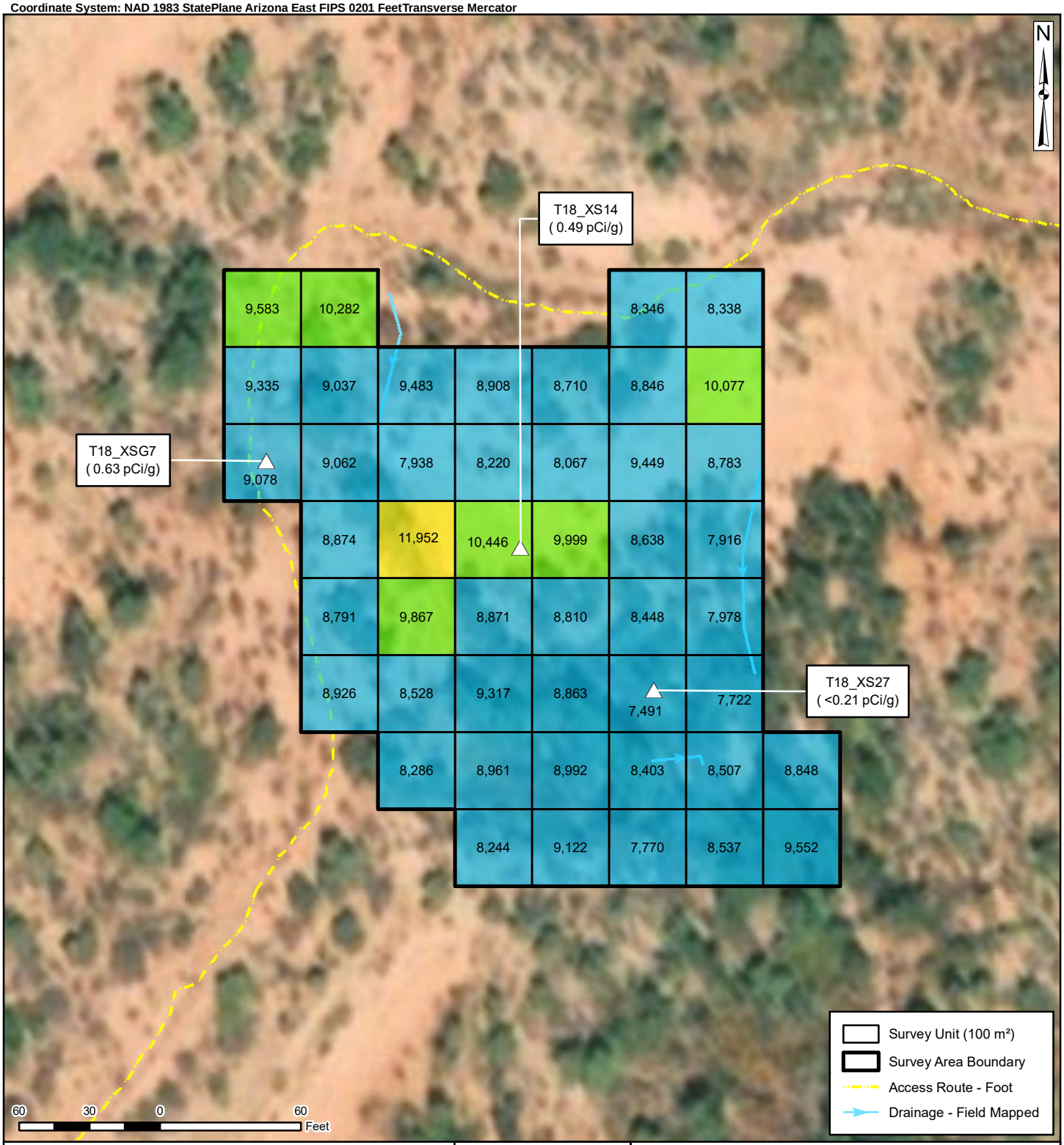


Figure I18-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-01 (T18) and BSA-19 (Jse)

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



Grid Averaged Gamma Reading (cpm)*

≤ 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

*The applied gamma background threshold value (BTV) for M5-01 (T18) is 11,319 cpm derived from BSA-19 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M5-01 (T18) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I18-11
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.1.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T18. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 8.1.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 8.1.6.2.

8.1.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T18: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I18-1 and I18-2. All the results of the XRF confirmation soil samples are presented in Table I18-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T18 following the methods outlined in Section 2.4 and shown in Figure I18-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 48 measurements were collected across 51 survey units from the survey area of Target T18 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I18-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T18 at a depth of 0 to 3 inches bgs. Three XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I18-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 8.1.7.

Table I18-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-01 (T18)

Analyte	Units	Applied BTV	T18-XS14-01-061118		T18-XS27-01-061118		T18-XSG7-01-091518	
			Result	Q	Result	Q	Result	Q
Survey Unit			X14		X27		G7	
Aluminum	mg/kg	6,410	5,000		1,900		4,300	
Antimony	mg/kg	0.138	<0.1	U	<0.096	U	<0.086	U
Arsenic	mg/kg	2.4	1.8		0.66		2	
Barium	mg/kg	166	50		38		220	
Beryllium	mg/kg	0.46	0.29		0.11		0.29	
Cadmium	mg/kg	0.150	<0.2	U	<0.19	U	0.029	J
Calcium	mg/kg	25,300	18,000		18,000		13,000	
Chromium	mg/kg	7.4	5.1		1.7		4.7	
Cobalt	mg/kg	3.2	2.8		0.89		2	
Copper	mg/kg	11	2.5		0.93	J-	2.1	
Iron	mg/kg	5,830	5,300		1,700		3,800	
Lead	mg/kg	9.3	4.1		1.9		3.9	
Lithium	mg/kg	13	13		3.8		13	
Magnesium	mg/kg	7,000	5,500		1,700		5,000	
Manganese	mg/kg	264	200		110		150	
Molybdenum	mg/kg	0.20	0.13	J	0.054	J	0.078	J
Nickel	mg/kg	4.9	4.8		1.6	J	2.6	
Potassium-40	pCi/g	20.2	14.5	J-	8.8	LT	15.7	
Radium-226	pCi/g	1.57	0.49	J-	<0.21	U	0.63	LT
Radium-228	pCi/g	0.84	<0.47	UJ	<0.12	U	<0.65	U
Selenium	mg/kg	0.84	0.59	J	<0.96	U	1	
Silver	mg/kg	0.019	<0.05	U	<0.048	U	<0.043	U
Sodium	mg/kg	36	27	J	<96	U	<86	U
Thallium	mg/kg	0.046	0.033		0.0096		0.022	
Thorium	mg/kg	2.4	2.3		0.66		1.8	
Uranium	mg/kg	1.3	0.52		0.29		0.34	
Vanadium	mg/kg	22	7.8		4.6		9.3	
Zinc	mg/kg	28	14		5.5	J	14	

Notes:
BTV Background threshold value
J Estimated value
J- Estimated value, may be biased low
LT Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
M3 The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg Milligrams per kilogram
NA Not applicable
NV No Value
pCi/g Picocuries per gram
Q Qualification
U Not considered detected. The associated value is the method detection limit (MDL).
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

Table I18-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-01 (T18)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.4	5,830	9.3	264	0.20	2.4	1.3	22	28
Measurements	#	48	48	48	48	48	48	48	48	48
Detects	#	12	48	48	48	5	46	22	5	48
Nondetects	#	36	0	0	0	43	2	26	43	0
Minimum	mg/kg	2.0	3,059	2.4	119.8	0.0	1.1	0.2	16.3	9.9
Maximum	mg/kg	2.8	7,489	7.3	351.3	0.5	3.5	2.6	19.9	22.9
Standard Deviation	mg/kg	0.3	1,140	1.1	48	0.18	0.6	0.6	1	3.0
Average	mg/kg	2.4	5,290	5.1	204	0.21	2.1	1.0	17.9	15.5
Median	mg/kg	2.5	5,281	5.0	204	0.17	2.0	0.9	17.5	15.2
Relative Standard Deviation	%	11.9	21.5	22.6	23.3	85.2	28.0	58.0	8.1	19.1
90th Percentile	mg/kg	2.7	6,797	6.4	244	0.4	2.7	1.8	19	20
95th Percentile	mg/kg	2.7	7,260	6.9	304	0.4	3.1	1.9	20	21
99th Percentile	mg/kg	2.8	7,464	7.2	337	0.5	3.4	2.5	20	22
Measurements Above Applied BTV	#	7	14	0	4	2	13	6	0	0
Measurements Above Applied BTV	%	14.3	28.6	0.0	8.2	4.1	26.5	12.2	0.0	0.0

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value
mg/kg Milligram per kilogram
XRF X-ray fluorescence

8.1.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T18 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T18 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T18. The estimated BTVs are identified in Section 8.1.4 and Table I18-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I18-7 presents a summary of the background comparison for different measurement and soil depths at Target T18. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T18. However, gamma radiation screening indicated that gamma levels at Target T18 are elevated in comparison to the BSA and appear to be associated with outcropping of Jse. Therefore, while multiple COPCs have been identified at Target T18 based on a conservative comparison to background, risk screening will be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I18-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-01 (T18)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic		✓	✓
Barium	✓		✓
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron		✓	✓
Lead			
Lithium			
Magnesium			
Manganese		✓	✓
Molybdenum			
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium	✓		✓
Silver			
Sodium			
Thallium			
Thorium		✓	✓
Uranium		✓	✓
Vanadium			
Zinc			

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

8.1.7 Primary Contaminant Mapping

8.1.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 8.1.6.2 identified the COPCs at Target T18. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 8.1.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I18-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T18 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 8.1.7.1 through Section 8.1.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T18. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

8.1.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I18-7. Arsenic exceeded the applied BTV in 14.3 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for arsenic is 2.4 mg/kg for Target T18 as presented in Section 8.1.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I18-5 and Attachment I3, respectively. Figure I18-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T18 and BSA-19 (Jse) samples. Figure I18-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T18 and BSA-19 (Jse) samples. Summary statistics for XRF measurements are provided in Section 8.1.6.1. Arsenic XRF concentrations measured in surface soils at Target T18 ranged between 2.0 and 2.8 mg/kg with an average and standard deviation of 2.4 mg/kg and 0.3 mg/kg, respectively. The average arsenic XRF concentration is below the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T18 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I18-14. Overall, the majority of detectable arsenic results in surface soils were at the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials Target T18.

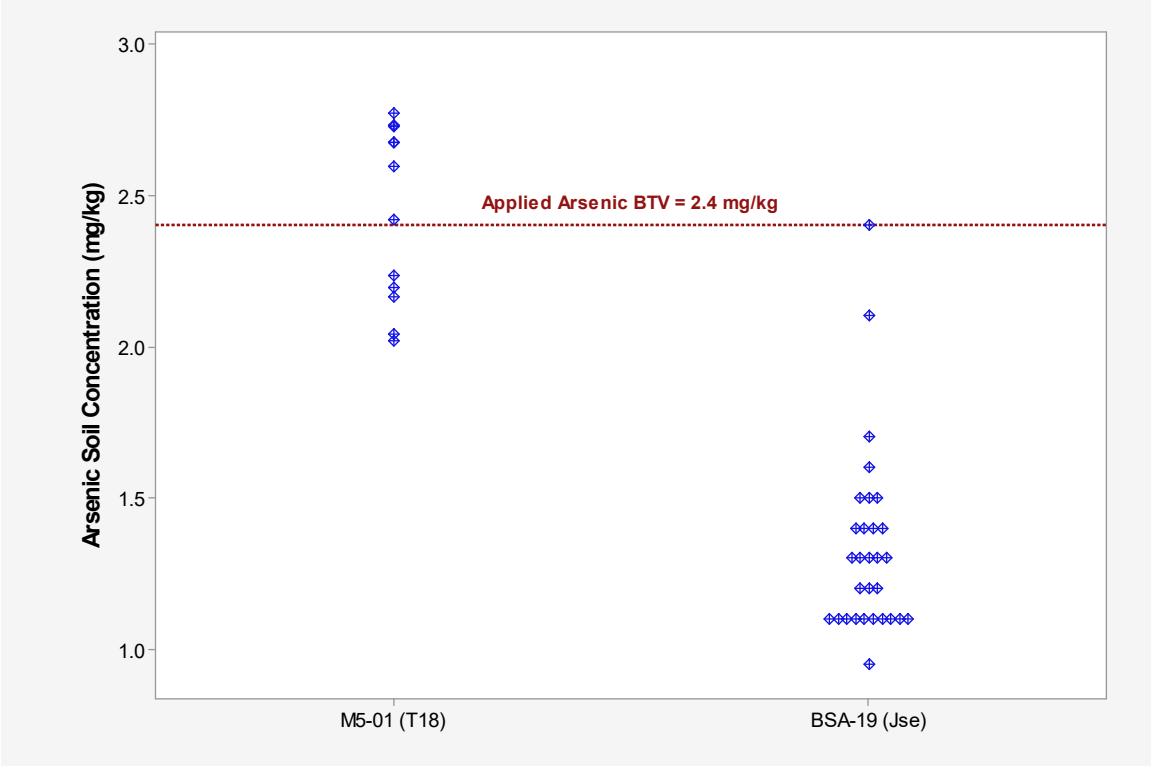


Figure I18-12. Individual Value Plot for Target M5-01 (T18) and BSA-19 (Jse) Arsenic Soil Concentrations

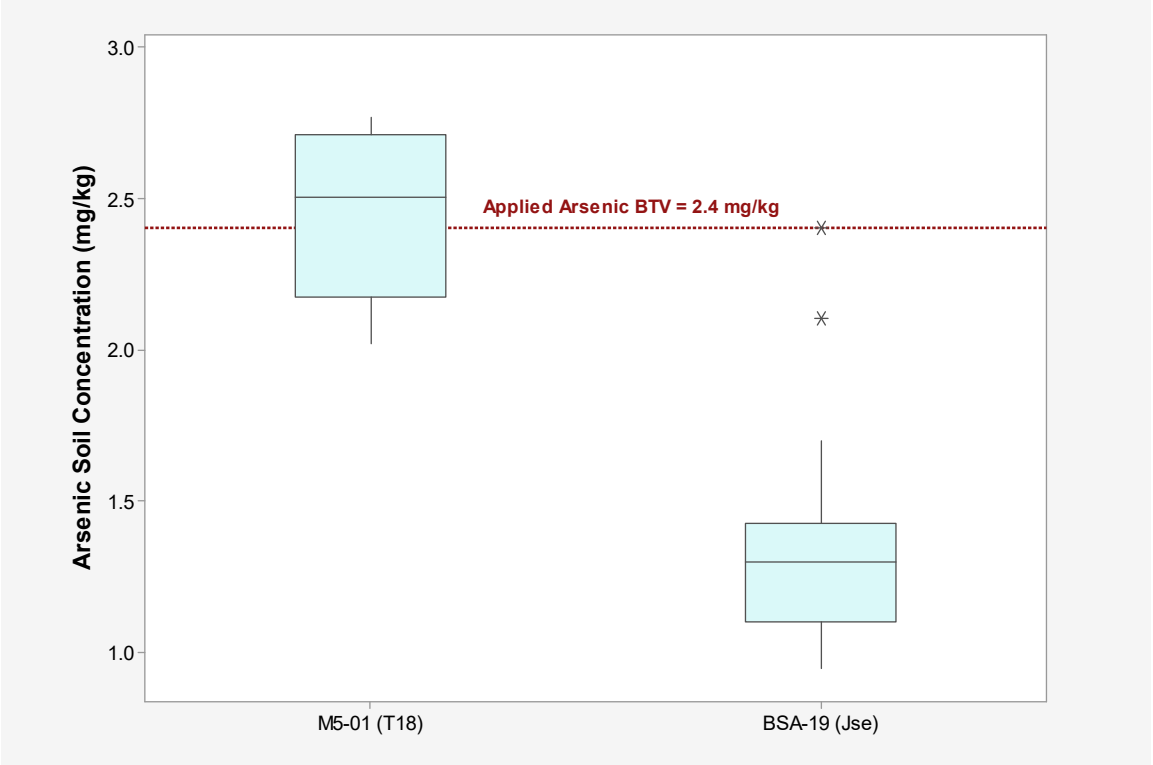
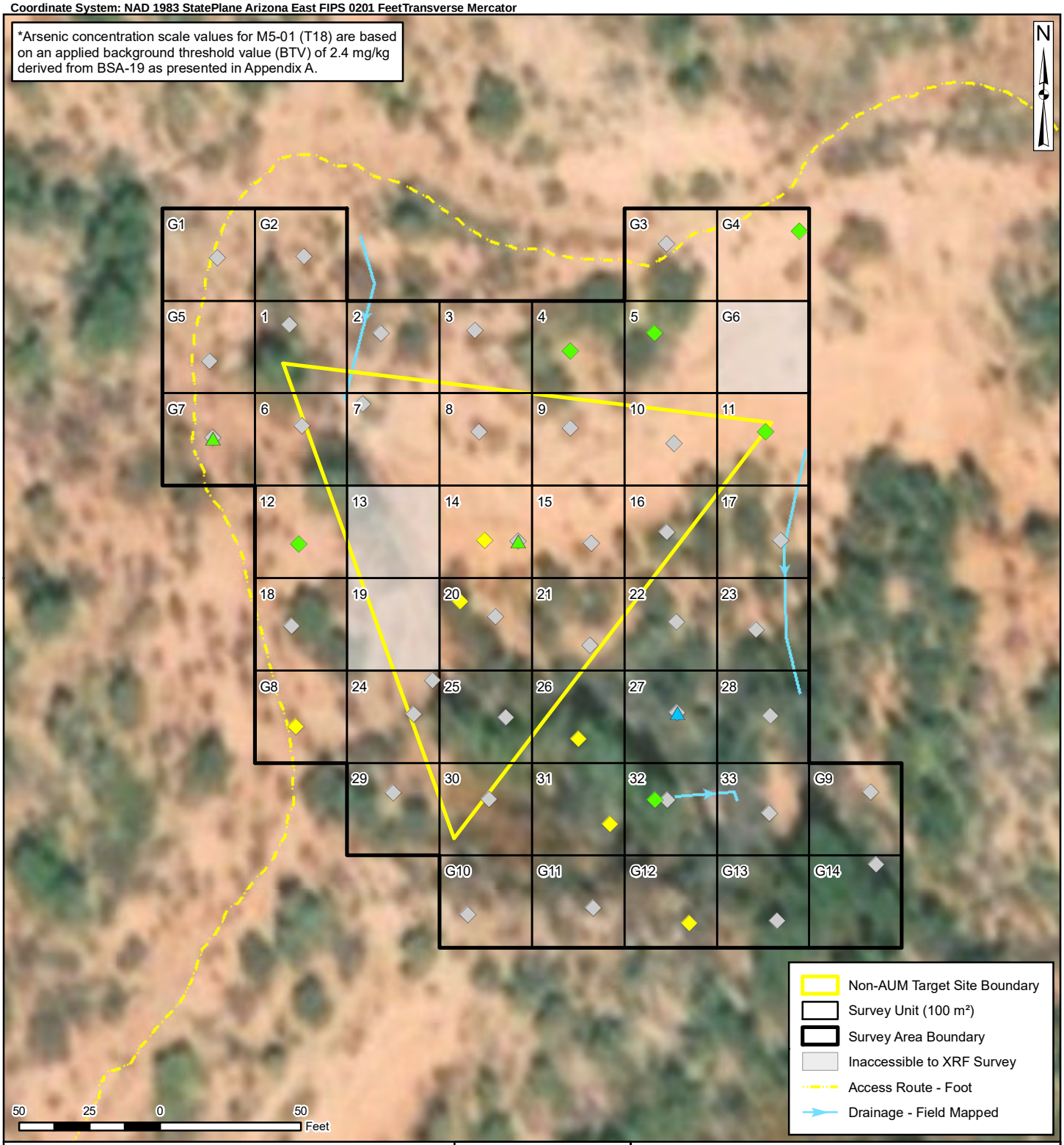


Figure I18-13. Box Plot for Target M5-01 (T18) and BSA-19 (Jse) Arsenic Soil Concentrations

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



Arsenic Concentration Scale (mg/kg)*

- ≤ 1.3
- 1.3 - 2.4
- 2.4 - 4.8
- 4.8 - 7.2
- 7.2 - 10
- 10 - 24
- ≥ 24
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

Prepared for: USEPA Region 9

Prepared By:

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NON-AUM TARGET M5-01 (T18) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I18-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.1.7.3 Lead

Lead was not identified as a COPC in surface soil as shown in Table I18-7. Lead did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for lead is 9.3 mg/kg for Target T18 as presented in Section 8.1.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I18-5 and Attachment I3, respectively. Figure I18-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T18 and BSA-19 (Jse) samples. Figure I18-16 presents a box plot of detectable lead XRF soil concentrations for Target T18 and BSA-19 (Jse) samples. Summary statistics for XRF measurements are provided in Section 8.1.6.1. Lead XRF concentrations measured in surface soils at Target T18 ranged between 2.4 and 7.3 mg/kg with an average and standard deviation of 5.1 mg/kg and 1.1 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T18 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I18-17. All lead results in surface soils were less than the applied BTV.

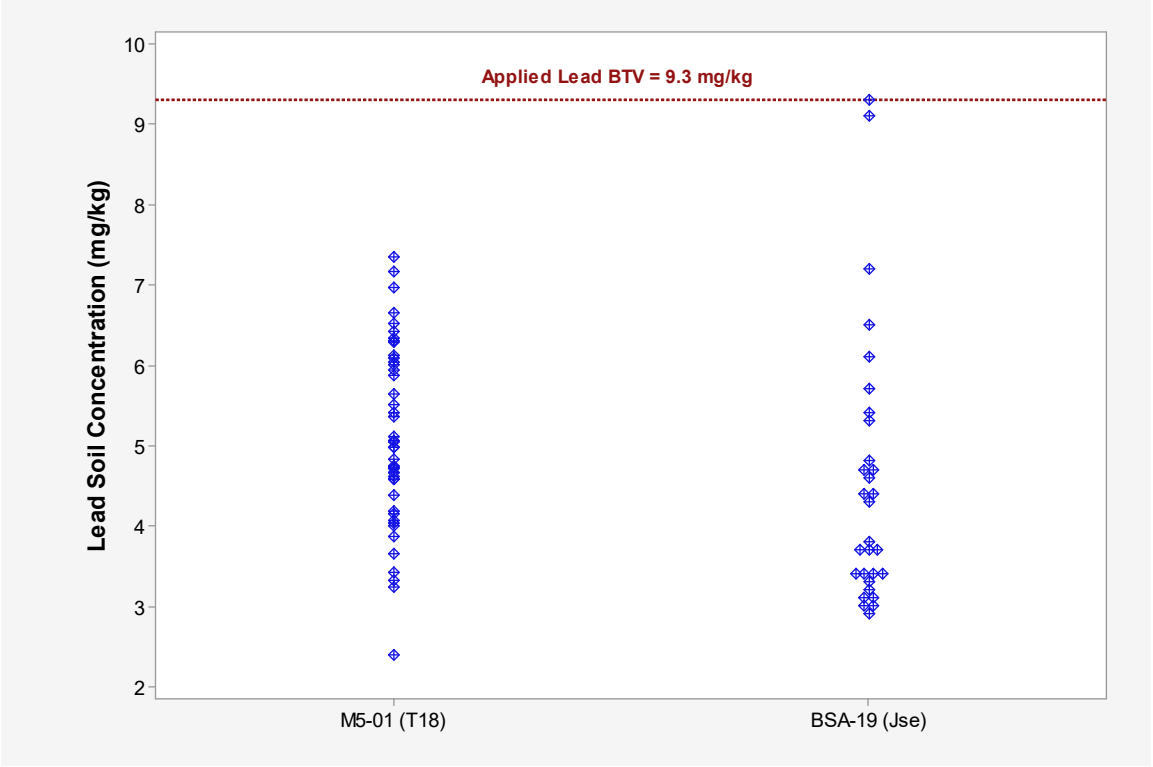


Figure I18-15. Individual Value Plot for Target M5-01 (T18) and BSA-19 (Jse) Lead Soil Concentrations

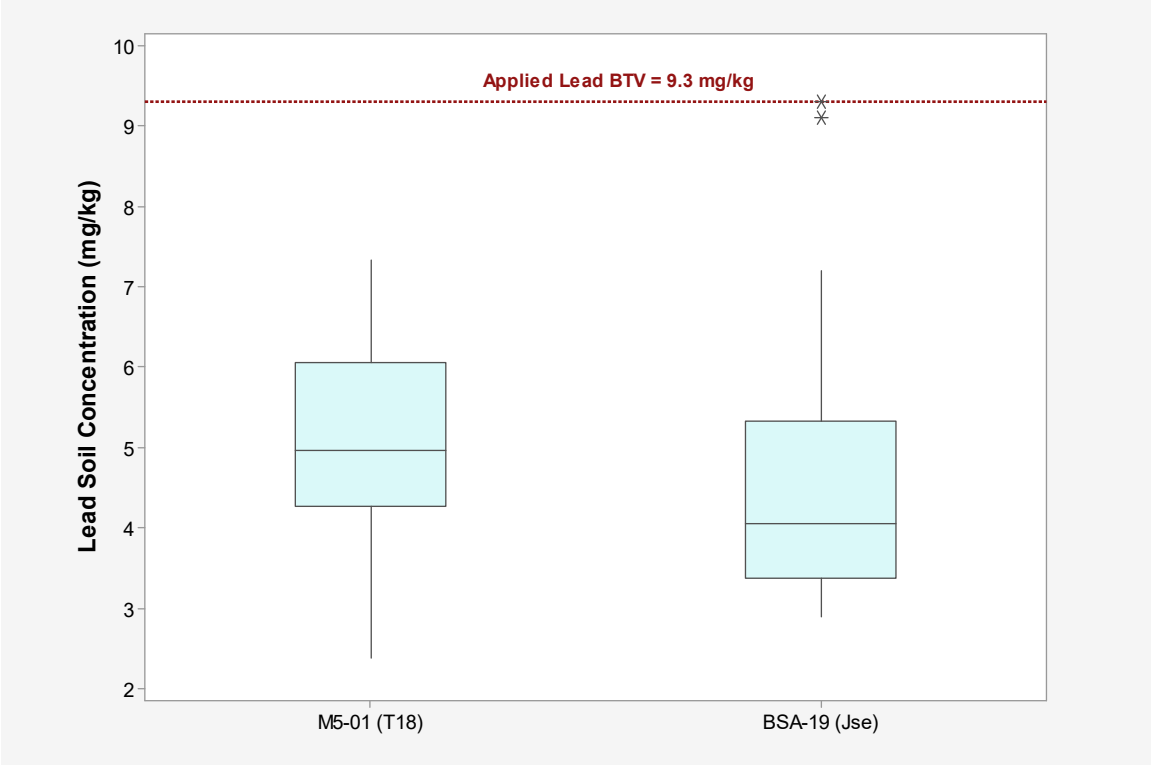
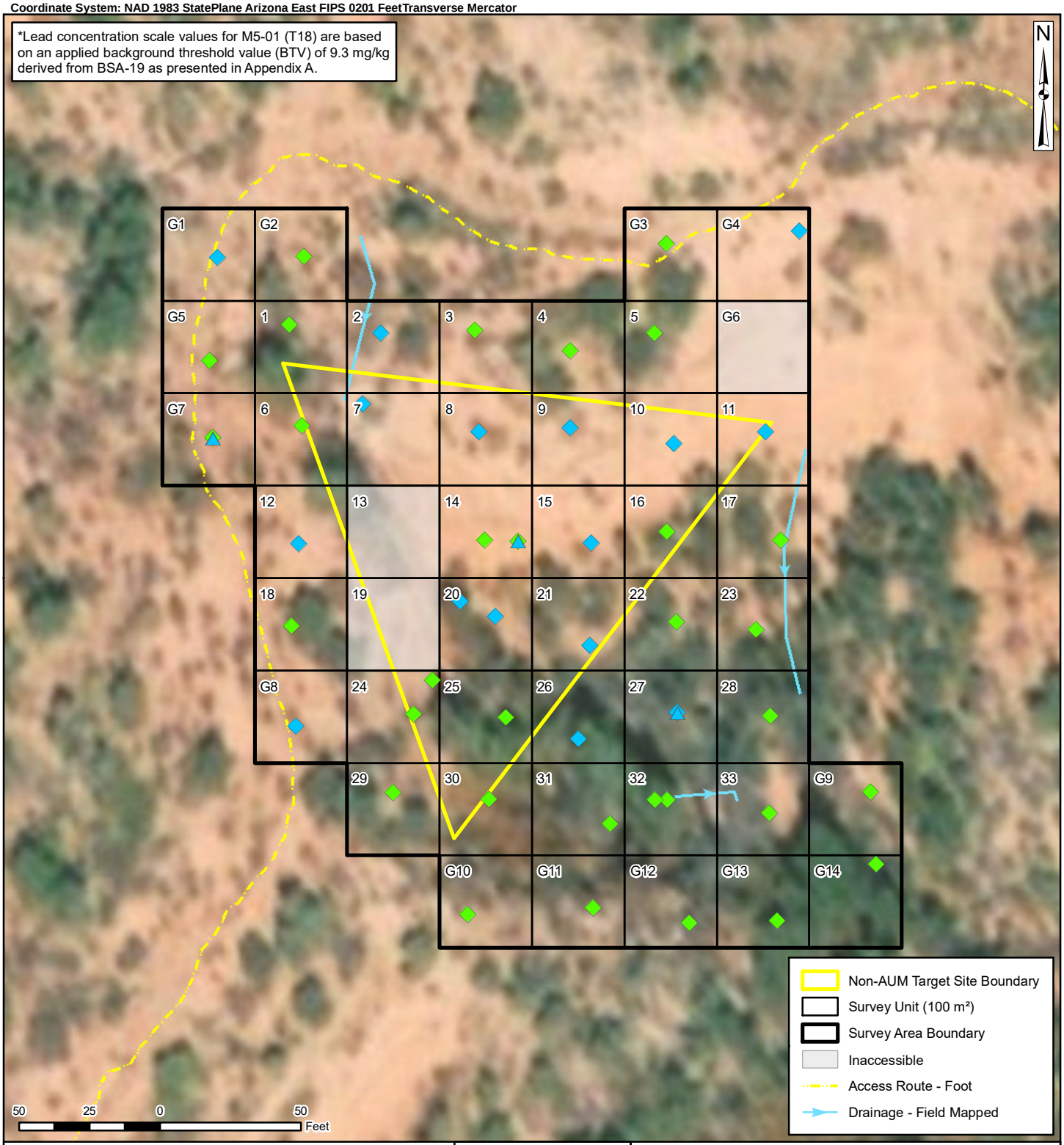


Figure I18-16. Box Plot for Target M5-01 (T18) and BSA-19 (Jse) Lead Soil Concentrations

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



Lead Concentration Scale (mg/kg)*

- ≤ 4.6
- 4.6 - 9.3
- 9.3 - 19
- 19 - 28
- 28 - 37
- 37 - 93
- ≥ 93

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

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NON-AUM TARGET M5-01 (T18) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I18-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.1.7.4 Thorium

Thorium was identified as a COPC in surface soil as shown in Table I18-7. Thorium exceeded the applied BTV in 26.5 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for thorium is 2.4 mg/kg for Target T18 as presented in Section 8.1.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I18-5 and Attachment I3, respectively. Figure I18-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T18 and BSA-19 (Jse) samples. Figure I18-19 presents a box plot of detectable thorium XRF soil concentrations for Target T18 and BSA-19 (Jse) samples. Summary statistics for XRF measurements are provided in Section 8.1.6.1. Thorium XRF concentrations measured in surface soils at Target T18 ranged between 1.1 and 3.5 mg/kg with an average and standard deviation of 2.1 mg/kg and 0.6 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T18 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I18-20. Overall, the majority of detectable thorium results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials Target T18.

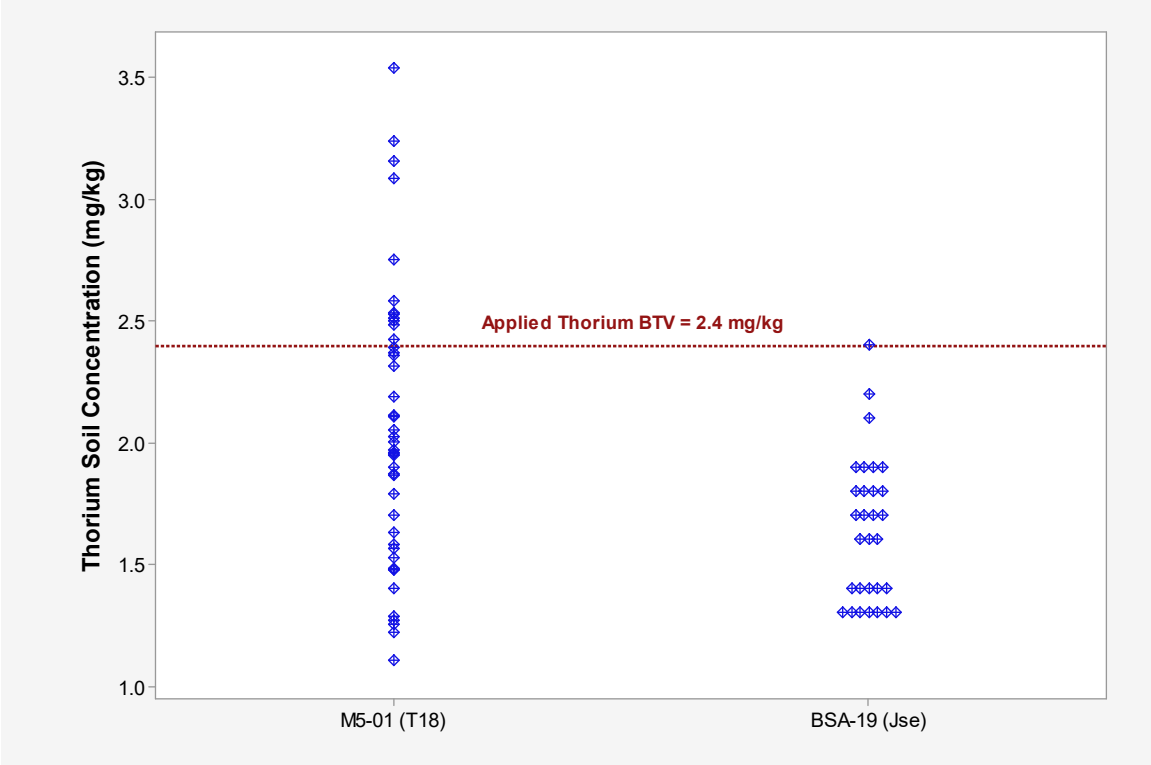


Figure I18-18. Individual Value Plot for Target M5-01 (T18) and BSA-19 (Jse) Thorium Soil Concentrations

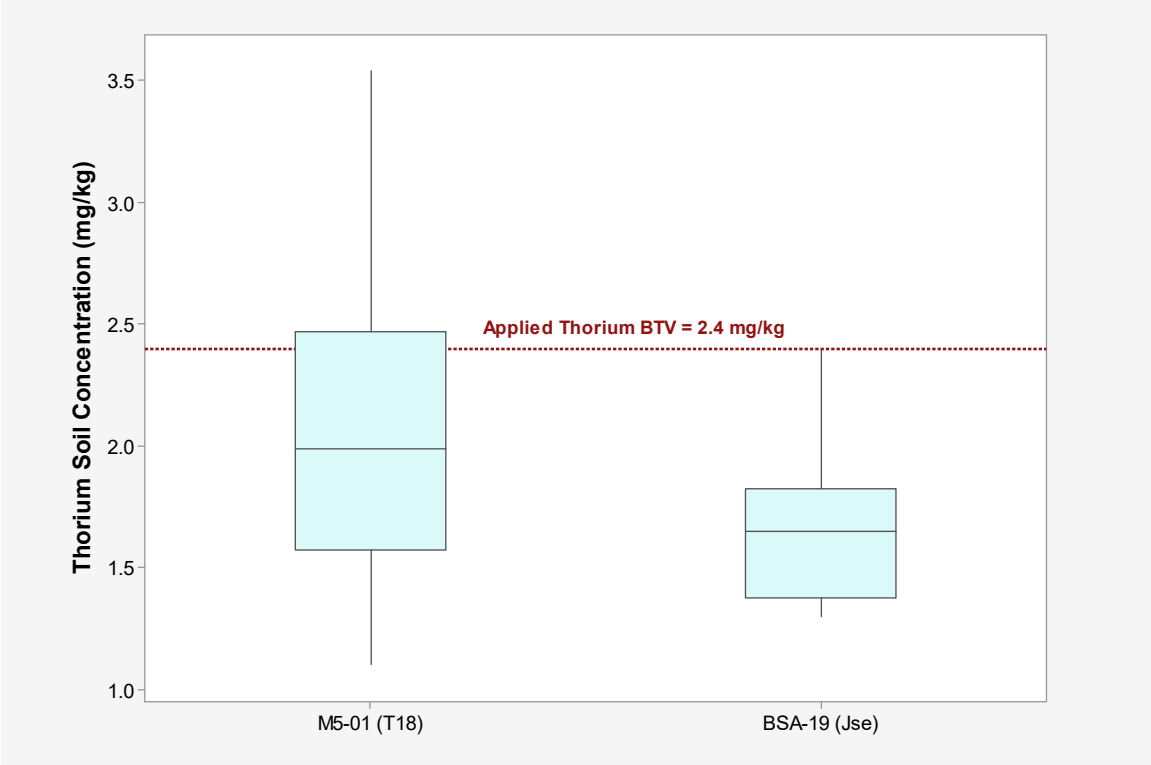
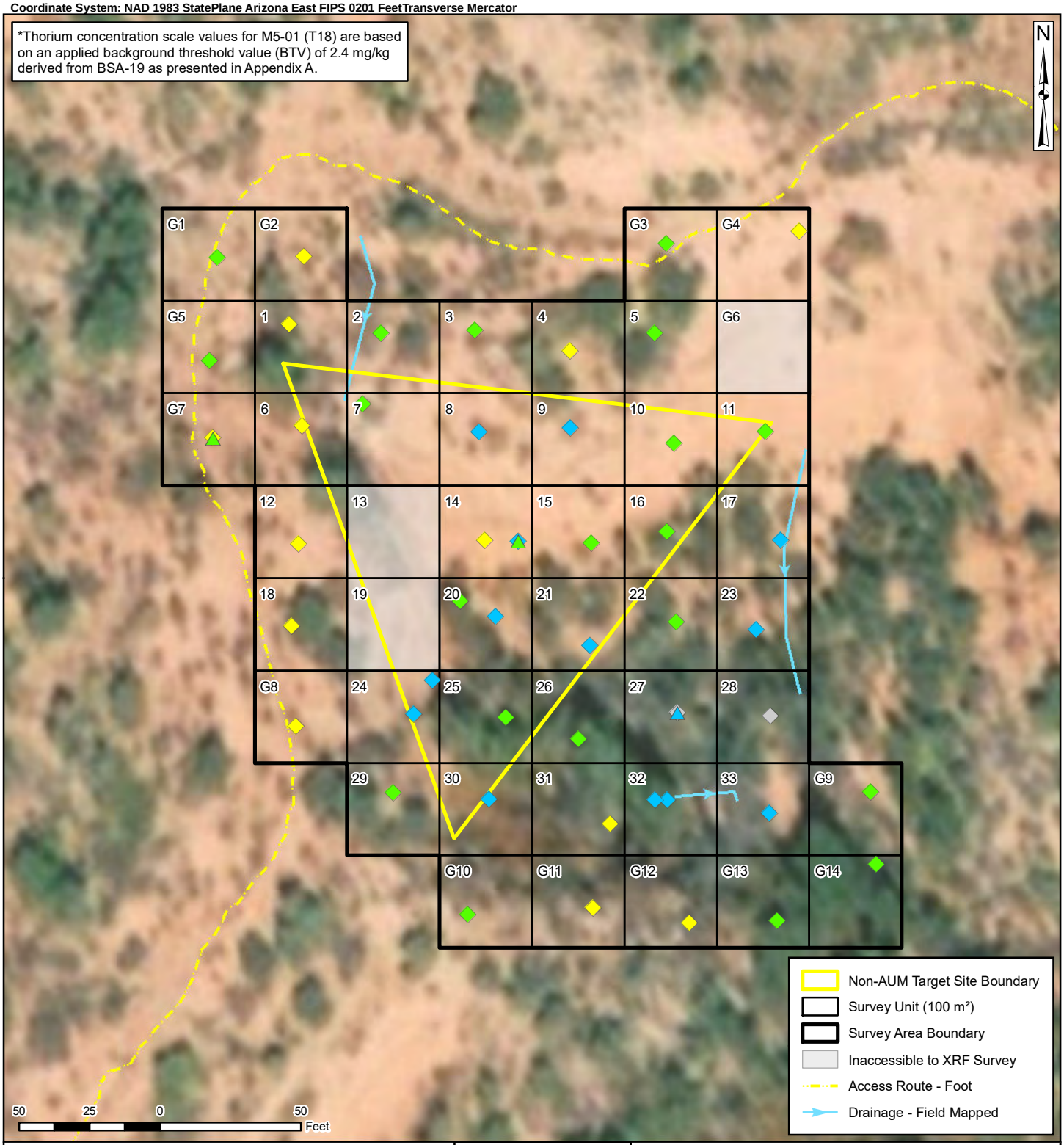


Figure I18-19. Box Plot for Target M5-01 (T18) and BSA-19 (Jse) Thorium Soil Concentrations

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



Thorium Concentration Scale (mg/kg)*

- ≤ 1.6
- 1.6 - 2.4
- 2.4 - 4.8
- 4.8 - 7.2
- 7.2 - 10
- 10 - 24
- ≥ 24
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

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NON-AUM TARGET M5-01 (T18) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I18-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.1.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I18-7. Uranium exceeded the applied BTV in 12.2 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for uranium is 1.3 mg/kg for Target T18 as presented in Section 8.1.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I18-5 and Attachment I3, respectively. Figure I18-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T18 and BSA-19 (Jse) samples. Figure I18-22 presents a box plot of detectable uranium XRF soil concentrations for Target T18 and BSA-19 (Jse) samples. Summary statistics for XRF measurements are provided in Section 8.1.6.1. Uranium XRF concentrations measured in surface soils at Target T18 ranged between 0.2 and 2.6 mg/kg with an average and standard deviation of 1.0 mg/kg and 0.6 mg/kg, respectively. The average uranium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T18 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I18-23. Overall, the majority of detectable uranium results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials Target T18.

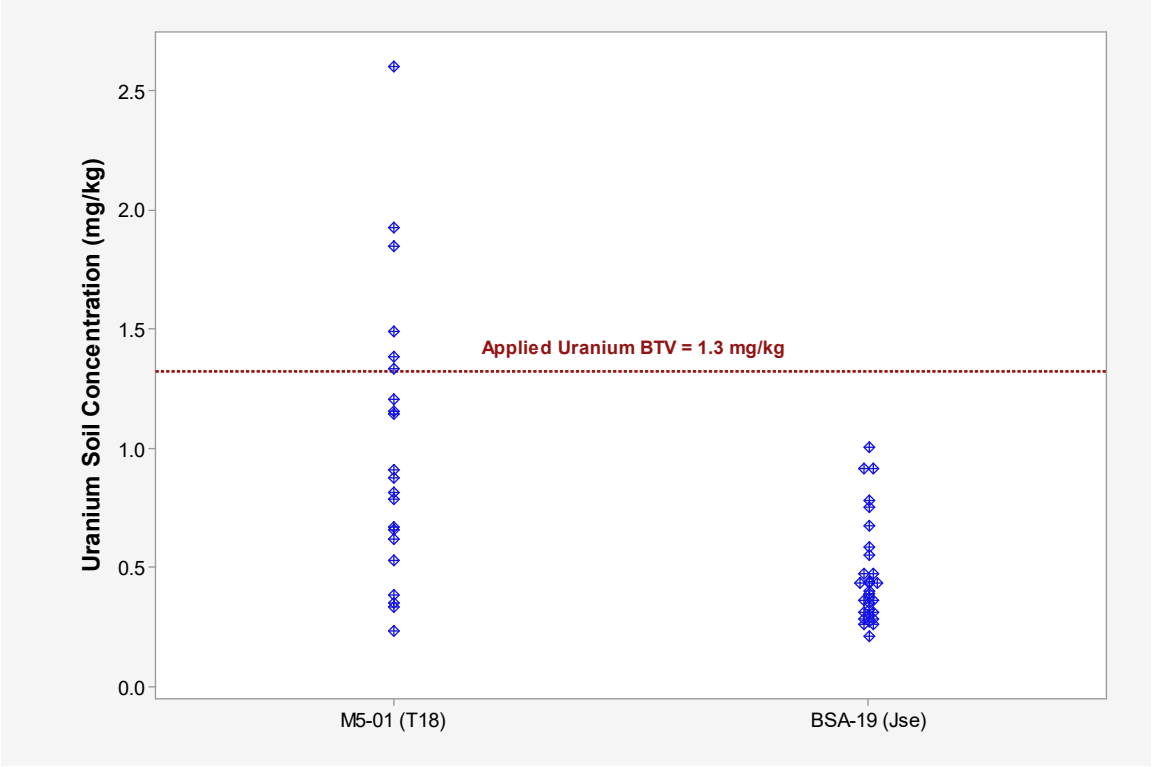


Figure I18-21. Individual Value Plot for Target M5-01 (T18) and BSA-19 (Jse) Uranium Soil Concentrations

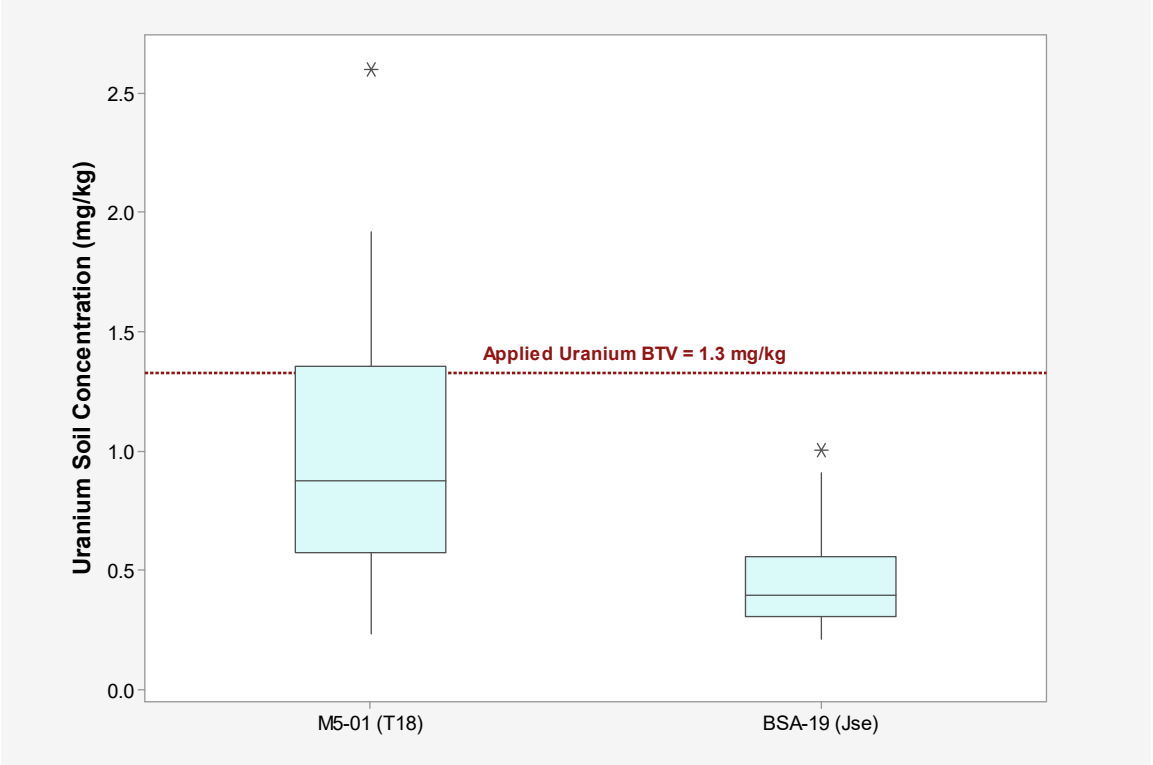
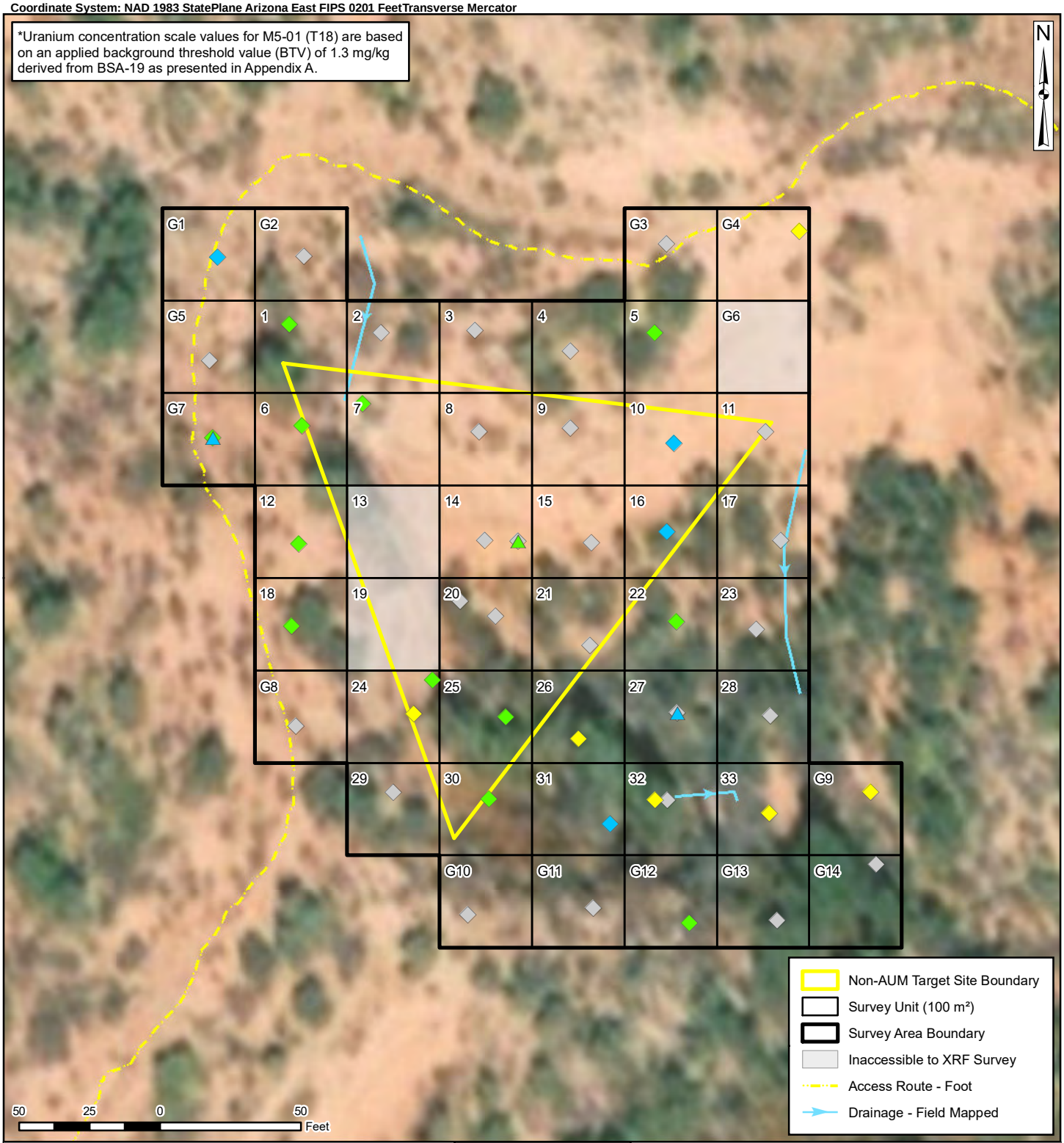


Figure I18-22. Box Plot for Target M5-01 (T18) and BSA-19 (Jse) Uranium Soil Concentrations

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



Uranium Concentration Scale (mg/kg)*

- ≤ 0.46
- 0.46 - 1.3
- 1.3 - 2.6
- 2.6 - 3.9
- 3.9 - 5.2
- 5.2 - 13
- ≥ 13
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

Prepared for: USEPA Region 9

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NON-AUM TARGET M5-01 (T18) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I18-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.1.7.6 Vanadium

Vanadium was not identified as a COPC in surface soils as shown in Table I18-7. Vanadium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for vanadium is 22 mg/kg for Target T18 as presented in Section 8.1.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I18-5 and Attachment I3, respectively. Figure I18-24 presents an individual value plot of detectable vanadium soil XRF concentrations for Target T18 and BSA-19 (Jse) samples. Figure I18-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T18 and BSA-19 (Jse) samples. Summary statistics for XRF measurements are provided in Section 8.1.6.1. Vanadium XRF concentrations measured in surface soils at Target T18 ranged between 16.3 and 19.9 mg/kg with an average and standard deviation of 15.5 mg/kg and 3.0 mg/kg, respectively. The average vanadium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T18 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I18-26. All vanadium results in surface soils were less than the applied BTV.

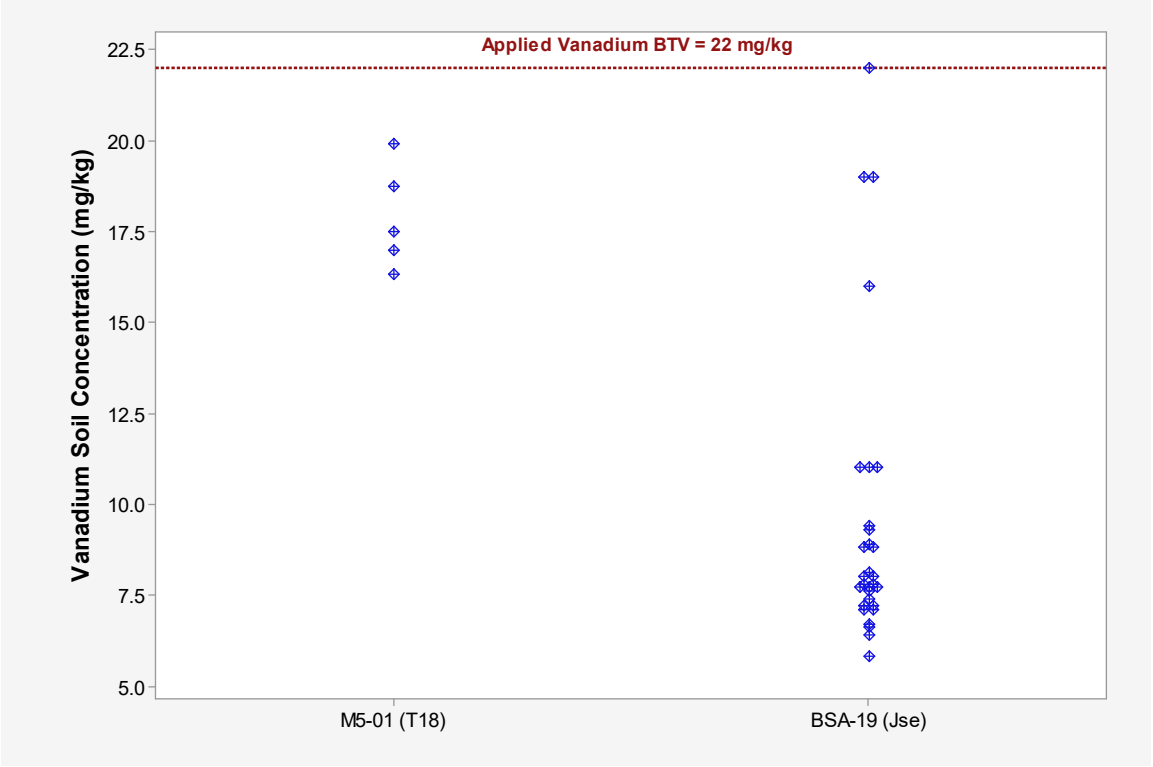


Figure I18-24. Individual Value Plot for Target M5-01 (T18) and BSA-19 (Jse) Vanadium Soil Concentrations

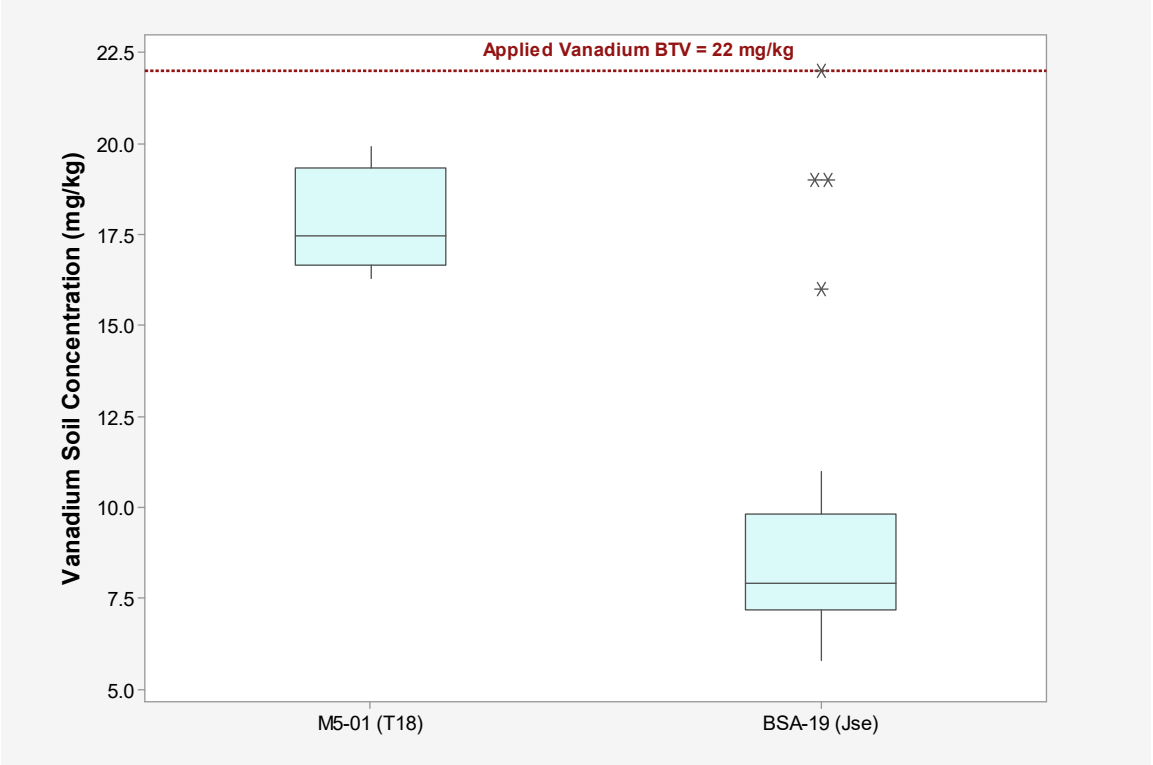
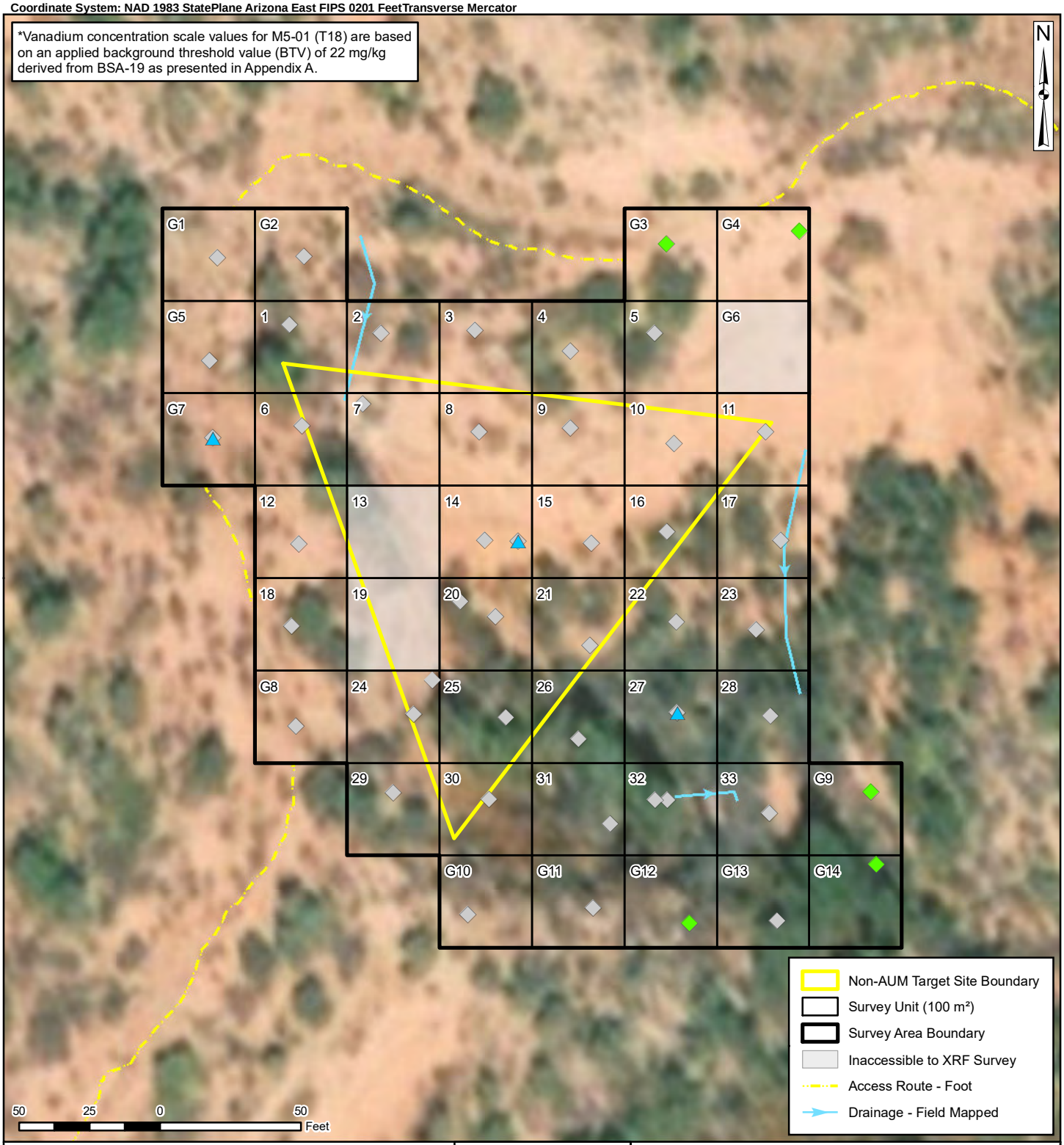


Figure I18-25. Box Plot for Target M5-01 (T18) and BSA-19 (Jse) Vanadium Soil Concentrations

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



Vanadium Concentration Scale (mg/kg)*

- ≤ 9.5
- 9.5 - 22
- 22 - 44
- 44 - 66
- 66 - 88
- 88 - 220
- ≥ 220
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

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NON-AUM TARGET M5-01 (T18) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I18-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.1.8 Conclusions

Target T18 (M5-01) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T18. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T18 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T18. ASPECT gamma survey results generally correlated with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T18 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T18 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. However, grid averaged gamma measurements slightly exceeded the applied BTV in 1 of 47 survey units by a factor of 1.06.
- A total of 25 analytes were identified as occurring within the surface environment. Of these analytes, 7 were identified as COPCs. No COPCs exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T18 does not contain TENORM. No mining-related activities or features were observed in the field, and no historical exploratory borings, vents, or other mine openings were noted in the file review or during field observation. Outcropping of Jse was identified in the area of highest gamma activity, and the entire cliff face comprises NORM.
- Natural erosion of outcroppings may have increased the lateral extent of NORM.
- There are no immediate significant physical hazards present at Target T18.
- Access is by dirt road with a small four-wheel-drive vehicle followed by footpath.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No existing groundwater wells are documented within the vicinity of Target T18. No seeps or springs were observed during the RSE investigation.

- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T18. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No mine waste was observed at Target T18; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; no data gaps remain for Target T18.

8.2 NON-AUM TARGET T19 (M5-02)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T19 (M5-02).

8.2.1 Access, Physical Conditions, and Field Observations

Target T19 (M5-02) is grouped with two other non-AUM Targets: T18 (M5-01) and T20 (M5-03). Target T19 is in the Lukachukai Mountains Region in Subarea Group F within the Cove Chapter of the Navajo Nation and accessed by four-wheel-drive vehicle off of Indian Route 33. Target T19 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. No residential structures are near the Target. A Target location and access map for Target T19 is shown in Figure I19-1.

A topographical relief map for Target T19 and associated AUM areas is provided in Figure I19-2. The elevation at Target T19 ranges from 7,240 to 7,301 feet amsl with an average of 7,273 feet amsl. The slope at Target T19 ranges from 10 to 38 percent with an average of 25 percent. Target T19 is entirely within the Jse and located within soil type Hozho-Quezcan-Rock outcrop complex (MUSYM 413) primarily and within the Arabrab-Wetherill complex (MUSYM 414) partly (Figures I-22 and I-23).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T19. Weston did not conduct a background study for Target T19. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 23 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T19:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T19 is accessible directly from the main Mesa V access road off of Indian Route 33.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  Outcrops of Jse, which contain NORM, were present. TENORM was not observed.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  No drainages were observed at the Target. The Middle 1 drainage is located 0.8 mile southeast of the Target and discussed in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

  No exploratory borings were identified. Indian Route 33 is located at the bottom of the Target area.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  Road construction, involving widening and installing water control ditches, occurred during the RSE field investigation, and disturbed material soil was relocated to the middle of the Target area. Additional NORM-bearing geology may have been exposed.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T19 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Section 2.3 and 8.2.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 8.2.3 with results presented in Sections 8.2.6 and 8.2.7)
- Conducting a gamma radiation survey (results presented in Section 8.2.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped

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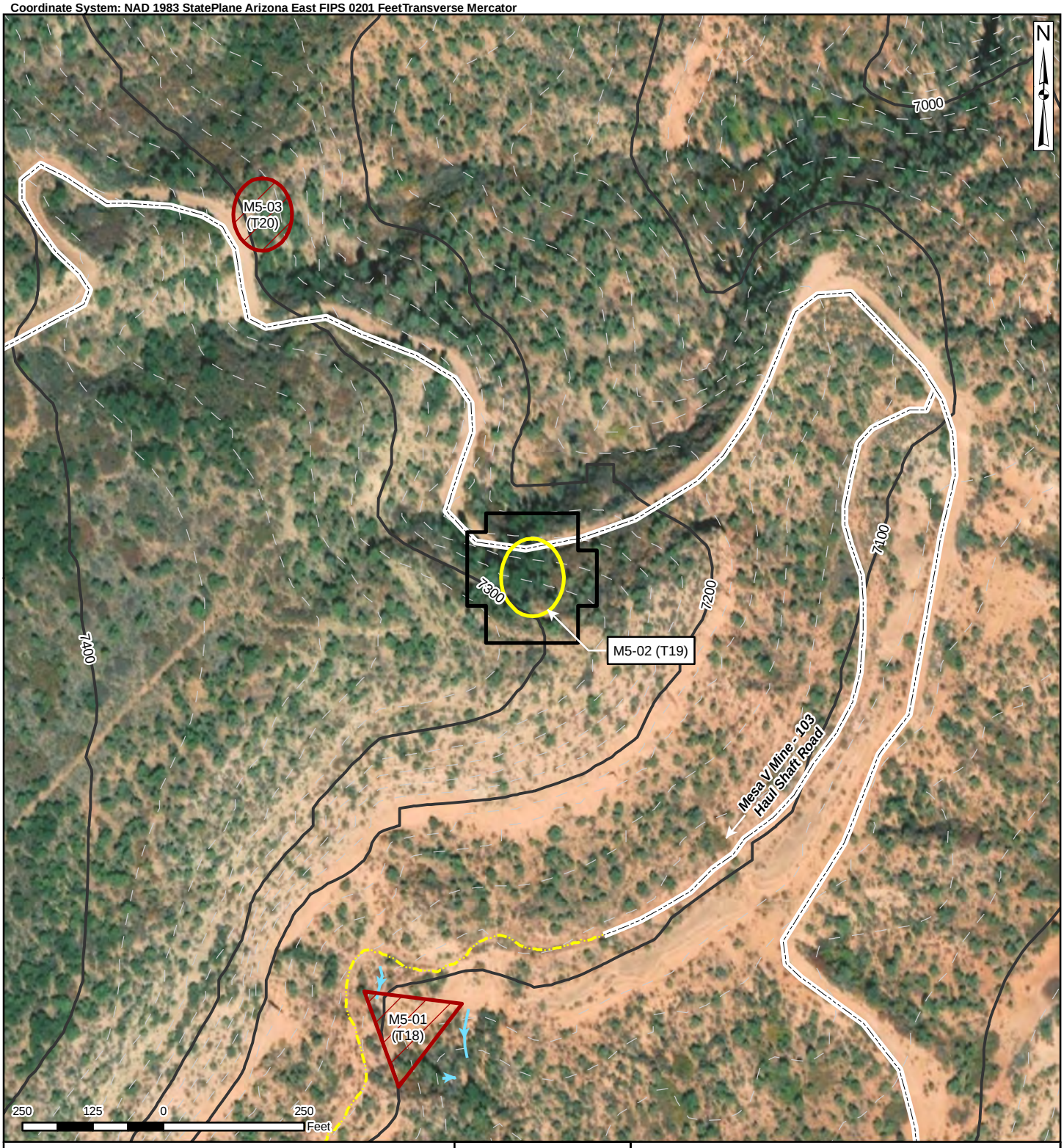
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NON-AUM TARGET M5-02 (T19) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I19-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped
100 ft Contour*
20 ft Contour*

* 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.

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NON-AUM TARGET M5-02 (T19) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I19-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.2.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I19-3) within the survey area of the non-AUM Target T19 as part of the Baseline Study in June 2018. Additional Goback gamma radiation surveys were performed in September 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T19 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I19-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 23, of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at 21 survey units. All gamma survey and XRF survey units were evaluated.

8.2.3 XRF Confirmation Sampling Overview

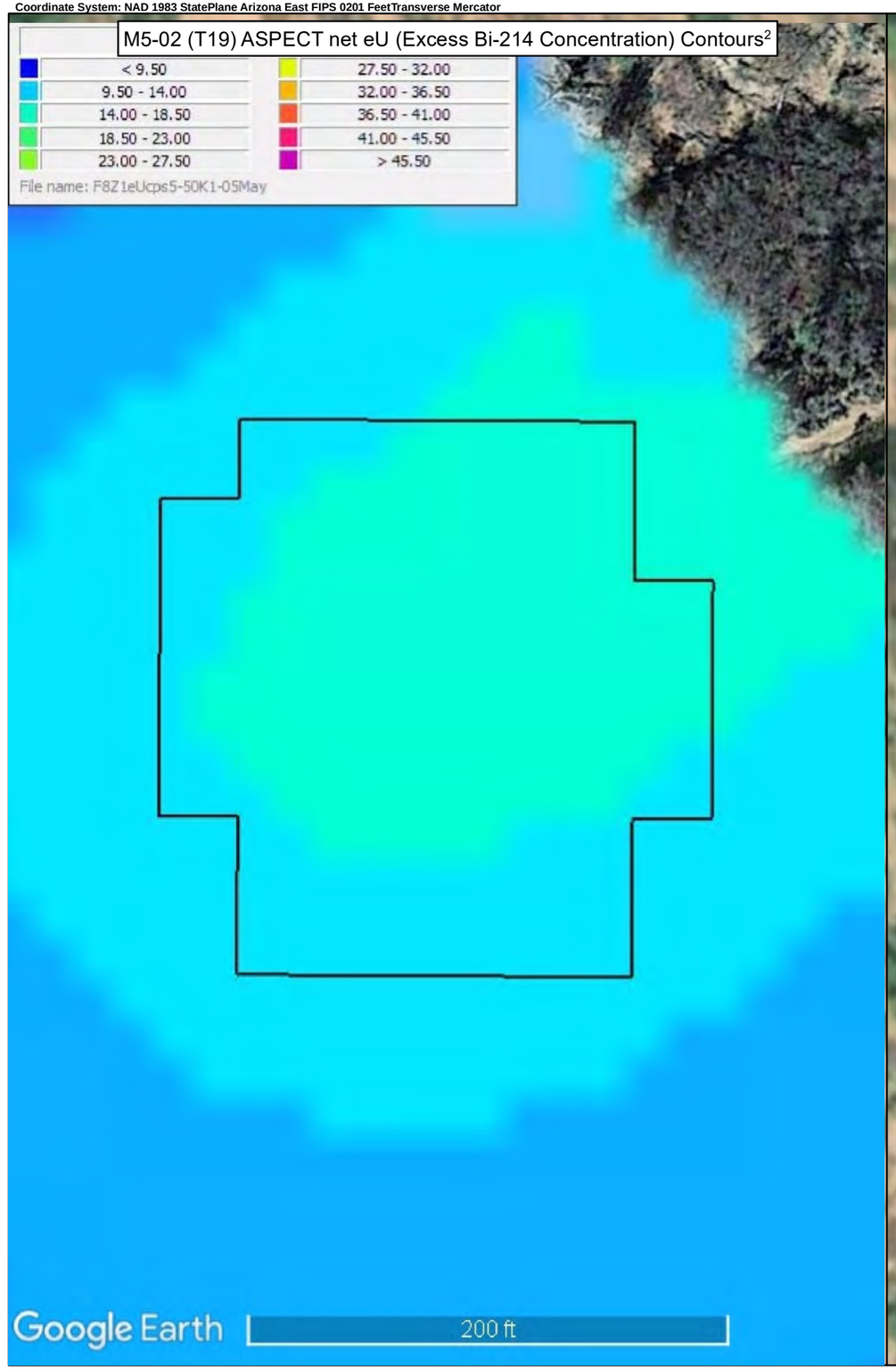
Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T19. One XRF soil confirmation sample was collected at a depth of 0 to 3 inches bgs from one location (Table I19-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I19-4 and I19-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table 19-2. The results of XRF confirmation sample analysis are provided in Section 8.2.6.1. Correlated XRF field measurements are provided in Attachment I3.

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

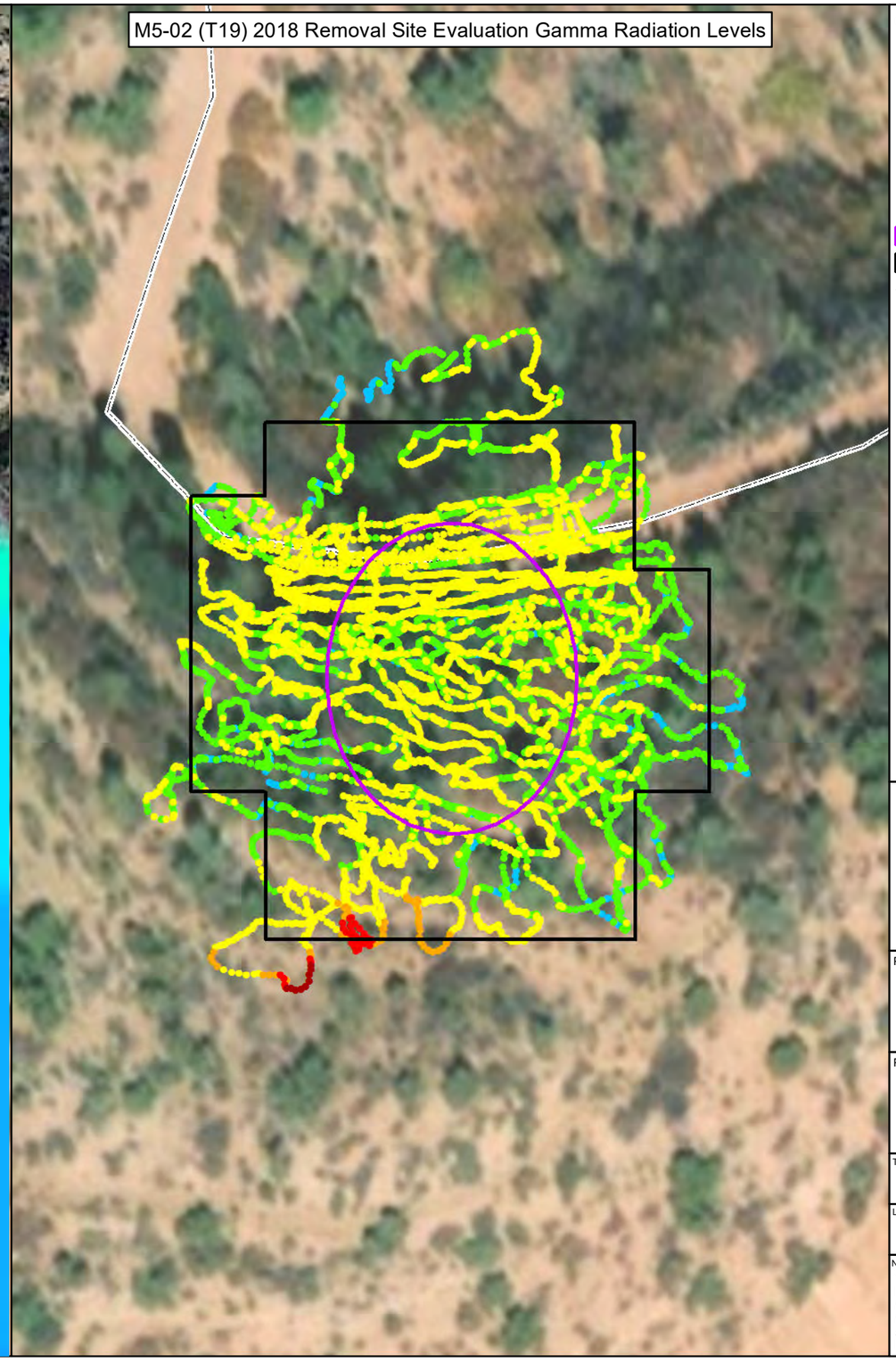
M5-02 (T19) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F8Z1eUcps5-50K1-05May



M5-02 (T19) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)[1]

≤ 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

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Vehicular

[1]The applied gamma background threshold value (BTV) for M5-02 (T19) Non-AUM Target is 11,319 cpm derived from BSA-19 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET M5-02 (T19) 2018 REMOVAL SITE EVALUATION AND ASPECT GAMMA RADIATION LEVELS SURVEY MAP

Prepared For:

Prepared By:

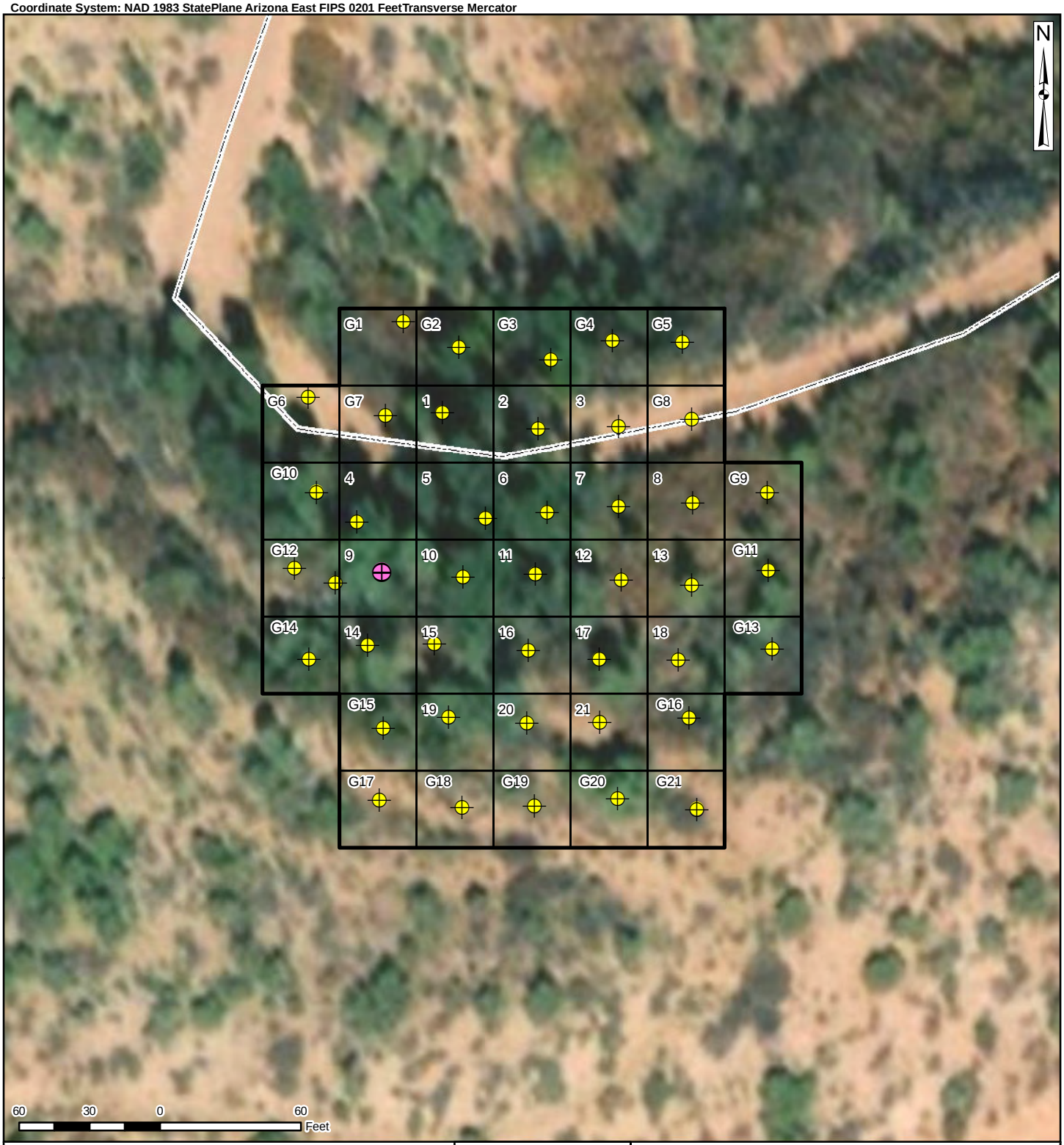
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/13/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborn Spectral Photometric Environmental Collection Technology.

Figure No.: **I19-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

Prepared for: USEPA Region 9

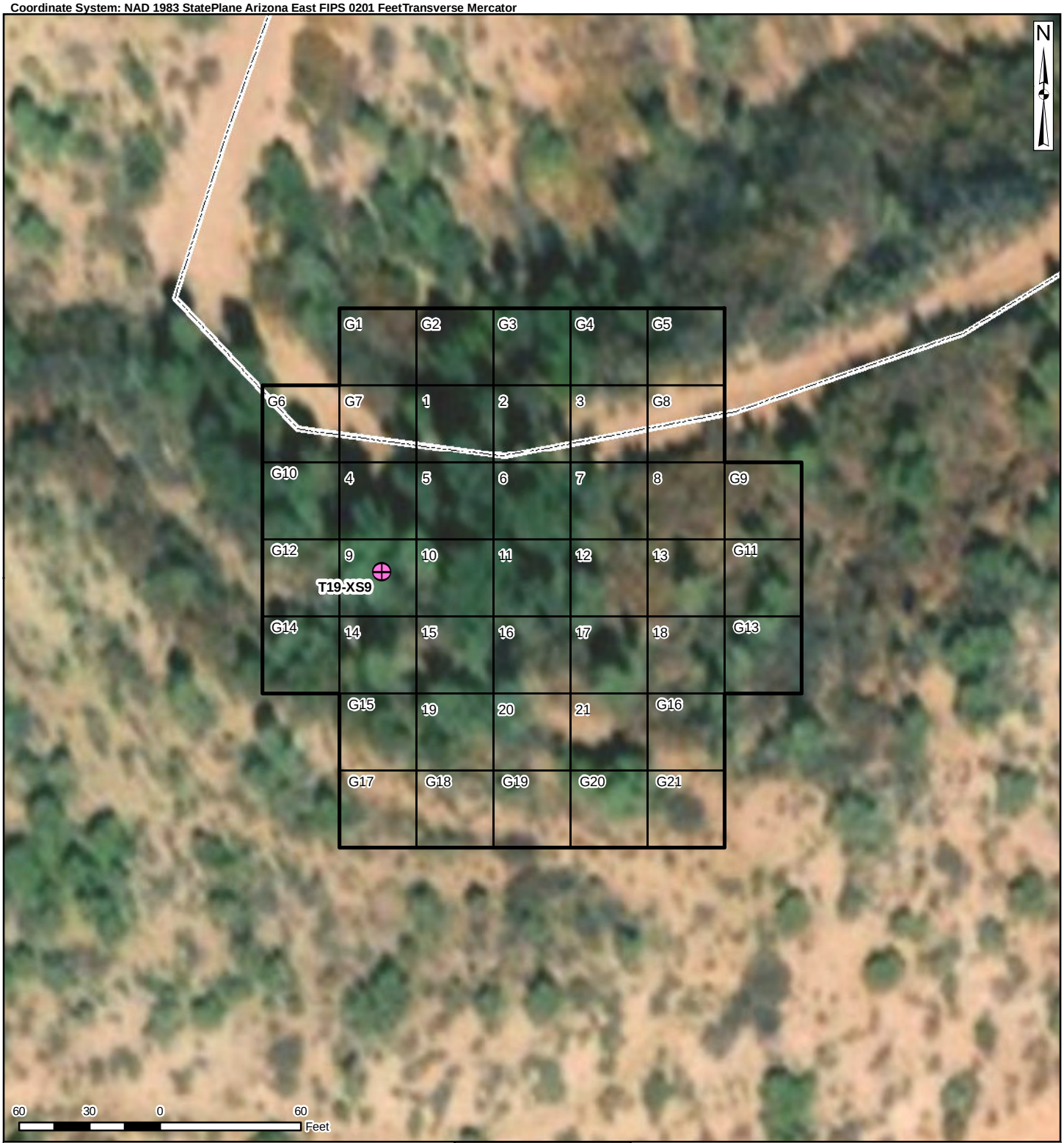
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NON-AUM TARGET M5-02 (T19)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I19-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

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



XRF Confirmation Soil Sample*
(0 - 3 inches bgs)

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

*T19-XS9 = site T19 XRF confirmation soil sample collected at survey unit 9. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET M5-02 (T19)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I19-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

Table I19-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-02 (T19)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T19-XS9-01-091118	9	0-3	XRF Confirmation	Primary	9/11/2018	36.5429710	-109.2394652	1809473-36, 1809474-36

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I19-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-02 (T19)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

8.2.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 8.2.1, Target T19 surface geology is entirely within Jse with soils within the Hozho-Quezcan-Rock outcrop complex (MUSYM 413) (Figures I-22 and I-23). As a result, BSA-19 was selected for that combination of geology and soil type. Additionally, the Jse regional geological background would also be applicable for this Target. Table I19-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T19. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T19. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T19. The "Applied BTV" for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I19-3. Applied Background Threshold Values for Non-AUM Target M5-02 (T19)

Analyte	Units	Site-Specific BTV (BSA-19)	Regional BTV (Jse)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	6,410	7,400	6,410	Site-Specific BTV
Antimony	mg/kg	0.138	0.163	0.138	Site-Specific BTV
Arsenic	mg/kg	2.4	4.8	2.4	Site-Specific BTV
Barium	mg/kg	241	166	166	Regional BTV
Beryllium	mg/kg	0.46	0.51	0.46	Site-Specific BTV
Cadmium	mg/kg	0.150	0.160	0.150	Site-Specific BTV
Calcium	mg/kg	25,300	36,000	25,300	Site-Specific BTV
Chromium	mg/kg	7.4	11	7.4	Site-Specific BTV
Cobalt	mg/kg	3.2	4.4	3.2	Site-Specific BTV
Copper	mg/kg	13	11	11	Regional BTV
Iron	mg/kg	5,830	8,000	5,830	Site-Specific BTV
Lead	mg/kg	9.3	12	9.3	Site-Specific BTV
Lithium	mg/kg	18	13	13	Regional BTV
Magnesium	mg/kg	7,240	7,000	7,000	Regional BTV
Manganese	mg/kg	264	500	264	Site-Specific BTV
Mercury	mg/kg	0.0407	0.0298	0.0298	Regional BTV
Molybdenum	mg/kg	0.20	0.34	0.20	Site-Specific BTV
Nickel	mg/kg	4.9	11	4.9	Site-Specific BTV
Potassium-40	pCi/g	20.2	23.7	20.2	Site-Specific BTV
Radium-226	pCi/g	1.57	4.15	1.57	Site-Specific BTV
Radium-228	pCi/g	-	0.84	0.84	Regional BTV
Selenium	mg/kg	0.84	0.98	0.84	Site-Specific BTV
Silver	mg/kg	0.019	0.055	0.019	Site-Specific BTV
Sodium	mg/kg	43	36	36	Regional BTV
Thallium	mg/kg	0.046	0.091	0.046	Site-Specific BTV
Thorium	mg/kg	2.4	3.6	2.4	Site-Specific BTV
Uranium	mg/kg	1.3	3.4	1.3	Site-Specific BTV
Vanadium	mg/kg	22	31	22	Site-Specific BTV
Zinc	mg/kg	28	28	28	Regional BTV
Gamma Radiation	cpm	11,319	15,781	11,319	Site-Specific BTV

Notes:
- No BTV
BSA Background Study Area
BTV background threshold value
cpm counts per minute
Jse Summerville, Entrada Formation (Undifferentiated)
mg/kg milligrams per kilogram
pCi/g picocuries per gram

8.2.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T19 and the raw gamma radiation and grid averaged gamma radiation survey results.

8.2.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T19 in June 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in September 2018 to collect data within the Goback survey units. The applied gamma BTV for non-AUM Target T19 is 11,319 cpm. A total of 8,494 measurements were collected as part of the gamma radiation survey at non-AUM Target T19 across 42 survey units. Because of thick vegetation and steep slopes, not all survey units were scanned at 100 percent density. An average scan density of 202 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I19-4.

Table I19-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-02 (T19)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,319	
Measurements	#	8,494	42
Minimum	cpm	7,330	10,352
Maximum	cpm	42,931	19,544
Average	cpm	11,675	11,701
Median	cpm	11,319	11,366
Standard Deviation	cpm	2,188	1,632
90th Percentile	cpm	13,557	12,443
95th Percentile	cpm	14,534	15,034
99th Percentile	cpm	18,312	17,830
Measurements per Grid	#/grid	202	
Measurements Above Gamma BTV	#	4,246	23
Measurements Above Gamma BTV	%	50.0	54.8

Notes:
BTV background threshold value
cpm counts per minute

8.2.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 50 percent of the measurements within the Target boundaries, in some cases exceeding greater than four times the applied gamma BTV (11,319 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-19 (Jse) gamma survey results is provided on Figure I19-6. This graph shows that the spread of radiation data at Target T19 (shown on left) begins above the middle range of BSA-19 (Jse) gamma levels (shown on right) and then rises to more than twice the top range for background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T19 is higher than the data cloud from the BSA-19 (Jse) data set. A box plot showing the quartiles of the data sets is provided in Figure I19-7. The box plot shows that the median of Target T19 radiation levels is higher than the median of the BSA-19 (Jse) data set and slightly higher than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I19-8. No mining activity was observed within the survey area of Target T19. In general, Target T19 has surficial gamma radiation levels above BSA-19 (Jse) levels across the majority of the Target area that increase to the south or upslope onto the uranium-bearing geology, indicating that the area of elevated gamma activity identified by the ASPECT gamma survey has been confirmed (Figures I19-3 and I19-8). No TENORM or mining-related activities were observed. Section 8.2.5.3 presents the grid averaged results of the gamma radiation survey.

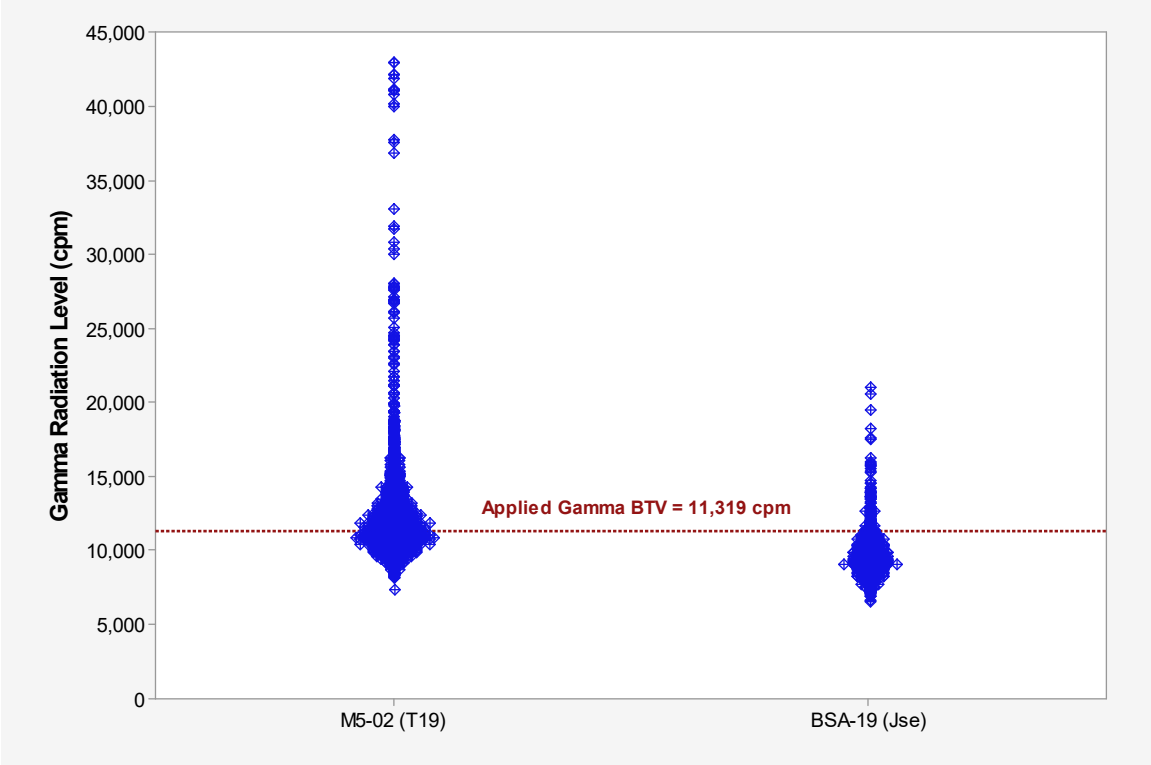


Figure I19-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M5-02 (T19) and BSA-19 (Jse)

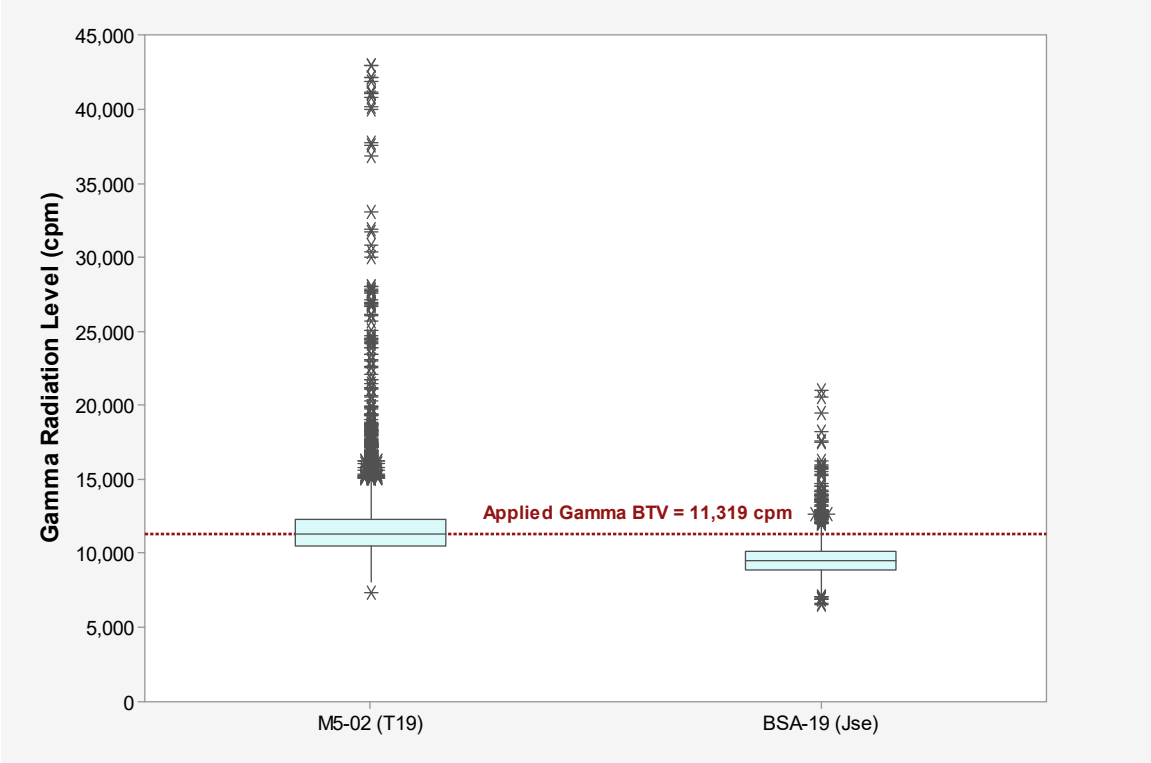
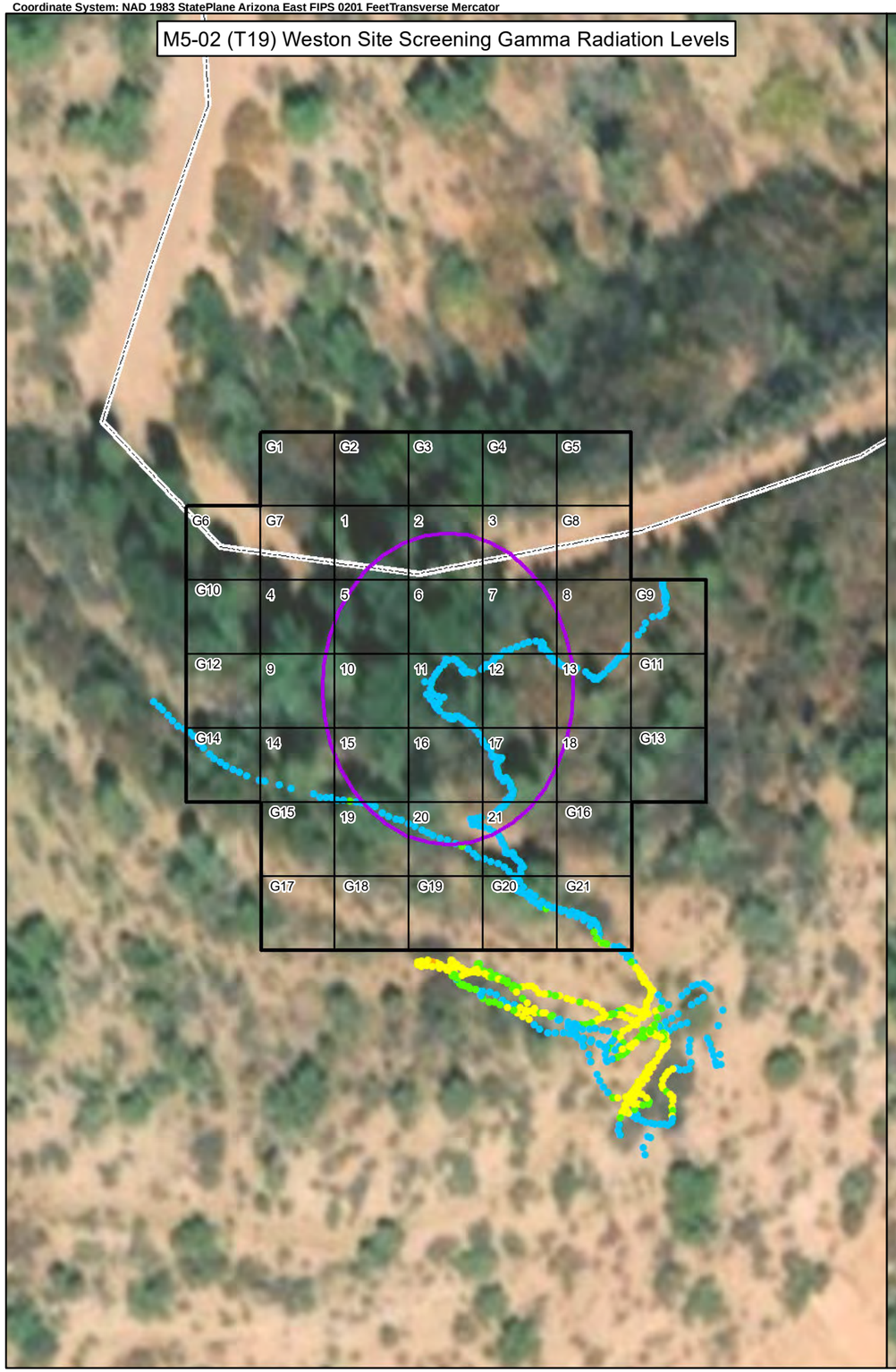
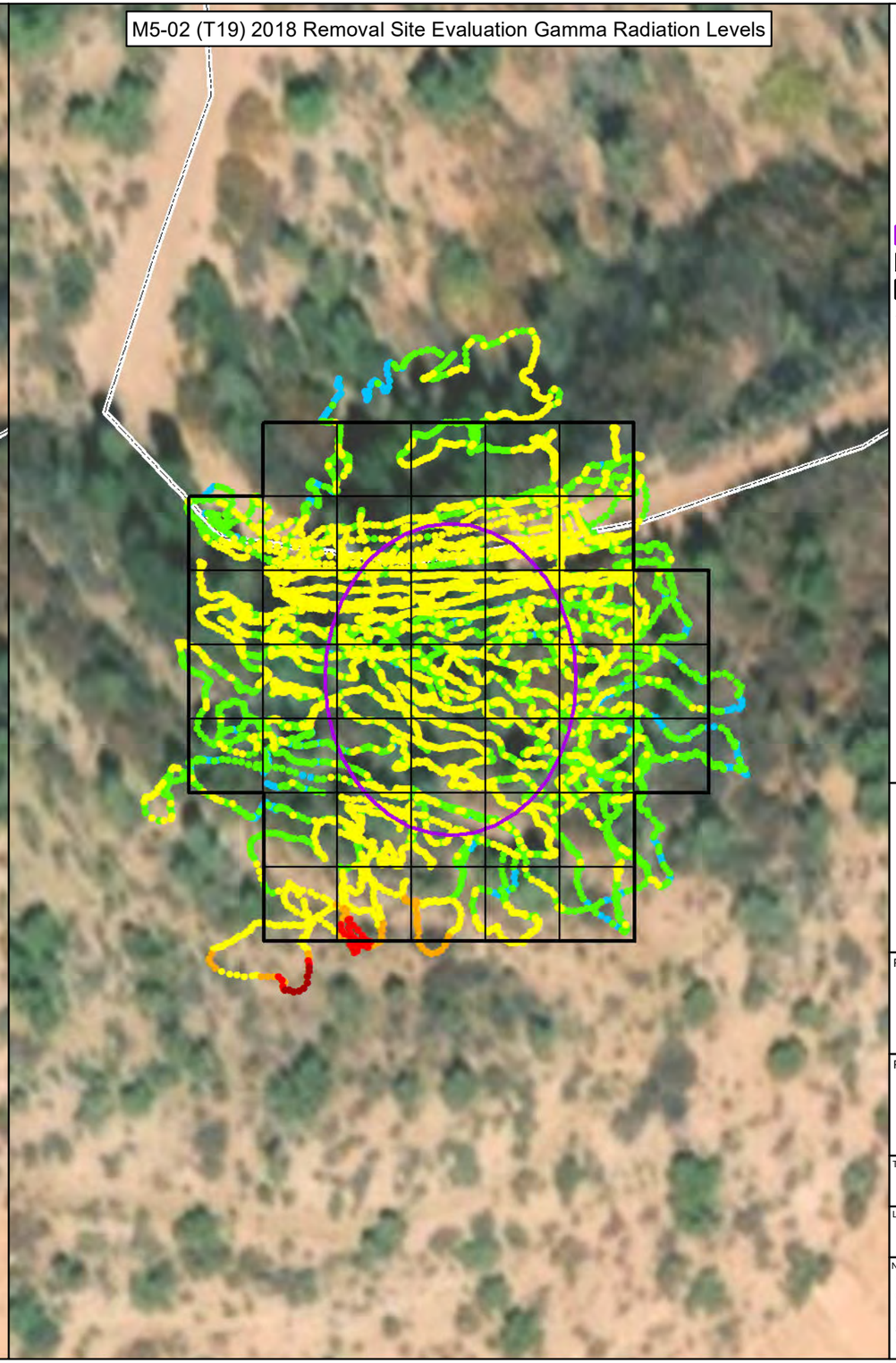


Figure I19-7. Box Plot of Raw Gamma Radiation Levels at Target M5-02 (T19) and BSA-19 (Jse)

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





Gamma Reading (cpm)*

≤ 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

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Access Route - Vehicular

1 in = 60 ft

1:720

N
W E
S

0 30 60 120 Feet

NON-AUM TARGET M5-02 (T19) 2018 REMOVAL SITE EVALUATION VS WESTON SITE SCREENING GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019

Notes:
*The applied gamma background threshold value (BTV) for M5-02 (T19) is 11,319 cpm derived from BSA-19 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I19-8**

8.2.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 8.2.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 8.2.5.1. Figure I19-9 and Figure I19-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-19 (Jse) data set (shown on right). A total of 54.8 percent of the survey units (23 of 42) within the survey area of Target T19 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I19-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I19-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. The elevated regions of the Target correspond with the uranium-bearing geology on the hillside, as well as exposure along the haul road.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 8.2.6.

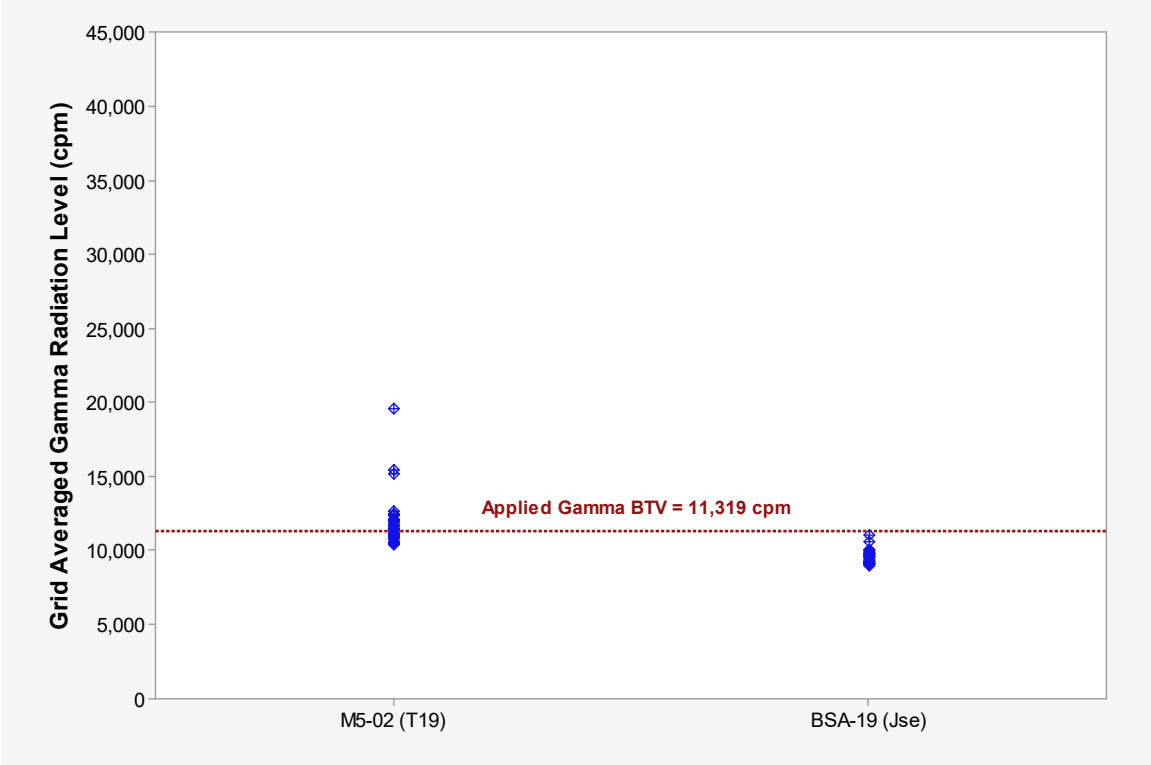


Figure I19-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-02 (T19) and BSA-19 (Jse)

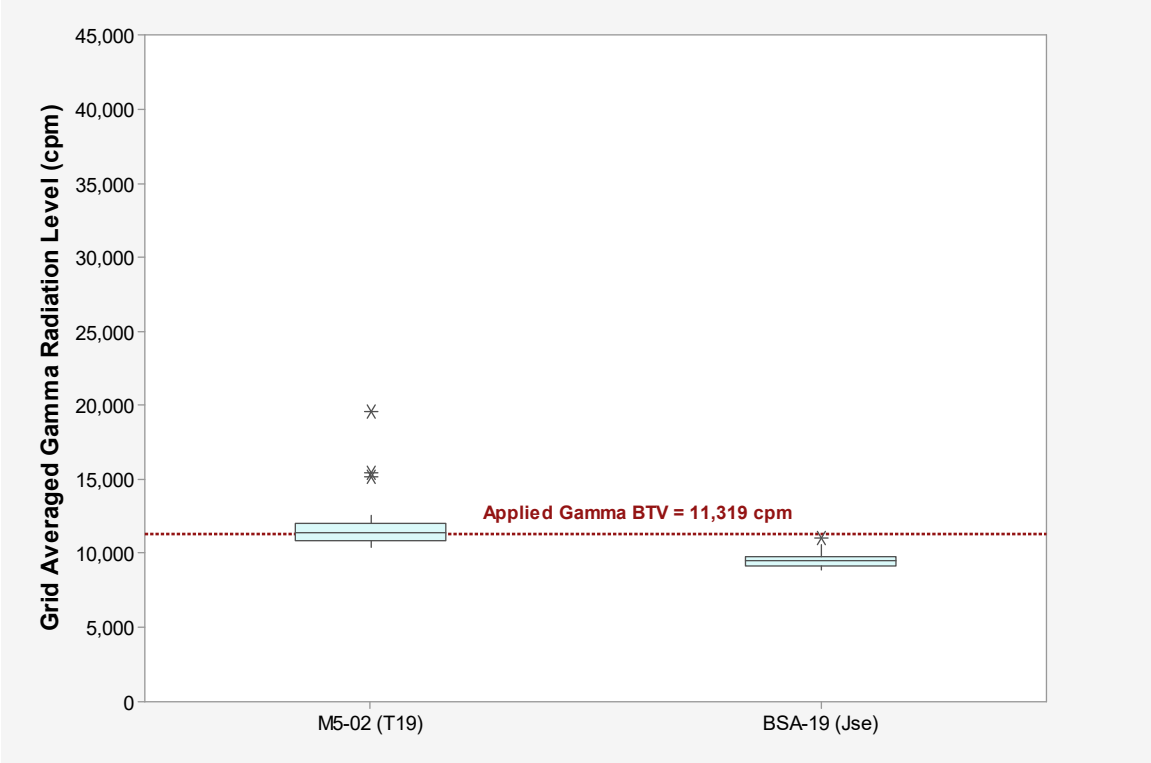
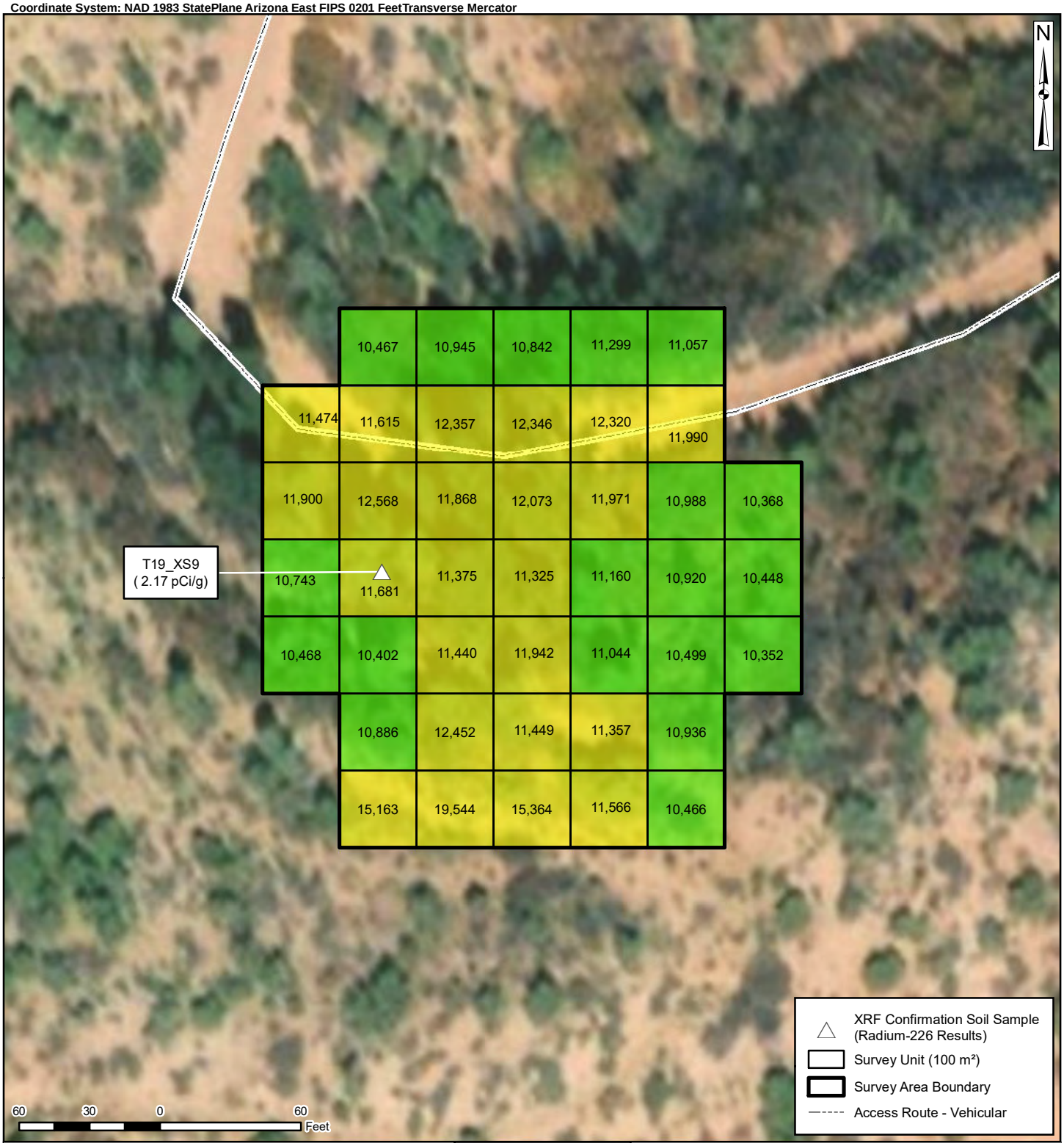


Figure I19-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-02 (T19) and BSA-19 (Jse)

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



Grid Averaged Gamma Reading (cpm)*

≤ 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

*The applied gamma background threshold value (BTV) for M5-02 (T19) is 11,319 cpm derived from BSA-19 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M5-02 (T19) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I19-11
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.2.6 Soil Sampling Results

This section presents the results of analyses for soil within the survey area of Target T19. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 8.2.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 8.2.6.2.

8.2.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T19: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples are presented in Tables I19-1 and I19-2. All the results of the XRF confirmation soil samples are presented in Table I19-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T19 following the methods outlined in Section 2.4 and shown in Figure I19-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 43 measurements were collected across 42 survey units from the survey area of Target T19 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I19-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T19 at a depth of 0 to 3 inches bgs. One XRF confirmation soil sample was collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I19-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 8.2.7.

Table I19-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-02 (T19)

Analyte	Units	Applied BTV	T19-XS9-01-091118	
			Result	Q
Survey Unit			**X9**	
Aluminum	mg/kg	6,410	4,400	
Antimony	mg/kg	0.138	0.15	
Arsenic	mg/kg	2.4	3.6	
Barium	mg/kg	166	82	
Beryllium	mg/kg	0.46	0.28	
Cadmium	mg/kg	0.15	0.084	J
Calcium	mg/kg	25,300	5,400	
Chromium	mg/kg	7.4	8.2	
Cobalt	mg/kg	3.2	2.8	
Copper	mg/kg	11	6.7	
Iron	mg/kg	5,830	6,100	
Lead	mg/kg	9.3	7.3	
Lithium	mg/kg	13	6.2	
Magnesium	mg/kg	7,000	2,300	
Manganese	mg/kg	264	270	
Molybdenum	mg/kg	0.20	0.69	
Nickel	mg/kg	4.9	4.4	
Potassium-40	pCi/g	20.2	13.3	J+
Radium-226	pCi/g	1.57	2.17	J+
Radium-228	pCi/g	0.84	<0.69	UJ
Selenium	mg/kg	0.84	0.89	J
Silver	mg/kg	0.019	0.019	J
Sodium	mg/kg	36	<100	U
Thallium	mg/kg	0.046	0.075	
Thorium	mg/kg	2.4	2.1	
Uranium	mg/kg	1.3	1.4	
Vanadium	mg/kg	22	44	
Zinc	mg/kg	28	15	

Notes:
BTV Background threshold value
J Estimated value
J- Estimated value, may be biased low
LT Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration

Table I19-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-02 (T19)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.4	5,830	9.3	264	0.20	2.4	1.3	22	28
Measurements	#	43	43	43	43	43	43	43	43	43
Detects	#	32	43	43	43	25	43	37	43	43
Nondetects	#	11	0	0	0	18	0	6	0	0
Minimum	mg/kg	1.91	3,593	3.05	162	0.06	1.15	0.20	20.5	9.4
Maximum	mg/kg	7	8,261	16	602	6.2	3.6	6.2	272	28
Standard Deviation	mg/kg	1.4	1,028	2.5	99	1.35	0.5	1.2	50	4.7
Average	mg/kg	4.0	6,046	6.9	314	1.33	2.4	1.9	78.3	17.6
Median	mg/kg	4.0	6,068	6.5	303	1.03	2.5	1.6	64.9	17.2
Relative Standard Deviation	%	34.2	17.0	36.9	31.5	102.0	20.2	65.1	64.1	26.6
90th Percentile	mg/kg	6.2	7,102	9.9	439	2.6	2.9	2.9	128	23
95th Percentile	mg/kg	6.3	7,435	10.4	515	3.4	3.0	3.5	177	27
99th Percentile	mg/kg	7.0	7,974	14.8	590	5.6	3.5	5.9	243	28
Measurements Above Applied BTV	#	27	26	7	28	20	23	22	42	0
Measurements Above Applied BTV	%	62.8	60.5	16.3	65.1	46.5	53.5	51.2	97.7	0.0

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value
mg/kg Milligram per kilogram
XRF X-ray fluorescence

8.2.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T19 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T19 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T19. The estimated BTVs are identified in Section 8.2.4 and Table I19-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I19-7 presents a summary of the background comparison for different measurement and soil depths at Target T19. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T19. However, gamma radiation screening indicated that gamma levels at Target T19 are elevated in comparison to the BSA and appear to be associated with outcropping of Jse. Therefore, while multiple COPCs have been identified at Target T19 based on a conservative comparison to background, risk screening will be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I19-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-02 (T19)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony	✓		✓
Arsenic	✓	✓	✓
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium	✓		✓
Cobalt			
Copper			
Iron	✓	✓	✓
Lead		✓	✓
Lithium			
Magnesium			
Manganese	✓	✓	✓
Molybdenum	✓	✓	✓
Nickel			
Potassium-40			
Radium-226	✓		✓
Radium-228			
Selenium	✓		✓
Silver			
Sodium			
Thallium	✓		✓
Thorium		✓	✓
Uranium	✓	✓	✓
Vanadium	✓	✓	✓
Zinc			

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

8.2.7 Primary Contaminant Mapping

8.2.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 8.2.6.2 identified the COPCs at Target T19. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 8.2.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I19-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T19 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 8.2.7.1 through Section 8.2.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T19. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

8.2.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I19-7. Arsenic exceeded the applied BTV in 62.8 percent of in situ XRF measurements and in the XRF confirmation sample. The applied BTV for arsenic is 2.4 mg/kg for Target T19 as presented in Section 8.2.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I19-5 and Attachment I3, respectively. Figure I19-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T19 and BSA-19 (Jse) samples. Figure I19-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T19 and BSA-19 (Jse) samples. Summary statistics for XRF measurements are provided in Section 8.2.6.1. Arsenic XRF concentrations measured in surface soils at Target T19 ranged between 1.9 and 7 mg/kg with an average and standard deviation of 4 mg/kg and 1.4 mg/kg, respectively. The average arsenic XRF concentration is above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T19 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I19-14. Overall, the majority of detectable arsenic results in surface soils were above the applied BTV. However, the maximum XRF value was 2.9 times higher than the applied BTV and does not appear to be associated with mining-related materials.

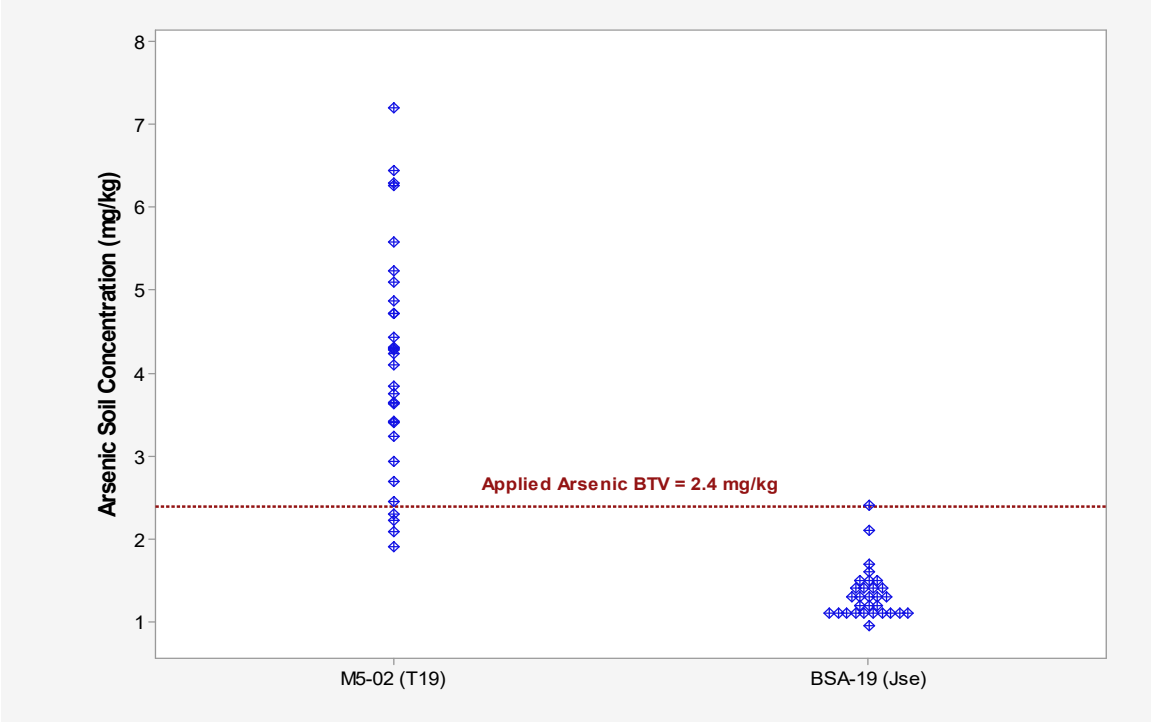


Figure I19-12. Individual Value Plot for Target M5-02 (T19) and BSA-19 (Jse) Arsenic Soil Concentrations

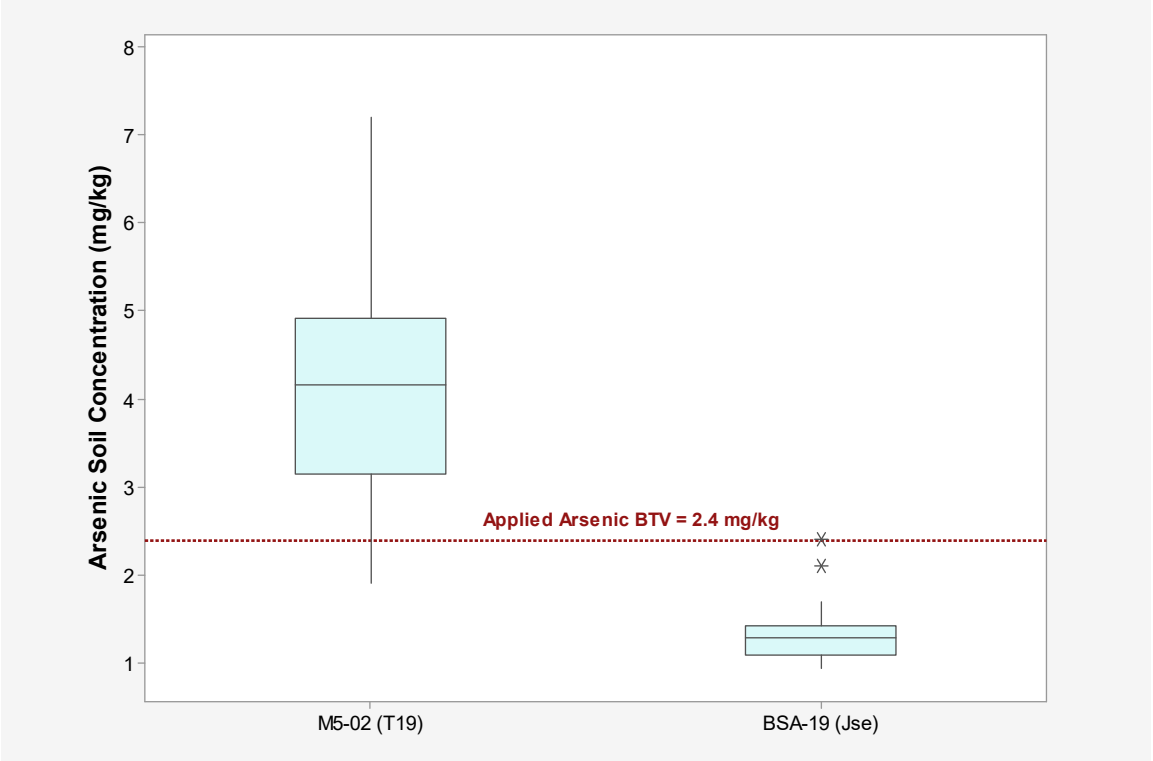
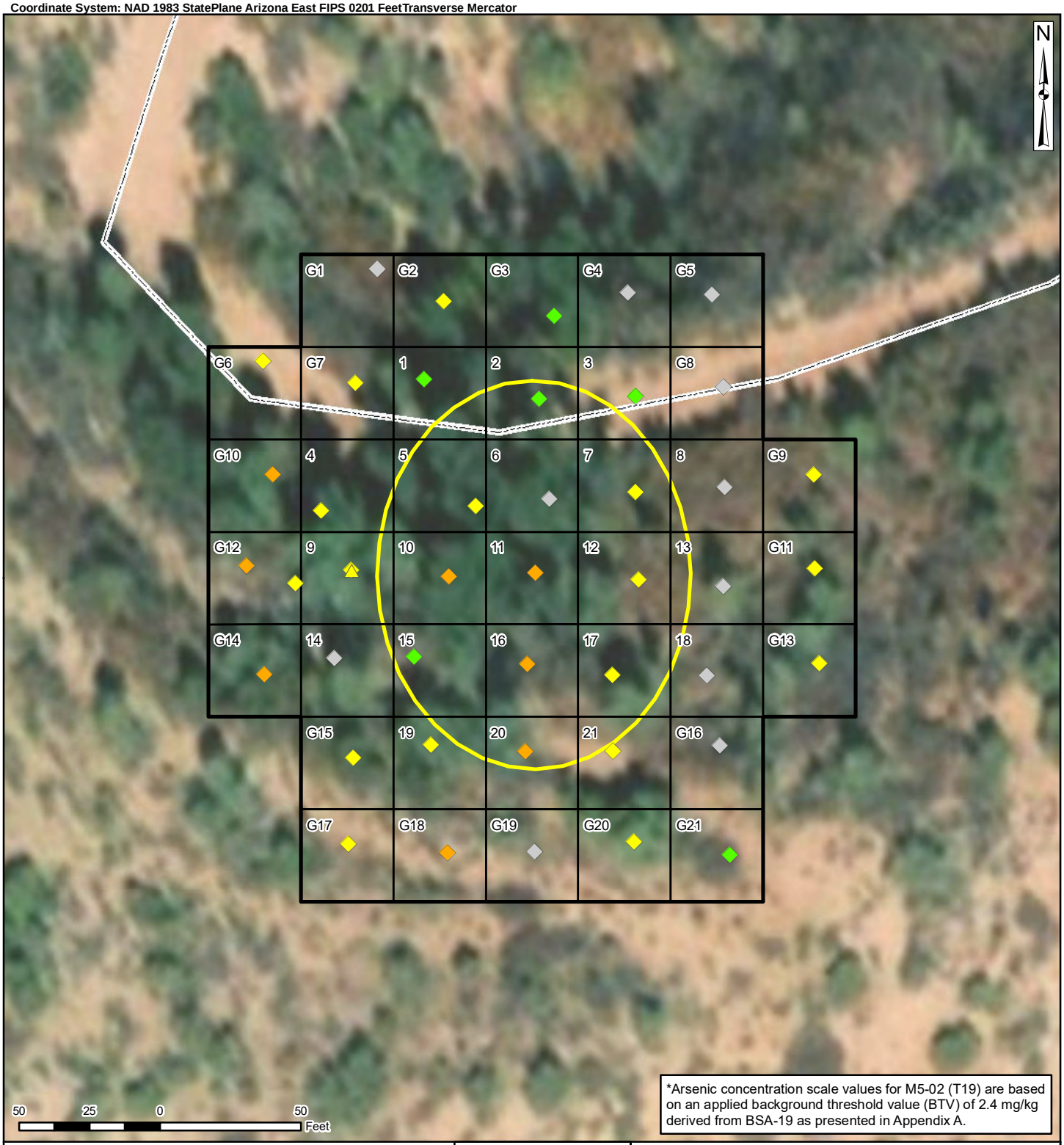


Figure I19-13. Box Plot for Target M5-02 (T19) and BSA-19 (Jse) Arsenic Soil Concentrations

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



*Arsenic concentration scale values for M5-02 (T19) are based on an applied background threshold value (BTV) of 2.4 mg/kg derived from BSA-19 as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 1.3
- 1.3 - 2.4
- 2.4 - 4.8
- 4.8 - 7.2
- 7.2 - 10
- 10 - 24
- ≥ 24
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M5-02 (T19) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I19-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.2.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I19-7. Lead exceeded the applied BTV in 16.3 percent of in situ XRF measurements but not in the XRF confirmation sample. The applied BTV for lead is 9.3 mg/kg for Target T19 as presented in Section 8.2.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I19-5 and Attachment I3, respectively. Figure I19-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T19 and BSA-19 (Jse) samples. Figure I19-16 presents a box plot of detectable lead XRF soil concentrations for Target T19 and BSA-19 (Jse) samples. Summary statistics for XRF measurements are provided in Section 8.2.6.1. Lead XRF concentrations measured in surface soils at Target T19 ranged between 3.05 and 16 mg/kg with an average and standard deviation of 6.9 mg/kg and 2.5 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T19 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I19-17. Overall, the majority of detectable lead results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials.

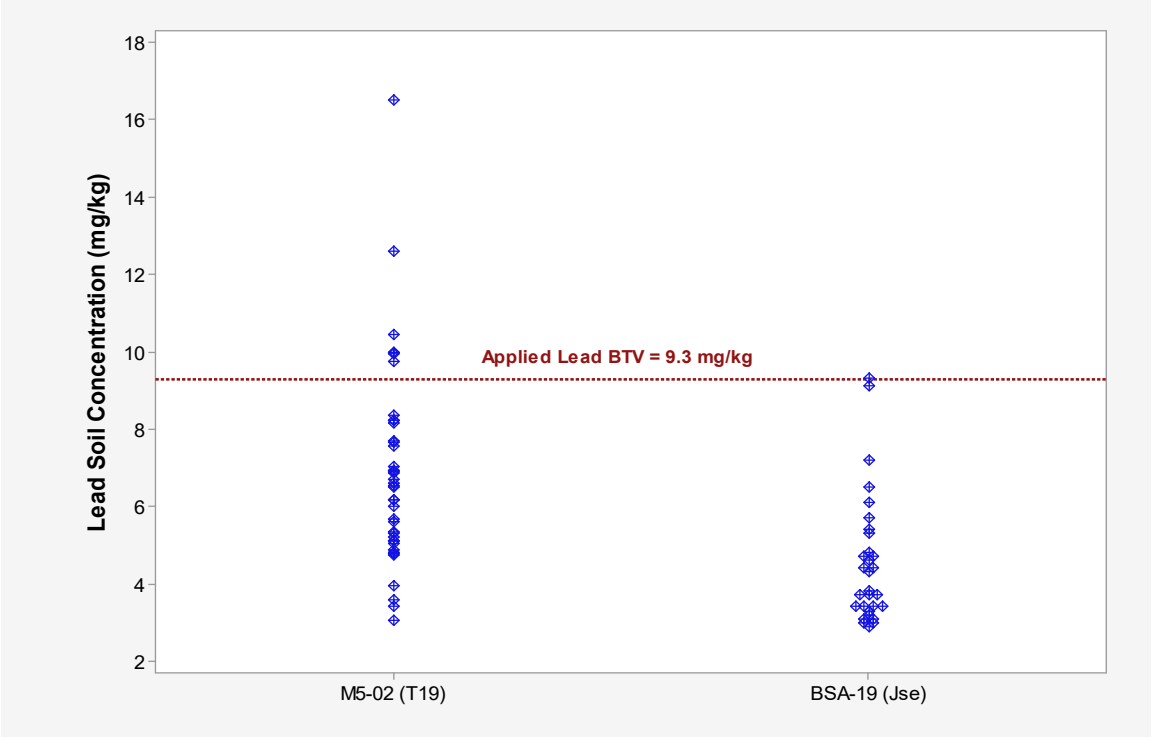


Figure I19-15. Individual Value Plot for Target M5-02 (T19) and BSA-19 (Jse) Lead Soil Concentrations

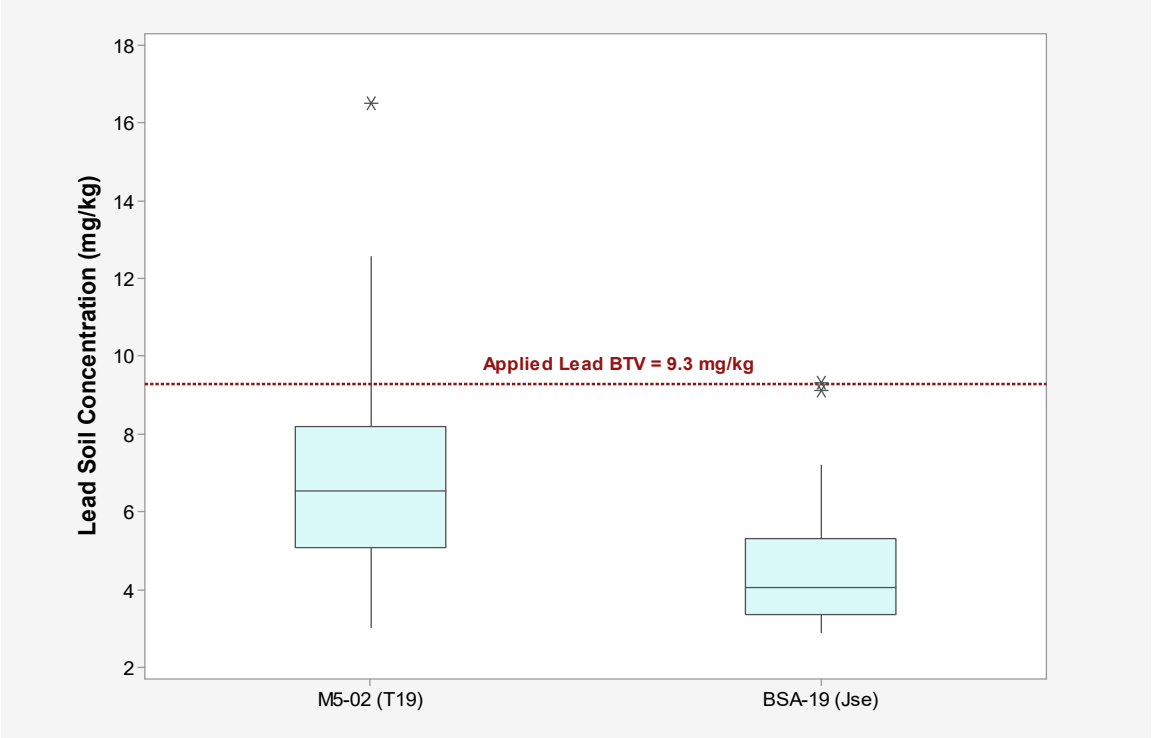
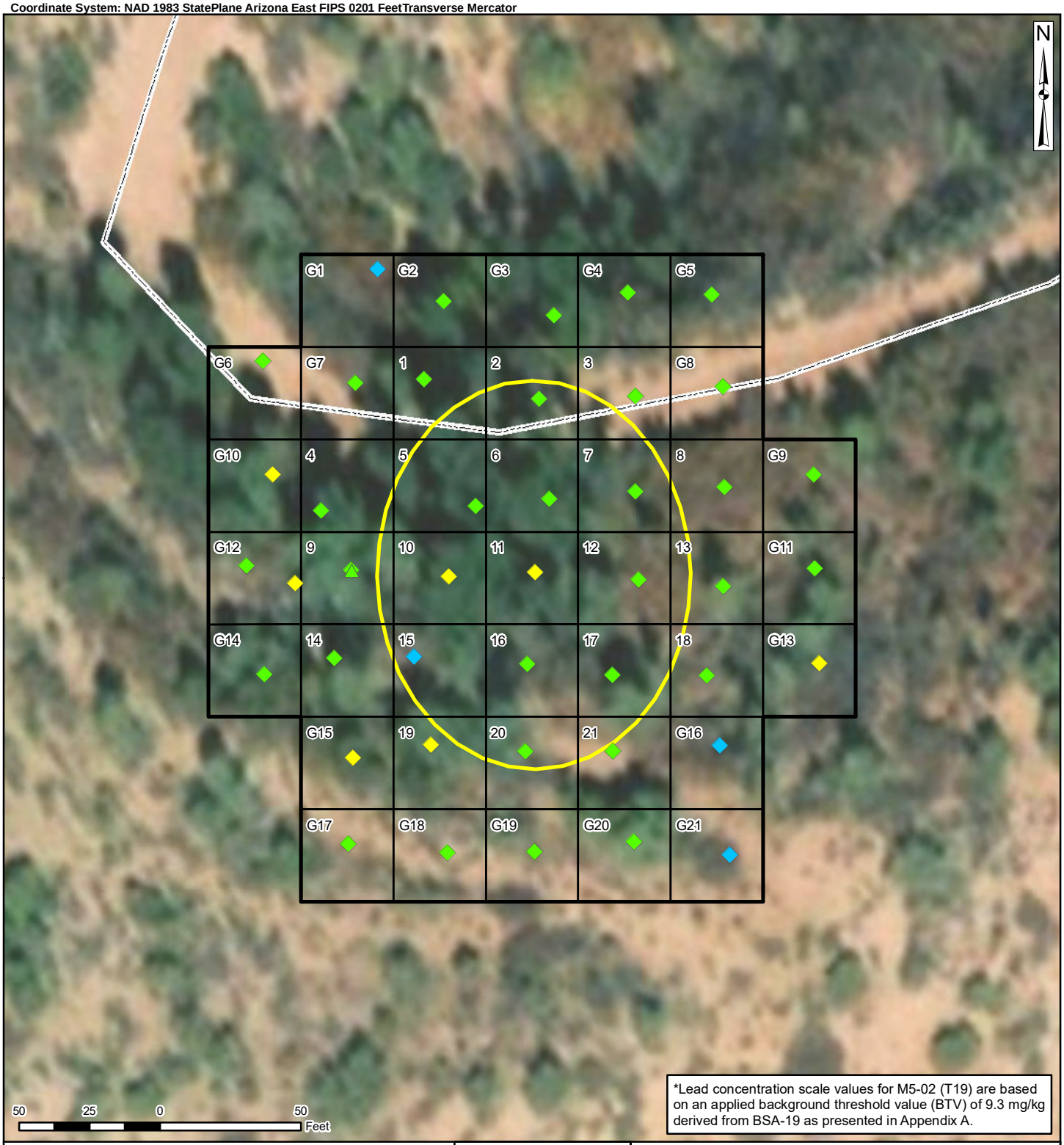


Figure I19-16. Box Plot for Target M5-02 (T19) and BSA-19 (Jse) Lead Soil Concentrations



*Lead concentration scale values for M5-02 (T19) are based on an applied background threshold value (BTV) of 9.3 mg/kg derived from BSA-19 as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 4.6
- 4.6 - 9.3
- 9.3 - 19
- 19 - 28
- 28 - 37
- 37 - 93
- ≥ 93

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M5-02 (T19) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I19-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.2.7.4 Thorium

Thorium was identified as a COPC in surface soil as shown in Table I19-7. Thorium exceeded the applied BTV in 53.5 percent of in situ XRF measurements but not in the XRF confirmation sample. The applied BTV for thorium is 2.4 mg/kg for Target T19 as presented in Section 8.2.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I19-5 and Attachment I3, respectively. Figure I19-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T19 and BSA-19 (Jse) samples. Figure I19-19 presents a box plot of detectable thorium XRF soil concentrations for Target T19 and BSA-19 (Jse) samples. Summary statistics for XRF measurements are provided in Section 8.2.6.1. Thorium XRF concentrations measured in surface soils at Target T19 ranged between 1.15 and 3.6 mg/kg with an average and standard deviation of 2.4 mg/kg and 0.5 mg/kg, respectively. The average thorium XRF concentration is at the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T19 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I19-20. Overall, the majority of detectable thorium results in surface soils were at the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials.

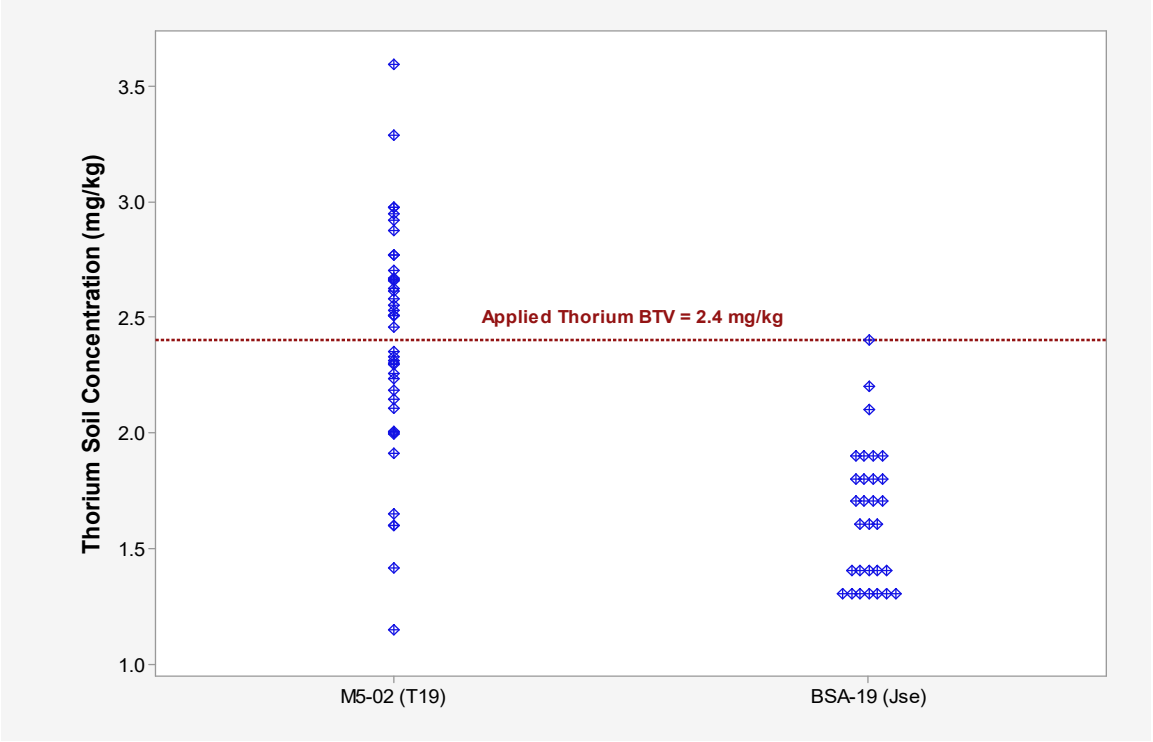


Figure I19-18. Individual Value Plot for Target M5-02 (T19) and BSA-19 (Jse) Thorium Soil Concentrations

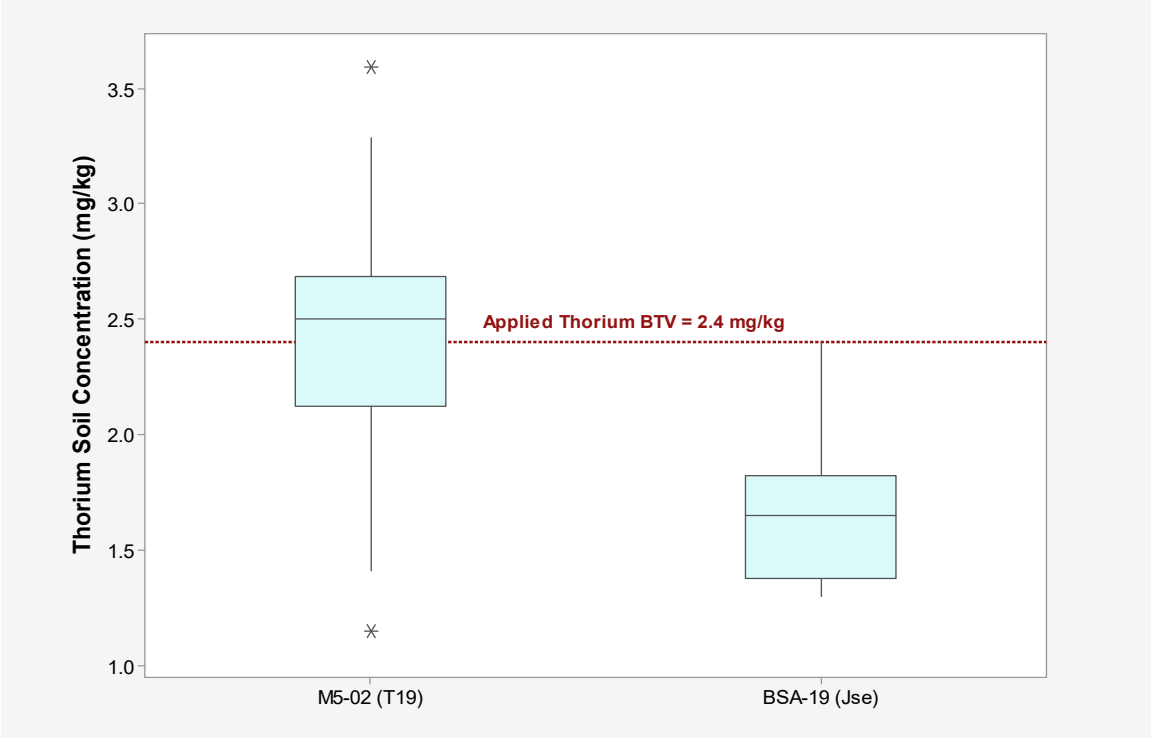
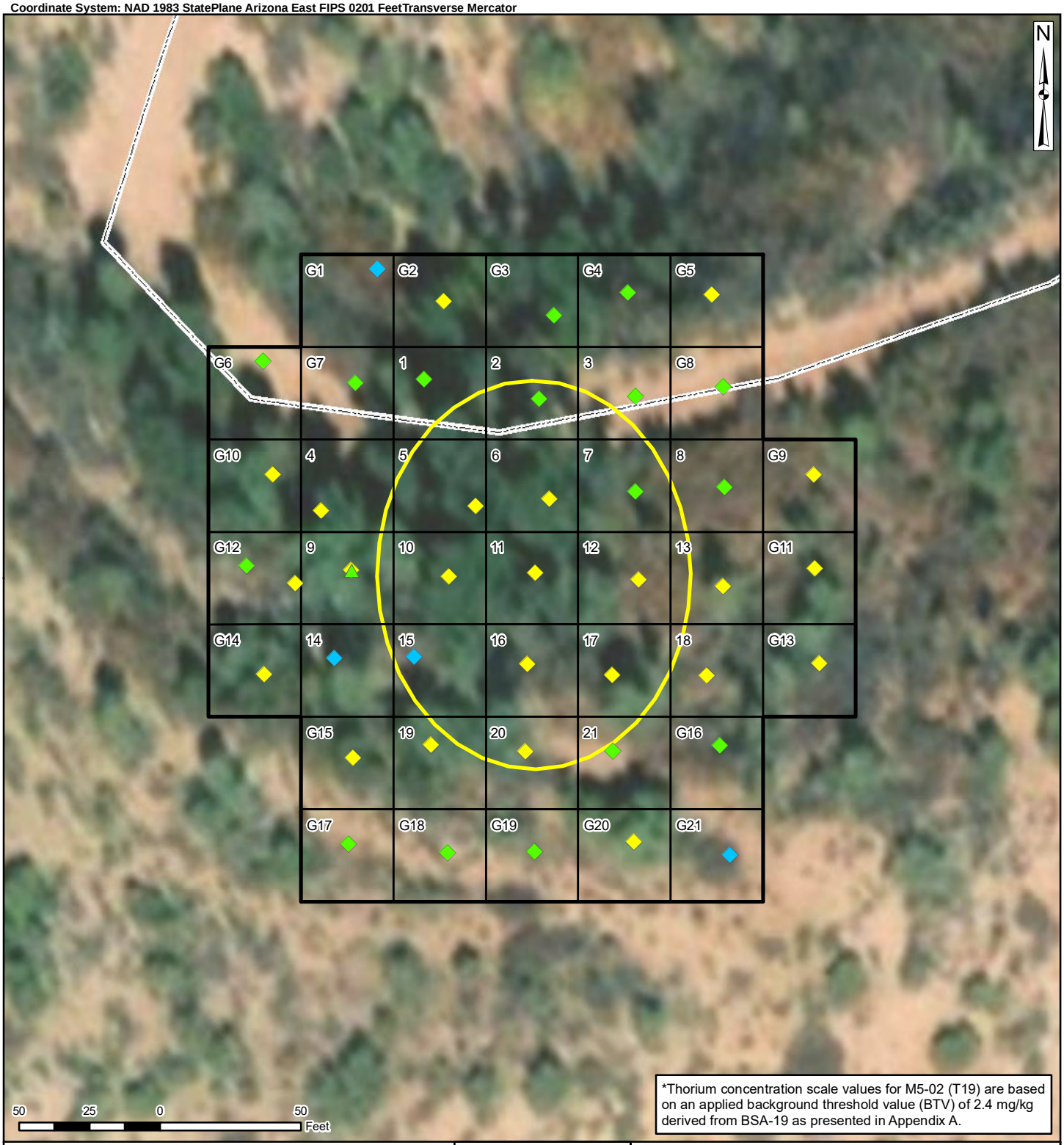


Figure I19-19. Box Plot for Target M5-02 (T19) and BSA-19 (Jse) Thorium Soil Concentrations

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



*Thorium concentration scale values for M5-02 (T19) are based on an applied background threshold value (BTV) of 2.4 mg/kg derived from BSA-19 as presented in Appendix A.

Thorium Concentration Scale (mg/kg)*

- ≤ 1.6
- 1.6 - 2.4
- 2.4 - 4.8
- 4.8 - 7.2
- 7.2 - 10
- 10 - 24
- ≥ 24

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M5-02 (T19) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I19-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.2.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I19-7. Uranium exceeded the applied BTV in 51.2 percent of in situ XRF measurements and in the XRF confirmation sample. The applied BTV for uranium is 1.3 mg/kg for Target T19 as presented in Section 8.2.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I19-5 and Attachment I3, respectively. Figure I19-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T19 and BSA-19 (Jse) samples. Figure I19-22 presents a box plot of detectable uranium XRF soil concentrations for Target T19 and BSA-19 (Jse) samples. Summary statistics for XRF measurements are provided in Section 8.2.6.1. Uranium XRF concentrations measured in surface soils at Target T19 ranged between 0.2 and 6.2 mg/kg with an average and standard deviation of 1.9 mg/kg and 1.2 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T19 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I19-23. Overall, the majority of detectable uranium results in surface soils were above the applied BTV. However, the maximum XRF value was 4.8 times higher than the applied BTV and does not appear to be associated with mining-related materials.

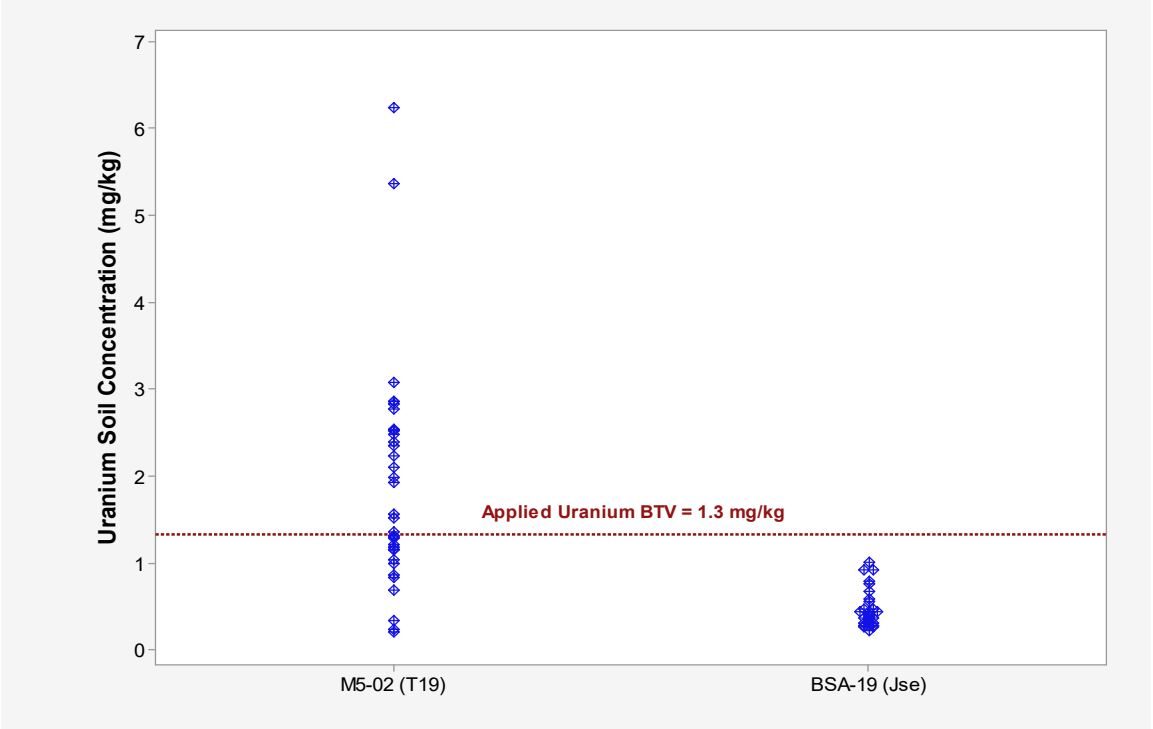


Figure I19-21. Individual Value Plot for Target M5-02 (T19) and BSA-19 (Jse) Uranium Soil Concentrations

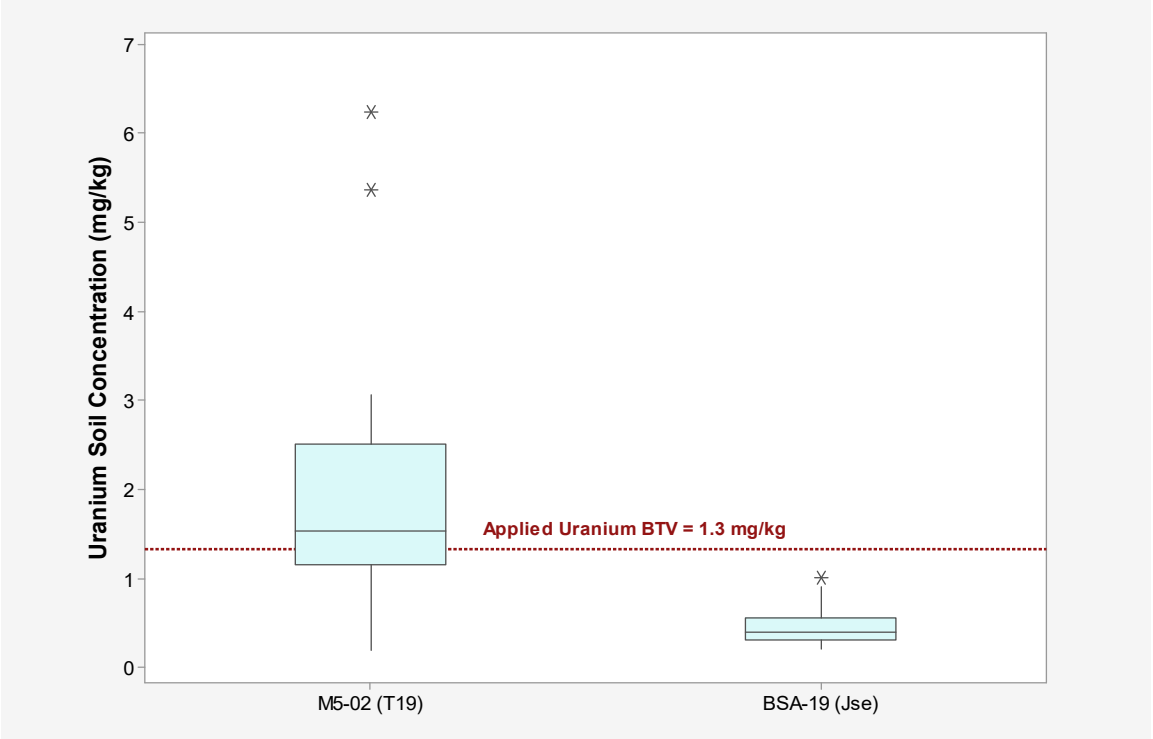
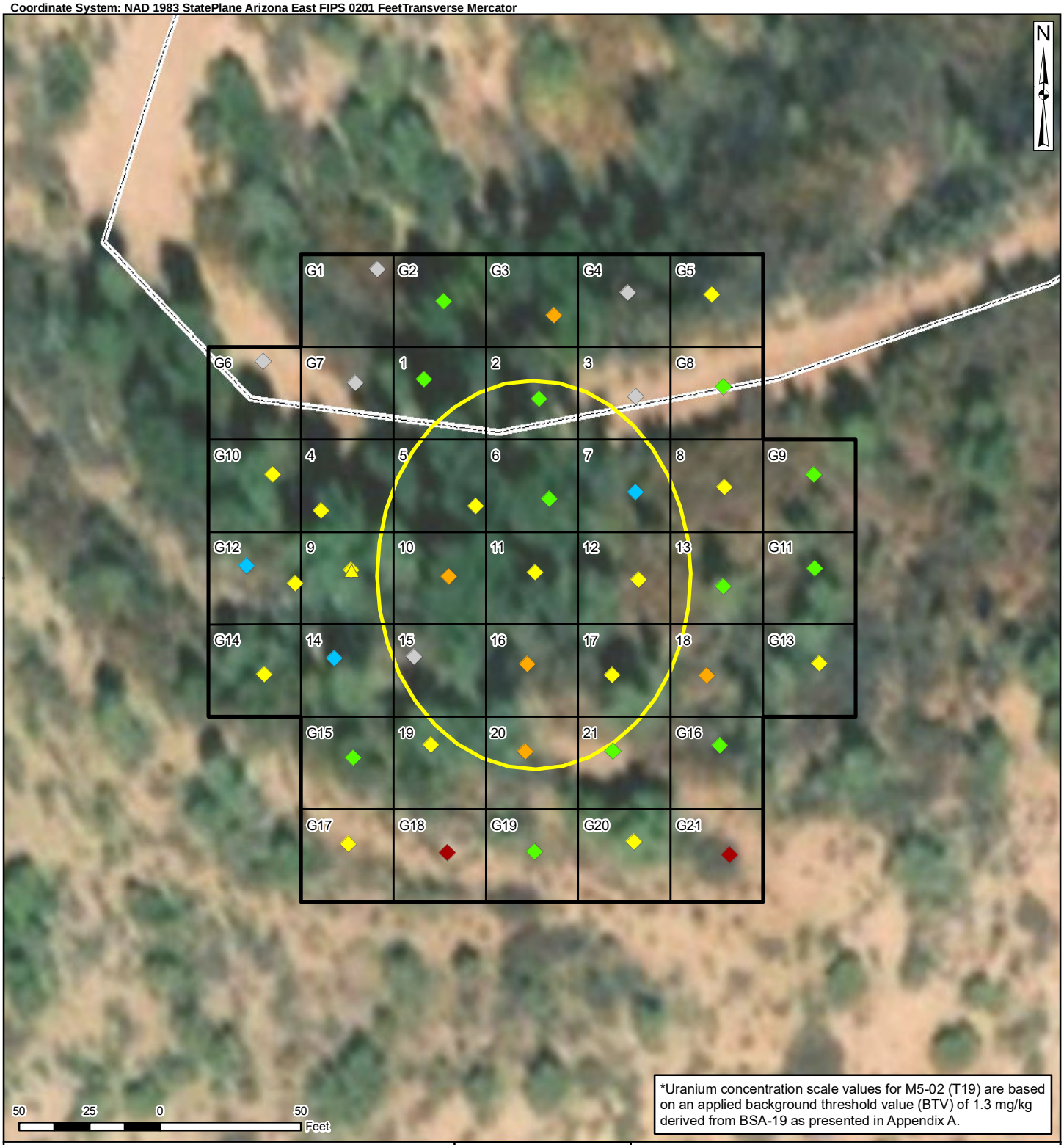


Figure I19-22. Box Plot for Target M5-02 (T19) and BSA-19 (Jse) Uranium Soil Concentrations

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



*Uranium concentration scale values for M5-02 (T19) are based on an applied background threshold value (BTV) of 1.3 mg/kg derived from BSA-19 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 0.46
- 0.46 - 1.3
- 1.3 - 2.6
- 2.6 - 3.9
- 3.9 - 5.2
- 5.2 - 13
- ≥ 13
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M5-02 (T19) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I19-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.2.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I19-7. Vanadium exceeded the applied BTV in 97.7 percent of in situ XRF measurements and in the XRF confirmation sample. The applied BTV for vanadium is 22 mg/kg for Target T19 as presented in Section 8.2.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I19-5 and Attachment I3, respectively. Figure I19-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T19 and BSA-19 (Jse) samples. Figure I19-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T19 and BSA-19 (Jse) samples. Summary statistics for XRF measurements are provided in Section 8.2.6.1. Vanadium XRF concentrations measured in surface soils at Target T19 ranged between 20.5 and 272 mg/kg with an average and standard deviation of 78.3 mg/kg and 50 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T19 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I19-26. Overall, the majority of detectable vanadium results in surface soils were above the applied BTV. The maximum XRF value was 12.4 times higher than the applied BTV and does not appear to be associated with mining-related materials.

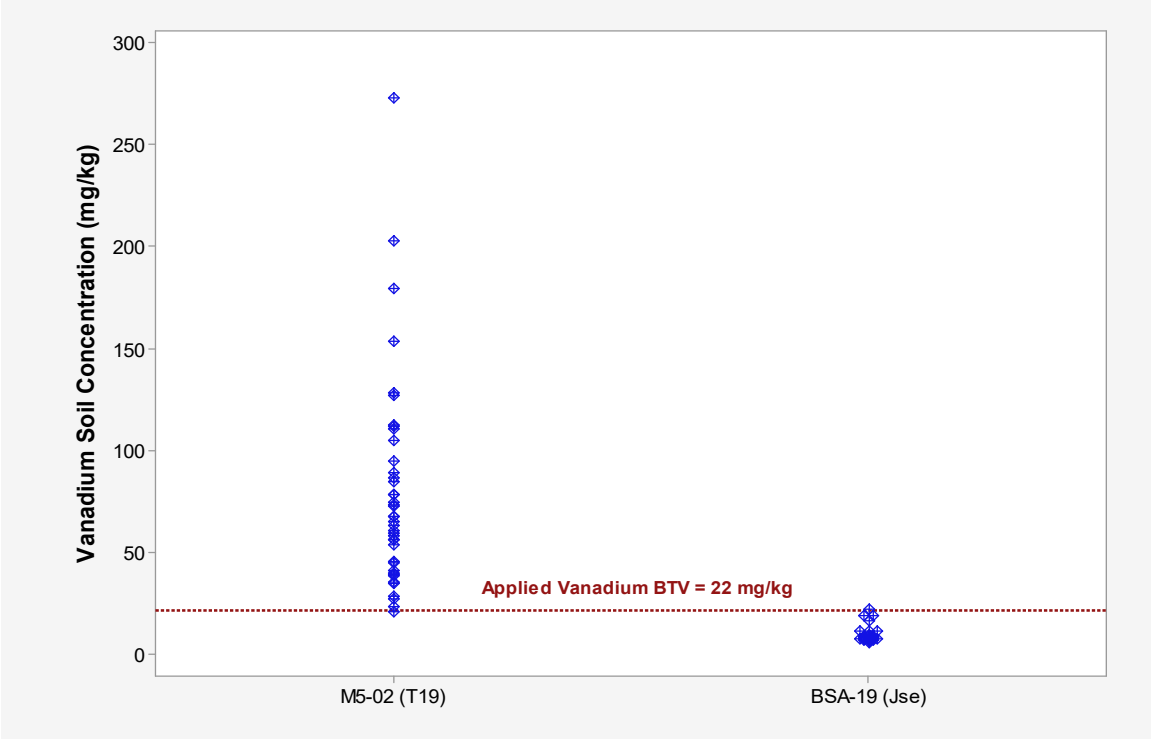


Figure I19-24. Individual Value Plot for Target M5-02 (T19) and BSA-19 (Jse) Vanadium Soil Concentrations

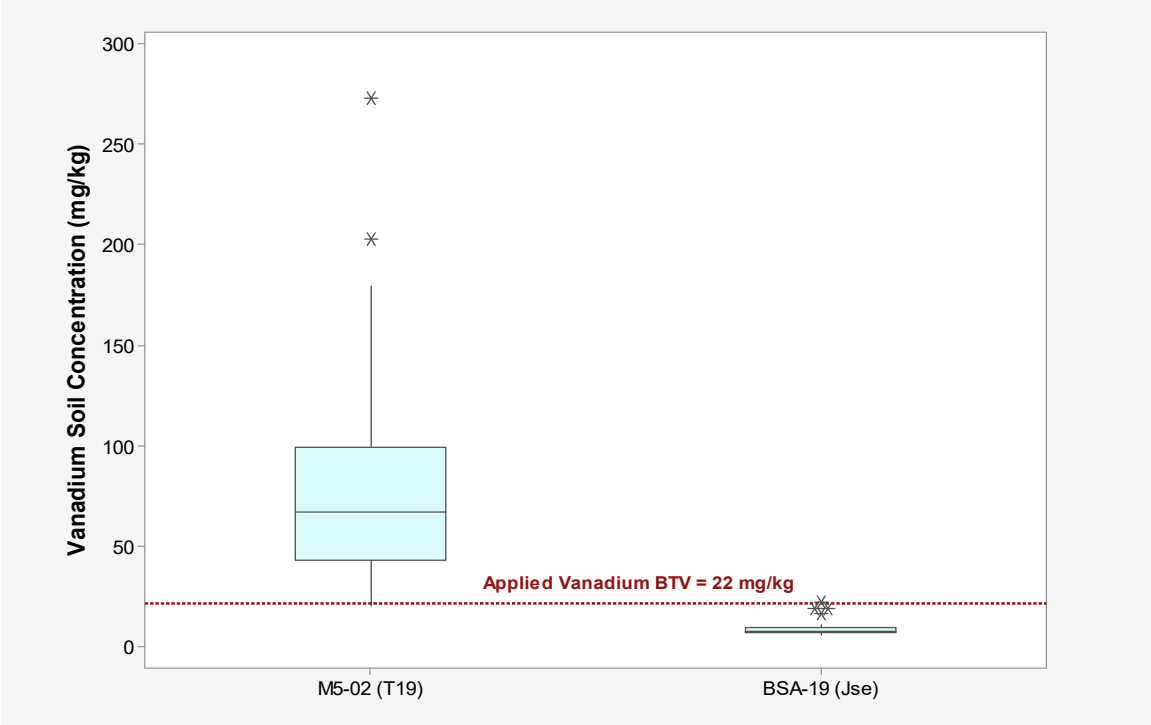
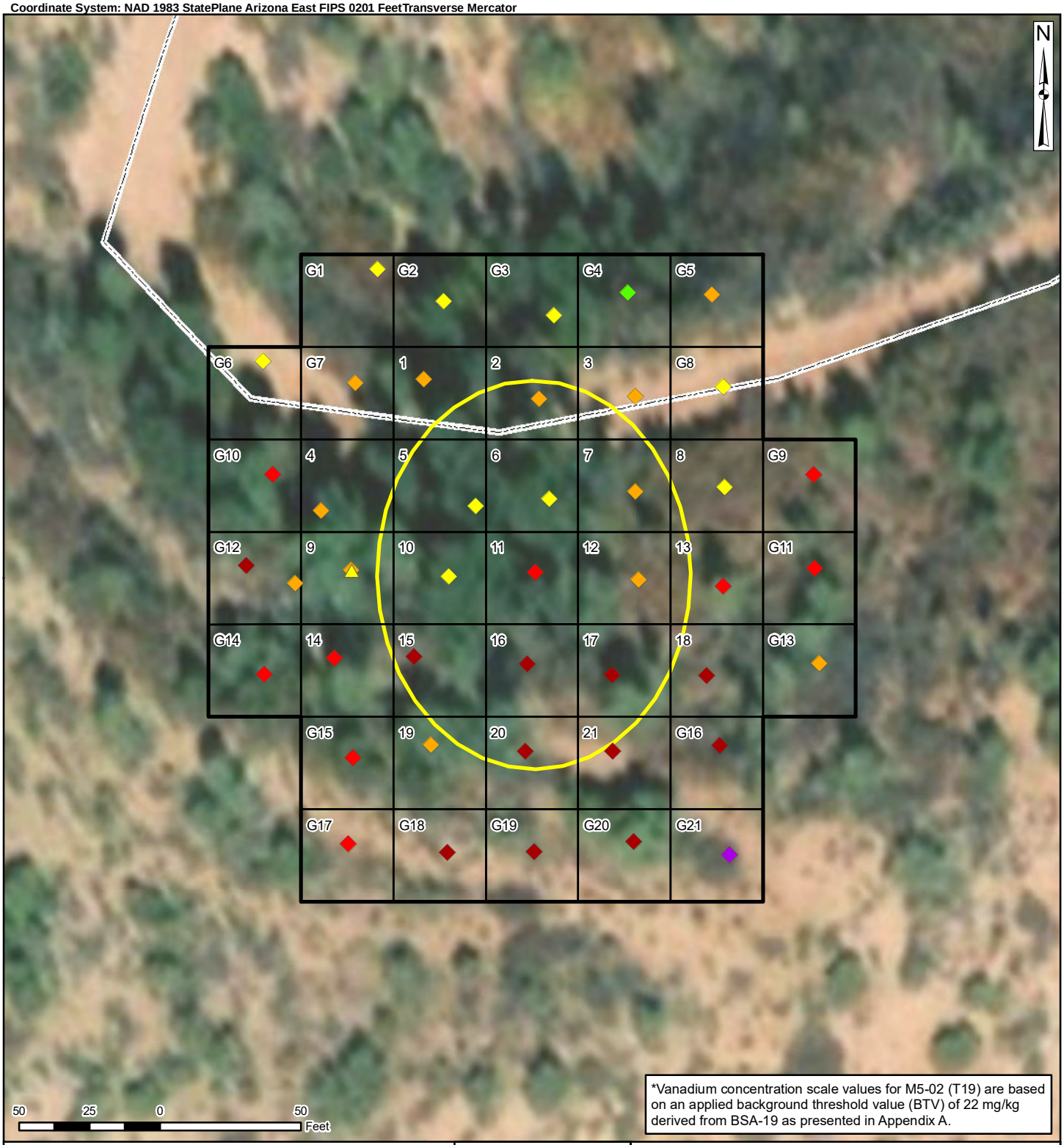


Figure I19-25. Box Plot for Target M5-02 (T19) and BSA-19 (Jse) Vanadium Soil Concentrations

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



*Vanadium concentration scale values for M5-02 (T19) are based on an applied background threshold value (BTV) of 22 mg/kg derived from BSA-19 as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 9.5
- 9.5 - 22
- 22 - 44
- 44 - 66
- 66 - 88
- 88 - 220
- ≥ 220

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M5-02 (T19) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I19-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.2.8 Conclusions

Target T19 (M5-02) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T19. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T19 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T19. ASPECT gamma survey results generally correlated with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T19 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in one XRF confirmation sample from survey unit 9 (the area of elevated gamma activity) exceeded the applied BTV by a factor of 1.4. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T19 geology and soil types were established through a background study.
- Mean raw gamma measurements exceeded the applied BTV by a factor of 1.03. In addition, grid averaged gamma measurements exceeded the applied BTV in 23 of the 42 survey units by a factor of up to 1.9.
- A total of 26 analytes were identified as occurring within the surface environment. Of these analytes, 13 were identified as COPCs. Arsenic, uranium, and vanadium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T19 does not contain TENORM. No mining-related activities or features were observed in the field. Outcropping of Jse was identified in the area of highest gamma activity, and the entire hillside comprises NORM.
- Natural erosion of outcroppings and road construction may have increased the lateral extent of NORM.
- There are no immediate significant physical hazards present at Target T19.
- Access is by dirt road with a small four-wheel-drive vehicle.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No existing groundwater wells are documented within the vicinity of Target T19. No seeps or springs were observed during the RSE investigation.

- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T19. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No mine waste was observed at Target T19; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; however, a few data gaps remain for Target T19. The remaining data gaps include expanding the gamma survey to the south and field mapping and verification of NORM in outcroppings.

8.3 NON-AUM TARGET T20 (M5-03)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T20 (M5-03).

8.3.1 Access, Physical Conditions, and Field Observations

Target T29 (M5-03) is grouped with two other non-AUM Targets: T18 (M5-01) and T19 (M5-02). Target T29 is in the Lukachukai Mountains Region in Subarea Group F within the Cove Chapter of the Navajo Nation and accessed by four-wheel-drive vehicle off of Indian Route 33. Target T29 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. No residential structures are near the Target. A Target location and access map for Target T20 is shown in Figure I20-1.

A topographical relief map for Target T20 and associated AUM areas is provided in Figure I20-2. The elevation at Target T20 ranges from 7,274 to 7,306 feet amsl with an average of 7,290 feet amsl. The slope at Target T20 ranges from 14 to 24 percent with an average of 25 percent. Target T20 is entirely within Jml, which comprises the Recapture and Salt Wash Members, and within the soil type Hozho-Quezcan-Rock outcrop complex (MUSYM 413) (Figures I-20 and I-21).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T20. Weston did not conduct a background study for Target T20. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 23 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T20:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T20 is accessible directly from the main Mesa V access road off of Indian Route 33.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  Outcrops of Jml, which contain NORM, were identified at the Target. No TENORM was observed.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  No drainages were identified at the Target. The Middle 1 drainage is located 0.8 mile southeast of the Target and discussed in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

No exploratory borings were identified. Indian Route 33 is located at the top of the Target area.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  Road construction, involving widening and installing water control ditches, occurred during the RSE field investigation, and additional NORM-bearing geology may have been exposed. The underlying geology, the NORM-bearing Jml, may contribute to elevated gamma levels on the exposed hillside.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

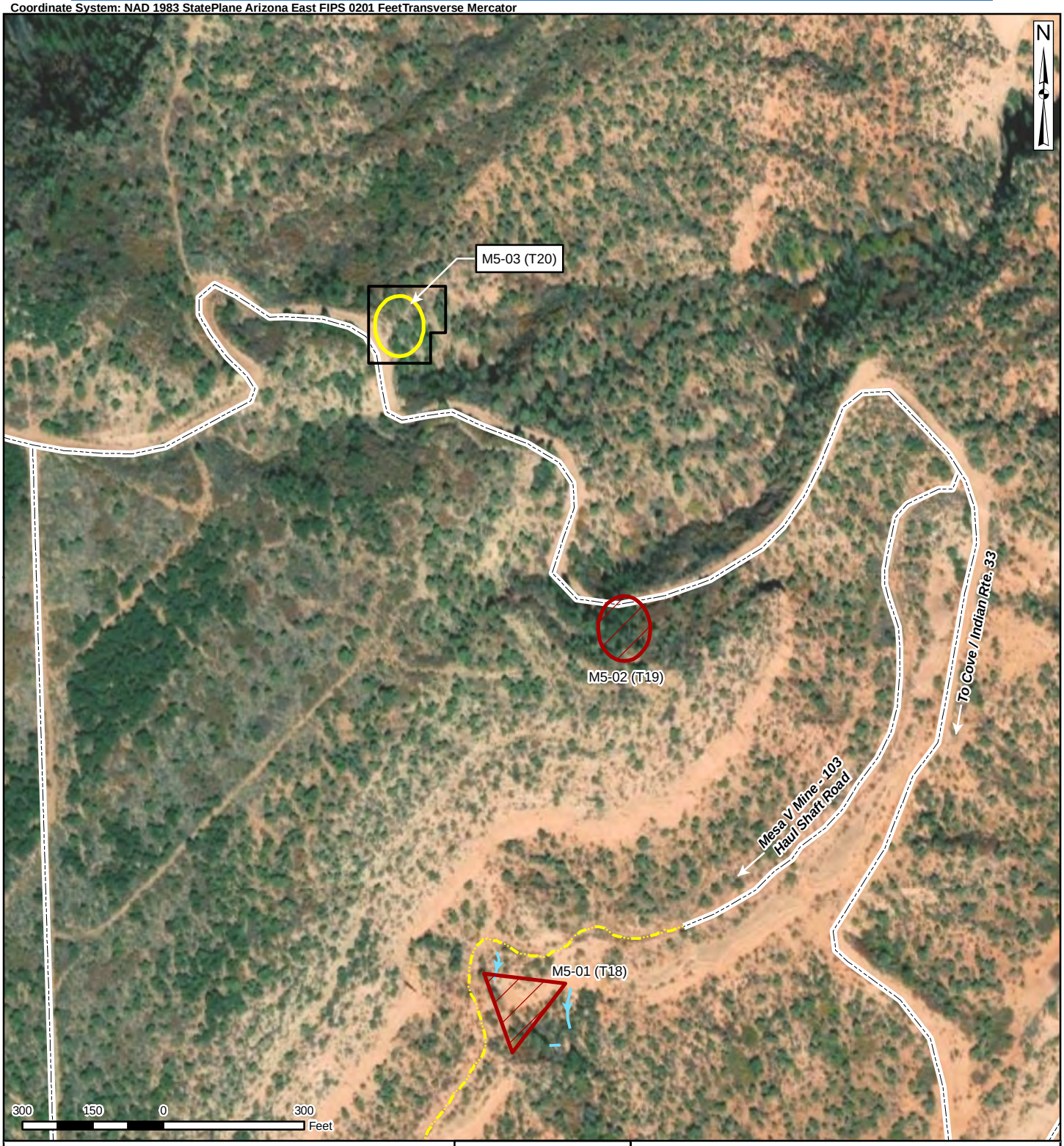
- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T20 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Sections 2.3 and 8.3.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 8.3.3 with results presented in Sections 8.3.6 and 8.3.7)
- Conducting a gamma radiation survey (results presented in Section 8.3.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped

Prepared for: USEPA Region 9

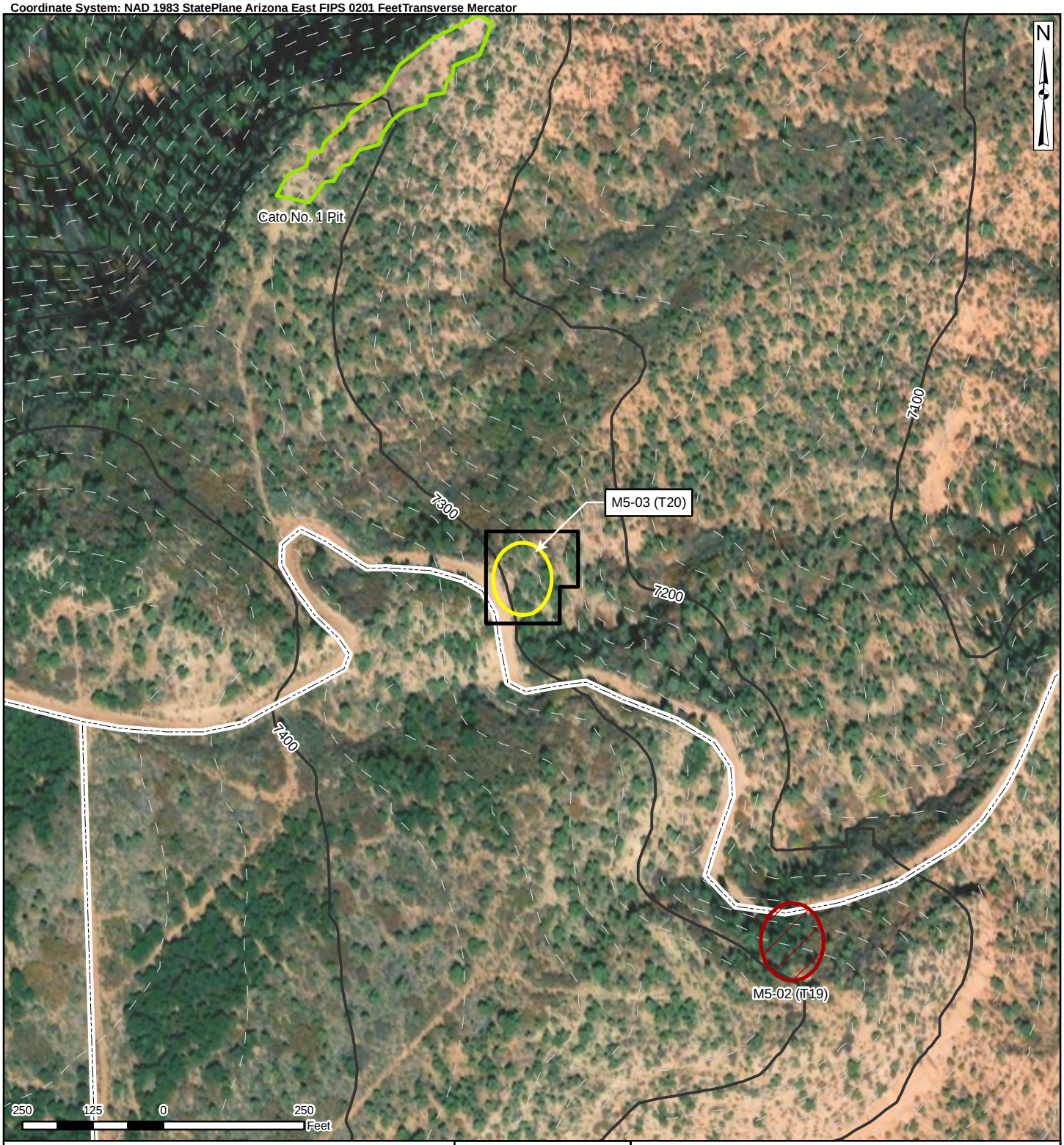
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NON-AUM TARGET M5-03 (T20) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I20-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Non-Tronox AUM Site
Access Route - Vehicular
100 ft Contour*
20 ft Contour*

* 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.

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NON-AUM TARGET M5-03 (T20) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I20-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

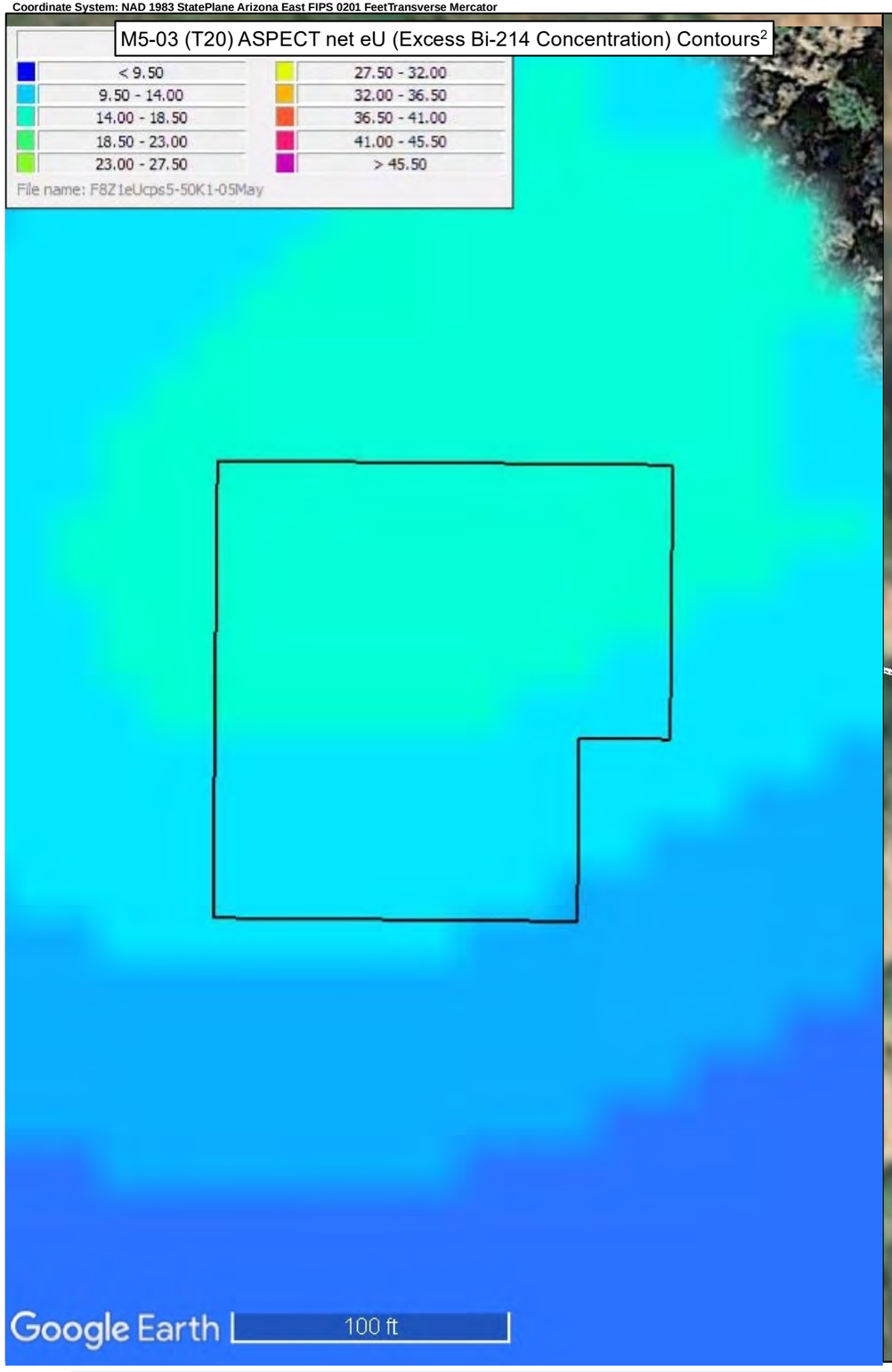
8.3.2 Gamma Radiation Survey and Field XRF Measurements

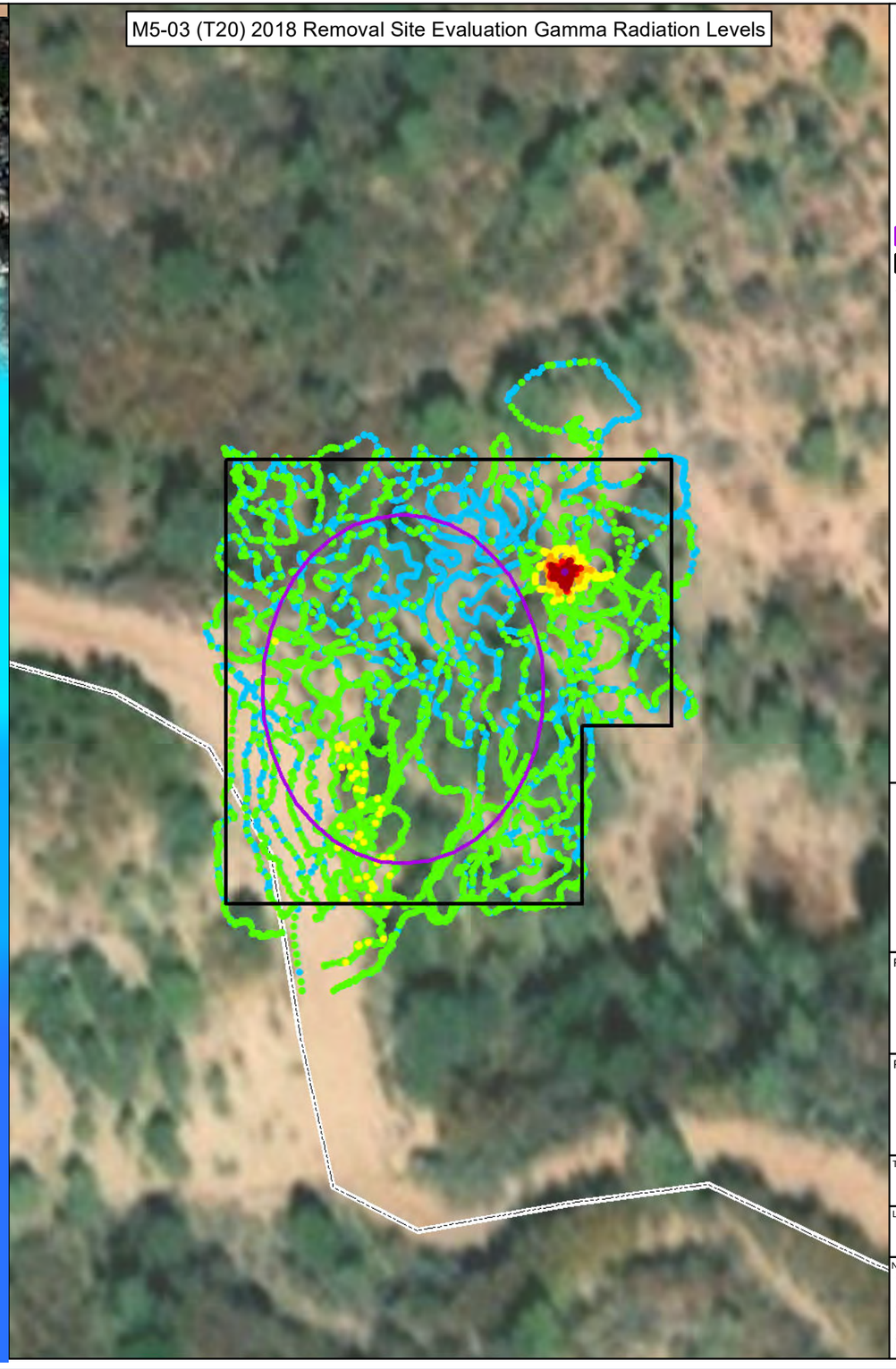
Tetra Tech performed GPS-based gamma radiation surveys (Figure I20-3) within the survey area of the non-AUM Target T20 as part of the Baseline Study in May 2018. Additional Goback gamma radiation surveys were performed in September 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T20 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I20-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 23, of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at three survey units. All gamma survey and XRF survey units were evaluated.

8.3.3 XRF Confirmation Sampling Overview

Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T20. Two XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from two locations (Table I20-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I20-4 and I20-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I20-2. The results of XRF confirmation sample analysis are provided in Section 8.3.6.1. Correlated XRF field measurements are provided in Attachment I3.

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





Gamma Reading (cpm)[1]

≤ 9,712	≤ Avg. BG
9,712 - 14,566	Avg. BG - 1 x BTV
14,566 - 29,132	1 x BTV - 2 x BTV
29,132 - 43,698	2 x BTV - 3 x BTV
43,698 - 58,264	3 x BTV - 4 x BTV
58,264 - 145,660	4 x BTV - 10 x BTV
≥ 145,660	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Vehicular

[1]The applied gamma radiation background threshold value (BTV) for M5-03 (T20) Non-AUM Target is 14,566 cpm derived from gamma survey data for BSAs within the Jml formation as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 50 ft

1:600

N W E S

0 25 50 100 Feet

NON-AUM TARGET M5-03 (T20)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborne Spectral Photometric Environmental Collection Technology.

Figure No.: **I20-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

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NON-AUM TARGET M5-03 (T20) XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I20-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

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



XRF Confirmation Soil Sample* (0 - 3 inches bgs)

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

*T20-XSG3 = site T20 XRF confirmation soil sample collected at survey unit G3. 0 - 3 in bgs = 0 to 3 inches below ground surface.

Prepared for: USEPA Region 9

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NON-AUM TARGET M5-03 (T20) SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I20-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

Table I20-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-03 (T20)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T20-XS14-01-052218	14	0-3	XRF Confirmation	Primary	5/22/2018	36.5446702	-109.2409166	1805632-10, 1805633-10
T20-XSG3-01-091118	G3	0-3	XRF Confirmation	Primary	9/11/2018	36.5447746	-109.2405555	1809473-37, 1809474-37

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I20-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-03 (T20)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

8.3.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 8.3.1, Target T20 surface geology is entirely within Jml with soils within the Hozho-Quezcan-Rock outcrop complex (MUSYM 413) (Figures I-22 and I-23). As a result, BSA-21 was selected for that combination of geology and soil type. Additionally, the Jml regional geological background would also be applicable for this Target. Table I20-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T20. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T20. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T20. The "Applied BTV" for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I20-3. Applied Background Threshold Values for Non-AUM Target M5-03 (T20)

Analyte	Units	Site-Specific BTV (BSA-21)	Regional BTV (Jml)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	11,000	7,000	7,000	Regional BTV
Antimony	mg/kg	0.196	0.140	0.140	Regional BTV
Arsenic	mg/kg	24	3.5	3.5	Regional BTV
Barium	mg/kg	270	270	270	Regional BTV
Beryllium	mg/kg	0.55	0.57	0.55	Site-Specific BTV
Cadmium	mg/kg	0.150	0.160	0.150	Site-Specific BTV
Calcium	mg/kg	48,000	32,000	32,000	Regional BTV
Chromium	mg/kg	9.4	5.2	5.2	Regional BTV
Cobalt	mg/kg	7.6	4.4	4.4	Regional BTV
Copper	mg/kg	21	12	12	Regional BTV
Iron	mg/kg	16,000	8,897	8,897	Regional BTV
Lead	mg/kg	10	11	10	Site-Specific BTV
Lithium	mg/kg	29	8.8	8.8	Regional BTV
Magnesium	mg/kg	12,000	3,900	3,900	Regional BTV
Manganese	mg/kg	620	440	440	Regional BTV
Mercury	mg/kg	0.0190	0.0378	0.0190	Site-Specific BTV
Molybdenum	mg/kg	4.1	0.29	0.29	Regional BTV
Nickel	mg/kg	11	6.2	6.2	Regional BTV
Potassium-40	pCi/g	22.5	26.9	22.5	Site-Specific BTV
Radium-226	pCi/g	7.46	2.23	2.23	Regional BTV
Radium-228	pCi/g	0.83	0.75	0.75	Regional BTV
Selenium	mg/kg	2.1	0.99	0.99	Regional BTV
Silver	mg/kg	0.186	0.037	0.037	Regional BTV
Sodium	mg/kg	270	45	45	Regional BTV
Thallium	mg/kg	0.270	0.075	0.075	Regional BTV
Thorium	mg/kg	4.5	4.7	4.5	Site-Specific BTV
Uranium	mg/kg	13.2	1.5	1.5	Regional BTV
Vanadium	mg/kg	217	24.0	24.0	Regional BTV
Zinc	mg/kg	53	27	27	Regional BTV
Gamma Radiation	cpm	18,239	14,566	14,566	Regional BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
Jse Summerville, Entrada Formation (Undifferentiated)
mg/kg milligrams per kilogram
pCi/g picocuries per gram

8.3.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T20 and the raw gamma radiation and grid averaged gamma radiation survey results.

8.3.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T20 in May 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in September 2018 to collect data within the Goback survey units. The applied gamma BTV for non-AUM Target T20 is 14,566 cpm. A total of 5,442 measurements were collected as part of the gamma radiation survey at non-AUM Target T20 across 23 survey units. Because of the thick vegetation and steep topography, not all survey units were scanned at 100 percent density. An average scan density of 237 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I20-4.

Table I20-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-03 (T20)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	14,566	
Measurements	#	5,442	23
Minimum	cpm	6,707	8,647
Maximum	cpm	146,568	29,263
Average	cpm	12,197	10,854
Median	cpm	10,102	10,016
Standard Deviation	cpm	11,329	4,082
90th Percentile	cpm	13,046	11,550
95th Percentile	cpm	16,166	11,833
99th Percentile	cpm	78,982	25,433
Measurements per Survey Unit	#/grid	237	
Measurements Above Gamma BTV	#	363	1
Measurements Above Gamma BTV	%	6.7	4.3

Notes:
BTV background threshold value
cpm counts per minute

8.3.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 6.7 percent of the measurements within the Target boundaries, in some cases exceeding greater than 10 times the applied gamma BTV (14,566 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to Jml regional gamma survey results is provided on Figure I20-6. This graph shows that the spread of radiation data at Target T20 (shown on left) begins within the middle range of Jml regional gamma levels (shown on right) and then rises to more than five times background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T20 is higher than the data cloud from the Jml regional data set. A box plot showing the quartiles of the data sets is provided in Figure I20-7. The box plot shows that the median of Target T20 radiation levels is slightly higher than the median of the Jml regional data set but is lower than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I20-8. No mining activity was observed within the survey area of Target T20. In general, Target T20 has surficial gamma radiation levels below Jml regional levels across the majority of the Target except for a hotspot located primarily in survey unit 8, indicating that the survey encompassed the area of elevated gamma activity identified by the ASPECT gamma survey (Figure I20-3). No TENORM or mining-related activities were observed. Section 8.3.5.3 presents the grid averaged results of the gamma radiation survey.

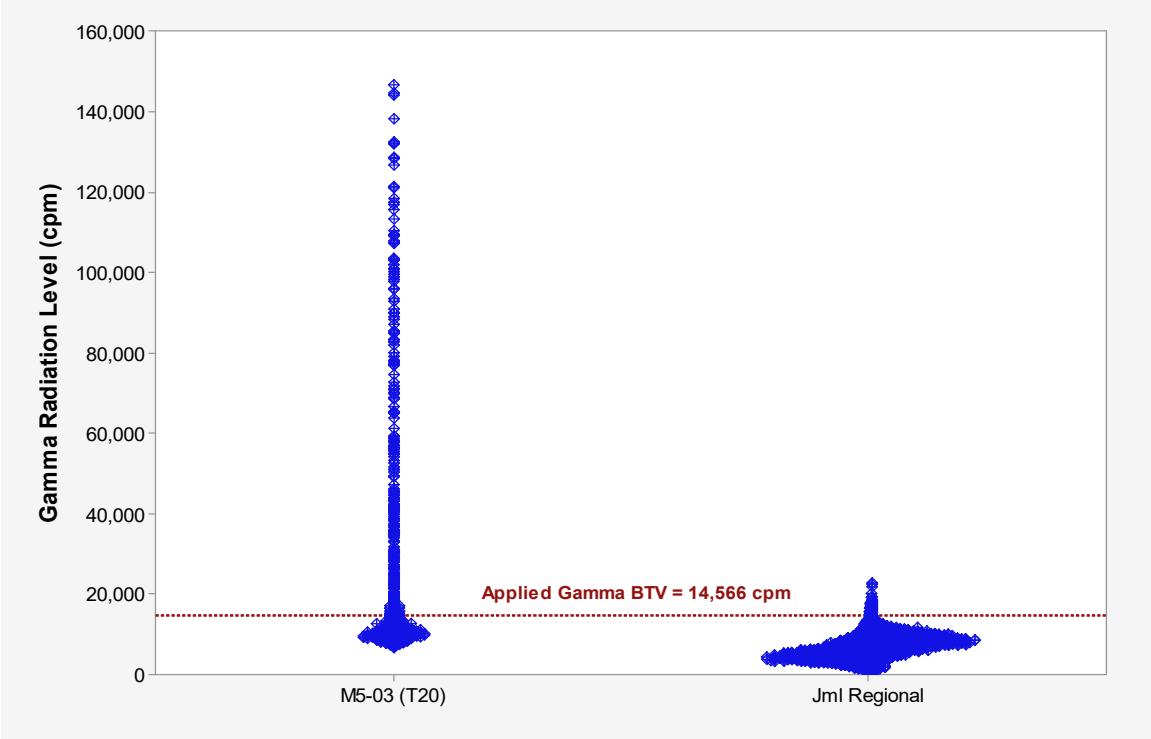


Figure I20-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M5-03 (T20) and Jml Regional

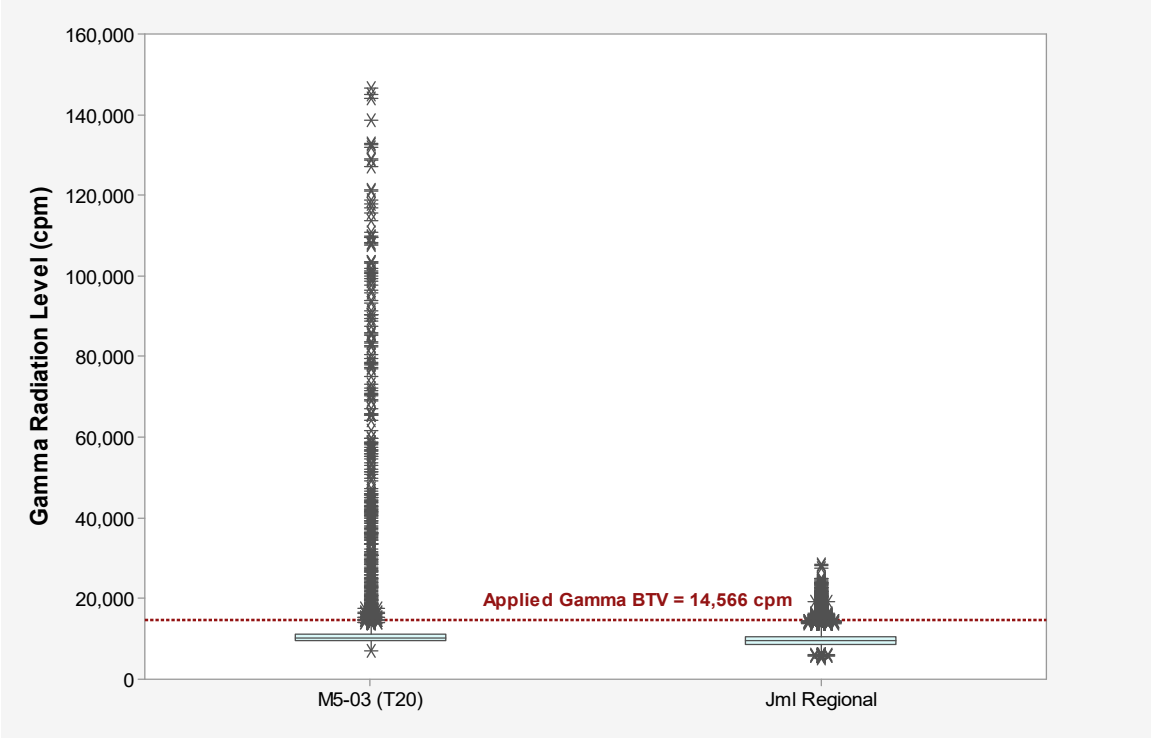
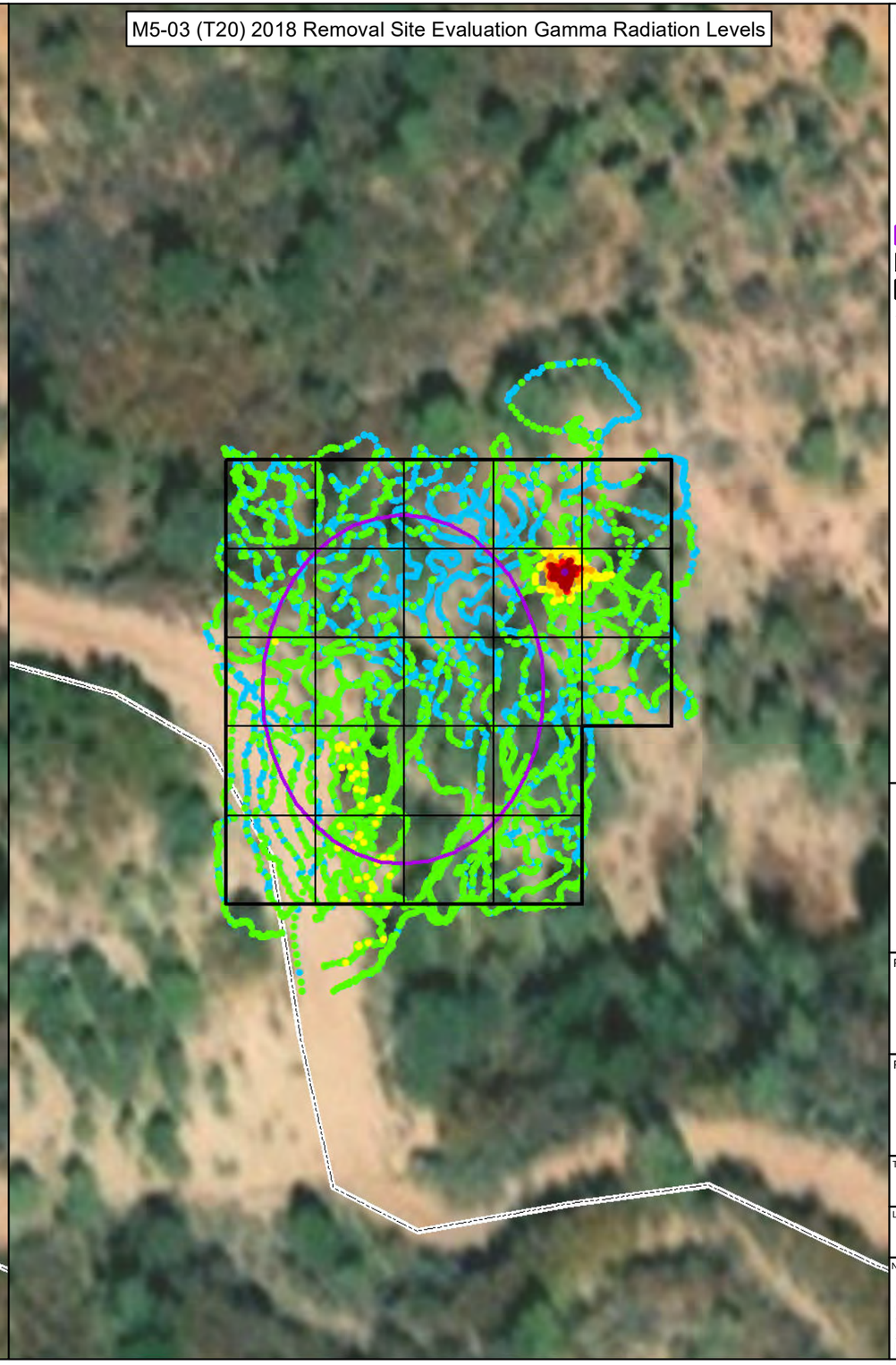


Figure I20-7. Box Plot of Raw Gamma Radiation Levels at Target M5-03 (T20) and Jml Regional

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





Gamma Reading (cpm)*

≤ 9,712	≤ Avg. BG
9,712 - 14,566	Avg. BG - 1 x BTV
14,566 - 29,132	1 x BTV - 2 x BTV
29,132 - 43,698	2 x BTV - 3 x BTV
43,698 - 58,264	3 x BTV - 4 x BTV
58,264 - 145,660	4 x BTV - 10 x BTV
≥ 145,660	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Access Route - Vehicular

1 in = 50 ft

1:600

N
W E
S

0 30 60 120 Feet

NON-AUM TARGET M5-03 (T20)
2018 REMOVAL SITE EVALUATION
VS WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/14/2019

Notes:
*The applied gamma background threshold value (BTV) for M5-03 (T20) is 14,566 cpm derived from gamma survey data from BSAs within the Jml formation as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I20-8**

8.3.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 8.3.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 8.3.5.1. Figure I20-9 and Figure I20-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to Jml regional data set (shown on right). A total of 4.3 percent of the survey units (1 of 23) within the survey area of Target T20 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I20-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I20-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. The elevated regions of the Target correspond with the uranium-bearing geology on the hillside, as well as exposure along the haul road.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 8.3.6.

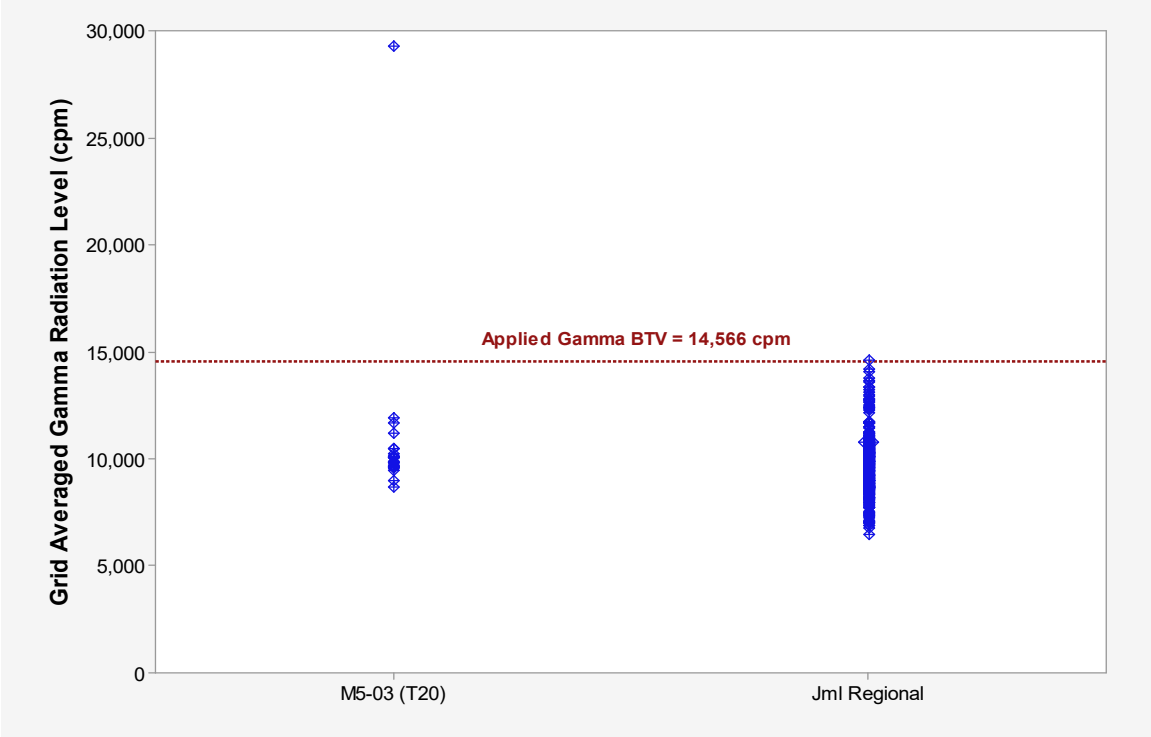


Figure I20-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-03 (T20) and Jml Regional

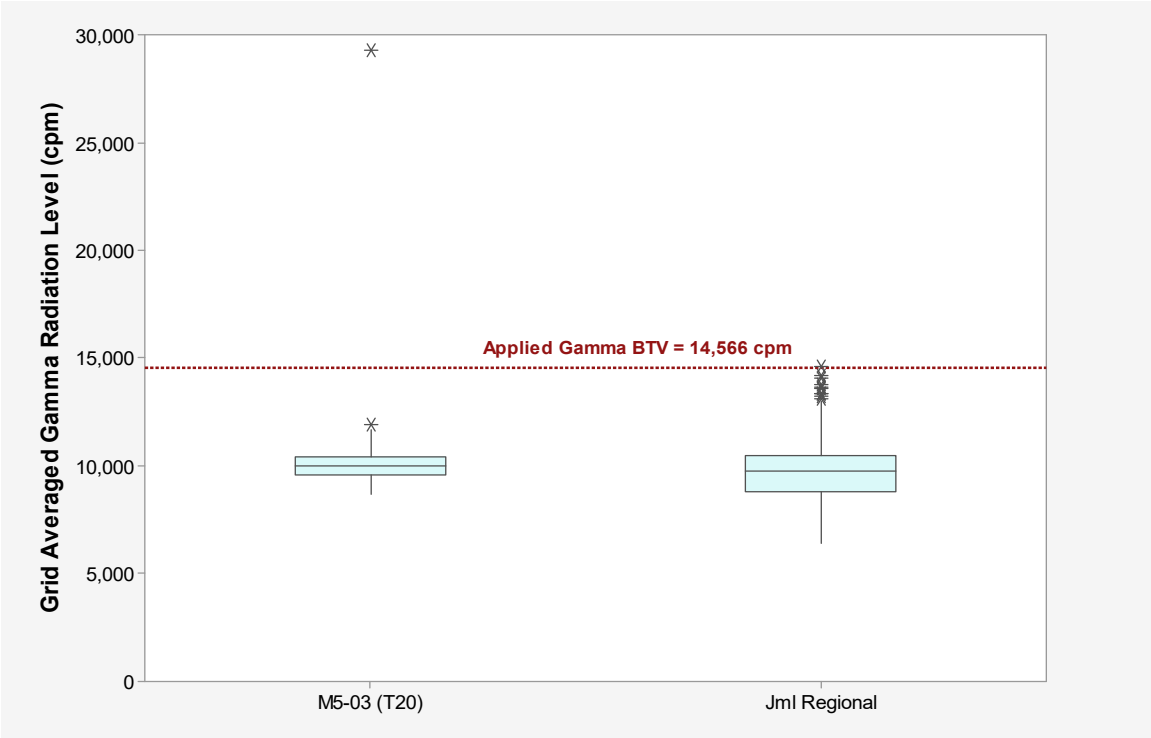


Figure I20-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-03 (T20) and Jml Regional

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



Grid Averaged Gamma Reading (cpm)*

≤ 9,712	≤ Avg. BG
9,712 - 14,566	Avg. BG - 1 x BTV
14,566 - 29,132	1 x BTV - 2 x BTV
29,132 - 43,698	2 x BTV - 3 x BTV
43,698 - 58,264	3 x BTV - 4 x BTV
58,264 - 145,660	4 x BTV - 10 x BTV
≥ 145,660	≥ 10 x BTV

*The applied gamma radiation background threshold value (BTV) for M5-03 (T20) is 14,566 cpm derived from gamma survey data for BSAs within the Jml formation as presented in Appendix A.

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NON-AUM TARGET M5-03 (T20) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I20-11
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.3.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T20. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 8.3.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 8.3.6.2.

8.3.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T20: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I20-1 and I20-2. All the results of the XRF confirmation soil samples are presented in Table I20-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T20 following the methods outlined in Section 2.4 and shown in Figure I20-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 23 measurements were collected across 23 survey units from the survey area of Target T20 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I20-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T20 at a depth of 0 to 3 inches bgs. Two XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I20-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 8.3.7.

Table I20-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-03 (T20)

Analyte	Units	Applied BTV	T20-XS14-01-052218		T20-XSG3-01-091118	
			Result	Q	Result	Q
Survey Unit			X14		G3	
Aluminum	mg/kg	7,000	3,200		3,500	
Antimony	mg/kg	0.140	0.047	J	0.12	
Arsenic	mg/kg	3.5	2.4		2.1	
Barium	mg/kg	270	94		79	
Beryllium	mg/kg	0.55	0.32		0.28	
Cadmium	mg/kg	0.150	0.04	J	0.099	J
Calcium	mg/kg	32,000	3,400		4,500	
Chromium	mg/kg	5.2	2.7		2.9	
Cobalt	mg/kg	4.4	2		2.2	
Copper	mg/kg	12	4.2		5.2	
Iron	mg/kg	8,897	4,300		4,800	
Lead	mg/kg	10	4.2		6.8	
Lithium	mg/kg	8.8	3.9		4.3	
Magnesium	mg/kg	3,900	1,300		1,700	
Manganese	mg/kg	440	210		170	
Molybdenum	mg/kg	0.29	0.15	J	0.15	J
Nickel	mg/kg	6.2	3.7		3.2	
Potassium-40	pCi/g	22.5	17.5		15.5	
Radium-226	pCi/g	2.23	0.63	LT	0.8	LT
Radium-228	pCi/g	0.75	<0.29	U	<0.59	U
Selenium	mg/kg	0.99	0.66	J	0.83	J
Silver	mg/kg	0.037	0.012	J	0.018	J
Sodium	mg/kg	45	<98	U	<97	U
Thallium	mg/kg	0.075	0.042		0.047	
Thorium	mg/kg	4.5	2.9		3.4	
Uranium	mg/kg	1.5	0.51		0.83	
Vanadium	mg/kg	24	13		11	
Zinc	mg/kg	27	<9.8	U	13	

Notes:

BTV Background threshold value
J Estimated value
J- Estimated value, may be biased low
LT Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
M3 The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg Milligrams per kilogram
NA Not applicable
NV No Value
pCi/g Picocuries per gram
Q Qualification
U Not considered detected. The associated value is the method detection limit (MDL).
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

Table I20-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-03 (T20)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	3.5	8,897	10	440	0.29	4.5	1.5	24	27
Measurements	#	23	23	23	23	23	23	23	23	23
Detects	#	12	23	23	21	6	22	17	16	23
Nondetects	#	11	0	0	2	17	1	6	7	0
Minimum	mg/kg	2.0	3,708	4.2	176.4	0.1	1.0	0.4	17.6	11.5
Maximum	mg/kg	4	7,798	10.5	457	3.2	2.9	6.0	149.2	34.8
Standard Deviation	mg/kg	0.7	906	1.8	73	1.51	0.6	1.3	37	5.8
Average	mg/kg	3.0	5,945	7.7	302	1.54	2.0	1.7	41.2	18.8
Median	mg/kg	3.0	6,036	7.5	278	1.35	2.2	1.4	27.1	17.6
Relative Standard Deviation	%	24.1	15.2	22.8	24.2	97.9	27.8	80.5	88.8	30.7
90th Percentile	mg/kg	3.6	6,861	10.2	384	3.1	2.6	2.7	87	26
95th Percentile	mg/kg	4.0	7,323	10.3	429	3.2	2.8	4.1	115	29
99th Percentile	mg/kg	4.3	7,704	10.4	451	3.2	2.8	5.6	142	34
Measurements Above Applied BTV	#	2	0	4	1	3	0	7	11	2
Measurements Above Applied BTV	%	8.7	0.0	17.3	4.3	13.0	0.0	30.4	47.8	8.7

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value

mg/kg Milligram per kilogram

XRF X-ray fluorescence

8.3.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T20 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T20 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T20. The estimated BTVs are identified in Section 8.3.4 and Table I20-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I20-7 presents a summary of the background comparison for different measurement and soil depths at Target T20. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T20. However, gamma radiation screening indicated that gamma levels at Target T20 are elevated in comparison to the BSA and appear to be associated with outcropping of Jml. Therefore, while multiple COPCs have been identified at Target T20 based on a conservative comparison to background, risk screening will be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I20-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-03 (T20)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic		✓	✓
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron			
Lead		✓	✓
Lithium			
Magnesium			
Manganese			
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium			
Silver			
Sodium			
Thallium			
Thorium			
Uranium		✓	✓
Vanadium		✓	✓
Zinc		✓	✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

8.3.7 Primary Contaminant Mapping

8.3.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 8.3.6.2 identified the COPCs at Target T20. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 8.3.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I20-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T20 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 8.3.7.1 through Section 8.3.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T20. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

8.3.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I20-7. Arsenic exceeded the applied BTV in 8.7 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for arsenic is 3.5 mg/kg for Target T20 as presented in Section 8.3.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I20-5 and Attachment I3, respectively. Figure I20-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T20 and Jml regional samples. Figure I20-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T20 and Jml regional samples. Summary statistics for XRF measurements are provided in Section 8.3.6.1. Arsenic XRF concentrations measured in surface soils at Target T20 ranged between 2.0 and 4.0 mg/kg with an average and standard deviation of 3.0 mg/kg and 0.7 mg/kg, respectively. The average arsenic XRF concentration is below the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T20 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I20-14. Overall, the majority of detectable arsenic results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials.

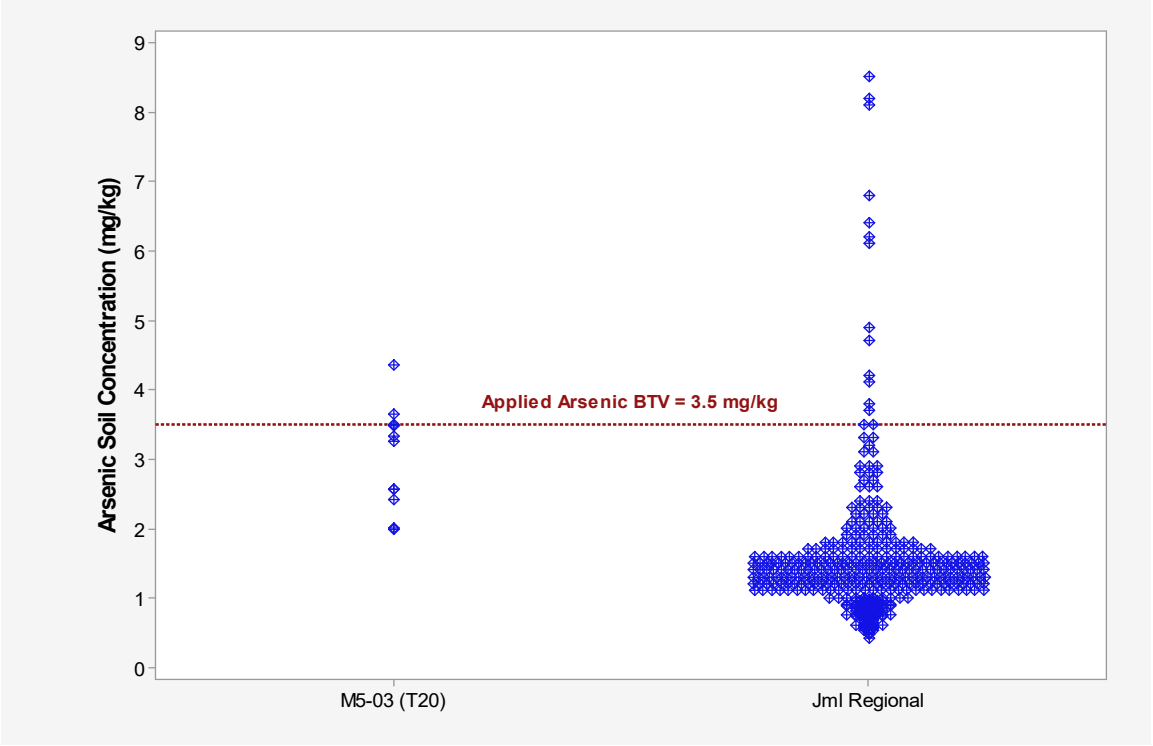


Figure I20-12. Individual Value Plot for Target M5-03 (T20) and Jml Regional Arsenic Soil Concentrations

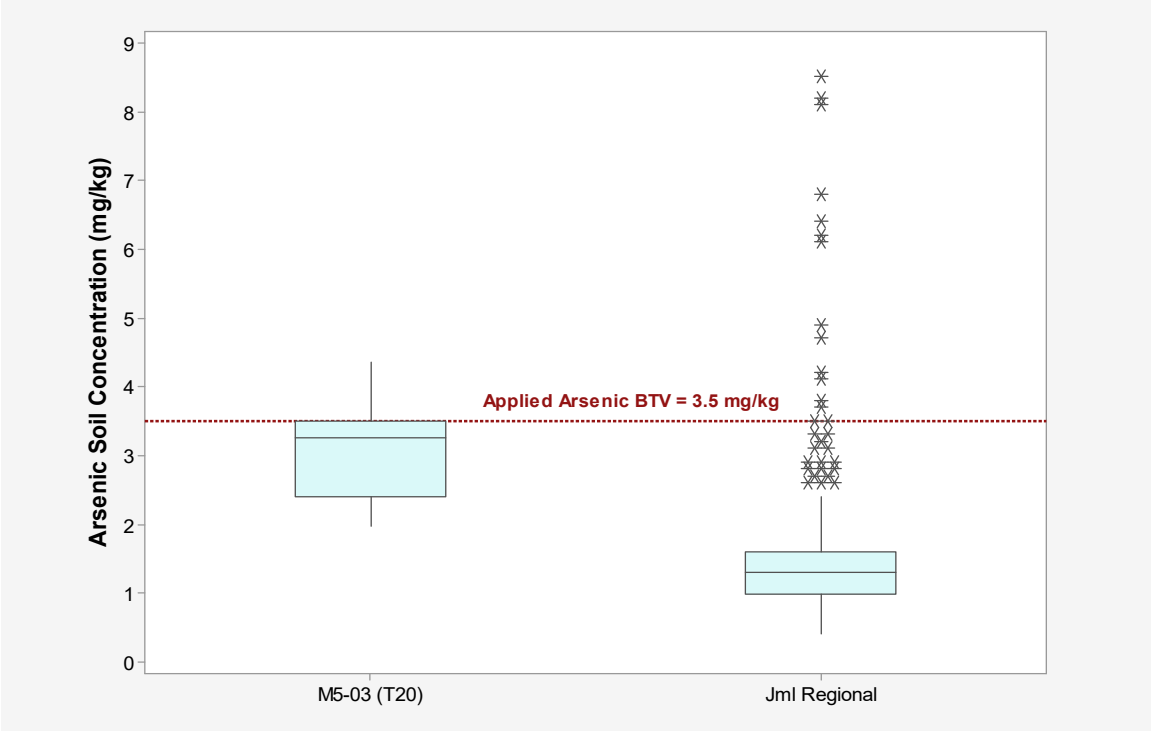


Figure I20-13. Box Plot for Target M5-03 (T20) and Jml Regional Arsenic Soil Concentrations

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



*Arsenic concentration scale values for M5-03 (T20) are based on an applied background threshold value (BTV) of 3.5 mg/kg derived from BSAs within the Jml formation as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 1.5
- 1.5 - 3.5
- 3.5 - 7.0
- 7.0 - 11
- 11 - 14
- 14 - 35
- ≥ 35
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M5-03 (T20) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I20-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.3.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I20-7. Lead exceeded the applied BTV in 17.3 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for lead is 10 mg/kg for Target T20 as presented in Section 8.3.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I20-5 and Attachment I3, respectively. Figure I20-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T20 and BSA-21 (Jml) samples. Figure I20-16 presents a box plot of detectable lead XRF soil concentrations for Target T20 and BSA-21 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.3.6.1. Lead XRF concentrations measured in surface soils at Target T20 ranged between 4.2 and 10.5 mg/kg with an average and standard deviation of 7.7 mg/kg and 1.8 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T20 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I20-17. Overall, the majority of detectable lead results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials.

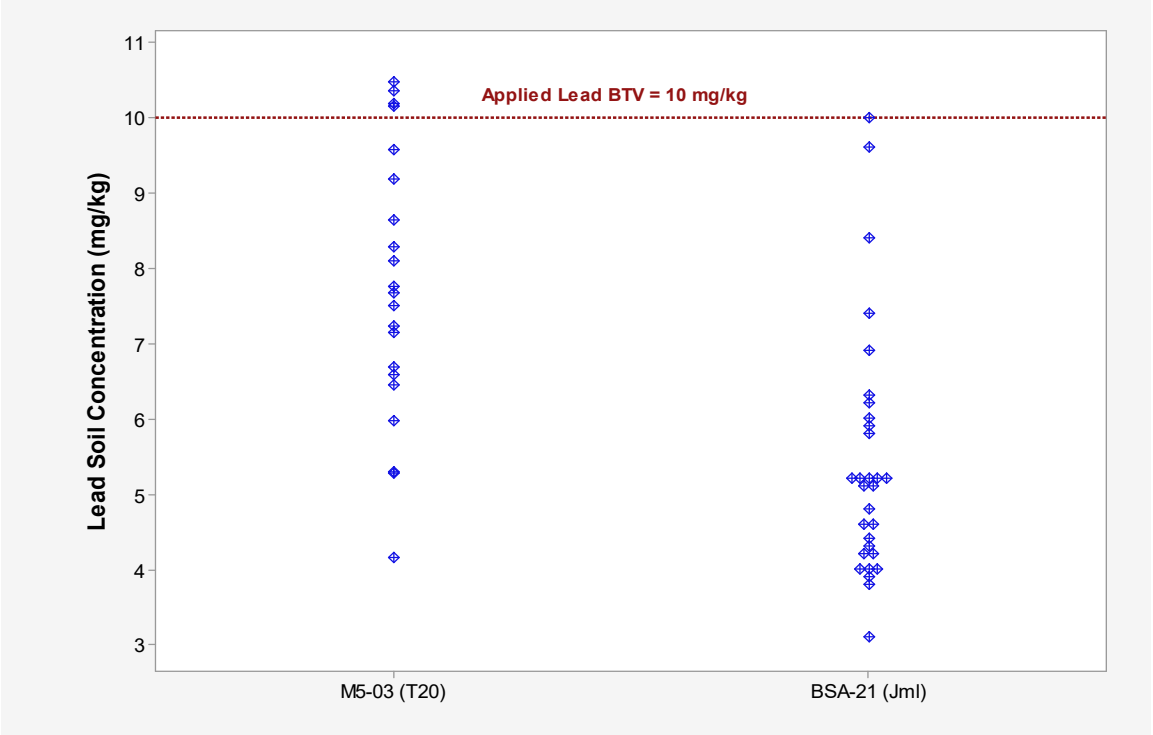


Figure I20-15. Individual Value Plot for Target M5-03 (T20) and BSA-21 (Jml) Lead Soil Concentrations

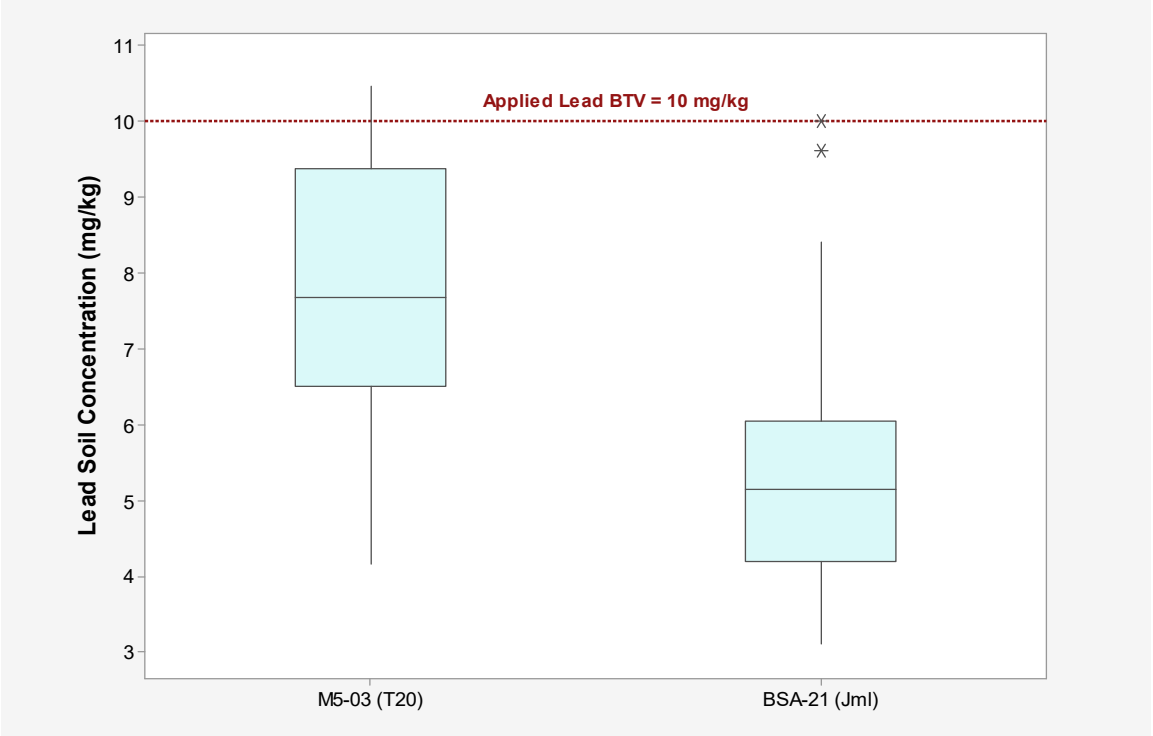


Figure I20-16. Box Plot for Target M5-03 (T20) and BSA-21 (Jml) Lead Soil Concentrations

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



Lead Concentration Scale (mg/kg)*

- ≤ 5.4
- 5.4 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 100
- ≥ 100

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M5-03 (T20) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I20-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.3.7.4 Thorium

Thorium was not identified as a COPC in surface soil as shown in Table I20-7. Thorium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for thorium is 4.5 mg/kg for Target T20 as presented in Section 8.3.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I20-5 and Attachment I3, respectively. Figure I20-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T20 and BSA-21 (Jml) samples. Figure I20-19 presents a box plot of detectable thorium XRF soil concentrations for Target T20 and BSA-21 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.3.6.1. Thorium XRF concentrations measured in surface soils at Target T20 ranged between 1.0 and 2.9 mg/kg with an average and standard deviation of 2.0 mg/kg and 0.6 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T20 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I20-20. All thorium results in surface soils were less than the applied BTV.

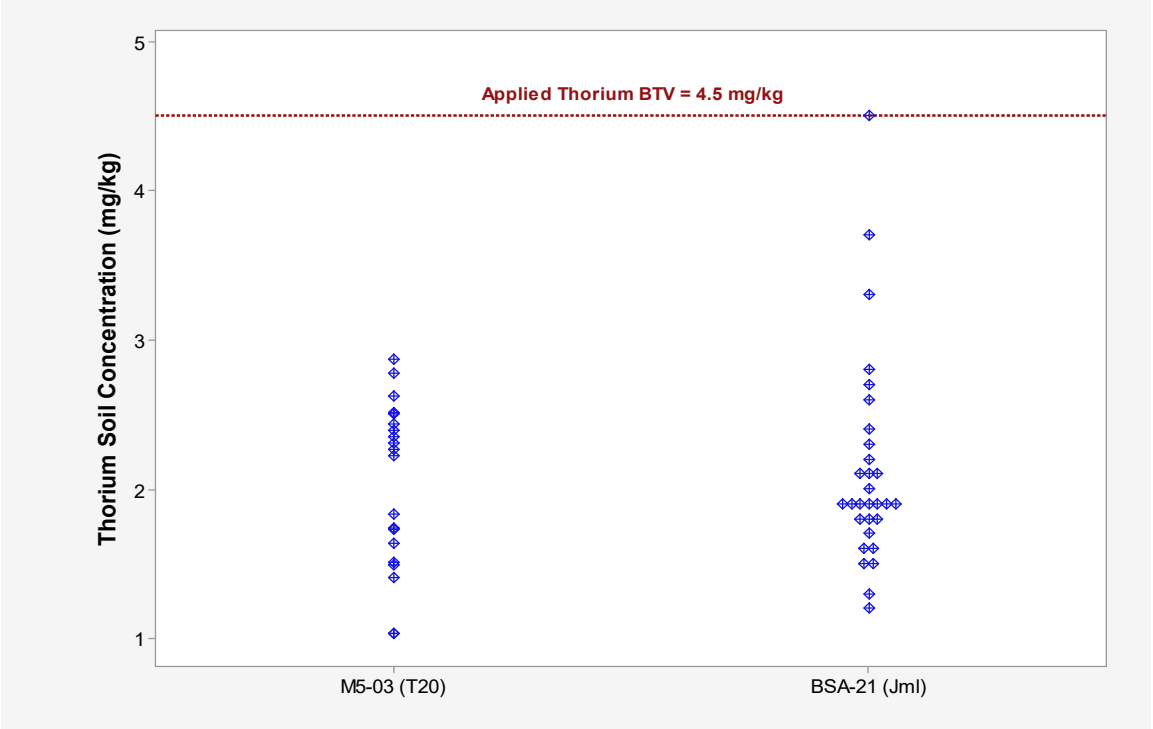


Figure I20-18. Individual Value Plot for Target M5-03 (T20) and BSA-21 (Jml) Thorium Soil Concentrations

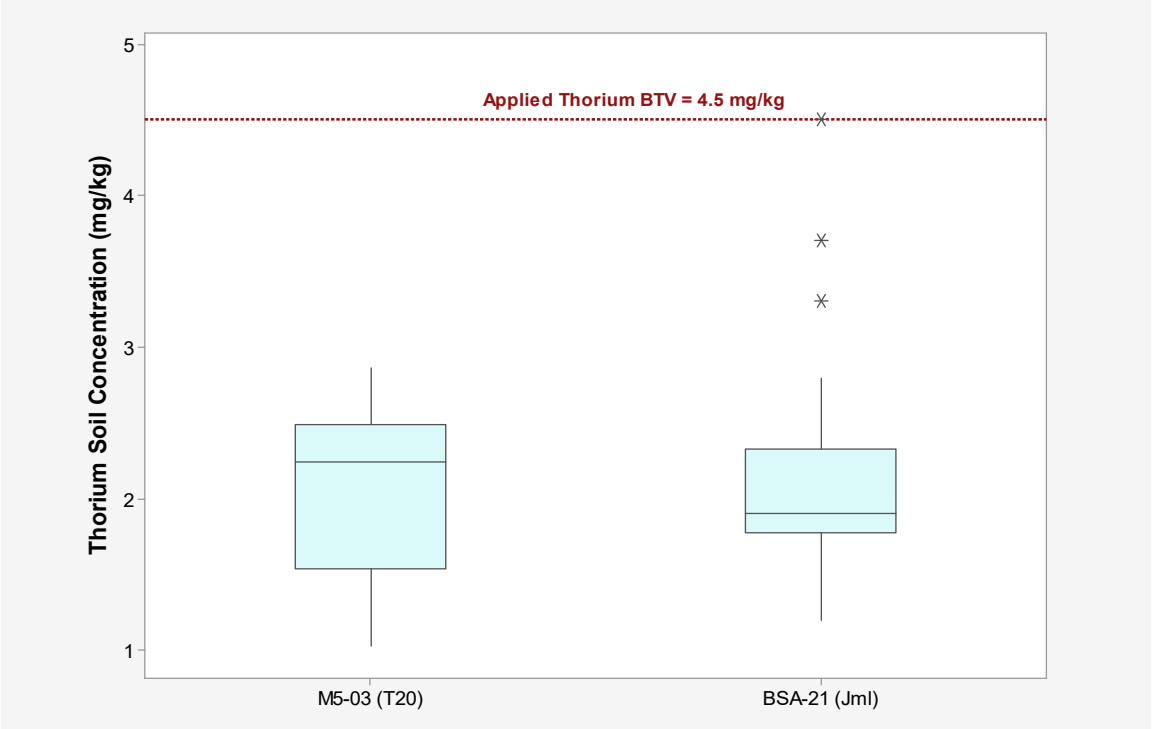
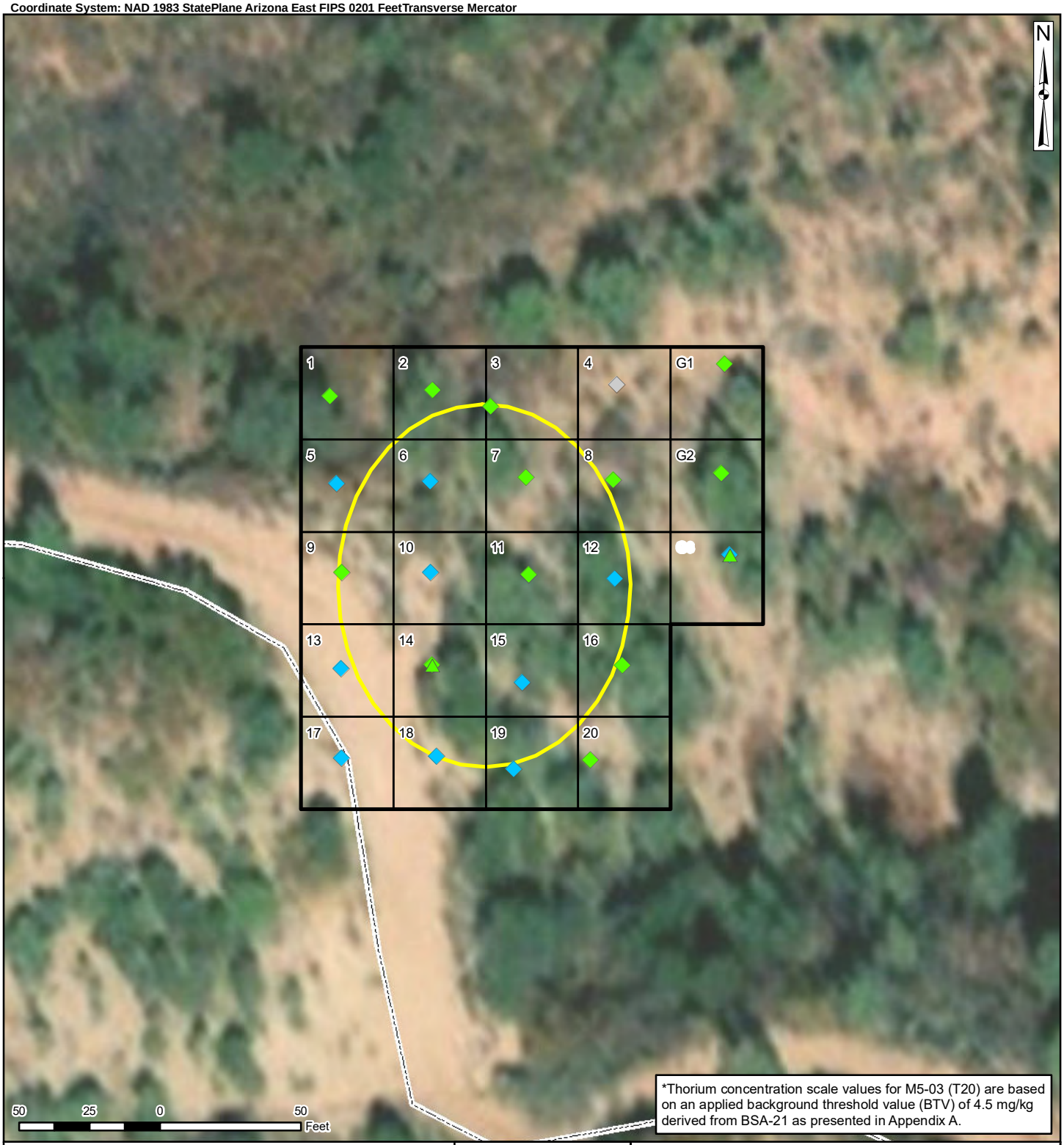


Figure I20-19. Box Plot for Target M5-03 (T20) and BSA-21 (Jml) Thorium Soil Concentrations

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



Thorium Concentration Scale (mg/kg)*

- ≤ 2.1
- 2.1 - 4.5
- 4.5 - 9.0
- 9.0 - 14
- 14 - 18
- 18 - 45
- ≥ 45
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M5-03 (T20) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I20-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.3.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I20-7. Uranium exceeded the applied BTV in 30.4 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for uranium is 1.5 mg/kg for Target T20 as presented in Section 8.3.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I20-5 and Attachment I3, respectively. Figure I20-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T20 and Jml regional samples. Figure I20-22 presents a box plot of detectable uranium XRF soil concentrations for Target T20 and Jml regional samples. Summary statistics for XRF measurements are provided in Section 8.3.6.1. Uranium XRF concentrations measured in surface soils at Target T20 ranged between 0.4 and 6.0 mg/kg with an average and standard deviation of 1.7 mg/kg and 1.3 mg/kg, respectively. The average uranium XRF concentration is slightly above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T20 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I20-23. Overall, the majority of detectable uranium results in surface soils were above the applied BTV. However, the maximum XRF value was about 4 times higher than the applied BTV and does not appear to be associated with mining-related materials.

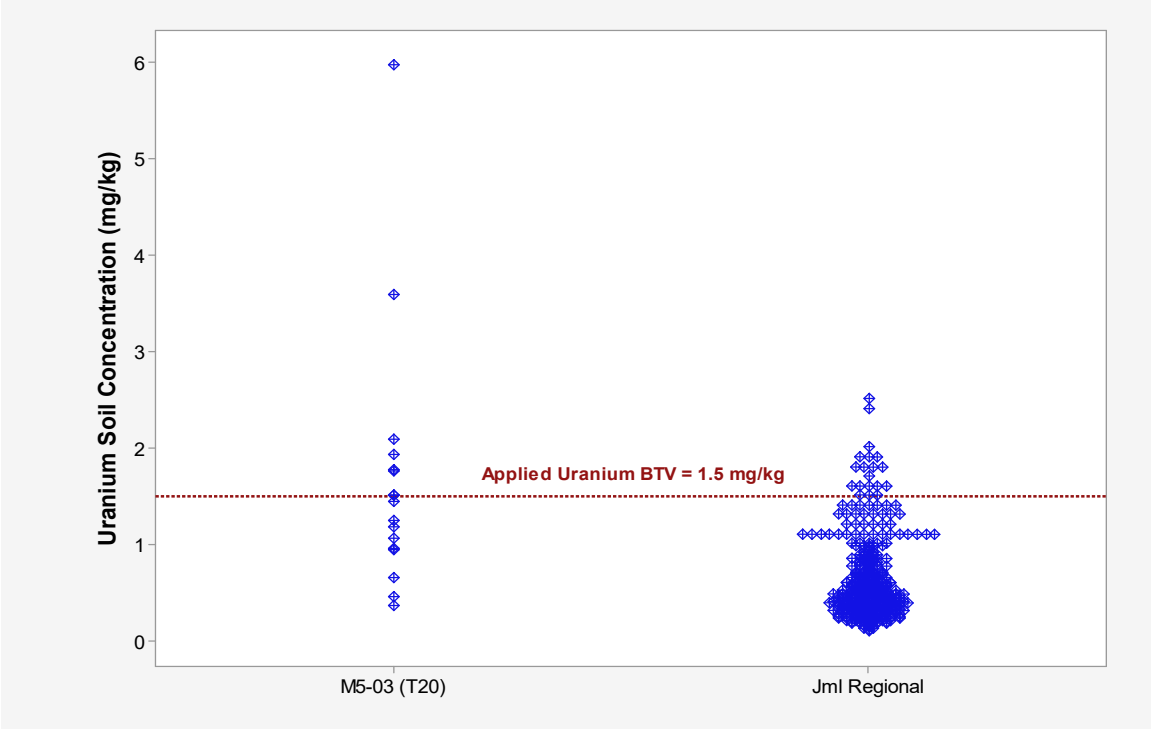


Figure I20-21. Individual Value Plot for Target M5-03 (T20) and Jml Regional Uranium Soil Concentrations

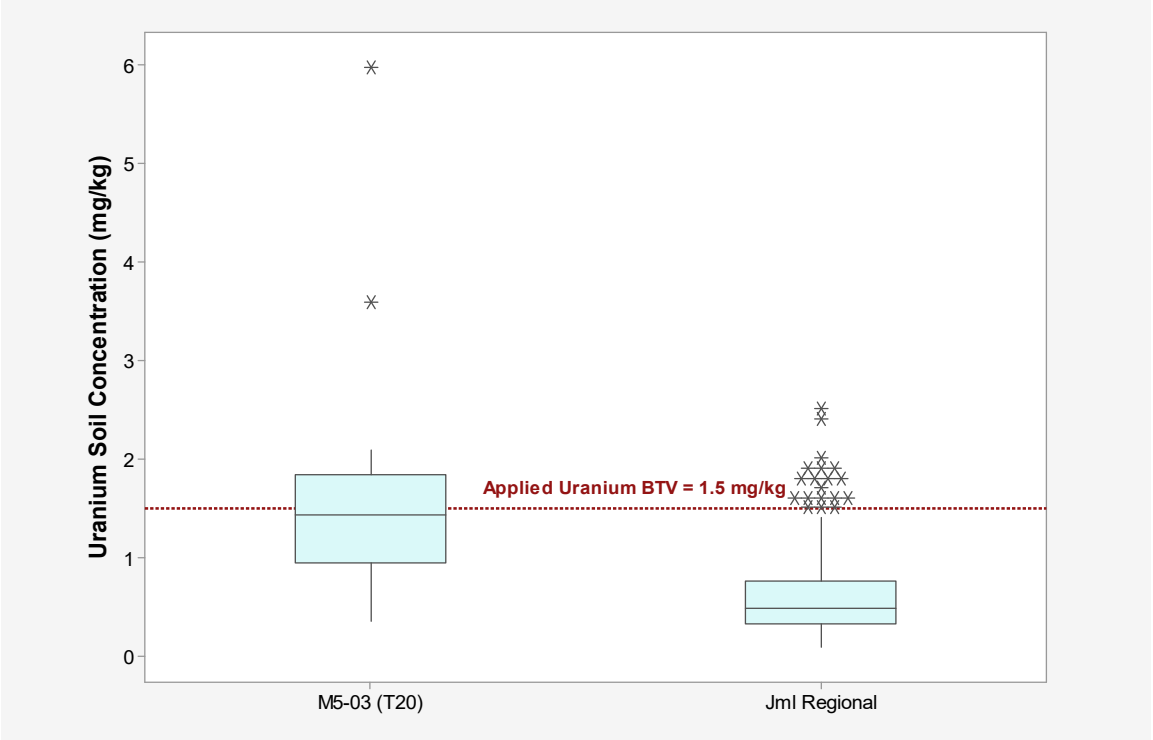


Figure I20-22. Box Plot for Target M5-03 (T20) and Jml Regional Uranium Soil Concentrations

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



*Uranium concentration scale values for M5-03 (T20) are based on an applied background threshold value (BTV) of 1.5 mg/kg derived from BSAs within the Jml formation as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 0.61
- 0.61 - 1.5
- 1.5 - 3.0
- 3.0 - 4.5
- 4.5 - 6.0
- 6.0 - 15
- ≥ 15
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M5-03 (T20) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I20-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.3.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I20-7. Vanadium exceeded the applied BTV in 47.8 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for vanadium is 24 mg/kg for Target T20 as presented in Section 8.3.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I20-5 and Attachment I3, respectively. Figure I20-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T20 and Jml regional samples. Figure I20-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T20 and Jml regional samples. Summary statistics for XRF measurements are provided in Section 8.3.6.1. Vanadium XRF concentrations measured in surface soils at Target T20 ranged between 17.6 and 149.2 mg/kg with an average and standard deviation of 41.2 mg/kg and 37 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T20 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I20-26. Overall, the majority of detectable vanadium results in surface soils were above the applied BTV. However, the maximum value was 6.2 times higher than the applied BTV and does not appear to be associated with mining-related materials.

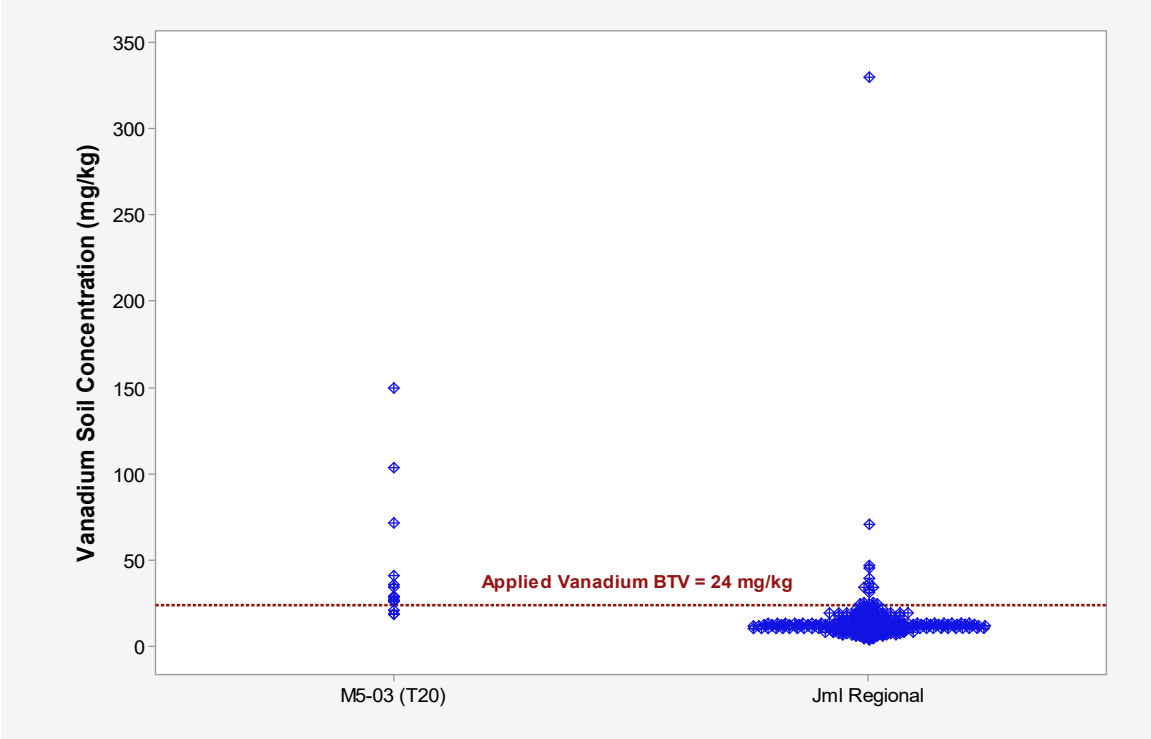


Figure I20-24. Individual Value Plot for Target M5-03 (T20) and Jml Regional Vanadium Soil Concentrations

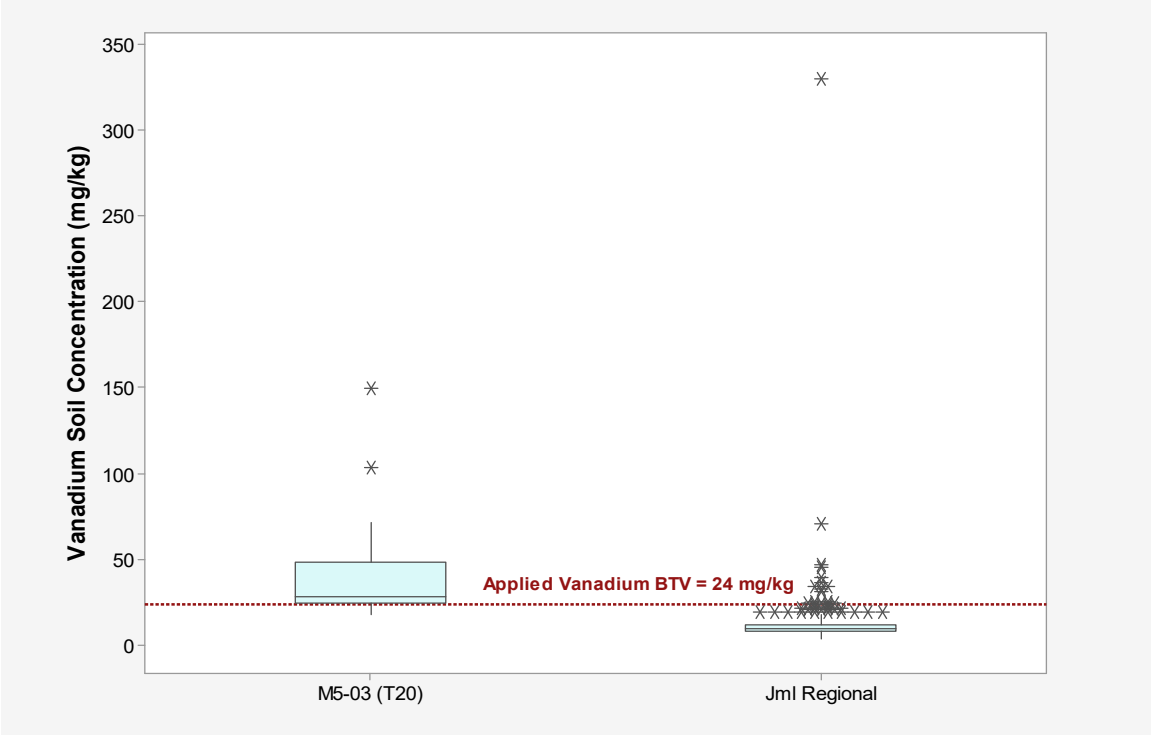


Figure I20-25. Box Plot for Target M5-03 (T20) and Jml Regional Vanadium Soil Concentrations

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



*Vanadium concentration scale values for M5-03 (T20) are based on an applied background threshold value (BTV) of 24 mg/kg derived from BSAs within the Jml formation as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 12
- 12 - 24
- 24 - 48
- 48 - 72
- 72 - 96
- 96 - 240
- ≥ 240
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET M5-03 (T20) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I20-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.3.8 Conclusions

Target T20 (M5-03) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T20. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T20 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T20. ASPECT gamma survey results generally correlated with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T20 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T20 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. However, grid averaged gamma measurements exceeded the applied BTV in 1 of 23 survey units by a factor of up to 2.
- A total of 26 analytes were identified as occurring within the surface environment. Of these analytes, 9 were identified as COPCs. Uranium and vanadium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T20 does not contain TENORM. No mining-related activities or features were observed in the field. Outcropping of Jml was identified in the area of highest gamma activity.
- Natural erosion of outcroppings and road construction may have increased the lateral extent of NORM.
- There are no immediate significant physical hazards present at Target T20.
- Access is by dirt road with a small four-wheel-drive vehicle.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No existing groundwater wells are documented within the vicinity of Target T20. No seeps or springs were observed during the RSE investigation.

- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T20. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No mine waste was observed at Target T20; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; however, one data gap remains for Target T20 and that is field mapping and verification of NORM in outcroppings.

8.4 NON-AUM TARGET T21 (M5-05)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T21 (M5-05).

8.4.1 Access, Physical Conditions, and Field Observations

Target T21 (M5-05) is grouped with non-AUM Target T22 (M5-06) and is located adjacent to the AUM-related burial cell NA-0344B. Target T21 is in the Lukachukai Mountains Region in Subarea Group F within the Cove Chapter of the Navajo Nation and accessed by four-wheel-drive vehicle off of Indian Route 33. Target T21 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. No residential structures are near the Target. A Target location and access map for Target T21 is shown in Figure I21-1.

A topographical relief map for Target T21 and associated AUM areas is provided in Figure I21-2. The elevation at Target T21 ranges from 7,426 to 7,436 feet amsl with an average of 7,432 feet amsl. The slope at Target T21 ranges from 1 to 7 percent with an average of 2 percent. Target T21 is entirely within Jml and within the Arabrab-Wetherill soil complex (MUSYM 414) (Figures I-22 and I-23).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T21. Weston did not conduct a background study for Target T21. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 24 of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T21:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T21 is accessible by four-wheel-drive vehicle off of Indian Route 33.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM was not observed at the Target. Soil covers the top of the Jml, and no outcropping was observed. TENORM may be associated with exploratory borings.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  No drainages were identified at the Target. The closest major drainage is the Middle 1A drainage, which is located approximately 1,000 feet south of the Target and discussed in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

  Seventeen historical exploratory borings were identified during the file review. No haul roads were located at the Target; however, a haul road for the Mesa V Incline (M5) is located to the west.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  Other than the potential historic exploratory borings identified during the file review, no AUM or non-AUM Target features were present at the Target.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target

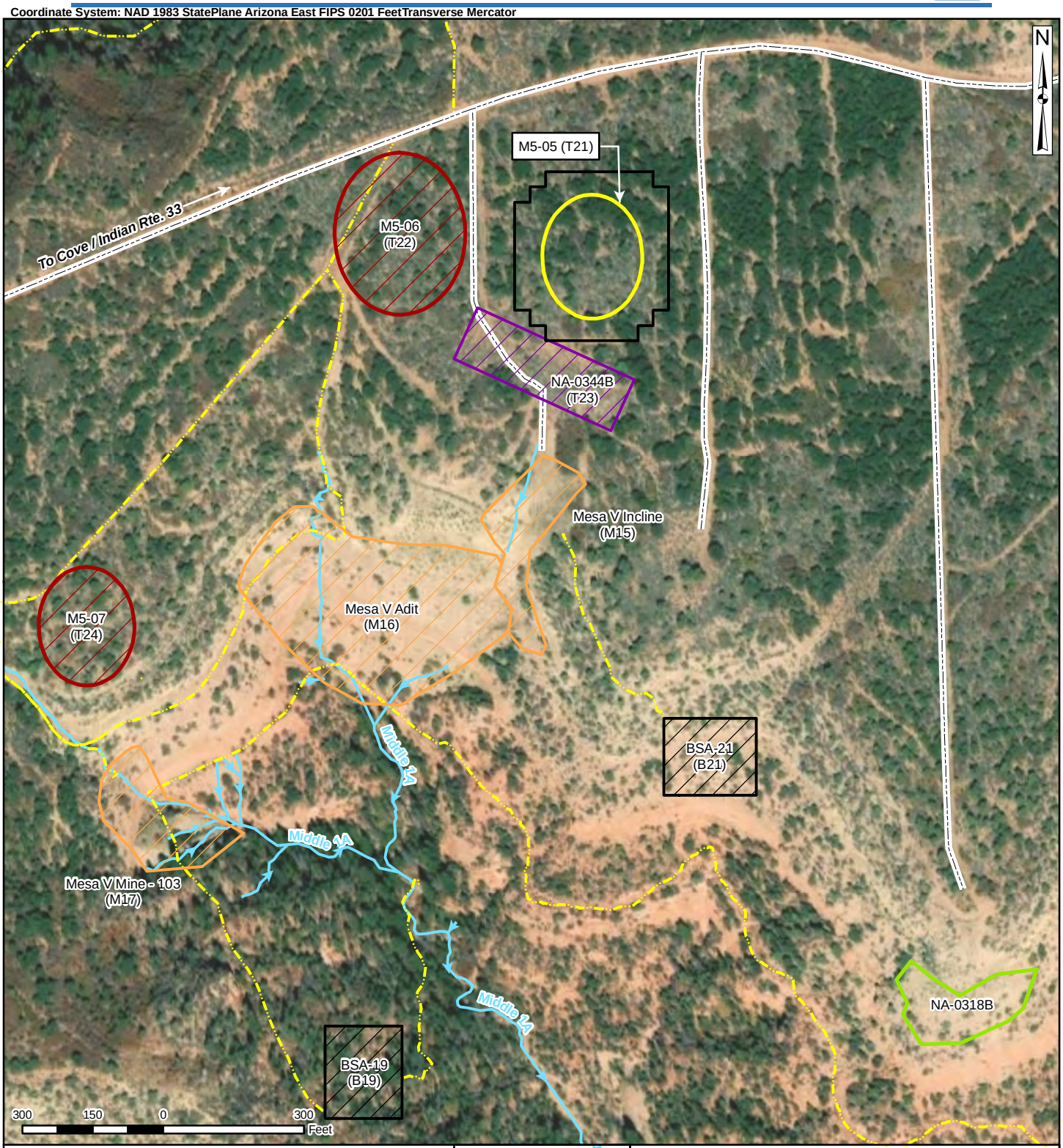
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T21 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Sections 2.3 and 8.4.3)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 8.4.3 with results presented in Sections 8.4.6 and 8.4.7)
- Conducting a gamma radiation survey (results presented in Section 8.4.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



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

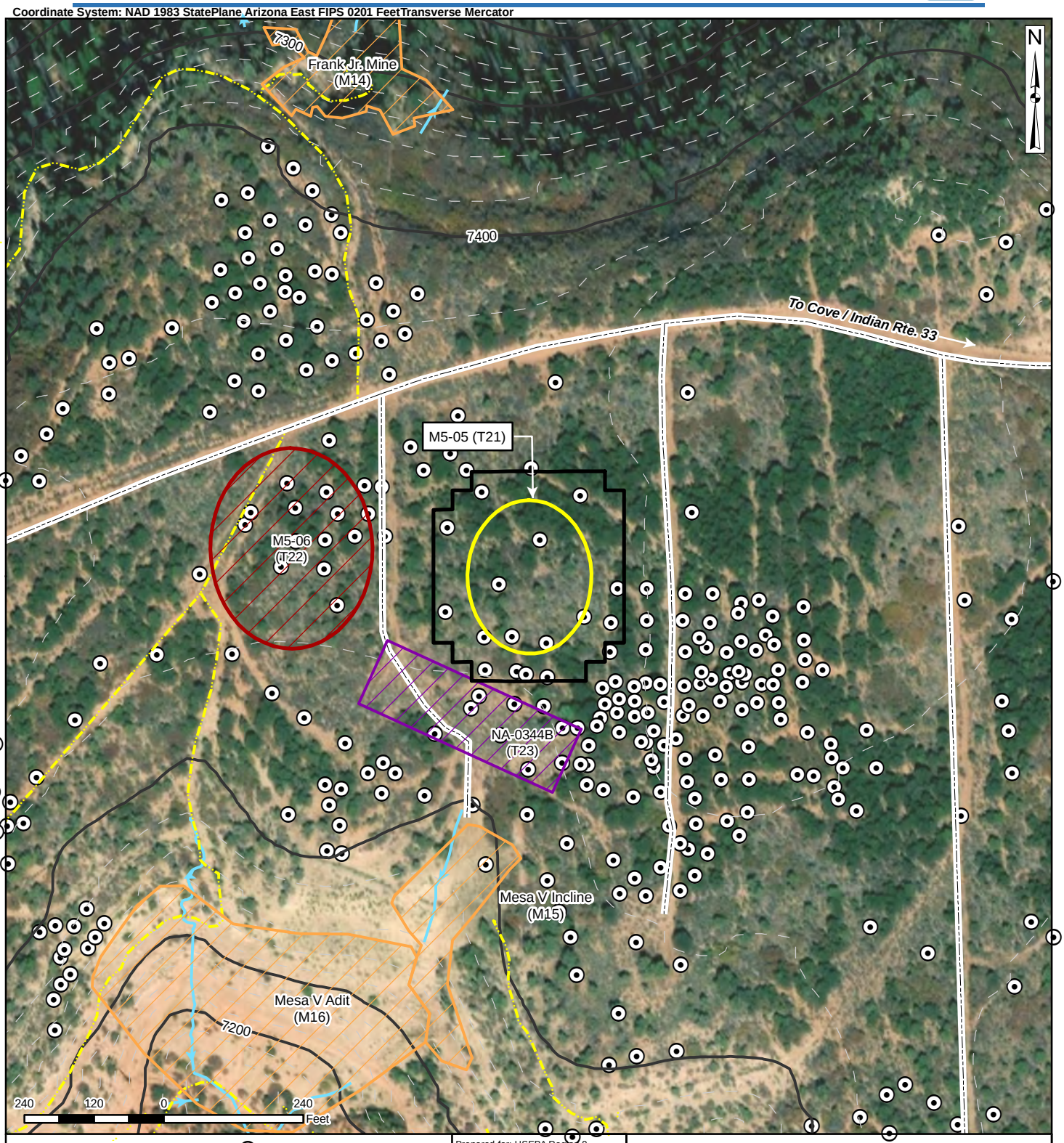
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NON-AUM TARGET M5-05 (T21) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I21-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	



- Non-AUM Target Site Boundary
- Related Survey Area
- Other Non-AUM Target Site
- Tronox AUM Site Boundary
- AUM Related Site Boundary
- Exploratory Bore Hole
- Access Route - Foot
- Access Route - Vehicular
- Drainage - Field Mapped
- 100 ft Contour*
- 20 ft Contour*

* 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.

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NON-AUM TARGET M5-05 (T21) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I21-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	

8.4.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I21-3) within the survey area of the non-AUM Target T21 as part of the Baseline Study in May 2018. Additional Goback gamma radiation surveys were performed in September 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T21 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I21-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 24, of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at 32 survey units. All gamma survey and XRF survey units were evaluated.

8.4.3 XRF Confirmation Sampling Overview

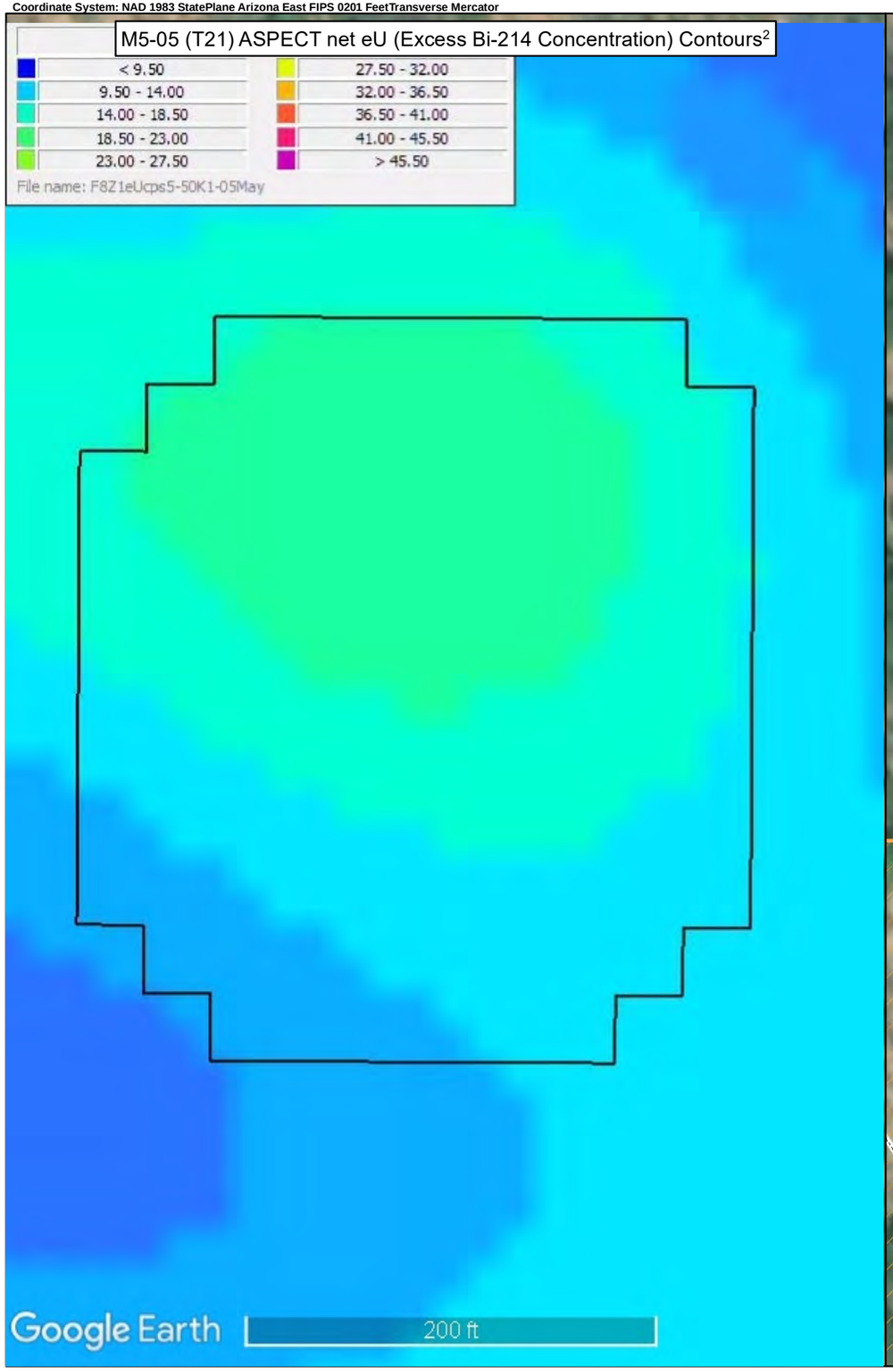
Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T21. Six XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from five locations (Table I21-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I21-4 and I21-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I21-2. The results of XRF confirmation sample analysis are provided in Section 8.4.6.1. Correlated XRF field measurements are provided in Attachment I3.

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

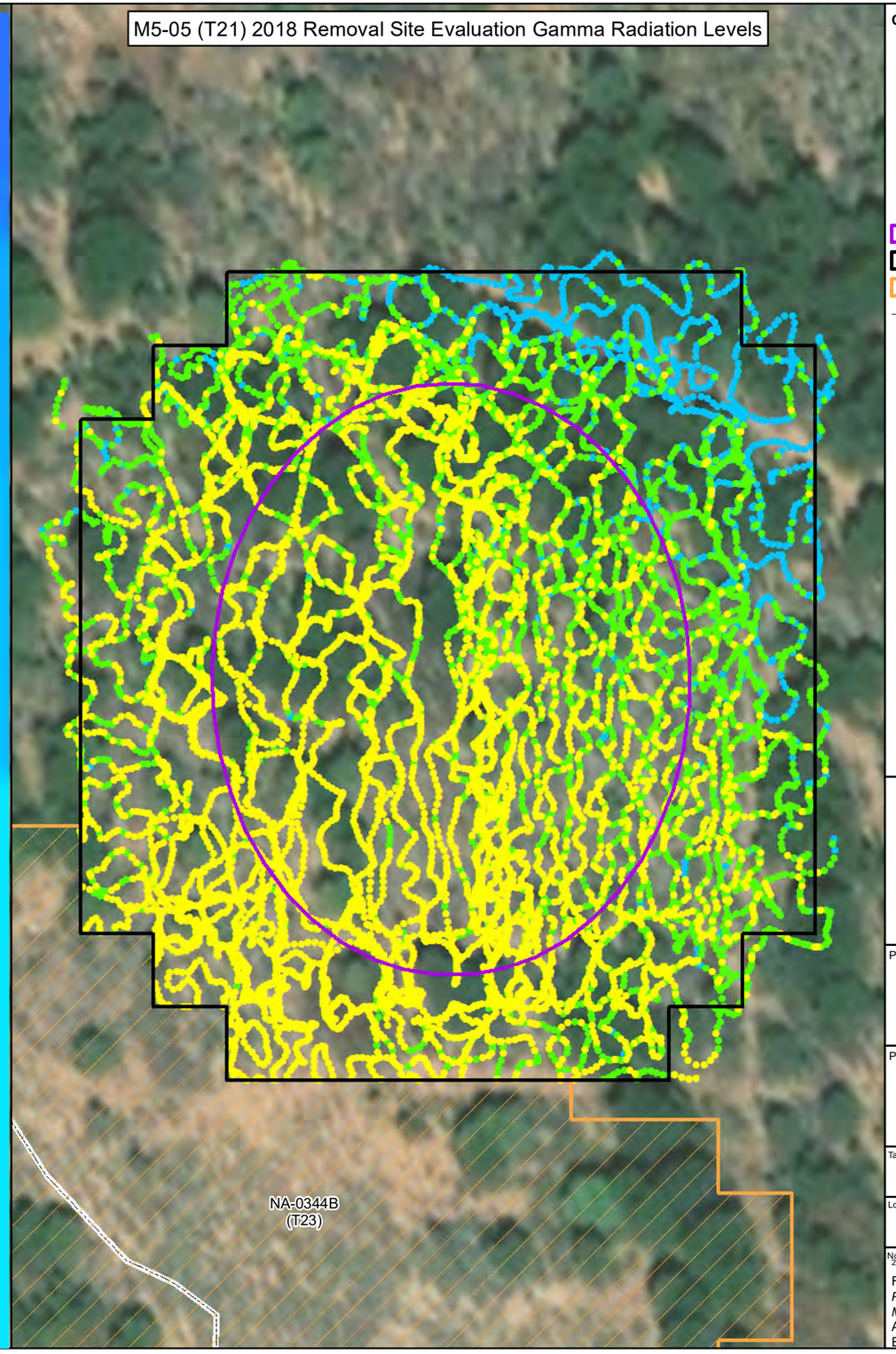
M5-05 (T21) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F8Z1eUcps5-50K1-05May



M5-05 (T21) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)[1]

≤ 10,285	≤ Avg. BG
10,285 - 11,907	Avg. BG - 1 x BTV
11,907 - 23,814	1 x BTV - 2 x BTV
23,814 - 35,721	2 x BTV - 3 x BTV
35,721 - 47,628	3 x BTV - 4 x BTV
47,628 - 119,070	4 x BTV - 10 x BTV
≥ 119,070	≥ 10 x BTV

- Non-AUM Target Site Boundary
- Survey Area Boundary
- Other Survey Area
- Access Route - Vehicular

[1]The applied gamma background threshold value (BTV) for M5-05 (T21) Non-AUM Target is 11,907 cpm derived from BSA-22 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET M5-05 (T21)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

Prepared By:

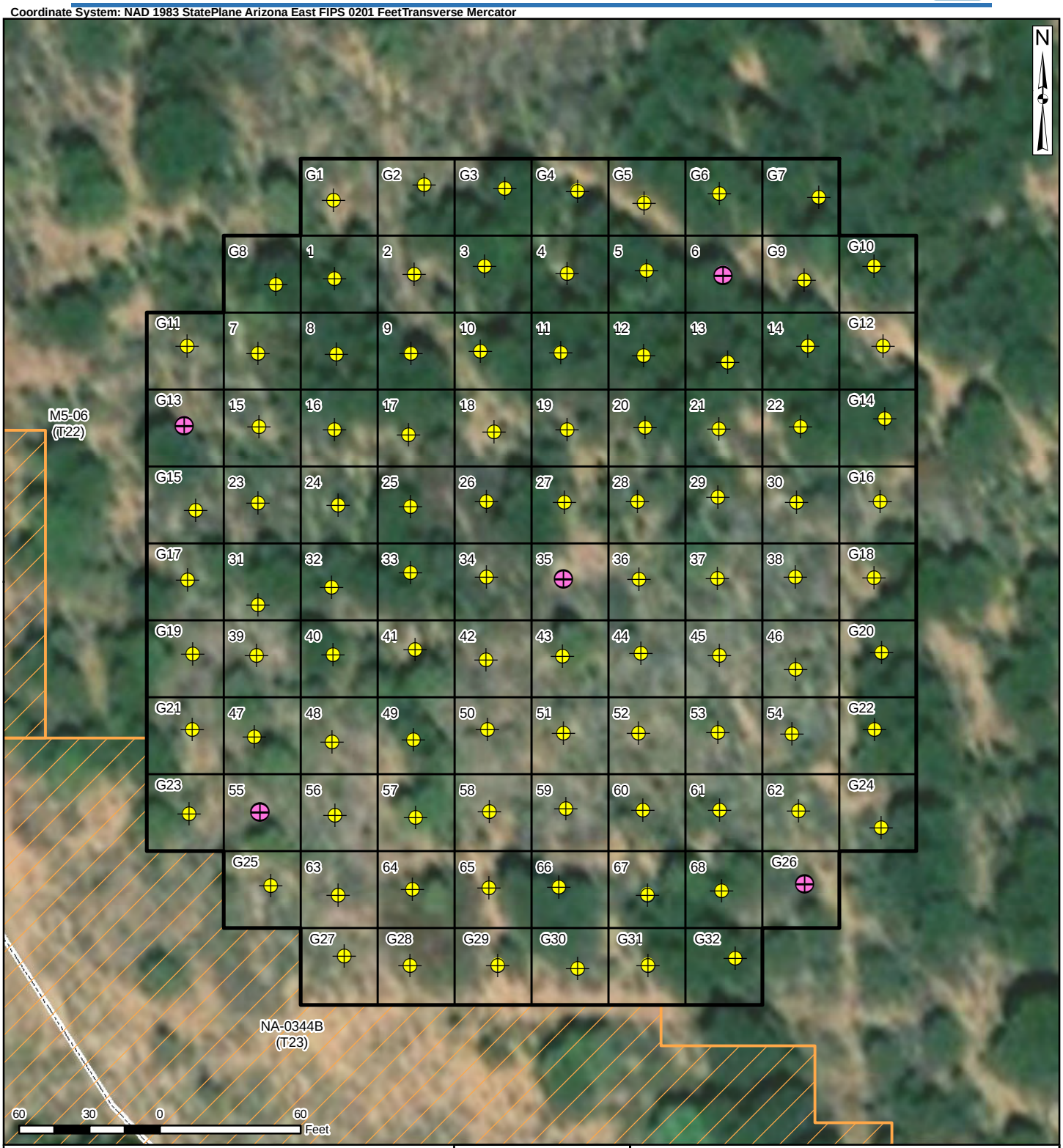
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/13/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborne Spectral Photometric Environmental Collection Technology.

Figure No.: **I21-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Unit (100 m²)

Survey Area Boundary

Other Survey Area

Access Route - Vehicular

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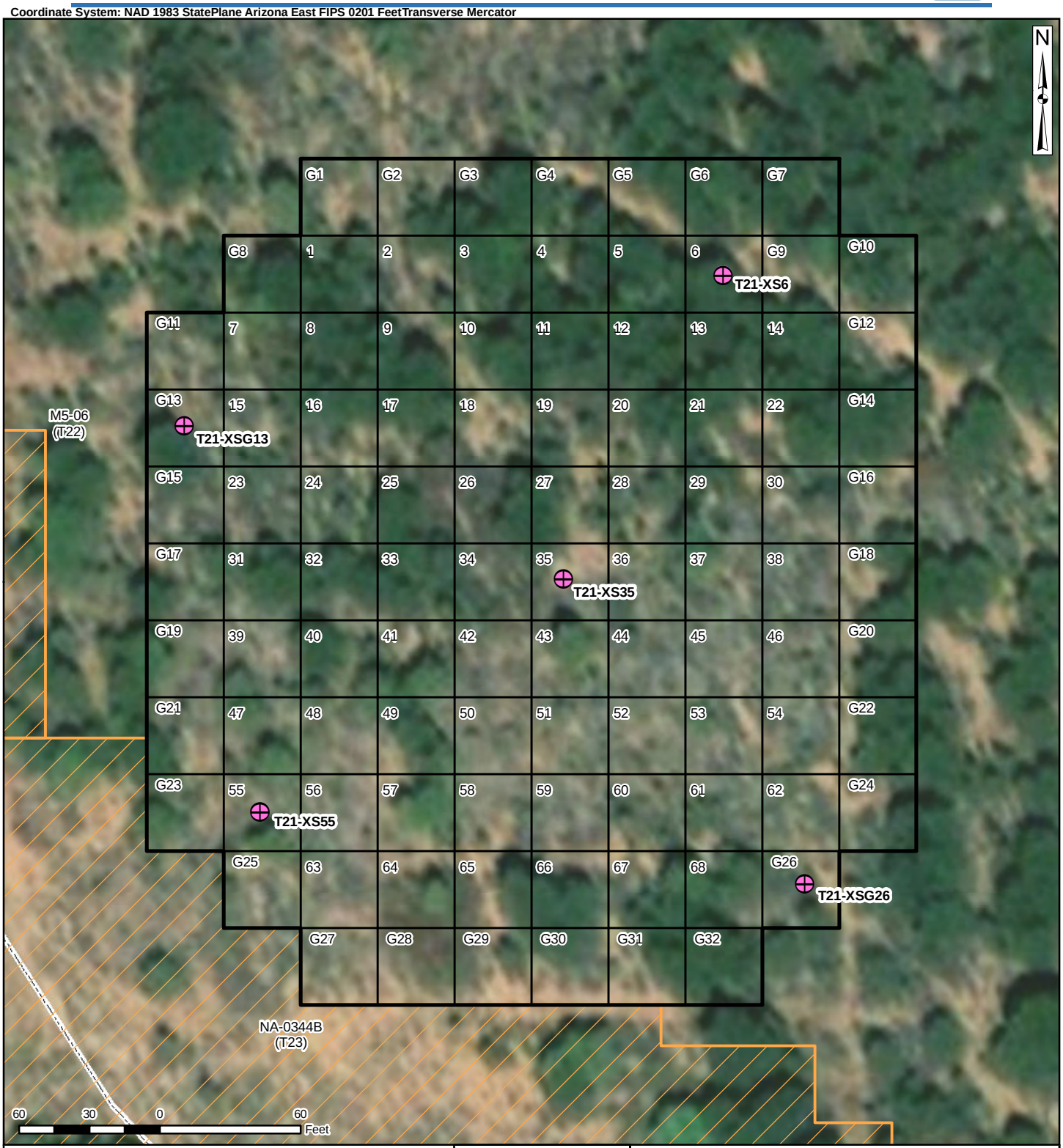
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NON-AUM TARGET M5-05 (T21) XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I21-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

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



XRF Confirmation Soil Sample*
(0 - 3 inches bgs)

Survey Unit (100 m²)

Survey Area Boundary

Other Survey Area

Access Route - Vehicular

*T21-XS6 = site T21 XRF confirmation soil sample collected at survey unit 6. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET M5-05 (T21)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I21-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

Table I21-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-05 (T21)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T21-XS6-01-052118	6	0-3	XRF Confirmation	Primary	5/21/2018	36.5434020	-109.2456711	1805589-17, 1805592-17
T21-XS35-01-052118	35	0-3	XRF Confirmation	Primary	5/21/2018	36.5430476	-109.2459065	1805589-14, 1805592-14
T21-XS55-01-052118	55	0-3	XRF Confirmation	Primary	5/21/2018	36.5427780	-109.2463502	1805589-15, 1805592-15
T21-XS55-02-052118	55	0-3	XRF Confirmation	Duplicate	5/21/2018	36.5427780	-109.2463502	1805589-16, 1805592-16
T21-XSG13-01-091118	G13	0-3	XRF Confirmation	Primary	9/11/2018	36.5432313	-109.2464544	1809473-38, 1809474-38
T21-XSG26-01-091118	G26	0-3	XRF Confirmation	Primary	9/11/2018	36.5426879	-109.2455612	1809473-39, 1809474-39

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I21-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-05 (T21)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

8.4.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 8.4.1, Target T21 surface geology is entirely within Jml and soils within the Arabrab-Wetherill soil complex (MUSYM 414) (Figures I-22 and I-23). As a result, Background Study Area 22 (BSA-22) was selected for that combination of geology and soil type. Additionally, the Jml regional geological background would also be applicable for this Target. Table I21-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T21. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T21. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T21. The “Applied BTV” for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I21-3. Applied Background Threshold Values for Non-AUM Target M5-05 (T21)

Analyte	Units	Site-Specific BTV (BSA-22)	Regional BTV (Jml)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	5,580	7,000	5,580	Site-Specific BTV
Antimony	mg/kg	0.160	0.140	0.140	Regional BTV
Arsenic	mg/kg	2.2	3.5	2.2	Site-Specific BTV
Barium	mg/kg	201	270	201	Site-Specific BTV
Beryllium	mg/kg	0.41	0.57	0.41	Site-Specific BTV
Cadmium	mg/kg	0.192	0.160	0.160	Regional BTV
Calcium	mg/kg	4,960	32,000	4,960	Site-Specific BTV
Chromium	mg/kg	6.1	5.2	5.2	Regional BTV
Cobalt	mg/kg	3.9	4.4	3.9	Site-Specific BTV
Copper	mg/kg	10	12	10	Site-Specific BTV
Iron	mg/kg	7,470	8,897	7,470	Site-Specific BTV
Lead	mg/kg	9.7	11	9.7	Site-Specific BTV
Lithium	mg/kg	5.4	8.8	5.4	Site-Specific BTV
Magnesium	mg/kg	2,500	3,900	2,500	Site-Specific BTV
Manganese	mg/kg	517	440	440	Regional BTV
Mercury	mg/kg	0.0261	0.0378	0.0261	Site-Specific BTV
Molybdenum	mg/kg	0.36	0.29	0.29	Regional BTV
Nickel	mg/kg	6.3	6.2	6.2	Regional BTV
Potassium-40	pCi/g	23.2	26.9	23.2	Site-Specific BTV
Radium-226	pCi/g	1.54	2.23	1.54	Site-Specific BTV
Radium-228	pCi/g	0.50	0.75	0.50	Site-Specific BTV
Selenium	mg/kg	0.93	0.99	0.93	Site-Specific BTV
Silver	mg/kg	0.033	0.037	0.033	Site-Specific BTV
Sodium	mg/kg	29	45	29	Site-Specific BTV
Thallium	mg/kg	0.068	0.075	0.068	Site-Specific BTV
Thorium	mg/kg	3.6	4.7	3.6	Site-Specific BTV
Uranium	mg/kg	1.3	1.5	1.3	Site-Specific BTV
Vanadium	mg/kg	15	24	15	Site-Specific BTV
Zinc	mg/kg	24	27	24	Site-Specific BTV
Gamma Radiation	cpm	11,907	14,566	11,907	Site-Specific BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
Jml Morrison Formation (Lower)
mg/kg milligrams per kilogram
pCi/g picocuries per gram

8.4.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T21 and the raw gamma radiation and grid averaged gamma radiation survey results.

8.4.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T21 in May 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in September 2018 to collect data within the Goback survey units. The applied gamma BTV for non-AUM Target T21 is 11,907 cpm. A total of 11,608 measurements were collected as part of the gamma radiation survey at non-AUM Target T21 across 100 survey units. Because of the thick vegetation, not all survey units were scanned at 100 percent density. An average scan density of 116 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I21-4.

Table I21-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-05 (T21)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,907	
Measurements	#	11,608	100
Minimum	cpm	7,622	9,304
Maximum	cpm	17,996	14,531
Average	cpm	12,119	11,999
Median	cpm	12,055	12,073
Standard Deviation	cpm	1,419	1,143
90th Percentile	cpm	13,959	13,332
95th Percentile	cpm	14,542	13,806
99th Percentile	cpm	15,618	14,451
Measurements per Survey Unit	#/grid	116	
Measurements Above Gamma BTV	#	6,343	55
Measurements Above Gamma BTV	%	54.6	55.0

Notes:
BTV background threshold value
cpm counts per minute

8.4.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 54.6 percent of the measurements within the Target boundaries, in some cases exceeding greater than 1.5 times the applied gamma BTV (11,608 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-22 (Jml) gamma survey results is provided on Figure I21-6. This graph shows that the spread of radiation data at Target T21 (shown on left) begins within the upper range of BSA-22 (Jml) gamma levels (shown on right) and then rises to more than 1.2 times the top range of background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T21 is higher than the data cloud from the BSA-22 (Jml) data set. A box plot showing the quartiles of the data sets is provided in Figure I21-7. The box plot shows that the median of Target T21 radiation levels is higher than the median of the BSA-22 (Jml) data set and higher than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I21-8. No mining activity was observed within the survey area of Target T21. However, historic exploratory borings were identified in the file review. A review of historic aerial photographs and reclamation records is warranted to determine if the Target area was disturbed by reclamation activities at AUM-related burial cell NA-0344b to the south.

In general, Target T21 has surficial gamma radiation levels above BSA-22 (Jml) levels across the majority of the Target except for the northern and eastern edges of the survey boundary, indicating that the survey encompassed the area of elevated gamma activity identified by the ASPECT and Weston MCAP gamma surveys (Figures I21-3 and I21-8). No TENORM or mining-related activities were observed. Section 8.4.5.4 presents the grid averaged results of the gamma radiation survey.

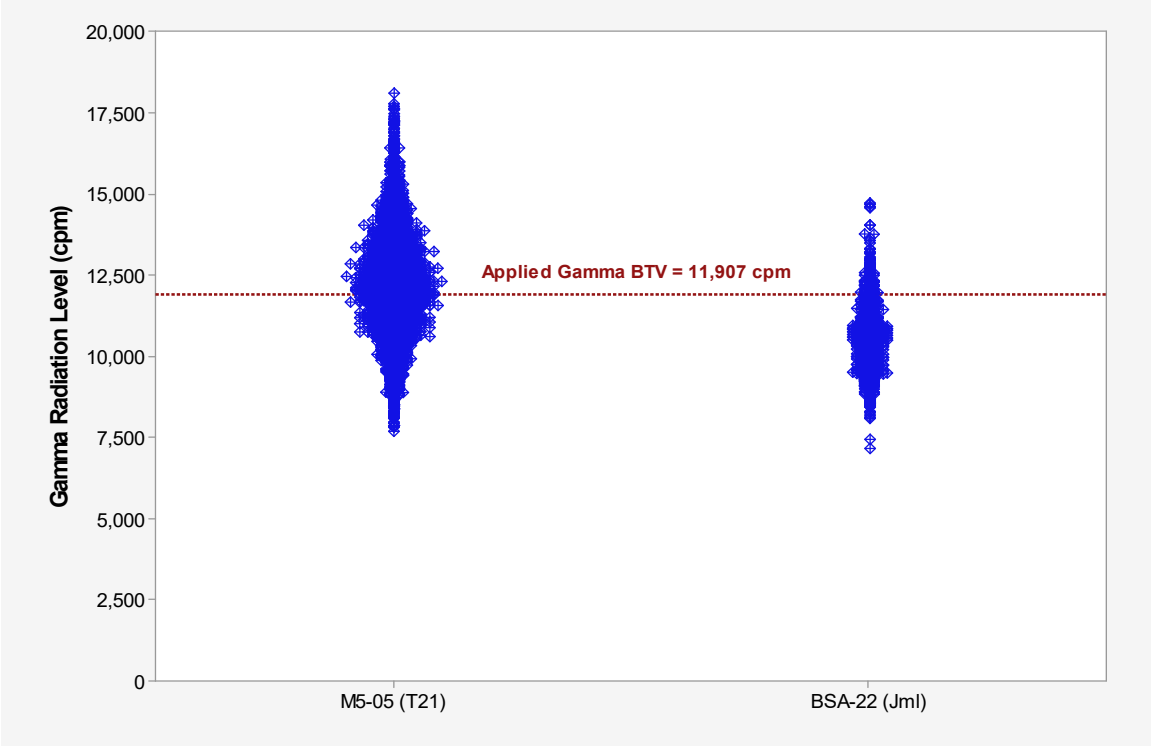


Figure I21-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M5-05 (T21) and BSA-22 (JmI)

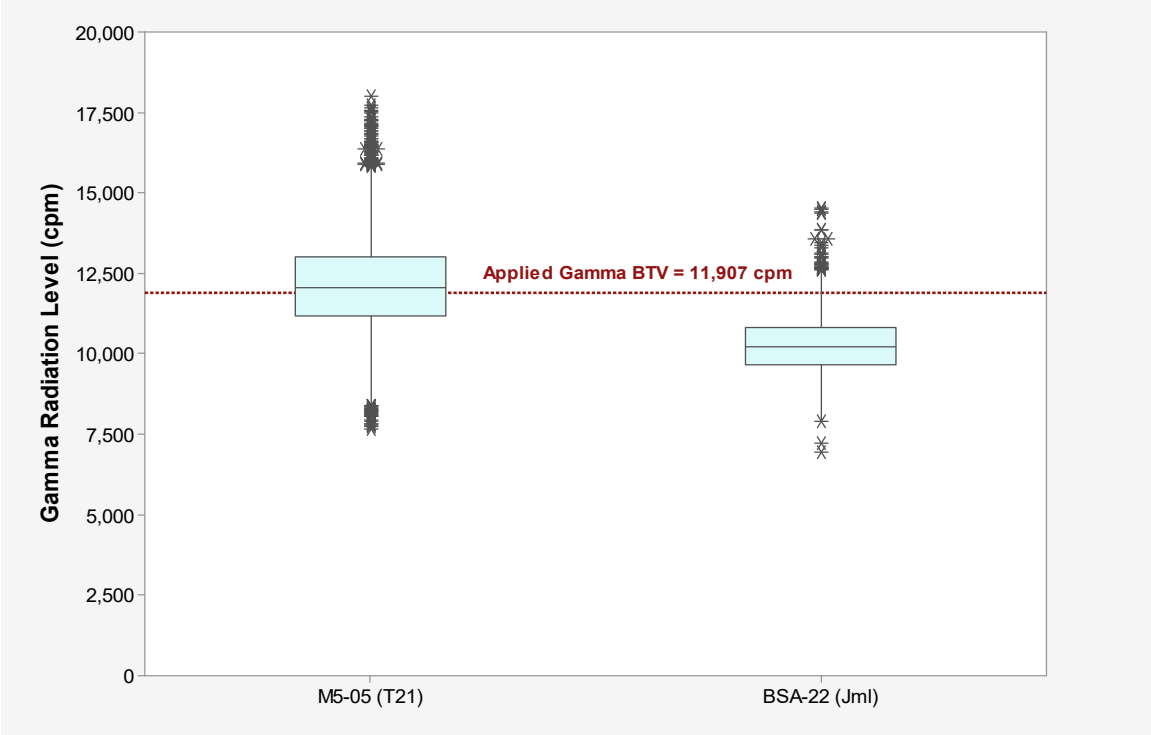
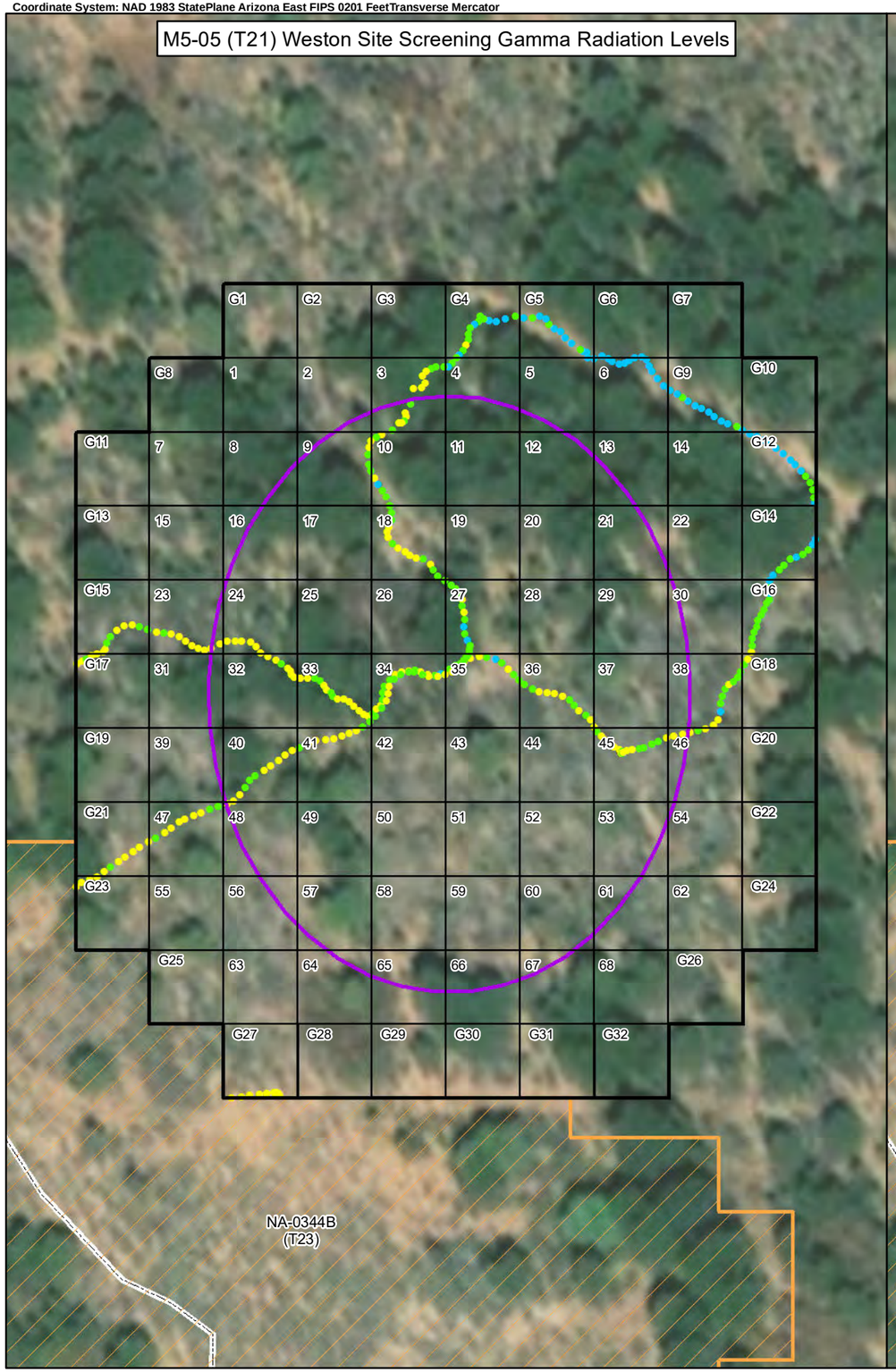
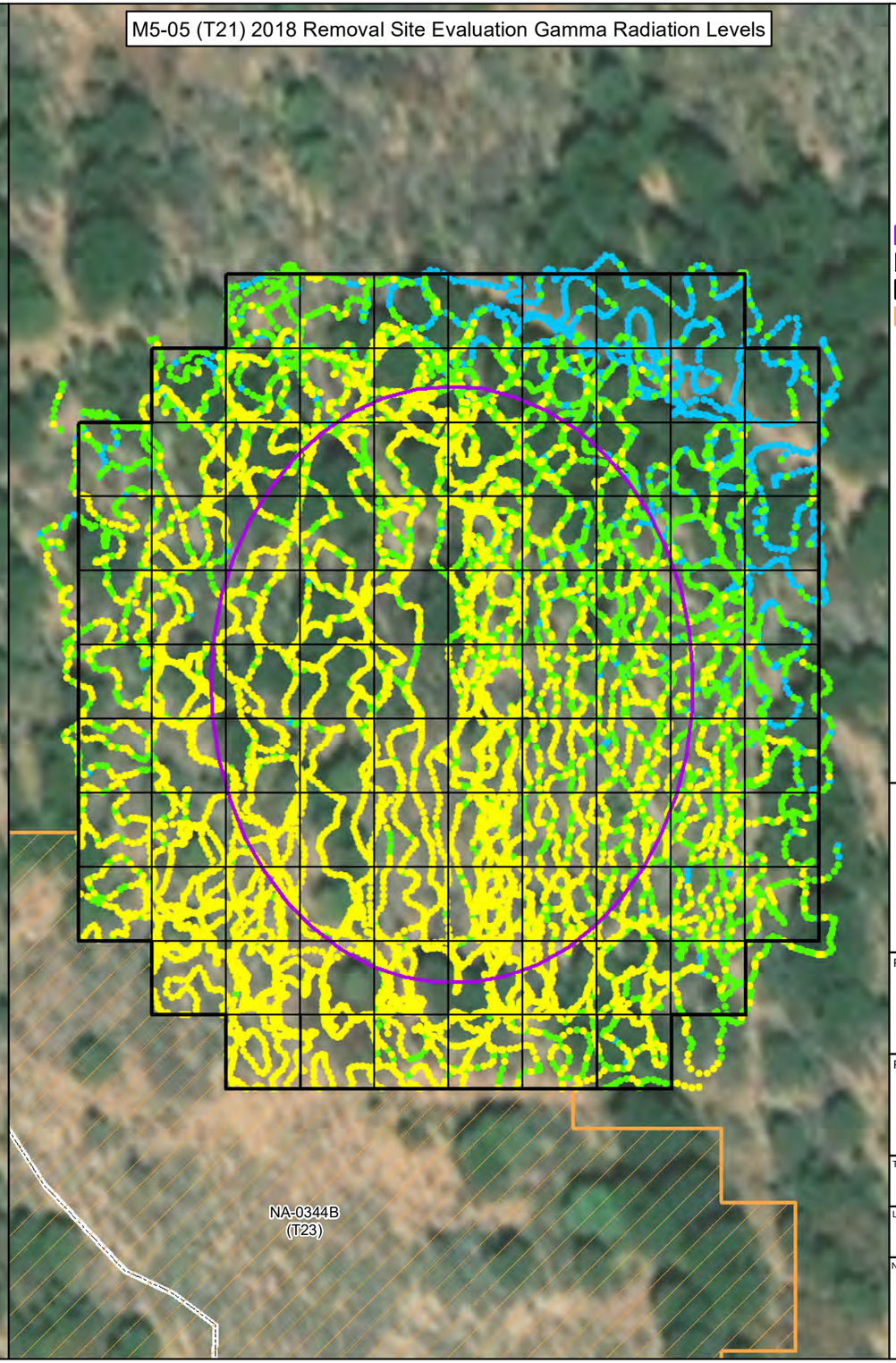


Figure I21-7. Box Plot of Raw Gamma Radiation Levels at Target M5-05 (T21) and BSA-22 (JmI)

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





Gamma Reading (cpm)*

≤ 10,285	≤ Avg. BG
10,285 - 11,907	Avg. BG - 1 x BTV
11,907 - 23,814	1 x BTV - 2 x BTV
23,814 - 35,721	2 x BTV - 3 x BTV
35,721 - 47,628	3 x BTV - 4 x BTV
47,628 - 119,070	4 x BTV - 10 x BTV
≥ 119,070	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Other Survey Area
Access Route - Vehicular

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET M5-05 (T21) 2018 REMOVAL SITE EVALUATION VS WESTON SITE SCREENING GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/13/2019

Notes:
*The applied gamma background threshold value (BTV) for M5-05 (T21) is 11,907 cpm derived from BSA-22 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I21-8**

8.4.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 8.4.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 8.4.5.1. Figure I21-9 and Figure I21-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-22 (Jml) data set (shown on right). A total of 55 percent of the survey units (55 of 100) within the survey area of Target T21 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I21-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I21-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. The elevated regions of the Target may correspond with historic exploratory borings at the Target or reclamation activities at the AUM-related burial cell to the south.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 8.4.6.

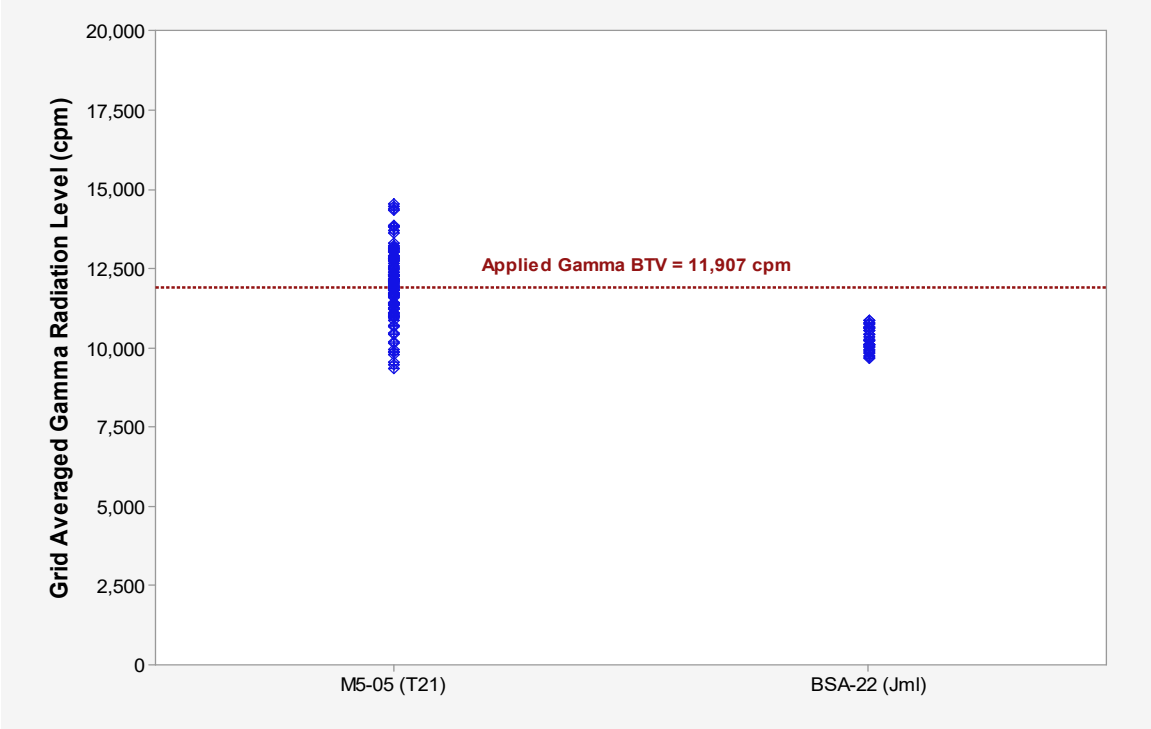


Figure I21-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-05 (T21) and BSA-22 (Jml)

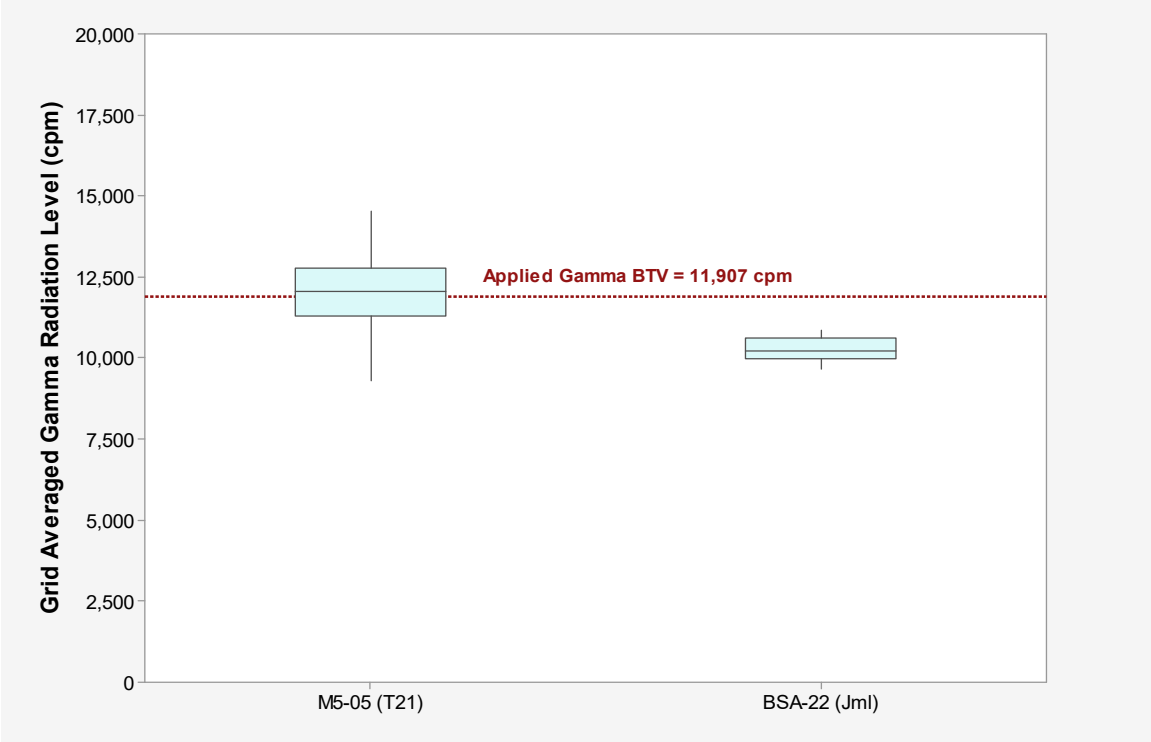
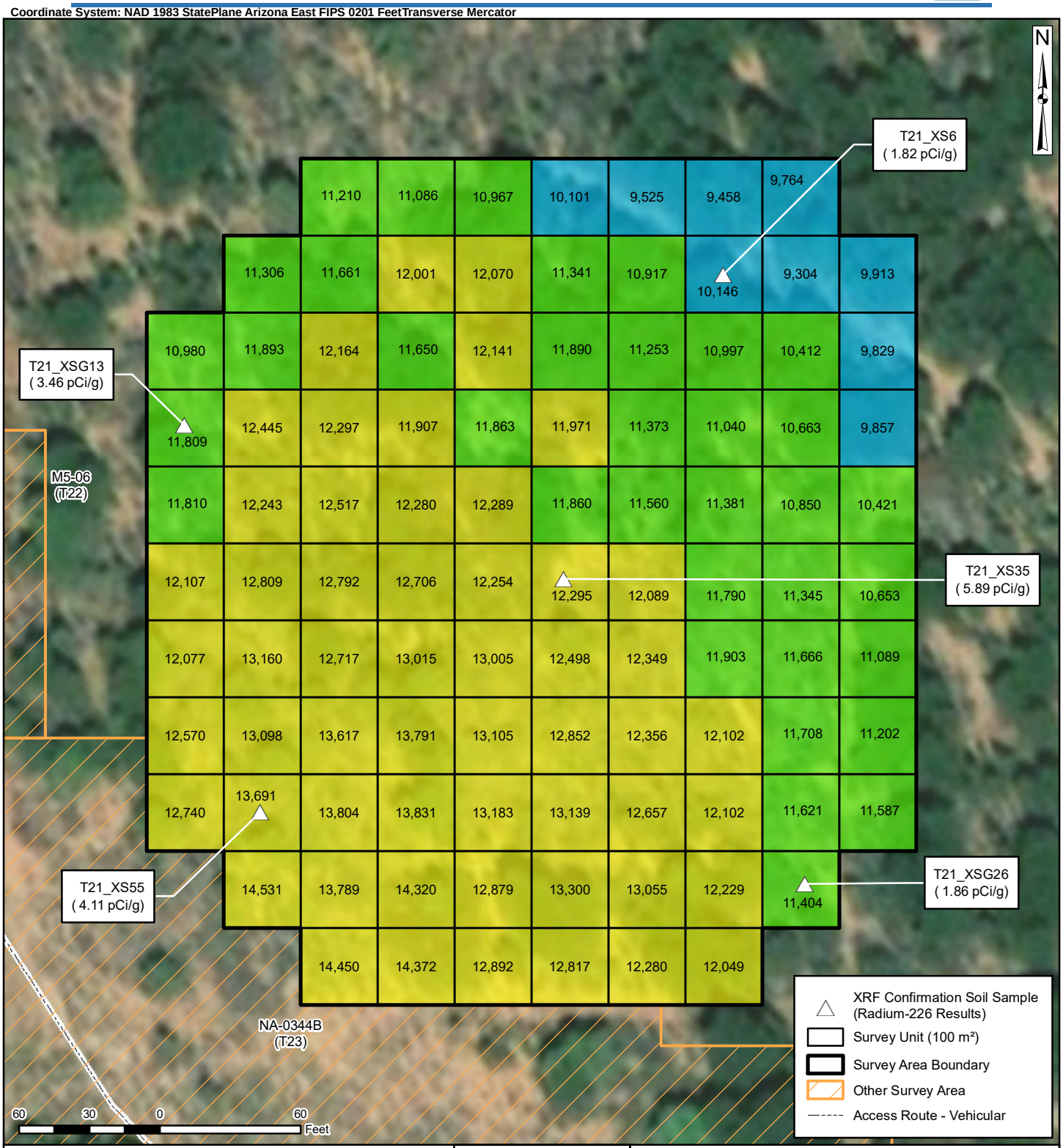


Figure I21-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-05 (T21) and BSA-22 (Jml)



Grid Averaged Gamma Reading (cpm)*

≤ 10,285	≤ Avg. BG
10,285 - 11,907	Avg. BG - 1 x BTV
11,907 - 23,814	1 x BTV - 2 x BTV
23,814 - 35,721	2 x BTV - 3 x BTV
35,721 - 47,628	3 x BTV - 4 x BTV
47,628 - 119,070	4 x BTV - 10 x BTV
≥ 119,070	≥ 10 x BTV

*The applied gamma background threshold value (BTV) for M5-05 (T21) is 11,907 cpm derived from BSA-22 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M5-05 (T21) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I21-11
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.4.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T21. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 8.4.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 8.4.6.2.

8.4.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T21: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I21-1 and I21-2. All the results of the XRF confirmation soil samples are presented in Table I21-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T21 following the methods outlined in Section 2.4 and shown in Figure I21-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 100 measurements were collected across 100 survey units from the survey area of Target T21 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I21-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T21 at a depth of 0 to 3 inches bgs. Six XRF confirmation soil samples were collected from five locations during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I21-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 8.4.7.

Table I21-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-05 (T21)

Analyte	Units	Applied BTV	T21-XS35-01-052118		T21-XS55-01-052118		T21-XS6-01-052118		T21-XSG13-01-091118		T21-XSG26-01-091118	
			Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Survey Unit			X35		X55		X6		G13		G26	
Aluminum	mg/kg	5,580	4,200		4,600		3,100		4,300		3,400	
Antimony	mg/kg	0.140	0.12		0.12		<0.096	U	0.12		<0.092	U
Arsenic	mg/kg	2.2	1.9		1.9		1.2		2.5		1.9	
Barium	mg/kg	201	82		85		56		100		85	
Beryllium	mg/kg	0.41	0.26		0.28		0.19		0.29		0.25	
Cadmium	mg/kg	0.160	0.13	J	0.098	J	0.07	J	0.17	J	0.09	J
Calcium	mg/kg	4,960	3,300		3,200		2,200		2,700		2,200	
Chromium	mg/kg	5.2	4.9		5		3.4		4.9		3.9	
Cobalt	mg/kg	3.9	2.6		2.8		1.8		3		2.5	
Copper	mg/kg	10	5.7		6.2		3.7		7.5		5.5	
Iron	mg/kg	7,470	5,900		6,000		4,400		6,400		5,100	
Lead	mg/kg	9.7	8.6		6.3		5.5		8.4		5.7	
Lithium	mg/kg	5.4	5.1		5		3.7		5.5		4.4	
Magnesium	mg/kg	2,500	2,000		2,100		1,400		2,000		1,600	
Manganese	mg/kg	440	250		230		180		310		250	
Molybdenum	mg/kg	0.29	0.44		0.32		0.24		0.34		0.21	
Nickel	mg/kg	6.2	4.6		4.7		3		5.1		4.2	
Potassium-40	pCi/g	23.2	15.7		15.8		15.2		16.8		18.1	
Radium-226	pCi/g	1.54	5.89		4.11		1.82		3.46		1.86	
Radium-228	pCi/g	0.50	<0.48	U	<0.79	UJ	<0.62	UJ	<0.77	U	<0.64	UJ
Selenium	mg/kg	0.93	1.4		1.4		0.68	J	1.3		0.98	
Silver	mg/kg	0.033	0.02	J	0.02	J	0.011	J	0.022	J	0.015	J
Sodium	mg/kg	29	17	J	<98	U	<96	U	<98	U	<92	U
Thallium	mg/kg	0.068	0.058		0.054		0.038		0.062		0.052	
Thorium	mg/kg	3.6	2.6		2.6		1.8		2.9		2.4	
Uranium	mg/kg	1.3	11		8.7		3.7		4.7		1.7	
Vanadium	mg/kg	15	41		36		19		25		15	
Zinc	mg/kg	24	15		15		11		32		13	

Notes:
BTV Background threshold value
ID Identification
J Estimated value
J- Estimated value, may be biased low
LT Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
M3 The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg Milligrams per kilogram
NA Not applicable
NV No value
pCi/g Picocuries per gram
Q Qualification
U Not considered detected. The associated value is the method detection limit (MDL).
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

Table I21-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-05 (T21)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.2	7,470	9.7	440	0.29	3.6	1.3	15	24
Measurements	#	100	100	100	100	100	100	100	100	100
Detects	#	65	100	100	89	30	100	99	87	100
Nondetects	#	35	0	0	11	70	0	1	13	0
Minimum	mg/kg	1.9	4,089	4.5	164.5	0.1	1.1	0.2	16.2	9.4
Maximum	mg/kg	6.1	9,848	15.8	452.1	6.7	3.7	35.0	111.5	44.9
Standard Deviation	mg/kg	0.9	953	2.1	64	1.24	0.5	6.7	19	6.2
Average	mg/kg	2.9	6,038	9.7	329	1.12	2.3	7.9	40.4	20.3
Median	mg/kg	2.7	5,976	9.4	326	0.84	2.2	6.0	35.3	19.2
Relative Standard Deviation	%	32.2	15.8	21.6	19.3	111	21.4	85.6	48.1	30.7
90th Percentile	mg/kg	4.3	7,060	12.5	415	2.1	2.9	14.8	67	27
95th Percentile	mg/kg	4.7	7,368	13.5	436	2.3	3.0	23.8	80	33
99th Percentile	mg/kg	6.1	9,074	15.7	446	5.5	3.4	31.5	97	45
Measurements Above Applied BTV	#	46	4	44	3	26	1	89	87	16
Measurements Above Applied BTV	%	46	4	44	3	26	1	89	87	16

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value
mg/kg Milligram per kilogram
XRF X-ray fluorescence

8.4.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T21 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T21 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T21. The estimated BTVs are identified in Section 8.4.4 and Table I21-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I21-7 presents a summary of the background comparison for different measurement and soil depths at Target T21. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T21. However, gamma radiation screening indicated that gamma levels at Target T21 are elevated in comparison to the BSA. Elevated gamma levels may be associated with exploration at the Target and reclamation activities at adjacent AUMs. Therefore, while multiple COPCs have been identified at Target T21 based on a conservative comparison to background, risk screening will be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I21-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-05 (T21)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic	✓	✓	✓
Barium			
Beryllium			
Cadmium	✓		✓
Calcium			
Chromium			
Cobalt			
Copper			
Iron			
Lead		✓	✓
Lithium	✓		✓
Magnesium			
Manganese			
Molybdenum	✓	✓	✓
Nickel			
Potassium-40			
Radium-226	✓		✓
Radium-228			
Selenium	✓		✓
Silver			
Sodium			
Thallium			
Thorium			
Uranium	✓	✓	✓
Vanadium	✓	✓	✓
Zinc	✓	✓	✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

8.4.7 Primary Contaminant Mapping

8.4.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 8.4.6.2 identified the COPCs at Target T21. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 8.4.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I21-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T21 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 8.4.7.1 through Section 8.4.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T21. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

8.4.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I21-7. Arsenic exceeded the applied BTV in 46 percent of in situ XRF measurements and one of the five XRF confirmation samples. The applied BTV for arsenic is 2.2 mg/kg for Target T21 as presented in Section 8.4.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I21-5 and Attachment I3, respectively. Figure I21-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T21 and BSA-22 (Jml) samples. Figure I21-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T21 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.4.6.1. Arsenic XRF concentrations measured in surface soils at Target T21 ranged between 1.9 and 6.1 mg/kg with an average and standard deviation of 2.9 mg/kg and 0.9 mg/kg, respectively. The average arsenic XRF concentration is above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T21 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I21-14. Overall, the majority of detectable arsenic results in surface soils were above the applied BTV. However, the maximum XRF value was 2.8 times higher than the applied BTV and does not appear to be associated with mining-related materials.

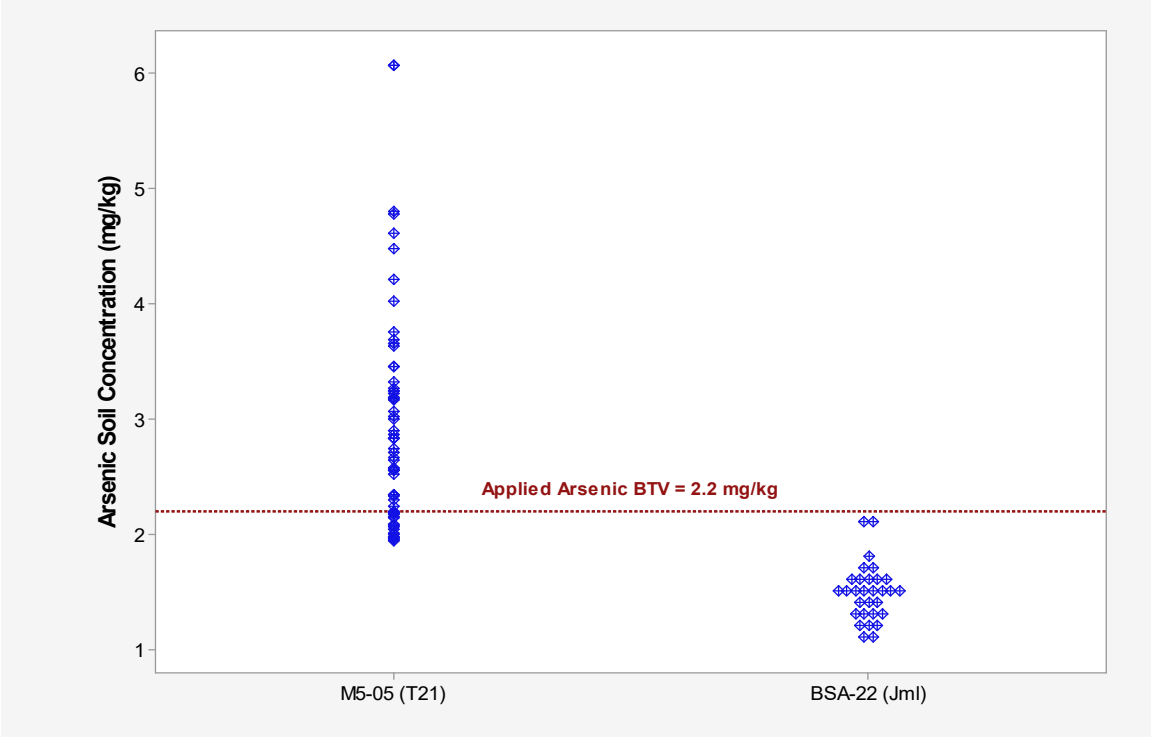


Figure I21-12. Individual Value Plot for Target M5-05 (T21) and BSA-22 (Jml) Arsenic Soil Concentrations

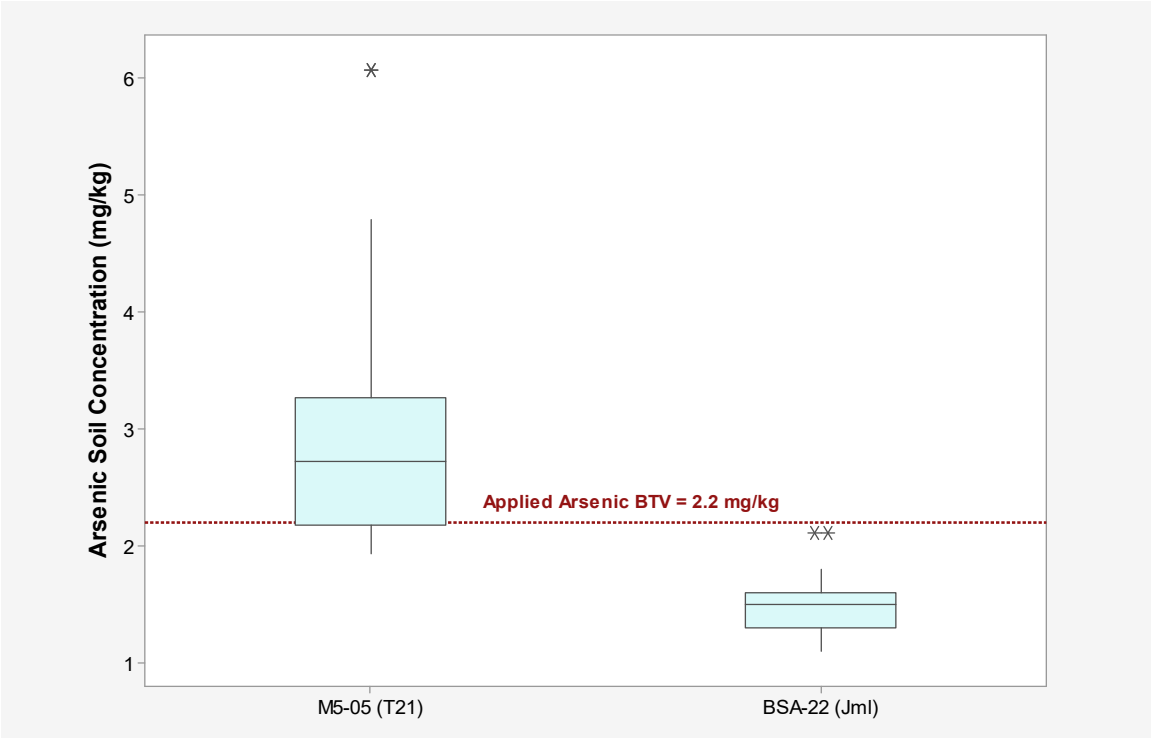
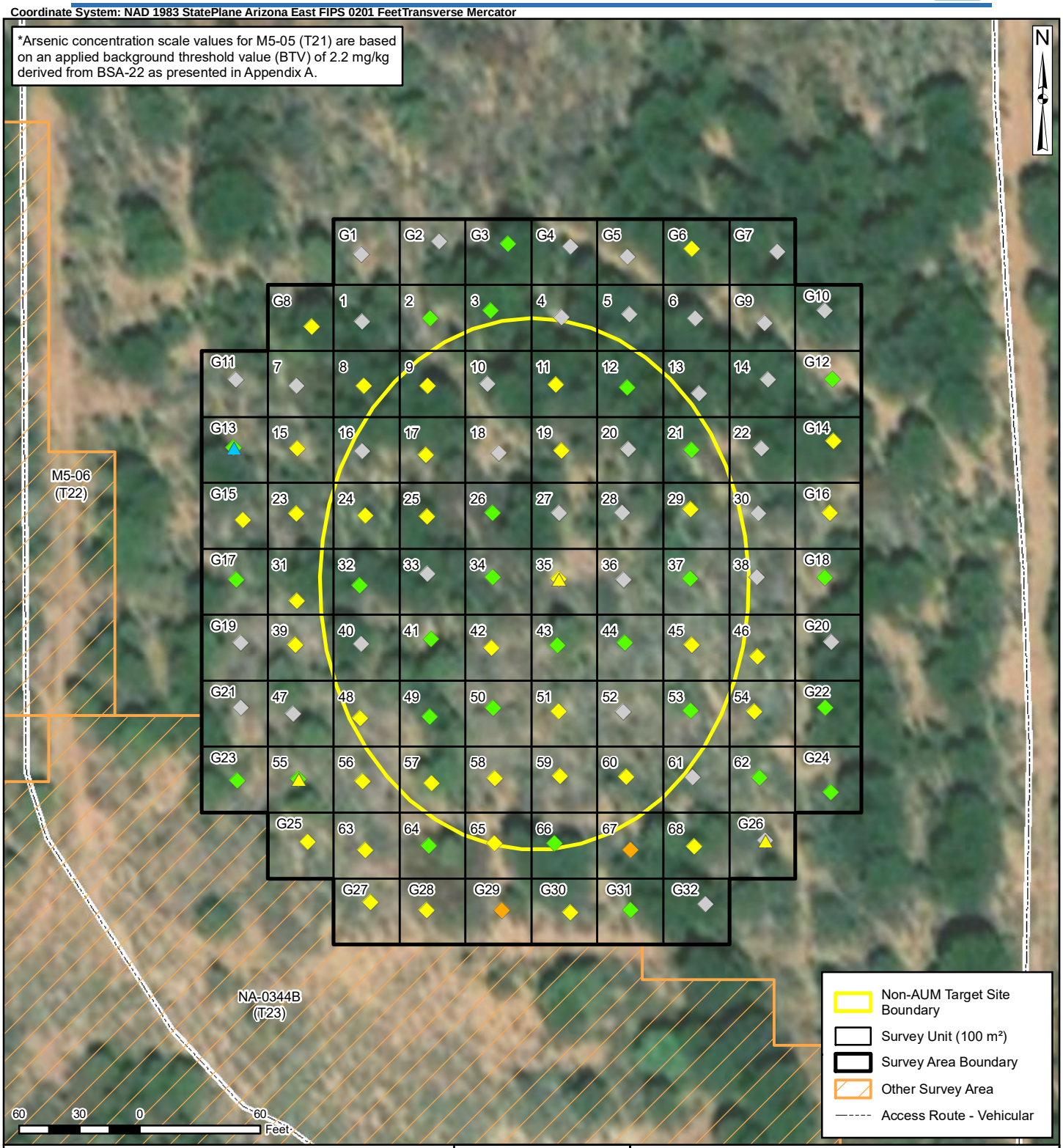


Figure I21-13. Box Plot for Target M5-05 (T21) and BSA-22 (Jml) Arsenic Soil Concentrations

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



Arsenic Concentration Scale (mg/kg)*

- ≤ 1.5
- 1.5 - 2.2
- 2.2 - 4.4
- 4.4 - 6.6
- 6.6 - 8.8
- 8.8 - 22
- ≥ 22
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

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NON-AUM TARGET M5-05 (T21) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I21-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.4.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I21-7. Lead exceeded the applied BTV in 44 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for lead is 9.7 mg/kg for Target T21 as presented in Section 8.4.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I21-5 and Attachment I3, respectively. Figure I21-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T21 and BSA-22 (Jml) samples. Figure I21-16 presents a box plot of detectable lead XRF soil concentrations for Target T21 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.4.6.1. Lead XRF concentrations measured in surface soils at Target T21 ranged between 4.5 and 15.8 mg/kg with an average and standard deviation of 9.7 mg/kg and 2.1 mg/kg, respectively. The average lead XRF concentration is at the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T21 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I21-17. Overall, the majority of detectable lead results in surface soils were at the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials.

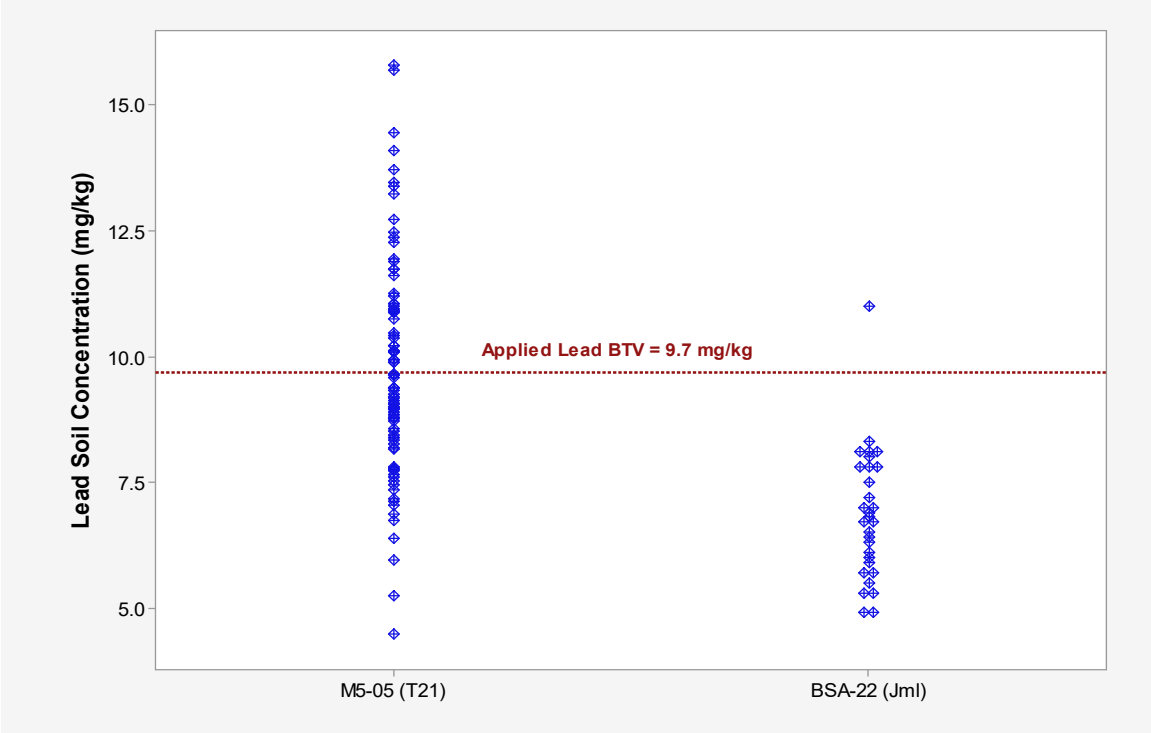


Figure I21-15. Individual Value Plot for Target M5-05 (T21) and BSA-22 (Jml) Lead Soil Concentrations

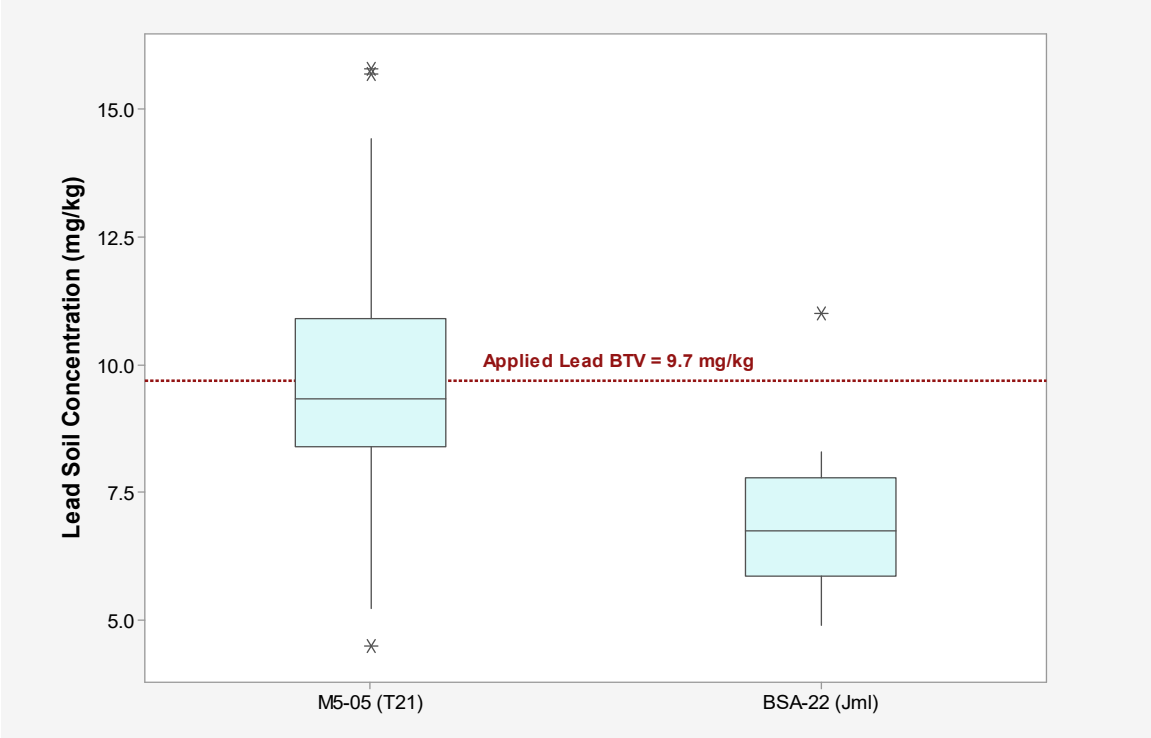
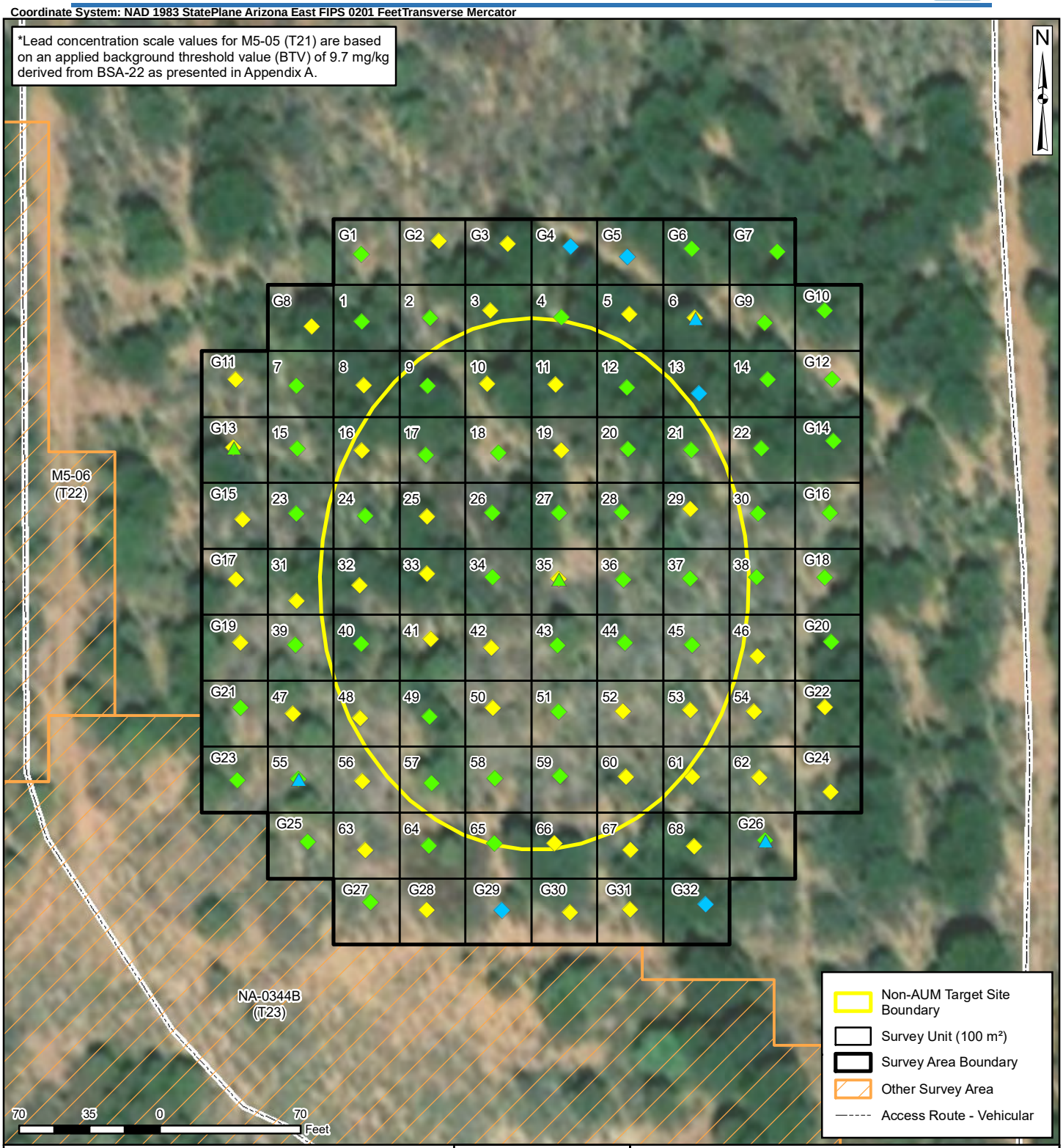


Figure I21-16. Box Plot for Target M5-05 (T21) and BSA-22 (Jml) Lead Soil Concentrations



Lead Concentration Scale (mg/kg)*

- ≤ 6.8
- 6.8 - 9.7
- 9.7 - 19
- 19 - 29
- 29 - 39
- 39 - 97
- ≥ 97

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

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NON-AUM TARGET M5-05 (T21) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I21-17
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/13/2019	

8.4.7.4 Thorium

Thorium was not identified as a COPC in surface soil as shown in Table I21-7. Thorium exceeded the applied BTV in 1 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for thorium is 3.6 mg/kg for Target T21 as presented in Section 8.4.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I21-5 and Attachment I3, respectively. Figure I21-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T21 and BSA-22 (Jml) samples. Figure I21-19 presents a box plot of detectable thorium XRF soil concentrations for Target T21 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.4.6.1. Thorium XRF concentrations measured in surface soils at Target T21 ranged between 1.1 and 3.7 mg/kg with an average and standard deviation of 2.3 mg/kg and 0.5 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T21 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I21-20. Overall, the majority of detectable thorium results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials.

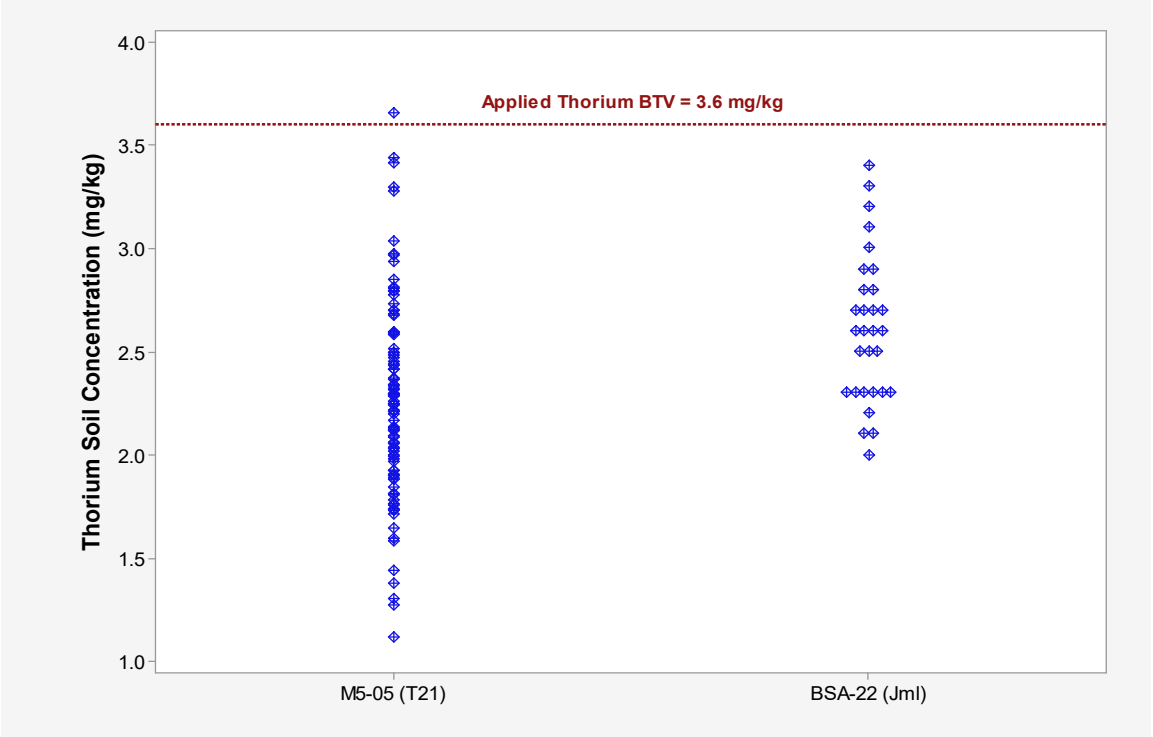


Figure I21-18. Individual Value Plot for Target M5-05 (T21) and BSA-22 (JmI) Thorium Soil Concentrations

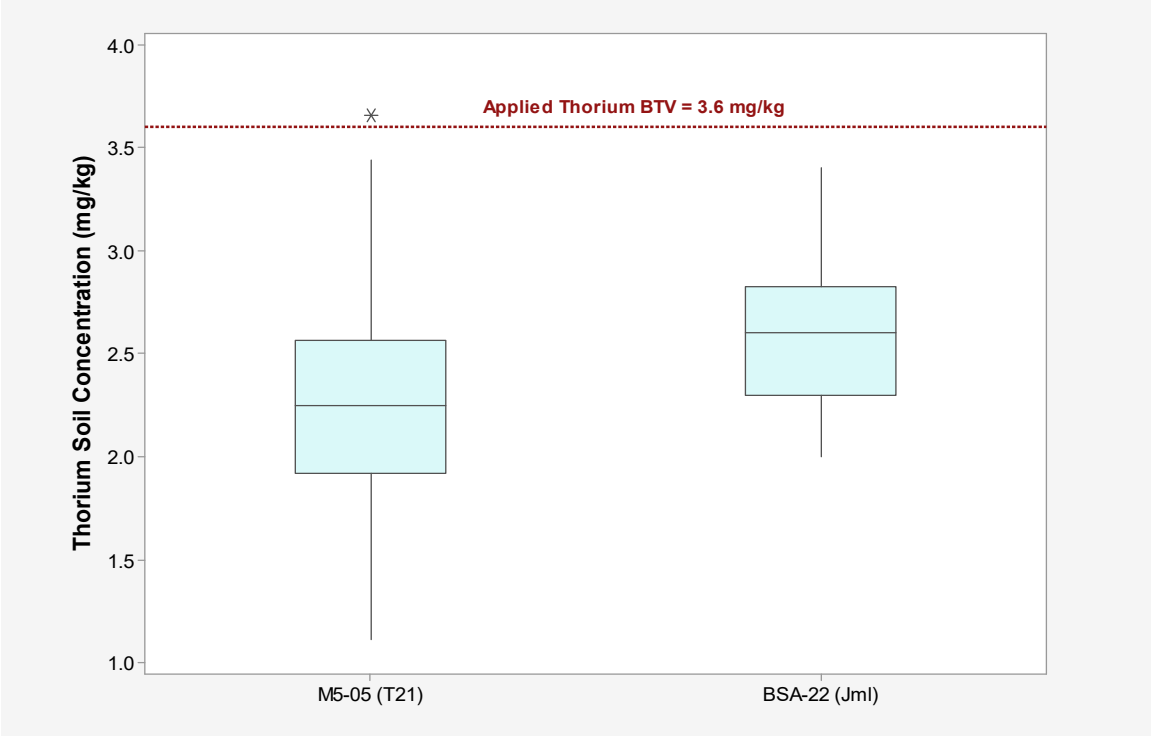
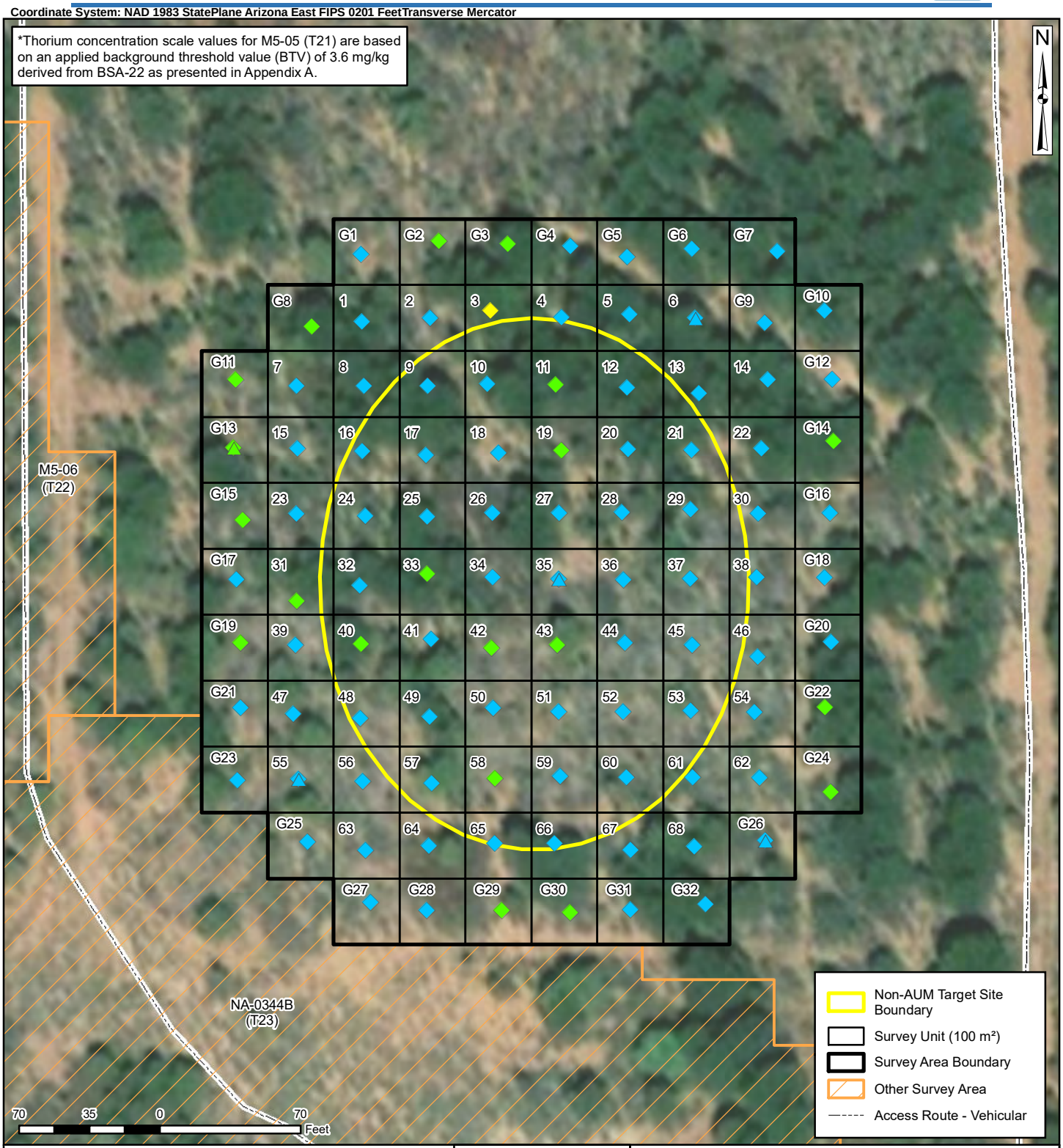


Figure I21-19. Box Plot for Target M5-05 (T21) and BSA-22 (JmI) Thorium Soil Concentrations

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



Thorium Concentration Scale (mg/kg)*

- ≤ 2.6
- 2.6 - 3.6
- 3.6 - 7.2
- 7.2 - 11
- 11 - 14
- 14 - 36
- ≥ 36

Thorium Concentration Value Source

- ◇ In Situ XRF Measurement
- △ XRF Confirmation Soil Sample

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NON-AUM TARGET M5-05 (T21) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I21-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.4.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I21-7. Uranium exceeded the applied BTV in 89 percent of in situ XRF measurements and in all five XRF confirmation samples. The applied BTV for uranium is 1.3 mg/kg for Target T21 as presented in Section 8.4.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I21-5 and Attachment I3, respectively. Figure I21-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T21 and BSA-22 (Jml) samples. Figure I21-22 presents a box plot of detectable uranium XRF soil concentrations for Target T21 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.4.6.1. Uranium XRF concentrations measured in surface soils at Target T21 ranged between 0.2 and 35 mg/kg with an average and standard deviation of 7.9 mg/kg and 6.7 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T21 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I21-23. Overall, the majority of detectable uranium results in surface soils were above the applied BTV. However, the maximum XRF value was 26.9 times higher than the applied BTV and does not appear to be associated with mining-related materials.

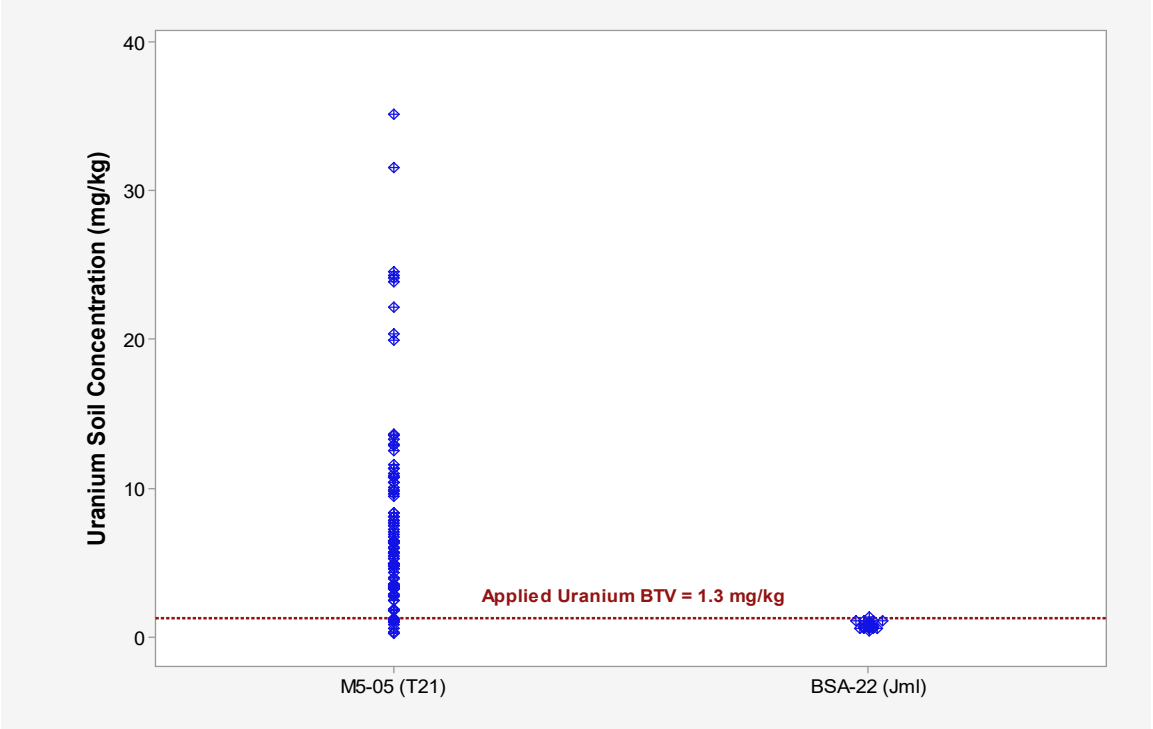


Figure I21-21. Individual Value Plot for Target M5-05 (T21) and BSA-22 (Jml) Uranium Soil Concentrations

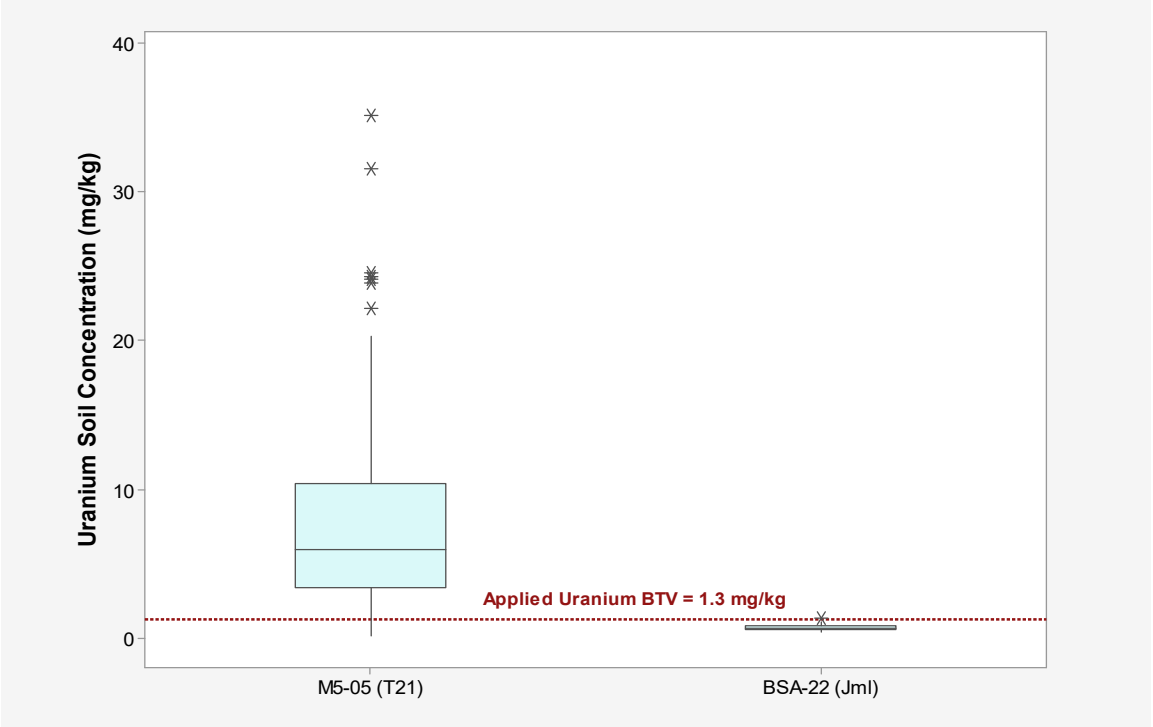
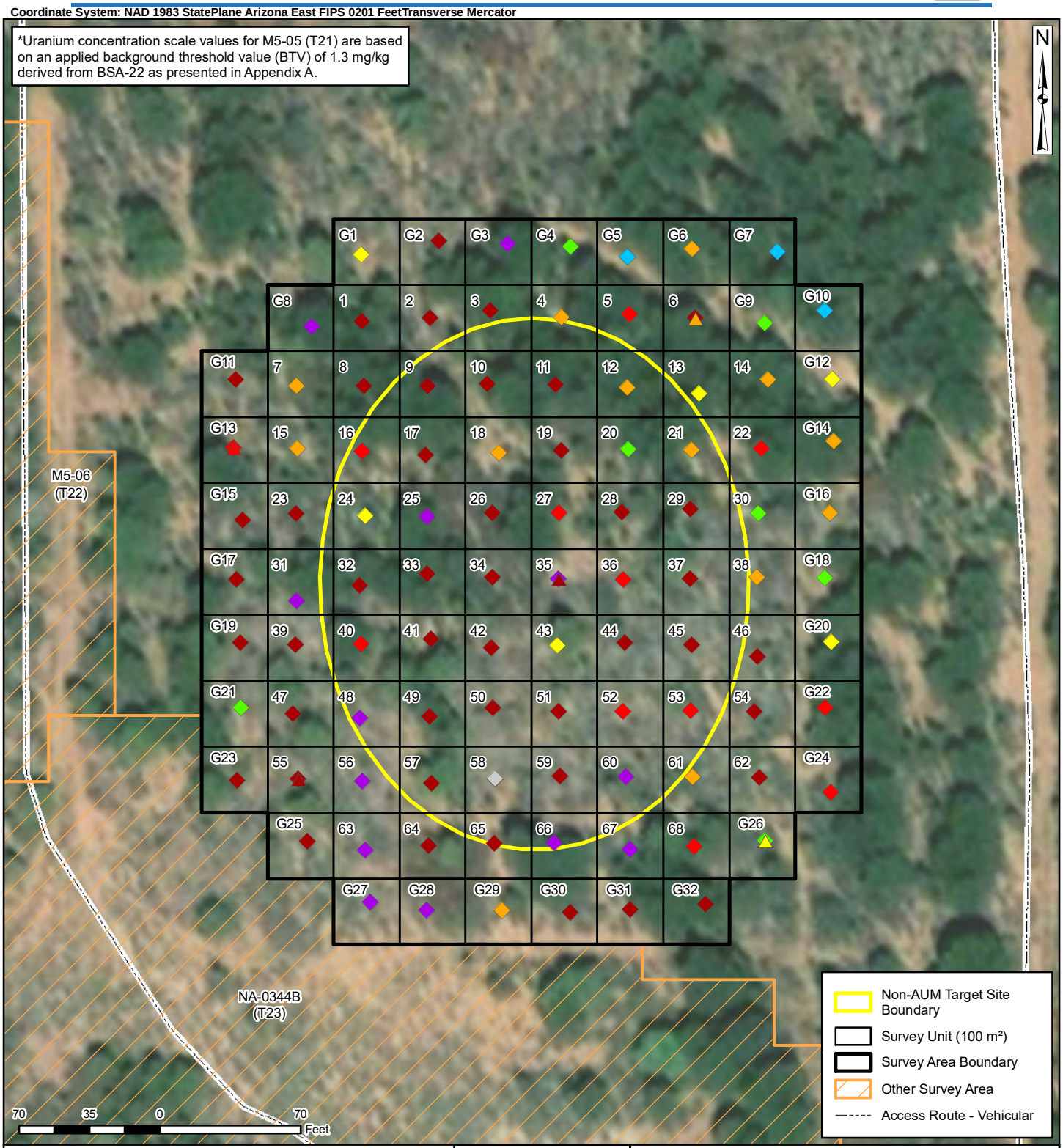


Figure I21-22. Box Plot for Target M5-05 (T21) and BSA-22 (Jml) Uranium Soil Concentrations

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



Uranium Concentration Scale (mg/kg)*

- ≤ 0.76
- 0.76 - 1.3
- 1.3 - 2.6
- 2.6 - 3.9
- 3.9 - 5.2
- 5.2 - 13
- ≥ 13
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

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NON-AUM TARGET M5-05 (T21) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I21-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.4.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I21-7. Vanadium exceeded the applied BTV in 87 percent of in situ XRF measurements and four of the five XRF confirmation samples. The applied BTV for vanadium is 15 mg/kg for Target T21 as presented in Section 8.4.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I21-5 and Attachment I3, respectively. Figure I21-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T21 and BSA-22 (Jml) samples. Figure I21-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T21 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.4.6.1. Vanadium XRF concentrations measured in surface soils at Target T21 ranged between 16.2 and 111.5 mg/kg with an average and standard deviation of 40.4 mg/kg and 19 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T21 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I21-26. Overall, the majority of detectable vanadium results in surface soils were above the applied BTV. However, the maximum XRF value was 7.4 times higher than the applied BTV and does not appear to be associated with mining-related materials.

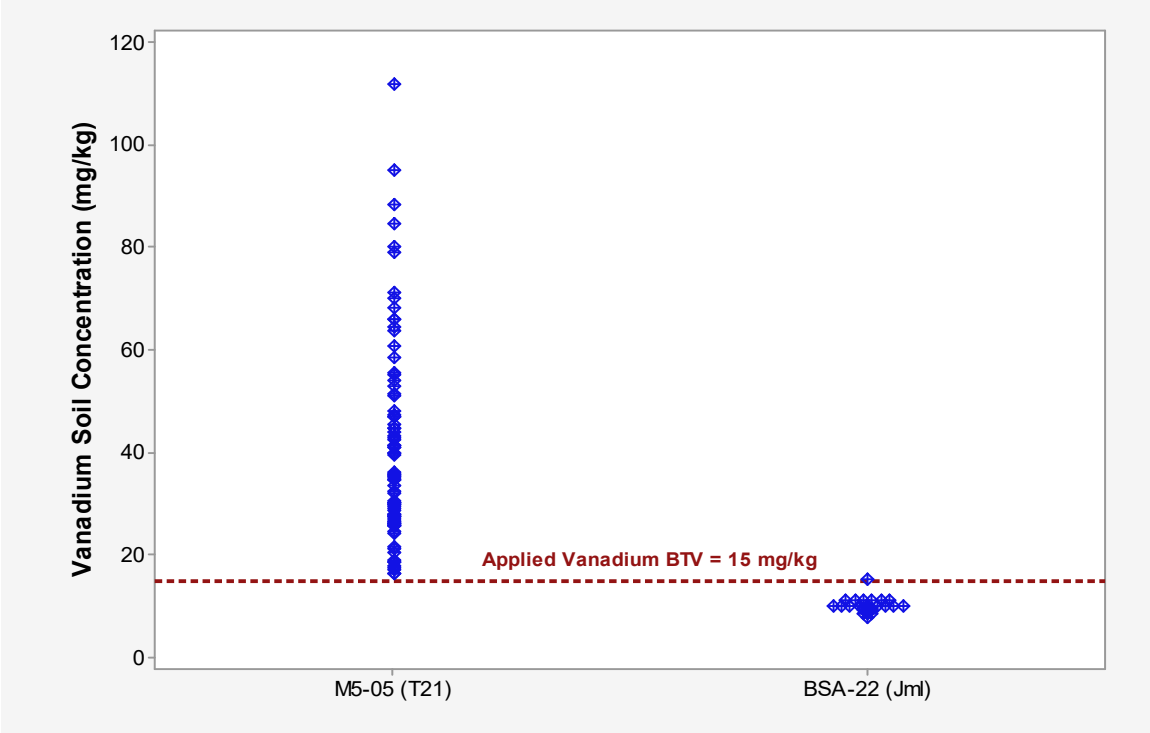


Figure I21-24. Individual Value Plot for Target M5-05 (T21) and BSA-22 (Jml) Vanadium Soil Concentrations

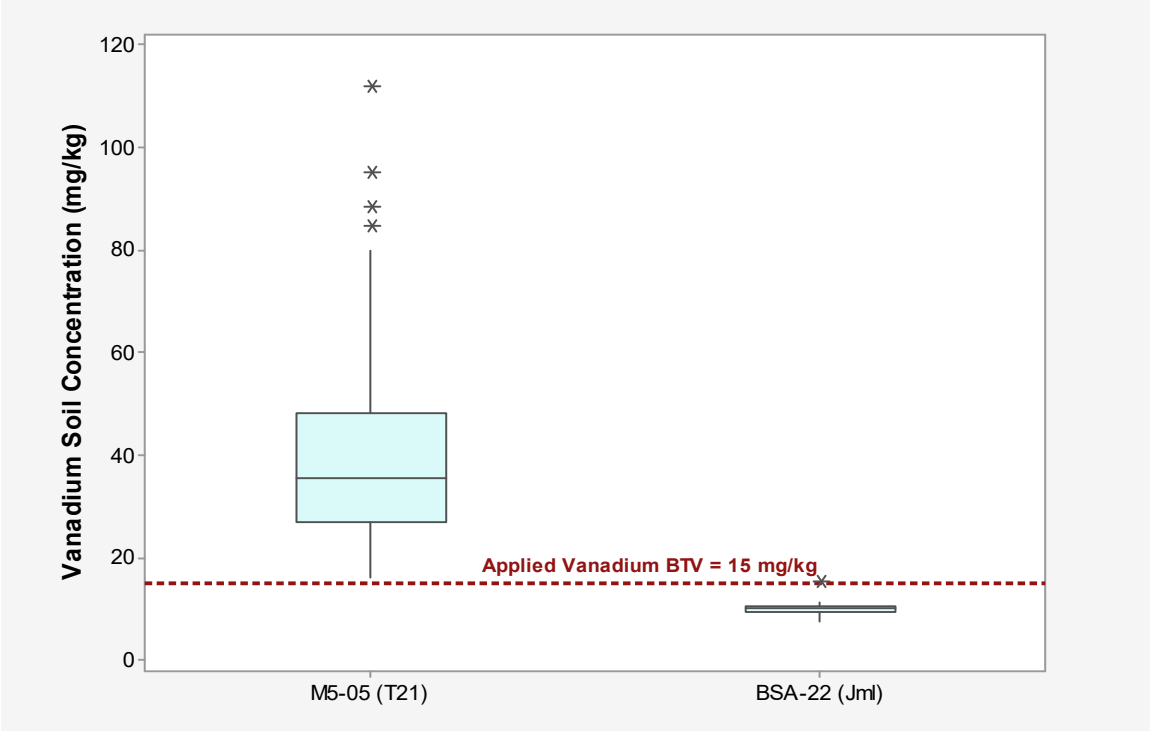
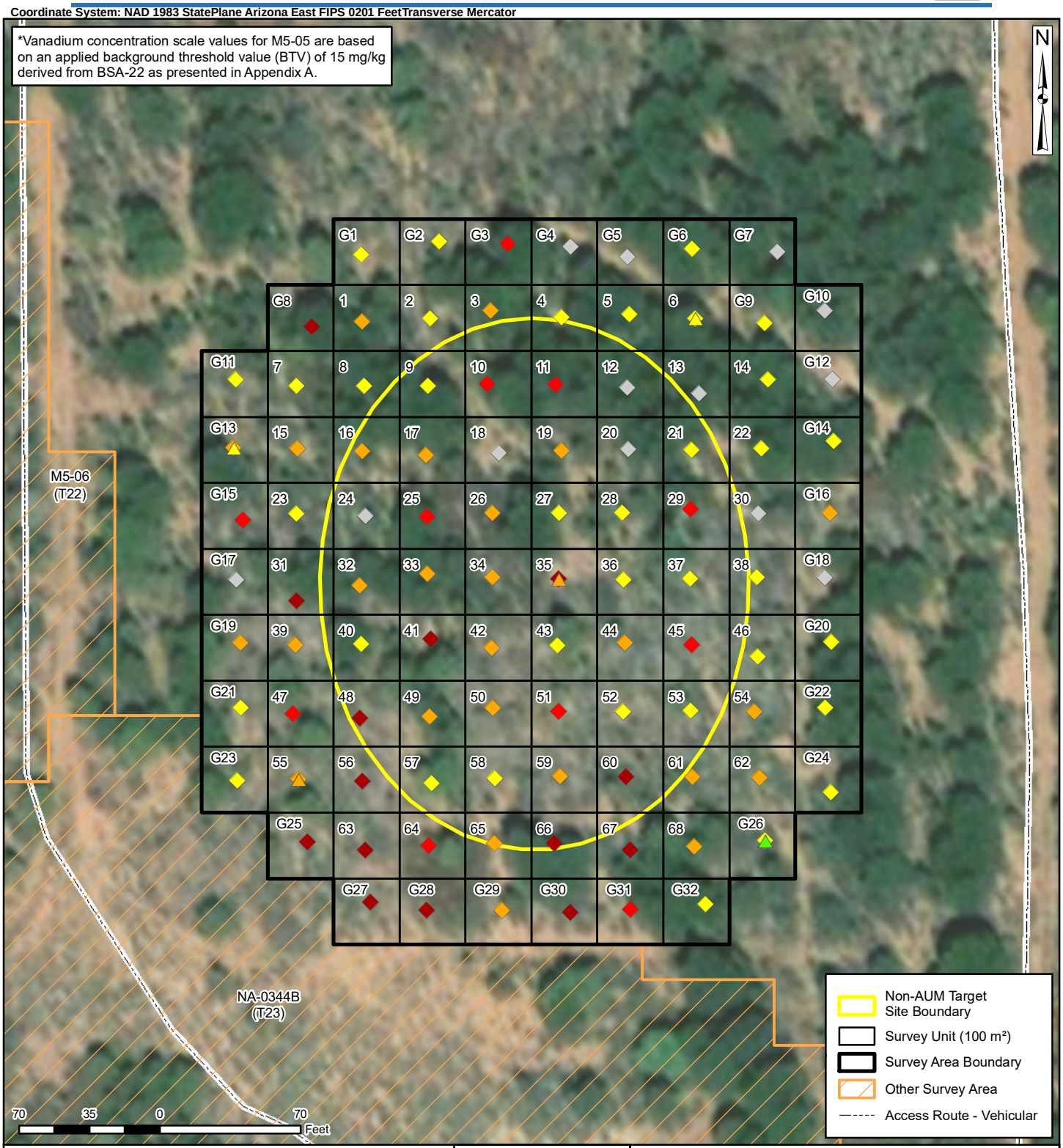


Figure I21-25. Box Plot for Target M5-05 (T21) and BSA-22 (Jml) Vanadium Soil Concentrations



Vanadium Concentration Scale (mg/kg)*

- ≤ 9.9
- 9.9 - 15
- 15 - 30
- 30 - 45
- 45 - 60
- 60 - 150
- ≥ 150
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

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NON-AUM TARGET M5-05 (T21) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I21-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/26/2019	

8.4.8 Conclusions

Target T21 (M5-05) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T21. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T21 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T21. ASPECT gamma survey results generally correlated with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE; however, historic exploratory borings at the Target and reclamation activities at adjacent AUMs may explain elevated gamma levels.
- The lateral extent of elevated radiological activity at Target T21 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in all five XRF confirmation samples exceeded the applied BTV by a factor of 3.8. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T21 geology and soil types were established through a background study.
- Mean raw gamma measurements exceeded the applied BTV by a factor of 1.02. In addition, grid averaged gamma measurements exceeded the applied BTV in 55 of the 100 survey units by a factor of up to 1.2.
- A total of 27 analytes were identified as occurring within the surface environment. Of these analytes, 10 were identified as COPCs. Arsenic, uranium, and vanadium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T21 does not contain TENORM. No mining-related activities or features were observed in the field, but 17 potential historical exploratory borings were noted in the file review. TENORM may be associated with these borings. NORM was not identified visually or by gamma survey.
- There are no immediate significant physical hazards present at Target T21.
- Access is by dirt road with a small four-wheel-drive vehicle followed by footpath.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No existing groundwater wells are documented within the vicinity of Target T21. No seeps or springs were observed during the RSE investigation.

- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T21. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No mine waste was observed at Target T21; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; however, a few data gaps remain for Target T21. The remaining data gaps include field verification of the reclamation status of the potential historic exploratory borings and subsurface sampling to determine if elevated gamma activity increases with depth or is related to reclamation grading.

8.5 NON-AUM TARGET T22 (M5-06)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T22 (M5-06).

8.5.1 Access, Physical Conditions, and Field Observations

Target T22 (M5-06) is grouped with non-AUM Target T21 (M5-05) and is located adjacent to AUM related burial cell NA-0344B. Target T22 is in the Lukachukai Mountains Region in Subarea Group F within the Cove Chapter of the Navajo Nation and accessed by four-wheel-drive vehicle off of Indian Route 33. Target T22 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. No residential structures are near the Target. A Target location and access map for Target T22 is shown in Figure I22-1.

A topographical relief map for Target T22 and associated AUM areas is provided in Figure I22-2. The elevation at Target T22 ranges from 7,420 to 7,429 feet amsl with an average of 7,426 feet amsl. The slope at Target T22 ranges from 0 to 5 percent with an average of 2 percent. Target T22 is entirely within Jml and within the Arabrab-Wetherill soil complex (MUSYM 414) (Figures I-22 and I-23).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T22. Weston did not conduct a background study for Target T22. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 24, of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T22:

- Identified any immediate physical hazards at the non-AUM Target:

  A vertical opening was identified in the northeastern portion of the Target.

- Located access routes, including foot pathways and roads:

  Target T22 is accessible by four-wheel-drive vehicle south from Indian Route 33.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM was not observed at the Target. Soil covers the top of Jml, and no outcropping was observed. Borehole corings and disturbed material from the vertical opening could be considered TENORM; however, elevated gamma readings do not appear to correlate with the location of the borehole corings or vertical opening.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  No drainages were identified at the Target. The closest major drainage is the Middle 1A drainage, which is located approximately 800 feet south of the Target and discussed in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

  Nineteen historic exploratory borings were identified at the Target during the file review. Four of these exploratory borings potentially coincide with underground mine workings. No haul roads were located at the Target; however, a haul road for the Mesa V Incline (M5) is located to the east.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  A vertical opening was identified on the northeastern part of the Target. Underground mine workings of the Frank Jr. Mine (M14) are potentially located beneath the Target, and four exploratory borings potentially coincide with these underground mine workings. Exploratory borehole corings were identified in survey units 8 and 15 by field personnel. The geology of Target T22 is the NORM-bearing Jml.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target

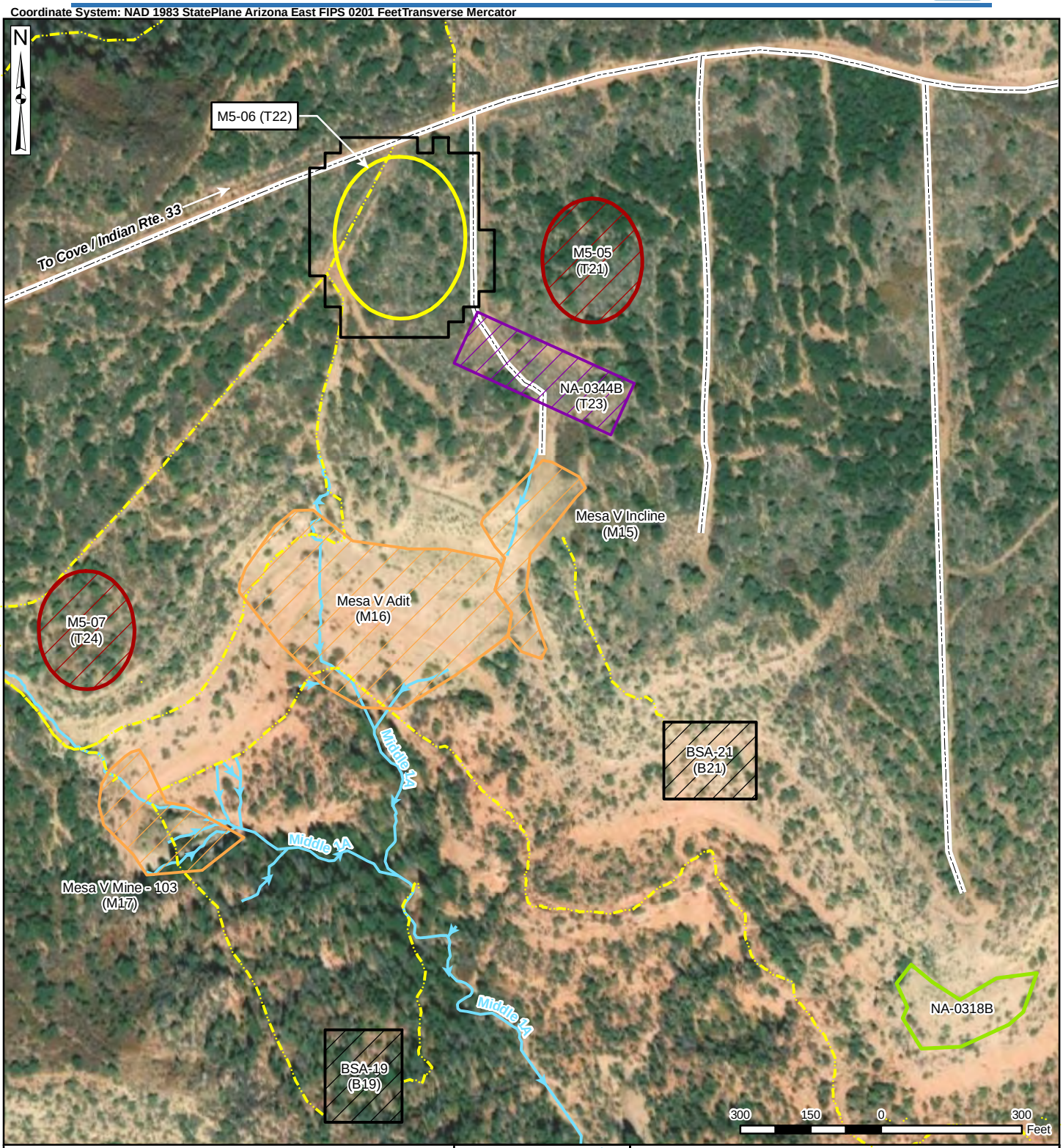
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T22 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Sections 2.3 and 8.5.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 8.5.3 with results presented in Sections 8.5.6 and 8.5.7)
- Conducting a gamma radiation survey (results presented in Section 8.5.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



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

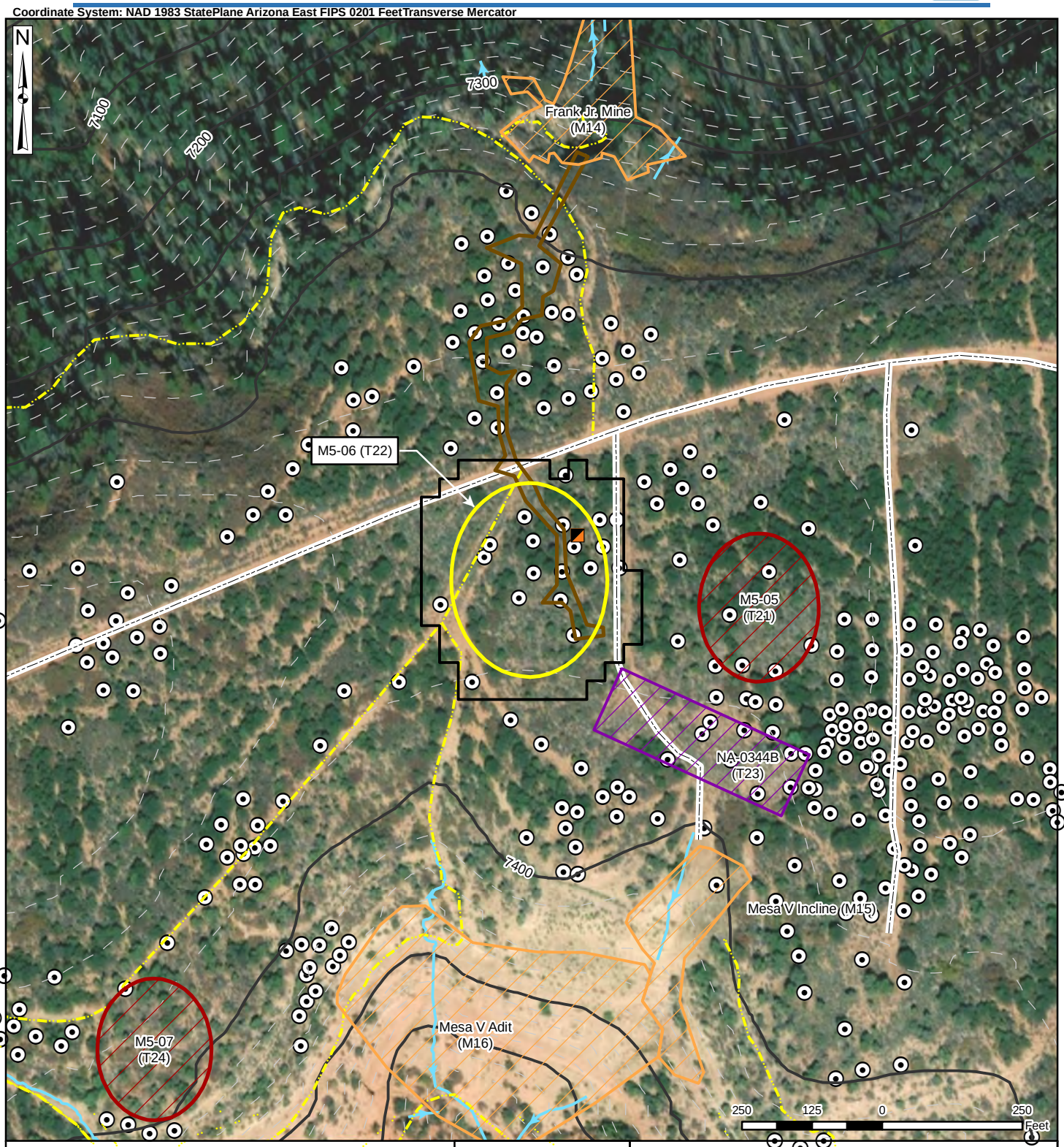
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NON-AUM TARGET M5-06 (T22) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I22-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Tronox AUM Site Boundary
AUM Related Site Boundary
Underground Workings

Exploratory Bore Hole
Vertical Opening (Field Mapped)
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped
100 ft Contour*
20 ft Contour*

* 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.

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NON-AUM TARGET M5-06 (T22) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I22-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	

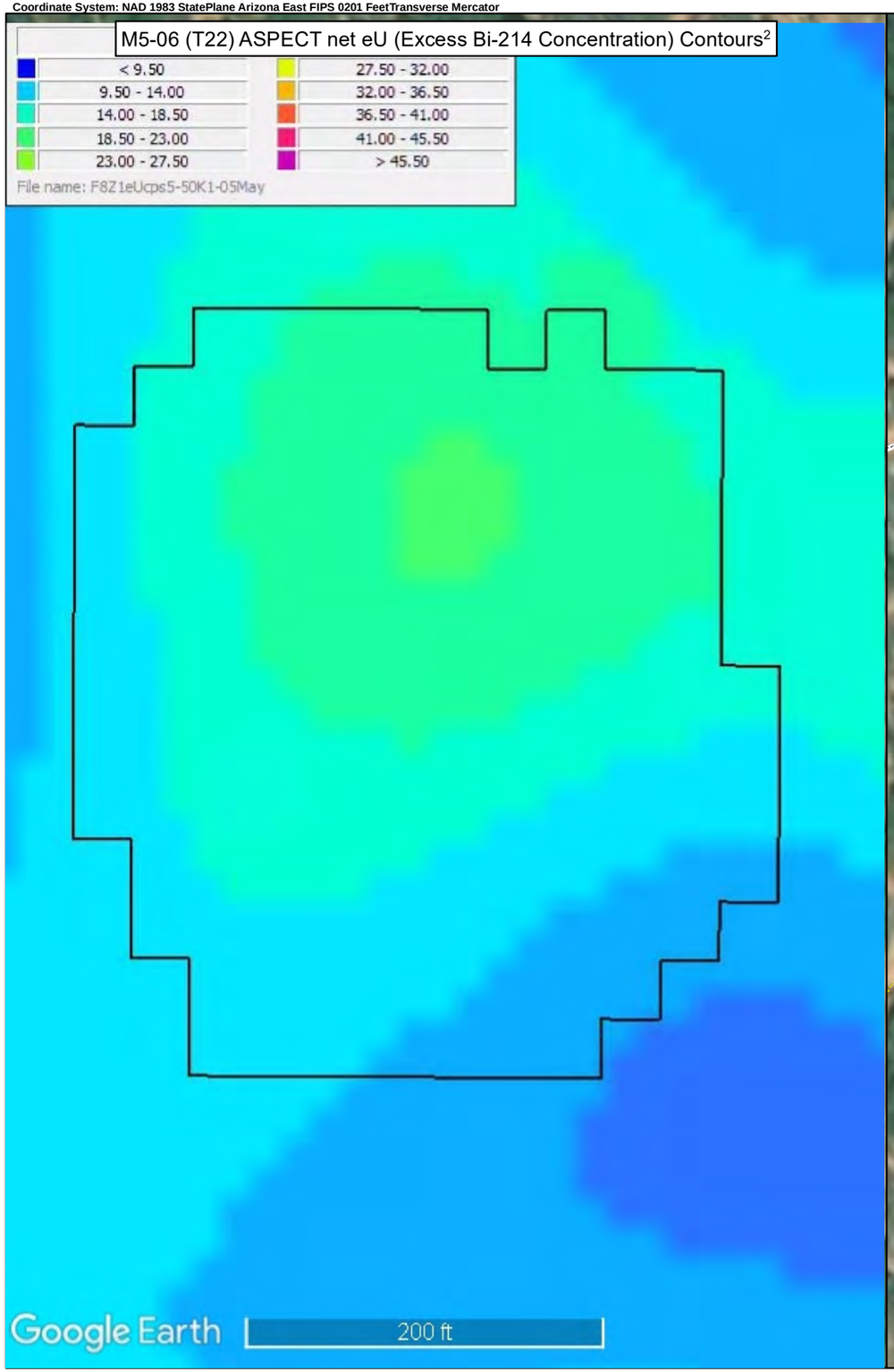
8.5.2 Gamma Radiation Survey and Field XRF Measurements

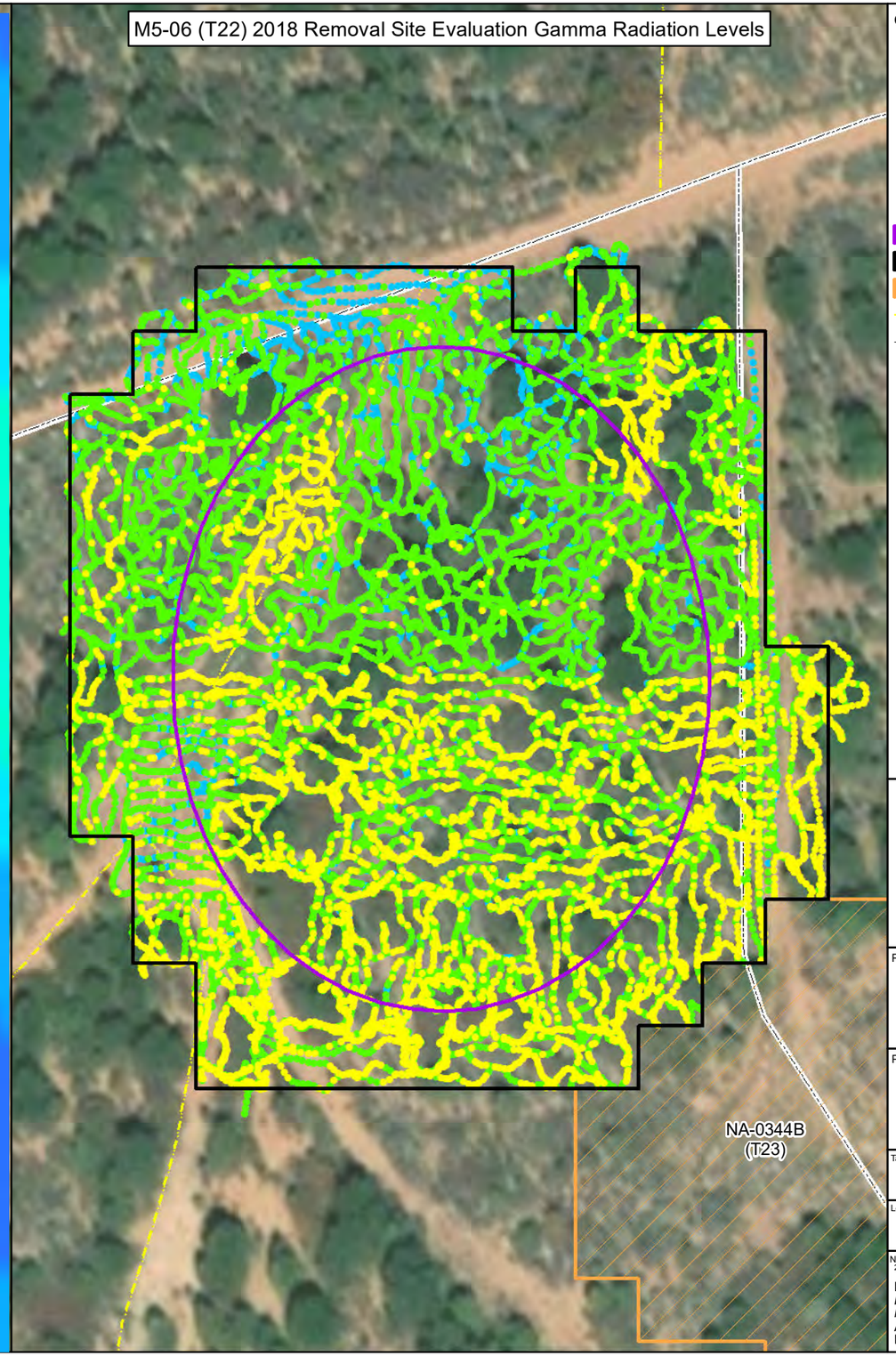
Tetra Tech performed GPS-based gamma radiation surveys (Figure I22-3) within the survey area of the non-AUM Target T22 as part of the Baseline Study in May 2018. Additional Goback gamma radiation surveys were performed in September 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T22 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I22-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 24, of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at 36 survey units. All gamma survey and XRF survey units were evaluated.

8.5.3 XRF Confirmation Sampling Overview

Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T22. Three XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from three locations (Table I22-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I22-4 and I22-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I22-2. The results of XRF confirmation sample analysis are provided in Section 8.5.6.1. Correlated XRF field measurements are provided in Attachment I3.

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





Gamma Reading (cpm)[1]

≤ 10,285	≤ Avg. BG
10,285 - 11,907	Avg. BG - 1 x BTV
11,907 - 23,814	1 x BTV - 2 x BTV
23,814 - 35,721	2 x BTV - 3 x BTV
35,721 - 47,628	3 x BTV - 4 x BTV
47,628 - 119,070	4 x BTV - 10 x BTV
≥ 119,070	≥ 10 x BTV

- Non-AUM Target Site Boundary
- Survey Area Boundary
- Other Survey Area
- Access Route - Foot
- Access Route - Vehicular

[1]The applied gamma background threshold value (BTV) for M5-06 (T22) Non-AUM Target is 11,907 cpm derived from BSA-22 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 70 ft

1:840

N W E S

0 35 70 140 Feet

NON-AUM TARGET M5-06 (T22)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

Prepared By:

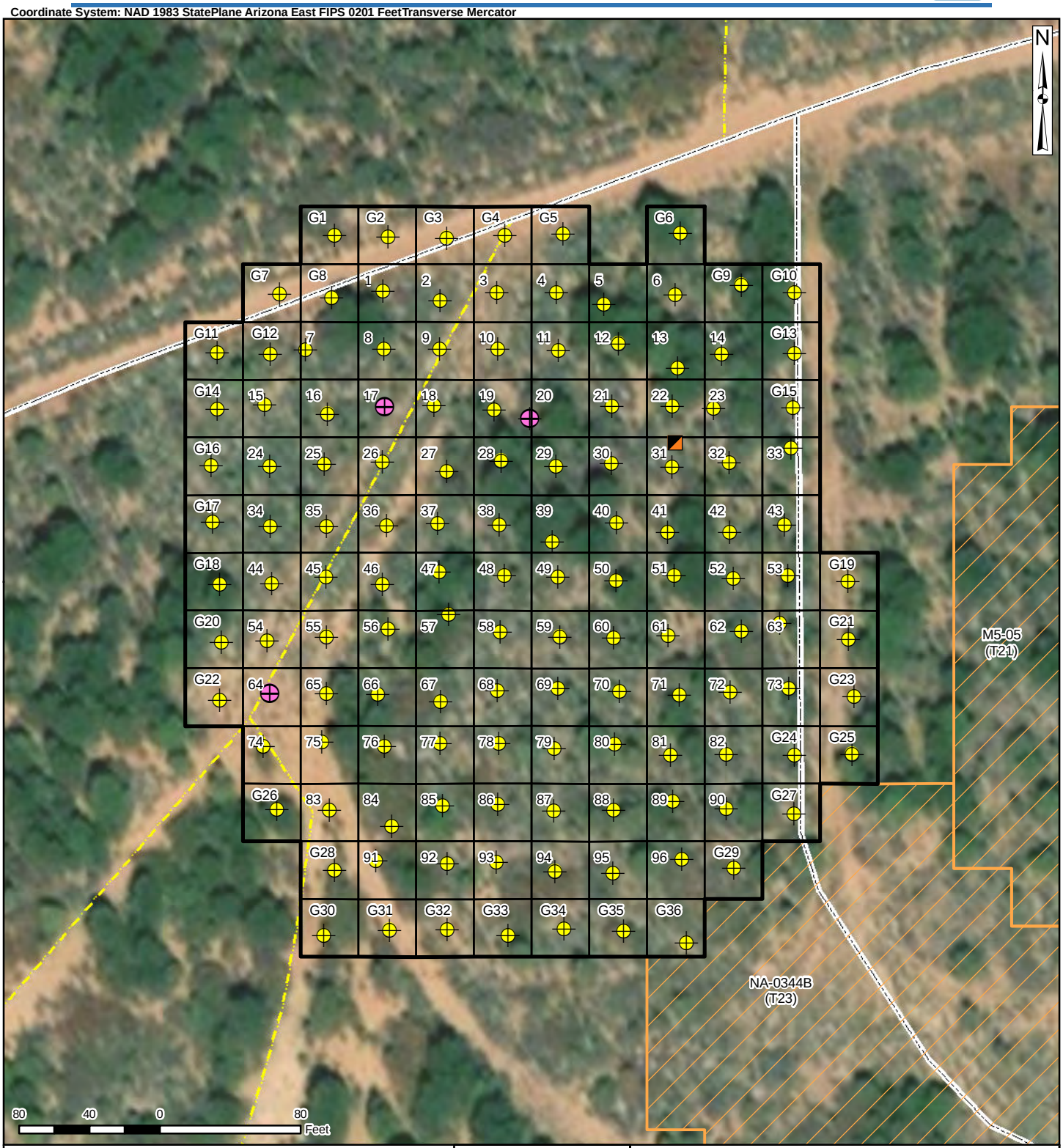
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/13/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborne Spectral Photometric Environmental Collection Technology.

Figure No.: **I22-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Vertical Opening (Field Mapped)

Survey Unit (100 m²)

Survey Area Boundary

Other Survey Area

Access Route (Foot)

Access Route (Vehicular)

Prepared for: USEPA Region 9

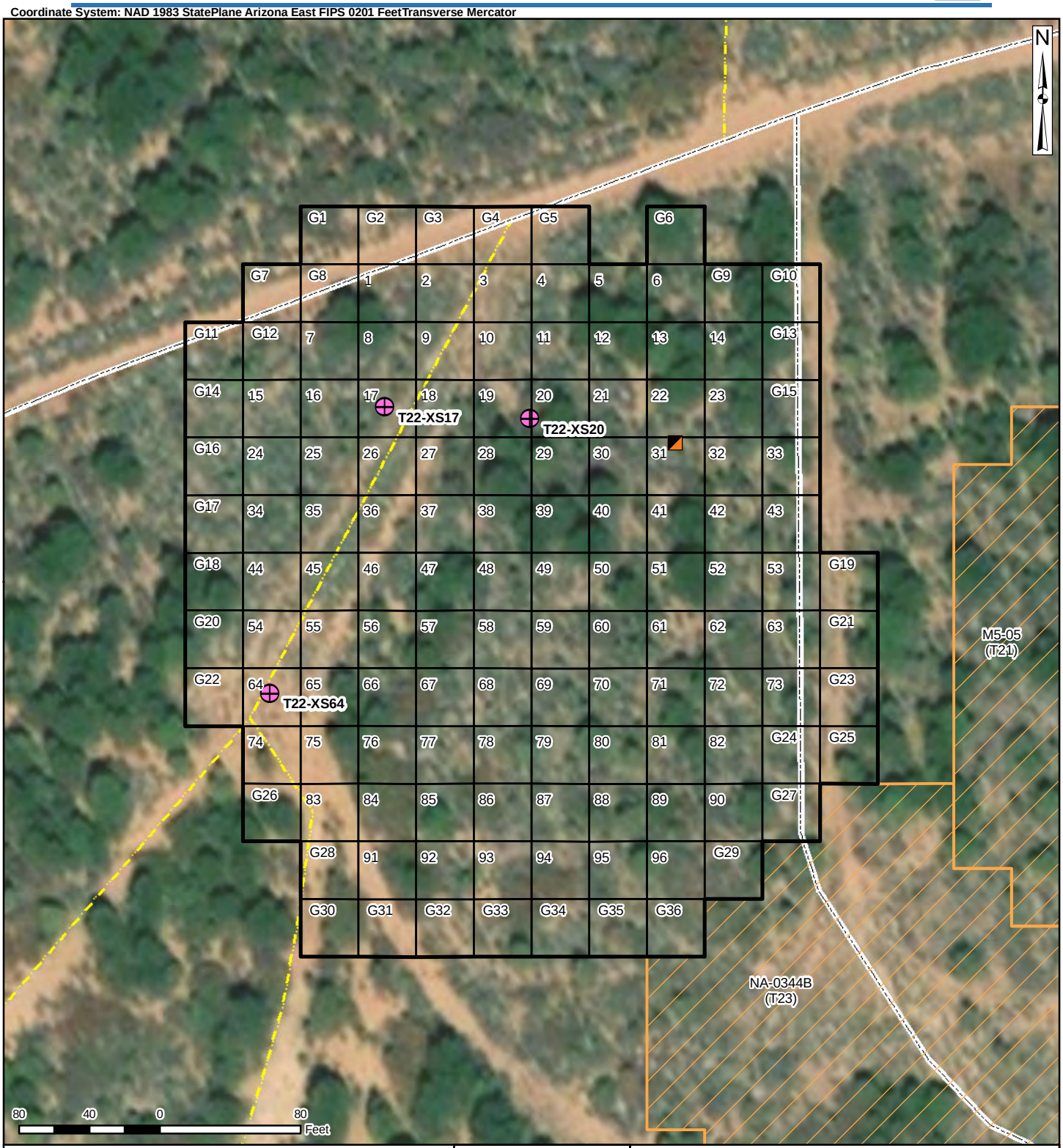
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NON-AUM TARGET M5-06 (T22) XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I22-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

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



XRF Confirmation Soil Sample* (0 - 3 inches bgs)

Vertical Opening (Field Mapped)

Survey Unit (100 m²)

Survey Area Boundary

Other Survey Area

Access Route (Foot)

Access Route (Vehicular)

*T22-XS17 = site T22 XRF confirmation soil sample collected at survey unit 17. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET M5-06 (T22) SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I22-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

Table I22-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-06 (T22)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T22-XS17-01-052118	17	0-3	XRF Confirmation	Primary	5/21/2018	36.5434630	-109.2476081	1805589-18, 1805592-18
T22-XS20-01-091118	20	0-3	XRF Confirmation	Primary	9/11/2018	36.5434429	-109.2473276	1809473-15, 1809474-15
T22-XS64-01-052218	64	0-3	XRF Confirmation	Primary	5/22/2018	36.5430182	-109.2478358	1805632-11, 1805633-11

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I22-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-06 (T22)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

8.5.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 8.5.1, Target T22 surface geology is entirely within Jml with soils within the Arabrab-Wetherill soil complex (MUSYM 414) (Figures I-22 and I-23). As a result, BSA-22 was selected for that combination of geology and soil type. Additionally, the Jml regional geological background would also be applicable for this Target. Table I22-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T22. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T22. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T22. The "Applied BTV" for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I22-3. Applied Background Threshold Values for Non-AUM Target M5-06 (T22)

Analyte	Units	Site-Specific BTV (BSA-22)	Regional BTV (Jml)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	5,580	7,000	5,580	Site-Specific BTV
Antimony	mg/kg	0.160	0.140	0.140	Regional BTV
Arsenic	mg/kg	2.2	3.5	2.2	Site-Specific BTV
Barium	mg/kg	201	270	201	Site-Specific BTV
Beryllium	mg/kg	0.41	0.57	0.41	Site-Specific BTV
Cadmium	mg/kg	0.192	0.160	0.160	Regional BTV
Calcium	mg/kg	4,960	32,000	4,960	Site-Specific BTV
Chromium	mg/kg	6.1	5.2	5.2	Regional BTV
Cobalt	mg/kg	3.9	4.4	3.9	Site-Specific BTV
Copper	mg/kg	10	12	10	Site-Specific BTV
Iron	mg/kg	7,470	8,897	7,470	Site-Specific BTV
Lead	mg/kg	9.7	11	9.7	Site-Specific BTV
Lithium	mg/kg	5.4	8.8	5.4	Site-Specific BTV
Magnesium	mg/kg	2,500	3,900	2,500	Site-Specific BTV
Manganese	mg/kg	517	440	440	Regional BTV
Mercury	mg/kg	0.0261	0.0378	0.0261	Site-Specific BTV
Molybdenum	mg/kg	0.36	0.29	0.29	Regional BTV
Nickel	mg/kg	6.3	6.2	6.2	Regional BTV
Potassium-40	pCi/g	23.2	26.9	23.2	Site-Specific BTV
Radium-226	pCi/g	1.54	2.23	1.54	Site-Specific BTV
Radium-228	pCi/g	0.50	0.75	0.50	Site-Specific BTV
Selenium	mg/kg	0.93	1.0	0.93	Site-Specific BTV
Silver	mg/kg	0.033	0.037	0.033	Site-Specific BTV
Sodium	mg/kg	29	45	29	Site-Specific BTV
Thallium	mg/kg	0.068	0.075	0.068	Site-Specific BTV
Thorium	mg/kg	3.6	4.7	3.6	Site-Specific BTV
Uranium	mg/kg	1.3	1.5	1.3	Site-Specific BTV
Vanadium	mg/kg	15	24	15	Site-Specific BTV
Zinc	mg/kg	24	27	24	Site-Specific BTV
Gamma Radiation	cpm	11,907	14,566	11,907	Site-Specific BTV

Notes:

BSA	Background Study Area
BTV	background threshold value
cpm	counts per minute
Jml	Morrison Formation (Lower)
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram

8.5.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T22 and the raw gamma radiation and grid averaged gamma radiation survey results.

8.5.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T22 in May 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in September 2018 to collect data within the Goback survey units. The applied gamma BTV for non-AUM Target T22 is 11,907 cpm. A total of 15,547 measurements were collected as part of the gamma radiation survey at non-AUM Target T22 across 132 survey units. Because of the thick vegetation, not all survey units were scanned at 100 percent density. An average scan density of 118 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I22-4.

Table I22-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-06 (T22)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,907	
Measurements	#	15,547	132
Minimum	cpm	8,281	9,815
Maximum	cpm	20,342	14,434
Average	cpm	11,502	11,471
Median	cpm	11,405	11,560
Standard Deviation	cpm	1,042	644
90th Percentile	cpm	12,736	12,134
95th Percentile	cpm	13,201	12,368
99th Percentile	cpm	14,844	12,917
Measurements per Survey Unit	#/grid	118	
Measurements Above Gamma BTV	#	4,691	28
Measurements Above Gamma BTV	%	30.2	21.2

Notes:
BTV background threshold value
cpm counts per minute

8.5.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 30.2 percent of the measurements within the Target boundaries, in some cases exceeding greater than 1.7 times the applied gamma BTV (11,9070 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-22 (Jml) gamma survey results is provided on Figure I22-6. This graph shows that the spread of radiation data at Target T22 (shown on left) begins within the middle range of BSA-22 (Jml) gamma levels (shown on right) and then rises to more than 1.3 times the top range of background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T22 is higher than the data cloud from the BSA-22 (Jml) data set. A box plot showing the quartiles of the data sets is provided in Figure I22-7. The box plot shows that the median of Target T22 radiation levels is higher than the median of the BSA-22 (Jml) data set but less than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I22-8. A vertical opening was identified in the northeast portion of Target T22. Further, historic exploratory borings were identified in the file review. Both types of features may have left mine-related debris at ground surface. A review of historic aerial photographs and reclamation records is also warranted to determine if the Target area was disturbed by reclamation activities at AUM-related burial cell NA-0344b to the south.

In general, Target T22 has surficial gamma radiation levels about the same as BSA-22 (Jml) levels across the majority of the Target except for the southern portion of the survey area, which abuts an AUM-related Target. The area of elevated gamma activity does not correlate with the ASPECT gamma survey findings (Figure I22-3). No TENORM was observed at the Target. Section 8.5.5.3 presents the grid averaged results of the gamma radiation survey.

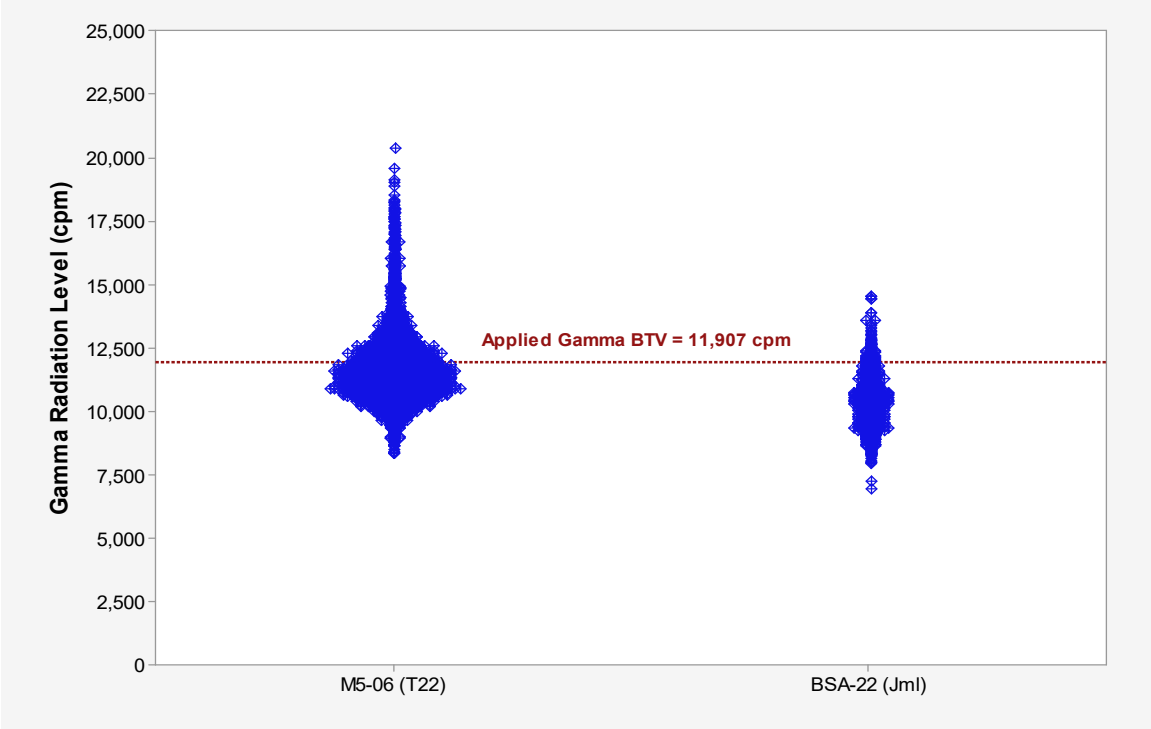


Figure I22-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M5-06 (T22) and BSA-22 (Jml)

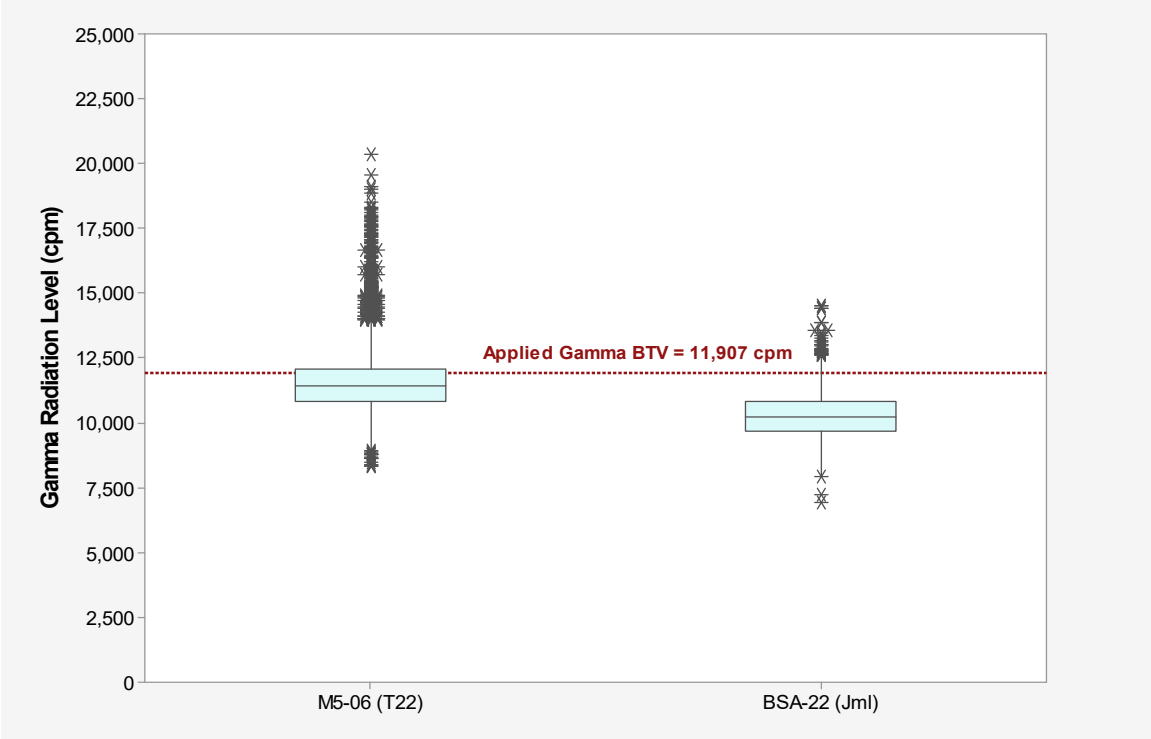
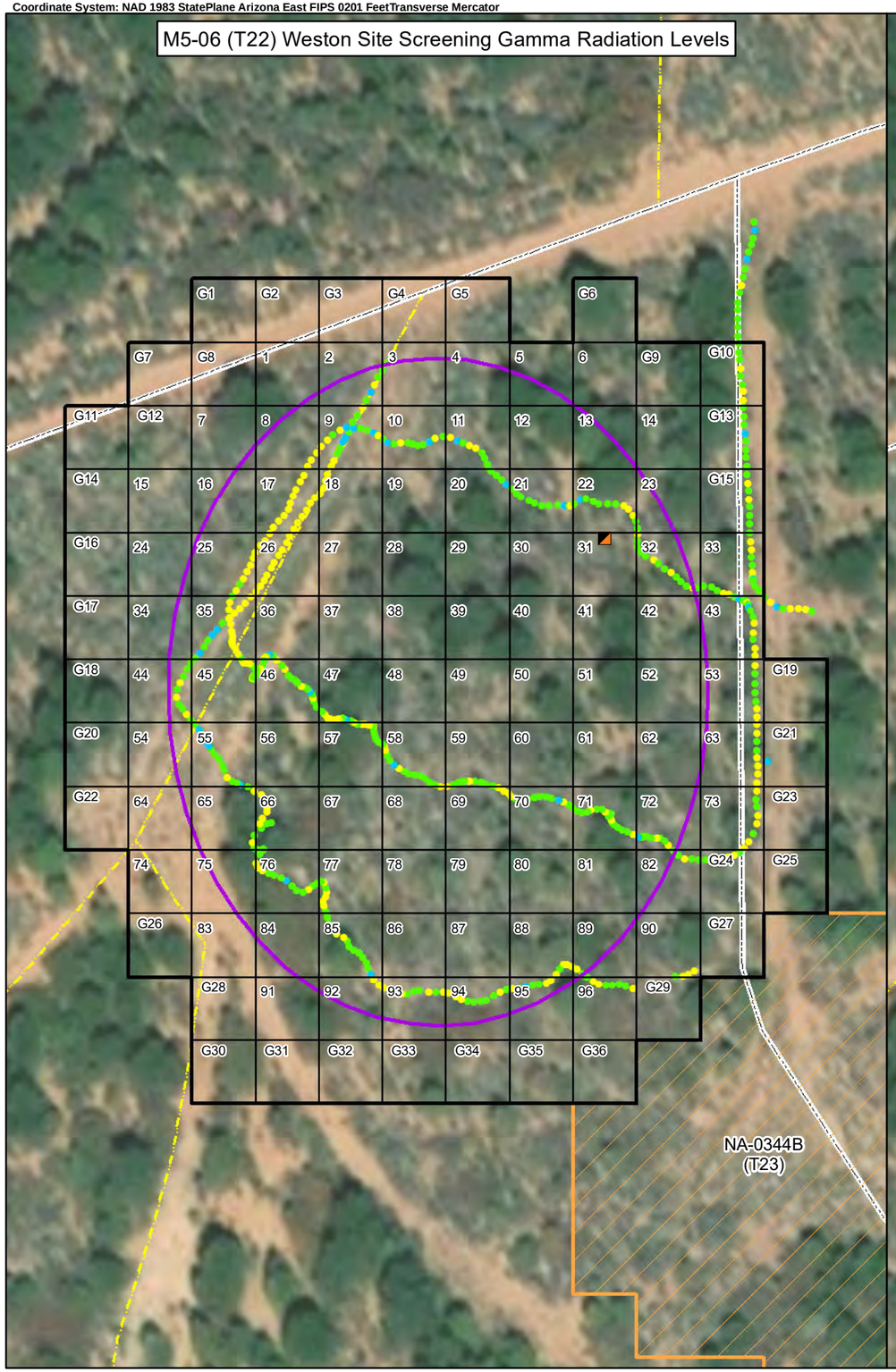


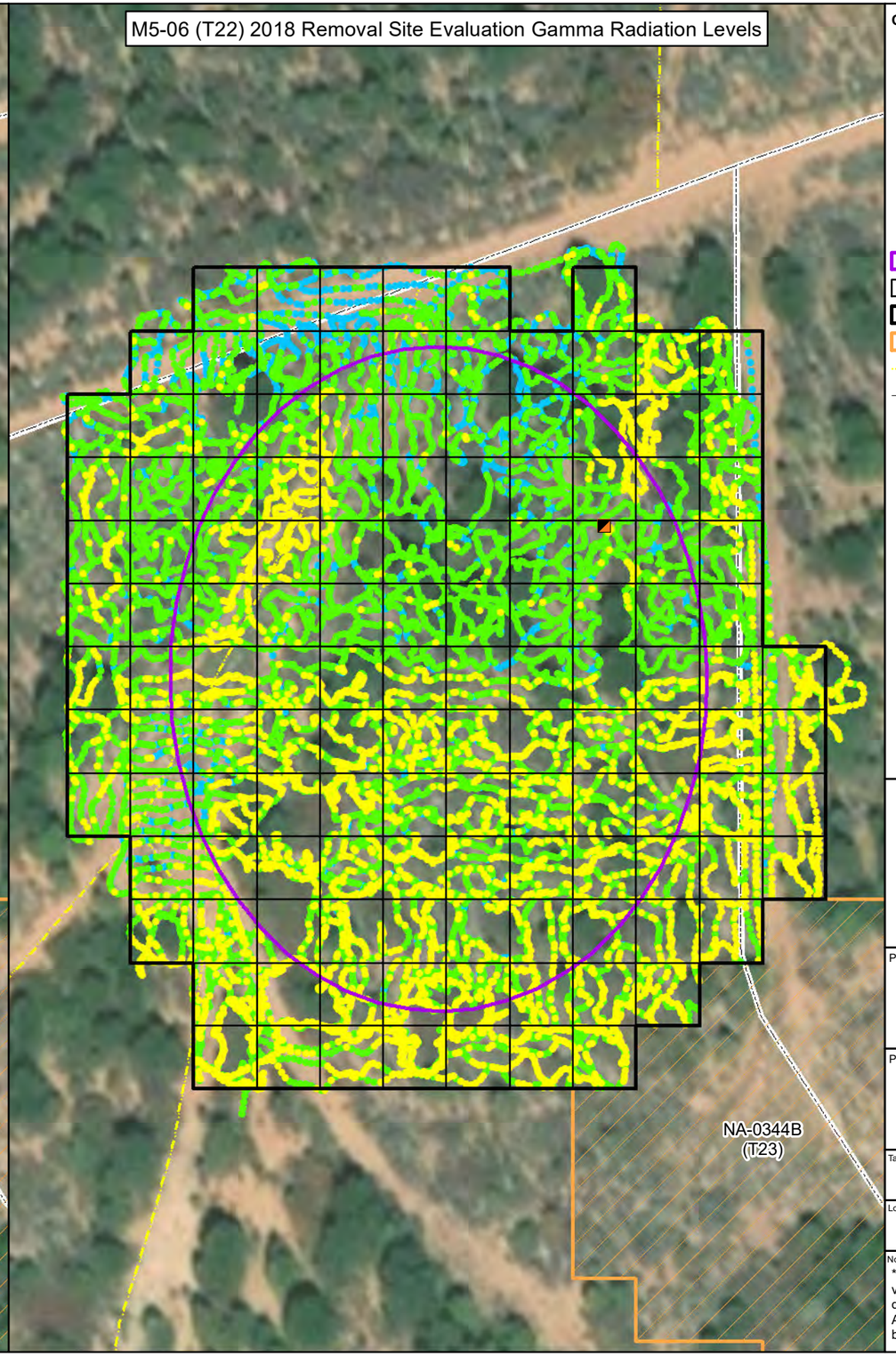
Figure I22-7. Box Plot of Raw Gamma Radiation Levels at Target M5-06 (T22) and BSA-22 (Jml)

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

M5-06 (T22) Weston Site Screening Gamma Radiation Levels



M5-06 (T22) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)*

≤ 10,285	≤ Avg. BG
10,285 - 11,907	Avg. BG - 1 x BTV
11,907 - 23,814	1 x BTV - 2 x BTV
23,814 - 35,721	2 x BTV - 3 x BTV
35,721 - 47,628	3 x BTV - 4 x BTV
47,628 - 119,070	4 x BTV - 10 x BTV
≥ 119,070	≥ 10 x BTV

- Vertical Opening - Field Mapped
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Other Survey Area
- Access Route - Foot
- Access Route - Vehicular

1 in = 70 ft

1:840

N
W E
S

0 35 70 140 Feet

NON-AUM TARGET M5-06 (T22)
2018 REMOVAL SITE EVALUATION
VS WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/15/2019

Notes:
*The applied gamma background threshold value (BTV) for M5-06 (T22) is 11,907 cpm derived from BSA-22 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I22-8**

8.5.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 8.5.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 8.5.5.1. Figure I22-9 and Figure I22-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-22 (Jml) data set (shown on right). A total of 21.2 percent of the survey units (28 of 132) within the survey area of Target T22 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I22-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I22-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. The elevated regions of the Target may correspond with historic exploratory borings at the Target or reclamation activities at the AUM-related burial cell to the south. Other elevated areas may correlate with areas of historical geological borings (see Figure I22-2).

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 8.5.6.

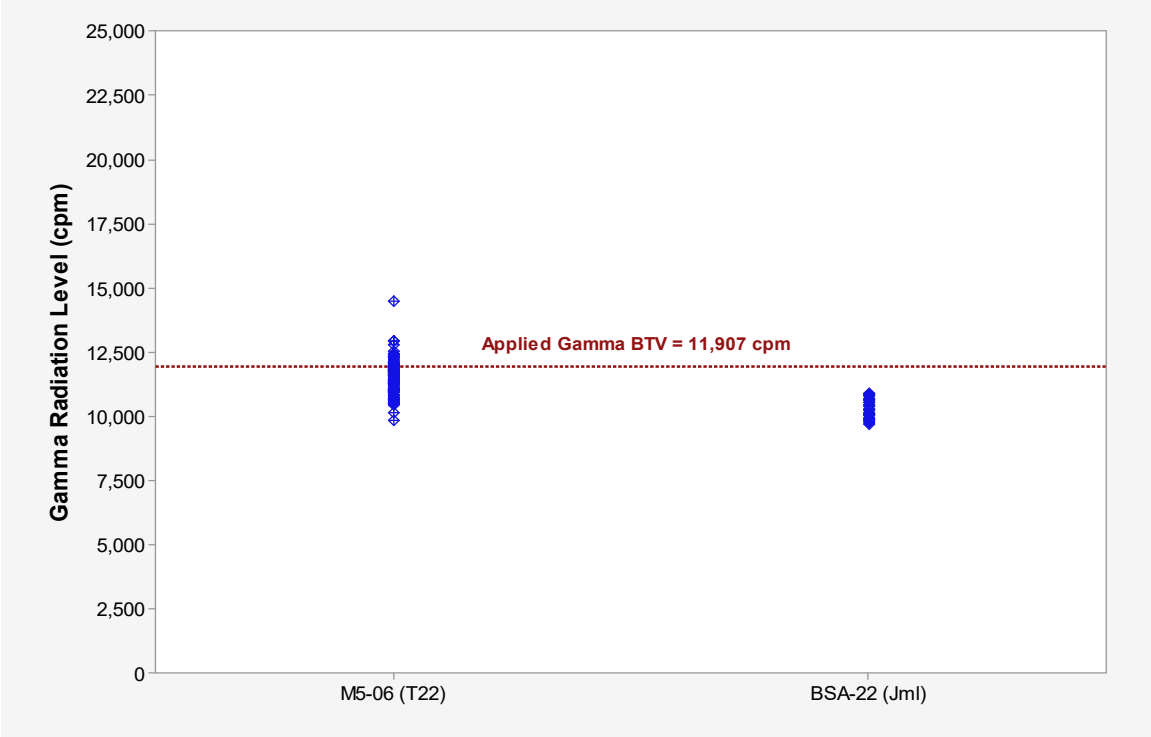


Figure I22-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-06 (T22) and BSA-22 (Jml)

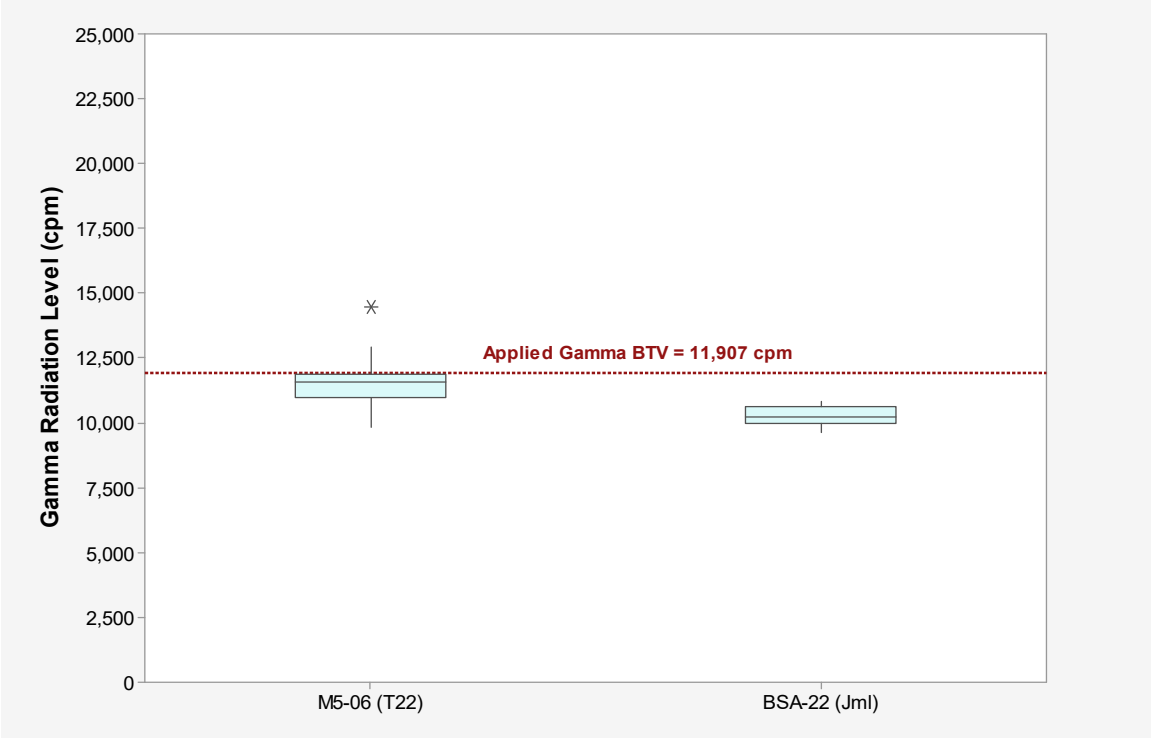
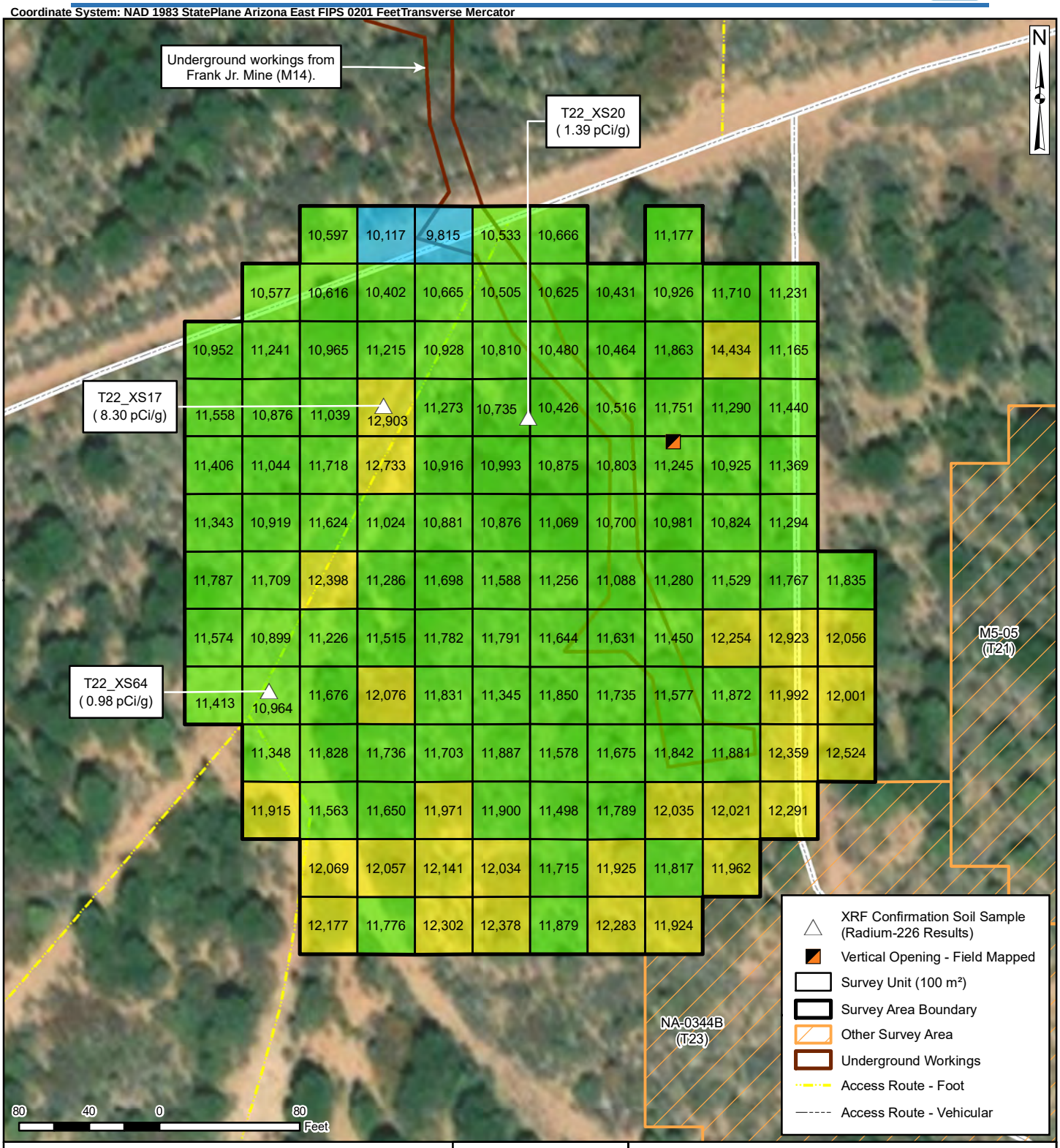


Figure I22-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-06 (T22) and BSA-22 (Jml)



Grid Averaged Gamma Reading (cpm)*

≤ 10,285	≤ Avg. BG
10,285 - 11,907	Avg. BG - 1 x BTV
11,907 - 23,814	1 x BTV - 2 x BTV
23,814 - 35,721	2 x BTV - 3 x BTV
35,721 - 47,628	3 x BTV - 4 x BTV
47,628 - 119,070	4 x BTV - 10 x BTV
≥ 119,070	≥ 10 x BTV

*The applied gamma background threshold value (BTV) for M5-06 is 11,907 cpm derived from BSA-22 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M5-06 (T22) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I22-11
Location: COVE CHAPTER NAVAJO NATION	Date: 7/9/2019	

8.5.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T22. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 8.5.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 8.5.6.2.

8.5.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T22: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I22-1 and I22-2. All the results of the XRF confirmation soil samples are presented in Table I22-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T22 following the methods outlined in Section 2.4 and shown in Figure I22-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 133 measurements were collected across 132 survey units from the survey area of Target T22 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I22-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T22 at a depth of 0 to 3 inches bgs. Three XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I22-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 8.5.7.

Table I22-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-06 (T22)

Analyte	Units	Applied BTV	T22-XS17-01-052118		T22-XS20-01-091118		T22-XS64-01-052218	
			Result	Q	Result	Q	Result	Q
Survey Unit			X17		X20		X64	
Aluminum	mg/kg	5,580	4,800		3,700		4,400	
Antimony	mg/kg	0.140	0.11		<0.094	U	0.047	J
Arsenic	mg/kg	2.2	1.7		2		1.7	
Barium	mg/kg	201	85		80		85	
Beryllium	mg/kg	0.41	0.31		0.27		0.30	
Cadmium	mg/kg	0.160	0.068	J	0.064	J	0.035	J
Calcium	mg/kg	4,960	2,600		2,700		2,600	
Chromium	mg/kg	5.2	4.9		4.2		4.2	
Cobalt	mg/kg	3.9	2.7		2.6		2.7	
Copper	mg/kg	10	5.2		5.1		3.7	
Iron	mg/kg	7,470	6,200		5,600		5,600	
Lead	mg/kg	9.7	5.7		5.3		4.6	
Lithium	mg/kg	5.4	5.4		5.2		6	
Magnesium	mg/kg	2,500	2,200		1,800		2,200	
Manganese	mg/kg	440	250		230		200	
Molybdenum	mg/kg	0.29	0.27		0.22		0.21	
Nickel	mg/kg	6.2	5		4.5		4.3	
Potassium-40	pCi/g	23.2	14.1		17.1		14.1	
Radium-226	pCi/g	1.54	8.3		1.39		0.98	LT
Radium-228	pCi/g	0.50	<0.94	UJ	<0.56	U	<0.43	U
Selenium	mg/kg	0.93	0.67	J	0.79	J	0.56	J
Silver	mg/kg	0.033	0.015	J	0.014	J	0.015	J
Sodium	mg/kg	29	<100	U	<94	U	17	J
Thallium	mg/kg	0.068	0.054		0.052		0.046	
Thorium	mg/kg	3.6	2.7		2.2		2.5	
Uranium	mg/kg	1.3	1.5		0.74		0.59	
Vanadium	mg/kg	15	17		12		13	
Zinc	mg/kg	24	14		13		12	

Notes:
BTV Background threshold value
J Estimated value
J- Estimated value, may be biased low
LT Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
M3 The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg Milligrams per kilogram
NA Not applicable
NV No Value
pCi/g Picocuries per gram
Q Qualification
U Not considered detected. The associated value is the method detection limit (MDL).
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

Table I22-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-06 (T22)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.22	7,470	9.71	440	0.29	3.60	1.35	15	24
Measurements	#	133	133	133	133	133	133	133	133	133
Detects	#	88	133	133	133	62	133	126	104	132
Nondetects	#	45	0	0	0	71	0	7	29	1
Minimum	mg/kg	1.85	3,078	3.65	167	0.04	1.27	0.09	16.1	9.1
Maximum	mg/kg	6	9,606	35	855	3.7	3.9	12.2	62	42
Standard Deviation	mg/kg	0.8	943	3.2	109	0.92	0.5	1.9	7	4.8
Average	mg/kg	3.0	6,164	9.2	354	1.05	2.5	3.0	24.9	20.5
Median	mg/kg	2.7	6,131	8.7	326	0.69	2.5	2.8	23.2	19.3
Relative Standard Deviation	%	27.3	15.3	34.8	30.9	87.5	20.8	62.1	29.8	23.6
90th Percentile	mg/kg	4.0	7,339	11.7	513	2.5	3.1	5.6	35	29
95th Percentile	mg/kg	4.6	7,857	12.6	549	2.8	3.3	6.3	39	29
99th Percentile	mg/kg	5.3	8,437	18.1	722	3.5	3.8	8.2	42	34
Measurements Above Applied BTV	#	72	11	40	22	49	3	104	104	107
Measurements Above Applied BTV	%	54.1	8.3	30.1	16.5	36.8	1.5	78.2	78.2	80.5

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value
mg/kg Milligram per kilogram
XRF X-ray fluorescence

8.5.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T22 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T22 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T22. The estimated BTVs are identified in Section 8.5.4 and Table I22-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I22-7 presents a summary of the background comparison for different measurement and soil depths at Target T22. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T22. However, gamma radiation screening indicated that gamma levels at Target T22 are elevated in comparison to the BSA. Elevated gamma levels may be associated with exploratory borings at the Target and reclamation activities at adjacent AUMs. Therefore, while multiple COPCs have been identified at Target T22 based on a conservative comparison to background, risk screening will be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I22-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-06 (T22)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic		✓	✓
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron		✓	✓
Lead		✓	✓
Lithium	✓		✓
Magnesium			
Manganese		✓	✓
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226	✓		✓
Radium-228			
Selenium			
Silver			
Sodium			
Thallium			
Thorium			
Uranium	✓	✓	✓
Vanadium	✓	✓	✓
Zinc		✓	✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

8.5.7 Primary Contaminant Mapping

8.5.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 8.5.6.2 identified the COPCs at Target T22. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 8.5.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I22-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T22 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 8.5.7.1 through Section 8.5.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T22. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

8.5.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I22-7. Arsenic exceeded the applied BTV in 54.1 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for arsenic is 2.22 mg/kg for Target T22 as presented in Section 8.5.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I22-5 and Attachment I3, respectively. Figure I22-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T22 and BSA-22 (Jml) samples. Figure I22-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T22 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.5.6.1. Arsenic XRF concentrations measured in surface soils at Target T22 ranged between 1.85 and 6.0 mg/kg with an average and standard deviation of 3.0 mg/kg and 0.8 mg/kg, respectively. The average arsenic XRF concentration is above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T22 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I22-14. Overall, the majority of detectable arsenic results in surface soils were above the applied BTV. However, the maximum XRF value was 2.7 times higher than the applied BTV and does not appear to be associated with mining-related materials.

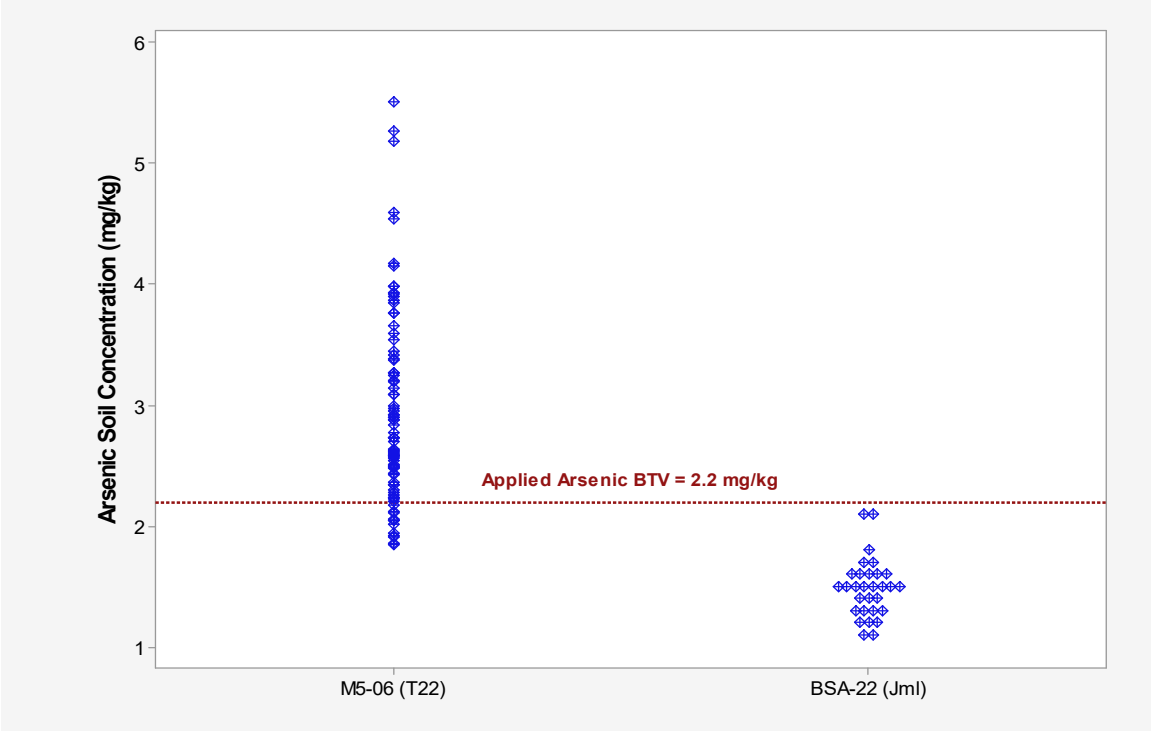


Figure I22-12. Individual Value Plot for Target M5-06 (T22) and BSA-22 (Jml) Arsenic Soil Concentrations

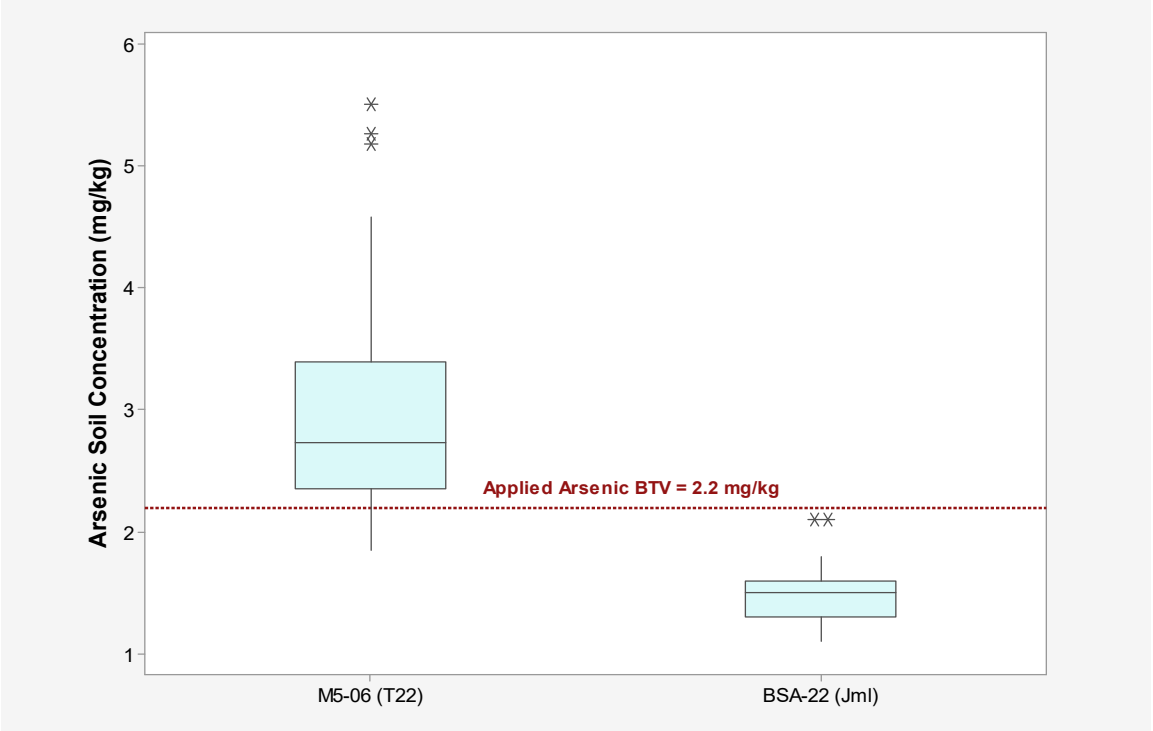
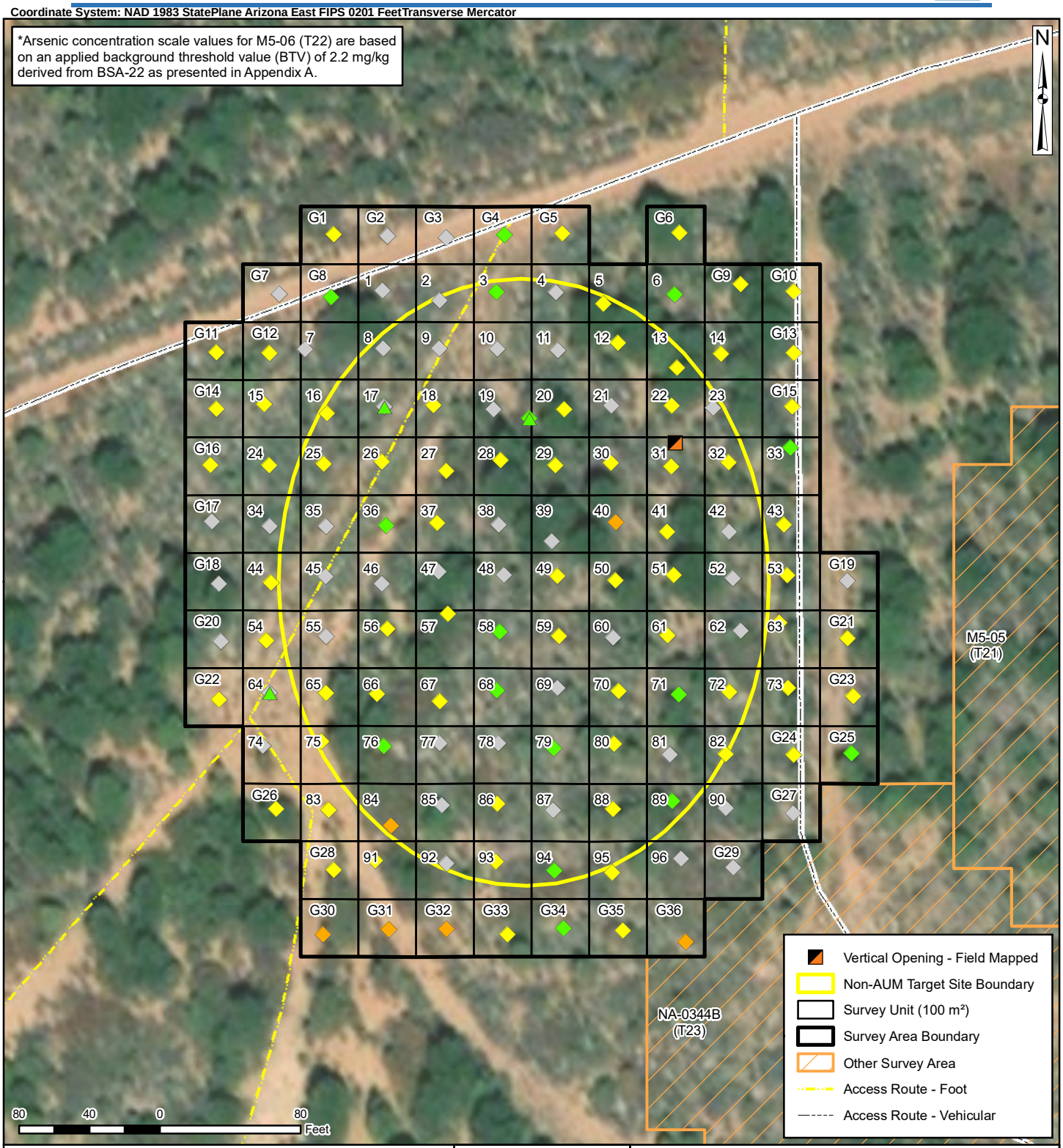


Figure I22-13. Box Plot for Target M5-06 (T22) and BSA-22 (Jml) Arsenic Soil Concentrations

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



Arsenic Concentration Scale (mg/kg)*

- ≤ 1.5
- 1.5 - 2.2
- 2.2 - 4.4
- 4.4 - 6.6
- 6.6 - 8.8
- 8.8 - 22
- ≥ 22
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

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NON-AUM TARGET M5-06 (T22) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I22-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.5.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I22-7. Lead exceeded the applied BTV in 30.1 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for lead is 9.7 mg/kg for Target T22 as presented in Section 8.5.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I22-5 and Attachment I3, respectively. Figure I22-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T22 and BSA-22 (Jml) samples. Figure I22-16 presents a box plot of detectable lead XRF soil concentrations for Target T22 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.5.6.1. Lead XRF concentrations measured in surface soils at Target T22 ranged between 3.65 and 35 mg/kg with an average and standard deviation of 9.2 mg/kg and 3.2 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T22 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I22-17. Overall, the majority of detectable lead results in surface soils were below the applied BTV. However, the maximum XRF value was 3.6 times higher than the applied BTV and does not appear to be associated with mining-related materials.

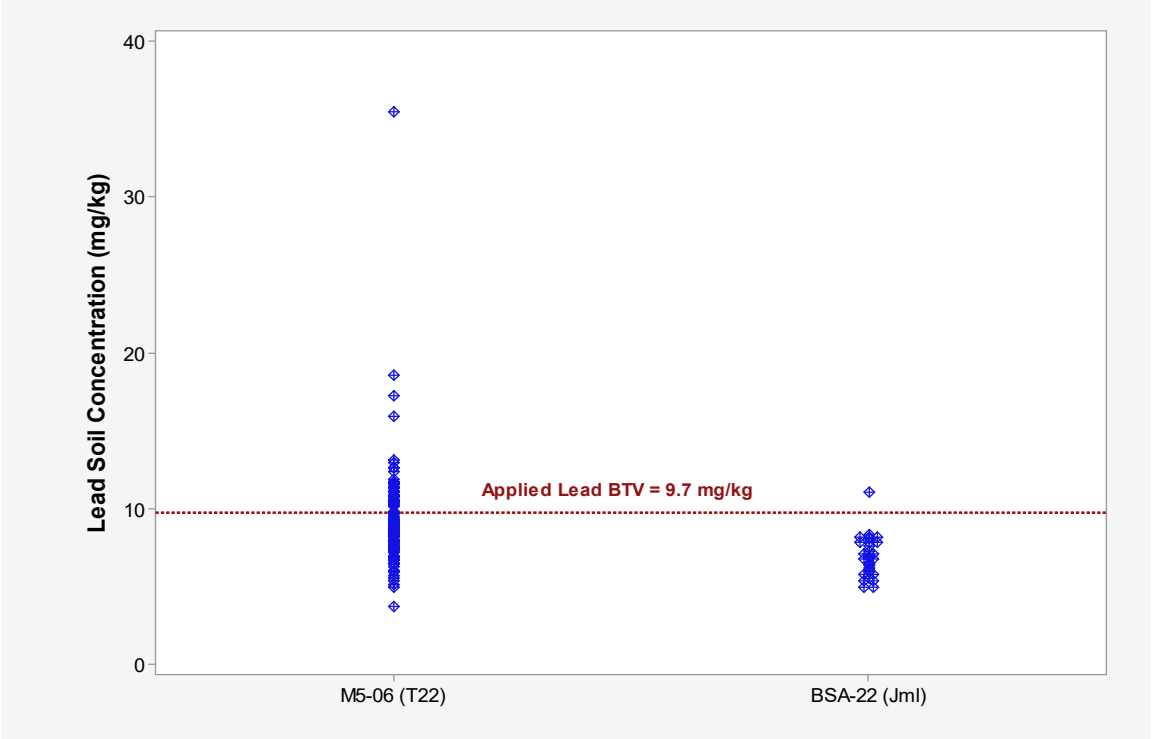


Figure I22-15. Individual Value Plot for Target M5-06 (T22) and BSA-22 (Jml) Lead Soil Concentrations

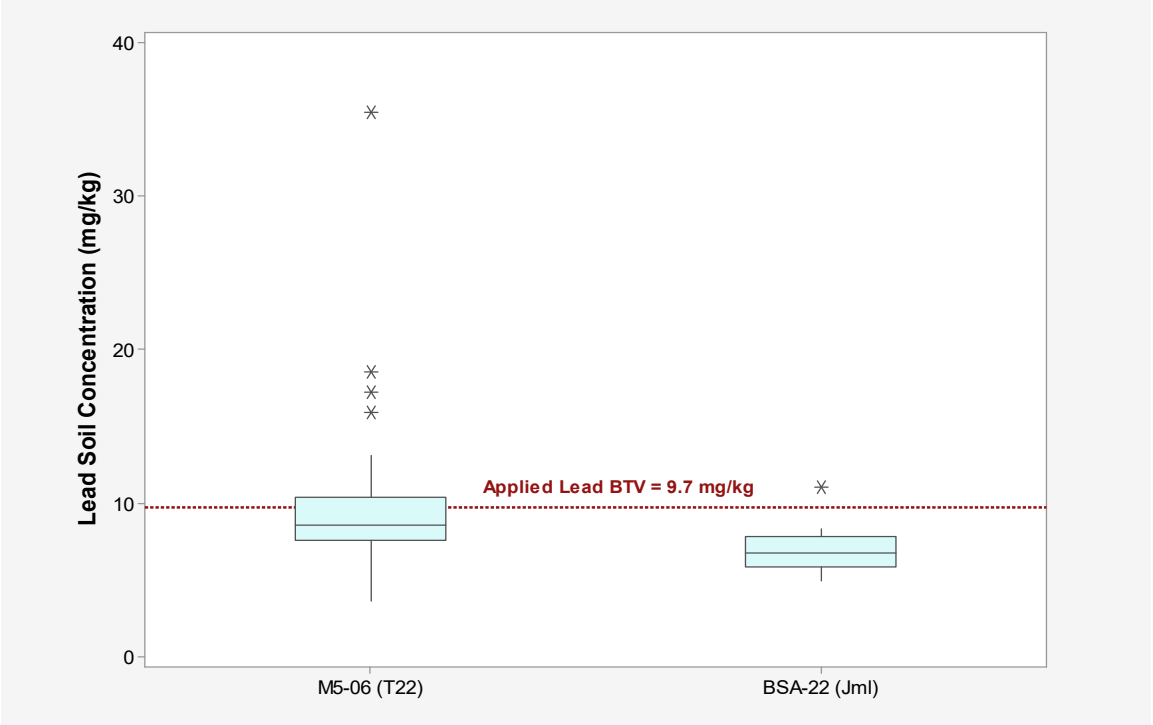
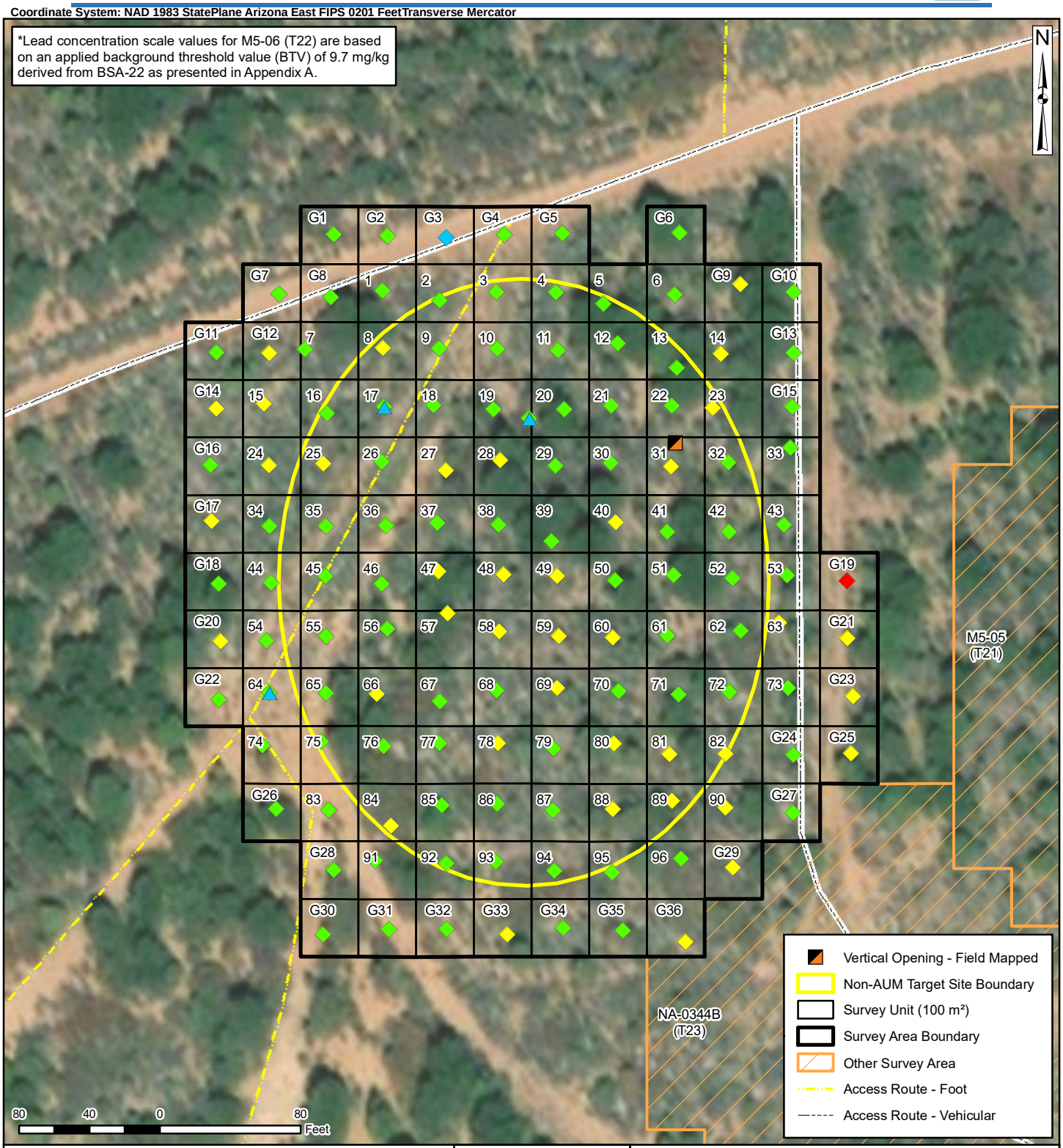


Figure I22-16. Box Plot for Target M5-06 (T22) and BSA-22 (Jml) Lead Soil Concentrations

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



Lead Concentration Scale (mg/kg)*

- ≤ 6.8
- 6.8 - 9.7
- 9.7 - 19
- 19 - 29
- 29 - 39
- 39 - 97
- ≥ 97

Lead Concentration Value Source

- ◇ In Situ XRF Measurement
- △ XRF Confirmation Soil Sample

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NON-AUM TARGET M5-06 (T22) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I22-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.5.7.4 Thorium

Thorium was not identified as a COPC in surface soil as shown in Table I22-7. Thorium exceeded the applied BTV in 1.5 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for thorium is 3.6 mg/kg for Target T22 as presented in Section 8.5.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I22-5 and Attachment I3, respectively. Figure I22-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T22 and BSA-22 (Jml) samples. Figure I22-19 presents a box plot of detectable thorium XRF soil concentrations for Target T22 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.5.6.1. Thorium XRF concentrations measured in surface soils at Target T22 ranged between 1.27 and 3.9 mg/kg with an average and standard deviation of 2.5 mg/kg and 0.5 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T22 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I22-20. Overall, the majority of detectable thorium results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials.

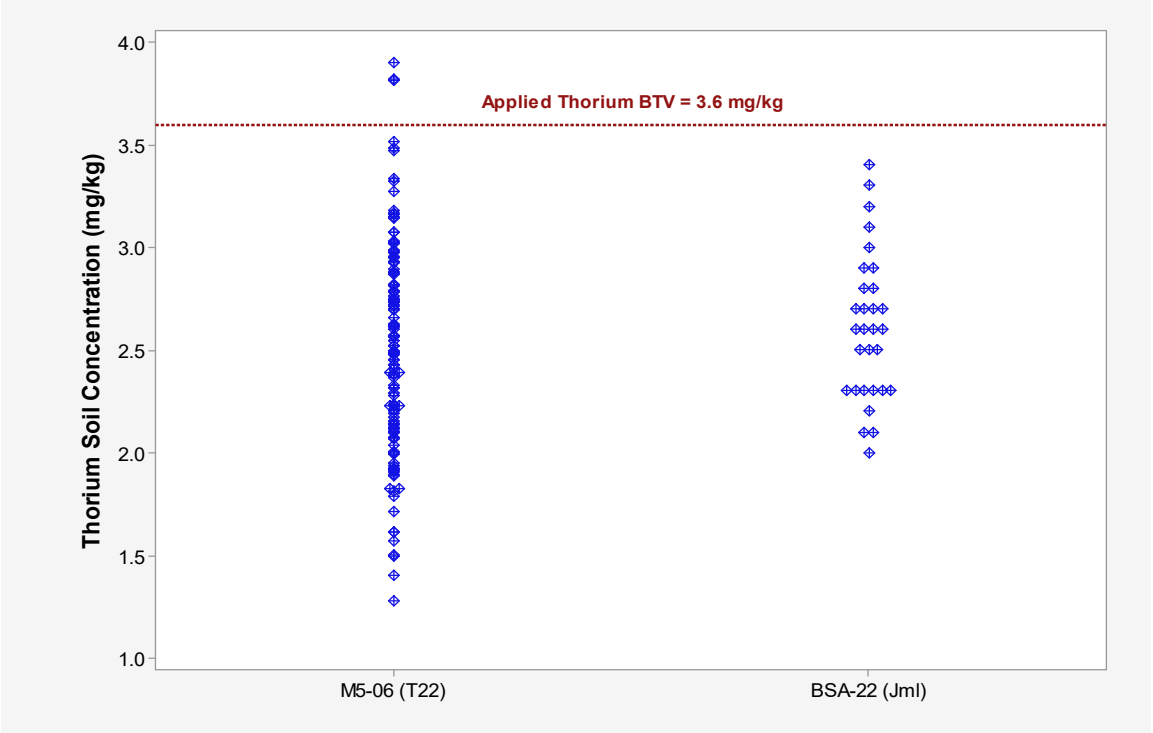


Figure I22-18. Individual Value Plot for Target M5-06 (T22) and BSA-22 (Jml) Thorium Soil Concentrations

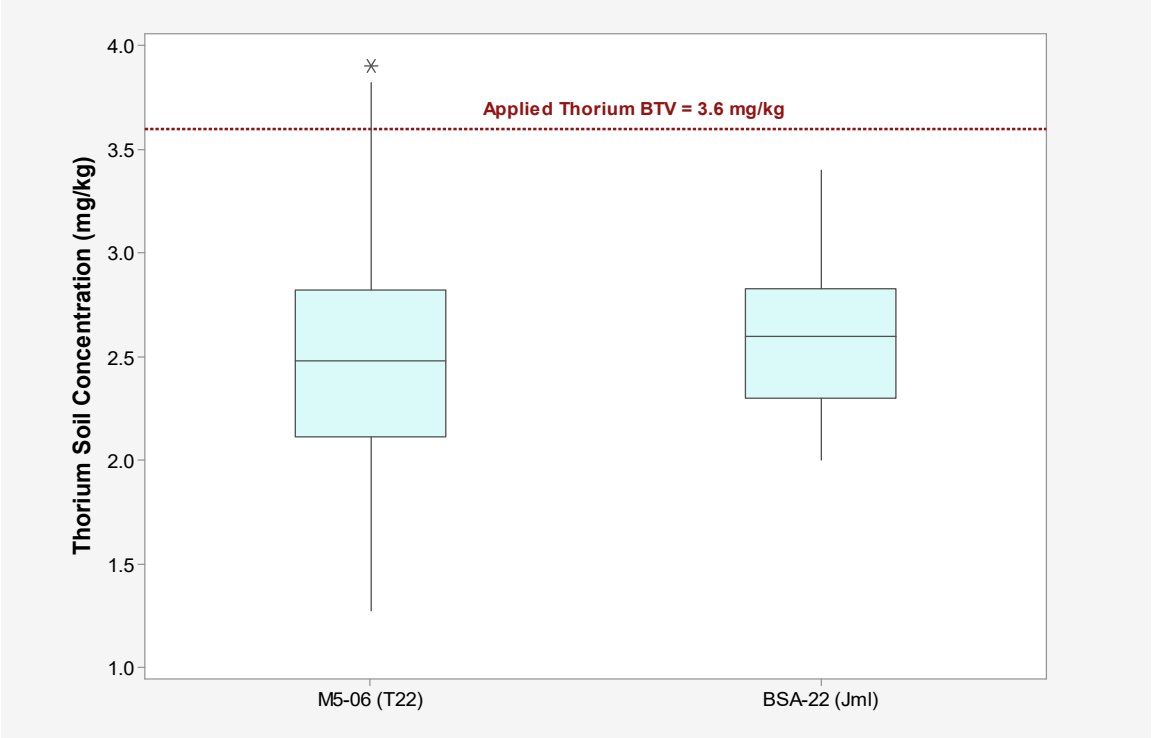
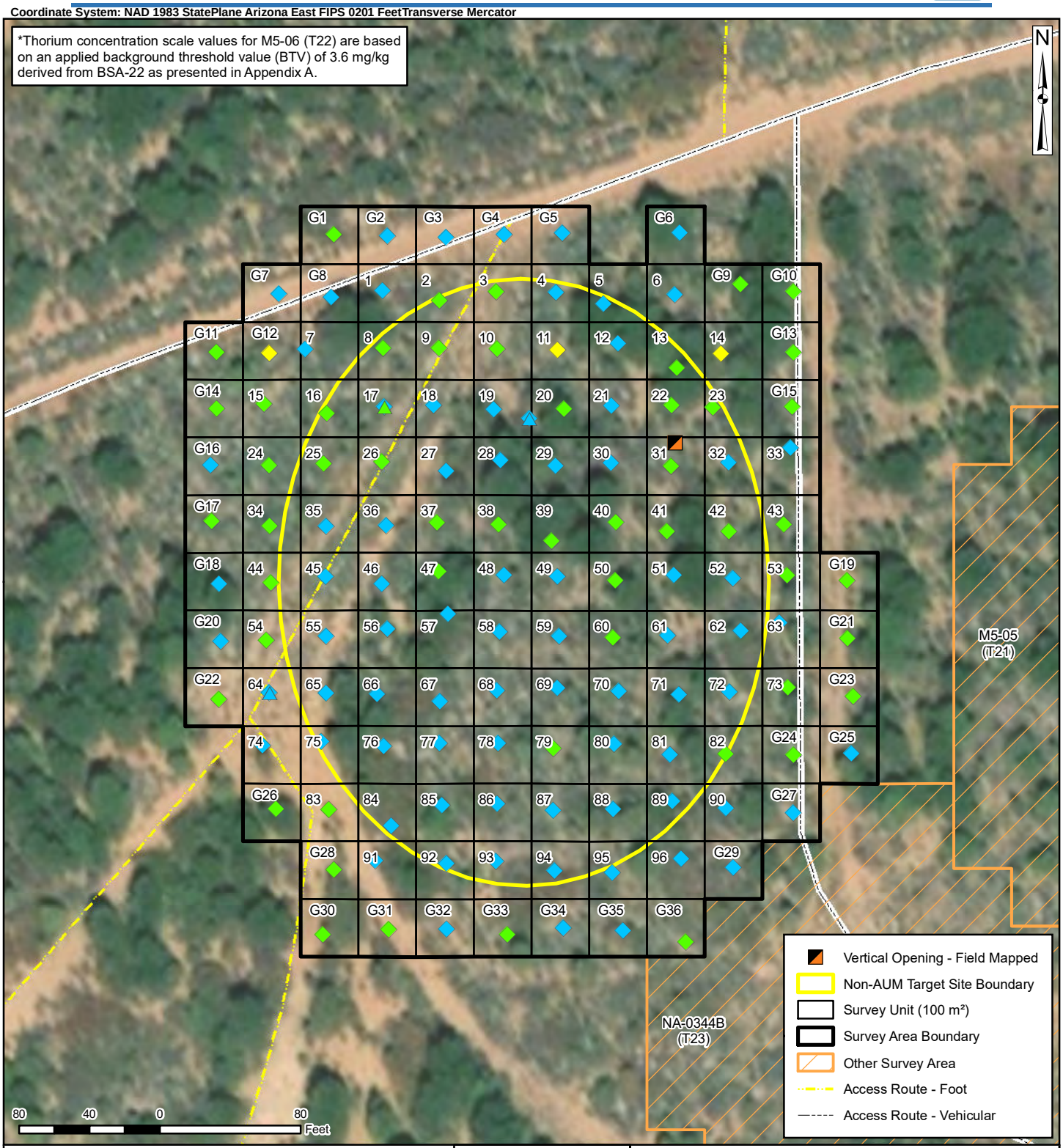


Figure I22-19. Box Plot for Target M5-06 (T22) and BSA-22 (Jml) Thorium Soil Concentrations



Thorium Concentration Scale (mg/kg)*

- ≤ 2.6
- 2.6 - 3.6
- 3.6 - 7.2
- 7.2 - 11
- 11 - 14
- 14 - 36
- ≥ 36

Thorium Concentration Value Source

- ◇ In Situ XRF Measurement
- △ XRF Confirmation Soil Sample

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NON-AUM TARGET M5-06 (T22) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I22-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.5.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I22-7. Uranium exceeded the applied BTV in 78.2 percent of in situ XRF measurements and one of the three XRF confirmation samples. The applied BTV for uranium is 1.35 mg/kg for Target T22 as presented in Section 8.5.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I22-5 and Attachment I3, respectively. Figure I22-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T22 and BSA-22 (Jml) samples. Figure I22-22 presents a box plot of detectable uranium XRF soil concentrations for Target T22 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.5.6.1. Uranium XRF concentrations measured in surface soils at Target T22 ranged between 0.09 and 12.2 mg/kg with an average and standard deviation of 3.0 mg/kg and 1.9 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T22 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I22-23. Overall, the majority of detectable uranium results in surface soils were above the applied BTV. However, the maximum XRF value was about 9 times higher than the applied BTV and does not appear to be associated with mining-related materials.

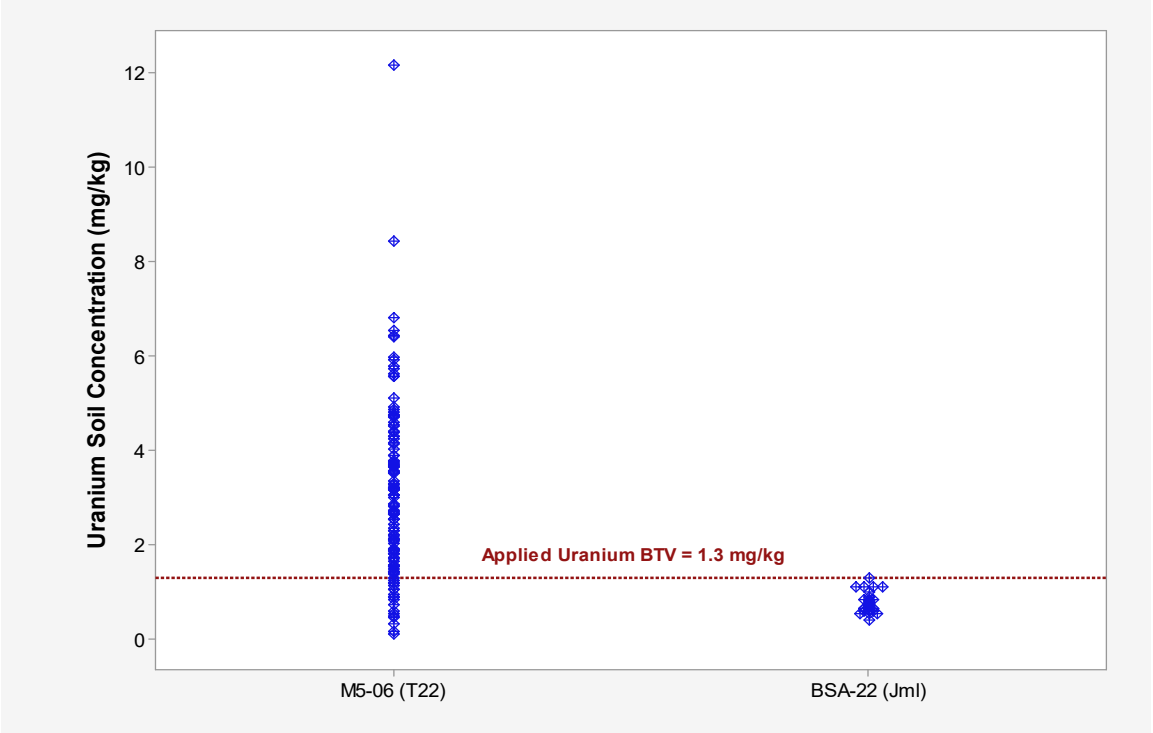


Figure I22-21. Individual Value Plot for Target M5-06 (T22) and BSA-22 (Jml) Uranium Soil Concentrations

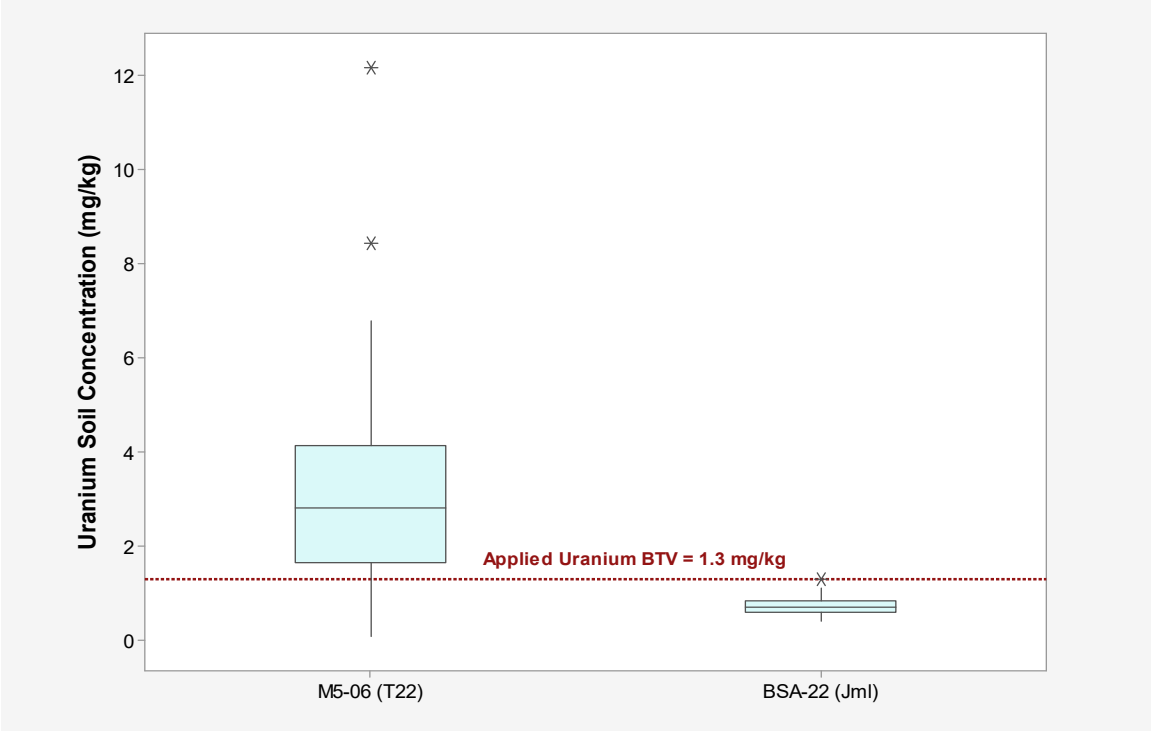
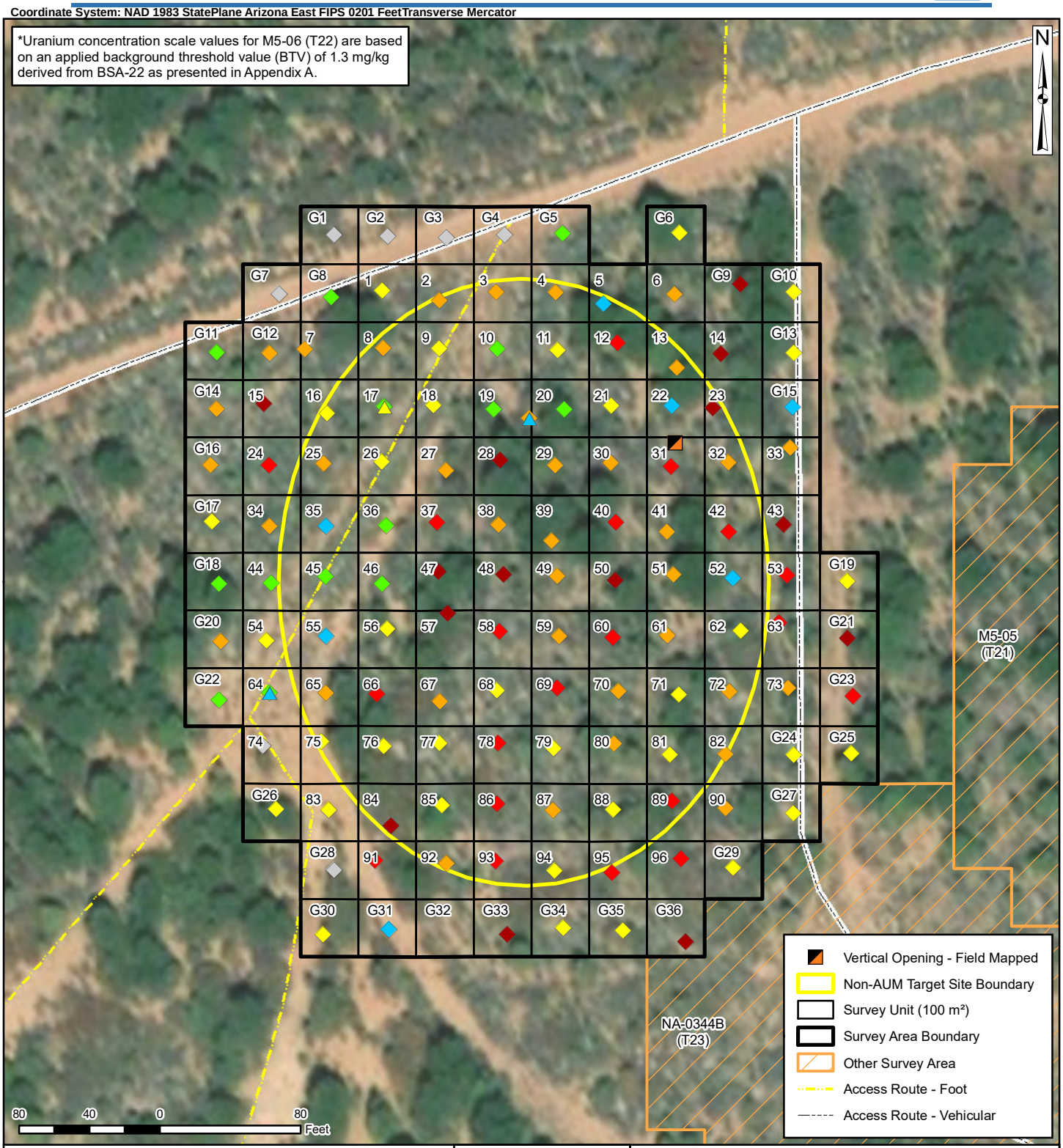


Figure I22-22. Box Plot for Target M5-06 (T22) and BSA-22 (Jml) Uranium Soil Concentrations

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



Uranium Concentration Scale (mg/kg)*

- ≤ 0.76
- 0.76 - 1.3
- 1.3 - 2.6
- 2.6 - 3.9
- 3.9 - 5.2
- 5.2 - 13
- ≥ 13
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

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NON-AUM TARGET M5-06 (T22) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I22-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.5.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I22-7. Vanadium exceeded the applied BTV in 78.2 percent of in situ XRF measurements and one of the three XRF confirmation samples. The applied BTV for vanadium is 15 mg/kg for Target T22 as presented in Section 8.5.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I22-5 and Attachment I3, respectively. Figure I22-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T22 and BSA-22 (Jml) samples. Figure I22-25 presents a box plot of detectable vanadium soil XRF concentrations for Target T22 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.5.6.1. Vanadium XRF concentrations measured in surface soils at Target T22 ranged between 16.1 and 62 mg/kg with an average and standard deviation of 24.9 mg/kg and 7.0 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T22 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I22-26. Overall, the majority of detectable vanadium results in surface soils were above the applied BTV. However, the maximum XRF value was 4.1 times higher than the applied BTV and does not appear to be associated with mining-related materials.

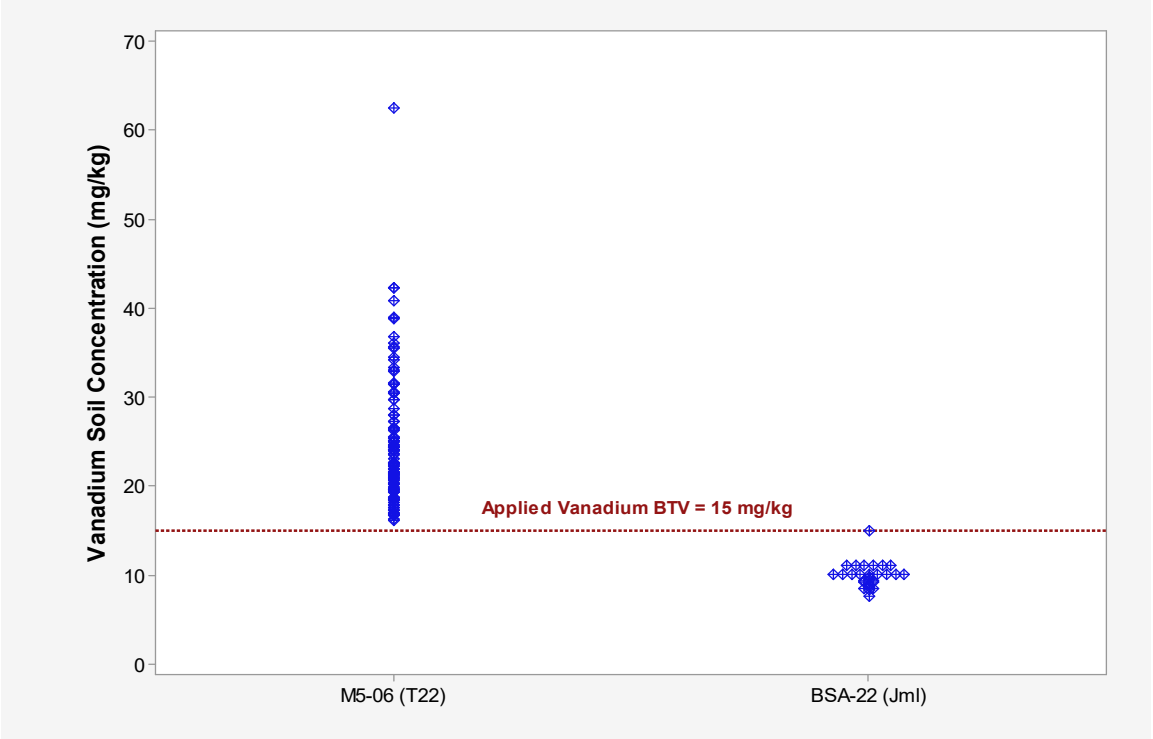


Figure I22-24. Individual Value Plot for Target M5-06 (T22) and BSA-22 (Jml) Vanadium Soil Concentrations

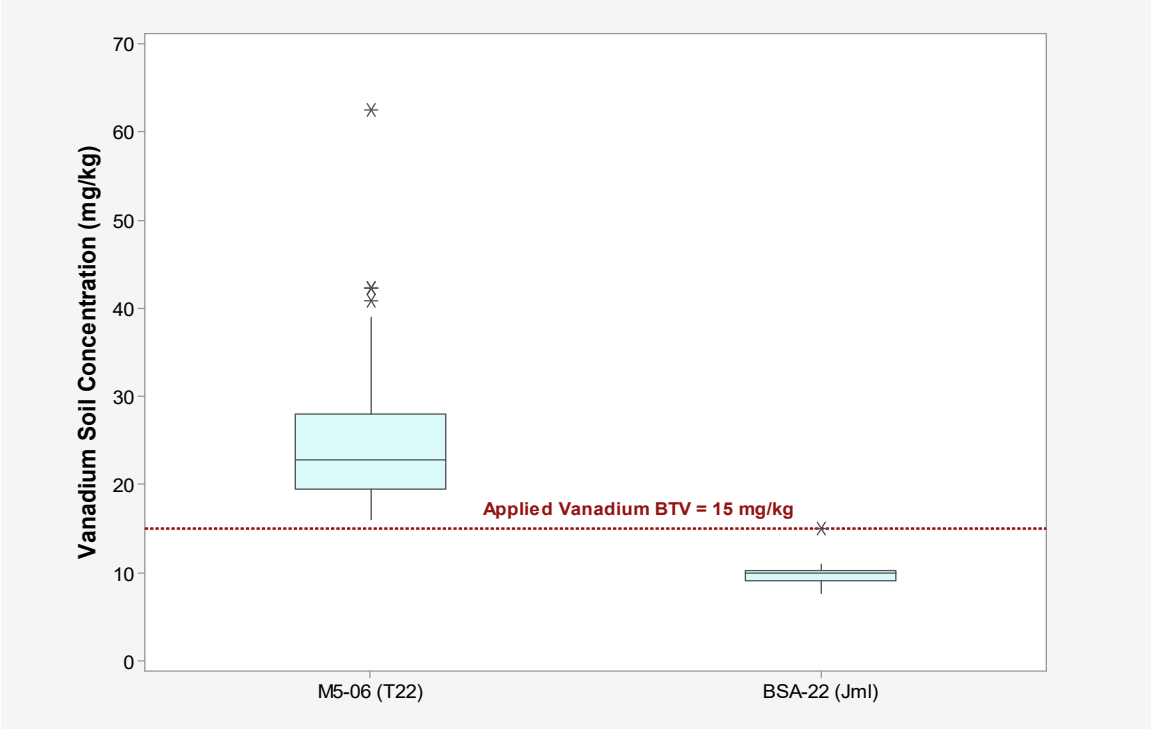
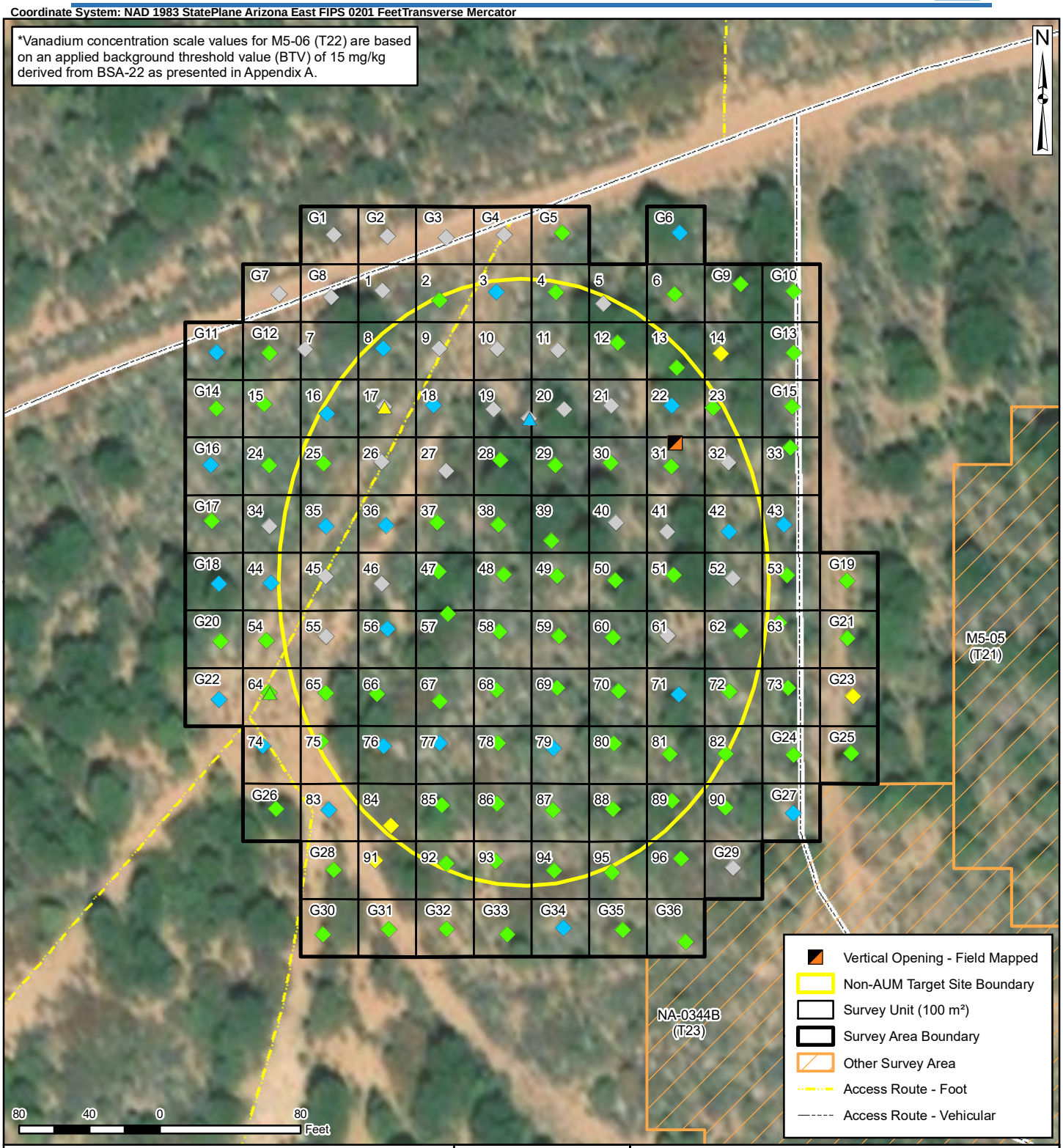


Figure I22-25. Box Plot for Target M5-06 (T22) and BSA-22 (Jml) Vanadium Soil Concentrations

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



Vanadium Concentration Scale (mg/kg)*

- ≤ 10
- 10 - 15
- 15 - 30
- 30 - 45
- 45 - 60
- 60 - 150
- ≥ 150
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample

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NON-AUM TARGET M5-06 (T22) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I22-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/13/2019	

8.5.8 Conclusions

Target T22 (M5-06) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T22. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T22 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T22. Core cuttings were also observed at two locations. ASPECT gamma survey results did not correlate with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE; however, exploratory borings at the Target and reclamation activities at adjacent AUMs and an AUM-related burial cell may explain elevated gamma levels.
- The lateral extent of elevated radiological activity at Target T22 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T22 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. However, grid averaged gamma measurements exceeded the applied BTV in 28 of the 132 survey units by a factor of up to 1.2.
- A total of 27 analytes were identified as occurring within the surface environment. Of these analytes, 10 were identified as COPCs. Arsenic, lead, uranium, and vanadium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T22 does not contain TENORM. No mining-related activities or features were observed in the field, but 19 potential historical exploratory borings were noted in the file review. Core cuttings, possibly from exploratory boreholes, were observed at two locations. NORM was not identified visually or by gamma survey.
- A vertical opening was field mapped in the northeast portion of the Target area. The vertical opening needs to be evaluated to determine if it represents an immediate physical hazard at Target T22.
- Access is by dirt road with a small four-wheel-drive vehicle followed by footpath.

- No open or reclaimed mine portals were identified in historic records or observed during field activities. A vertical opening was mapped in the field and appears to be associated with underground workings of the Frank Jr. Mine to the north.
- No existing groundwater wells are documented within the vicinity of Target T22. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No significant quantities of mine waste or TENORM was observed at Target T22. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No significant quantities of mine waste was observed at Target T22; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; however, a few data gaps remain for Target T22. The remaining data gaps include field inspection of the mapped vertical opening to determine hazard status; field verification of the reclamation status of the potential historic exploratory borings, gamma screening of observed borehole corings, and debris from the mapped vertical opening; and subsurface sampling to determine if elevated gamma activity increases with depth or is related to reclamation grading.

8.6 NON-AUM TARGET T24 (M5-07)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T24 (M5-07).

8.6.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T24 (M5-07) is associated with the Mesa V Mine 103 (M17), a former underground mine in the Lukachukai Mountains Region in Subarea Group F that is administered by the Red Mesa and Cove Chapters of the Navajo Nation and accessible by four-wheel-drive vehicle off of Indian Route 33. Target T24 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. No residences are located near the Target. A Target location and access map for Target T24 is shown in Figure I24-1.

A topographical relief map for the Mesa V Mine 103 area and associated non-AUM Targets is provided in Figure I24-2. The elevation at Target T24 ranges from 7,395 to 7,429 feet amsl with an average of 7,415 feet amsl. The slope at the Target ranges from 2 to 25 percent with an average of 9 percent. The area of the Mesa V Mine 103 is located partly within Jml and Jse. The Target T24 soil type is within the Hozho-Quezcan-Rock outcrop complex (MUSYM 413) at 35 to 70 percent slopes and within the Arabrab-Wetherill complex (MUSYM 414) at 3 to 15 percent slopes (Figures I-22 and I-23). The soils at the Target can be thin and overlay the Jml and Jse. Outcrops of Jml and Jse are exposed on the hillside and historic haul roads that cut through the Target.

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T24. Weston did not conduct a background study for Target T242. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 20, of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T24:

- Identified any immediate physical hazards at the non-AUM Target:
  No physical hazards were identified.
- Located access routes, including foot pathways and roads:
  Target T24 is accessed by taking Indian Route 33 to the Mesa V mine area and then following a four-wheel-drive road for 0.2 mile to the southwest.
- Differentiated NORM/TENORM through geological assessment and visual observation:
  Outcrops of Jml amd Jse, which contain NORM, were present at the Target. TENORM may be associated with exploratory borings.
- Mapped all drainages and potential surface water pathways at the non-AUM Target:

An ephemeral drainage was located adjacent to Target T24 that drains into the Middle 1A drainage 400 feet to the southeast. Middle 1A drainage is evaluated in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

  Five historic exploratory borings were identified at the Target during the file review. Approximately 50 historical exploratory borings may be located within 500 feet upslope of the Target. Historic haul roads were also located up and downslope of the Target.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  Other than the potential historic exploratory borings, no AUM or non-AUM Target features were present at the Target.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

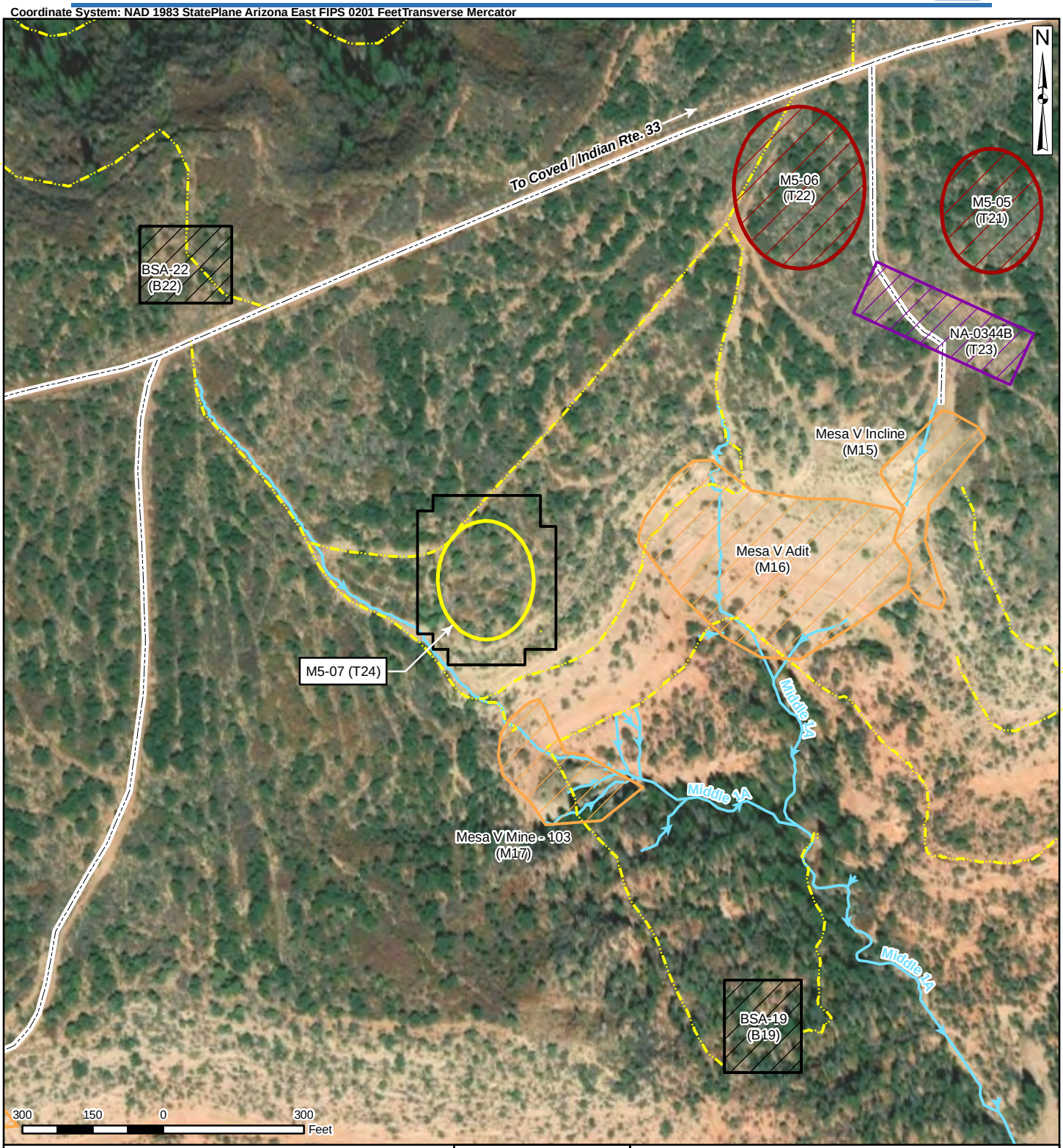
- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

  No mine waste was identified at the Target. The soils borrow area covers 0.8 acre with a depth ranging from 2 to 5 feet.

Baseline Study field survey, measurement, and sampling activities at Target T24 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Sections 2.3 and 8.6.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 8.6.3 with results presented in Sections 8.6.6 and 8.6.7)
- Conducting a gamma radiation survey (results presented in Section 8.6.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.



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

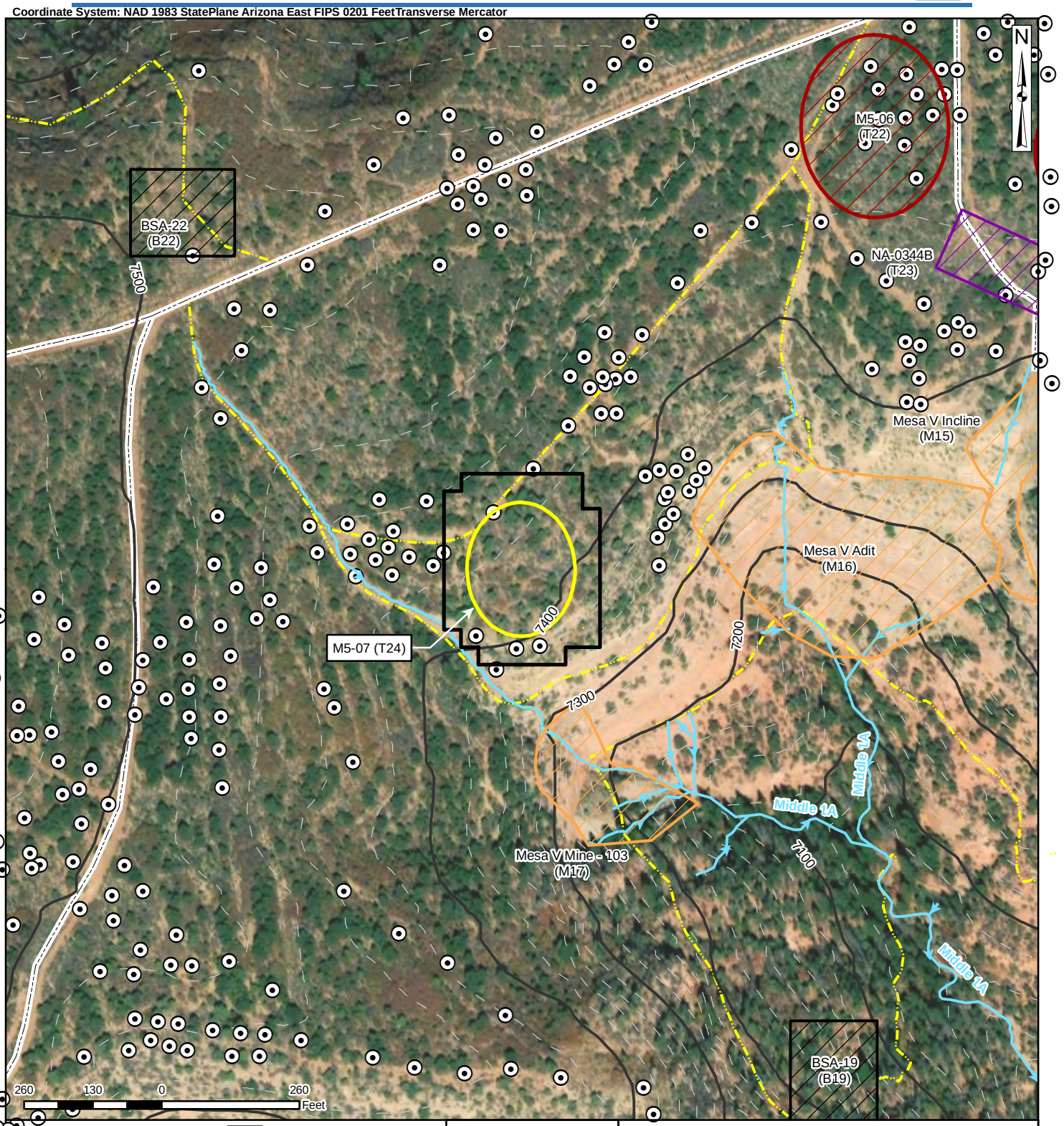
Prepared for: USEPA Region 9

Prepared By:

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NON-AUM TARGET M5-07 (T24) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I24-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/14/2019	



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Tronox AUM Site Boundary
AUM Related Site Boundary
Background Location
Exploratory Bore Hole
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped
100 ft Contour*
20 ft Contour*

* 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.

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NON-AUM TARGET M5-07 (T24) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I24-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	

8.6.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I24-3) within the survey area of the non-AUM Target T24 as part of the Baseline Study in May 2018. Additional Goback gamma radiation surveys were performed in September 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T24 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I24-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 20, of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at 32 survey units. All gamma survey and XRF survey units were evaluated.

8.6.3 XRF Confirmation Sampling Overview

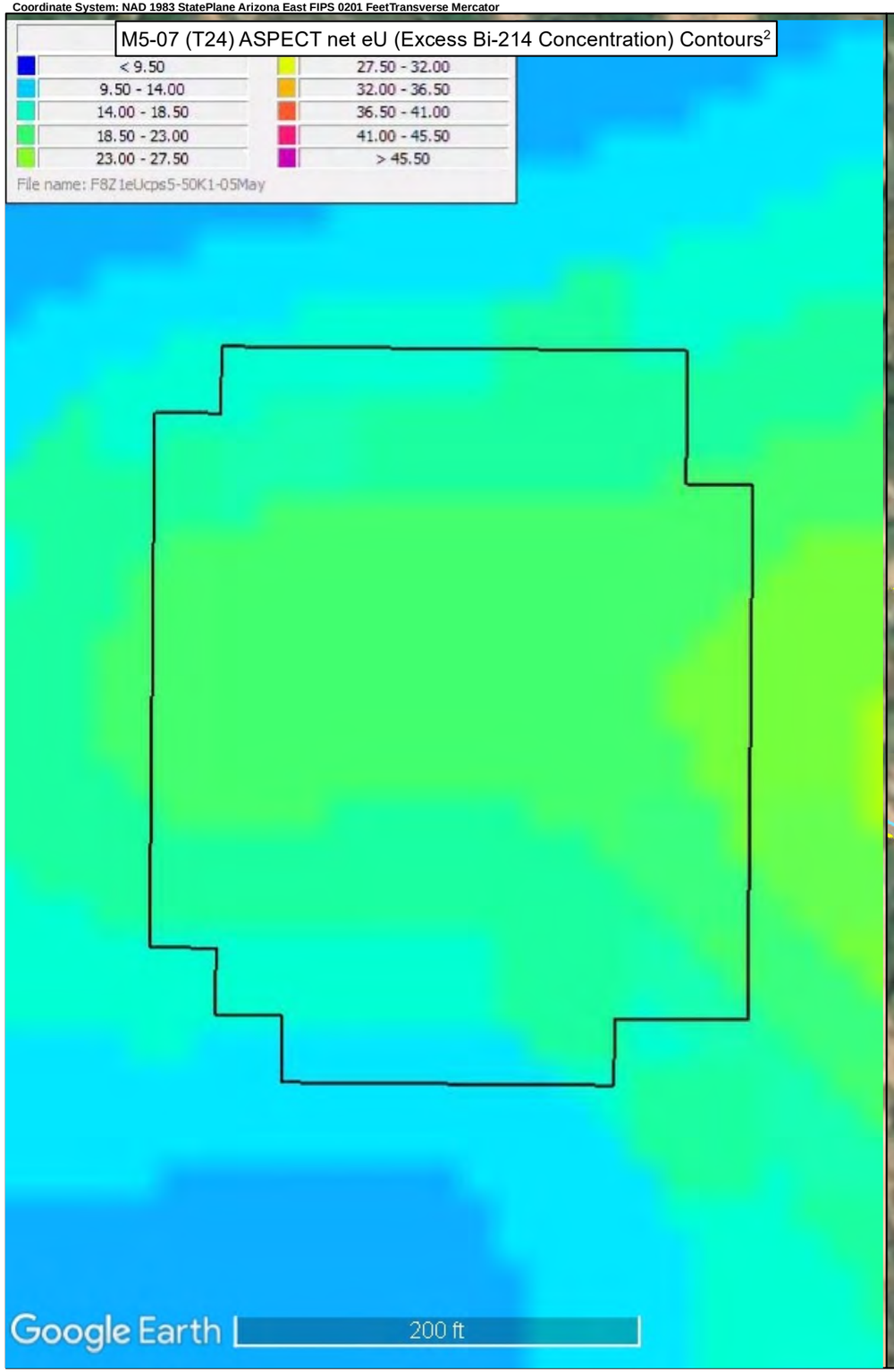
Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T24. Three XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from three locations (Table I24-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I24-4 and I24-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I24-2. The results of XRF confirmation sample analysis are provided in Section 8.6.6.1. Correlated XRF field measurements are provided in Attachment I3.

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

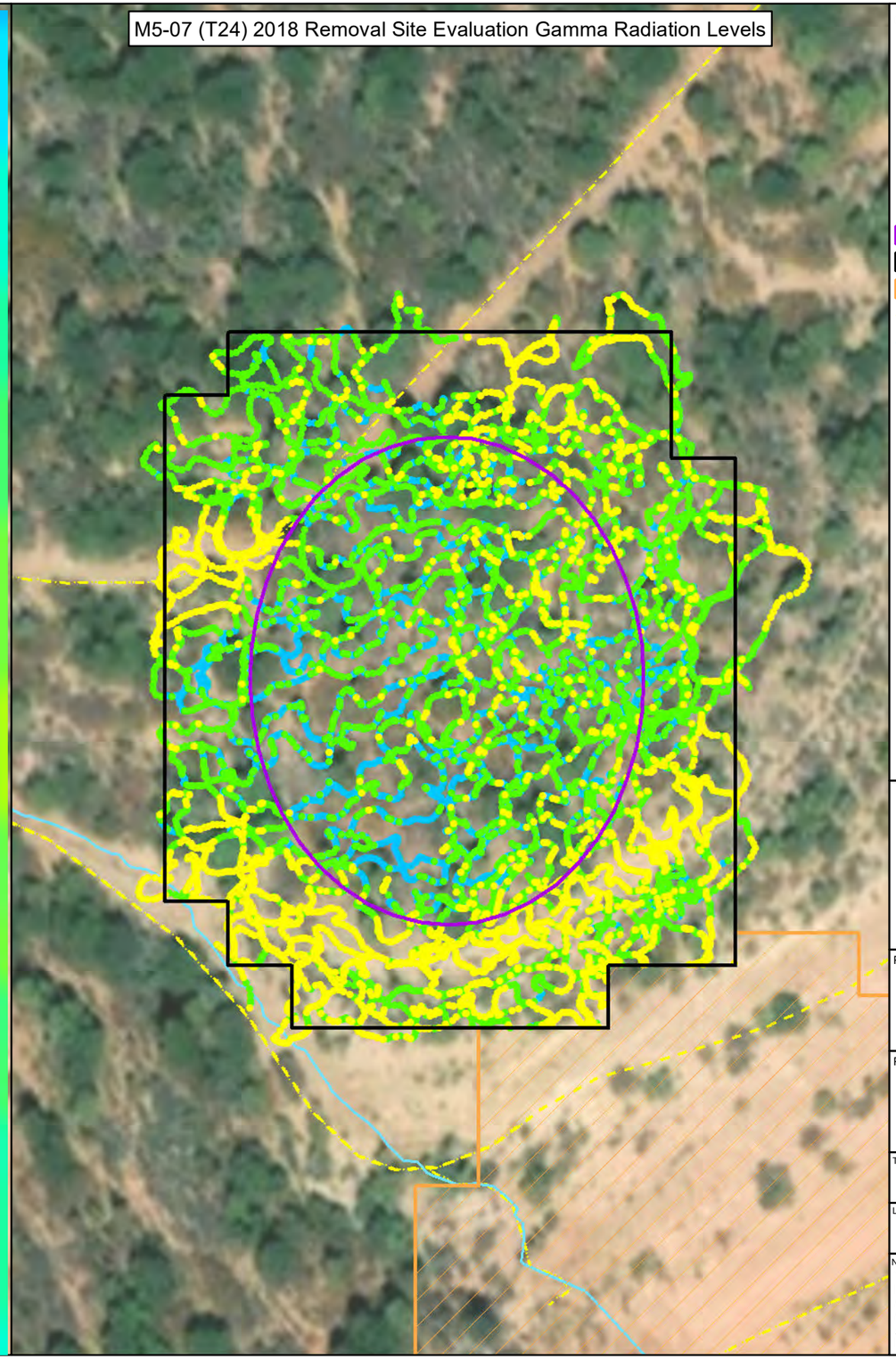
M5-07 (T24) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F8Z1eUcps5-50K1-05May



M5-07 (T24) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)[1]

≤ 10,285	≤ Avg. BG
10,285 - 11,907	Avg. BG - 1 x BTV
11,907 - 23,814	1 x BTV - 2 x BTV
23,814 - 35,721	2 x BTV - 3 x BTV
35,721 - 47,628	3 x BTV - 4 x BTV
47,628 - 119,070	4 x BTV - 10 x BTV
≥ 119,070	≥ 10 x BTV

- Non-AUM Target Site Boundary
- Survey Area Boundary
- Other Survey Area
- Access Route - Foot
- Drainage - Field Mapped

[1]The applied gamma background threshold value (BTV) for M5-07 (T24) Non-AUM Target is 11,907 cpm derived from BSA-22 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 70 ft

1:840

N W E S

0 35 70 140 Feet

NON-AUM TARGET M5-07 (T24)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

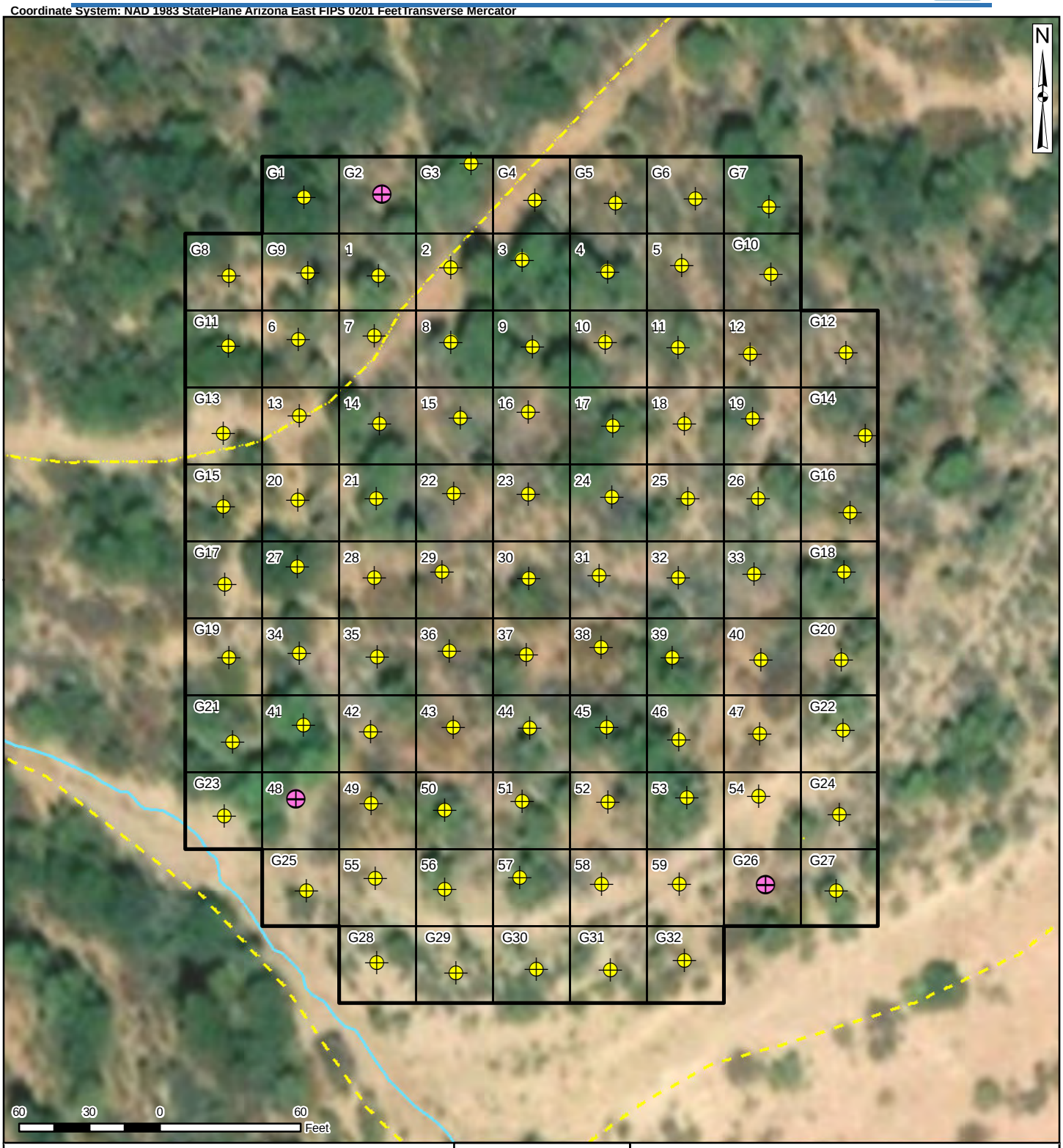
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/14/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborne Spectral Photometric Environmental Collection Technology.

Figure No.: **I24-3**



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Foot

Drainage - Field Mapped

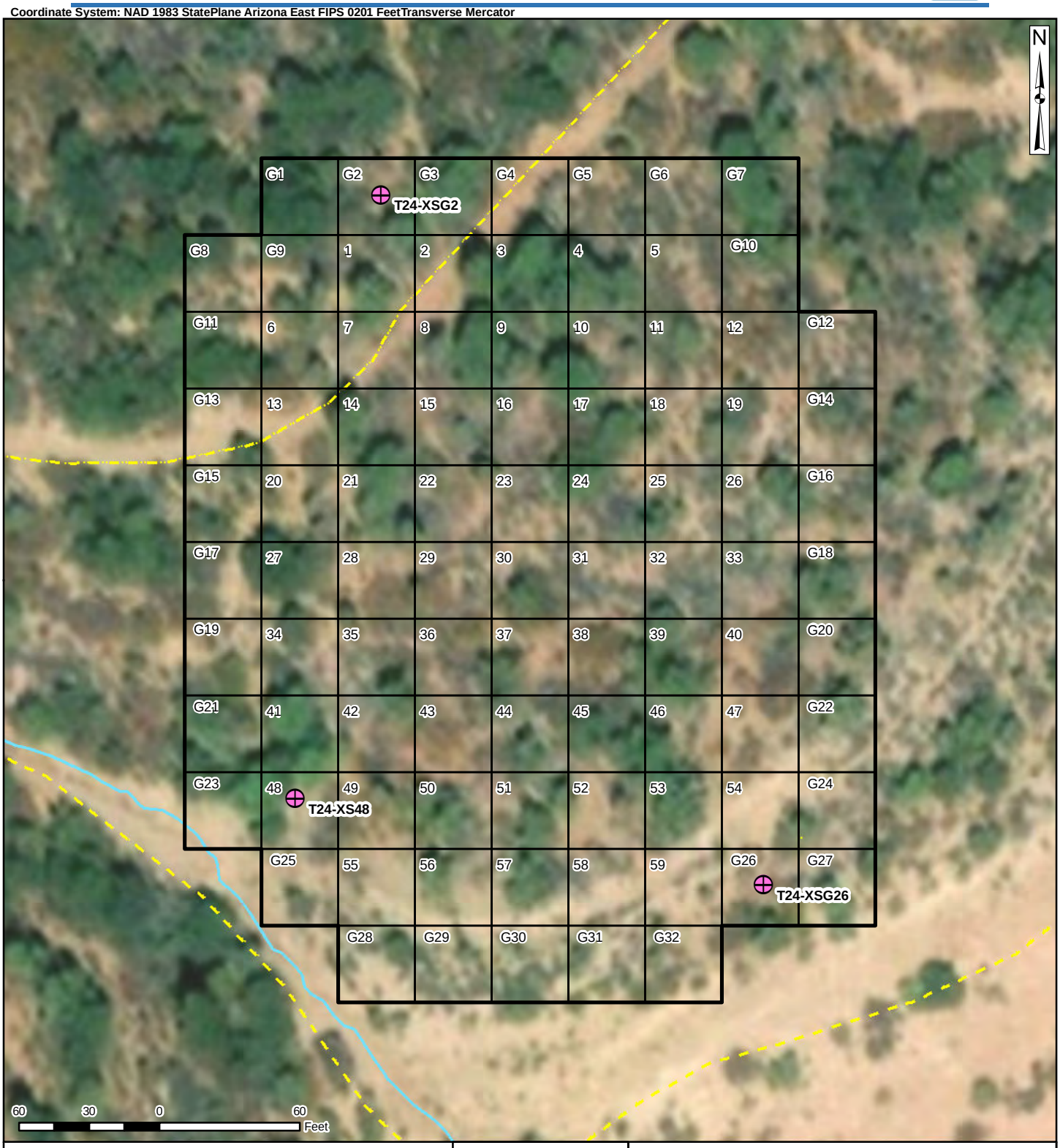
Prepared for: USEPA Region 9

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NON-AUM TARGET M5-07 (T24) XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I24-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/14/2019	



XRF Confirmation Soil Sample* (0 - 3 inches bgs)

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Foot

Drainage - Field Mapped

*T24-XSG2 = site T24 XRF confirmation soil sample collected at survey unit G2. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET M5-07 (T24)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I24-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/14/2019	

Table I24-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-07 (T24)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T24-XS48-01-052418	48	0-3	XRF Confirmation	Primary	5/24/2018	36.5406535	-109.2499818	1805632-12, 1805633-12
T24-XSG2-01-091118	G2	0-3	XRF Confirmation	Primary	9/11/2018	36.5413611	-109.2498489	1809473-18, 1809474-18
T24-XSG26-01-091118	G26	0-3	XRF Confirmation	Primary	9/11/2018	36.5405472	-109.2493017	1809473-19, 1809474-19

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I24-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-07 (T24)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

8.6.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 8.6.1, Target T24 surface geology is within both Jml and Jse with soils within the Arabrab-Wetherill complex (MUSYM 414) (Figures I-22 and I-23). As a result, BSA-22 was selected for that combination of geology and soil type. Additionally, the Jml and Jse regional geological backgrounds would also be applicable for this Target. Table I24-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T24. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T24. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T24. The "Applied BTV" for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I24-3. Applied Background Threshold Values for Non-AUM Target M5-07 (T24)

Analyte	Units	Site-Specific BTV (BSA-22)	Regional BTV (Jse)	Regional BTV (Jml)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	5,580	7,400	7,000	5,580	Site-Specific BTV
Antimony	mg/kg	0.160	0.163	0.140	0.140	Regional Jml BTV
Arsenic	mg/kg	2.2	4.8	3.5	2.2	Site-Specific BTV
Barium	mg/kg	201	166	270	166	Regional Jse BTV
Beryllium	mg/kg	0.41	0.51	0.57	0.41	Site-Specific BTV
Cadmium	mg/kg	0.192	0.160	0.160	0.160	Regional Jml/Jse BTV
Calcium	mg/kg	4,960	36,000	32,000	4,960	Site-Specific BTV
Chromium	mg/kg	6.1	11.0	5.2	5.2	Regional Jml BTV
Cobalt	mg/kg	3.9	4.4	4.4	3.9	Site-Specific BTV
Copper	mg/kg	10	11	12	10	Site-Specific BTV
Iron	mg/kg	7,470	8,000	8,897	7,470	Site-Specific BTV
Lead	mg/kg	9.7	12.0	11	9.7	Site-Specific BTV
Lithium	mg/kg	5.4	13.0	8.8	5.4	Site-Specific BTV
Magnesium	mg/kg	2,500	7,000	3,900	2,500	Site-Specific BTV
Manganese	mg/kg	517	500	440	440	Regional Jml BTV
Mercury	mg/kg	0.0261	0.0298	0.0378	0.0261	Site-Specific BTV
Molybdenum	mg/kg	0.36	0.34	0.29	0.29	Regional Jml BTV
Nickel	mg/kg	6.3	11.0	6.2	6.2	Regional Jml BTV
Potassium-40	pCi/g	23.2	23.7	26.9	23.2	Site-Specific BTV
Radium-226	pCi/g	1.54	4.15	2.23	1.54	Site-Specific BTV
Radium-228	pCi/g	0.50	0.84	0.75	0.50	Site-Specific BTV
Selenium	mg/kg	0.93	0.98	0.99	0.93	Site-Specific BTV
Silver	mg/kg	0.033	0.055	0.037	0.033	Site-Specific BTV
Sodium	mg/kg	29	36	45	29	Site-Specific BTV
Thallium	mg/kg	0.068	0.091	0.075	0.068	Site-Specific BTV
Thorium	mg/kg	3.6	3.6	4.7	3.6	Site-Specific BTV
Uranium	mg/kg	1.3	3.4	1.5	1.3	Site-Specific BTV
Vanadium	mg/kg	15	31	24	15	Site-Specific BTV
Zinc	mg/kg	24	28	27	24	Site-Specific BTV
Gamma Radiation	cpm	11,907	15,781	14,566	11,907	Site-Specific BTV

Notes:

BSA	Background Study Area
BTV	background threshold value
cpm	counts per minute
Jml	Morrison Formation (Lower)
Jse	Summerville and Entrada Formation (undifferentiated)
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram

8.6.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T24 and the raw gamma radiation and grid averaged gamma radiation survey results.

8.6.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T24 in May 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in September 2018 to collect data within the Goback survey units. The applied gamma BTV for non-AUM Target T24 is 11,907 cpm. A total of 9,736 measurements were collected as part of the gamma radiation survey at non-AUM Target T24 across 91 survey units. Because of the thick vegetation, not all survey units were scanned at 100 percent density. An average scan density of 107 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I24-4.

Table I24-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-07 (T24)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,907	
Measurements	#	9,736	91
Minimum	cpm	7,880	9,754
Maximum	cpm	19,510	14,525
Average	cpm	11,405	11,358
Median	cpm	11,225	11,163
Standard Deviation	cpm	1,364	947
90th Percentile	cpm	13,228	12,572
95th Percentile	cpm	14,009	13,121
99th Percentile	cpm	15,430	14,500
Measurements per Survey Unit	#/grid	107	
Measurements Above Gamma BTV	#	2,877	22
Measurements Above Gamma BTV	%	29.6	24.2

Notes:
BTV background threshold value
cpm counts per minute

8.6.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 29.6 percent of the measurements within the Target boundaries, in some cases exceeding greater than 1.6 times the applied gamma BTV (11,907 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-22 (Jml) gamma survey results is provided on Figure I24-6. This graph shows that the spread of radiation data at Target T24 (shown on left) begins within the lower range of BSA-22 (Jml) gamma levels (shown on right) and then rises to more than 1.3 times background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T24 is higher than the data cloud from the BSA-22 (Jml) data set. A box plot showing the quartiles of the data sets is provided in Figure I24-7. The box plot shows that the median of Target T24 radiation levels is higher than the median of the BSA-22 (Jml) data set but less than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I24-8. No mining activity was observed within the survey area of Target T24. However, historic exploratory borings were identified in the file review, historic haul roads are located up and down slope, outcropping of Jml is present, and Mesa V Mine 103 is located south adjacent to the Target.

In general, Target T24 has surficial gamma radiation levels below BSA-22 (Jml) levels across the majority of the Target except for the southern survey boundary which abuts Mesa V Mine 103, indicating that the survey results do not correlate with the area of elevated gamma activity identified by the ASPECT gamma survey (Figure I24-3). No TENORM or mining-related activities were observed. Section 8.6.5.3 presents the grid averaged results of the gamma radiation survey.

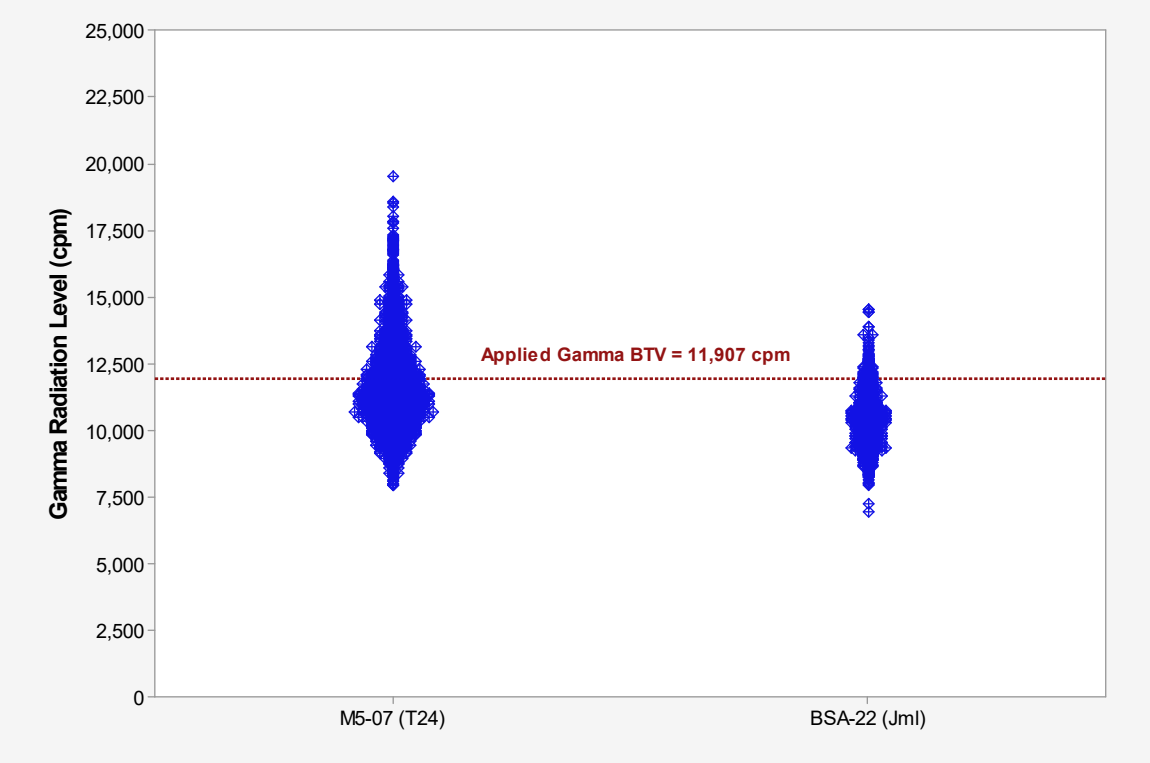


Figure I24-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M5-07 (T24) and BSA-22 (Jml)

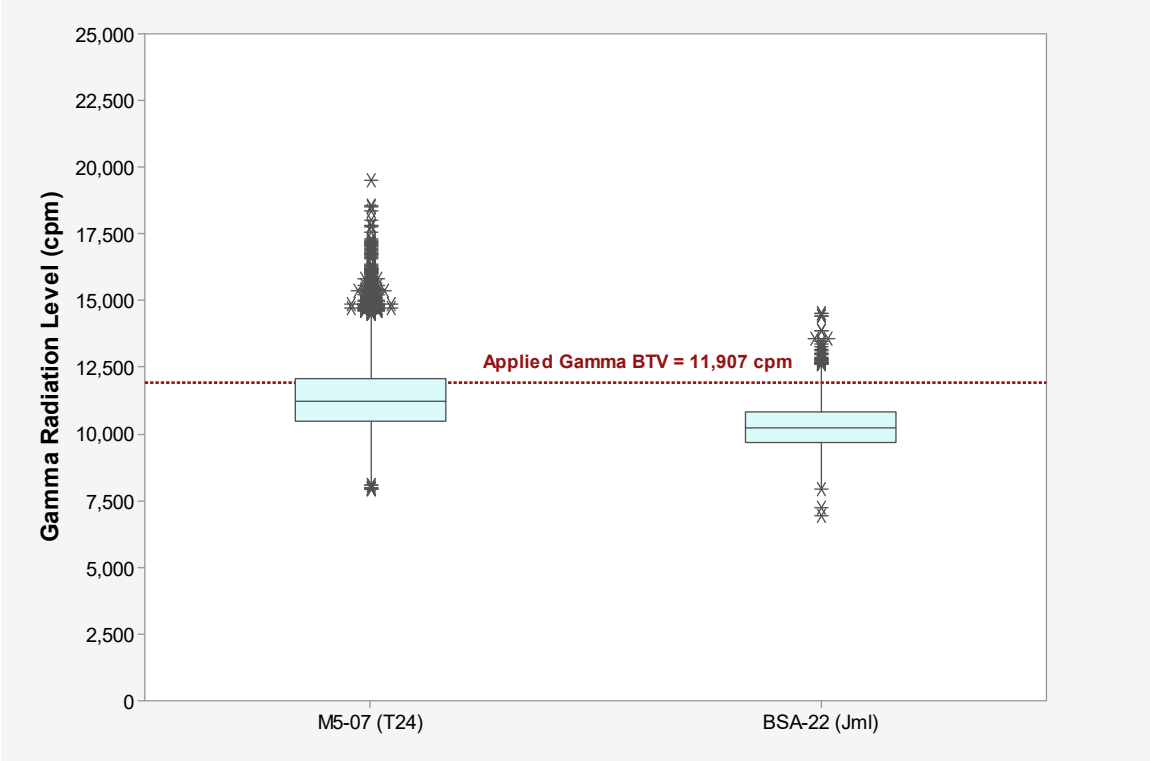
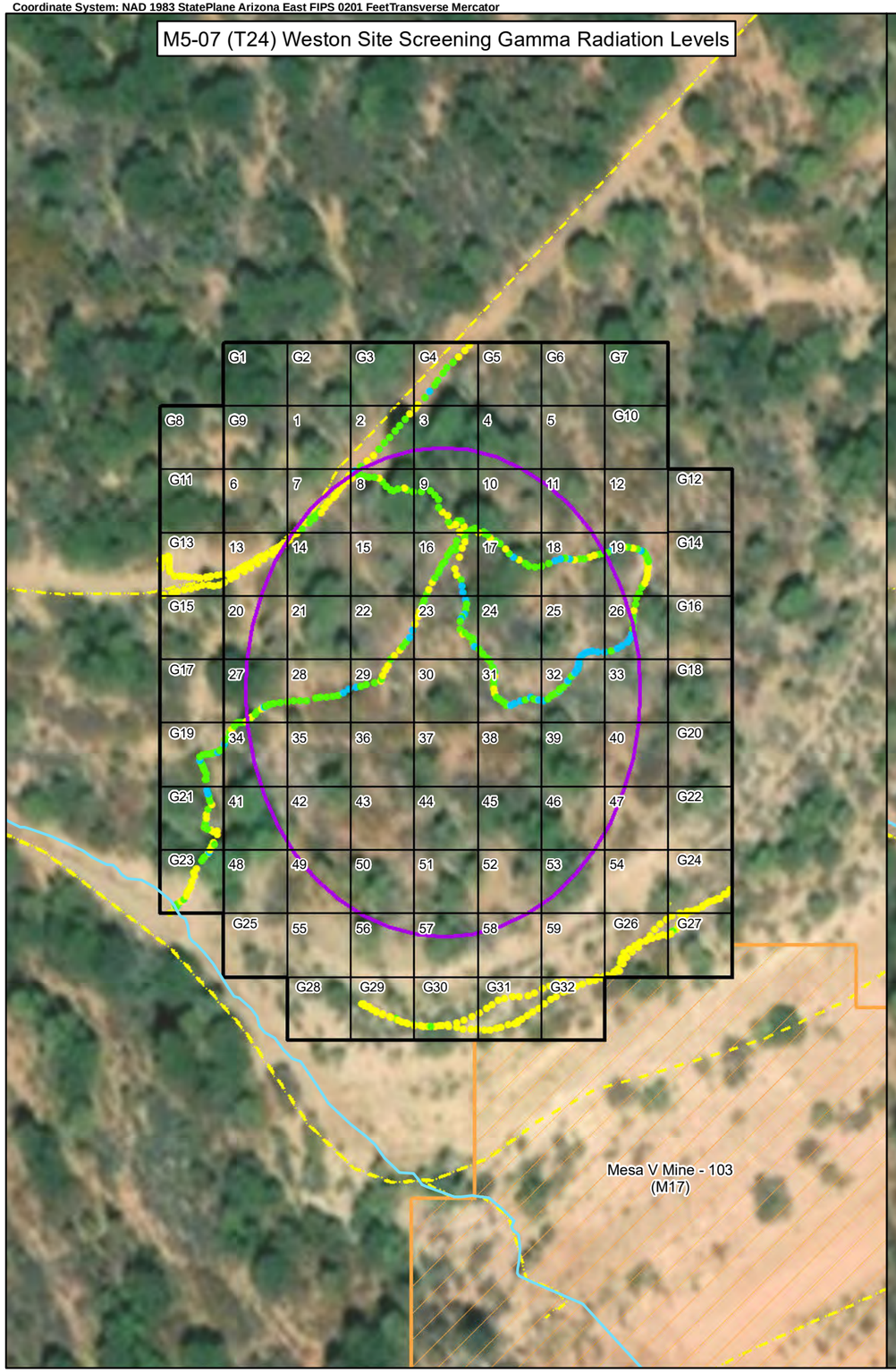


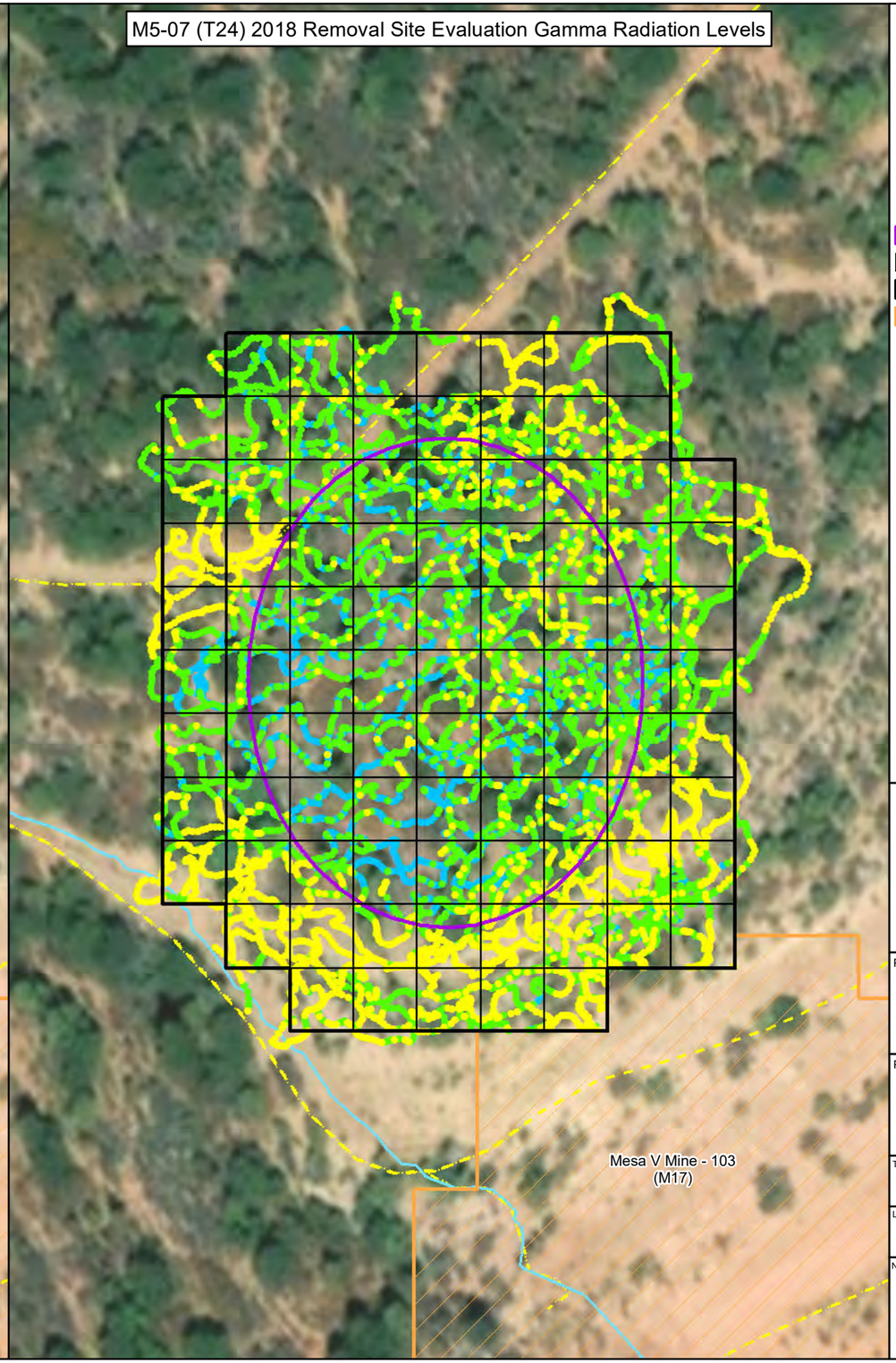
Figure I24-7. Box Plot of Raw Gamma Radiation Levels at Target M5-07 (T24) and BSA-22 (Jml)

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

M5-07 (T24) Weston Site Screening Gamma Radiation Levels



M5-07 (T24) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)*

≤ 10,285	≤ Avg. BG
10,285 - 11,907	Avg. BG - 1 x BTV
11,907 - 23,814	1 x BTV - 2 x BTV
23,814 - 35,721	2 x BTV - 3 x BTV
35,721 - 47,628	3 x BTV - 4 x BTV
47,628 - 119,070	4 x BTV - 10 x BTV
≥ 119,070	≥ 10 x BTV

- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Other Survey Area
- Access Route - Foot
- Drainage - Field Mapped

1 in = 70 ft

1:840

N
W E
S

0 35 70 140 Feet

NON-AUM TARGET M5-07 (T24)
2018 REMOVAL SITE EVALUATION
VS WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

Prepared For:

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/14/2019

Notes:
*The applied gamma background threshold value (BTV) for M5-07 (T24) is 11,907 cpm derived from BSA-22 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I24-8**

8.6.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 8.6.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 8.6.5.1. Figure I24-9 and Figure I24-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-22 (Jml) data set (shown on right). A total of 24.2 percent of the survey units (22 of 91) within the survey area of Target T24 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I24-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I24-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. The elevated regions of the Target correspond with proximity to Mesa V Mine 103 to the south, outcropping of NORM, historic haul routes up and down slope, and historic exploratory borings (see Figure I24-2).

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 8.6.6.

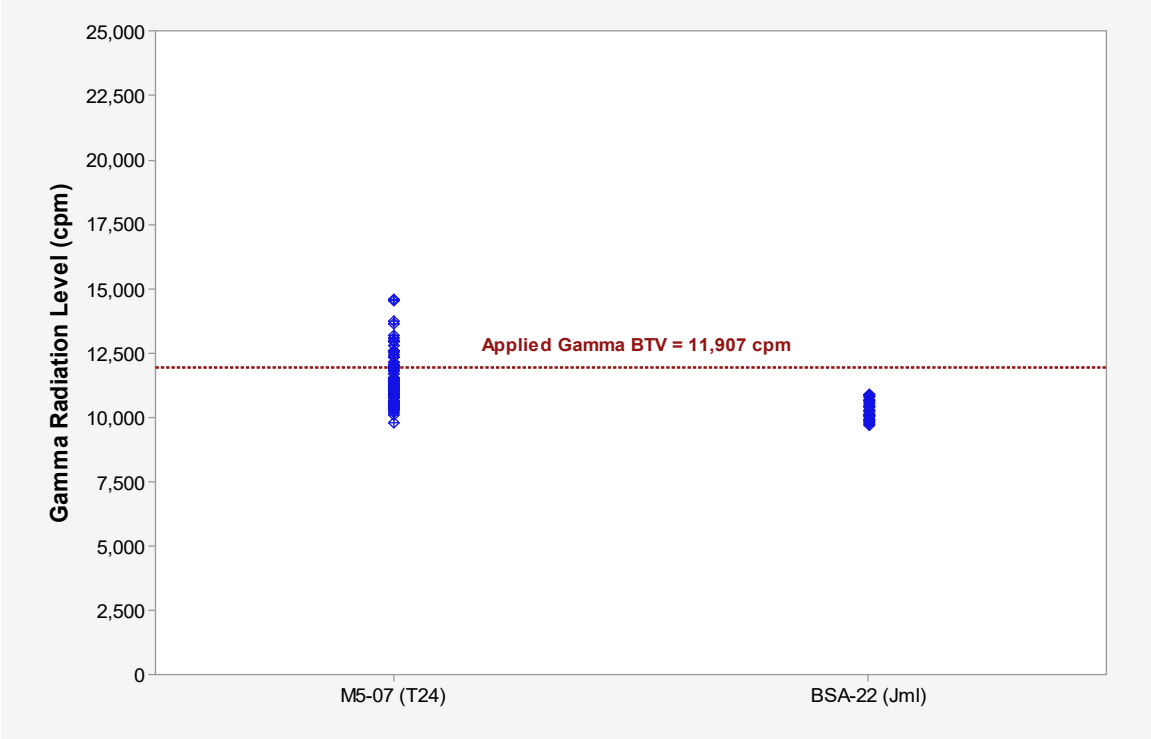


Figure I24-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-07 (T24) and BSA-22 (Jml)

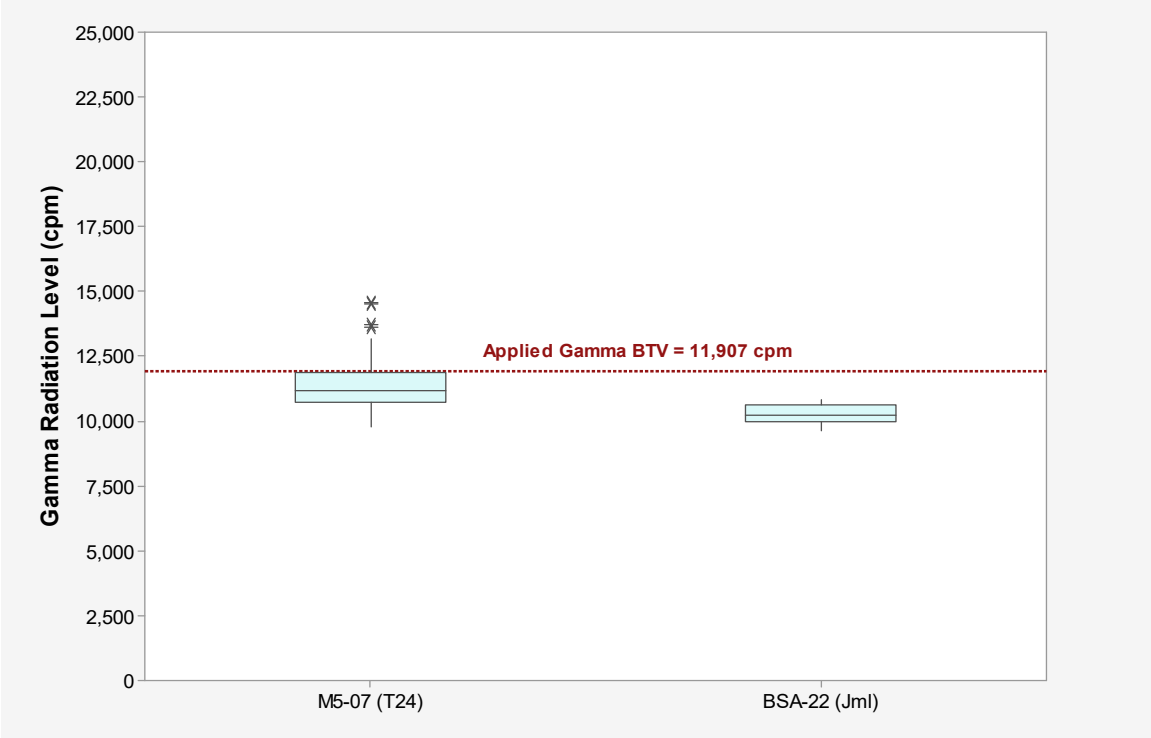
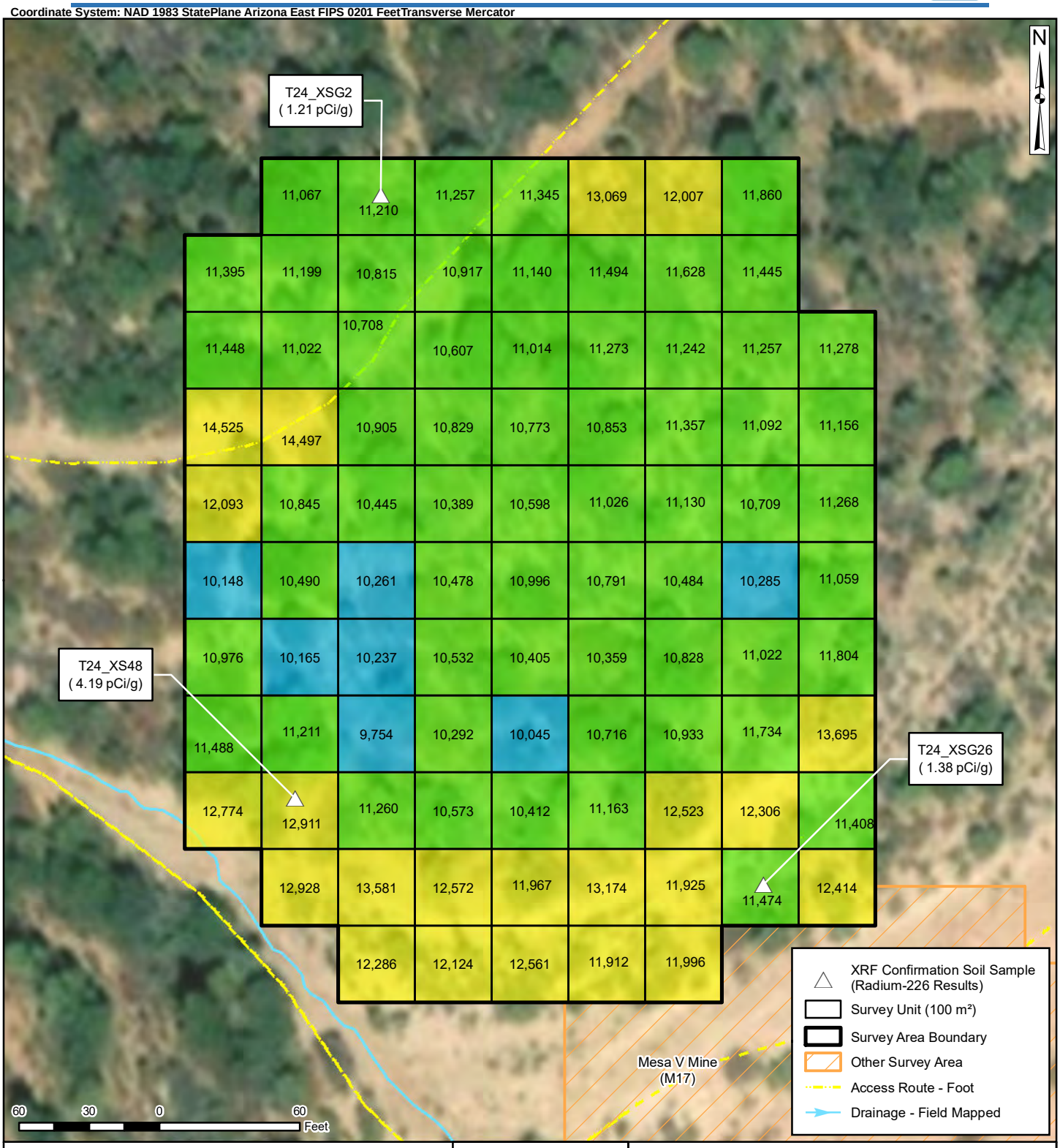


Figure I24-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-07 (T24) and BSA-22 (Jml)



Grid Averaged Gamma Reading (cpm)*

≤ 10,285	≤ Avg. BG
10,285 - 11,907	Avg. BG - 1 x BTV
11,907 - 23,814	1 x BTV - 2 x BTV
23,814 - 35,721	2 x BTV - 3 x BTV
35,721 - 47,628	3 x BTV - 4 x BTV
47,628 - 119,070	4 x BTV - 10 x BTV
≥ 119,070	≥ 10 x BTV

*The applied gamma background threshold value (BTV) for M5-07 (T24) is 11,907 cpm derived from BSA-22 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M5-07 (T24)
GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I24-11
Location: COVE CHAPTER NAVAJO NATION	Date: 6/14/2019	

8.6.6 Soil Sampling Results

This section presents the results of analyses for soil within the survey area of Target T24. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 8.6.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 8.6.6.2.

8.6.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T24: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I24-1 and I24-2. All the results of the XRF confirmation soil samples are presented in Table I24-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T24 following the methods outlined in Section 2.4 and shown in Figure I24-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 91 measurements were collected across 91 survey units from the survey area of Target T24 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I24-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T24 at a depth of 0 to 3 inches bgs. Three XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I24-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 8.6.7.

Table I24-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-07 (T24)

Analyte	Units	Applied BTV	T24-XS48-01-052418		T24-XSG2-01-091118		T24-XSG26-01-091118	
			Result	Q	Result	Q	Result	Q
Survey Unit			X48		XG2		G26	
Aluminum	mg/kg	5,580	10,000		3,500		3,700	
Antimony	mg/kg	0.140	0.21		<0.095	U	<0.086	U
Arsenic	mg/kg	2.2	29		1.8		6.2	
Barium	mg/kg	166	120		92		44	
Beryllium	mg/kg	0.41	0.77		0.24		0.2	
Cadmium	mg/kg	0.160	0.15	J	0.083	J	0.043	J
Calcium	mg/kg	4,960	25,000		2,900		5,800	
Chromium	mg/kg	5.2	3.9		3.9		1.9	
Cobalt	mg/kg	3.9	11		2.3		2.2	
Copper	mg/kg	10	27		5		5.5	
Iron	mg/kg	7,470	16,000		5,200		5,000	
Lead	mg/kg	9.7	12		6.3		4.6	
Lithium	mg/kg	5.4	13		4.8		5.3	
Magnesium	mg/kg	2,500	6,000		1,800		2,300	
Manganese	mg/kg	440	210		210		100	
Molybdenum	mg/kg	0.29	1.6		0.2		0.41	
Nickel	mg/kg	6.2	8.5		3.8		2.6	
Potassium-40	pCi/g	23.2	23.2	J+	14.9		13.9	
Radium-226	pCi/g	1.54	4.19	J+	1.21		1.38	
Radium-228	pCi/g	0.50	<1.04	UJ	<0.7	UJ	<0.4	U
Selenium	mg/kg	0.93	1.5		0.78	J	0.57	J
Silver	mg/kg	0.033	0.03	J	0.021	J	0.014	J
Sodium	mg/kg	29	39	J	<95	U	<86	U
Thallium	mg/kg	0.068	0.23		0.046		0.037	
Thorium	mg/kg	3.6	5.9		2.3		1.5	
Uranium	mg/kg	1.3	3.6		0.57		1.3	
Vanadium	mg/kg	15	14		11		8.7	
Zinc	mg/kg	24	41		13		12	

Notes:
BTV Background threshold value
J Estimated value
J- Estimated value, may be biased low
LT Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
M3 The requested minimum detected concentration was not met, but the reported activity is greater than the reported minimum detected concentration.
mg/kg Milligrams per kilogram
NA Not applicable
NV No Value
pCi/g Picocuries per gram
Q Qualification
U Not considered detected. The associated value is the method detection limit (MDL).
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

Table I24-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-07 (T24)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.2	7,470	9.7	440	0.29	3.6	1.3	15	24
Measurements	#	91	91	91	91	91	91	91	91	91
Detects	#	76	91	91	91	29	91	87	61	91
Nondetects	#	15	0	0	0	62	0	4	30	0
Minimum	mg/kg	1.9	3,076	2.1	100.1	0.0	1.2	0.2	16.5	7.9
Maximum	mg/kg	27.6	17,781	18.3	674	4.9	8.1	9.3	40.6	43.6
Standard Deviation	mg/kg	4.6	2,739	2.7	111	1.25	1.0	1.9	6	8.0
Average	mg/kg	5.4	7,766	8.3	333	1.49	2.9	3.0	26.5	24.0
Median	mg/kg	4.0	7,208	8.0	319	1.31	2.8	2.8	25.2	22.9
Relative Standard Deviation	%	85.1	35.3	32.5	33.2	83.8	35.1	64.7	24.1	33.4
90th Percentile	mg/kg	9.6	11,793	11.4	470	3.0	3.7	5.5	35	35
95th Percentile	mg/kg	11.4	13,097	12.9	501	4.2	4.5	6.5	38	40
99th Percentile	mg/kg	24.2	16,976	16.7	667	4.9	6.1	8.2	39	43
Measurements Above Applied BTV	#	72	42	20	15	24	17	67	61	38
Measurements Above Applied BTV	%	79.1	46.2	22.0	16.5	26.4	18.7	73.6	67.0	41.8

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value
mg/kg Milligram per kilogram
XRF X-ray fluorescence

8.6.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T24 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T24 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T24. The estimated BTVs are identified in Section 8.6.4 and Table I24-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I24-7 presents a summary of the background comparison for different measurement and soil depths at Target T24. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T24. However, gamma radiation screening indicated that gamma levels at Target T24 are elevated in comparison to the BSA. Elevated gamma levels may be associated with exploration activities and the adjacent AUM. Therefore, while multiple COPCs have been identified at Target T24 based on a conservative comparison to background, risk screening will be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I24-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-07 (T24)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum	✓		✓
Antimony	✓		✓
Arsenic	✓	✓	✓
Barium			
Beryllium	✓		✓
Cadmium			
Calcium	✓		✓
Chromium			
Cobalt	✓		✓
Copper	✓		✓
Iron	✓	✓	✓
Lead	✓	✓	✓
Lithium	✓		✓
Magnesium	✓		✓
Manganese		✓	✓
Molybdenum	✓	✓	✓
Nickel	✓		✓
Potassium-40			
Radium-226	✓		✓
Radium-228			
Selenium	✓		✓
Silver			
Sodium	✓		✓
Thallium	✓		✓
Thorium	✓	✓	✓
Uranium	✓	✓	✓
Vanadium		✓	✓
Zinc	✓	✓	✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

8.6.7 Primary Contaminant Mapping

8.6.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 8.6.6.2 identified the COPCs at Target T24. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 8.6.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I24-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T24 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 8.6.7.1 through Section 8.6.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T24. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

8.6.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I24-7. Arsenic exceeded the applied BTV in 79.1 percent of in situ XRF measurements and in two of the three XRF confirmation samples. The applied BTV for arsenic is 2.2 mg/kg for Target T24 as presented in Section 8.6.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I24-5 and Attachment I3, respectively. Figure I24-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T24 and BSA-22 (Jml) samples. Figure I24-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T24 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.6.6.1. Arsenic XRF concentrations measured in surface soils at Target T24 ranged between 1.9 and 27.6 mg/kg with an average and standard deviation of 5.4 mg/kg and 4.6 mg/kg, respectively. The average arsenic XRF concentration is above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T24 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I24-14. Overall, the majority of detectable arsenic results in surface soils were above the applied BTV. However, the maximum XRF value was 12.5 times higher than the applied BTV and does not appear to be associated with mining-related materials.

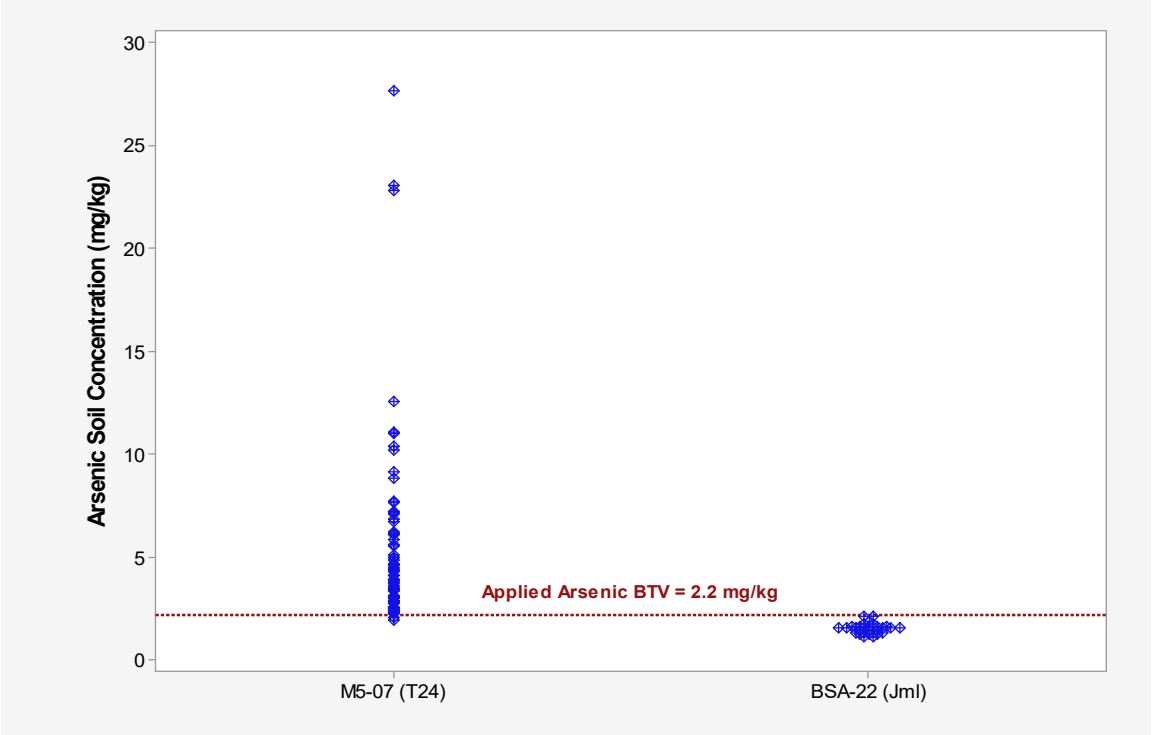


Figure I24-12. Individual Value Plot for Target M5-07 (T24) and BSA-22 (Jml) Arsenic Soil Concentrations

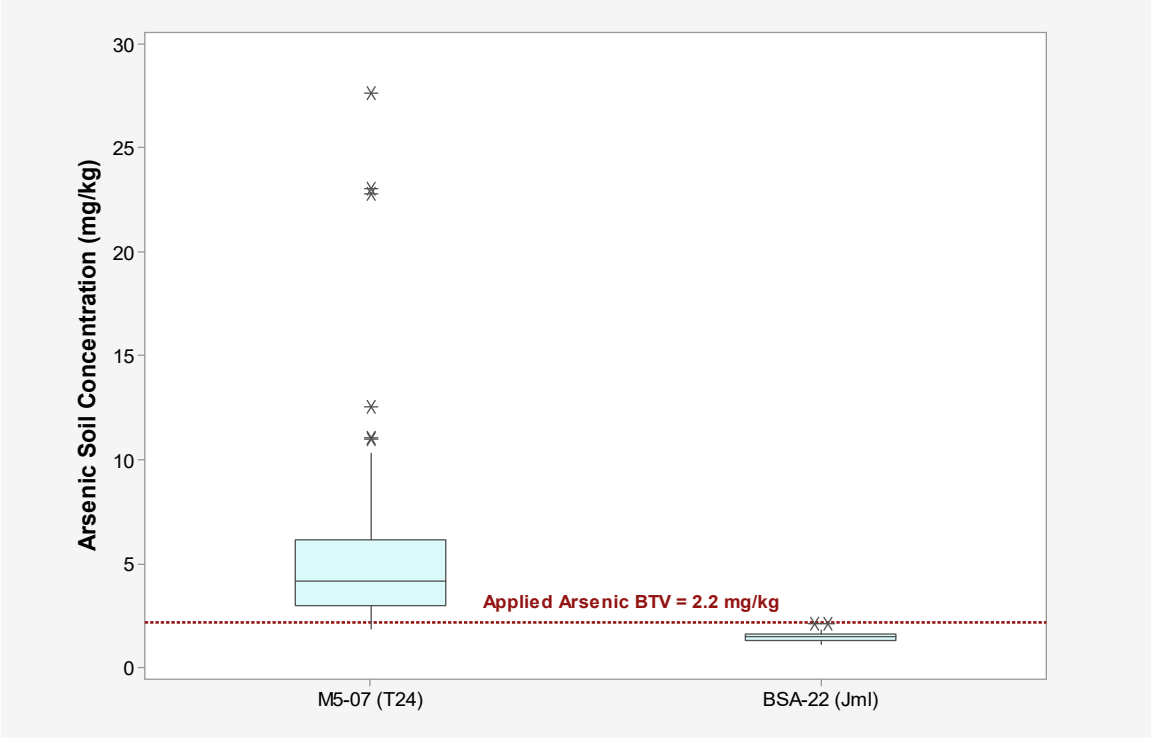
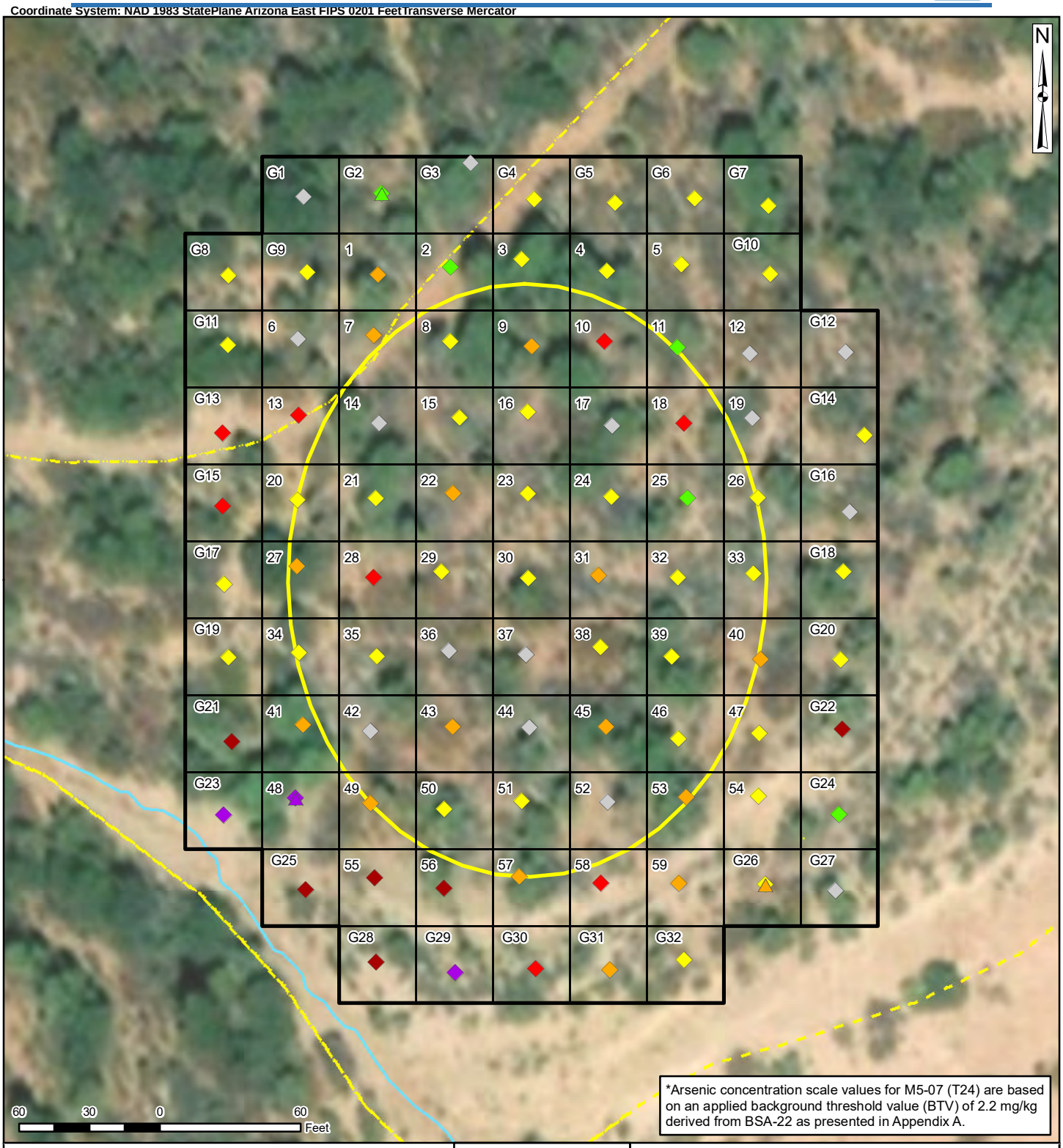


Figure I24-13. Box Plot for Target M5-07 (T24) and BSA-22 (Jml) Arsenic Soil Concentrations



Arsenic Concentration Scale (mg/kg)*

- ≤ 1.5
- 1.5 - 2.2
- 2.2 - 4.4
- 4.4 - 6.6
- 6.6 - 8.8
- 8.8 - 22
- ≥ 22
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot
- Drainage - Field Mapped

Prepared for: USEPA Region 9

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

NON-AUM TARGET M5-07 (T24) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I24-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/14/2019	

8.6.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I24-7. Lead exceeded the applied BTV in 22 percent of in situ XRF measurements and in one of the three XRF confirmation samples. The applied BTV for lead is 9.7 mg/kg for Target T24 as presented in Section 8.6.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I24-5 and Attachment I3, respectively. Figure I24-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T24 and BSA-22 (Jml) samples. Figure I24-16 presents a box plot of detectable lead XRF soil concentrations for Target T24 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.6.6.1. Lead XRF concentrations measured in surface soils at Target T24 ranged between 2.1 and 18.3 mg/kg with an average and standard deviation of 8.3 mg/kg and 2.7 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T24 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I24-17. Overall, the majority of detectable lead results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials.

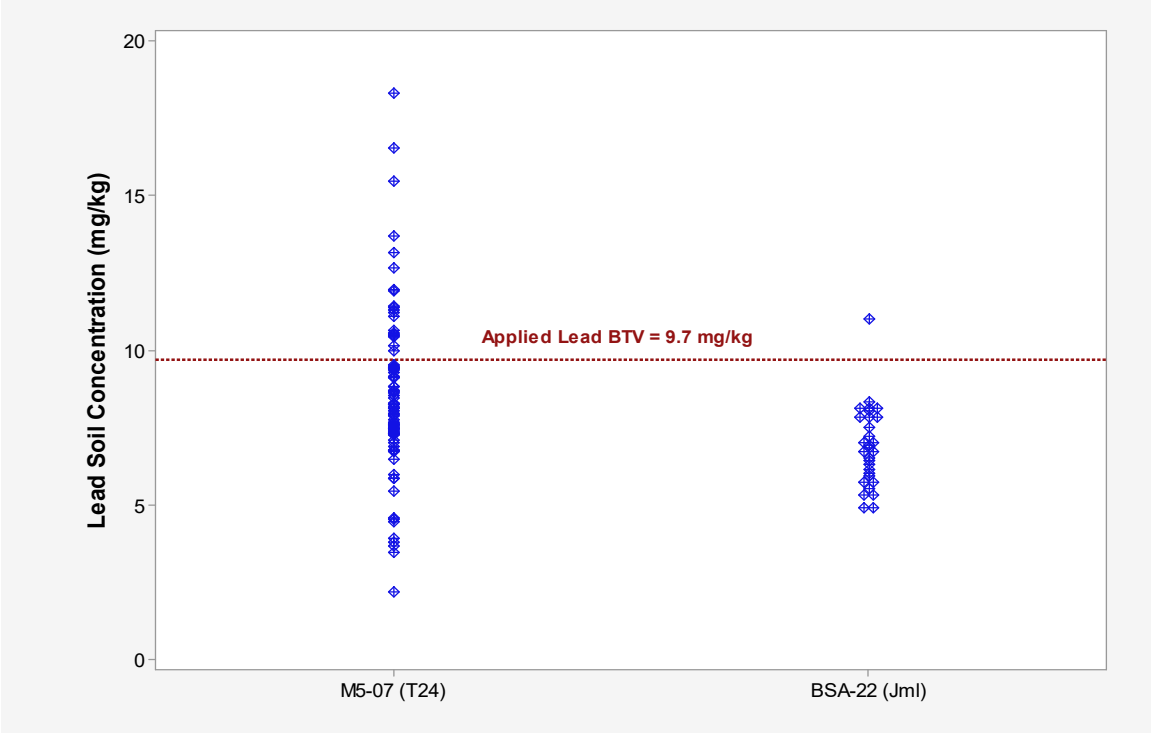


Figure I24-15. Individual Value Plot for Target M5-07 (T24) and BSA-22 (Jml) Lead Soil Concentrations

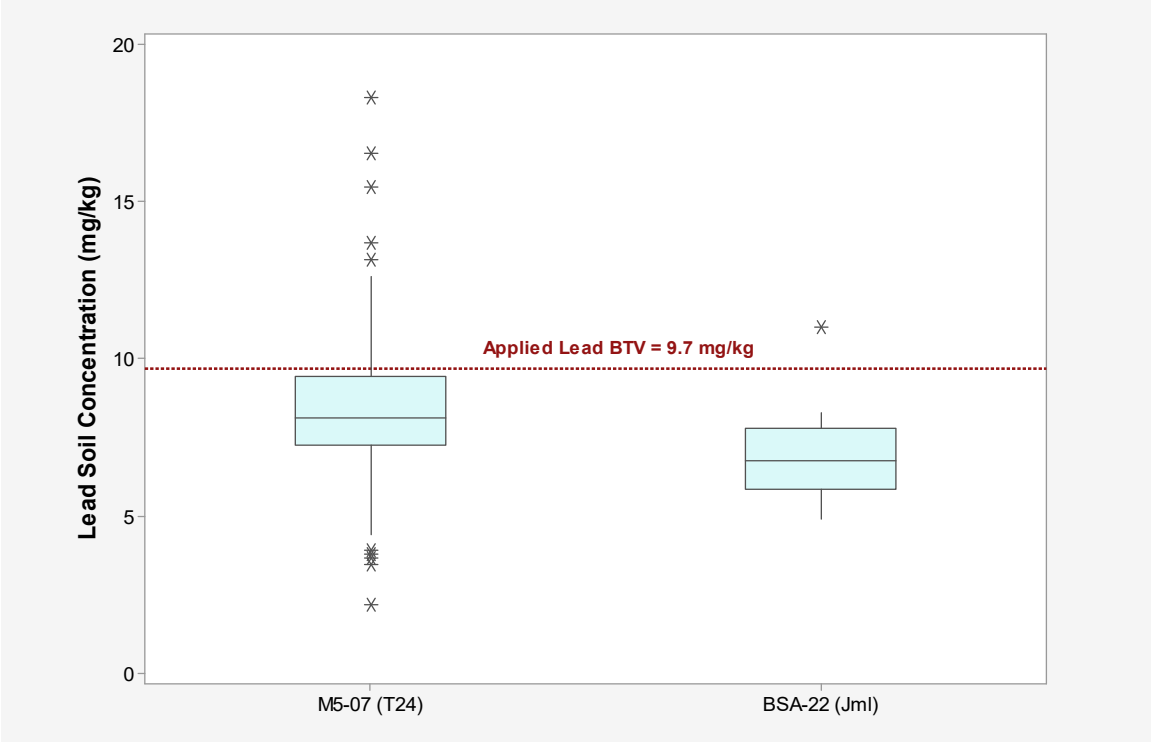
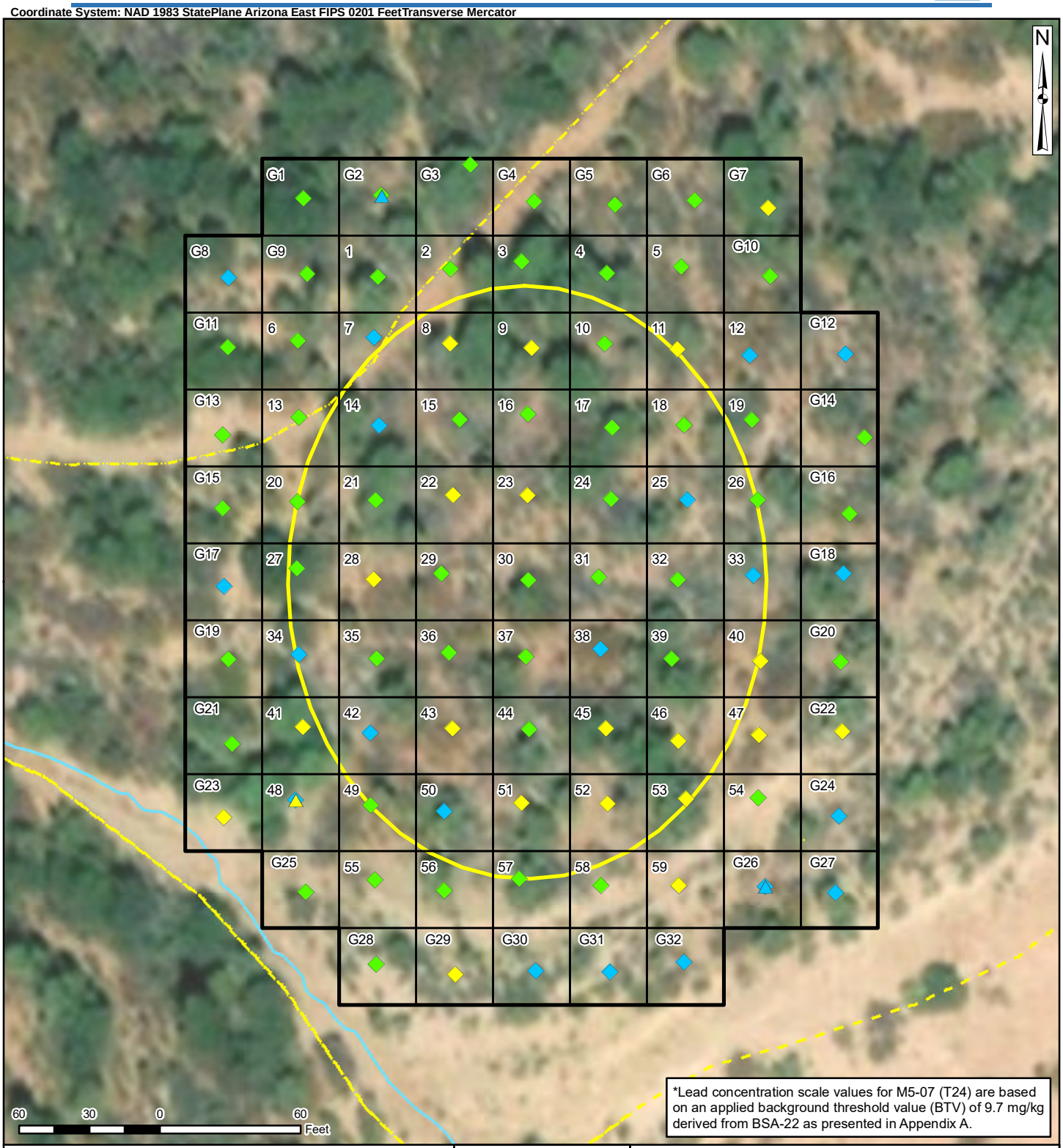


Figure I24-16. Box Plot for Target M5-07 (T24) and BSA-22 (Jml) Lead Soil Concentrations



Lead Concentration Scale (mg/kg)*

- ≤ 6.8
- 6.8 - 9.7
- 9.7 - 19
- 19 - 29
- 29 - 39
- 39 - 97
- ≥ 97

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot
- Drainage - Field Mapped

Prepared for: USEPA Region 9

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NON-AUM TARGET M5-07 (T24) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I24-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/14/2019	

8.6.7.4 Thorium

Thorium was identified as a COPC in surface soil as shown in Table I24-7. Thorium exceeded the applied BTV in 18.7 percent of in situ XRF measurements and in one of the three XRF confirmation samples. The applied BTV for thorium is 3.6 mg/kg for Target T24 as presented in Section 8.6.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I24-5 and Attachment I3, respectively. Figure I24-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T24 and BSA-22 (Jml) samples. Figure I24-19 presents a box plot of detectable thorium XRF soil concentrations for Target T24 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.6.6.1. Thorium XRF concentrations measured in surface soils at Target T24 ranged between 1.2 and 8.1 mg/kg with an average and standard deviation of 2.9 mg/kg and 1.0 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T24 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I24-20. Overall, the majority of detectable thorium results in surface soils were below the applied BTV. However, the maximum XRF value was 2.3 times higher than the applied BTV and does not appear to be associated with mining-related materials.

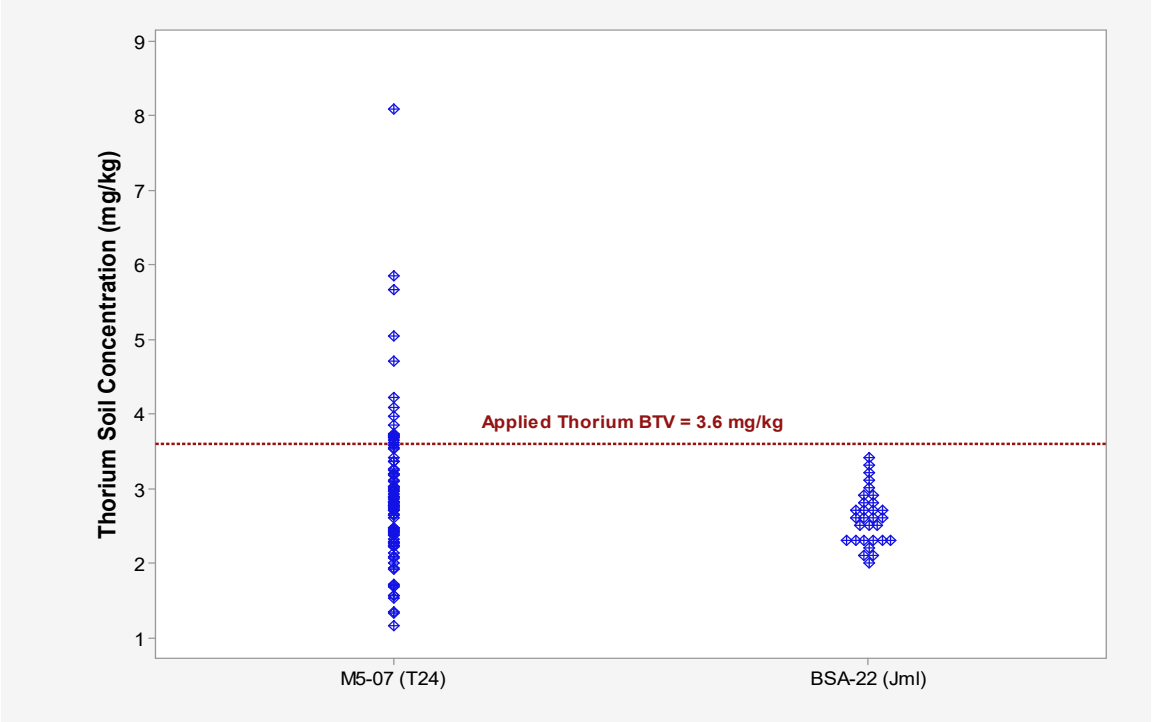


Figure I24-18. Individual Value Plot for Target M5-07 (T24) and BSA-22 (Jml) Thorium Soil Concentrations

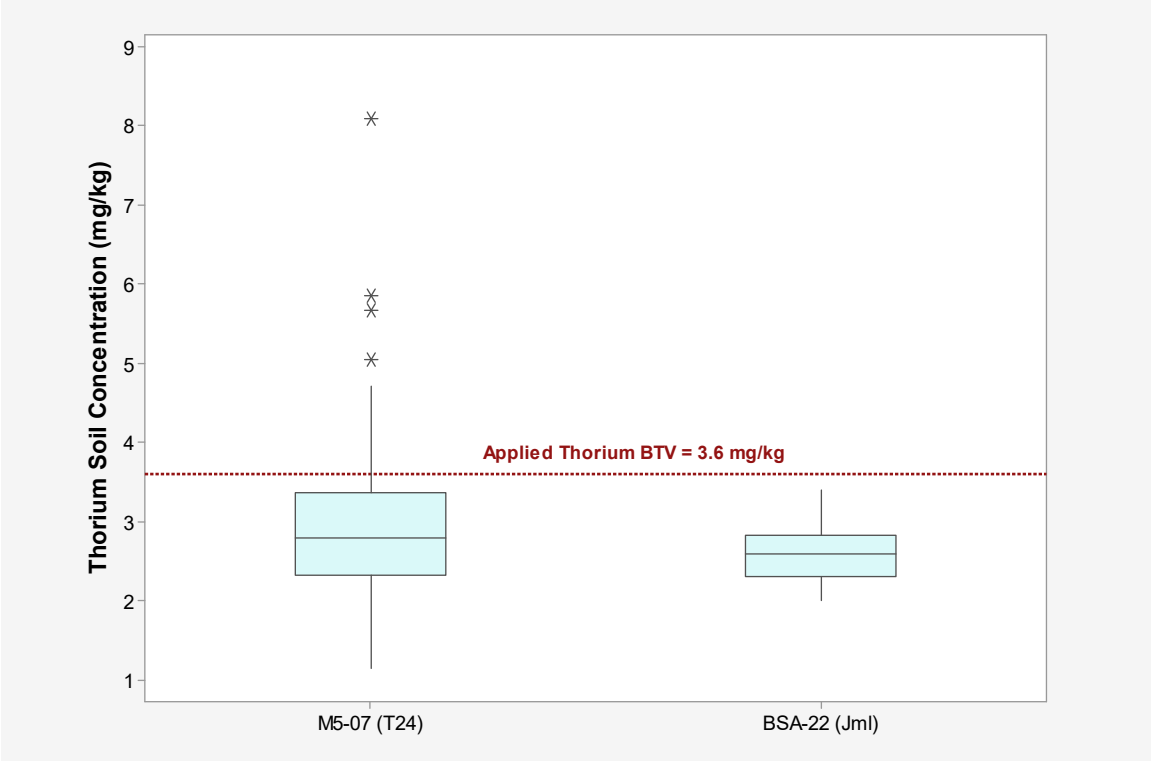
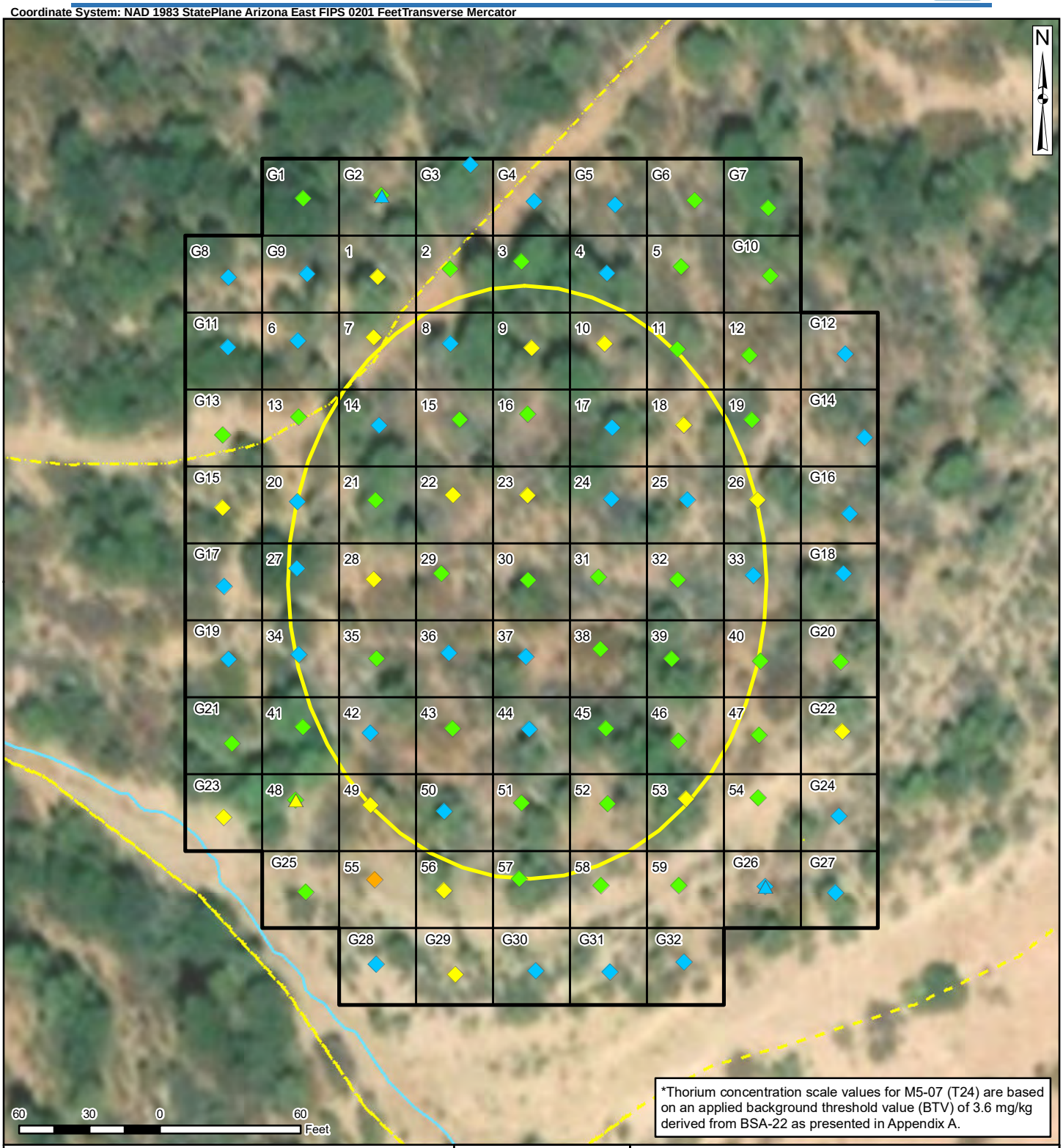


Figure I24-19. Box Plot for Target M5-07 (T24) and BSA-22 (Jml) Thorium Soil Concentrations



Thorium Concentration Scale (mg/kg)*

- ≤ 2.6
- 2.6 - 3.6
- 3.6 - 7.2
- 7.2 - 11
- 11 - 14
- 14 - 36
- ≥ 36

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot
- Drainage - Field Mapped

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NON-AUM TARGET M5-07 (T24) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I24-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/14/2019	

8.6.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I24-7. Uranium exceeded the applied BTV in 73.6 percent of in situ XRF measurements and in one of the three XRF confirmation samples. The applied BTV for uranium is 1.3 mg/kg for Target T24 as presented in Section 8.6.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I24-5 and Attachment I3, respectively. Figure I24-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T24 and BSA-22 (Jml) samples. Figure I24-22 presents a box plot of detectable uranium XRF soil concentrations for Target T24 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.6.6.1. Uranium XRF concentrations measured in surface soils at Target T24 ranged between 0.2 and 9.3 mg/kg with an average and standard deviation of 3.0 mg/kg and 1.9 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T24 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I24-23. Overall, the majority of detectable uranium results in surface soils were above the applied BTV. However, the maximum XRF value was 7.2 times higher than the applied BTV and does not appear to be associated with mining-related materials.

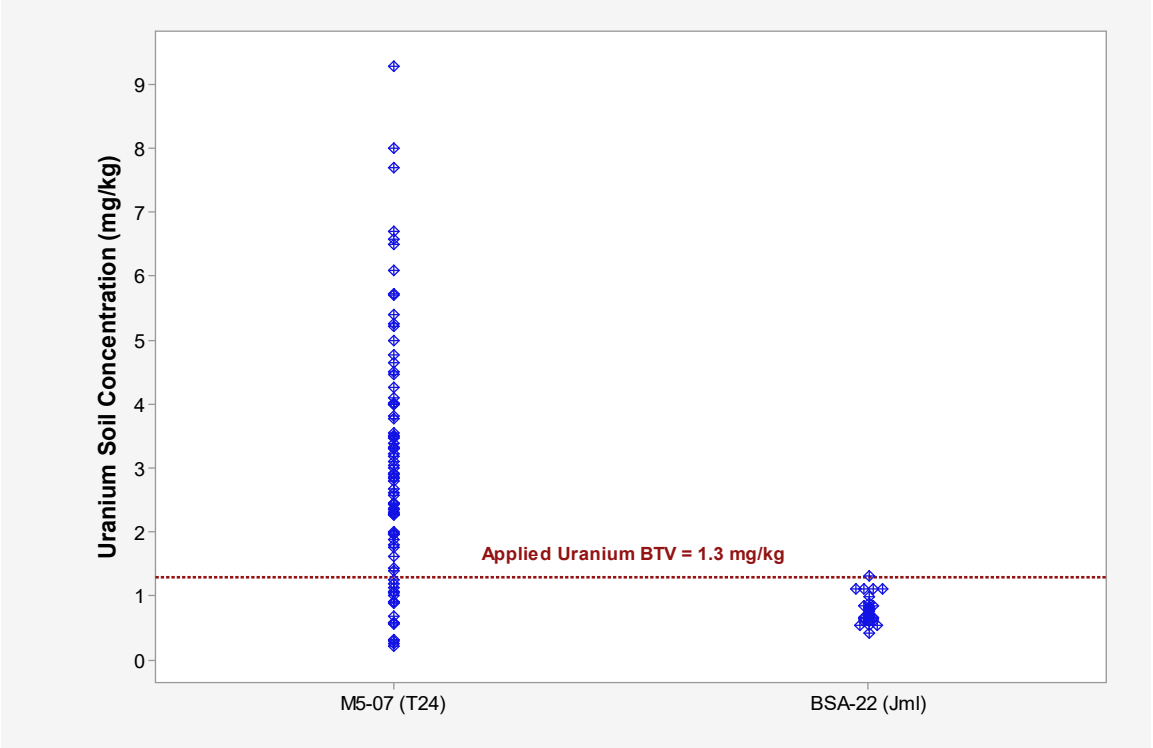


Figure I24-21. Individual Value Plot for Target M5-07 (T24) and BSA-22 (Jml) Uranium Soil Concentrations

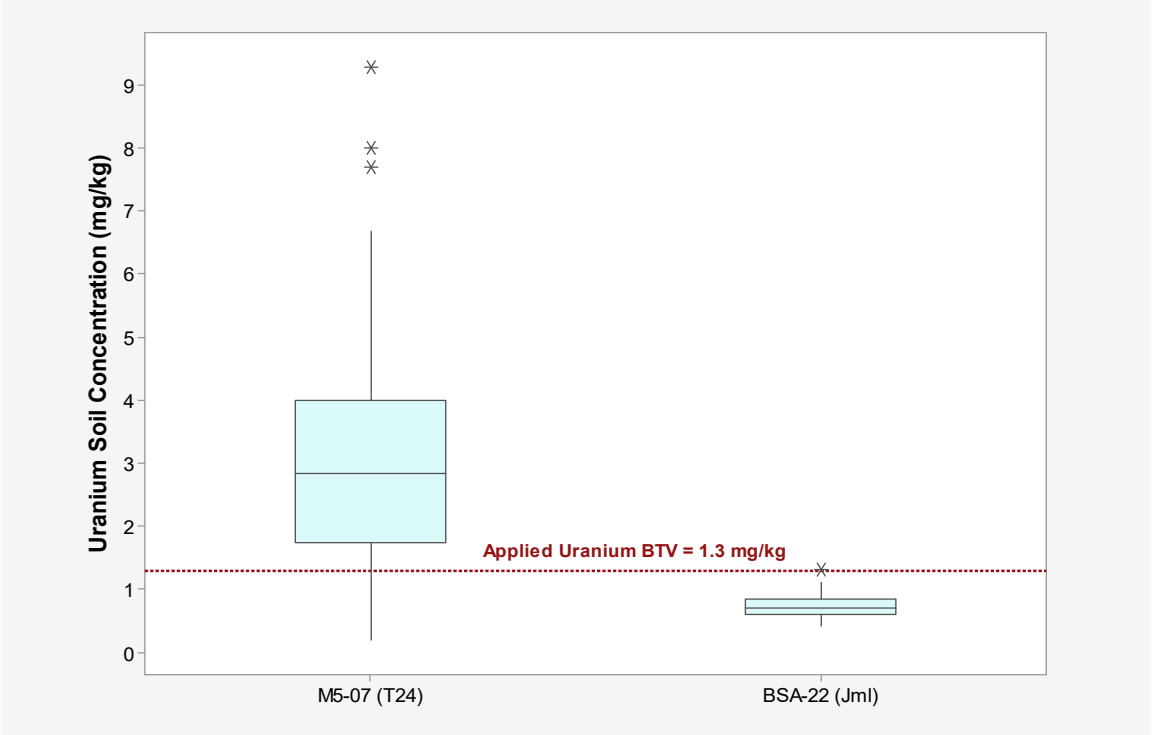
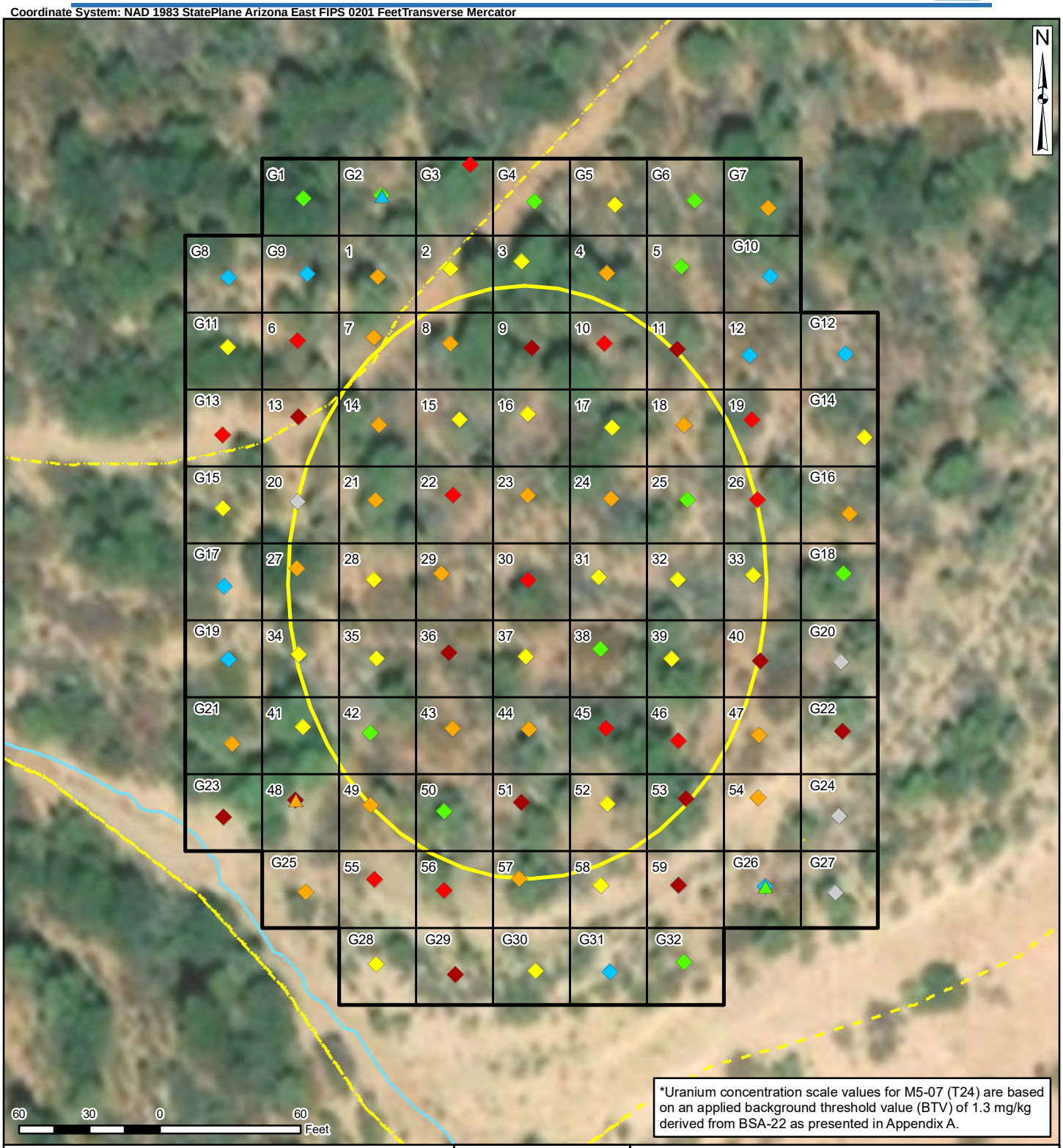


Figure I24-22. Box Plot for Target M5-07 (T24) and BSA-22 (Jml) Uranium Soil Concentrations



*Uranium concentration scale values for M5-07 (T24) are based on an applied background threshold value (BTV) of 1.3 mg/kg derived from BSA-22 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 0.76
- 0.76 - 1.3
- 1.3 - 2.6
- 2.6 - 3.9
- 3.9 - 5.2
- 5.2 - 13
- ≥ 13
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot
- Drainage - Field Mapped

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NON-AUM TARGET M5-07 (T24) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I24-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/14/2019	

8.6.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I24-7. Vanadium exceeded the applied BTV in 67 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for vanadium is 15 mg/kg for Target T24 as presented in Section 8.6.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I24-5 and Attachment I3, respectively. Figure I24-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T24 and BSA-22 (Jml) samples. Figure I24-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T24 and BSA-22 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.6.6.1. Vanadium XRF concentrations measured in surface soils at Target T24 ranged between 16.5 and 40.6 mg/kg with an average and standard deviation of 26.5 mg/kg and 6.0 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T24 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I24-26. Overall, the majority of detectable vanadium results in surface soils were above the applied BTV. However, the maximum XRF value was 2.7 times higher than the applied BTV and does not appear to be associated with mining-related materials.

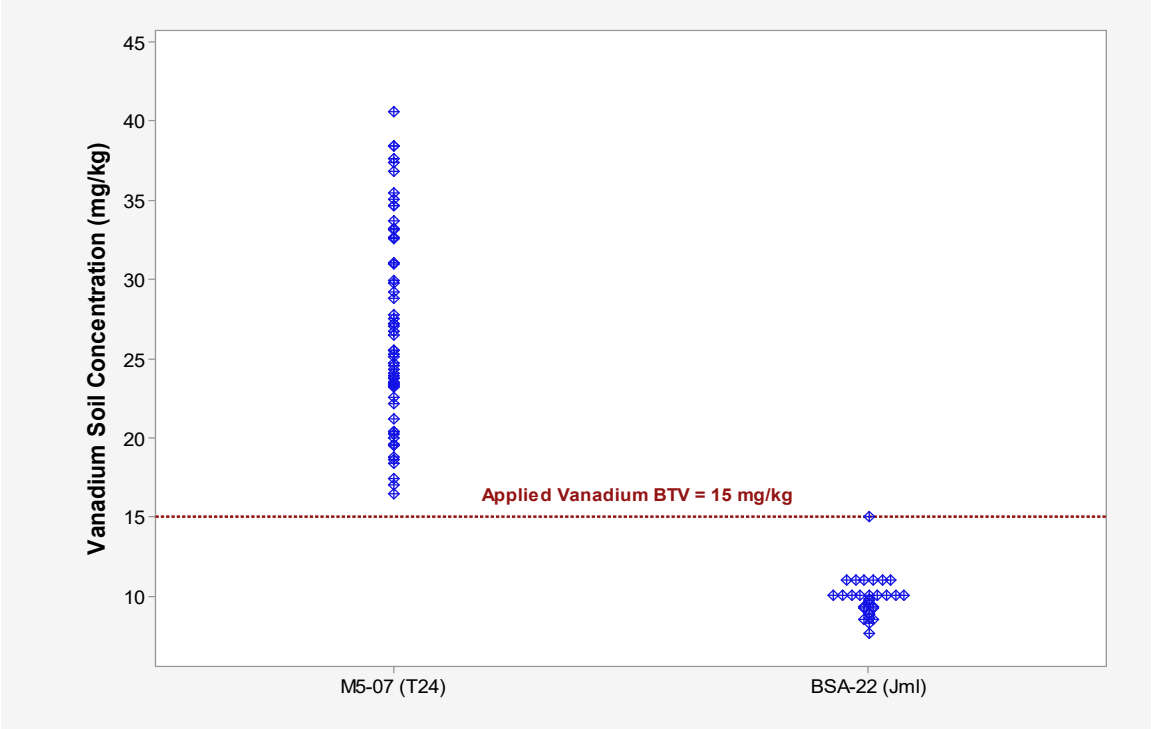


Figure I24-24. Individual Value Plot for Target M5-07 (T24) and BSA-22 (Jml) Vanadium Soil Concentrations

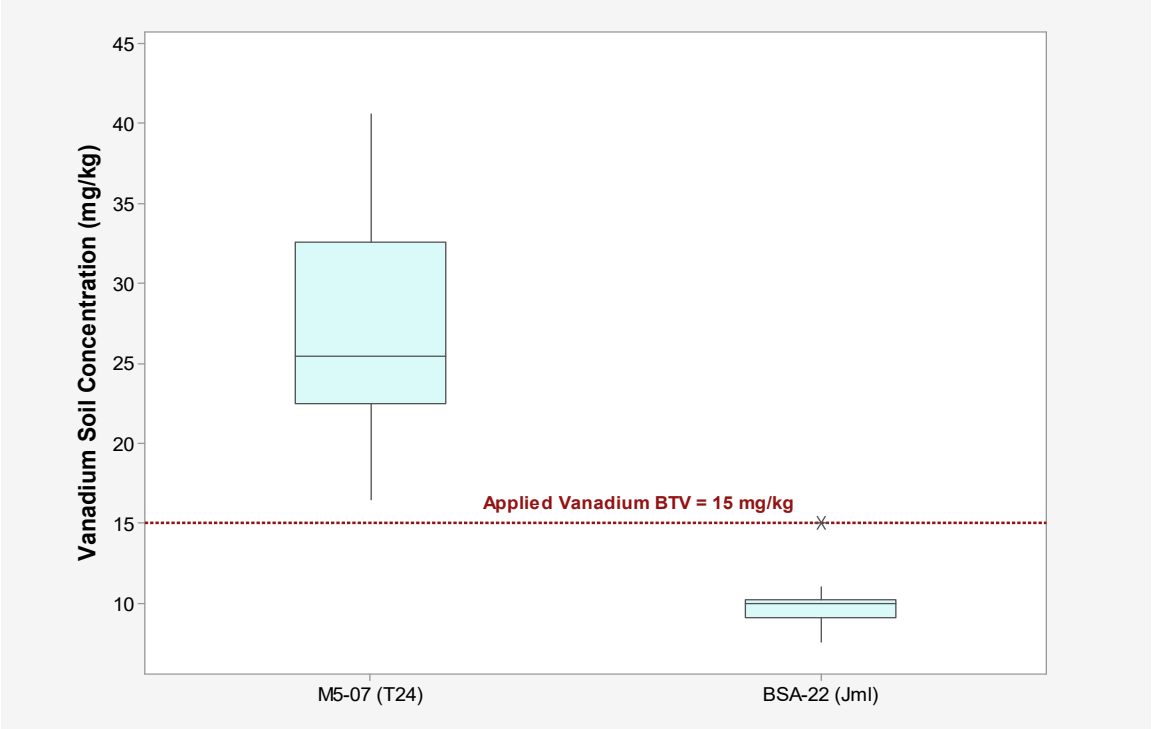
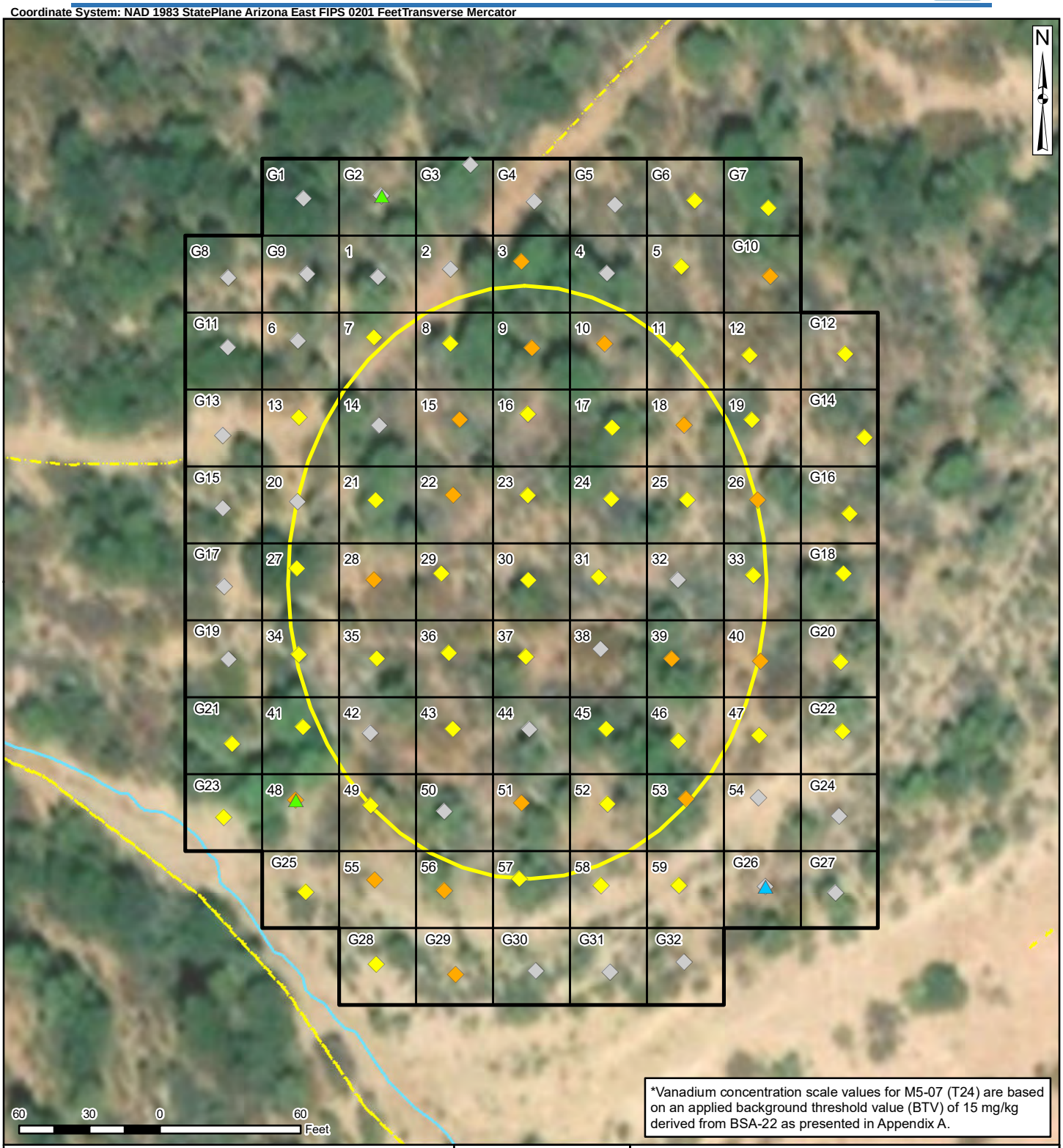


Figure I24-25. Box Plot for Target M5-07 (T24) and BSA-22 (Jml) Vanadium Soil Concentrations

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



Vanadium Concentration Scale (mg/kg)*

- ≤ 10
- 10 - 15
- 15 - 30
- 30 - 45
- 45 - 60
- 60 - 150
- ≥ 150
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot
- Drainage - Field Mapped

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NON-AUM TARGET M5-07 (T24) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I24-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/14/2019	

8.6.8 Conclusions

Target T24 (M5-07) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T24. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T24 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T24. ASPECT gamma survey results did not correlate with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE; however, outcropping of NORM, historic exploration activities, and an adjacent AUM may explain elevated gamma levels.
- The lateral extent of elevated radiological activity at Target T24 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in one of the three XRF confirmation samples exceeded the applied BTV by a factor of 2.7. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T24 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. However, grid averaged gamma measurements exceeded the applied BTV in 22 of the 91 survey units by a factor of up to 1.2.
- A total of 27 analytes were identified as occurring within the surface environment. Of these analytes, 22 were identified as COPCs. Arsenic, thorium, uranium, and vanadium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T24 does not contain TENORM. No mining-related activities or features were observed in the field, but five potential historical exploratory borings were noted in the file review. TENORM may be associated with these exploratory borings. Outcropping of Jml and Jse was identified in the area of highest gamma activity.
- Natural erosion of outcroppings may have increased the lateral extent of NORM.
- There are no immediate significant physical hazards present at Target T24.
- Access is by dirt road with a small four-wheel-drive vehicle followed by footpath.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.

- No existing groundwater wells are documented within the vicinity of Target T24. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T24. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No mine waste was observed at Target T24; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; however, a few data gaps remain for Target T24. The remaining data gaps include field verification of the reclamation status of the potential historic exploratory borings, verification of NORM in outcroppings, and conduct additional gamma surveying along the historic haul roads up and downslope of the Target.

8.7 NON-AUM TARGET T25 (M5-08)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T25 (M5-08).

8.7.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T25 (M5-08) is grouped with another non-AUM Target T26 (M5-09). Target T25 is in the Lukachukai Mountains Region in Subarea Group F within the Cove Chapter of the Navajo Nation and is accessible by four-wheel-drive vehicle off of the Mesa V access road. Target T25 is identified in the MCAP r (Weston 2016), but no known historical information is associated with the Target. No residential structures are near the Target. A Target location and access map for Target T25 is shown in Figure I25-1.

A topographical relief map for non-AUM Target T25 is provided in Figure I25-2. The elevation at Target T25 ranges from 7,638 feet to 7,723 feet amsl with an average of 7,673 feet amsl. The slope at Target T25 ranges from 12 to 44 percent with an average of 32 percent. The Target T25 is located entirely within Jml, which comprises the Recapture and Salt Wash Members. The soil type for the Target is the Narbona-Zilditloi complex (MUSYM 608) (Figures I-22 and I-23).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T25. Weston did not conduct a background study for Target T25. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 25, of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T25:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T25 is accessible by four-wheel-drive vehicle from the Mesa V access road off of Indian Route 33.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  The geology of the Target, Jml, contains NORM. Observations of NORM were not recorded by personnel. TENORM may be associated with exploratory borings.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  No drainages were located on or adjacent to the Target. The Target is 0.1 mile upslope from the Cove Wash North drainage, which is evaluated in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

  Three historic exploratory borings were identified on the southeastern portion of the Target and one exploratory boring approximately 70 feet from the northwestern corner of the Target in a file review.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  Exploratory borings were present at the Target and in the immediate area surrounding the Target. The Target overlies the Jml, which contains NORM.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

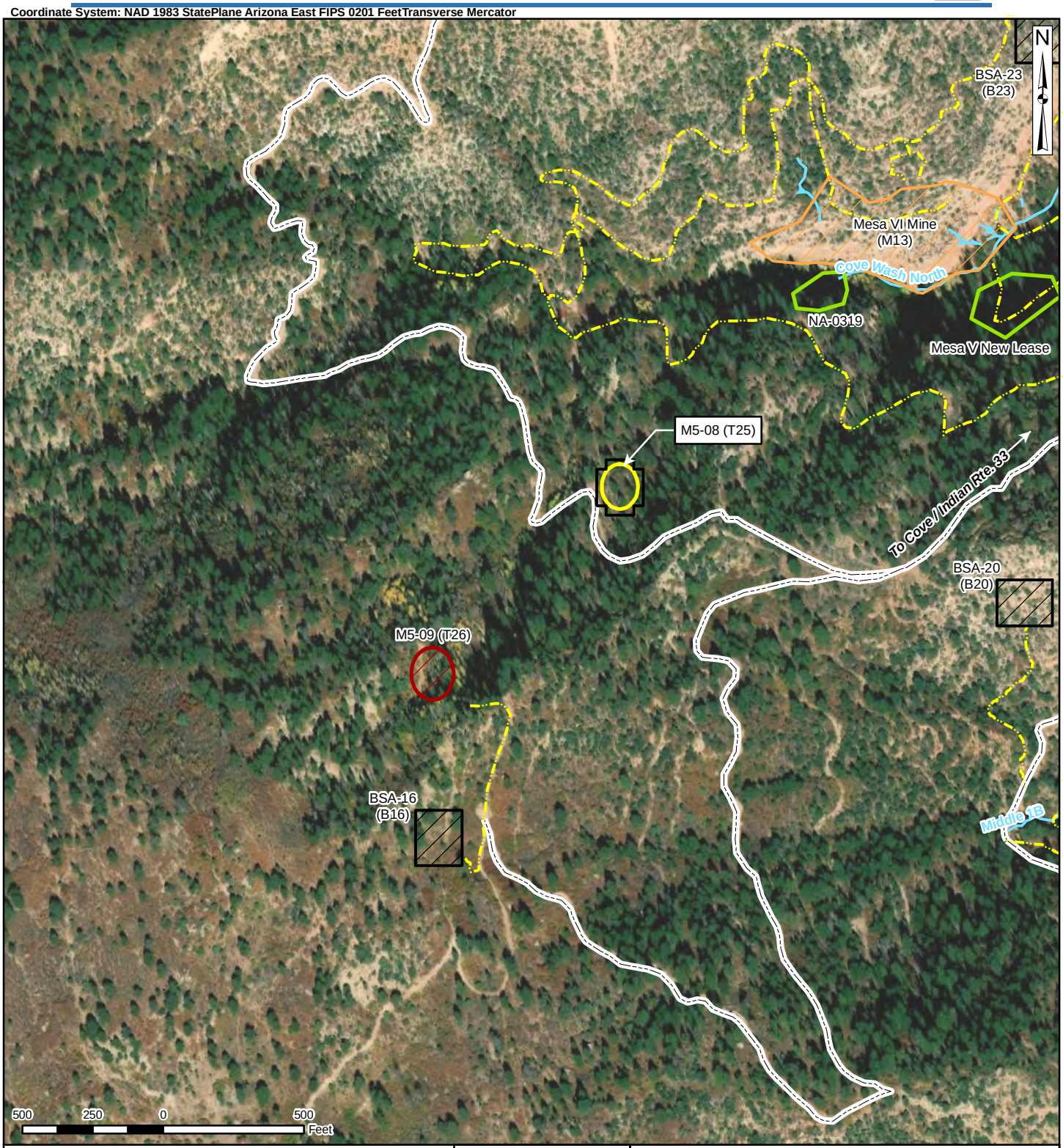
  No mine waste was identified.

Baseline Study field survey, measurement, and sampling activities at Target T25 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Sections 2.3 and 8.7.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 8.7.3 with results presented in Sections 8.7.6 and 8.7.7)
- Conducting a gamma radiation survey (results presented in Section 8.7.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



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

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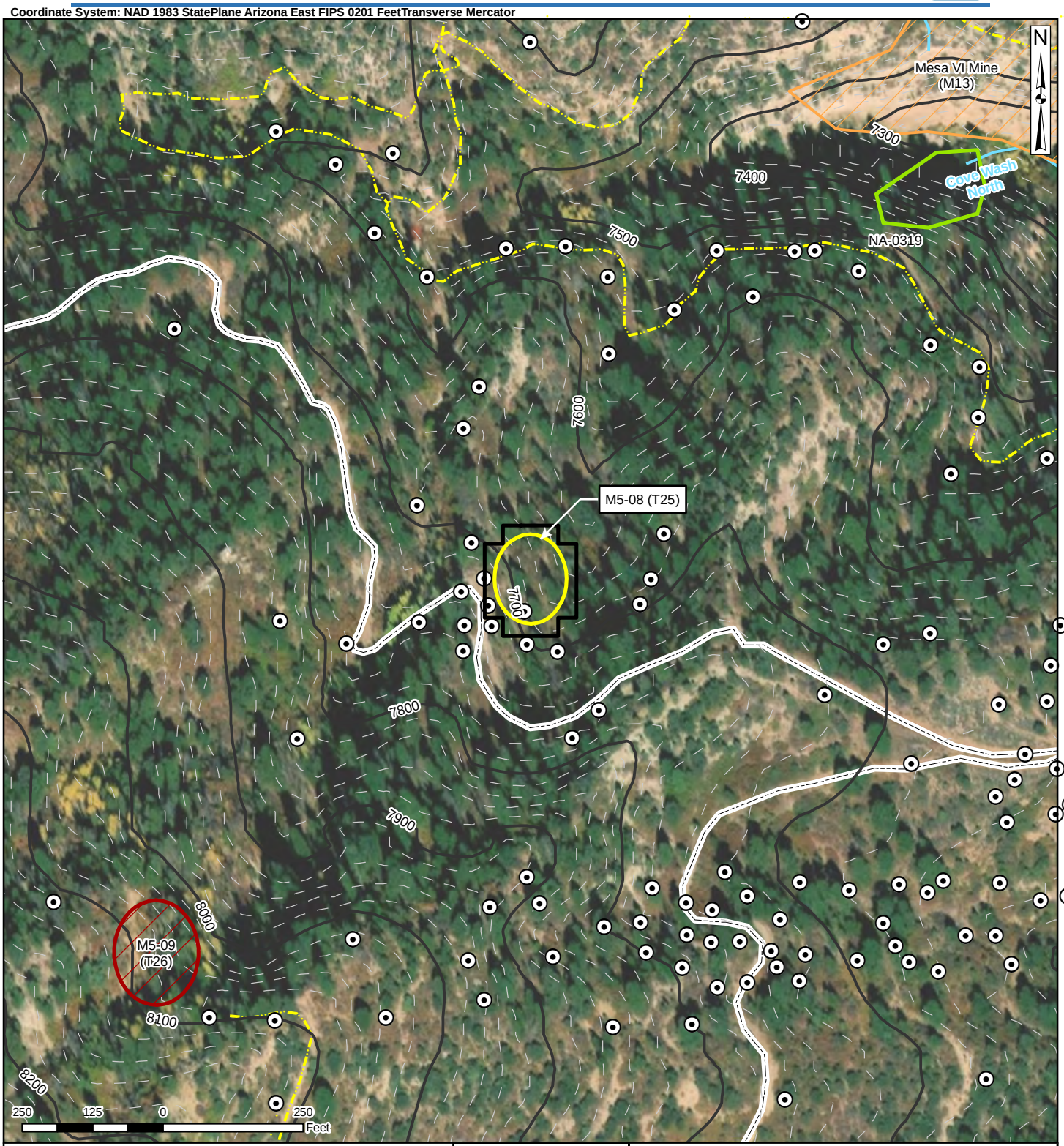
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NON-AUM TARGET M5-08 (T25) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I25-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Tronox AUM Site Boundary
Non-Tronox AUM Site

Exploratory Bore Hole
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped
100 ft Contour*
20 ft Contour*

* 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.

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NON-AUM TARGET M5-08 (T25) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I25-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	

8.7.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I25-3) within the survey area of the non-AUM Target T25 as part of the Baseline Study in May 2018. Additional Goback gamma radiation surveys were not performed at Target T25. Tetra Tech also performed an XRF field survey at non-AUM Target T25 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I25-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 25, of the RSE Work Plan (Tetra Tech 2018). All gamma survey and XRF survey units were evaluated.

8.7.3 XRF Confirmation Sampling Overview

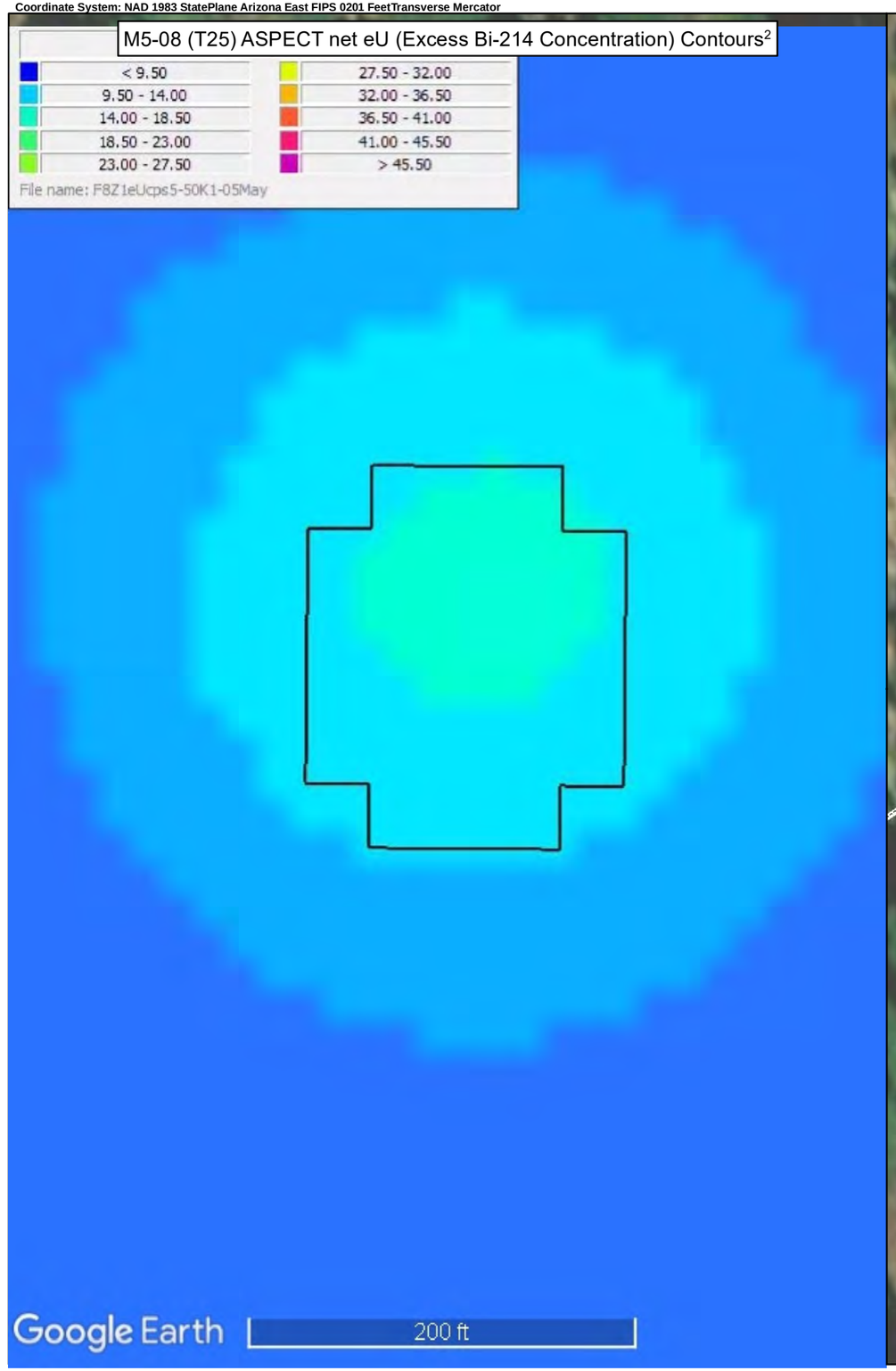
Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T25. One XRF soil confirmation sample was collected at a depth of 0 to 3 inches bgs from one location (Table I25-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I25-4 and I25-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I25-2. The results of XRF confirmation sample analysis are provided in Section 8.7.6.1. Correlated XRF field measurements are provided in Attachment I3.

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

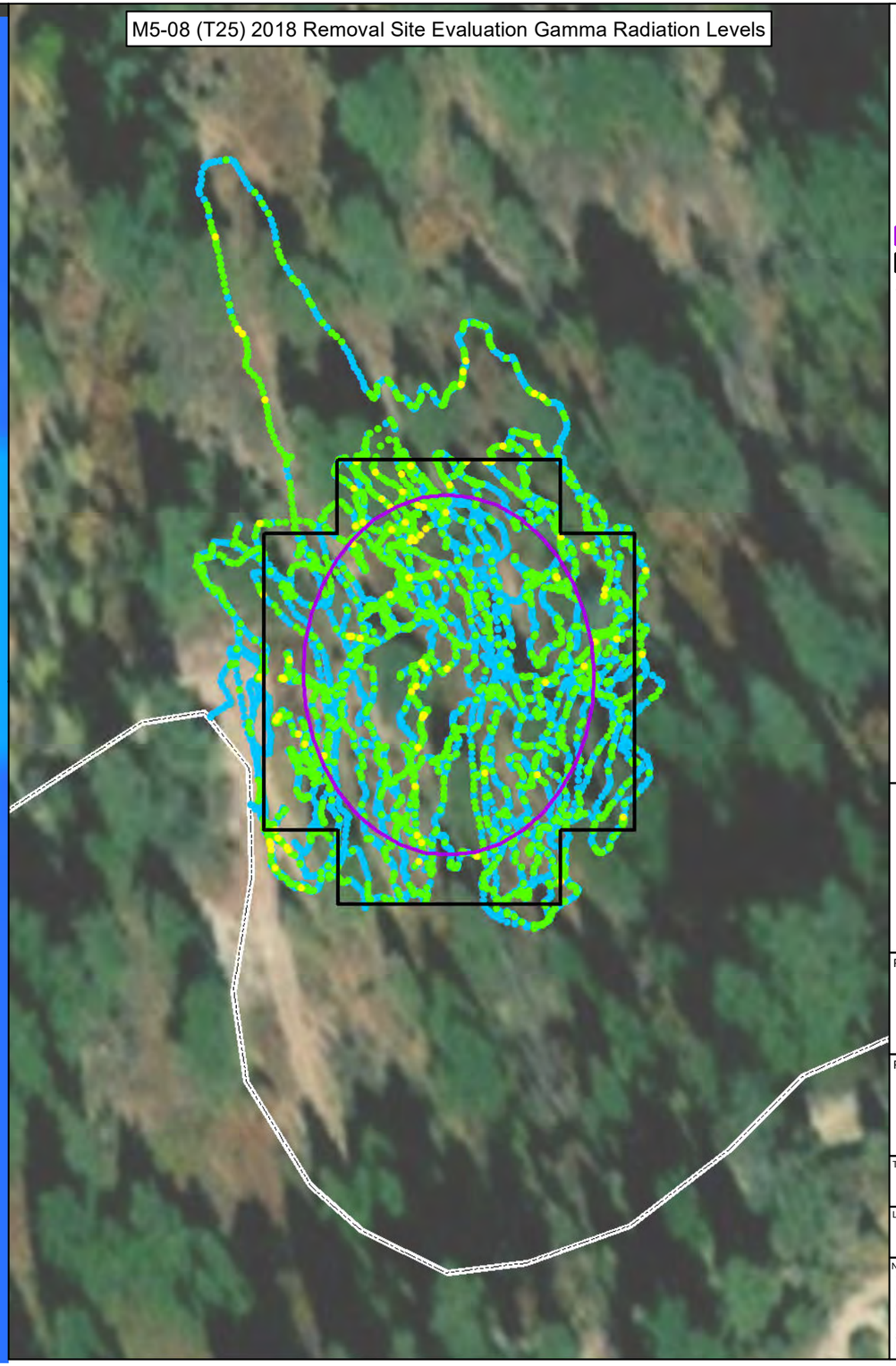
M5-08 (T25) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F8Z1eUcps5-50K1-05May



M5-08 (T25) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)[1]

≤ 9,603	≤ Avg. BG
9,603 - 11,528	Avg. BG - 1 x BTV
11,528 - 23,056	1 x BTV - 2 x BTV
23,056 - 34,584	2 x BTV - 3 x BTV
34,584 - 46,112	3 x BTV - 4 x BTV
46,112 - 115,280	4 x BTV - 10 x BTV
≥ 115,280	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Vehicular

[1]The applied gamma background threshold value (BTV) for M5-08 (T25) Non-AUM Target is 11,528 cpm derived from BSA-17 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET M5-08 (T25)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

Prepared By:

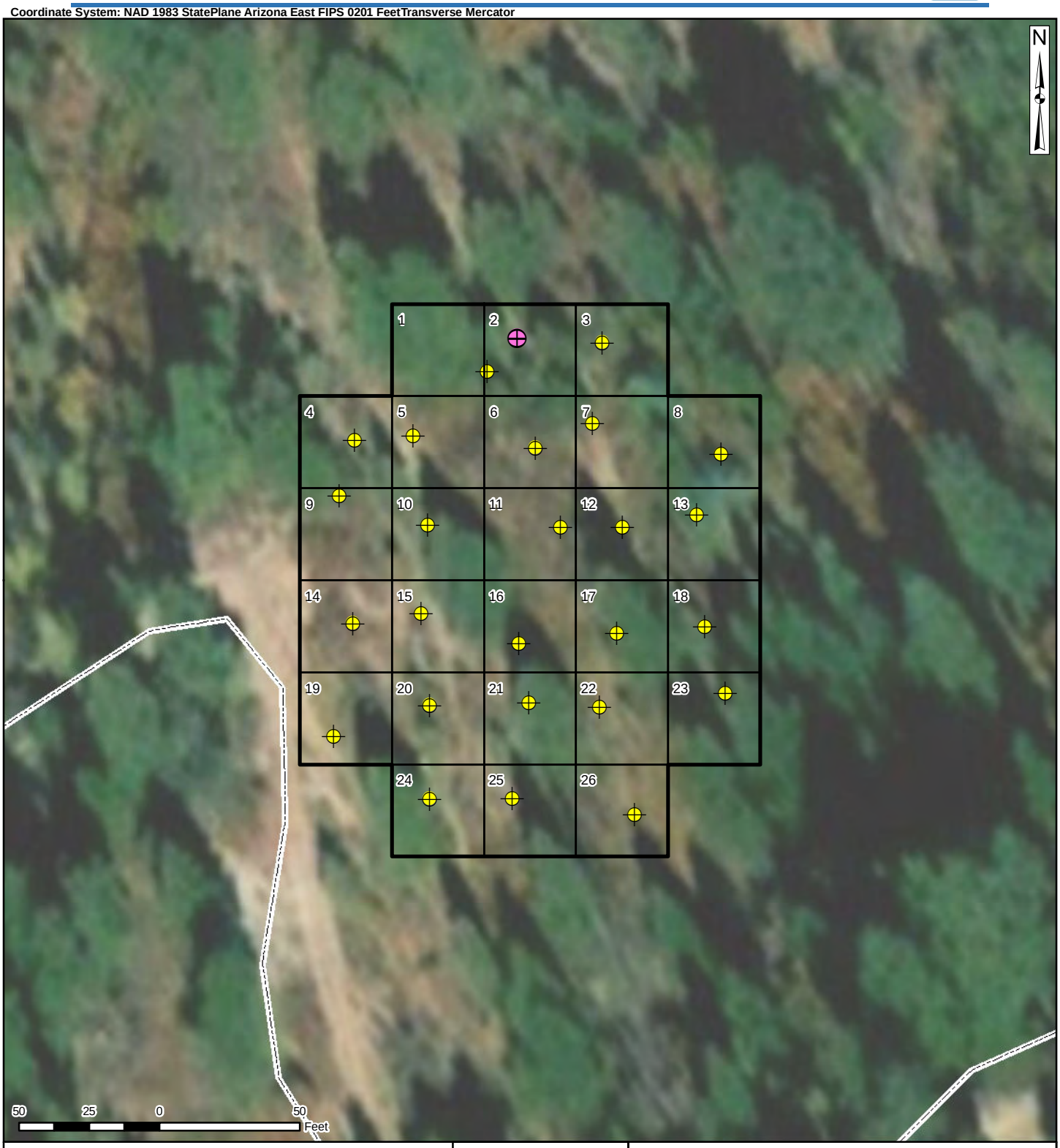
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborne Spectral Photometric Environmental Collection Technology.

Figure No.: **I25-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

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NON-AUM TARGET M5-08 (T25)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I25-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

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



XRF Confirmation Soil Sample*
(0 - 3 inches bgs)

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

*T26-XS2 = site T26 XRF confirmation soil sample collected at survey unit 2. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET M5-08 (T25)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I25-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

Table I25-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-08 (T25)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T25-XS2-01-060618	2	0-3	XRF Confirmation	Primary	6/6/2018	36.5406980	-109.2618709	1806222-32, 1806235-32

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I25-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-08 (T25)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

8.7.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 8.7.1, Target T25 surface geology is entirely within Jml with soils within the Narbona-Zilditloi complex (MUSYM 608) (Figures I-22 and I-23). As a result, Background Study Area 17 (BSA-17) was selected for that combination of geology and soil type. Additionally, the Jml regional geological background would also be applicable for this Target. Table I25-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T25. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T25. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T25. The “Applied BTV” for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I25-3. Applied Background Threshold Values for Non-AUM Target M5-08 (T25)

Analyte	Units	Site-Specific BTV (BSA-17)	Regional BTV (Jml)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	5,900	7,000	5,900	Site Specific BTV
Antimony	mg/kg	0.190	0.140	0.140	Regional BTV
Arsenic	mg/kg	2.2	3.5	2.2	Site Specific BTV
Barium	mg/kg	569	270	270	Regional BTV
Beryllium	mg/kg	0.72	0.57	0.57	Regional BTV
Cadmium	mg/kg	0.255	0.160	0.160	Regional BTV
Calcium	mg/kg	7,410	32,000	7,410	Site Specific BTV
Chromium	mg/kg	6	5.2	5.2	Regional BTV
Cobalt	mg/kg	4.8	4.4	4.4	Regional BTV
Copper	mg/kg	17	12	12	Regional BTV
Iron	mg/kg	10,000	8,897	8,897	Regional BTV
Lead	mg/kg	16	11	11	Regional BTV
Lithium	mg/kg	6.3	8.8	6.3	Site Specific BTV
Magnesium	mg/kg	2,850	3,900	2,850	Site Specific BTV
Manganese	mg/kg	605	440	440	Regional BTV
Mercury	mg/kg	0.0430	0.0378	0.0378	Regional BTV
Molybdenum	mg/kg	0.35	0.29	0.29	Regional BTV
Nickel	mg/kg	6.4	6.2	6.2	Regional BTV
Potassium-40	pCi/g	23.3	26.9	23.3	Site Specific BTV
Radium-226	pCi/g	1.40	2.23	1.40	Site Specific BTV
Radium-228	pCi/g	1.08	0.75	0.75	Regional BTV
Selenium	mg/kg	0.99	0.93	0.93	Regional BTV
Silver	mg/kg	0.039	0.037	0.037	Regional BTV
Sodium	mg/kg	41	45	41	Site Specific BTV
Thallium	mg/kg	0.087	0.075	0.075	Regional BTV
Thorium	mg/kg	6.6	4.7	4.7	Regional BTV
Uranium	mg/kg	0.97	1.5	0.97	Site Specific BTV
Vanadium	mg/kg	12	24	12	Site Specific BTV
Zinc	mg/kg	30	27	27	Regional BTV
Gamma Radiation	cpm	11,528	11,907	11,528	Site Specific BTV

Notes:

BSA	Background Study Area
BTV	background threshold value
cpm	counts per minute
Jse	Summerville, Entrada Formation (Undifferentiated)
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram

8.7.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T25 and the raw gamma radiation and grid averaged gamma radiation survey results.

8.7.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T25 in May 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine if any additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. No additional scanning, measurements, or sampling were required. The applied gamma BTV for non-AUM Target T25 is 11,528 cpm. A total of 5,325 measurements were collected as part of the gamma radiation survey at non-AUM Target T25 across 26 survey units. Because of the steep topography and thick vegetation, not all survey units were scanned at 100 percent density. An average scan density of 205 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I25-4.

Table I25-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-08 (T25)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,528	
Measurements	#	5,325	26
Minimum	cpm	6,714	8,983
Maximum	cpm	13,067	10,074
Average	cpm	9,355	9,372
Median	cpm	9,315	9,340
Standard Deviation	cpm	858	247
90th Percentile	cpm	10,471	9,619
95th Percentile	cpm	10,835	9,651
99th Percentile	cpm	11,604	9,971
Measurements per Survey Unit	#/grid	205	
Measurements Above Gamma BTV	#	67	0
Measurements Above Gamma BTV	%	1.3	0.0

Notes:
BTV background threshold value
cpm counts per minute

8.7.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 1.3 percent of the measurements within the Target boundaries, in some cases slightly above the applied gamma BTV (11,528 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-17 (Jml) gamma survey results is provided on Figure I25-6. This graph shows that the spread of radiation data at Target T25 (shown on left) begins within the lower range of BSA-17 (Jml) gamma levels (shown on right) and then rises to within the top range of background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T25 is about the same as the data cloud from the BSA-17 (Jml) data set. A box plot showing the quartiles of the data sets is provided in Figure I25-7. The box plot shows that the median of Target T25 radiation levels is slightly lower than the median of the BSA-17 (Jml) data set and below the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I25-8. No mining activity was observed within the survey area of Target T25. In general, Target T25 has surficial gamma radiation levels similar to BSA-17 (Jml) levels across the majority of the Target and surrounding area, indicating low correlation with elevated gamma activity identified by the ASPECT gamma survey (Figure I25-3). No TENORM or mining-related activities were observed; however, historic exploratory borings may be present along the southern and western margins of the survey area (see Figure I25-2). Section 8.7.5.3 presents the grid averaged results of the gamma radiation survey.

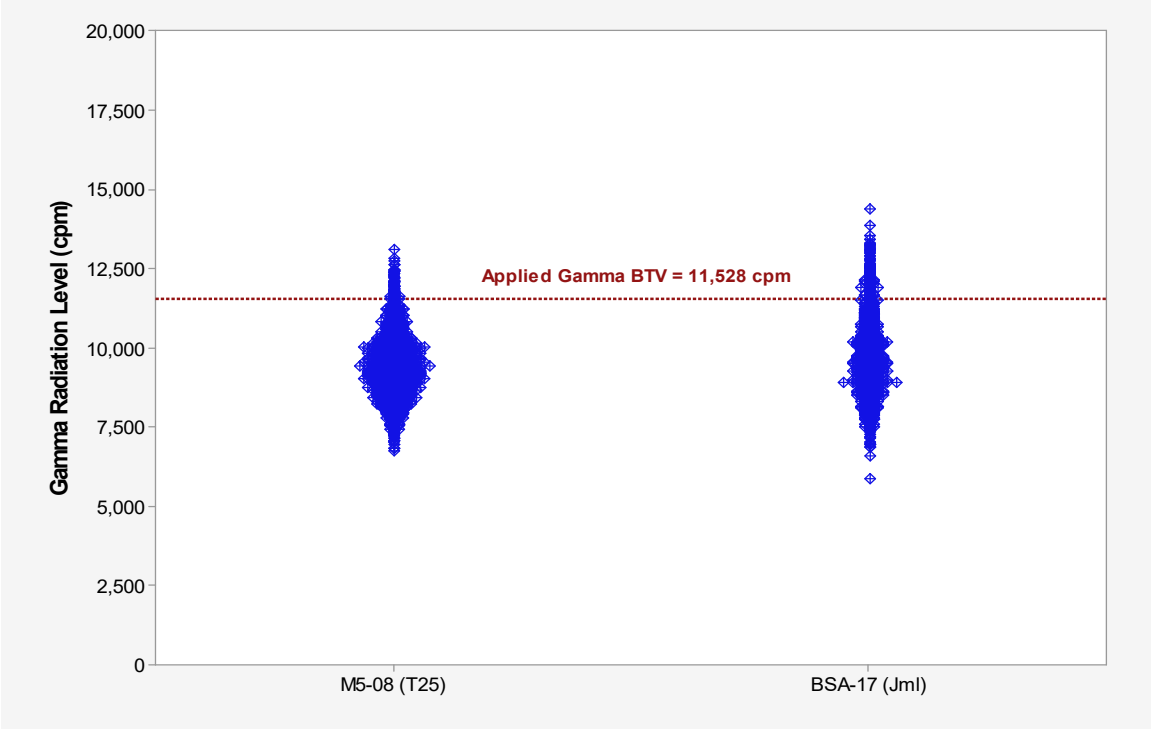


Figure I25-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M5-08 (T25) and BSA-17 (JmI)

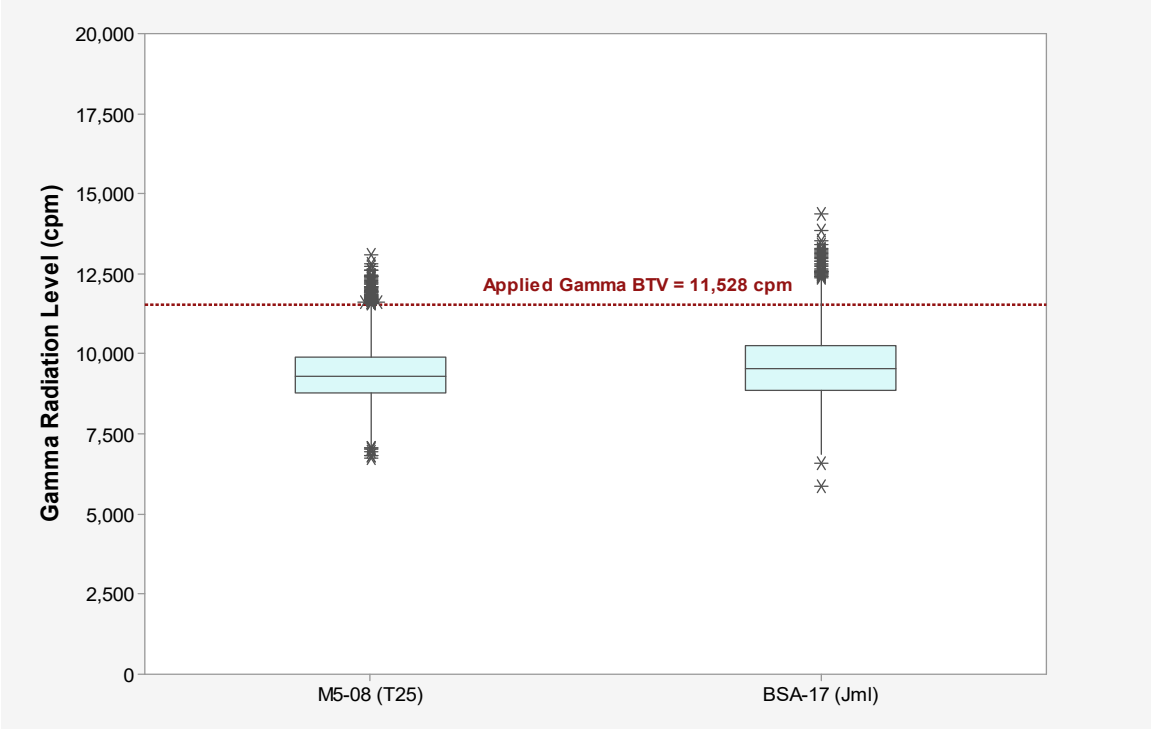
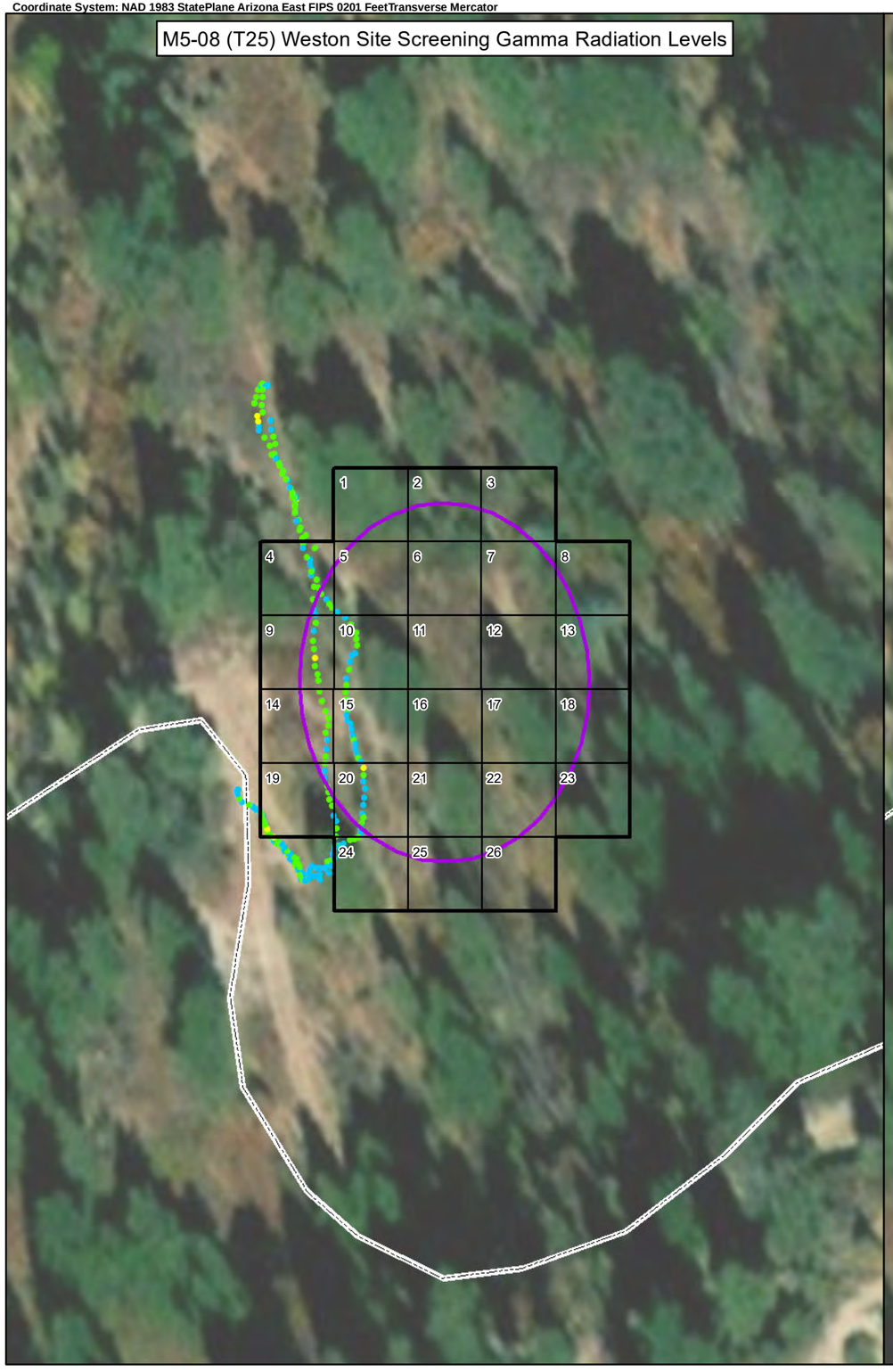
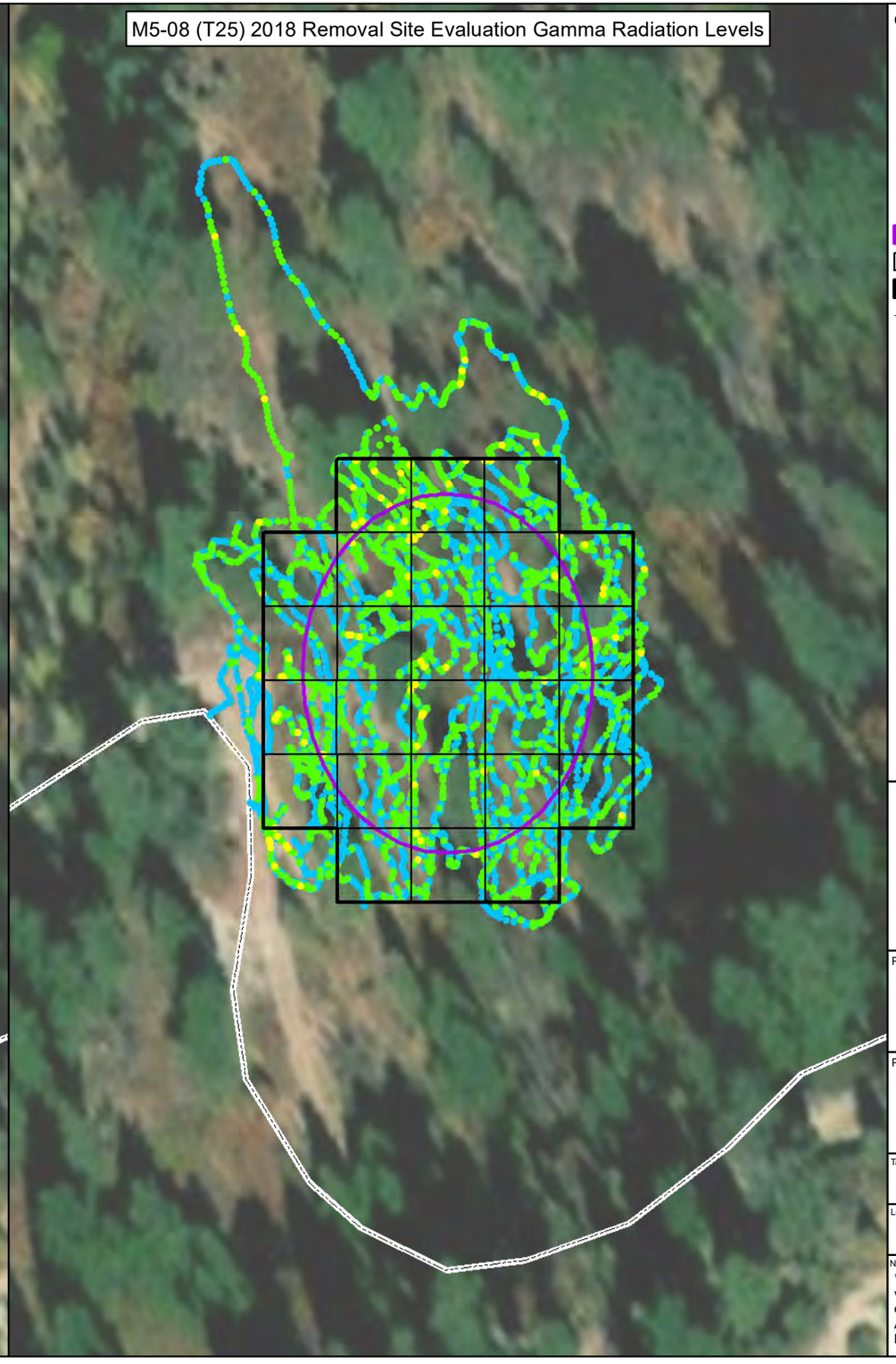


Figure I25-7. Box Plot of Raw Gamma Radiation Levels at Target M5-08 (T25) and BSA-17 (JmI)

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





Gamma Reading (cpm)*

≤ 9,603	≤ Avg. BG
9,603 - 11,528	Avg. BG - 1 x BTV
11,528 - 23,056	1 x BTV - 2 x BTV
23,056 - 34,584	2 x BTV - 3 x BTV
34,584 - 46,112	3 x BTV - 4 x BTV
46,112 - 115,280	4 x BTV - 10 x BTV
≥ 115,280	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Access Route - Vehicular

1 in = 60 ft

1:720

N
W E
S

0 30 60 120 Feet

NON-AUM TARGET M5-08 (T25)
2018 REMOVAL SITE EVALUATION
VS WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019

Notes:
*The applied gamma background threshold value (BTV) for M5-08 (T25) is 11,528 cpm derived from BSA-17 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I25-8**

8.7.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 8.7.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 8.7.5.1. Figure I25-9 and Figure I25-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-17 (Jml) data set (shown on right). No survey units within the survey area of Target T25 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I25-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I25-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. No regions of the Target exceeded the gamma BTW.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 8.7.6.

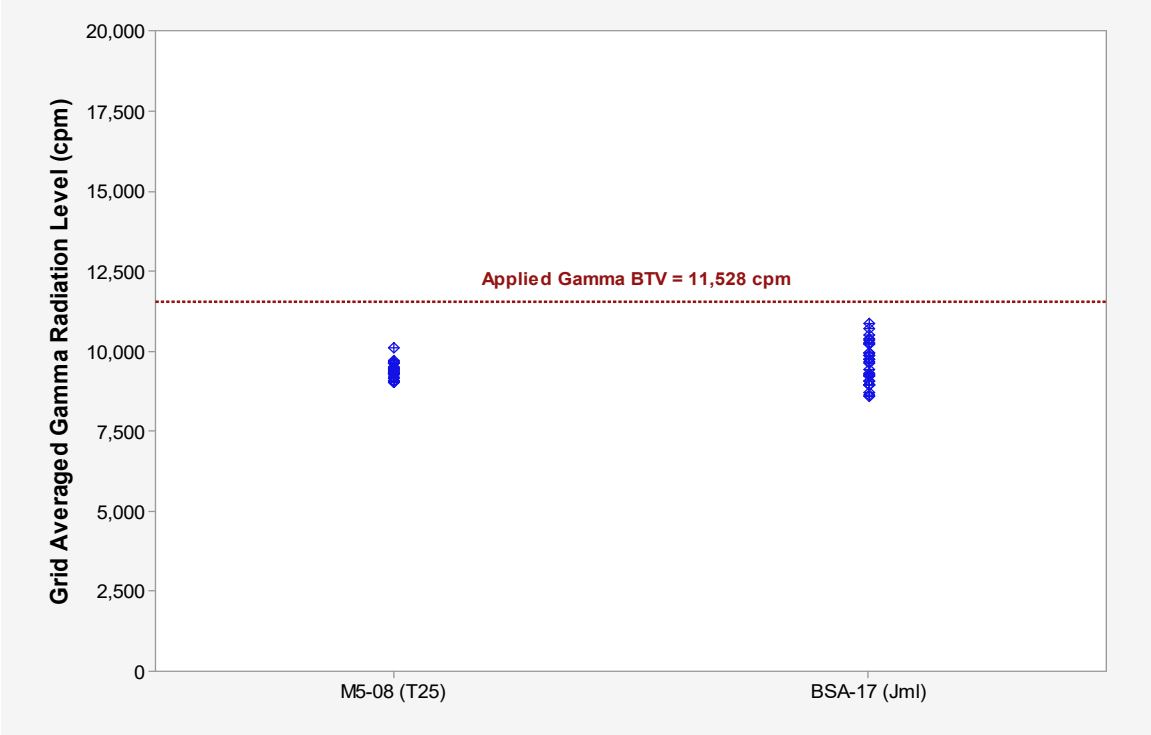


Figure I25-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-08 (T25) and BSA-17 (Jml)

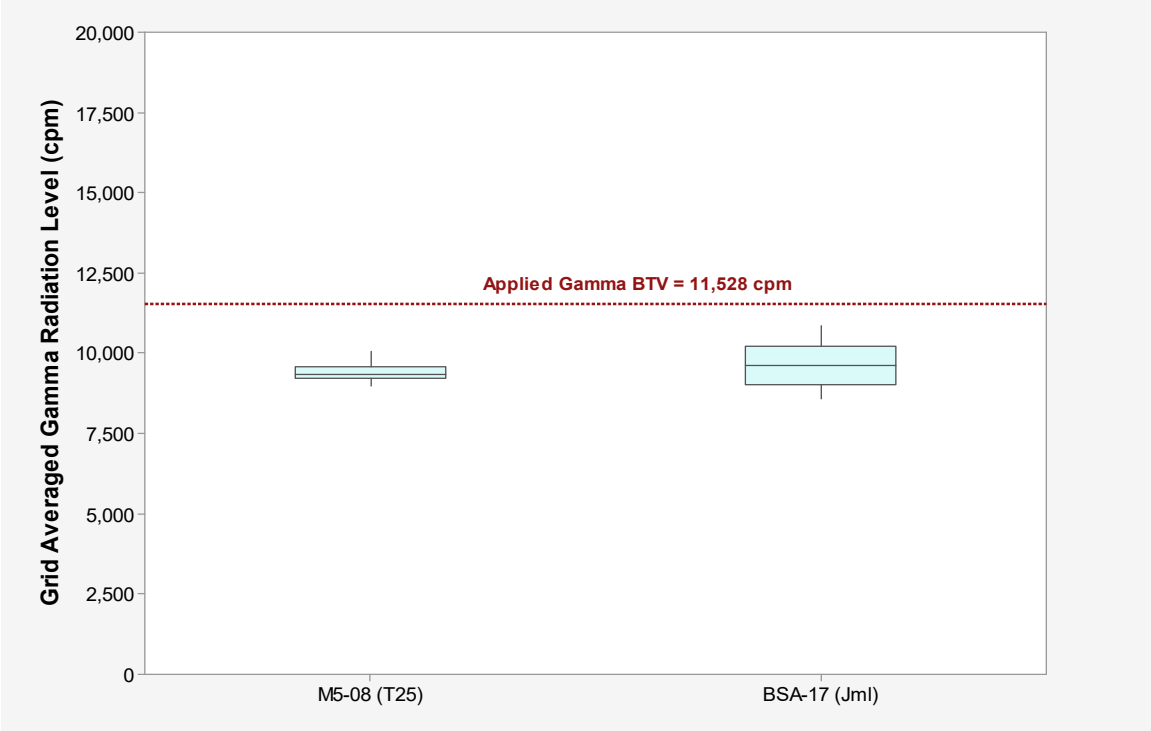
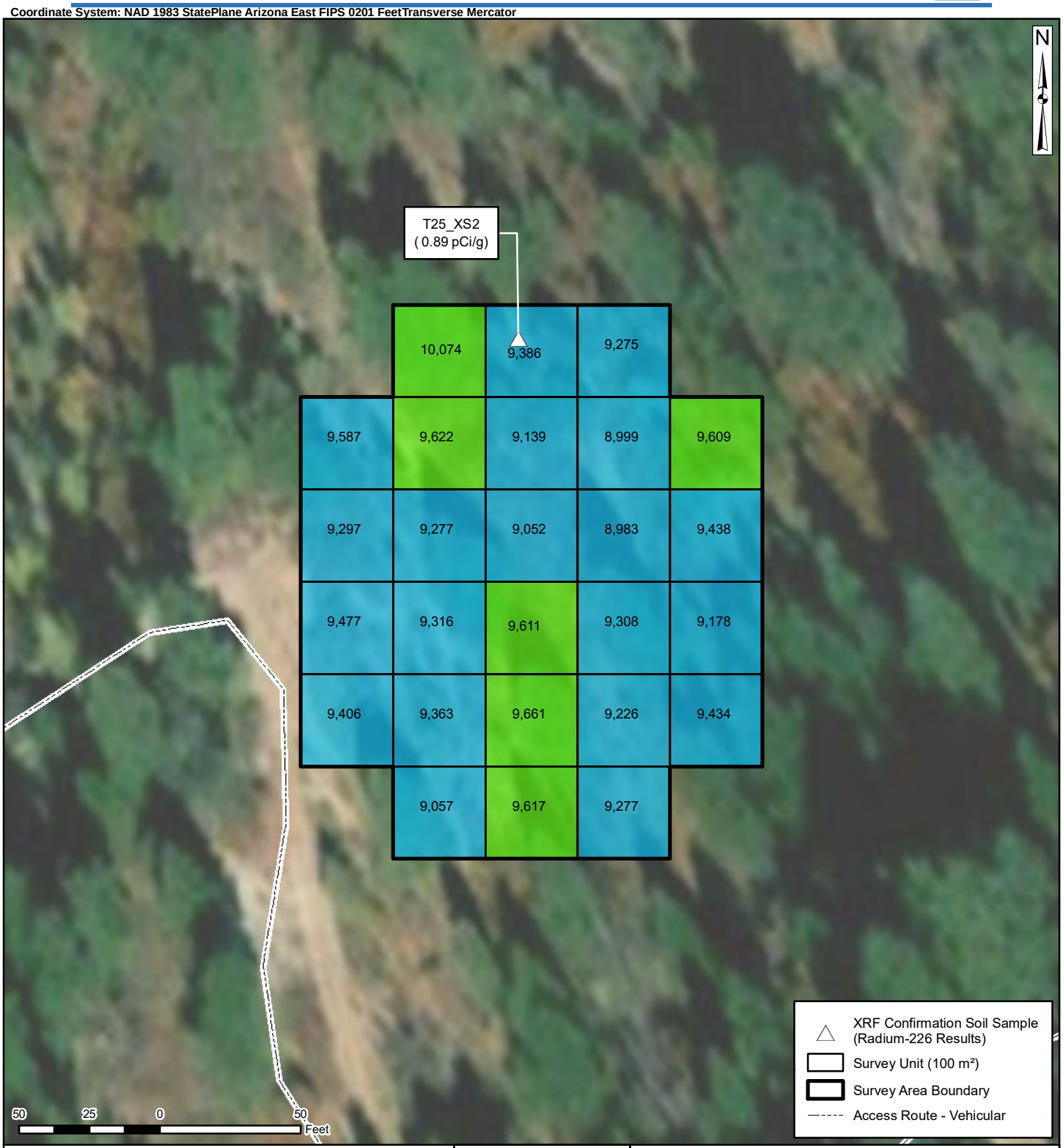


Figure I25-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-08 (T25) and BSA-17 (Jml)



Grid Averaged Gamma Reading (cpm)*

≤ 9,603	≤ Avg. BG
9,603 - 11,528	Avg. BG - 1 x BTV
11,528 - 23,056	1 x BTV - 2 x BTV
23,056 - 34,584	2 x BTV - 3 x BTV
34,584 - 46,112	3 x BTV - 4 x BTV
46,112 - 115,280	4 x BTV - 10 x BTV
≥ 115,280	≥ 10 x BTV

*The applied gamma background threshold value (BTV) for M5-08 (T25) is 11,528 cpm derived from BSA-17 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M5-08 (T25) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I25-11
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

8.7.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T25. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 8.7.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 8.7.6.2.

8.7.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T25: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I25-1 and I25-2. All the results of the XRF confirmation soil samples are presented in Table I25-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T25 following the methods outlined in Section 2.4 and shown in Figure I25-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 26 measurements were collected across 26 survey units from the survey area of Target T25 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I25-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T25 at a depth of 0 to 3 inches bgs. One XRF confirmation soil sample was collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I25-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 8.7.7.

Table I25-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-08 (T25)

Analyte	Units	Applied BTV	T25-XS2-01-060618	
			Result	Q
Survey Unit			X2	
Aluminum	mg/kg	5,900	3,600	
Antimony	mg/kg	0.140	<0.095	U
Arsenic	mg/kg	2.2	2.6	
Barium	mg/kg	270	52	
Beryllium	mg/kg	0.57	0.28	
Cadmium	mg/kg	0.160	0.04	J
Calcium	mg/kg	7,410	4,100	
Chromium	mg/kg	5.2	3.2	
Cobalt	mg/kg	4.4	2.2	
Copper	mg/kg	12	3.2	
Iron	mg/kg	8,897	6,100	
Lead	mg/kg	11	4.3	
Lithium	mg/kg	6.3	3.2	
Magnesium	mg/kg	2,850	1,300	
Manganese	mg/kg	440	260	
Molybdenum	mg/kg	0.29	0.23	
Nickel	mg/kg	6.2	2.4	
Potassium-40	pCi/g	23.3	14.8	
Radium-226	pCi/g	1.40	0.89	LT
Radium-228	pCi/g	0.75	<0.78	UJ
Selenium	mg/kg	0.93	0.67	J
Silver	mg/kg	0.037	0.024	J
Sodium	mg/kg	41	<95	U
Thallium	mg/kg	0.075	0.049	
Thorium	mg/kg	4.7	2.8	
Uranium	mg/kg	0.97	0.85	
Vanadium	mg/kg	12	11	
Zinc	mg/kg	27	11	

Notes:
BTV Background threshold value
J Estimated value
LT Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
mg/kg Milligrams per kilogram
NA Not applicable
NV No Value

Table I25-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-08 (T25)

Summary Statistic	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.2	8,897	11	440	0.29	4.7	0.97	12	27
Measurements	#	26	26	26	26	26	26	26	26	26
Detects	#	1	26	26	26	6	26	15	14	26
Nondetects	#	132	107	107	107	127	107	118	119	107
Minimum	mg/kg	2.0	4,724	3.8	219.2	0.4	1.8	0.1	18.0	11.6
Maximum	mg/kg	2.0	11,212	9.1	625.0	1.7	3.9	1.8	33.6	26.5
Standard Deviation	mg/kg	-	1,441	1.4	87	0.50	0.6	0.5	4	3.7
Average	mg/kg	-	7,153	6.3	345	0.83	2.7	0.7	22.4	17.1
Median	mg/kg	-	6,866	6.1	335	0.65	2.5	0.6	20.4	16.4
Relative Standard Deviation	%	-	20.2	21.4	25.1	59.7	23.0	78.8	20.0	21.8
90th Percentile	mg/kg	-	8,941	8.0	407	1.4	3.6	1.4	28	21
95th Percentile	mg/kg	-	9,223	8.4	500	1.6	3.8	1.6	31	21
99th Percentile	mg/kg	-	10,737	9.0	601	1.7	3.9	1.7	33	25
Measurements Above Applied BTV	#	0	4	0	2	6	0	4	14	0
Measurements Above Applied BTV	%	0.0	15.3	0.0	7.7	23.1	0.0	15.3	53.8	0.0

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.
- No statistical data calculated based on a single detection.
BTV Background threshold value
mg/kg Milligram per kilogram
XRF X-ray fluorescence

8.7.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T25 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T25 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T25. The estimated BTVs are identified in Section 8.7.4 and Table I25-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I25-7 presents a summary of the background comparison for different measurement and soil depths at Target T25. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T25. Further gamma radiation screening indicated that gamma levels at Target T25 are similar to those at the BSA. Therefore, while multiple COPCs have been identified at Target T25 based on a conservative comparison to background, risk screening may be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I25-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-08 (T25)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic	✓		✓
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron		✓	✓
Lead			
Lithium			
Magnesium			
Manganese		✓	✓
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium			
Silver			
Sodium			
Thallium			
Thorium			
Uranium		✓	✓
Vanadium		✓	✓
Zinc			

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

8.7.7 Primary Contaminant Mapping

8.7.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 8.7.6.2 identified the COPCs at Target T25. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 8.7.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I25-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T25 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 8.7.7.1 through Section 8.7.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T25. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

8.7.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I25-7. Arsenic did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for arsenic is 2.2 mg/kg for Target T25 as presented in Section 8.7.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I25-5 and Attachment I3, respectively. Figure I25-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T25 and BSA-17 (Jml) samples. Figure I25-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T25 and BSA-17 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.7.6.1. Arsenic XRF was measured in one surface soil sample at Target T25 at a concentration of 2.0 mg/kg, which is below the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T25 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I25-14. Overall, the arsenic XRF result in surface soils was below the applied BTV. However, one XRF confirmation sample exceeded the applied BTV by a factor of 1.2 and does not appear to be associated with mining-related materials.

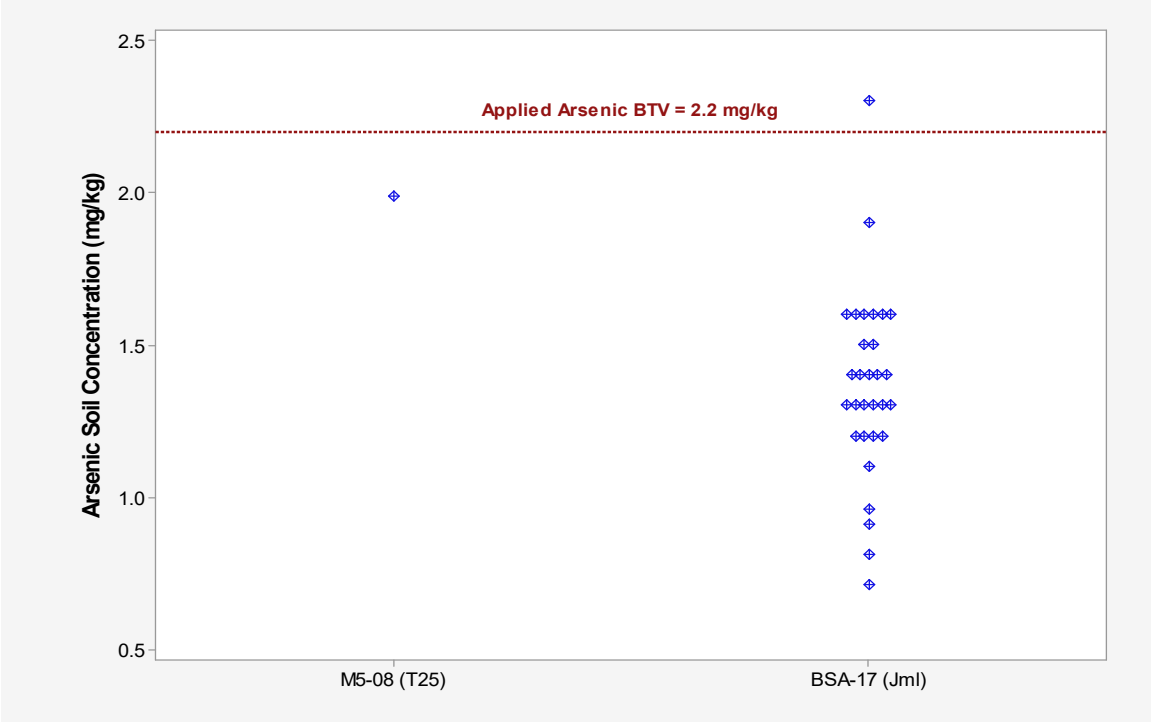


Figure I25-12. Individual Value Plot for Target M5-08 (T25) and BSA-17 (JmI) Arsenic Soil Concentrations

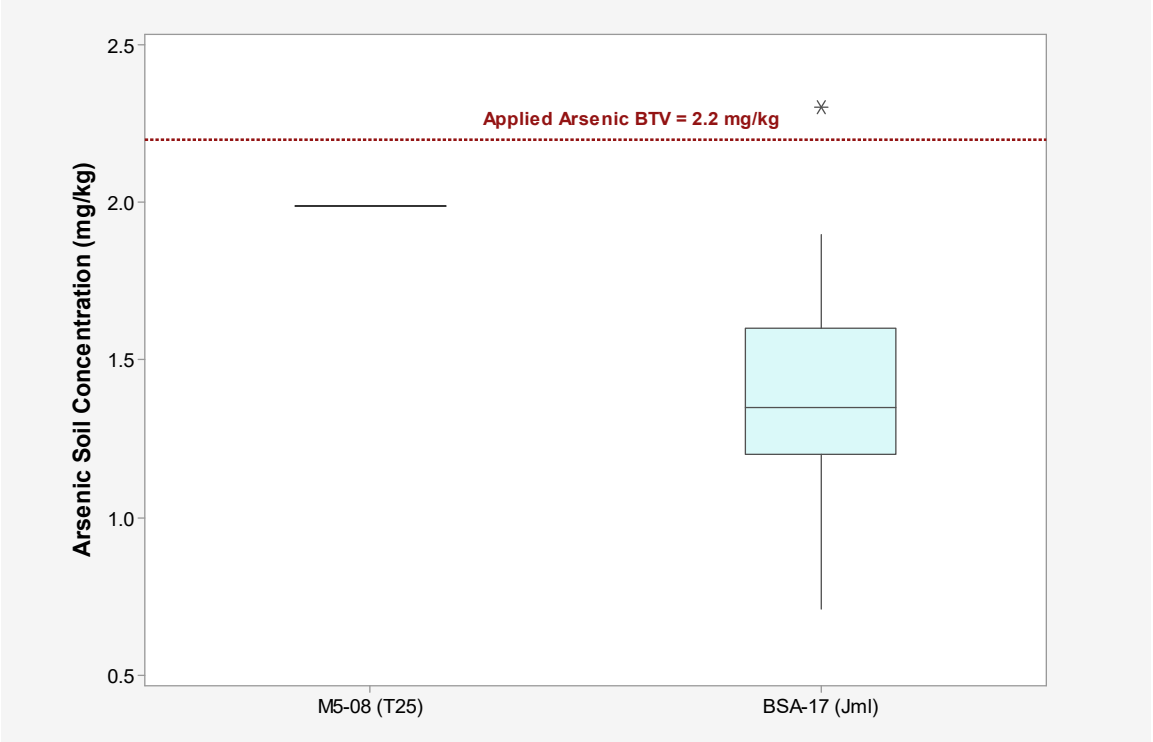


Figure I25-13. Box Plot for Target M5-08 (T25) and BSA-17 (JmI) Arsenic Soil Concentrations

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



Arsenic Concentration Scale (mg/kg)*

- ≤ 1.4
- 1.4 - 2.2
- 2.2 - 4.4
- 4.4 - 6.6
- 6.6 - 8.8
- 8.8 - 22
- ≥ 22
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M5-08 (T25) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I25-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

8.7.7.3 Lead

Lead was not identified as a COPC in surface soil as shown in Table I25-7. Lead did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for lead is 11 mg/kg for Target T25 as presented in Section 8.7.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I25-5 and Attachment I3, respectively. Figure I25-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T25 and Jml regional samples. Figure I25-16 presents a box plot of detectable lead XRF soil concentrations for Target T25 and Jml regional samples. Summary statistics for XRF measurements are provided in Section 8.7.6.1. Lead XRF concentrations measured in surface soils at Target T25 ranged between 3.8 and 9.1 mg/kg with an average and standard deviation of 6.3 mg/kg and 1.4 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T25 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I25-17. All lead results in surface soils were less than the applied BTV.

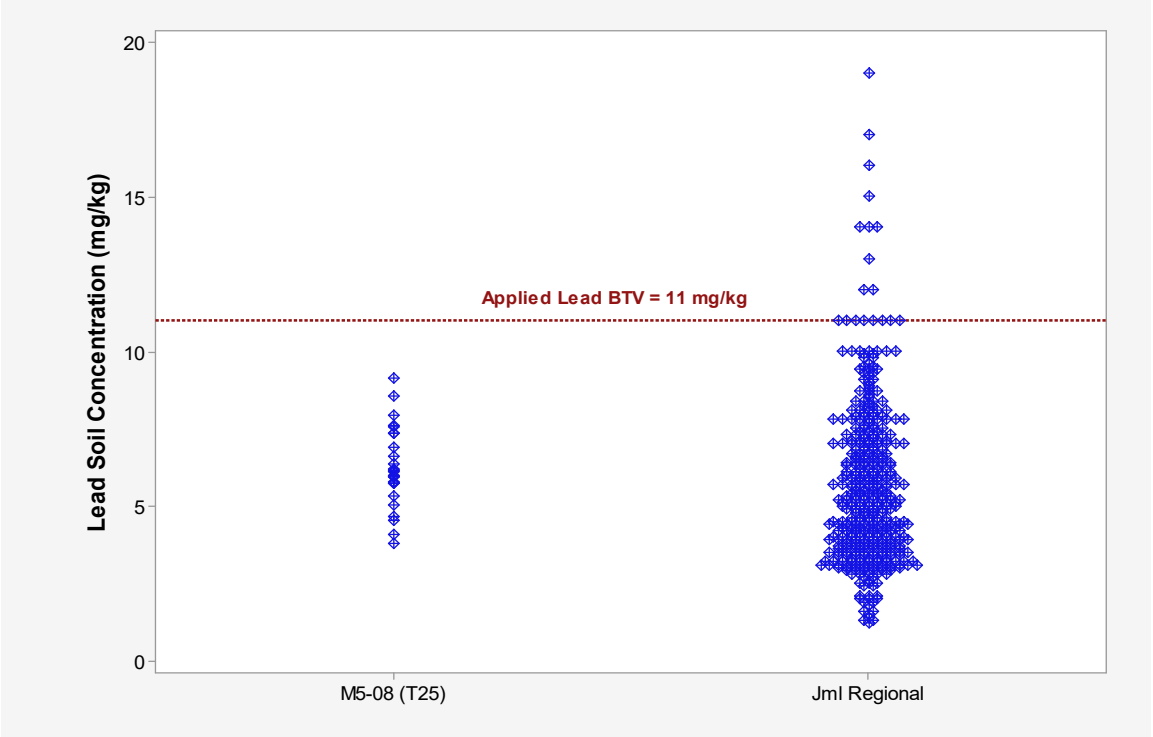


Figure I25-15. Individual Value Plot for Target M5-08 (T25) and Jml Regional Lead Soil Concentrations

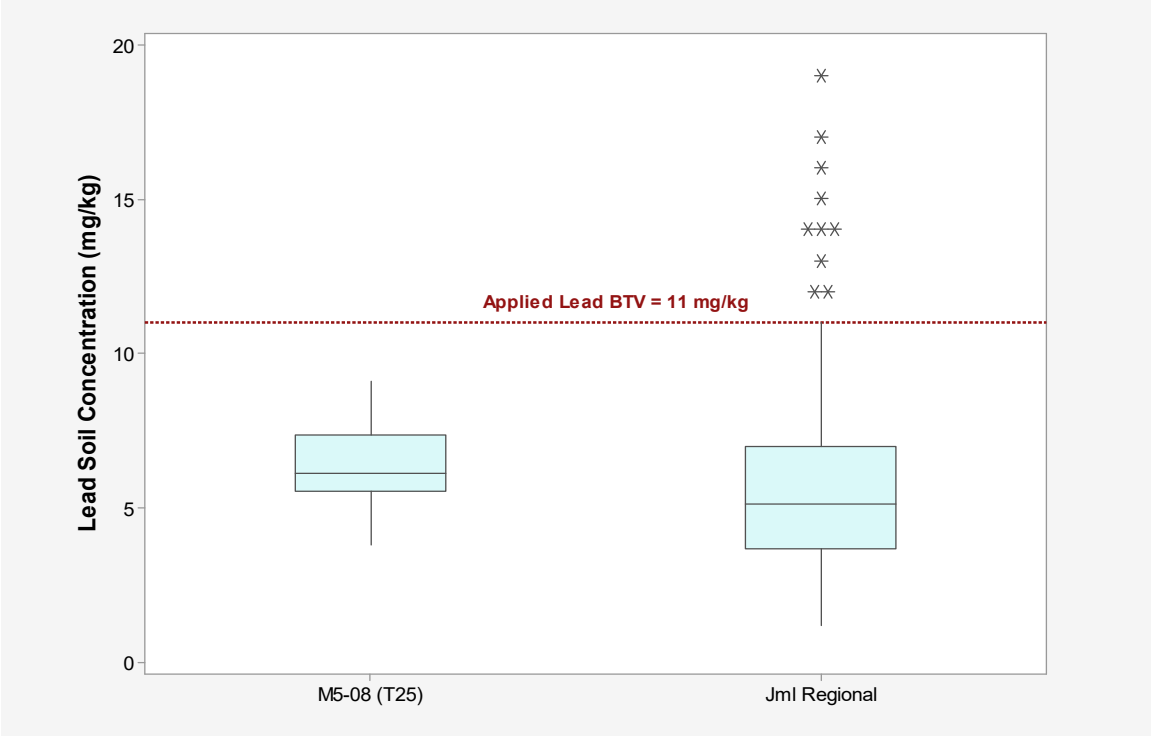
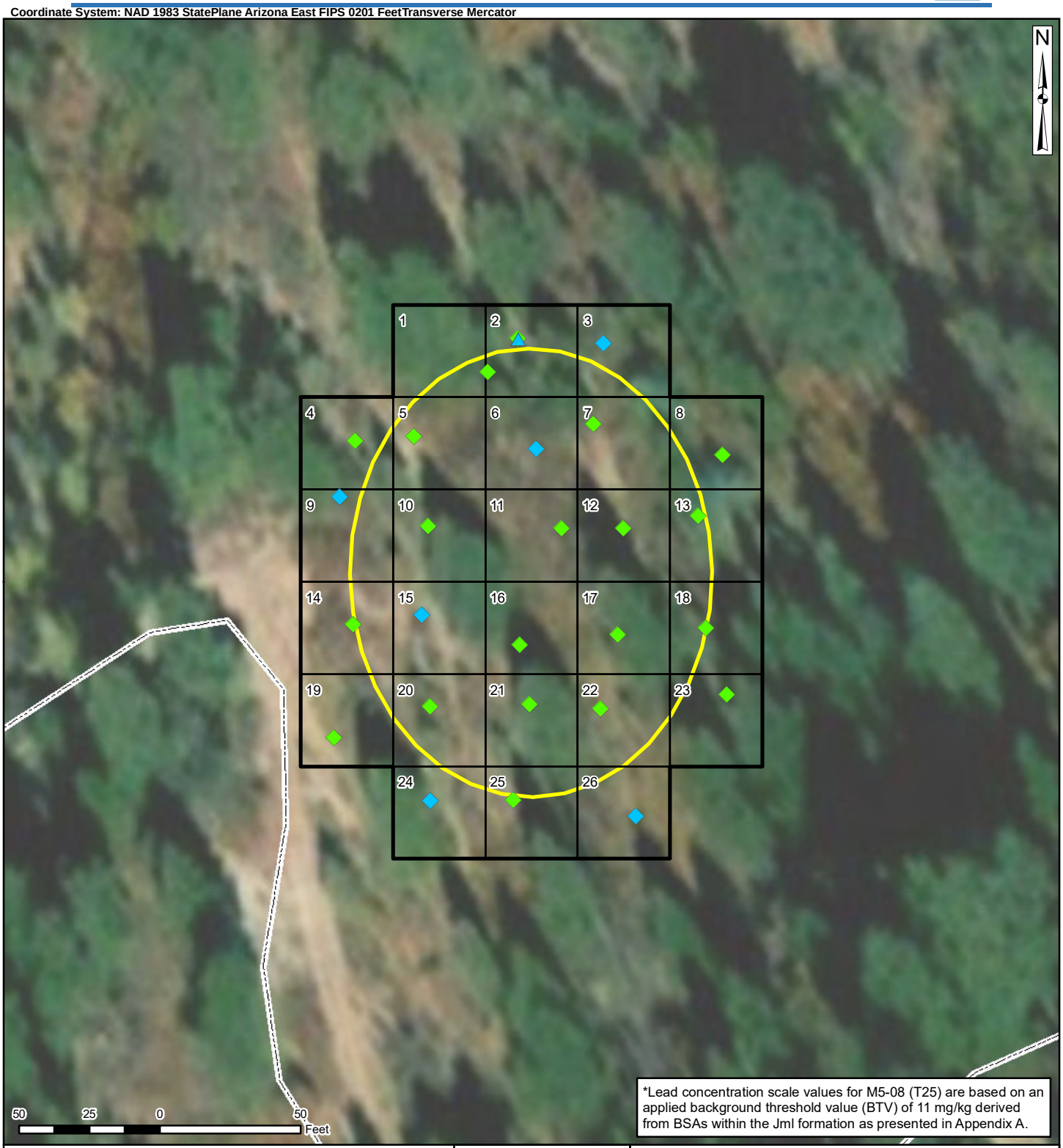


Figure I25-16. Box Plot for Target M5-08 (T25) and Jml Regional Lead Soil Concentrations

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



*Lead concentration scale values for M5-08 (T25) are based on an applied background threshold value (BTV) of 11 mg/kg derived from BSAs within the Jml formation as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 5.6
- 5.6 - 11
- 11 - 22
- 22 - 33
- 33 - 44
- 44 - 110
- ≥ 110

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M5-08 (T25) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I25-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

8.7.7.4 Thorium

Thorium was not identified as a COPC in surface soil as shown in Table I25-7. Thorium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for thorium is 4.7 mg/kg for Target T25 as presented in Section 8.7.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I25-5 and Attachment I3, respectively. Figure I25-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T25 and Jml regional samples. Figure I25-19 presents a box plot of detectable thorium XRF soil concentrations for Target T25 and Jml regional samples. Summary statistics for XRF measurements are provided in Section 8.7.6.1. Thorium XRF concentrations measured in surface soils at Target T25 ranged between 1.8 and 3.9 mg/kg with an average and standard deviation of 2.7 mg/kg and 0.6 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T25 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I25-20. All thorium results in surface soils were less than the applied BTV.

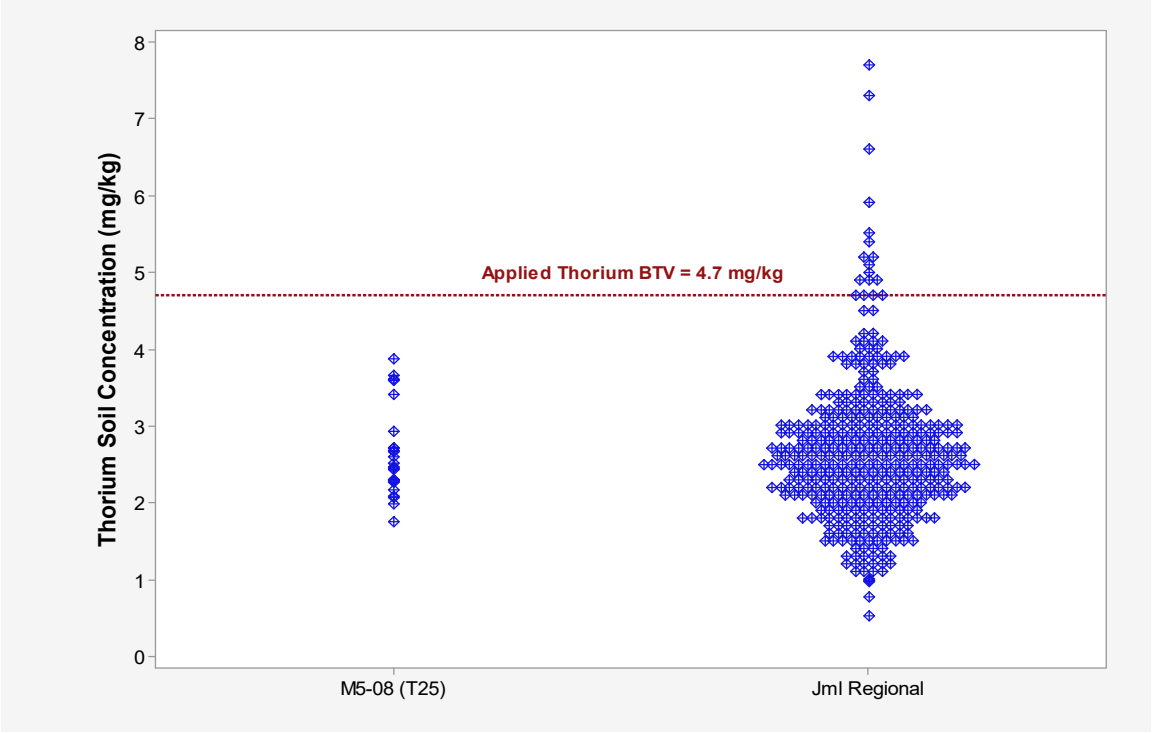


Figure I25-18. Individual Value Plot for Target M5-08 (T25) and Jml Regional Thorium Soil Concentrations

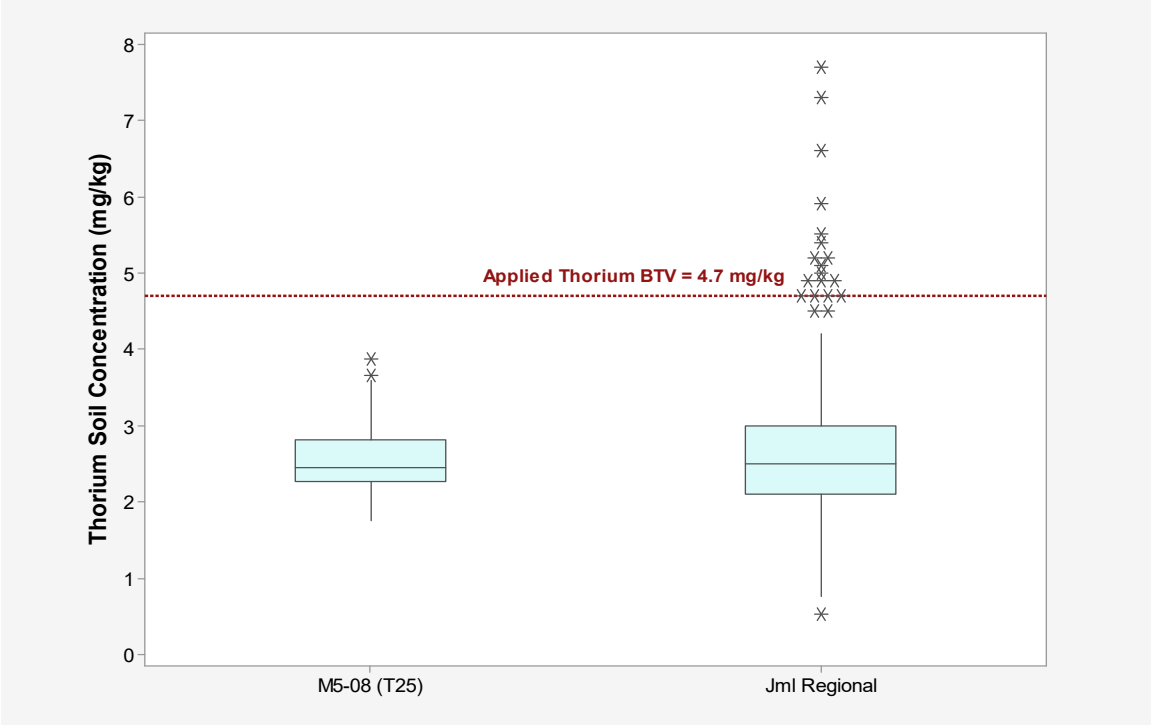
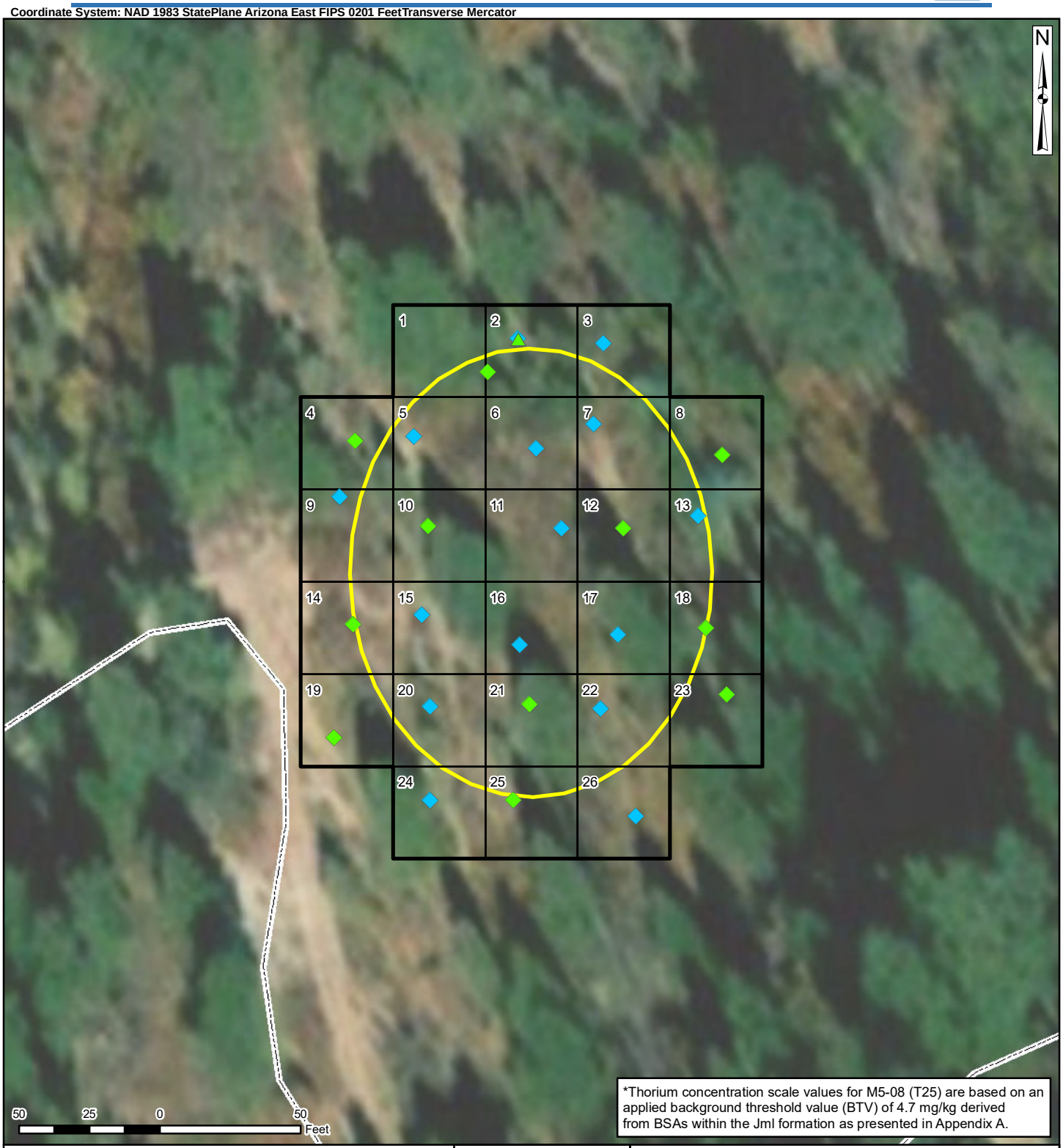


Figure I25-19. Box Plot for Target M5-08 (T25) and Jml Regional Thorium Soil Concentrations



*Thorium concentration scale values for M5-08 (T25) are based on an applied background threshold value (BTV) of 4.7 mg/kg derived from BSAs within the Jml formation as presented in Appendix A.

Thorium Concentration Scale (mg/kg)*

- ≤ 2.6
- 2.6 - 4.7
- 4.7 - 9.4
- 9.4 - 14
- 14 - 19
- 19 - 47
- ≥ 47

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M5-08 (T25) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I25-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

8.7.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I25-7. Uranium exceeded the applied BTV in 15.3 percent of in situ XRF measurements but not in the XRF confirmation sample. The applied BTV for uranium is 0.97 mg/kg for Target T25 as presented in Section 8.7.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I25-5 and Attachment I3, respectively. Figure I25-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T25 and BSA-17 (Jml) samples. Figure I25-22 presents a box plot of detectable uranium XRF soil concentrations for Target T25 and BSA-17 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.7.6.1. Uranium XRF concentrations measured in surface soils at Target T25 ranged between 0.1 and 1.8 mg/kg with an average and standard deviation of 0.7 mg/kg and 0.5 mg/kg, respectively. The average uranium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T25 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I25-23. Overall, the majority of detectable uranium results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials.

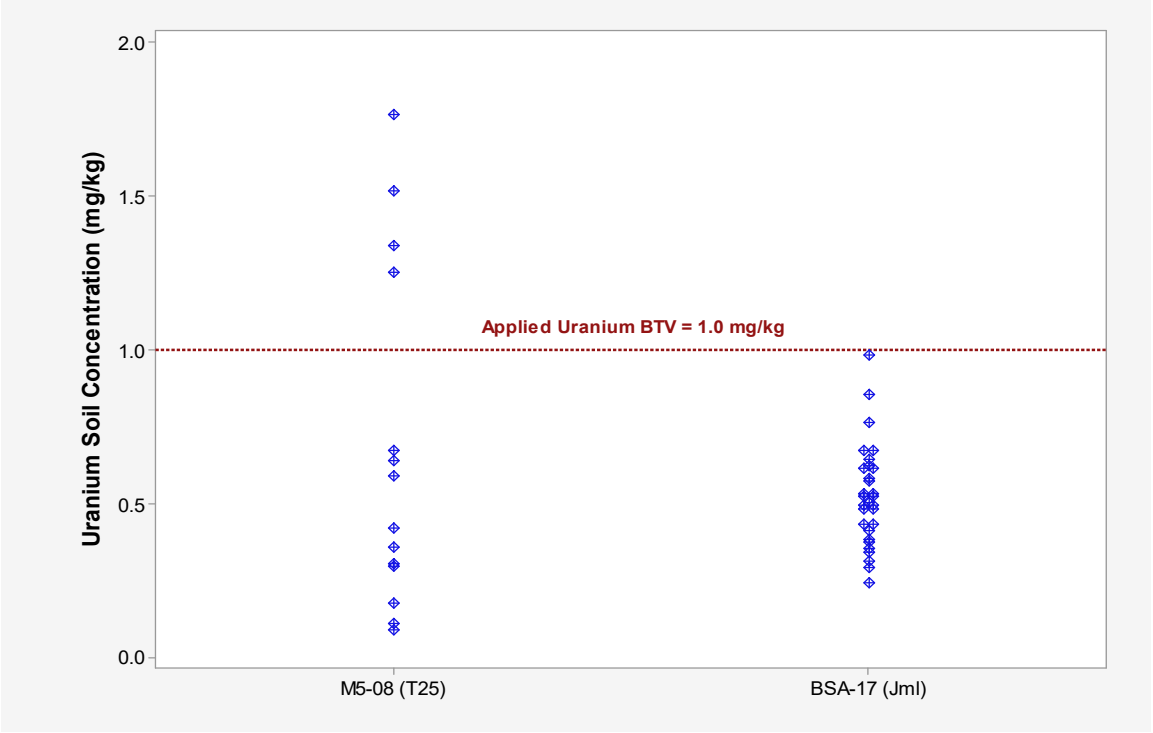


Figure I25-21. Individual Value Plot for Target M5-08 (T25) and BSA-17 (Jml) Uranium Soil Concentrations

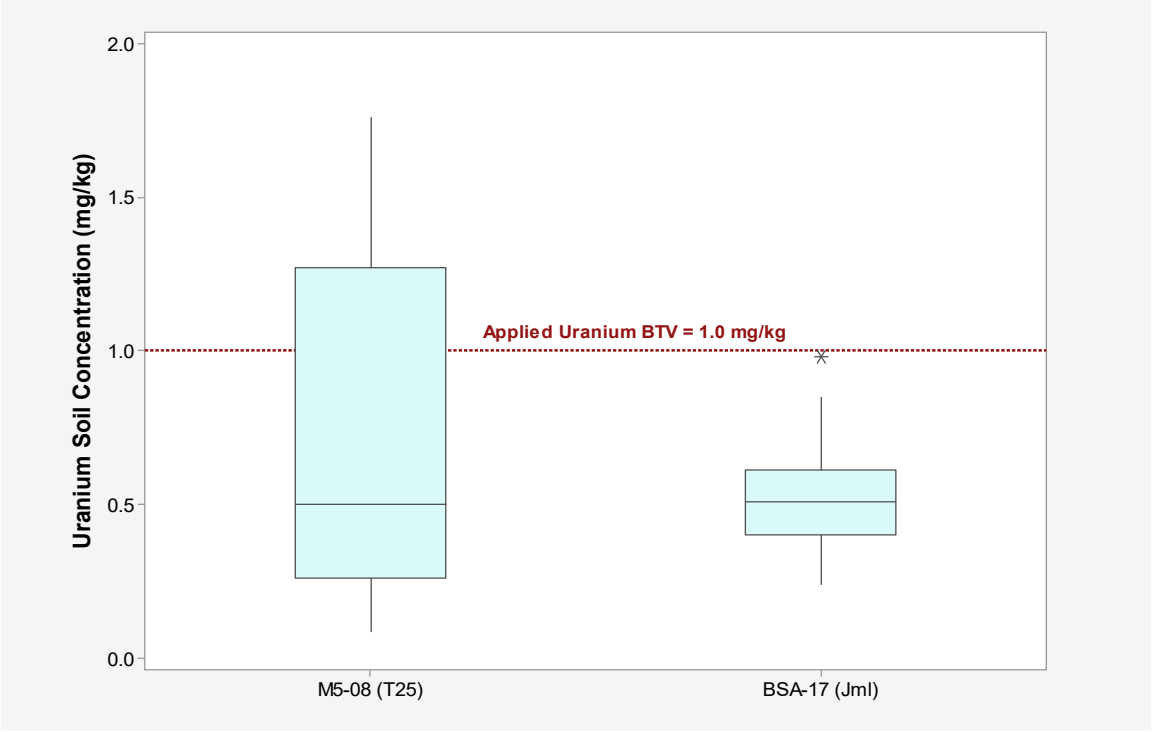
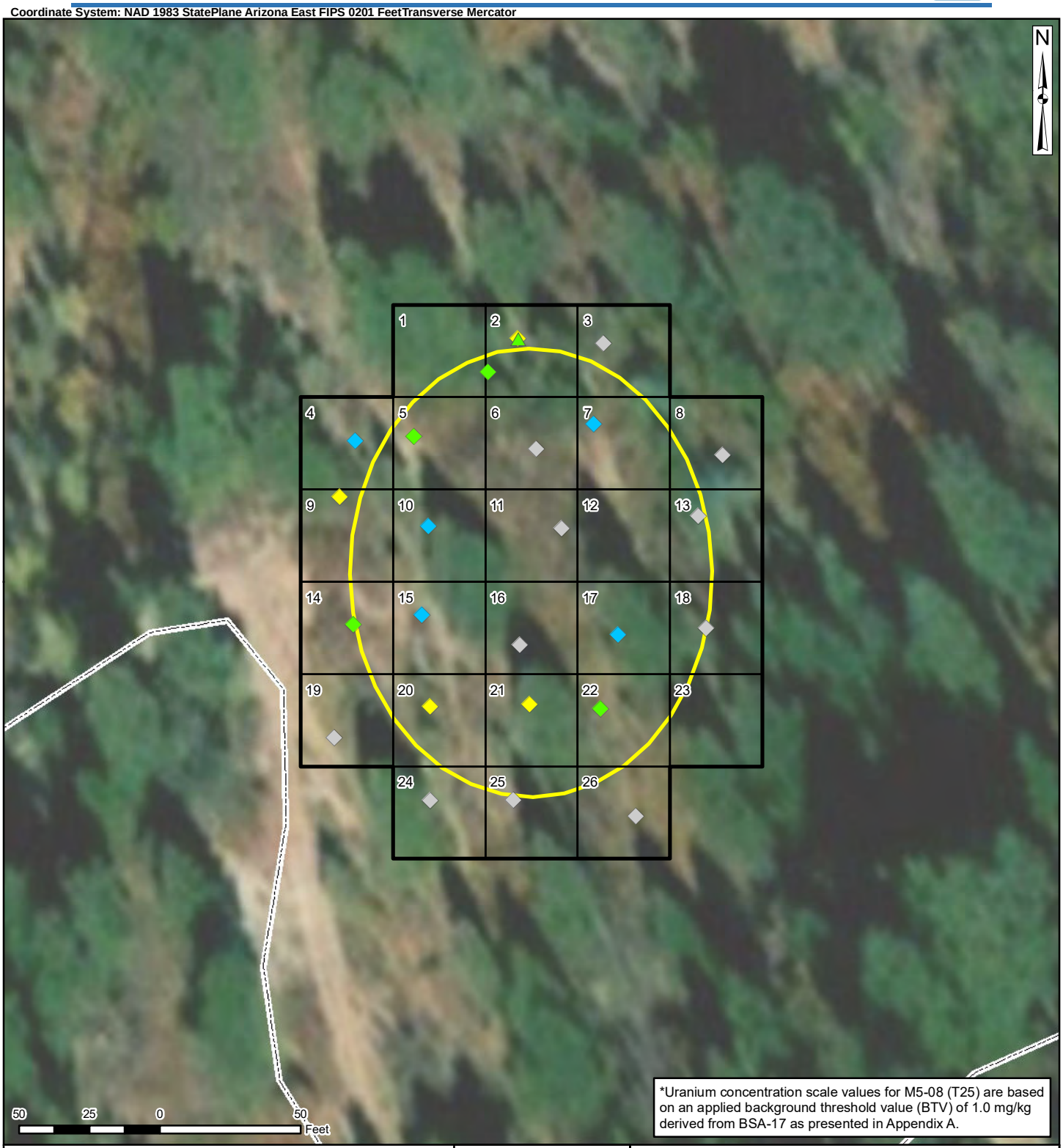


Figure I25-22. Box Plot for Target M5-08 (T25) and BSA-17 (Jml) Uranium Soil Concentrations

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



Uranium Concentration Scale (mg/kg)*

- ≤ 0.52
- 0.52 - 1.0
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- 4.0 - 10
- ≥ 10
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M5-08 (T25) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I25-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

8.7.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I25-7. Vanadium exceeded the applied BTV in 53.8 percent of in situ XRF measurements but not in the XRF confirmation sample. The applied BTV for vanadium is 12 mg/kg for Target T25 as presented in Section 8.7.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I25-5 and Attachment I3, respectively. Figure I25-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T25 and BSA-17 (Jml) samples. Figure I25-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T25 and BSA-17 (Jml) samples. Summary statistics for XRF measurements are provided in Section 8.7.6.1. Vanadium XRF concentrations measured in surface soils at Target T25 ranged between 18 and 33.6 mg/kg with an average and standard deviation of 22.4 mg/kg and 4 mg/kg, respectively. The average XRF vanadium concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T25 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I25-26. Overall, the majority of detectable vanadium results in surface soils were above the applied BTV. However, the maximum XRF value was 2.8 times higher than the applied BTV and does not appear to be associated with mining-related materials.

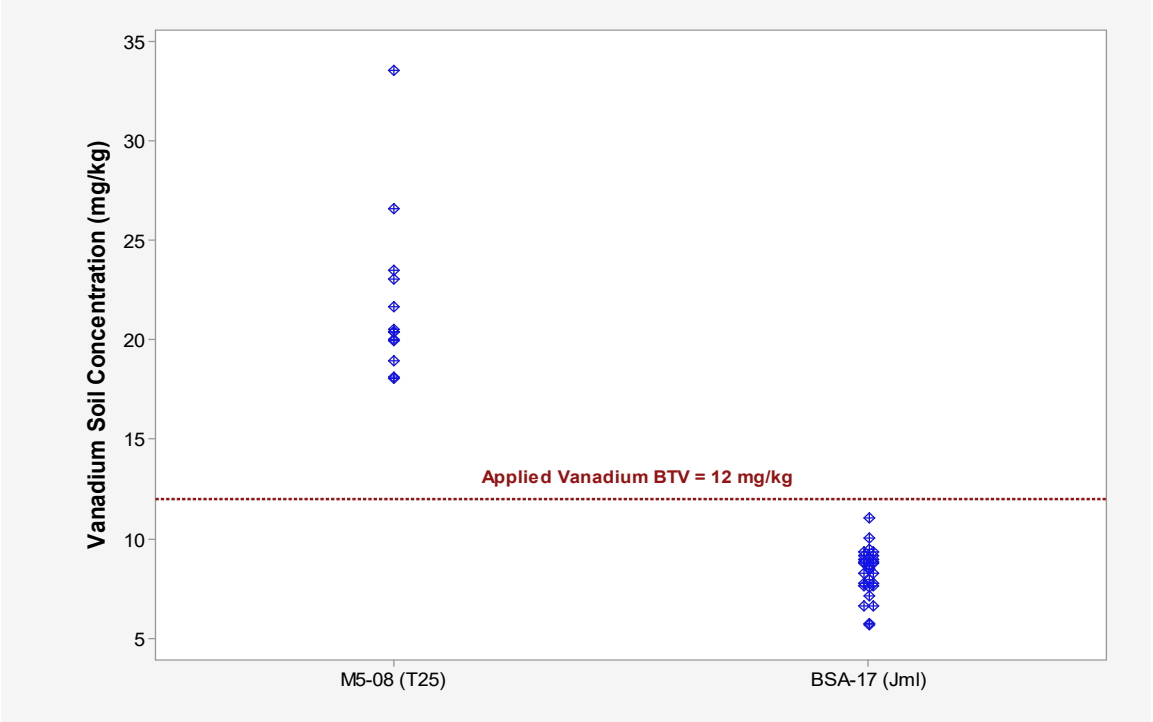


Figure I25-24. Individual Value Plot for Target M5-08 (T25) and BSA-17 (Jml) Vanadium Soil Concentrations

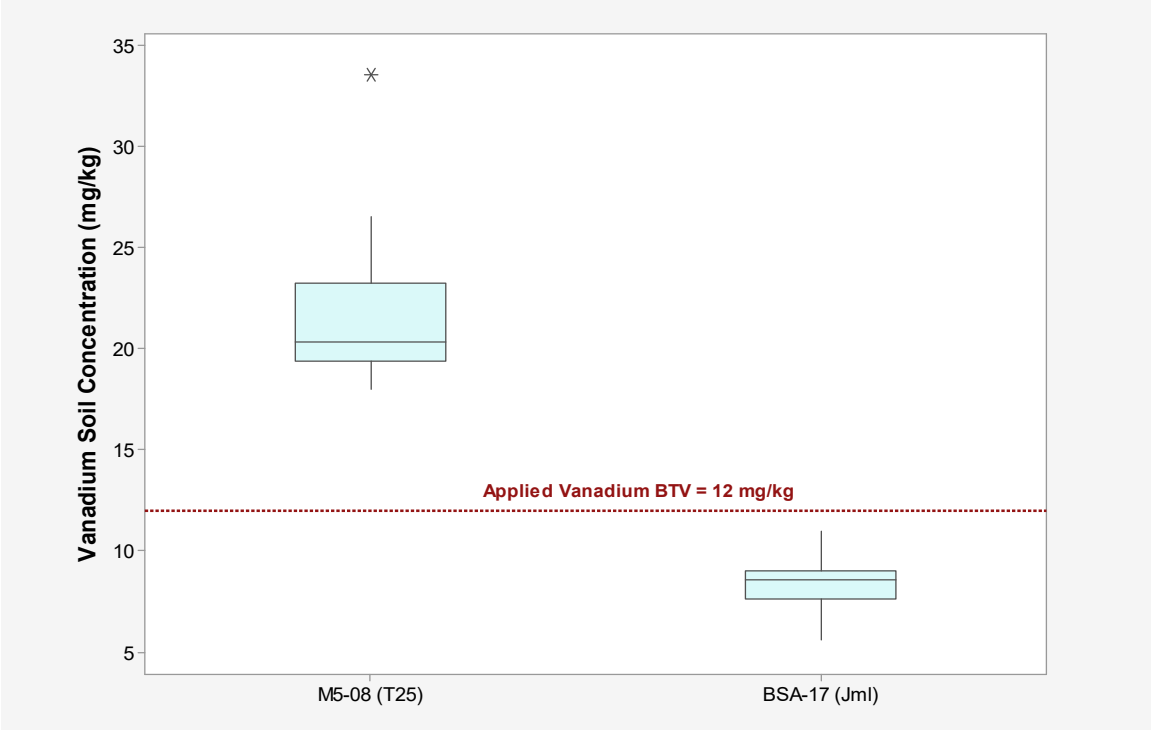


Figure I25-25. Box Plot for Target M5-08 (T25) and BSA-17 (Jml) Vanadium Soil Concentrations

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



*Vanadium concentration scale values for M5-08 (T25) are based on an applied background threshold value (BTV) of 12 mg/kg derived from BSA-17 as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 8.3
- 8.3 - 12
- 12 - 24
- 24 - 36
- 36 - 48
- 48 - 120
- ≥ 120
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M5-08 (T25) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I25-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

8.7.8 Conclusions

Target T25 (M5-08) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T25. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T25 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T25. ASPECT gamma survey results generally did not correlate with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T25 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T25 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. No grid averaged gamma measurements exceeded the applied BTV.
- A total of 25 analytes were identified as occurring within the surface environment. Of these analytes, 6 were identified as COPCs. Only vanadium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T25 does not contain TENORM. No mining-related activities or features were observed in the field, but four historical exploratory borings were identified in the file review. TENORM may be associated with these exploratory borings. Outcropping of Jml was identified below the road. NORM was observed but not verified in the field.
- Natural erosion of outcroppings may have increased the lateral extent of NORM.
- There are no immediate significant physical hazards present at Target T25.
- Access is by dirt road with a small four-wheel-drive vehicle followed by footpath.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No existing groundwater wells are documented within the vicinity of Target T25. No seeps or springs were observed during the RSE investigation.

- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T25. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No mine waste was observed at Target T25; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; however, a few data gaps remain for Target T25. The remaining data gaps include field verification of the reclamation status of the potential historic exploratory borings and field mapping and verification of NORM in outcroppings.

8.8 NON-AUM TARGET T26 (M5-09)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T26 (M5-09).

8.8.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T26 (M5-09) is grouped with non-AUM Target T25 (M5-08). Target T26 is in the Lukachukai Mountains Region in Subarea Group F within the Cove Chapter of the Navajo Nation and accessible by foot from Mesa IV 1/2 Road. Target T26 is identified in the MCAP (Weston 2016), but no known historical information is associated with the Target. No residential structures are near the Target. A Target location and access map for Target T26 is shown in Figure I26-1.

A topographical relief map for non-AUM Target T26 is provided in Figure I26-2. The elevation at Target T26 ranges from 8,030 to 8,110 feet amsl with an average of 8,076 feet amsl. The slope at Target T26 ranges from 11 to 44 percent with an average of 27 percent. Target T26 is located within Tc and Jml, and the soil type for the Target is the Narbona-Zilditloi complex (MUSYM 608) (Figures I-22 and I-23).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T26. Weston did not conduct a background study for Target T26. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 25, of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T26:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T26 is accessed by taking Indian Route 33 to Mesa IV 1/2 Road and then hiking 0.4 mile off-trail to the northeast.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  The geology of the northeast portion of the Target, Jml, contains NORM. Observations of NORM were not recorded by personnel. TENORM may be associated with exploratory borings.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  No drainages were located on or adjacent to the Target. The Target is 0.25 mile upslope from the Cove Wash North drainage, which is evaluated in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

Two exploratory borings were identified at the Target in a file review; one at the southeastern corner and the other approximately 70 feet from the northwestern corner. No historic haul roads were identified at the Target.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  Two pipes were observed in the southeast portion of the Target. Two historic exploratory borings were identified on the Target in a file review. Other historic exploratory borings were identified in a file review to the east and in close proximity to the Target. The Target partially overlies Jml, which contains NORM.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T26 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Sections 2.3 and 8.8.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 8.8.3 with results presented in Sections 8.8.6 and 8.8.7)
- Collecting surface soil samples to 3 inches (described in Section 8.8.3 with results presented in Section 8.8.6)
- Conducting a gamma radiation survey (results presented in Section 8.8.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



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

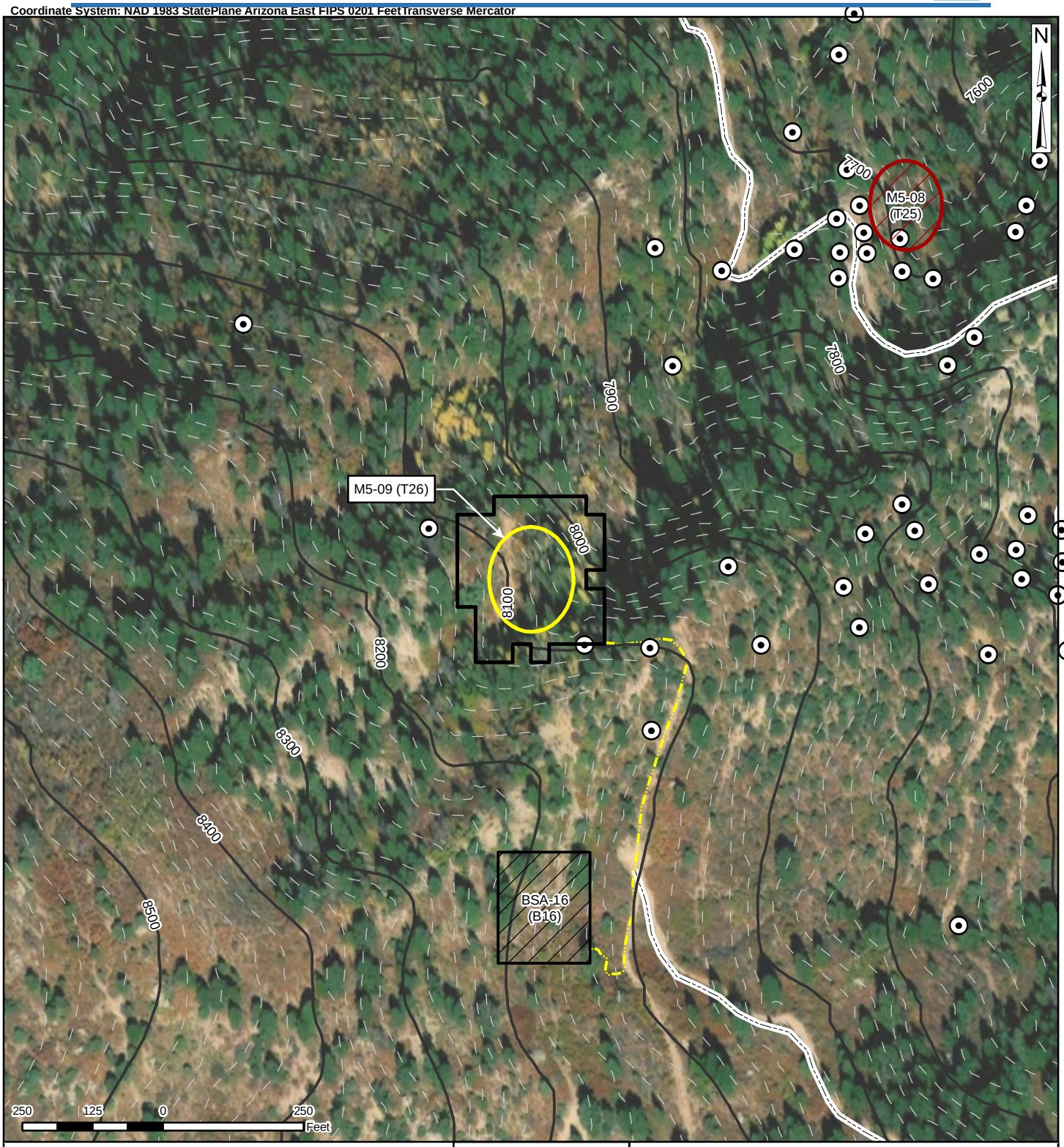
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NON-AUM TARGET M5-09 (T26) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I26-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Background Location
Exploratory Bore Hole
Access Route - Foot
Access Route - Vehicular
100 ft Contour*
20 ft Contour*

* 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.

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NON-AUM TARGET M5-09 (T26) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I26-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/18/2019	

8.8.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I26-3) within the survey area of the non-AUM Target T26 as part of the Baseline Study in June 2018. Additional Goback gamma radiation surveys were performed in September 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T26 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I26-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 25, of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at 23 survey units. All gamma survey and XRF survey units were evaluated.

8.8.3 XRF Confirmation Sampling Overview

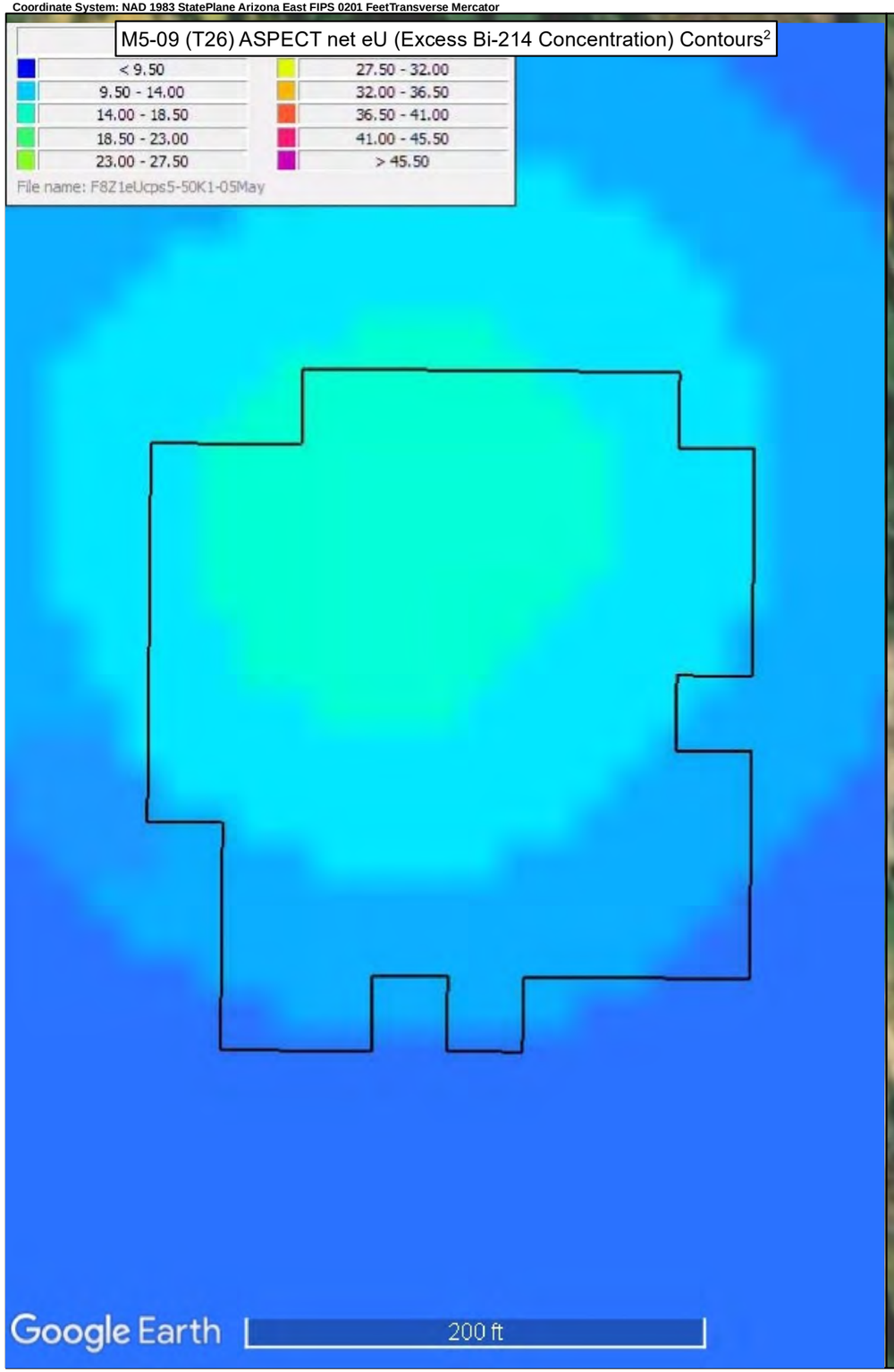
Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T26. Four XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from four locations (Table I26-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I26-4 and I26-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I26-2. The results of XRF confirmation sample analysis are provided in Section 8.8.6.1. Correlated XRF field measurements are provided in Attachment I3.

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

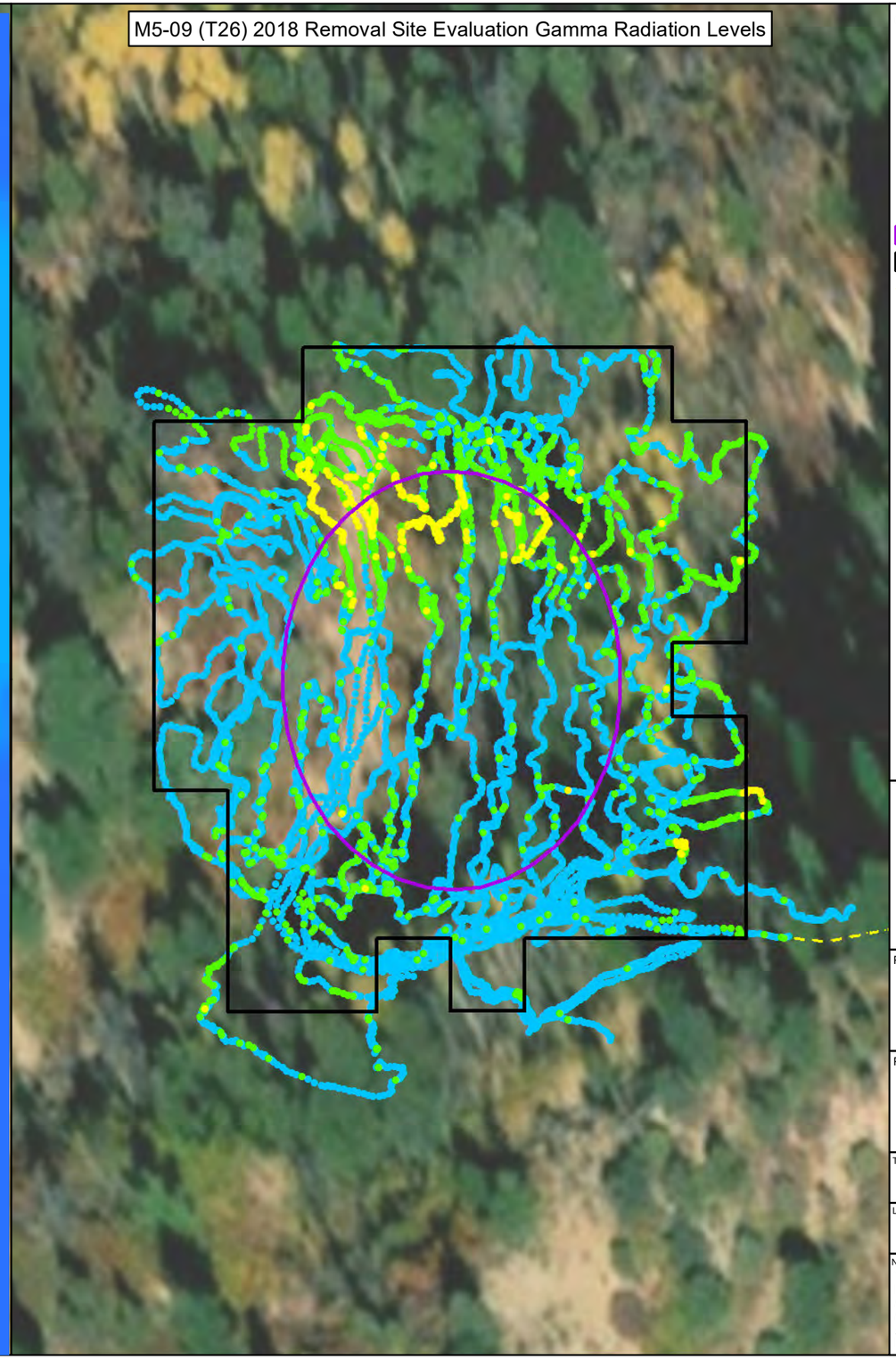
M5-09 (T26) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F8Z1eUcps5-50K1-05May



M5-09 (T26) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)[1]

≤ 10,383	≤ Avg. BG
10,383 - 12,473	Avg. BG - 1 x BTV
12,473 - 24,946	1 x BTV - 2 x BTV
24,946 - 37,419	2 x BTV - 3 x BTV
37,419 - 49,892	3 x BTV - 4 x BTV
49,892 - 124,730	4 x BTV - 10 x BTV
≥ 124,730	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Foot

[1]The applied gamma background threshold value (BTV) for M5-09 (T26) Non-AUM Target is 12,473 cpm derived from BSA-16 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET M5-09 (T26) 2018 REMOVAL SITE EVALUATION AND ASPECT GAMMA RADIATION LEVELS SURVEY MAP

Prepared For:

Prepared By:

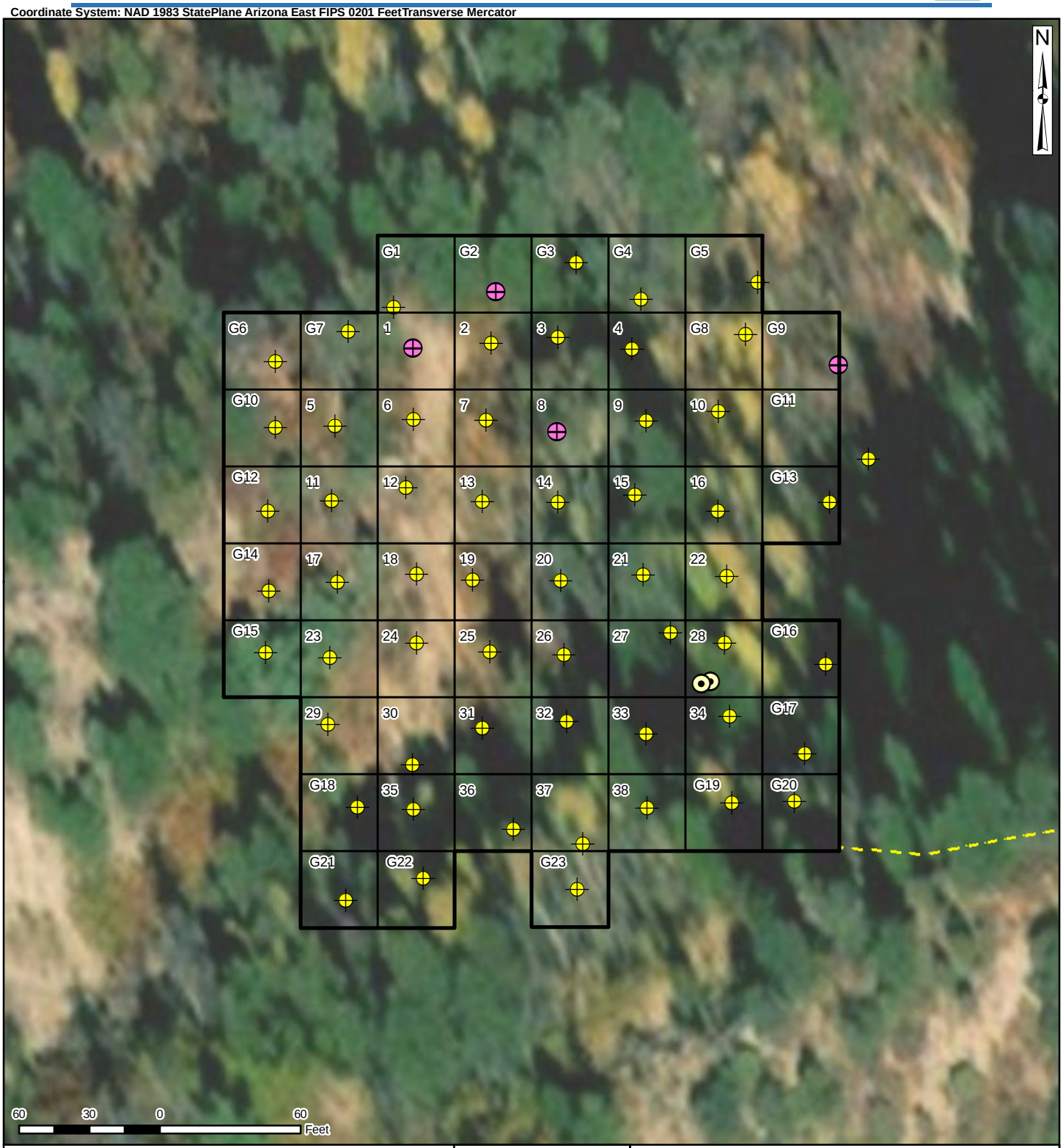
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TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/15/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborne Spectral Photometric Environmental Collection Technology.

Figure No.: **I26-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Pipe - Field Mapped

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Foot

Prepared for: USEPA Region 9

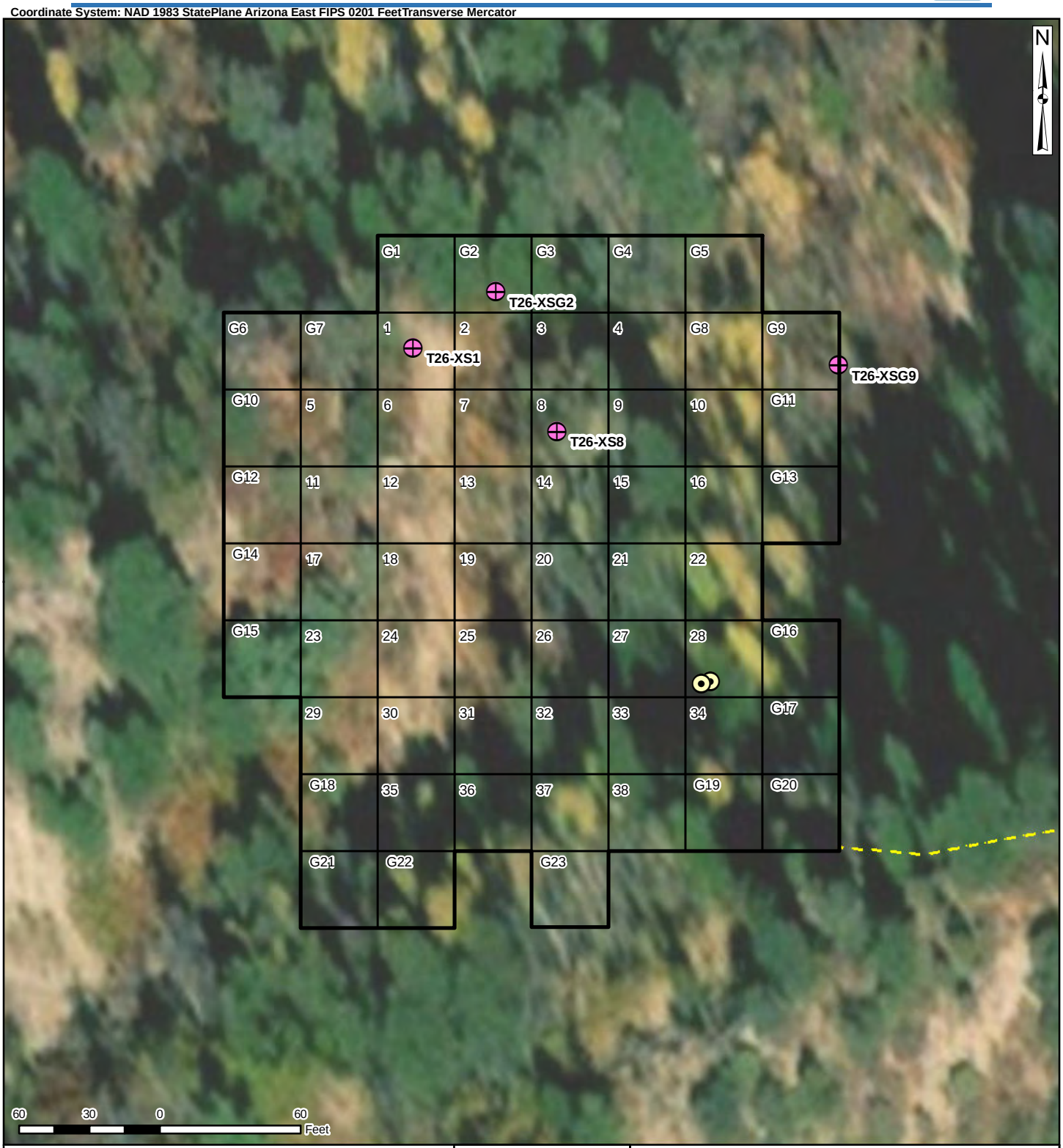
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NON-AUM TARGET M5-09 (T26) XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I26-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

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



XRF Confirmation Soil Sample*
(0 - 3 inches bgs)

Pipe - Field Mapped

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Foot

*T26-XSG2 = site T26 XRF confirmation soil sample collected at survey unit G2. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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Prepared By:

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NON-AUM TARGET M5-09 (T26)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I26-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

Table I26-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-09 (T26)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T26-XS1-01-061018	1	0-3	XRF Confirmation	Primary	6/10/2018	36.5389360	-109.2643171	1806226-8, 1806233-8
T26-XS8-01-061018	8	0-3	XRF Confirmation	Primary	6/10/2018	36.5388366	-109.2641091	1806226-9, 1806233-9
T26-XSG2-01-091518	G2	0-3	XRF Confirmation	Primary	9/15/2018	36.5390010	-109.2641958	1809475-43, 1809476-43
T26-XSG9-01-091518	G9	0-3	XRF Confirmation	Primary	9/15/2018	36.5389112	-109.2636999	1809475-44, 1809476-44

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I26-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-09 (T26)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

8.8.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 8.8.1, Target T26 surface geology is within both Tc and Jml with soils within the Narbona-Zilditloi complex (MUSYM 608) (Figures I-22 and I-23). As a result, Background Study Area 16 (BSA-16) was selected for that combination of geology and soil type. Table I26-3 presents the Target-specific BTVs for 29 analytes and gamma radiation levels for Target T26. No regional BTVs were established for Target T26. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T26. The "Applied BTV" for each analyte is the Target-specific BTV.

Table I26-3. Applied Background Threshold Values for Non-AUM Target M5-09 (T26)

Analyte	Units	Site-Specific BTV (BSA-16)	Regional BTV (Tc)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	3,930	None	3,930	Site-Specific BTV
Antimony	mg/kg	0.130	None	0.130	Site-Specific BTV
Arsenic	mg/kg	2.3	None	2.3	Site-Specific BTV
Barium	mg/kg	129	None	129	Site-Specific BTV
Beryllium	mg/kg	0.27	None	0.27	Site-Specific BTV
Cadmium	mg/kg	0.137	None	0.137	Site-Specific BTV
Calcium	mg/kg	7,800	None	7,800	Site-Specific BTV
Chromium	mg/kg	5.2	None	5.2	Site-Specific BTV
Cobalt	mg/kg	2.5	None	2.5	Site-Specific BTV
Copper	mg/kg	5.6	None	5.6	Site-Specific BTV
Iron	mg/kg	5,130	None	5,130	Site-Specific BTV
Lead	mg/kg	8.6	None	8.6	Site-Specific BTV
Lithium	mg/kg	4.5	None	4.5	Site-Specific BTV
Magnesium	mg/kg	1,630	None	1,630	Site-Specific BTV
Manganese	mg/kg	421	None	421	Site-Specific BTV
Mercury	mg/kg	0.0321	None	0.0321	Site-Specific BTV
Molybdenum	mg/kg	0.26	None	0.26	Site-Specific BTV
Nickel	mg/kg	4.2	None	4.2	Site-Specific BTV
Potassium-40	pCi/g	18.8	None	18.8	Site-Specific BTV
Radium-226	pCi/g	1.42	None	1.42	Site-Specific BTV
Radium-228	pCi/g	0.62	None	0.62	Site-Specific BTV
Selenium	mg/kg	0.64	None	0.64	Site-Specific BTV
Silver	mg/kg	0.016	None	0.016	Site-Specific BTV
Sodium	mg/kg	22.0	None	22.0	Site-Specific BTV
Thallium	mg/kg	0.054	None	0.054	Site-Specific BTV
Thorium	mg/kg	7.7	None	7.7	Site-Specific BTV
Uranium	mg/kg	0.87	None	0.87	Site-Specific BTV
Vanadium	mg/kg	8.6	None	8.6	Site-Specific BTV
Zinc	mg/kg	22	None	22	Site-Specific BTV
Gamma Radiation	cpm	12,473	None	12,473	Site-Specific BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
mg/kg milligrams per kilogram
pCi/g picocuries per gram
Tc Chuska Sandstone

8.8.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T26 and the raw gamma radiation and grid averaged gamma radiation survey results.

8.8.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T26 in June 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in September 2018 to collect data within the Goback survey units. The applied gamma BTV for non-AUM Target T26 is 12,473 cpm. A total of 11,558 measurements were collected as part of the gamma radiation survey at non-AUM Target T26 across 61 survey units. Because of the steep topography and thick vegetation, not all survey units were scanned at 100 percent density. An average scan density of 189 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I26-4.

Table I26-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-09 (T26)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	12,473	
Measurements	#	11,558	61
Minimum	cpm	6,204	8,226
Maximum	cpm	17,279	12,513
Average	cpm	9,503	9,585
Median	cpm	9,326	9,304
Standard Deviation	cpm	1,283	884
90th Percentile	cpm	11,133	10,592
95th Percentile	cpm	11,911	11,340
99th Percentile	cpm	13,497	11,958
Measurements per Survey Unit	#/grid	189	
Measurements Above Gamma BTV	#	331	1
Measurements Above Gamma BTV	%	2.9	1.6

Notes:
BTV background threshold value
cpm counts per minute

8.8.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 2.9 percent of the measurements within the Target boundaries, in some cases exceeding greater than 1.3 times the applied gamma BTV (12,473 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-16 (Tc) gamma survey results is provided on Figure I26-6. This graph shows that the spread of radiation data at Target T26 (shown on left) begins within the lower range of BSA-16 (Tc) gamma levels (shown on right) and then rises to the top range of the background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T26 is about the same as the data cloud from the BSA-16 (Tc) data set. A box plot showing the quartiles of the data sets is provided in Figure I26-7. The box plot shows that the median of Target T26 radiation levels is lower than the median of the BSA-16 (Tc) data set and lower than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I26-8. No mining activity was observed within the survey area of Target T26. However, there were a few distinct elevated areas of gamma activity located in the northern portion of the survey area. No Target features were noted, but the area does correlate with a change in geology from the Tc to the Jml. There was no correlation with pipes mapped in the southeast corner of the survey area (Figure I26-11) or with historic exploratory borings to the northwest and southeast (Figure I26-2). In general, Target T26 has surficial gamma radiation levels below BSA-16 (Tc) levels across the majority of the Target except for the northern portion of the survey area, which correlates with elevated gamma activity identified by the ASPECT gamma survey (Figure I26-3). No TENORM or mining-related activities were observed. Section 8.8.5.3 presents the grid averaged results of the gamma radiation survey.

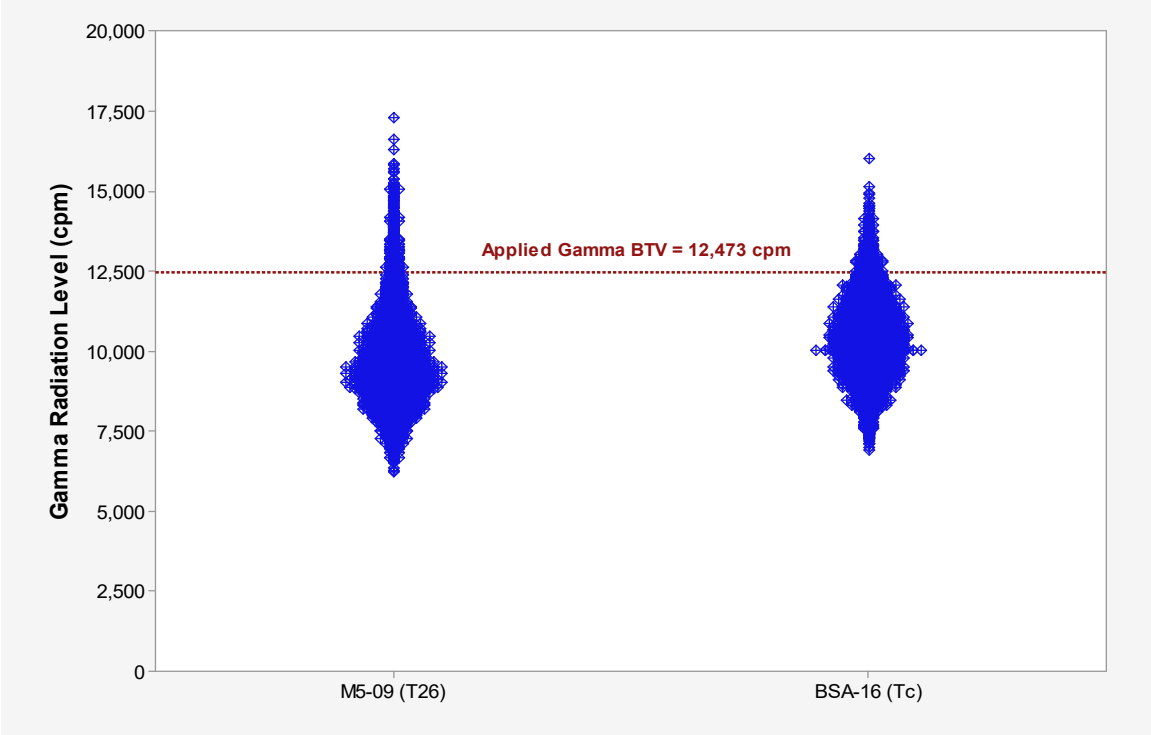


Figure I26-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M5-09 (T26) and BSA-16 (Tc)

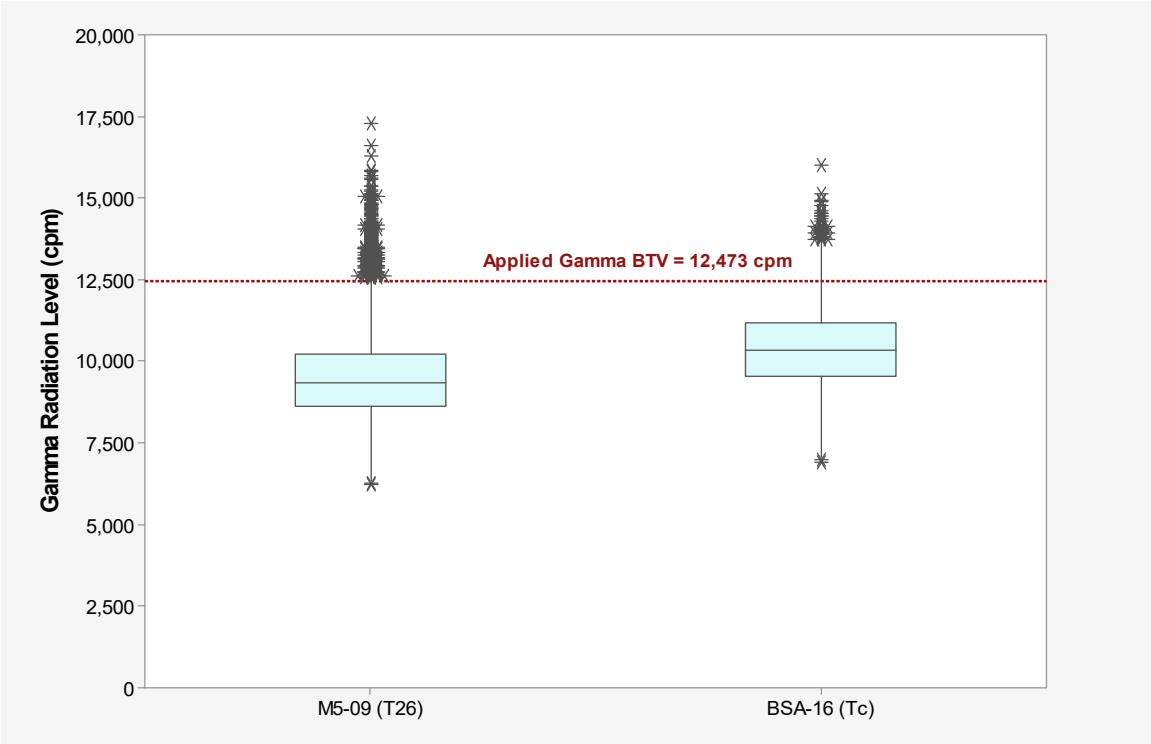
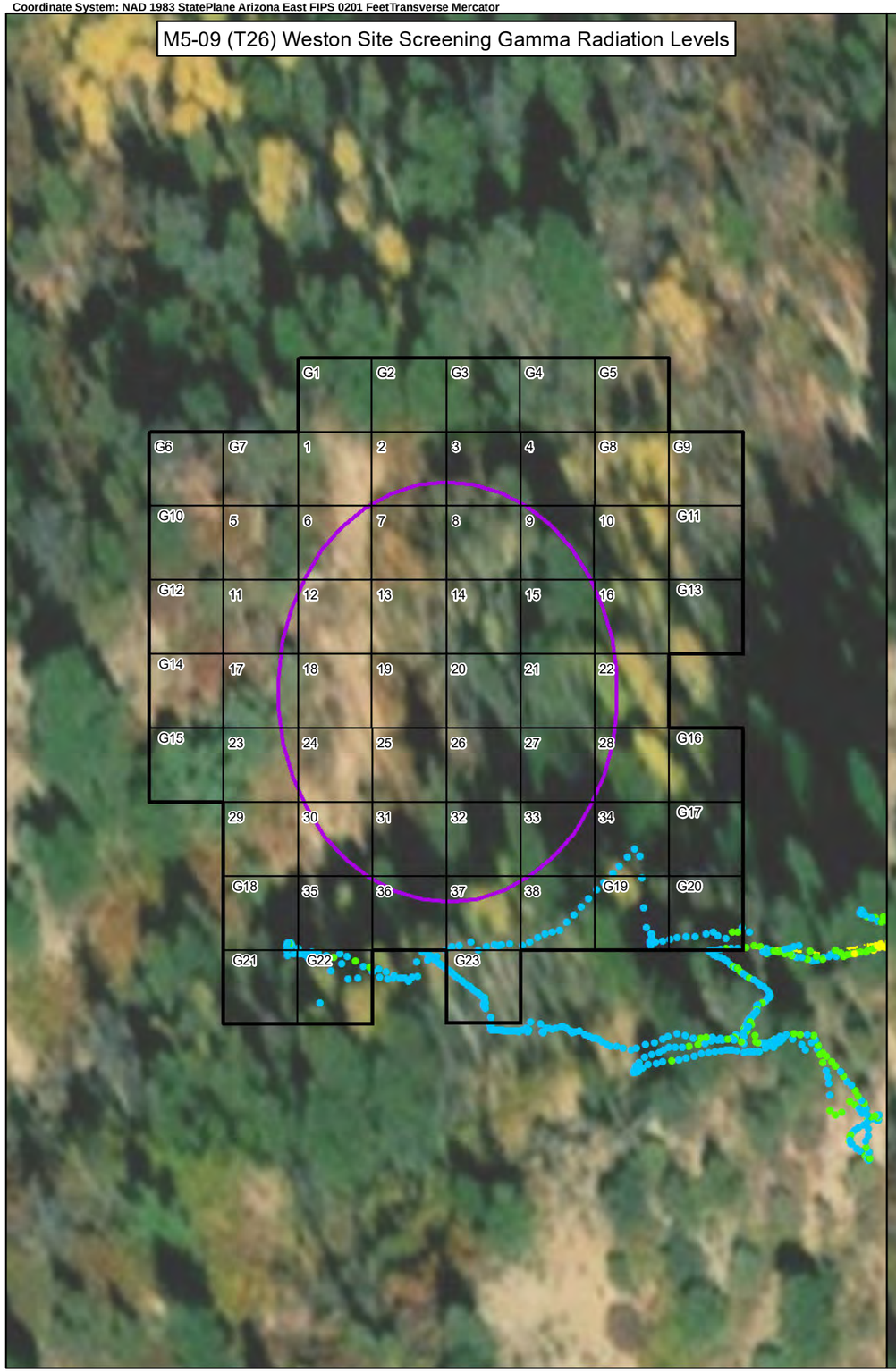


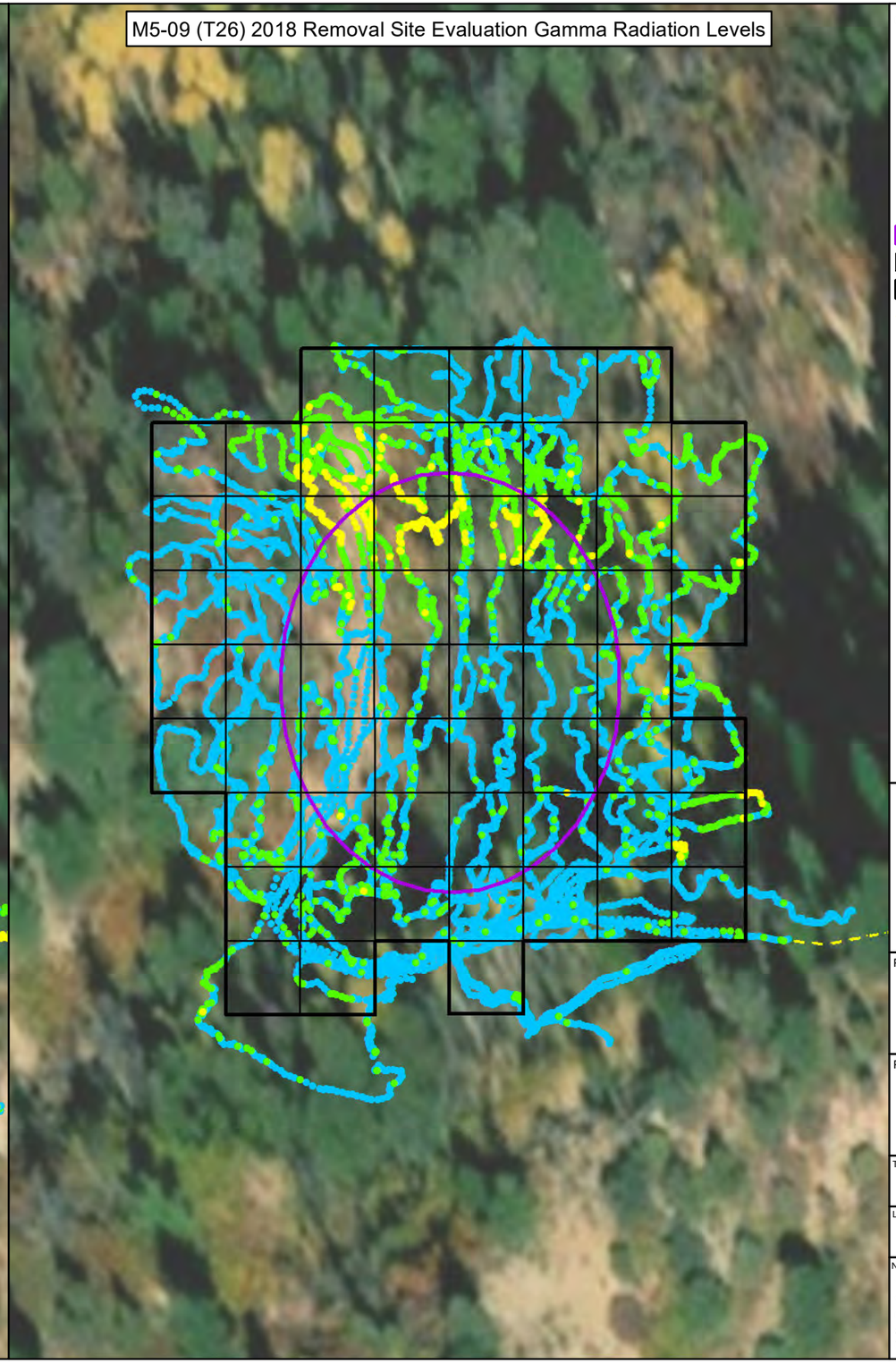
Figure I26-7. Box Plot of Raw Gamma Radiation Levels at Target M5-09 (T26) and BSA-16 (Tc)

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

M5-09 (T26) Weston Site Screening Gamma Radiation Levels



M5-09 (T26) 2018 Removal Site Evaluation Gamma Radiation Levels



Gamma Reading (cpm)*

≤ 10,383	≤ Avg. BG
10,383 - 12,473	Avg. BG - 1 x BTV
12,473 - 24,946	1 x BTV - 2 x BTV
24,946 - 37,419	2 x BTV - 3 x BTV
37,419 - 49,892	3 x BTV - 4 x BTV
49,892 - 124,730	4 x BTV - 10 x BTV
≥ 124,730	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Access Route - Foot

1 in = 60 ft

1:720

N
W E
S

0 30 60 120 Feet

NON-AUM TARGET M5-09 (T26)
2018 REMOVAL SITE EVALUATION
VS WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019

Notes:
*The applied gamma background threshold value (BTV) for M5-09 (T26) is 12,473 cpm derived from BSA-16 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I26-8**

8.8.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 8.8.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 8.8.5.1. Figure I26-9 and Figure I26-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-16 (Tc) data set (shown on right). A total of 1.6 percent of the survey units (1 of 61) within the survey area of Target T26 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I26-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I26-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. One elevated area may correlate with a change in geology from the Tc to the Jml.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 8.8.6.

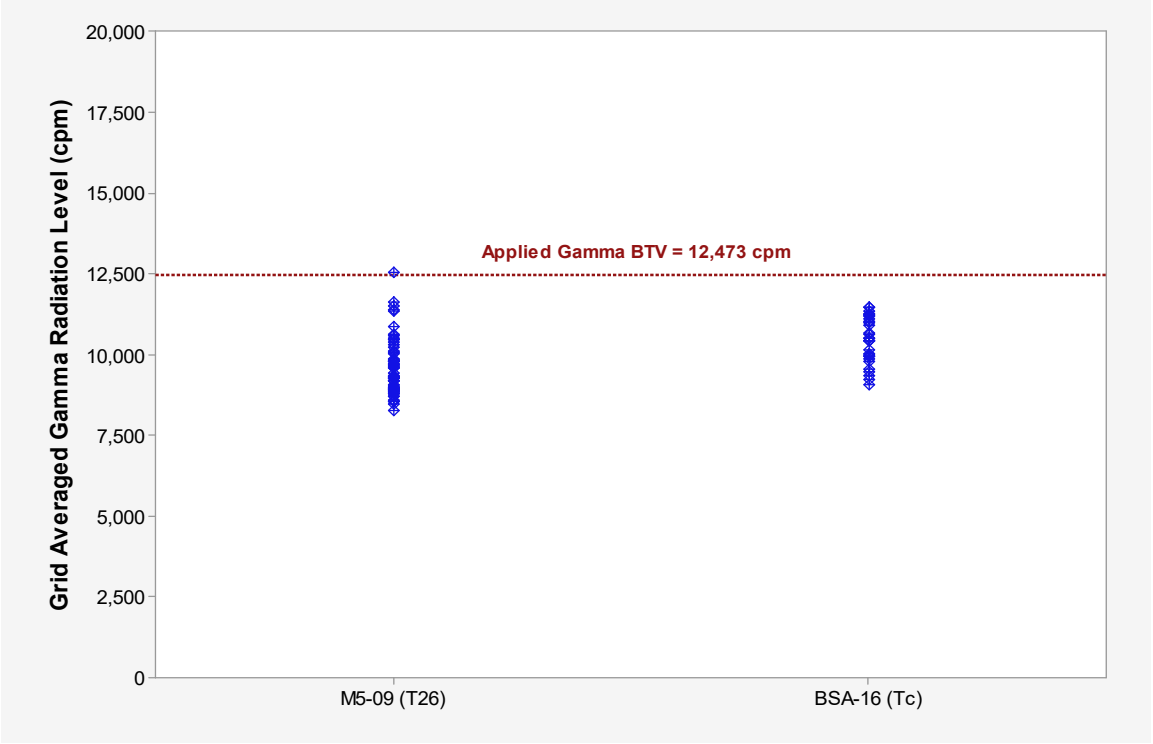


Figure I26-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-09 (T26) and BSA-16 (Tc)

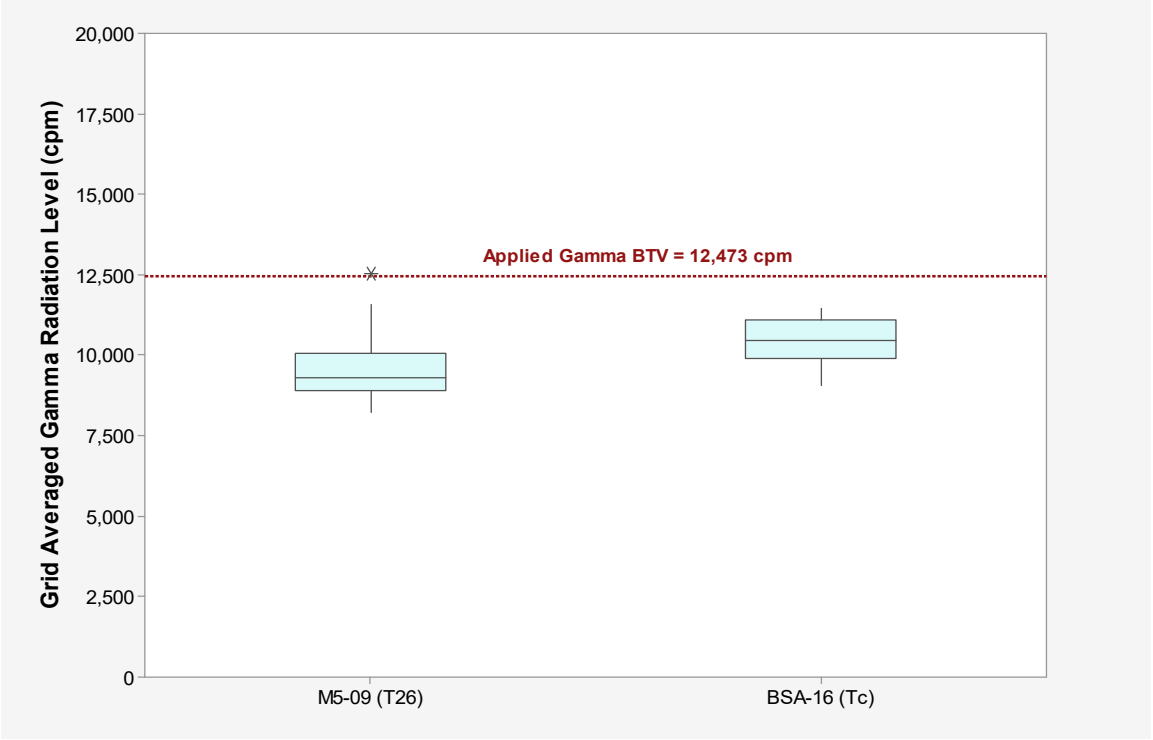
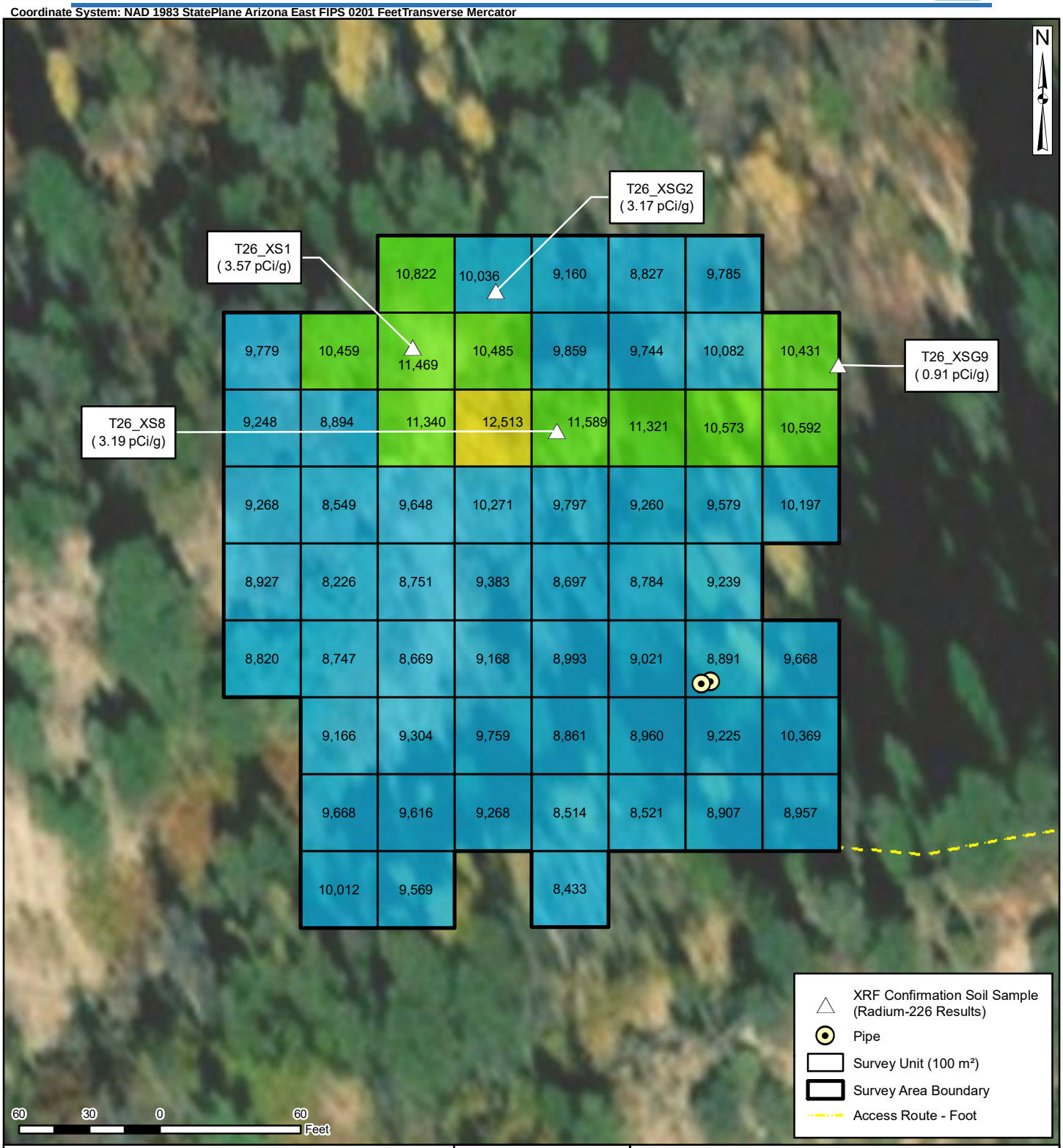


Figure I26-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-09 (T26) and BSA-16 (Tc)

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



Grid Averaged Gamma Reading (cpm)*

≤ 10,383	≤ Avg. BG
10,383 - 12,473	Avg. BG - 1 x BTV
12,473 - 24,946	1 x BTV - 2 x BTV
24,946 - 37,419	2 x BTV - 3 x BTV
37,419 - 49,892	3 x BTV - 4 x BTV
49,892 - 124,730	4 x BTV - 10 x BTV
≥ 124,730	≥ 10 x BTV

*The applied gamma background threshold value (BTV) for M5-09 (T26) is 12,473 cpm derived from BSA-16 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M5-09 (T26) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I26-11
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

8.8.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T26. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 8.8.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 8.8.6.2.

8.8.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T26: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I26-1 and I26-2. All the results of the XRF confirmation soil samples are presented in Table I26-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T26 following the methods outlined in Section 2.4 and shown in Figure I26-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 61 measurements were collected across 61 survey units from the survey area of Target T26 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I26-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T26 at a depth of 0 to 3 inches bgs. Four XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I26-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 8.8.7.

Table I26-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-09 (T26)

Analyte	Units	Applied BTV	T26-XS1-01-061018		T26-XS8-01-061018		T26-XSG2-01-091518		T26-XSG9-01-091518	
			Result	Q	Result	Q	Result	Q	Result	Q
Survey Unit			X1		X8		G2		G9	
Aluminum	mg/kg	3,930	3,800		3,300		2,500		3,200	
Antimony	mg/kg	0.130	0.1		<0.098	U	0.11	J	<0.092	U
Arsenic	mg/kg	2.3	5.4		7		6.1	J	3.6	
Barium	mg/kg	129	56		49		46		170	
Beryllium	mg/kg	0.27	0.36		0.26		0.23		0.27	
Cadmium	mg/kg	0.137	0.035	J	<0.2	U	<0.2	U	<0.18	U
Calcium	mg/kg	7,800	3,200		2,300		2,800	J	29,000	
Chromium	mg/kg	5.2	1.8		1.7		1.2		1	
Cobalt	mg/kg	2.5	1.6		1.7		1.4		1.5	
Copper	mg/kg	5.6	2.6		2.6		2.3		3	
Iron	mg/kg	5,130	4,500		4,700		4,200		4,300	
Lead	mg/kg	8.6	4.9		4.5		5.3		3.7	
Lithium	mg/kg	4.5	3.3		3.6		2.7		3.1	
Magnesium	mg/kg	1,630	1,200		1,100		910	J	1,200	
Manganese	mg/kg	421	140		120		130		130	
Molybdenum	mg/kg	0.26	2.1		6		1.9		0.81	
Nickel	mg/kg	4.2	1.7	J	1.5	J	1.4	J	1.4	J
Potassium-40	pCi/g	18.8	9.6	LT	9.9	LT	12.1		14.9	
Radium-226	pCi/g	1.42	3.57		3.19		3.17		0.91	LT
Radium-228	pCi/g	0.62	<0.25	U	<0.38	U	<0.45	U	<0.32	U
Selenium	mg/kg	0.64	0.81	J	0.75	J	1.1		1.2	
Silver	mg/kg	0.016	<0.049	U	<0.049	U	<0.049	U	<0.046	U
Sodium	mg/kg	22.0	<99	U	<98	U	<98	U	<92	U
Thallium	mg/kg	0.054	0.047		0.06		0.036		0.046	
Thorium	mg/kg	7.7	2.9		2.1		2.3		2.2	
Uranium	mg/kg	0.87	4.4		4.8		5.6		1.1	
Vanadium	mg/kg	8.6	18		17		18	J	7.5	
Zinc	mg/kg	22	7.9	J	8.8	J	6.6	J	7.8	J

Notes:
BTV Background threshold value
J Estimated value
J- Estimated value, may be biased low
LT Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
mg/kg Milligrams per kilogram
NA Not applicable
NV No Value
pCi/g Picocuries per gram
Q Qualification
U Not considered detected. The associated value is the method detection limit (MDL).
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

Table I26-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-09 (T26)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.3	5,130	8.6	421	0.26	7.7	0.87	8.6	22
Measurements	#	61	61	61	61	61	61	61	61	61
Detects	#	52	61	60	61	22	58	46	19	60
Nondetects	#	9	0	1	0	39	3	15	42	1
Minimum	mg/kg	1.8	2,191	1.1	88.5	0.3	1.1	0.1	17.0	8.7
Maximum	mg/kg	8.7	7,271	18.9	903.3	6.2	4.4	10.1	162.9	31.8
Standard Deviation	mg/kg	1.7	1,043	3.7	143	1.77	0.6	2.6	33	5.8
Average	mg/kg	4.4	5,165	5.2	242	2.57	2.1	2.5	35.4	15.3
Median	mg/kg	4.5	5,159	4.4	198	2.06	2.0	1.6	22.4	13.5
Relative Standard Deviation	%	37.6	20.2	70.1	59.0	68.8	28.9	104.7	93.9	37.9
90th Percentile	mg/kg	6.6	6,575	9.9	383	5.1	2.7	7.1	51	25
95th Percentile	mg/kg	7.1	6,738	12.0	490	6.0	3.0	8.1	68	30
99th Percentile	mg/kg	8.1	7,107	18.6	781	6.1	3.9	9.7	144	31
Measurements Above Applied BTV	#	47	33	7	6	21	0	33	19	8
Measurements Above Applied BTV	%	77.0	54.1	11.5	9.8	34.4	0.0	54.1	31.1	13.1

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value

mg/kg Milligram per kilogram

XRF X-ray fluorescence

8.8.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T26 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T26 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T26. The estimated BTVs are identified in Section 8.8.4 and Table I26-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I26-7 presents a summary of the background comparison for different measurement and soil depths at Target T26. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T26. However, gamma radiation screening indicated that gamma levels at Target T26 are elevated in comparison to the BSA and appear to be associated with outcropping of the Jml. Therefore, while multiple COPCs have been identified at Target T26 based on a conservative comparison to background, risk screening will be required to support any future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I26-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-09 (T26)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic	✓	✓	✓
Barium	✓		✓
Beryllium	✓		✓
Cadmium			
Calcium	✓		✓
Chromium			
Cobalt			
Copper			
Iron		✓	✓
Lead		✓	✓
Lithium			✓
Magnesium			
Manganese		✓	✓
Molybdenum	✓	✓	✓
Nickel			
Potassium-40			
Radium-226	✓		✓
Radium-228			
Selenium	✓		✓
Silver			
Sodium			
Thallium	✓		✓
Thorium			
Uranium	✓	✓	✓
Vanadium	✓	✓	✓
Zinc		✓	✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

8.8.7 Primary Contaminant Mapping

8.8.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 8.8.6.2 identified the COPCs at Target T26. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 8.8.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I26-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T26 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 8.8.7.1 through Section 8.8.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T26. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

8.8.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I26-7. Arsenic exceeded the applied BTV in 77 percent of in situ XRF measurements and in all four XRF confirmation samples. The applied BTV for arsenic is 2.3 mg/kg for Target T26 as presented in Section 8.8.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I26-5 and Attachment I3, respectively. Figure I26-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T26 and BSA-16 (Tc) samples. Figure I26-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T26 and BSA-16 (Tc) samples. Summary statistics for XRF measurements are provided in Section 8.8.6.1. Arsenic XRF concentrations measured in surface soils at Target T26 ranged between 1.8 and 8.7 mg/kg with an average and standard deviation of 4.4 mg/kg and 1.7 mg/kg, respectively. The average arsenic XRF concentration is above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T26 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I26-14. Overall, the majority of detectable arsenic results in surface soils were above the applied BTV. However, the maximum XRF value was 3.8 times higher than the applied BTV and does not appear to be associated with mining-related materials.

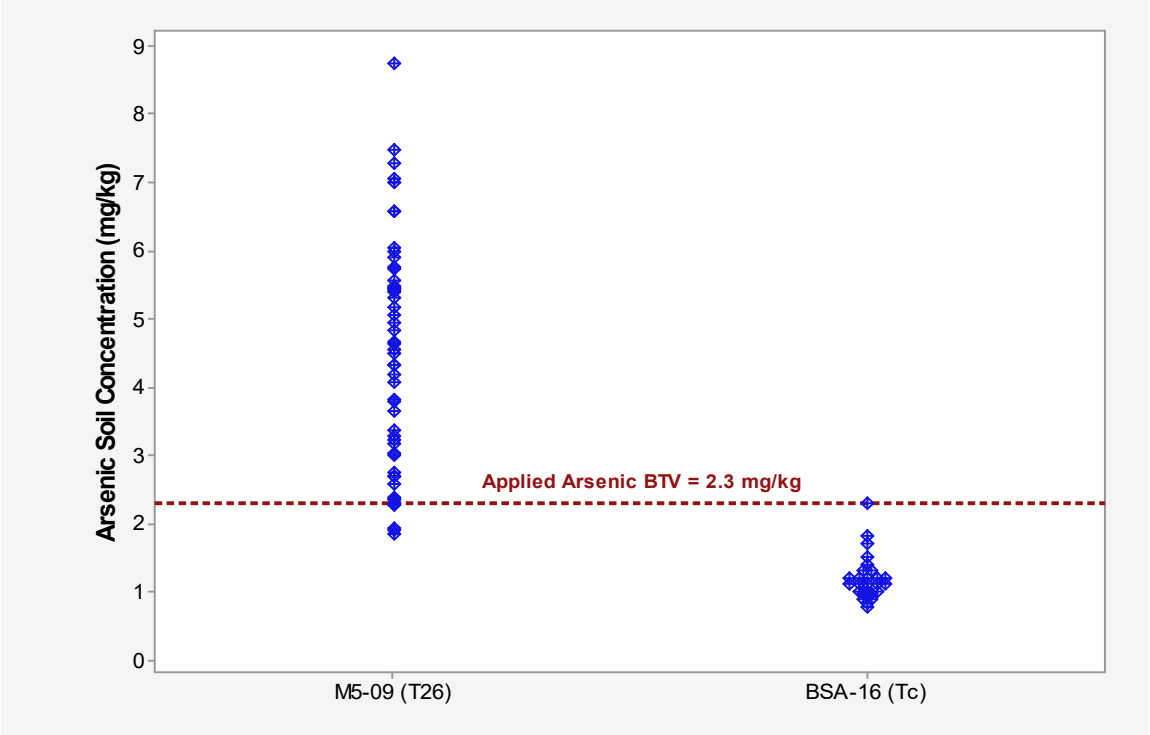


Figure I26-12. Individual Value Plot for Target M5-09 (T26) and BSA-16 (Tc) Arsenic Soil Concentrations

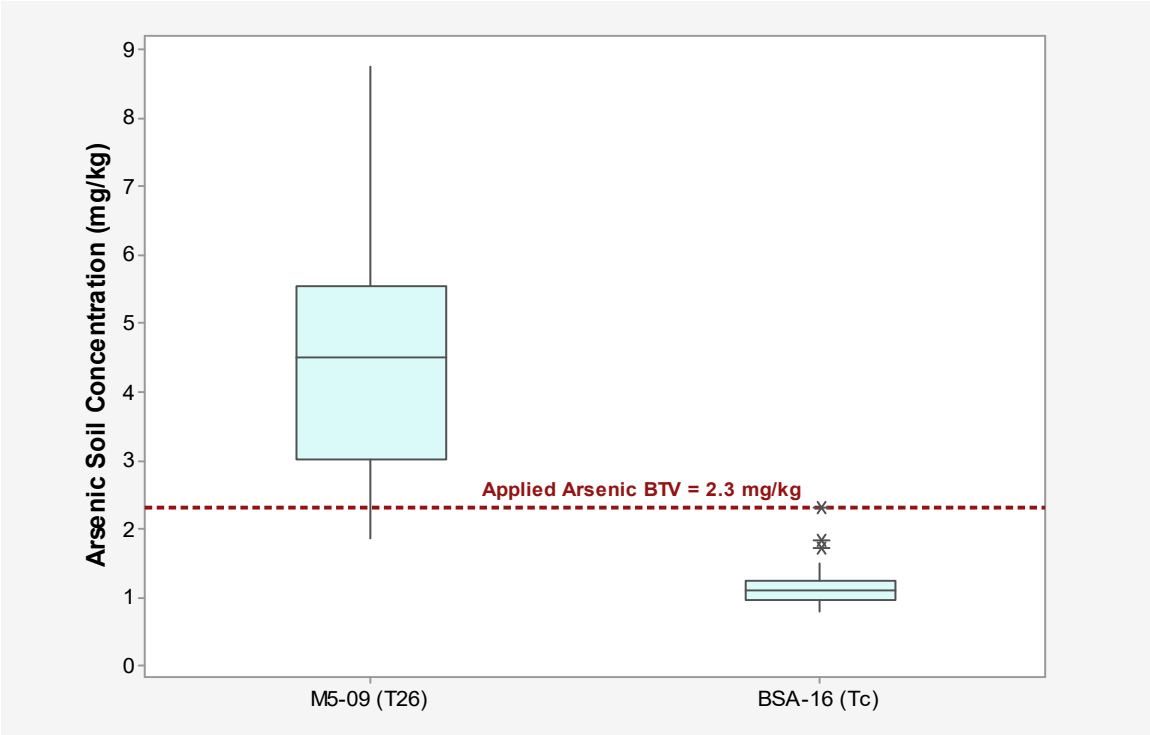
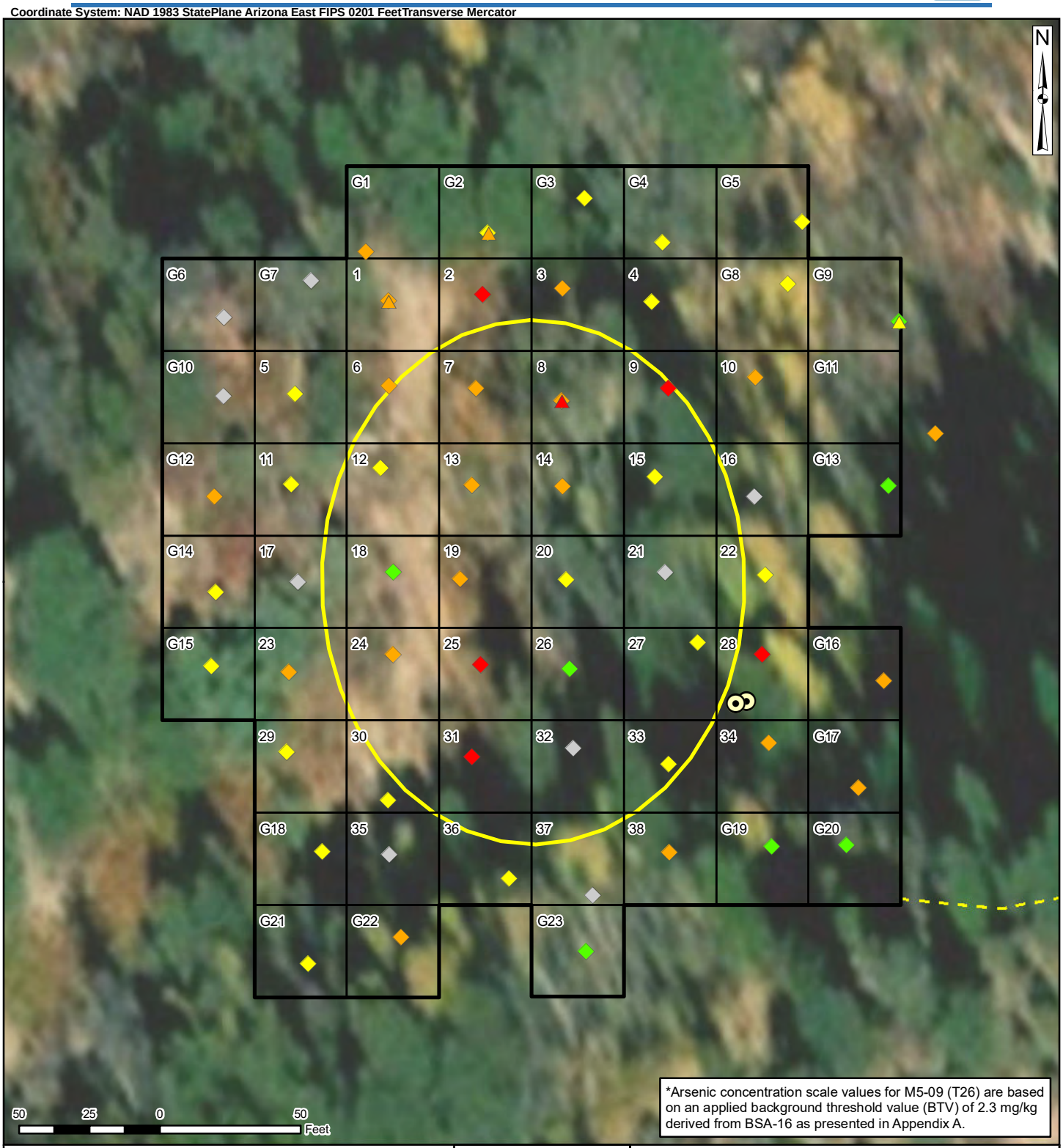


Figure I26-13. Box Plot for Target M5-09 (T26) and BSA-16 (Tc) Arsenic Soil Concentrations

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



Arsenic Concentration Scale (mg/kg)*

- ≤ 1.2
- 1.2 - 2.3
- 2.3 - 4.6
- 4.6 - 6.9
- 6.9 - 9.2
- 9.2 - 23
- ≥ 23
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Pipe - Field Mapped
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot

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NON-AUM TARGET M5-09 (T26) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I26-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

8.8.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I26-7. Lead exceeded the applied BTV in 11.5 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for lead is 8.6 mg/kg for Target T26 as presented in Section 8.8.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I26-5 and Attachment I3, respectively. Figure I26-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T26 and BSA-16 (Tc) samples. Figure I26-16 presents a box plot of detectable lead XRF soil concentrations for Target T26 and BSA-16 (Tc) samples. Summary statistics for XRF measurements are provided in Section 8.8.6.1. Lead concentrations measured in surface soils at Target T26 ranged between 1.1 and 18.9 mg/kg with an average and standard deviation of 5.2 mg/kg and 3.7 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T26 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I26-17. Overall, the majority of detectable lead results in surface soils were below the applied BTV. However, the maximum XRF value was 2.2 times higher than the applied BTV and does not appear to be associated with mining-related materials.

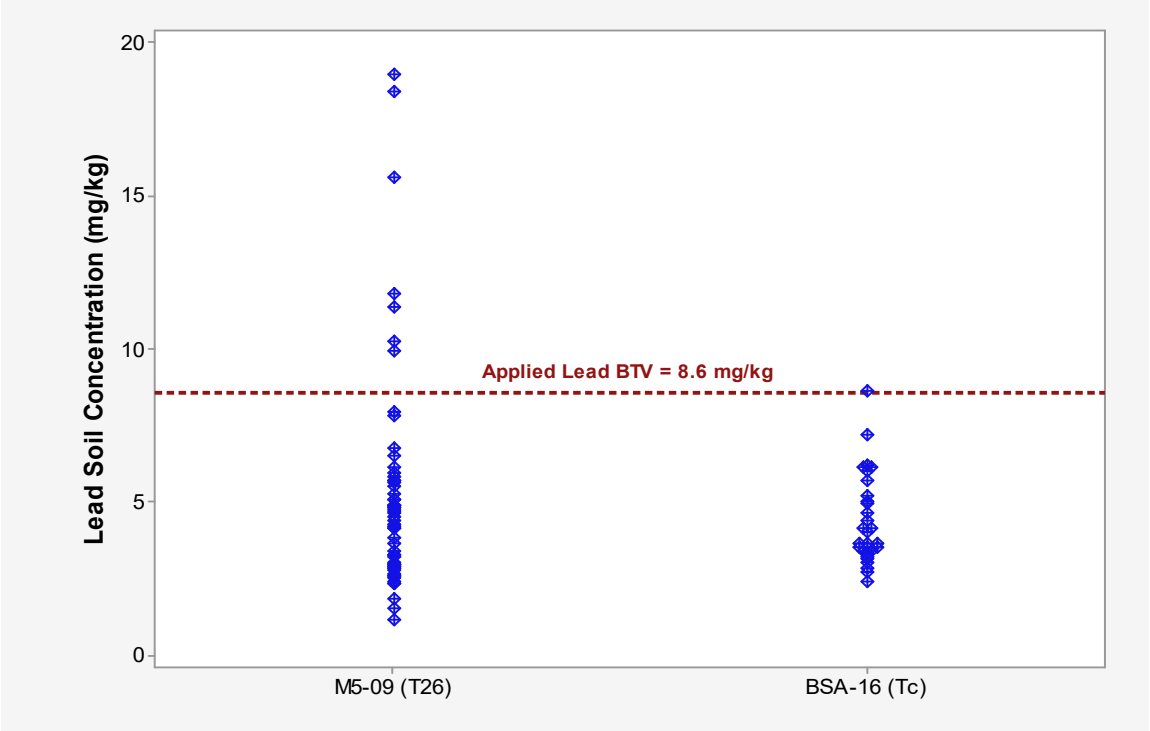


Figure I26-15. Individual Value Plot for Target M5-09 (T26) and BSA-16 (Tc) Lead Soil Concentrations

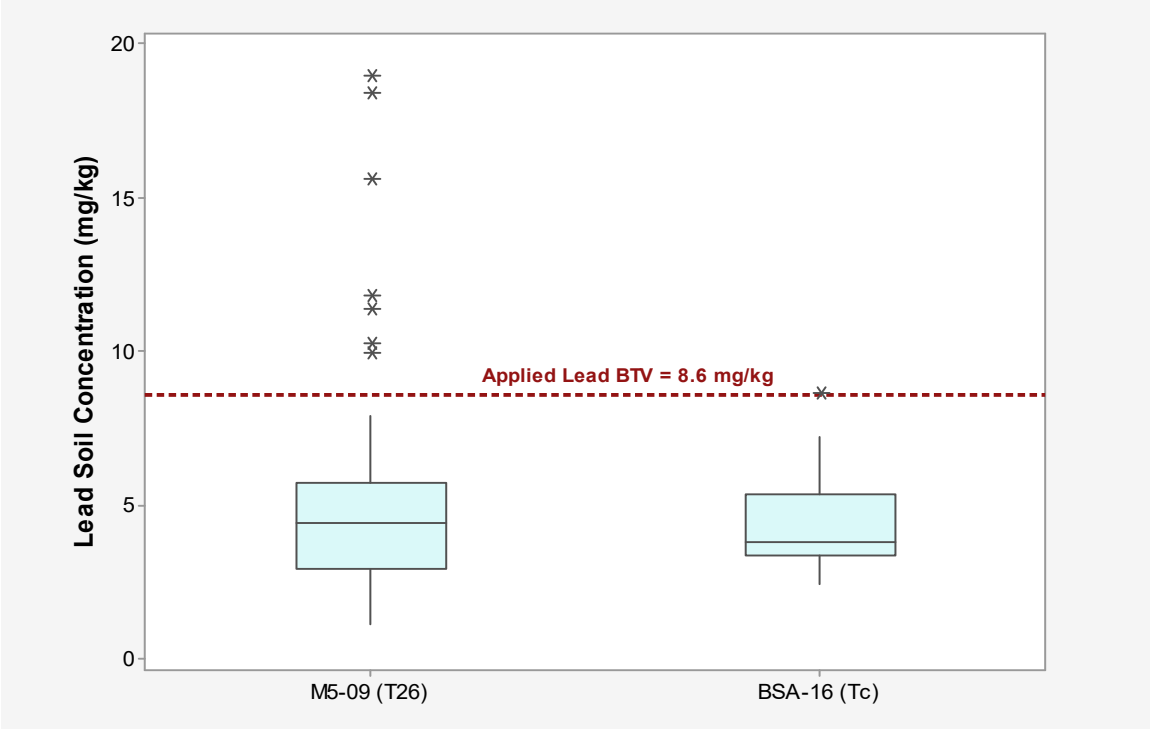
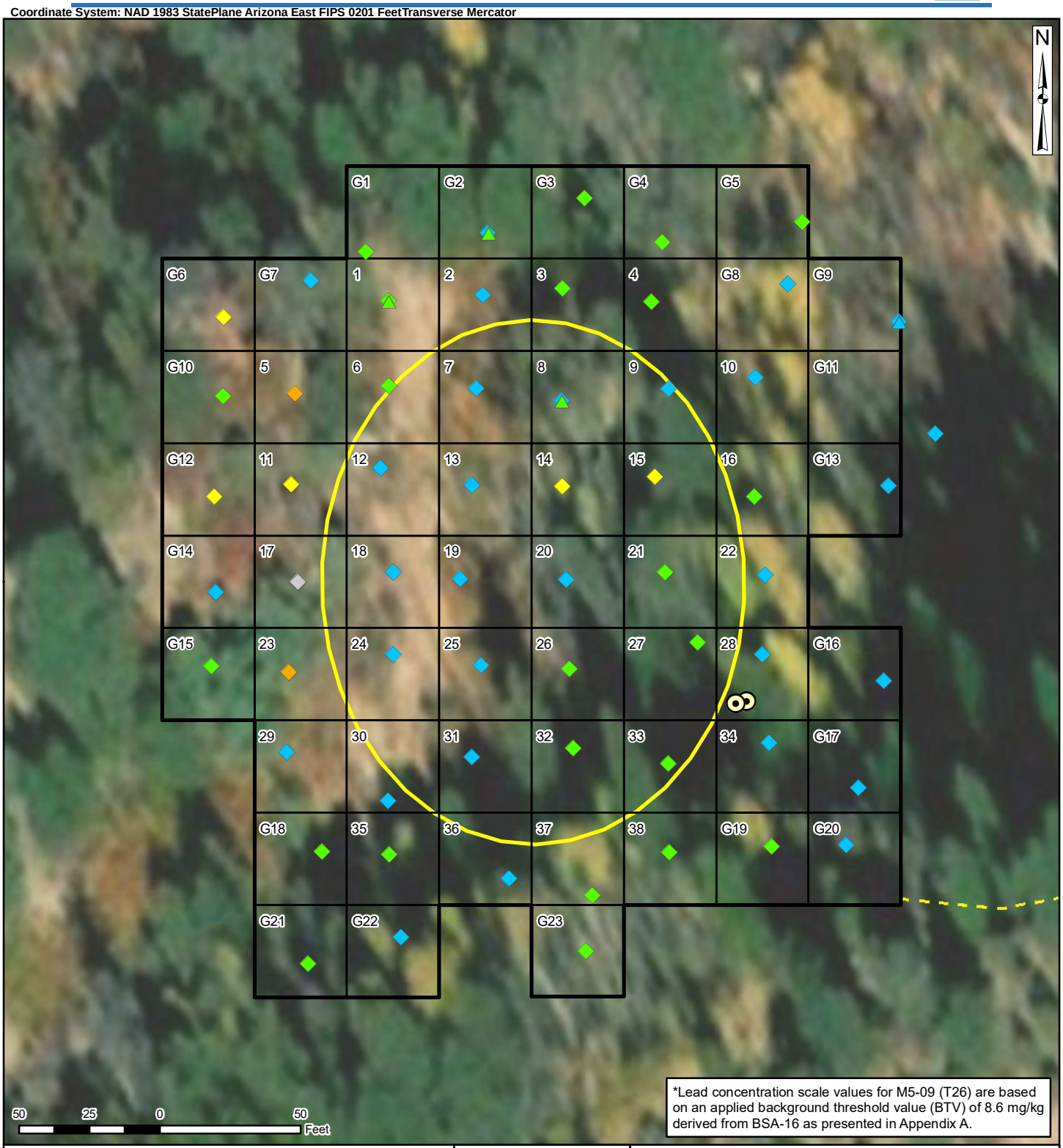


Figure I26-16. Box Plot for Target M5-09 (T26) and BSA-16 (Tc) Lead Soil Concentrations

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



Lead Concentration Scale (mg/kg)*

- ≤ 4.4
- 4.4 - 8.6
- 8.6 - 17
- 17 - 26
- 26 - 34
- 34 - 86
- ≥ 86

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Pipe - Field Mapped
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot

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NON-AUM TARGET M5-09 (T26) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I26-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

8.8.7.4 Thorium

Thorium was not identified as a COPC in surface soil as shown in Table I26-7. Thorium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for thorium is 7.7 mg/kg for Target T26 as presented in Section 8.8.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I26-5 and Attachment I3, respectively. Figure I26-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T26 and BSA-16 (Tc) samples. Figure I26-19 presents a box plot of detectable thorium XRF soil concentrations for Target T26 and BSA-16 (Tc) sample types. Summary statistics for XRF measurements are provided in Section 8.8.6.1. Thorium XRF concentrations measured in surface soils at Target T26 ranged between 1.1 and 4.4 mg/kg with an average and standard deviation of 2.1 mg/kg and 0.6 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T26 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I26-20. All thorium results in surface soils were less than the applied BTV.

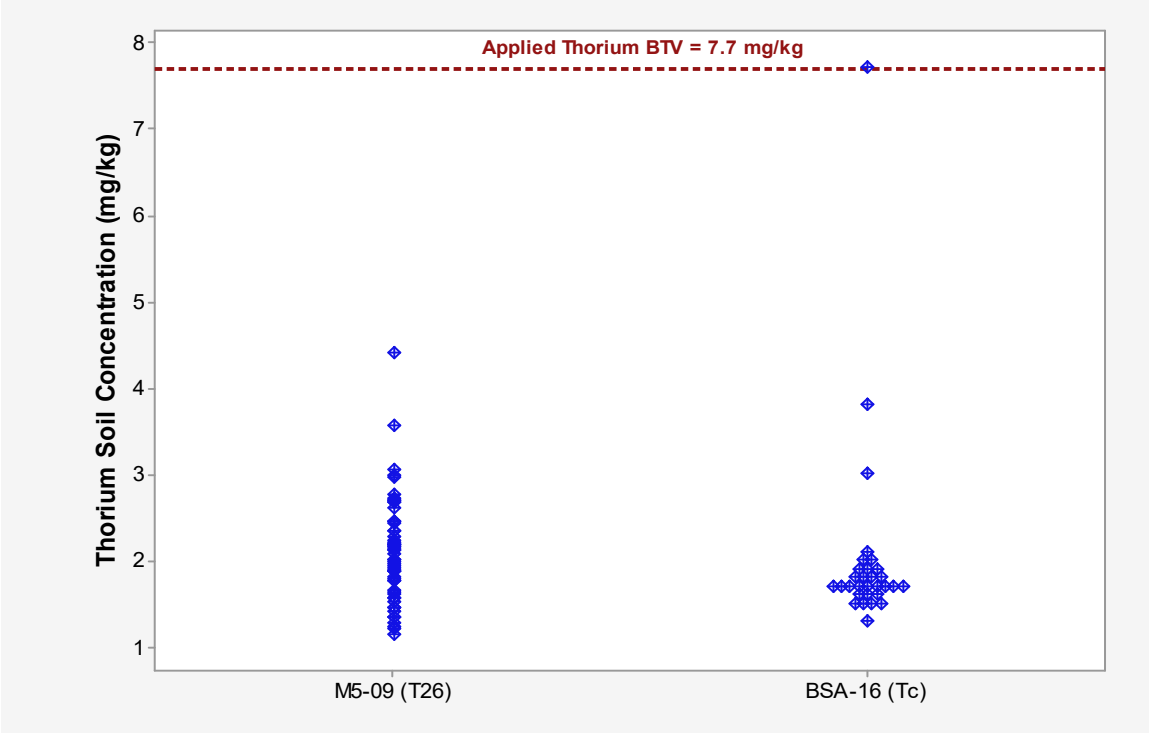


Figure I26-18. Individual Value Plot for Target M5-09 (T26) and BSA-16 (Tc) Thorium Soil Concentrations

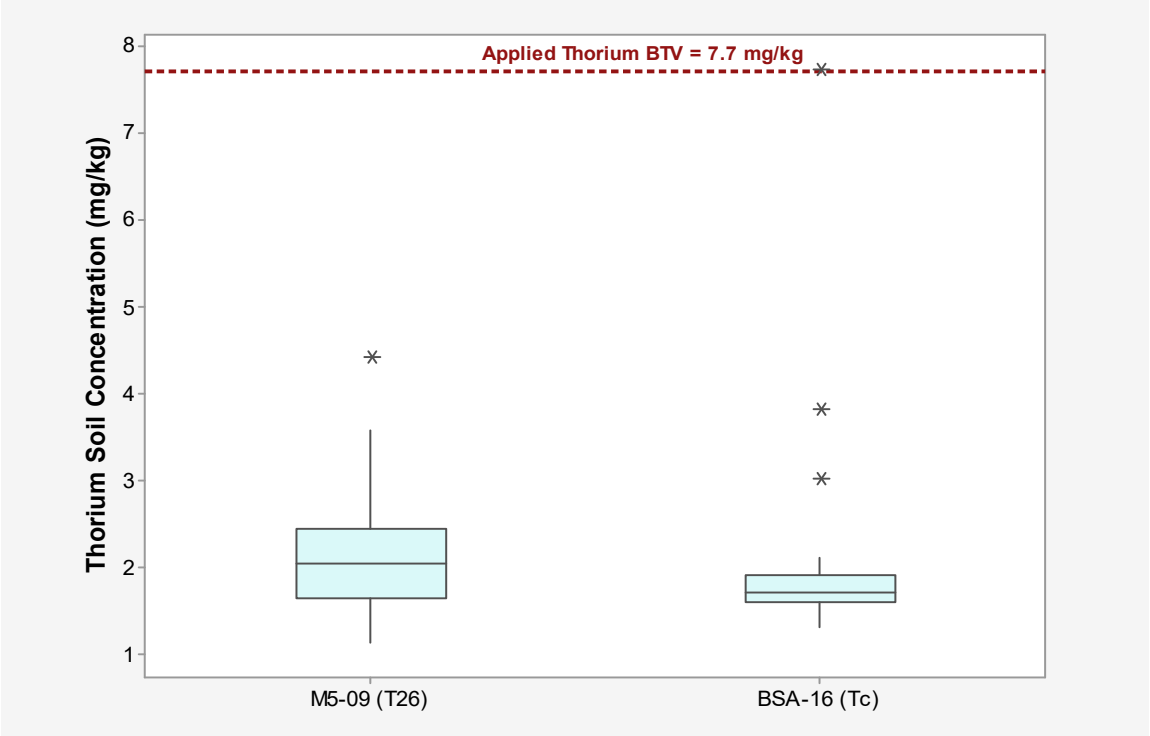
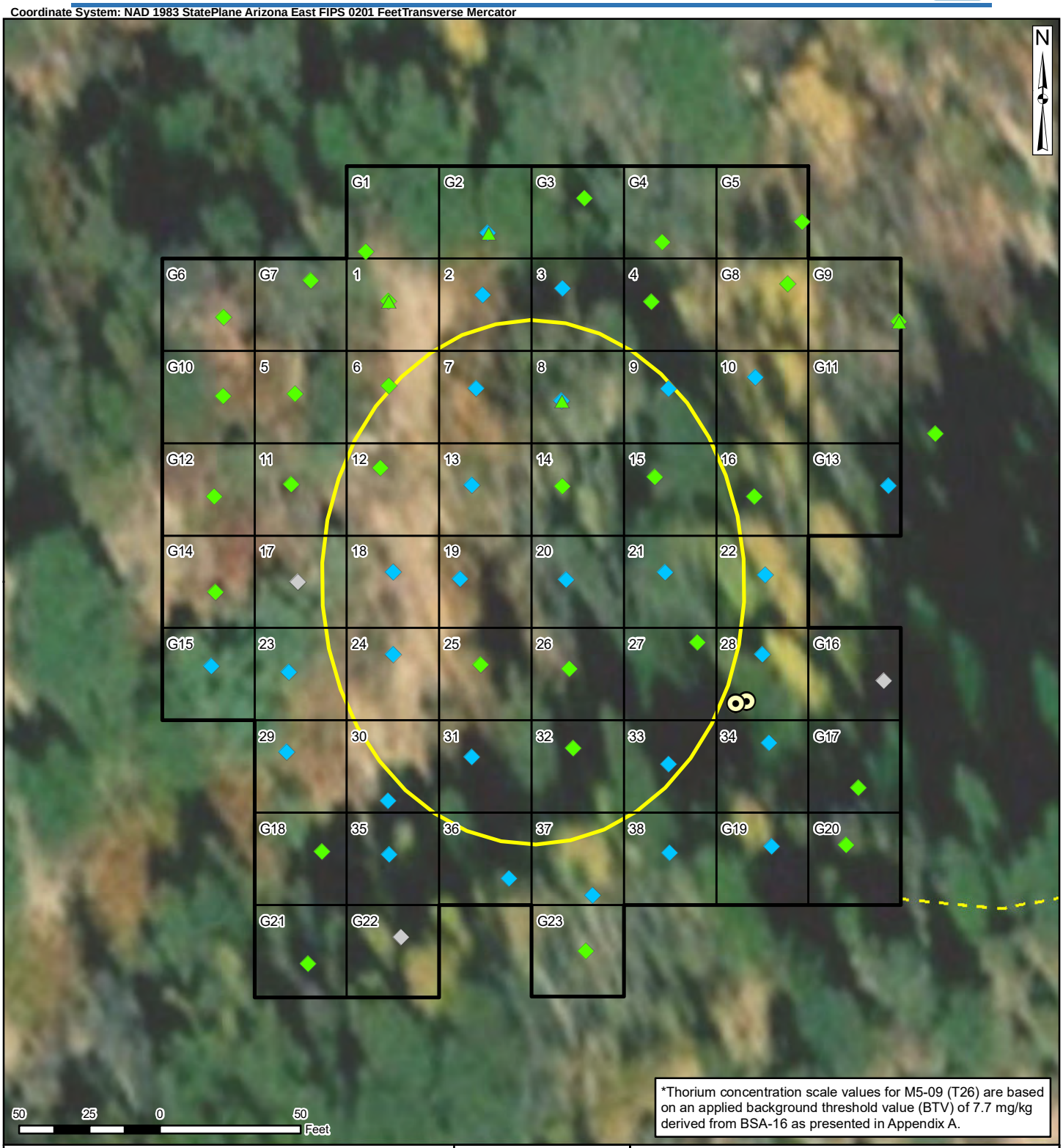


Figure I26-19. Box Plot for Target M5-09 (T26) and BSA-16 (Tc) Thorium Soil Concentrations

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



Thorium Concentration Scale (mg/kg)*

- ≤ 2.0
- 2.0 - 7.7
- 7.7 - 15
- 15 - 23
- 23 - 31
- 31 - 77
- ≥ 77
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Pipe - Field Mapped
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot

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NON-AUM TARGET M5-09 (T26) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I26-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

8.8.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I26-7. Uranium exceeded the applied BTV in 54.1 percent of in situ XRF measurements and in all four XRF confirmation samples. The applied BTV for uranium is 0.87 mg/kg for Target T26 as presented in Section 8.8.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I26-5 and Attachment I3, respectively. Figure I26-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T26 and BSA-16 (Tc) samples. Figure I26-22 presents a box plot of detectable uranium XRF soil concentrations for Target T26 and BSA-16 (Tc) samples. Summary statistics for XRF measurements are provided in Section 8.8.6.1. Uranium XRF concentrations measured in surface soils at Target T26 ranged between 0.1 and 10.1 mg/kg with an average and standard deviation of 2.5 mg/kg and 2.6 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T26 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I26-23. Overall, the majority of detectable uranium results in surface soils were above the applied BTV. However, the maximum XRF value was 11.6 times higher than the applied BTV and does not appear to be associated with mining-related materials.

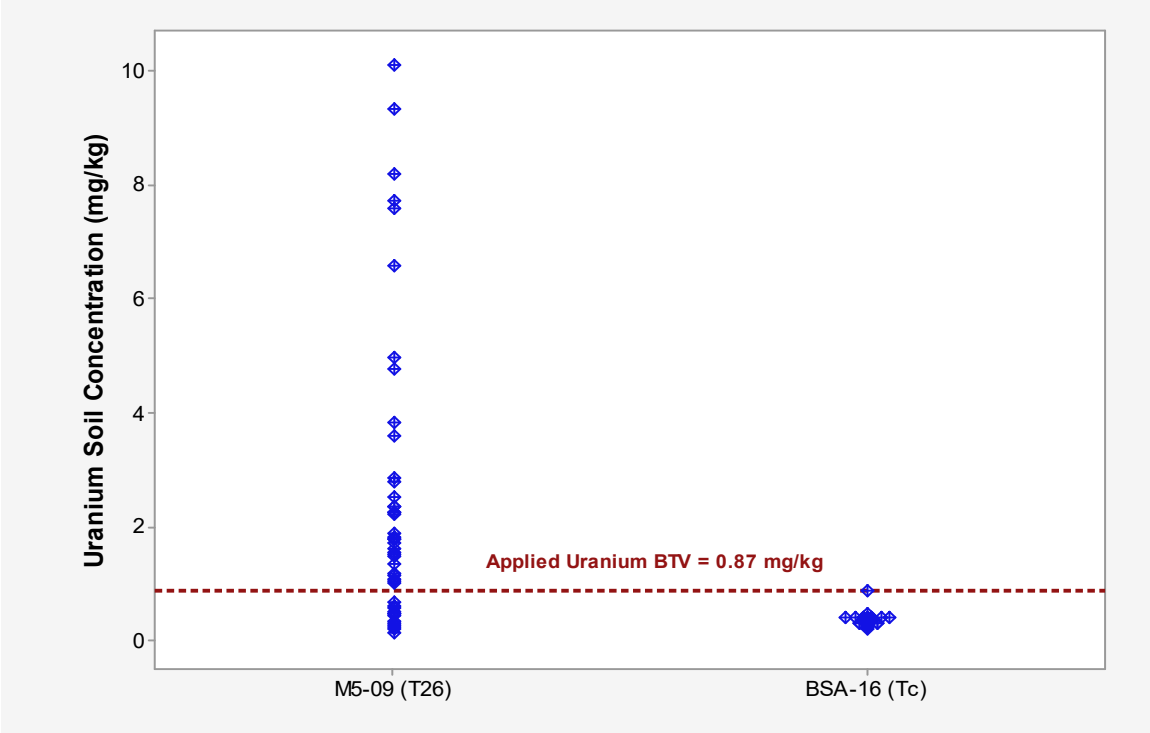


Figure I26-21. Individual Value Plot for Target M5-09 (T26) and BSA-16 (Tc) Uranium Soil Concentrations

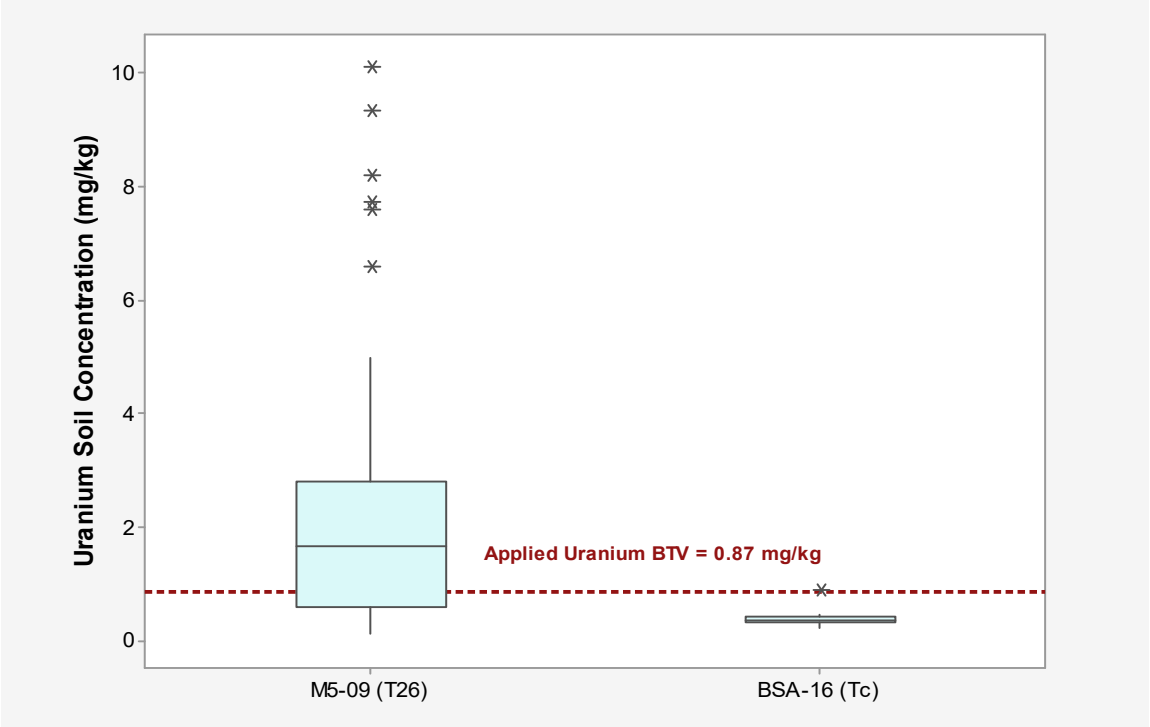
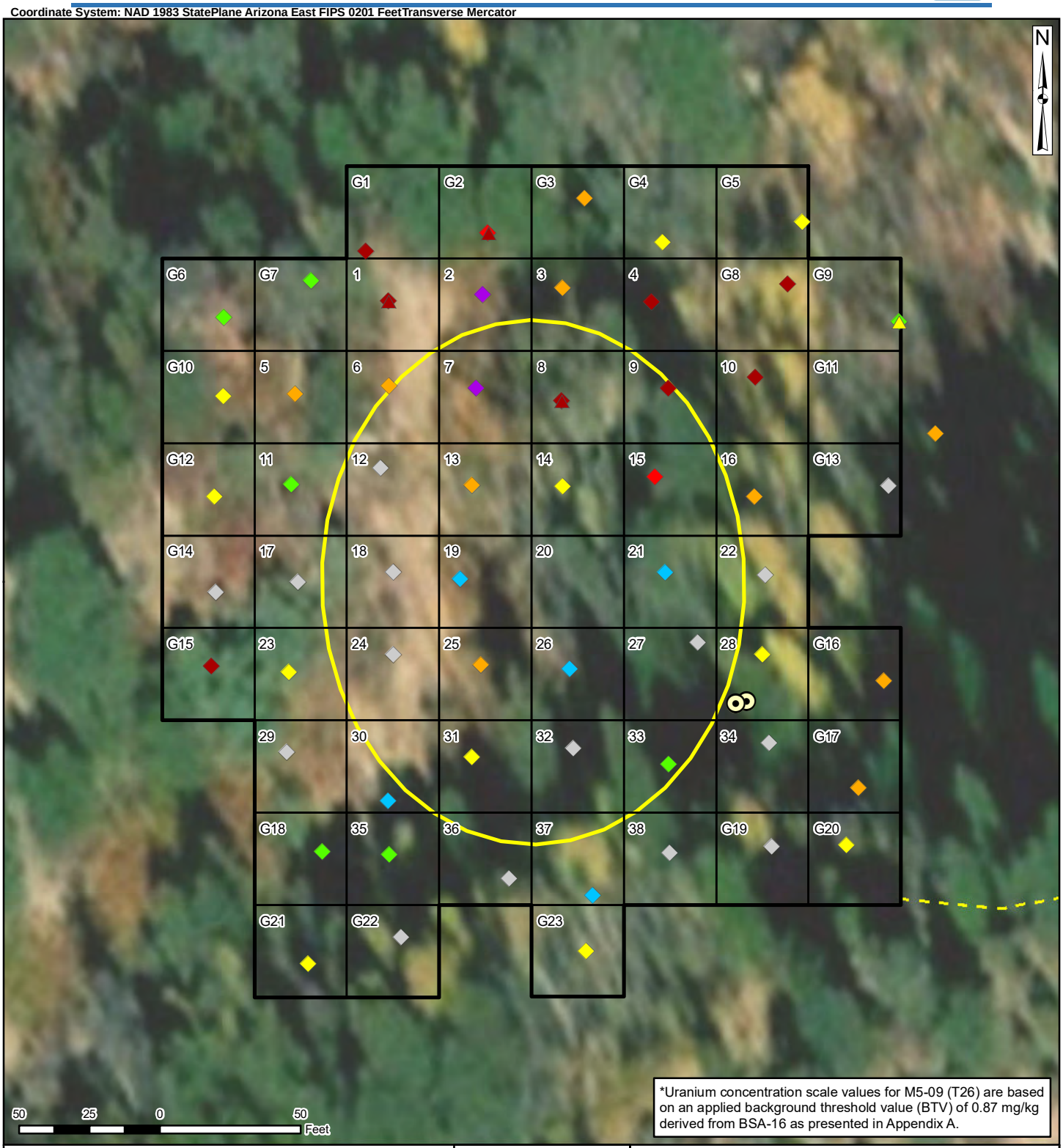


Figure I26-22. Box Plot for Target M5-09 (T26) and BSA-16 (Tc) Uranium Soil Concentrations

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



*Uranium concentration scale values for M5-09 (T26) are based on an applied background threshold value (BTV) of 0.87 mg/kg derived from BSA-16 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 0.36
- 0.36 - 0.87
- 0.87 - 1.7
- 1.7 - 2.6
- 2.6 - 3.5
- 3.5 - 8.7
- ≥ 8.7
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Pipe - Field Mapped
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot

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NON-AUM TARGET M5-09 (T26) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I26-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

8.8.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I26-7. Vanadium exceeded the applied BTV in 31.1 percent of in situ XRF measurements and in three of the four XRF confirmation samples. The applied BTV for vanadium is 8.6 mg/kg for Target T26 as presented in Section 8.8.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I26-5 and Attachment I3, respectively. Figure I26-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T26 and BSA-16 (Tc) samples. Figure I26-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T26 and BSA-16 (Tc) samples. Summary statistics for XRF measurements are provided in Section 8.8.6.1. Vanadium XRF concentrations measured in surface soils at Target T26 ranged between 17 and 162.9 mg/kg with an average and standard deviation of 35.4 mg/kg and 33 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T26 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I26-26. Overall, the majority of detectable vanadium results in surface soils were above the applied BTV. However, the maximum XRF value was 18.9 times higher than the applied BTV and does not appear to be associated with mining-related materials.

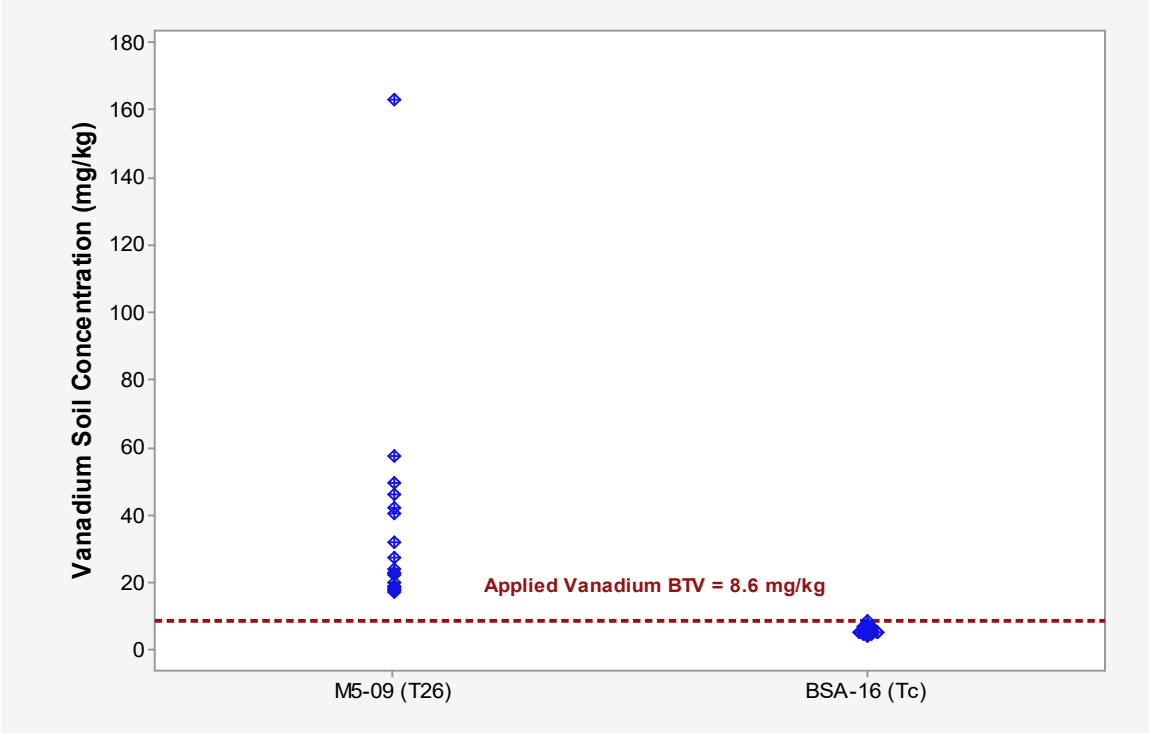


Figure I26-24. Individual Value Plot for Target M5-09 (T26) and BSA-16 (Tc) Vanadium Soil Concentrations

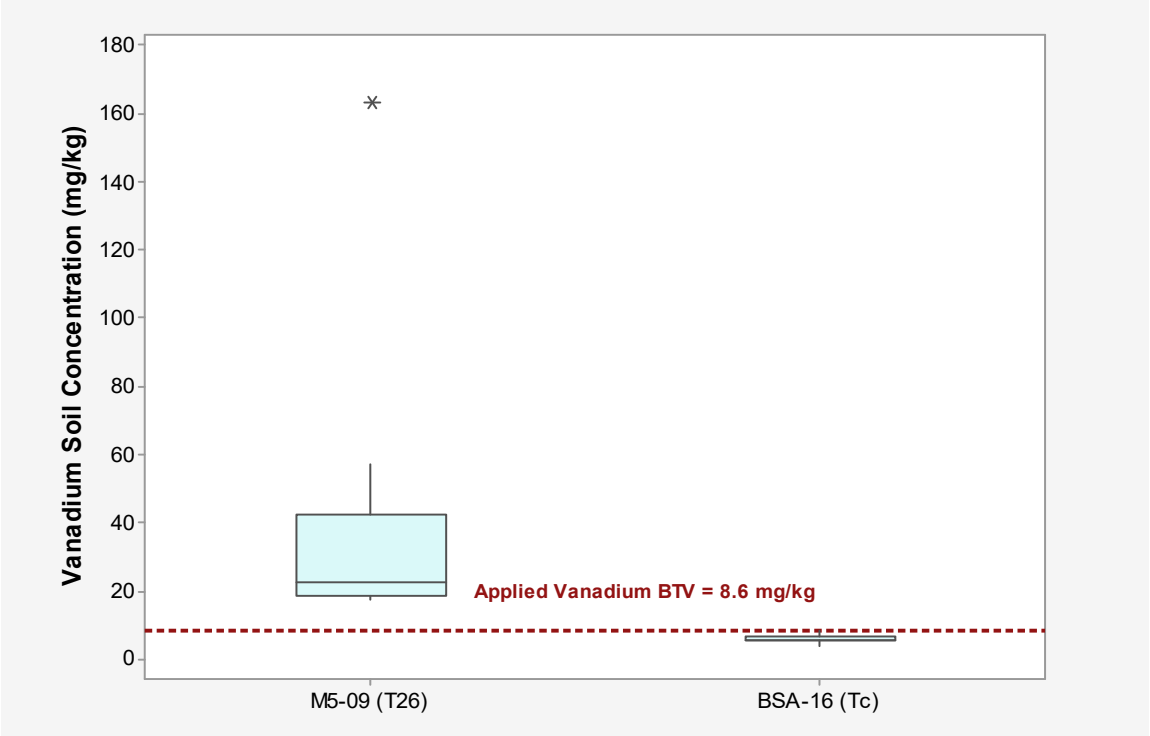
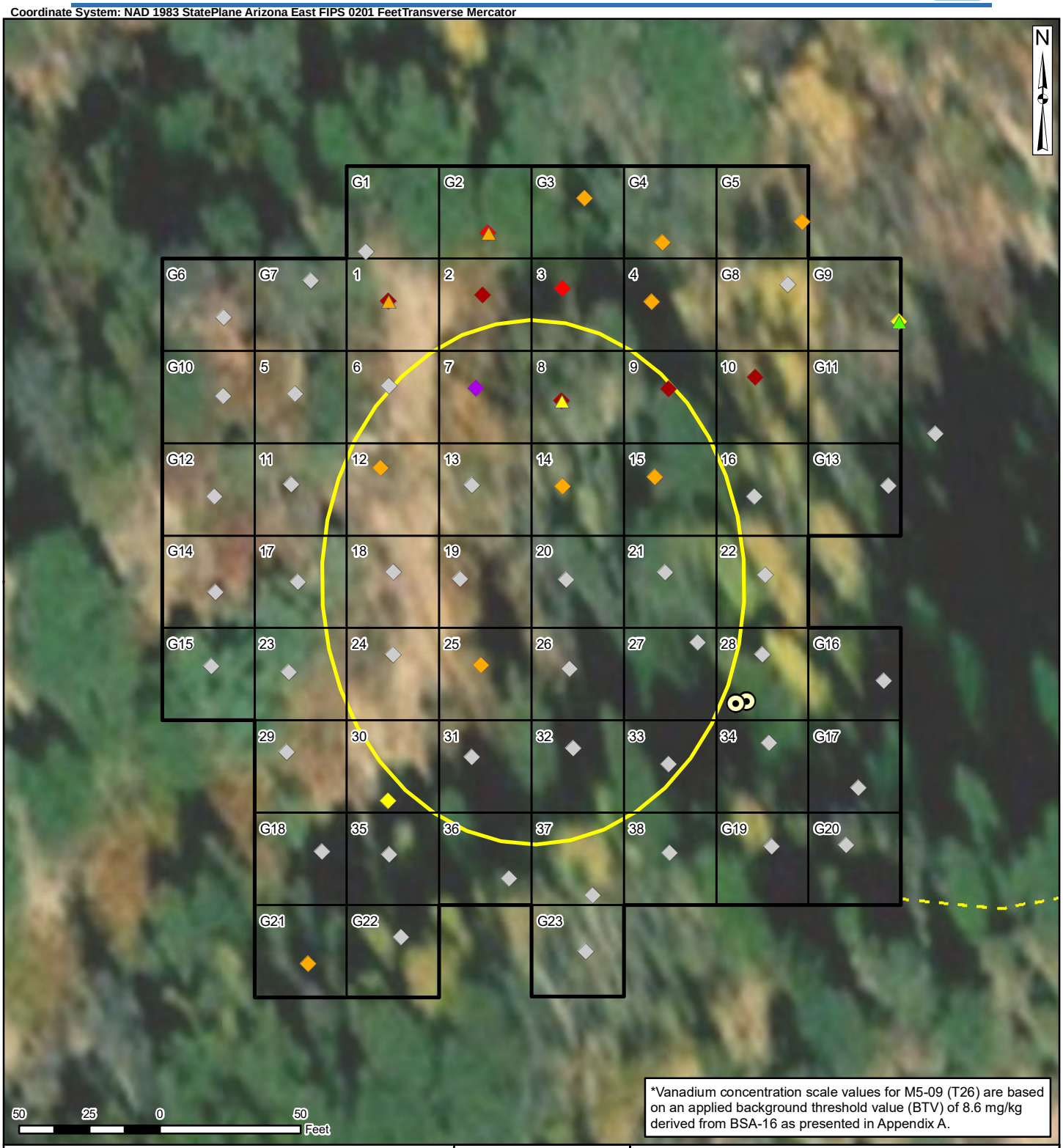


Figure I26-25. Box Plot for Target M5-09 (T26) and BSA-16 (Tc) Vanadium Soil Concentrations

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



Vanadium Concentration Scale (mg/kg)*

- ≤ 5.8
- 5.8 - 8.6
- 8.6 - 17
- 17 - 26
- 26 - 34
- 34 - 86
- ≥ 86
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Pipe - Field Mapped
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot

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NON-AUM TARGET M5-09 (T26) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I26-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

8.8.8 Conclusions

Target T26 (M5-09) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T26. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T26 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T26. ASPECT gamma survey results generally correlated with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T26 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in one XRF confirmation sample from survey unit 1 (the area of elevated gamma reading and observed NORM) exceeded the applied BTV by a factor of 2.5. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific BTVs for Target T26 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. However, grid averaged gamma measurements slightly exceeded the applied BTV in 1 of the 61 survey units by a factor of 1.003.
- A total of 25 analytes were identified as occurring within the surface environment. Of these analytes, 15 were identified as COPCs. Arsenic, lead, uranium, and vanadium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T26 does not contain TENORM. No mining-related activities or features were observed in the field, but two historical exploratory borings were identified in the file review and two pipes were observed in the field. TENORM may be associated with these exploratory borings. Outcropping of Jml was identified in the area of highest gamma activity. NORM was observed but not verified in the field.
- Natural erosion of outcroppings may have increased the lateral extent of NORM.
- There are no immediate significant physical hazards present at Target T26.
- Access is by dirt road with a small four-wheel-drive vehicle followed by footpath.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.

- No existing groundwater wells are documented within the vicinity of Target T26. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T26. Therefore, evaluation of the leachability of metals and radionuclides is not required.
- No mine waste was observed at Target T26; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; however, a few data gaps remain for Target T26. The remaining data gaps include field verification of the reclamation status of the potential historic exploratory borings and field mapping and verification of NORM in outcroppings.

9.0 GROUP G FIELD SAMPLING RESULTS

This section presents field sampling results for Group G Target T27 (M4-02). Non-AUM Target T28 (M4-03) is encompassed by and included in the Mesa IV, Mine 3 AUM (M22) SSRSE Report, and Target (M4-04) is encompassed by and included in the Mesa IV, Mine 1 AUM (M20) SSRSE Report; both reports are in Appendix H of the RSE Report.

9.1 NON-AUM TARGET T27 (M4-02)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T27 (M4-02).

9.1.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T27 (M4-02) is a Target associated with the Mesa IV, West Mine (M23), a former underground mine in the Lukachukai Mountains Region in Subarea Group G. Target T27 is administered by the Cove Chapter of the Navajo Nation and accessible by foot and four-wheel-drive vehicle off of Indian Route 33. Target T27 is identified in the MCAP as "Other Tronox" (Weston 2016). The Mesa IV, West Mine was operated in 1963 by Vanadium Corporation of America (VCA) (Roux 2011), but no known historical information is associated with Target T27. No residences are near the Target. A Target location and access map for Target T27 is shown in Figure I27-1.

A topographical relief map for Mesa IV, West Mine area and associated non-AUM Target T27 is provided in Figure I27-2. The elevation at the Target ranges from 7,664 to 7,708 feet amsl with an average of 7,685 feet amsl. The slope at the Target ranges from 14 to 25 percent with an average of 19 percent. No drainages are located on or adjacent to the Target, but an ephemeral drainage is located approximately 100 feet to the northwest. Target T27 is located entirely within the Jml, and the soil type is the Yahmore-Sandark complex (MUSYM 604) (Figures I-24 and I-25).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover and Weston (2016) screening level gamma survey data to determine the RSE survey area for Target T27. Weston did not conduct a background study for Target T27. As a part of the RSE for Mesa IV, West Mine, Tetra Tech also evaluated the associated non-AUM Target T27. ASPECT imagery and previous gamma screening data were used to guide the sampling approach, which is specified in Appendix F, FSP 29, of the RSE Work Plan (Figure I27-3) (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T27:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T27 is accessed by taking Indian Route 33 to Mesa V Road. The Target is on the road.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  The geology of the Target, Jml, contains NORM. Observations of NORM were not recorded by field personnel. No TENORM was observed.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  No drainages were located on or adjacent to the Target. An ephemeral drainage located approximately 100 feet to the northwest joins the Cove Middle 1E drainage, which is evaluated in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

  No exploratory borings were identified at the Target. The haul road crosses through the Target twice.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  No AUM or non-AUM Target features were identified. However, the haul road is AUM related, and the Target overlies the NORM-bearing Jml.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T27 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Sections 2.3 and 9.1.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 9.1.3 with results presented in Sections 9.1.6 and 9.1.7)
- Conducting a gamma radiation survey (results presented in Section 9.1.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



Non-AUM Target Site Boundary
Related Survey Area
Background Location
Access Route - Vehicular

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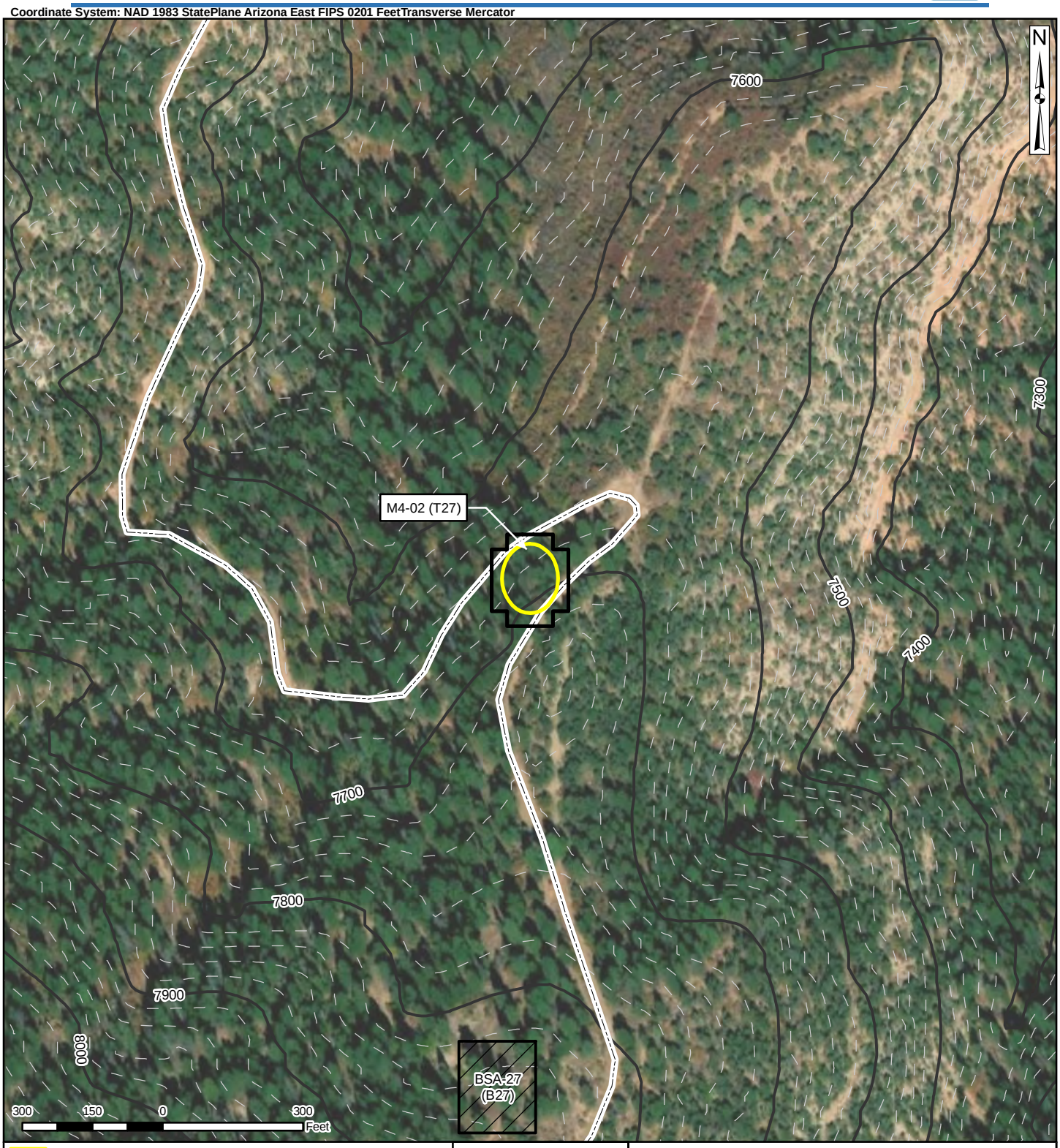
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NON-AUM TARGET M4-02 (T27) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I27-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

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



Non-AUM Target Site Boundary
Related Survey Area
Background Location
Access Route - Vehicular
100 ft Contour*
20 ft Contour*

* 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.

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NON-AUM TARGET M4-02 (T27) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I27-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

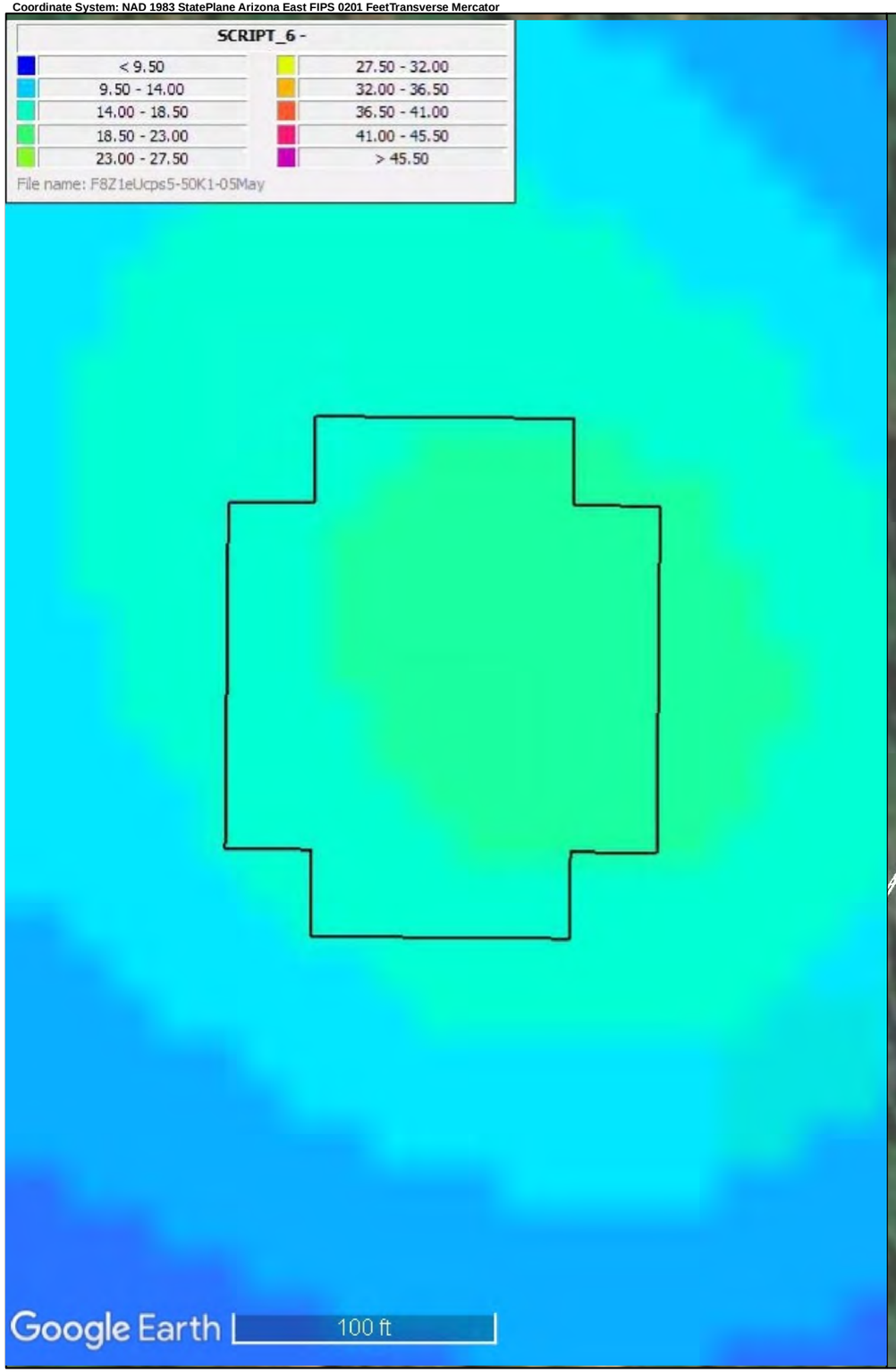
9.1.2 Gamma Radiation Survey and Field XRF Measurements

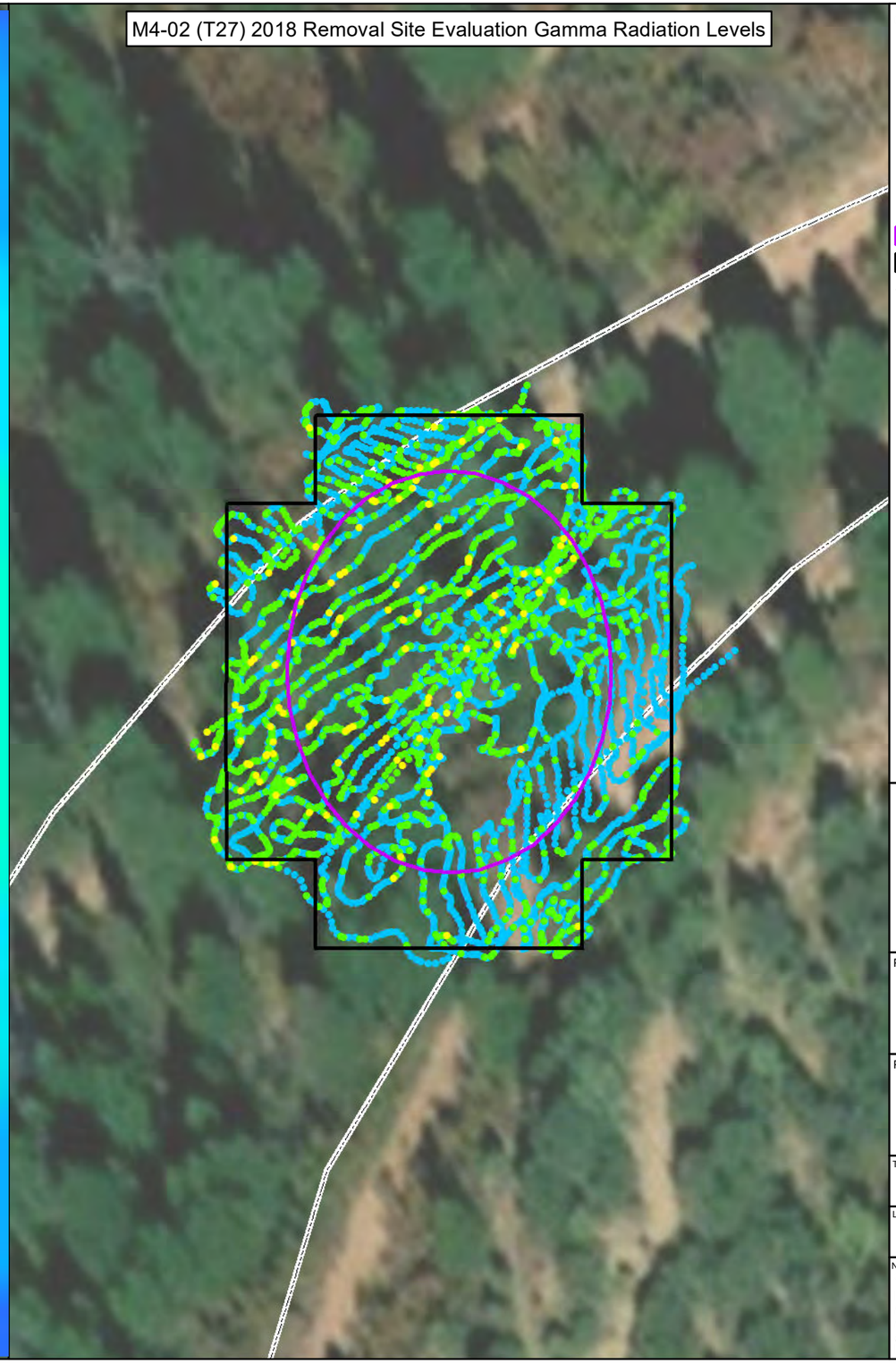
Tetra Tech performed GPS-based gamma radiation surveys (Figure I27-3) within the survey area of the non-AUM Target T27 as part of the Baseline Study in June 2018. Additional Goback gamma radiation surveys were not performed at Target T27. Tetra Tech also performed an XRF field survey at non-AUM Target T27 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I27-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 29, of the RSE Work Plan (Tetra Tech 2018). All gamma survey and XRF survey units were evaluated.

9.1.3 XRF Confirmation Sampling Overview

Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T27. Two XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from two locations (Table I27-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I27-4 and I27-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I27-2. The results of XRF confirmation sample analysis are provided in Section 9.1.6.1. Correlated XRF field measurements are provided in Attachment I3.

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





Gamma Reading (cpm)[1]

≤ 10,501	≤ Avg. BG
10,501 - 12,303	Avg. BG - 1 x BTV
12,303 - 24,606	1 x BTV - 2 x BTV
24,606 - 36,909	2 x BTV - 3 x BTV
36,909 - 49,212	3 x BTV - 4 x BTV
49,212 - 123,030	4 x BTV - 10 x BTV
≥ 123,030	≥ 10 x BTV

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Vehicular

[1]The applied gamma background threshold value (BTV) for M4-02 (T27) Non-AUM Target is 12,303 cpm derived from BSA-27 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 50 ft

1:600

N W E S

0 25 50 100 Feet

NON-AUM TARGET M4-02 (T27)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATON LEVELS
SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborne Spectral Photometric Environmental Collection Technology.

Figure No.: **I27-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

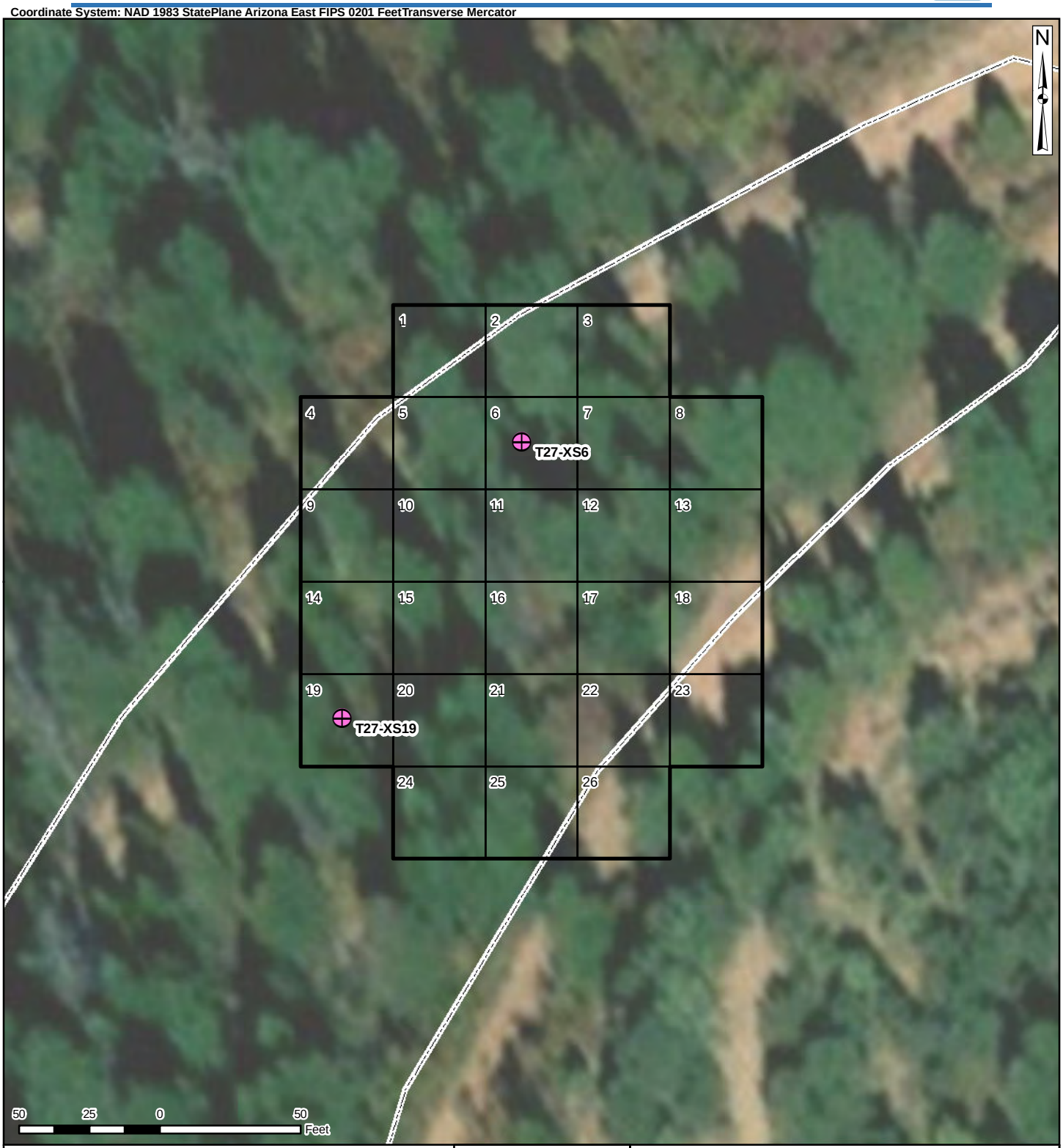
Prepared for: USEPA Region 9

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NON-AUM TARGET M4-02 (T27)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I27-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	



XRF Confirmation Soil Sample* (0 - 3 inches bgs)

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

*T27-XS8 = site T27 XRF confirmation soil sample collected at survey unit 8. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET M4-02 (T27)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I27-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

Table I27-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M4-02 (T27)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T27-XS6-01-061018	6	0-3	XRF Confirmation	Primary	6/10/2018	36.5234515	-109.2579966	1806226-11, 1806233-11
T27-XS19-01-061018	19	0-3	XRF Confirmation	Primary	6/10/2018	36.5231834	-109.2582170	1806226-10, 1806233-10

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I27-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M4-02 (T27)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

9.1.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 9.1.1, Target T27 surface geology is entirely within Jml with soils within the Yahmore-Sandark complex (MUSYM 604) (Figures I-24 and I-25). As a result, Background Study Area 27 (BSA-27) was selected for that combination of geology and soil type. Additionally, the Jml regional geological background would also be applicable for this Target. Table I27-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T27. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T27. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T27. The "Applied BTV" for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I27-3. Applied Background Threshold Values for Non-AUM Target M4-02 (T27)

Analyte	Units	Site-Specific BTV (BSA-27)	Regional BTV (Jml)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	4,780	7,000	4,780	Site Specific BTV
Antimony	mg/kg	0.099	0.140	0.099	Site Specific BTV
Arsenic	mg/kg	2.0	3.5	2.0	Site Specific BTV
Barium	mg/kg	122	270	122	Site Specific BTV
Beryllium	mg/kg	0.33	0.57	0.33	Site Specific BTV
Cadmium	mg/kg	0.163	0.160	0.160	Regional BTV
Calcium	mg/kg	7,000	32,000	7,000	Site Specific BTV
Chromium	mg/kg	4.5	5.2	4.5	Site Specific BTV
Cobalt	mg/kg	2.3	4.4	2.3	Site Specific BTV
Copper	mg/kg	5.7	12	5.7	Site Specific BTV
Iron	mg/kg	5,740	8,897	5,740	Site Specific BTV
Lead	mg/kg	8.8	11	8.8	Site Specific BTV
Lithium	mg/kg	6.5	8.8	6.5	Site Specific BTV
Magnesium	mg/kg	2,170	3,900	2,170	Site Specific BTV
Manganese	mg/kg	293	440	293	Site Specific BTV
Mercury	mg/kg	0.0461	0.0378	0.0378	Regional BTV
Molybdenum	mg/kg	0.23	0.29	0.23	Site Specific BTV
Nickel	mg/kg	3.9	6.2	3.9	Site Specific BTV
Potassium-40	pCi/g	23.4	26.9	23.4	Site Specific BTV
Radium-226	pCi/g	1.33	2.23	1.33	Site Specific BTV
Radium-228	pCi/g	0.65	0.75	0.65	Site Specific BTV
Selenium	mg/kg	0.71	0.99	0.71	Site Specific BTV
Silver	mg/kg	0.028	0.037	0.028	Site Specific BTV
Sodium	mg/kg	48	45	45	Regional BTV
Thallium	mg/kg	0.051	0.075	0.051	Site Specific BTV
Thorium	mg/kg	3.0	4.7	3.0	Site Specific BTV
Uranium	mg/kg	0.6	1.5	0.6	Site Specific BTV
Vanadium	mg/kg	11	24	11	Site Specific BTV
Zinc	mg/kg	28	27	27	Regional BTV
Gamma Radiation	cpm	12,303	14,566	12,303	Site Specific BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
Jml Morrison Formation (Lower)
mg/kg milligrams per kilogram
pCi/g picocuries per gram

9.1.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T27 and the raw gamma radiation and grid averaged gamma radiation survey results.

9.1.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T27 in June 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine if any additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. No additional scanning, measurements, or sampling were required. The applied gamma BTV for non-AUM Target T27 is 12,303 cpm. A total of 4,560 measurements were collected as part of the gamma radiation survey at non-AUM Target T27 across 26 survey units. An average scan density of 175 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I27-4.

Table I27-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M4-02 (T27)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	12,303	
Measurements	#	4,560	26
Minimum	cpm	7,056	9,226
Maximum	cpm	14,835	10,631
Average	cpm	10,147	10,127
Median	cpm	10,096	10,226
Standard Deviation	cpm	1,016	357
90th Percentile	cpm	11,464	10,514
95th Percentile	cpm	11,916	10,559
99th Percentile	cpm	12,826	10,616
Measurements per Survey Unit	#/grid	175	
Measurements Above Gamma BTV	#	115	0
Measurements Above Gamma BTV	%	2.5	0.0

Notes:
BTV background threshold value
cpm counts per minute

9.1.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 2.5 percent of the measurements within the Target boundaries, in some cases slightly exceeding the applied gamma BTV (12,303 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-27 (Jml) gamma survey results is provided on Figure I27-6. This graph shows that the spread of radiation data at Target T27 (shown on left) begins within the same range of BSA-27 (Jml) gamma levels (shown on right) and then rises to the top range of background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T27 is about the same as the data cloud from the BSA-27 (Jml) data set. A box plot showing the quartiles of the data sets is provided in Figure I27-7. The box plot shows that the median of Target T27 radiation levels is lower than the median of the BSA-27 (Jml) data set and lower than the applied gamma BTV.

A map showing the results of the 2018 RSE versus Weston site screening gamma radiation surveys is provided in Figure I27-8. No mining activity was observed within the survey area of Target T27. In general, Target T27 has surficial gamma radiation levels below BSA-27 (Jml) levels across the Target and surrounding area, indicating poor correlation with the area of elevated gamma activity identified by the ASPECT gamma survey (Figure I27-3). No TENORM or mining-related activities were observed. Section 9.1.5.3 presents the grid averaged results of the gamma radiation survey.

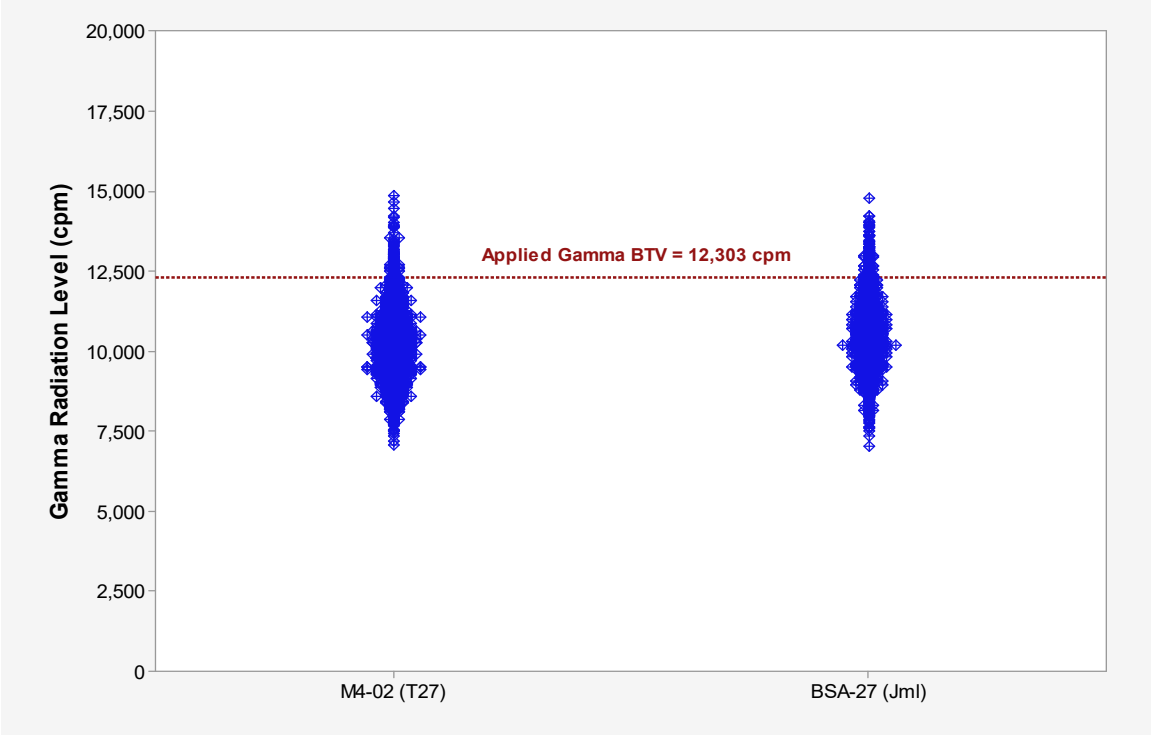


Figure I27-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M4-02 (T27) and BSA-27 (Jml)

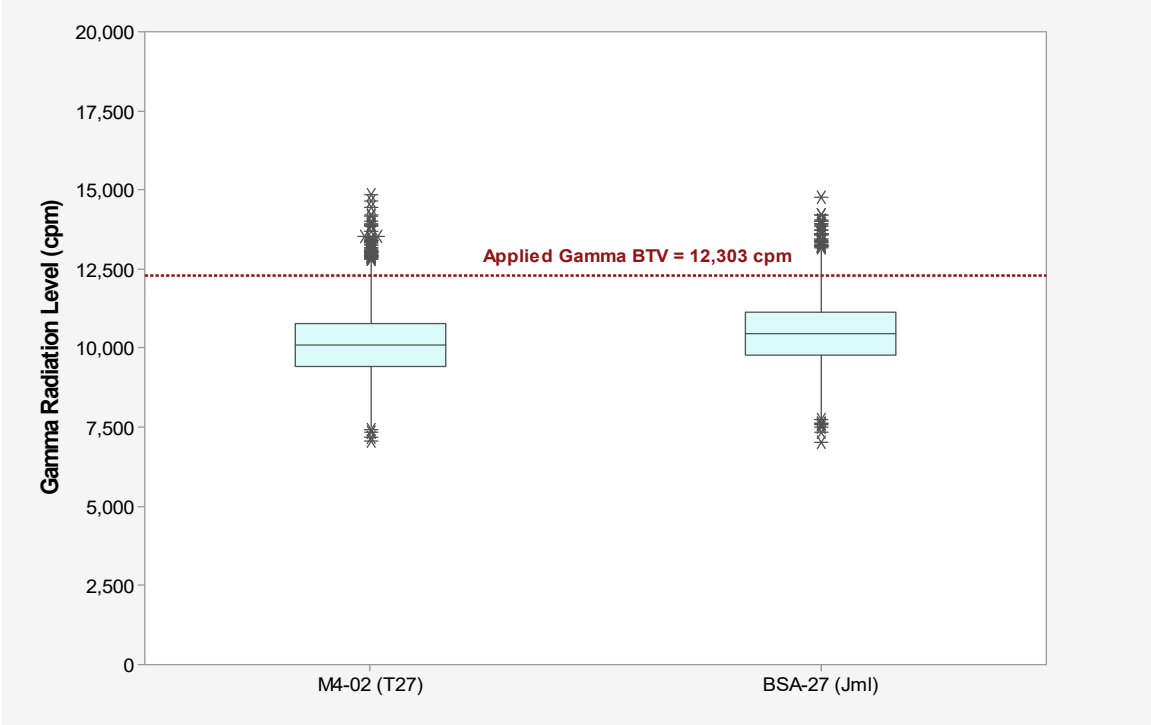
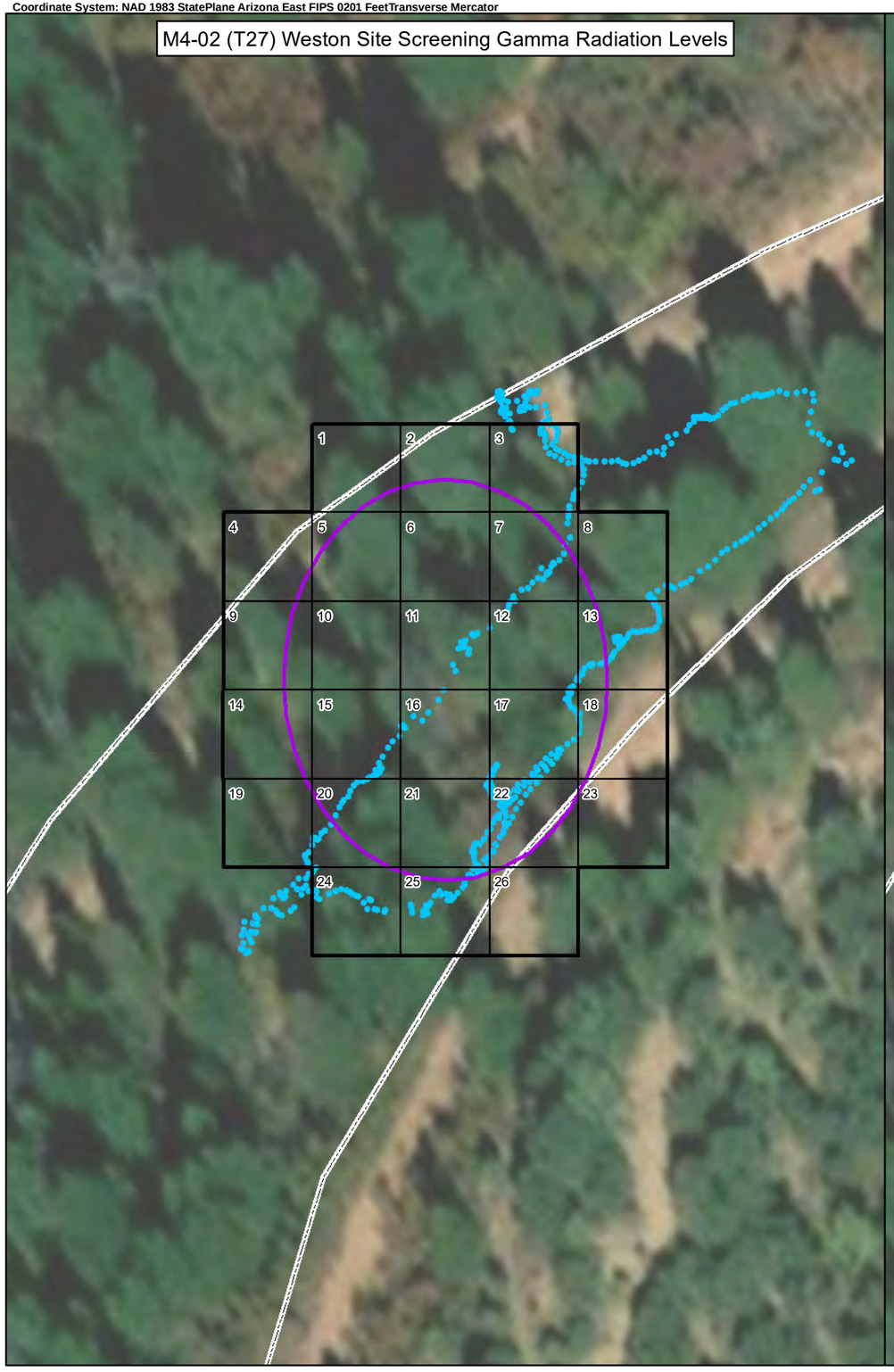
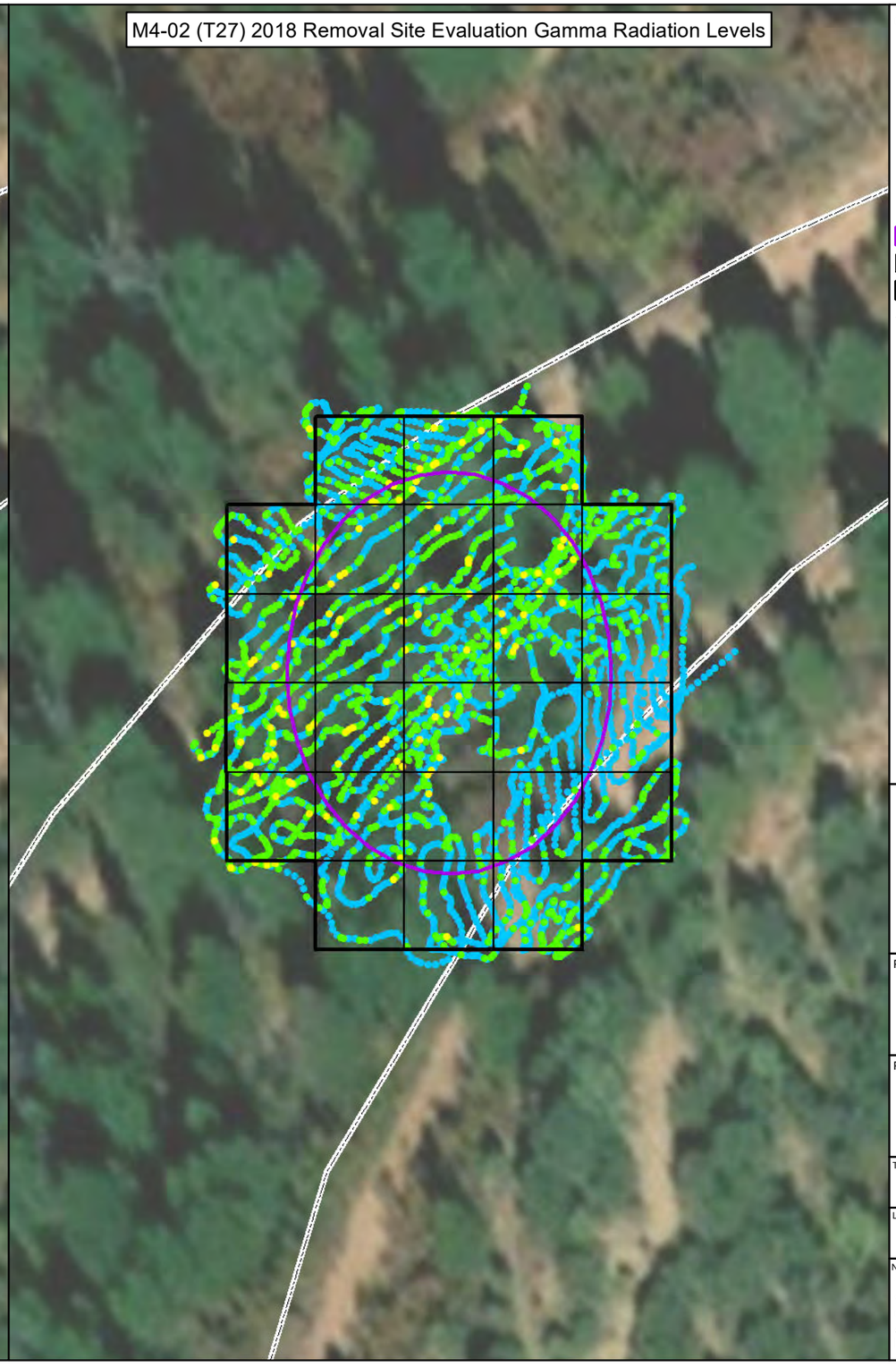


Figure I27-7. Box Plot of Raw Gamma Radiation Levels at Target M4-02 (T27) and BSA-27 (Jml)

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





Gamma Reading (cpm)*

≤ 10,501	≤ Avg. BG
10,501 - 12,303	Avg. BG - 1 x BTV
12,303 - 24,606	1 x BTV - 2 x BTV
24,606 - 36,909	2 x BTV - 3 x BTV
36,909 - 49,212	3 x BTV - 4 x BTV
49,212 - 123,030	4 x BTV - 10 x BTV
≥ 123,030	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Unit (100 m²)
Survey Area Boundary
Access Route - Vehicular

1 in = 50 ft

1:600

N
W E
S

0 25 50 100 Feet

NON-AUM TARGET M4-02 (T27)
2018 REMOVAL SITE EVALUATION
VS WESTON SITE SCREENING
GAMMA RADIATION LEVELS SURVEY MAP

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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019

Notes:
*The applied gamma background threshold value (BTV) for M4-02 (T27) is 12,303 cpm derived from BSA-27 as presented in Appendix A. Avg. BG: Average value of the background data set.

Figure No.: **I27-8**

9.1.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 9.1.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 9.1.5.1. Figure I27-9 and Figure I27-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-27 (Jml) data set (shown on right). No survey units within the survey area of Target T27 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I27-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I27-11 as discussed further in Section 2.8. No survey units exceeded the gamma BTV.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 9.1.6.

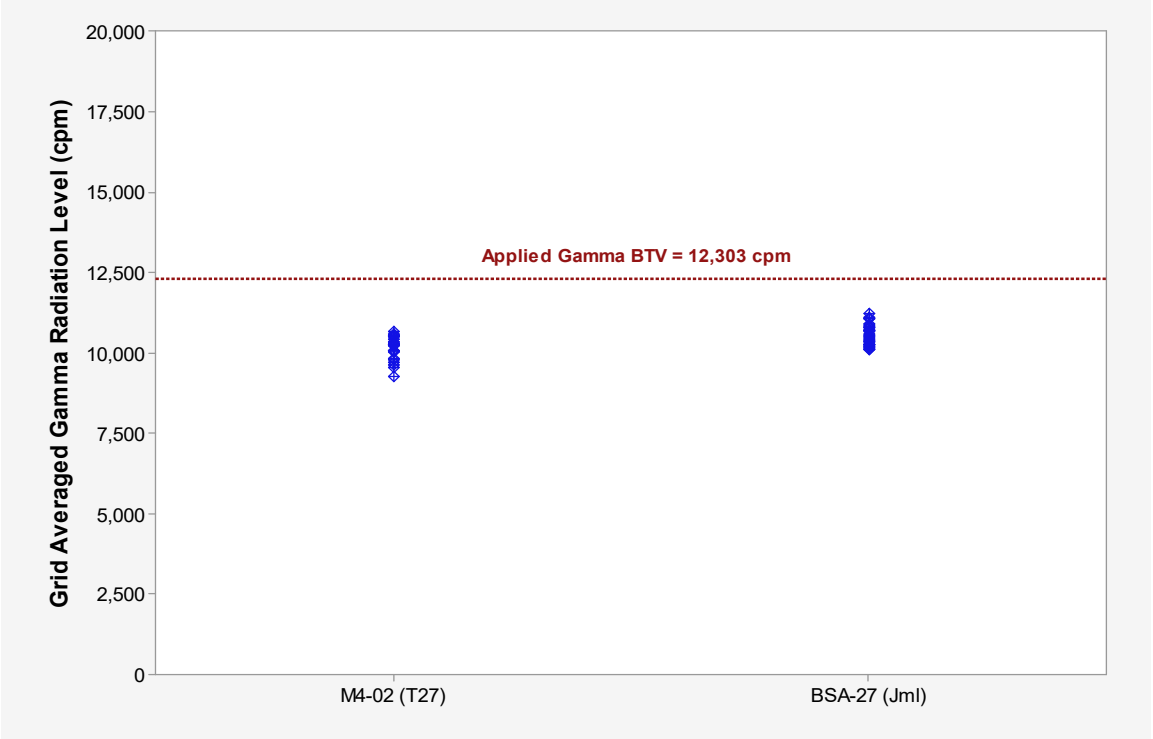


Figure I27-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M4-02 (T27) and BSA-27 (Jml)

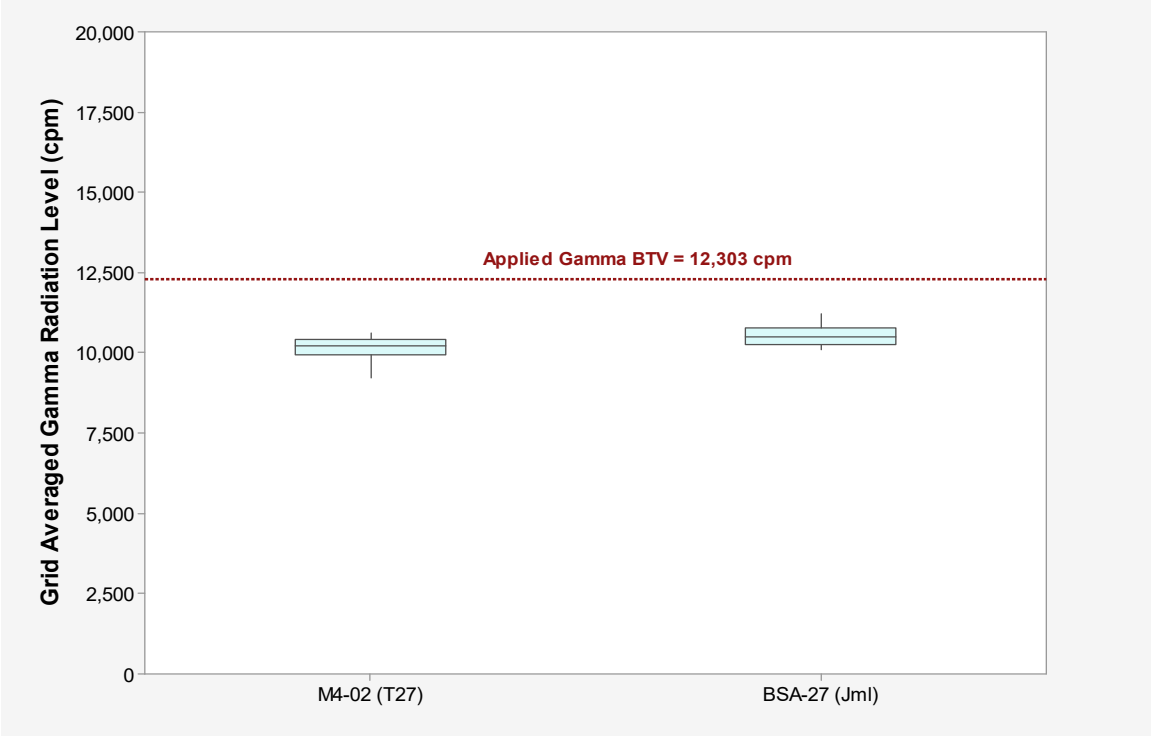


Figure I27-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M4-02 (T27) and BSA-27 (Jml)



Grid Averaged Gamma Reading (cpm)*

≤ 10,501	≤ Avg. BG
10,501 - 12,303	Avg. BG - 1 x BTV
12,303 - 24,606	1 x BTV - 2 x BTV
24,606 - 36,909	2 x BTV - 3 x BTV
36,909 - 49,212	3 x BTV - 4 x BTV
49,212 - 123,030	4 x BTV - 10 x BTV
≥ 123,030	≥ 10 x BTV

*The applied gamma background threshold value (BTV) for M4-02 is 12,303 cpm derived from BSA-27 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M4-02 (T27) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I27-11
Location: COVE CHAPTER NAVAJO NATION	Date: 7/9/2019	

9.1.6 Soil Sampling Results

This section presents the results of analyses for soil within the survey area of Target T27. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 9.1.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 9.1.6.2.

9.1.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T27: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I27-1 and I27-2. All the results of the XRF confirmation soil samples are presented in Table I27-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T27 following the methods outlined in Section 2.4 and shown in Figure I27-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 26 measurements were collected across 26 survey units from the survey area of Target T27 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I27-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T27 at a depth of 0 to 3 inches bgs. Two XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I27-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 9.1.7.

Table I27-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M4-02 (T27)

Analyte	Units	Applied BTV	T27-XS19-01-061018		T27-XS6-01-061018	
			Result	Q	Result	Q
Survey Unit			X19		X6	
Aluminum	mg/kg	4,780	2,800		3,600	
Antimony	mg/kg	0.099	<0.098	U	<0.1	U
Arsenic	mg/kg	2	1.2		1.6	
Barium	mg/kg	122	58		87	
Beryllium	mg/kg	0.33	0.19		0.26	
Cadmium	mg/kg	0.160	0.039	J	0.087	J
Calcium	mg/kg	7,000	1,600		3,100	
Chromium	mg/kg	4.5	2.8		3.5	
Cobalt	mg/kg	2.3	1.5		2.2	
Copper	mg/kg	5.7	2.6		4.4	
Iron	mg/kg	5,740	4,000		4,700	
Lead	mg/kg	8.8	4.3		7.9	
Lithium	mg/kg	6.5	3.6		4.8	
Magnesium	mg/kg	2,170	1,100		1,700	
Manganese	mg/kg	293	130		250	
Molybdenum	mg/kg	0.23	0.12	J	0.16	J
Nickel	mg/kg	3.9	2.2		3.4	
Potassium-40	pCi/g	23.4	16.6		18.5	J+
Radium-226	pCi/g	1.33	0.79	LT	0.91	J+
Radium-228	pCi/g	0.65	<0.61	U	<0.57	UJ
Selenium	mg/kg	0.71	0.42	J	0.54	J
Silver	mg/kg	0.028	<0.049	U	0.01	J
Sodium	mg/kg	45	18	J	30	J
Thallium	mg/kg	0.051	0.032		0.046	
Thorium	mg/kg	3.0	2.4		2.3	
Uranium	mg/kg	0.6	0.42		0.72	
Vanadium	mg/kg	11	7.7		8.7	
Zinc	mg/kg	27	9.3	J	13	

Notes:

BTV	Background threshold value
ID	Identification
J	Estimated value
J-	Estimated value, may be biased low
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	Qualification
U	Not considered detected. The associated value is the method detection limit (MDL).
UJ	Not considered detected. The associated value is the reported concentration, which is estimated.

Table I27-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M4-02 (T27)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2	5,740	8.8	293	0.23	3	0.6	11	27
Measurements	#	26	26	26	26	26	26	26	26	26
Detects	#	1	26	26	26	20	22	15	8	26
Nondetects	#	25	0	0	0	6	4	11	18	0
Minimum	mg/kg	2.2	2,474	1.4	145.8	0.5	1.0	0.2	16.9	14.7
Maximum	mg/kg	2.2	6,524	15.3	526.9	5.3	2.9	2.1	27.3	32.9
Standard Deviation	mg/kg	-	1,009	3.0	105	1.52	0.6	0.6	4	4.3
Average	mg/kg	2.2	4,261	6.6	263	2.17	2.1	1.0	19.9	20.8
Median	mg/kg	2.2	4,233	6.7	216	1.58	2.1	1.2	18.1	19.9
Relative Standard Deviation	%	-	23.7	45.1	39.8	70.2	28.8	58.0	20.2	20.6
90th Percentile	mg/kg	2.2	5,503	10.0	414	4.2	2.8	1.7	26	27
95th Percentile	mg/kg	2.2	5,814	10.3	434	4.5	2.9	1.9	27	28
99th Percentile	mg/kg	2.2	6,360	14.1	505	5.2	2.9	2.0	27	32
Measurements Above Applied BTV	#	1	2	4	7	20	0	11	8	3
Measurements Above Applied BTV	%	3.8	7.7	15.4	26.9	76.9	0.0	42.3	30.8	11.5

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value
mg/kg Milligram per kilogram
XRF X-ray fluorescence

9.1.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T27 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T27 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T27. The estimated BTVs are identified in Section 9.1.4 and Table I27-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I27-7 presents a summary of the background comparison for different measurement and soil depths at Target T27. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T27. Further gamma radiation screening indicated that gamma levels at Target T27 are similar to those at the BSA. Therefore, while multiple COPCs have been identified at Target T27 based on a comparison to background, risk screening will be required to support a future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I27-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M4-02 (T27)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic			
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron		✓	✓
Lead		✓	✓
Lithium			✓
Magnesium			
Manganese		✓	✓
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium			
Silver			
Sodium			
Thallium			
Thorium			
Uranium	✓	✓	✓
Vanadium		✓	✓
Zinc		✓	✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

9.1.7 Primary Contaminant Mapping

9.1.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 9.1.6.2 identified the COPCs at Target T27. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 9.1.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I27-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T27 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 9.1.7.1 through Section 9.1.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T27. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

9.1.7.2 Arsenic

Arsenic was not identified as a COPC in surface soils as shown in Table I27-7. Arsenic exceeded the applied BTV in 3.8 percent of in situ XRF measurements, but not XRF confirmation samples. The applied BTV for arsenic is 2 mg/kg for Target T27 as presented in Section 9.1.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I27-5 and Attachment I3, respectively. Insufficient XRF detections were available for statistical plots. Summary statistics for XRF measurements are provided in Section 9.1.6.1. Arsenic concentrations in XRF confirmation samples ranged from 1.2 mg/kg to 1.6 mg/kg and the one in situ XRF measurement was 2.2 mg/kg.

A soil contaminant map showing the individual arsenic concentrations observed at Target T27 from XRF confirmation samples is provided in Figure 27-12. Two of the three arsenic-detected values were less than the applied BTV. However, the one exceedance was not significantly higher than the applied BTV and does not appear to be associated with mining-related materials at Target T27.

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



Arsenic Concentration Scale (mg/kg)*

- ≤ 1.4
- 1.4 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- 6.0 - 8.0
- 8.0 - 20
- ≥ 20
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M4-02 (T27) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I27-12
Location: COVE CHAPTER NAVAJO NATION	Date: 6/21/2019	

9.1.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I27-7. Lead exceeded the applied BTV in 15.4 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for lead is 8.8 mg/kg for Target T27 as presented in Section 9.1.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I27-5 and Attachment I3, respectively. Figure I27-13 presents an individual value plot of detectable lead XRF soil concentrations for Target T27 and BSA-27 (Jml) samples. Figure I27-14 presents a box plot of detectable lead XRF soil concentrations for Target T27 and BSA-27 (Jml) samples. Summary statistics for XRF measurements are provided in Section 9.1.6.1. Lead XRF concentrations measured in surface soils at Target T27 ranged between 1.4 and 15.3 mg/kg with an average and standard deviation of 6.6 mg/kg and 3.0 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T27 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I27-15. Overall, the majority of detectable lead results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T27.

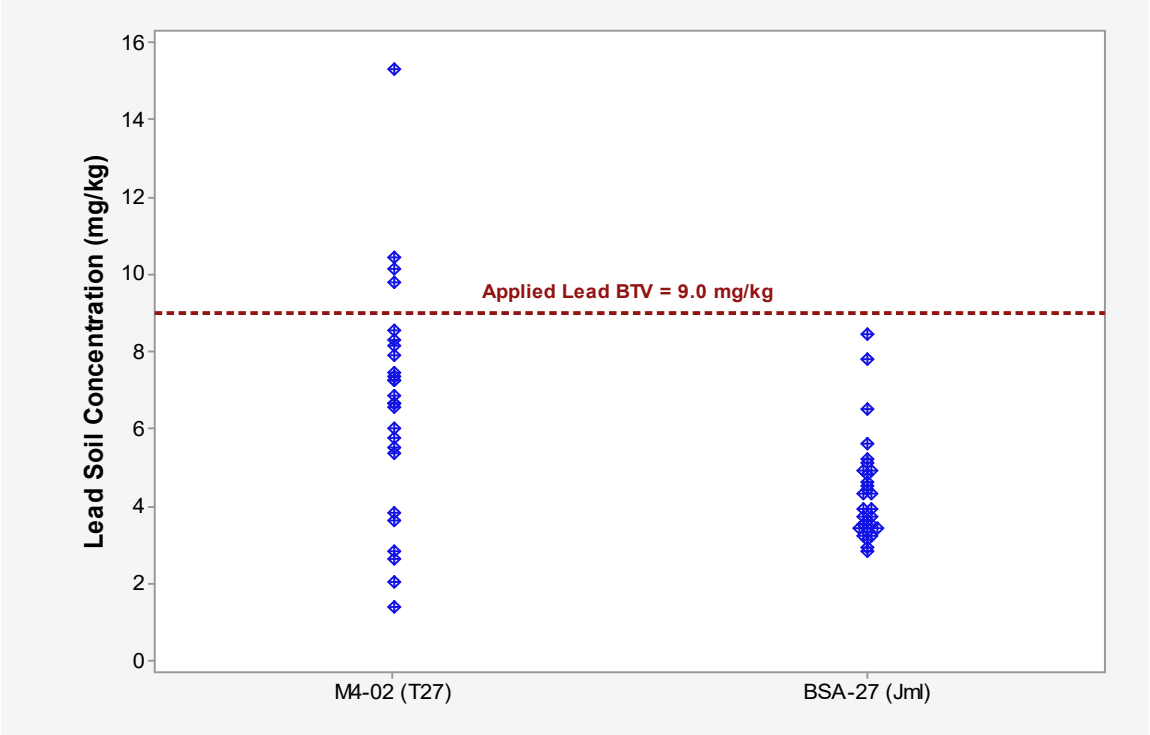


Figure I27-13. Individual Value Plot for Target M4-02 (T27) and BSA-27 (Jml) Lead Soil Concentrations

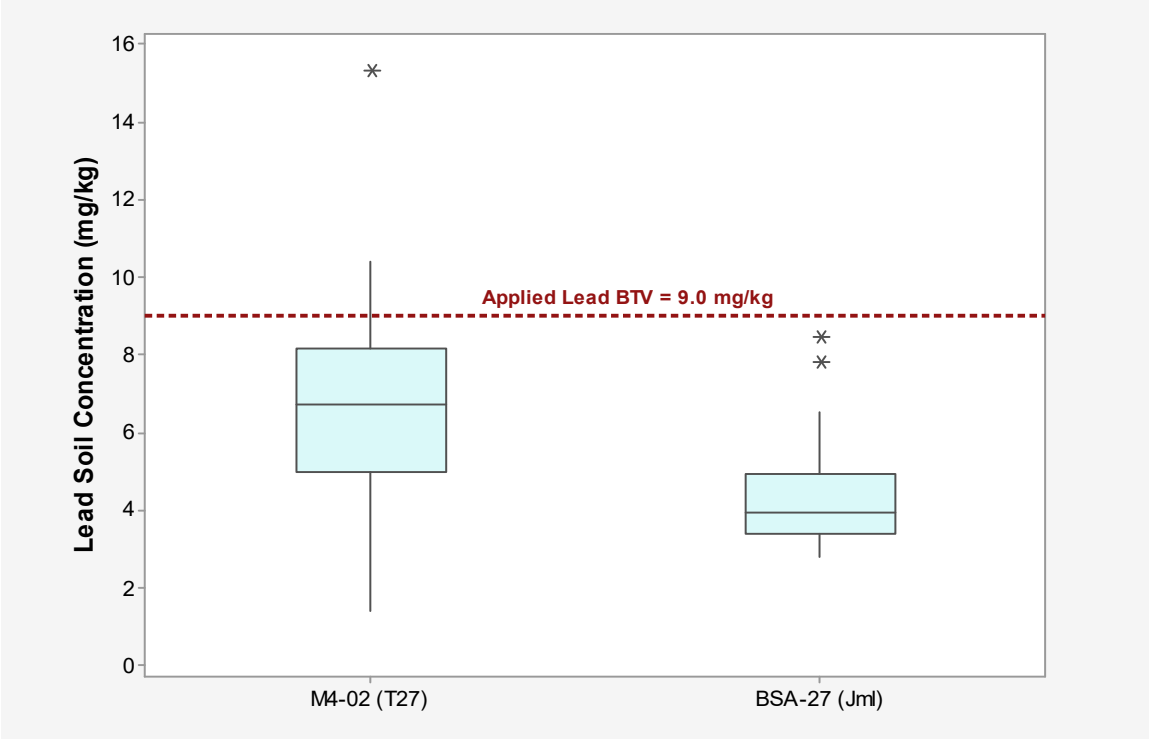


Figure I27-14. Box Plot for Target M4-02 (T27) and BSA-27 (Jml) Lead Soil Concentrations

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



Lead Concentration Scale (mg/kg)*

- ≤ 4.3
- 4.3 - 8.8
- 8.8 - 18
- 18 - 26
- 26 - 35
- 35 - 88
- ≥ 88

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M4-02 (T27) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I27-15
Location: COVE CHAPTER NAVAJO NATION	Date: 6/26/2019	

9.1.7.4 Thorium

Thorium was not identified as a COPC in surface soil as shown in Table I27-7. Thorium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for thorium is 3.0 mg/kg for Target T27 as presented in Section 9.1.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I27-5 and Attachment I3, respectively. Figure I27-16 presents an individual value plot of detectable thorium XRF soil concentrations for Target T27 and BSA-27 (Jml) samples. Figure I27-17 presents a box plot of detectable thorium XRF soil concentrations for Target T27 and BSA-27 (Jml) samples. Summary statistics for XRF measurements are provided in Section 9.1.6.1. Thorium XRF concentrations measured in surface soils at Target T27 ranged between 1.0 and 2.9 mg/kg with an average and standard deviation of 2.1 mg/kg and 0.6 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T27 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I27-18. All thorium results in surface soils were less than the applied BTV.

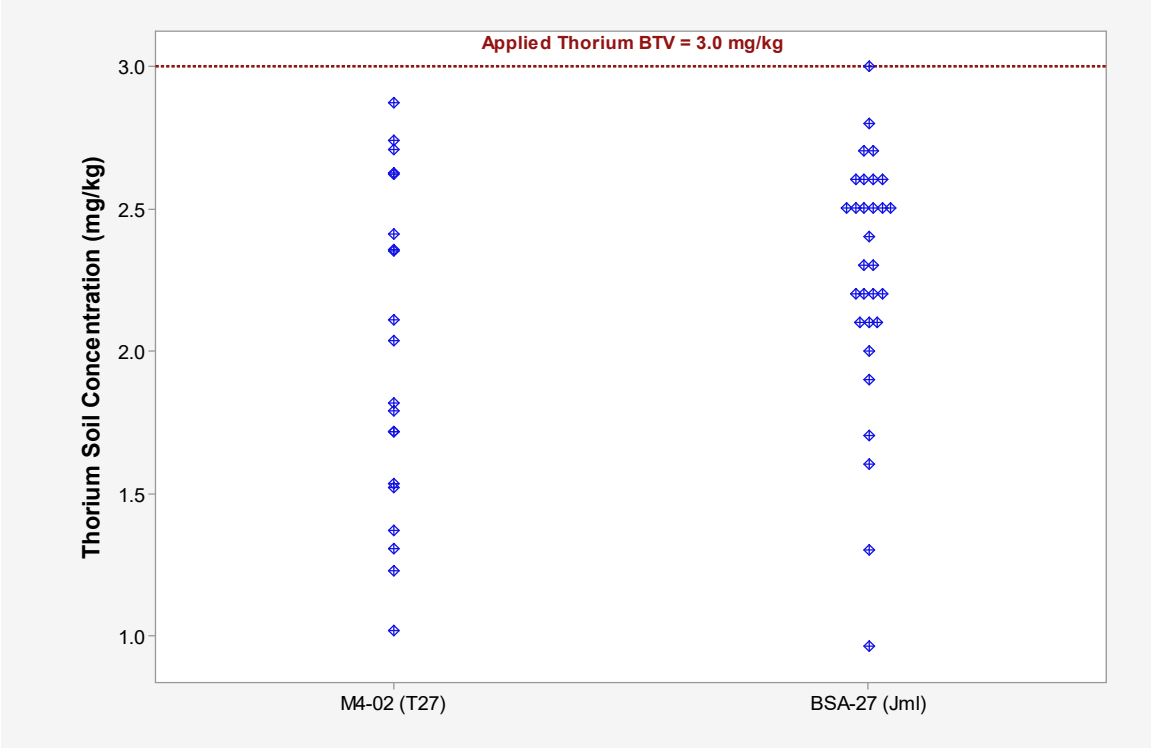


Figure I27-16. Individual Value Plot for Target M4-02 (T27) and BSA-27 (Jml) Thorium Soil Concentrations

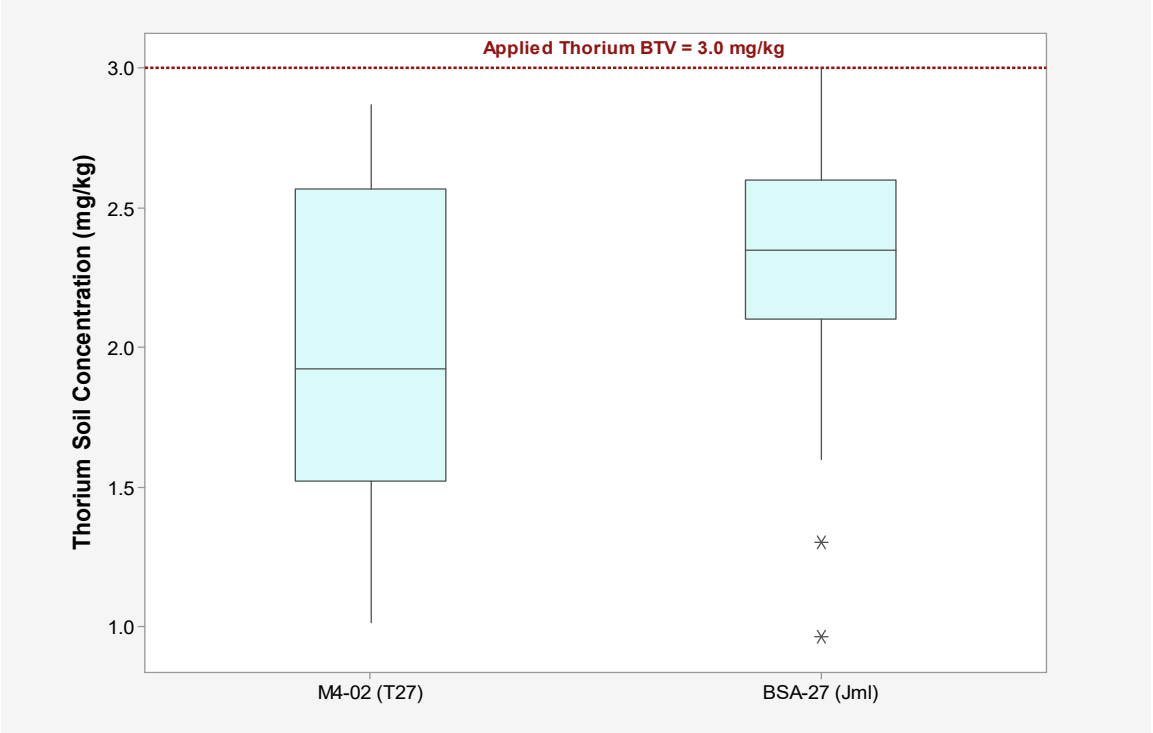


Figure I27-17. Box Plot for Target M4-02 (T27) and BSA-27 (Jml) Thorium Soil Concentrations

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



Thorium Concentration Scale (mg/kg)*

- ≤ 2.3
- 2.3 - 3.0
- 3.0 - 6.0
- 6.0 - 9.0
- 9.0 - 12
- 12 - 30
- ≥ 30
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M4-02 (T27) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I27-18
Location: COVE CHAPTER NAVAJO NATION	Date: 6/21/2019	

9.1.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I27-7. Uranium exceeded the applied BTV in 42.3 percent of in situ XRF measurements and in one of the two XRF confirmation samples. The applied BTV for uranium is 0.6 mg/kg for Target T27 as presented in Section 9.1.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I27-5 and Attachment I3, respectively. Figure I27-19 presents an individual value plot of detectable uranium XRF soil concentrations for Target T27 and BSA-27 (Jml) samples. Figure I27-20 presents a box plot of detectable uranium XRF soil concentrations for Target T27 and BSA-27 (Jml) samples. Summary statistics for XRF measurements are provided in Section 9.1.6.1. Uranium XRF concentrations measured in surface soils at Target T27 ranged between 16.9 and 27.3 mg/kg with an average and standard deviation of 1.0 mg/kg and 0.6 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T27 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I27-21. Overall, the majority of detectable uranium results in surface soils were above the applied BTV. However, the maximum XRF value was 3.5 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T27.

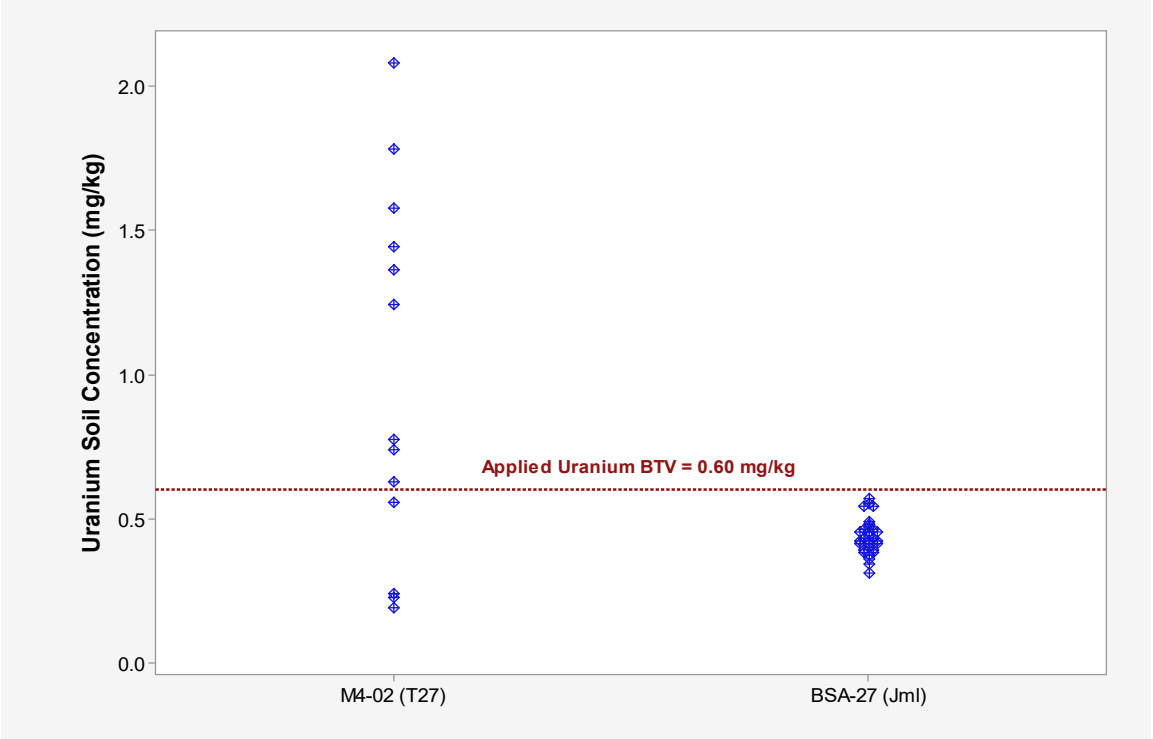


Figure I27-19. Individual Value Plot for Target M4-02 (T27) and BSA-27 (Jml) Uranium Soil Concentrations

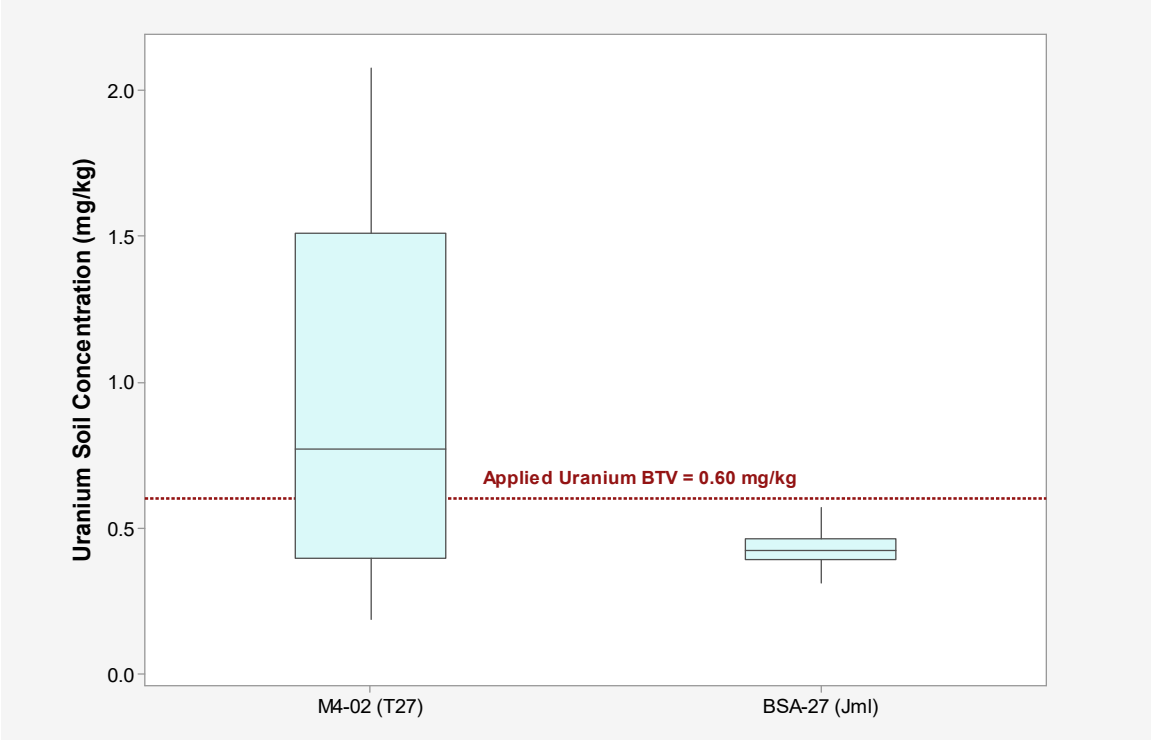


Figure I27-20. Box Plot for Target M4-02 (T27) and BSA-27 (Jml) Uranium Soil Concentrations

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



Uranium Concentration Scale (mg/kg)*

- ≤ 0.43
- 0.43 - 0.60
- 0.60 - 1.2
- 1.2 - 1.8
- 1.8 - 2.4
- 2.4 - 6.0
- ≥ 6.0
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M4-02 (T27) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I27-21
Location: COVE CHAPTER NAVAJO NATION	Date: 6/21/2019	

9.1.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I27-7. Vanadium exceeded the applied BTV in 30.8 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for vanadium is 11 mg/kg for Target T27 as presented in Section 9.1.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I27-5 and Attachment I3, respectively. Figure I27-22 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T27 and BSA-27 (Jml) samples. Figure I27-23 presents a box plot of detectable vanadium XRF soil concentrations for Target T27 and BSA-27 (Jml) samples. Summary statistics for XRF measurements are provided in Section 9.1.6.1. Vanadium XRF concentrations measured in surface soils at Target T27 ranged between 16.9 and 27.3 mg/kg with an average and standard deviation of 19.9 mg/kg and 4.0 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T27 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I27-24. Overall, the majority of detectable vanadium results in surface soils were above the applied BTV. However, the maximum XRF value was 2.5 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T27.

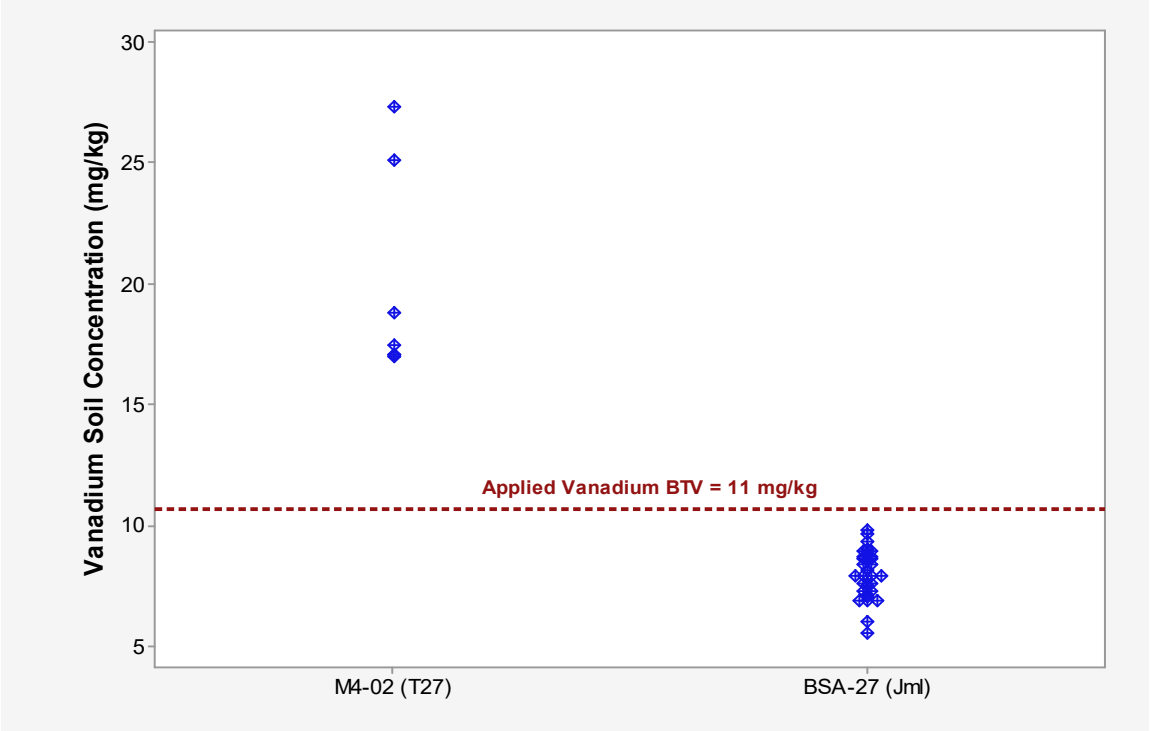


Figure I27-22. Individual Value Plot for Target M4-02 (T27) and BSA-27 (Jml) Vanadium Soil Concentrations

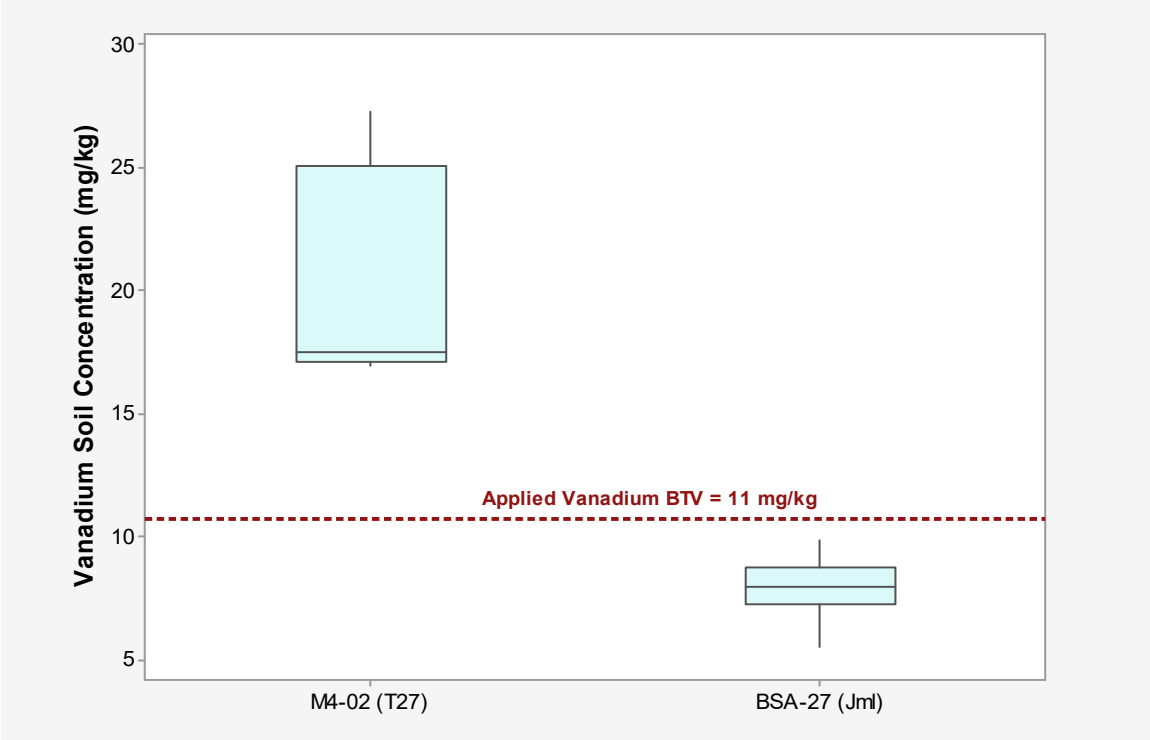


Figure I27-23. Box Plot for Target M4-02 (T27) and BSA-27 (Jml) Vanadium Soil Concentrations

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



Vanadium Concentration Scale (mg/kg)*

- ≤ 8.0
- 8.0 - 11
- 11 - 22
- 22 - 33
- 33 - 44
- 44 - 110
- ≥ 110
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Vehicular

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NON-AUM TARGET M4-02 (T27) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I27-24
Location: COVE CHAPTER NAVAJO NATION	Date: 6/21/2019	

9.1.8 Conclusions

Target T27 (M4-02) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T27. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T27 are:

- Potential mining-related sources of gamma radiation identified in ASPECT and MCAP gamma surveys were evaluated at Target T27. ASPECT gamma survey results generally did not correlate with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T27 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T27 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. No grid averaged gamma measurements exceeded the applied BTV.
- A total of 26 analytes were identified as occurring within the surface environment. Of these analytes, 8 were identified as COPCs. Only uranium and vanadium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T27 does not contain TENORM. No mining-related activities or features were observed in the field, and no historical exploratory borings, vents, or other mine openings were noted in the file review or during field observation. NORM was not identified visually or by gamma survey.
- There are no immediate significant physical hazards present at Target T27.
- Access is by dirt road with a small four-wheel-drive vehicle followed by footpath.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No existing groundwater wells are documented within the vicinity of Target T27. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T27. Therefore, evaluation of the leachability of metals and radionuclides is not required.

- No mine waste was observed at Target T27; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; no data gaps remain at Target T27.

10.0 GROUP H FIELD SAMPLING RESULTS

This section presents field sampling results for Group H Targets T30 (M1-07), T31 (M1-08), and T32 (M2-01). No other non-AUM Targets are located within Group H.

10.1 NON-AUM TARGET T30 (M1-07)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T30 (M1-07).

10.1.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T30 (M1-07) is in the Lukachukai Mountains Region in Subarea Group H and administered by the Lukachukai Chapter of the Navajo Nation. The Target is accessible by foot and located 0.25 mile off of Indian Route 33. Target T30 is identified in the MCAP (Weston 2016), but no historical information is associated with the Target. No residential structures are near the Target. A Target location and access map for Target T30 is shown in Figure I30-1

A topographical relief map for Target T30 is provided in Figure I30-2. The elevation at Target T30 ranges from 7,810 to 7,863 feet amsl with an average of 7,832 feet amsl. The slope at Target T30 ranges from 15 to 31 percent with an average of 20 percent. Target T30 is within Jml and within the Narbona-Zilditloi soil complex (MUSYM 608) (Figures I-26 and I-27).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover data to determine the RSE survey area for Target T30. ASPECT imagery was used to guide the sampling approach, which is specified in Appendix F, FSP 39, of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T30:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T30 is accessed by driving a four-wheel-drive vehicle and hiking off-trail for 0.25 mile off of Indian Route 33.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM was observed at the Target, but not verified. The underlying geology is the NORM-bearing Jml. No TENORM was observed.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  An ephemeral drainage was located below the Target. Middle 3A drainage, which is discussed in Appendix J of the RSE Report, is located 0.25 mile downstream of the Target.

- Identified any exploration borings or historic haul roads:

  No exploratory borings or haul roads were identified within the Target boundary.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  No AUM or non-AUM Target features were observed in the field, but NORM was observed at the Target. The underlying geology is the NORM-bearing Jml, which may contribute to elevated gamma readings.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

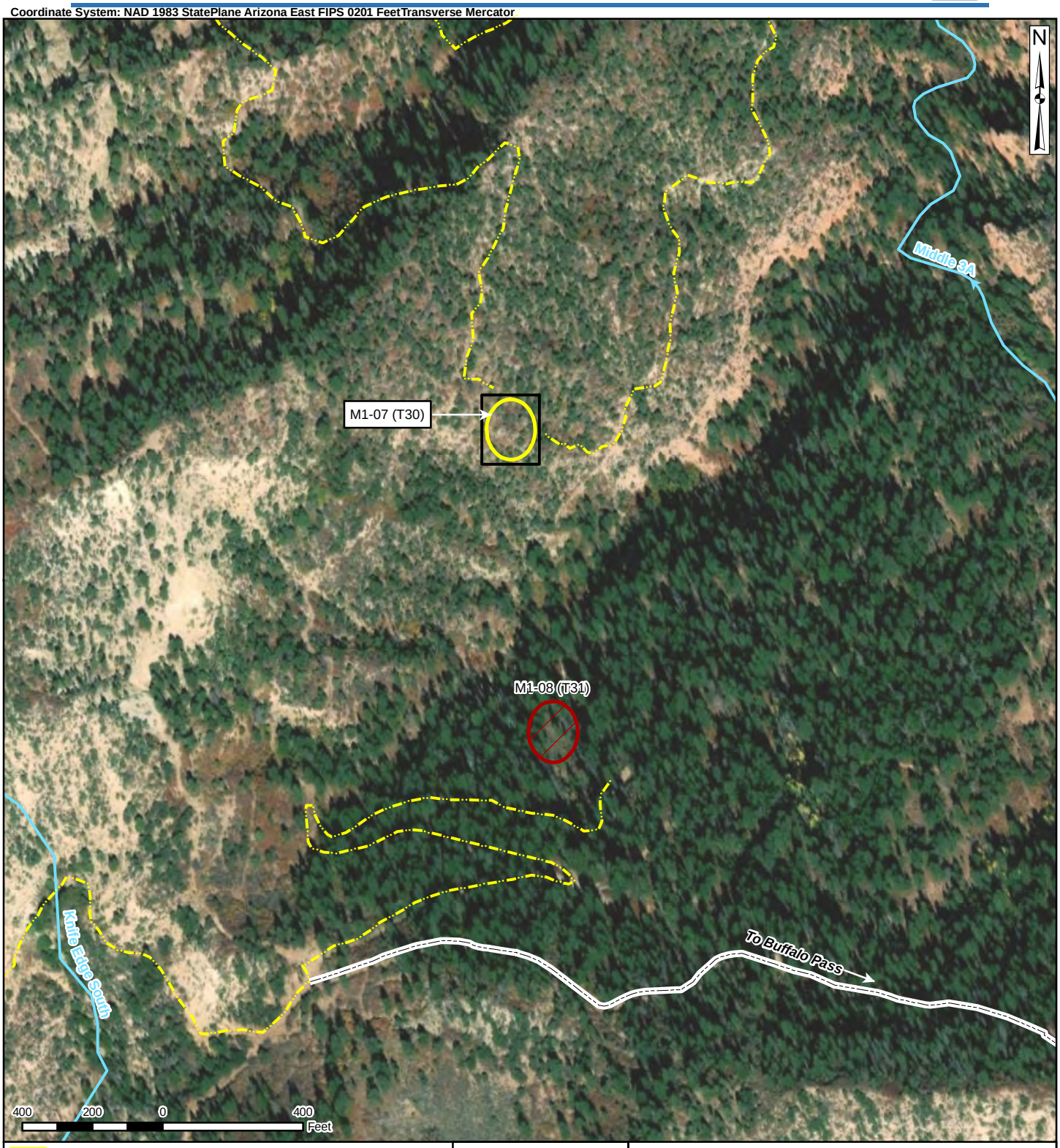
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T30 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Sections 2.3 and 10.1.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 10.1.3 with results presented in Sections 10.1.6 and 10.1.7)
- Conducting a gamma radiation survey (results presented in Section 10.1.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped

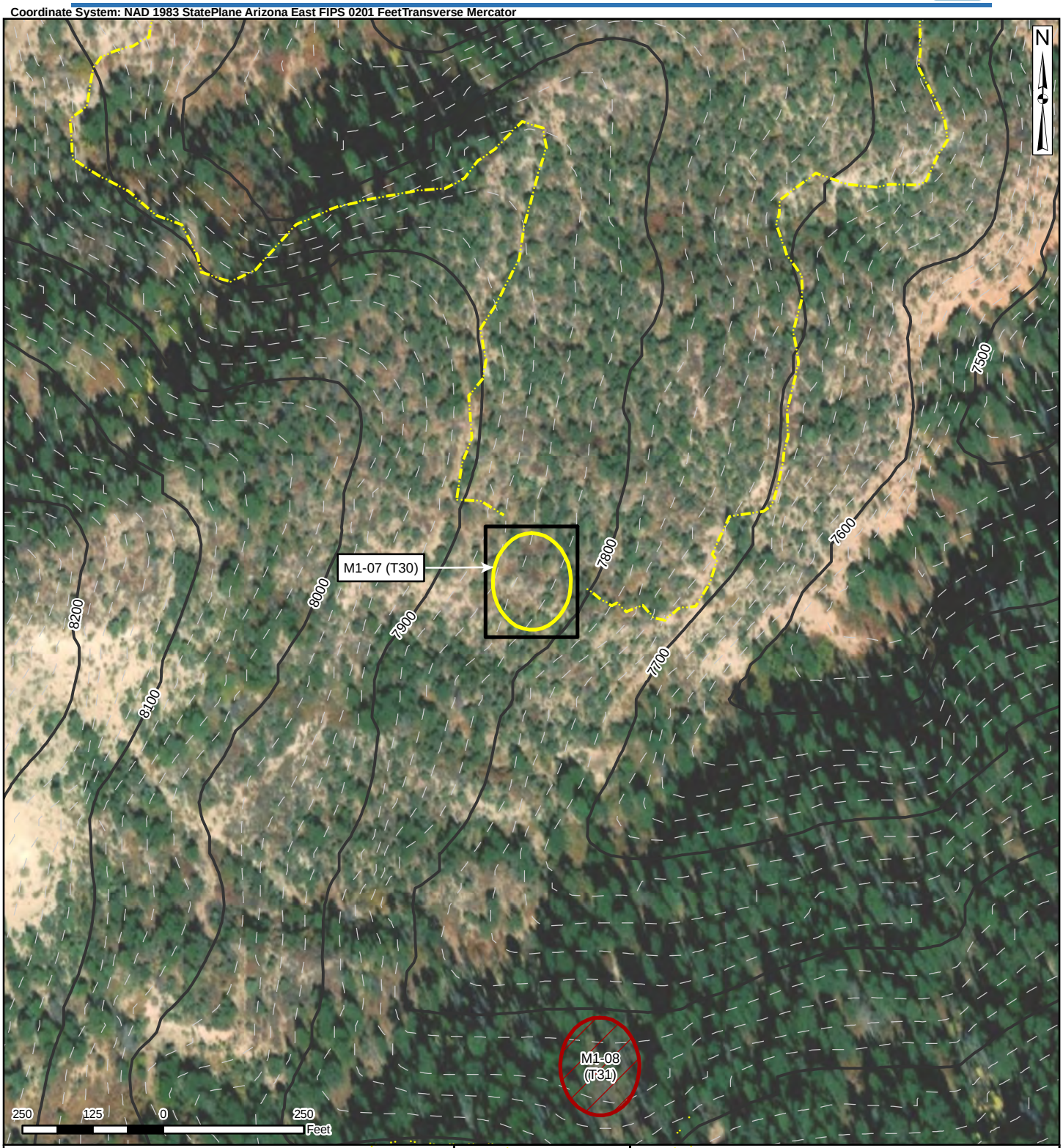
Prepared for: USEPA Region 9

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NON-AUM TARGET M1-07 (T30) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I30-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Access Route - Foot
100 ft Contour*
20 ft Contour*

* 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.

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NON-AUM TARGET M1-07 (T30) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I30-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.1.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I30-3) within the survey area of the non-AUM Target T30 as part of the Baseline Study in September 2018. Additional Goback gamma radiation surveys were not performed at Target T30. Tetra Tech also performed an XRF field survey at non-AUM Target T30 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I30-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 39, of the RSE Work Plan (Tetra Tech 2018). All gamma survey and XRF survey units were evaluated.

10.1.3 XRF Confirmation Sampling Overview

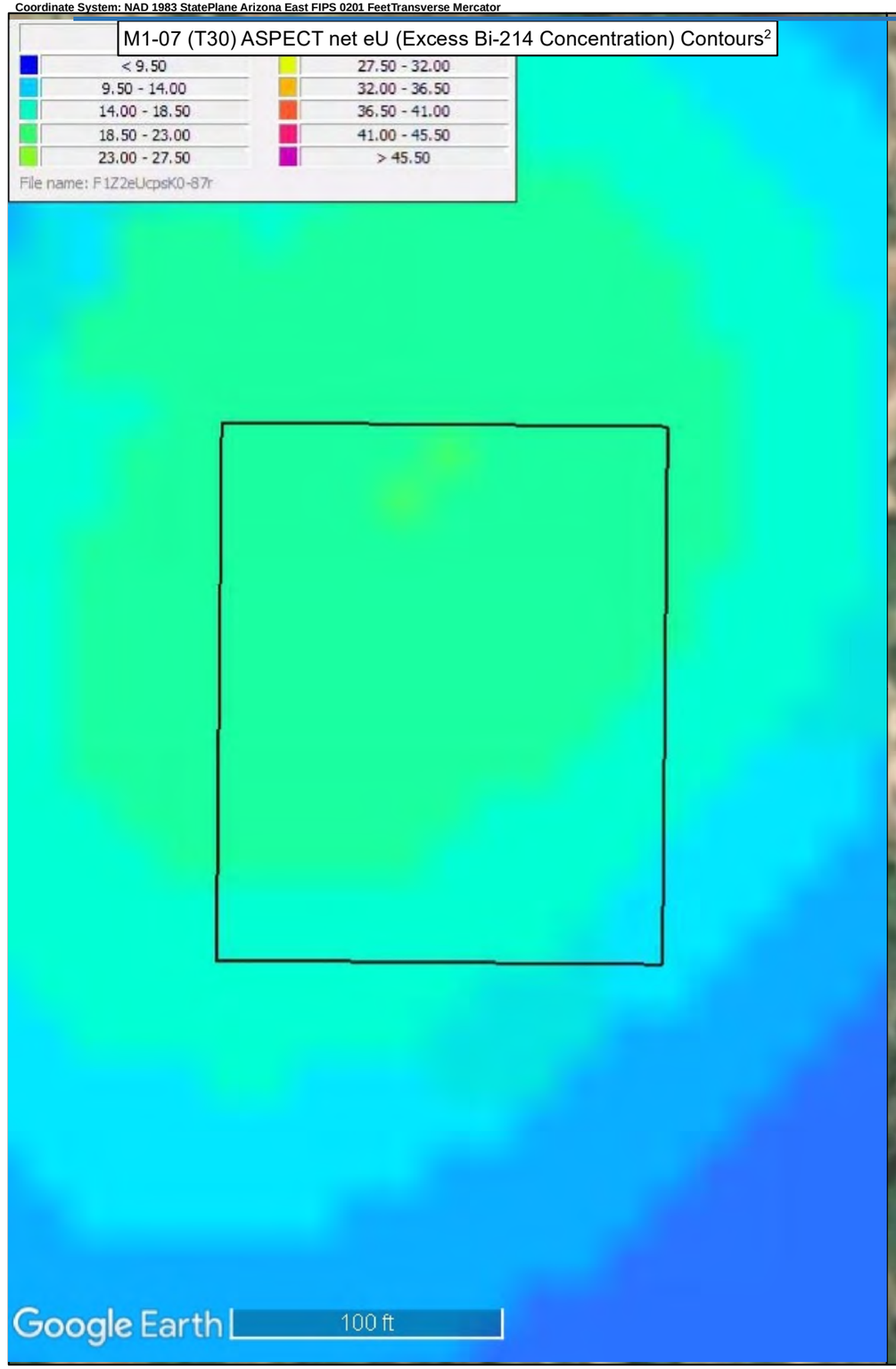
Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T30. Three XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from three locations (Table I30-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey Figures I30-4 and I30-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I30-2. The results of XRF confirmation sample analysis are provided in Section 10.1.6.1. Correlated XRF field measurements are provided in Attachment I3.

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

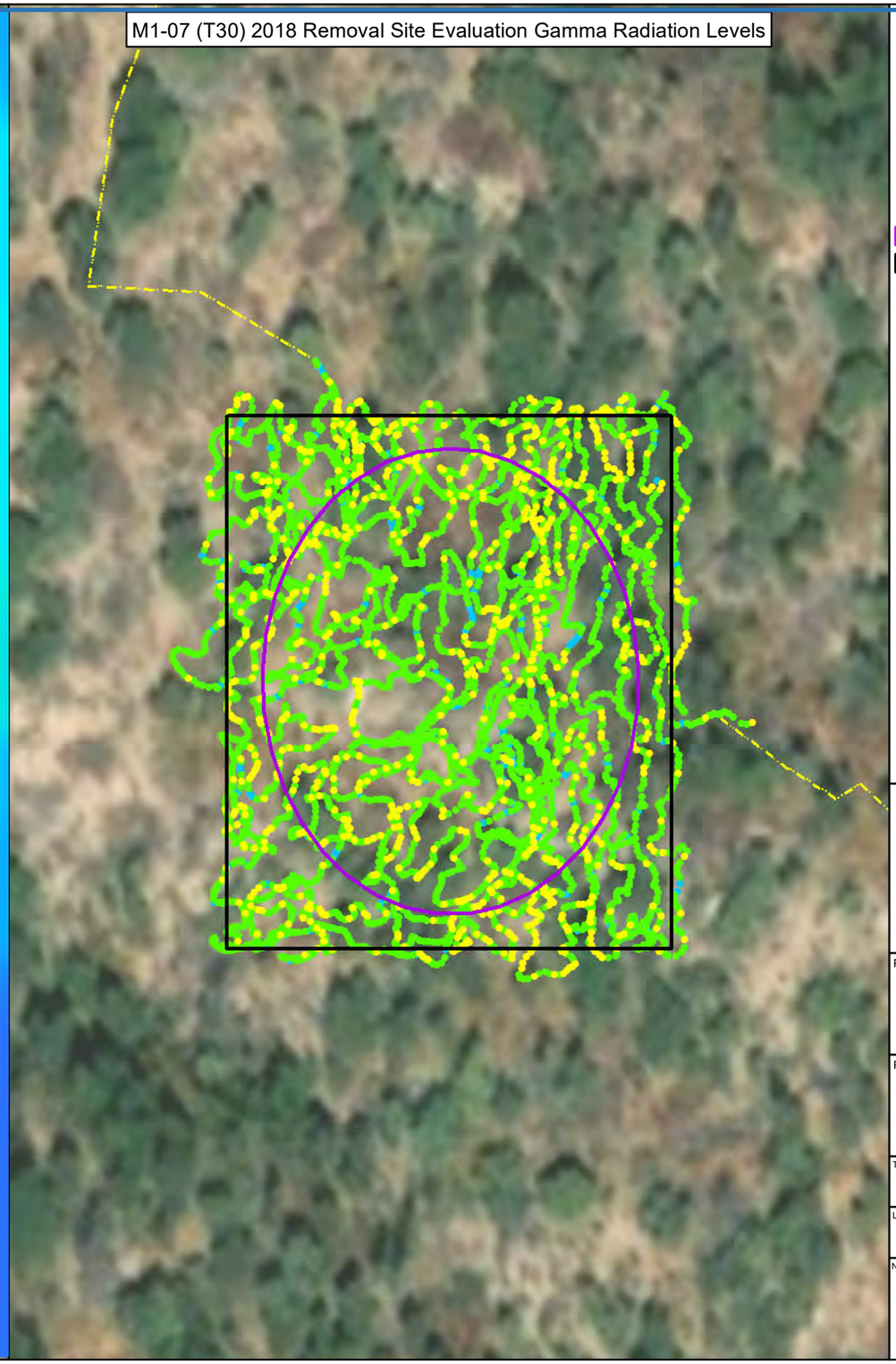
M1-07 (T30) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F1Z2eUcpsK0-87r



M1-07 (T30) 2018 Removal Site Evaluation Gamma Radiation Levels



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

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Foot

[1]The applied gamma background threshold value (BTV) for M1-07 (T30) is 11,378 cpm derived from BSA-30 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 50 ft

1:600

N W E S

0 25 50 100 Feet

NON-AUM TARGET M1-07 (T30)
2018 REMOVAL SITE EVALUATION
AND ASPECT GAMMA RADIATION LEVELS
SURVEY MAP

Prepared For:

Prepared By:

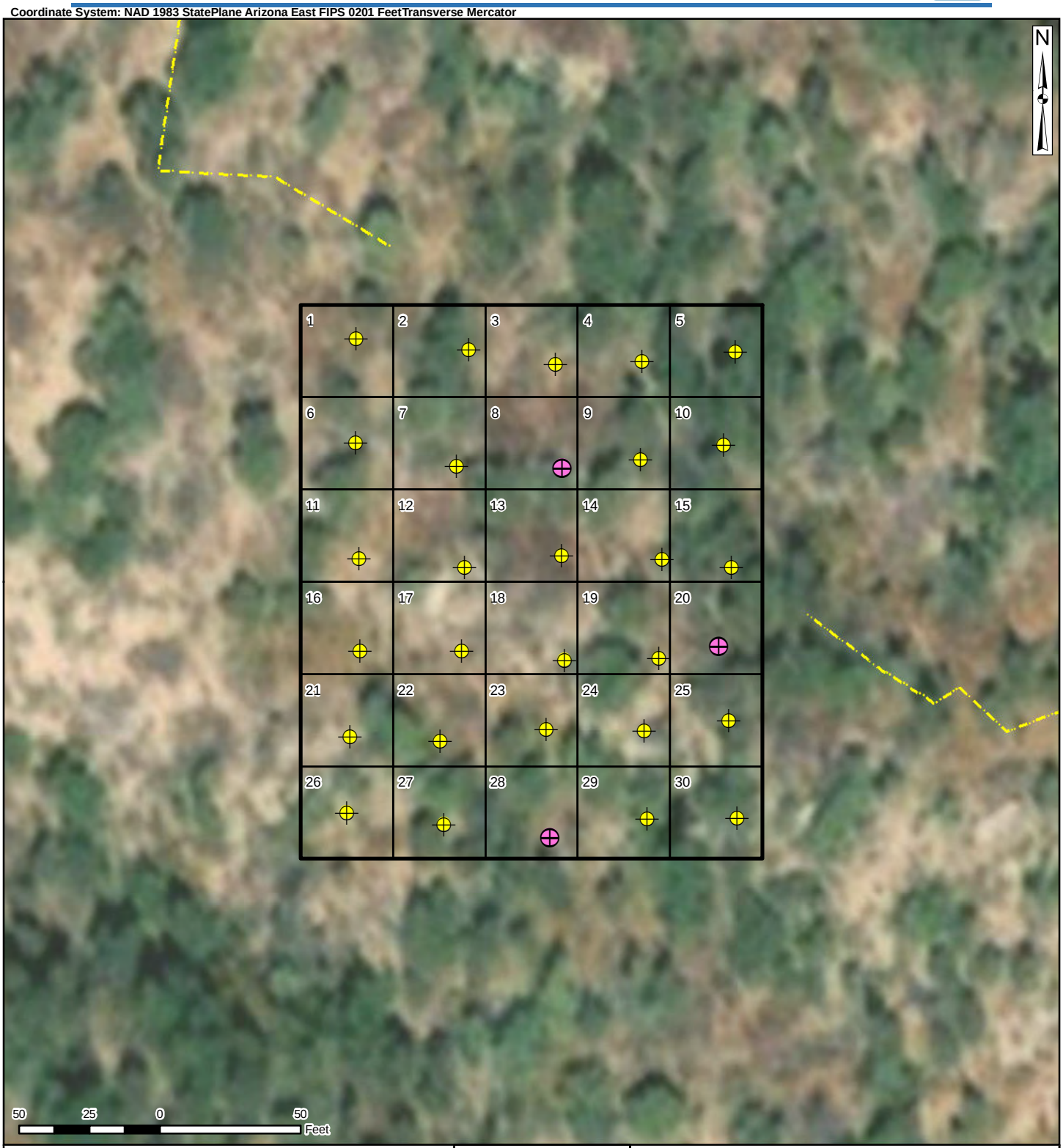
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/15/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborne Spectral Photometric Environmental Collection Technology.

Figure No.: **I30-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Foot

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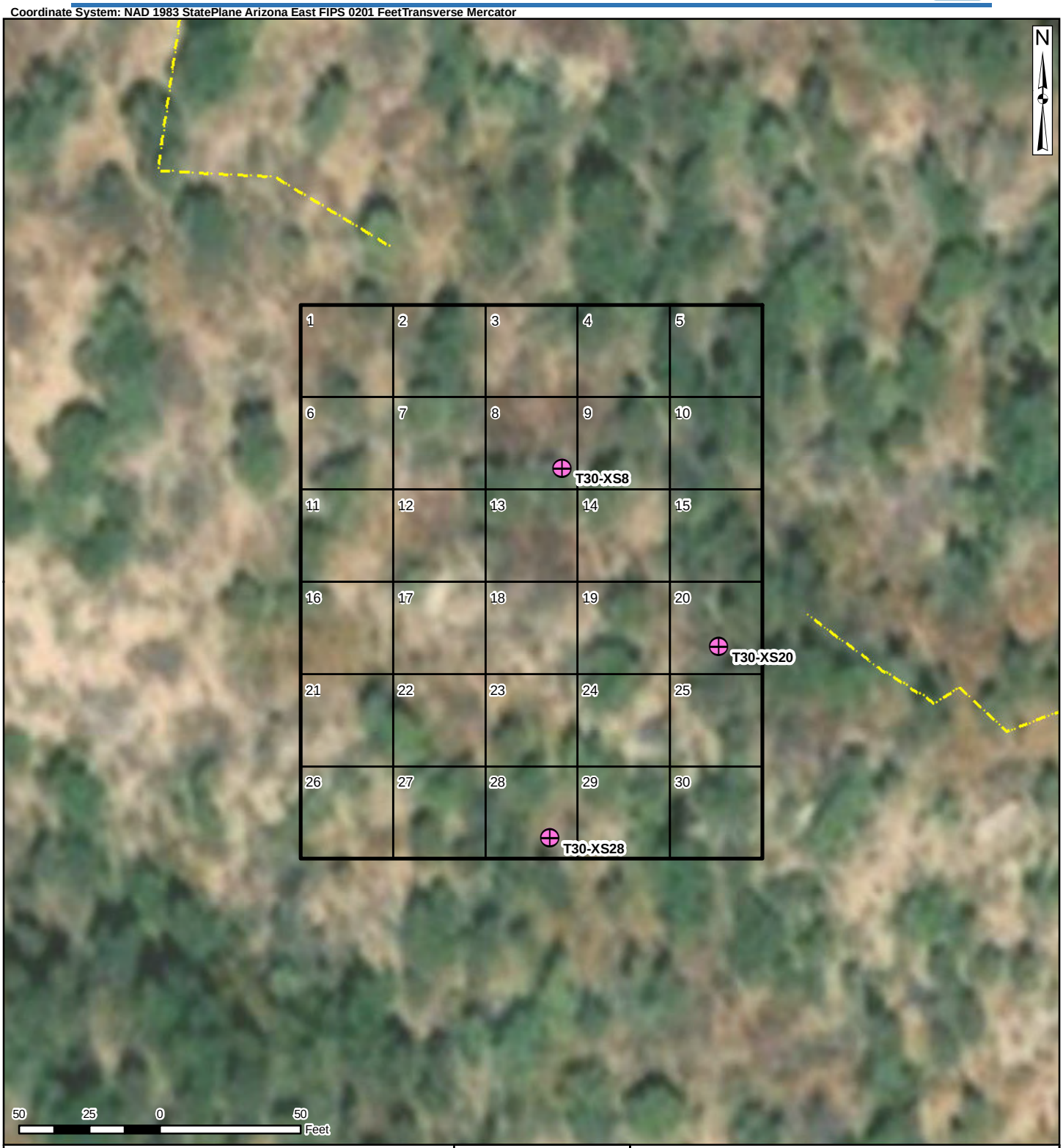
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NON-AUM TARGET M1-07 (T30)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I30-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

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



XRF Confirmation Soil Sample* (0 - 3 inches bgs)

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Foot

*T30-XS8 = site T30 XRF confirmation soil sample collected at survey unit 8. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET M1-07 (T30)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I30-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

Table I30-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M1-07 (T30)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T30-XS8-01-092518	8	0-3	XRF Confirmation	Primary	9/25/2018	36.5021649	-109.2317739	1810032-18, 1810033-18
T30-XS20-01-092518	20	0-3	XRF Confirmation	Primary	9/25/2018	36.5019888	-109.2315866	1810032-16, 1810033-16
T30-XS28-01-092518	28	0-3	XRF Confirmation	Primary	9/25/2018	36.5018041	-109.2317927	1810032-17, 1810033-17

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I30-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M1-07 (T30)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

10.1.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 10.1.1, Target T30 surface geology is entirely within Jml with soils within the Narbona-Zilditloi complex (MUSYM 608) (Figures I-26 and I-27). As a result, Background Study Area 30 (BSA-30) was selected for that combination of geology and soil type. Additionally, the Jml regional geological background would also be applicable for this Target. Table I30-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T30. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T30. The BTVs for a given analyte are calculated based on the UTL 95-95 or the USL 95. An applied BTV is selected to represent the unimpacted radiological and chemical conditions at Target T30. The "Applied BTV" for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I30-3. Applied Background Threshold Values for Non-AUM Target M1-07 (T30)

Analyte	Units	Site-Specific BTV (BSA-30)	Regional BTV (Jml)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	4,690	7,000	4,690	Site-Specific BTV
Antimony	mg/kg	0.171	0.140	0.140	Regional BTV
Arsenic	mg/kg	2.2	3.5	2.2	Site-Specific BTV
Barium	mg/kg	172	270	172	Site-Specific BTV
Beryllium	mg/kg	0.69	0.57	0.57	Regional BTV
Cadmium	mg/kg	0.145	0.160	0.145	Site-Specific BTV
Calcium	mg/kg	98,200	32,000	32,000	Regional BTV
Chromium	mg/kg	4.2	5.2	4.2	Site-Specific BTV
Cobalt	mg/kg	3.8	4.4	3.8	Site-Specific BTV
Copper	mg/kg	17	12	12	Regional BTV
Iron	mg/kg	14,200	8,897	8,897	Regional BTV
Lead	mg/kg	9.9	11	9.9	Site-Specific BTV
Lithium	mg/kg	5.3	8.8	5.3	Site-Specific BTV
Magnesium	mg/kg	2,600	3,900	2,600	Site-Specific BTV
Manganese	mg/kg	627	440	440	Regional BTV
Mercury	mg/kg	0.0160	0.0378	0.0160	Site-Specific BTV
Molybdenum	mg/kg	-	0.29	0.29	Regional BTV
Nickel	mg/kg	4.4	6.2	4.4	Site-Specific BTV
Potassium-40	pCi/g	25.7	26.9	25.7	Site-Specific BTV
Radium-226	pCi/g	0.87	2.23	0.87	Site-Specific BTV
Radium-228	pCi/g	0.60	0.75	0.60	Site-Specific BTV
Selenium	mg/kg	1.23	1.0	1.0	Regional BTV
Silver	mg/kg	0.048	0.037	0.037	Regional BTV
Sodium	mg/kg	95	45	45	Regional BTV
Thallium	mg/kg	0.124	0.075	0.075	Regional BTV
Thorium	mg/kg	6.3	4.7	4.7	Regional BTV
Uranium	mg/kg	0.64	1.5	0.64	Site-Specific BTV
Vanadium	mg/kg	22	24	22	Site-Specific BTV
Zinc	mg/kg	39	27	27	Regional BTV
Gamma Radiation	cpm	11,378	14,566	11,378	Site-Specific BTV

Notes:

BSA	Background Study Area
BTV	background threshold value
cpm	counts per minute
Jml	Morrison Formation (Lower)
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram

10.1.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T30 and the raw gamma radiation and grid averaged gamma radiation survey results.

10.1.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T30 in September 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine if any additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. No additional scanning, measurements, or sampling were required. The applied gamma BTV for non-AUM Target T30 is 11,378 cpm. A total of 4,790 measurements were collected as part of the gamma radiation survey at non-AUM Target T30 across 30 survey units. An average scan density of 160 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I30-4.

Table I30-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M1-07 (T30)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,378	
Measurements	#	4,790	30
Minimum	cpm	7,763	10,068
Maximum	cpm	15,052	11,050
Average	cpm	10,588	10,593
Median	cpm	10,552	10,587
Standard Deviation	cpm	888	202
90th Percentile	cpm	11,734	10,822
95th Percentile	cpm	12,151	10,847
99th Percentile	cpm	12,892	10,993
Measurements per Survey Unit	#/grid	160	
Measurements Above Gamma BTV	#	848	0
Measurements Above Gamma BTV	%	17.7	0.0

Notes:
BTV background threshold value
cpm counts per minute

10.1.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 17.7 percent of the measurements within the Target boundaries, in some cases slightly exceeding the applied gamma BTV (11,378 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-30 (Jml) gamma survey results is provided on Figure I30-6. This graph shows that the spread of radiation data at Target T30 (shown on left) begins within the upper range of BSA-30 (Jml) gamma levels (shown on right) and then rises to the top range of background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T30 is slightly higher than the data cloud from the BSA-30 (Jml) data set. A box plot showing the quartiles of the data sets is provided in Figure I30-7. The box plot shows that the median of Target T30 radiation levels is higher than the median of the BSA-30 (Jml) data set but below the applied gamma BTV.

A map showing the results of the 2018 RSE gamma radiation survey is provided in Figure I30-8. No mining activity was observed within the survey area of Target T30. The elevated gamma activity is likely associated with outcropping of Jml. In general, Target T30 has surficial gamma radiation levels at slightly below the BSA-30 (Jml) levels across the majority of the Target and surrounding area. The area of elevated gamma activity correlated with the ASPECT gamma survey (Figure I30-3). No TENORM or mining-related activities were observed. Section 10.1.5.2 presents the grid averaged results of the gamma radiation survey.

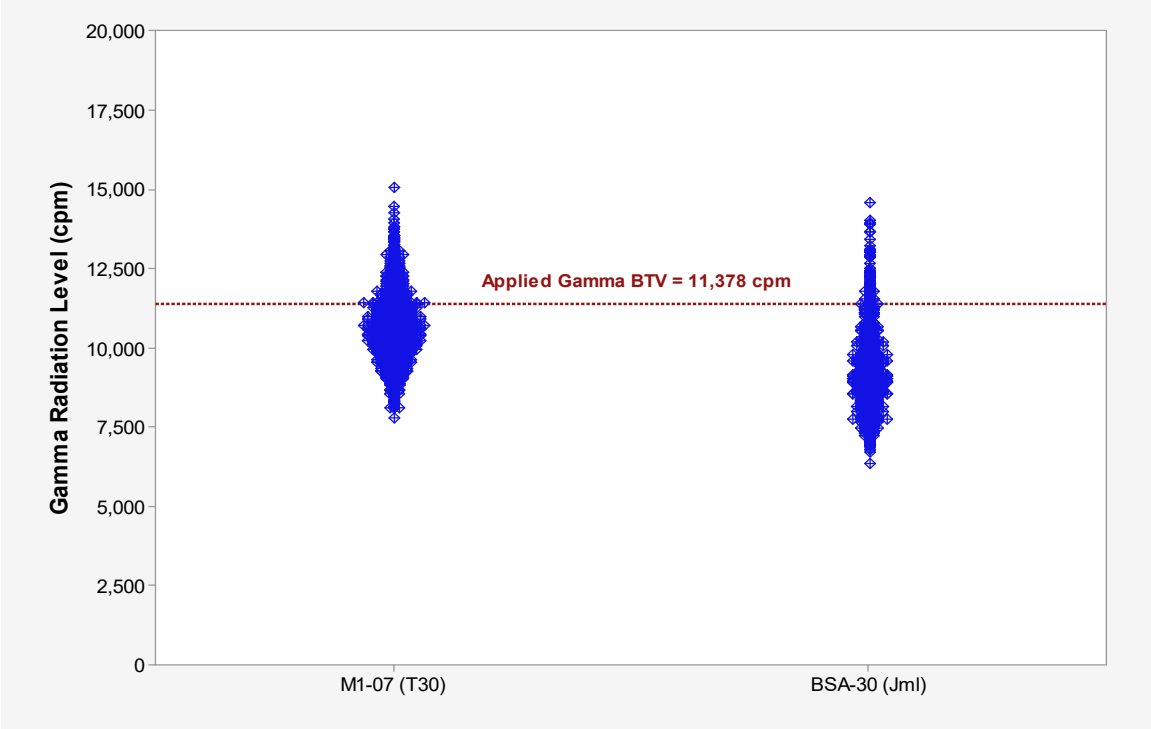


Figure I30-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M1-07 (T30) and BSA-30 (Jml)

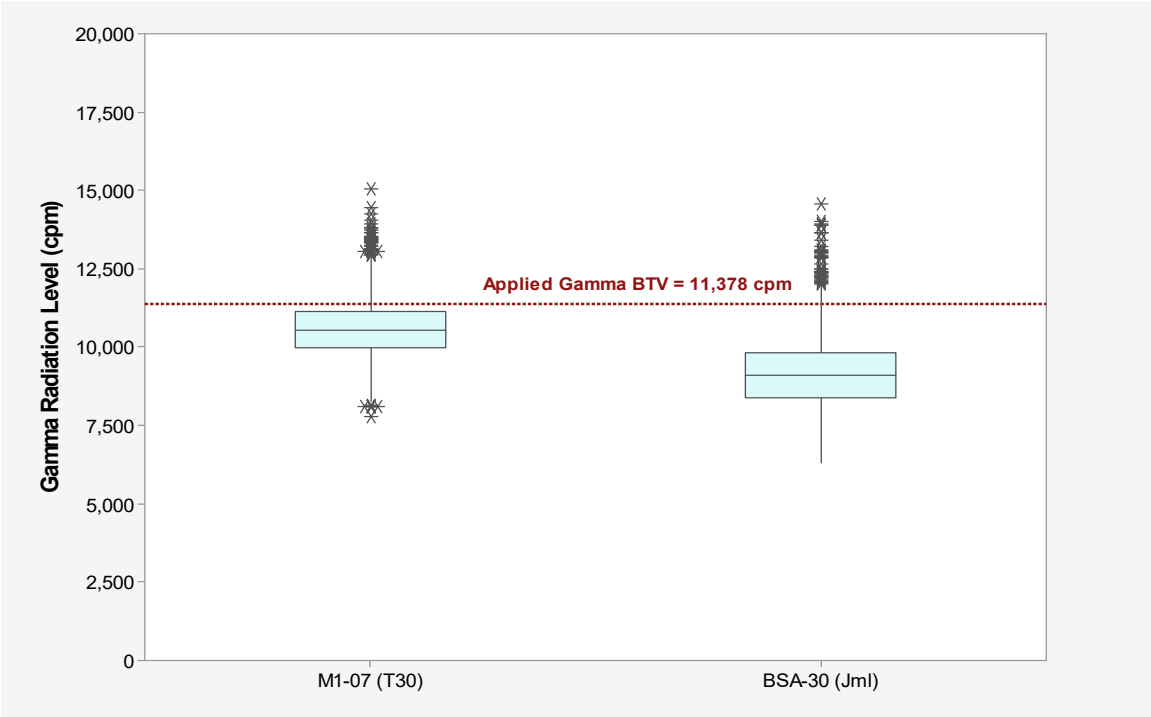
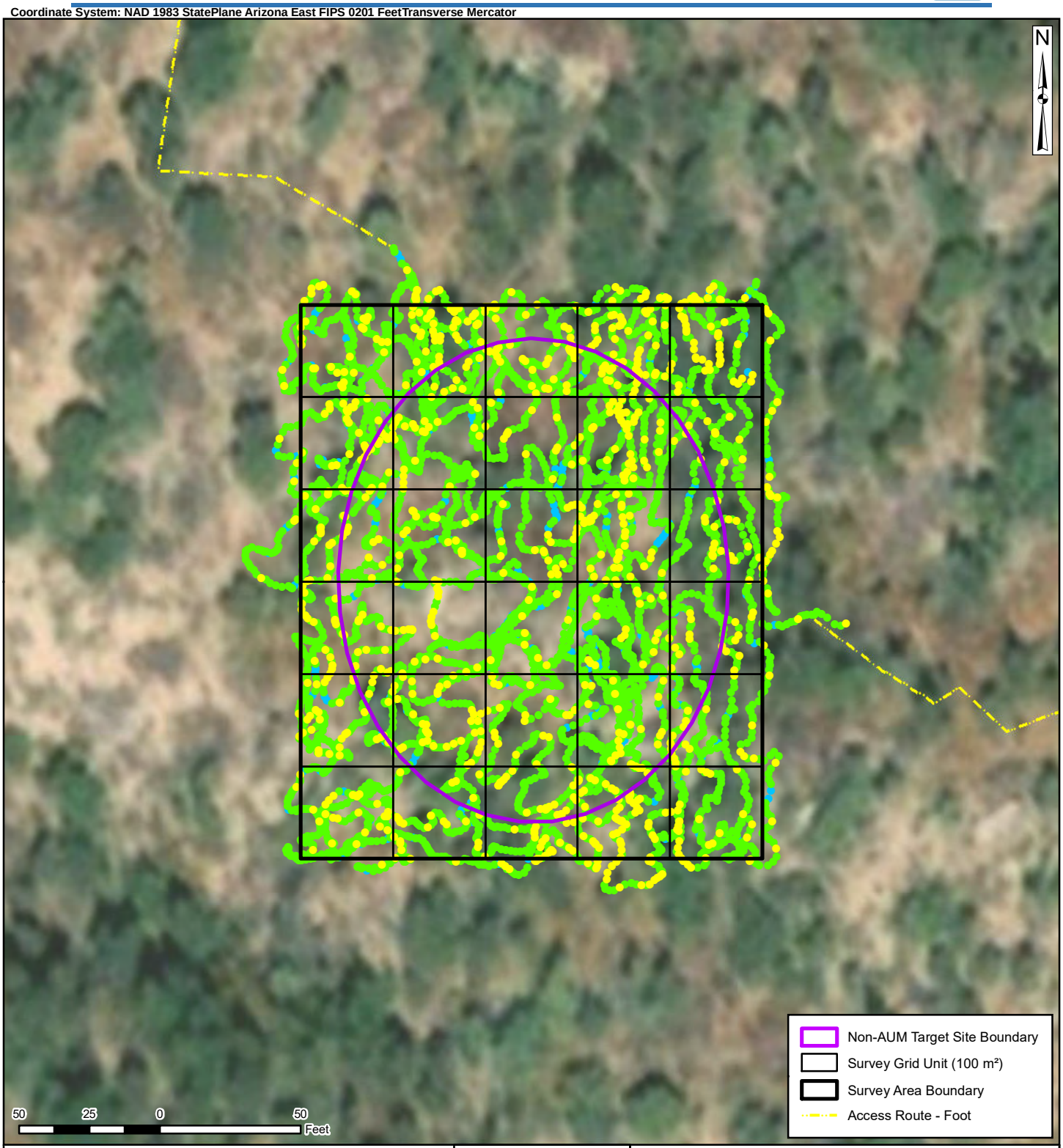


Figure I30-7. Box Plot of Raw Gamma Radiation Levels at Target M1-07 (T30) and BSA-30 (Jml)

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



Gamma Reading (cpm)*

●	≤ 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

*The applied gamma background threshold value (BTV) for M1-07 (T30) is 11,378 cpm derived from BSA-30 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M1-07 (T30)
2018 REMOVAL SITE EVALUATION
GAMMA RADIATION LEVELS SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
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Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.1.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 10.1.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 10.1.5.1. Figure I30-9 and Figure I30-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-30 (Jml) data set (shown on right). No survey units within the survey area of Target T30 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I30-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I30-11 as discussed further in Section 2.8. No survey units exceeded the gamma BTV.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 10.1.6.

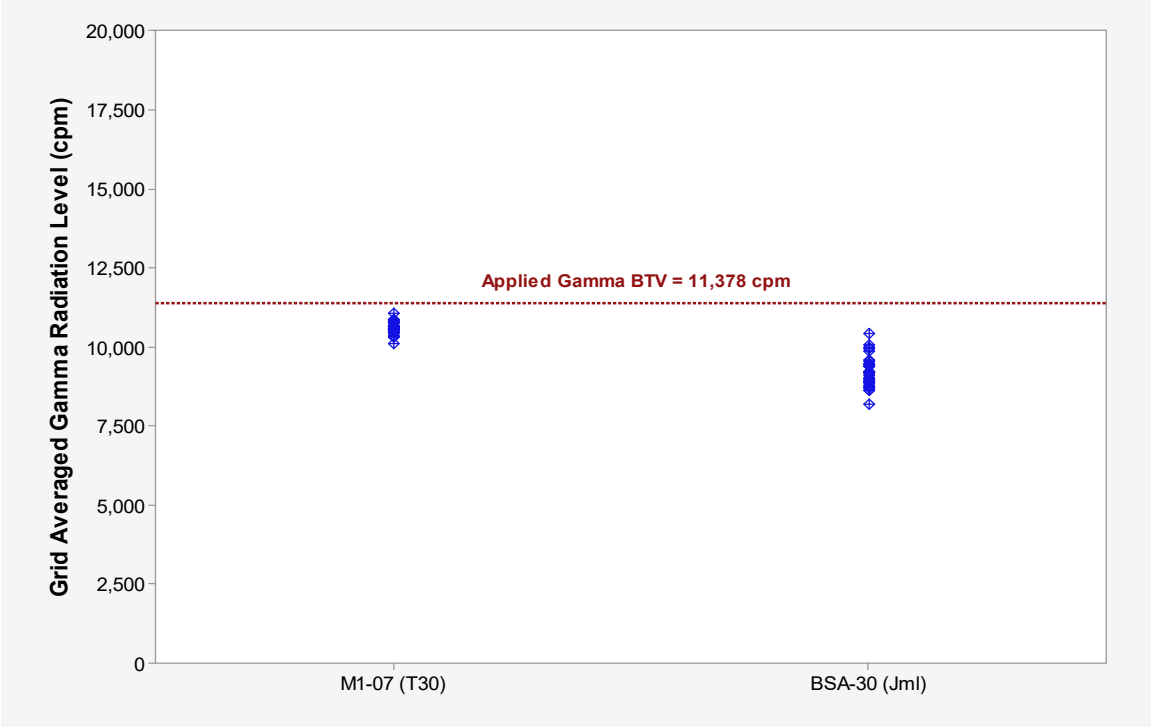


Figure I30-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M1-07 (T30) and BSA-30 (JmI)



Figure I30-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M1-07 (T30) and BSA-30 (JmI)

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



Grid Averaged Gamma Reading (cpm)*

≤ 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

*The applied gamma background threshold value (BTV) for M1-07 (T30) is 11,378 cpm derived from BSA-30 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M1-07 (T30) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
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Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.1.6 Soil Sampling Results

This section presents the results of analyses for soil within the survey area of Target T30. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 10.1.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 10.1.6.3.

10.1.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T30: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I30-1 and I30-2. All the results of the XRF confirmation soil samples are presented in Table I30-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T30 following the methods outlined in Section 2.4 and shown in Figure I30-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 30 measurements were collected across 30 survey units from the survey area of Target T30 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I30-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T30 at a depth of 0 to 3 inches bgs. Three XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I30-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 10.1.7.

Table I30-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M1-07 (T30)

Analyte	Units	Applied BTV	T30-XS20-01-092518		T30-XS28-01-092518		T30-XS8-01-092518	
			Result	Q	Result	Q	Result	Q
Survey Unit			X20		X28		X8	
Aluminum	mg/kg	4,690	4,300		3,700		3,300	
Antimony	mg/kg	0.140	0.09	J	0.076	J	0.056	J
Arsenic	mg/kg	2.2	2.4		2.2		1.7	
Barium	mg/kg	172	94		66		58	
Beryllium	mg/kg	0.57	0.3		0.25		0.24	
Cadmium	mg/kg	0.145	0.1	J	0.076	J	0.059	J
Calcium	mg/kg	32,000	3,800		3,200		2,500	
Chromium	mg/kg	4.2	4.2		3.7		3.3	
Cobalt	mg/kg	3.8	2.4		2		1.8	
Copper	mg/kg	12	5.1		4.2		3.1	
Iron	mg/kg	8,897	5,600		5,100		4,500	
Lead	mg/kg	9.9	9.3		6.2		4.5	
Lithium	mg/kg	5.3	6.1		5		4.7	
Magnesium	mg/kg	2,600	2,000	J	1,800		1,600	
Manganese	mg/kg	440	220		180		130	
Molybdenum	mg/kg	0.29	0.17	J	0.14	J	0.098	J
Nickel	mg/kg	4.4	4.3		3.4		3	
Potassium-40	pCi/g	25.7	17.2		16.5		13.9	
Radium-226	pCi/g	0.87	0.85	LT	0.68	LT	0.45	LT
Radium-228	pCi/g	0.60	<0.59	UJ	<0.67	U	<0.38	U
Selenium	mg/kg	1.0	0.66	J	0.72	J	0.62	J
Silver	mg/kg	0.037	0.015	J	0.015	J	0.0082	J
Sodium	mg/kg	45	40	J	30	J	30	J
Thallium	mg/kg	0.075	0.05		0.041		0.038	
Thorium	mg/kg	4.7	2.5		2.7		2.3	
Uranium	mg/kg	0.64	0.65		0.62		0.36	
Vanadium	mg/kg	22	10		9.4		7.6	
Zinc	mg/kg	27	15		14		11	

Notes:

BTV	Background threshold value
J	Estimated value
J-	Estimated value, may be biased low
LT	Result less than requested minimum detectable concentration, but greater than sample-specific minimum detectable concentration
mg/kg	Milligrams per kilogram
NA	Not applicable
NV	No Value
pCi/g	Picocuries per gram
Q	Qualification
U	Not considered detected. The associated value is the method detection limit (MDL).
UJ	Not considered detected. The associated value is the reported concentration, which is estimated.

Table I30-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M1-07 (T30)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.2	8,897	9.9	440	0.29	4.7	0.64	22	27
Measurements	#	30	30	30	30	30	30	30	30	30
Detects	#	22	30	30	30	18	30	29	10	30
Nondetects	#	8	0	0	0	12	0	1	20	0
Minimum	mg/kg	1.9	4,276	6.5	146.6	0.0	1.9	0.2	17.5	14.5
Maximum	mg/kg	4.3	7,636	16.6	502.7	3.0	4.4	4.1	25.9	36.7
Standard Deviation	mg/kg	0.6	694	2.2	63	0.89	0.5	1.0	3	4.4
Average	mg/kg	2.8	6,158	10.4	327	1.27	2.8	2.1	20.7	21.6
Median	mg/kg	2.6	6,132	10.7	321	0.96	2.6	2.0	19.6	21.7
Relative Standard Deviation	%	22.2	11.3	21.1	19.4	70.2	18.4	48.6	15.1	20.3
90th Percentile	mg/kg	3.6	7,211	12.7	384	2.5	3.4	3.5	25	26
95th Percentile	mg/kg	3.6	7,291	12.8	426	3.0	3.4	3.8	25	28
99th Percentile	mg/kg	4.1	7,553	15.5	484	3.0	4.1	4.0	26	34
Measurements Above Applied BTV	#	19	0	20	1	17	0	27	3	2
Measurements Above Applied BTV	%	63.3	0.0	66.7	3.3	56.7	0.0	90.0	10.0	6.7

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value

mg/kg Milligram per kilogram

XRF X-ray fluorescence

10.1.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T30 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T30 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T30. The estimated BTVs are identified in Section 10.1.4 and Table I30-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I30-7 presents a summary of the background comparison for different measurement and soil depths at Target T30. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T30. Further gamma radiation screening indicated that gamma levels at Target T30 are similar to those at the BSA. Therefore, while multiple COPCs have been identified at Target T30 based on a comparison to background, risk screening will be required to support a future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I30-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M1-07 (T30)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic	✓	✓	✓
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron			
Lead		✓	✓
Lithium	✓		✓
Magnesium			
Manganese			
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium			
Silver			
Sodium			
Thallium			
Thorium			
Uranium	✓	✓	✓
Vanadium		✓	✓
Zinc		✓	✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

10.1.7 Primary Contaminant Mapping

10.1.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 10.1.6.2 identified the COPCs at Target T30. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 10.1.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I30-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T30 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 10.1.7.1 through Section 10.1.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T30. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

10.1.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I30-7. Arsenic exceeded the applied BTV in 63.3 percent of in situ XRF measurements and one of the three XRF confirmation samples. The applied BTV for arsenic is 2.2 mg/kg for Target T30 as presented in Section 10.1.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I30-5 and Attachment I3, respectively. Figure I30-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T30 and BSA-30 (Jml) samples. Figure I30-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T30 and BSA-30 (Jml) samples. Summary statistics for XRF measurements are provided in Section 10.1.6.1. Arsenic XRF concentrations measured in surface soils at Target T30 ranged between 1.9 and 4.3 mg/kg with an average and standard deviation of 2.8 mg/kg and 0.6 mg/kg, respectively. The average arsenic XRF concentration is above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T30 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I30-14. Overall, the majority of detectable arsenic results in surface soils were above the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials Target T30.

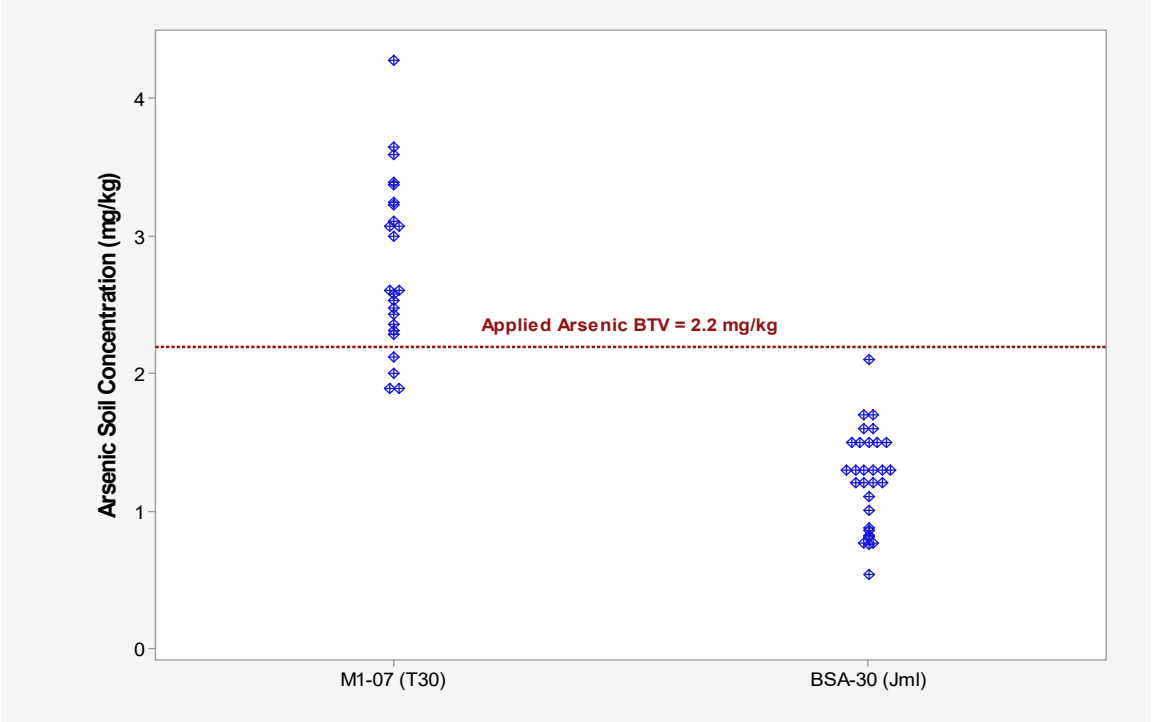


Figure I30-12. Individual Value Plot for Target M1-07 (T30) and BSA-30 (Jml) Arsenic Soil Concentrations

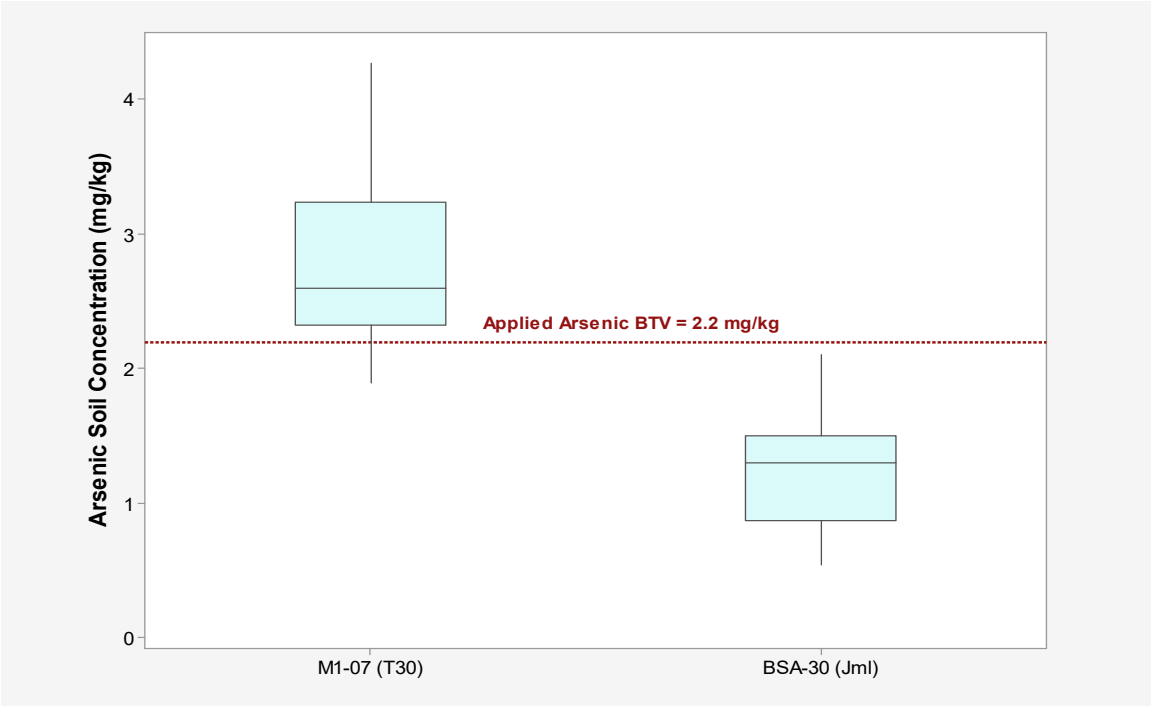
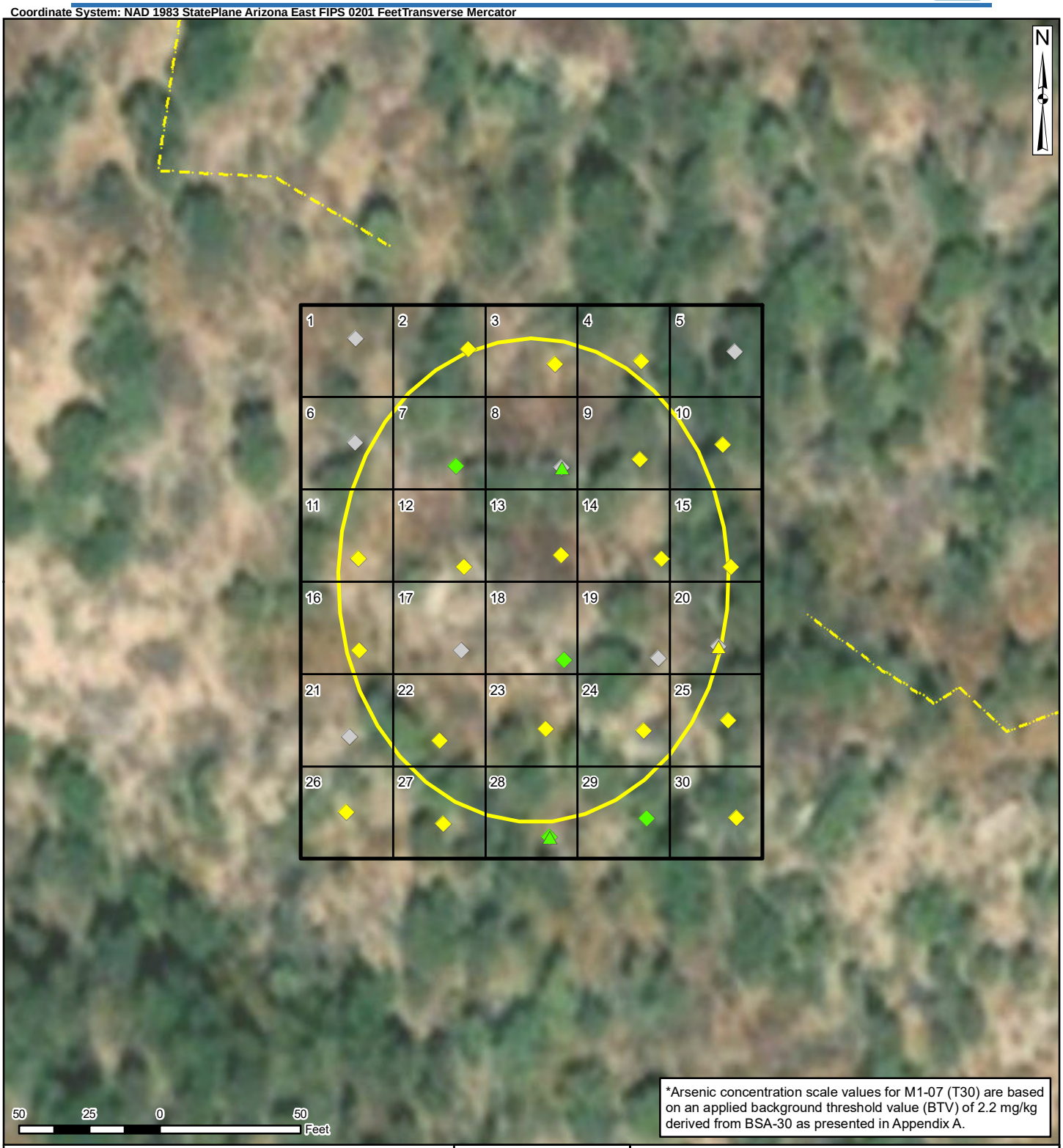


Figure I30-13. Box Plot for Target M1-07 (T30) and BSA-30 (Jml) Arsenic Soil Concentrations

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



Arsenic Concentration Scale (mg/kg)*

- ≤ 1.2
- 1.2 - 2.2
- 2.2 - 4.4
- 4.4 - 6.6
- 6.6 - 8.8
- 8.8 - 22
- ≥ 22
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot

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NON-AUM TARGET M1-07 (T30) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
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Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.1.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I30-7. Lead exceeded the applied BTV in 66.7 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for lead is 9.9 mg/kg for Target T30 as presented in Section 10.1.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I30-5 and Attachment I3, respectively. Figure I30-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T30 and BSA-30 (Jml) samples. Figure I30-16 presents a box plot of detectable lead XRF soil concentrations for Target T30 and BSA-30 (Jml) samples. Summary statistics for XRF measurements are provided in Section 10.1.6.1. Lead XRF concentrations measured in surface soils at Target T30 ranged between 6.5 and 16.6 mg/kg with an average and standard deviation of 10.4 mg/kg and 2.2 mg/kg, respectively. The average lead XRF concentration is above the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T30 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I30-17. Overall, the majority of detectable lead results in surface soils were above the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials Target T30.

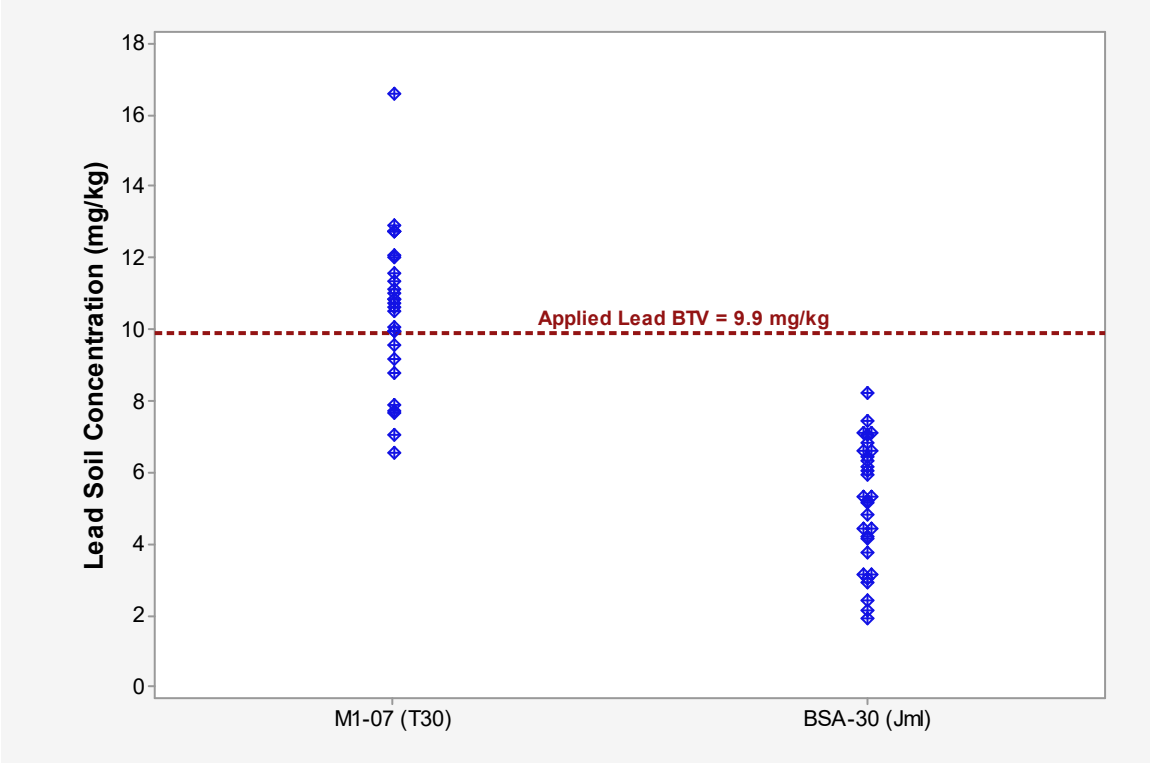


Figure I30-15. Individual Value Plot for Target M1-07 (T30) and BSA-30 (Jml) Lead Soil Concentrations

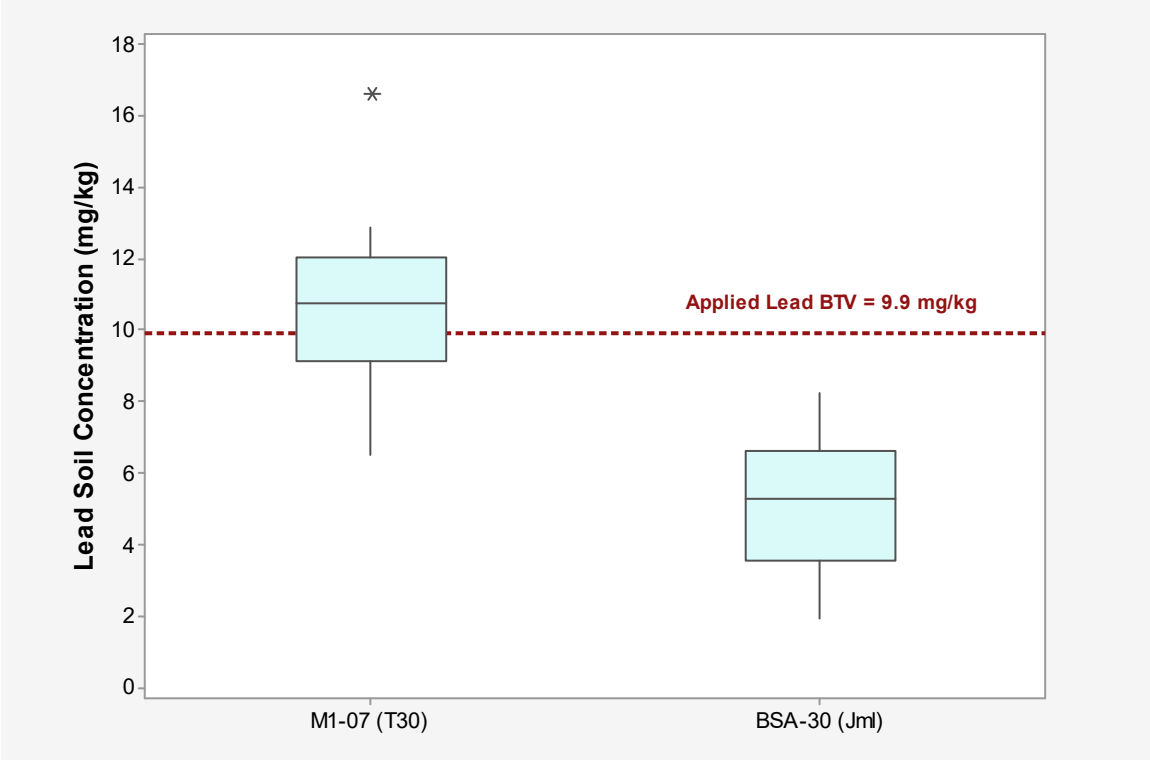
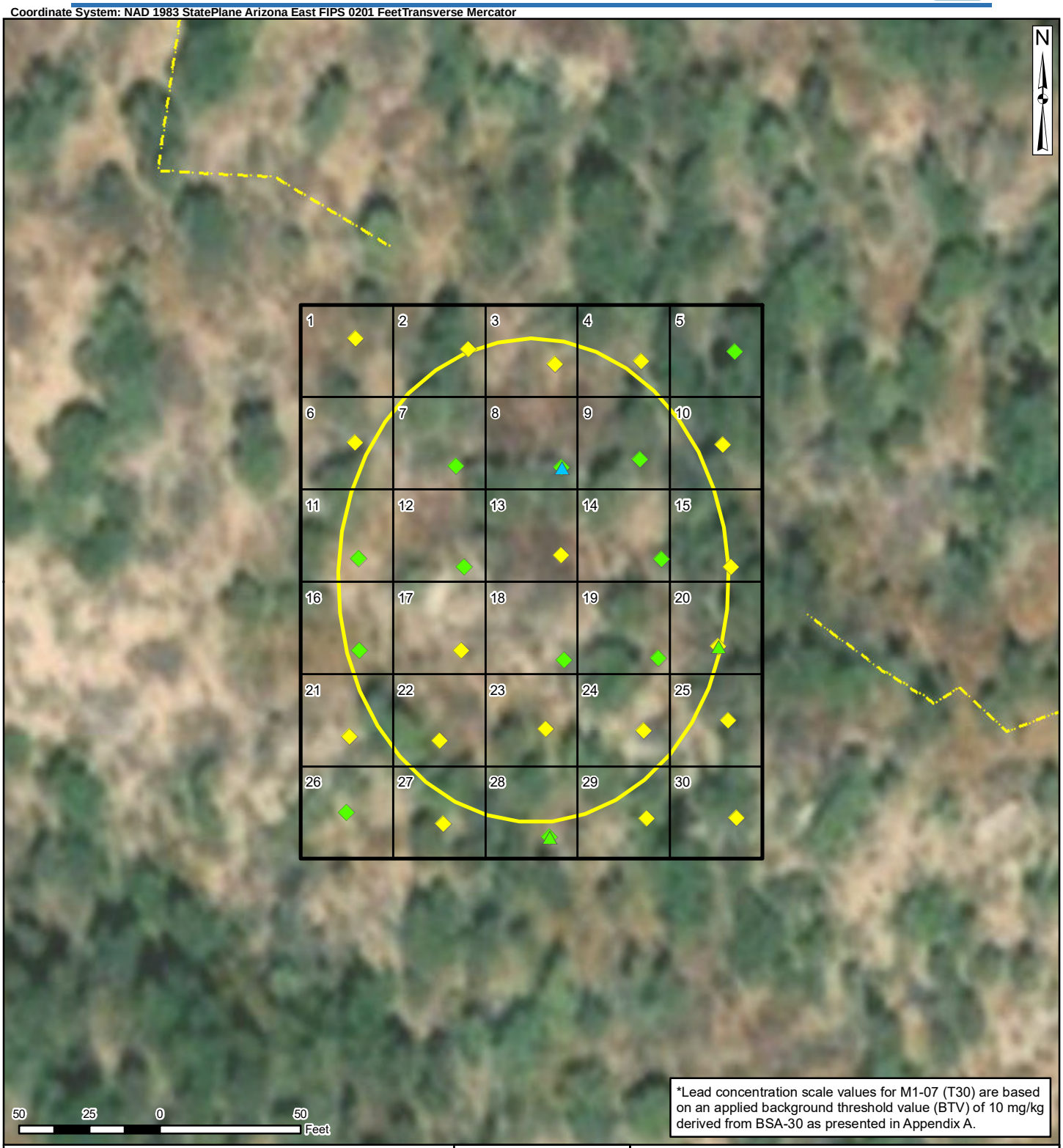


Figure I30-16. Box Plot for Target M1-07 (T30) and BSA-30 (Jml) Lead Soil Concentrations

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



*Lead concentration scale values for M1-07 (T30) are based on an applied background threshold value (BTV) of 10 mg/kg derived from BSA-30 as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 5.1
- 5.1 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 100
- ≥ 100

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot

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NON-AUM TARGET M1-07 (T30) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I30-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.1.7.4 Thorium

Thorium was not identified as a COPC in surface soil as shown in Table I30-7. Thorium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for thorium is 4.7 mg/kg for Target T30 as presented in Section 10.1.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I30-5 and Attachment I3, respectively. Figure I30-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T30 and Jml regional samples. Figure I30-19 presents a box plot of detectable thorium XRF soil concentrations for Target T30 and Jml regional samples. Summary statistics for XRF measurements are provided in Section 10.1.6.1. Thorium XRF concentrations measured in surface soils at Target T30 ranged between 1.9 and 4.4 mg/kg with an average and standard deviation of 2.8 mg/kg and 0.5 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T30 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I30-20. All thorium results in surface soils were less than the applied BTV.

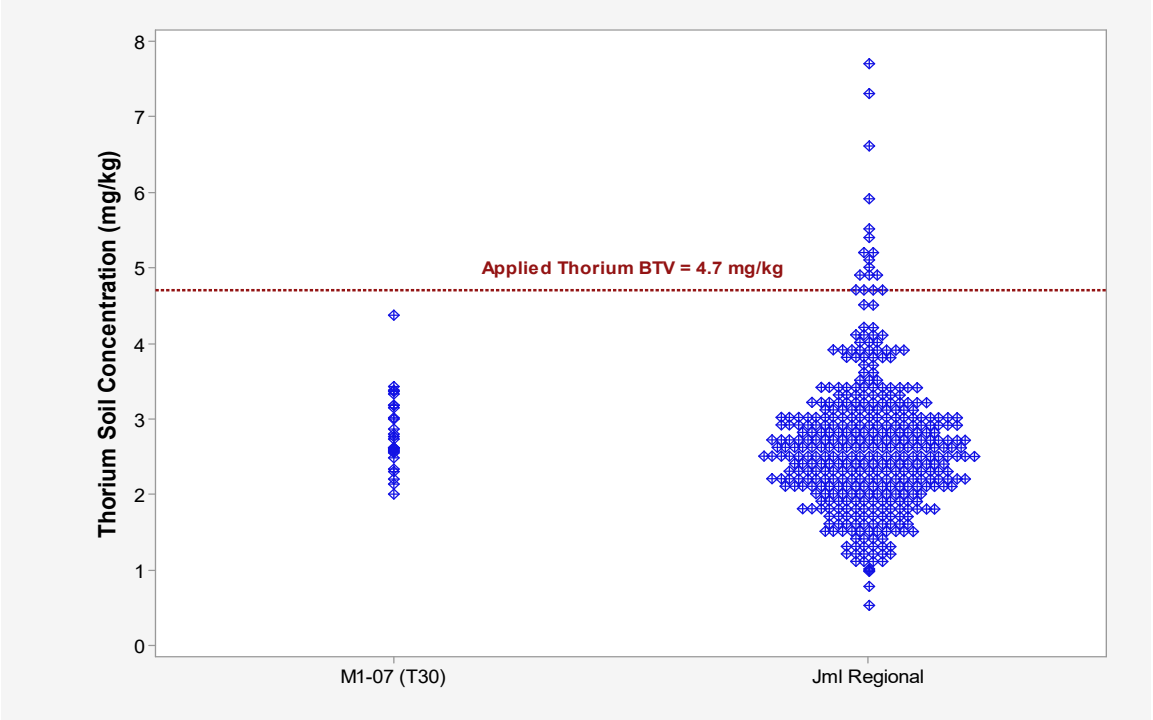


Figure I30-18. Individual Value Plot for Target M1-07 (T30) and Jml Regional Thorium Soil Concentrations

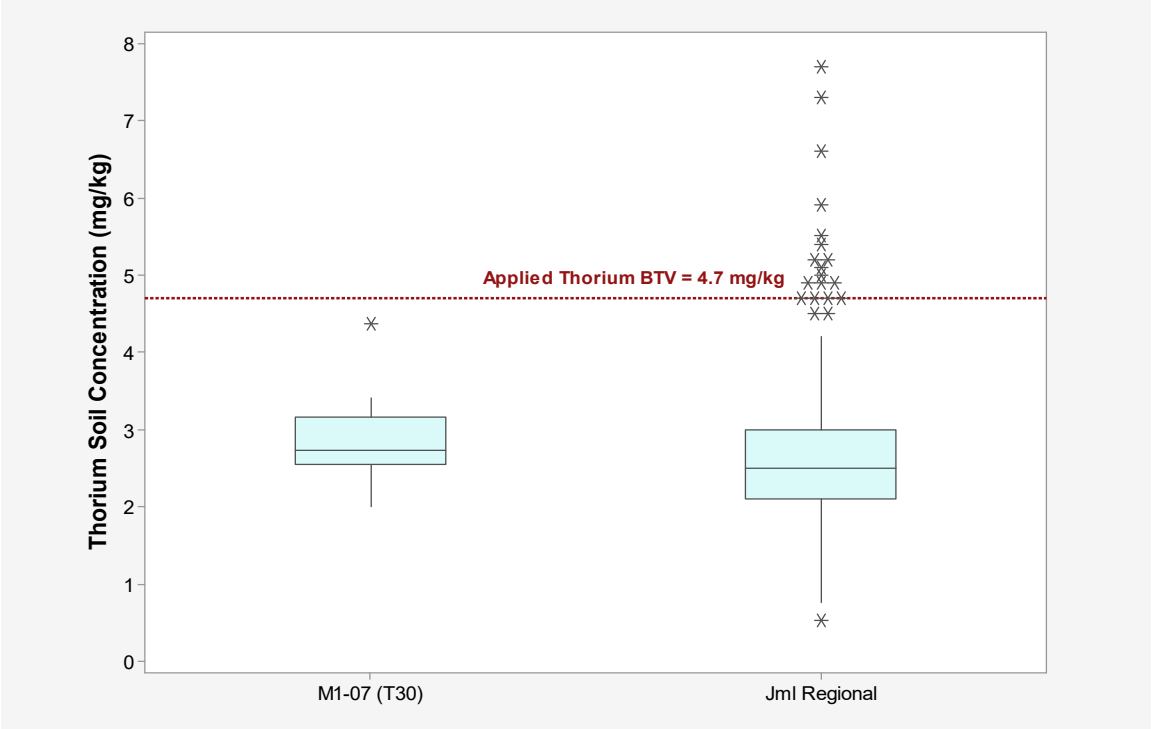
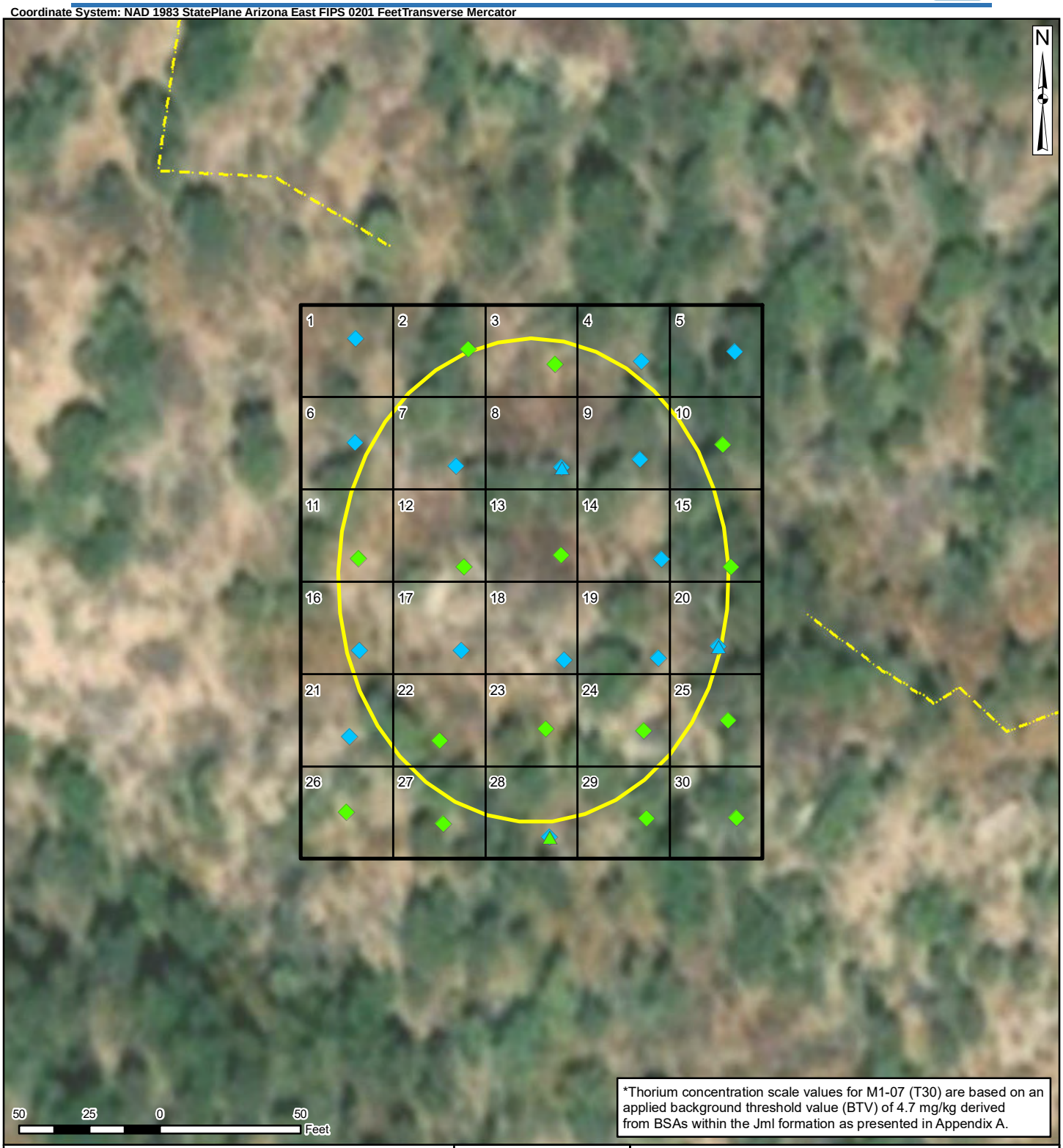


Figure I30-19. Box Plot for Target M1-07 (T30) and Jml Regional Thorium Soil Concentrations



*Thorium concentration scale values for M1-07 (T30) are based on an applied background threshold value (BTV) of 4.7 mg/kg derived from BSAs within the Jml formation as presented in Appendix A.

Thorium Concentration Scale (mg/kg)*

- ≤ 2.6
- 2.6 - 4.7
- 4.7 - 9.4
- 9.4 - 14
- 14 - 19
- 19 - 47
- ≥ 47

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot

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NON-AUM TARGET M1-07 (T30) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I30-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.1.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I30-7. Uranium exceeded the applied BTV in 90 percent of in situ XRF measurements and in one of the three XRF confirmation samples. The applied BTV for uranium is 0.64 mg/kg for Target T30 as presented in Section 10.1.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I30-5 and Attachment I3, respectively. Figure I30-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T30 and BSA-30 (Jml) samples. Figure I30-22 presents a box plot of detectable uranium XRF soil concentrations for Target T30 and BSA-30 (Jml) samples. Summary statistics for XRF measurements are provided in Section 10.1.6.1. Uranium XRF concentrations measured in surface soils at Target T30 ranged between 0.2 and 4.1 mg/kg with an average and standard deviation of 2.1 mg/kg and 1.0 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T30 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I30-23. Overall, the majority of detectable uranium results in surface soils were above the applied BTV. However, the maximum XRF value was 6.4 times higher than the applied BTV and does not appear to be associated with mining-related materials Target T30.

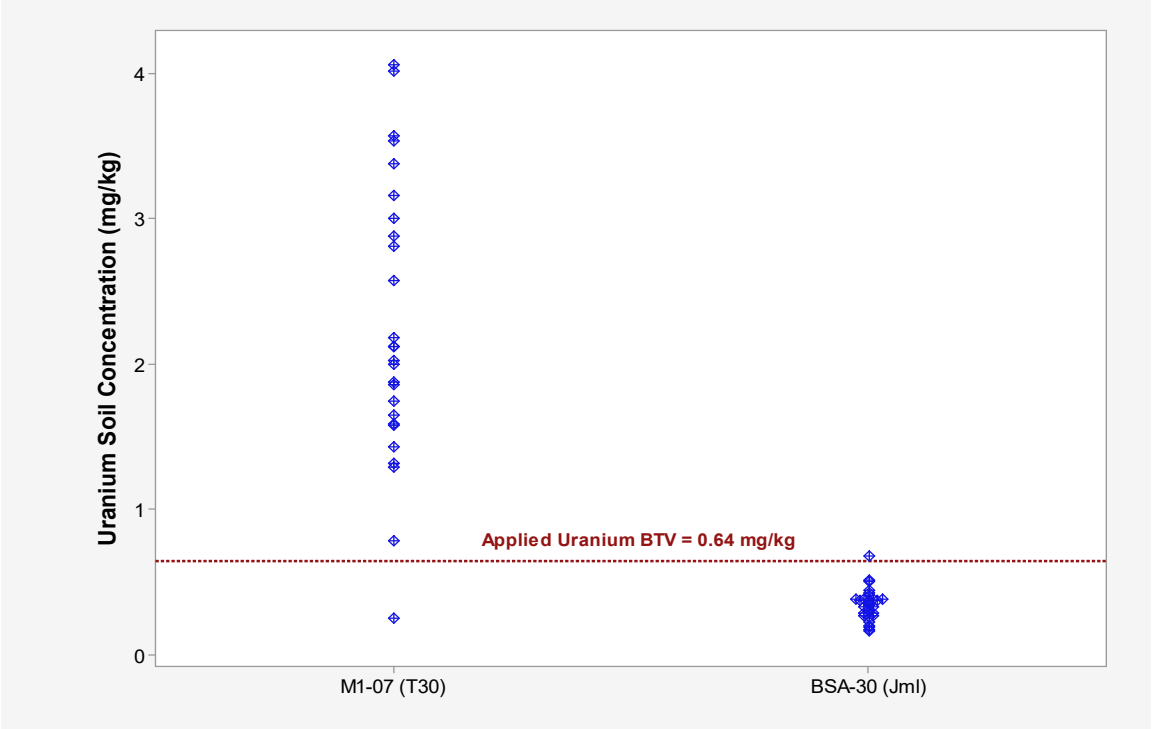


Figure I30-21. Individual Value Plot for Target M1-07 (T30) and BSA-30 (Jml) Uranium Soil Concentrations

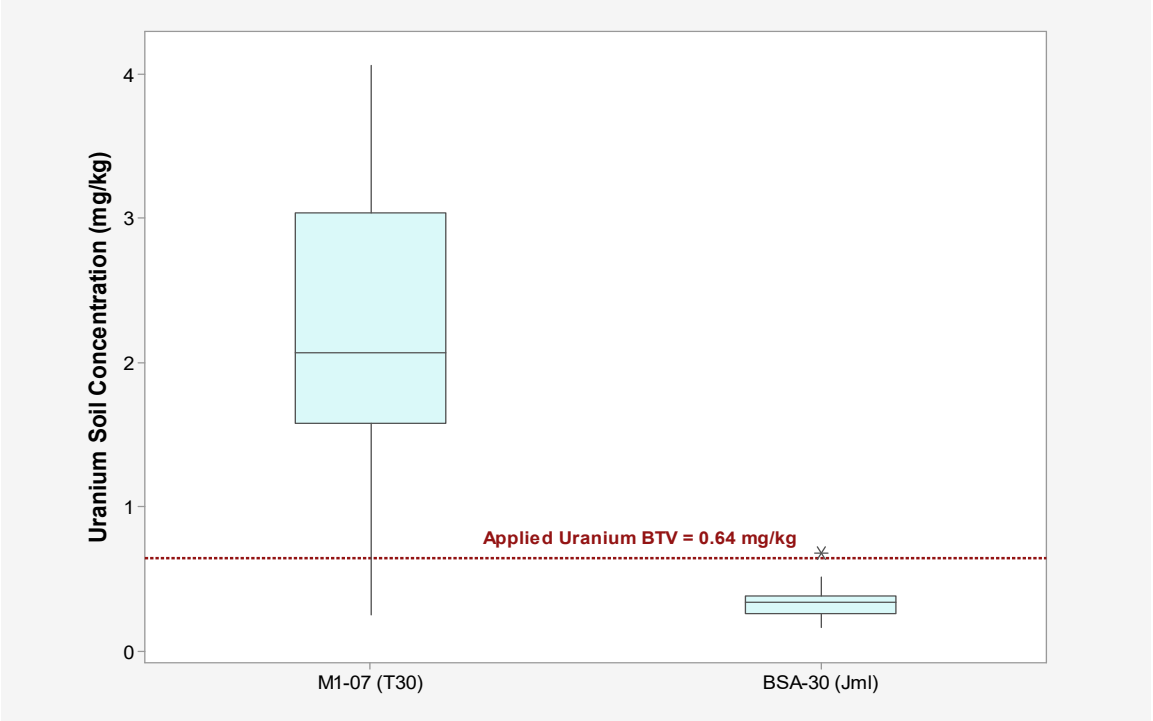
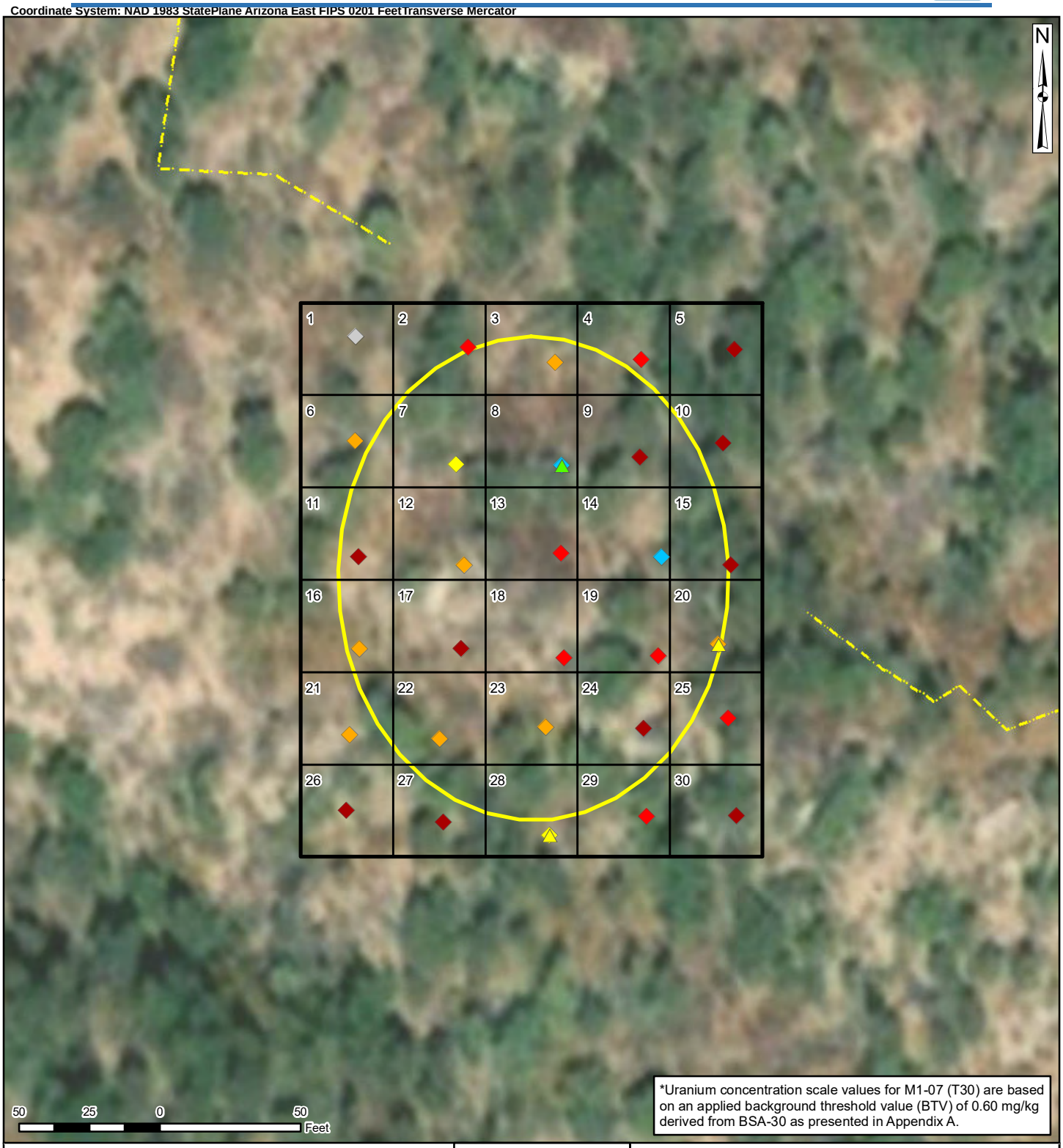


Figure I30-22. Box Plot for Target M1-07 (T30) and BSA-30 (Jml) Uranium Soil Concentrations

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 Feet Transverse Mercator



Uranium Concentration Scale (mg/kg)*

- ≤ 0.30
- 0.30 - 0.60
- 0.60 - 1.2
- 1.2 - 1.8
- 1.8 - 2.4
- 2.4 - 6.0
- ≥ 6.0
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot

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NON-AUM TARGET M1-07 (T30) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I30-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.1.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I30-7. Vanadium exceeded the applied BTV in 10 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for vanadium is 22 mg/kg for Target T30 as presented in Section 10.1.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I30-5 and Attachment I3, respectively. Figure I30-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T30 and BSA-30 (Jml) samples. Figure I30-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T30 and BSA-30 (Jml) samples. Summary statistics for XRF measurements are provided in Section 10.1.6.1. Vanadium XRF concentrations measured in surface soils at Target T30 ranged between 17.5 and 25.9 mg/kg with an average and standard deviation of 20.7 mg/kg and 3.0 mg/kg, respectively. The average vanadium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T30 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I30-26. Overall, the majority of detectable vanadium results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials Target T30.

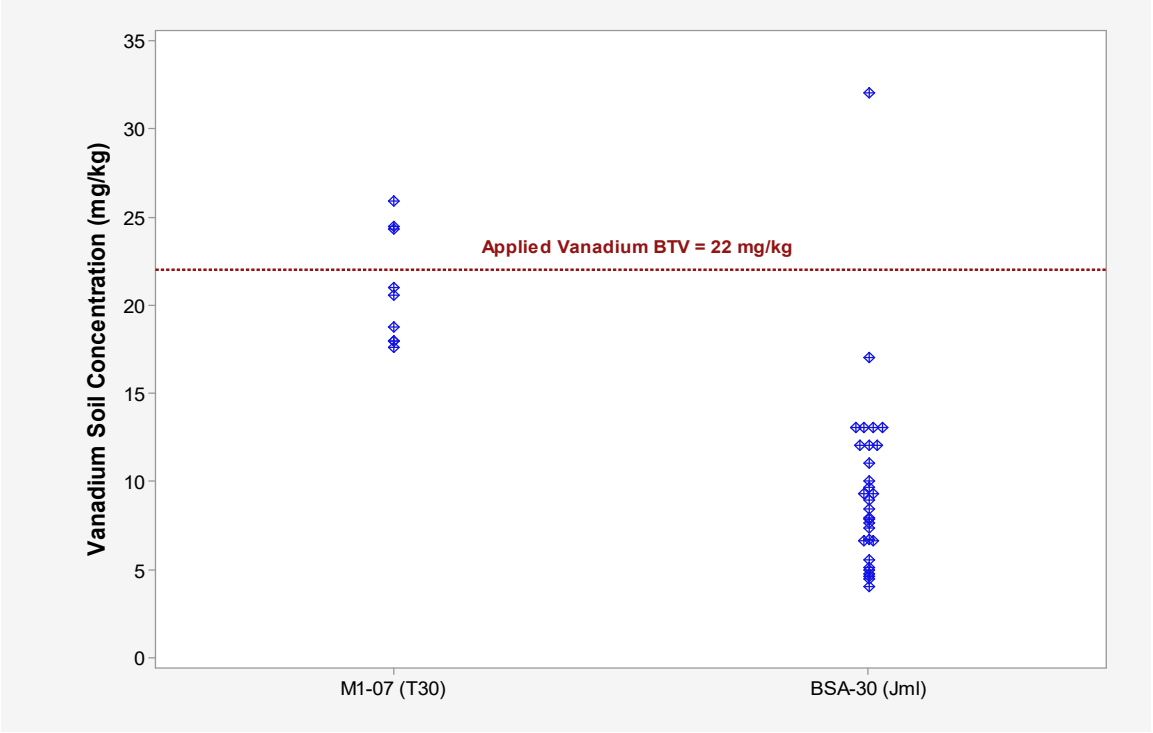


Figure I30-24. Individual Value Plot for Target M1-07 (T30) and BSA-30 (Jml) Vanadium Soil Concentrations

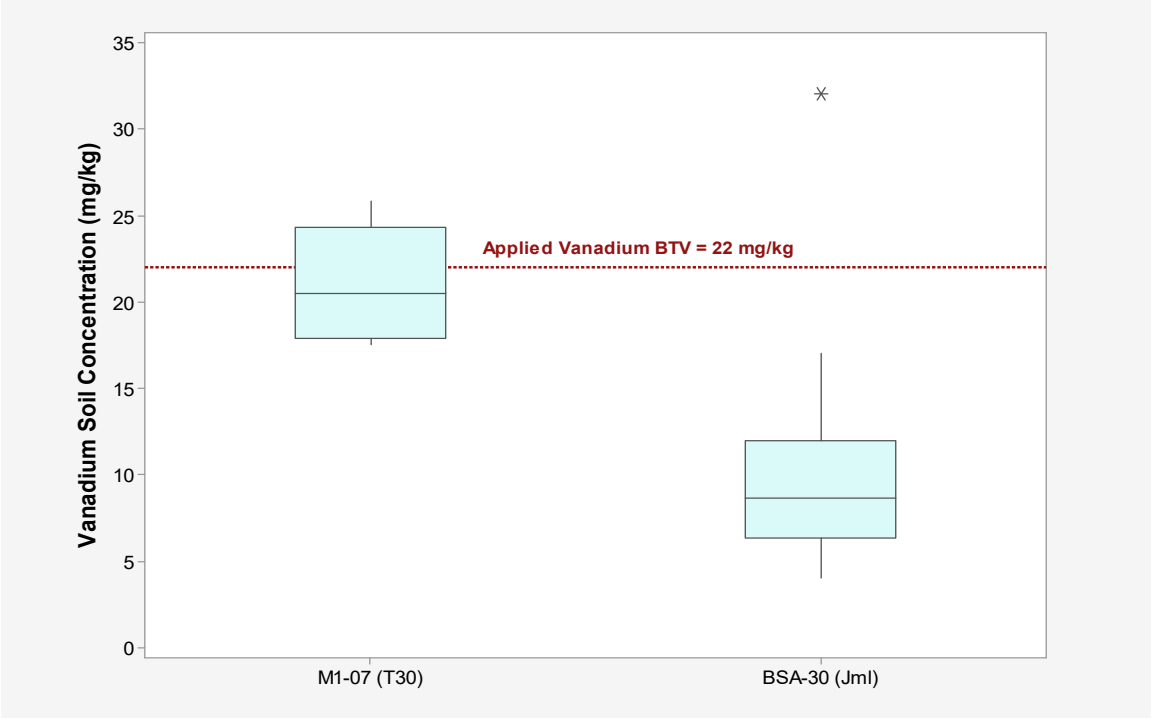
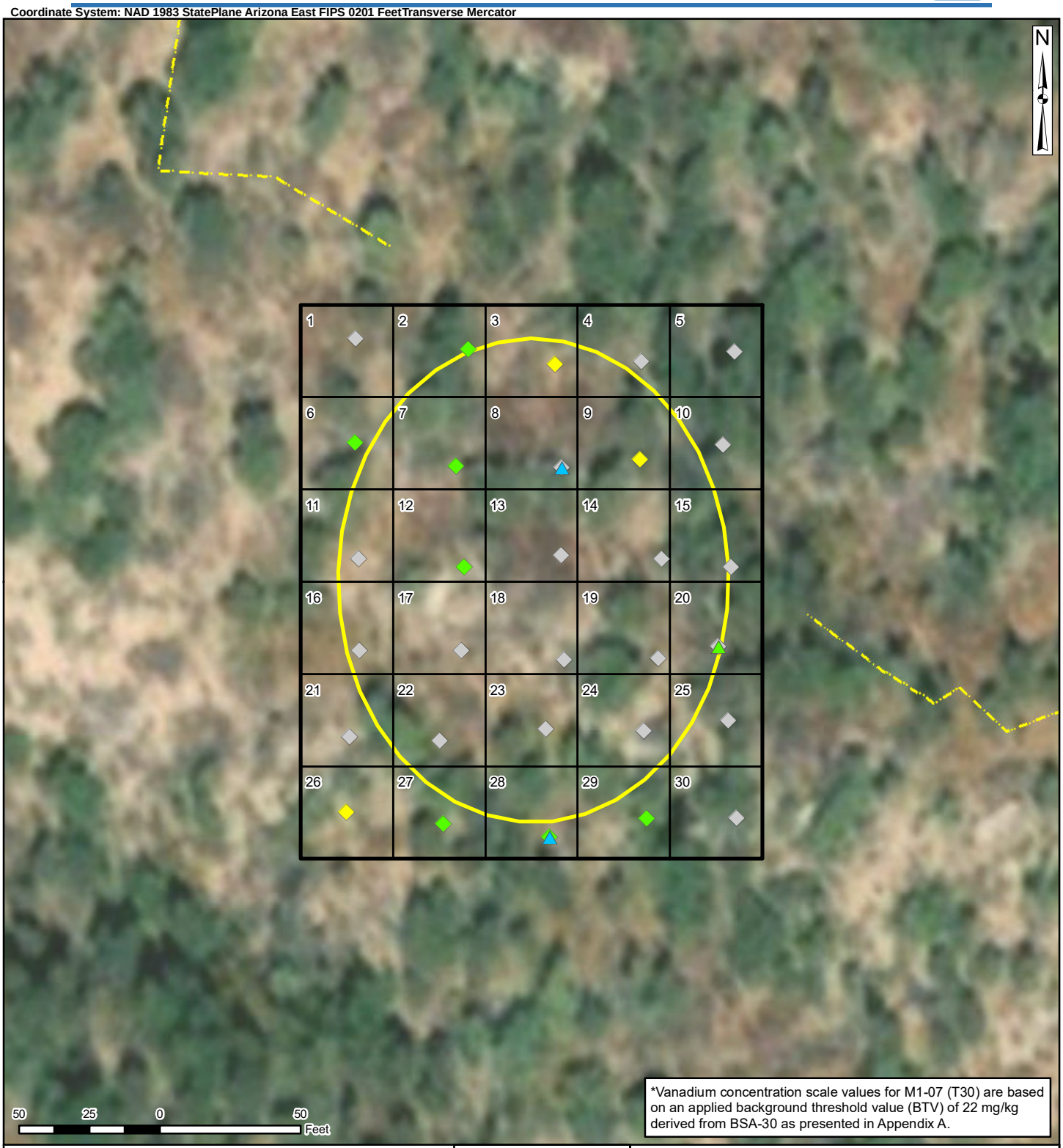


Figure I30-25. Box Plot for Target M1-07 (T30) and BSA-30 (Jml) Vanadium Soil Concentrations

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



Vanadium Concentration Scale (mg/kg)*

- ≤ 9.6
- 9.6 - 22
- 22 - 44
- 44 - 66
- 66 - 88
- 88 - 220
- ≥ 220
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route - Foot

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NON-AUM TARGET M1-07 (T30) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I30-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.1.8 Conclusions

Target T30 (M1-07) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T30. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T30 are:

- Potential mining-related sources of gamma radiation identified in ASPECT gamma survey were evaluated at Target T30. ASPECT gamma survey results correlated with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T30 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T30 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. No grid averaged gamma measurements exceeded the applied BTV.
- A total of 27 analytes were identified as occurring within the surface environment. Of these analytes, 7 were identified as COPCs. Only uranium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T30 does not contain TENORM. No mining-related activities or features were observed in the field. Outcropping of Jml was noted in the field but not evaluated to verify NORM.
- Natural erosion of outcroppings may have increased the lateral extent of NORM.
- There are no immediate significant physical hazards present at Target T30.
- Access is by dirt road with a small four-wheel-drive vehicle followed by footpath.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No existing groundwater wells are documented within the vicinity of Target T30. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T30. Therefore, evaluation of the leachability of metals and radionuclides is not required.

- No mine waste was observed at Target T30; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; no data gaps remain at Target T30.

10.2 NON-AUM TARGET T31 (M1-08)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T31 (M1-08).

10.2.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T31 (M1-08) is in the Lukachukai Mountains Region in Subarea Group H and administered by the Lukachukai Chapter of the Navajo Nation. The Target is accessible by foot and located 0.5 mile off of Indian Route 33. Target T31 is identified the MCAP (Weston 2016), but no historical information is associated with the Target. No residential structures are near the Target. A Target location and access map is shown in Figure I31-1.

A topographical relief map for Target T31 is provided in Figure I31-2. The elevation at Target T31 ranges from 7,810 to 7,863 feet amsl with an average of 7,832 feet amsl. The slope at Target T31 ranges from 15 to 31 percent with an average of 20 percent. No drainages are within the Target boundary. Target T31 is located within Jml and within the Narbona-Zilditloi soil complex (MUSYM 608) (Figures I-26 and I-27).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover data to determine the RSE survey area for Target T31. ASPECT imagery was used to guide the sampling approach, which is specified in Appendix F, FSP 39, of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T31:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T31 is accessed by driving a four-wheel-drive vehicle a hiking off-trail approximately 600 feet off of Indian Route 33.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  NORM was observed at the Target but not verified. The underlying geology is the NORM-bearing Jml. No TENORM was observed.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  An ephemeral drainage was located below the Target. Middle 3A drainage, which is discussed in Appendix J of the RSE Report, is located 0.3 mile downstream of the Target.

- Identified any exploration borings or historic haul roads:

  No exploratory borings or haul roads were identified within the Target boundary.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  No AUM or non-AUM Target features were observed in the field, but NORM was observed at the Target. The underlying geology is the NORM-bearing Jml, which may contribute to elevated gamma readings.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

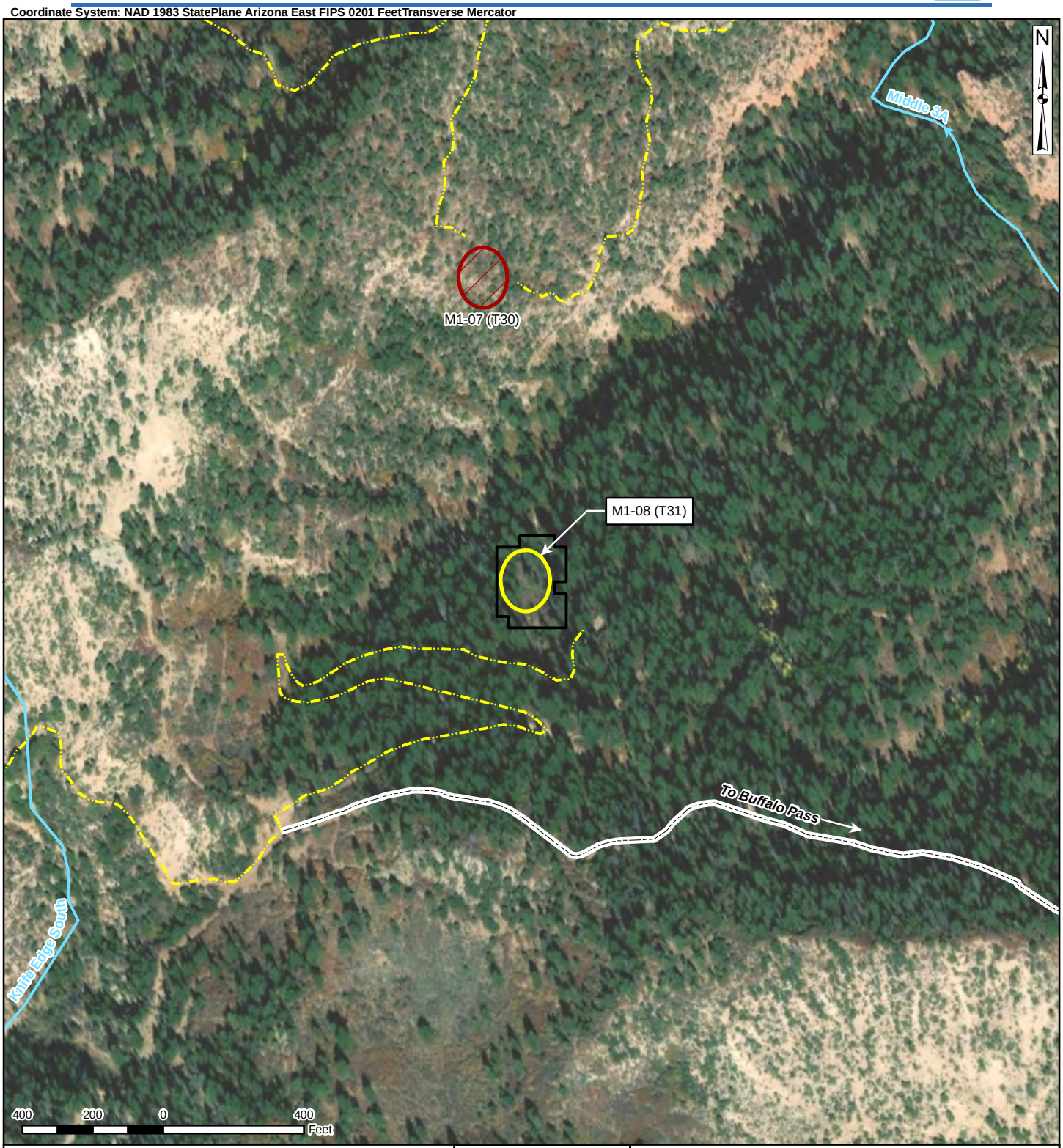
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T31 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Sections 2.3 and 10.2.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 10.2.3 with results presented in Sections 10.2.6 and 10.2.7)
- Conducting a gamma radiation survey (results presented in Section 10.2.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped

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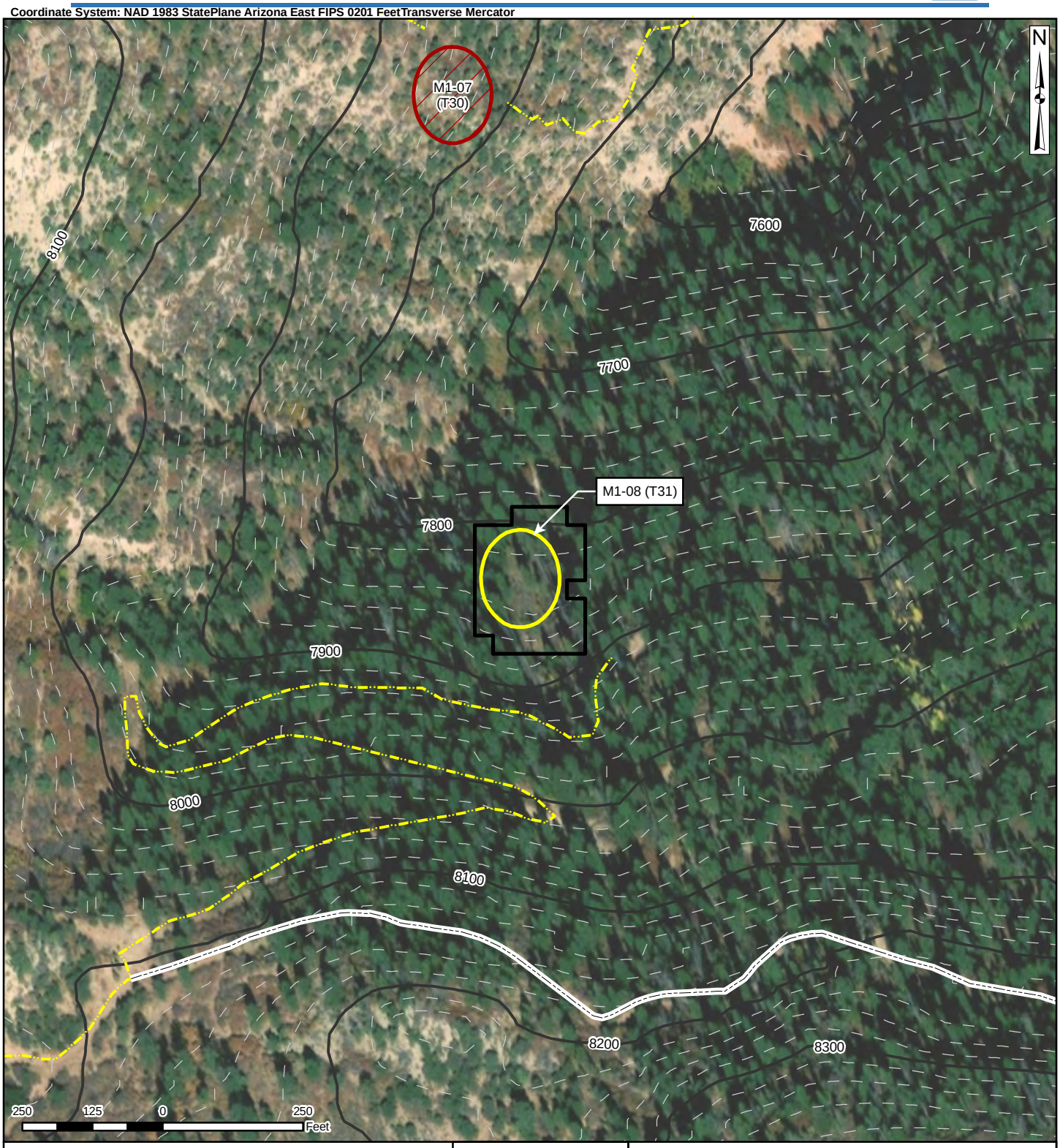
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NON-AUM TARGET M1-08 (T31) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I31-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

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



Non-AUM Target Site Boundary
Related Survey Area
Other Non-AUM Target Site
Access Route - Foot
Access Route - Vehicular
100 ft Contour*
20 ft Contour*

* 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.

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NON-AUM TARGET M1-08 (T31) TOPOGRAPHIC MAP

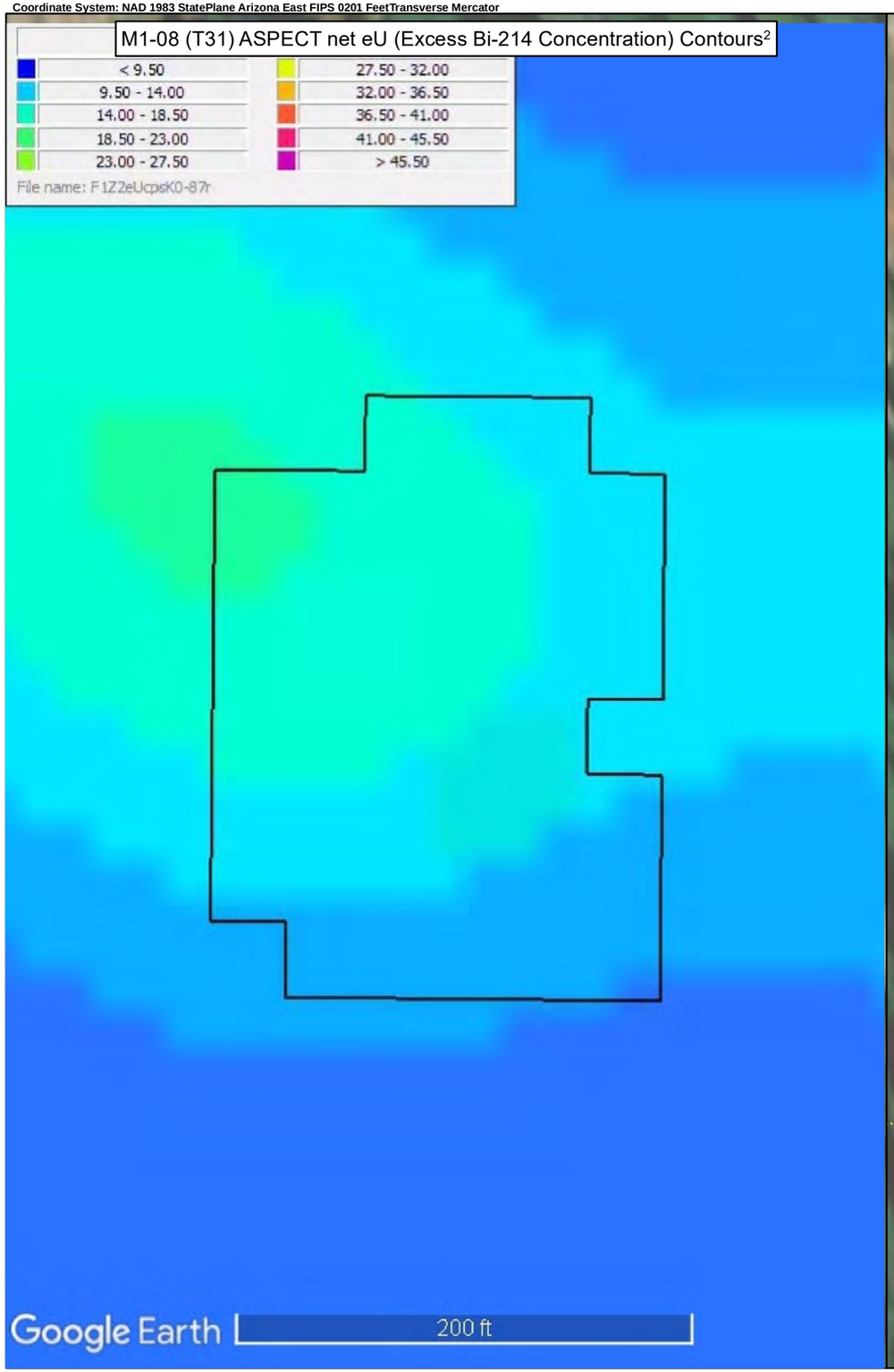
Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I31-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

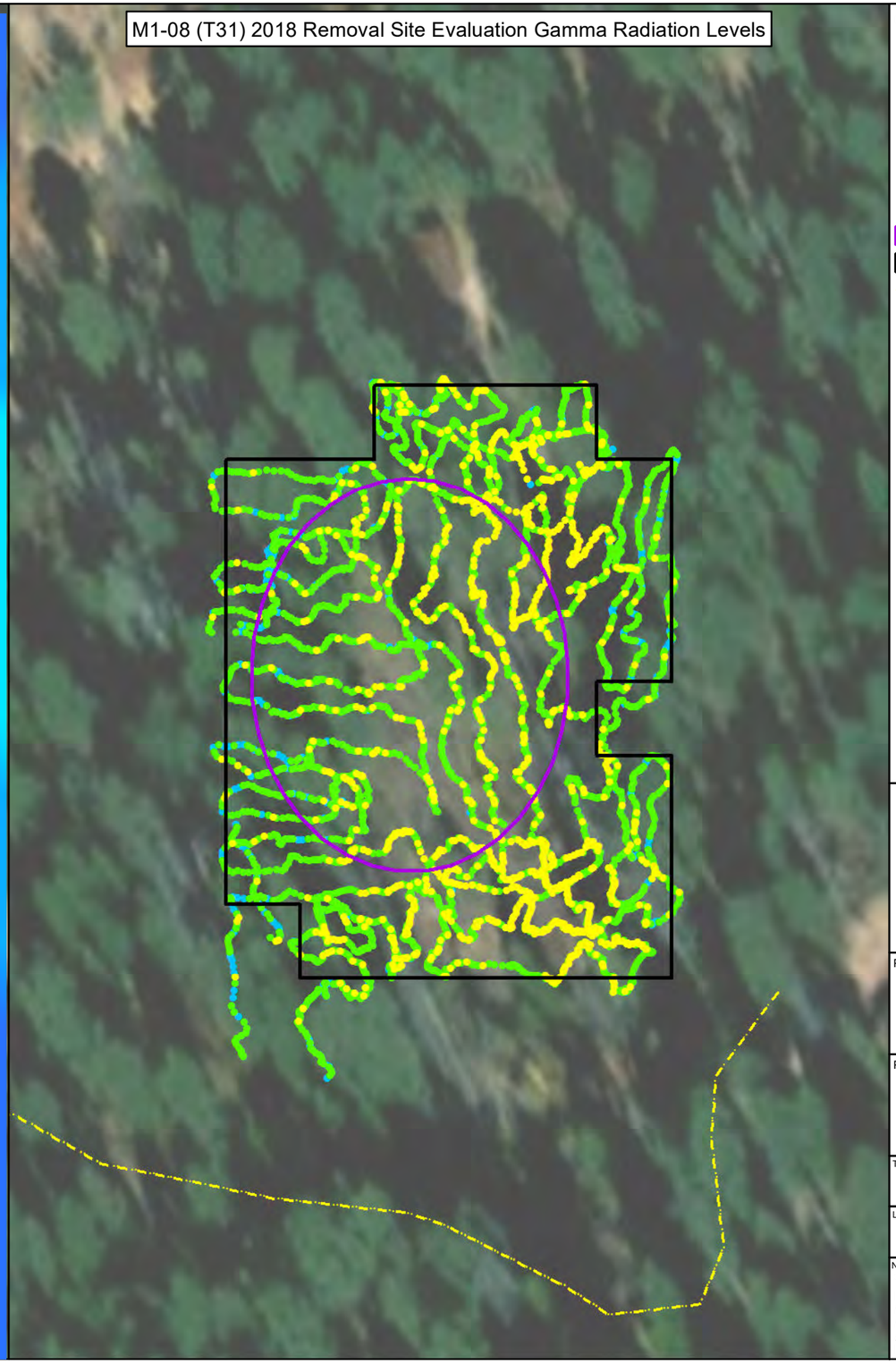
10.2.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I31-3) within the survey area of the non-AUM Target T31 as part of the Baseline Study in July 2018. Additional Goback gamma radiation surveys were performed in September 2018. Tetra Tech also performed an XRF field survey at non-AUM Target T31 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I31-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 39, of the RSE Work Plan (Tetra Tech 2018). Goback sampling involved additional gamma survey measurements and additional XRF measurements at 13 survey units. All gamma survey and XRF survey units were evaluated.

10.2.3 XRF Confirmation Sampling Overview

Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T31. Two XRF soil confirmation samples were collected at a depth of 0 to 3 inches bgs from two locations (Table I31-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I31-4 and I31-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I31-2. The results of XRF confirmation sample analysis are provided in Section 10.2.6.1. Correlated XRF field measurements are provided in Attachment I3.





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

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Foot

[1]The applied gamma background threshold value (BTV) for M1-08 (T31) is 11,378 cpm derived from BSA-30 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET M1-08 (T31) 2018 REMOVAL SITE EVALUATION AND ASPECT CONTOUR MAP

Prepared For:

Prepared By:

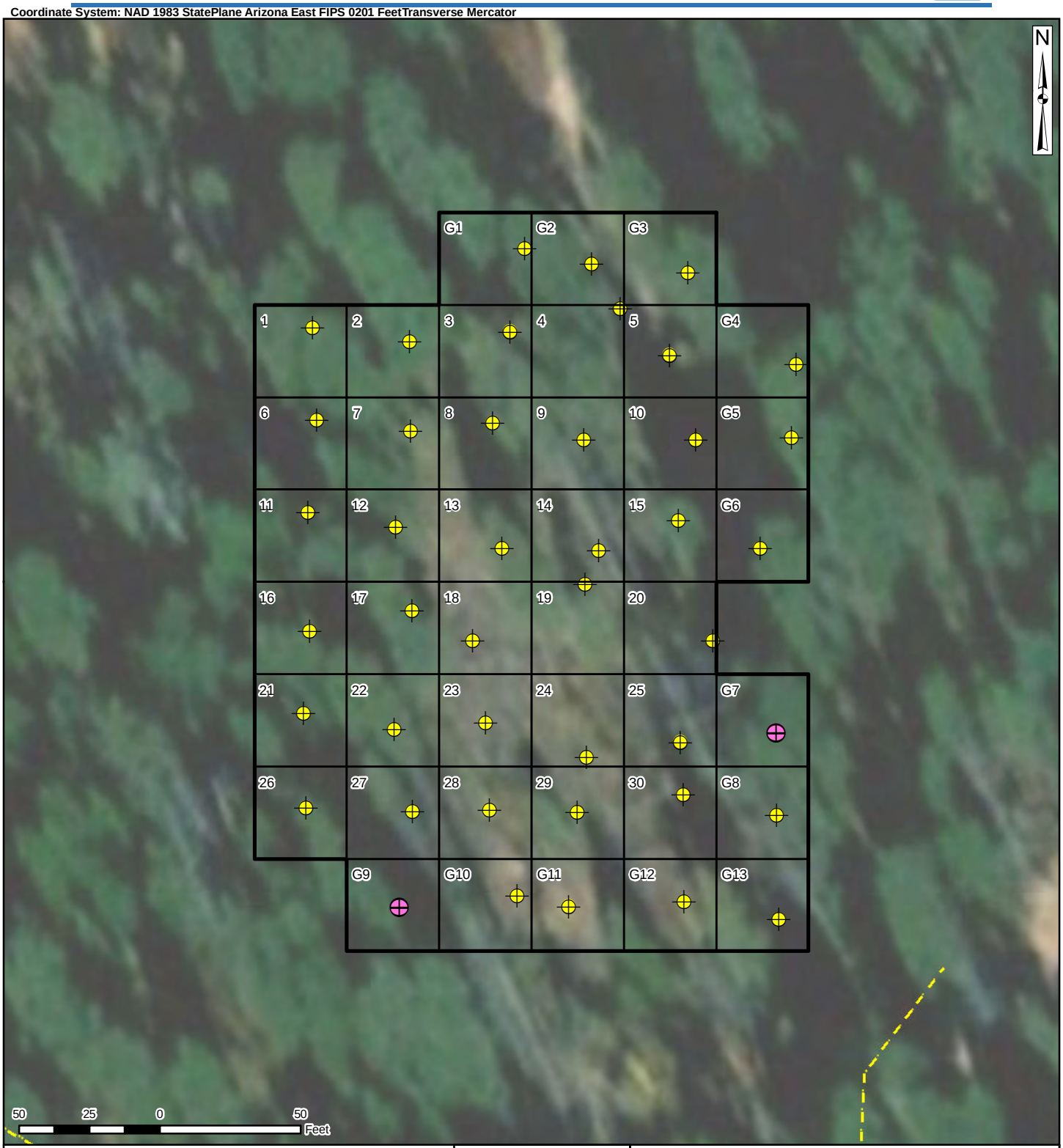
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborne Spectral Photometric Environmental Collection Technology.

Figure No.: **I31-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Foot

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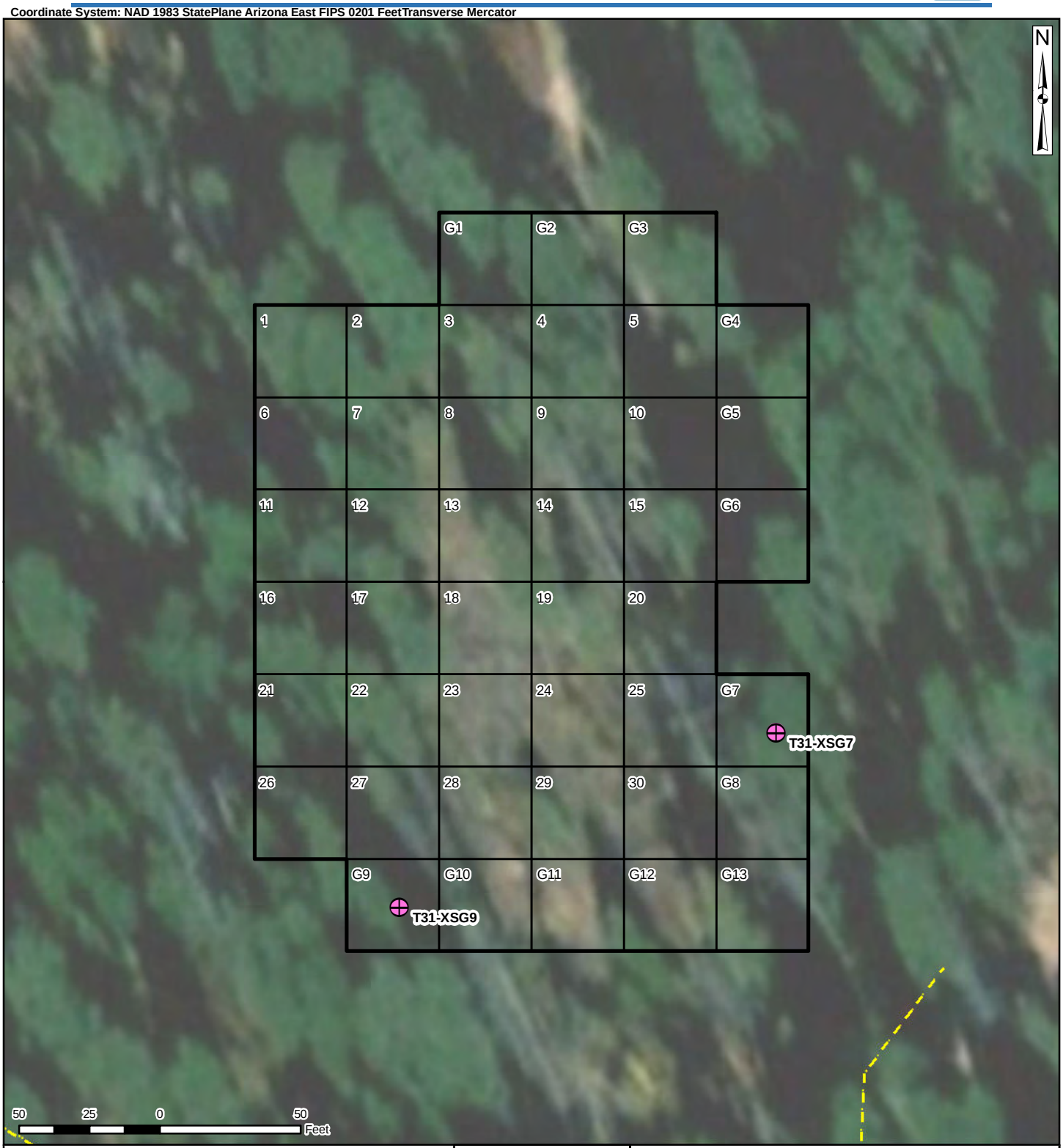
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NON-AUM TARGET M1-08 (T31)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I31-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

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



XRF Confirmation Soil Sample*
(0 - 3 inches bgs)

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Foot

*T31-XSG7 = site T31 XRF confirmation soil sample collected at survey unit G7. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET M1-08 (T31)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I31-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

Table I31-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M1-08 (T31)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T31-XSG7-01-092518	G7	0-3	XRF Confirmation	Primary	9/25/2018	36.4995283	-109.2310753	1810032-19, 1810033-19
T31-XSG9-01-092518	G9	0-3	XRF Confirmation	Primary	9/25/2018	36.4993613	-109.2315324	1810032-20, 1810033-20

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I31-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M1-08 (T31)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

10.2.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 10.2.1, Target T31 surface geology is entirely within Jml with soils within the Narbona-Zilditloi complex (MUSYM 608) (Figures I-26 and I-27). As a result, BSA-30 was selected for that combination of geology and soil type. Additionally, the Jml regional geological background would also be applicable for this Target. Table I31-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T31. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T31. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T31. The "Applied BTV" for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I31-3. Applied Background Threshold Values for Non-AUM Target M1-08 (T31)

Analyte	Units	Site-Specific BTV (BSA-30)	Regional BTV (Jml)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	4,690	7,000	4,690	Site-Specific BTV
Antimony	mg/kg	0.171	0.140	0.140	Regional BTV
Arsenic	mg/kg	2.2	3.5	2.2	Site-Specific BTV
Barium	mg/kg	172	270	172	Site-Specific BTV
Beryllium	mg/kg	0.69	0.57	0.57	Regional BTV
Cadmium	mg/kg	0.145	0.160	0.145	Site-Specific BTV
Calcium	mg/kg	98,200	32,000	32,000	Regional BTV
Chromium	mg/kg	4.2	5.2	4.2	Site-Specific BTV
Cobalt	mg/kg	3.8	4.4	3.8	Site-Specific BTV
Copper	mg/kg	17	12	12	Regional BTV
Iron	mg/kg	14,200	8,897	8,897	Regional BTV
Lead	mg/kg	9.9	11	9.9	Site-Specific BTV
Lithium	mg/kg	5.3	8.8	5.3	Site-Specific BTV
Magnesium	mg/kg	2,600	3,900	2,600	Site-Specific BTV
Manganese	mg/kg	627	440	440	Regional BTV
Mercury	mg/kg	0.0160	0.0378	0.0160	Site-Specific BTV
Molybdenum	mg/kg	-	0.29	0.29	Regional BTV
Nickel	mg/kg	4.4	6.2	4.4	Site-Specific BTV
Potassium-40	pCi/g	25.7	26.9	25.7	Site-Specific BTV
Radium-226	pCi/g	0.87	2.23	0.87	Site-Specific BTV
Radium-228	pCi/g	0.60	0.75	0.60	Site-Specific BTV
Selenium	mg/kg	1.23	1.0	1.0	Regional BTV
Silver	mg/kg	0.048	0.037	0.037	Regional BTV
Sodium	mg/kg	95	45	45	Regional BTV
Thallium	mg/kg	0.124	0.075	0.075	Regional BTV
Thorium	mg/kg	6.3	4.7	4.7	Regional BTV
Uranium	mg/kg	0.64	1.5	0.64	Site-Specific BTV
Vanadium	mg/kg	22	24	22	Site-Specific BTV
Zinc	mg/kg	39	27	27	Regional BTV
Gamma Radiation	cpm	11,378	14,566	11,378	Site-Specific BTV

Notes:

BSA	Background Study Area
BTV	background threshold value
cpm	counts per minute
Jml	Morrison Formation (Lower)
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram

10.2.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T31 and the raw gamma radiation and grid averaged gamma radiation survey results.

10.2.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T31 in July 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine how many additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. Additional gamma radiation surveys were performed in September 2018 to collect data within the Goback survey units. The applied gamma BTV for non-AUM Target T31 is 11,378 cpm. A total of 4,536 measurements were collected as part of the gamma radiation survey at non-AUM Target T31 across 43 survey units. An average scan density of 43 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I31-4.

Table I31-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M1-08 (T31)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,378	
Measurements	#	4,536	43
Minimum	cpm	7,418	9,410
Maximum	cpm	19,145	11,917
Average	cpm	10,765	10,729
Median	cpm	10,694	10,644
Standard Deviation	cpm	1,085	570
90th Percentile	cpm	12,169	11,478
95th Percentile	cpm	12,633	11,654
99th Percentile	cpm	13,603	11,889
Measurements per Survey Unit	#/grid	105	
Measurements Above Gamma BTV	#	1,187	6
Measurements Above Gamma BTV	%	26.2	14.0

Notes:
BTV background threshold value
cpm counts per minute

10.2.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 26.2 percent of the measurements within the Target boundaries, in some cases exceeding twice the applied gamma BTV (11,378 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-30 (Jml) gamma survey results is provided on Figure I31-6. This graph shows that the spread of radiation data at Target T31 (shown on left) begins within the middle range of BSA-30 (Jml) gamma levels (shown on right) and then rises to more than 1.5 times background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T31 is slightly higher than the data cloud from the BSA-30 (Jml) data set. A box plot showing the quartiles of the data sets is provided in Figure I31-7. The box plot shows that the median of Target T31 radiation levels is higher than the median of the BSA-30 (Jml) data set but less than the applied gamma BTV.

A map showing the results of the 2018 RSE gamma radiation survey is provided in Figure I31-8. No mining activity was observed within the survey area of Target T31. The elevated gamma activity is likely associated with outcropping of Jml.

In general, Target T31 has surficial gamma radiation levels above BSA-30 (Jml) levels across the majority of the Target except for the outside edges of the survey boundary, indicating that the survey encompassed the area of elevated gamma activity identified by the ASPECT gamma survey (Figure I31-3). No TENORM or mining-related activities were observed. Section 10.2.5.3 presents the grid averaged results of the gamma radiation survey.

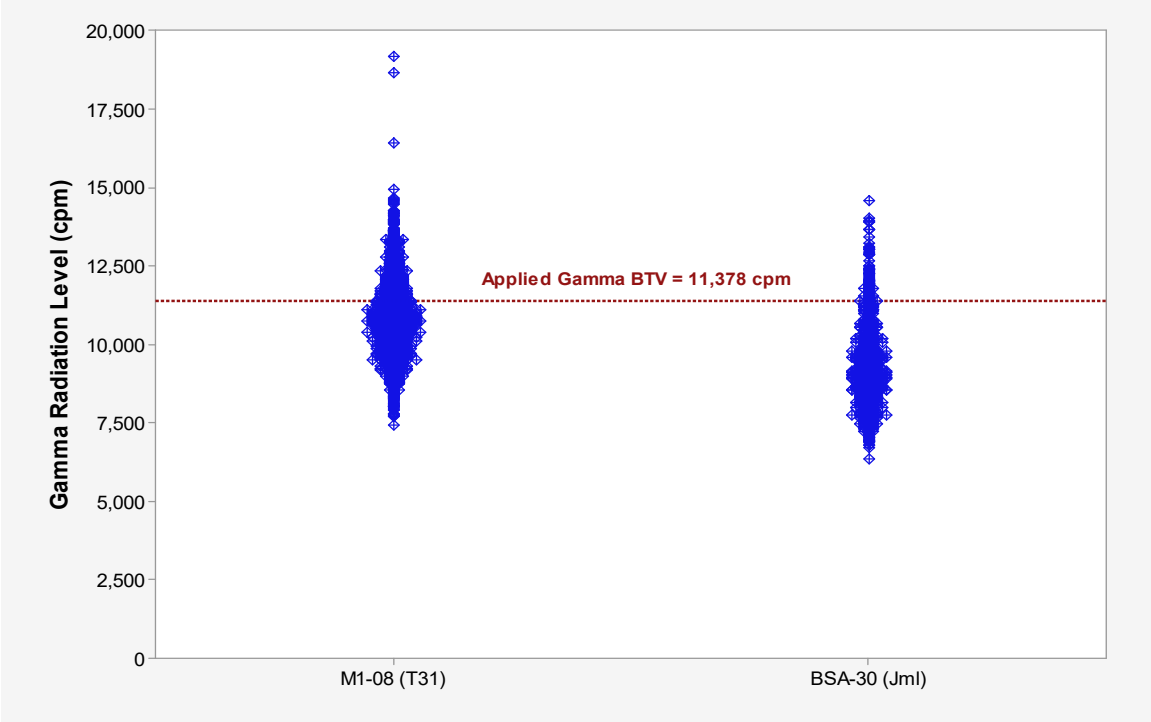


Figure I31-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M1-08 (T31) and BSA-30 (Jml)

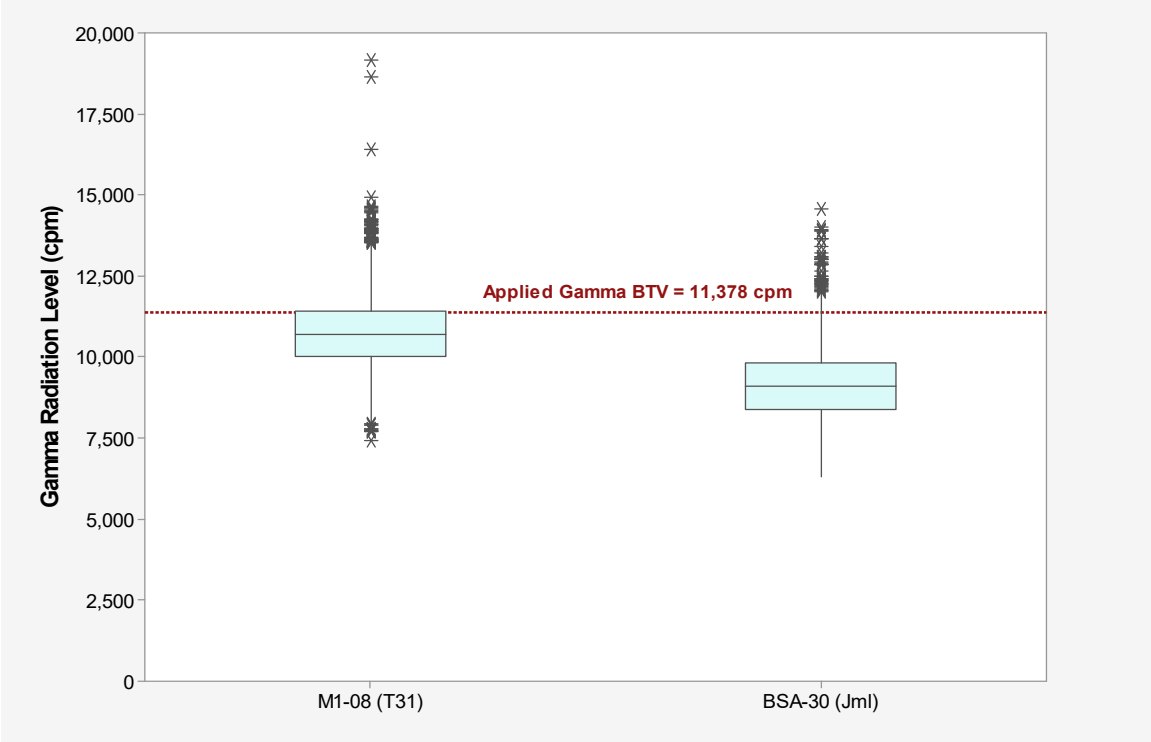
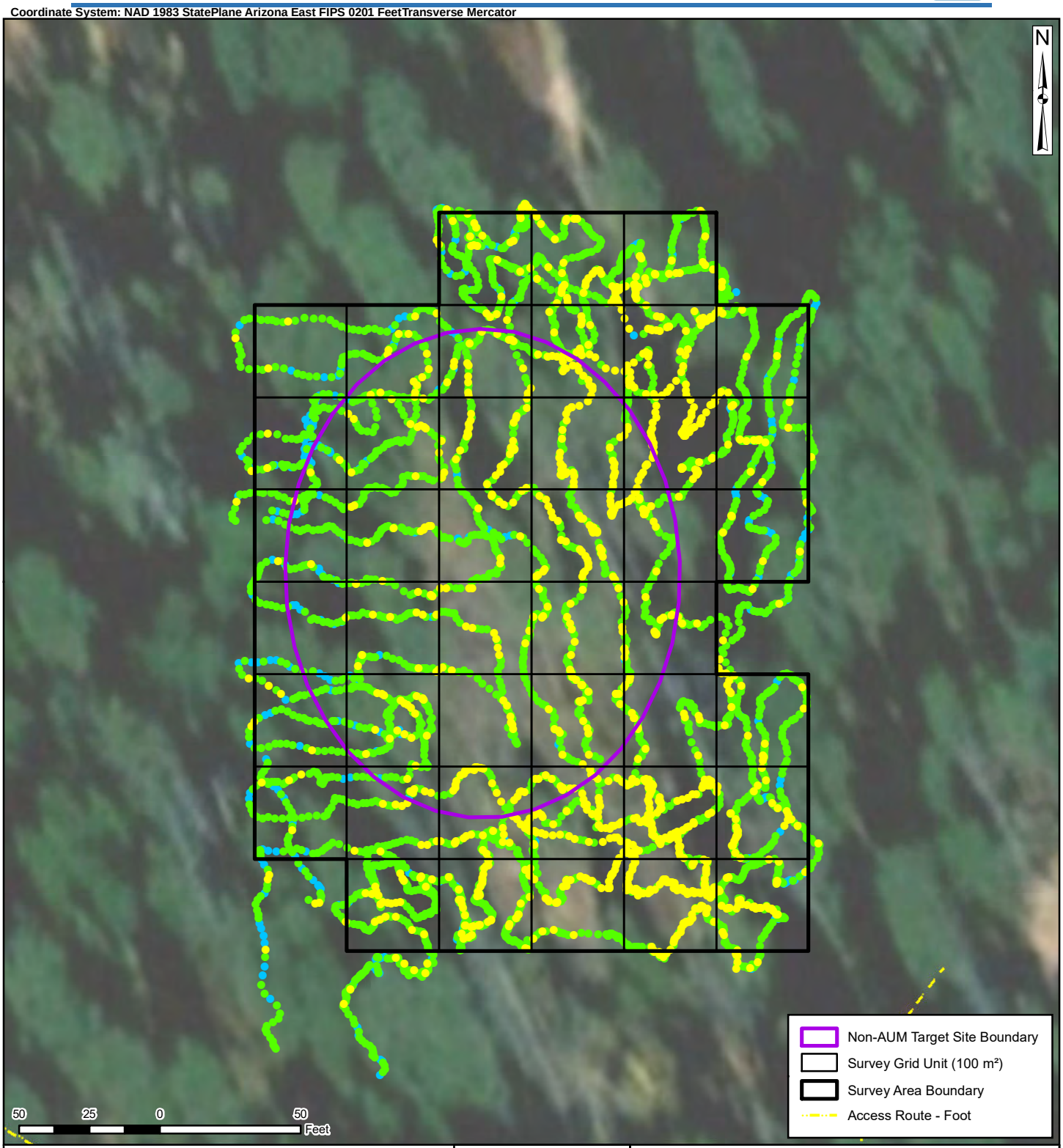


Figure I31-7. Box Plot of Raw Gamma Radiation Levels at Target M1-08 (T31) and BSA-30 (Jml)

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



Gamma Reading (cpm)*

≤ 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

*The applied gamma background threshold value (BTV) for M1-08 (T31) is 11,378 cpm derived from BSA-30 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M1-08 (T31)
2018 REMOVAL SITE EVALUATION
GAMMA RADIATION LEVELS SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I31-8
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.2.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 10.2.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 10.2.5.1. Figure I31-9 and Figure I31-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-30 (Jml) data set (shown on right). A total of 14 percent of the survey units (6 of 43) within the survey area of Target T31 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I31-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I31-11 as discussed further in Section 2.8. This map shows the locations of survey units exceeding the gamma BTV. The elevated regions are likely associated with outcropping of Jml.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 10.2.6.

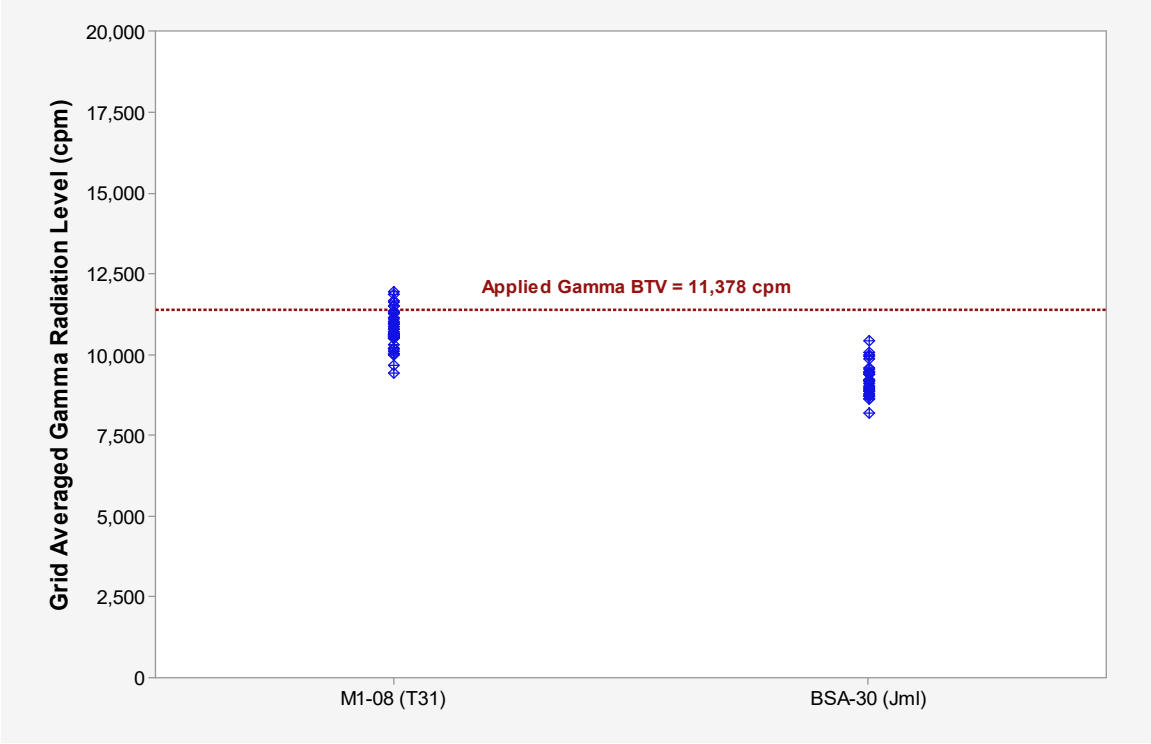


Figure I31-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M1-08 (T31) and BSA-30 (Jml)

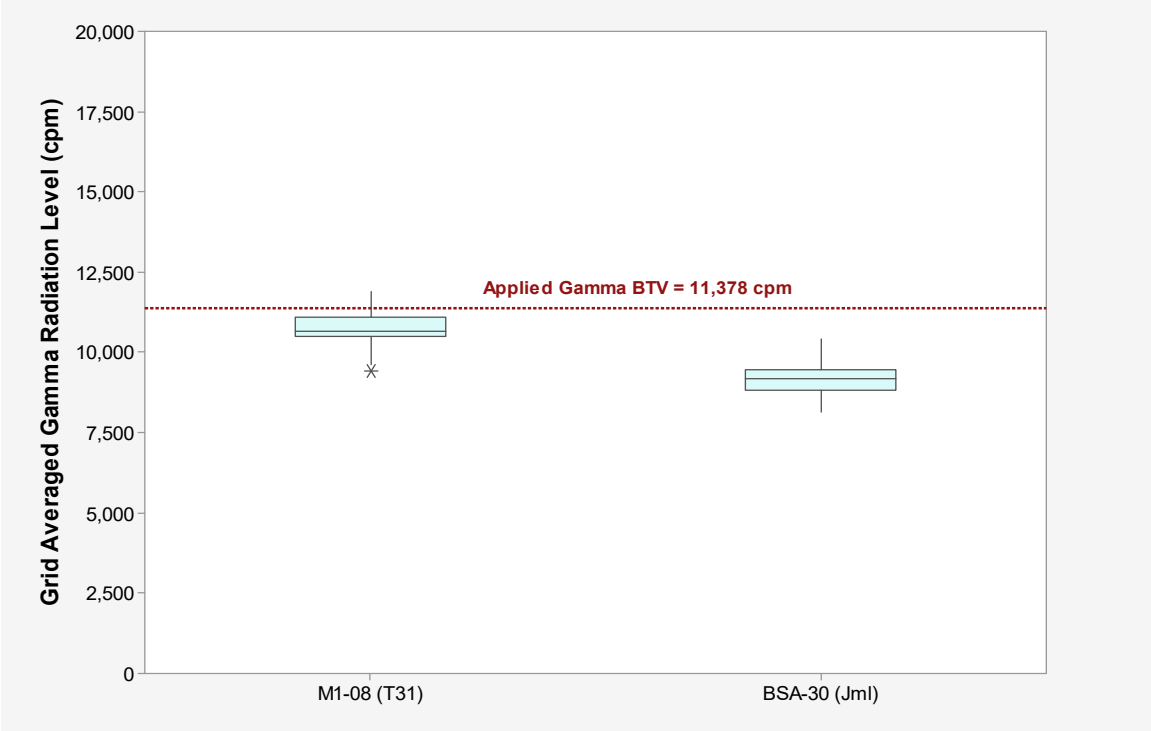
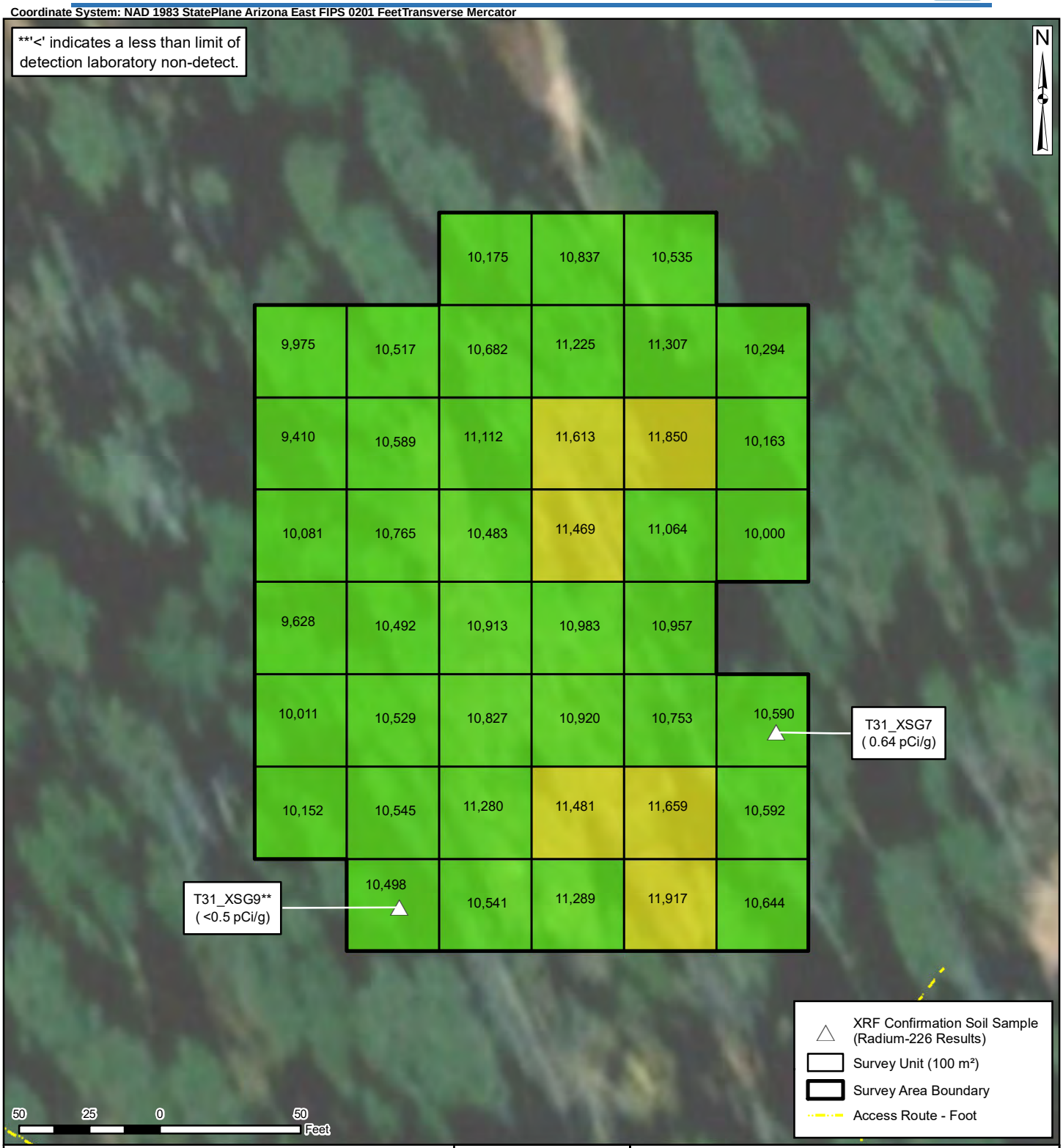


Figure I31-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M1-08 (T31) and BSA-30 (Jml)

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



Grid Averaged Gamma Reading (cpm)*

≤ 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

*The applied gamma background threshold value (BTV) for M1-08 (T31) is 11,378 cpm derived from BSA-30 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M1-08 (T31)
GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I31-11
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.2.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T31. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 10.2.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 10.2.6.2.

10.2.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T31: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I31-1 and I31-2. All the results of the XRF confirmation soil samples are presented in Table I31-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T31 following the methods outlined in Section 2.4 and shown in Figure I31-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 43 measurements were collected across 43 survey units from the survey area of Target T31 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I31-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T31 at a depth of 0 to 3 inches bgs. Two XRF confirmation soil samples were collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I31-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 10.2.7.

Table I31-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M1-08 (T31)

Analyte	Units	Applied BTV	T31-XSG7-01-092518		T31-XSG9-01-092518	
			Result	Q	Result	Q
Survey Unit			G7		G9	
Aluminum	mg/kg	4,690	2,500		2,800	
Antimony	mg/kg	0.140	0.062	J	0.07	J
Arsenic	mg/kg	2.2	1.5		1.8	
Barium	mg/kg	172	42		73	
Beryllium	mg/kg	0.57	0.21		0.24	
Cadmium	mg/kg	0.145	0.034	J	0.068	J
Calcium	mg/kg	32,000	1,800		3,900	
Chromium	mg/kg	4.2	2.6		3	
Cobalt	mg/kg	3.8	1.4		1.7	
Copper	mg/kg	12	2.6		3.4	
Iron	mg/kg	8,897	3,300		3,800	
Lead	mg/kg	9.9	3.4		5.1	
Lithium	mg/kg	5.3	4.8		4.5	
Magnesium	mg/kg	2,600	1,300		1,400	
Manganese	mg/kg	440	80		150	
Molybdenum	mg/kg	0.29	0.092	J	0.091	J
Nickel	mg/kg	4.4	2.5		2.9	
Potassium-40	pCi/g	25.7	15.8		15.7	
Radium-226	pCi/g	0.87	0.64	LT	<0.5	U
Radium-228	pCi/g	0.60	<0.4	U	<0.67	U
Selenium	mg/kg	1.0	0.48	J	0.7	J
Silver	mg/kg	0.037	<0.044	U	<0.048	U
Sodium	mg/kg	45	18	J	21	J
Thallium	mg/kg	0.075	0.028		0.034	
Thorium	mg/kg	4.7	2.3		2.2	
Uranium	mg/kg	0.64	0.38		0.48	
Vanadium	mg/kg	22	6.4		6.7	
Zinc	mg/kg	27	<8.9	U	10	

Notes:

BTV Background threshold value
J Estimated value
J- Estimated value, may be biased low
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 Qualification
U Not considered detected. The associated value is the method detection limit (MDL).

Table I31-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M1-08 (T31)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.2	8,897	9.9	440	0.29	4.7	0.64	22	27
Measurements	#	43	43	43	43	43	43	43	43	43
Detects	#	13	43	43	43	20	38	34	12	43
Nondetects	#	30	0	0	0	23	5	9	31	0
Minimum	mg/kg	2.0	2,103	2.6	123.1	0.1	1.2	0.1	16.1	12.3
Maximum	mg/kg	4.5	7,547	20.7	572.8	11.2	3.8	4.0	35.4	54.6
Standard Deviation	mg/kg	0.8	1,188	4.0	115	2.66	0.6	1.1	6	8.1
Average	mg/kg	3.0	4,580	8.9	320	2.60	2.3	1.8	22.3	21.8
Median	mg/kg	2.6	4,676	8.4	302	1.68	2.4	1.5	19.9	19.5
Relative Standard Deviation	%	28.3	25.9	44.3	35.9	102.3	27.8	61.0	27.0	37.3
90th Percentile	mg/kg	4.3	5,837	13.7	462	4.5	3.0	3.1	29	31
95th Percentile	mg/kg	4.5	6,254	15.1	531	7.5	3.1	3.4	32	34
99th Percentile	mg/kg	4.5	7,226	19.7	561	10.5	3.6	3.9	35	48
Measurements Above Applied BTV	#	11	0	14	7	18	0	28	4	9
Measurements Above Applied BTV	%	25.6	0.0	32.6	16.3	41.9	0.0	65.1	9.3	20.9

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value
mg/kg Milligram per kilogram
XRF X-ray fluorescence

10.2.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T31 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T31 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T31. The estimated BTVs are identified in Section 10.2.4 and Table I31-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I31-7 presents a summary of the background comparison for different measurement and soil depths at Target T31. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T31. Further gamma radiation screening indicated that gamma levels at Target T31 are similar to those at the BSA. Therefore, while multiple COPCs have been identified at Target T31 based on a comparison to background, risk screening will be required to support a future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I31-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M1-08 (T31)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic		✓	✓
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron			
Lead		✓	✓
Lithium			
Magnesium			
Manganese		✓	✓
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium			
Silver			
Sodium			
Thallium			
Thorium			
Uranium		✓	✓
Vanadium		✓	✓
Zinc		✓	✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

10.2.7 Primary Contaminant Mapping

10.2.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 10.2.6.2 identified the COPCs at Target T31. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 10.2.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I31-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T31 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 10.2.7.1 through Section 10.2.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T31. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

10.2.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I31-7. Arsenic exceeded the applied BTV in 25.6 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for arsenic is 2.2 mg/kg for Target T31 as presented in Section 10.2.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I31-5 and Attachment I3, respectively. Figure I31-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T31 and BSA-30 (Jml) samples. Figure I31-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T31 and BSA-30 (Jml) samples. Summary statistics for XRF measurements are provided in Section 10.2.6.1. Arsenic XRF concentrations measured in surface soils at Target T31 ranged between 2.0 and 4.5 mg/kg with an average and standard deviation of 3.0 mg/kg and 0.8 mg/kg, respectively. The average arsenic XRF concentration is above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T31 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I31-14. Overall, the majority of detectable arsenic results in surface soils were above the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials Target T31.

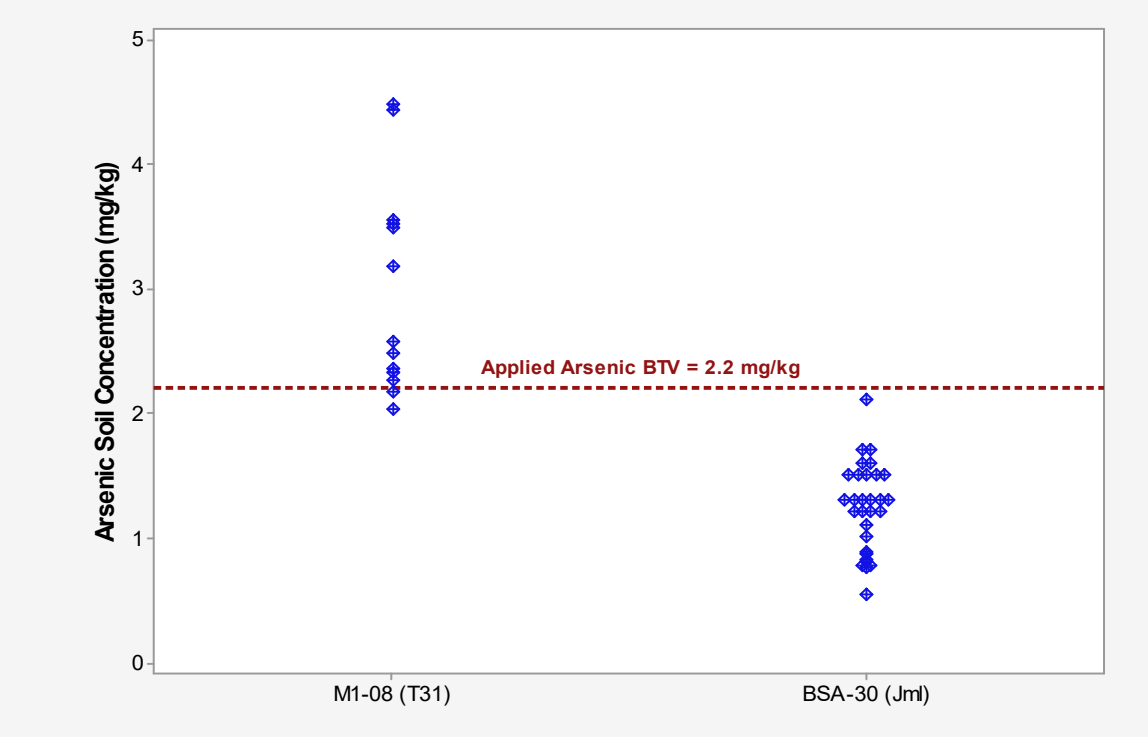


Figure I31-12. Individual Value Plot for Target M1-08 (T31) and BSA-30 (Jml) Arsenic Soil Concentrations

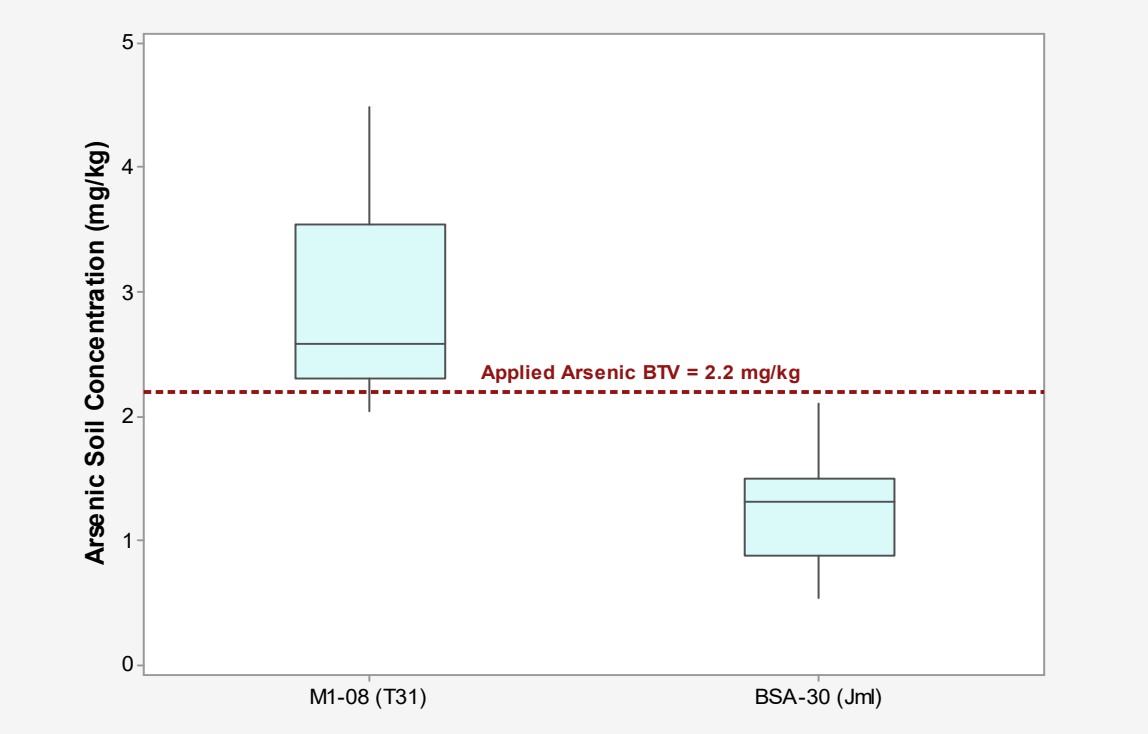
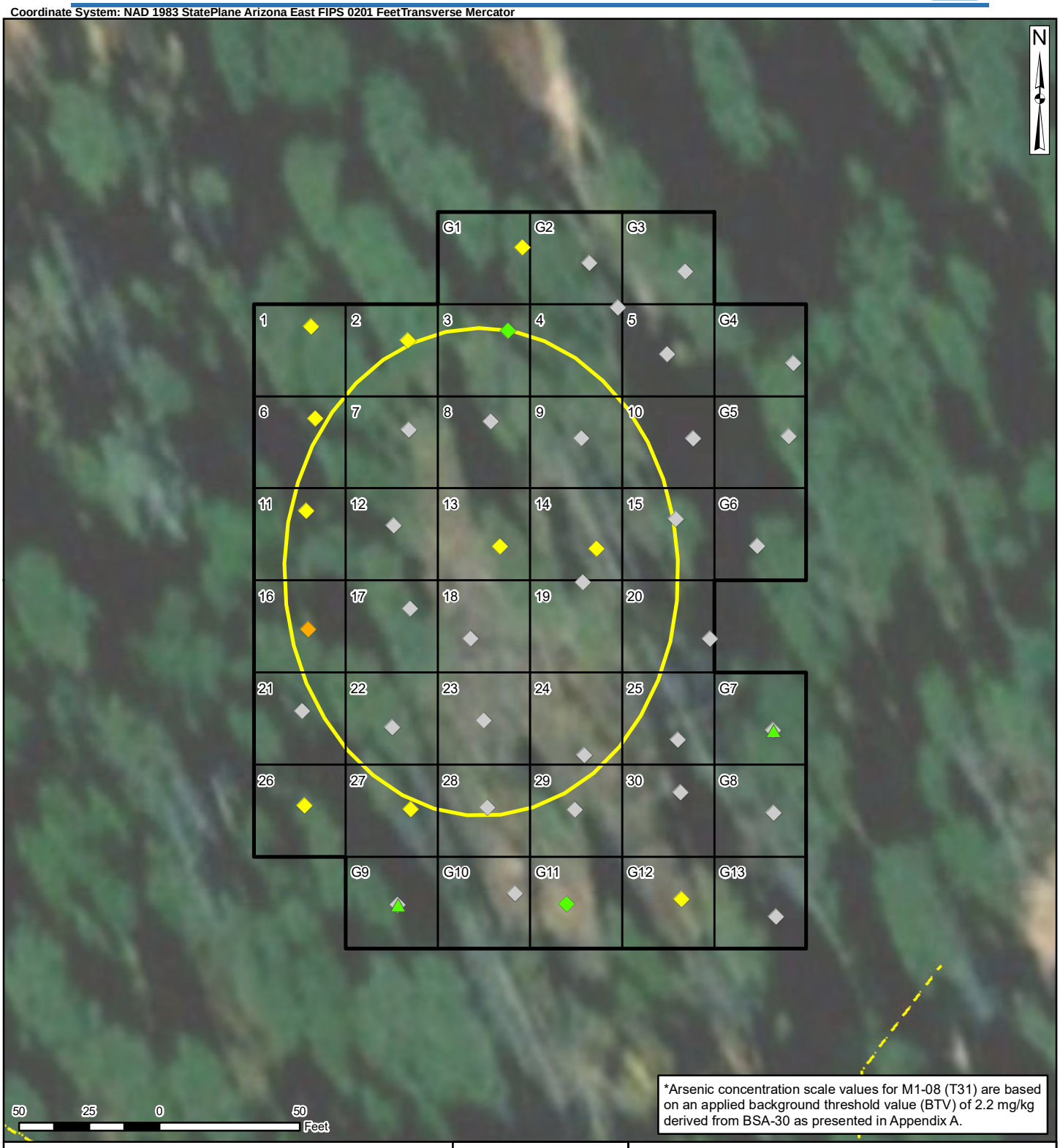


Figure I31-13. Box Plot for Target M1-08 (T31) and BSA-30 (Jml) Arsenic Soil Concentrations

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



*Arsenic concentration scale values for M1-08 (T31) are based on an applied background threshold value (BTV) of 2.2 mg/kg derived from BSA-30 as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 1.2
- 1.2 - 2.2
- 2.2 - 4.4
- 4.4 - 6.6
- 6.6 - 8.8
- 8.8 - 22
- ≥ 22
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET M1-08 (T31) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I31-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.2.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I31-7. Lead exceeded the applied BTV in 32.6 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for lead is 9.9 mg/kg for Target T31 as presented in Section 10.2.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I31-5 and Attachment I3, respectively. Figure I31-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T31 and BSA-30 (Jml) samples. Figure I31-16 presents a box plot of detectable lead XRF soil concentrations for Target T31 and BSA-30 (Jml) samples. Summary statistics for XRF measurements are provided in Section 10.2.6.1. Lead XRF concentrations measured in surface soils at Target T31 ranged between 2.6 and 20.7 mg/kg with an average and standard deviation of 8.9 mg/kg and 4.0 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T31 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I31-17. Overall, the majority of detectable lead results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials Target T31.

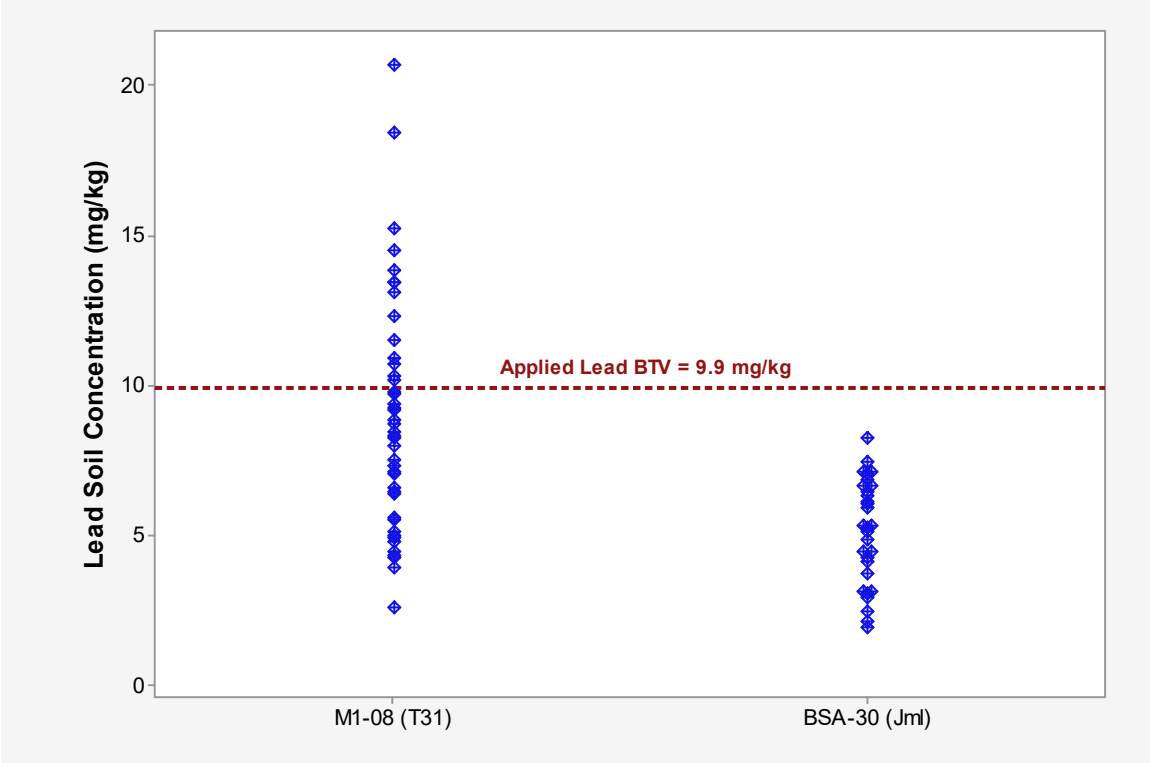


Figure I31-15. Individual Value Plot for Target M1-08 (T31) and BSA-30 (Jml) Lead Soil Concentrations

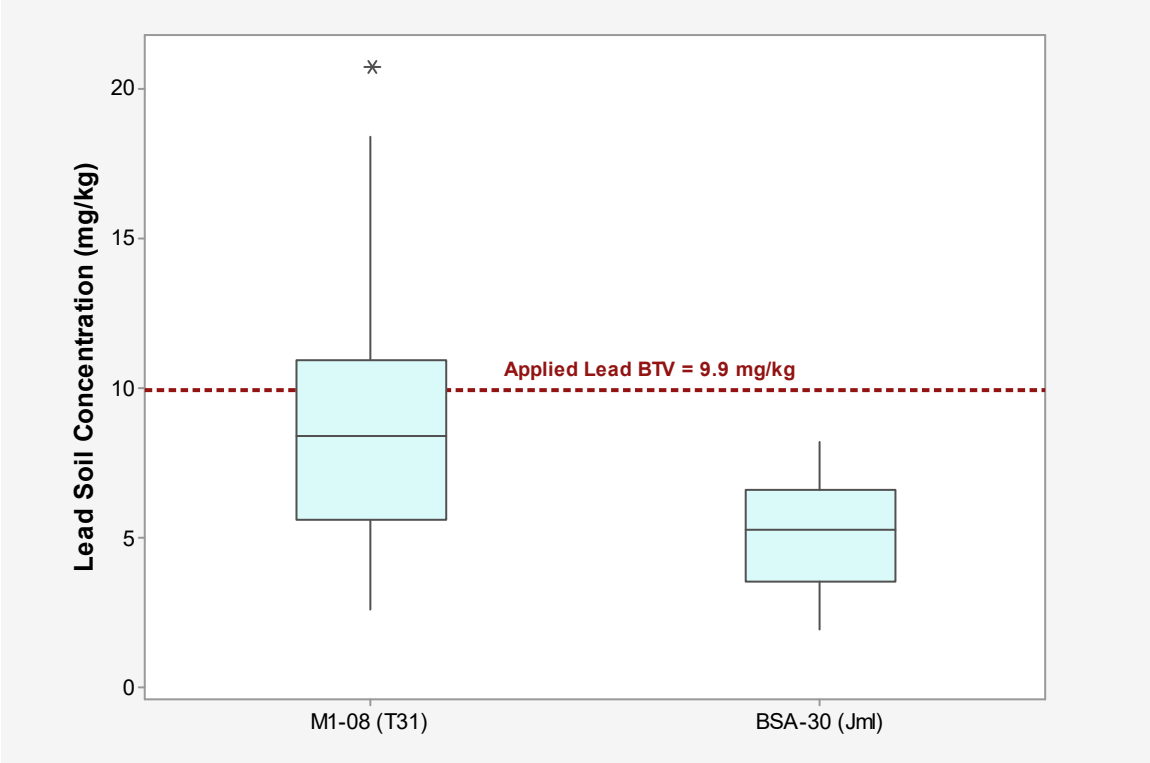
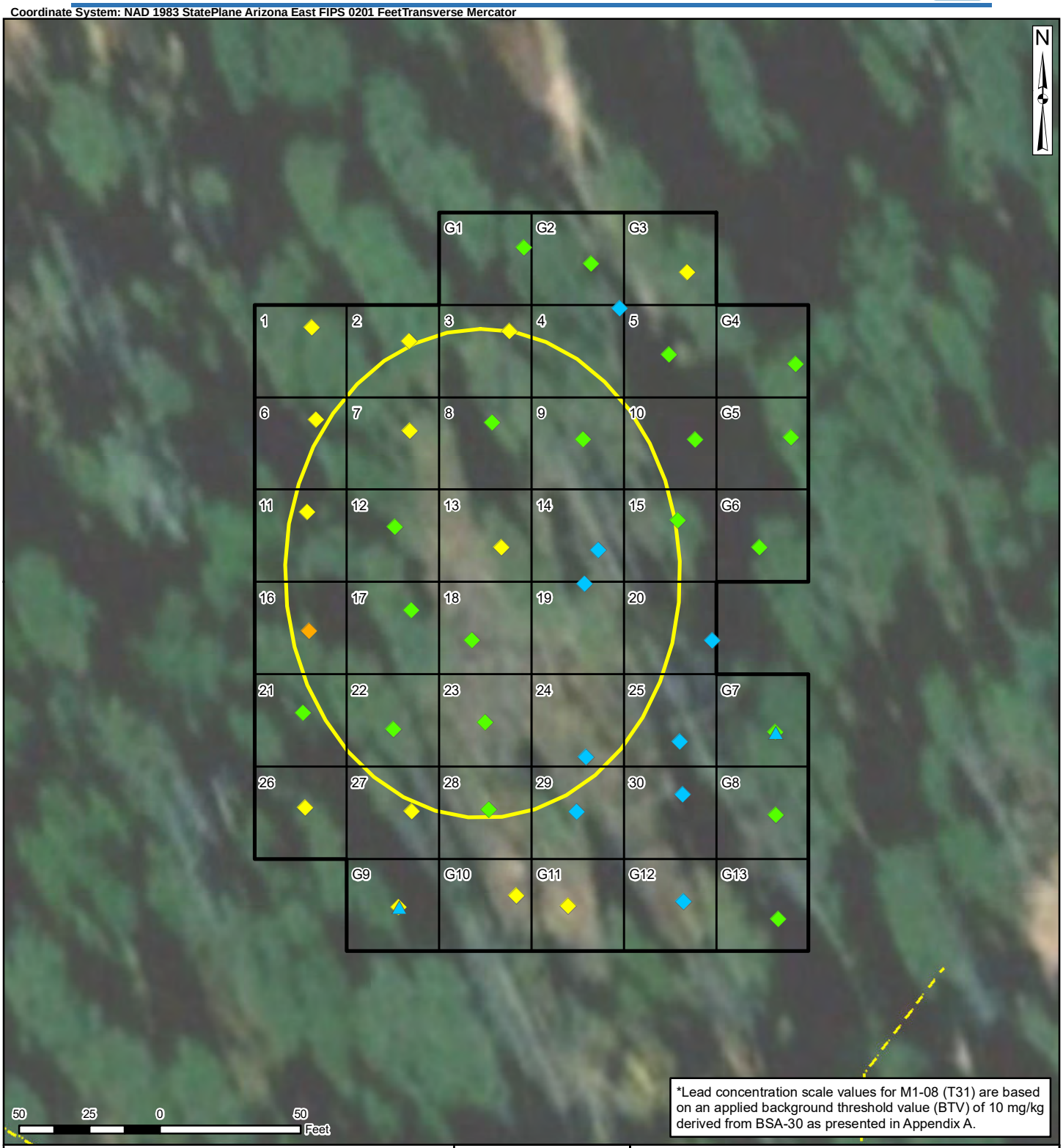


Figure I31-16. Box Plot for Target M1-08 (T31) and BSA-30 (Jml) Lead Soil Concentrations

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



*Lead concentration scale values for M1-08 (T31) are based on an applied background threshold value (BTV) of 10 mg/kg derived from BSA-30 as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 5.1
- 5.1 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 100
- ≥ 100

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET M1-08 (T31) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I31-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.2.7.4 Thorium

Thorium was not identified as a COPC in surface soil as shown in Table I31-7. Thorium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for thorium is 4.7 mg/kg for Target T31 as presented in Section 10.2.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I31-5 and Attachment I3, respectively. Figure I31-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T31 and Jml regional samples. Figure I31-19 presents a box plot of detectable thorium XRF soil concentrations for Target T31 and Jml regional sample types. Summary statistics for XRF measurements are provided in Section 10.2.6.1. Thorium XRF concentrations measured in surface soils at Target T31 ranged between 1.2 and 3.8 mg/kg with an average and standard deviation of 2.3 mg/kg and 0.6 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T31 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I31-20. All thorium results in surface soils were less than the applied BTV.

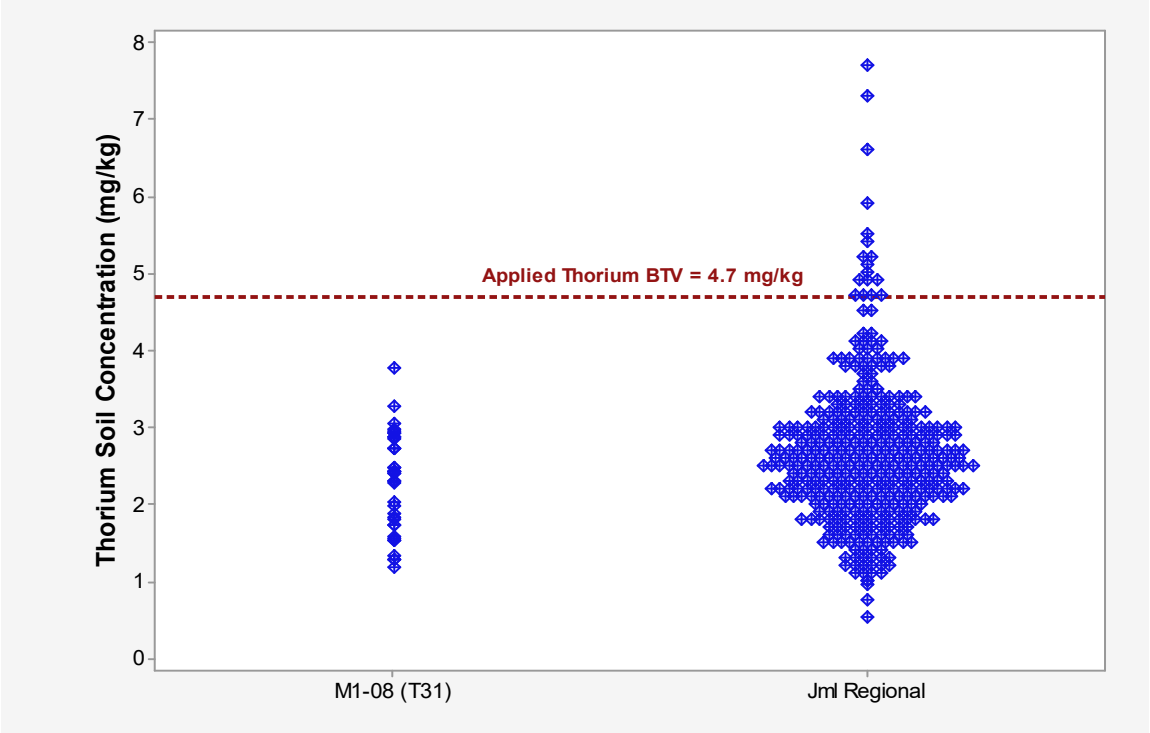


Figure I31-18. Individual Value Plot for Target M1-08 (T31) and Jml Regional Thorium Soil Concentrations

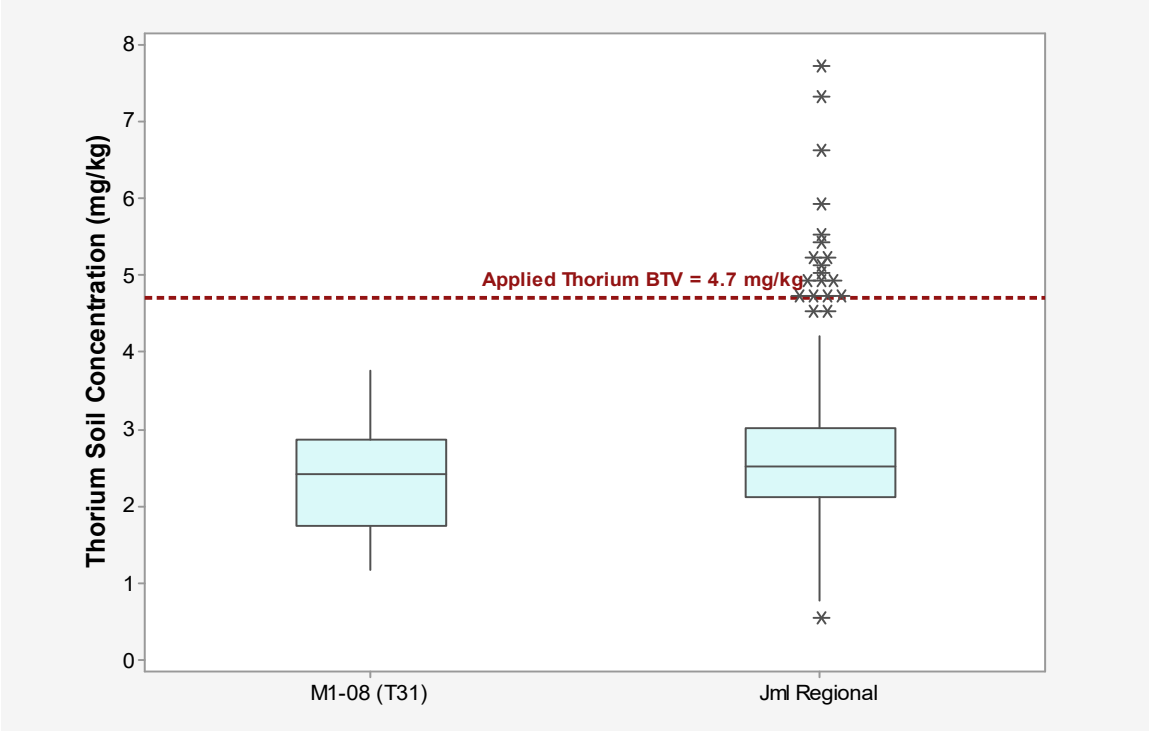
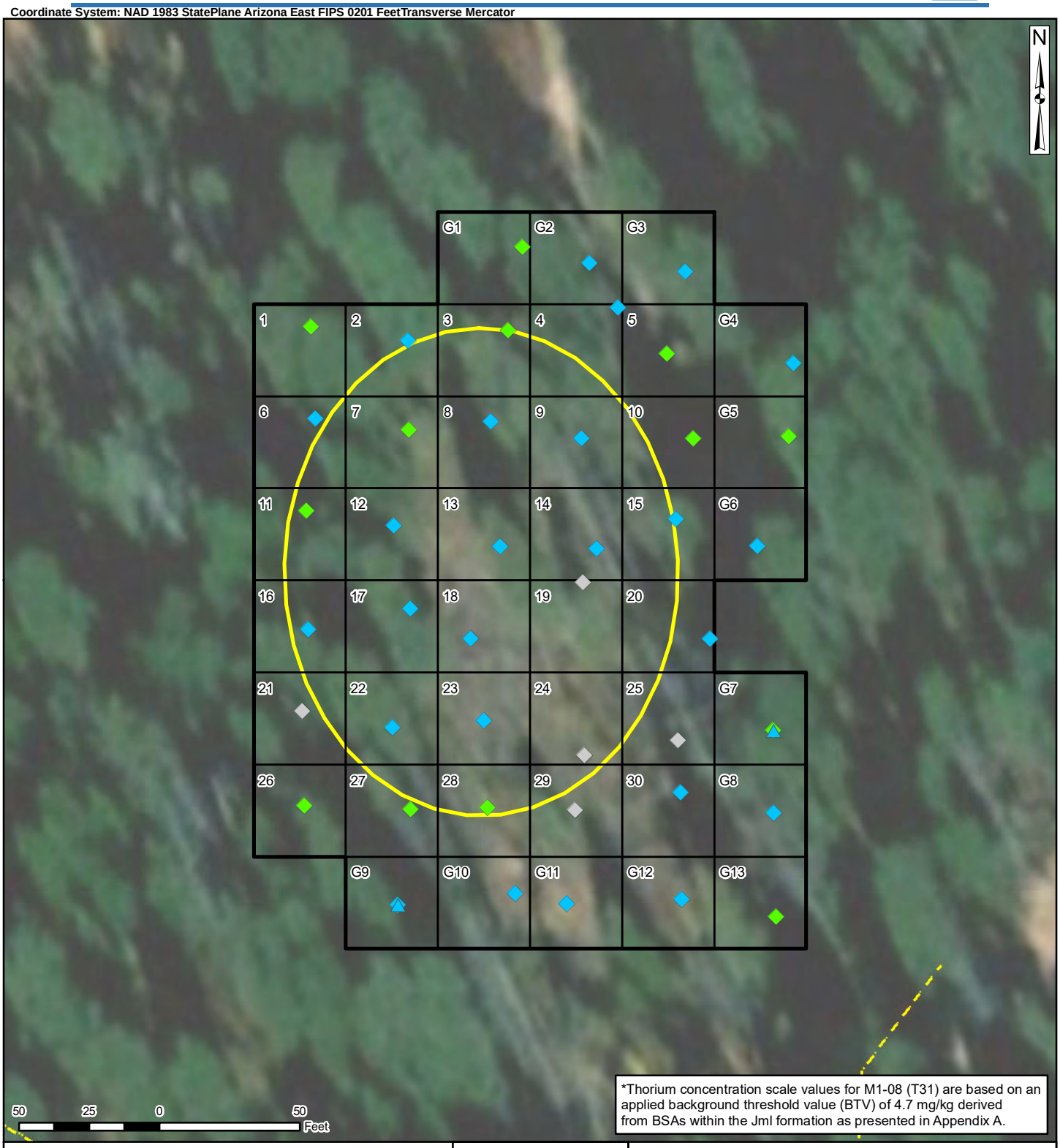


Figure I31-19. Box Plot for Target M1-08 (T31) and Jml Regional Thorium Soil Concentrations

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



*Thorium concentration scale values for M1-08 (T31) are based on an applied background threshold value (BTV) of 4.7 mg/kg derived from BSAs within the Jml formation as presented in Appendix A.

Thorium Concentration Scale (mg/kg)*

- ≤ 2.6
- 2.6 - 4.7
- 4.7 - 9.4
- 9.4 - 14
- 14 - 19
- 19 - 47
- ≥ 47
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET M1-08 (T31) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I31-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.2.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I31-7. Uranium exceeded the applied BTV in 65.1 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for uranium is 0.64 mg/kg for Target T31 as presented in Section 10.2.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I31-5 and Attachment I3, respectively. Figure I31-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T31 and BSA-30 (Jml) samples. Figure I31-22 presents a box plot of detectable uranium XRF soil concentrations for Target T31 and BSA-30 (Jml) samples. Summary statistics for XRF measurements are provided in Section 10.2.6.1. Uranium XRF concentrations measured in surface soils at Target T31 ranged between 0.1 and 4.0 mg/kg with an average and standard deviation of 1.8 mg/kg and 1.1 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T31 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I31-23. Overall, the majority of detectable uranium results in surface soils were above the applied BTV. However, the maximum XRF value was 6.3 times higher than the applied BTV and does not appear to be associated with mining-related materials Target T31.

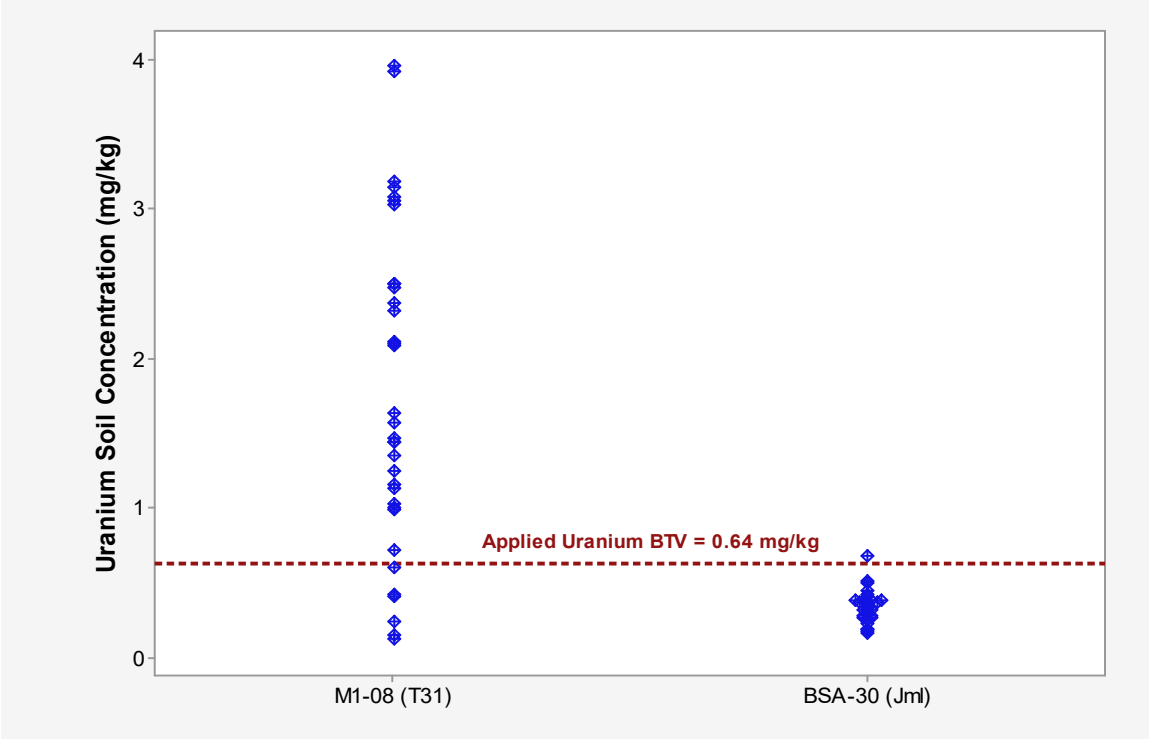


Figure I31-21. Individual Value Plot for Target M1-08 (T31) and BSA-30 (Jml) Uranium Soil Concentrations

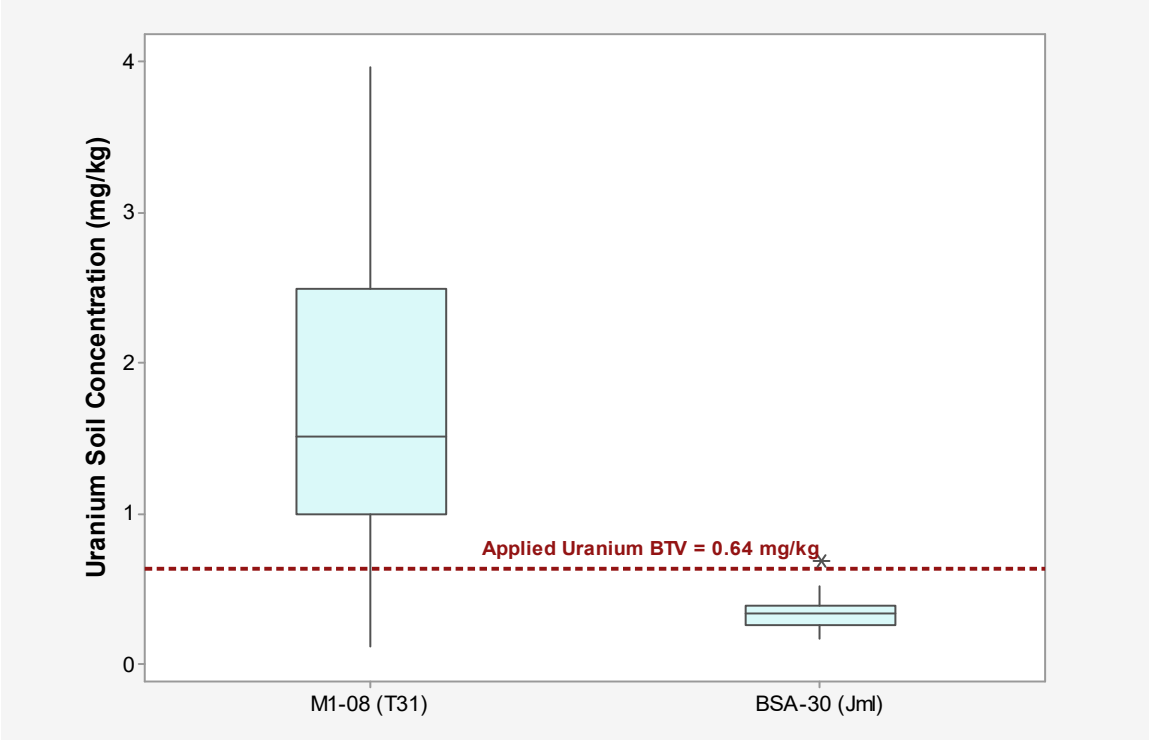
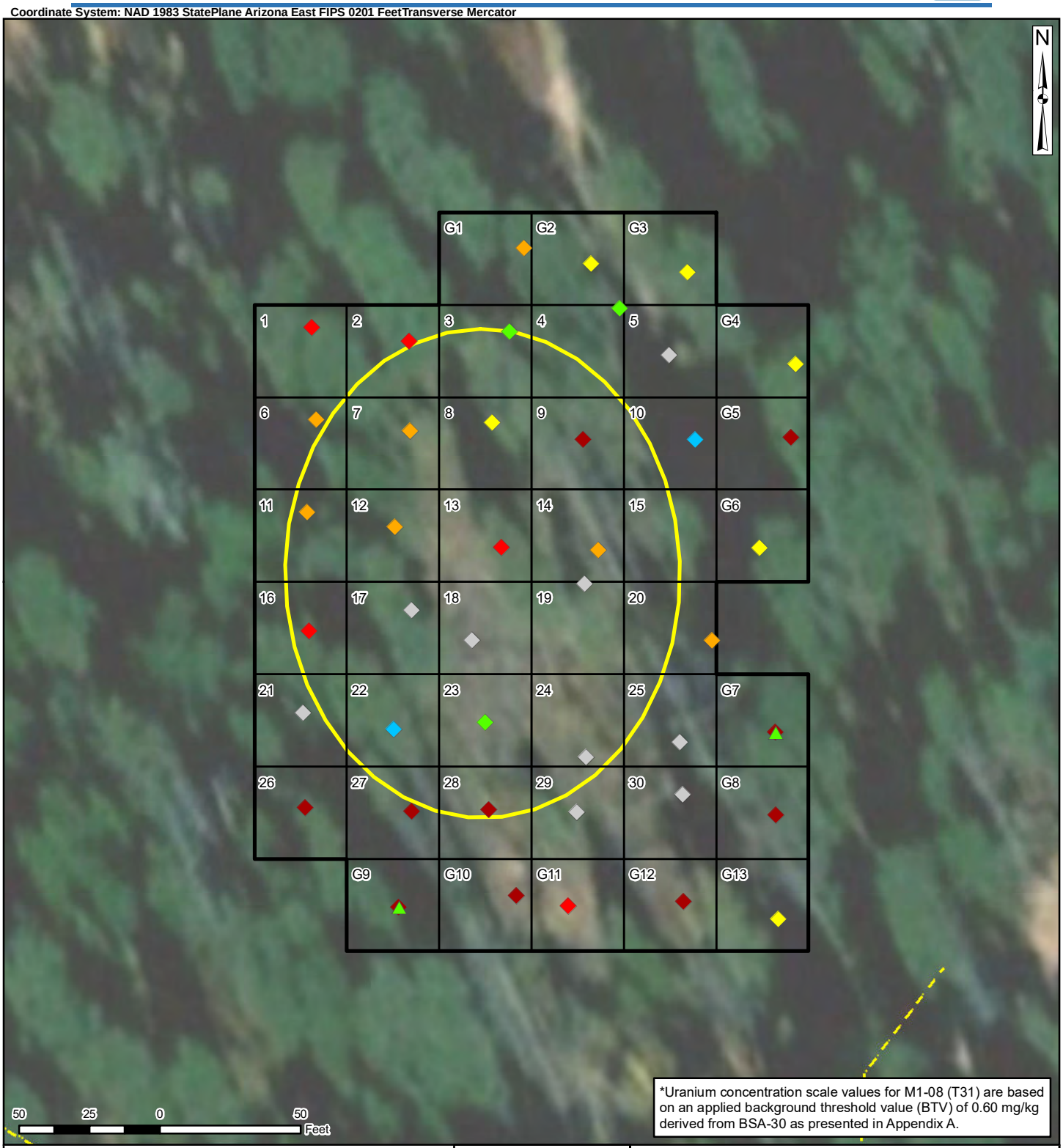


Figure I31-22. Box Plot for Target M1-08 (T31) and BSA-30 (Jml) Uranium Soil Concentrations

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



*Uranium concentration scale values for M1-08 (T31) are based on an applied background threshold value (BTV) of 0.60 mg/kg derived from BSA-30 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 0.30
- 0.30 - 0.60
- 0.60 - 1.2
- 1.2 - 1.8
- 1.8 - 2.4
- 2.4 - 6.0
- ≥ 6.0
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET M1-08 (T31) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I31-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.2.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I31-7. Vanadium exceeded the applied BTV in 9.3 percent of in situ XRF measurements but not in XRF confirmation samples. The applied BTV for vanadium is 22 mg/kg for Target T31 as presented in Section 10.2.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I31-5 and Attachment I3, respectively. Figure I31-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T31 and BSA-30 (Jml) samples. Figure I31-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T31 and BSA-30 (Jml) samples. Summary statistics for XRF measurements are provided in Section 10.2.6.1. Vanadium XRF concentrations measured in surface soils at Target T31 ranged between 16.1 and 35.4 mg/kg with an average and standard deviation of 22.3 mg/kg and 6.0 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T31 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I31-26. Overall, the majority of detectable vanadium results in surface soils were slightly above the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials Target T31.

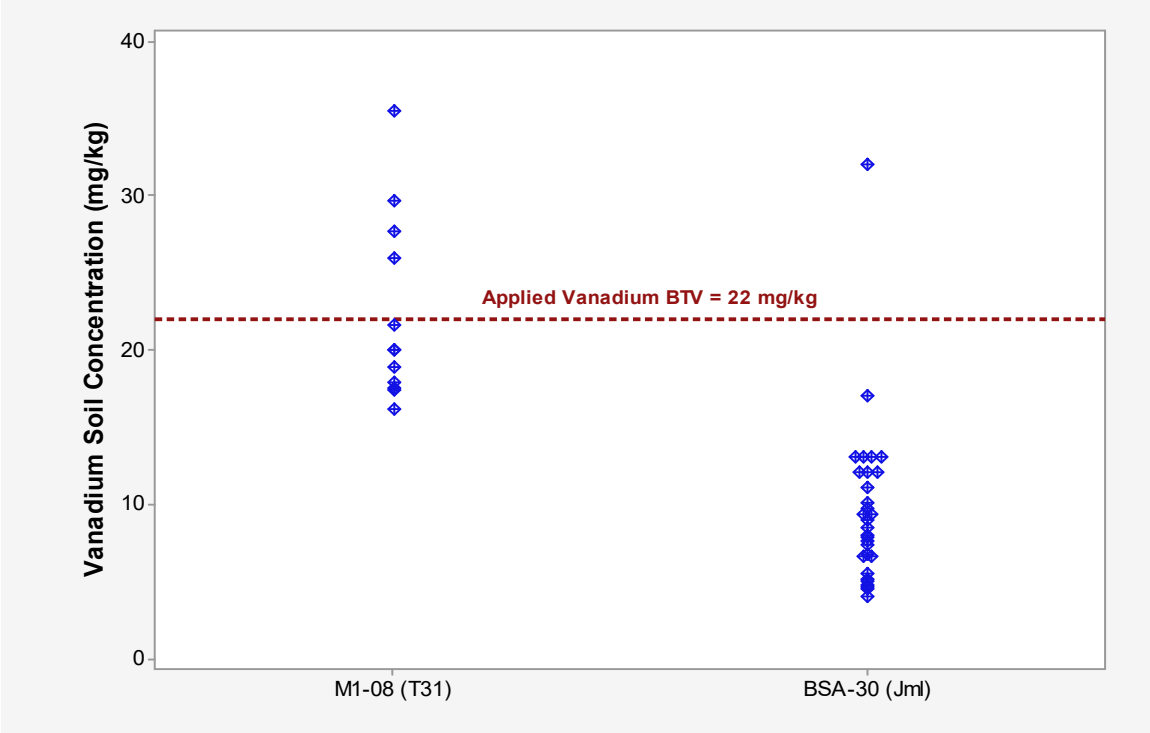


Figure I31-24. Individual Value Plot for Target M1-08 (T31) and BSA-30 (Jml) Vanadium Soil Concentrations

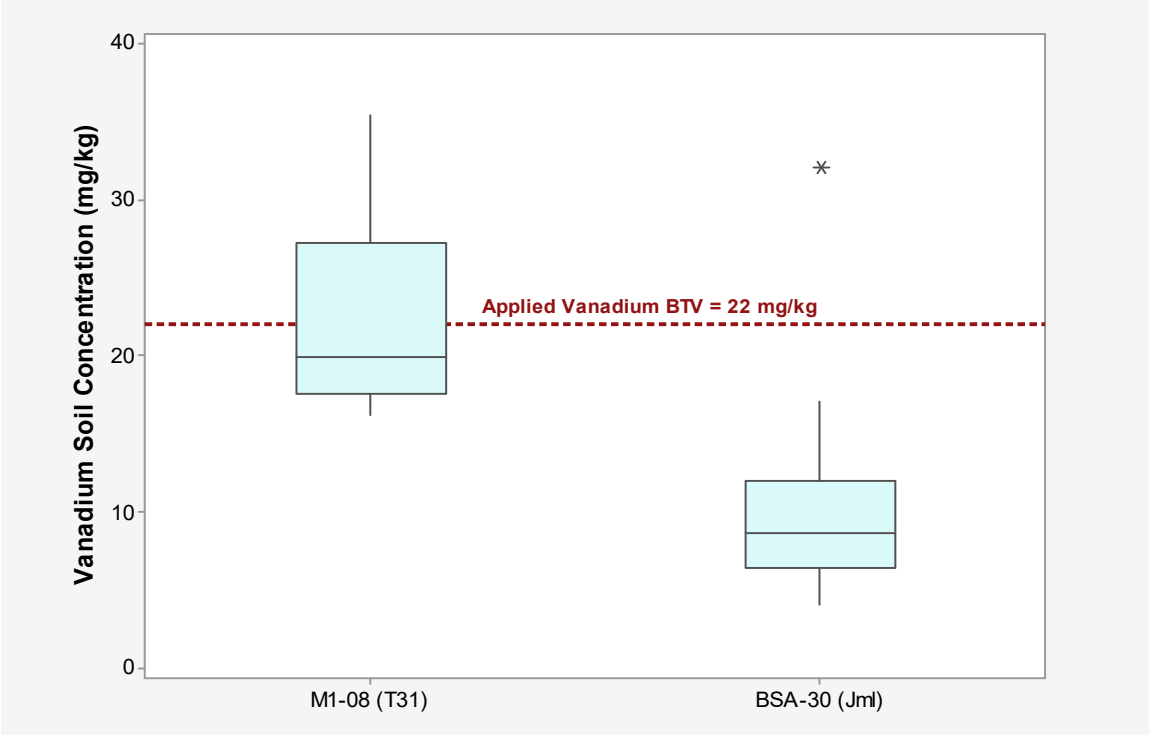
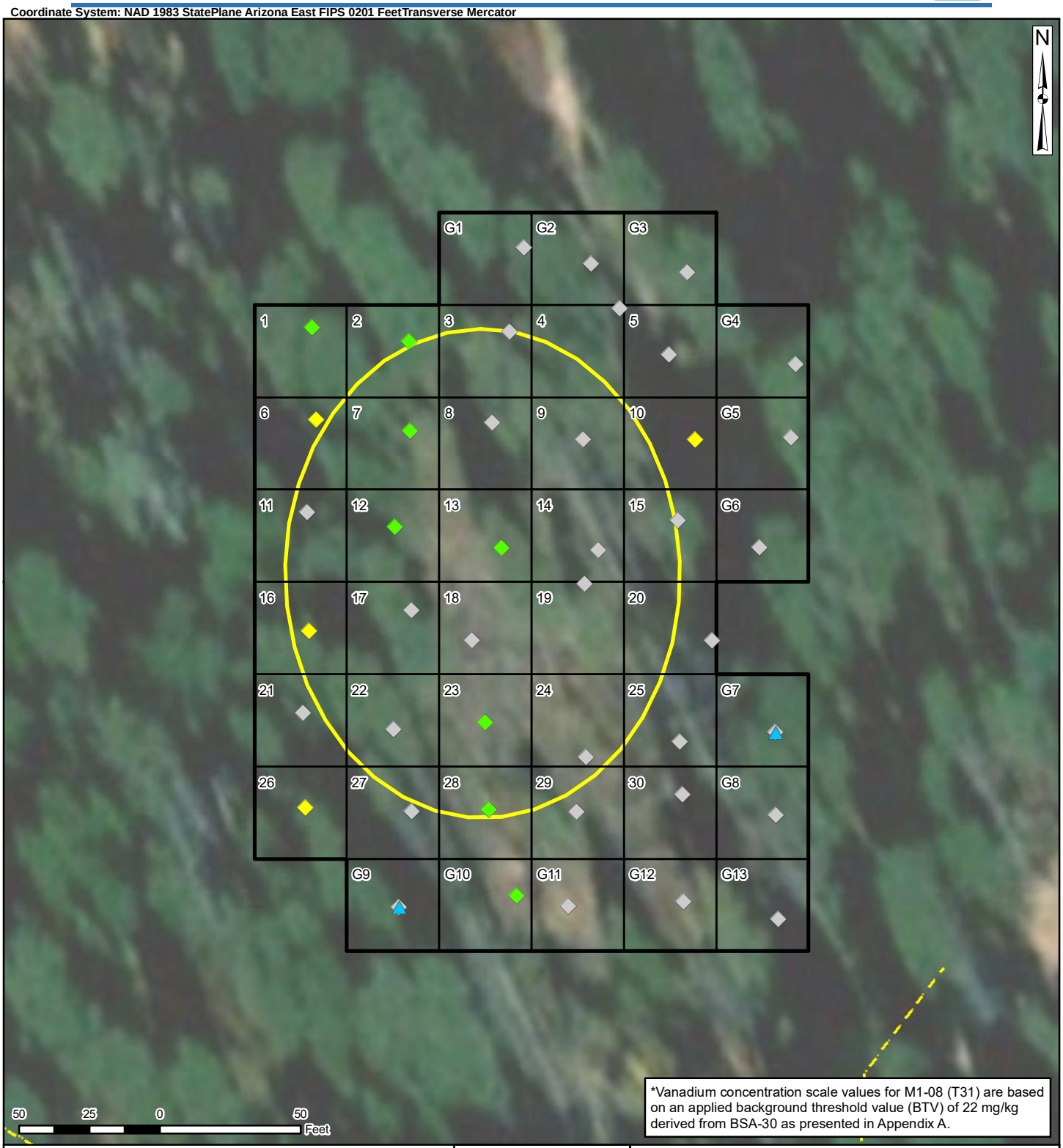


Figure I31-25. Box Plot for Target M1-08 (T31) and BSA-30 (Jml) Vanadium Soil Concentrations



*Vanadium concentration scale values for M1-08 (T31) are based on an applied background threshold value (BTV) of 22 mg/kg derived from BSA-30 as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 9.6
- 9.6 - 22
- 22 - 44
- 44 - 66
- 66 - 88
- 88 - 220
- ≥ 220
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Foot)

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NON-AUM TARGET M1-08 (T31) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I31-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.2.8 Conclusions

Target T31 (M1-08) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T31. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T31 are:

- Potential mining-related sources of gamma radiation identified in ASPECT gamma survey were evaluated at Target T31. ASPECT gamma survey results generally correlated with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T31 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T31 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. However, grid averaged gamma measurements exceeded the applied BTV in 6 of the 43 survey units by a factor of up to 1.04.
- A total of 26 analytes were identified as occurring within the surface environment. Of these analytes, 7 were identified as COPCs. Only uranium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T31 does not contain TENORM. No mining-related activities or features were observed in the field. Outcropping of Jml was noted in the field but not evaluated to verify NORM.
- Natural erosion of outcroppings may have increased the lateral extent of NORM.
- There are no immediate significant physical hazards present at Target T31.
- Access is by dirt road with a small four-wheel-drive vehicle followed by footpath.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No existing groundwater wells are documented within the vicinity of Target T31. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T31. Therefore, evaluation of the leachability of metals and radionuclides is not required.

- No mine waste was observed at Target T31; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; no data gaps remain at Target T31.

10.3 NON-AUM TARGET T32 (M2-01)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T32 (M2-01).

10.3.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T32 (M2-01) is associated with the Mesa II 1/2 Mine (M3), a former underground mine in the Lukachukai Mountains Region in Subarea Group H that is administered by the Cove Chapter of the Navajo Nation. The Mesa II 1/2 Mine was operated by Kerr-McGee between 1956 and 1963 and by VCA between 1964 and 1967 (Roux 2011), but no known historical information is associated with Target T32. The Target is accessed via Indian Route 33 to Mesa II 1/2 Mine Road. Target T32 is identified in the MCAP (Weston 2016). No residential structures are near the Target. A Target location and access map for Target T32 is shown in Figure I32-1.

A topographical relief map for the Mesa II 1/2 Mine area and associated non-AUM Target T32 is provided in Figure I32-2. The elevation at Target T32 ranges from 7,517 to 7,582 feet amsl with an average of 7,549 feet amsl. The slope at Target T32 ranges from 28 to 33 percent with an average of 30 percent. No drainages exist on or adjacent to the Target, but an ephemeral drainage is located 650 feet to the north. Target T32 is located entirely within Jml and with the Narbona-Zilditloi complex soil type (MUSYM 608) (Figures I-26 and I-27).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover data to determine the RSE survey area for Target T32. As a part of the RSE for Mesa II 1/2 Mine, Tetra Tech also evaluated the associated non-AUM Target T32. ASPECT imagery was used to guide the sampling approach, which is specified in Appendix F, FSP 36, of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T32:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards were identified.

- Located access routes, including foot pathways and roads:

  Target T32 is accessed via Indian Route 33 to Mesa II 1/2 Mine Road. The Target is located primarily upslope of the haul road.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  The geology of the Target, Jml, contain NORM. Observations of NORM were not recorded by field personnel. No TENORM was observed.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  No drainages were located on or adjacent to the Target. An ephemeral drainage, Cove Middle 2B, is located 650 feet to the north and evaluated in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

  No exploratory borings were identified at the Target. The haul road crosses through the Target.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  No AUM or non-AUM Target features were identified. The haul road is AUM related, and the Target overlies the NORM-bearing Jml.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T32 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Sections 2.3 and 10.3.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for COPCs (described in Section 10.3.3 with results presented in Sections 10.3.6 and 10.3.7)
- Conducting a gamma radiation survey (results presented in Section 10.3.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.



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

Prepared for: USEPA Region 9

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NON-AUM TARGET M2-01 (T32) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I32-1
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

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



Non-AUM Target Site Boundary
Related Survey Area
Background Location
Access Route - Foot
Access Route - Vehicular
Drainage - Field Mapped
100 ft Contour*
20 ft Contour*

* 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.

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NON-AUM TARGET M2-01 (T32) TOPOGRAPHIC MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I32-2
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.3.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I32-3) within the survey area of the non-AUM Target T32 as part of the Baseline Study in June 2018. Additional Goback gamma radiation surveys were not performed at Target T32. Tetra Tech also performed an XRF field survey at non-AUM Target T32 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I32-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 36, of the RSE Work Plan (Tetra Tech 2018). All gamma survey and XRF survey units were evaluated.

10.3.3 XRF Confirmation Sampling Overview

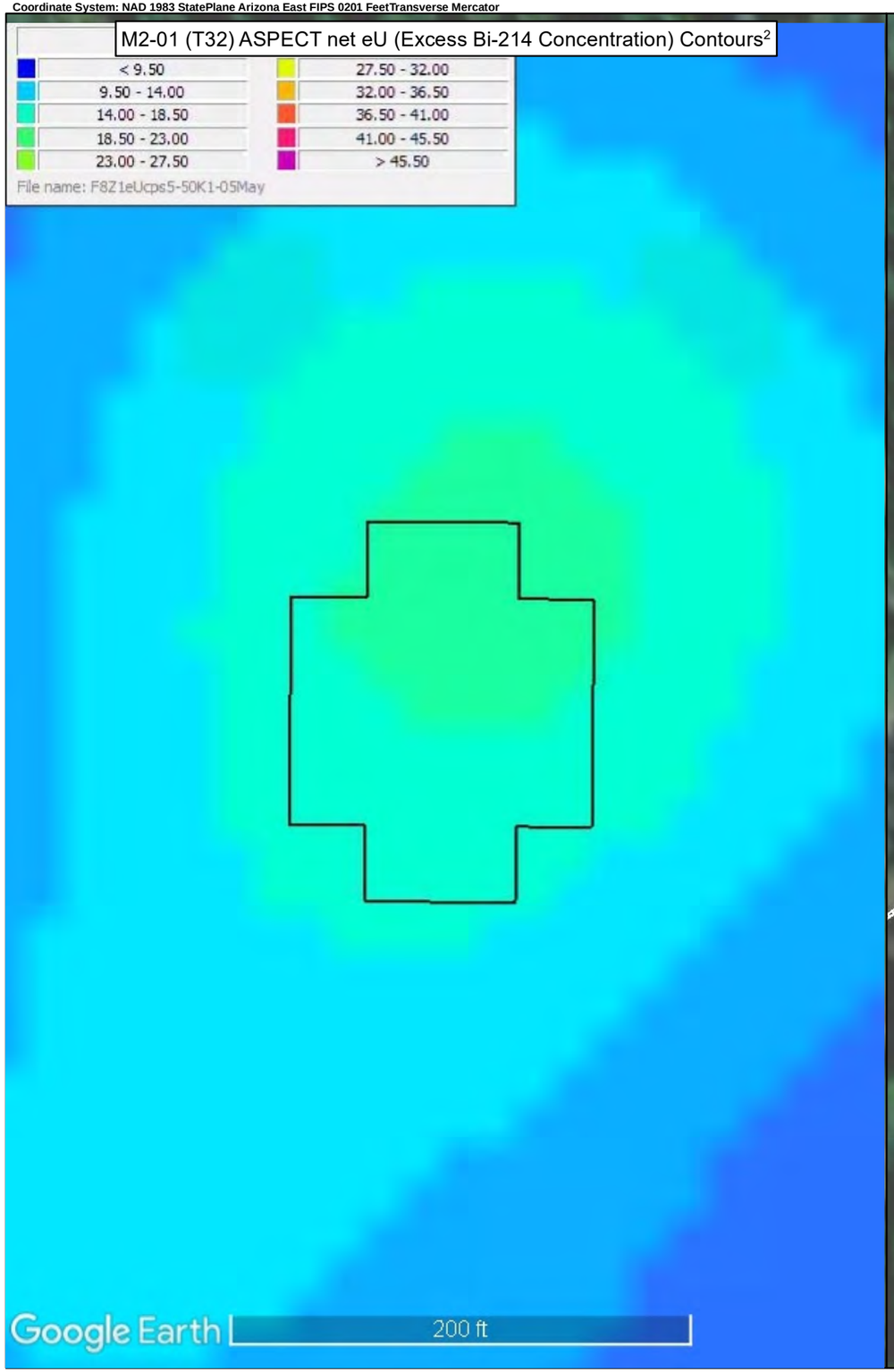
Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T32. One XRF soil confirmation sample was collected at a depth of 0 to 3 inches bgs from one location (Table I32-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I32-4 and I32-5 identify the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I32-2. The results of XRF confirmation sample analysis are provided in Section 10.3.6.1. Correlated XRF field measurements are provided in Attachment I3.

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

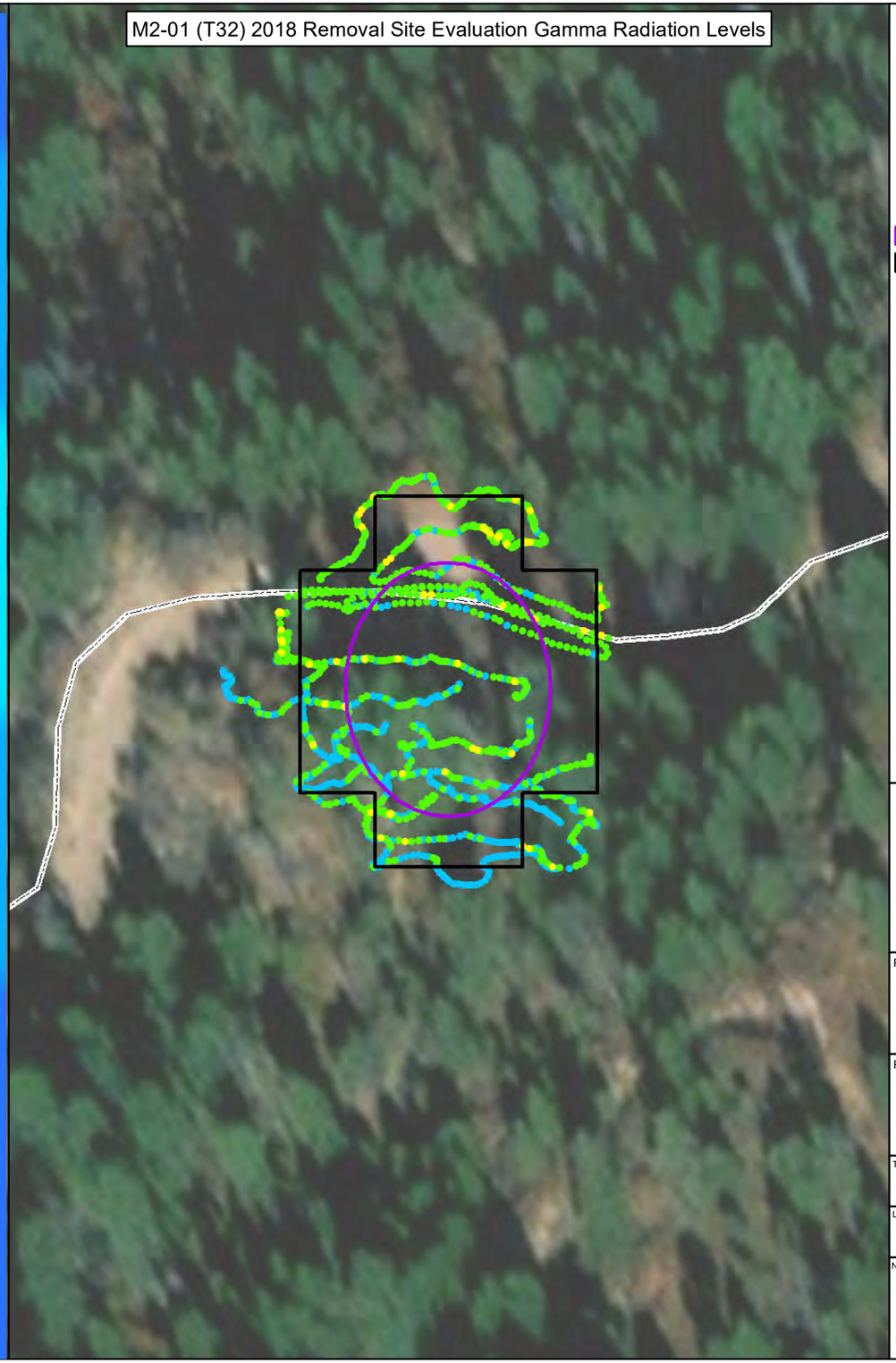
M2-01 (T32) ASPECT net eU (Excess Bi-214 Concentration) Contours[2]

< 9.50	27.50 - 32.00
9.50 - 14.00	32.00 - 36.50
14.00 - 18.50	36.50 - 41.00
18.50 - 23.00	41.00 - 45.50
23.00 - 27.50	> 45.50

File name: F8Z1eUcps5-50K1-05May



M2-01 (T32) 2018 Removal Site Evaluation Gamma Radiation Levels



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

Non-AUM Target Site Boundary

Survey Area Boundary

Access Route - Vehicular

[1]The applied gamma background threshold value (BTV) for M2-01 (T32) is 11,378 cpm derived from BSA-30 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 60 ft

1:720

N W E S

0 30 60 120 Feet

NON-AUM TARGET M2-01 (T32) 2018 REMOVAL SITE EVALUATION AND ASPECT CONTOUR MAP

Prepared For:

Prepared By:

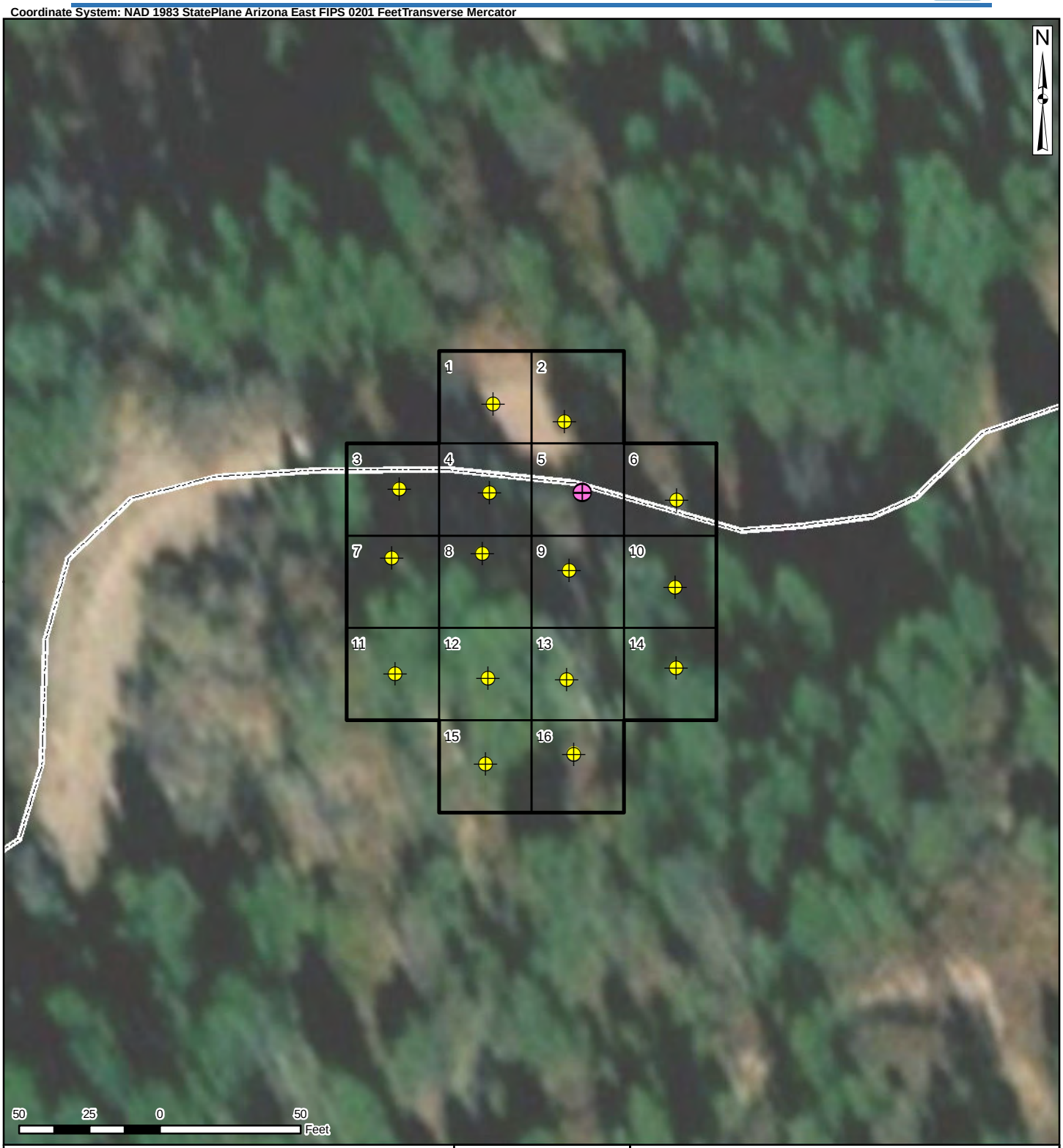
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Task Order No.:	Contract No.:
TO0001	EP-S9-17-03
Location: COVE CHAPTER NAVAJO NATION	**Date:** 6/15/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation*. May, 2015. ASPECT - Airborne Spectral Photometric Environmental Collection Technology.

Figure No.: **I32-3**

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



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

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NON-AUM TARGET M2-01 (T32)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I32-4
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

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



XRF Confirmation Soil Sample*
(0 - 3 inches bgs)

Survey Unit (100 m²)

Survey Area Boundary

Access Route - Vehicular

*T32-XS5 = site T32 XRF confirmation soil sample collected at survey unit 5. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET M2-01 (T32)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I32-5
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

Table I32-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M2-01 (T32)

Sample ID	Sample Survey Unit	Depth (inches bgs)	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T32-XS5-01-062018	5	0-3	XRF Confirmation	Primary	6/20/2018	36.5183673	-109.2392529	1806558-22, 1806561-22

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I32-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M2-01 (T32)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

10.3.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 10.3.1, Target T32 surface geology is entirely within Jml with soils within the Narbona-Zilditloi complex (MUSYM 608) (Figures I-26 and I-27). As a result, BSA-30 was selected for that combination of geology and soil type. Additionally, the Jml regional geological background would also be applicable for this Target. Table I32-3 presents the Target-specific and regional geological BTVs for 29 analytes and gamma radiation levels for Target T32. The regional BTVs were based on soil sampling and gamma radiation survey results from multiple AUMs and Targets across the region for the primary geologic unit at Target T32. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T32. The "Applied BTV" for each analyte is the lower of the Target-specific BTV and the regional BTV.

Table I32-3. Applied Background Threshold Values for Non-AUM Target M2-01 (T32)

Analyte	Units	Site-Specific BTV (BSA-30)	Regional BTV (Jml)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	4,690	7,000	4,690	Site-Specific BTV
Antimony	mg/kg	0.171	0.140	0.140	Regional BTV
Arsenic	mg/kg	2.2	3.5	2.2	Site-Specific BTV
Barium	mg/kg	172	270	172	Site-Specific BTV
Beryllium	mg/kg	0.69	0.57	0.57	Regional BTV
Cadmium	mg/kg	0.145	0.160	0.145	Site-Specific BTV
Calcium	mg/kg	98,200	32,000	32,000	Regional BTV
Chromium	mg/kg	4.2	5.2	4.2	Site-Specific BTV
Cobalt	mg/kg	3.8	4.4	3.8	Site-Specific BTV
Copper	mg/kg	17	12	12	Regional BTV
Iron	mg/kg	14,200	8,897	8,897	Regional BTV
Lead	mg/kg	9.9	11	9.9	Site-Specific BTV
Lithium	mg/kg	5.3	8.8	5.3	Site-Specific BTV
Magnesium	mg/kg	2,600	3,900	2,600	Site-Specific BTV
Manganese	mg/kg	627	440	440	Regional BTV
Mercury	mg/kg	0.0160	0.0378	0.0160	Site-Specific BTV
Molybdenum	mg/kg	-	0.29	0.29	Regional BTV
Nickel	mg/kg	4.4	6.2	4.4	Site-Specific BTV
Potassium-40	pCi/g	25.7	26.9	25.7	Site-Specific BTV
Radium-226	pCi/g	0.87	2.23	0.87	Site-Specific BTV
Radium-228	pCi/g	0.60	0.75	0.60	Site-Specific BTV
Selenium	mg/kg	1.2	1.0	1.0	Regional BTV
Silver	mg/kg	0.048	0.037	0.037	Regional BTV
Sodium	mg/kg	95	45	45	Regional BTV
Thallium	mg/kg	0.124	0.075	0.075	Regional BTV
Thorium	mg/kg	6.3	4.7	4.7	Regional BTV
Uranium	mg/kg	0.64	1.5	0.64	Site-Specific BTV
Vanadium	mg/kg	22	24	22	Site-Specific BTV
Zinc	mg/kg	39	27	27	Regional BTV
Gamma Radiation	cpm	11,378	14,566	11,378	Site-Specific BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
Jml Morrison Formation (Lower)
mg/kg milligrams per kilogram
pCi/g picocuries per gram

10.3.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T32 and the raw gamma radiation and grid averaged gamma radiation survey results.

10.3.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T32 in June 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine if any additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. No additional scanning, measurements, or sampling were required. The applied gamma BTV for non-AUM Target T32 is 11,378 cpm. A total of 1,092 measurements were collected as part of the gamma radiation survey at non-AUM Target T32 across 16 survey units. Because of the heavy vegetation, not all survey units were scanned at 100 percent density. An average scan density of 68 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I32-4.

Table I32-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M2-01 (T32)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	11,378	
Measurements	#	1,092	16
Minimum	cpm	5,892	8,053
Maximum	cpm	14,279	10,128
Average	cpm	9,450	9,462
Median	cpm	9,430	9,512
Standard Deviation	cpm	1,046	501
90th Percentile	cpm	10,780	9,939
95th Percentile	cpm	11,179	10,049
99th Percentile	cpm	12,006	10,112
Measurements per Survey Unit	#/grid	68	
Measurements Above Gamma BTV	#	34	0
Measurements Above Gamma BTV	%	3.1	0.0

Notes:
BTV background threshold value
cpm counts per minute

10.3.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 3.1 percent of the measurements within the Target boundaries, in some cases slightly exceeding the applied gamma BTV (11,378 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-30 (Jml) gamma survey results is provided on Figure I32-6. This graph shows that the spread of radiation data at Target T32 (shown on left) begins within the same range of BSA-30 (Jml) gamma levels (shown on right) and then rises to the top range of background radiation in some locations. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T32 is about the same as the data cloud from the BSA-30 (Jml) data set. A box plot showing the quartiles of the data sets is provided in Figure I32-7. The box plot shows that the median of Target T32 radiation levels is about the same as the median of the BSA-30 (Jml) data set and below than the applied gamma BTV.

A map showing the results of the 2018 RSE gamma radiation survey is provided in Figure I32-8. No mining activity was observed within the survey area of Target T32. In general, Target T32 has surficial gamma radiation levels below BSA-30 (Jml) levels across the majority of the Target that decrease in the south (upslope) and increase in the north (downslope of the haul road). The area of elevated gamma activity correlates with the ASPECT gamma survey (Figure I32-3). No TENORM or mining-related activities were observed. Section 10.3.5.2 presents the grid averaged results of the gamma radiation survey.

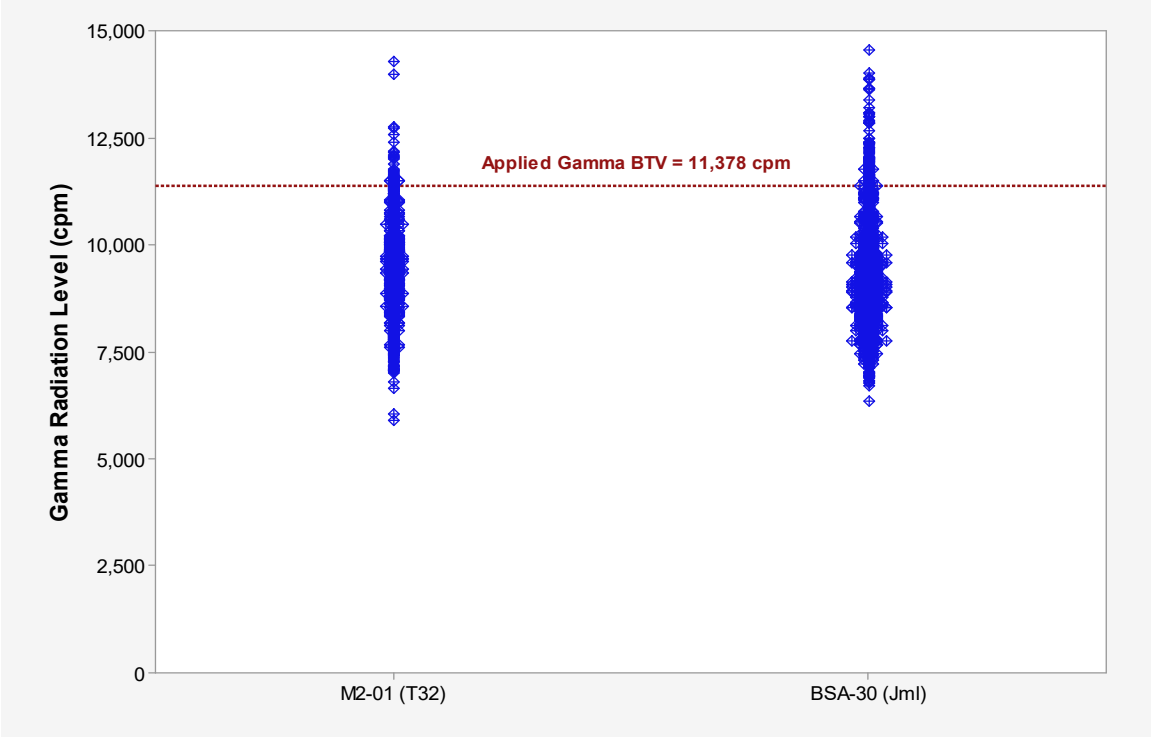


Figure I32-6. Individual Value Plot of Raw Gamma Radiation Levels at Target M2-01 (T32) and BSA-30 (Jml)

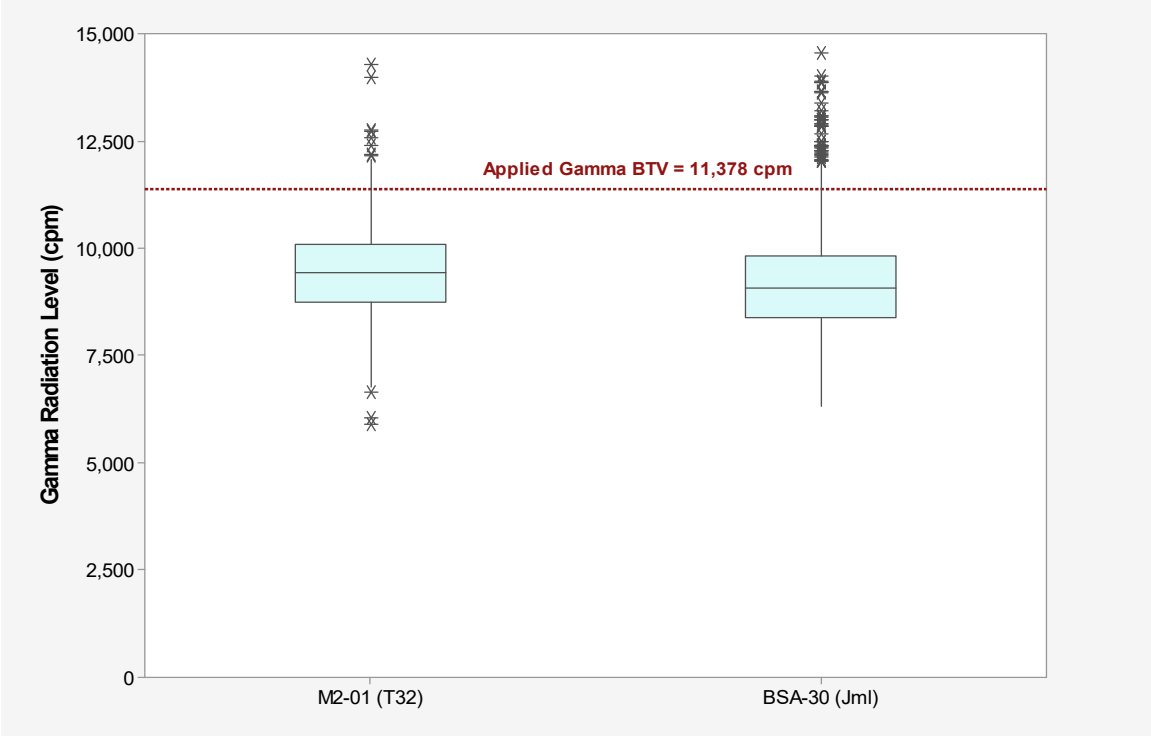
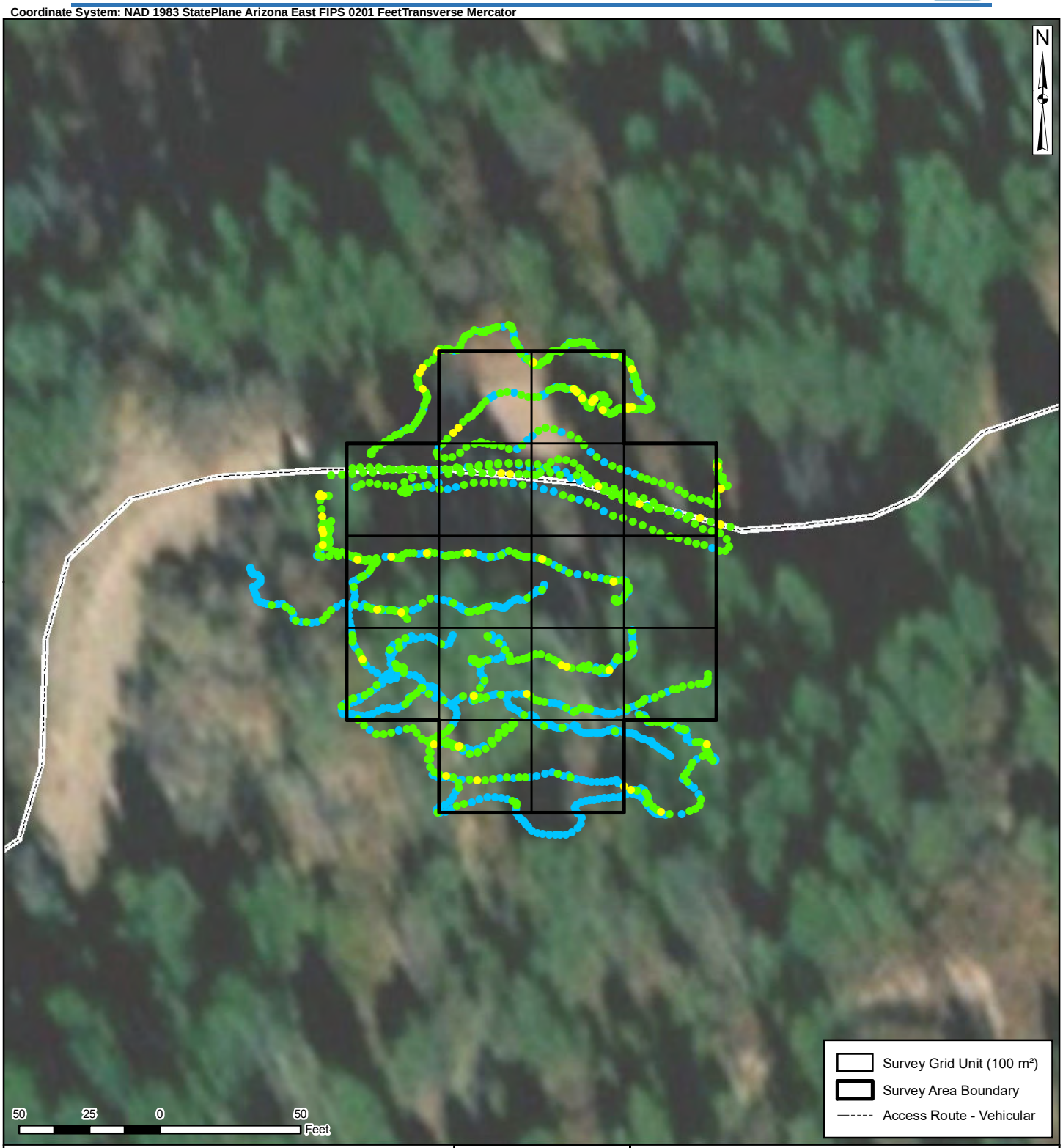


Figure I32-7. Box Plot of Raw Gamma Radiation Levels at Target M2-01 (T32) and BSA-30 (Jml)

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



Gamma Reading (cpm)*

≤ 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

*The applied gamma background threshold value (BTV) for M2-01 (T32) is 11,378 cpm derived from BSA-30 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M2-01 (T32)
2018 REMOVAL SITE EVALUATIONS
GAMMA RADIATION LEVELS SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I32-8
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.3.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 10.3.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 10.3.5.1. Figure I32-9 and Figure I32-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-30 (Jml) data set (shown on right). No survey units within the survey area of Target T32 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I32-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I32-11 as discussed further in Section 2.8. No survey units exceeded the gamma BTV.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 10.3.6.

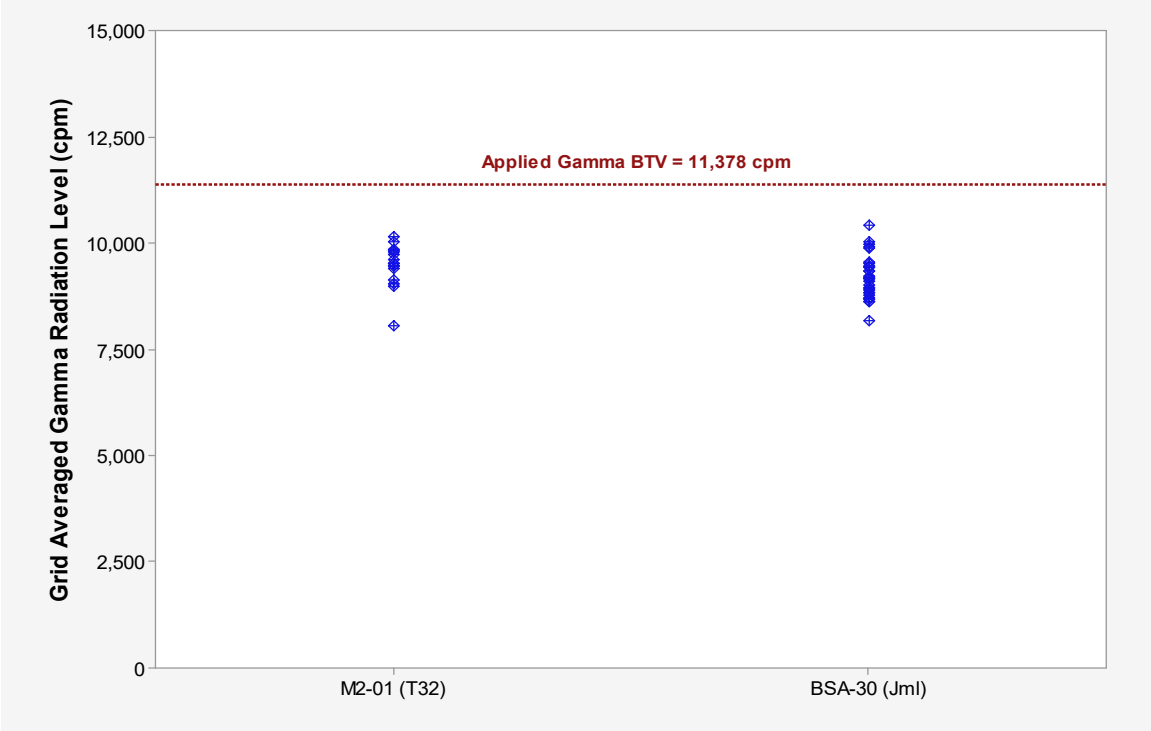


Figure I32-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M2-01 (T32) and BSA-30 (Jml)

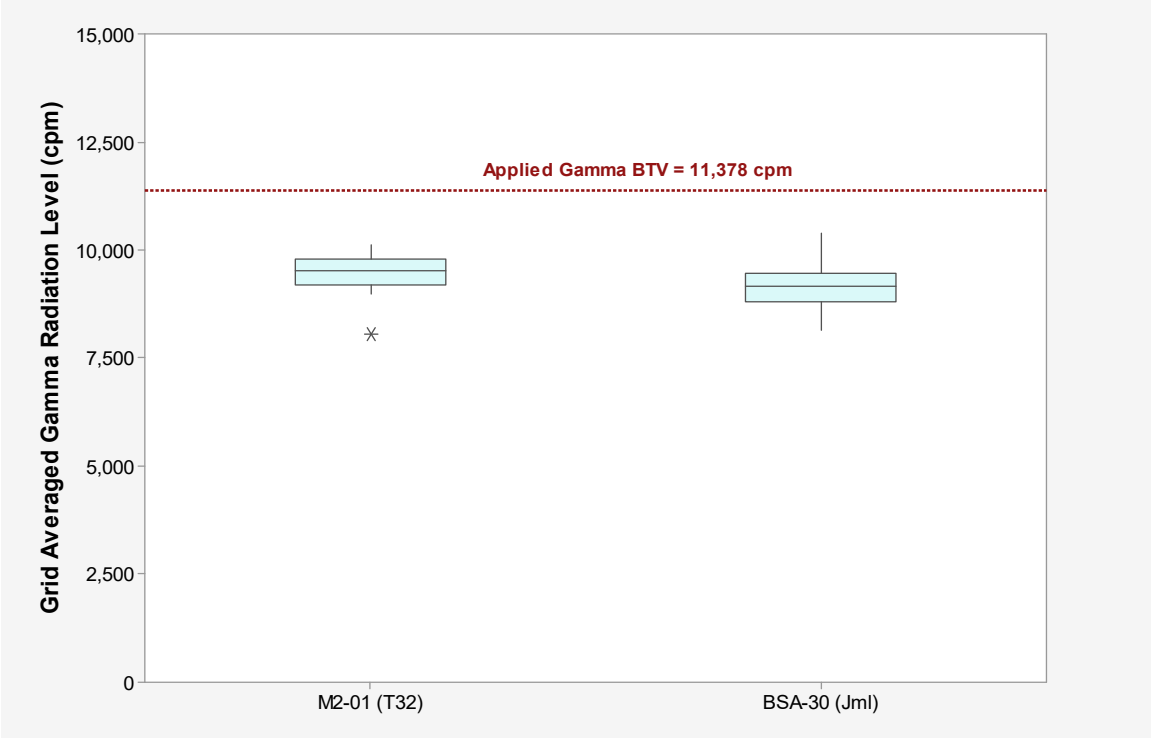
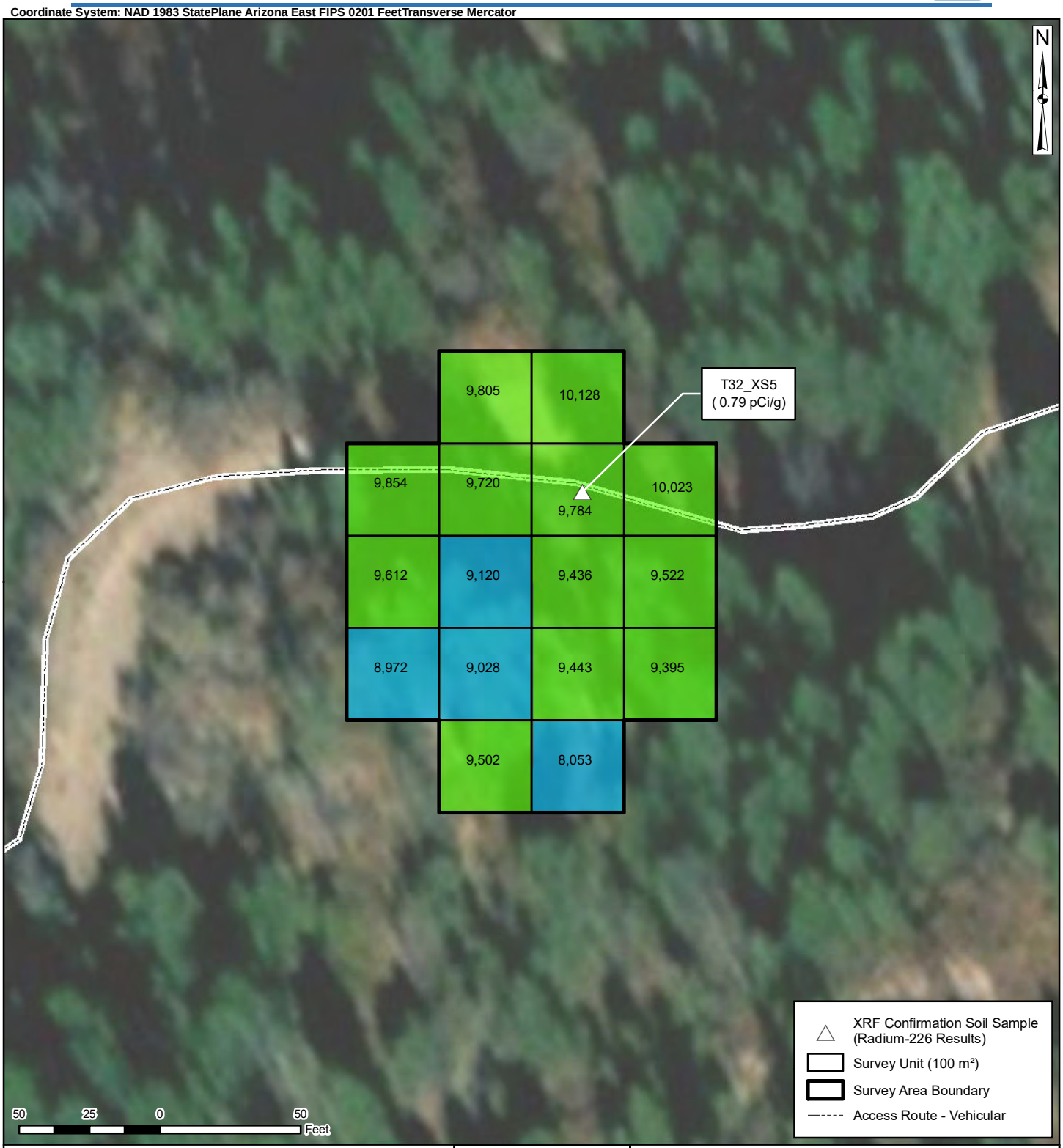


Figure I32-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target M2-01 (T32) and BSA-30 (Jml)

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



Grid Averaged Gamma Reading (cpm)*

≤ 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

*The applied gamma background threshold value (BTV) for M2-01 (T32) is 11,378 cpm derived from BSA-30 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET M2-01 (T32) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I32-11
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.3.6 Soil Sampling Results

This subsection presents the results of analyses for soil within the survey area of Target T32. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 10.3.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 10.3.6.3.

10.3.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T32: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I32-1 and I32-2. All the results of the XRF confirmation soil samples are presented in Table I32-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T32 following the methods outlined in Section 2.4 and shown in Figure I32-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 16 measurements were collected across 16 survey units from the survey area of Target T32 during the Baseline Study. The summary statistics of the XRF field survey results are provided in Table I32-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T32 at a depth of 0 to 3 inches bgs. One XRF confirmation soil sample was collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I32-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 10.3.7.

Table I32-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M2-01 (T32)

Analyte	Units	Applied BTV	T32-XS5-01-062018	
			Result	Q
Survey Unit			**X5**	
Aluminum	mg/kg	4,690	2,900	
Antimony	mg/kg	0.140	0.047	J
Arsenic	mg/kg	2.2	1.1	
Barium	mg/kg	172	68	
Beryllium	mg/kg	0.57	0.24	
Cadmium	mg/kg	0.145	0.042	J
Calcium	mg/kg	32,000	2,600	
Chromium	mg/kg	4.2	2.3	
Cobalt	mg/kg	3.8	2	
Copper	mg/kg	12	4	
Iron	mg/kg	8,897	4,000	
Lead	mg/kg	9.9	4.2	
Lithium	mg/kg	5.3	3.7	
Magnesium	mg/kg	2,600	1,500	
Manganese	mg/kg	440	140	
Molybdenum	mg/kg	0.29	0.19	J
Nickel	mg/kg	4.4	2.4	
Potassium-40	pCi/g	25.7	13.8	
Radium-226	pCi/g	0.87	0.79	LT
Radium-228	pCi/g	0.60	<0.37	U
Selenium	mg/kg	1.0	0.43	J
Silver	mg/kg	0.037	0.017	J
Sodium	mg/kg	45	<100	U
Thallium	mg/kg	0.075	0.031	
Thorium	mg/kg	4.7	1.7	
Uranium	mg/kg	0.64	0.55	
Vanadium	mg/kg	22	8.5	
Zinc	mg/kg	27	11	

Notes:

BTV	Background threshold value
J	Estimated value
J-	Estimated value, may be biased low
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	Qualification
U	Not considered detected. The associated value is the method detection limit (MDL).

Table I32-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M2-01 (T32)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	2.2	8,897	9.9	440	0.29	4.7	0.64	22	27
Measurements	#	16	16	16	16	16	16	16	16	16
Detects	#	5	16	16	16	9	15	12	14	16
Nondetects	#	11	0	0	0	7	1	4	2	0
Minimum	mg/kg	1.9	3,349	4.2	157.4	0.2	1.2	0.6	16.1	18.0
Maximum	mg/kg	3.7	6,431	10.7	827.4	4.4	3.2	2.7	28.1	29.9
Standard Deviation	mg/kg	0.7	791	1.5	168	1.73	0.6	0.6	3	3.3
Average	mg/kg	2.5	5,232	7.0	335	2.26	2.1	1.3	22.2	23.0
Median	mg/kg	2.2	5,306	6.7	272	2.59	2.1	1.2	22.2	22.1
Relative Standard Deviation	%	30.0	15.1	21.4	50.0	76.6	26.1	48.0	13.7	14.4
90th Percentile	mg/kg	3.3	6,089	8.5	520	4.2	2.8	2.2	25	29
95th Percentile	mg/kg	3.5	6,247	9.2	678	4.3	3.0	2.5	26	30
99th Percentile	mg/kg	3.7	6,394	10.4	797	4.4	3.2	2.7	28	30
Measurements Above Applied BTV	#	2	0	1	2	7	0	11	6	3
Measurements Above Applied BTV	%	12.5	0.0	6.3	12.5	43.8	0.0	68.8	37.5	18.8

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value
mg/kg Milligram per kilogram
XRF X-ray fluorescence

10.3.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T32 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T32 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T32. The estimated BTVs are identified in Section 10.3.4 and Table I32-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I32-7 presents a summary of the background comparison for different measurement and soil depths at Target T32. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM was not identified at Target T32. Further gamma radiation screening indicated that gamma levels at Target T32 are similar to those at the BSA. Therefore, while multiple COPCs have been identified at Target T32 based on a comparison to background, risk screening will be required to support a future risk management decision. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I32-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target M2-01 (T32)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic		✓	✓
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium			
Cobalt			
Copper			
Iron			
Lead		✓	✓
Lithium			
Magnesium			
Manganese		✓	✓
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium			
Silver			
Sodium			
Thallium			
Thorium			
Uranium		✓	✓
Vanadium		✓	✓
Zinc		✓	✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

10.3.7 Primary Contaminant Mapping

10.3.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 10.3.6.2 identified the COPCs at Target T32. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 10.3.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I32-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T32 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 10.3.7.1 through Section 10.3.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T32. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

10.3.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I32-7. Arsenic exceeded the applied BTV in 12.5 percent of in situ XRF measurements but not in the XRF confirmation sample. The applied BTV for arsenic is 2.2 mg/kg for Target T32 as presented in Section 10.3.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I32-5 and Attachment I3, respectively. Figure I32-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T32 and BSA-30 (Jml) samples. Figure I32-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T32 and BSA-30 (Jml) samples. Summary statistics for XRF measurements are provided in Section 10.3.6.1. Arsenic XRF concentrations measured in surface soils at Target T32 ranged between 1.9 and 3.7 mg/kg with an average and standard deviation of 2.5 mg/kg and 0.7 mg/kg, respectively. The average arsenic XRF concentration is above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T32 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I32-14. Overall, the majority of detectable arsenic results in surface soils were above the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T32.

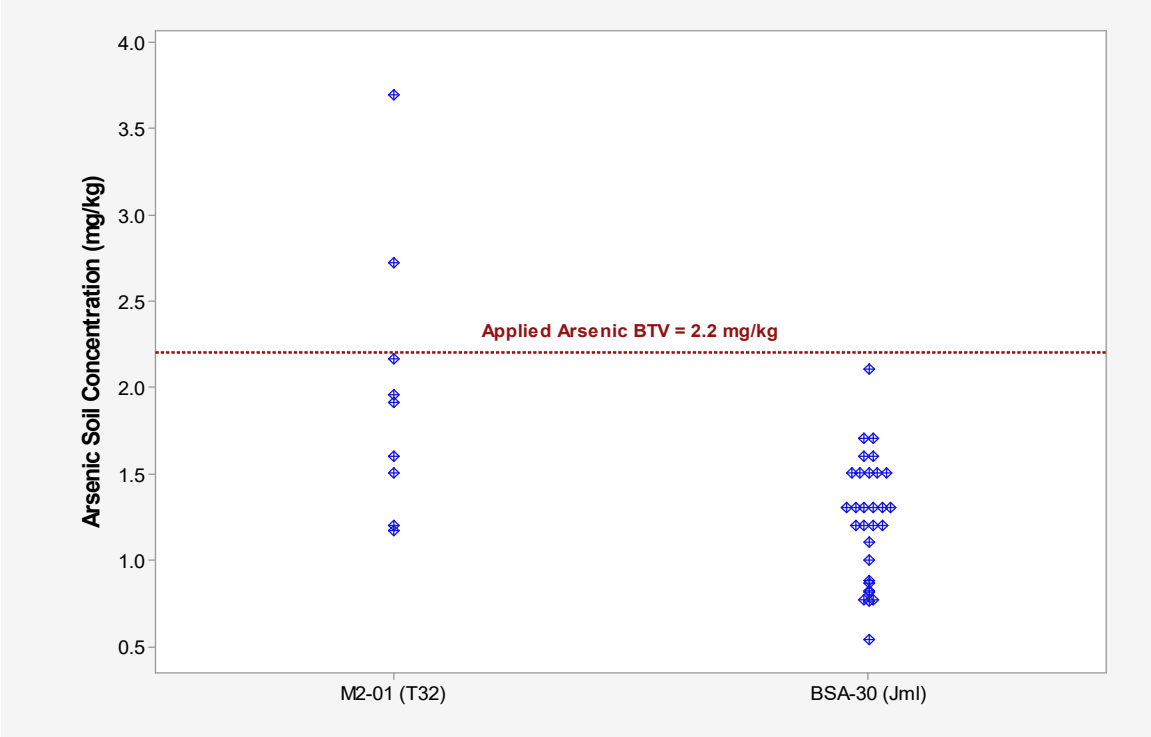


Figure I32-12. Individual Value Plot for Target M2-01 (T32) and BSA-30 (Jml) Arsenic Soil Concentrations

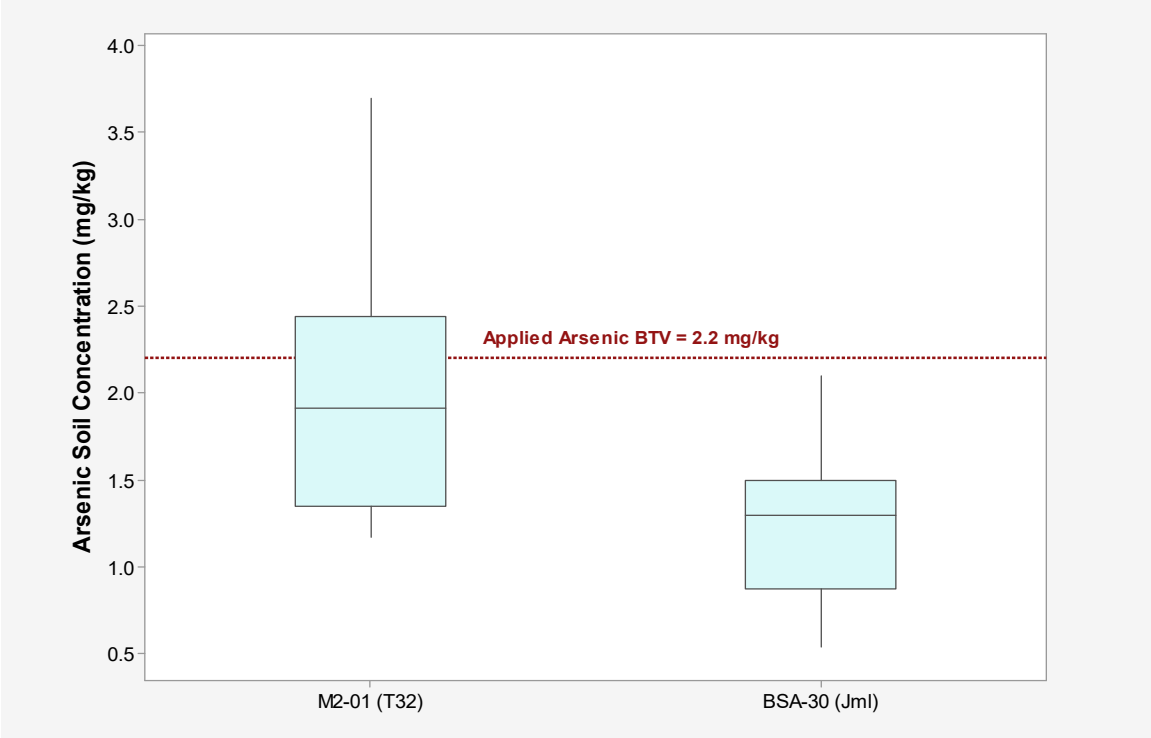
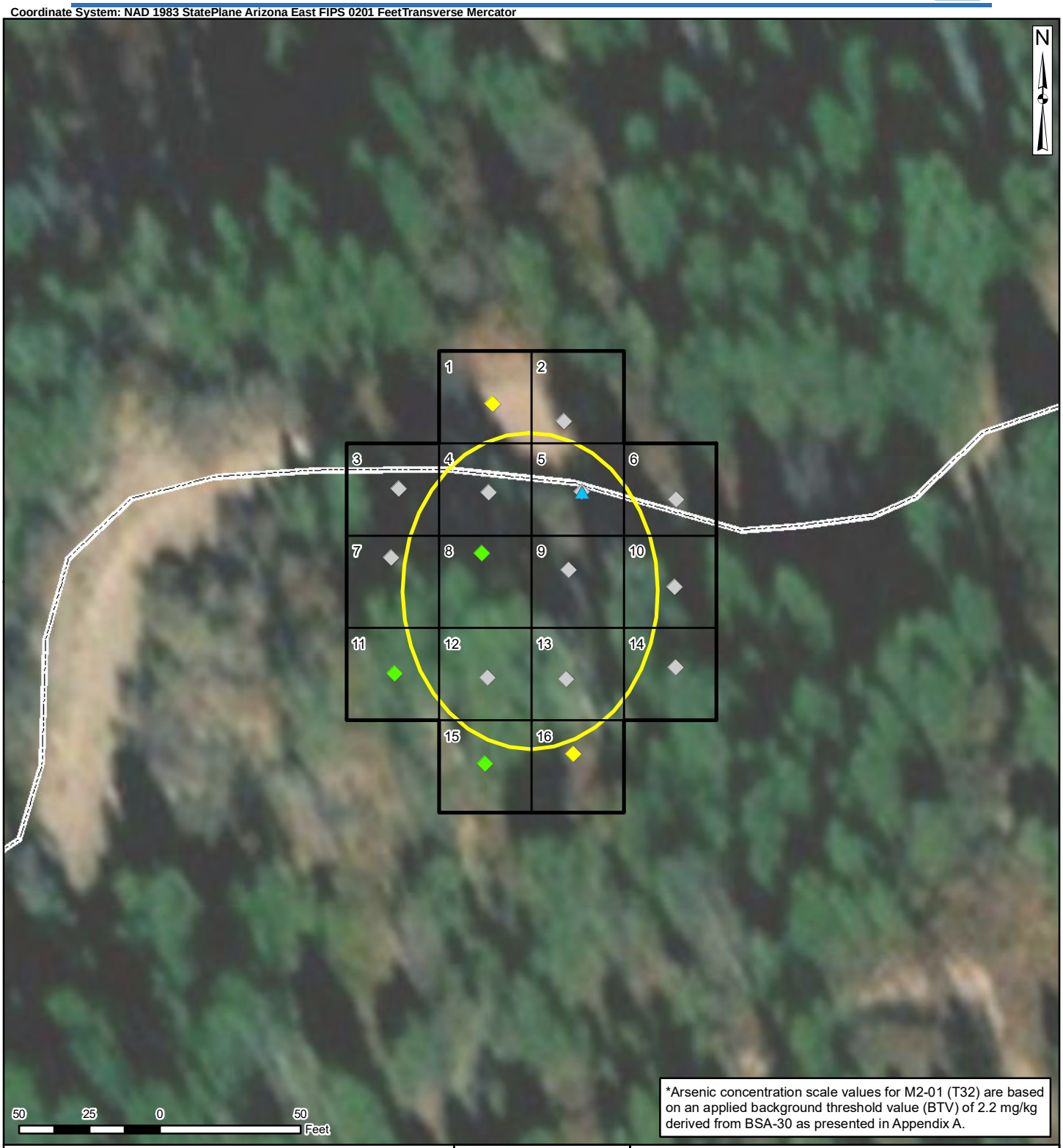


Figure I32-13. Box Plot for Target M2-01 (T32) and BSA-30 (Jml) Arsenic Soil Concentrations



*Arsenic concentration scale values for M2-01 (T32) are based on an applied background threshold value (BTV) of 2.2 mg/kg derived from BSA-30 as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 1.2
- 1.2 - 2.2
- 2.2 - 4.4
- 4.4 - 6.6
- 6.6 - 8.8
- 8.8 - 22
- ≥ 22
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET M2-01 (T32) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I32-14
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.3.7.3 Lead

Lead was identified as a COPC in surface soil as shown in Table I32-7. Lead exceeded the applied BTV in 6.3 percent of in situ XRF measurements but not in the XRF confirmation sample. The applied BTV for lead is 9.9 mg/kg for Target T32 as presented in Section 10.3.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I32-5 and Attachment I3, respectively. Figure I32-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T32 and BSA-30 (Jml) samples. Figure I32-16 presents a box plot of detectable lead XRF soil concentrations for Target T32 and BSA-30 (Jml) samples. Summary statistics for XRF measurements are provided in Section 10.3.6.1. Lead XRF concentrations measured in surface soils at Target T32 ranged between 4.2 and 10.7 mg/kg with an average and standard deviation of 7.0 mg/kg and 1.5 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T32 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I32-17. Overall, the majority of detectable lead results in surface soils were below the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T32.

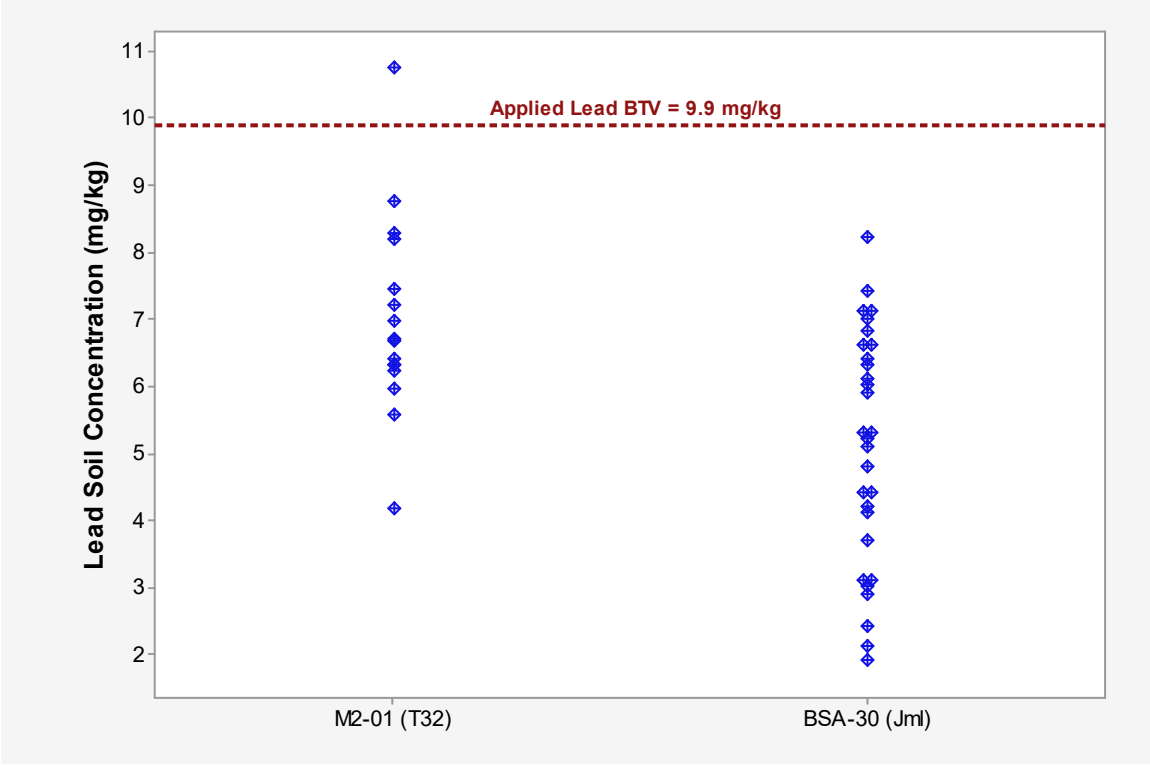


Figure I32-15. Individual Value Plot for Target M2-01 (T32) and BSA-30 (Jml) Lead Soil Concentrations

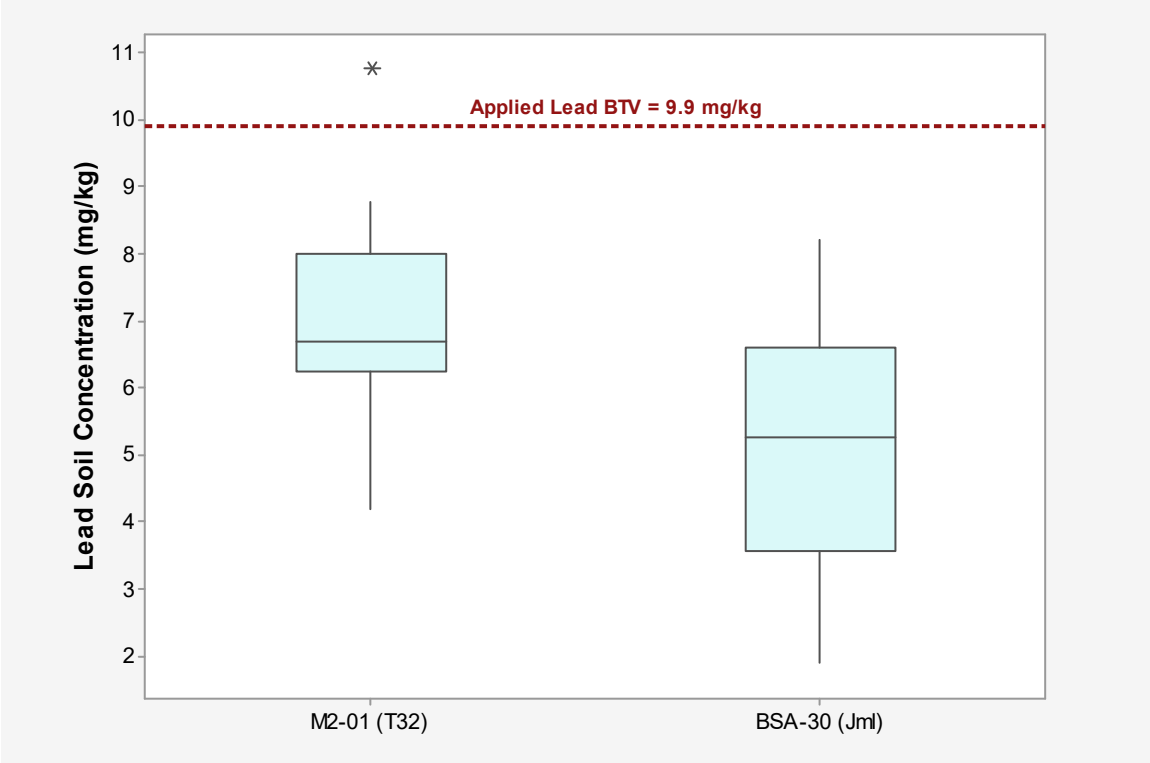
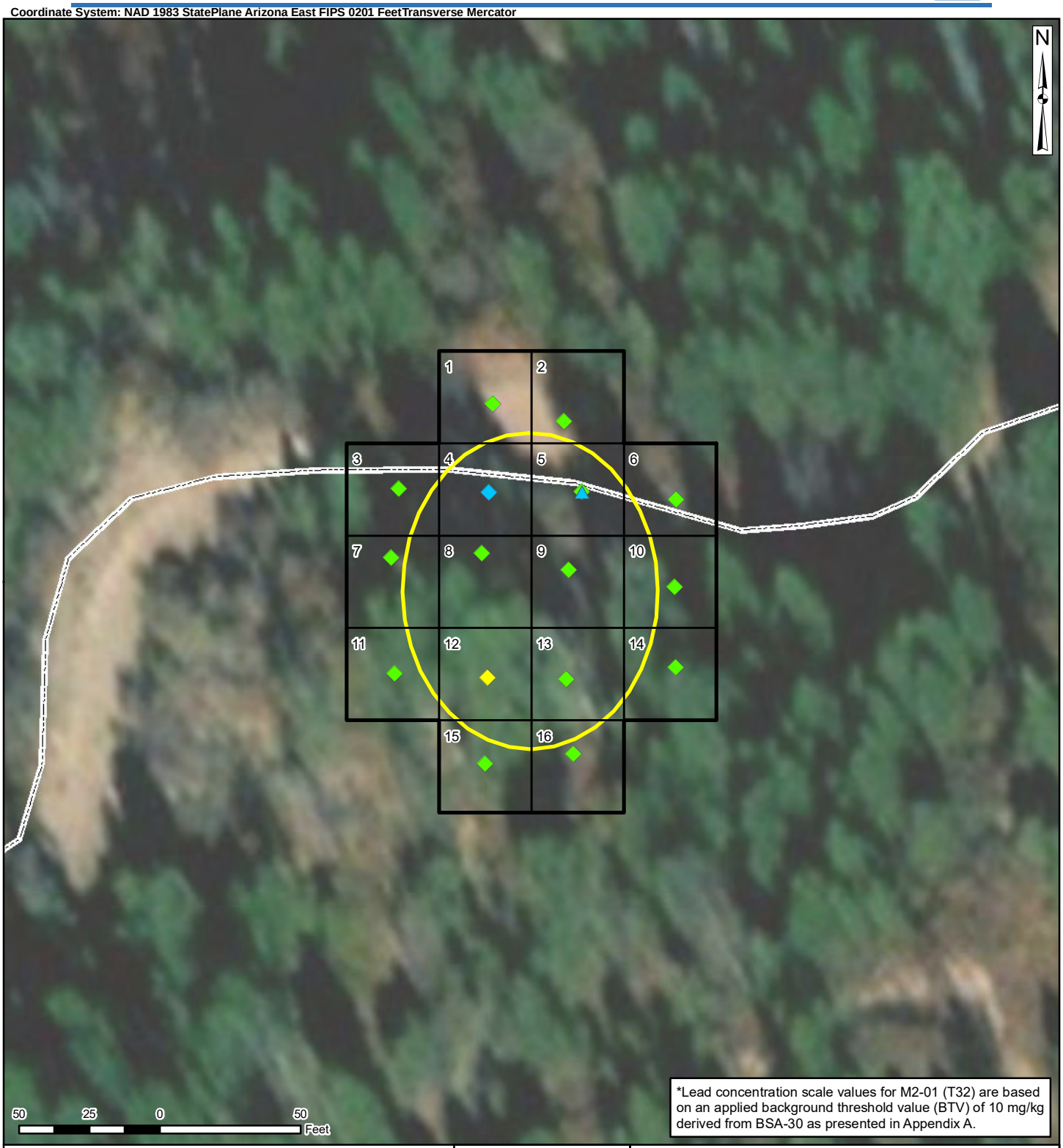


Figure I32-16. Box Plot for Target M2-01 (T32) and BSA-30 (Jml) Lead Soil Concentrations



*Lead concentration scale values for M2-01 (T32) are based on an applied background threshold value (BTV) of 10 mg/kg derived from BSA-30 as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 5.1
- 5.1 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 100
- ≥ 100

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET M2-01 (T32) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I32-17
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.3.7.4 Thorium

Thorium was not identified as a COPC in surface soil as shown in Table I32-7. Thorium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for thorium is 4.7 mg/kg for Target T32 as presented in Section 10.3.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I32-5 and Attachment I3, respectively. Figure I32-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T32 and Jml Regional samples. Figure I32-19 presents a box plot of detectable thorium XRF soil concentrations for Target T32 and Jml Regional samples. Summary statistics for XRF measurements are provided in Section 10.3.6.1. Thorium XRF concentrations measured in surface soils at Target T32 ranged between 1.2 and 3.2 mg/kg with an average and standard deviation of 2.1 mg/kg and 0.6 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T32 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I32-20. All thorium results in surface soils were less than the applied BTV.

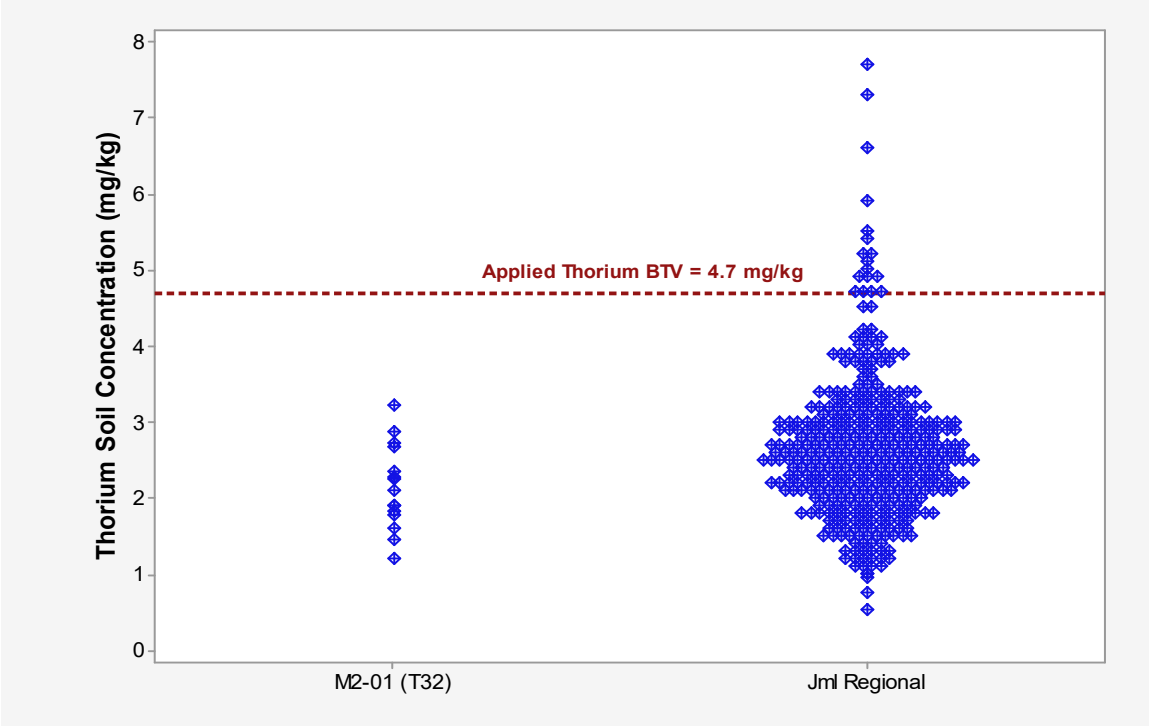


Figure I32-18. Individual Value Plot for Target M2-01 (T32) and Jml Regional Thorium Soil Concentrations

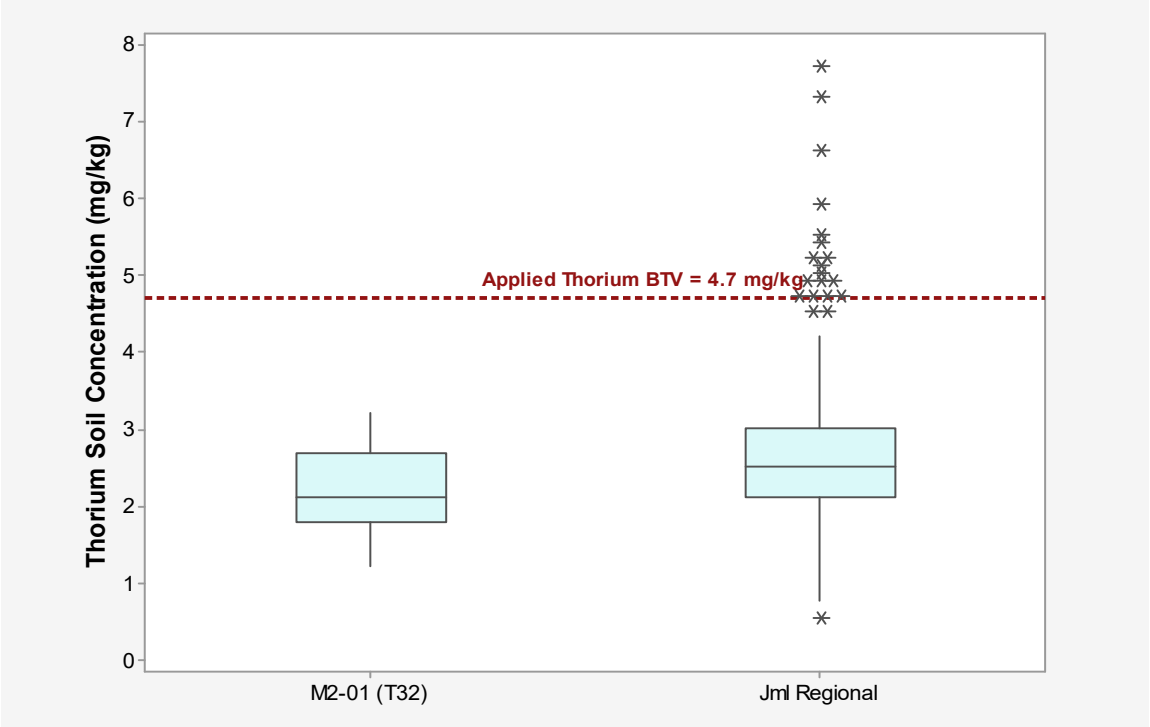


Figure I32-19. Box Plot for Target M2-01 (T32) and Jml Regional Thorium Soil Concentrations



*Thorium concentration scale values for M2-01 (T32) are based on an applied background threshold value (BTV) of 4.7 mg/kg derived from BSAs within the Jml formation as presented in Appendix A.

Thorium Concentration Scale (mg/kg)*

- ≤ 2.6
- 2.6 - 4.7
- 4.7 - 9.4
- 9.4 - 14
- 14 - 19
- 19 - 47
- ≥ 47
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET M2-01 (T32) SURFACE SOIL THORIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I32-20
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.3.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I32-7. Uranium exceeded the applied BTV in 68.8 percent of in situ XRF measurements but not in the XRF confirmation sample. The applied BTV for uranium is 0.64 mg/kg for Target T32 as presented in Section 10.3.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I32-5 and Attachment I3, respectively. Figure I32-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T32 and BSA-30 (Jml) samples. Figure I32-22 presents a box plot of detectable uranium XRF soil concentrations for Target T32 and BSA-30 (Jml) samples. Summary statistics for XRF measurements are provided in Section 10.3.6.1. Uranium XRF concentrations measured in surface soils at Target T32 ranged between 0.6 and 2.7 mg/kg with an average and standard deviation of 1.3 mg/kg and 0.6 mg/kg, respectively. The average uranium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T32 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I32-23. Overall, the majority of detectable uranium results in surface soils were above the applied BTV. However, the maximum XRF value was 4.2 times higher than the applied BTV and does not appear to be associated with mining-related materials at Target T32.

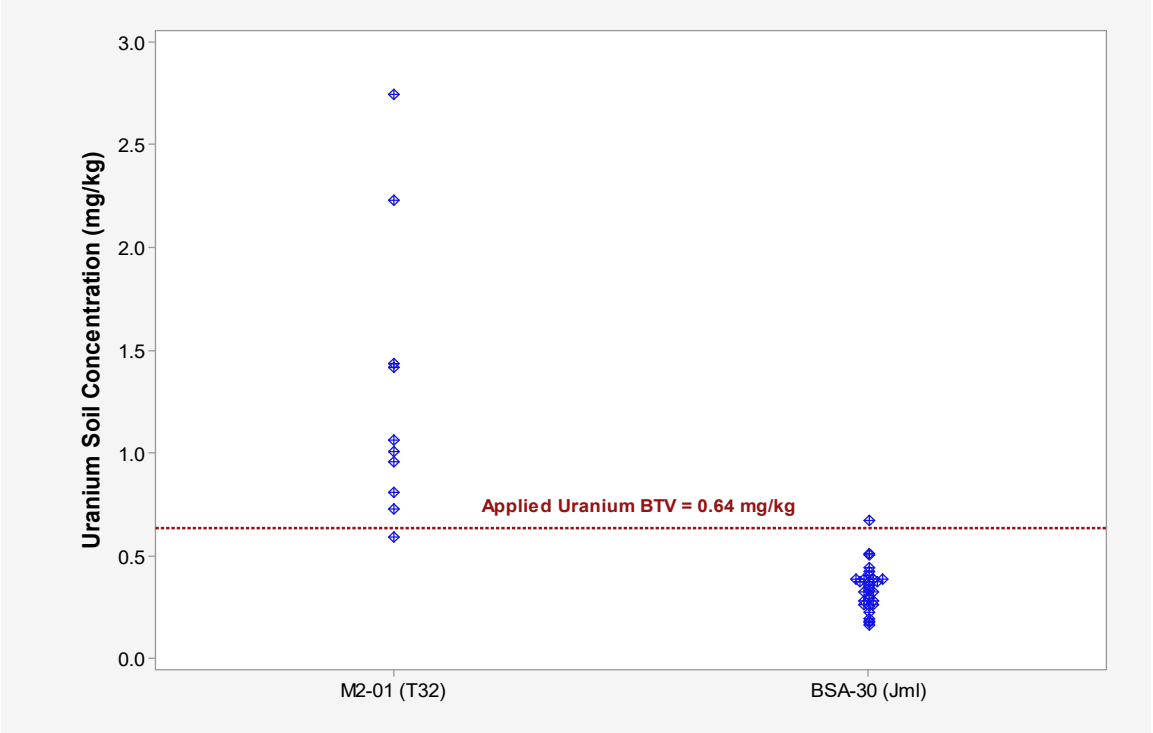


Figure I32-21. Individual Value Plot for Target M2-01 (T32) and BSA-30 (Jml) Uranium Soil Concentrations

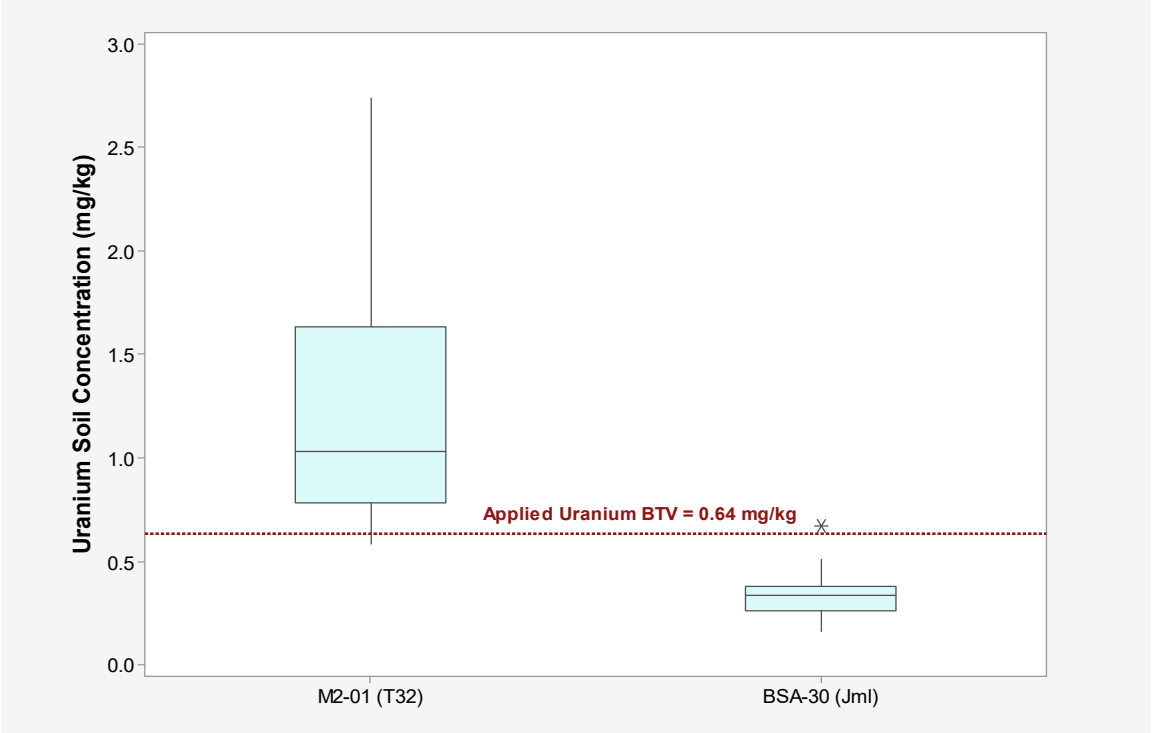


Figure I32-22. Box Plot for Target M2-01 (T32) and BSA-30 (Jml) Uranium Soil Concentrations



*Uranium concentration scale values for M2-01 (T32) are based on an applied background threshold value (BTV) of 0.60 mg/kg derived from BSA-30 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 0.30
- 0.30 - 0.60
- 0.60 - 1.2
- 1.2 - 1.8
- 1.8 - 2.4
- 2.4 - 6.0
- ≥ 6.0
- Non-Detect - Less Than Limit of Detection

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET M2-01 (T32) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I32-23
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.3.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I32-7. Vanadium exceeded the applied BTV in 37.5 percent of in situ XRF measurements but not in the XRF confirmation sample. The applied BTV for vanadium is 22 mg/kg for Target T32 as presented in Section 10.3.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I32-5 and Attachment I3, respectively. Figure I32-24 presents an individual value plot of detectable vanadium XRF soil concentrations for Target T32 and BSA-30 (Jml) samples. Figure I32-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T32 and BSA-30 (Jml) samples. Summary statistics for XRF measurements are provided in Section 10.3.6.1. Vanadium XRF concentrations measured in surface soils at Target T32 ranged between 16.1 and 28.1 mg/kg with an average and standard deviation of 23.0 mg/kg and 3.3 mg/kg, respectively. The average vanadium XRF concentration is above the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T32 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I32-26. Overall, the majority of detectable vanadium results in surface soils were above the applied BTV. However, the exceedances were not significantly higher than the applied BTV and do not appear to be associated with mining-related materials at Target T32.

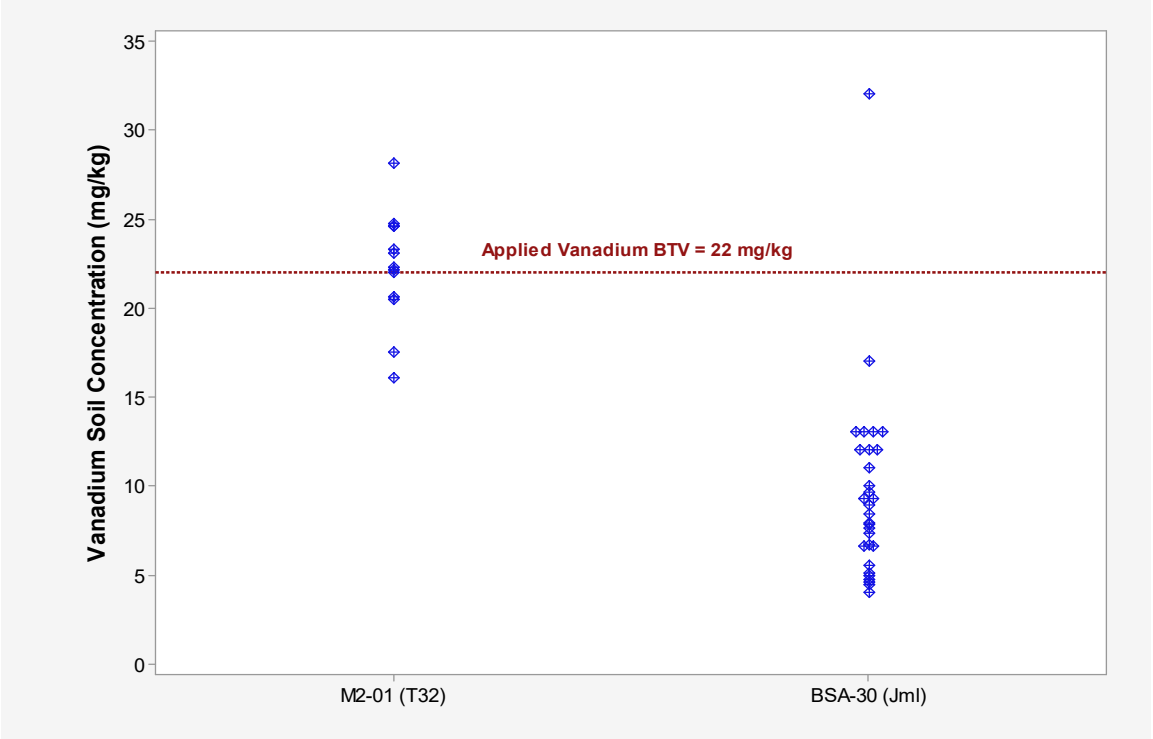


Figure I32-24. Individual Value Plot for Target M2-01 (T32) and BSA-30 (Jml) Vanadium Soil Concentrations

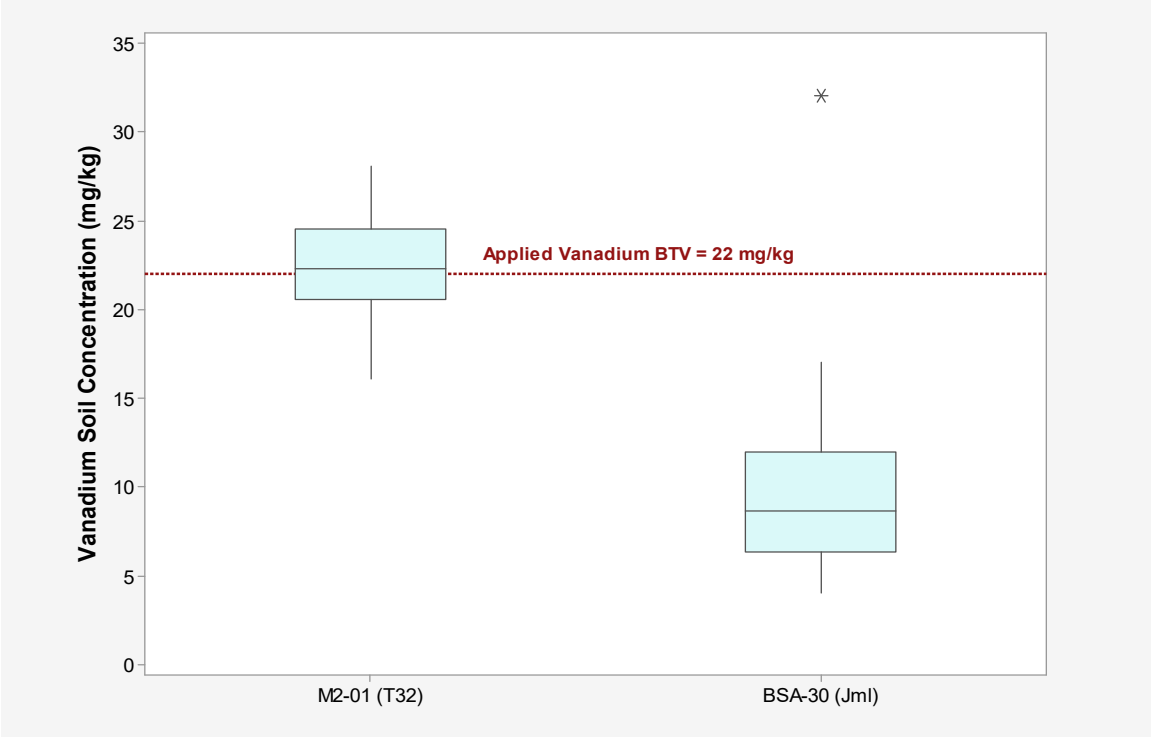


Figure I32-25. Box Plot for Target M2-01 (T32) and BSA-30 (Jml) Vanadium Soil Concentrations



*Vanadium concentration scale values for M2-01 (T32) are based on an applied background threshold value (BTV) of 22 mg/kg derived from BSA-30 as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 9.6
- 9.6 - 22
- 22 - 44
- 44 - 66
- 66 - 88
- 88 - 220
- ≥ 220
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Access Route (Vehicular)

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NON-AUM TARGET M2-01 (T32) SURFACE SOIL VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I32-26
Location: COVE CHAPTER NAVAJO NATION	Date: 6/15/2019	

10.3.8 Conclusions

Target T32 (M2-01) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T32. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T32 are:

- Potential mining-related sources of gamma radiation identified in ASPECT gamma survey were evaluated at Target T32. ASPECT gamma survey results generally correlated with 2018 RSE investigation gamma survey results. No mining-related activities or features were identified by Tetra Tech during the RSE.
- The lateral extent of elevated radiological activity at Target T32 was well documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific and regional BTVs for Target T32 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. No grid averaged gamma measurements exceeded the applied BTV.
- A total of 26 analytes were identified as occurring within the surface environment. Of these analytes, 7 were identified as COPCs. Only uranium exceeded the applied BTV by a factor greater than 2.
- Based on Tetra Tech's RSE observations, Target T32 does not contain TENORM. No mining-related activities or features were observed in the field, and no historical exploratory borings, vents, or other mine openings were noted in the file review or during field observation. NORM was not identified visually or by gamma survey.
- There are no immediate significant physical hazards present at Target T32.
- Access is by dirt road with a small four-wheel-drive vehicle followed by footpath.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.
- No existing groundwater wells are documented within the vicinity of Target T32. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. No mine waste or TENORM was observed at Target T32. Therefore, evaluation of the leachability of metals and radionuclides is not required.

- No mine waste was observed at Target T32; therefore, evaluation of leachable metals for disposal of waste in a permitted landfill or a low-level radioactive waste disposal facility is not required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; no data gaps remain at Target T32.

11.0 GROUP I FIELD SAMPLING RESULTS

This section presents field sampling results for Group I Target T33 (KE-01). Non-AUM Target T34 (KE-02) was inaccessible.

11.1 NON-AUM TARGET T33 (KE-01)

This section describes access, physical conditions, and field observations; summarizes field measurements and sampling activities; presents the field sampling results; and identifies metals and radionuclides exceeding Target-specific BTVs for non-AUM Target T33 (KE-01).

11.1.1 Access, Physical Conditions, and Field Observations

Non-AUM Target T33 (KE-01) is associated with the Knife Edge Mesa Mine (M33), a former underground mine in the Lukachukai Mountains Region in Subarea Group I that is administered by the Lukachukai Chapter of the Navajo Nation. The Knife Edge Mesa Mine was operated by VCA in 1966 only, producing 1,032 tons of ore (Roux 2011), but no historical information is associated with Target T33. The Target is accessible by foot and the closest main road is Indian Route 33. Target T33 is identified in the MCAP (Weston 2016). No residences are near the Target. A Target location and access map for Target T33 is shown in Figure I33-1.

A topographical relief map for the Knife Edge Mesa Mine area and the associated non-AUM Target is provided in Figure I33-2. The elevation at Target T33 ranges from 7,619 to 7,790 feet amsl with an average of 7,712 feet amsl. The slope at Target T33 ranges from 26 to 55 percent with an average of 42 percent. Target T33 is entirely within Jste and within the Typic Haplustolls complex soil type (MUSYM 58) (Figures I-28 and I-29).

Tetra Tech performed a geospatial analysis of 2014 and 2015 ASPECT gamma flyover data to determine the RSE survey area for Target T33. As a part of the RSE for Knife Edge Mesa Mine, Tetra Tech also evaluated the associated non-AUM Target T33. ASPECT imagery was used to guide the sampling approach, which is specified in Appendix F, FSP 40, of the RSE Work Plan (Tetra Tech 2018).

Tetra Tech performed the following field observation activities at Target T33:

- Identified any immediate physical hazards at the non-AUM Target:

  No physical hazards other than dangerous cliffs were identified.

- Located access routes, including foot pathways and roads:

  The Knife Edge Mesa Mine is accessed by four-wheel-drive vehicle followed by a rigorous hike. The Target is accessed via the Mesa 1 haul road off of Indian Route 33, taking a right at Sheep Camp, and then continuing for approximately 3 miles. A 45-minute hike on a footpath across rugged terrain is used to access the Target from the top of the Knife Edge Mesa Mine.

- Differentiated NORM/TENORM through geological assessment and visual observation:

  A potential waste pile was identified in survey unit 34 and is likely TENORM. NORM was observed at the Target but not verified. The underlying geology is the NORM-bearing Jste.

- Mapped all drainages and potential surface water pathways at the non-AUM Target:

  No drainages were identified at the Target. A large, unnamed drainage was identified at the bottom of the cliffs east of the mesa. The unnamed drainage and the Knife Edge Drainage, located west of the mesa, are discussed in Appendix J of the RSE Report.

- Identified any exploration borings or historic haul roads:

  No exploratory borings or haul roads were identified within the Target boundary. However, approximately 20 historic exploratory borings to the south of the Target were identified in the file review.

- Confirmed any existing non-AUM Target features and identified additional potential mine-related features relevant to the RSE investigation process:

  Approximately 20 borings were located south of the Target in the file review. A potential waste pile was observed in the field with approximate dimensions of 5- by 5-feet. The underlying geology is the NORM-bearing Jste, which may contribute to elevated gamma readings.

- Verified soil types and geological formations at each non-AUM Target:

  Target geology and soils types were confirmed in the field by visual observation.

- Conducted physical measurements and visual estimates of any identified mine waste and volumes of waste materials at each non-AUM Target:

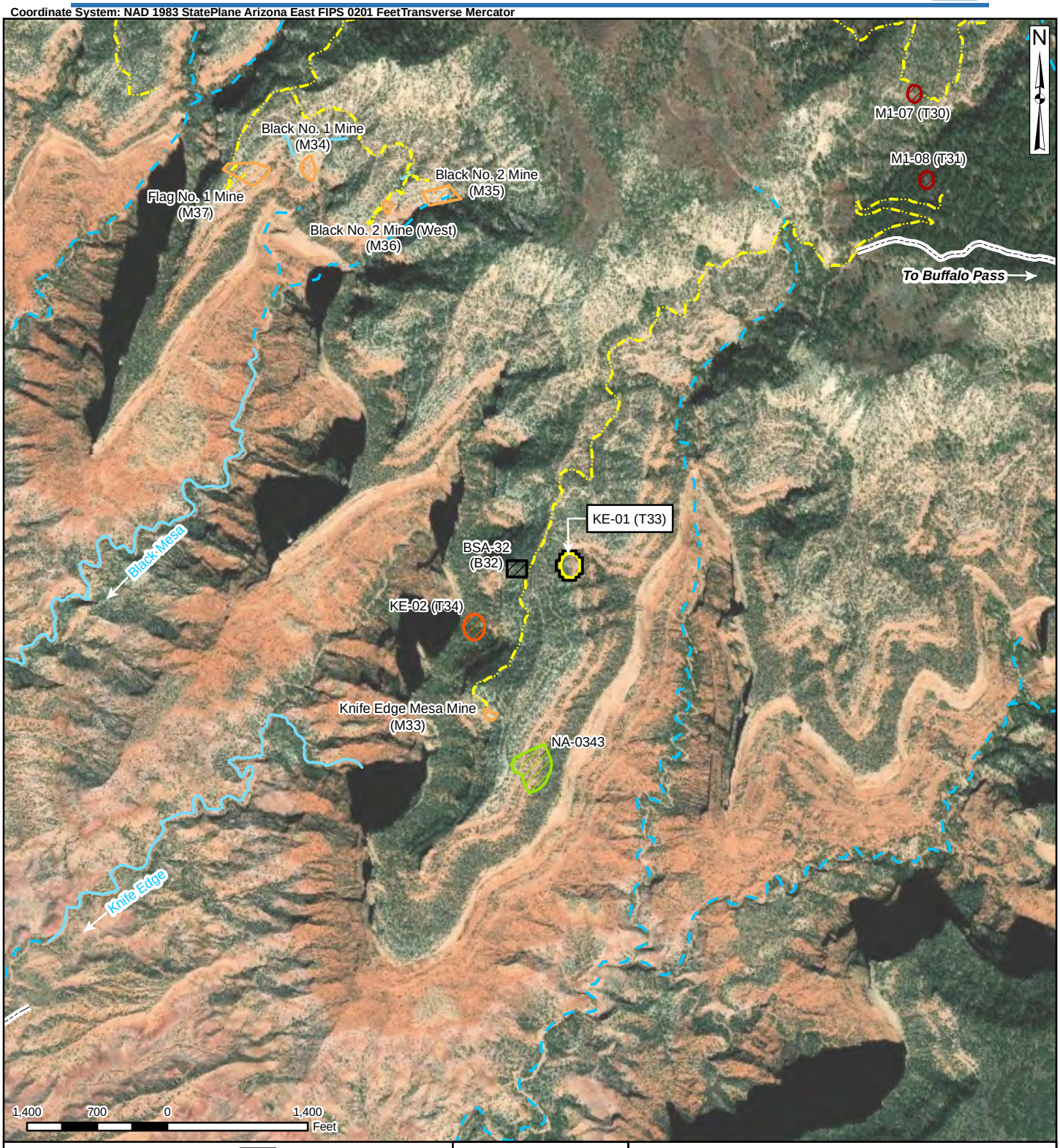
  No mine waste was identified.

The Baseline Study field survey, measurement, and sampling activities at Target T33 included:

- Mapping Target features (observations described above)
- Establishing a BSA and developing BTVs (described in Sections 2.3 and 11.1.4)
- Conducting an XRF field survey
- Collecting XRF confirmation soil samples to develop a correlation with laboratory reported metal soil concentrations for select COPCs (described in Section 11.1.3 with results presented in Sections 11.1.6 and 11.1.7)
- Conducting a gamma radiation survey (results presented in Section 11.1.5)

Attachment I1 presents a photographic log of the RSE activities and any other previous field activities by other parties. Field maps and sampling forms are included in Attachment I2.

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



Non-AUM Target Site Boundary
Related Survey Area
Non-AUM Target Site Boundary - *Inaccessible*
Other Non-AUM Target Site
Tronox AUM Site Boundary
Background Location
Non-Tronox AUM Site
Access Route - Foot
Access Route - Vehicular
Drainage*
Drainage - Field Mapped

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

Prepared for: USEPA Region 9

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NON-AUM TARGET KE-01 (T33) LOCATION AND ACCESS MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I33-1
Location: LUKACHUKAI CHAPTER NAVAJO NATION	Date: 6/15/2019	



Non-AUM Target Site Boundary
Related Survey Area
Non-AUM Target Site Boundary - *Inaccessible*
Background Location
Access Route - Foot
100 ft Contour*
20 ft Contour*

* 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.

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NON-AUM TARGET KE-01 (T33) TOPOGRAPHIC MAP

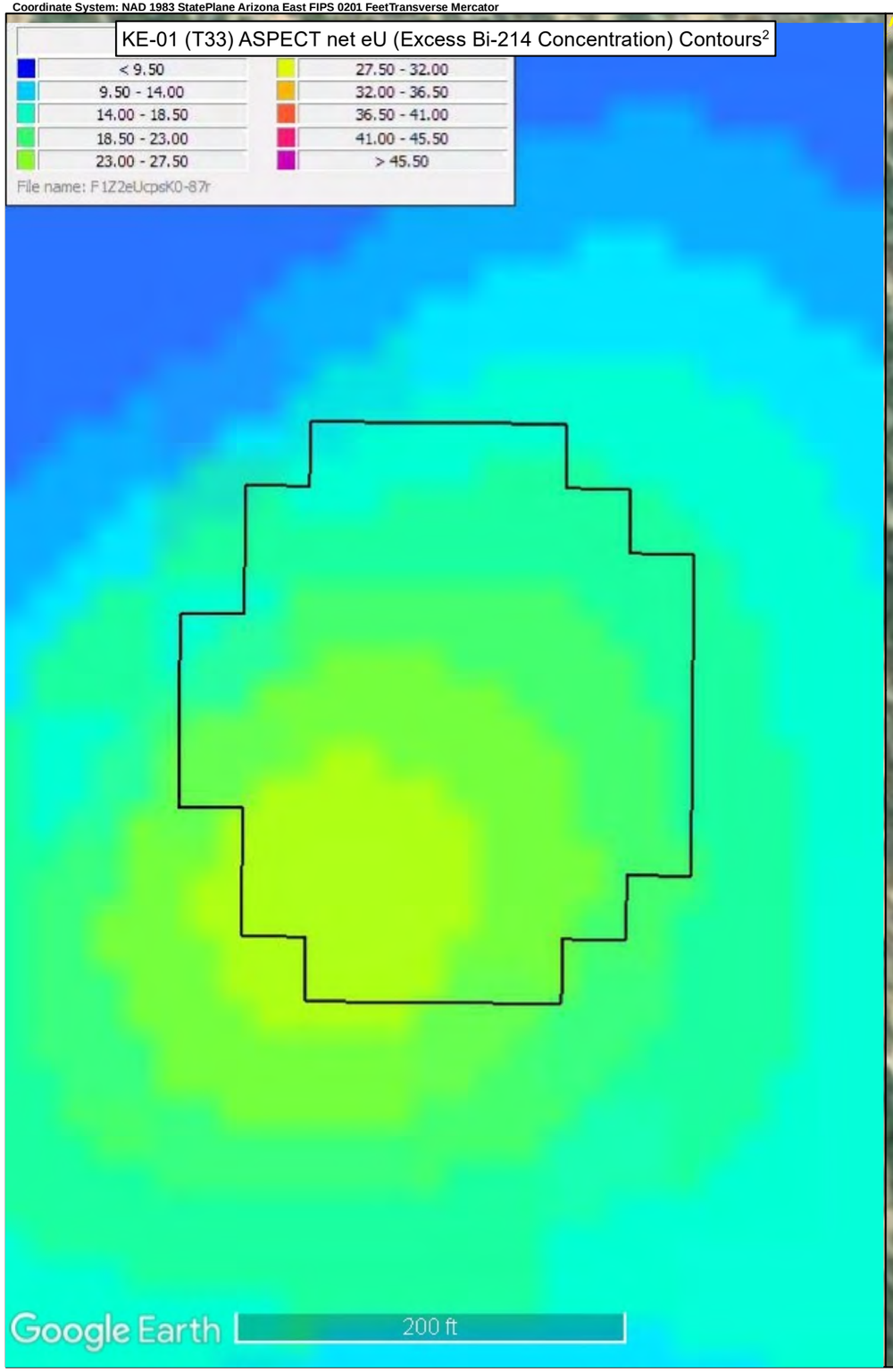
Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I33-2
Location: LUKACHUKAI CHAPTER NAVAJO NATION	Date: 6/15/2019	

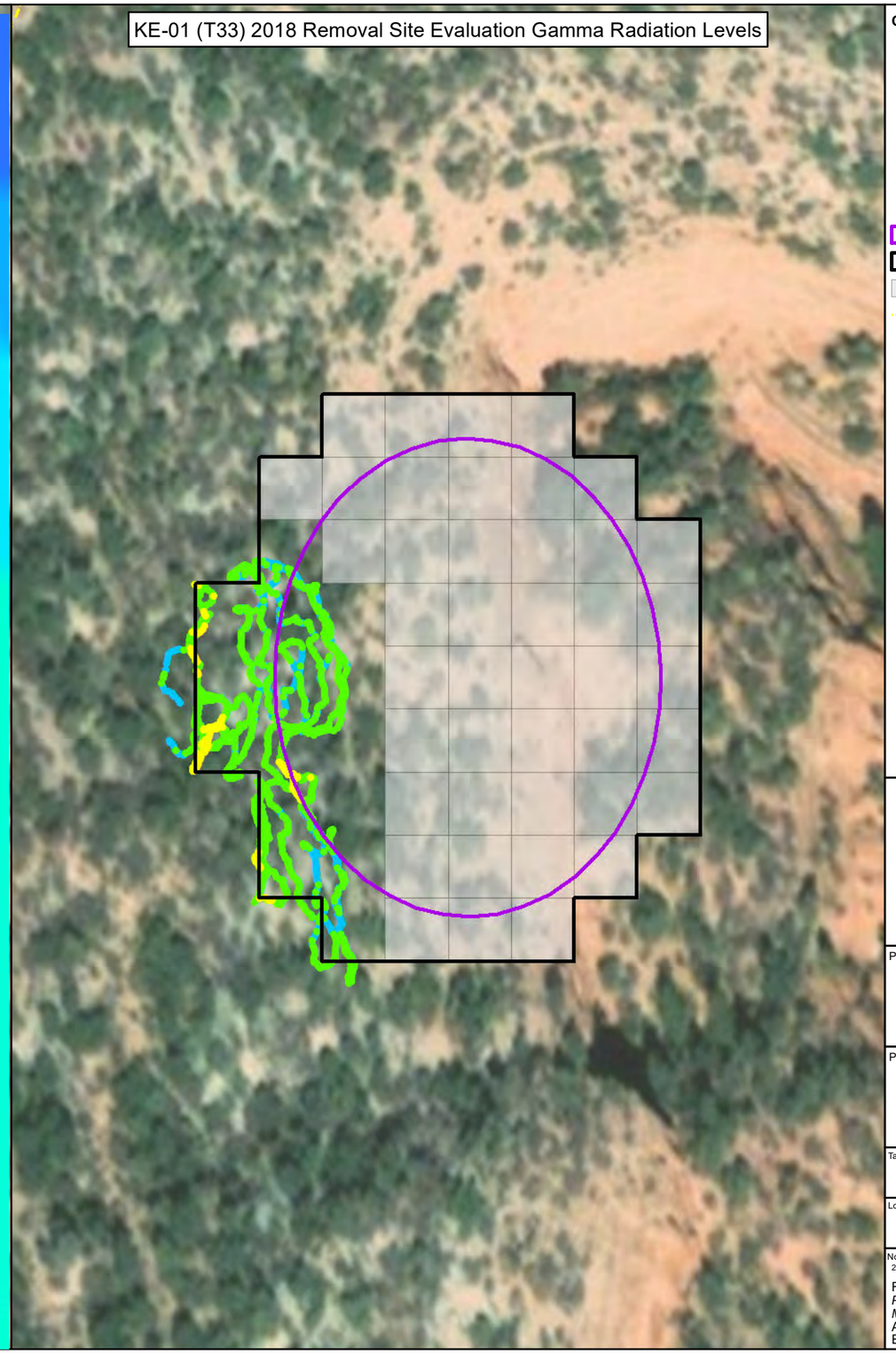
11.1.2 Gamma Radiation Survey and Field XRF Measurements

Tetra Tech performed GPS-based gamma radiation surveys (Figure I33-3) within the survey area of the non-AUM Target T33 as part of the Baseline Study in July 2018. Additional Goback gamma radiation surveys were not performed at Target T33. Tetra Tech also performed an XRF field survey at non-AUM Target T33 that involved the collection of an in situ XRF measurement within the approximate center of each 100 m^2 survey unit (Figure I33-4). The initial gamma survey area and XRF measurement survey units are identified in Appendix F, FSP 40, of the RSE Work Plan (Tetra Tech 2018). A total of 47 gamma survey and 47 XRF survey units were not evaluated because of accessibility issues related to steep terrain and health and safety concerns.

11.1.3 XRF Confirmation Sampling Overview

Tetra Tech collected XRF soil confirmation samples at a minimum frequency of 5 percent of XRF measurement locations at non-AUM Target T33. One XRF soil confirmation sample was collected at a depth of 0 to 3 inches bgs from one location (Table I33-1) following the field protocol described in Section 2.5.1. XRF confirmation samples were collected during the XRF field survey. Figures I33-4 and I33-5 identifies the locations of in situ XRF measurements and XRF confirmation soil samples, respectively. XRF confirmation samples were submitted for laboratory analysis in accordance with USEPA SW-846 Method 6200. A summary of the laboratory analytical procedures for the XRF confirmation soil samples is provided in Table I33-2. The results of XRF confirmation sample analysis are provided in Section 11.1.6.1. Correlated XRF field measurements are provided in Attachment I3.





Gamma Reading (cpm)[1]

≤ 12,011	≤ Avg. BG
12,011 - 20,165	Avg. BG - 1 x BTV
20,165 - 40,330	1 x BTV - 2 x BTV
40,330 - 60,495	2 x BTV - 3 x BTV
60,495 - 80,660	3 x BTV - 4 x BTV
80,660 - 201,650	4 x BTV - 10 x BTV
≥ 201,650	≥ 10 x BTV

Non-AUM Target Site Boundary
Survey Area Boundary
Inaccessible
Access Route - Foot

[1]The applied gamma background threshold value (BTV) for KE-01 (T33) is 20,165 cpm derived from BSA-32 as presented in Appendix A. Avg. BG: Average value of the background data set.

1 in = 70 ft

1:840

N W E S

0 35 70 140 Feet

NON-AUM TARGET KE-01 (T33) 2018 REMOVAL SITE EVALUATION AND ASPECT CONTOUR MAP

Prepared For:

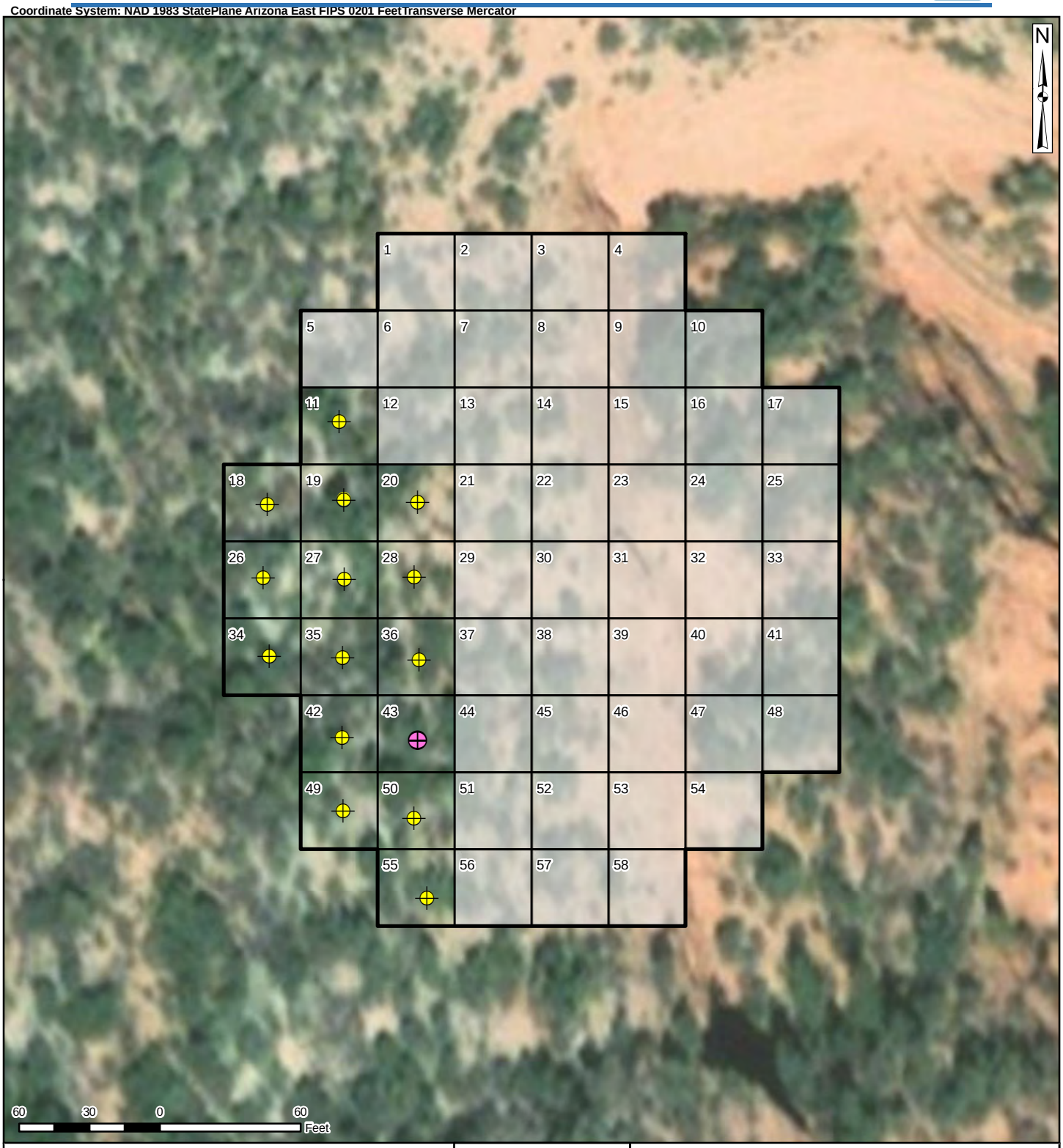
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Task Order No.: TO0001	Contract No.: EP-S9-17-03
Location: LUKACHUKAI CHAPTER NAVAJO NATION	Date: 6/15/2019

Notes:
[2]U.S Environmental Protection Agency, Region 9, Superfund Program, *An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation.* May, 2015. ASPECT - Airborne Spectral Photometric Environmental Collection Technology.

Figure No.: **I33-3**



XRF Confirmation Soil Sample (0 - 3 inches bgs)

In Situ XRF Measurement Location

Survey Unit (100 m²)

Survey Area Boundary

Inaccessible

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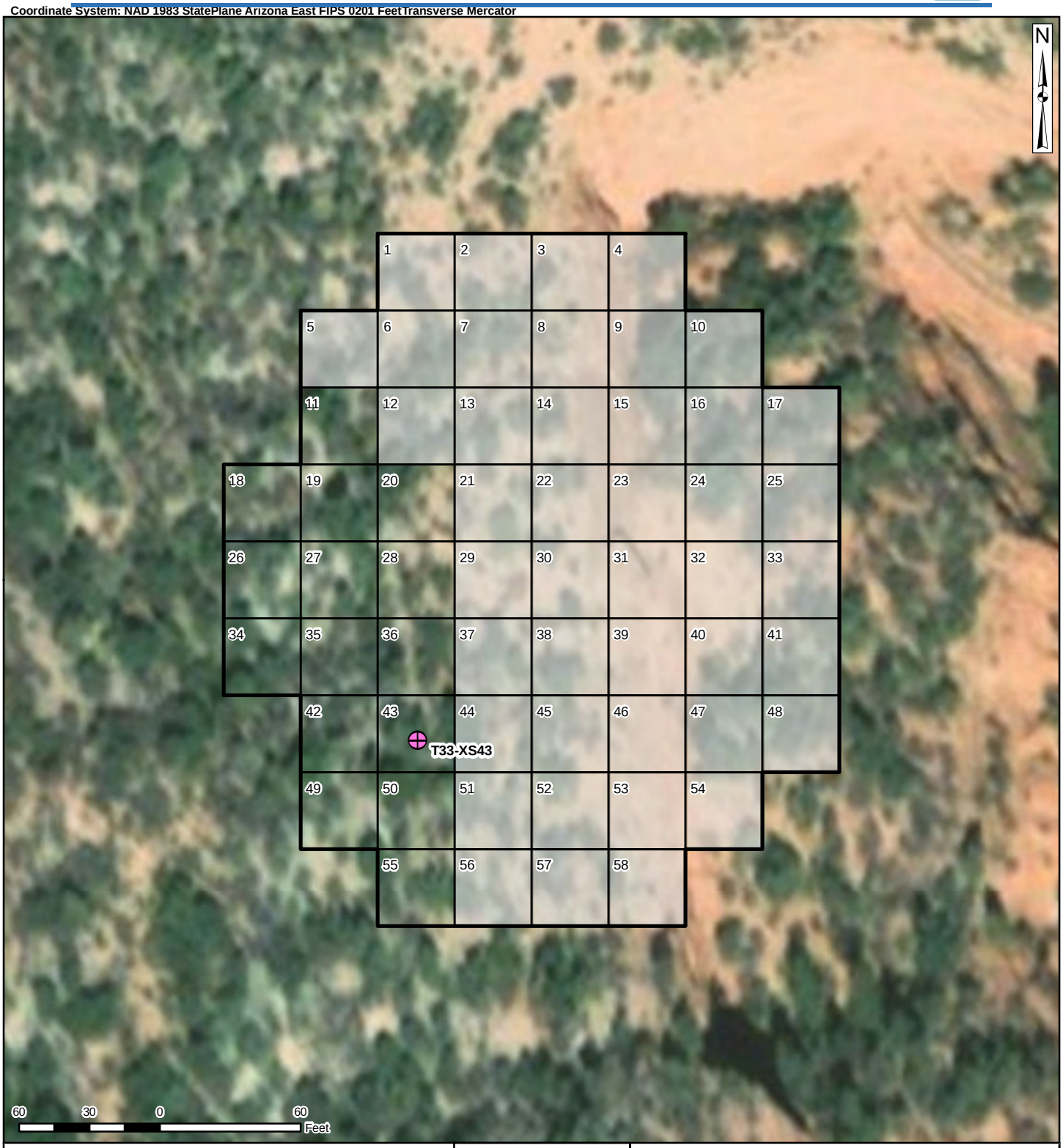
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NON-AUM TARGET KE-01 (T33)
XRF FIELD SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I33-4
Location: LUKACHUKAI CHAPTER NAVAJO NATION	Date: 6/15/2019	

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 Feet Transverse Mercator



XRF Confirmation Soil Sample*
(0 - 3 inches bgs)

Survey Unit (100 m²)

Survey Area Boundary

Inaccessible

*T33-XS43 = site T33 XRF confirmation soil sample collected at survey unit 43. 0 - 3 in bgs = 0 to 3 inches below ground surface.

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NON-AUM TARGET KE-01 (T33)
SURFACE SOIL SAMPLE LOCATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I33-5
Location: LUKACHUKAI CHAPTER NAVAJO NATION	Date: 6/15/2019	

Table I33-1. Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target KE-01 (T33)

Sample ID	Sample Grid No.	Depth	Sample Type	Sample QC	Date Sampled	Latitude[1]	Longitude	Laboratory ID
T33-XS43-01-071718	43	0-3	XRF Confirmation	Primary	7/17/2018	36.4890380	-109.2438360	1807451-5, 1807452-5

Notes:
[1] WGS84 Coordinate System
bgs below ground surface
QC Quality control

Table I33-2. Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM KE-01 (T33)

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

Notes:
- Not applicable
ASTM ASTM International
CAS Chemical abstracts service
USEPA U.S. Environmental Protection Agency
XRF X-ray fluorescence

11.1.4 Applied Background Threshold Values

A radiological and chemical soils background investigation was performed as part of the Northern Agency Tronox Mines RSE investigation, which involves a Target-specific background investigation and a regional background investigation as described in Appendix A of the RSE Report. There were four primary geologies evaluated as part of the regional background investigation.

As described in Section 11.1.1, Target T33 surface geology is entirely within Jste with soils within the Typic Haplustolls complex (MUSYM 58) (Figures I-28 and I-29). As a result, Background Study Area 32 (BSA-32) was selected for that combination of geology and soil type. Additionally, no Jste regional geological background dataset has been developed. Table I33-3 presents the Target-specific BTVs for 29 analytes and gamma radiation levels for Target T33. The BTVs for a given analyte were calculated based on the UTL 95-95 or the USL 95. An applied BTV was selected to represent the unimpacted radiological and chemical conditions at Target T33. The "Applied BTV" for each analyte is in this case the lower Target-specific BTV.

Table I33-3. Applied Background Threshold Values for Non-AUM Target KE-01 (T33)

Analyte	Units	Site-Specific BTV (BSA-32)	Regional BTV (Jste)	Applied BTV	Applied BTV Selection
Aluminum	mg/kg	10,300	None	10,300	Site-Specific BTV
Antimony	mg/kg	0.183	None	0.183	Site-Specific BTV
Arsenic	mg/kg	68	None	68	Site-Specific BTV
Barium	mg/kg	300	None	300	Site-Specific BTV
Beryllium	mg/kg	0.92	None	0.92	Site-Specific BTV
Cadmium	mg/kg	0.203	None	0.203	Site-Specific BTV
Calcium	mg/kg	66,500	None	66,500	Site-Specific BTV
Chromium	mg/kg	7.0	None	7.0	Site-Specific BTV
Cobalt	mg/kg	7.8	None	7.8	Site-Specific BTV
Copper	mg/kg	22	None	22	Site-Specific BTV
Iron	mg/kg	11,200	None	11,200	Site-Specific BTV
Lead	mg/kg	14	None	14	Site-Specific BTV
Lithium	mg/kg	20	None	20	Site-Specific BTV
Magnesium	mg/kg	8,630	None	8,630	Site-Specific BTV
Manganese	mg/kg	819	None	819	Site-Specific BTV
Mercury	mg/kg	0.0347	None	0.0347	Site-Specific BTV
Molybdenum	mg/kg	1.1	None	1.1	Site-Specific BTV
Nickel	mg/kg	10	None	10	Site-Specific BTV
Potassium-40	pCi/g	25.5	None	25.5	Site-Specific BTV
Radium-226	pCi/g	20.2	None	20.2	Site-Specific BTV
Radium-228	pCi/g	None	None	None	Site-Specific BTV
Selenium	mg/kg	2.1	None	2.1	Site-Specific BTV
Silver	mg/kg	0.062	None	0.062	Site-Specific BTV
Sodium	mg/kg	99	None	99	Site-Specific BTV
Thallium	mg/kg	0.202	None	0.202	Site-Specific BTV
Thorium	mg/kg	5.9	None	5.9	Site-Specific BTV
Uranium	mg/kg	21	None	21	Site-Specific BTV
Vanadium	mg/kg	42	None	42	Site-Specific BTV
Zinc	mg/kg	33	None	33	Site-Specific BTV
Gamma Radiation	cpm	20,165	None	20,165	Site-Specific BTV

Notes:
BSA Background Study Area
BTV background threshold value
cpm counts per minute
Jste Summerville, Todilto, and Entrada Formations (Undifferentiated)
mg/kg milligrams per kilogram
pCi/g picocuries per gram

11.1.5 Gamma Radiation Survey Results

This subsection presents an overview of the gamma radiation survey performed at non-AUM Target T33 and the raw gamma radiation and grid averaged gamma radiation survey results.

11.1.5.1 Overview

An initial gamma radiation survey was performed as part of the Baseline Study at non-AUM Target T33 in July 2018 following the methods outlined in Section 2.2. The results of the survey were evaluated following the completion of the Baseline Study to determine if any additional Goback survey units would need to be added to complete the evaluation of the lateral extent of gamma radiation above the BTV. No additional scanning, measurements, or sampling were required. The applied gamma BTV for non-AUM Target T33 is 20,165 cpm. A total of 1,760 measurements were collected as part of the gamma radiation survey at non-AUM Target T33 across 15 survey units. Because of the steep topography, not all survey units were scanned at 100 percent density or were not scanned at all. An average scan density of 117 measurements per survey unit was calculated. Summary statistics for the raw and grid averaged gamma radiation survey results are listed in Table I33-4.

Table I33-4. Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target KE-01 (T33)

Summary Statistic	Units	Raw Gamma Radiation Survey Results	Grid Averaged Gamma Radiation Survey Results
Applied Gamma BTV	cpm	20,165	
Measurements	#	1,760	15
Minimum	cpm	8,964	11,756
Maximum	cpm	31,627	17,662
Average	cpm	15,098	14,347
Median	cpm	14,200	14,309
Standard Deviation	cpm	3,449	1,905
90th Percentile	cpm	19,810	16,318
95th Percentile	cpm	21,668	16,785
99th Percentile	cpm	25,137	17,487
Measurements per Survey Unit	#/grid	117	
Measurements Above Gamma BTV	#	154	0
Measurements Above Gamma BTV	%	8.8	0.0

Notes:
BTV background threshold value
cpm counts per minute

11.1.5.2 Raw Gamma Radiation Survey Results

The results of the gamma radiation survey confirmed elevated gamma readings for 8.8 percent of the measurements within the Target boundaries, in some cases exceeding greater than 1.5 times the applied gamma BTV (20,165 cpm). An individual value plot showing the spread of gamma radiation survey data collected at the Target compared to the BSA-32 (Jste) gamma survey results is provided on Figure I33-6. This graph shows that the spread of radiation data at Target T33 (shown on left) begins within the lower range of BSA-32 (Jste) gamma levels (shown on right) and then rises to a top range similar to background radiation. Additionally, this individual value plot shows that the majority and largest amount of radiation data collected from Target T33 is slightly higher than the data cloud from the BSA-32 (Jste) data set. A box plot showing the quartiles of the data sets is provided in Figure I33-7. The box plot shows that the median of Target T33 radiation levels is higher than the median of the BSA-32 (Jste) data set but less than the applied gamma BTV.

A map showing the results of the 2018 RSE versus gamma radiation survey is provided in Figure I33-8. Survey units classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I33-8 as discussed further in Section 2.8. No mining activity was observed within the survey area of Target T33; however, a 5- by 5-foot waste pile in survey unit 34 was noted in the field. An unidentified prospect may also be associated with the waste pile noted at survey unit 34. Overall, the elevated gamma activity is likely associated with outcropping of Jste. The Knife Edge Mesa Mine is located in the same formation further to the south.

In general, Target T33 has surficial gamma radiation levels below BSA-32 (Jste) levels across the majority of the Target except for the upslope area, indicating that the area of elevated gamma activity identified by the ASPECT gamma survey (Figure I33-3) is associated with outcropping of Jste. The waste pile within survey unit 34 may be TENORM; however, no mining-related activities were observed. Section 11.1.5.3 presents the grid averaged results of the gamma radiation survey.

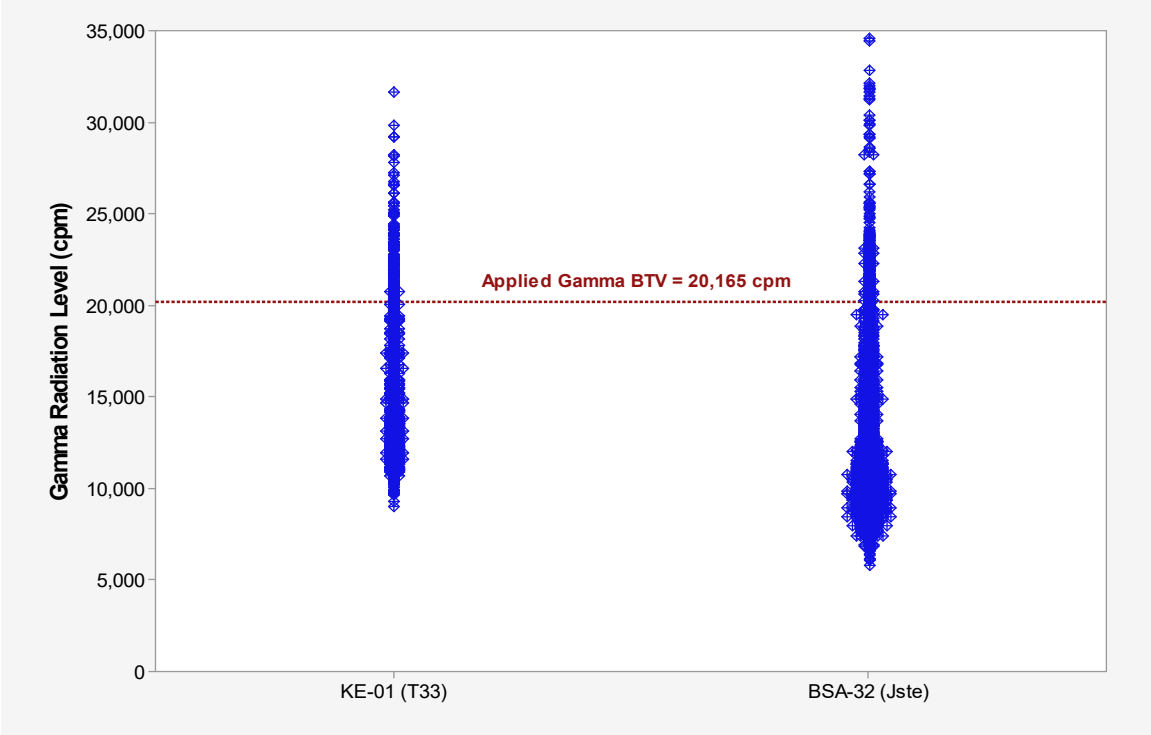


Figure I33-6. Individual Value Plot of Raw Gamma Radiation Levels at Target KE-01 (T33) and BSA-32 (Jste)

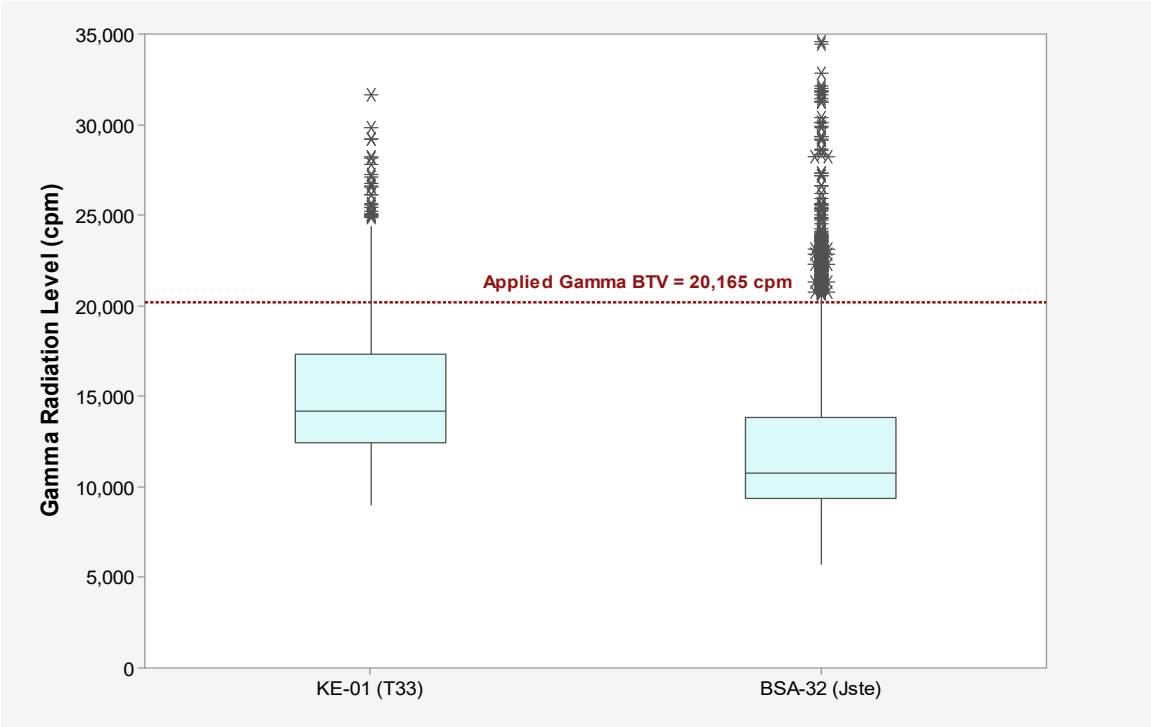
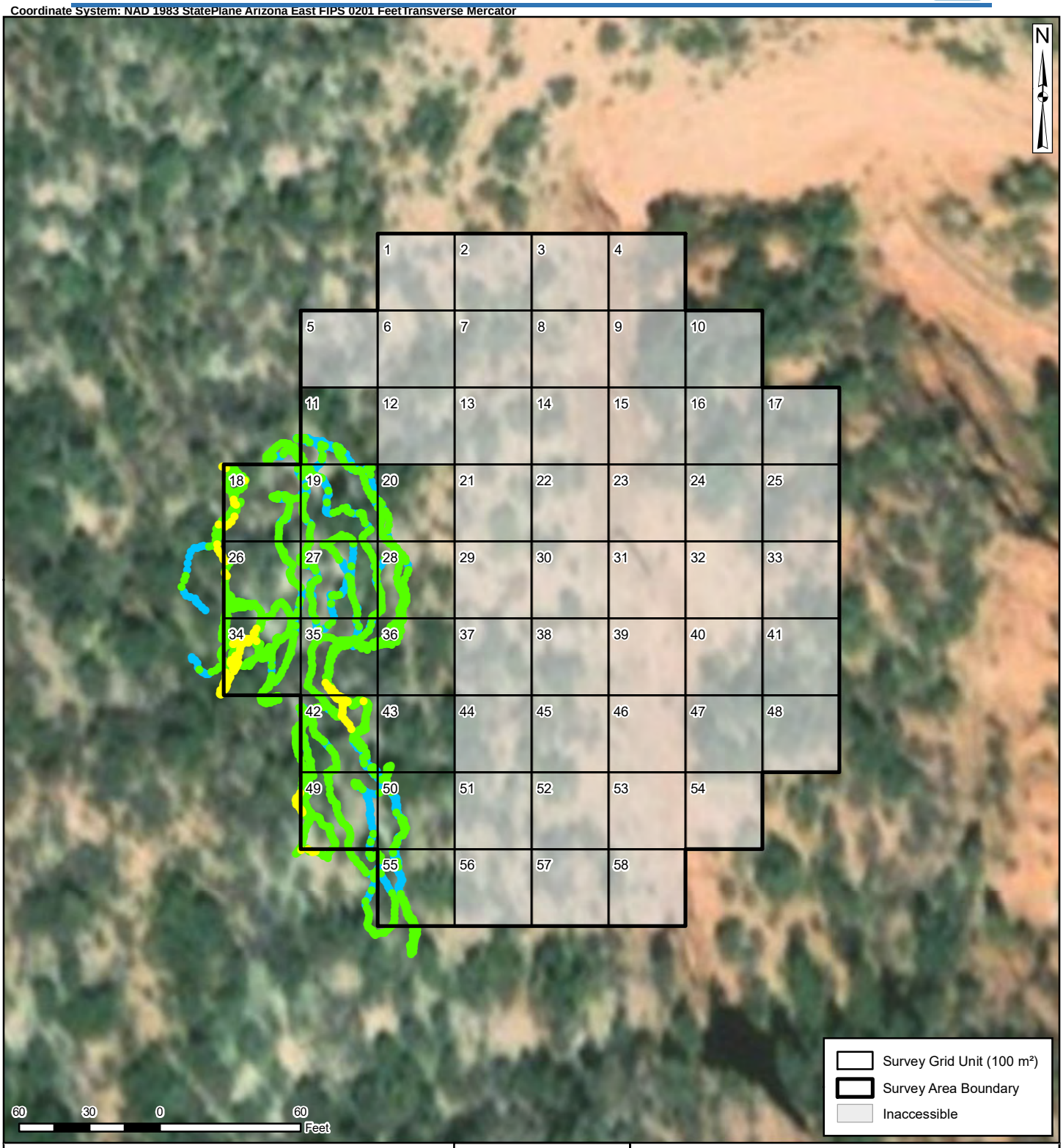


Figure I33-7. Box Plot of Raw Gamma Radiation Levels at Target KE-01 (T33) and BSA-32 (Jste)

Coordinate System: NAD 1983 StatePlane Arizona East FIPS 0201 Feet Transverse Mercator



Gamma Reading (cpm)*

≤ 12,011	≤ Avg. BG
12,011 - 20,165	Avg. BG - 1 x BTV
20,165 - 40,330	1 x BTV - 2 x BTV
40,330 - 60,495	2 x BTV - 3 x BTV
60,495 - 80,660	3 x BTV - 4 x BTV
80,660 - 201,650	4 x BTV - 10 x BTV
≥ 201,650	≥ 10 x BTV

*The applied gamma background threshold value (BTV) for KE-01 (T33) is 20,165 cpm derived from BSA-32 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET KE-01 (T33)
2018 REMOVAL SITE EVALUTAIONS
GAMMA RADIATION LEVELS SURVEY MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I33-8
Location: LUKACHUKAI CHAPTER NAVAJO NATION	Date: 6/15/2019	

11.1.5.3 Grid Averaged Gamma Survey Results

The raw results of the gamma radiation survey are presented in Section 11.1.5.2, and the summary statistics of the grid averaged analysis of the gamma radiation survey data are provided in Section 11.1.5.1. Figure I33-9 and Figure I33-10 show an individual value plot and a box plot, respectively, for the grid averaged gamma radiation data (shown on left) compared to BSA-32 (Jste) data set (shown on right). No survey units within the survey area of Target T33 had a grid averaged gamma radiation level above the applied gamma BTV.

A map showing the Target features (on left) and the grid averaged gamma radiation levels (on right) with color-coordinated levels is provided in Figure I33-11. Survey units that were classified as inaccessible during the gamma radiation survey are shown as gray squares on Figure I33-11 as discussed further in Section 2.8. No survey units exceeded the gamma BTV.

The procedure of grid averaging the gamma radiation levels in survey units is useful for simplifying the statistical analysis of a very large data set, future risk assessment exposure assessment, and MARSSIM site classification methods described in Section 2.9. Several analytical surface soil samples were collected at the Target across the survey units and are presented in Section 11.1.6.

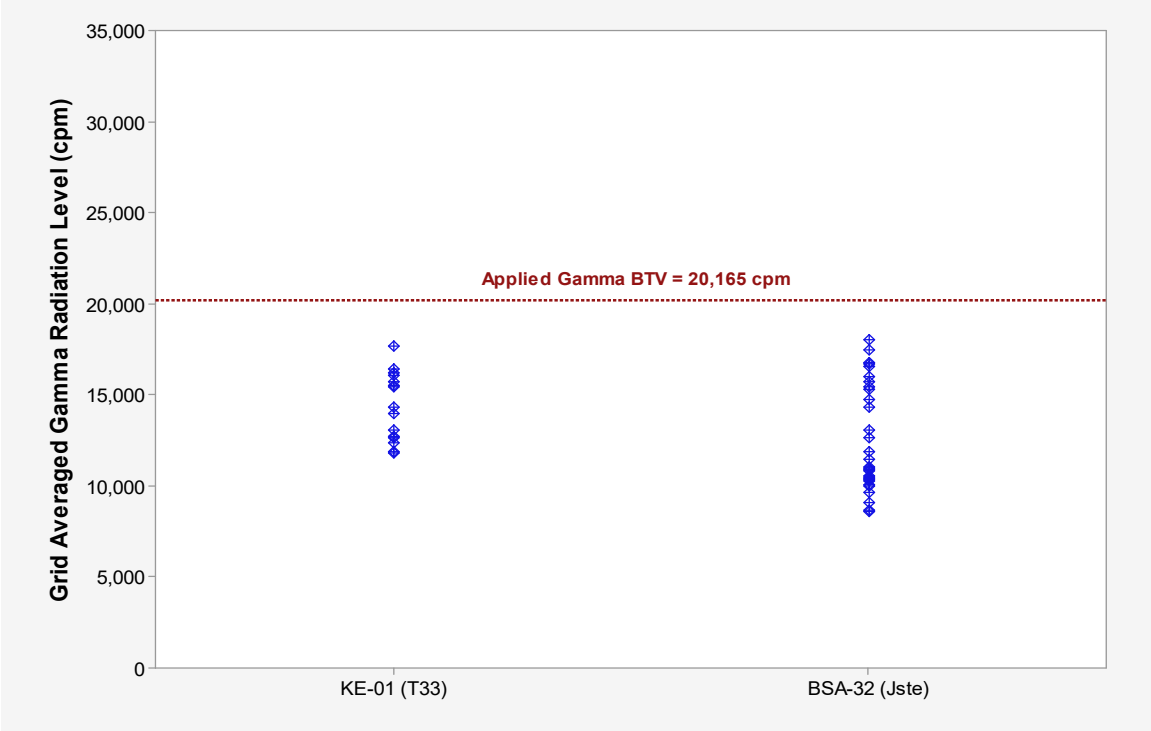


Figure I33-9. Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target KE-01 (T33) and BSA-32 (Jste)

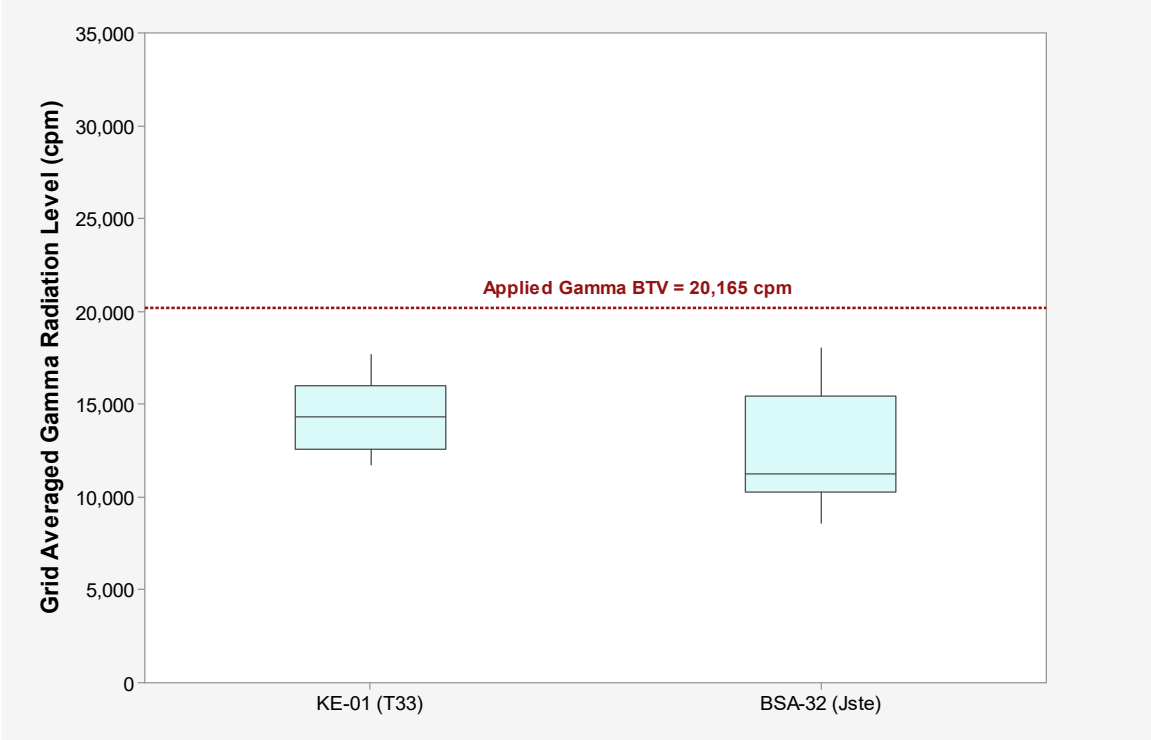
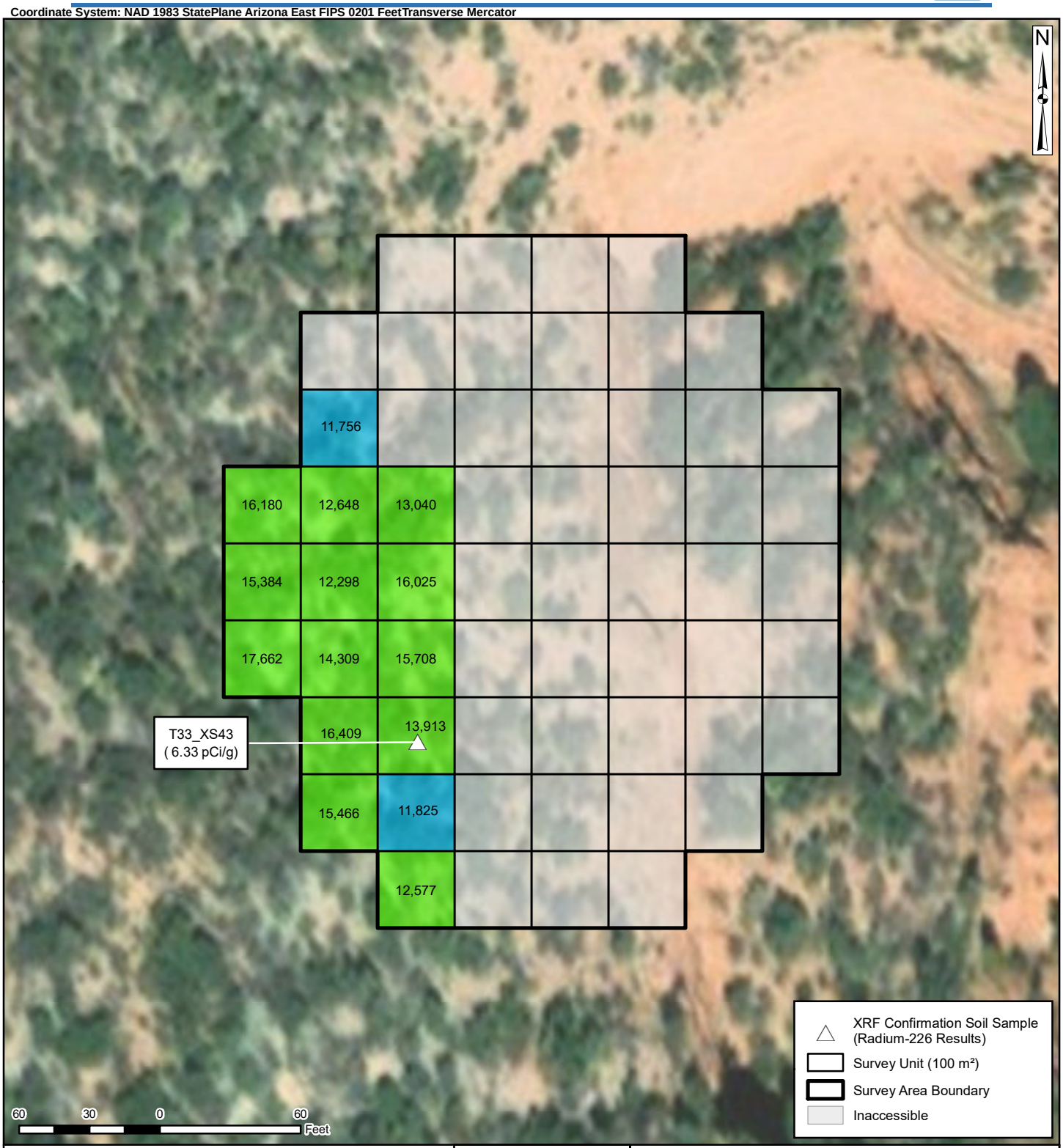


Figure I33-10. Box Plot of Grid Averaged Gamma Radiation Levels at Target KE-01 (T33) and BSA-32 (Jste)

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



Grid Averaged Gamma Reading (cpm)*

≤ 12,011	≤ Avg. BG
12,011 - 20,165	Avg. BG - 1 x BTV
20,165 - 40,330	1 x BTV - 2 x BTV
40,330 - 60,495	2 x BTV - 3 x BTV
60,495 - 80,660	3 x BTV - 4 x BTV
80,660 - 201,650	4 x BTV - 10 x BTV
≥ 201,650	≥ 10 x BTV

*The applied gamma background threshold value (BTV) for KE-01 is 20,165 cpm derived from BSA-32 as presented in Appendix A. Avg. BG: Average value of the background data set.

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NON-AUM TARGET KE-01 (T33) GRID AVERAGED GAMMA RADIATION LEVELS AND RADIUM-226 RESULTS

Task Order No.:	Contract No.:	Figure No.:
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11.1.6 Soil Sampling Results

This section presents the results of analyses for soil within the survey area of Target T33. Radionuclide and metal concentrations within the surface environment (top 3 inches) were investigated following the methods described in Section 2.5. Surface soils were evaluated using two sample types: (1) in situ XRF measurements and (2) XRF confirmation soil samples at a depth of 0 to 3 inches bgs. The results from these two sample types are presented in Section 11.1.6.1. Identification of COPCs based on field measurements and laboratory analytical results are presented in Section 11.1.6.2.

11.1.6.1 Surface Sampling

As described above, there are two primary surface sample types for Target T33: (1) in situ XRF measurements and (2) XRF confirmation soil samples. A description of the geospatial locations and laboratory sample delivery group identification for the XRF confirmation soil samples and the surface soil samples is presented in Tables I33-1 and I33-2. All the results of the XRF confirmation soil samples are presented in Table I33-5. The results of the final in situ XRF measurements are presented in Attachment I3.

The XRF field survey was performed on a systematic square grid system at Target T33 following the methods outlined in Section 2.4 and shown in Figure I33-4. The in situ XRF measurements were corrected to represent the predicted laboratory soil concentrations for nine elements following the methodology presented in the XRF Correlation Report in Appendix B of the RSE Report. The in situ XRF measurements presented in Attachment I3 include the final measurement for the nine elements. A total of 15 measurements were collected across 15 survey units from the survey area of Target T33 during the Baseline Study. No all grid units were measured because of access limitations posed by cliffs and overstep topography. The summary statistics of the XRF field survey results are provided in Table I33-6.

Per USEPA Method 6200 (USEPA 2007), confirmatory soil samples were also collected at Target T33 at a depth of 0 to 3 inches bgs. One XRF confirmation soil sample was collected during the XRF field survey. The laboratory analytical results for the XRF confirmation soil samples are presented in Table I33-5. Summary statistics for the XRF confirmation soil samples were not prepared because of the small number of samples collected.

The results of the combined surface soil results for select analytes in the form of contaminant maps are provided in Section 11.1.7.

Table I33-5. Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target KE-01 (T33)

Analyte	Units	Applied BTV	T33-XS43-01-071718	
			Result	Q
Survey Unit			X43	
Aluminum	mg/kg	10,300	8,600	
Antimony	mg/kg	0.183	0.15	
Arsenic	mg/kg	68	3.1	
Barium	mg/kg	300	170	
Beryllium	mg/kg	0.92	0.56	
Cadmium	mg/kg	0.203	0.095	J
Calcium	mg/kg	66,500	52,000	
Chromium	mg/kg	7.0	7.6	
Cobalt	mg/kg	7.8	6	
Copper	mg/kg	22	16	
Iron	mg/kg	11,200	11,000	
Lead	mg/kg	14	9.6	
Lithium	mg/kg	20	19	
Magnesium	mg/kg	8,630	8,300	
Manganese	mg/kg	819	300	
Molybdenum	mg/kg	1.1	<0.2	U
Nickel	mg/kg	10	10	
Potassium-40	pCi/g	25.5	21.2	
Radium-226	pCi/g	20.2	6.33	
Radium-228	pCi/g	None	<0.8	UJ
Selenium	mg/kg	2.1	1.1	
Silver	mg/kg	0.062	0.06	
Sodium	mg/kg	99	120	
Thallium	mg/kg	0.202	0.073	
Thorium	mg/kg	5.9	4.8	
Uranium	mg/kg	21	5.3	
Vanadium	mg/kg	42	23	
Zinc	mg/kg	33	33	

Notes:
BTV Background threshold value
ID Identification
J Estimated value
mg/kg Milligrams per kilogram
pCi/g Picocuries per gram
Q Qualification
U Not considered detected. The associated value is the method detection limit (MDL)
UJ Not considered detected. The associated value is the reported concentration, which is estimated.

Table I33-6. XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target KE-01 (T33)

Summary Statistic[1]	Units	Arsenic	Iron	Lead	Manganese	Molybdenum	Thorium	Uranium	Vanadium	Zinc
Applied BTV	mg/kg	68	11,200	14	819	1.1	5.9	21	42	33
Measurements	#	15	15	15	15	15	15	15	15	15
Detects	#	7	15	15	15	7	11	15	7	15
Nondetects	#	8	0	0	0	8	4	0	8	0
Minimum	mg/kg	3.3	2,574	1.1	87.6	0.5	1.1	1.5	20.9	12.8
Maximum	mg/kg	32.5	9,239	8.2	293.1	3.1	4.2	8.7	45.9	38.6
Standard Deviation	mg/kg	10.9	2,080	2.3	60	1.08	0.8	2.7	8	7.1
Average	mg/kg	14.9	5,477	5.0	223	1.64	2.4	4.7	29.7	23.8
Median	mg/kg	13.7	5,712	4.8	235	1.40	2.5	5.4	28.3	26.1
Relative Standard Deviation	%	73.3	38.0	45.4	27.1	66.0	34.0	56.8	28.2	29.8
90th Percentile	mg/kg	28.6	7,770	8.1	282	2.9	3.0	8.3	38	30
95th Percentile	mg/kg	30.6	8,212	8.1	287	3.0	3.6	8.5	42	33
99th Percentile	mg/kg	32.2	9,034	8.2	292	3.1	4.1	8.7	45	37
Measurements Above Applied BTV	#	0	0	0	0	4	0	0	1	1
Measurements Above Applied BTV	%	0.0	0.0	0.0	0.0	26.6	0.0	0.0	6.7	6.7

Notes:

[1] Summary statistics for in situ XRF measurements presented are detected (only) laboratory equivalent values.

BTV Background threshold value
mg/kg Milligram per kilogram
XRF X-ray fluorescence

11.1.6.2 Identification of Contaminants of Potential Concern

A Target-to-background analysis was performed on the different data types collected at Target T33 to identify the radionuclide and metal COPCs in surface soils. Soil concentrations at Target T33 were measured using in situ XRF analysis and laboratory XRF confirmation surface soil samples. Applied BTVs have been selected to represent background conditions for metals and K-40, Ra-266, and Ra-228 at Target T33. The estimated BTVs are identified in Section 11.1.4 and Table I33-3.

As discussed in Section 2.10, a criterion of greater than 5 percent of samples exceeding the applied BTV was used to identify a COPC as being above background for a particular sample type regardless of the presence or absence of TENORM. Table I33-7 presents a summary of the background comparison for different measurement and soil depths at Target T33. The "Final COPC Determination" column shows which COPCs will be carried over for further evaluation.

TENORM in the form of a potential waste pile was identified at Target T33. Therefore, site classification and reevaluation of COPCs will be conducted in the EE/CA in accordance with the methodology developed for AUMs. Risk screening and removal action determination will be conducted in conjunction with the development of an EE/CA for the Northern Agency Tronox Mines.

The following section presents COPC mapping and discusses primary and secondary COPCs.

Table I33-7. All Analytes Greater Than Background Threshold Values at Non-AUM Target KE-01 (T33)

Analyte	XRF Soil Confirmation	In Situ XRF Measurements[1]	Final COPC Determination
Aluminum			
Antimony			
Arsenic			
Barium			
Beryllium			
Cadmium			
Calcium			
Chromium	✓		✓
Cobalt			
Copper			
Iron			
Lead			
Lithium			
Magnesium			
Manganese			
Molybdenum		✓	✓
Nickel			
Potassium-40			
Radium-226			
Radium-228			
Selenium			
Silver			
Sodium	✓		✓
Thallium			
Thorium			
Uranium			
Vanadium		✓	✓
Zinc		✓	✓

Notes:
[1] In situ measurements were converted to laboratory equivalent values; this only applied to nine analytes (arsenic, iron, lead, manganese, molybdenum, thorium, uranium, vanadium, and zinc).
COPC Contaminant of potential concern
XRF X-ray fluorescence

11.1.7 Primary Contaminant Mapping

11.1.7.1 Overview

A total of 29 analytes were evaluated for this investigation, not including gamma radiation. These analytes include 26 metals and the radionuclides K-40, Ra-226, and Ra-228, each with its own applied BTV determined through a background investigation. Section 11.1.6.2 identified the COPCs at Target T33. Because of the large number of analytes evaluated as part of this study with concentrations above background, the analytes were categorized as either primary or secondary. Primary analytes were identified as being typically associated with uranium-vanadium mining activities and generally more hazardous to human health and the environment than secondary analytes. The primary analytes are:

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

Of these eight primary analytes, only XRF results for five analytes could be quantitatively correlated to laboratory results, which are:

- Arsenic
- Lead
- Thorium
- Uranium
- Vanadium

Ra-226 is also considered a primary analyte but cannot be evaluated by XRF analysis. Gamma correlation is typically used to identify the distribution of Ra-226. The distribution of gamma radiation and Ra-226 analytical laboratory results are presented in Section 11.1.5. XRF confirmation results are also shown on contaminant mapping in the following sections; however, the number of these samples alone is not adequate to document contaminant distribution.

K-40, Ra-228, and 21 metals not listed above are considered secondary analytes; all analytes that were selected as COPCs are shown in Table I33-7. The primary reason for differentiating between primary and secondary analytes are for contaminant mapping purposes. All COPCs (primary and secondary) identified for Target T33 will be considered in a screening level risk assessment as part of the EE/CA. Primary analytes are likely to be risk drivers, and the maps provided in this section are focused only on these contaminants. The results for all primary analytes are presented regardless of whether the concentrations exceed applied BTVs.

A discussion and map of individual surface XRF measurements and XRF confirmation sample results are presented for each primary analyte in Section 11.1.7.1 through Section 11.1.7.6. The data presented in these maps and elsewhere are used to help define the lateral extent of contamination at Target T33. The soil contaminant maps present each sample type as a different shape (that is, triangle or diamond), and each point is color coded based on its relationship to the applied BTV for the analyte. Any point that is blue or green is below the applied BTV for a metal, and any color that is yellow, orange, red, burgundy, or purple is above the applied BTV. The color codes are associated with how many times the value is above the BTV (that is, blue is

below the mean of the background; green is above the mean but below 1 times BTV; yellow represents 1 to 2 times BTV; orange represents 2 to 3 times BTV; red represents 3 to 4 times BTV; burgundy represents 4 to 10 times BTV; and purple represents ≥10 times BTV). Any point with a gray color indicates a nondetect result for that sample. For the sample locations shown on these maps where an XRF confirmation soil sample and an in situ XRF measurement were collected, both soil sample results are provided.

11.1.7.2 Arsenic

Arsenic was identified as a COPC in surface soils as shown in Table I33-7. Arsenic did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for arsenic is 68 mg/kg for Target T33 as presented in Section 11.1.4. The analytical results for arsenic for XRF confirmation and in situ field XRF measurements are provided in Table I33-5 and Attachment I3, respectively. Figure I33-12 presents an individual value plot of detectable arsenic XRF soil concentrations for Target T33 and BSA-32 (Jste) samples. Figure I33-13 presents a box plot of detectable arsenic XRF soil concentrations for Target T33 and BSA-32 (Jste) samples. Summary statistics for XRF measurements are provided in Section 11.1.6.1. Arsenic XRF concentrations measured in surface soils at Target T33 ranged between 3.3 and 32.5 mg/kg with an average and standard deviation of 14.9 mg/kg and 10.9 mg/kg, respectively. The average arsenic XRF concentration is above the applied BTV.

A soil contaminant map showing the individual arsenic concentrations observed at Target T33 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I33-14. All arsenic results in surface soils were less than the applied BTV.

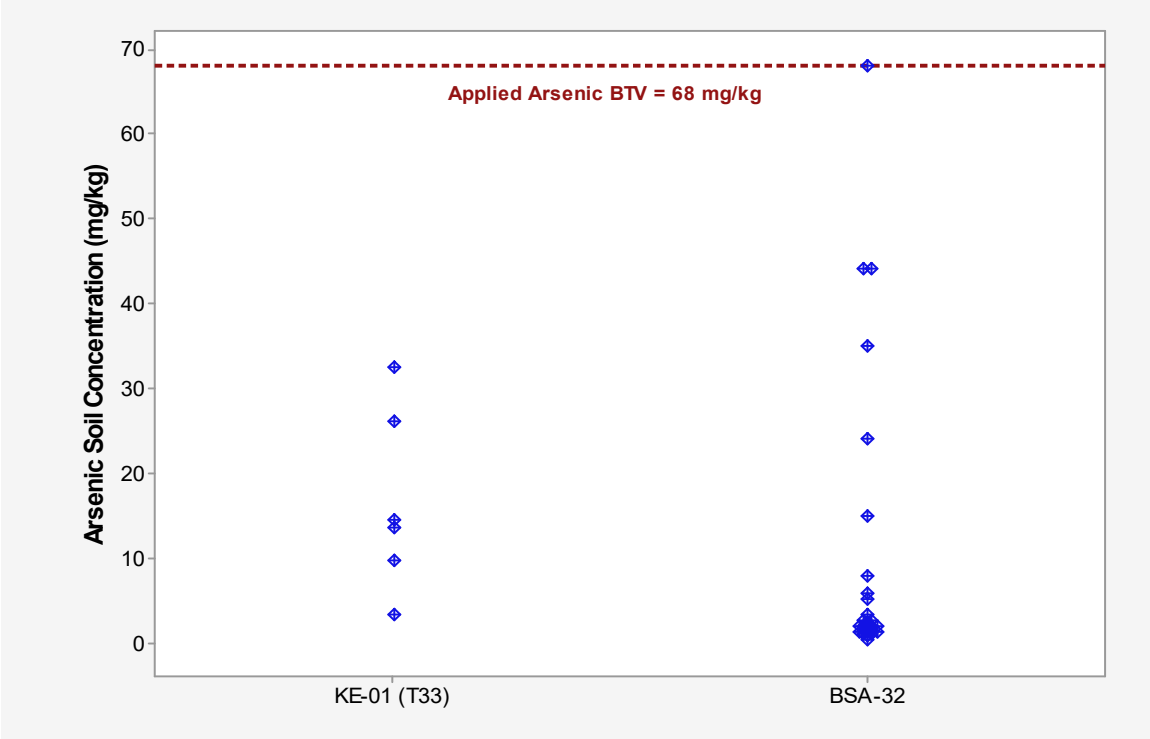


Figure I33-12. Individual Value Plot for Target KE-01 (T33) and BSA-32 (Jste) Arsenic Soil Concentrations

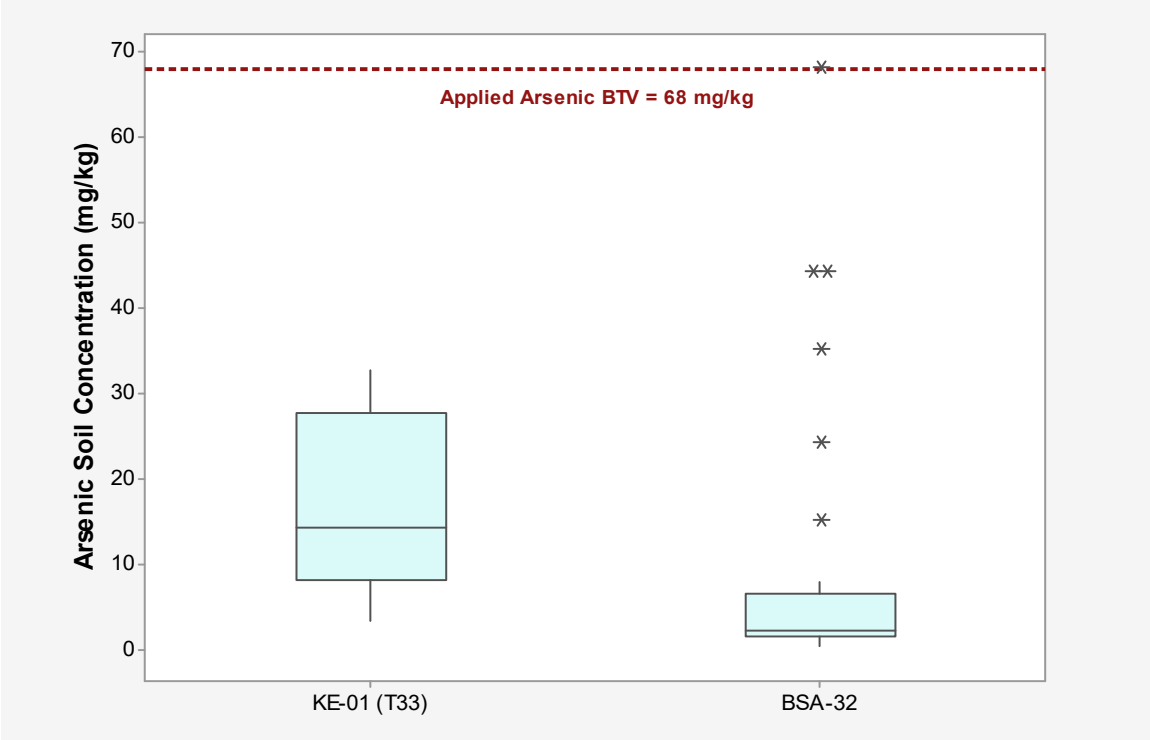
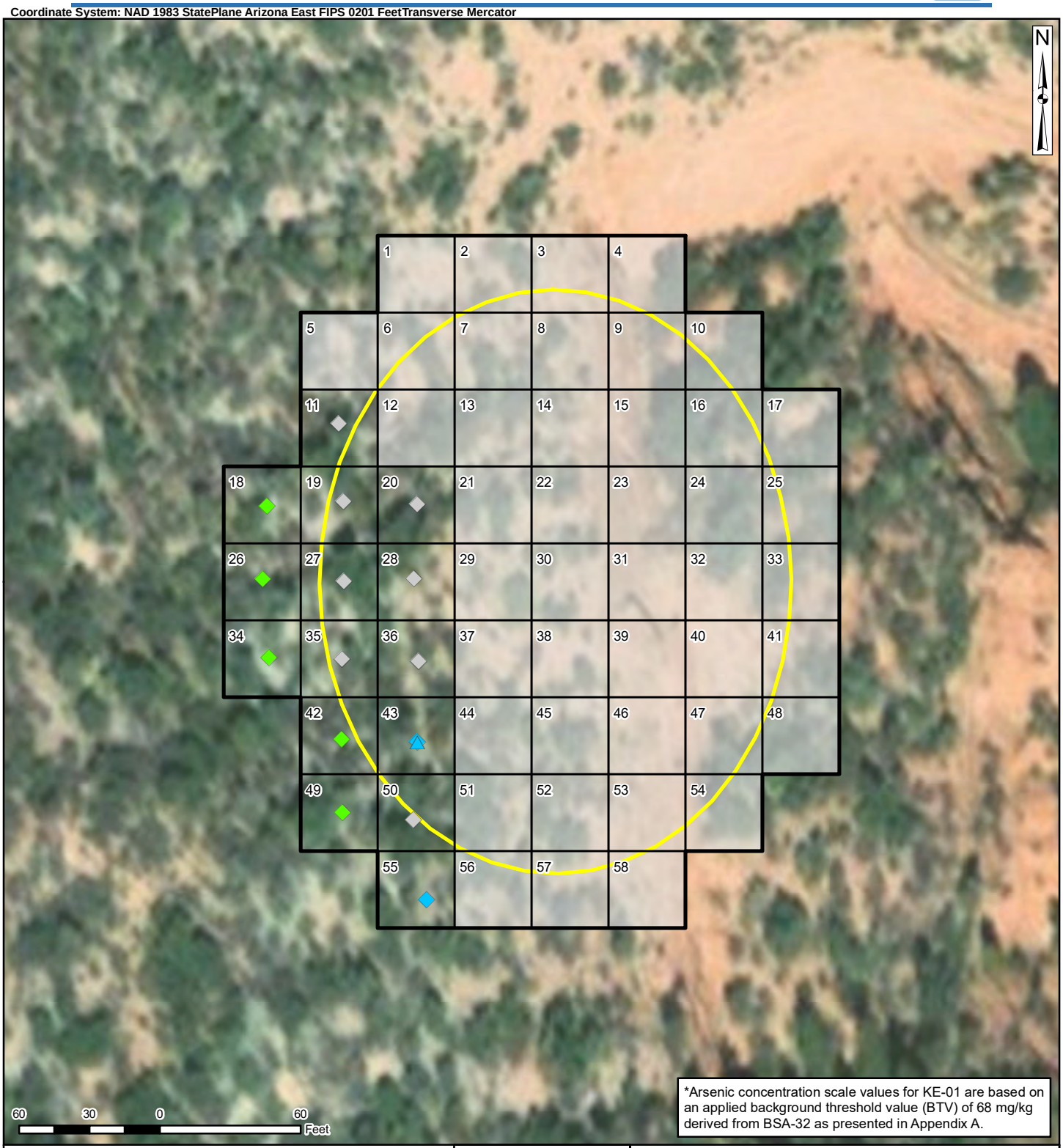


Figure I33-13. Box Plot for Target KE-01 (T33) and BSA-32 (Jste) Arsenic Soil Concentrations

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



*Arsenic concentration scale values for KE-01 are based on an applied background threshold value (BTV) of 68 mg/kg derived from BSA-32 as presented in Appendix A.

Arsenic Concentration Scale (mg/kg)*

- ≤ 9.5
- 9.5 - 68
- 68 - 136
- 136 - 204
- 204 - 272
- 272 - 680
- ≥ 680
- Non-Detect - Less Than Limit of Detection

Arsenic Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Inaccessible

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NON-AUM TARGET KE-01 (T33) SURFACE SOIL ARSENIC CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
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Location: LUKACHUKAI CHAPTER NAVAJO NATION	Date: 7/9/2019	

11.1.7.3 Lead

Lead was not identified as a COPC in surface soil as shown in Table I33-7. Lead did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for lead is 14 mg/kg for Target T33 as presented in Section 11.1.4. The analytical results for lead for XRF confirmation and in situ field XRF measurements are provided in Table I33-5 and Attachment I3, respectively. Figure I33-15 presents an individual value plot of detectable lead XRF soil concentrations for Target T33 and BSA-32 (Jste) samples. Figure I33-16 presents a box plot of detectable lead XRF soil concentrations for Target T33 and BSA-32 (Jste) samples. Summary statistics for XRF measurements are provided in Section 11.1.6.1. Lead XRF concentrations measured in surface soils at Target T33 ranged between 1.1 and 8.2 mg/kg with an average and standard deviation of 5.0 mg/kg and 2.3 mg/kg, respectively. The average lead XRF concentration is below the applied BTV.

A soil contaminant map showing the individual lead concentrations observed at Target T33 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I33-17. All lead results in surface soils were less than the applied BTV.

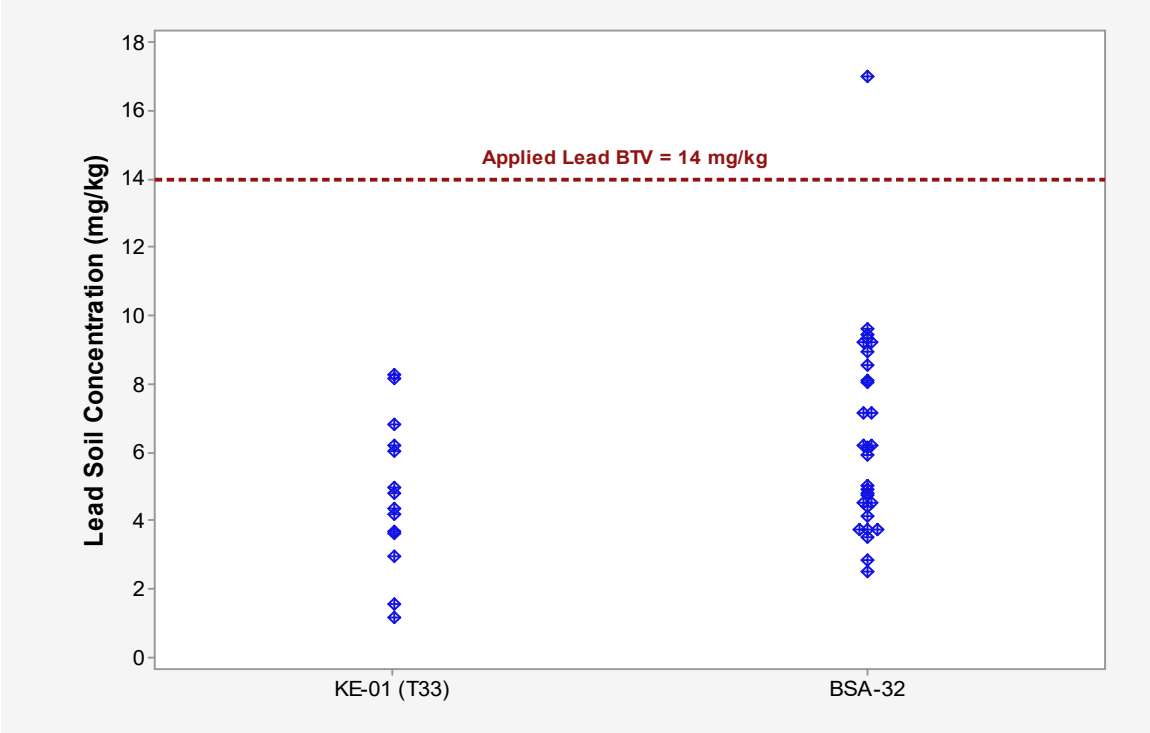


Figure I33-15. Individual Value Plot for Target KE-01 (T33) and BSA-32 (Jste) Lead Soil Concentrations

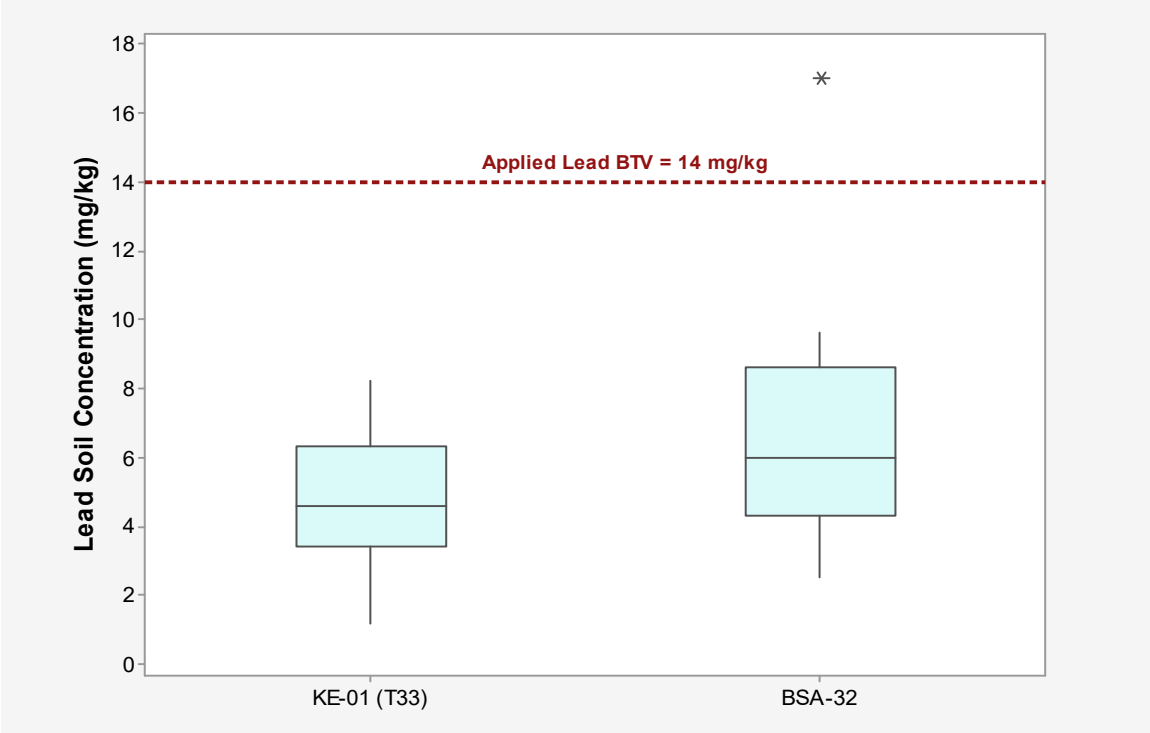
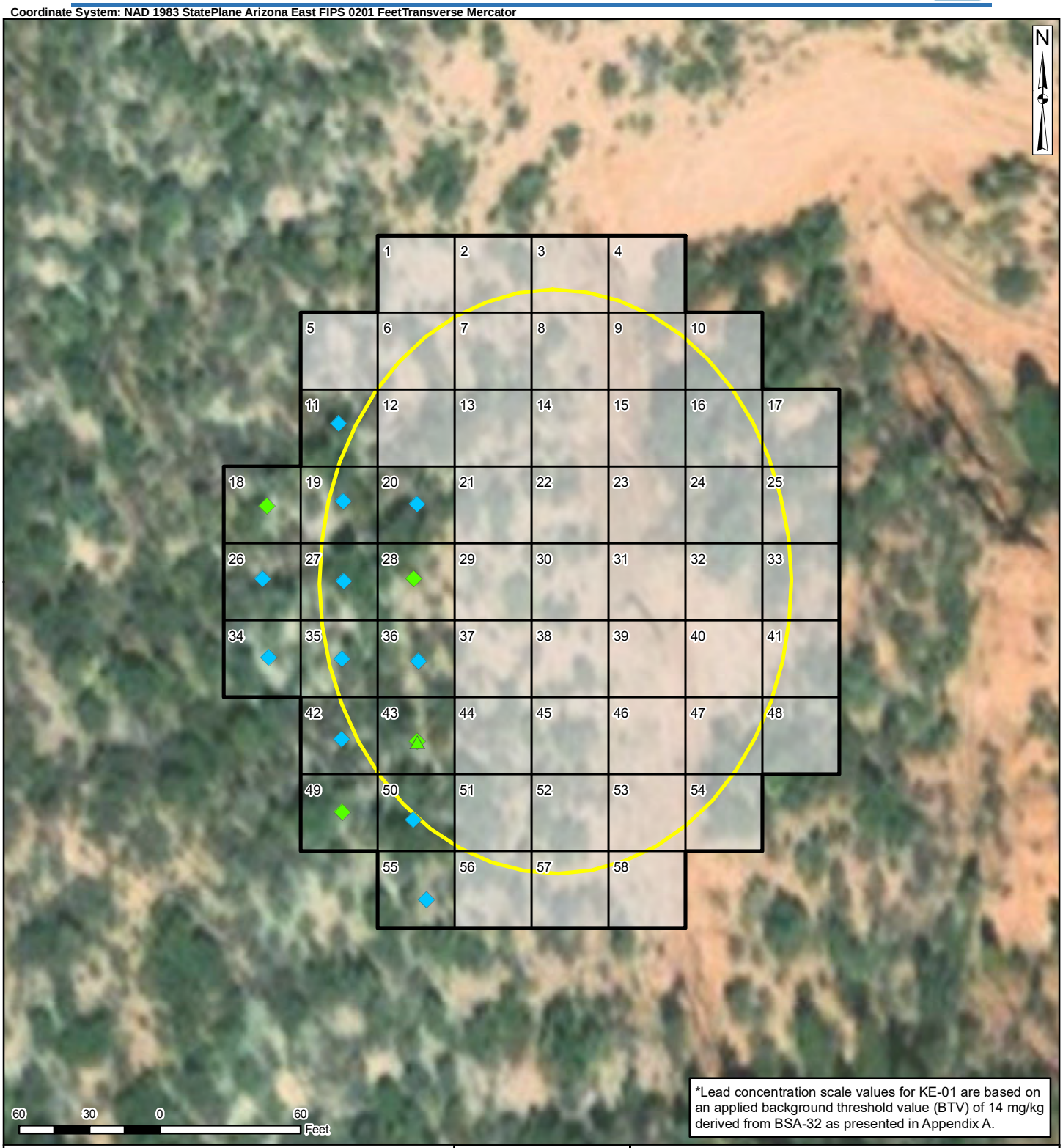


Figure I33-16. Box Plot for Target KE-01 (T33) and BSA-32 (Jste) Lead Soil Concentrations

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



*Lead concentration scale values for KE-01 are based on an applied background threshold value (BTV) of 14 mg/kg derived from BSA-32 as presented in Appendix A.

Lead Concentration Scale (mg/kg)*

- ≤ 6.4
- 6.4 - 14
- 14 - 28
- 28 - 42
- 42 - 56
- 56 - 140
- ≥ 140

Lead Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Inaccessible

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NON-AUM TARGET KE-01 (T33) SURFACE SOIL LEAD CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
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Location: LUKACHUKAI CHAPTER NAVAJO NATION	Date: 7/9/2019	

11.1.7.4 Thorium

Thorium was identified as a COPC in surface soil as shown in Table I33-7. Thorium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for thorium is 5.9 mg/kg for Target T33 as presented in Section 11.1.4. The analytical results for thorium for XRF confirmation and in situ field XRF measurements are provided in Table I33-5 and Attachment I3, respectively. Figure I33-18 presents an individual value plot of detectable thorium XRF soil concentrations for Target T33 and BSA-32 (Jste) samples. Figure I33-19 presents a box plot of detectable thorium XRF soil concentrations for Target T33 and BSA-32 (Jste) samples. Summary statistics for XRF measurements are provided in Section 11.1.6.1. Thorium XRF concentrations measured in surface soils at Target T33 ranged between 1.1 and 4.2 mg/kg with an average and standard deviation of 2.4 mg/kg and 0.8 mg/kg, respectively. The average thorium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual thorium concentrations observed at Target T33 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I33-20. All thorium results in surface soils were less than the applied BTV.

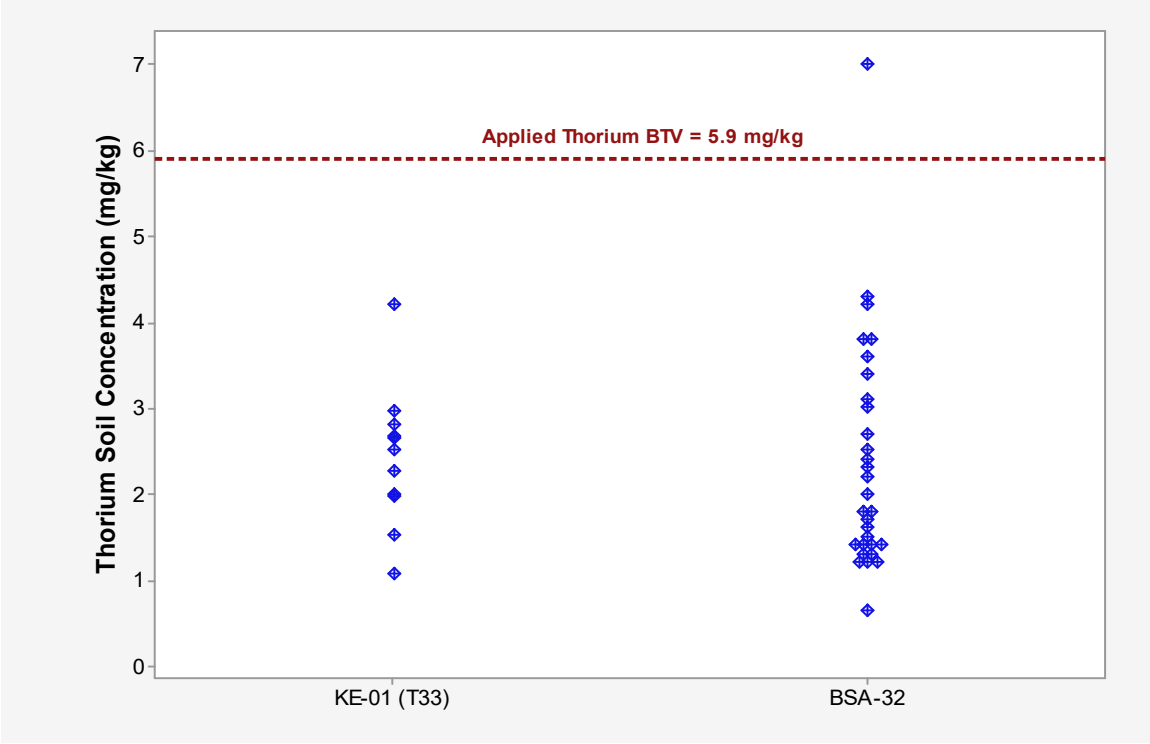


Figure I33-18. Individual Value Plot for Target KE-01 (T33) and BSA-32 (Jste) Thorium Soil Concentrations

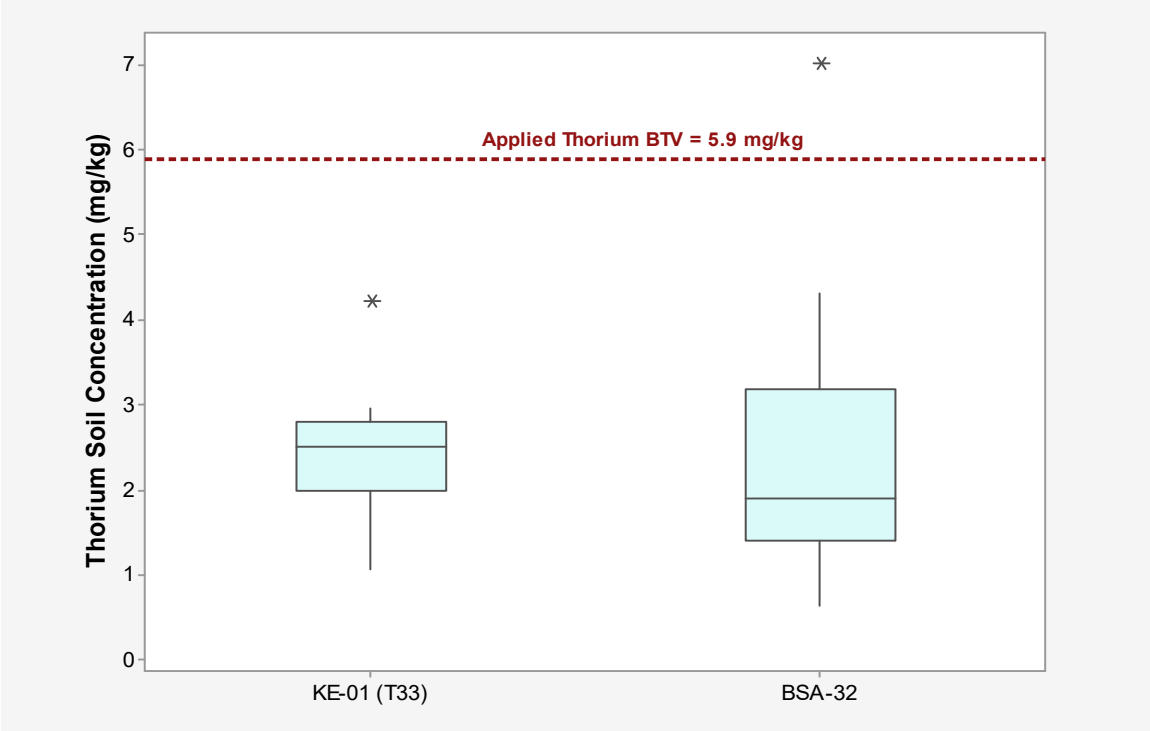
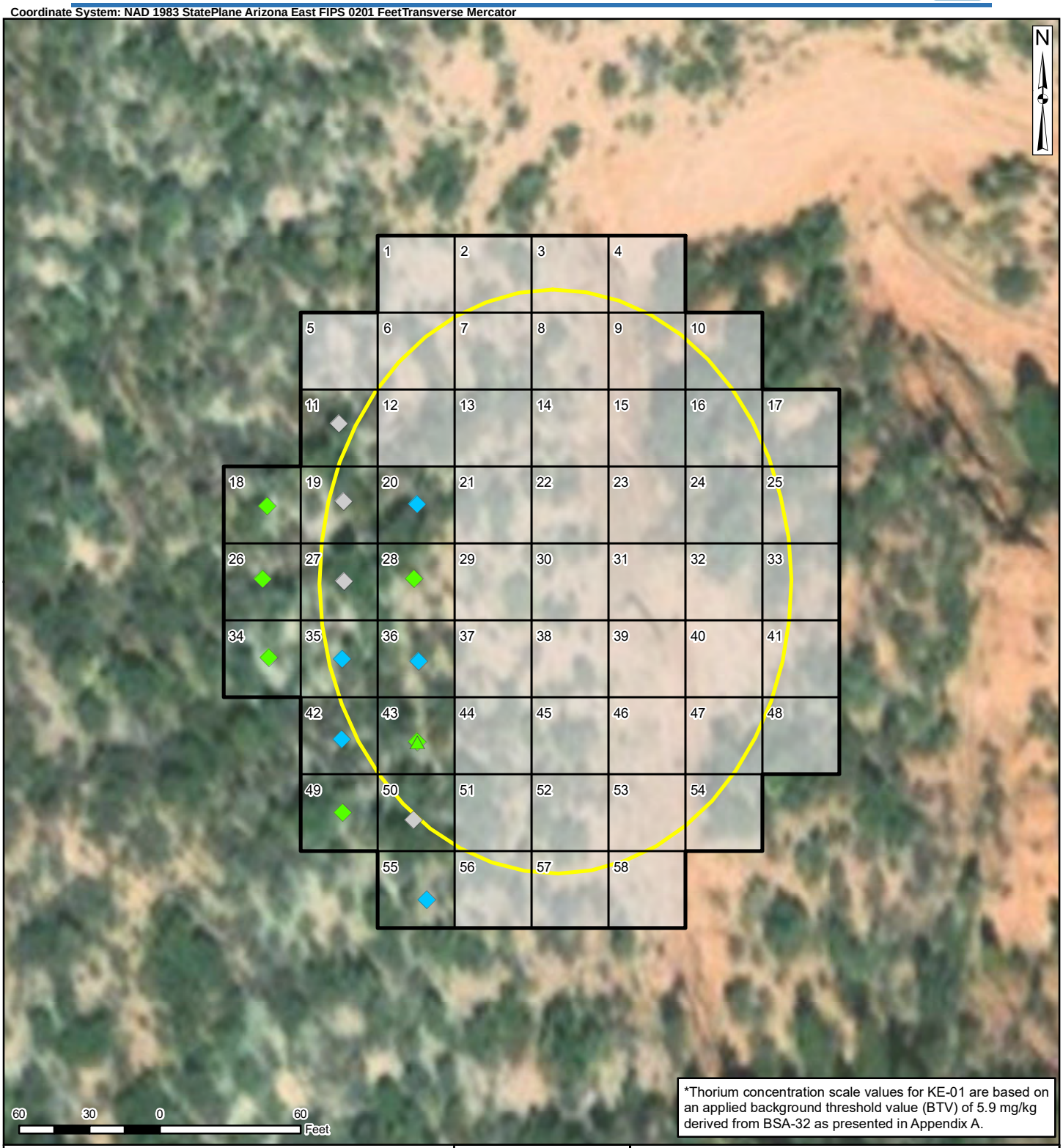


Figure I33-19. Box Plot for Target KE-01 (T33) and BSA-32 (Jste) Thorium Soil Concentrations

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



*Thorium concentration scale values for KE-01 are based on an applied background threshold value (BTV) of 5.9 mg/kg derived from BSA-32 as presented in Appendix A.

Thorium Concentration Scale (mg/kg)*

- ≤ 2.4
- 2.4 - 5.9
- 5.9 - 12
- 12 - 18
- 18 - 24
- 24 - 59
- ≥ 59
- Non-Detect - Less Than Limit of Detection

Thorium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Inaccessible

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NON-AUM TARGET KE-01 (T33) SURFACE SOIL THORIUM CONCENTRATION MAP

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Location: LUKACHUKAI CHAPTER NAVAJO NATION	Date: 7/9/2019	

11.1.7.5 Uranium

Uranium was identified as a COPC in surface soil as shown in Table I33-7. Uranium did not exceed the applied BTV for in situ XRF measurements or XRF confirmation sampling scenarios. The applied BTV for uranium is 21 mg/kg for Target T33 as presented in Section 11.1.4. The analytical results for uranium for XRF confirmation and in situ field XRF measurements are provided in Table I33-5 and Attachment I3, respectively. Figure I33-21 presents an individual value plot of detectable uranium XRF soil concentrations for Target T33 and BSA-32 (Jste) samples. Figure I33-22 presents a box plot of detectable uranium XRF soil concentrations for Target T33 and BSA-32 (Jste) samples. Summary statistics for XRF measurements are provided in Section 11.1.6.1. Uranium concentrations measured in surface soils at Target T33 ranged between 1.5 and 8.7 mg/kg with an average and standard deviation of 4.7 mg/kg and 2.7 mg/kg, respectively. The average uranium concentration is above the applied BTV.

A soil contaminant map showing the individual uranium concentrations observed at Target T33 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I33-23. All uranium results in surface soils were less than the applied BTV.

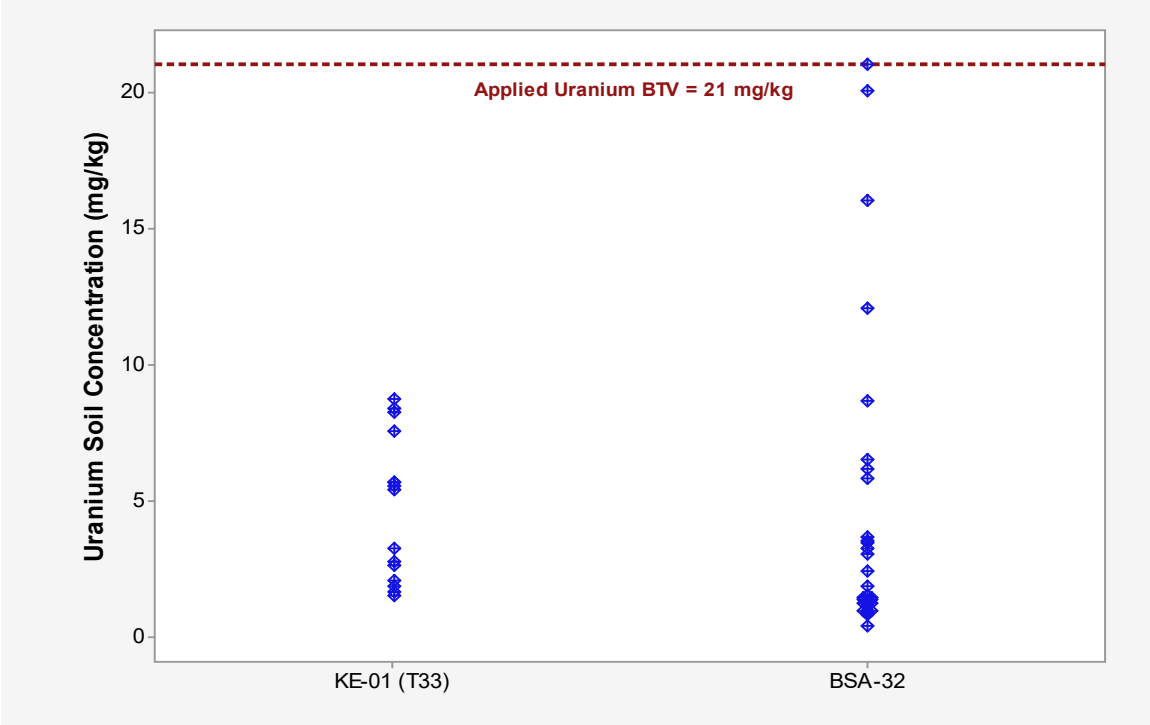


Figure I33-21. Individual Value Plot for Target KE-01 (T33) and BSA-32 (Jste) Uranium Soil Concentrations

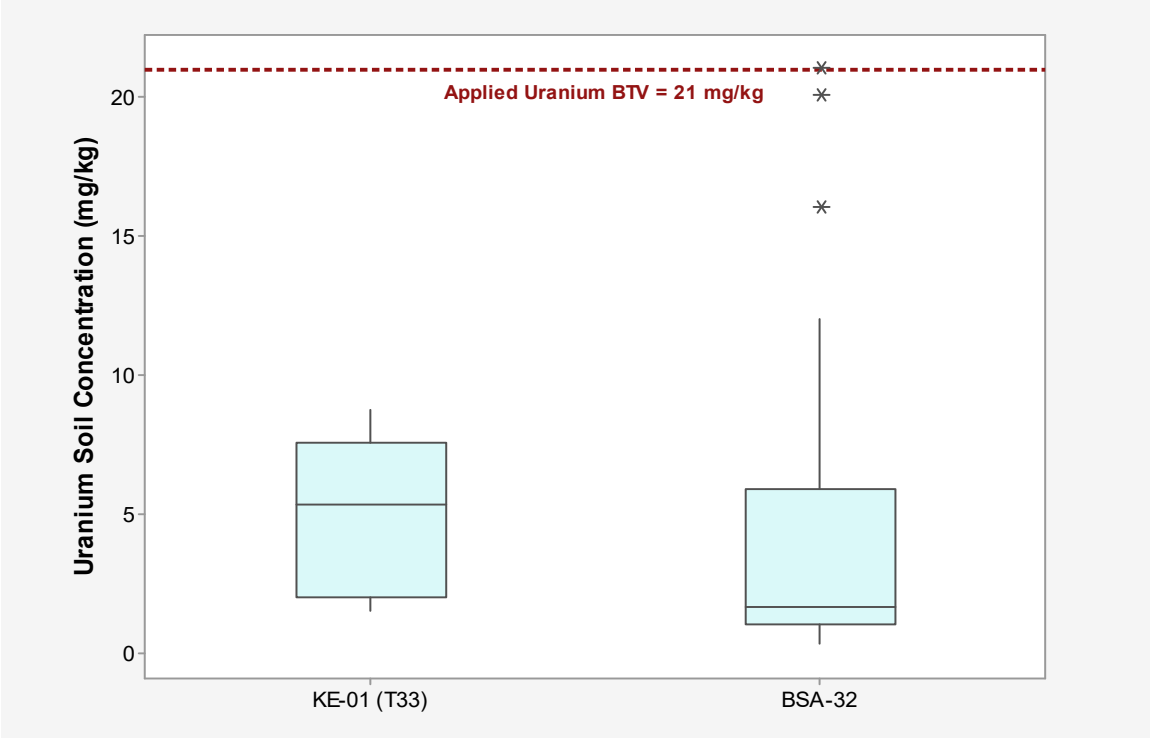
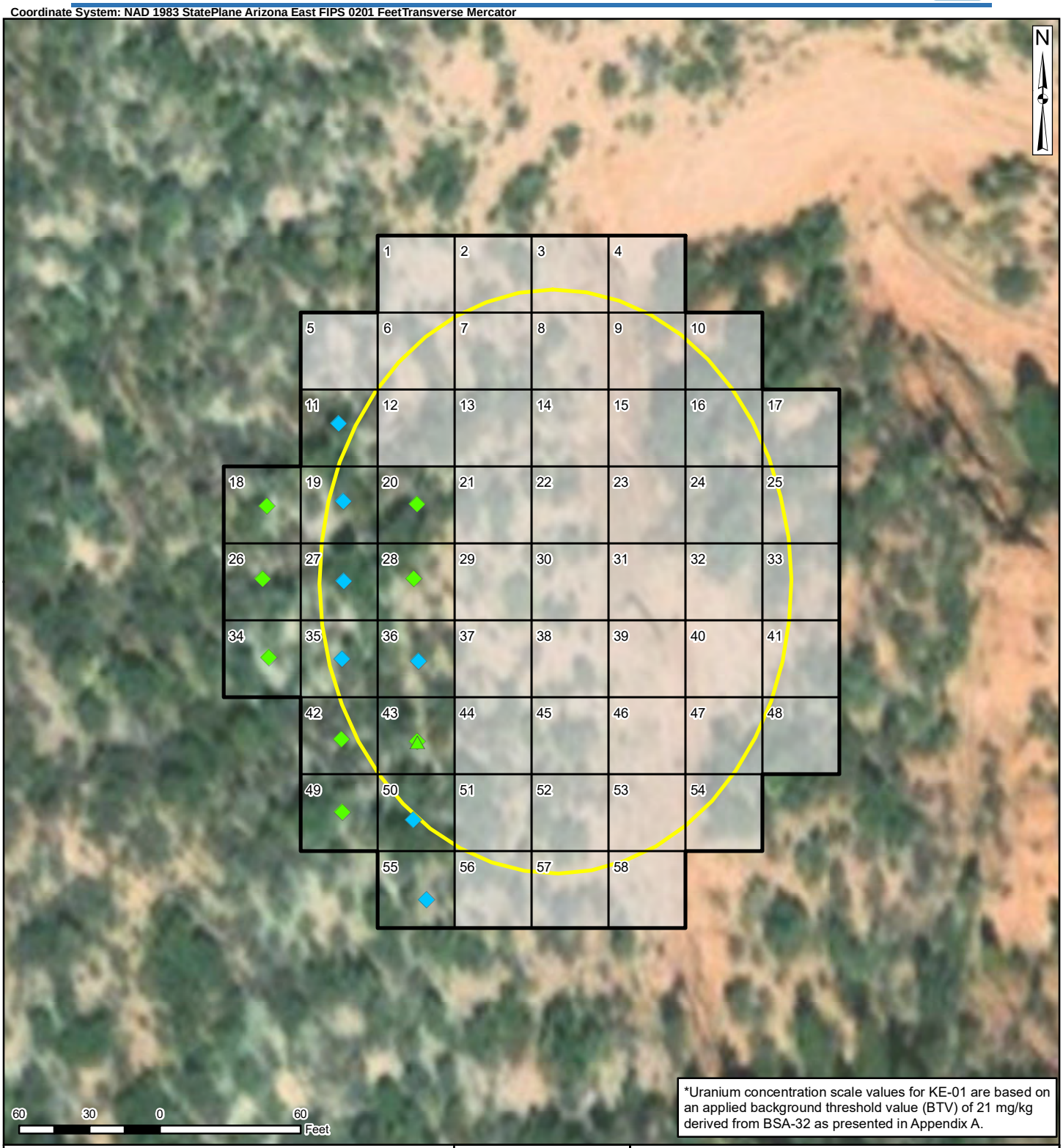


Figure I33-22. Box Plot for Target KE-01 (T33) and BSA-32 (Jste) Uranium Soil Concentrations

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



*Uranium concentration scale values for KE-01 are based on an applied background threshold value (BTV) of 21 mg/kg derived from BSA-32 as presented in Appendix A.

Uranium Concentration Scale (mg/kg)*

- ≤ 4.4
- 4.4 - 21
- 21 - 42
- 42 - 63
- 63 - 84
- 84 - 210
- ≥ 210

Uranium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Inaccessible

Prepared for: USEPA Region 9

Prepared By:

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NON-AUM TARGET KE-01 (T33) SURFACE SOIL URANIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I33-23
Location: LUKACHUKAI CHAPTER NAVAJO NATION	Date: 7/9/2019	

11.1.7.6 Vanadium

Vanadium was identified as a COPC in surface soils as shown in Table I33-7. Vanadium exceeded the applied BTV in 6.7 percent of in situ XRF measurements but not in the XRF confirmation sample. The applied BTV for vanadium is 42 mg/kg for Target T33 as presented in Section 11.1.4. The analytical results for vanadium for XRF confirmation and in situ field XRF measurements are provided in Table I33-5 and Attachment I3, respectively. Figure I33-24 presents an individual value plot of detectable vanadium soil concentrations for Target T33 and BSA-32 (Jste) samples. Figure I33-25 presents a box plot of detectable vanadium XRF soil concentrations for Target T33 and BSA-32 (Jste) samples. Summary statistics for XRF measurements are provided in Section 11.1.6.1. Vanadium XRF concentrations measured in surface soils at Target T33 ranged between 20.9 and 45.9 mg/kg with an average and standard deviation of 29.7 mg/kg and 8.0 mg/kg, respectively. The average vanadium XRF concentration is below the applied BTV.

A soil contaminant map showing the individual vanadium concentrations observed at Target T33 from the different sample types (that is, in situ XRF measurements and XRF confirmation samples) is provided in Figure I33-26. Overall, the majority of detectable vanadium results in surface soils were below the applied BTV. However, the one exceedance was not significantly higher than the applied BTV and do not appear to be associated with mining-related materials Target T33.

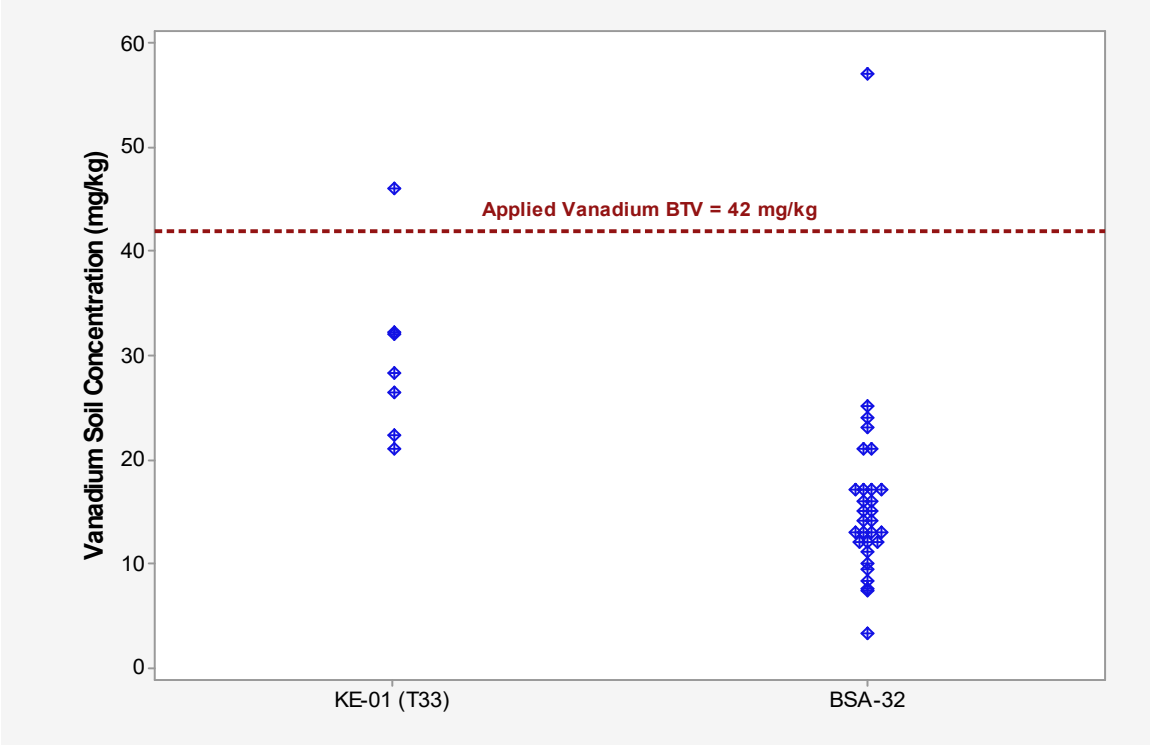


Figure I33-24. Individual Value Plot for Target KE-01 (T33) and BSA-32 (Jste) Vanadium Soil Concentrations

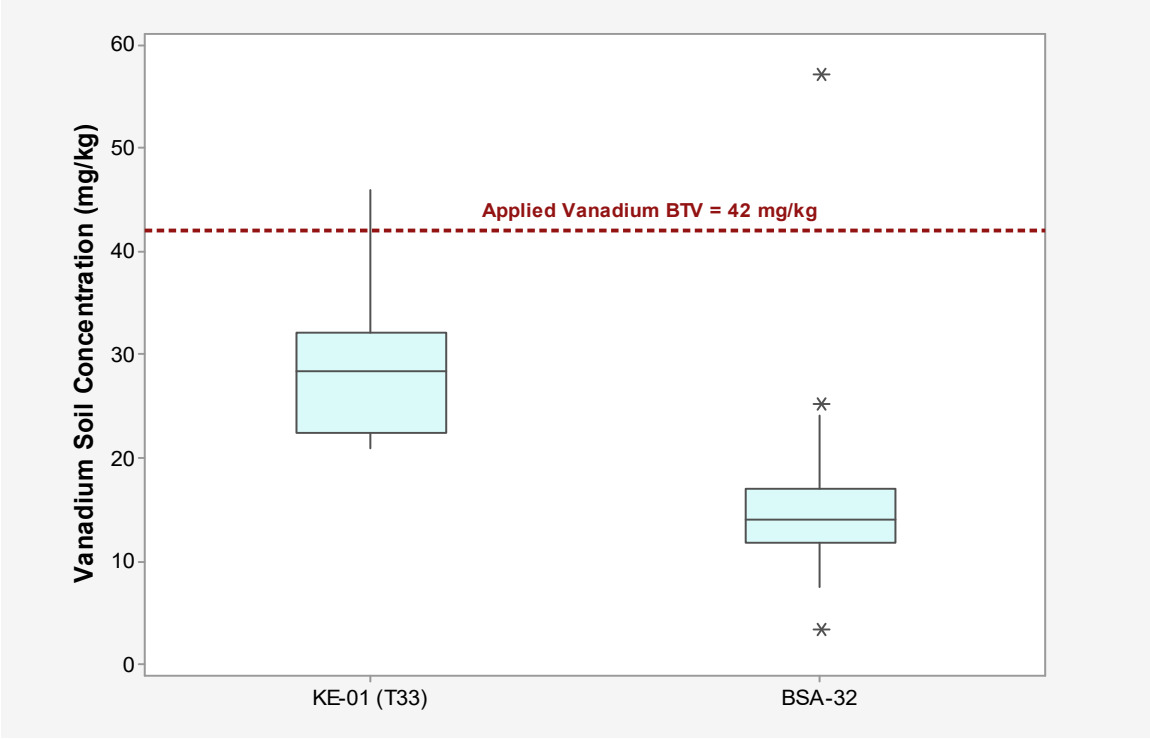
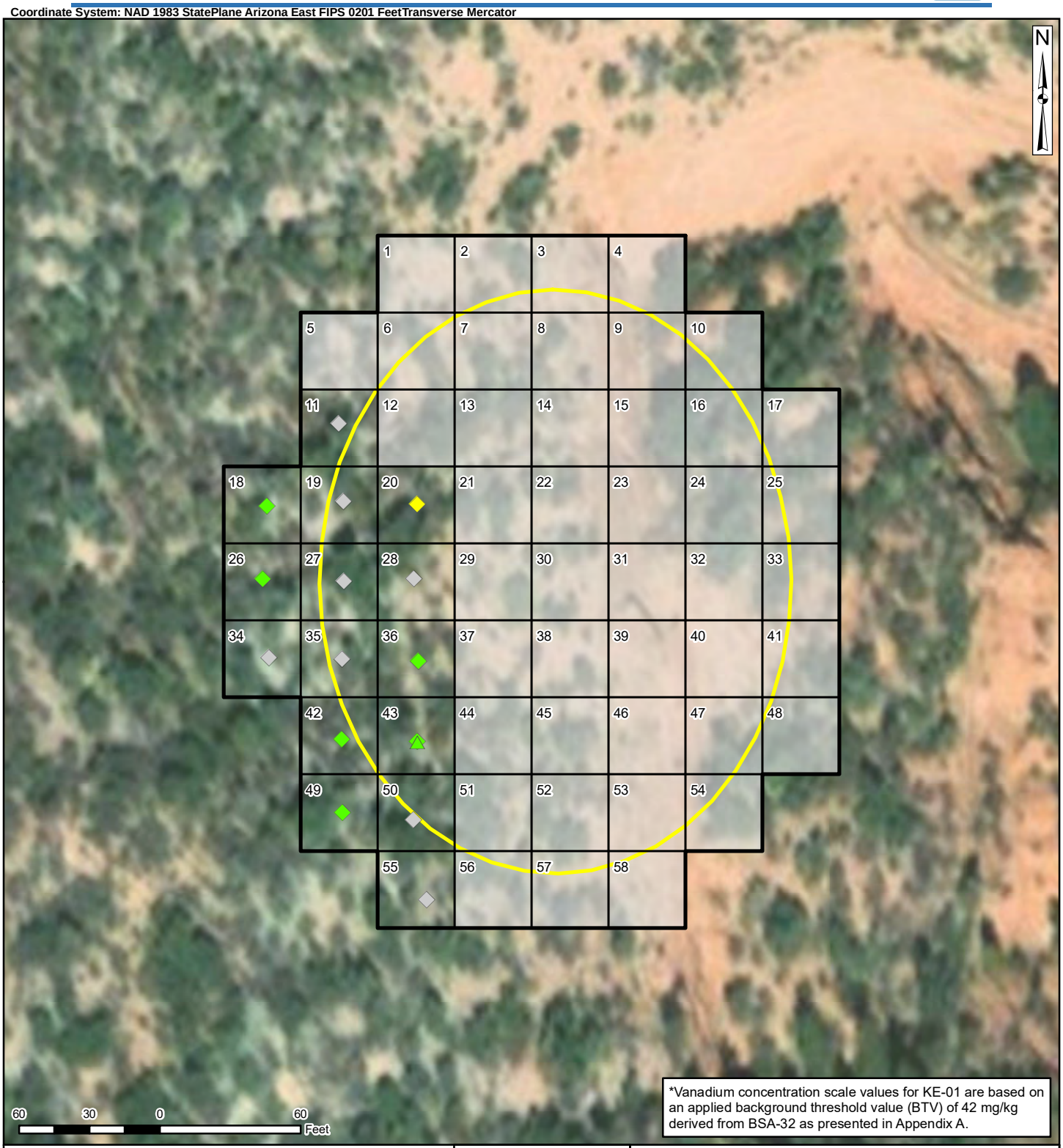


Figure I33-25. Box Plot for Target KE-01 (T33) and BSA-32 (Jste) Vanadium Soil Concentrations

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



*Vanadium concentration scale values for KE-01 are based on an applied background threshold value (BTV) of 42 mg/kg derived from BSA-32 as presented in Appendix A.

Vanadium Concentration Scale (mg/kg)*

- ≤ 16
- 16 - 42
- 42 - 84
- 84 - 126
- 126 - 168
- 168 - 420
- ≥ 420
- Non-Detect - Less Than Limit of Detection

Vanadium Concentration Value Source

- In Situ XRF Measurement
- XRF Confirmation Soil Sample
- Non-AUM Target Site Boundary
- Survey Unit (100 m²)
- Survey Area Boundary
- Inaccessible

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NON-AUM TARGET KE-01 (T33)
SURFACE SOIL
VANADIUM CONCENTRATION MAP

Task Order No.:	Contract No.:	Figure No.:
TO0001	EP-S9-17-03	I33-26
Location: LUKACHUKAI CHAPTER NAVAJO NATION	Date: 7/9/2019	

11.1.8 Conclusions

Target T33 (KE-01) underwent an RSE investigation during the 2018 field season by Tetra Tech. There were several field mobilizations as part of the Baseline Study. A background study and comprehensive gamma radiation and XRF surveys were performed at Target T33. Similarly, many soil samples were collected from surface soils and analyzed for metals and radionuclides. The conclusions from the RSE investigation at Target T33 are:

- Potential mining-related sources of gamma radiation identified in ASPECT gamma survey were evaluated at Target T33. ASPECT gamma survey results generally correlated with 2018 RSE investigation gamma survey results. A waste pile was observed during the RSE investigation.
- The lateral extent of elevated radiological activity at Target T33 was documented through gamma radiation surveys, and the extent of metals above the applied BTV levels has been characterized except for the area near the edge of the cliff; the bench below was not accessed. The survey area was not extended because safety concerns. Ra-226 in XRF confirmation samples did not exceed the applied BTV. Ra-226 concentrations may be predicted using gamma correlation from AUMs in similar geology.
- Gamma survey coverage is sufficient to establish a basis from which subsurface soils can be further investigated if required. No mining-related features were identified requiring additional subsurface sampling.
- Site-specific BTVs for Target T33 geology and soil types were established through a background study.
- Mean raw gamma measurements did not exceed the applied BTV. No grid averaged gamma measurements exceeded the applied BTV.
- A total of 26 analytes were identified as occurring within the surface environment. Of these analytes, 5 were identified as COPCs. No COPCs exceeded the applied BTV by a factor greater than 2.
- A potential waste pile was identified in survey unit 34 at Target T33, which is likely TENORM. The source of the potential waste pile was not evident, but because of the small size (25 square feet), there may have been a prospect. No other mining-related activities or features were observed in the field, and no historical exploratory borings, vents, or other mine openings were noted in the file review or during field observation. Outcropping of NORM was observed but not verified by gamma survey.
- Natural erosion of outcroppings may have increased the lateral extent of NORM.
- There are no immediate significant physical hazards other than dangerous cliffs present at Target T33.
- Access is by dirt road with a small four-wheel-drive vehicle followed by footpath.
- No open or reclaimed mine portals were identified in historic records or observed during field activities.

- No existing groundwater wells are documented within the vicinity of Target T33. No seeps or springs were observed during the RSE investigation.
- Potential leachability of metals and radionuclides was not addressed as part of the Baseline Study. A potential waste pile was observed at Target T33. Therefore, evaluation of the leachability of metals and radionuclides may be required.
- Evaluation of leachable metals for potential disposal of the waste pile in a permitted landfill or a low-level radioactive waste disposal facility may be required.

In general, the RSE investigation was successful at fulfilling the DQOs identified in Section 1.3; however, a few data gaps remain for Target T33. The remaining data gaps are to collect a sample from the waste pile in survey unit 34, attempt to locate the prospect or collapsed/hidden adit, and potentially evaluate waste on the bench below if safely accessible. Data gaps will likely remain for extremely treacherous inaccessible areas that could not be surveyed during the RSE investigation.

12.0 REFERENCES

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ATTACHMENT I1

PHOTOGRAPHIC LOG

TARGET T1 (BR-01)

PHOTOGRAPHIC LOG

Target T1 (BR-01)
Photographic Log

The following photos were taken during the BR-01 (T1) visit to the Cove Chapter of the Navajo Nation on August 19, 2018.



PHOTOGRAPH 1

Date/Time: 8/19/18

Location: Target T1

Direction: East

Description:
Photograph shows equipment within borrow area.



PHOTOGRAPH 2

Date/Time:
11/19/2018

Location: Target T1

Direction: East

Description:
Photograph shows field personnel mapping Target T1.

TARGET T3 (BR-03)

PHOTOGRAPHIC LOG

Target T3 (BR-03)
Photographic Log

The following photos were taken during the BR-03 (T3) visit to the Cove Chapter of the Navajo Nation on May 12, 2018.



PHOTOGRAPH 1

Date/Time:
5/12/2018

Location: Target T3

Direction: North

Description:
Overview of undisturbed target. No outcropping visible.

TARGET T4 (BR-04)

PHOTOGRAPHIC LOG

Target T4 (BR-04)
Photographic Log

The following photos were taken during the BR-04 (T4) visit to the Cove Chapter of the Navajo Nation on May 13, 2018, and August 19, 2018.



PHOTOGRAPH 1

Date/Time: 8/19/18

Location: Target T4

Direction: South

Description:
Panoramic view from Target looking toward Brodie 1 Mine.



PHOTOGRAPH 2

Date/Time: 8/19/18

Location: Target T4

Direction: West

Description:
Panoramic view from Target across Tse Tah west drainage.



PHOTOGRAPH 3

Date/Time: 8/19/18

Location: Target T4

Direction: Northwest

Description:
Panoramic view from Target of incised Tse Tah west drainage.



PHOTOGRAPH 4

Date/Time: 8/19/18

Location: Target T4

Direction: East

Description:
Personnel conducting gamma survey along outcropping.



PHOTOGRAPH 5

Date/Time: 5/13/18

Location: Target T4

Direction: North

Description:
Panoramic view from Target looking along edge of outcropping.



PHOTOGRAPH 6

Date/Time: 5/13/18

Location: Target T4

Direction: East

Description:
Migrating NORM in drainage below outcropping.



PHOTOGRAPH 7

Date/Time: 8/19/18

Location: Target T4

Direction: Southeast

Description: Downgradient in same drainage below outcropping



PHOTOGRAPH 8

Date/Time: 8/19/18

Location: Target T4

Direction: North

Description: Initial exposure of NORM outcrop on eastern side of Target.

TARGET T5 (BR-05)

PHOTOGRAPHIC LOG

Target T5 (BR-05)
Photographic Log

The following photos were taken during the BR-05 (T5) visit to the Cove Chapter of the Navajo Nation on May 12, 2018 and August 19, 2018.



PHOTOGRAPH 1

Date/Time:
5/12/2018

Location: Target T5

Direction: N/A

Description:
Location of highest gamma readings.



PHOTOGRAPH 2

Date/Time:
5/12/2018

Location: Target T5

Direction: West

Description:
Outcroppings of NORM on western portion of Target.



PHOTOGRAPH 3

Date/Time:
8/19/2018

Location: Target T5

Direction: North

Description: Field personnel taking XRF measurements at Target.

TARGET T6 (BR-06)

PHOTOGRAPHIC LOG

Target T6 (BR-06)
Photographic Log

The following photos were taken during the BR-06 (T6) visit to the Cove Chapter of the Navajo Nation on May 12, 2018.



PHOTOGRAPH 1

Date/Time:
5/12/2018

Location: Target T6

Direction: South

Description:
Western edge of mounded area, outcropping in distance.



PHOTOGRAPH 2

Date/Time:
5/12/2018

Location: Target T6

Direction: North-East

Description:
Mounded area on Target.



PHOTOGRAPH 3

Date/Time:
5/12/2018

Location: Target T6

Direction: East

Description: Eastern edge of mounded area. Note aeolian sands. Outcropping of rear.



PHOTOGRAPH 4

Date/Time:
5/12/2018

Location: Target T6

Direction: South-West

Description: West of mounded area, aeolian sands in foreground.



PHOTOGRAPH 5

Date/Time:
5/12/2018

Location: Target T6

Direction: North

Description:
Looking downslope toward Tse Tah west drainage.

TARGET T7 (BK-01)

PHOTOGRAPHIC LOG

Target T7 (BK-01)
Photographic Log

The following photos were taken during the BK-01 (T7) visit to the Cove Chapter of the Navajo Nation on August 19, 2018.



PHOTOGRAPH 1

Date/Time: 8/19/18

Location: Target T7

Direction: Northeast

Description: Land Surveying equipment



PHOTOGRAPH 2

Date/Time: 8/19/18

Location: Target T7

Direction: South

Description: Personnel conducting XRF measurements

TARGET T8 (BK-02)

PHOTOGRAPHIC LOG

Target T8 (BK-02)
Photographic Log

The following photos were taken during BK-02 (T8) visit to the Cove Chapter of the Navajo Nation on April 24, 2018.



PHOTOGRAPH 1

Date/Time:
4/24/2018

Location: Target T8

Direction: Southeast

Description:
Concrete debris and animal burrows adjacent to fence line.

TARGET T10 (CT-01)

PHOTOGRAPHIC LOG

Target T10 (CT-01)
Photographic Log

The following photos were taken during the CT-01 (T10) visit to the Cove Chapter of the Navajo Nation on September 25, 2018 and August 18, 2018.

PHOTOGRAPH 1



Date/Time: 9/25/18

Location: Target T10

Direction: South

Description: Field personnel gamma surveying the area



PHOTOGRAPH 2

Date/Time: 8/18/18

Location: Target T10

Direction: West

Description: Field personnel mapping soil sample location.

TARGET T11 (CT-02)

PHOTOGRAPHIC LOG

Target T11 (CT-02)
Photographic Log

The following photos were taken during the CT-02 (T11) visit to the Cove Chapter of the Navajo Nation on September 25, 2018.



PHOTOGRAPH 1

Date/Time: 9/25/18

Location: Target T11

Direction: Northeast

Description: Field personnel gamma surveying the area

TARGET T12 (CT-03)

PHOTOGRAPHIC LOG (No Field Photographs Available)

TARGET T13 (M1-01)

PHOTOGRAPHIC LOG (No Field Photographs Available)

TARGET T14 (M1-02)

PHOTOGRAPHIC LOG

Target T14 (M1-02)
Photographic Log

The following photos were taken during the M1-02 (T14) visit to the Cove Chapter of the Navajo Nation on May 8, 2018.



PHOTOGRAPH 1

Date/Time: 5/8/2018

Location: Target T14

Direction: South-West

Description: Panoramic view from Target looking toward Mesa I, Mine 14.



PHOTOGRAPH 2

Date/Time: 5/8/2018

Location: Target T14

Direction: East

Description: Looking upslope toward road in tree line.



PHOTOGRAPH 3

Date/Time: 5/8/2018

Location: Target T14

Direction: N/A

Description: NORM outcropping at Target.



PHOTOGRAPH 4

Date/Time: 5/8/2018

Location: Target T14

Direction: N/A

Description: Closeup of NORM with Mesa Tablet.

TARGET T15 (M1-03)

PHOTOGRAPHIC LOG (No Field Photographs Available)

TARGET T18 (M5-01)

PHOTOGRAPHIC LOG

Target T18 (M5-01)
Photographic Log

The following photos were taken during the M5-01 (T18) visit to the Cove Chapter of the Navajo Nation on May 24, 2018.



PHOTOGRAPH 1

Date/Time: 5/24/2018

Location: Target T18

Direction: North

Description: Outcropping at Target



PHOTOGRAPH 2

Date/Time: 5/24/2018

Location: Target T18

Direction: North

Description: Outcropping at Target



PHOTOGRAPH 3

Date/Time:
5/24/2018

Location: Target T18

Direction: Southeast

Description:
Looking at ephemeral drainage at Target.



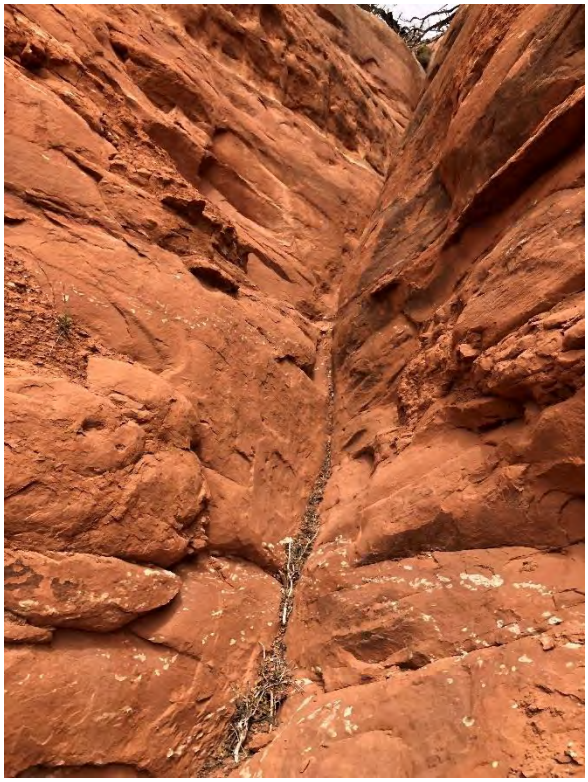
PHOTOGRAPH 4

Date/Time:
5/24/2018

Location: Target T18

Direction: East

Description: View of drainage bisecting target from below



PHOTOGRAPH 5

Date/Time:
5/24/2018

Location: Target T18

Direction: N/A

Description:
Closeup of slot drainage down cliff face.



PHOTOGRAPH 6

Date/Time:
5/24/2018

Location: Target T18

Direction:
Northwest

Description: Field personnel mapping.

TARGET T19 (M5-02)

PHOTOGRAPHIC LOG (No Field Photographs Available)

TARGET T20 (M5-03)

PHOTOGRAPHIC LOG

Target T20 (M5-03)
Photographic Log

The following photos were taken during M5-03 (T20) visit to the Cove Chapter of the Navajo Nation on April 15, 2019.



PHOTOGRAPH 1

Date/Time:04/15/2019 13:27

Location: Target T20

Direction: Northwest

Description: Access from Mesa V road



PHOTOGRAPH 2

Date/Time:04/15/2019 13:22

Location: Target T20

Direction: Northeast

Description: Grid 4 northern survey boundary



PHOTOGRAPH 3

Date/Time:04/15/2019 13:23

Location: Target T20

Direction: Southwest

Description: Grid 8 overview



PHOTOGRAPH 4

Date/Time:04/15/2019 13:21

Location: Target T20

Direction: Southwest

Description: Grid 8 hot spot with yellow rock



PHOTOGRAPH 5

Date/Time:04/15/2019 13:27

Location: Target T20

Direction: South

Description: Grid 14

TARGET T21 (M5-05)

PHOTOGRAPHIC LOG

Target T21 (M5-05)
Photographic Log

The following photos were taken during the M5-05 (T21) visit to the Cove Chapter of the Navajo Nation on September 11, 2018.



PHOTOGRAPH 1

Date/Time: 9/11/2018

Location: Target T21

Direction: North

Description: Field personnel mapping along access road.

TARGET T22 (M5-06)

PHOTOGRAPHIC LOG

Target T22 (M5-06)
Photographic Log

The following photos were taken during the M5-06 (T22) visit to the Cove Chapter of the Navajo Nation on September 11, 2018.



PHOTOGRAPH 1

Date/Time:
9/11/2018

Location: Target T22

Direction: Southwest

Description: Field personnel mapping.

TARGET T24 (M5-07)

PHOTOGRAPHIC LOG

Target T24 (M5-07)
Photographic Log

The following photos were taken during the M5-07 (T24) visit to the Cove Chapter of the Navajo Nation on September 11, 2018.



PHOTOGRAPH 1

Date/Time: 9/11/2018

Location: Target T24

Direction: East

Description: Historic haul road upslope of Target.



PHOTOGRAPH 2

Date/Time: 9/11/2018

Location: Target T24

Direction: East

Description: Looking downslope toward Mesa V adit.

TARGET T25 (M5-08)

PHOTOGRAPHIC LOG (No Field Photographs Available)

TARGET T26 (M5-09)

PHOTOGRAPHIC LOG (No Field Photographs Available)

TARGET T27 (M4-02)

PHOTOGRAPHIC LOG

Target T27 (M4-02)
Photographic Log

The following photos were taken during the M4-02 (T27) visit to the Cove Chapter of the Navajo Nation on June 10, 2018.



PHOTOGRAPH 1

Date/Time:
6/10/2018

Location: Target T27

Direction: Northeast

Description: View of haul road on southeast side of Target.

TARGET T30 (M1-07)

PHOTOGRAPHIC LOG

Target T30 (M1-07)
Photographic Log

The following photos were taken during the M1-07 (T30) visit to the Cove Chapter of the Navajo Nation on September 25, 2018.



PHOTOGRAPH 1

Date/Time:
9/25/2018

Location: Target T30

Direction: North

Description:
Outcropping on hillside.



PHOTOGRAPH 2

Date/Time:
9/25/2018

Location: Target T30

Direction: South

Description:
Outcropping on hillside.

TARGET T31 (M1-08)

PHOTOGRAPHIC LOG

Target T31 (M1-08)
Photographic Log

The following photos were taken during the M1-08 (T31) visit to the Cove Chapter of the Navajo Nation on September 25, 2018.



PHOTOGRAPH 1

Date/Time:
9/25/2018

Location: Target T31

Direction: Southwest

Description:
Drainage, looking across to Target T31 hill side.

TARGET T32 (M2-01)

PHOTOGRAPHIC LOG

Target T32 (M2-01)
Photographic Log

The following photos were taken during the M2-01 (T32) visit to the Cove Chapter of the Navajo Nation on June 20, 2018.



PHOTO 1

Date/Time: 6/20/2018

Location: Target T32

Direction: Southeast

Description: Brushy slope along road. Outcropping visible in road cut.

TARGET T33 (KE-01)

PHOTOGRAPHIC LOG

Target T33 (KE-01)
Photographic Log

The following photos were taken during the KE-01 (T33) visit to the Cove Chapter of the Navajo Nation on July 12, 2018.



PHOTOGRAPH 1

Date/Time:
7/12/2018

Location: Target T33

Direction: Southeast

Description:
Steepness of cliff at Target.



PHOTOGRAPH 2

Date/Time:
7/12/2018

Location: Target T33

Direction: East

Description:
Steepness of cliff at Target.



PHOTOGRAPH 3

Date/Time:
7/12/2018

Location: Target T33

Direction: West

Description: Path along top of slope at Target.



PHOTOGRAPH 4

Date/Time:
7/12/2018

Location: Target T33

Direction: N/A

Description:
Potential waste rock at Target.

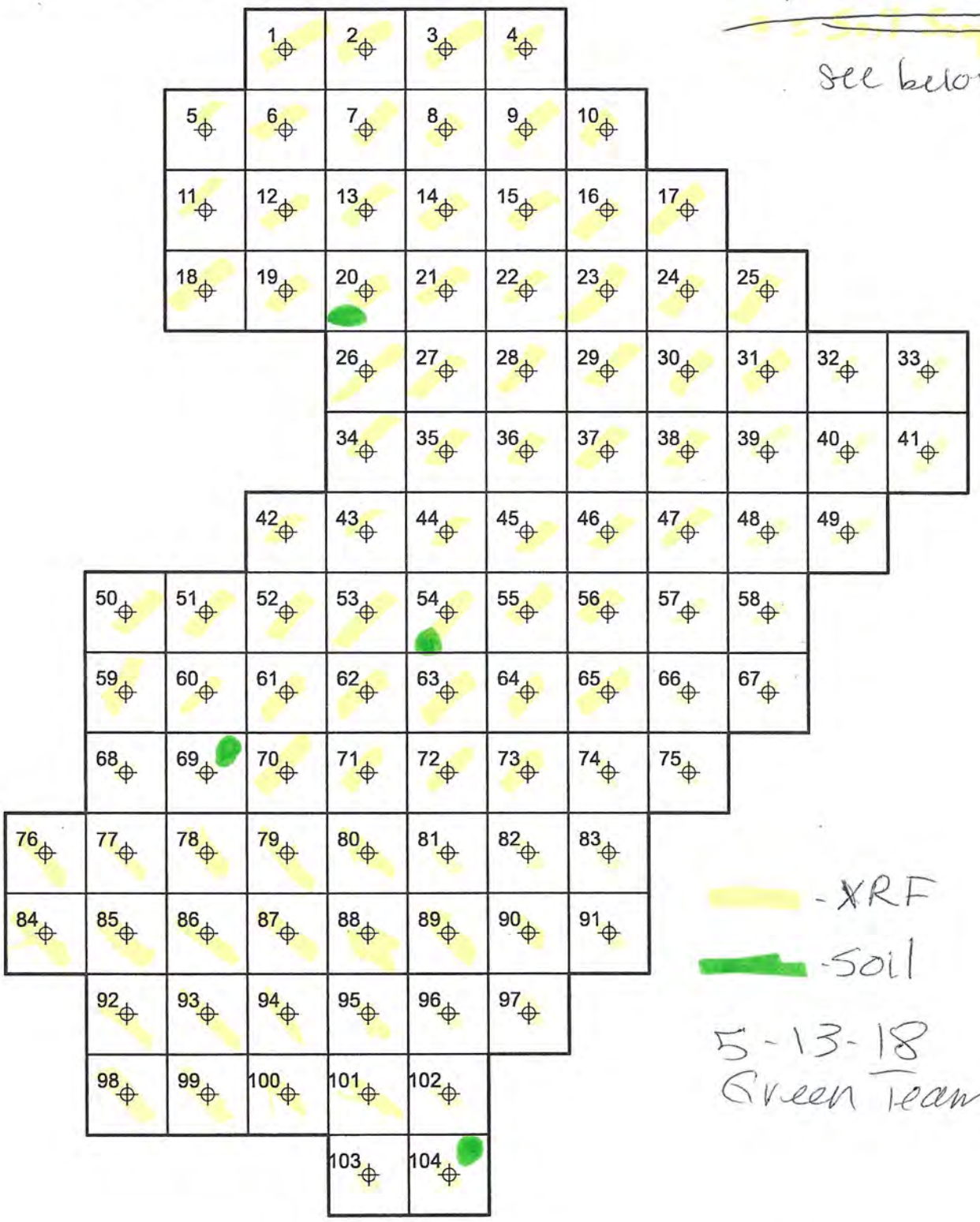
ATTACHMENT I2

TARGET FIELD FORMS

TARGET T1

FIELD FORMS

XRF SURVEY GRID MAP



see below MS 5/13/18

- XRF
- Soil

5-13-18
Green Team

Type: Target Site **Site Name: BR-01**	**TT ID: T1** **Subarea Group: A**	0 30 60 Feet N

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T:\LOCAL OPERATIONS\FORT COLLINS\RADIATION\RAES 2018\FINAL GIS\MXD\TO1\XRF_FIELD_MAPS\GROUP_A.MXD 04/13/18

XRF Form

Template ID: T1-XS#-01-051318

Site Type: Target
AUM Site: DR-01
Tetra Tech ID: T1
Sampling team: CL, MS, AN
XRF Color: Green

Date: 5/13/2018
Weather:

Page No.: 1 of 11
GPS Color: Green

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
~~X1~~	5/13/18	0952	N	V 25 / U 5	V 24 / U 5	N		N		
X2		1005	N	V 27 / U <LOD 3		N		N		U <LOD 3
X3		1006	N	V 25 / U 4		N		N		
X4		1008	N	V 21 / U 3		N		N		
X10		1010	N	V 30 / U 4		N		N		
X9		1011	N	V 24 / U 5		N		N		
X8		1013	N	V 19 / U 4		N		N		
X7		1015	N	V 30 / U 5		N		N		
X6		1016	N	V 26 / U 3		N		N		
X5	↓	1018	N	V 21 / U 3		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.

P1

Template FD

XRF Form

TI-XS#-01-051318

Site Type: Target
AUM Site: BR-01
Tetra Tech ID: TI
Sampling team: CL, MS, AN
XRF Color: Green

Date: 5/13/2018
Weather: Clear Windy > 25mph
Page No.: 2 of 11
GPS Color: Green

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

V/U

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
X11	5/13/18	1020	N	V 26 / U 4-4		N		N		
X12		1022	N	V 27 / U <LOD3		N		N		U <LOD3
X13		1023	N	V 25 / U 4-8		N		N		
X14		1025	N	V 23 / U 4-3		N		N		
X15		1027	N	V 23 / U 4		N		N		
X16		1028	N	V 14 / U 4-4		N		N		
X17		1030	N	V 20 / U <LOD3		N		N		U <LOD3
X25		1032	N	V 21 / U 4-4		N		N		
X24		1034	N	V 19 / U 4-4		N		N		
X23	↓	1035	N	V 30 / U 4-3		N				

Notes to field team:
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If a grid cannot be accessed, make a note and describe the reason.
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XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

P2

XRF Form

Template ID
TI-XS#-01-051318

Site Type: Target
AUM Site: BR-01
Tetra Tech ID: TI
Sampling team: CL, MS, AN
XRF Color: Green

V/4

Date: 5/13/2018
Weather:

Page No.: 3 of 11
GPS Color: Green

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
X22	5/13/18	1037	N	V27 / U5		N		N		
X21		1038	N	V23 / U4		N		N		
X20		1040	N	V38 / U8	V36 / U7	YES	TI-XS20-01-051318 Sample time 1046	N		Sample time 1046
X19		1051	N	V19 / U3		N		N		
X18		1053	N	V19 / U5		N		N		
X26		1054	N	V29 / U4		N		N		
X27		1056	N	V29 / U4		N		N		
X28		1058	N	V33 / U4		N		N		
X29		1100	N	V20 / U4		N		N		
X30		1101	N	V17 / U4						

Notes to field team:
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If a grid cannot be accessed, make a note and describe the reason.
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XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

P3

XRF Form

Template ID
T1-XS#-01-051318

Site Type: Target
AUM Site: BR-01
Tetra Tech ID: T1
Sampling team: CL, MS, AN
XRF Color: Green

V/4

Date: 5/13/2018
Weather: Clear, windy
Page No.: 4 of 11
GPS Color: Green

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
X31	5/13/18	1104	N	V28 / U4		N		N		
X38		1106	N	V31 / U4		N		N		
X37		1107	N	V24 / U7		N		N		
X36		1109	N	V26 / U5		N		N		
X35		1111	N	V19 / U5		N		N		
X34		1113	N	V30 / U4		N		N		
X42		1114	N	V20 / U4		N		N		
X43		1117	N	V28 / U6		N		N		
X44		1119	N	V20 / U5		N		N		
X45		1121	N	V22 / U5		N		N		

Notes to field team:
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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.

P4

XRF Form

TI-XS#-01-051318

Site Type: Target
AUM Site: BR-01
Tetra Tech ID: TI
Sampling team: CL, MS, AN
XRF Color: Green

V/4

Date: 5/13/2018
Weather: Clear Windy
Page No.: 5 of 11
GPS Color: Green

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
X46	5/13/18	1123	N	V 30 / U 6		N		N		
X47		1126	N	V 25 / U 3		N		N		
X56		1128	N	V 12 / U<LOD3		N		N		U<LOD3
X55		1130	N	V 14 / U 4		N		N		
X54		1133	N	V 24 / U 8.1	V 20 / U 11	YES	TI-XS54-01-051318	YES	TI-XS54-02-051318	Sample time 1140
X53		1150	N	V 27 / U 6		N		N		
X52		1153	N	V 30 / U 4		N		N		
X51		1155	N	V 16 / U 4		N		N		
X50		1157	N	V 20 / U 4		N		N		
X59	↓	1159	N	V 25 / U 4		N		N		

Notes to field team:
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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.

P5

Template ID
T1-XS#-01-052318

XRF Form

Site Type: Target
AUM Site: BR-01
Tetra Tech ID: T1
Sampling team: CL, MS, AN
XRF Color: Green

V/4

Date: 5/13/2018
Weather:
Page No.: 6 of 11
GPS Color: Green

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
X60	5/13/18	1201	N	V29 U4		N		N		
X61		1203	N	V41 U10		N		N		
X62		1205	N	V17 U4		N		N		
X63		1206	N	V31 U12		N		N		
X64		1208	N	V23 U6		N		N		
X65		1210	N	V20 U7		N		N		
X73		1211	N	V23 U4		N		N		
X72		1213	N	V20 U4		N		N		
X71		1215	N	V37 U12		N		N		
X70	↓	1217	N	V25 U12		N		N		

Notes to field team:
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XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

P6

XRF Form

Template ID
T1-XS#-01-051318

Site Type: Target
AUM Site: BR-01
Tetra Tech ID: T1
Sampling team: CL, MS, AN
XRF Color: Green

Date: 5/13/2018
Weather: Clear, 75°F, 15-20 mph winds N
Page No.: 7 of 11
GPS Color: Green

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
X69	5/13/18	1314	N	V 39 U 28	V 47 U 26	Y	T1-XS69-01-051318	N	–	Slight slope ST: 1325
X68	|	1329	N	V 27 U 4	–	N	–	N	–	Flat contour
X76	|	1330	N	V 25 U <3	–	N	–	N	–	Flat contour
X77	|	1333	N	V 33 U 7	–	N	–	N	–	Slight slope
X78	|	1336	N	V 38 U 12	–	N	–	N	–	Flat contour
X79	|	1338	N	V 50 U 19	–	N	–	N	–	Flat
X80	|	1341	N	V 27 U 8	–	N	–	N	–	Flat
X81	|	1343	N	V 23 U 8	–	N	–	N	–	Flat
X89	|	1345	N	V 15 U 4	–	N	–	N	–	Flat, near fence
X88	↓	1347	N	V 24 U 4	–	N	–	N	–	Flat

Notes to field team:
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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.

P7

XRF (. Form

Template ID
TI-XS#-01-051318

Site Type: Target
AUM Site: BR-01
Tetra Tech ID: TI
Sampling team: CL, MS, AN
XRF Color: Green

Date: 5/13/2018
Weather:
Page No.: 8 of 11
GPS Color: Green

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
X87	5/13/18	1349	N	V 34 U 6	—	N	—	N	—	Flat
X86	5/13/18	1351	N	V 34 U 9	—	N	—	N	—	Flat
X85	5/13/18	1352	N	V 26 U 5	—	N	—	N	—	Flat
X84	5/13/18	1354	N	V 28 U 3	—	N	—	N	—	flat
X92	5/13/18	1356	N	V 22 U 4	—	N	—	N	—	slight slope
X93	5/13/18	1358	N	V 37 U 4	—	N	—	N	—	slight slope
X94	5/13/18	1400	N	V 25 U 4	—	N	—	N	—	flat
X95	5/13/18	1401	N	V 27 U 4	—	N	—	N	—	slight slope, near fence
X101	5/13/18	1403	N	V 26 U <3	—	N	—	N	—	Flat, near fence
X100	5/13/18	1465	N	V 30 U 4	—	N	—	N	—	Flat

Notes to field team:
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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.

P8

XRF Form

Template ID
TI-XS#-01-051318

Site Type: Target
AUM Site: BR-01
Tetra Tech ID: TI
Sampling team: CL, MS, AN
XRF Color: Green

Date: 5/13/2018
Weather:
Page No.: 9 of 11
GPS Color: Green

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
X99	5/13/18	1406	N	V 20 U 4	—	N	—	N	—	flat
X98	5/13/18	1408	N	V 25 U <3	—	N	—	N	—	flat
X103	5/13/18	1415	N	V 17 U <3	—	N	—	N	—	east side of fence, flat
X104	5/13/18	1417	N	V 51 U 14	V 47 U 16	Y	TI-XS104-01-051318	N	—	east side of fence, slight slope ST: 1425
X102	5/13/18	1431	N	V 21 U <3	—	N	—	N	—	slope, east of fence / **Reading 96 +97 battery died, re run
X96	5/13/18	1435	N	V <9 U <3	—	N	—	N	—	flat, east of fence
X97	5/13/18	1437	N	V 98 U 92	—	N	—	N	—	slope, E of fence
X90	5/13/18	1439	N	V 25 U 5	—	N	—	N	—	E of fence, flat
X91	5/13/18	1440	N	V 54 U 7	—	N	—	N	—	E of fence, flat
X83	5/13/18	1442	N	V 65 U 43	—	N	—	N	—	E of fence, slope

Notes to field team:
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If a grid cannot be accessed, make a note and describe the reason.
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XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

P9

XRF Form

Template ID
TI-XS# -01 -051318

Site Type: Target
AUM Site: BR-01
Tetra Tech ID: TI
Sampling team: CL, MS, AN
XRF Color: Green

Date: 5/13/2018
Weather:
Page No.: 10 of 11
GPS Color: Green

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
B	X82	5/13/18	1443	N	V ~~13~~ edt 54 13 U <3	—	N	—	N	—	E of fence, flat
G	X74	5/13/18	1445	N	V 20 U 3	—	N	—	N	—	E of fence, flat
G	X75	5/13/18	1447	N	V 27 U 9	—	N	—	N	—	E of fence, slope
B	X66	5/13/18	1448	N	V 43 U 16	—	N	—	N	—	E of fence, slope
G	X67	5/13/18	1450	N	V 21 U <3	—	N	—	N	—	E of fence, flat
B	X59	5/13/18	1450	N	V 29 U 14	—	N	—	N	—	E of fence, flat
G	X58	5/13/18	1453	N	V 29 U 4	—	N	—	N	—	E of fence, slope
B	X48	5/13/18	1454	N	V 22 U 4	—	N	—	N	—	E of fence, flat
G	X49	5/13/18	1456	N	V 26 U 6	—	N	—	N	—	E of fence, flat
B	X39	5/13/18	1459	N	V 24 U 4	—	N	—	N	—	E of fence, flat

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.

P 10

XRF (. Form

Template ID
T1-XS#-01-051318

Site Type: Target
AUM Site: BR-01
Tetra Tech ID: T1
Sampling team: CC, MS, AN
XRF Color: Green

Date: 5/13/2018
Weather:
Page No.: P11 of 11
GPS Color: Green

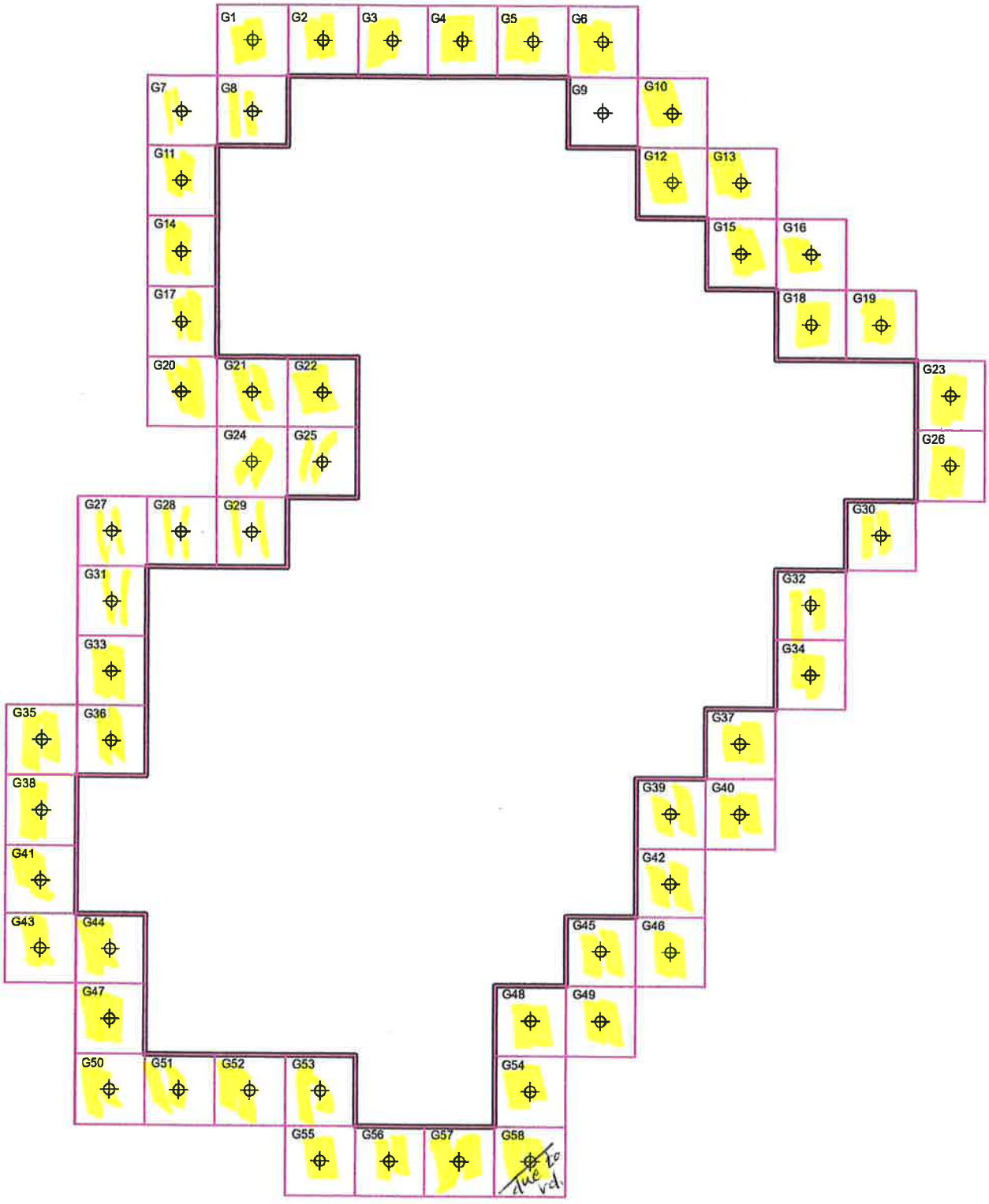
Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

	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
G	X40	5/13/18	1500	N	V 18 U <4	—	N	—	N	—	E of fence, slope
B	X41	5/13/18	1500	N	V 16 U <3	—	N	—	N	—	E of fence, ~~slope~~ flat
G	X33	5/13/18	1502	N	V 19 U 3	—	N	—	N	—	E of fence, flat
B	X32	5/13/18	1502	N	V 28 U 4	—	N	—	N	—	E of fence, flat

Notes to field team:
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XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

P11

XRF SURVEY GRID MAP



Type: Non-AUM Target **Site Name: BR-01 Non-AUM Target**	**TT ID: T1** **Subarea Group: A**	0 35 70 Feet N

iiná bá, Inc. TETRA TECH ERG

T:\LOCAL OPERATIONS\FORT COLLINS\RADIATION\RAES 2019\FINAL GIS\MXD\T01\FIELD_PRODUCTS\FIELD DEPLOYMENT MAPS\XRF_FIELD_MAPS.MXD 08/08/19

XRF Field Form

Site Type: Non-AUM
AUM Site: BR-01 Non-AUM
Tetra Tech ID: T1
Sampling team: CL, AL, JD, RK, MW
XRF Color: Green/Yellow

Date: 8/19/18
Weather: Sunny - hazy - hot - breezy
Page No.: 1 of 7
GPS Color: Black

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
G	G56	8/19/18	14:02	N	V 17 U <4	X U					U=LOD 4
Y	G55		14:00		V 22 U <3	X U					U=LOD 3, reading 58
G	G47		14:04		V 21 U <7						U=LOD 7
Y	G54		14:03		V 27 U 5						
G	G48		14:06		V 17 U <4						LOD 4
Y	G49		14:06	yes	V 36 U 14						offset by approx. 2 m. due to rd.
G	G45		14:08	N	V 19 U <4						LOD 4
X	G46				V U						In roadway no reading
Y	G42		14:07		V 20 U 6						
G	G39		14:11		V 15 U <6						LOD 6

Notes to field team:
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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: Non AUM
AUM Site: BR01 Non AUM
Tetra Tech ID: TT
Sampling team: CL, AC, JD, RK, MW
XRF Color: Green / yellow

Date: 8/19/18
Weather: sunny-hazy - hot - breezy

Page No.: 2 of 7
GPS Color: Black

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
Y	G40	8/19/18	14:10	yes	V 27 U 5						offset 4m due to rd.
G	G37		14:13	N	V 16 U <4						LOD 4 = U
Y	G34		14:12	yes	V 21 U 3						offset 4m due to road
G	G32		14:15	N	V 21 U <6						LOD 6 = U
Y	G30		14:14	yes	V 16 U 5						offset 1m due to rd.
G	G26		14:19	N	V 24 U 6						offset 4m due to rd. LOD 6 = U
Y	G23		14:17		V 12 U 3						
G	G19		14:21		V <14 U <5						LOD 14 = V LOD 5 = U
Y	G18		14:20		V 15 U <3						LOD 3 = U
* G	G46		14:28		V 37 U 6						offset 4m due to rd.

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: Non AUM
AUM Site: BR-01 Non AUM
Tetra Tech ID: TI
Sampling team: CL, AC, JD, RK, MW
XRF Color: Green-yellow

Date: 8/19/18
Weather: Sunny - hazy-hot - breezy
Page No.: 3 of 7
GPS Color: Black

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
Y*	G58	8/19/18	14:27	yes	V 38 U 10						offset 3m due to rd.
G	G49A		14:33	N	V <18 U 8	V <21 U 7	Yes	TI-XSG49A-01-081918			V=LOD 18; LOD 21=V Sample time 14:36
Y	G53		14:46		V 20 U 6						
G	G52		14:50		V 23 U <5						U=LOD 5
Y	G51		14:49		V 22 U <3						U=LOD 3
G	G50		14:52		V 29 U <6						U=LOD 6
Y	G47		14:51		V 30 U 6						
G	G44		14:54		V 16 U <6						U=LOD 6
Y	G43		14:54		V 26 U 4						
G	G41		14:57		V <17 U <4						V=LOD 17 U=LOD 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.

XRF Field Form

Site Type: Non AUM
AUM Site: BR-01 Non AUM
Tetra Tech ID: TI
Sampling team: CL, AC, JD, MW, RK
XRF Color: Green, yellow

Date: 8/19/18
Weather: Sunny - hazy - hot - breezy
Page No.: 4 of 7
GPS Color: Black

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
Y	G38	8/19/18	14:56	NO	V 28 U 4	V 27 U 4	Yes	THS G38-01-081918			Soil @ 1501
G	G35		14:59		V <16 U <4						LOD 16 = V LOD 4 = U
Y	G33		15:08		V 26 U 4						
G	G31		15:13		V 20 U <4						U = LOD 4
Y	G27		1512		V 34 U 4						Reading 45
G	G28		1515		V 22 U <4						U = LOD 4
Y	G29		1514		V 29 U 4						
G	G36		1518		V 21 U <4						U = LOD 4
Y	G24		1518		V 21 U 5						
G	G25		1524		V 19 U <4						U = LOD 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.

XRF Field Form

Site Type: Non AUM
AUM Site: BR-01
Tetra Tech ID: TI
Sampling team: CL, AC, RK, JD, MW
XRF Color: Green-Yellow

Date: 8/19/18
Weather: Sunny, hazy

Page No.: 5 of 7
GPS Color: Black

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
Y	G22	8/19/18	15:20		V 28 U 7						
Y	G21	"	1522		V 17 U 4						
G	G20	"	1526		V <LOD 18 U <5						V=LOD 18 U=LOD 5
Y	G17	"	1524		V 20 U 4						
G	G14	"	1528		V <LOD 16 U <8						V=LOD 16 U=LOD 8
Y	G11	"	1526		V 23 U 4						
G	G7	"	1530		V 20 U <4						on access road U=LOD 4
Y	~~G8~~	"	1528		V 21 U 3						
G	G1	"	1532		V 18 U <5						on access Rd U=LOD 5
Y	G2	↓	1530		V 18 U 3						

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: Navajo
AUM Site: BR-01
Tetra Tech ID: T1
Sampling team: CL, AC, JD, RK, MW
XRF Color: green, yellow

Date: 8/19/18
Weather: sunny, hazy

Page No.: 6 of 7
GPS Color: Black

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
G	G3	8/19/18	1534	N	V 32 U <6						U = LOD 6
Y	G4		1533		V 33 U 6						
G	G5		1536		V 23 U 39						
~~G~~ G	G5A		1538		V <18 U <6	V U	yes	T1-XSG5A-01-081918			V = LOD 18 soil sample U = LOD 6 1542 time
Y	G6		1535		V 26 U 4						
Y	G9		1547		V 24 U 5						
G	G10		1551		V 28 U <4						U = LOD 4
Y	G12		1549		V 22 U 7						
G	G13		1553		V 14 U <5						U = LOD 5
Y	G15		1551		V 20 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.

XRF Field Form

Site Type: Non AUM
AUM Site: BR-01
Tetra Tech ID: TI
Sampling team: CL, AC, JD, RK, MW
XRF Color: Green / Yellow

Date: 8/19/18
Weather: sunny, hazy
Page No.: 7 of 7
GPS Color: Black

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
G	G16	8/19/18	1555	N	V 22 U <4						U=LOD 4
Y	~~X13A~~		1557		V 29 U 8						
G	X14A		1601		V 33 U 8						
G	X83A		1609		V 33 U 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.

Gamma C[illegible]elation Soil
Field Form

Site Type: Non AUM/AUM
Site Name: Subarea Group A
Tetra Tech ID: T1,
Sampling Team: DW, TA (ERG
Page No.: 1/

Date: 8/19/18
Weather: Clear/Smoky 90°F
GPS Color: Mesa (ERG)

Example Sample ID: M1-CORR1-01-042218
Example Duplicate ID: M1-CORR1-02-042218

Plot Location	Date (M/D/Y)	Time (MST)	Approx Gamma (cpm)	Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	HPIC Value (µR/Hr)	Notes
T1	8/19/18	1130	~15,000	T1-CORR1-01-081918	N	—	Logged in Instrument	Near HWY ~50' Sparse veg.
T1	8/19/18	1200	~50,000	T1-CORR2-01-081918	N	—	Logged in HPIC	Sparse veg. Lt Brown Reddish sandy, fine to med grains
T2	8/19/18	1300	~10,000	T2-CORR1-01-081918	N	—	Logged HPIC	Silty sand fine to med grains Lt Brown Reddish
T4	8/19/18	1345	~40,000	T4-CORR1-01-081918	N	—	Logged HPIC	Silty sand w/ sandstone present in aggregate above Valley floor Grey
B3	8/19/18	1500	~7000	B3-CORR1-01-081918	YES	B3-CORR1-02-081918	Logged HPIC	Silty sand, Lt. Brown Reddish flat, sparse veg
M2	8/19/18	1600	~~~12,000 Dw~~ ~~10,000~~	M2-CORR1-01-081918	N	—	Logged HPIC	Silty sand, Lt Brown Reddish
M2	8/19/18	1640	~9,000	M2-CORR2-01-081918	N	—	Logged HPIC	Silty sand, Reddish Brown
M2	8/19/18	1700	~7,500	M2-CORR3-01-081918	N	—	Logged HPIC	Silty sand, Reddish Brown
T7	8/19/18	1730	~8,000	~~T7~~ T7-CORR1-01-081918	N	—	Logged HPIC	Silty sand Reddish Brown

Notes to field team:
Record the centroid of each plot on the Trimble GPS Unit.
All correlation samples are nine-point composite samples of 0" to 6" bgs.

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Subsurface Sample by Hand Field Form

Site Name: BR-01
Tetra Tech Site ID: T1
Grid Location No.: 14
Date:
Example Sample IDs: Surface Sample (0-6 inches) M1-SS1-01-090518
Subsurface Sample (6-12 inches) M1-SB1-0612-01-090518
Subsurface Sample (12-18 inches) M1-SB1-1218-01-090518

Weather: SUNNY 60
GPS Color: RED
Sampling Team: SK, MP
Page No.:

Field Sample ID	Time (MST)	Duplicate Collected? (Yes or No)	Depth Range (inches)	Duplicate ID	Analysis (Long/Short)	Field Notes
T1-SS14-01-091618	11:20	NO	0" - 6"		Long (extra bag) + SHORT.	REFUSAL METER 6". ROCK
T1-SB14-0612-01-			6" - 12"		Long (extra bag)	
T1-SB14-1218-01-			12" - 18"		Long (extra bag)	

Subsurface Sample by Hand Field Form

Site Name: BR-01
Tetra Tech Site ID: T1
Grid Location No.: 23
Date:

Weather: SUNNY, 85
GPS Color: RED
Sampling Team: SK, MP
Page No.:

Example Sample IDs: Surface Sample (0-6 inches) M1-SS1-01-090518
Subsurface Sample (6-12 inches) M1-SB1-0612-01-090518
Subsurface Sample (12-18 inches) M1-SB1-1218-01-090518

Field Sample ID	Time (MST)	Duplicate Collected? (Yes or No)	Depth Range (inches)	Duplicate ID	Analysis (Long/Short)	Field Notes
T1-SS23-01-091618	11:29	NO	0" - 6"		Short	REFUSAL AFTER 6". ROCK
T1-SB23-0612-01-			6" - 12"		Short	
T1-SB23-1218-01-			12" - 18"		Short	

Subsurface Sample by Hand Field Form

Site Name: BR-01
Tetra Tech Site ID: T1
Grid Location No.: 33
Date:
Example Sample IDs: Surface Sample (0-6 inches) M1-SS1-01-090518
Subsurface Sample (6-12 inches) M1-SB1-0612-01-090518
Subsurface Sample (12-18 inches) M1-SB1-1218-01-090518

Weather: SUNNY 85
GPS Color: RED
Sampling Team: SK, MC
Page No.:

Field Sample ID	Time (MST)	Duplicate Collected? (Yes or No)	Depth Range (inches)	Duplicate ID	Analysis (Long/Short)	Field Notes
T1-SS33-01- 09/6/18	11:50	NO	0" - 6"		Short	
T1-SB33-0612-01-	—		6" - 12"		Short	ROCK AFTER 1'
~~T1-SB33-1218-01-~~			12" - 18"		Short	

Subsurface Sample by Hand Field Form

Site Name: BR-01
Tetra Tech Site ID: T1
Grid Location No.: 37
Date:

Weather: SUNNY 85
GPS Color: REP
Sampling Team: SK
Page No.:

Example Sample IDs: Surface Sample (0-6 inches) M1-SS1-01-090518
Subsurface Sample (6-12 inches) M1-SB1-0612-01-090518
Subsurface Sample (12-18 inches) M1-SB1-1218-01-090518

Field Sample ID	Time (MST)	Duplicate Collected? (Yes or No)	Depth Range (inches)	Duplicate ID	Analysis (Long/Short)	Field Notes
T1-SS37-01- 091618	11:40	NO	0" - 6"		Short	REFUSAL AFTER 6", ROCK
T1-SB37-0612-01-			6" - 12"		Short	
T1-SB37-1218-01-			12" - 18"		Short	

Subsurface Sample by Hand Field Form

Site Name: BR-01
Tetra Tech Site ID: T1
Grid Location No.: 40
Date:

Weather: SUNNY, 80
GPS Color: RED
Sampling Team: SK, MP
Page No.:

Example Sample IDs: Surface Sample (0-6 inches) M1-SS1-01-090518

Subsurface Sample (6-12 inches) M1-SB1-0612-01-090518

Subsurface Sample (12-18 inches) M1-SB1-1218-01-090518

Field Sample ID	Time (MST)	Duplicate Collected? (Yes or No)	Depth Range (inches)	Duplicate ID	Analysis (Long/Short)	Field Notes
T1-SS40-01- 091618	11:44	NO	0" - 6"		Short	
T1-SB40-0612-01- 091618	11:46 SK	NO	6" - 12"		Short	ROCK AFTER 12".
~~T1-SB40-1218-01-~~			~~12" - 18"~~		~~Short~~	

Gamma C[illegible]elation Soil
Field Form

Site Type: Non AUM/AUM
Site Name: Subarea Group A
Tetra Tech ID: T1,
Sampling Team: DW, TA (ERG
Page No.: 1/

Date: 8/19/18
Weather: Clear/Smoky 90°F
GPS Color: Mesa (ERG)

Example Sample ID: M1-CORR1-01-042218
Example Duplicate ID: M1-CORR1-02-042218

Plot Location	Date (M/D/Y)	Time (MST)	Approx Gamma (cpm)	Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	HPIC Value (µR/Hr)	Notes
T1	8/19/18	1130	~15,000	T1-CORR1-01-081918	N	—	Logged in Instrument	Near HWY ~50' Sparse veg.
T1	8/19/18	1200	~50,000	T1-CORR2-01-081918	N	—	Logged in HPIC	Sparse veg. Lt Brown Reddish sandy, fine to med grains
T2	8/19/18	1300	~10,000	T2-CORR1-01-081918	N	—	Logged HPIC	Silty sand fine to med grains Lt Brown Reddish
T4	8/19/18	1345	~40,000	T4-CORR1-01-081918	N	—	Logged HPIC	Silty sand w/ sandstone present in aggregate above Valley floor Grey
B3	8/19/18	1500	~7000	B3-CORR1-01-081918	YES	B3-CORR1-02-081918	Logged HPIC	Silty sand, Lt. Brown Reddish flat, sparse veg
M2	8/19/18	1600	~~~12,000 Dw~~ ~~10,000~~	M2-CORR1-01-081918	N	—	Logged HPIC	Silty sand, Lt Brown Reddish
M2	8/19/18	1640	~9,000	M2-CORR2-01-081918	N	—	Logged HPIC	Silty sand, Reddish Brown
M2	8/19/18	1700	~7,500	M2-CORR3-01-081918	N	—	Logged HPIC	Silty sand, Reddish Brown
T7	8/19/18	1730	~8,000	~~T7~~ T7-CORR1-01-081918	N	—	Logged HPIC	Silty sand Reddish Brown

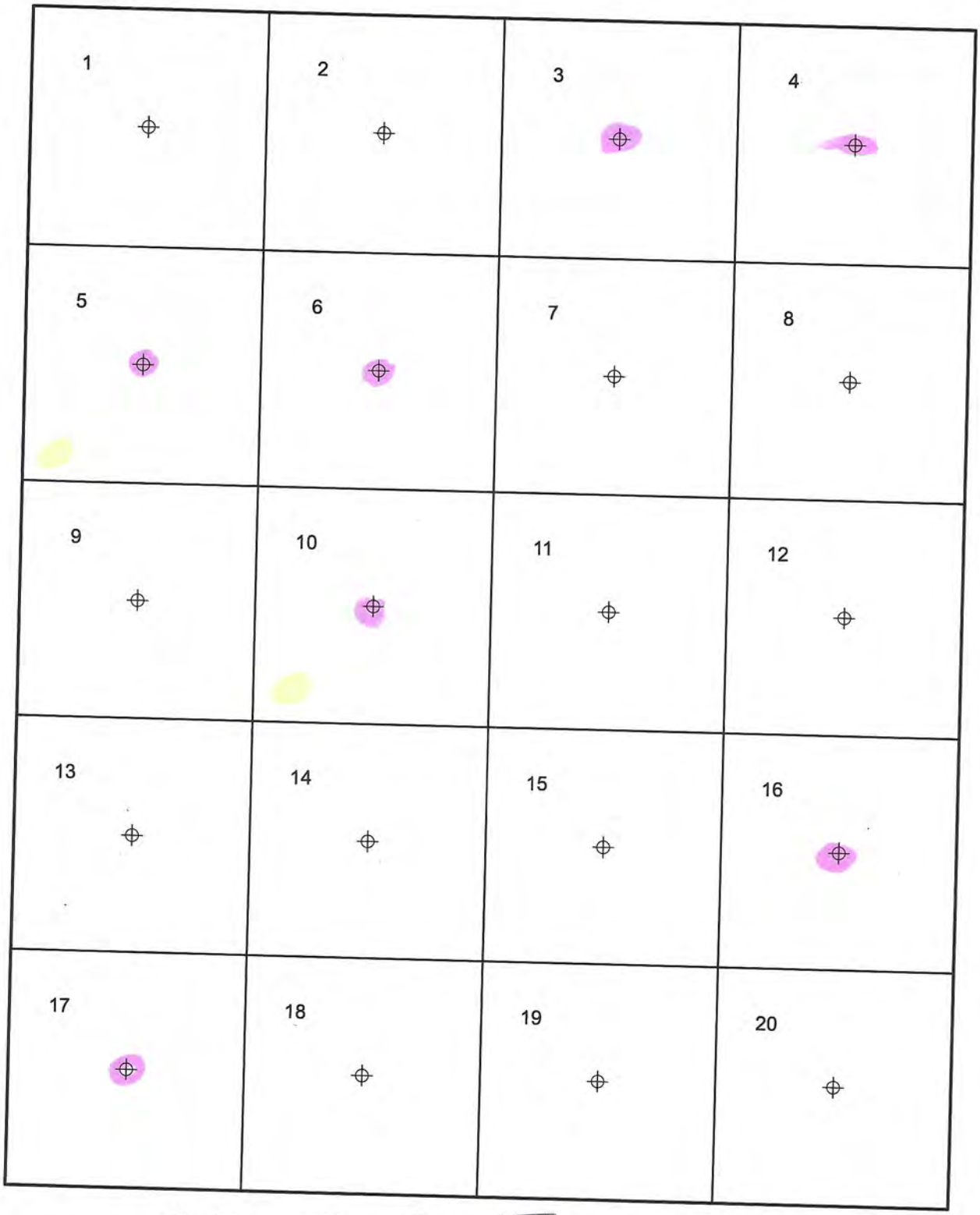
Notes to field team:
Record the centroid of each plot on the Trimble GPS Unit.
All correlation samples are nine-point composite samples of 0" to 6" bgs.

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TARGET T3

FIELD FORMS

XRF SURVEY GRID MAP



5-12-18 Green Team: KS, AD, AN, RB

Type: Target Site
Site Name: BR-03

TT ID: T3
Subarea Group: A

0 10 20 Feet

N

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- Soil
- XRF

XRF Form

T3-XS10-01-051218

Site Type: AUM Target
AUM Site: T3
Tetra Tech ID: BR-03
Sampling team: KS, AD, AN, RB
XRF Color: Green

Date: 5-12-18
Weather: High Winds, clear
Page No.: 1
GPS Color: Green

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

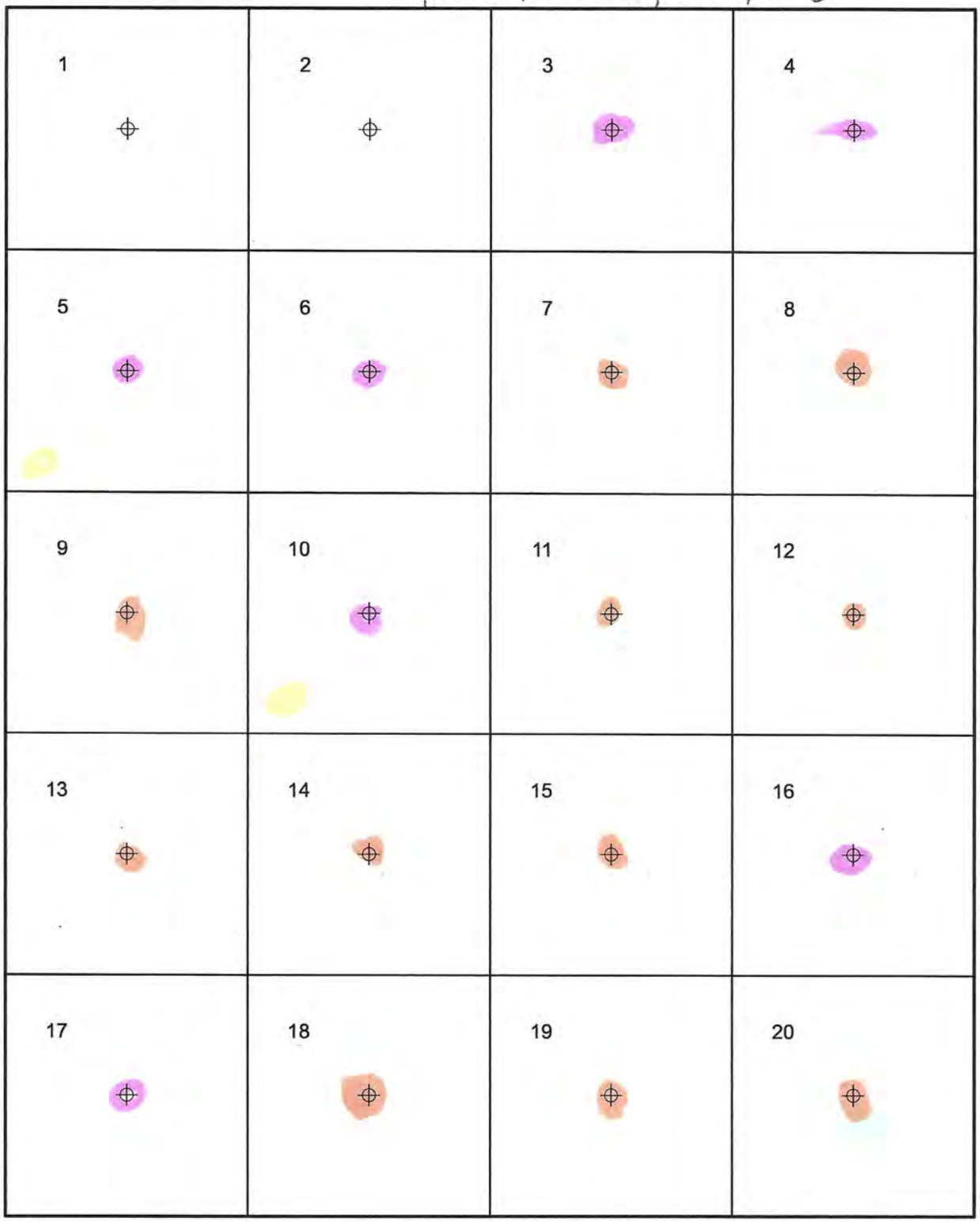
XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
X6	5/12/18	1329	N	V24 / U3		N		N		
X16		1333	N	V27 / U<3		N		N		Adjacent to small drainage
X17		1335	N	V21 / U3		N		N		
X3		1338	Yes	V61 / U<2		N		N		Adjusted rock outcrop in small drainage
X4		1341	N	V27 / U<3		N		N		
X10		1344	Yes	33 / U4		N/Yes	Sample time 1351 T3-XS10-01-051218	N		Adjusted due to rock Soil sample time 1351
X5		1347	N	V29 / U4		Yes	T3-XS05-01-51218	N		~~Soil sample time~~ Soil sample time 1357

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.

5/13/18 XRF

XRF SURVEY GRID MAP

Yellow XRF: AD, MP, DD



5-12-18 Green Team: KS, AD, AN, RB

Type: Target Site **Site Name: BR-03**	**TT ID: T3** **Subarea Group: A**	0 10 20 Feet N

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-Soil } 5/12/18
XRF }

XRF Form

T3-XS1001-051218

Page 1 (1)

Site Type: AUM Target
AUM Site: T3
Tetra Tech ID: BR-03
Sampling team: KS, AD, AN, RB
XRF Color: Green

Date: 5-12-18
Weather: High Winds, clear
Page No.: 1
GPS Color: Green

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
X6	5/12/18	1329	N	V 24 / U 3		N		N		
X16		1333	N	V 27 / U<3		N		N		Adjacent to small drainage
X17		1335	N	V 21 / U 3		N		N		
X3		1338	Yes	V 61 / U<2		N		N		Adjusted rock outcrop in small drainage
X4		1341	N	V 27 / U<3		N		N		
X10		1344	Yes	33 / U 4		AN Y/es	Sample time T3-XS10-01-051218	N		Adjusted due to rock soil sample time 1351
X5		1347	N	V 29 / U 4		Yes	T3-XS05-01-51218	N		~~Soil sample time ~~ AN Soil sample time 1357
X18	5/13/18	1147	N	17/3	-	-	-	-	-	Precip 42
X19		1150	N	22/3	-	-	-	-	-	
X20		1151	N	23/4	-	-	-	-	-	

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.

XRF Form

Site Type: Target 03
AUM Site: T3
Tetra Tech ID: AD, MP, DJ
Sampling team: Yellow
XRF Color: V/U

Date: 5/13/18
Weather: Sunny, slight wind
Page No.: 2
GPS Color: Pink

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
X15	5/13/18	1153	No	25/3	-	-	-	-	-	
X14	↓	1155	No	26/23	-	-	-	-	-	
X13		1157	No	40/4	-	-	-	-	-	
X9		1159	No	23/4	-	-	-	-	-	
X11		1200	No	22/23	-	-	-	-	-	
X12		1202	No	29/4	-	-	-	-	-	
X8		1204	No	16/25	-	-	-	-	-	
~~X7~~		1206	No	18/3	-	-	-	-	-	
X2		1208	No	28/23	35/23	-	-	-	-	XRF Duplicate
X1	↓	1211	No	24/3	-	-	-	-	-	

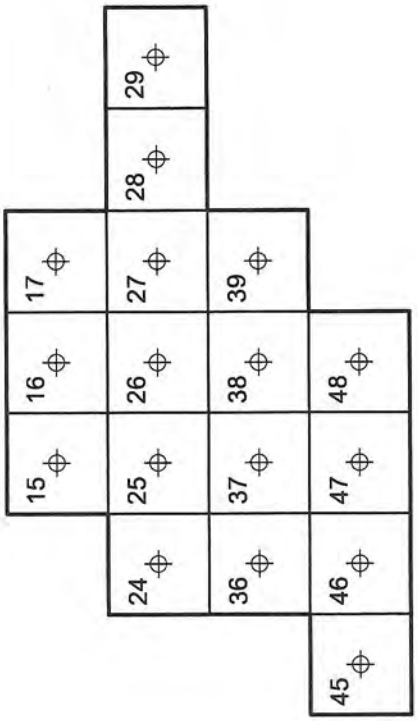
Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are 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.

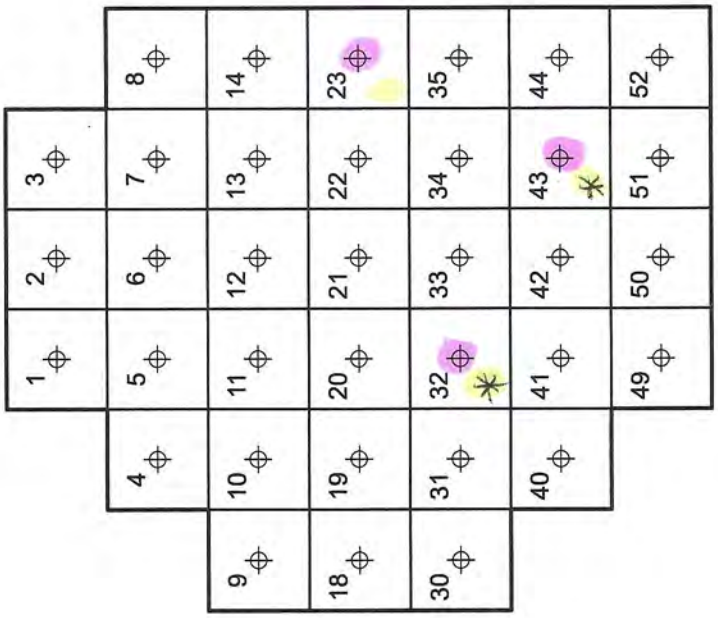
TARGET T4

FIELD FORMS

XRF SURVEY GRID MAP

5-12-18
Green Team
KS, AD, AN, BB
Soil sample
XRF





Type: Target Site **Site Name: BR-04**	**TT ID: T4** **Subarea Group: A**	0 30 60 Feet N

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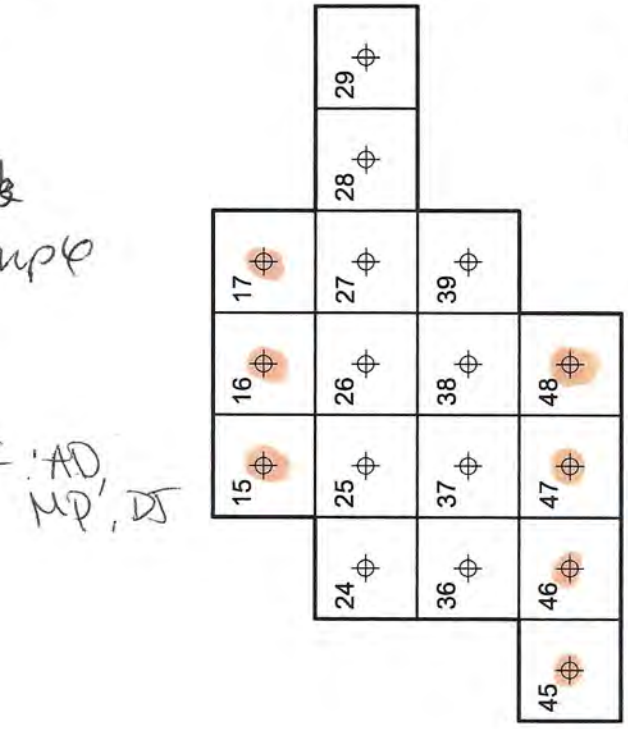
* 43. 32 4 Gamma readings

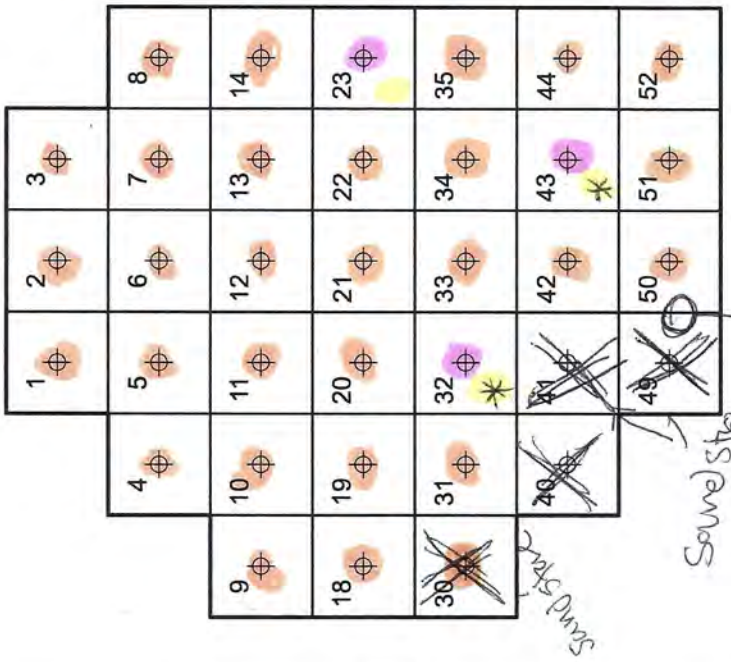
XRF SURVEY GRID MAP

5-12-18
Green Team
KS, AD, AN, BB
Soil sample
XRF

5/13/18
Yellow XRF: AD, MP, DJ
XRF

No soil samples after 5/13/18 needed





Type: Target Site **Site Name: BR-04**	**TT ID: T4** **Subarea Group: A**	0 30 60 Feet N

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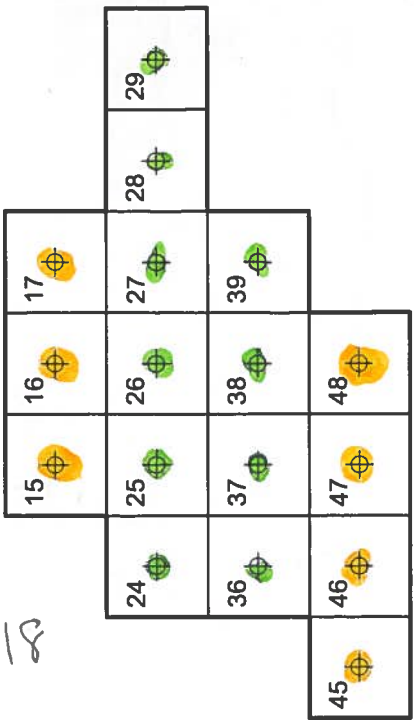
* 43. 32 4 Gamma readings

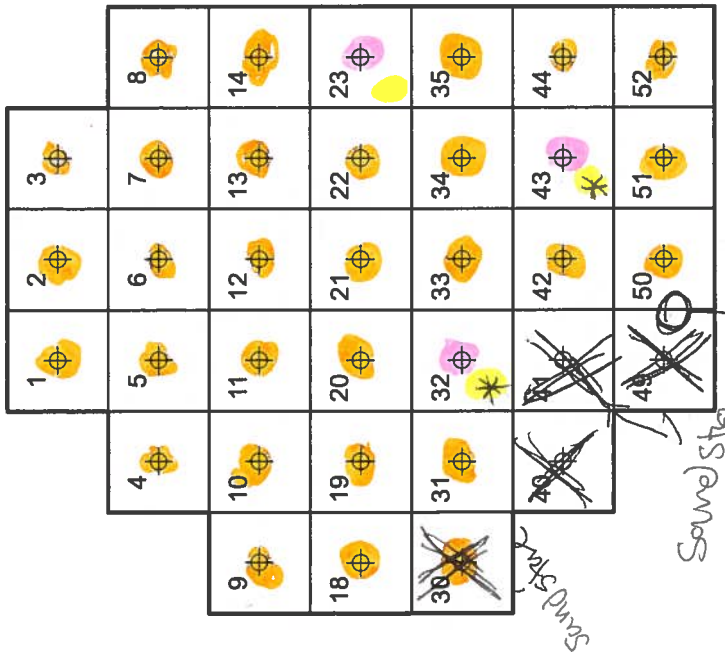
XRF SURVEY GRID MAP

5-12-18
Green Team
KS, AD, AN, BB
Soil sample
XRF

5/13/18
Yellow XRF: AD, MP, DJ
XRF
XRF on 5/14/18

No Soil Samples after ~~5/14~~ 5/13/18 needed





Type: Target Site **Site Name: BR-04**	**TT ID: T4** **Subarea Group: A**	0 30 60 Feet, N

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* 43.32 4 Gamma readings

XRF Form

T4-XS1-

Site Type: Target
AUM Site:
Tetra Tech ID: T4
Sampling team: KS, AD, AN, BB
XRF Color: Green

Date: 5-12-18
Weather: Clear, high winds
Page No.: 1
GPS Color: Green

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
X43	5/12/18	~~1414~~	Y	V40 / U28		Y	T4-XS1-~~43~~-051218 (AN) X5~~43~~01 (AN)	N		Soil sample time 1422
X32	"	1427	N	V152 / 49	V151 / 49	~~Y~~	T4-XS32-01-051218 Soil Sample Time 1431	N		Adjusted due to rocky surface. Reading #23 error* Soil sample on rock outcrop Soil Sample time 1431
X23	"	1442	Y	V=26 / U=7	—	Y	T4-XS23-01-051218	N	—	Soil sample @ 1446

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.

5/13/18 Team: AD, MP, DJ

XRF . Form

T4-XS1-

Site Type: Target
AUM Site:
Tetra Tech ID: T4
Sampling team: KS, AD, AN, BB
XRF Color: Green / Yellow

Date: 5-12-18 / 5-13-18
Weather: Clear, high winds
Page No.: 1
GPS Color: Green / Pink

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
										Soil sample time 1422
X43	5/12/18	~~1414~~	Y	V40 / U28		Y	T4-XS1-~~43~~ AN-051218 XS43-01	N		Adjusted due to rocky surface. Reading #23 error*
X32	↓	1427	N	V152 / 49	V151 / 49	Y	T4-XS32-01-051218 Soil Sample Time 1431	N		Soil sample on rock outcrop Soil Sample time 1431
X23	↓	1442	Y	V=26 / U=7	—	Y	T4-XS23-01-051218	N	—	Soil sample @ 1446
X48	5/13/18	1243	Y	39 / 6	-	-	-	-	-	Adjusted due to rock
X47	↓	1245	N	22 / 4	-	-	-	-	-	
X46	↓	1247	N	29 / 7	-	-	-	-	-	
X45	↓	1248	N	21 / 8	-	-	-	-	-	
X52	↓	1252	N	19 / 7	-	-	-	-	-	
X51	↓	1254	N	33 / 5	-	-	-	-	-	
X44	↓	1257	N	32 / 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 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 . Form

Site Type: Target
AUM Site:
Tetra Tech ID: T4
Sampling team: AD, MP, DJ
XRF Color: Yellow V / U

Date: 5/13/18
Weather: Sunny, clear, windy
Page No.: 3
GPS Color: Pink

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
X35	5/13/18	1258	No	21 / 11	-	-	-	-	-	
X34		1302	No	22 / 10	-	-	-	-	-	Reading # 65
X33		1305	No	53 / 10	-	-	-	-	-	
X42		1307	No	43 / 6	-	-	-	-	-	Iron nail in rock
X50		1309	No	36 / 3	-	-	-	-	-	Sand patch on large rock outcrop
X22		1343	No	23 / 6	-	-	-	-	-	sand patch on rock outcrop
X21		1345	No	43 / 13	-	-	-	-	-	
X20		1347	No	74 / 14	-	-	-	-	-	
X19		1348	No	61 / 11	-	-	-	-	-	
X31		1350	No	48 / 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.

X30 & X40 → inaccessible? Characteristically different than rest of Target Site 04.

XRF Form

Site Type: Target
AUM Site:
Tetra Tech ID: T4
Sampling team: AD, MP, DT
XRF Color: Yellow

Date: 5/13/18
Weather: Sunny/windy
Page No.: 3
GPS Color: Pink

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
x30	5/13/18	1352	Yes	51/5	-	-	-	-	-	
x18		1355	N	79/26	-	-	-	-	-	
x9		1356	Y	45/10	-	-	-	-	-	rock outcrop adjustment
x16		1358	N	22/8	-	-	-	-	-	
x11		1400	N	34/10	-	-	-	-	-	
x12		1402	N	18/8	-	-	-	-	-	~~XRF duplicate~~ AD 5/13/18
x13		1404	N	28/6	22/6	-	-	-	-	XRF DUP ☆
x14		1407	N	23/6	-	-	-	-	-	
x8		1409	N	14/3	-	-	-	-	-	
x7	↓	1411	N	25/7	-	-	-	-	-	

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 . . Form

Site Type: Target
AUM Site: Target 04
Tetra Tech ID: T4
Sampling team: AD, MP, DS
XRF Color: Yellow

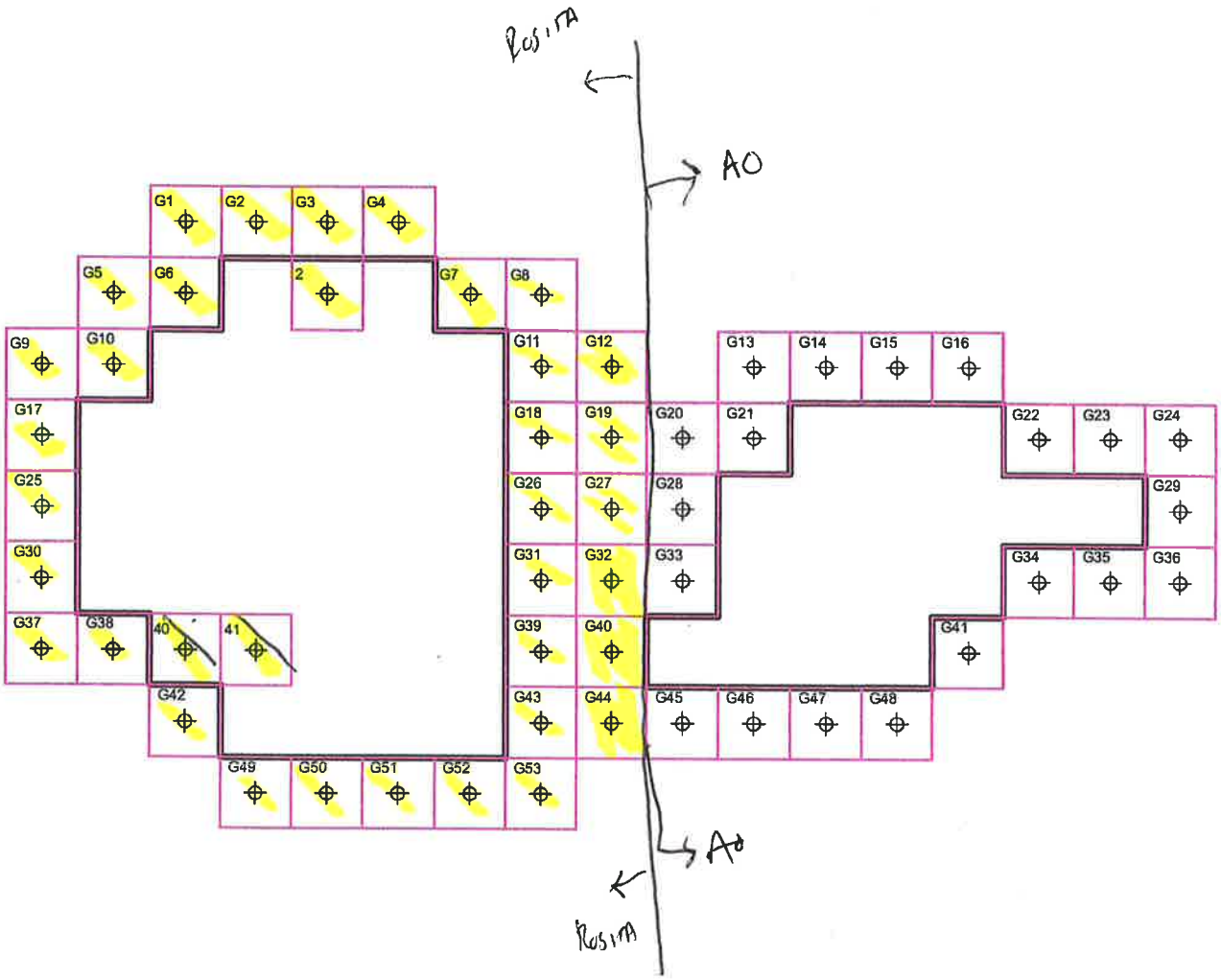
Date: 5/13/18
Weather: Sunny, windy
Page No.: 4
GPS Color: Pink

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
X6	5/13/18	1413	N	28/5	-	-	-	-	-	
X5		1415	N	36/10	-	-	-	-	-	
X4		1417	N	48/15	-	-	-	-	-	
X1		1419	N	49/19	-	-	-	-	-	
X2		1420	N	57/8	-	-	-	-	-	
X3		1422	N	19/5	-	-	-	-	-	
X15		1426	N	33/9	-	-	-	-	-	
X16		1428	N	26/7	-	-	-	-	-	
X17		1429	N	24/6	-	-	-	-	-	

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 seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
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XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

XRF SURVEY GRID MAP

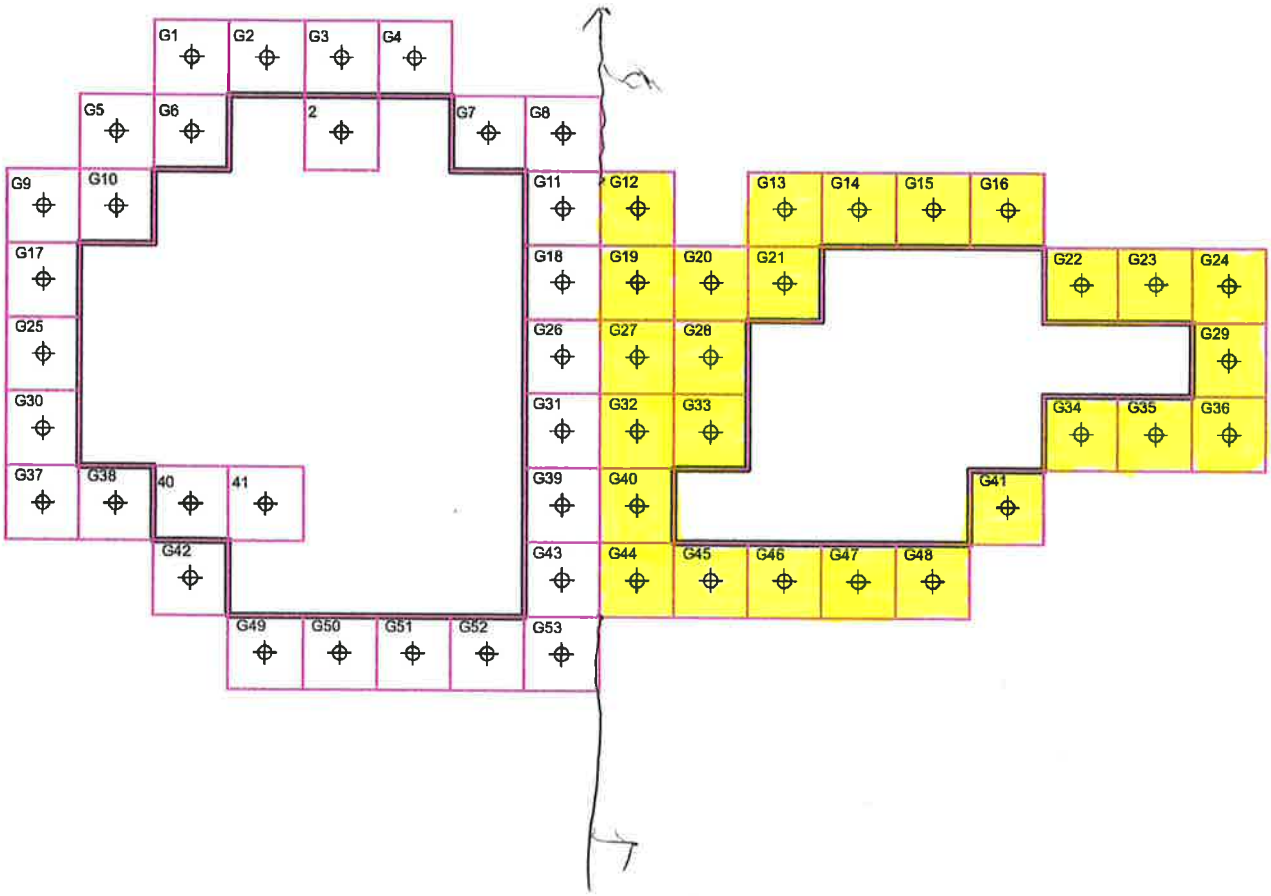


Type: Non-AUM Target **Site Name: BR-04 Non-AUM Target**	**TT ID: T4** **Subarea Group: A**	0 40 80 Feet N

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XRF SURVEY GRID MAP



Type: Non-AUM Target **Site Name: BR-04 Non-AUM Target**	**TT ID: T4** **Subarea Group: A**	0 40 80 Feet N

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XRF Field Form

Site Type: NON-AUM Target site
AUM Site: BR-04 Non-AUM Target
Tetra Tech ID: T4
Sampling team: AO, CB, AB
XRF Color: Blue

Date: 8/19/18
Weather: Sunny, hazy, breezy
Page No.: 1 of 3
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
G24	8/19/18	1112	No	V = 26 U = ~~<3~~ 3	V = 24 U = <3	No	—	—	—	Triplicate Performed xrf lifted b/w 1&2
G29	8/19/18	1122	No	V = 21 U = <3	—	No	—	—	—	located on old road
G36	8/19/18	1124	No	V = 24 U = <5	—	No	—	—	—	
G35	↓	1126	No	V = 51 U = 10	—	No	—	—	—	
G34		1128	~~Yes~~ No	V = 50 U = 11	—	No	—	—	—	shifted for rock
G41		1130	No	V = 35 U = 4	—	No	—	—	—	
G48		1137	No	V = 17 U = 3	—	No	—	—	—	
G47		1139	No	V = 30 U = 3	—	No	—	—	—	
G46		1141	No	V = 24 U = 4	—	No	—	—	—	located on on outcrop, thin layer of soil shot
G45	↓	1143	No	V = 17 U = 5	—	No	—	—	—	Arc. scatter located w/in outcrop formation

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: target site
AUM Site: BR-04 Non AUM Target
Tetra Tech ID: T4
Sampling team: AO, CB, AB
XRF Color: Blue

Date: 8/19/18
Weather: sunny, hazy, breezy
Page No.: 2 of 3
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
G44	8/19/18	1145	yes	V = 44 u: 6	—	No	—	—	—	adjusted due to Rock
G40		1148	yes	V: 48 u: 6	—	No	—	—	—	adjusted due to Rock
~~G32~~		1150	No	V = 25 u: 3	—	No	—	—	—	
G33		1152	No	V = 23 u = 4	—	No	—	—	—	
G28		1154	No	V: 48 u = 6	—	No	—	—	—	Located in outcrop in brown sand w/ silt & among desert shrubs
G27		1156	yes	V = 21 u = 3	—	No	—	—	—	shifted due to sandstone
G19		1157	No	V = 23 u: 5	—	No	—	—	—	
G12		1159	No	V = 35 u: 4	—	No	—	—	—	
G20		1201	No	V = 22 u: 5	—	No	—	—	—	
G21	↓	1206	yes	V = 29 u: 5	—	No	—	—	—	adjusted due to Rock outcropping

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: Target site
AUM Site: BR-04-Non Uranium target
Tetra Tech ID: T4
Sampling team: AO, CB, AB
XRF Color: Blue

Date: 8/19/18
Weather: Sunny, hazy, breezy
Page No.: 3 of 3
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
G13	8/19/18	1208	yes	V = 29 U = 5	—	NO	—	-	—	adjusted due to rock
G14		1210	No	V = 25 U = 10	—	No	—	-	—	above rock outcropping
G15		1212	No	V = 36 U = 5	—	No	-	—	—	
G16		1214	No	V = 31 U = 3	—	NO	—	—	—	
G22		1217	No	V = 36 U = 4	—	No	—	—	—	
G23		1219	No	V = 45 U = 5	—	No	—	—	—	right below, rock outcropping small
X15A		1226	No	V = 76 U = 67	V = 73 U = 67	yes	T4-X515A-01-081918 Time: 1230	—	—	Sample Time ~~1226~~ CB 1230 silt stone, dark grey to grey soil & rock

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: NON-AUM
AUM Site: DR-04 NON-AUM
Tetra Tech ID: T4
Sampling team: AC, CL, RK, JD, MW
XRF Color: Green/yellow

Date: Aug 19, 2018
Weather: Sunny - Hazy
Page No.: 1 of 4
GPS Color: Black

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
CL GN G44	8/19	11:07 ~~11:17~~	N	V 25 U 5	V 29 ← U 7	11:09				
JD YlW G40	8/19	11:07	↓	V 60 U 9	V 47 U 7					Reading 2
GN G32	↓	11:17	1 meter	V 36 U 3						~~offset~~ by 1 meter due to rocks
GN G27		11:19	N	V 24 U 8						
YW G19		11:17	↓	V ~~27~~ 19 U 7						
GN G12		11:21		V 42 U 3						
YW G8		11:20		V 27 U 8						
GN G11		11:25	↓	V 28 U 4						
YW G18		11:22	yes	V 27 U 4						offset by mete due to rocks
YW G26	↓	11:24	N	V 41 U 8						

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: Non-Aum
AUM Site: BR04 Non Aum
Tetra Tech ID: T4
Sampling team: AC, CL, RK, JD, MW
XRF Color: Green/yellow

Date: Aug 19, 2018
Weather: Sunny-Hazy
Page No.: 2 of 4
GPS Color: Black

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
GN	G31	8/19/18	11:27	N	V 45 U 5	V U					
yllw	G39		11:27		V ~~13~~ 22 U 5	V 17 U 6	yes	T4-XSG39-01-081918			Soil Time @ 11:31 am ✓
GN	G43		11:32		V 77 U 7						
yllw	G53		11:39		V 21 U 3						
GN	G52		11:43		V 38 U 6						
yllw	G51		11:42		V 29 U 5						
Grn	G50		11:47		V 160 U 28						
Grn	G49		11:51		V 69 U <3						U-LOD 3
yllw	G42		11:50		V 70 U 7						
GN	X40		11:56	✓	V 74 U <~~2~~		yes				offset by 2 meters off face of cliff U - LOD 2

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: Non-AUM
AUM Site: BR-04 Non-AUM
Tetra Tech ID: T4
Sampling team: AC, CL, RK, JD, MW
XRF Color: Green/yellow

Date: Aug. 19, 2018
Weather: Sunny - Hazy
Page No.: 3 of 4
GPS Color: Black

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
G41	8/18/18	11:58	yes	V 55 U <2						~~Offset~~ by <1 meters due to ~~cliff~~ cliff face
G38		11:58	N	V 40 U 4						
G37		12:02		V 34 U <LOD 2						LOD 2
G30		12:01		V 36 U 15						offset 1 meter due to cliff
G25		12:05		V 12 U 7						
G17		12:04		V 44 U 17						
G9		12:10		V 74 U 8						offset 4m. due to rocks
G5		12:17		V 41 U 18						
G10		12:17		V 23 U 9	V 28 U 10		T4-XSG10-01-081918			Soil sample time at 12:29
G6		12:27		V 26 U 11						

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: Non Aum
AUM Site: BR-04 Non Aum
Tetra Tech ID: T4
Sampling team: AC
XRF Color: Green/yellow

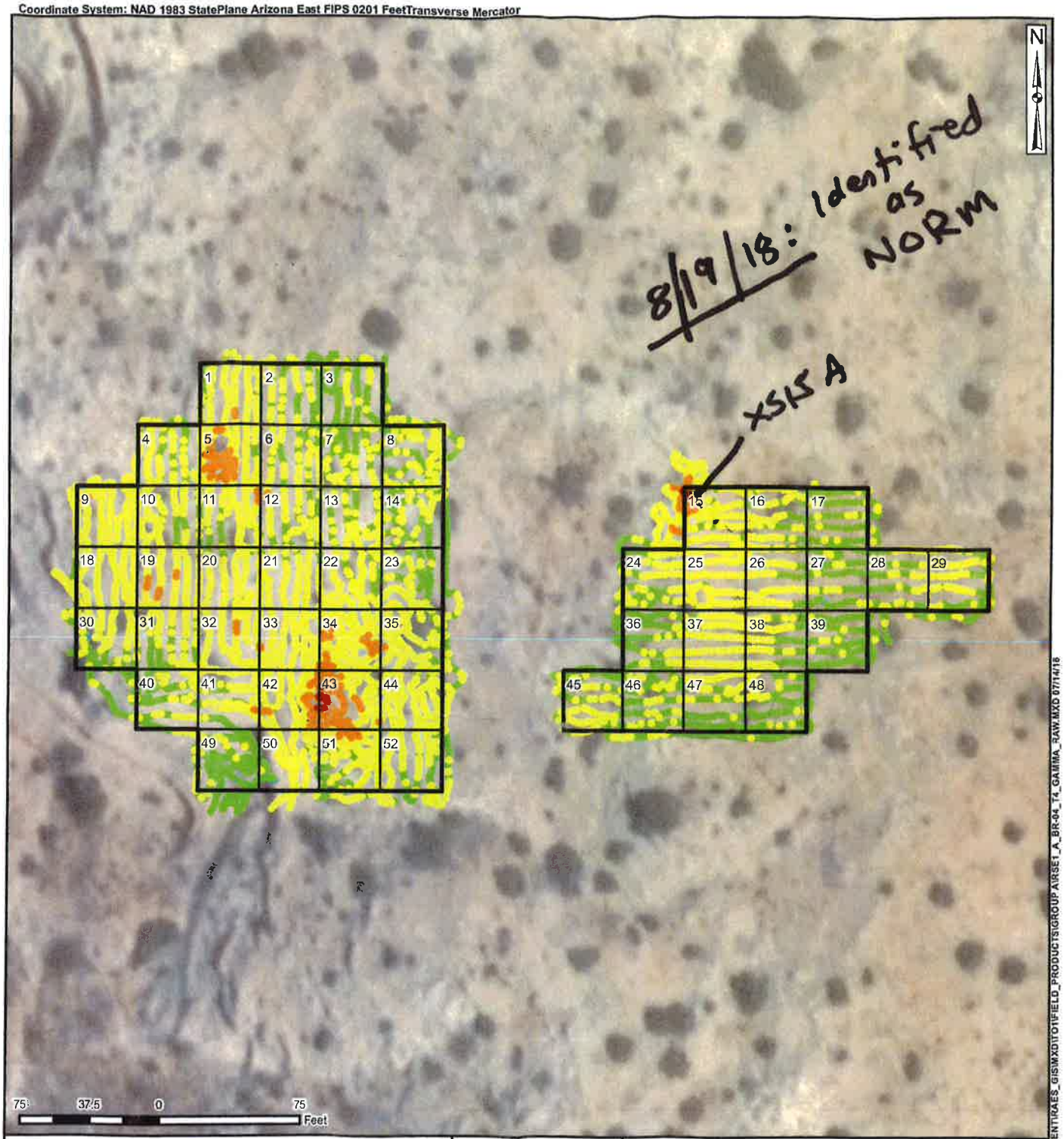
Date: 8/19/18
Weather: Sunny-hazy- hot, breezy
Page No.: 4 of 4
GPS Color: Black

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
G	G1	8/19/18	12:31	N	V ~~26~~ 25 U ~~X~~ 4						
Y	G2		12:30		V 35 U 9						
G	G3		12:34		V 34 U 6						
Y	X2		12:32		V 46 U 8						Reading 25
G	G4		12:36		V 27 U 5						~~Reading 25~~
Y	G7		12:39		V 17 U 9						
G	G50A		12:45		V 123 U 19	V 108 ← 12:46 U 17	yes	T4-XSG50A-01-081819			Sample Time 12:49

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



Gamma Reading (cpm)

- ≤ 7,500
- 7,500 - 10,287
- 10,287 - 20,574
- 20,574 - 41,148
- 41,148 - 75,000
- 75,000 - 175,000
- ≥ 175,000

Survey Grid Unit (100 m²)

Survey Boundary

DRAFT

Note: the Investigation Level (IL) for BR-04 is the 10,287 cpm, which is the UTL 95-95 calculated from gamma radiation levels at BSA-1.

Prepared for: USEPA Region 9

Prepared By:

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

BR-04 TARGET SITE
GAMMA RADIATION LEVEL (cpm)

Task Order No.:	Contract No.:	Figure No.:
TO 001	EP-S9-17-03	T4-A
Location: SWEETWATER CHAPTER NAVAJO NATION	Date: 7/17/2018	

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Gamma C[illegible]elation Soil
Field Form

Site Type: Non AUM/AUM
Site Name: Subarea Group A
Tetra Tech ID: T1,
Sampling Team: DW, TA (ERG
Page No.: 1/

Date: 8/19/18
Weather: Clear/Smoky 90°F
GPS Color: Mesa (ERG)

Example Sample ID: M1-CORR1-01-042218
Example Duplicate ID: M1-CORR1-02-042218

Plot Location	Date (M/D/Y)	Time (MST)	Approx Gamma (cpm)	Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	HPIC Value (µR/Hr)	Notes
T1	8/19/18	1130	~15,000	T1-CORR1-01-081918	N	—	Logged in Instrument	Near HWY ~50' Sparse veg.
T1	8/19/18	1200	~50,000	T1-CORR2-01-081918	N	—	Logged in HPIC	Sparse veg. Lt Brown Reddish sandy, fine to med grains
T2	8/19/18	1300	~10,000	T2-CORR1-01-081918	N	—	Logged HPIC	Silty sand fine to med grains Lt Brown Reddish
T4	8/19/18	1345	~40,000	T4-CORR1-01-081918	N	—	Logged HPIC	Silty sand w/ sandstone present in aggregate above Valley floor Grey
B3	8/19/18	1500	~7000	B3-CORR1-01-081918	YES	B3-CORR1-02-081918	Logged HPIC	Silty sand, Lt. Brown Reddish flat, sparse veg
M2	8/19/18	1600	~~~12,000 Dw~~ ~~10,000~~	M2-CORR1-01-081918	N	—	Logged HPIC	Silty sand, Lt Brown Reddish
M2	8/19/18	1640	~9,000	M2-CORR2-01-081918	N	—	Logged HPIC	Silty sand, Reddish Brown
M2	8/19/18	1700	~7,500	M2-CORR3-01-081918	N	—	Logged HPIC	Silty sand, Reddish Brown
T7	8/19/18	1730	~8,000	~~T7~~ T7-CORR1-01-081918	N	—	Logged HPIC	Silty sand Reddish Brown

Notes to field team:
Record the centroid of each plot on the Trimble GPS Unit.
All correlation samples are nine-point composite samples of 0" to 6" bgs.

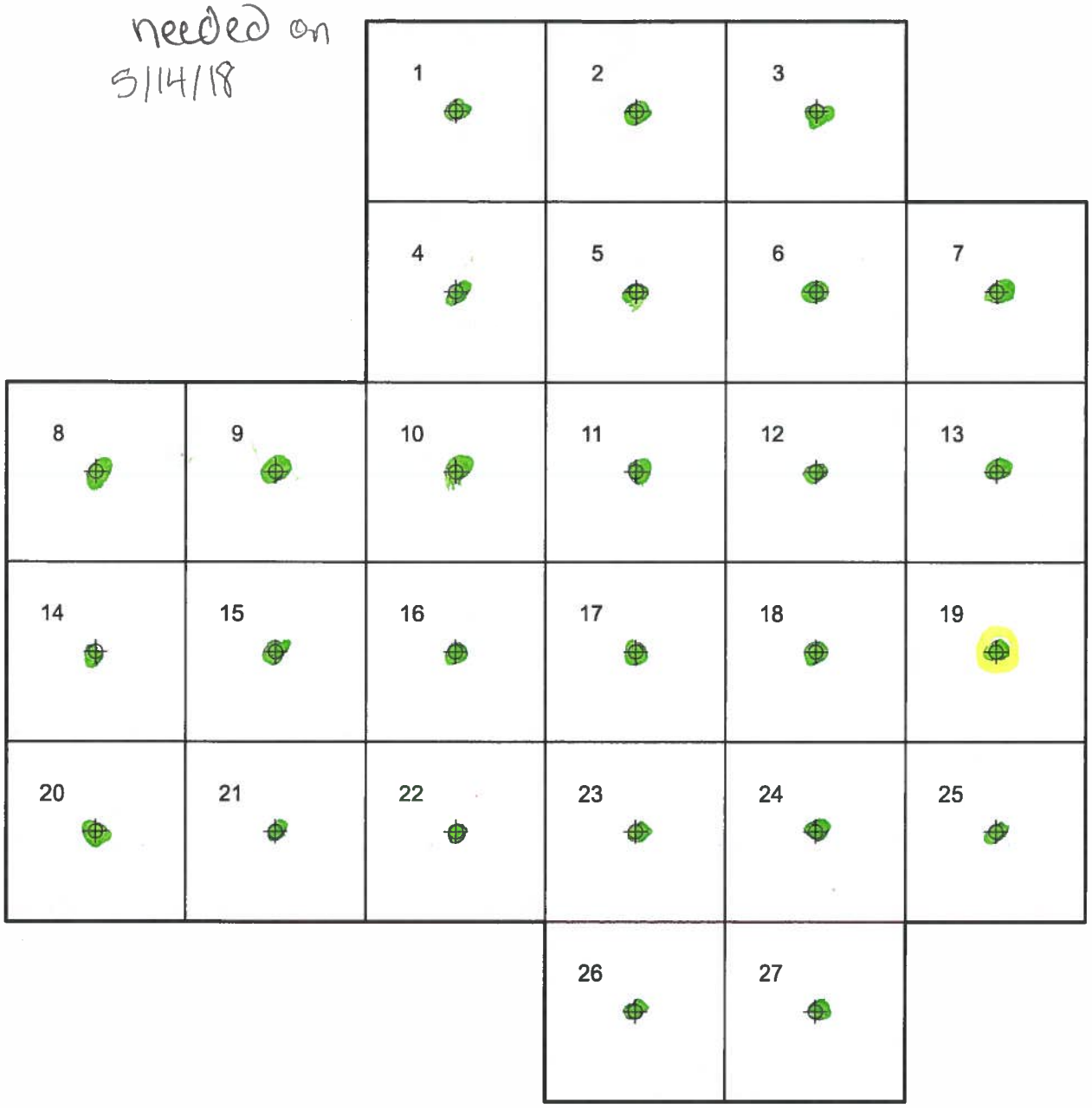
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TARGET T5

FIELD FORMS

XRF SURVEY GRID MAP

#1 Soil Sample needed on 5/14/18



Type: Target Site **Site Name: BR-05**	**TT ID: T5** **Subarea Group: A**	0 12.5 25 Feet N

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XRF . Form

(1)

Site Type: Target
AUM Site: T5
Tetra Tech ID:
Sampling team: AD, CL
XRF Color: green

Date: 5/14/18
Weather: Sunny, windy, 70°F
Page No.: 1 of 3
GPS Color: green

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
x1	5/14/18	1003	V 30 U 7							
x2		1006	V 21 U 4							
x3		1008	V 18 U 4							
x7		1010	V 18 U 6							
x6		1013	V 19 U 3							
x5		1014	V 22 U 3							
x4		1016	V 31 U 6							
x8		1019	V 22 U 7		V 27 U 9					
x9		1023	V 49 U 11							
x10		1025	V 20 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.

P1

XRF Form

(2)

Site Type: Target
AUM Site: T4
Tetra Tech ID:
Sampling team: AD, CL
XRF Color: green

Date: 5/14/18
Weather: sunny, slight wind, 70°F
Page No.: 2 of 3
GPS Color: green

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) V/U	Duplicate Metal Concentration (In Situ XRF Measurement, ppm) V/U	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
x11	5/14/18	1027	N	V 29 U 6						
x12	↓	1030	N	V 26 U 6						
x13		1032	N	V 23 U 5						
x19		1035	N	V 40 U 10	V 35 U 11	Y	T5-XS19-01-051418	N	—	point on access road soil collected @ 1043
x18		1052	N	V 21 U 5						
x17		1055	N	V 22 U 5						
x16		1056	N	V 26 U 6						
x15		1059	N	V 34 U 7						
x14		1101	N	V 32 U 5						
x20	↓	1104	N	V 56 U 7						

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 Form

Site Type: Target
AUM Site: T4
Tetra Tech ID:
Sampling team: AD, CL
XRF Color: Green

V/U

Date: 5/14/18
Weather:

Page No.: 3 of 3
GPS Color: Green

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
x21	5/14/18	1107	N	V 40 U 4						
x22		1109	N	V 30 U 7						
x23		1111	N	V 25 U 4						
x24		1113	N	V 28 U 5						
x25		1116	N	V 30 U 5						
x27		1119	N	V 21 U 1003						
x26		1121	Y	V 22 U 5						adjusted 1m west b/c of sandstone outcrop

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 Form

Site Type: Target
AUM Site:
Tetra Tech ID: T4
Sampling team: AD, CL
XRF Color: green

V/U

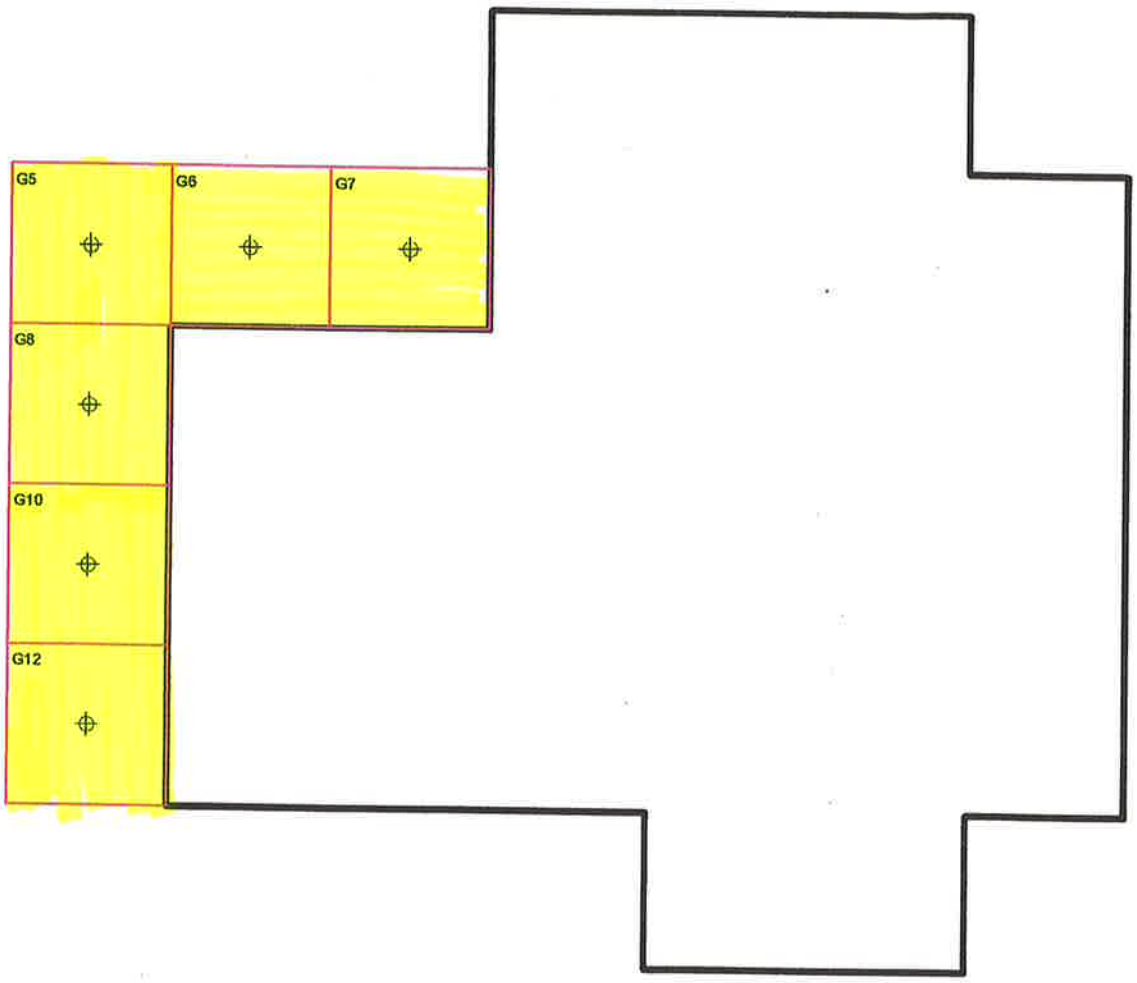
Date: 5/14/18
Weather: cool breeze, 60°F
Page No.: 5
GPS Color: green

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
X24	5/14/18	0915	Yes	V 32 U 6	V 33 U 5	No	-	-	-	XRF Trip. adj 1m east b/c of bedrock
x36	"	0926	N	V 31 U 6	-	"	-	-	-	
x37	"	0928	N	V 44 U 17	-	"	-	-	-	
x25	"	0931	N	V 33 U 5	-	"	-	-	-	
x26	"	0934	N	V 26 U 6	-	"	-	-	-	
x38	"	0938	Y	V 36 U 6	-	"	-	-	-	adjusted 1m east b/c of bedrock
x39	"	0940	N	V 38 U 6	-	"	-	-	-	
x27	"	0943	N	V 33 U 6	-	"	-	-	-	
x28	"	0945	N	V 31 U 6	-	"	-	-	-	
x29	"	0947	N	V 44 U 7	-	"	-	-	-	

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 SURVEY GRID MAP



Type: Non-AUM Target **Site Name: BR-05 Non-AUM Target**	**TT ID: T5** **Subarea Group: A**	0 15 30 Feet N

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XRF Field Form

Site Type: Non-AUM Target
AUM Site: BR05-NON-AUM-Target
Tetra Tech ID: TS
Sampling team: AO, CB, AB
XRF Color: Blue

Date: 8/19/18
Weather: Sunny, hazy, Breezy
Page No.: 1 of 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
G12	8/19/18	1520	No	V = 22 U = 3	—	No	—	—	—	
G10	8/19/18	1525	Yes	V = 41 U = 20	V = 35 U = 21	Yes	TS-XSG10-01-081918 sample time: 1530	—	—	was "hot" from scanning, offset by tree ↗
G8	↓	1532	No	V = 27 U = 7	—	No	—	—	—	
G5		1534	No	V = 24 U = 4	—	No	—	—	—	
G6		1536	No	V = 20 U = 4	—	No	—	—	—	
G7		1538	No	V = 46 U = 6	—	No	—	—	—	

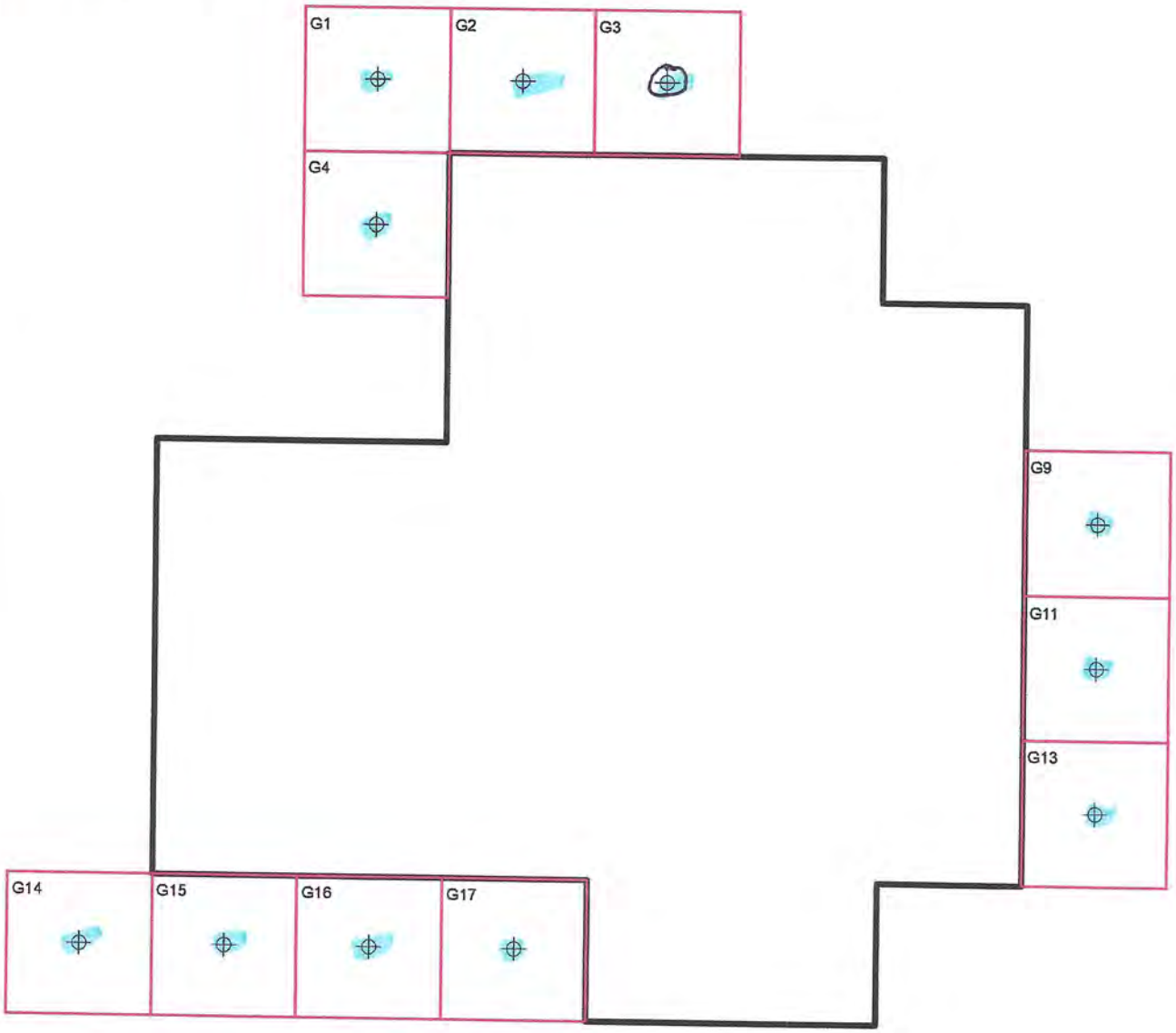
Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are 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 GOBACK SURVEY MAP

Cultural sensitive areas

= XRF

O = sample Collected



Type: Non-AUM Target **Site Name: BR-05 Non-AUM Target**	**TT ID: T5** **Subarea Group: A**	0 15 30 Feet N

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XRF Field Form

AUM site

Site Type: Target Site BRT-05
AUM Site:
Tetra Tech ID: T5
Sampling team: JH, JD
XRF Color: Red

Date: 9-28-2018
Weather: sunny - clear
Page No.: 1/2
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
G17	9-28-18	0906 ~~0907~~	No	V 31 U 6		No		No		
G16		0910	No	V 24 U 6		No		No		
G15		0911	No	V 26 U 4		No		No		
G14		0916	No	V 28 U 6		No		No		
G4		0921	No	V 29 U 6		No		No		
G1		0924	No	V 22 U 5		No		No		
G2		0928	No	V 26 U 6		No		No		
~~G3~~		0932	No	V 28 U 5	V 28 U 5	Yes	T5-XS3-01-092818 XSG3 ~~3~~ 4	Yes	T5-~~XS3~~-02-092818 XSG3 ~~3~~ 4	Bedrock at 3 inch Sample time 0935
G9		0949	No	V 36 U 4		No		No		
G11		0951	No	V 31 U 6		No		No		on two-track road

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

AUM 1

Site Type: Target site BR-05
AUM Site:
Tetra Tech ID: TS
Sampling team: JH, JD
XRF Color: Red

Date: 9-28-2018
Weather: Sunny - clear
Page No.: 2/2
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
G13	9/28/18	0956	No	V 25 V 3		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.

TARGET T6

FIELD FORMS

CA
MS
LS

XRF Form

Site Type: TARGET
AUM Site: BRO-6
Tetra Tech ID: TC
Sampling team: BLUE
XRF Color:

Date: 5/12/18
Weather: CLEAR, WINDY, WARM
Page No.: 1/1
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
X1	5/12/18	1125	NO	V = 22 U = 7	V = 29 U = 3					SLOPE
X2	5/12/18	1134	NO	V = 21 U = <3	V = 27 U = <3	Y	~~PUBS~~ TT-XS2-01-051218			SLOPE ST = 1140
X3	5/12/18	1143	NO	V = 16 U = <4						FLAT CONTOUR
X4	5/12/18	1145	NO	V = 17 U = <5						FLAT CONTOUR
X5	5/12/18	1147	NO	V = 25 U = <4						FLAT CONTOUR
X10	5/12/18	1149	NO	V = 15 U = <3						FLAT CONTOUR
X9	5/12/18	1150	NO	V = 21 U = <3						FLAT CONTOUR
X8	5/12/18	1152	NO	V = 18 U = <3						FLAT CONTOUR
X7	5/12/18	1153	NO	V = 19 U = <4						FLAT CONTOUR
X6	5/12/18	1155	NO	V = 21 U = <5						FLAT CONTOUR

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 Form

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

Date: 2/4
Weather: CLEAR, WINDY, WARM

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
X11	5/12/18	1156	NO	V= 30 U= 4						FLAT CONTOUR
X12	5/12/18	1158	NO	V= 16 U= <4						FLAT CONTOUR
X13	5/12/18	1200	NO	V= 16 U= <3						SLIGHT SLOPE
X14	5/12/18	1201	NO	V= 30 U= <3						SLOPE
X15	5/12/18	1203	NO	V= 26 U= <3						SLIGHT SLOPE
X16	5/12/18	1204	NO	V= 21 U= <5						FLAT CONTOUR
X17	5/12/18	1206	NO	V= 30 U= <3						SLOPE
X24	5/12/18	1208	NO	V= 27 U= <3						SLOPE
X23	5/12/18	1209	NO	V= 33 U= <3						SLOPE
X22	5/12/18	1211	NO	V= 30 U= 4						SLOPE

Notes to field team:
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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.

(MS, CA, LS

XRF (Form

Site Type: T6
AUM Site:
Tetra Tech ID:
Sampling team:
XRF Color:

Date: 5/12/18
Weather: CLEAR, WINDY, HOT
Page No.: 3/4
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
X21	5/12/18	1213	NO	V = 14 U = 4						SLIGHT SLOPE
X20	5/12/18	1215	NO	V = 13 U = <4						SLIGHT SLOPE
X19	5/12/18	1216	NO	V = 25 U = 4						FLAT CONTOUR
X18	5/12/18	1218	NO	V = 26 U = <3						FLAT CONTOUR
X25	5/12/18	1220	NO	V = 22 U = <4	V = 25 U = 3	Yes	T6-XS25-01-051218	N		ST: 1230 FLAT CONTOUR
X26	5/12/18	1228	NO	V 23 U <4						FLAT Reading 3B should be labeled X26
X27	5/12/18	1230	NO	V 16 U <3						FLAT
X28	5/12/18	1233	NO	V = 23 U = <3						FLAT
X29	5/12/18	1235	NO	V = 23 U = <3						Slight slope
X34	5/12/18	1237	NO	V = 23 U = <3						

Notes to field team:
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XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

XRF Form

Site Type: T6
AUM Site:
Tetra Tech ID:
Sampling team: MS, CA, LS
XRF Color: green

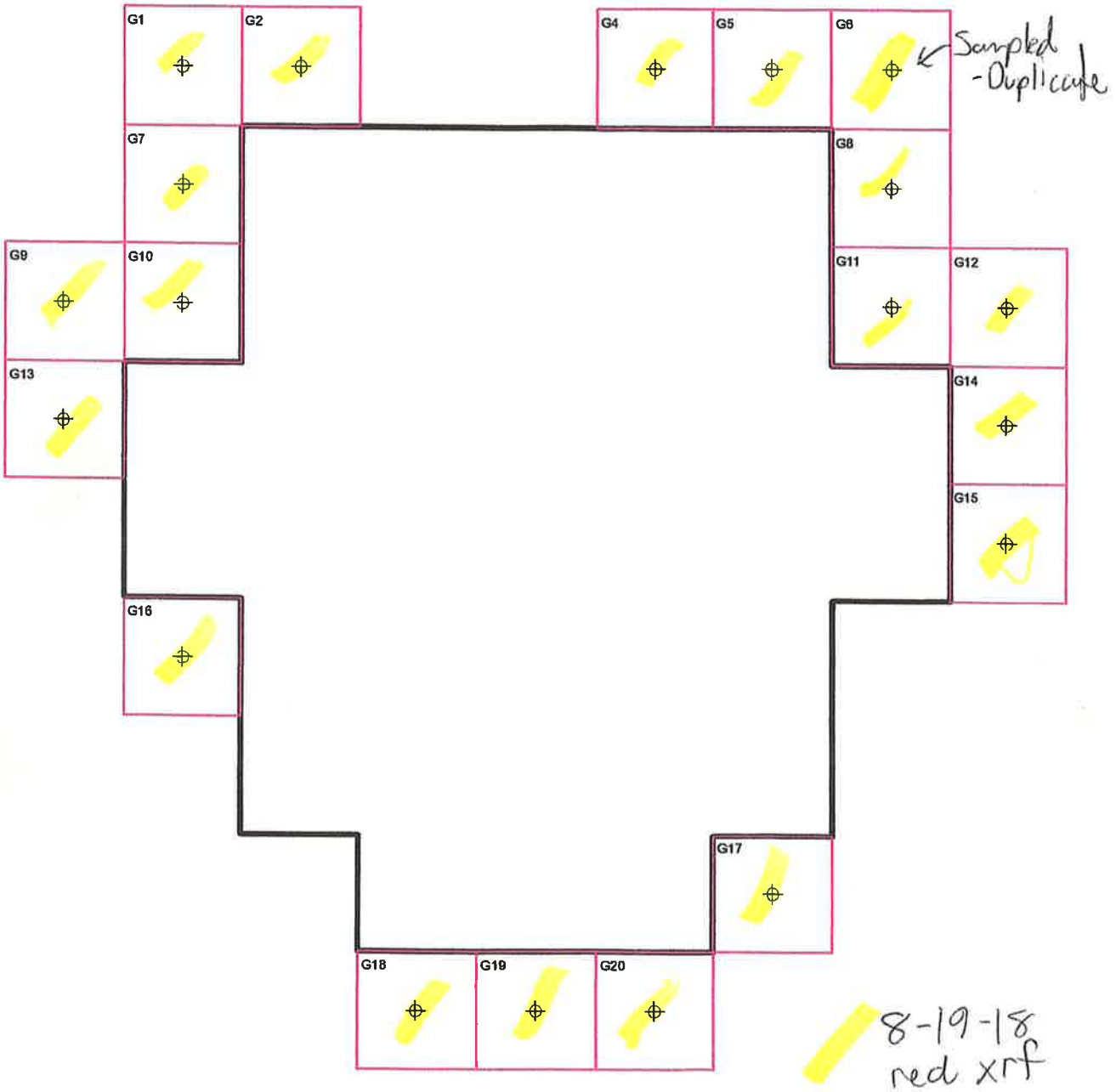
Date: 5/12/18
Weather: clear, 75°F, high winds
Page No.: 4/4
GPS Color: green

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
x33	5/12/18	1238	No	V = 12 U = <4						flat contour
x32	5/12/18	1240	No	V = 11 U = <3						flat contour
x31	5/12/18	1241	No	V = 20 U = 3						flat contour
x30	5/12/18	1243	No	V = 15 U = <3						flat contour
x35	5/12/18	1244	No	V = 20 U = <3						slight slope
x36	5/12/18	1246	No	V = 24 U = <3						slight slope
x37	5/12/18	1248	No	V = 19 U = 4						flat contour

Notes to field team:
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*Select metals TBD in field, note the metal on logsheet.

XRF SURVEY GRID MAP



Type: Non-AUM Target **Site Name: BR-06 Non-AUM Target**	**TT ID: T6** **Subarea Group: A**	0 20 40 Feet N

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XRF Form

Site Type: AUM BR-06 NON AUM TARGET
AUM Site:
Tetra Tech ID: T-6
Sampling team: PATRICK, BRYAN, LEM, MITCH
XRF Color: RED

Date: 8/19/18
Weather: WARM & CLEAR
Page No.: 1
GPS Color: ORANGE

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
G6	8/19/18	1547	NO	V 21 W LOD4	V 18 W LOD3	yes	T6-XSG6-01-081918 sample time 1550	yes	T6-XSG6-02-081918	triplicate
#9 G5		1600	NO	V 15 W LOD4	—	NO		NO		
G4		1602	NO	V 17 W LOD3	—	NO				
G3		1603	NO	V 22 W 3	—	NO				
#12 G2		1606	NO	V 23 W LOD3	—	NO				
G1		1607	NO	V 33 W LOD3	—	NO				
#14 G7		1609	NO	V 24 W 2	—	NO				
~~#15~~ G10		1611	NO	V 17 W LOD4	—	NO				
#16 G9		1613	NO	V 27 W LOD4	—	NO				
G13	↓	1615	NO	V 24 W 3	—	NO				

Notes to field team:
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If a grid cannot be accessed, make a note and describe the reason.
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*Select metals TBD in field, note the metal on logsheet.

XRF Form

Site Type: Target
AUM Site: GRSG T-6
Tetra Tech ID:
Sampling team: PM, MP, LS
XRF Color: red

Date: 8-19-18
Weather: warm & clear

Page No.: 2
GPS Color: orange

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

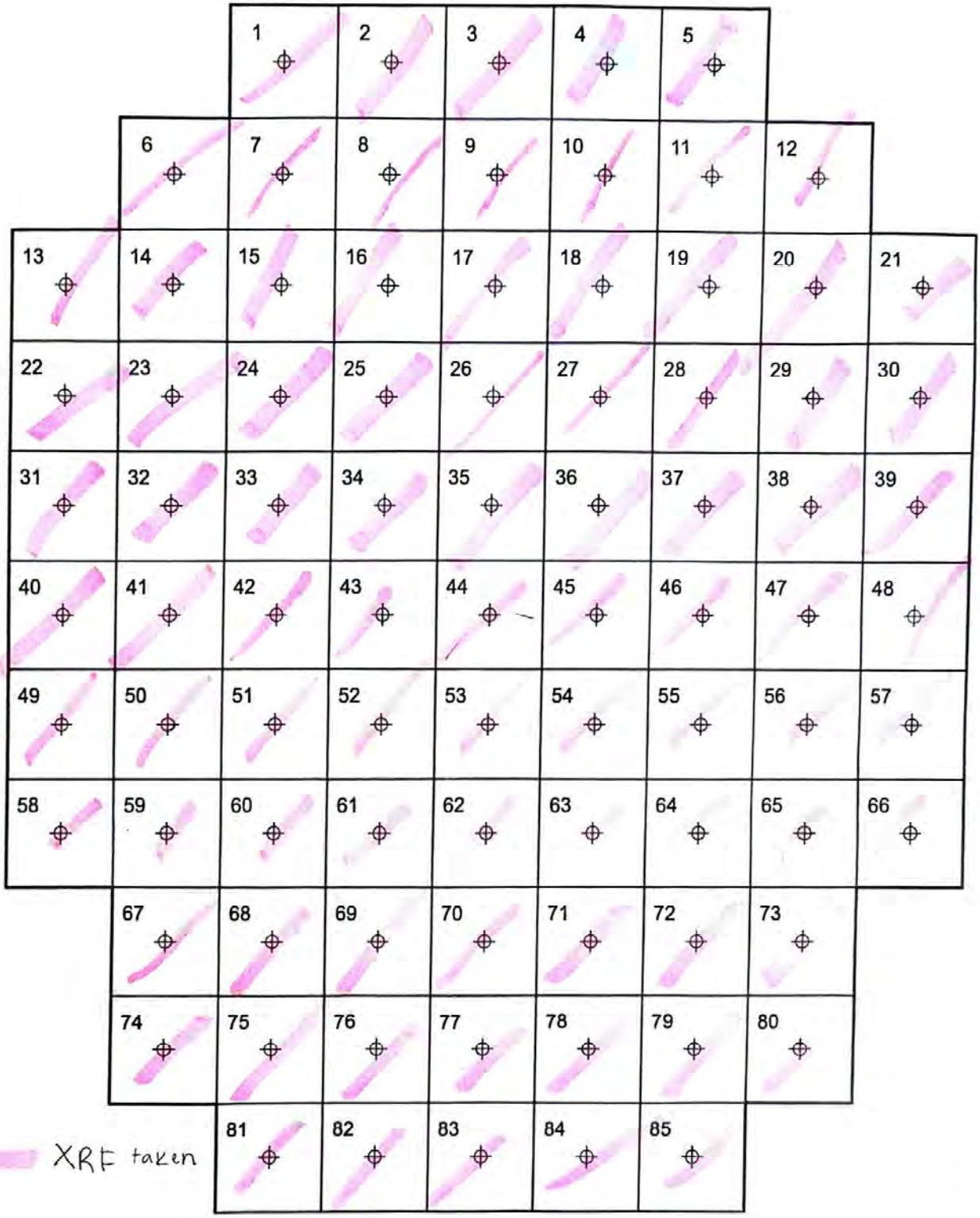
XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
G16	8-19-18	1617	no	V 30 U LOD2	—	no				
#19 G18	↓	1619	no	V 26 U LOD4	—	no				
G19		1621	no	V 20 U LOD3	—	no				
G20		1623	no	V 23 U LOD4	—	no				
#22 G17		1624	no	V 17 U LOD4	—	no				
G15		1627	no	V 19 U LOD2	—	no				
#25 G14		1629	no	V 18 U LOD5	—	no				
G12		1631	no	V 21 U LOD3	—	no				
#27 G11		1634	no	V 22 U LOD2	—	no				
G8	↓	1635	no	V 17 U 3	—	no				

Notes to field team:
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*Select metals TBD in field, note the metal on logsheet.

TARGET T7

FIELD FORMS

XRF SURVEY GRID MAP



Type: Target Site **Site Name: BK-01**	**TT ID: T7** **Subarea Group: B**	0 20 40 Feet N

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XRF Field Form

Site Type: Target Site
Target Site: BK-01
Tetra Tech ID: T7
Sampling team: Megan, Sean, Christian, Antonita
XRF Color: Green

Date: 4/24/18
Weather: Sunny, 65°
GPS Color: Green

Example Sample ID: T7-XS1-01-042218
Example Duplicate ID: T7-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
T7-X1	4/24/18	1025	N	AS 1.0	AS 1.0	N	–	N	–	
T7-X2	4/24/18	1032	N	2.0	/	N	–	N	–	
T7-X3	4/24/18	1036	N	1.0	/	N	–	N	–	took a 2nd XRF scan due to technical error
T7-X4	4/24/18	1048	N	~~LOD~~	/ LOD	N	–	N	–	
T7-X5	4/24/18	1051	N	1.0	/	Y	T7-XS5-01-042418	N	—	Sample taken @ 1636
T7-X6		1053	N	1.0	/	N	–	N	–	
T7-X7		1056	N	~~LOD~~	/	Y	T7-XS7-01-042418 ~~T7-XS7-042418~~	N	—	Sample taken @ 1655
T7-X8		1058	N	1.0	/	N	–	N	–	
T7-X9		1100	N	3.0	/	Y	T7-XS9-01-042418	N	–	Sample taken @ 1651
T7-X10		1104	N	1.0	/	N	–	N	–	

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Bin = Met 1
Bin = Rad 1

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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
T7-X11	4/24/18	1106	N	2.0	/	Y	TT-XS11-01-042418	N	—	Sample taken @1629
T7-X12	4/24/18	1109	N	1.0	/	N	—	N	—	
T7-X13	4/24/18	1114	N	1.0	/		—		-	
T7-X14		1116	N	1.0	/		-		-	
T7-X15		1119	N	1.0	/		-		-	
T7-X16		1121	N	2.0	/		-		-	
T7-X17		1123	N	<LOD	/		-		-	
T7-X18		1126	N	2.0	/		-		-	
T7-X19		1129	N	<LOD	/		-		-	
T7-X20	↓	1131	N	2.0	1.0	↓	-	↓	-	

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XRF Field Form

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
T7-X21	4/24/18	1135	N	>LOD	/	N	-	N	-	
T7-X22	↓	1153	N	2	/	↓	-	↓	-	
T7-X23		1201	N	1.0	/		-		-	
T7-X24		12:05	N	2.0	/		-		-	
T7-X25		12:08	N	>LOD	/		-		-	
T7-X26		12:14	N	>LOD	/		-		-	
T7-X27		12:17	N	>LOD	/		-		-	
T7-X28		12:22	N	1.0	/		-		-	
T7-X29		12:24	N	1.0	/		-		-	
T7-X30	↓	12:24	N	1.0	/	↓	-	↓	-	

Notes to field team:
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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
T7-X31	4/25/18	12:26	N	2.0	—	N	—	N	—	
T7-X32		12:28	N	2.0	—		—		—	
T7-X33		12:31	N	>LOD	—		—		—	
T7-X34		12:33	N	1.0	—		—		—	
T7-X35		12:36	N	>LOD	—		—		—	
T7-X36		12:38	N	>LOD	—		—		—	
T7-X37		12:40	N	2.0	—		—		—	
T7-X38		12:43	N	2.0	—		—		—	
T7-X39		12:46	N	2.0	—		—		—	
T7-X40		1249	N	3.0	2.0	Y	—	Y	—	

Notes to field team:
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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
T7-X41	4/24/18	1252	N	>LOD	—	N	—	N	—	
T7-X42		12:55	N	>LOD	—		—		—	
T7-X43		12:58	N	>LOD	—		—		—	
T7-X44		13:02	N	>LOD	—		—		—	
T7-X45		13:05	N	1.0	—		—		—	
T7-X46		13:08	N	1.0	—		—		—	
T7-X47		1310	N	2.0	—		—		—	
T7-X48		13:13	N	>LOD	—		—		—	
T7-X49		14:08	N	>LOD	—		—		—	
T7-X50		14:11	N	1.0	—		—		—	

Notes to field team:
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XRF Fi[illegible]Form

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
T7-X51	4/24/18	14:14	N	1.0	—	N	—	N	—	
T7-X52	4/24/18	14:16	N	1.0	—	N	—	N	—	
T7-X53	4/24/18	14:19	N	2.0	—	N	—	N	—	
T7-X54	4/24/18	14:22	N	3.0	—	N	—	N	—	
T7-X55	4/24/18	14:25	N	2.0	—	N	—	N	—	
T7-X56	4/24/18	14:27	N	<LOD	—	N	—	N	—	
T7-X57	4/24/18	14:30	N	<LOD	—	N	—	N	—	
T7-X58	4/24/18	14:34	N	4.0	—	Y	T7-XS58-01-042418	N	—	1615 ↓ for soil sample
T7-X59	4/24/18	14:36	N	<LOD	—	N	—	N	—	
T7-X60	4/24/18	14:43	N	<LOD	LOD	N	—	N	—	

Notes to field team:
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XRF F[illegible] Form

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
T7-X61	4/24/14	14:51	N	<LOD	—	N	—	N	—	
T7-X62	4/24/14	14:52	N	1.0	—		—		—	
T7-X63	4/24/14	14:54	N	2.0	—		—		—	
T7-X64	4/24/14	14:56	N	1.0	—		—		—	
T7-X65	4/24/14	14:59	N	2.0	—		—		—	
T7-X66	4/24/14	15:01	N	<LOD	—		—		—	
T7-X67	4/24/14	1511	N	<LOD	—		—		—	
T7-X68	4/24/14	1514	N	1.0	—		—		—	
T7-X69	4/24/14	1515	N	<LOD	—		—		—	
T7-X70	4/24/14	1517	N	1.0	—		—		—	x7 shots - same location see below

Notes to field team:
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*Select metals TBD in field, note the metal on logsheet.

X70
1. 1.0
2. <LOD
3. 1.0
4. 2.0
5. <LOD
6. 1.0
7. 1.0

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
T7-X71	4/24/18	1528	N	1.0	—	N	—	N	—	
T7-X72	4/24/18	1530	N	<LOD	—		—		—	
T7-X73	4/24/18	1532	N	<LOD	—		—		—	
T7-X74	4/24/18	1536	N	<LOD	—		—		—	
T7-X75	4/24/18	1539	N	<LOD	—		—		—	
T7-X76	4/24/18	1541	N	1.0	—		—		—	
T7-X77	4/24/18	1542	N	1.0	—		—		—	
T7-X78	4/24/18	1544	N	<LOD	—		—		—	
T7-X79	4/24/18	1546	N	<LOD	—		—		—	
T7-X80	4/24/18	1549	N	1.0	—		—		—	

Notes to field team:
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*Select metals TBD in field, note the metal on logsheet.

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
T7-X81	4/24/18	1552	N	< LOD	—	N	—	N	—	
T7-X82	4/24/18	1554	N	< LOD	—	↓	—	↓	—	
T7-X83	4/24/18	1557	N	< LOD	—	↓	—	↓	—	
T7-X84	4/24/18	1601	N	1.0	—	↓	—	↓	—	
T7-X85	4/24/18	1603	N	1.0	—	↓	—	↓	—	

Equipment Rinsate Blank Collected? (Yes or No)	
If Yes, Sample ID	
Date	
Time	

EXAMPLE: T7-ER-042218 (Mine ID dash ER for equipment rinsate dash date)

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 in the notes section and describe the reason.
XRF confirmation samples are collected with in situ XRF measuremnts.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metal TBD in field, noted on logsheet.

Gamma C[illegible]elation Soil
Field Form

Site Type: Non AUM/AUM
Site Name: Subarea Group A
Tetra Tech ID: T1,
Sampling Team: DW, TA (ERG
Page No.: 1/

Date: 8/19/18
Weather: Clear/Smoky 90°F
GPS Color: Mesa (ERG)

Example Sample ID: M1-CORR1-01-042218
Example Duplicate ID: M1-CORR1-02-042218

Plot Location	Date (M/D/Y)	Time (MST)	Approx Gamma (cpm)	Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	HPIC Value (µR/Hr)	Notes
T1	8/19/18	1130	~15,000	T1-CORR1-01-081918	N	—	Logged in Instrument	Near HWY ~50' Sparse veg.
T1	8/19/18	1200	~50,000	T1-CORR2-01-081918	N	—	Logged in HPIC	Sparse veg. Lt Brown Reddish sandy, fine to med grains
T2	8/19/18	1300	~10,000	T2-CORR1-01-081918	N	—	Logged HPIC	Silty sand fine to med grains Lt Brown Reddish
T4	8/19/18	1345	~40,000	T4-CORR1-01-081918	N	—	Logged HPIC	Silty sand w/ sandstone present in aggregate above Valley floor Grey
B3	8/19/18	1500	~7000	B3-CORR1-01-081918	YES	B3-CORR1-02-081918	Logged HPIC	Silty sand, Lt. Brown Reddish flat, sparse veg
M2	8/19/18	1600	~~~12,000 Dw~~ ~~10,000~~	M2-CORR1-01-081918	N	—	Logged HPIC	Silty sand, Lt Brown Reddish
M2	8/19/18	1640	~9,000	M2-CORR2-01-081918	N	—	Logged HPIC	Silty sand, Reddish Brown
M2	8/19/18	1700	~7,500	M2-CORR3-01-081918	N	—	Logged HPIC	Silty sand, Reddish Brown
T7	8/19/18	1730	~8,000	~~T7~~ T7-CORR1-01-081918	N	—	Logged HPIC	Silty sand Reddish Brown

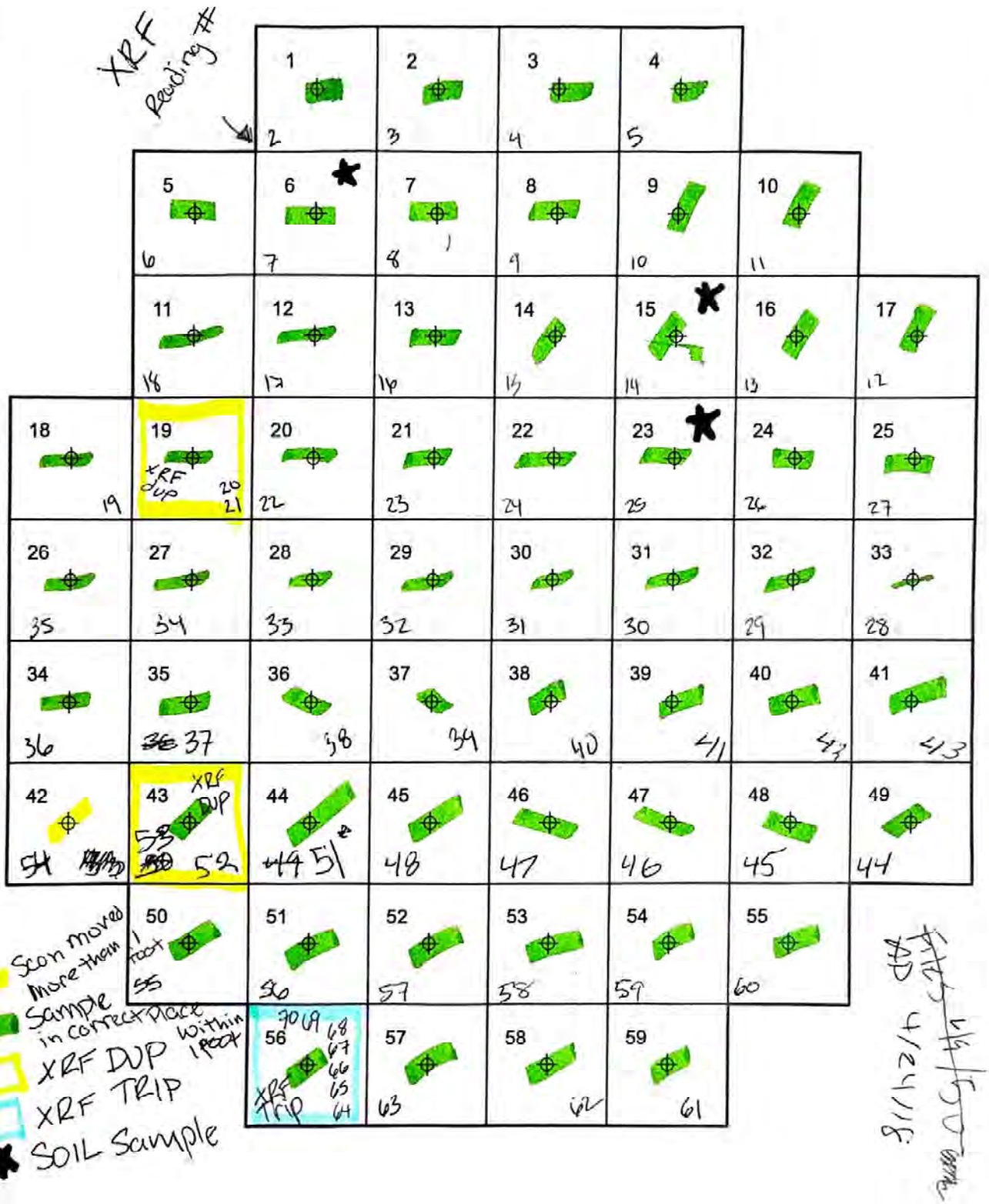
Notes to field team:
Record the centroid of each plot on the Trimble GPS Unit.
All correlation samples are nine-point composite samples of 0" to 6" bgs.

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TARGET T8

FIELD FORMS

XRF SURVEY GRID MAP



Type: Target Site **Site Name: BK-02**	**TT ID: T8** **Subarea Group: B**	0 15 30 Feet N

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XRF Field Form

Site Type: Target Site
Target Site: BK-02
Tetra Tech ID: T8
Sampling team: Matt B. Mark N. Annika D. As / H.
XRF Color: Orange Jim

Date: 4/24/18
Weather: sunny, light breeze
GPS Color: Orange

Example Sample ID: T8-XS1-01-042218
Example Duplicate ID: T8-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
T8-X1	4/24/18		no	~~2.0/3.0~~ AD 4/24/18 2.0/3.0	no					Mn: 138
T8-X2	11		no	<1.0/<3.0	no					Mn: 90.0
T8-X3	11		no	1.0/<3.0	no					Mn: 137
T8-X4	11	10:28	no	<2.0/<3.0	no					Mn: 142.0
T8-X5	11	10:36	no	<2.0/<3.0	no					Mn: 120.
T8-X6	11	10:38	no	<1.0/<3.0	no	yes	T8-XS6-01-042418	no		Mn: 71.0 Sample Time 15:01 *
T8-X7	11	10:44	no	2.0/<3.0	no					Mn: 109
T8-X8	11	10:48	~~yes~~ no	2.0/<3.0	no					Mn: 127
T8-X9	11	10:52	no	1.0/3.0	no					Mn: 87.0
T8-X10	11	10:56	no	<1.0/<1.0	no					Mn: 133

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.

Bin = Rad 1
Bin = Met 1

As/U

ple	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
T8-X11	4/24/18	11:21	no	1.0/<3.0	no					Mn = 156.0
T8-X12	11	11:18	no	1.0/<3.0	no					Mn = 107.0
T8-X13	11	11:13	no	1.0/<3.0	no					Mn = 137.0
T8-X14	11	11:09	no	1.0/4.0	no					Mn: 139
T8-X15	11	11:06	no	1.0/3.0	no	~~YES~~	T8-XSB-01-042418	N		Sample time: 1516 Mn: 135.0
T8-X16	11	11:02	no	2.0/<3.0	no					Mn: 158
T8-X17	11	10:58	no	<2.0/4.0	no					Mn: 120.0
T8-X18	11	11:24	no	2.0/<3.0	no					Mn=83.0
T8-X19	11	11:26	no	<1.0/3.0 <2.0/4.0 dup	YES					Mn = 109.0 Mn = 110.0 Dup
T8-X20	11	11:31	no	<1.0/<3.0	no					Mn=144.0

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.

AS/U

XRF Fi[illegible]orm

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
T8-X21	4/24/18	11:34	no	~~<3.0~~ <1.0/<3.0 AD 4/24/18	no					Mn = 113.0
T8-X22	"	11:36	no	2.0/3.0	no					Mn = 121.0
T8-X23	"	11:38	no	1.0/3.0	no	Yes	T8-XS23-01-042418	N		Mn = 179.0 Sample: 15:28 *
T8-X24	"	11:41	no	<1.0/<3.0	no					Mn = 112.0
T8-X25	"	11:47	no	1.0/3.0	no					Mn = 151.0
T8-X26	"	12:11	no	2.0/4.0	no					Mn = 139.0
T8-X27	"	12:07	no	1.0/<3.0	no					Mn = 114.0
T8-X28	"	12:05	no	2.0/3.0	no					Mn = 172.0
T8-X29	"	12:01	no	~~3.0~~ 1.0/~~1.0~~ 3.0	no					Mn = 142.0
T8-X30	"	11:59	no	1.0/<3.0	no					Mn = 106.0

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.

As/U

XRF Fi Form

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
T8-X31	4/24/18	11:51	no	<1.0/3.0	no					Mn= 153.0
T8-X32	"	11:54	no	<1.0/3.0	no					Mn = 125
T8-X33	"	11:50	no	2.0/<3.0	no					Mn = ~~to~~ 139.0 AO 4/~~24~~/18
T8-X34	"	12:16	no	2.0/<3.0	no					Mn = 120.0
T8-X35	"	12:19	no	1.0/3.0	no					Mn = 109.0
T8-X36	"	12:24	no	1.0/3.0	no					Mn = 143.0
T8-X37	"	12:29	no	1.0/<3.0	no					Mn = 134.0
T8-X38	"	12:32	no	<2.0/<3.0	no					Mn = 127.0
T8-X39	"	12:35	no	<1.0/<3.0	no					Mn = 97.0 Pile of Site was under manure
T8-X40	"	12:39	no	1.0/<3.0	no					Mn = 150.0

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.

As/U

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
T8-X41	4/24/18	12:41	no	2.0/<3.0	no					Mn=136.0
49 T8-X42	"	12:43	no	1.0/<3.0	no					~~Mn 104.0~~ Mn=104.0
T8-X43	"	13:19 13:18	no	1.0/<3.0 2.0/<3.0	yes				Mn 115 @	/ Dup Mn= 116
T8-X44	"	13:13	no	2.0/<3.0	no					~~Dup data Mn ①~~ Mn=100 ~~Mn ②~~
T8-X45	"	13:03	no	<1.0/<3.0	no					Mn=105.0
T8-X46	"	13:00	no	1.0/<3.0	no					Mn=111.0
T8-X47	"	12:58	no	1.0/<3.0	no					Mn=84.0
~~52~~ T8-X48	"	12:55	no	<2.0/<3.0	no					Mn= 108.0
42 T8-X49	"	1326	~~no~~ yes	<2.0/<3.0	no					Mn=110 Bush on proposed point
T8-X50	"	1330	no	20/<30	no					Mn=136

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.

* T8-X44: Readings 49 and 50 did not run full 60s → need to mark scan as unused. Scan #51 was correct for T8-X44 & ran full time.

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AS/U

XRF Fi[illegible] Form

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
T8-X51	4/24/18	1332	no	<2.0/<3.0	no					Mn = 128.0
T8-X52	"	1335	no	2.0/<3.0	no					Mn = 163.0
T8-X53	"	1338	no	1.0/<3.0	no					Mn = 86.0
T8-X54	"	1340	no	1.0/3.0	no					Mn = 121.0
T8-X55	"	1344	no	2.0/3.0	no					Mn = 132.0
T8-X56	"	1400	no	Reading 70 2.0/<3.0	yes → 7 shots					Triplicate: 7 shots Mn = 166
T8-X57	"	1351	no	3.0/<3.0	no					Mn = 150
T8-X58	"	1349	no	2.0/<3.0	no					Mn = 137
T8-X59	"	1347	no	1.0/<3.0	no					Mn = 134.0

Equipment Rinsate Blank Collected? (Yes or No)	NO
If Yes, Sample ID	
Date	
Time	

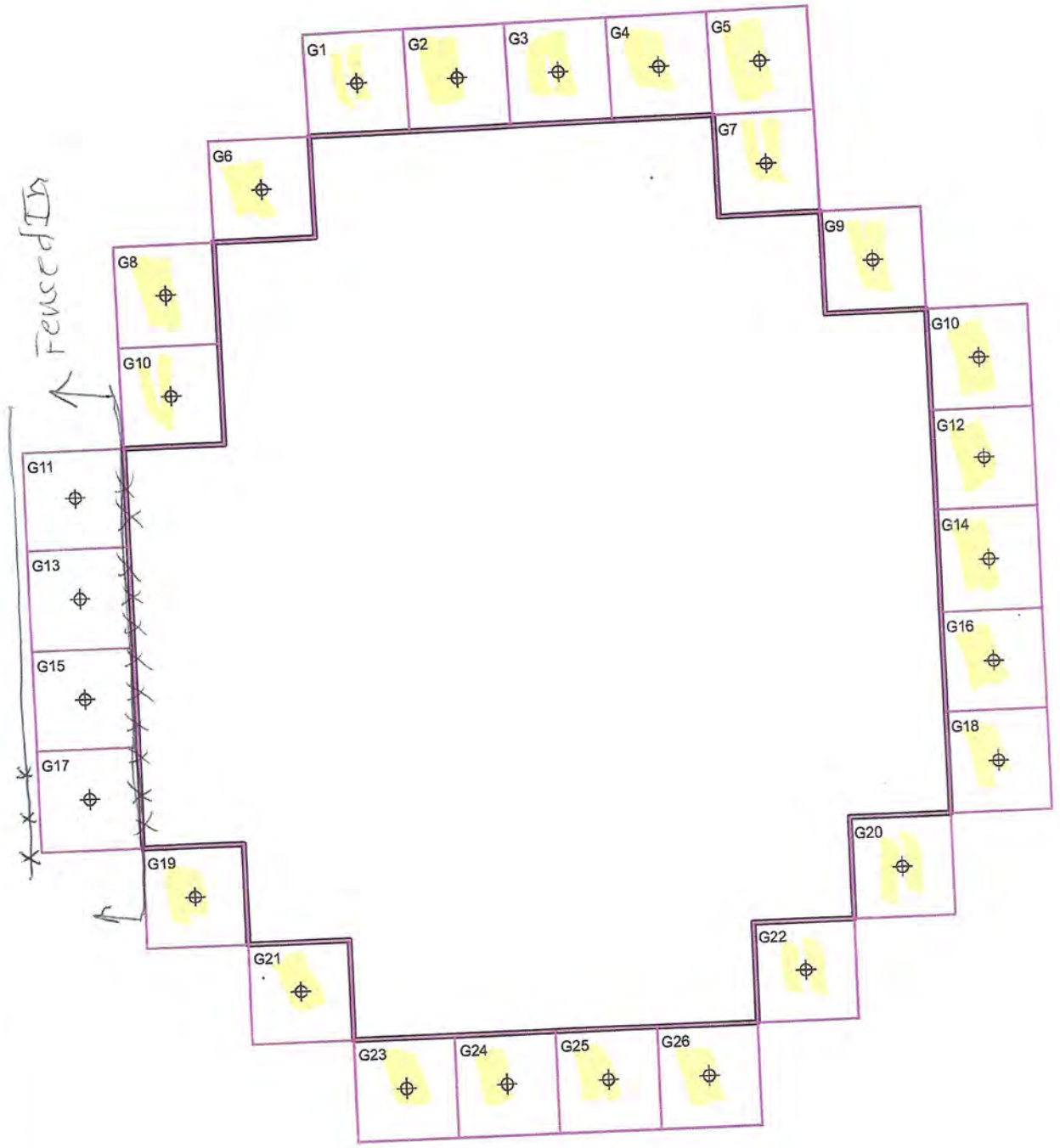
EXAMPLE: T8-ER-042218 (Mine ID dash ER for equipment rinsate dash date)

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 in the notes section and describe the reason.
XRF confirmation samples are collected with in situ XRF measuremnts.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metal TBD in field, noted on logsheet.

XRF SURVEY GRID MAP



Type: Non-AUM Target	**TT ID: T8**	0 25 50 Feet
Site Name: BK-02 Non-AUM Target	**Subarea Group: B**	N

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XRF Field Form

Site Type: NonAUM
AUM Site: BK-02
Tetra Tech ID: T8
Sampling team: CL, AC, JO, RK, MW
XRF Color: Green-yellow

Date: 8/19/18
Weather: Sunny - Hazy -
Page No.: 1 of 3
GPS Color: Black

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
Y	G7	8/19/18	16:52		V 19 U <4						U = LOD 4
G	G5	8/19/18	16:53		V 19 U <3						Reading 61 U = LOD 3
G	G4		16:55		V 18 U <6						U = LOD 6
Y	G3		1654		V 18 U 3						
G	~~G2~~		1657		V 24 U <4						In access Rd. U = LOD 4
Y	G1		1656		V 25 U 4						
G	G6*		1659		V 69 U						Low battery retest
Y	G8		1659		V 19 U <3						U = LOD 3
G	G6*		1703		V ~~19~~ U ~~<3~~						retesting
Y	G10	↓	1701		V 19 U <3						NW Corner U = LOD 3

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: Non AUM
AUM Site: BK-02
Tetra Tech ID: TT
Sampling team: EL, AC, JD, IR, MW
XRF Color: Green, yellow

Date: 8/19/18
Weather: sunny, hazy
Page No.: 2 of 3
GPS Color: Black

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
G	G6	8/19/18	1705		V 20 U <3						reading 72 Backup battery to retesting failed
G	G21		1707		V 35 U <5						U = LOD 5
Y	G19		1704		V 28 U <3						U = LOD 3
Y	G23		1707		V 25 U 4						
G	G24		1710		V 26 U <4						U = LOD 4
Y	G25		1709		V 26 U 4						
G	G26		1712		V 33 U <4						U = LOD 4
Y	G22		17 11		V 24 U 5						
G	G20		1715		V 20 U <7						U = LOD 7
Y	G18	↓	1714		V 22 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.

XRF Field Form

Site Type: NonAUM
AUM Site: BK-02
Tetra Tech ID: T8
Sampling team: LL, AC, JD, RK, MW
XRF Color: Green, yellow

Date: 8/19/18
Weather: sunny, hot

Page No.: 3 of 3
GPS Color: Black

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
G	G16	8/19/18	1717		V 32 U <LOD						U = LOD 6
Y	G14				V 18 U 6						
G	G12		1719		V 23 U_1 <LOD	V 28 U_2 <LOD					U_2 = LOD 6 U_1 = LOD 7
Y	G10		1722		V_1 23 U_1 4	V_2 25 U_2 5					NE corner
G	G9		1725 ~~1525~~		V 26 U <~~LOD~~	~~U_2~~ ~~U_2~~					U_1 = LOD 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.

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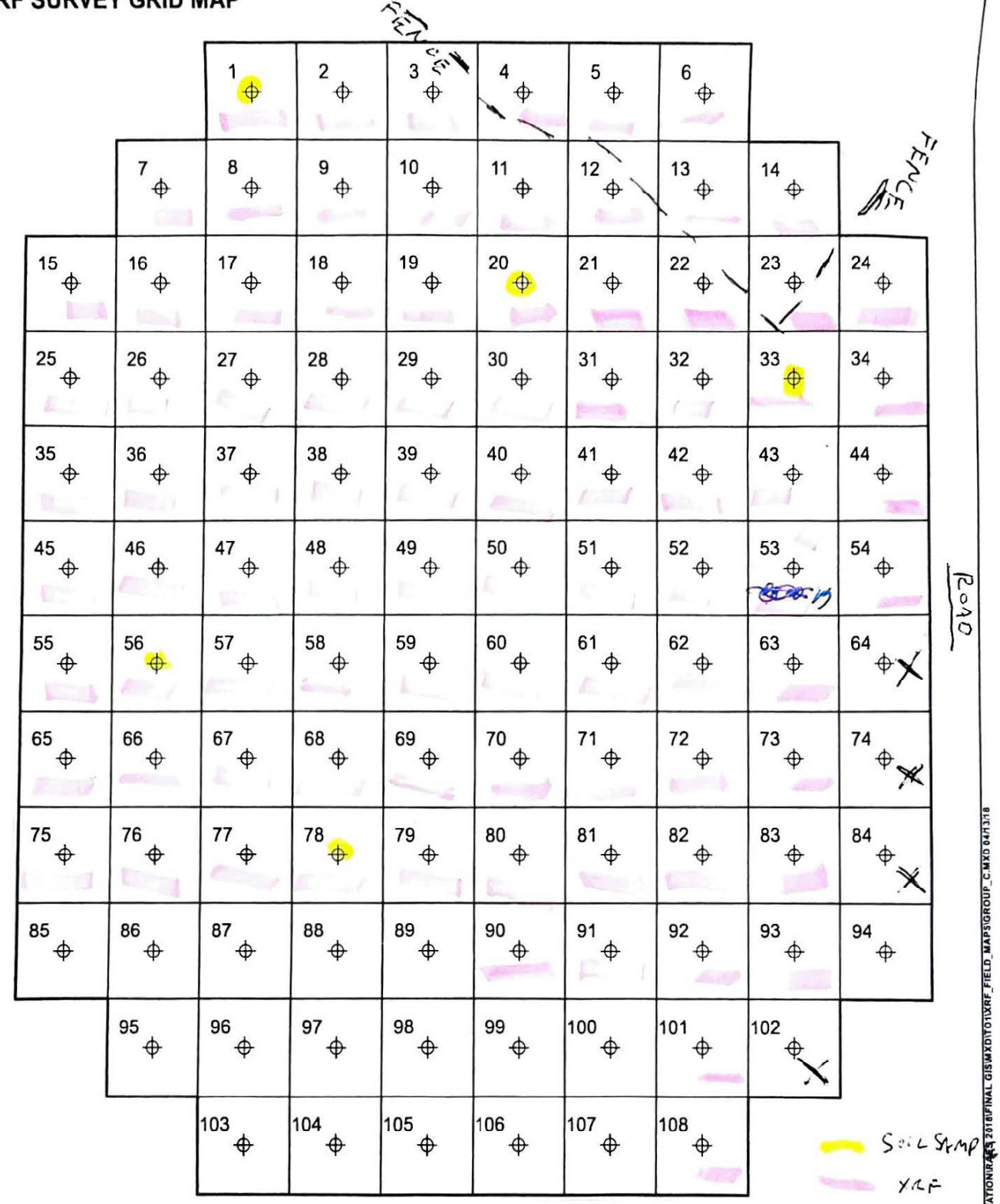
ERG

TARGET T10

FIELD FORMS

04/25/18

XRF SURVEY GRID MAP



Type: Target Site **Site Name:** CT-01	**TT ID:** T10 **Subarea Group:** C	0 20 40 Feet N

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YES 4/25/18
~~4/25 AB samples put in~~
~~Rad 3 bin & M~~

XRF Field Form

Site Type: Target Site
Target Site: CT-01
Tetra Tech ID: T10
Sampling team: MP, CL, RD, JRT, MB
XRF Color: GREEN

Date: 04 25 18
Weather: SUNNY 60° LIGHT BREEZE,
GPS Color: GREEN

Example Sample ID: T10-XS1-01-042218
Example Duplicate ID: T10-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
										Sample taken at 1107 ↓
T10-X1	04/25/18	1051	N	V 46, 41, 46, 42, 42, 41, 38	YES (7)	YES	T-10-XS1-01-042518	~~X~~ NO	~~T-10-XS1-02-042518~~ NONE	7 XRFs TAKEN A2 U5 NO DUPLICATE SOIL
T10-X2	04/25/18	1105	N	V 36	N	N				
T10-X3	04/25/18	1111	N	V 40	N	N				A U3
T10-X4	04/25/18	1115	N	V 40	N	N				A2 U4
T10-X5	04/25/18	1119	N	V 52	N	N				
T10-X6	04/25/18	1121	N	V 36	N	N				
T10-X7	04/25/18	1141	N	V 30	N					
T10-X8	04/25/18	1139	N	V 39	N					U4 A2
T10-X9	04/25/18	1137	N	V 38	N	N				U5 A3
T10-X10	04/25/18	1135	N	V 26	N	N				U4 SAND

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.

Note: Samples from 4125 QC'd and put in bins Rad 3 and Metal 3

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
T10-X11	04/25/18	1132	N	V 40	N	N				SANDY U4 A2
T10-X12	04/25/18	1129	N	V 26	N	N				U4
T10-X13	04/25/18	1127	N	V23	N	N				
T10-X14	04/25/18	1124	N	V 26	N	N				
T10-X15	04/25/18	1144	N	V40	N					U3 A2
T10-X16	04/25/18	~~1144~~ 1148	N	~~V40~~ V44	N					~~U3~~ U5 ~~A2~~ A3 SANDY
T10-X17	04/25/18	1149	N	V33	N					U4 A2
T10-X18	04/25/18	1151	N	V25	N					
T10-X19	04/25/18	1153	N	V31	N					A1
T10-X20	04/25/18	1157 1159	N	V44 V41	YES	YES	T10-XS20-01-042518			A1 2 XRFs TAKEN

Sample time 1205

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.

[illegible]	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
[illegible]1	04/25/18	1211	N	V55	N					U5 A2
[illegible]22	04/25/18	1213	N	V38	N					U5
[illegible]-X23	04/25/18	1217	N	V32	N					
[illegible]0-X24	04/25/18	1225	N	V35	N					U6 A1
[illegible]10-X25	04/25/18	1435	N	V44	N					U4 A3
T10-X26	4/25/18	1433	N	V47	N					U4 A2
T10-X27	4/25/18	1431	N	V37	N					U5 A3
T10-X28	4/25/18	1429	N	V38	N					U5 A3
T10-X29	4/25/18	1427	N	V49	N					U6 A3
T10-X30	4/25/18	1426	N	V41	N					U- A2

Notes to field team:
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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 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
T10-X31	4/25/18	1424	N	V32	N	N				U4 A2
T10-X32	4/25/18	1423	N	V30	N	N				U3
T10-X33	4/25/18	1408	N	V41	V32	Y	T10-XS33-01-042518	N		U4 A1 Sample Time: 1415
T10-X34	04/25/18	1229	N	V33	N					U5 A2
T10-X35	4/25/18	1438	N	V35	N 4-25-18 XRM	N		N		U- A3
T10-X36	4/25/18	1439	N	V40	N	N		N		U7 A3
T10-X37	4/25/18	1442	N	V40	N	N				U5 A3
T10-X38	4/25/18	1443	N	V43		N				U4 A3
T10-X39	4/25/18	1446	N	V31		N				U4 A3
T10-X40	4/25/18	1447	N	V36		N				U5 A3

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 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
T10-X41	04/25/18	1449	N	V37		N				U4 A1
T10-X42	4/25/18	1451	N	V42		N				U4 A3
T10-X43	4/25/18	1453	N	V36		N				U4 A—
T10-X44	04/25/18	1230	N	V41	N					U5 A3
T10-X45	4/25/18	1511	N	V35		N				U4 A3
T10-X46	4/25/18	1509	N	V38		N				U5 A4
T10-X47	4/25/18	1507	N	V46		N				U5 A2
T10-X48	4/25/18	1505	N	V54		N				U4 A3
T10-X49	4/25/18	1503	N	V42		N				U4 A2
T10-X50	4/25/18	1501	N	V28		N				U5 A1

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 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
T10-X51	4/25/18	1500	N	V34		N				U 5 A 3
T10-X52	4/25/18	1457	N	V42		N				U 6 A 3 Possible Grid # not changed
T10-X53	4/25/18	1455	N	V43		N				U 5 A 2
T10-X54	04/25/18	~~1230~~ 1233	N	~~V41~~ V34	N					U 5 A 3 XRF GRID A SAFETY CHK MSG
T10-X55	4/25/18	1513	N mm 4-25-18	V49		N				U 4 A 4
T10-X56	4/25/18	1515	~~N~~ mm 4-25-18 N	V49	V42	~~N~~ mm 4-25-18 Y	T10-X556-01-042518	N		U 6 A 3 Sample Time: 1520
T10-X57	4/25/18	1520	N	V39		N				U 4 A 4
T10-X58	4/25/18	1522	N	V32		N				U 6 A 3
T10-X59	4/25/18	1524	N	V41		N				U 3 A 2
T10-X60	4/25/18	1526	N	V38		N				U 5 A 2

Notes to field team:
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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 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
T10-X61	4/25/18	1528	N	V 35		N				U 5 A 4
T10-X62	4/25/18	1529	N	V 34		N				U 5 A 1
T10-X63	04/25/18	1236	N	V 25	N					U 4 A 2
T10-X64										NOT MEASURED LOCATION IS IN THE ROAD
T10-X65	4/25/18	1545	N	V 35		N				U 3 A 3
T10-X66	4/25/18	1543	N	V 37		N				U 7 A 2
T10-X67	4/25/18	1541	N	V 35		N				U 5 A 3
T10-X68	4/25/18	1539	N	V 37		N				U 5 A 3
T10-X69	4/25/18	1537	N	V 39		N				U 4 A 2
T10-X70	4/25/18	1535	N	V 42		N				U 4 A 1

Notes to field team:
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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 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
T10-X71	4/25/18	1533	N	V 41		N				U 5 A 2
T10-X72	4/25/18	1531	N	V 48		N				U 6 A 1
T10-X73	04/25/18	~~1244~~ 1238	N	V 40	N					U 5 A 2
T10-X74										NOT SAMPLED IN ROAD
T10-X75	4/25/18	1547	N	V 35		N				U 3 A 3
T10-X76	4/25/18	1549	N	V 42		N				U 4 A 3
T10-X77	4/25/18	1551	N	V 44		N				U 5 A 2
T10-X78	4/25/18	1553	N	V	V 51	Y	T10-X578-01-042518	N		U A Sample Time: 1555
T10-X79	4/25/18	1603	N	~~V 40~~ V 4-25-18		N				U 5 A 2
T10-X80	4/25/18	1605	N	V 39		N				U 4 A 2

Notes to field team:
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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 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
T10-X81	4/25/18	1607	N	V55		N				U 9 A 2
T10-X82	4/25/18	1609	N	V43		N				U 6 A 2
T10-X83	4/25/18	1534	N	V47	N					US A2
T10-X84										NOT SAMPLED IN ROAD
T10-X85										
T10-X86										
T10-X87										
T10-X88										
T10-X89										
T10-X90	4/25/18	1614	N	V40		N				U 3 A 1

Notes to field team:
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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 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
T10-X91	4/25/18	1212	N	V48		N				V 7 A 2
T10-X92	04/25/18	1243	N	V43	N					UC A2
T10-X93	04/25/18	~~1244~~ 1241	N	V41	N					UC A3
T10-X94										
T10-X95										
T10-X96										
T10-X97										
T10-X98										
T10-X99										
T10-X100										

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.
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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 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
T10-X101	04/25/18	1246	N	V50	N					US A3
T10-X102										NOT SAMPLED IN ROAD
T10-X103										
T10-X104										
T10-X105										
T10-X106										
T10-X107	4/25/18	~~1249~~ 0f	N							
T10-X108	04/25/18	1249	N	V31	N	N				U5, A1

Equipment Rinsate Blank Collected? (Yes or No)	
If Yes, Sample ID	
Date	
Time	

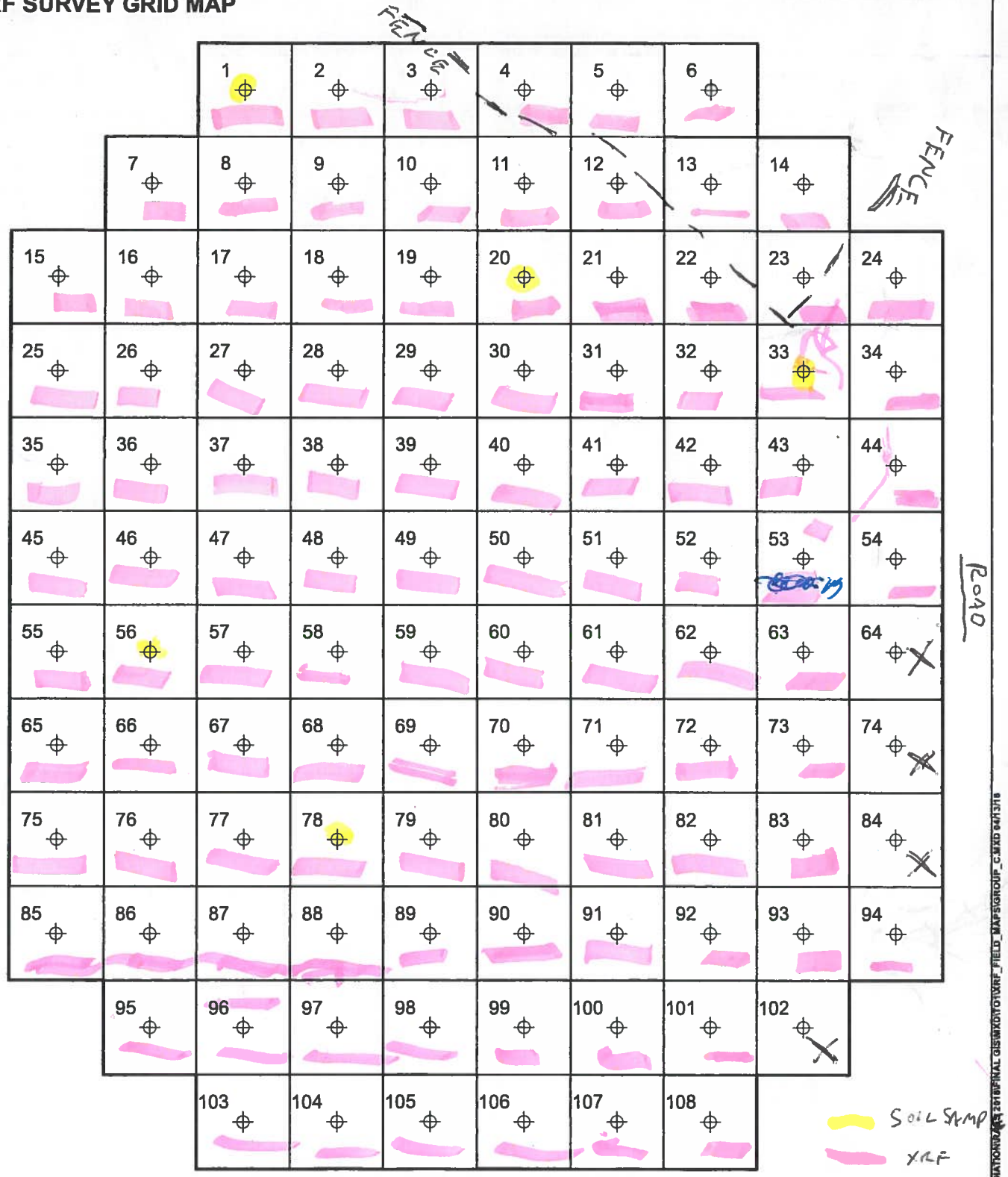
EXAMPLE: T10-ER-042218 (Mine ID dash ER for equipment rinsate dash date)

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 in the notes section and describe the reason.
XRF confirmation samples are collected with in situ XRF measuremnts.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metal TBD in field, noted on logsheet.

04/25/18

XRF SURVEY GRID MAP



Type: Target Site **Site Name:** CT-01	**TT ID:** T10 **Subarea Group:** C	0 20 40 Feet N

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T10
TR
T37

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XRF . Form

Site Type: AUM
AUM Site: CTU1 AMONITA
Tetra Tech ID: T10 LEMUR
Sampling team: MITCH
XRF Color: ORANGE

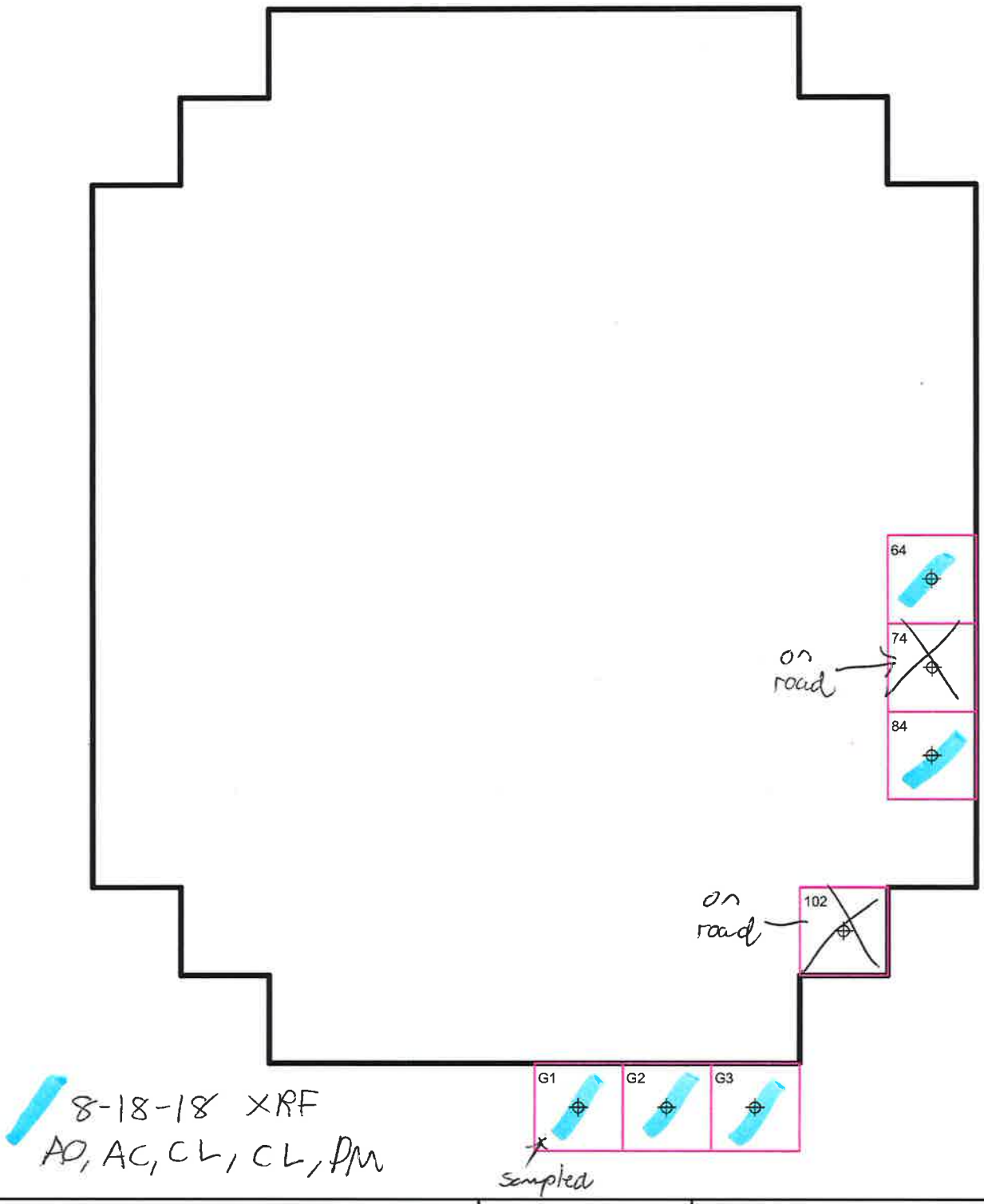
Date: 5/14/18
Weather: SUNNY 70 BREEZE 4
Page No.: 2
GPS Color: ORANGE

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
X100	5/14/18 ~~1037~~	1037	N	V 44 U C		N				
X89	5/14/18	1039	N	V 36 U 5		N				R21
X88	5/14/18	1041	N	V 37 U 5		N				R22
X87	5/14/18	1042	N	V 50 U <3		N				
X86	5/14/18	1044	N	V 32 U <6		N				
X85	5/14/18	1046	N	V 47 U 4		N				
X94	5/14/18	1050	N	V 51 U 6		N				OFFSET DUE TO CULVERTS

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 SURVEY GRID MAP



Type: Non-AUM Target **Site Name: CT-01 Non-AUM Target**	**TT ID: T10** **Subarea Group: C**	0 25 50 Feet N

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XRF Form

Site Type: Target
AUM Site: CTO1
Tetra Tech ID: T10
Sampling team: CL, CL, PM, AO, AC
XRF Color: purple, red, blue

Date: 8-18-18
Weather: clear, windy
Page No.: 1
GPS Color: Black

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
P G3 #39	8-18-18	1624	no	V 36 U 4						
B G2	8-18-18	1622	no	V 37 U 7						
R X84		1626	no	V 39 U 7						
P X64 #40		1627	yes	V 28 U LOD4						offset rd.
B G1		1627	no	V 26 U 5	V 46 U 5		T10-XSG1-01-051818 sample time 1630			

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.

Gamma Correlation Soil
Field Form

Site Type: AUM + TARGETS
Site Name: Mesa II, Cove Transfer
Tetra Tech ID: M27, T11, T9, T10
Sampling Team: TA, DW
Page No.: 1/1

Date: 9/25/18
Weather: Partly Cloudy 80°F
GPS Color: ERG Mesa

Example Sample ID: M1-CORR1-01-042218
Example Duplicate ID: M1-CORR1-02-042218

Plot Location	Date (M/D/Y)	Time (MST)	Approx Gamma (cpm)	Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	HPIC Value (µR/Hr)	Notes
M27	9/25/18	1000	30K	M27-CORR1-01-092518	N	—	—	H05
M27		1015	23K	M27-CORR2-01-092518	N	—	—	H04
T11		1320	9K	T11-CORR1-01-092518	Yes	T11-CORR1-02-092518	—	C04
T9		1400	10K	T9-CORR1-01-092518	N	—	—	C03
T10	↓	1440	13K	T10-CORR1-01-092518	N	—	—	C05
—								

Notes to field team:
Record the centroid of each plot on the Trimble GPS Unit.
All correlation samples are nine-point composite samples of 0" to 6" bgs.

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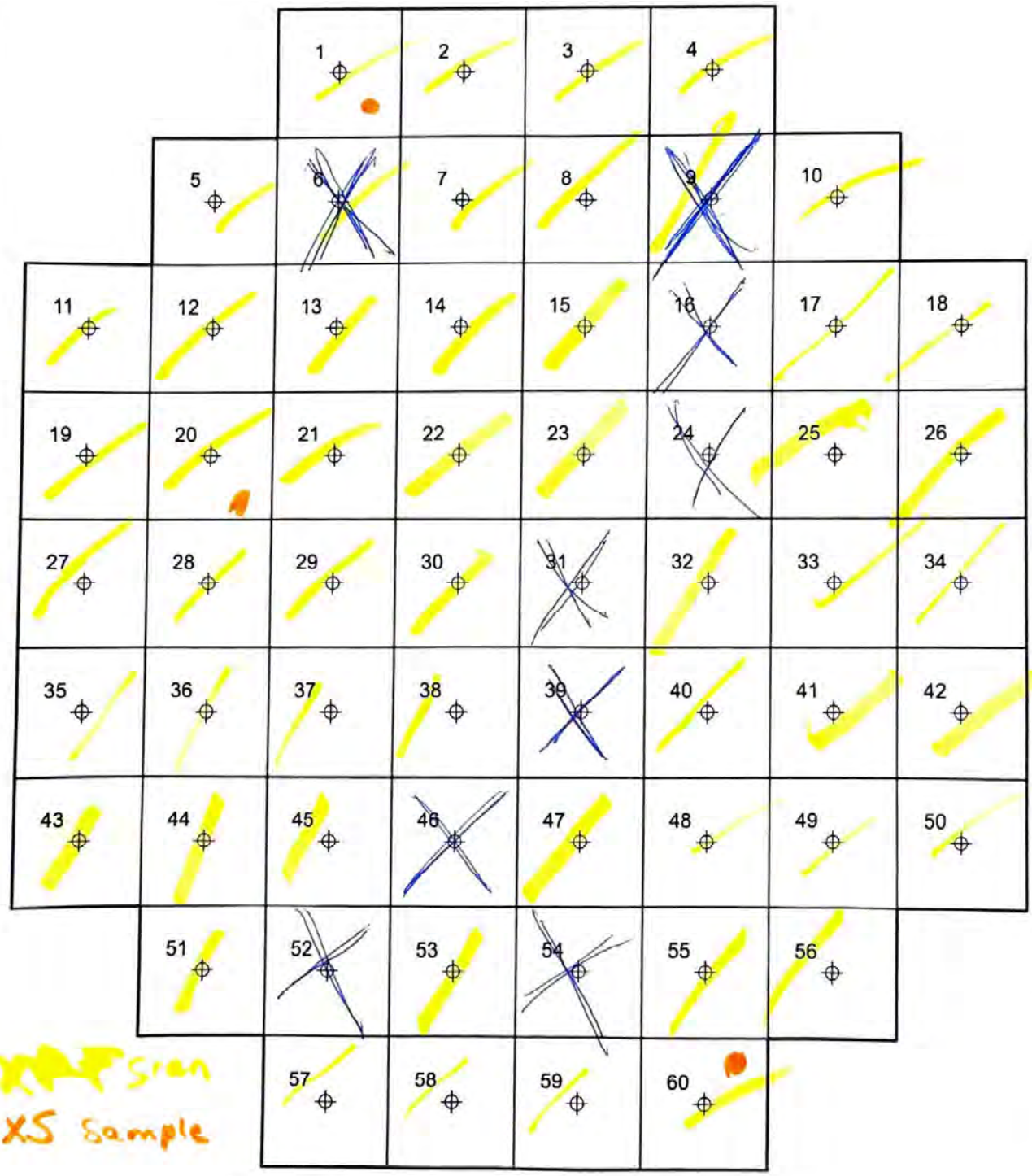
TETRA TECH

ERG

TARGET T11

FIELD FORMS

XRF SURVEY GRID MAP



• XRF Scan

• XS Sample

X pavement

Type: Target Site **Site Name:** CT-02	**TT ID:** T11 **Subarea Group:** C	0 15 30 Feet N

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Completed Grid on 4/25

XRF Field Form

Site Type: Target Site
Target Site: CT-02
Tetra Tech ID: T11
Sampling team: Antonita, Sean, Mikus, Megan
XRF Color: Blue

Date: 4-25-2018
Weather: Clear, sunny, 65°F
GPS Color: BLUE

Example Sample ID: T11-XS1-01-042218
Example Duplicate ID: T11-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
T11-X1	4/25/18	1040	N	AS 4.0	AS 3.0	Y	T11-XS1-01-042518 1045	N	–	time 1045 triplicate (see below)
T11-X2		1048	N	3.0	–	N	–	N	–	
T11-X3		1052	N	2.0	–	N	–	N	–	XRF Reading taken in middle of roadway
T11-X4		1055	N	6.0	–	N	–	N	–	
T11-X5		1058	N	3.0	–	N	–	N	–	
T11-X6		1100	N	2.0	–	N	–	N	–	
T11-X7		1102	N	2.0	–	N	–	N	–	
T11-X8		1215	N	<LOD	–	N	–	N	–	
T11-X9										paved road
T11-X10		1316	N	1.0	–	N	–	N	–	

Notes to field team:
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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.

4/25/18 samples were QC'd and put in Met 3 and Rud 3 bins.

Additional XRF samples at XT: ~~LOD~~ (3) 4.0
(4) 2.0
(5) 3.0
(6) 3.0
(7) 4.0

TETRA TECH

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
T11-X11	4/25/18	1112	N	3.0	—	N	—	N	—	
T11-X12		1110	N	3.0	—	N	—	N	—	
T11-X13		1108	N	2.0	—	N	—	N	—	
T11-X14		1106	N	3.0	—	N	—	N	—	
T11-X15		1213	N	<LOD	—	N	—	N	—	
T11-X16										paved road
T11-X17		1314	N	<LOD	~~N~~	N	—	N	—	
T11-X18		4/25/18	N	2.0	—	N	—	N	—	
T11-X19		1113	N	3.0	—	N	—	N	—	
T11-X20		1115	N	3.0	3.0	Y	T11-XS20-01-042518	N	—	Sample taken @ 1146

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.
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XRF confirmation samples are collected from 0" to 3" bgs.
*Select metals TBD in field, note the metal on logsheet.

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
T11-X21	4/25/18	1120	N	2.0	—	N	—	N	—	
T11-X22	4/25/18	1124	N	3.0	—	N	—	N	—	was not removed to x22 (x21 again)
T11-X23	4/25/18	1211	N	<LOD	—	N	—	N	—	
T11-X24										paved road
T11-X25	4/25/18	1313	N	1.0	—	N	—	N	—	
T11-X26	4/25/18	1320	N	2.0	—	N	—	N	—	
T11-X27	4/25/18	1130	N	2.0	—	N	—	N	—	
T11-X28	4/25/18	1126	N	3.0	—	N	—	N	—	
T11-X29	4/25/18	1124	N	3.0	—	N	—	N	—	
T11-X30	4/25/18	1209	N	<LOD	—	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 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
T11-X31										paved Road
T11-X32	4/25/18	1220	N	2.0	—	N	—	N	—	
T11-X33	4/25/18	1325	N	<LOD	—	N	—	N	—	
T11-X34	4/25/18	1324	N	1.0	—	N	—	N	—	
T11-X35	4/25/18	1133	N	2.0	—	N	—	N	—	
T11-X36	4/25/18	1135	N	2.0	—	N	—	N	—	
T11-X37	4/25/18	1137	N	3.0	—	N	—	N	—	
T11-X38	4/25/18	1206	N	<LOD	—	N	—	N	—	
T11-X39										paved
T11-X40	4/25/18	1310	N	2.0	—	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 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
T11-X41	4/25/18	1327	N	3.0	—	N	—	N	—	
T11-X42	4/25/18	1330	N	2.0	—	N	—	N	—	
T11-X43	4/25/18	1140	N	<LOD	—	N	—	N	—	
T11-X44	4/25/18	1142	N	2.0	—	N	—	N	—	
T11-X45	4/25/18	1203	N	<LOD	—	N	—	N	—	
T11-X46										paved road
T11-X47	4/25/18	1307	N	3.0	—	N	—	N	—	
T11-X48	4/25/18	1336	N	<LOD		N	—	N	—	
T11-X49	4/25/18	1335	N	1.0	—	N	—	N	—	
T11-X50	4/25/18	1332	N	2.0	—	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 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
T11-X51	4/25/18	1201	N	2.0	~~N~~ —	N	—	N	—	trigger pulled more than once
T11-X52					—	N	—	N		paved road
T11-X53	4/25/18	1305	N	3.0	—	N	—	N	—	~~edge~~ Side of road right of way
T11-X54										paved driveway off of paved road
T11-X55	4/25/18	1338	N	2.0	—	N	—	N	—	
T11-X56	4/25/18	1340	N	<LOD	—	N	—	N	—	
T11-X57	4/25/18	1259	N	<LOD	—	N	—	N	—	
T11-X58	4/25/18	1301	N	2.0	—	N	—	N	—	
T11-X59	4/25/18	1350	N	2.0	—	N	—	N	—	
T11-X60	4/25/18	1342	N	1.0	1.0	Y	T11-XS60-01-042518	N	—	Sample taken @ 1345

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.

Equipment Rinsate Blank Collected? (Yes or No)	
If Yes, Sample ID	EXAMPLE: T11-ER-042218 (Mine ID dash ER for equipment rinsate dash date)
Date	
Time	

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 in the notes section and describe the reason.
XRF confirmation samples are collected with in situ XRF measuremnts.
XRF confirmation samples are collected from 0" to 3" bgs.
*Select metal TBD in field, noted on logsheet.

Gamma Correlation Soil
Field Form

Site Type: AUM + TARGETS
Site Name: Mesa II, Cove Transfer
Tetra Tech ID: M27, T11, T9, T10
Sampling Team: TA, DW
Page No.: 1/1

Date: 9/25/18
Weather: Partly Cloudy 80°F
GPS Color: ERG Mesa

Example Sample ID: M1-CORR1-01-042218
Example Duplicate ID: M1-CORR1-02-042218

Plot Location	Date (M/D/Y)	Time (MST)	Approx Gamma (cpm)	Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	HPIC Value (µR/Hr)	Notes
M27	9/25/18	1000	30K	M27-CORR1-01-092518	N	—	—	H05
M27		1015	23K	M27-CORR2-01-092518	N	—	—	H04
T11		1320	9K	T11-CORR1-01-092518	Yes	T11-CORR1-02-092518	—	C04
T9		1400	10K	T9-CORR1-01-092518	N	—	—	C03
T10	↓	1440	13K	T10-CORR1-01-092518	N	—	—	C05
—								

Notes to field team:
Record the centroid of each plot on the Trimble GPS Unit.
All correlation samples are nine-point composite samples of 0" to 6" bgs.

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TETRA TECH

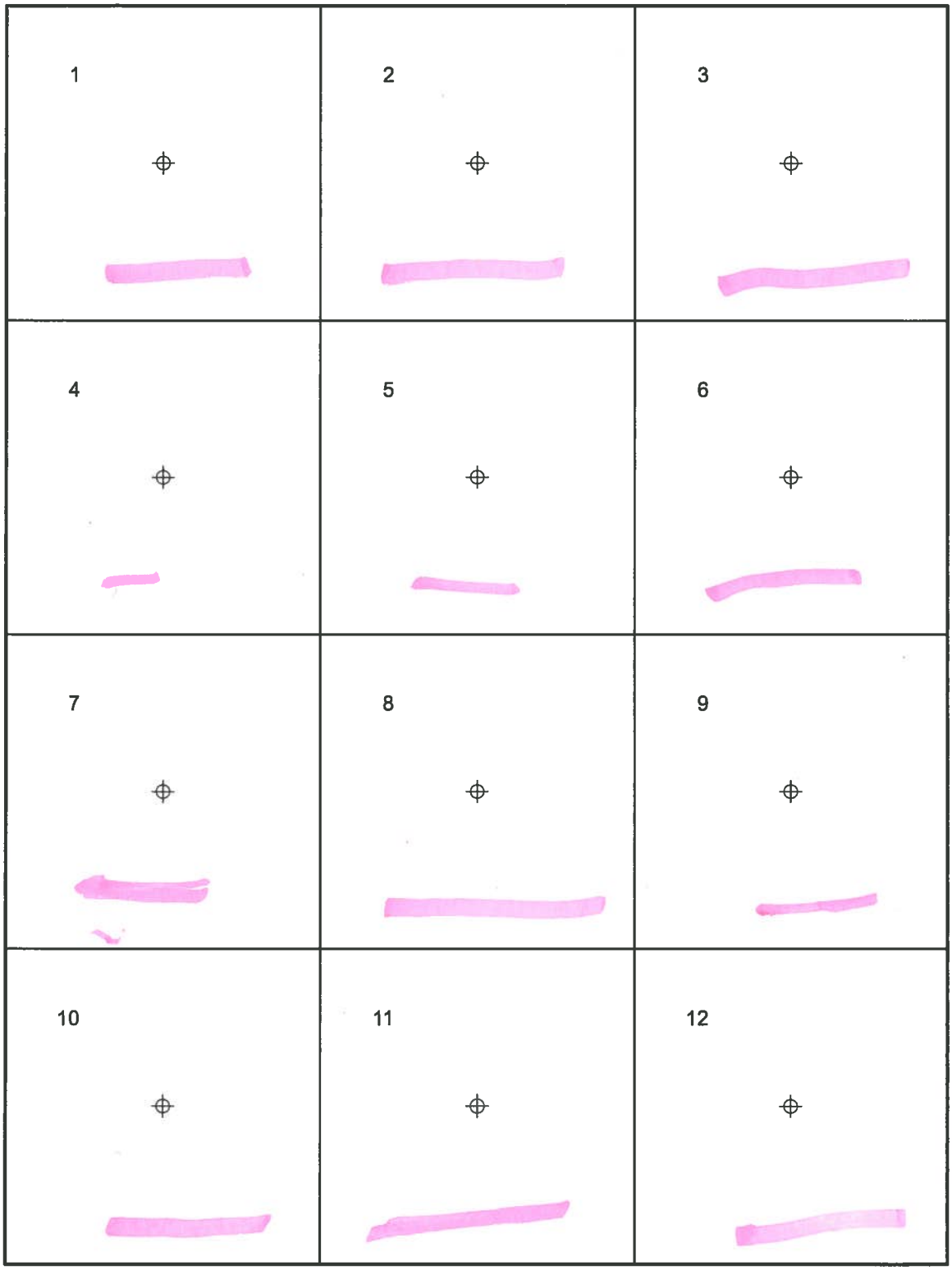
ERG

TARGET T12

FIELD FORMS

XRF SURVEY GRID MAP

= XRF PITCH 5/14/18



Type: Target Site **Site Name: CT-03**	**TT ID: T12** **Subarea Group: C**	0 5 10 Feet N

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XRF ORANGE - OK

XRF . Form

Site Type: AUN
AUM Site: CT-03
Tetra Tech ID: T-12
Sampling team: ANTONITA, LEMUEL, MITCH
XRF Color: ~~ORANGE~~ BLACK

Date: ~~5~~/14/18
Weather:
Page No.: 1
GPS Color: ~~ORANGE~~ GPS BLACK

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

FILE B050418A

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
X7	5/14/18	1322	V 41 U 5			N				R=53
X10	5/14/18	1324	V 37 U <3	V 29 U 4		N				
X11	5/14/18	1327	V 31 U 3			N				
X12	5/14/18	1329	V 39 U 5			N				R=57
X9	5/14/18	1331	V 45 U <3			N				
X8	5/14/18	1333	V 45 U 4			N				
X6	5/14/18	1335	V 46 U 5			N				
X3	5/14/18	1337	V 43 U <3			N				
X2	5/14/18	1339	V 52 U 5			N				
X1	5/14/18	1341	V 39 U 4			N				R G3

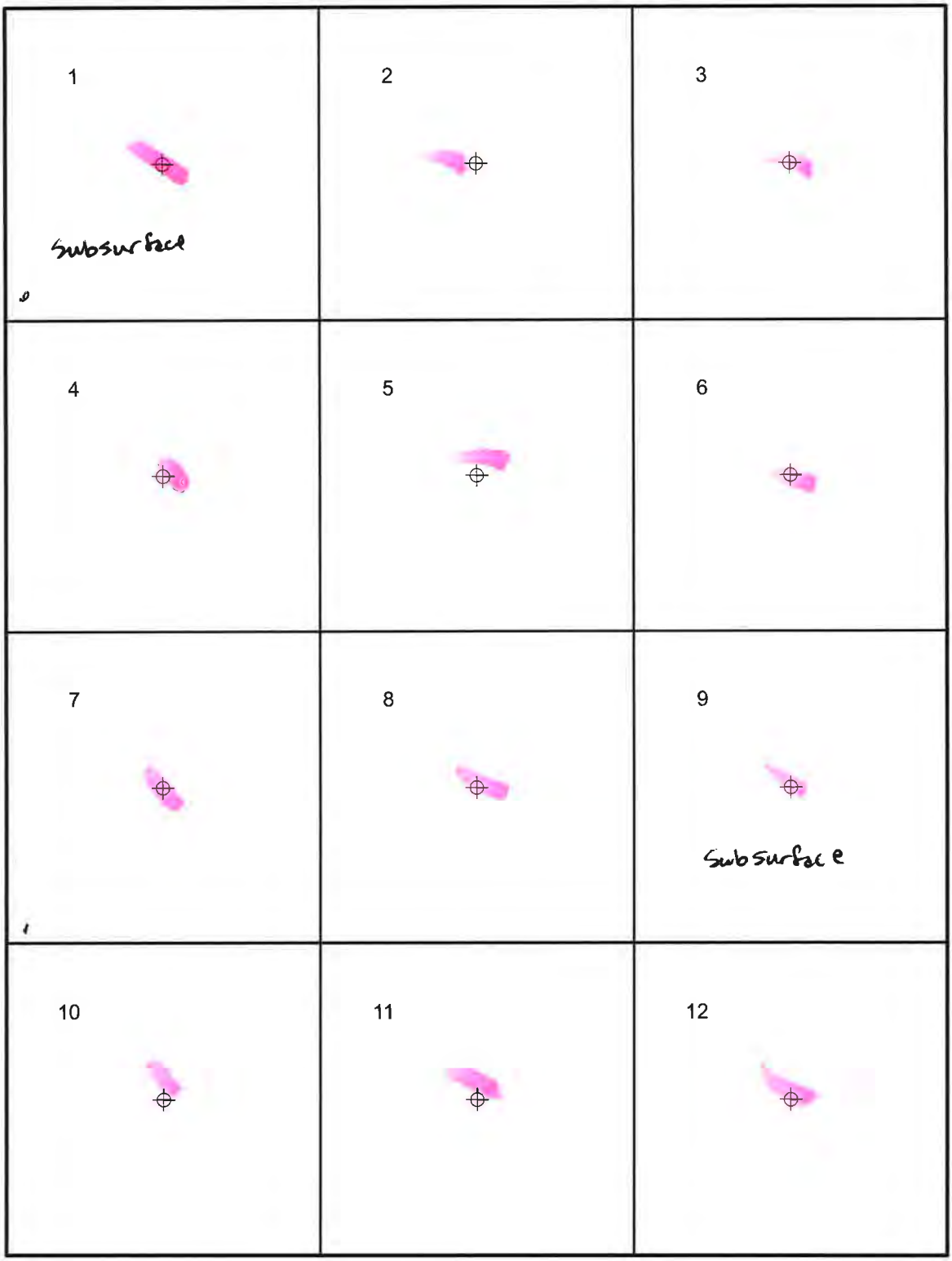
Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes section and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are 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.

X4 5/14/18 1343 V 44 U <3 N

X5 5/14/18 1345 V 44 U 4 N

SOIL SAMPLING

~~XRF SURVEY~~ GRID MAP



Type: Target Site **Site Name: CT-03**	**TT ID: T12** **Subarea Group: C**	0 5 10 Feet N

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Subsurface Sample by Hand Field Form

Site Name: CT-03
Tetra Tech Site ID: T12
Grid Location No.: 1
Date:

Weather:
GPS Color:
Sampling Team:
Page No.:

Example Sample IDs: Surface Sample (0-6 inches) M1-SS1-01-090518
Subsurface Sample (6-12 inches) M1-SB1-0612-01-090518
Subsurface Sample (12-18 inches) M1-SB1-1218-01-090518

Field Sample ID	Time (MST)	Duplicate Collected? (Yes or No)	Depth Range (inches)	Duplicate ID	Analysis (Long/Short)	Field Notes
T12-SS1-01- 091218	15:30	No	0" - 6"		Short	reddish-brown dry clayey silt surrounded by sage brush
T12-SB1-0612-01- 091218	15:30	No	6" - 12"		Short	
T12-SS2-01-091218	15:40	No	0-6		Short	
T12-SS3-01-091218	15:45	No	0-6		Short	reddish-brown dry clayey silt
T12-SS4-01-091218	15:50	No	0-6		Short	

Subsurface Sample by Hand Field Form

Site Name: CT-03
Tetra Tech Site ID: T12
Grid Location No.: 3
Date:

Weather:
GPS Color:
Sampling Team:
Page No.:

Example Sample IDs: Surface Sample (0-6 inches) M1-SS1-01-090518

Subsurface Sample (6-12 inches) M1-SB1-0612-01-090518

Subsurface Sample (12-18 inches) M1-SB1-1218-01-090518

Field Sample ID	Time (MST)	Duplicate Collected? (Yes or No)	Depth Range (inches)	Duplicate ID	Analysis (Long/Short)	Field Notes
~~T12-SS3-01~~			0" - 6"		Short	
~~T12-SB3-0612-01~~			6" - 12"		Short	
ICR ~~T21-0~~ ~~SS9~~ T21-SS7-01-091218 T12 ~~SS4-01~~	16:15		0-6		Short	
T12-SS10-01-091218	16:20		0-6		Short	
T12-SS11-01-091218	16:25		0-6		Short	

Subsurface Sample by Hand Field Form

Site Name: CT-03
Tetra Tech Site ID: T12
Grid Location No.: 7
Date:

Weather:
GPS Color:
Sampling Team:
Page No.:

Example Sample IDs: Surface Sample (0-6 inches) M1-SS1-01-090518
Subsurface Sample (6-12 inches) M1-SB1-0612-01-090518
Subsurface Sample (12-18 inches) M1-SB1-1218-01-090518

Field Sample ID	Time (MST)	Duplicate Collected? (Yes or No)	Depth Range (inches)	Duplicate ID	Analysis (Long/Short)	Field Notes
q T12-SS~~7~~01- 091218 Kr	16:05	No	0" - 6"	—	Short	Soil description consistent
q T12-SB~~7~~0612-01-091218 Kr	16:05	No	6" - 12"	—	Short	
T12~~5~~55-01-091218	15:55	No	0-6	—	Short	
T12-556-01-091218	16:00	No	0-6	—	Short	
T12-55~~8~~-01-091218	16:10	No	0-6	—	Short	

Subsurface Sample by Hand Field Form

Site Name: CT-03
Tetra Tech Site ID: T12
Grid Location No.: 2
Date:

Weather:
GPS Color:
Sampling Team:
Page No.:

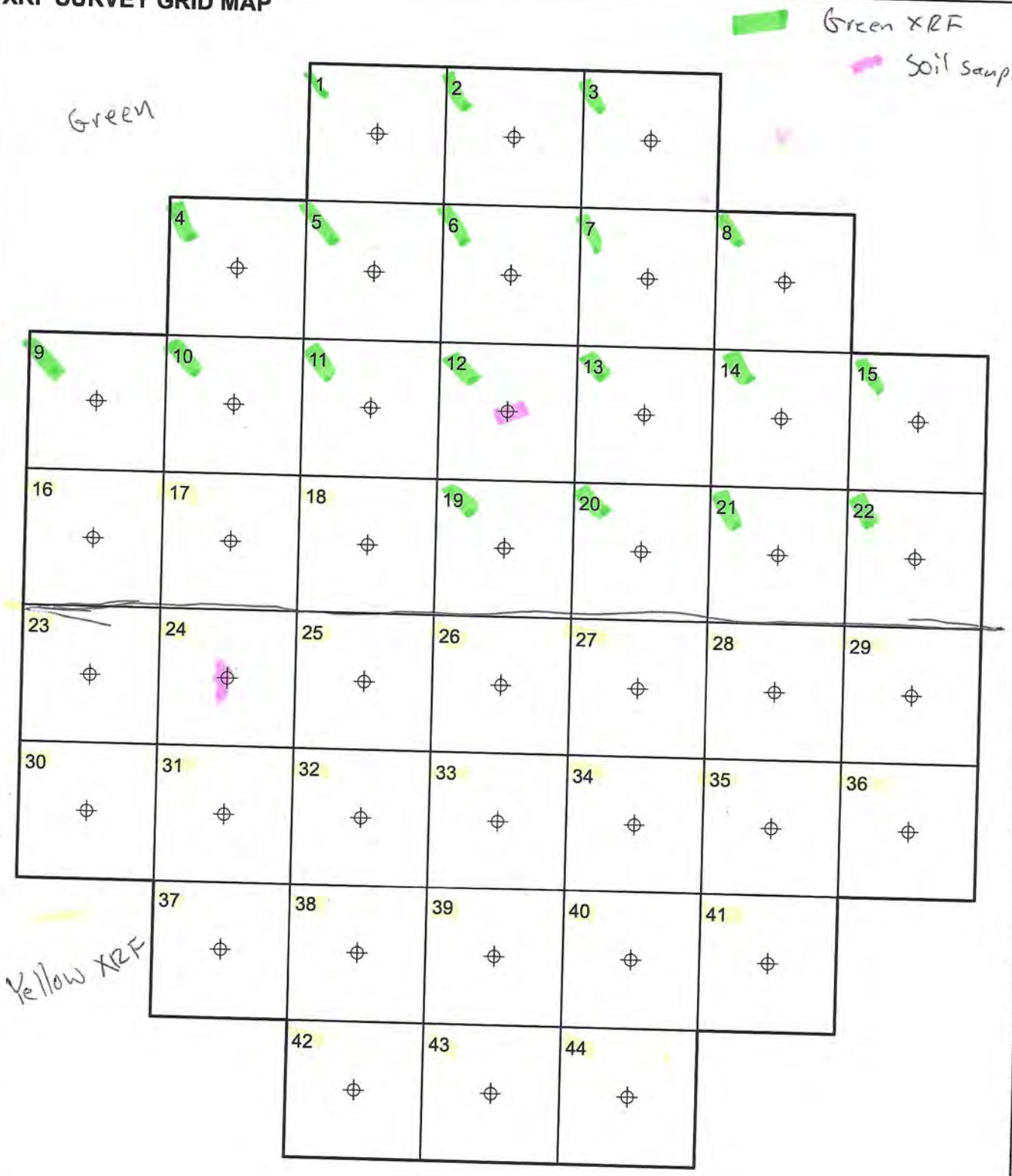
Example Sample IDs: Surface Sample (0-6 inches) M1-SS1-01-090518
Subsurface Sample (6-12 inches) M1-SB1-0612-01-090518
Subsurface Sample (12-18 inches) M1-SB1-1218-01-090518

Field Sample ID	Time (MST)	Duplicate Collected? (Yes or No)	Depth Range (inches)	Duplicate ID	Analysis (Long/Short)	Field Notes
T12-~~SS2-01~~			~~0" - 6"~~		~~Short~~	
T12-~~SB2-0612-01~~			~~6" - 12"~~		~~Short~~	
T12-SS12-01-091218	16:30	No	0-6	—	Short	

TARGET T13

FIELD FORMS

XRF SURVEY GRID MAP



Type: Target Site **Site Name: M1-01**	**TT ID: T13** **Subarea Group: D**	0 15 30 Feet N

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XRF Form

Site Type: Target
AUM Site: M1-01
Tetra Tech ID: T13
Sampling team: DJ, AD, AC
XRF Color: yellow

Date: 5/8/2018
Weather: clear, Sunny
Page No.: 1 of 3
GPS Color: yellow

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
X44	5/8/18	1329	~~X~~ Y	V 34 U 6		N				
X43	↓	1331	N	V 28 U 4		↓				
X42		1335 ~~1336~~	Y	V 28 U 4						
X37		1337	N	V 38 U 5						
X38		1339	N	V 25 U 7						
X39		1342	Y	V 43 U LOD4						Adjusted due to vegetation
X40		1343	N	V 28 U 5						
X41		1345	N	V 31 U 4						
X36		1349	N	V 29 U 4						
X35	↓	1351	Y	V 20 U 6		↓				Adjusted due to tree

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 d Form

Page No.: 2 of 3

MI-01

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
X34	5/18/18	1353	N	V 36 U LOD4		N				
X33		1355	Y	V 27 U 4						Adjusted due to tree
X32		1357	N	V 33 U 4						
X31		1359	N	V 21 U 4						
X30		1401	Y	V 25 U 5						Adjusted due to bush
X23		1404	Y	V 29 U LOD3						Adjusted due to tree
X24		1406	N	V 12 U LOD3	V 14 U LOD3	Y	T13-XS24-01-050818			Sample taken at 1415
X25		1417	Y	V 31 U 4		N				Adjusted due to vegetation
X26		1421	N	V 33 U 4						
X27		1423	N	V 29 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.
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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 d Form

Page No.: 3 of 3

MI-01

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
X28	5/8/18	1425	N	V 31 U 4		No				
X29	↓	1427	Y	V 24 U 3		↓				Adjusted due to vegetation
X16		1432	Y	V 22 U LOD3						Adjusted due to vegetation
X17		1435	N	V 27 U LOD3						
X18	↓	1438	N	V 22 U 4	V 21 U LOD3	↓				XRF duplicate, no soil

Notes to field team:
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*Select metals TBD in field, note the metal on logsheet.

XRF Form

Site Type: Target
AUM Site: MY-01
Tetra Tech ID: T13
Sampling team: CL, SC, NB
XRF Color: Green

Date: 5/8/2018
Weather: clear, sunny, breezy
Page No.: 1 of 2
GPS Color: Green

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
X1	5/8/18	1336	N	V 34 U 5	—	N	—	N	—	
X2	5/8/18	1341	N	V 29 U 7	—	N	—	N	—	
X3	5-8-18	1343 1345	N	V 21 U 3	—	N	—	N	—	pt. 34 @ 24.3 seconds error, re-do
X8	5-8-18	1347	N	V 37 U 4	—	N	—	N	—	
X7	5-8-18	1349	N	V 24 U 5	—	N	—	N	—	
X6	5-8-18	1351	N	V 30 U 5	—	N	—	N	—	
X5	5-8-18	1353	N	V 37 U LOD 3	—	N	—	N	—	
X4	5-8-18	1356	N	V 29 U 6	—	N	—	N	—	
X9	5-8-18	1358	N	V 21 U LOD 2	—	N	—	N	—	
X10	5-8-18	1401	N	V 28 U 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.
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*Select metals TBD in field, note the metal on logsheet.

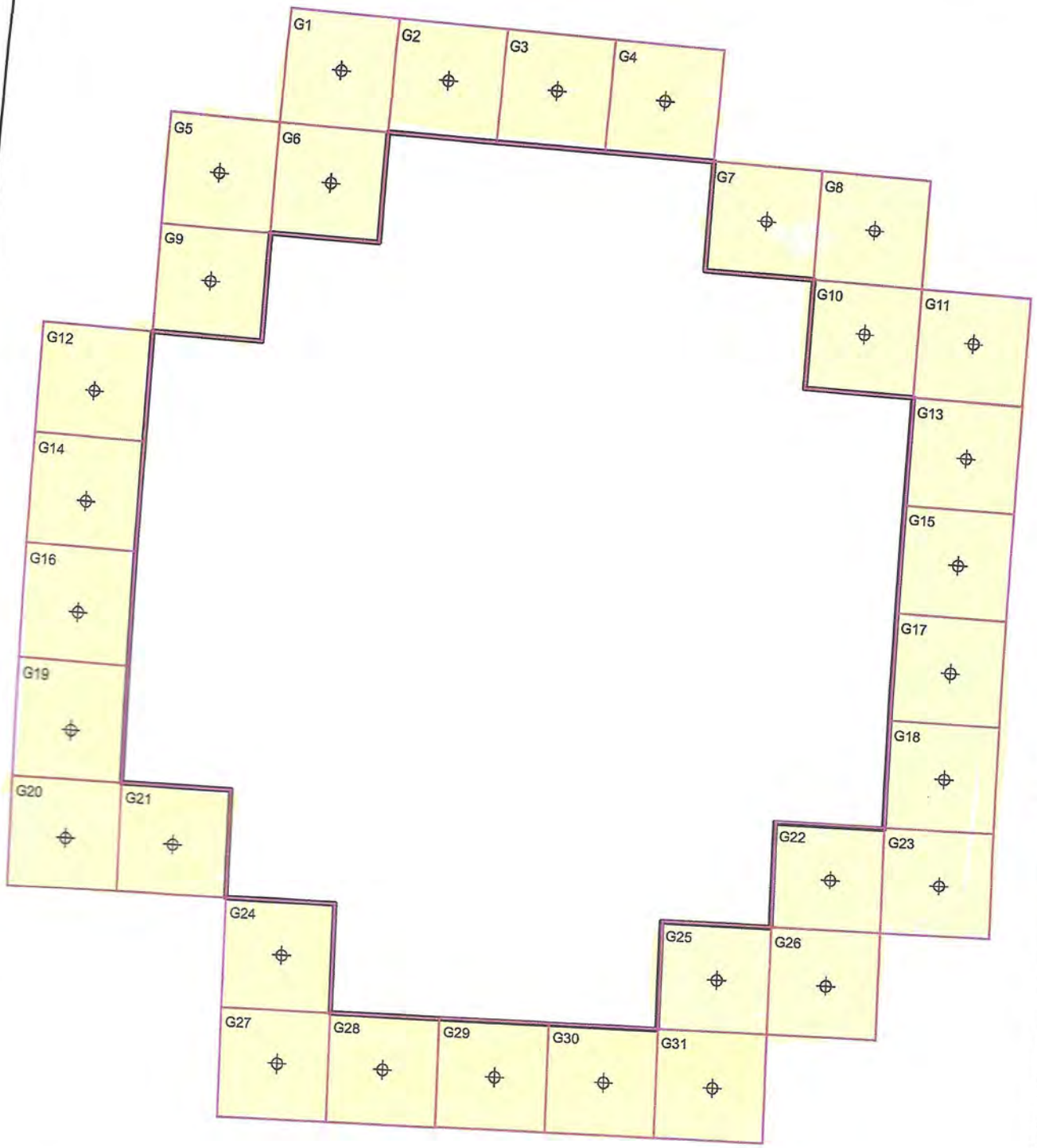
Color Green | Site type: Target | AOM site: M1-01 | TtID: T13 | Team: CL, SC, NB | Date: 5-8-18 | Weather: clear, sunny | GPS color: Green | XRF Field Form | T13-XS#-01-DATE

Page No.: 2 of 2

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
X11	5-8-18	1403	N	V 32 U 4	—	N	—	N	—	
X12	5-8-18	1407	N	V 46 U 6	V 44 U 6 ~~U 44~~ 08	Y	T13-XS12-01-050818	~~N~~	—	Sample @ 1414
X13	5-8-18	1426	N	V 27 U 6	—	N	—	N	—	
X14	5-8-18	1429	N	V 32 U 4	—	N	—	N	—	
X15	5-8-18	1431	N	V 33 U 3	—	N	—	N	—	
X22	5-8-18	1434	N	V 38 U 7	—	N	—	N	—	
X21	5-8-18	1437	N	V 34 U 5	—	N	—	N	—	
X20	5-8-18	1440	N	V 38 ULOD 3	—	N	—	N	—	
X19	5-8-18	1442	N	V 28 U 5	—	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 SURVEY GRID MAP



Type: Non-AUM Target Site Name: M1-01 Non-AUM Target	TT ID: T13 Subarea Group: D	0 20 40 Feet N

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XRF Field Form

Site Type: Non-ANM Target
AUM Site: M1-01 Non ANM Target
Tetra Tech ID: T13
Sampling team: AB, CB, CL
XRF Color: Blue

Date: 16 Aug. 2018
Weather: partly cloudy, hot and
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
G31	08/16/18	1159	N	V 48 U 6	V 40 U 5	N	—	N	—	~~Offset by 1m due to giant tree~~ - triplicate
G30		1209	N	V 43 U 7	—	N	—	N	—	
G29		1211	N	V 31 U 7	—	N	—	N	—	
G28		1213	N	V 75 U 12	—	N	—	N	—	~~offset due to poor GPS~~
G27		1215	N	V 59 U 9	—	N	—	N	—	offset due to poor GPS coverage & tree
G24		1217	Y	V 38 U 6	—	N	—	N	—	1m accuracy
G21		1219	N	V 51 U 6	—	N	—	N	—	
G20		1221	Y	V 54 U 7	—	N	—	N	—	offset due to large rock
G19		1223	Y	V 36 U 5	—	N	—	N	—	offset due to low accuracy
G16		1226	N	V 52 U 5	V 33 U 4	Y	T13-XSG16-01-081618	N	—	sample time 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.

XRF Field Form

Site Type: Non-Aum Target
AUM Site: M1-01 Non-Aum Target
Tetra Tech ID: T13
Sampling team: CB AB RL
XRF Color: Blue

Date: 16 Aug 2018
Weather: Partly cloudy
Page No.: 2
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
G14	8/14/18	1239	N	V 31 U 5	—	N	—	N	—	
G12	↓	1241	N	V 34 U 6	—	N	—	N	—	
G9		1243	N	V 51 U 7	—	N	—	N	—	
G5		1245	N	V 49 U 6	—	N	—	N	—	
G6		1247	N	V 50 U 3	—	N	—	N	—	
G1		1249	N	V 40 U 4	—	N	—	N	—	
G2		1251	N	V 32 U 4	—	N	—	N	—	
G3		1253	N	V 51 U 8	—	N	—	N	—	
G4		1256	N	V 51 U 7	—	N	—	N	—	
G7	↓	1258	N	V 50 U >3	V 46 U 6	Y	T13-XSG7-01-081618	N	—	Offset due to poor GPS accuracy sample time 1305

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: Non-AUM Target
AUM Site: M1-01 Non AUM Target
Tetra Tech ID: T13
Sampling team: AB, CB, CL
XRF Color: Blue

Date: 16 Aug. 2018
Weather: Partly Cloudy No wind
Page No.: 3
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
G8	8/16/18	1306	Y	V 46 U 5	—	N	—	N	—	offset due to poor accuracy.
G10		1308	N	V 52 U 73	—	N	—	N	—	off set due to low accuracy.
G11		1311	N	V 31 U 4	—	N	—	N	—	offset due to low accuracy
G13		1312	N	V 31 U 5	—	N	—	N	—	offset due to low accuracy
G15		1314	N	V 63 U 7	—	N	—	N	—	offset due to low accuracy
G17		1317	Y	V 42 U 6	—	N	—	N	—	offset due to low accuracy
G18		1319	Y	V 39 U 6	—	N	—	N	—	11 11
G23		1321	Y	V 42 U 4	—	N	—	N	—	11 11
G22		1322	N	V 57 U 5	—	N	—	N	—	11 11
G26	↓	1325	Y	V 59 U 7	V 56 U 8	Y	~~T13-XSG26-01-081618~~ T13-XSG26-01-081618	N	—	ST: 1330 offset due to low accuracy.

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: Non-AUM Target
AUM Site: M1-01 Non AUM Target
Tetra Tech ID: T13
Sampling team: AB CB CL
XRF Color: Blue

Date: 16 Aug. 2018
Weather: Cloudy, no wind
Page No.: 4
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
G25	08/16/18	1333	N	V 36 U 4	—	N	—	N	—	
—										
—										

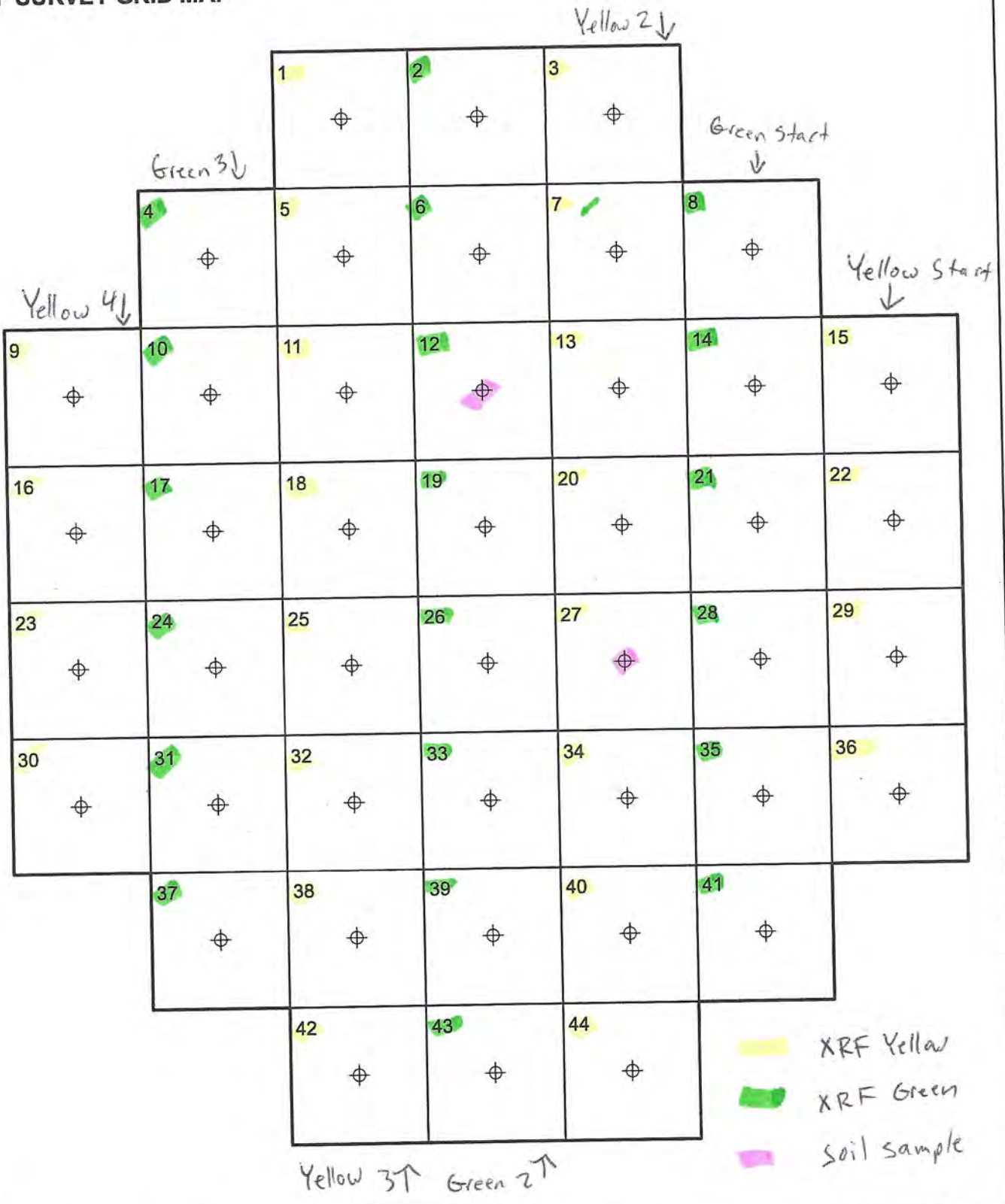
Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are 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.

—

TARGET T14

FIELD FORMS

XRF SURVEY GRID MAP



Type: Target Site **Site Name: M1-02**	**TT ID: T14** **Subarea Group: D**	0 15 30 Feet N

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XRF Form

Site Type: Target
AUM Site: M1-02
Tetra Tech ID: T14
Sampling team: DJ, AD, AC
XRF Color: Yellow

Date: 5/8/2018
Weather: clear, sunny
Page No.: 1 of 3
GPS Color: Yellow

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
X15	5/8/18	1520	N	V 26 U 4	V 32 U 4	No				XRF duplicate, no soil sample
X22	↓	1523	N	V 33 U LOD 3		↓				
X29		1525	N	V 28 U 4						
X36		1528	N	V 28 U 4						
X3		1533	N	V 34 U 4						
X7		1535	N	V 27 U LOD						
X13		1537	N	V 18 U 6						Lots of organic material, Disregard reading 68
X20		1539	N	V 25 U LOD 3		↓				
X27		1542	N	V 32 U 9	V 37 U 9	Yes	T14-XS27-01-050818	No		Soil @ 1555
X34	↓	1556	N	V 32 U LOD 3						

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.

XRI Field Form

Page No.: 2 of 3

M1-02

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
X40	5/8/18	1600 ~~1558~~	N	V 27 U 4		No				
X44		1602	N	V 32 U LOD 3						
X42		1605	N	V 28 U 3						
X38		1607	N	V 19 U LOD 3						
X32		1609	N	V 38 U 4						
X25		1610	N	V 26 U 3						
X18		1612	N	V 34 U 4						
X11		1615	N	V 39 U 4						
X5		1617	N	V 32 U LOD 3						
X1		1619	N	V 28 U LOD 3						

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.

XRI id Form

Page No.: 3 of 3

MI-02

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
X9	5/8/18	1621	N	V 26 U 5						
X16	↓	1624	N	V 28 U 4						
X23		1626	N	V 26 U LOD3						
X30		1628	N	V 22 U LOD3	V 22 U LOD3					

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 Form

Site Type: Target
AUM Site: M1-02
Tetra Tech ID: TJ4
Sampling team: CL, SC, NB
XRF Color: Green

Date: 5-8-18
Weather: clear, sunny, breezy, ~85°F
Page No.: 1 of 3
GPS Color: green

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
X8	5-8-18	1525	N	V 35 U 4	—	N	—	N	—	Pt. 54 has no I.D. stored in unit. re-do
X8	5-8-18	1530	N	V 39 U 4	—	N	—	N	—	
X14	5-8-18	1533	N	V 24 U LOD 3	—	N	—	N	—	
X21	5-8-18	1536	N	V 21 U 3	—	N	—	N	—	
X28	5-8-18	1538	N	V 40 U 4	—	N	—	N	—	
X35	5-8-18	1541	N	V 30 U 4	—	N	—	N	—	
X41	5-8-18	1544	N	V 24 U 3	—	N	—	N	—	
X43	5-8-18	1548	N	V 38 U 4	—	N	—	N	—	
X39	5-8-18	1550	N	V 36 U LOD 3	—	N	—	N	—	
X33	5-8-18	1553	N	V 37 U LOD 3	—	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 Form

Site Type: Target
AUM Site: M1-02
Tetra Tech ID: T14
Sampling team: CL, SC, NB
XRF Color: green

Date: 5-8-18
Weather: clear, ~~75~~, Breezy, ~85°F
Page No.: 2 of 3
GPS Color: green

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
X26	5-8-18	1555	N	V 20 U 4	—	N	—	N	—	
X19	5-8-18	1557	N	V 31 U LOD3	—	N	—	N	—	
X12	5-8-18	1559	N	V 41 U 5	V 36 U 6	Y ~~N~~ AC	T14-XS12-01-050818	N	—	sample @ 16:04
X6	5-8-18	1612	N	V 28 U 4	—	N	—	N	—	
X2	5-8-18	1614	N	V 43 U 4	—	N	—	N	—	
X4	5-8-18	1616	N	V 37 U 3	—	N	—	N	—	
X10	5-8-18	1619	N	V 37 U 5	—	N	—	N	—	
X17	5-8-18	1621	N	V 39 U 5	—	N	—	N	—	
X24	5-8-18	1623	N	V 20 U 4	—	N	—	N	—	
X31	5-8-18	1627	N	V 31 U 3	V 33 U LOD3	N	—	N	—	XRF QA/QC duplicate, unit reading only

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 Form

Site Type: Target
AUM Site: M1-02
Tetra Tech ID: T14
Sampling team: CL, SC, NB
XRF Color: Green

Date: 5-8-18
Weather: Clear, ☀, Breezy ~85°F
Page No.: 3 of 3
GPS Color: Green

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

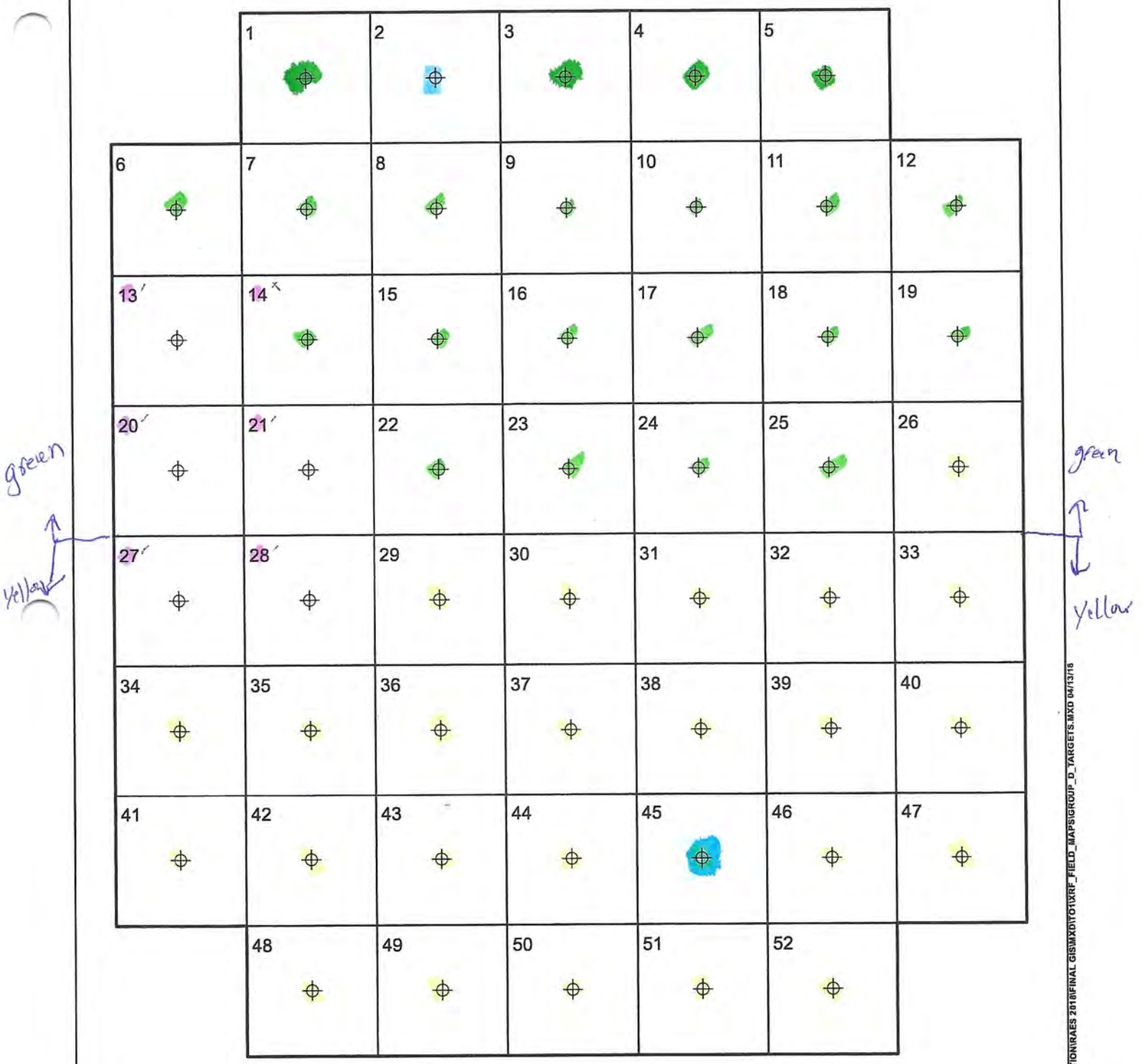
XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
X-37	5-8-18	1631	N	V 33 U 3	N	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.

TARGET T15

FIELD FORMS

XRF SURVEY GRID MAP



Type: Target Site **Site Name: M1-03**	**TT ID: T15** **Subarea Group: D**	0 15 30 Feet N

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XRF Form

Site Type: Target
AUM Site: M1-03
Tetra Tech ID: TIS
Sampling team: DJ, AD, AC
XRF Color: Yellow

Date: 5/8/2018
Weather: Clear, Sunny

Page No.: 1 OF 3
GPS Color: Yellow

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
X52	5/8/18	1026	N	V 30 U LOD 3						
X51		1031	N	V 26 U LOD 3						
X50		1033	N	V 30 U LOD 3						
X49		1038	N	V 17 U 8						
X48		1041	Yes	V 25 U LOD 5						Cactus
X41		1048	N	V 21 U LOD 3						
X34		1106	N	V 22 U LOD 3						
X35		1109	N	V 27 U LOD 3						
X42		1112	N	V 24 U LOD 5						
X43		1115	Yes	V 27 U 5						Rock

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.

5/8/2018
M1-03 yellow
TIS
DJ, AD, AC

XRF d Form

Page No.: 2 OF 3

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
X44	5/8/18	1117	N	V 26 U LOD3						
X45		1120	N	V 34 U ~~LOD~~ 4	V 20 U 4		TIS-XS45-01-050818			1128 Soil Sample
X46		1138	N	V 33 U 11						
X47		1140	N	V 38 U 6						
X40		1142	N	V 28 U LOD3						
X39		1145	N	V 24 U 4						
X38		1147	N	V 14 U 8						
X37		1149	N	V 35 U 5						
X36		1152	Yes	V 26 U 4						Tree's Cactus
X29		1154	N	V 36 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.

5/8/2018
MI-03 yellow
TIS
DJ, AD, AC

XRF d Form

Page No.: 3 OF 3

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
X30	5/8/2018	1156	N	V 28 U 4						
X31	"	1159	N	V 30 U 7						
X32	"	1202	N	V 25 U LOD 3						
X33	"	1204	N	V 37 U 6						
X26	"	1207	N	V 33 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 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 Form

Sample #: T15-XS#-01-DATE
Example

Site Type: Target
AUM Site: MW-03
Tetra Tech ID: T15
Sampling team: CL, SC, NB
XRF Color: Green

Date: 5/8/2018
Weather: clear, calm, sunny
Page No.: 1 of 3
GPS Color: Green

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
X12 ~~X10~~	5/8/18	1026	N	V 13 U <LOD 3	~~X~~ -			N		
X11	5/8/18	1030	N	V 28 U 6	- ~~X~~			N		
X10	5/8/18	1034	N	V 23 U <LOD 3	- ~~X~~	N	—	N	—	
X9	5/8/18	1039	N	V 21 U 4	—	N	—	N	—	
X8	5/8/18	1047	N	V 34 U 4	—	N	—	N	—	
X7	5/8/18	1050	N	V 31 U 4	—	N	—	N	—	
X6	5/8/18	1056	N	V 28 U <LOD 3	V 27 U <LOD 3	N	—	N	—	Triplicate performed
X1	5/8/18	1108	N	V 31 U 6	—	N	—	N	—	
X2	5/8/18	1113	N	V 40 U 5	V 34 U 5	Y	T15-XS2-01-050818	N	—	soil sample collected @ 1118
X3	5/8/18	1131	N	V 33 U 5	—	N	—	N	—	#18 ~1125 - accidental trigger pull

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.

1043: (a) X8 - had to restart XRF b/c of stylus/button issues - this happens every morning after ~ 2-4 shots

X20 + X21
X13 + X14 - no XRF b/c of arch site (points fall w/in site area)

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target
MI-03
T15
CL, SC, NB

XRF d Form

5/8/18
GPS: green
XRF: green

Page No.: 2 of 3

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
X4	5/8/18	1135	N	V 36 U 5	—	N	—	N	—	
X5	5/8/18	1138	N	V 30 U 9	—	N	—	N	—	
X19	5/8/18	1142	N	V 40 U 7	—	N	—	N	—	
X18	5/8/18	1145	N	V 47 U 5	—	N	—	N	—	
X17	5/8/18	1148	N	V 33 U 5	—	N	—	N	—	
X16	5/8/18	1153	N	V 39 U 4	—	N	—	N	—	
X15	5/8/18	1157	N	V 35 U 6	—	N	—	N	—	
X14	5/8/18	1203	N	V 36 U 4	—	N	—	N	—	X14 is ~20 ft outside of buffer zone - OK to take
X22	5/8/18	1206	N	V 36 U 7	—	N	—	N	—	
X23	5/8/18	1208	N	V 28 U 5	—	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.

Target
M1-03
T15
CL, SC, NB

XRF d Form

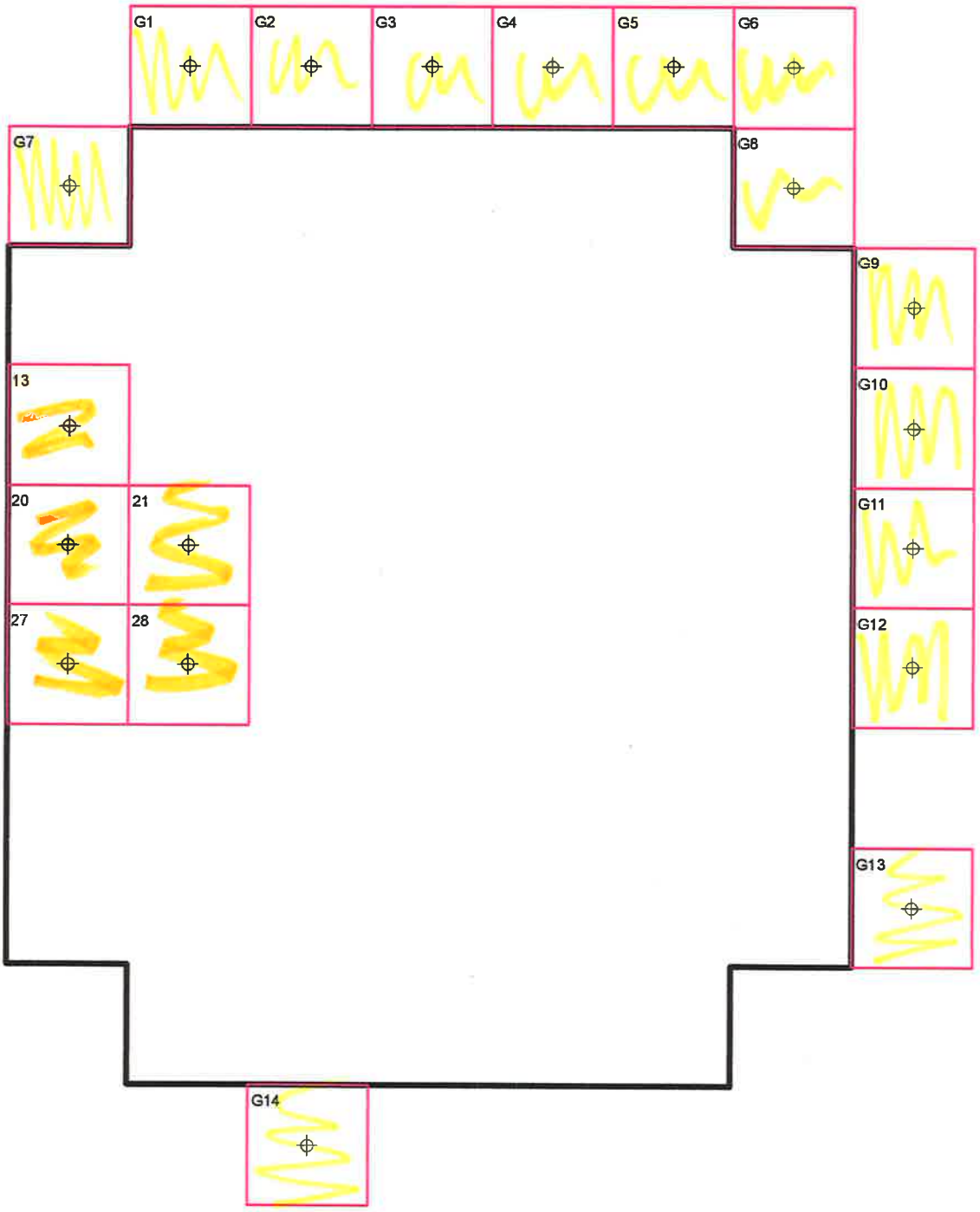
5/8/18
GPS: Green
XRF: Green

Page No.: 3 of 3

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
X24	5/8/18	1210	N	V 33 U 6	–	N	–	N	–	
X25	5/8/18	1213	N	V 56 U 5	–	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 SURVEY GRID MAP



Type: Non-AUM Target **Site Name: Target M1-03**	**TT ID: T15** **Subarea Group: D**	0 20 40 Feet N

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I:\LOCAL GP\ERATIONS\FORT COLLINS\RADIATION\RAES 2018\FINAL GIS\MXD\T01\FIELD_PRODUCTS\FIELD DEPLOYMENT MAPS\XRF_FIELD_MAPS.MXD 08/08/18

XRF Field Form

Site Type: Non-AUM Target
AUM Site: Target M1-03
Tetra Tech ID: TIS
Sampling team: JB, SL, M
XRF Color: Yellow/Green

Date: 08/17/~~30~~ 18 JB
Weather: Lightly cloudy
Page No.: 1 / 2
GPS Color: Yellow

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
67	08/17/18	830	N	V 23 U 5	V 20 U <3	N	—	N	—	x7 Yellow XRF
61	↓	830	N	V 47 U 3	V 44 U 6	N	—	N	—	Green XRF
62		841	N	V 35 U <3	—	N	—	N	—	Yellow XRF
63		845	N	V 41 U 4	—	N	—	N	—	Green XRF
64		843	N	V 30 U 5	—	N	—	N	—	Yellow XRF
65		845	N	V 36 U 6	V 30 U <3	Y	TIS-XS65-01-081718	N	—	Yellow XRF ST: 0850 ✓
66		849	N	V 46 U 4	—	N	—	N	—	Green XRF
68		854	N	V 38 U 4	—	N	—	N	—	Green XRF
69		859	N	V 38 U 4	—	N	—	N	—	#13 is labeled 68 Green XRF
610	↓	905	N	V 65 U 4						Green XRF

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: Non-AUM Target
AUM Site: Target M1-03
Tetra Tech ID: TIS
Sampling team: JD, CL, MM
XRF Color: Green/Yellow

Date: 8/17/18
Weather: Lightly cloudy
Page No.: 2 / 7
GPS Color: yellow

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
G11	8/17/18	907	N	V 42 U 4	—	N	—	N	—	Green XRF
G12	↓	910	N	V 18 U 6	—	N	—	N	—	Green XRF
G13		912	N	V 51 U <3	—	N	—	N	—	Green XRF
G14		917	N	V 45 U <3	—	N	—	N	—	
X27 ~~X38~~ JD		919	N	V 28 U <3	—	N	—	N	—	#19
X28		921	N	V 57 U 5	—	N	—	N	—	
X21		923	N	V 41 U 5	—	N	—	N	—	
X13		926	N	V 31 U <3	—	N	—	N	—	
X20		928	N	V 26 U <3	V 27 U <3	Y	TIS-XS20-01-081718	N	—	ST: 0930 ✓

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.

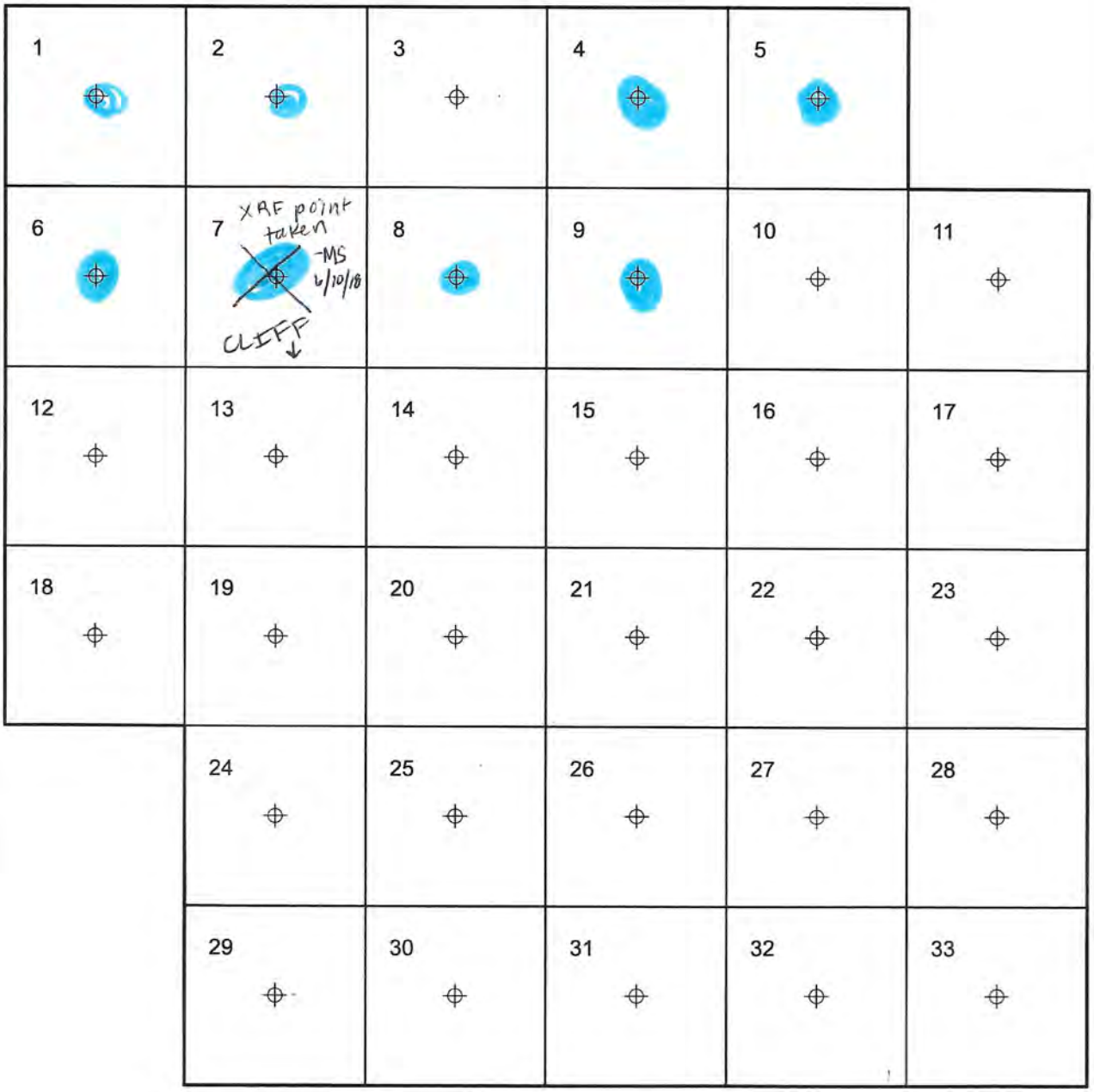
TARGET T18

FIELD FORMS

XRF SURVEY GRID MAP

yellow XRF 6/10/18
MS, CL, CORY

= XRF



Type: Target Site **Site Name: M5-01**	**TT ID: T18** **Subarea Group: F**	0 12.5 25 Feet N

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1

XRF Field Form

Site Type: T18
Site Name:
Tetra Tech ID: MS, CL, COKY
Sampling team:
XRF Color: Y

Date: 6/10/18 sunny, 90°F, slight breeze
Weather:
Page No.: 1
GPS Color: Y

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
X4	6/10/18	1546	N	V 29 U <3	—	N	—	N	—	Slight slope
X5	6/10/18	1548	N	V 21 U <3	—	N	—	N	—	slope
X9	6/10/18	1552	N	V 18 U <3	—	N	—	N	—	Slope above cliff
X8	6/10/18	1554	N	V 15 U <3	—	N	—	N	—	slight slope above cliff
X7	6/10/18	1556	Y	V 23 U <3	—	N	—	N	—	off set due to cliff
X6	6/10/18	1559	N	V 27 U <3	—	N	—	N	—	slope
X1	6/10/18	1601	N	V 22 U 4	—	N	—	N	—	slight slope
X2	6/10/18	1603	N	V 25 U <3	—	N	—	N	—	slight slope near drainage
X3	6/10/18	1605	N	V 29 U <3	—	N	—	N	—	flat

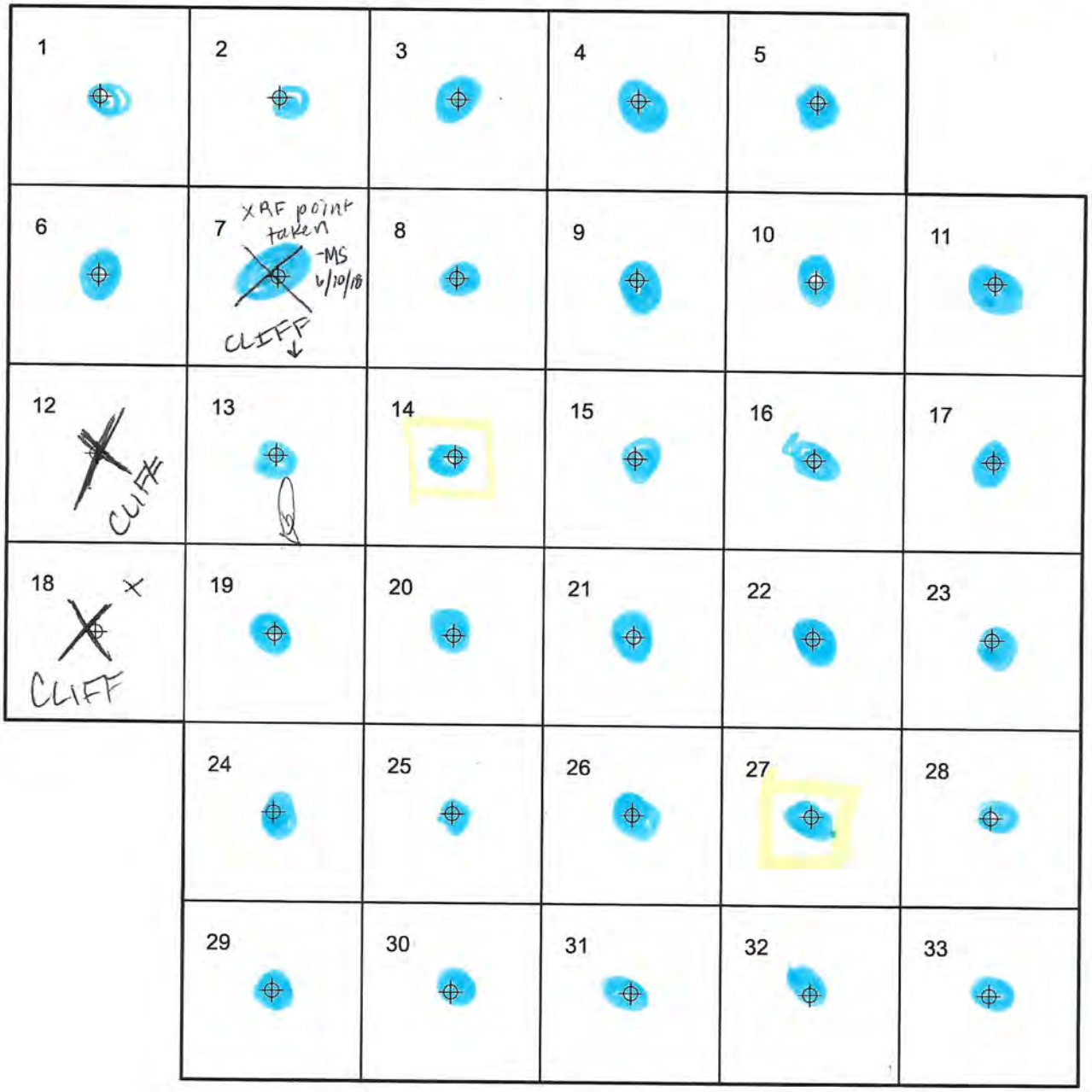
Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are 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 SURVEY GRID MAP

yellow XRF 6/10/18
MS, CL, CORY

= XRF

= soil Sample



Type: Target Site **Site Name: M5-01**	**TT ID: T18** **Subarea Group: F**	0 12.5 25 Feet N

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XRF Field Form

Site Type: TTB
Site Name:
Tetra Tech ID:
Sampling team: MS, LS, BE
XRF Color: Y

Date: 6/11/18
Weather: clear, 90°F, slight breeze
Page No.: 1
GPS Color: Y

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
X11	6/11/18	1400	N	V 28 U <3	—	N	—	N	—	reading #45 is X11 Slope under cliff
X10		1403	N	V 24 U <3	—	N	—	N	—	slope under cliff
X16		1405	N	V 21 U <3	—	N	—	N	—	slope
X17		1408	N	V 26 U <3	—	N	—	N	—	slope
X23		1409	N	V 20 U <3	—	N	—	N	—	slope
X29		1411	N	V 26 U <3	—	N	—	N	—	slope
X33		1413	N	V 33 U 4	—	N	—	N	—	slope
X32		1417	N	V 27 U <3	—	N	—	N	—	slope
X31		1419	N	V 32 U 5	—	N	—	N	—	slope
X30	↓	1422	N	V 24 U 3	—	N	—	N	—	slope

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: T18
Site Name:
Tetra Tech ID:
Sampling team: MS, LS, BE
XRF Color: Y

Date: 6/11/18
Weather: clear, 90°F, slight breeze
Page No.: 2
GPS Color: Y

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
X25	6/11/18	1426	N	V 26 W 4	—	N	—	N	—	Slope
X24	"	1428	N	V 33 W 4	—	N	—	N	—	Slope below c.i.x.p
X29		1431	N	V 23 W <3	—	N	—	N	—	Reading 57 accidental Slope
X19		1434	N	V 20 W <3	—	N	—	N	—	Slope
X26		1438	N	V 26 W 4	—	N	—	N	—	slopp
X27		1442	N	V 18 W <3	V 16 W <3	Y	T18-XS27-01-061118	N	—	ST: 1450 Slope
X22		1453	N	V 31 W <3	—	N	—	N	—	Slope
X15		1455	N	V 19 W <3	—	N	—	N	—	Slope
X21		1459	N	V 30 W <3	—	N	—	N	—	Slope
X20	↓	1459	N	V 21 W <3	—	N	=			in drainage

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: T18
Site Name:
Tetra Tech ID: MS, LS, BC
Sampling team:
XRF Color: Y

Date: 6/11/18
Weather: clear, 90°F
Page No.: 3
GPS Color: Y

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

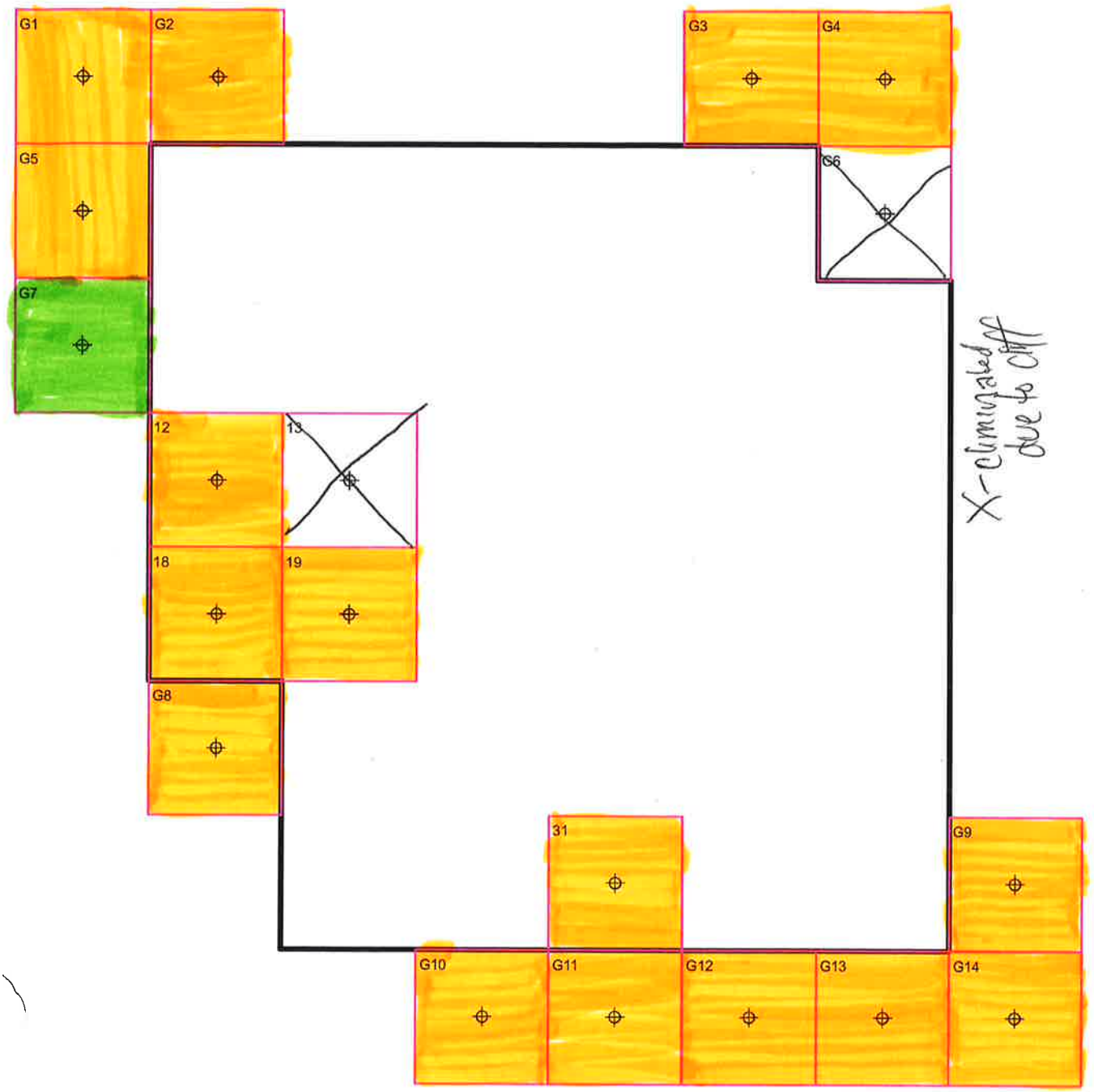
XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
X14	6/11/18	1501	N	V 22 U <3	V 26 U 4	Y	T18-XS14-01-061118	N	—	ST: 1510
X13	6/11/18	1504	N	V 31 U <3	—	N	—	N	—	SLOPE

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 SURVEY GRID MAP

= soil sample taken

= XRF-only sample



Type: Non-AUM Target **Site Name: M5-01 Non-AUM Target**	**TT ID: T18** **Subarea Group: F**	0 15 30 Feet N

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XRF Field Form

Site Type: Non-AMU Target
AUM Site: MS-01 Non-AUM Target
Tetra Tech ID: TIG
Sampling team: MB, CS, RJ
XRF Color: Blue

Date: 9/15/18
Weather: Sunny, Partly Cloudy, Breezy
Page No.: 1 of 2
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
G8	9/15/18	1435	N	V: 22 U: >3	—	N	—	N	—	system check Heat recorded as M16
X18		1439	Y	V: 40 U: >3	—	N	—	N	—	Offset due to cliff
G10		1443	Y	V: 31 U: >3	—	N	—	N	—	offset due to slope & bush
X19		1447	N	V: 34 U: 3	—	N	—	N	—	offset @ very edge of cell
X31		1451	Y	V: 39 U: >3	—	N	—	N	—	ODLA
G12		1454	N	V: 44 U: 4	—	N	—	N	—	ODLA
G13		1458	Y	V: 41 U: >3	—	N	—	N	—	ODLA
G14		1500	Y	V: 46 U: >3	—	N	—	N	—	ODLA
G9		1504	Y	V: 48 U: 6	—	N	—	N	—	ODLA
G11	↓	1508	N	V: 37 U: >3	—	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.

*ODLA - offset due to low accuracy.

XRF Field Form

Site Type: NoN AMW Target
AUM Site: M5-01 Non-AUM Target
Tetra Tech ID: T18
Sampling team: AB, CS, EJ
XRF Color: BLUE

Date: 9/15/18
Weather: Sunny, Partly cloudy, Breezy
Page No.: 2 of 2
GPS Color: Blue

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

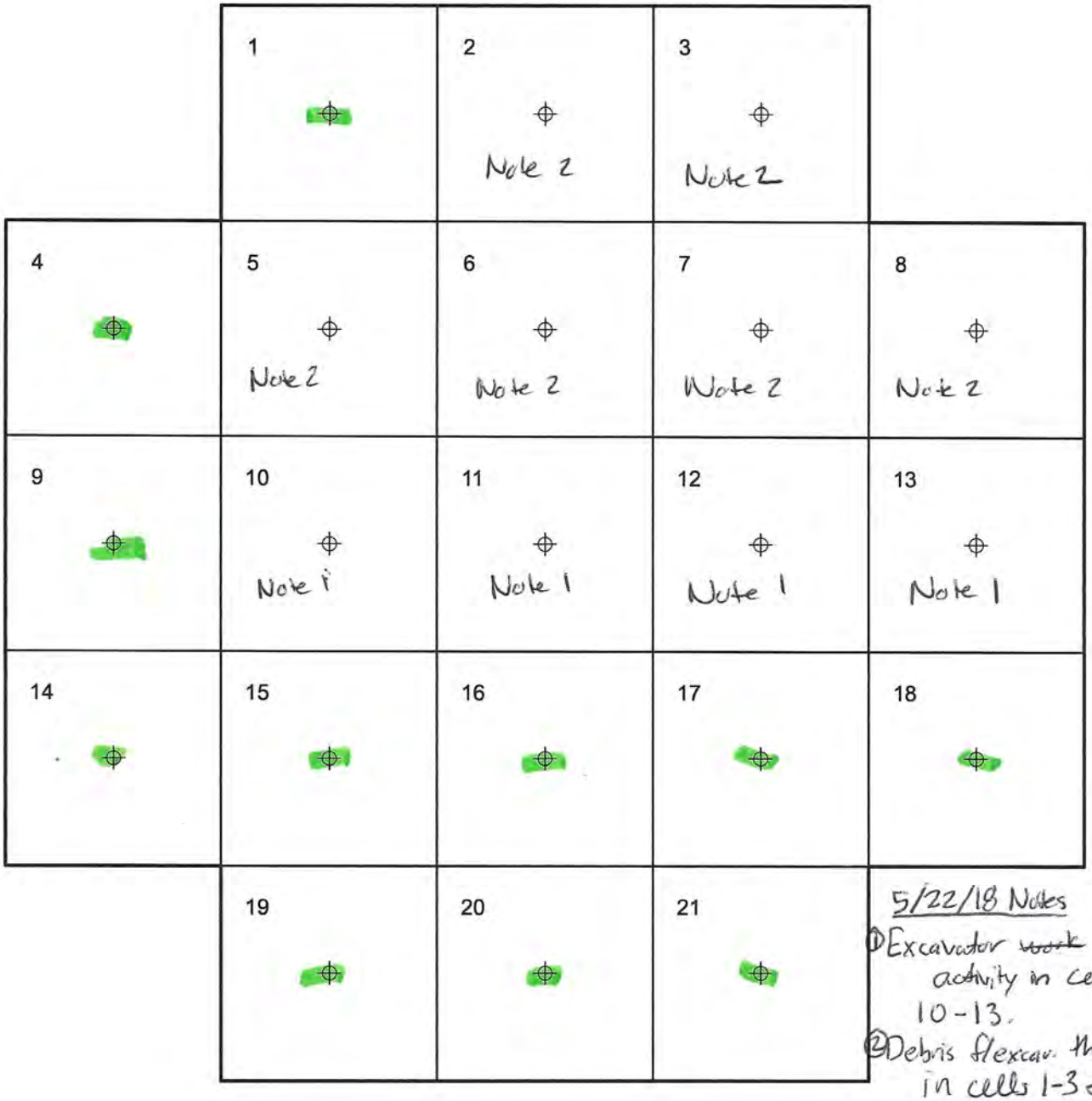
XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
X12	9/15/18	1512	Y	V: 22 U: 3	—	N	—	N	—	offset due to steep slope
G7		1515	N	V: 33 U: 4	V: 29 U: 4	Y	T18-XSG7-01-091518	N	—	ST: 1520
G5		1519	N	V: 37 U: 3	—	N	—	N	—	
G1		1521	N	V: 38 U: 3	—	N	—	N	—	
G2		1523	N	V: 39 U: 3	—	N	—	N	—	
G3		1527	N	V: 43 U: 3	—	N	—	N	—	
G4		1529	N	V: 44 U: 5	—	N	—	N	—	offset for cliff
				V: U:						
				V: U:						

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.

TARGET T19

FIELD FORMS

XRF SURVEY GRID MAP



5/22/18 Notes

① Excavator ~~work~~ activity in cells 10-13.

② Debris flexcav. thrown in cells 1-3 & 5-8.

Type: Target Site **Site Name: M5-02**	**TT ID: T19** **Subarea Group: F**	0 10 20 Feet N

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XRF SURVEY GRID MAP

6/10/18

yellow XRF

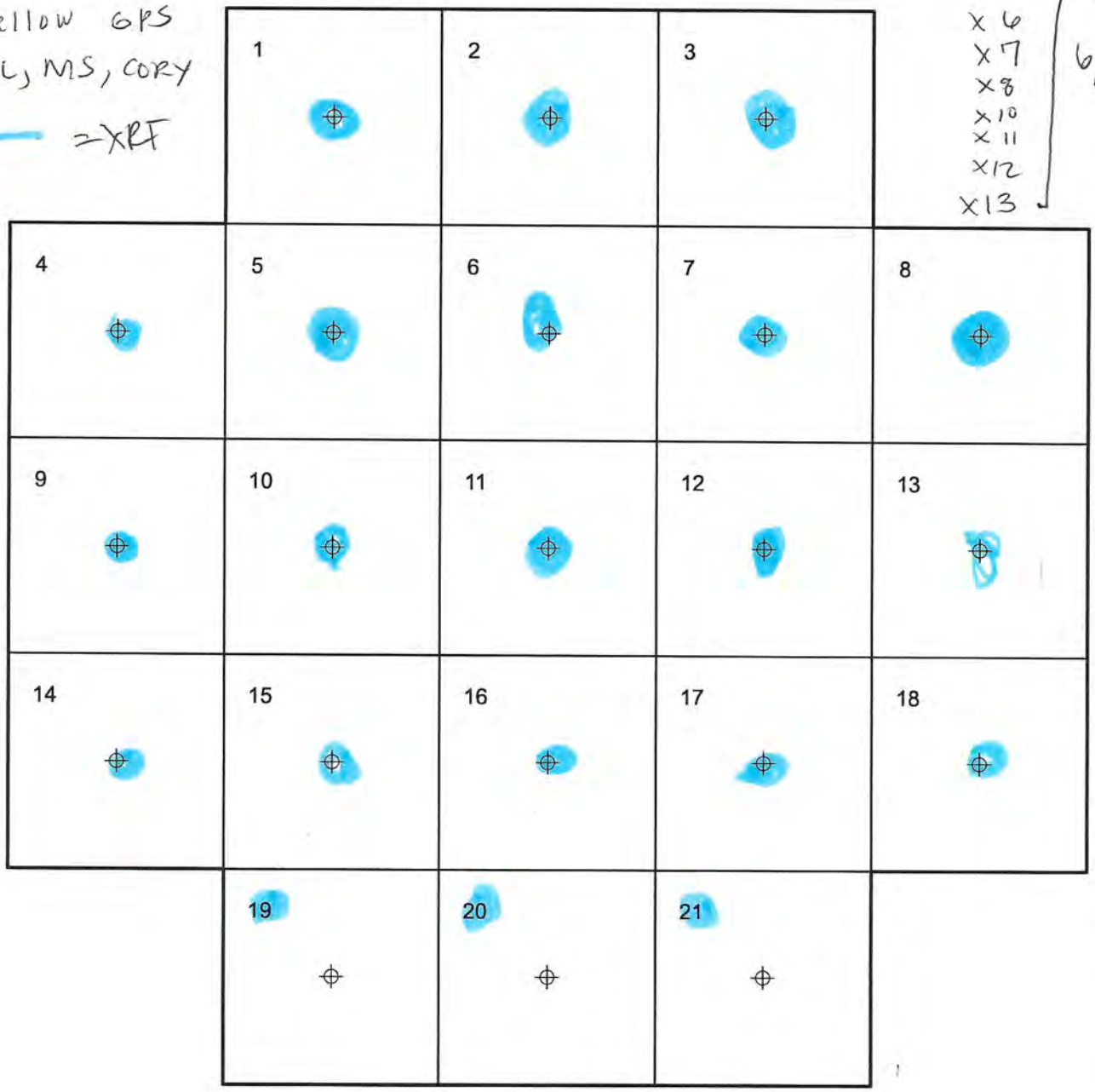
yellow GPS

CL, MS, CORY

— = XRF

Points X2
X3
X5
X6
X7
X8
X10
X11
X12
X13

taken on 6/10/18



Type: Target Site **Site Name: M5-02**	**TT ID: T19** **Subarea Group: F**	0 10 20 Feet N

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XRF Field Form

Site Type: T19
Site Name:
Tetra Tech ID: MS, CL, CORY
Sampling team:
XRF Color: yellow

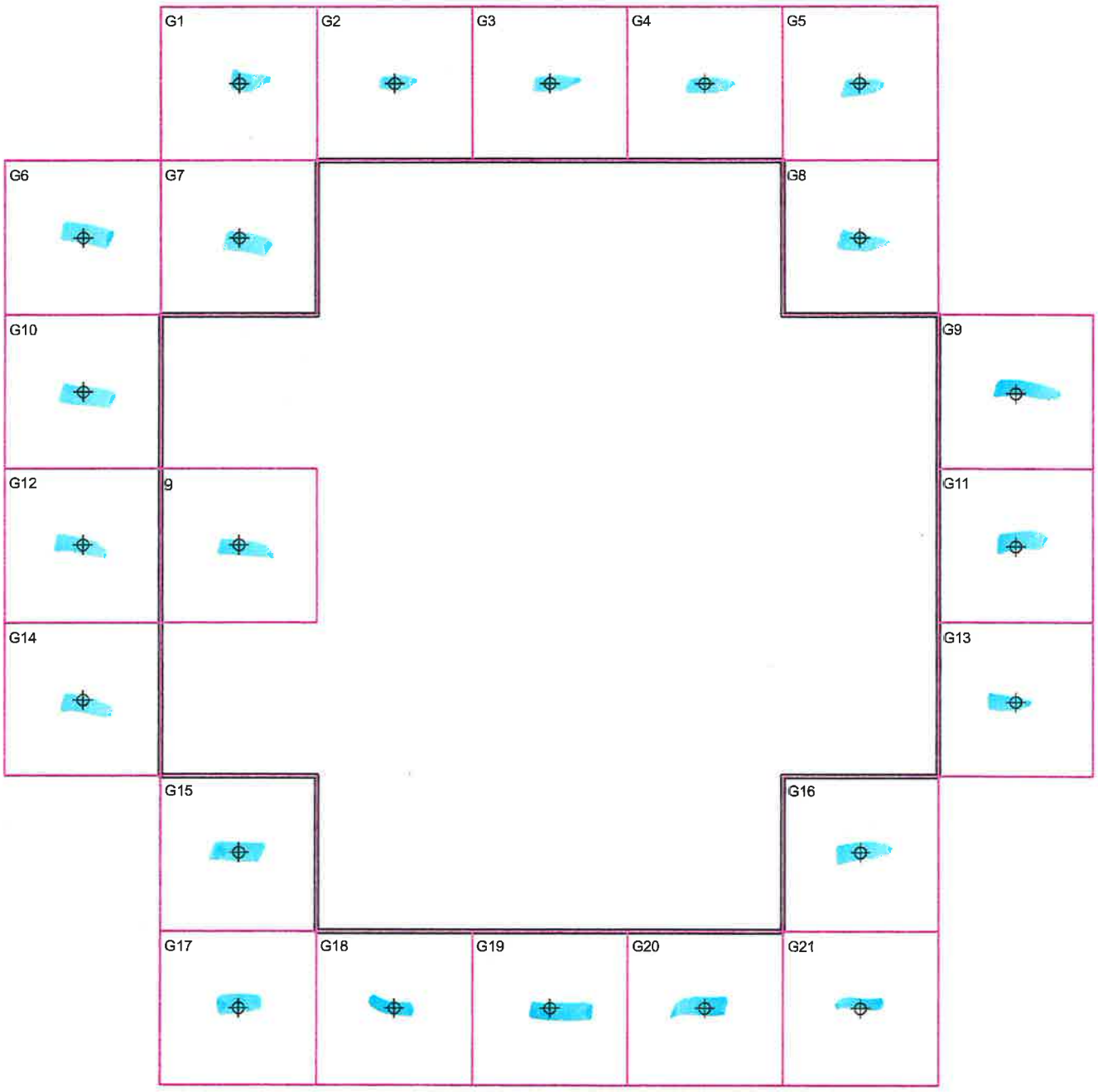
Date: 6/10/18
Weather: sunny, 90°F, slight breeze
Page No.: 1
GPS Color: yellow

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
X3	6/10/18	1456	N	V 91 W <3	V 85 W <3	N	—	N	—	±n road
X2		1459	N	V 90 W 4	—	N	—	N	—	In road
X8		1509	N	V 91 W 5	—	N	—	N	—	on slope above road + construction
X7		1510	N	V 79 W <3	—	N	—	N	—	" "
X6		1514	N	V 67 W 3	—	N	—	N	—	" "
X5		1517	S	V 71 W 5	—	N	—	N	—	*off-set due to slope, on graded slope
X10		1520	N	V 52 W 6	—	N	—	N	—	above road, above graded slope
X11		1523	N	V 120 W 5	—	N	—	N	—	" "
X12		1525	N	V 93 W 5	—	N	—	N	—	" "
X13		1527	N	V 107 W 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 SURVEY GRID MAP



Type: Non-AUM Target **Site Name: M5-02 Non-AUM Target**	**TT ID: T19** **Subarea Group: F**	0 15 30 Feet N

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XRF Field Form

Site Type: Target
AUM Site: M5-02
Tetra Tech ID: T19
Sampling team: KR, CA, MS
XRF Color: Green

Date: 9/11/18
Weather:

Page No.: 1/2
GPS Color: Green

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
G6	9/11/18	1409	No	V 72 U <3	—	No	—	No	—	
G7		1412	No	V 97 U <5	—	No	—	No	—	
G10		1418	No	V 121 U 5	—	No	—	No	—	
X9		1422	No	V 99 U 5	V 94 U 4	Yes	XS9 ~~XS9~~ T19-~~XS9~~-01-091118	—	—	STC 1425
G12		1432	No	V 162 U <3	—	No	—	No	—	
G14		1434	No	V 116 U 5	—	No	—	No	—	
G15		1437	No	V 129 U 4	—	No	—	No	—	
G17		1440	No	V 131 U 4	—	No	—	No	—	
G18		1442	No	V 276 U 10	—	No	—	No	—	
G19		1444	No	V 154 U 4	—	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: Target
AUM Site: MS-02
Tetra Tech ID: T19
Sampling team: KR, CA, MS
XRF Color: Green

Date: 9/11/18
Weather:

Page No.: 2/2
GPS Color: Green

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
G20	9/11/18	1446	No	V 215 U 4	—	No	—	No	—	
G21	"	1448	No	V 364 U 9						
G16		1451	No	V 183 U 3	—	No	—	No	—	
G13		1454	No	V 99 U 4	—	No	—	No	—	
G11		1456	No	V 114 U 4	—	No	—	No	—	
G9		1458	No	V 114 U 4	—	No	—	No	—	
	V									

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: [redacted]
AUM Site: [redacted] T19
Tetra Tech ID: [redacted]
Sampling team: AG, SK, MP
XRF Color: White

Date: 9/11/18
Weather:
Page No.: 1 of 1
GPS Color: White

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

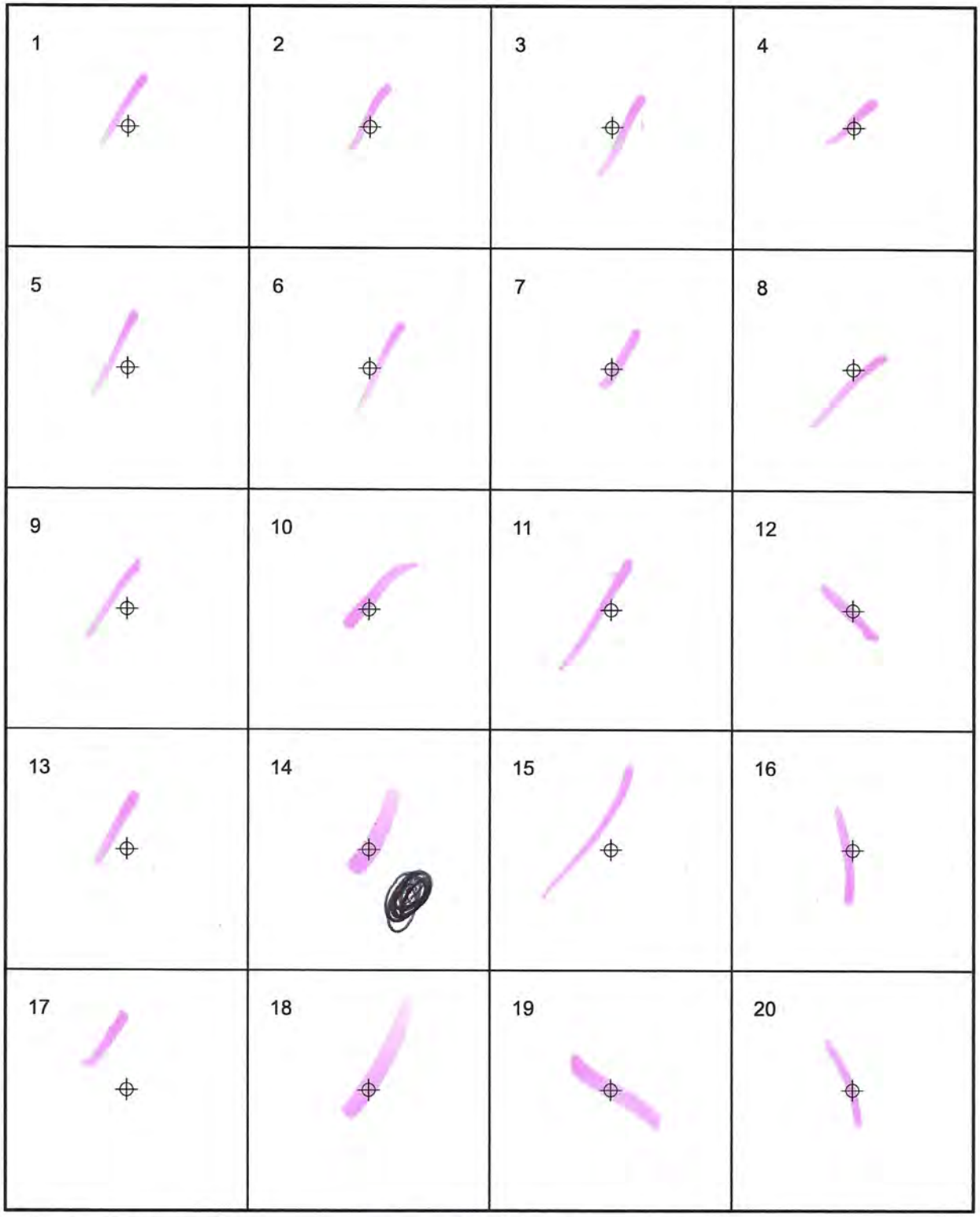
XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
G1	9/11/18	1441		V: 58 U: >3						Offset due to Brush pile [redacted] Rdg # 159
G2		1444		V: 66 U: 4						
G3		1447		V: 57 U: 6						
G4		1450		V: 48 U: >4						Rdg # 162
G5		1454		V: 102 U: 5						* In roadway & has been disturbed by roadway
G8		1458		V: 74 U: 4						* In roadway & has been disturbed by roadway.
				V: U:						
				V: U:						
				V: U:						
				V: U:						

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.

TARGET T20

FIELD FORMS

XRF SURVEY GRID MAP



pink = XRF ● = Soil Sample

Type: Target Site **Site Name: M5-03**	**TT ID: T20** **Subarea Group: F**	0 10 20 Feet N

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XRF Form 1 of 2

Site Type: T20
AUM Site:
Tetra Tech ID:
Sampling team: Pinkish Orange
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
X18	5-22-18	1425	no	V65 uLOD3						reading #76 trailed shot
X17	"	1430	no	V73 U4						
X13	"	1433	no	V36 uLOD3						
X9	"	1435	no	V67 U5						
X5	"	1441	no	V45 U5						
X1	"	1444	no	V55 U4						
X2	"	1449	no	V38 U4						
X3	"	1452	no	V30 U7						
X6	"	1454	no	V35 ~~U4~~ U4						
X7	"	1458	no	V48 U3						

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 . Form 2 of 2

Site Type: T20
AUM Site:
Tetra Tech ID:
Sampling team:
XRF Color: ~~Pinkse~~ Orange

Date:
Weather: Sun

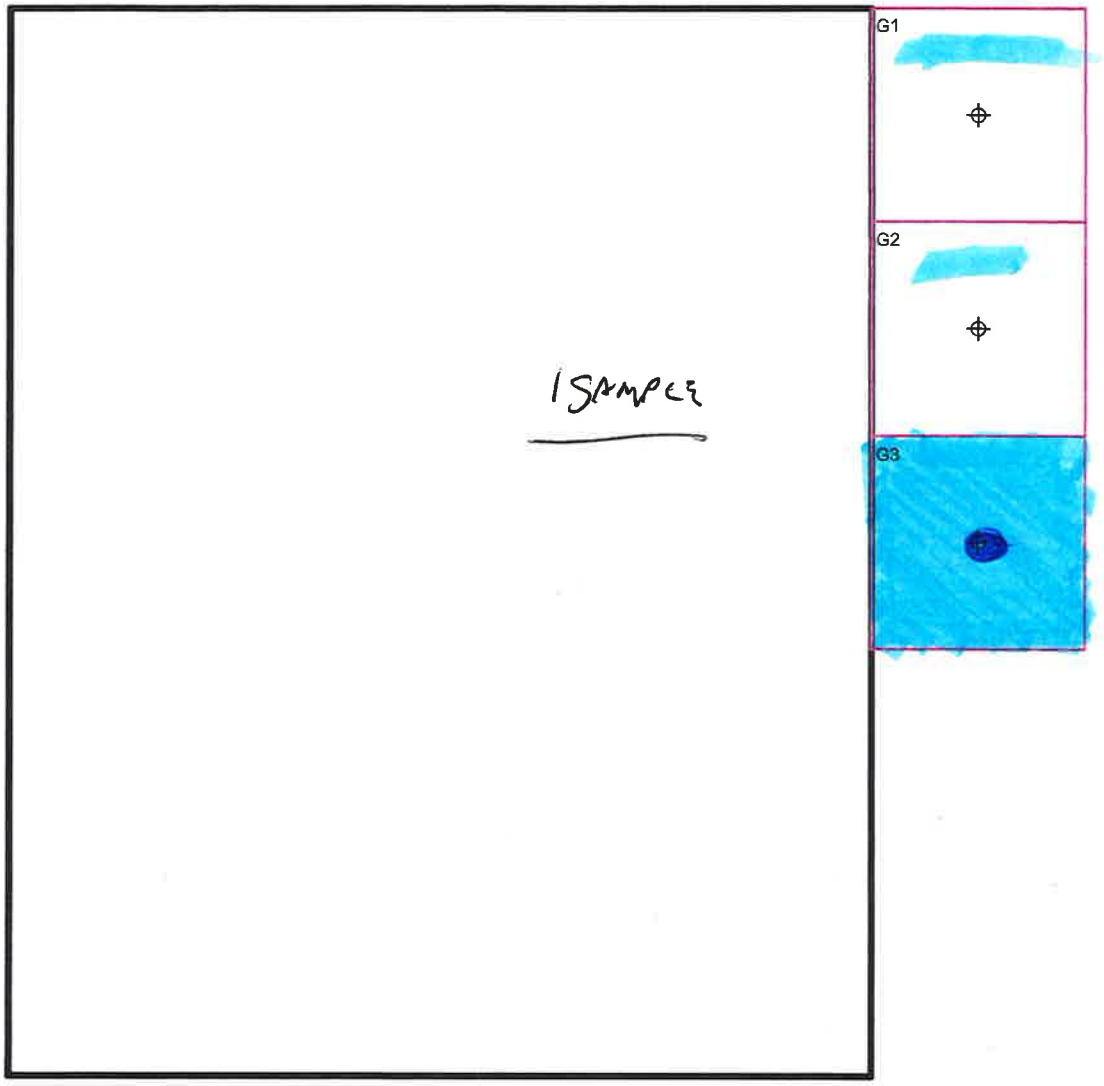
Page No.:
GPS Color:

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
X8	5-22-18	1502	no	V 55 U LOD 3						
X4	"	1507	no	V 210 U LOD 3						
X12	"	1511	no	V 40 U ~~PM~~ 3						
X16	"	1515	no	V ~~40~~ 41 U 4						
X20	"	1518	no	V 45 U LOD 3						~~2 m west of center of grid - tree~~
X19	"	1521	no	V 58 U 5						2 m west of center of grid - tree
X15	"	1527	no	V 55 U 4						2 m south (approx) of center of grid (tree)
X11	"	1529	no	V 40 U 4						
X10	"	1532	no	V 58 U 3						
X14	↓	1535	NO	V 46 U < 3	V 42 U 3	Y	T20-XS14-01-052218	N	—	ST: 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 SURVEY GRID MAP



Type: Non-AUM Target **Site Name: M5-03 Non-AUM Target**	**TT ID: T20** **Subarea Group: F**	0 12.5 25 Feet N

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XRF Field Form

Site Type: Non-AUM Target
AUM Site: M5-03 Non-AUM Target
Tetra Tech ID: T20
Sampling team: AB SK MP
XRF Color: White

Date: 9/11/18
Weather: Sunny
Page No.: 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
G3	9/11/18	1408	NO	V: 45 U: >3	V: 40 U: 73	Y	T20-XSG3-01-091118	NO	—	Rdg #155 Rdg #156 ST: 1412
G2	↓	1416	NO	V: 152 U: 10	—	N	—	NO	—	
G1	↓	1418	NO	V: 112 U: >4	—	N	—	NO	—	

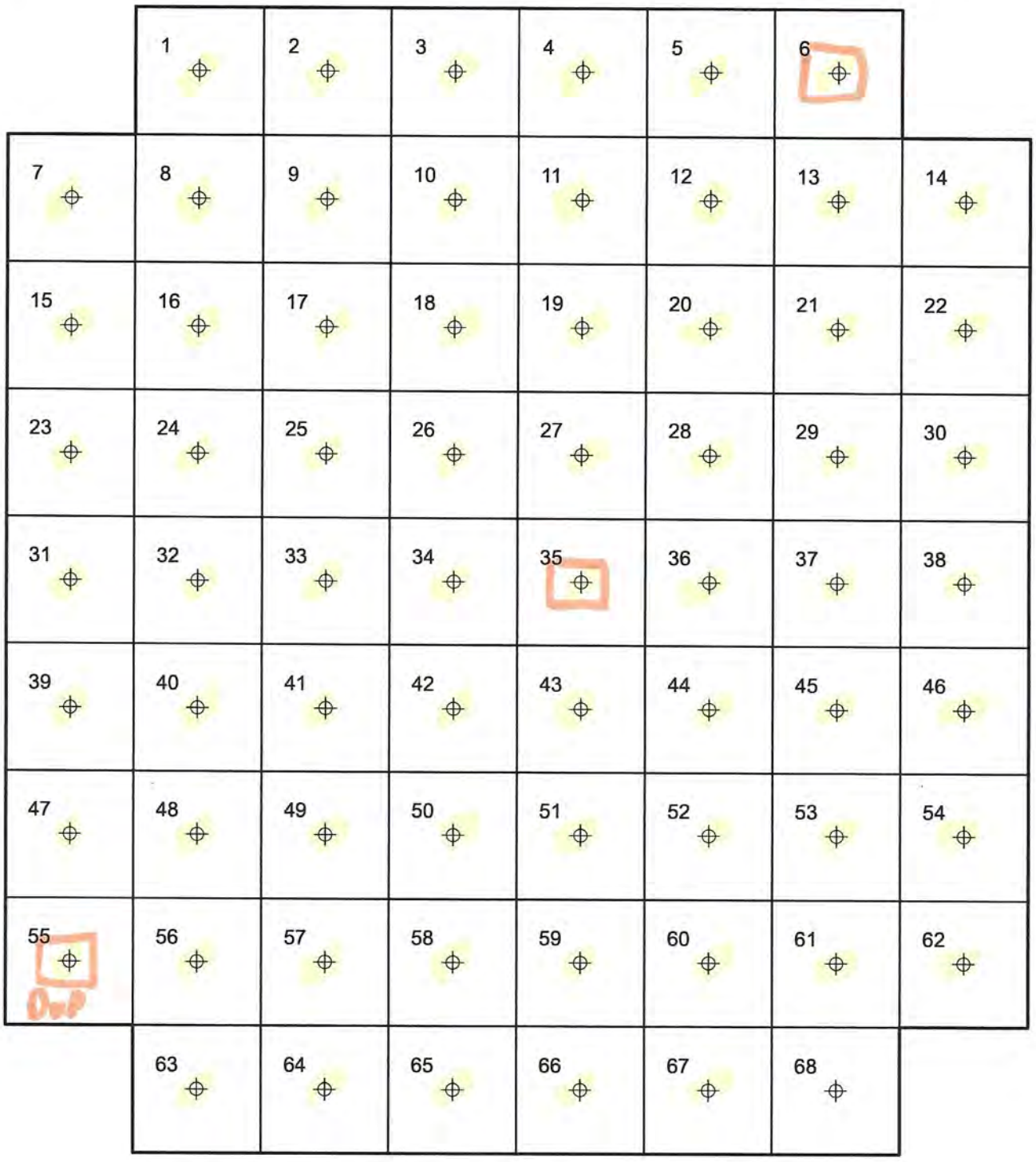
Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are 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.

TARGET T21

FIELD FORMS

XRF SURVEY GRID MAP

orange



Type: Target Site **Site Name: M5-05**	**TT ID: T21** **Subarea Group: F**	0 15 30 Feet N

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XRF Form

Site Type: TARGET
AUM Site: MS-05
Tetra Tech ID: T21
Sampling team: JM, CA, MB
XRF Color: ORANGE

Date: 5/21/18
Weather: SUNNY 75°F

Page No.: 1
GPS Color: ORANGE

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
X63	5/21/18	1420	Y	U 46 V 163	-	N	-	-	-	ADJUSTED DUE TO TREE
X64		1422	N	U 14 V 89	-	N	-	-	-	
X65		1425	N	U 12 V 79	-	N	-	-	-	
X66		1427	N	U 32 V 108	-	N	-	-	-	
X67		1429	N	U 27 V 122	-	N	-	-	-	
X68		1431	N	U 8 V 67	-	N	-	-	-	
X62		1433	N	U 10 V 76	-	N	-	-	-	
X61		1434	N	U 7 V 74	-	N	-	-	-	
X60		1437	N	U 19 V 102	-	N	-	-	-	
X59		1439	N	U 18 V 72	-	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 Form

Site Type: TARGET
AUM Site: M505
Tetra Tech ID: T21
Sampling team: CO, SM, MB
XRF Color: ORANGE

Date: 5/21/18
Weather: CLOUDY 70°F

Page No.: 2
GPS Color: ORANGE

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
X58	5/21/18	1440	N	U <3 V 53	-	N	-	-	-	
X57		1442	N	U 10 V 56	-	N	-	-	-	
X56		1444	N	U 30 V 123	-	N	-	-	-	
X55		1447	N	U 13 V 79	U 14 V 75	Y	T21-XS55-01-052118	Y	T21-XS55-02-052118	ST. 1452
X47		1458	N	U 15 V 81	-	N	-	-	-	
X48		1500	N	U 28 V 112	-	N	-	-	-	
X49		1502	N	U 16 V 74	-	N	-	-	-	
X50		1504	N	U 14 V 79	-	N	-	-	-	
X51		1506	N	U 12 V 67	-	N	-	-	-	
X52		1507	N	U 8 V 55	-	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 Form

Site Type: TARGET
AUM Site: M305
Tetra Tech ID: T2
Sampling team: JM, CA, NS
XRF Color: ORANGE

Date: 5/21/18
Weather: CLOUDY 70° F
Page No.: 3
GPS Color: ORANGE

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
XS3	5/21/18	1509	N	U 8 V 55	-	N	-	-	-	
XS4		1511	N	U 11 V 74	-	N	-	-	-	
XS6		1513	N	U 4 V 57	-	N	-	-	-	
XS5		1514	N	U 13 V 53	-	N	-	-	-	
XS4		1517	N	U 14 V 76	-	N	-	-	-	
XS3		1518	N	U 5 V 50	-	N	-	-	-	
XS2		1520	N	U 15 V 77	-	N	-	-	-	
XS1		1522	~~N~~ Y	U 16 V 99	-	N	-	-	-	OFFSET DUE TO TREE
XS0		1523	N	U 6 V 57	-	N	-	-	-	
XS9		1525	N	U 12 V 72	-	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 . Form

Site Type: TARGET
AUM Site: M505
Tetra Tech ID: T21
Sampling team: JM, LA, MB
XRF Color: ORANGE

Date: 5/21/18
Weather: CLOUDY 70°F

Page No.: 6
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
X19	5/21/18	1613	N	U 12 V 74	-	N	-	-	-	
X20		1615	N	U 4 V 34	-	N	-	-	-	
X21		1617	N	U 6 V 46	-	N	-	-	-	
X22		1619	N	U 8 V 60	-	N	-	-	-	
X~~18~~		1621	N	U 6 V 43	-	N	-	-	-	
X13		1623	N	U 5 V 39	-	✓	-	-	-	
X12		1625	N	U 7 V 35	-	N	-	-	-	
X11		1627	N	U 14 V 92	-	N	-	-	-	
X10		1630	N	U 14 V 84	-	N	-	-	-	
X9		1631	N	U 10 V 59	-	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 Form

Site Type: TARGET
AUM Site: MS-05
Tetra Tech ID: T21
Sampling team: JM, CA, MS
XRF Color:

Date: 5/21/16
Weather: CLOUDY 70°F

Page No.: 4
GPS Color: ORANGE

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
X31	5/21/16	1527	Y	U 33 V 103	-	N	-	-	-	OFFSET DUE TO TREE
X32		1524	N	U 11 V 43	-	N	-	-	-	
X33		1531	N	U 10 V 72	-	N	-	-	-	
X34		1533	N	U 17 V 68	-	N	-	-	-	
X35		1535	N	U 27 V 129	U 23 V 714	Y	T21-XS35-01-052116	N	-	ST: 1546
X36		1547	N	U 8 V 60	-	N	-	-	-	
X37		1548	N	U 11 V 55	-	N	-	-	-	
X38		1550	N	U 6 V 54	-	N	-	-	-	
X30		1552	N	U 4 V 36	-	N	-	-	-	
X29		1553	N	U 18 V 92	-	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 Form

Site Type: TARGET
AUM Site: M505
Tetra Tech ID: T21
Sampling team: JM, CA
XRF Color: ORANGE

Date: 5/21/18
Weather: CLOUDY 70°F

Page No.: 5
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
X28	5/21/18	1555	N	U 10 V 58	-	N	-	-	-	
X27		1557	N	U 8 V 49	-	N	-	-	-	
X26		1558	N	U 14 V 66	-	N	-	-	-	
X25		1601	N	U 14 V 96	-	N	-	-	-	
X24		1603	N	U 5 V 43	-	N	-	-	-	
X23		1605	N	U 10 V 60	-	N	-	-	-	
X15		1606	N	U 7 V 63	-	N	-	-	-	
X16		1608	N	U 8 V 64	-	N	-	-	-	
X17		1610	N	U 11 V 67	-	N	-	-	-	
X18		1612	N	U 6 V 41	-	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 Form

Site Type: TARGET
AUM Site: M505
Tetra Tech ID: T21
Sampling team: JM, CA, MB
XRF Color: ORANGE

Date: 5/21/18
Weather: CLOUDY 70°F

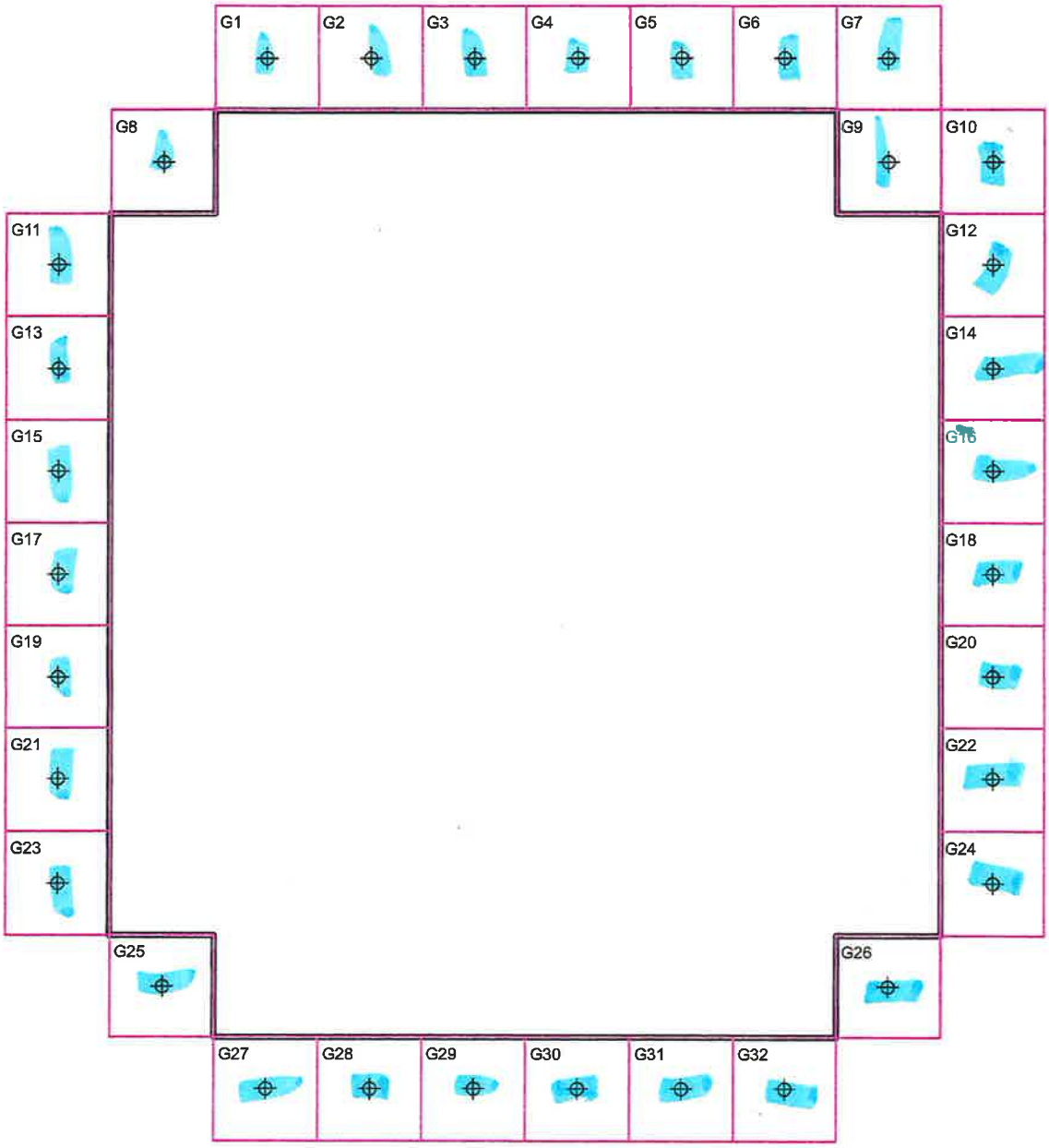
Page No.: 7
GPS Color: ORANGE

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
X6	5/21/18	1633	N	49 V 59	-	N	-	-	-	
X7		1635	N	44 V 55	-	N	-	-	-	
X1		1637	N	410 V 61	-	N	-	-	-	
X2		1639	N	49 V 54	-	N	-	-	-	
X3		1640	N	412 V 76	-	N	-	-	-	
X4		1642	N	46 V 44	-	N	-	-	-	
X5		1644	N	48 V 55	-	N	-	-	-	
X6		1646	N	49 V 40	410 V 55	Y	T21-XS6-01-052118	N	-	ST: 1650

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 SURVEY GRID MAP



Type: Non-AUM Target **Site Name: M5-05 Non-AUM Target**	**TT ID: T21** **Subarea Group: F**	0 25 50 Feet N

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XRF Field Form

Site Type: Target
AUM Site: M5-05
Tetra Tech ID: T21
Sampling team: KR, CH, AS
XRF Color: Green

Date: 9/11/18
Weather:

Page No.: 1/4
GPS Color: Green

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
G23	9/11/18	1225	No	V 55 U 9	—	No	—	No	—	
G21	"	1226	No	V 45 U 4	—	No	—	No	—	
G19	"	1228	No	V 68 U 10	—	No	—	No	—	
G17	"	1230	No	V 67 U 15	—	No	—	No	—	
G15	"	1233	No	V 90 U 16	—	No	—	No	—	
G13	"	1235	No	V 67 U 8	V 59 U 7	Yes	T21-XSG13-01-091118	No	—	STC 1240
G11	"	1239	No	V 60 U 9	—	No	—	No	—	
G8	"	1242	No	V 110 U 32	—	No	—	No	—	Light brown soil, area is heavily vegetated
G1	"	1244	No	V 44 U 4	—	No	—	No	—	
G2	"	1247	No	V 57 U 9		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: Target
AUM Site: MS-05
Tetra Tech ID: T21
Sampling team: KR, CA, MS
XRF Color: Green

Date: 9/11/18
Weather:

Page No.: 2/4
GPS Color: Green

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
G3	9/11/18	1248	No	V 82 U 19	—	No	—	No	—	
G4	"	1250	No	V 23 U 5	—	No	—	No	—	
G5	"	1252	No	V 39 U 3	—	No	—	No	—	
G6	"	1254	No	V 55 U 7	—	No	—	No	—	
G7	"	1256	No	V 34 U <3	—	No	—	No	—	
G9	"	1258	No	V 43 U 3	—	No	—	No	—	
G10	"	1300	No	V ~~49~~ 27 U 3	—	No	—	No	—	
G12	"	1302	No	V 30 U 5	—	No	—	No	—	
G14	"	1304	No	V 48 U 7	—	No	—	No	—	
G16	"	1306	No	V 64 U 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: Target
AUM Site: MS105
Tetra Tech ID: T21
Sampling team: KR, CA, MS
XRF Color: Green

Date: 9/11/18
Weather:

Page No.: 3/4
GPS Color: Green

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
G18	9/11/18	1307	No	V 29 U 4	—	No	—	No	—	
G20	"	1310	No	V 46 U 5	—	No	—	No	—	
G22	"	1311	No	V 57 U 8	—	No	—	No	—	
G24	"	1313	No	V 57 U 7	—	No	—	No	—	OFF set south due to thick Veg. / dark brown soil
G26 (was G28)	"	1318	No	V 46 U 4	V 46 U 4	Yes	T21-XSG26-01-091118	No	—	ST@ 1320 VOID #122
G32	"	1324	No	V 52 U 12	—	No	—	No	—	OFF SET Slightly NW due to trees, Soil is dark brown, lot of organic Matter
G31	"	1327	No	V 81 U 12	—	No	—	No	—	
G30	"	1328	No	V 105 U 14	—	No	—	No	—	
G29	"	1330	No	V 66 U 6	—	No	—	No	—	
G28	"	1332		V 142 U 42	—	No	—	No	—	OFF SET Slightly to west due to Veg.

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: Target
AUM Site: MS 105
Tetra Tech ID: T21
Sampling team: KR, CA, MS
XRF Color: Green

Date: 9/11/18
Weather:
Page No.: 4/4
GPS Color: Green

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
G27	9/11/18	1334	No	V 133 U 32	—	No	—	No	—	
G25		1336	No	V 105 U 13	—	No	—	No	—	
				V U						

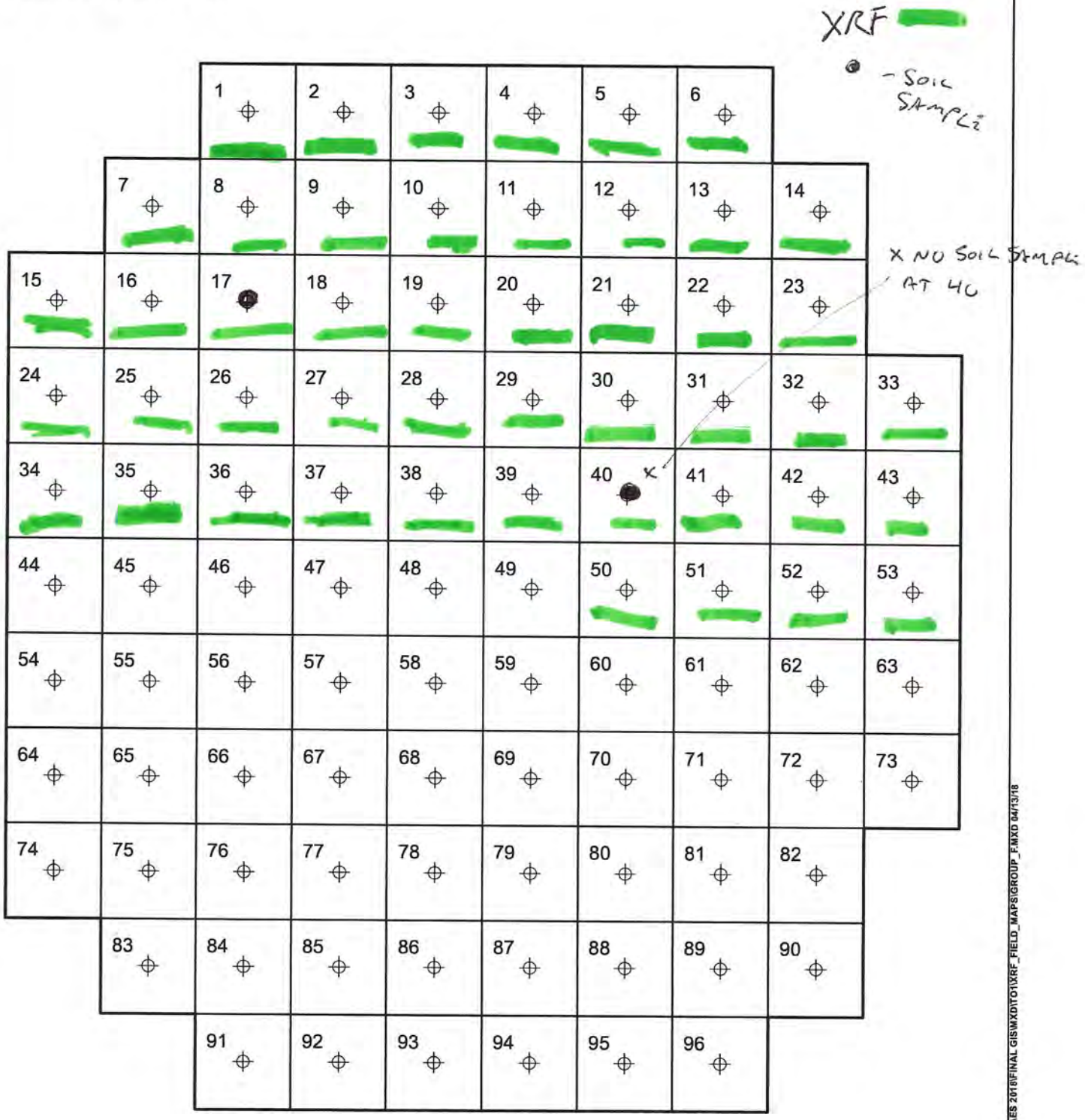
Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are 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.

TARGET T22

FIELD FORMS

Green

XRF SURVEY GRID MAP



Type: Target Site **Site Name: M5-06**	**TT ID: T22** **Subarea Group: F**	0 20 40 Feet N

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XRF Form

Site Type: TARGET MS-06 (I-22)
AUM Site:
Tetra Tech ID: LEMUEL, MIPCH, KATO
Sampling team:
XRF Color: GRN

Date: 5/21/18
Weather: SUNNY 75°
Page No.: 1
GPS Color: GRN

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

FILE G0521181B

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
X1	5/21/18	1439	N	V 39 U 5		N		N		R=79
X2	5/21/18	1446	N	V 61 U 6		N		N		
X3	5/21/18	1448	N	V 47 U 6		N		N		
X4	5/21/18	1450	N	V 46 U 6		N		N		R=82
X5	5/21/18	1453	N	V 42 U 3		N		N		
X6	5/21/18	1454	N	V 65 U 7		N		N		
X14	5/21/18	1456	Y	V 101 U 17		N		N		OFFSET - BUSH
X13	5/21/18	1458	Y	V 52 U 7		N		N		R=86 OFFSET - VEG
X12	5/21/18	1500	Y	V 49 U 7		N		N		OFFSET - VEG
X11	5/21/18	1502	Y	V 41 U 5		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 Form

Site Type: TARGET MS-06 (T-22)
AUM Site:
Tetra Tech ID: LEMUEL, KATO, MITCH
Sampling team:
XRF Color: GRN

Date: 5/21/18
Weather: SEE 8.1

Page No.: 2
GPS Color: GRN

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
X 10	5/21/18	1503	N	V 36 U 4		N		N		NEAR BADGER HOLE
X 9	5/21/18	1505	N	V 35 U 5		N		N		R=90 TURN
X 8	5/21/18	1507	N	V 45 U 6		N		N		~~TWO~~ SANDSTONE CORE SAMPLES FOUND HERE (GPS PHOTO)
X 7	5/21/18	1511	Y	V 36 U 6		N		N		OFF SET - TREES
X 15	5/21/18	1513	N	V 64 U 10		N		N		MORE SANDSTONE CORES
X 16	5/21/18	1515	N	V 46 U 5		N		N		
X 17	5/21/18	1517	N	V 38 U 4	V 44 U 3	Y	~~T22-XS17-01-~~ T22-XS17-01-052118	N		ST = 1519
X 18	5/21/18	1526	N	V 46 U 5		N		N		
X 19	5/21/18	1534	N	V 41 U 4		N		N		R=99
X 20	5/21/18	1536	Y	V 40 U 6		N		N		OFF SET - TREES

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 Form

Site Type: TARGET MS-06
AUM Site: T-22
Tetra Tech ID:
Sampling team: KATO, LEMUEL, WITCH, SWATOH
XRF Color: GRN

Date: 5/21/18
Weather: (52° P.1)
Page No.: 3
GPS Color: GRN

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
X21	5/21/18	1538	V 39 U 5	N		N		N		R=101
X22	5/21/18	1540	V 46 U 3	N		N		N		
X23	5/21/18	1542	V 60 U 9	YES		N		N		OFFSET - TREES
X33	5/21/18	1544	V 53 U 7	YES		N		N		OFFSET - TREE
X32	5/21/18	1546	V 41 U 6	N		N		N		
X31	5/21/18	1548	V 58 U 8	N		N		N		NEAR VERTICAL SHAFT?
X30	5/21/18	1550	V 58 U 6	N		N		N		R=107
X29	5/21/18	1553	V 54 U 6	N		N		N		
X28	5/21/18	1555	V 51 U 10	N		N		N		
X27	5/21/18	1558	V 41 U 6	N		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 Form

Site Type: TARGET MS-06 T-22
AUM Site:
Tetra Tech ID: KATO, MITCH, LEMUEL
Sampling team:
XRF Color: GRN

Date: 5/21/18
Weather: 70° SUNNY
Page No.: 4
GPS Color: GRN

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
X26	5/21/18	1600	N	V 37 U 5		N		N		
X25	5/21/18	1602	N	V 50 U 6		N		N		
X24	5/21/18	1604	N	V 53 U 8		N		N		
X34	5/21/18	1606	N	V 42 U 6		N		N		R=114
X35	5/21/18	1608	N	V 45 U <3		N		N		
X36	5/21/18	1610	N	V 43 U 3		N		N		
X37	5/21/18	1613	N	V 55 U 7		N		N		
X38	5/21/18	1615	N	V 51 U 7		N		N		
X39	5/21/18	1618	N	V 53 U 7		N		N		OFFSET - TREES
X40	5/21/18	1621	N	V 40 U 8		N		N		R=120

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.

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XRF Form

Site Type: TARGET MS-06
AUM Site: T-22
Tetra Tech ID: KATO, LEMURE, MITCH
Sampling team: GRN
XRF Color:

Date: 5/21/18
Weather: ~~(SEE P 4)~~ CLOUDY BREEZY 70°

Page No.: 5
GPS Color: GREEN

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
X41	5/21/18	1623	Y	V 43 u 6		N		N		OFFSET TREES
X42	5/21/18	1625	N	V 44 u 8		N		N		
X43	5/21/18	1627	N	V 47 u 9		N		N		
X53	5/21/18	1629	N	V 57 u 8		N		N		
X52	5/21/18	1630	N	V 37 u <3		N		N		
X51	5/21/18	1632	N	V ~~57~~ 53 u ~~8~~ 6		N		N		
X50	5/21/18	1635	N	V 54 u 9		N		N		R=127
X	5/21/18			V u						
X	5/21/18			V u						
X	5/21/18			V u						

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.

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XRF Form

Site Type: AUM TARGET MS-06
AUM Site: T-22
Tetra Tech ID: KATO, LEFORT, MITCH
Sampling team: GRN
XRF Color:

Date: 5/21/18
Weather: SEE PREVIOUS
Page No.: 6
GPS Color: GRN

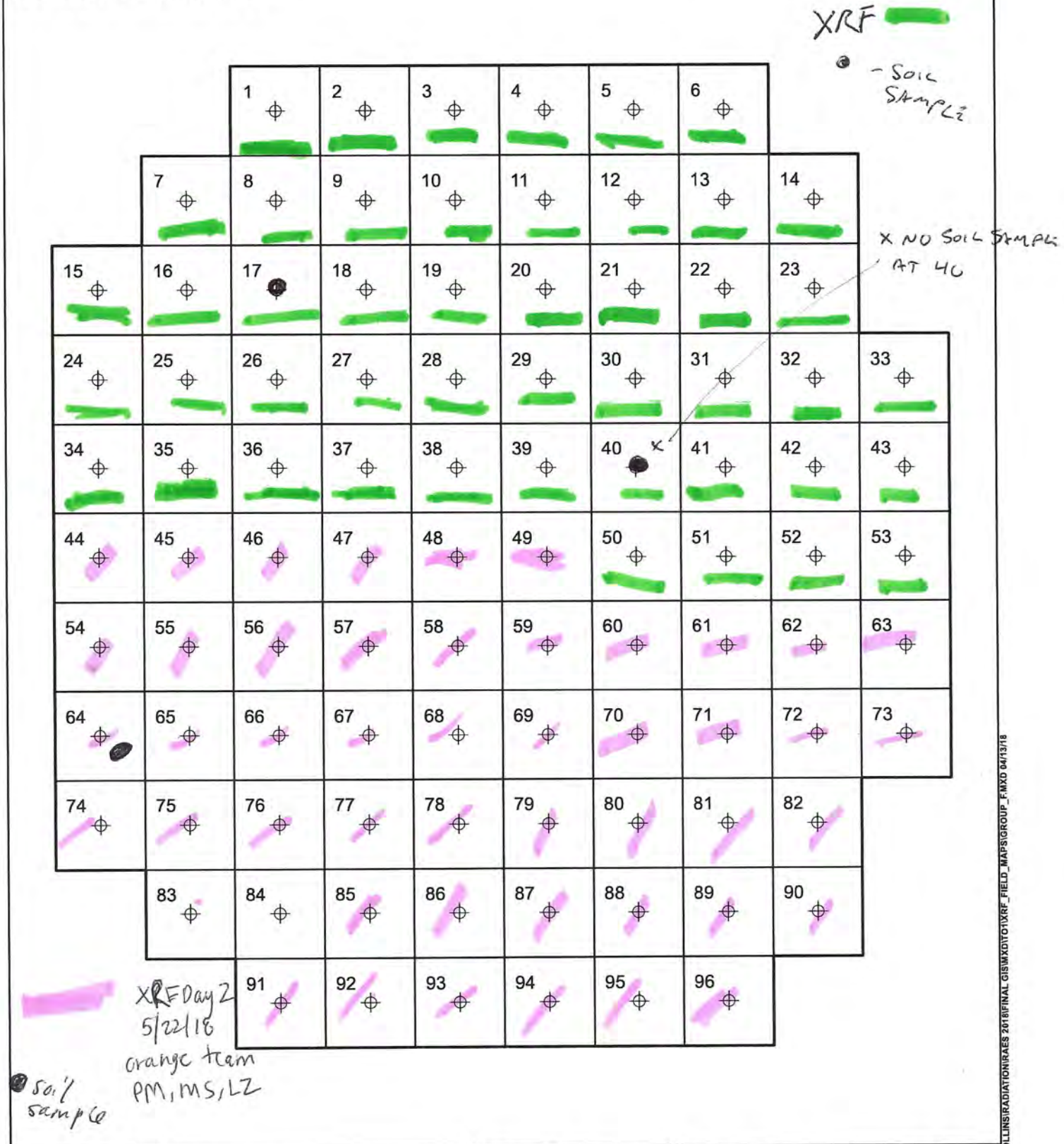
Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

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
X	5/21/18									
X	5/21/18									
X										
X										
X										
X										
X										
X										
X										
X										

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.

Orange [redacted]

XRF SURVEY GRID MAP



Type: Target Site	**TT ID: T22**	0 20 40 Feet, N
Site Name: M5-06	**Subarea Group: F**	

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XRF Form

Site Type: T22
AUM Site:
Tetra Tech ID:
Sampling team: PM, MS, CZ
XRF Color: OR

Date: 5/22/18
Weather:

Page No.: 5
GPS Color: OR

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
X85	5/22/18	1309	N	V 49 U 4	—	N		N		flat
X84	↓	1311	Y	V 76 U 13	—	N		↓		adjusted 3ft S due to brush
X83		1313	N	V 43 U 5	—	N				flat
X91		1316	N	V 74 U 8	—	N				flat, near trees
X92		1319	N	V 62 U 6	—	N				flat, Reading #67 ~~are~~ accidental shots + #68
X93		1321	N	V 54 U 8	—	N				flat
X94		1323	N	V 51 U 5	—	N				flat
X95		1325	N	V 55 U 8	—	N				flat
X96	↓	1330	N	V 48 U 8	—	N		↓		flat Reading #73, 74 accidental shot
				V U	—	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 . Form

Site Type: T22
AUM Site:
Tetra Tech ID: MS, PM, LZ
Sampling team:
XRF Color: OR

Date: 5/22/18
Weather:

Page No.: 4
GPS Color: OR

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
X78	5/22/18	1211	N	V 50 U 9	—	N				
X79		1213	N	V 46 U 5	—	N				
X80		1216	N	V 64 U 7	—	N				
X81		1218	N	V 49 U 5	—	N				
X82		1220	N	V 68 U 7	—	N				
X90		1257	N	V 67 U 7	—	N				
X89		1300	N	V 56 U 8	—	N				
X88		1302	N	V 54 U 4	—	N				
X87		1304	N	V 52 U 7	—	N				
X86	↓	1306	N	V 51 U 8	—	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.

T22

XRF . Form

Site Type:
AUM Site:
Tetra Tech ID:
Sampling team: PM, MS, LZ
XRF Color: OV

Date:
Weather:
Page No.: 3
GPS Color: OV

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
X69	5/22/18	1136	N	V 55 U 8	V 60 U 8	N				
X68	↓	1139	N	V 56 U 5	—	N				
X67		1142	N	V 60 U 7	—	N				
X66		1144	N	V 53 U 8	—	N				
X65		1147	N	V 66 U 6	—	N				
X64		1148	N	V 50 U 3	V 48 U <3	Y	T22-XS64-01-052218	N	—	ST: 1153
X74		1200	N	V 4 U <3	—	N				
X75		1203	N	V 47 U 4	—	N				
X76		1206	N	V 44 U 4	—	N				
X79	↓	1208	N	V 47 U 4	—	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 . Form

Site Type:
AUM Site:
Tetra Tech ID: T22
Sampling team: MS, PM, LZ
XRF Color: orange

Date: 5/22/18
Weather:
Page No.: 2
GPS Color: orange

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
X58	5/22/18	1105	N	V 52 U 8	—					flat
X59		1109	N	V 49 U 7	—					Reading #32 should be X59 ***
X60		1111	N	V 62 U 7	—					flat
X61		1113	N	V 35 U 6	—					flat
X62		1116	N	V 49 U 4	—					flat near trees
X63		1120	N	V 61 U 8	—					flat, offset due to tree
X73		1125	N	V 51 U 6	—					flat
X72		1127	N	V 56 U 6	—					flat
X71		1129	N	V 47 U 4	—					flat
X70	↓	1132	N	V 48 U 6	—					flat

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 . Form

Site Type: Target
AUM Site: MS-06 T22
Tetra Tech ID: [redacted]
Sampling team: MS, PM, LZ
XRF Color: orange

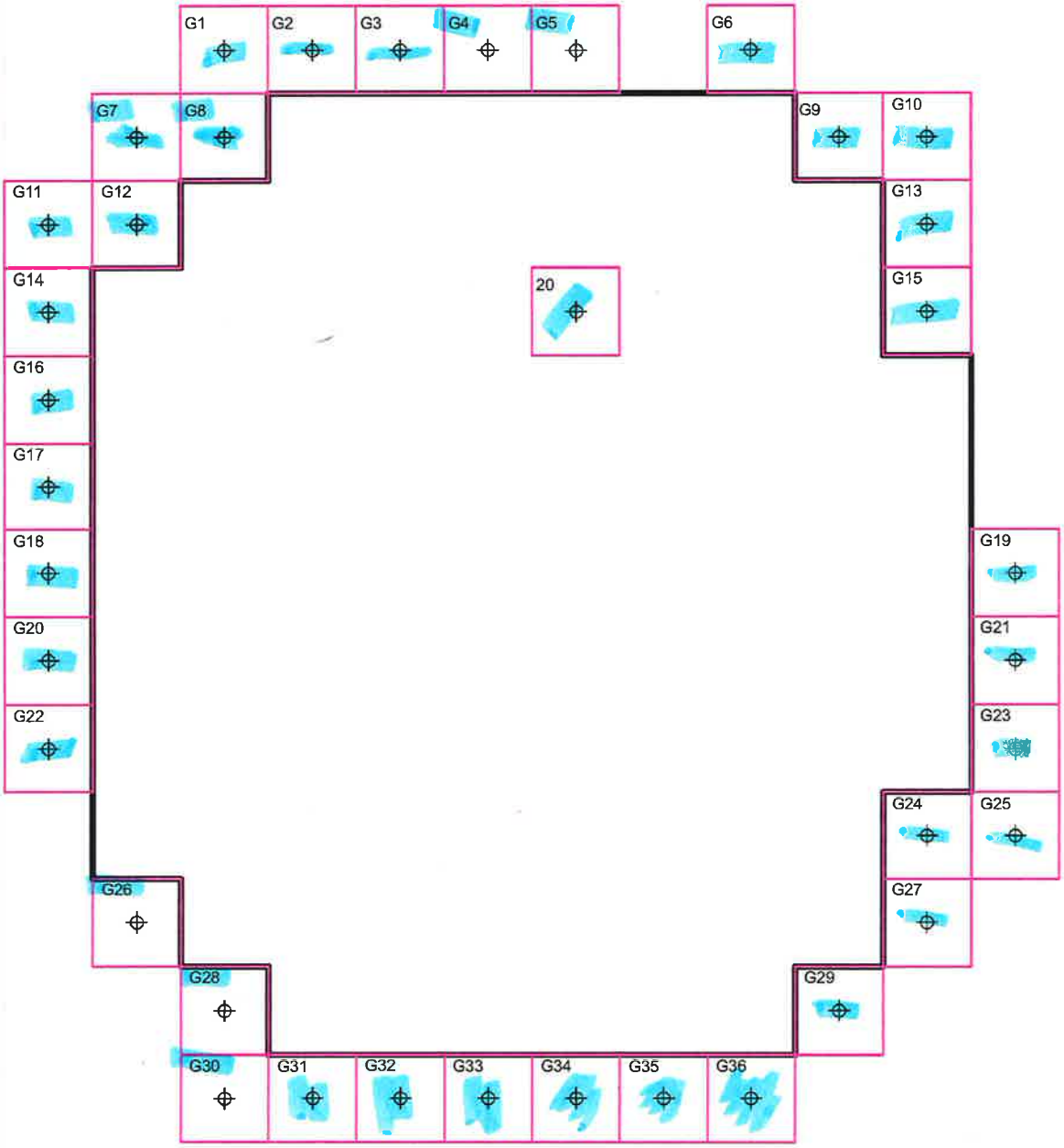
Date: 5/22/18
Weather: overcast, 70°F, slight breeze
Page No.: 1
GPS Color: orange

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
X49	5/22/18	1029	N	V 53 U 6	V 48 U 7	N	—	N	—	flat
X48	↓	1032	N	V 71 U 10	—	N				flat
X47		1035	N	V 53 U 11	—	N				flat near tree
X46		1039	N	V 39 U 3	—	N				flat
X45		1043	N	V 43 U 4	—	N				flat
X44		1046	N	V 45 U 4	—	N				flat
X54		1050	N	V 49 U 4	—	N				flat
X55		1052	N	V 33 U <3	—	N				flat
X56		1059	N	V 46 U 4	—	N				flat w/tree
X57	↓	1102	N	V 69 U 10	—	N				tree

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 SURVEY GRID MAP



Type: Non-AUM Target **Site Name: M5-06 Non-AUM Target**	**TT ID: T22** **Subarea Group: F**	0 30 60 Feet N

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XRF Field Form

* Green Trimble does not have XRF option "T22 G316" in Trimble

Site Type: Target
AUM Site: T22
Tetra Tech ID: MS-06
Sampling team: KR, CA, AS
XRF Color: Green

Date: 9/11/18
Weather:
Page No.: 1 / 4
GPS Color: Green

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

V/U

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
G36	9/11/18	0825	Yes	V 72 U 12	V 76 U 14	No	—	No	—	1st Reading #13 Adjusted due to Veg. Green XRF Dup Trip
G35		0838	No	V 51 U 4	—	No	—	No	—	
G34		0840	No	V 44 U 4	—	No	—	No	—	
G33		0842	No	V 58 U 9	—	No	—	No	—	
G32		0844	No	V 61 U <3	—	No	—	No	—	
G31		0845	No	V 54 U <3	—	No	—	No	—	
G30		0847	No	V 57 U 5	—	No	—	No	—	Slight offset due to Veg.
G28		0848	No	V 48 U <3	—	No	—	No	—	
G26		0851	No	V 50 U 4	—	No	—	No	—	
G22		0853	No	V U		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: Target
AUM Site: MS04
Tetra Tech ID: T22
Sampling team: KR, CH, MS
XRF Color: Green

Date: 9/11/18
Weather:

Page No.: 2/4
GPS Color: Green

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
G20	9/11/18	0855	No	V 44 U <3	—	No	—	No	—	
G18		0857	No	V 44 U 4	—	No	—	No	—	
G17		0859	No	V 64 U 5	—	No	—	No	—	
G16		0901	No	V ~~64~~ 44 U 6	—	No	—	No	—	
G14		0903	No	V 53 U 7	—	No	—	No	—	
G11		0905	No	V 46 U 3	—	No	—	No		
G12		0907	No	V 71 U 6	—	No	—	No	—	
G7		0909	No	V 23 U <5	—	No	—	No	—	ON the Road
G8		0910	No	V 39 U 4	—	No	—	No	—	
G1	↓	0912	No	V 40 U <3	—	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: Target
AUM Site: MS-06
Tetra Tech ID: T22
Sampling team: KR, CA, AS
XRF Color: Green

Date: 9/11/18
Weather:
Page No.: 3/4
GPS Color: Green

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
G2	9/11/18	0914	No	V 17 U <3	—	No	—	No	—	
G3		0915	No	V 10 U <4	—	No	—	No	—	On the Road
G4		0917	No	V 34 U <3	—	No	—	No	—	
G5		0918	No	V 47 U 4	—	No	—	No	—	
X20		0921	No	V 33 U 3	V 26 U 4	Yes	T22-X820-01-091118 (8)	No	—	9:25
G6		0937	No	V 43 U 4	—	No	—	No	—	
G9		0939	No	V 67 U 9	—	No	—	No	—	
G10		0940	No	V 49 U 5	—	No	—	No	—	
G13		0942	No	V 47 U 5	—	No	—	No	—	
G15	↓	0943	No	V 53 U <3						

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: Target
AUM Site: MS-01
Tetra Tech ID: T22
Sampling team: KR, CA, MS
XRF Color: Green

Date: 9/11/18
Weather:

Page No.: 4/4
GPS Color: Green

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
G19	9/11/18	0945	No	V 49 U 5	—	No	—	No	—	
G21		0947	No	V 62 U 10	—	No	—	No	—	
G23		0949	No	V 76 U 8	—	No	—	No	—	
G25		0951	No	V 49 U 5	—	No	—	No	—	
G24		0953	No	V 48 U 5	—	No	—	No	—	
G27		0954	No	V 43 U 5	—	No	—	No	—	
G29		0956	No	V 42 U 5	—	No	—	No	—	
	↓									

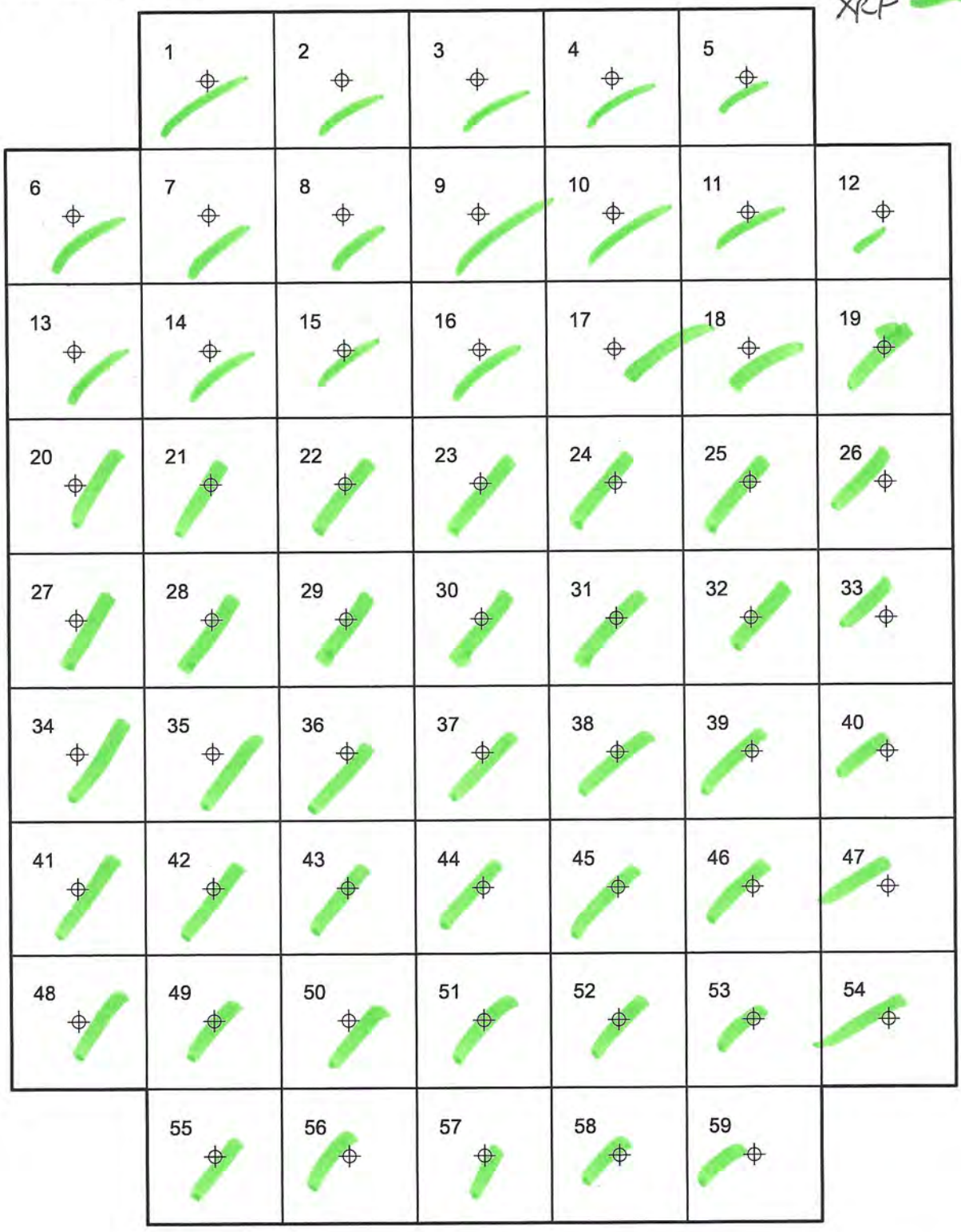
Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are 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.

TARGET T24

FIELD FORMS

XRF SURVEY GRID MAP

XRF



Type: Target Site **Site Name: M5-07**	**TT ID: T24** **Subarea Group: F**	0 15 30 Feet N

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XRF Form

Site Type: TARGET
AUM Site: mesa 5 #7 T-24
Tetra Tech ID:
Sampling team: Karina Redding, Mitch Peters, Dustin, Rius
XRF Color: BLUE

Date: 6/24/18
Weather: SUNNY 70°
Page No.: (1)
GPS Color: GREEN

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
X 34	5/24/18	10:29	N	V 45 U 4	V 49 U 3	N				TRIP & DUP R#2-8
X 27	5/24/18	10:41	N	V 54 U 7		N				~~#8 - Accidental trigger~~ #9
X 35	5/24/18	10:46	N	V 51 U 5		N				#10 10 second
X 36	5/24/18	10:49	N	V 52 U 9						12
X 37	5/24/18	10:51	N	V 47 U 4						13
X 38	5/24/18	10:54	N	V 41 U 4						#14
X 39	5/24/18	10:56	Y	V 61 U 5						offset due to tree
X 40	5/24/18	10:59	N	V 69 U 11						
X 47	5/24/18	11:01	N	V 52 U 6						
X 46	5/24/18	11:04	N	V 44 U 7						

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 Form

Site Type: Target
AUM Site: M5-07
Tetra Tech ID: T-24
Sampling team: Karine, Mitch, Dustin, Rius
XRF Color: Blue

Date: 5/24/18
Weather: Sunny 70°
Page No.: 2
GPS Color: Green

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
X45	5/24/18	11:09	N	V 57 U 8						
X 44	5/24/18	11:11	N	V 37 U 6						
X 43	5/24/18	11:13	N	V 48 U 7						
X 42	5/24/18	11:14	N	V 30 U 4						
X 41	5/24/18	11:16	N	V 48 U 5						#23 Same Time; Sample collected 1127 ~~metals~~ 1229 ~~XRF~~
X 48	5/24/18	11:18	N	V 21 U 14			T24-XS48-01-052418	N		
X 49	5/24/18	11:29	N	V 52 U 6						
X 50	5/24/18	11:34	N	V 39 U 4						
X 51	5/24/18	11:37	N	V 65 U 9						
X 52	5/24/18	11:44	N	V 56 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.

XRF Form

Site Type: Target
AUM Site: MS-07
Tetra Tech ID: T-24
Sampling team: Kevin, Mitch, Dustin, Rius
XRF Color: Blue

Date: 5/24/18
Weather: Sunny 70s
Page No.: 3
GPS Color: Green

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
X53	5/24/18	11:48	N	V 71 U 9						
X54	5/24/18	11:50	N	V 42 U 6						
X59	5/24/18	11:53	N	V 53 U 9						
X58	5/24/18	11:55	N	V 48 U 5						* Saved as "X 59" not "X58" on XRF, ie 2 "X 59"s
X57	5/24/18	11:59	N	V 54 U 7						#33 #34 false trigger, 1sec
X56	5/24/18	12:02	N	V 69 U 8						#35
X55		12:05	N	V 66 U 8						
X28		12:17	N	V 66 U 6						37
X29		12:19	N	V 57 U 7						
X30	↓	12:21	N	V 55 U 7						

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 Form

Site Type: Target
AUM Site: T-24
Tetra Tech ID: MS-07
Sampling team: Mitch, Karina
XRF Color: Blue

Date: 5/24/18
Weather: Sunny 70s
Page No.: 4
GPS Color: Green

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
X31	5/24/18	12:24	N	V 59 U 5		N				
X32	"	12:27	N	V 30 U 5		N				
X33	"	12:29	N	V 46 U 5		N				
X26	"	12:32	N	V 30 U 7		N				
X25	"	12:35	N	V 53 U <4		N				
X24	"	12:37	N	V 52 U 6		N				
X23	"	12:40	N	V 52 U 6		N				
X22	"	12:42	N	V 64 U 9		N				#42
X21	"	12:45	N	V 56 U 7		N				
X20	↓	12:47	N	V 25 U <3		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 Form

Site Type: AUM
AUM Site: MRSD 5 Ø7
Tetra Tech ID: T-24
Sampling team: MITCH/KARINA
XRF Color: BLUE

Date: 5/24/18
Weather: SUNNY 50°
Page No.: 5
GPS Color: GRN

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
X1	5/24/18	1356	N	V 36 U 6		N				R=50
X2	5/24/18	1359	N	V 38 U 4		N				
X3	5/24/18	1403	N	V 67 U 5		N				R=52
X4	5/24/18	1405	N	V 41 U 6		N				R53
X5	5/24/18	1407	N	V 52 U 4		N				
X12	5/24/18	1412	N	V 46 U <3		N				
X11	5/24/18	1414	N	V 47 U 10		N				
X10	5/24/18	1416	N	V 64 U 5		N				
X9	5/24/18	1419	N	V 63 U 9		N				R59
X8	5/24/18	1421	N	V 56 U 6		N				R60

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 Form

Site Type: AUM MESA 507 T-24
AUM Site:
Tetra Tech ID: MITCH, KEARNS
Sampling team:
XRF Color: BLUE

Date: 5/24/18
Weather: SUNNY 80°
Page No.: 6
GPS Color: GRN

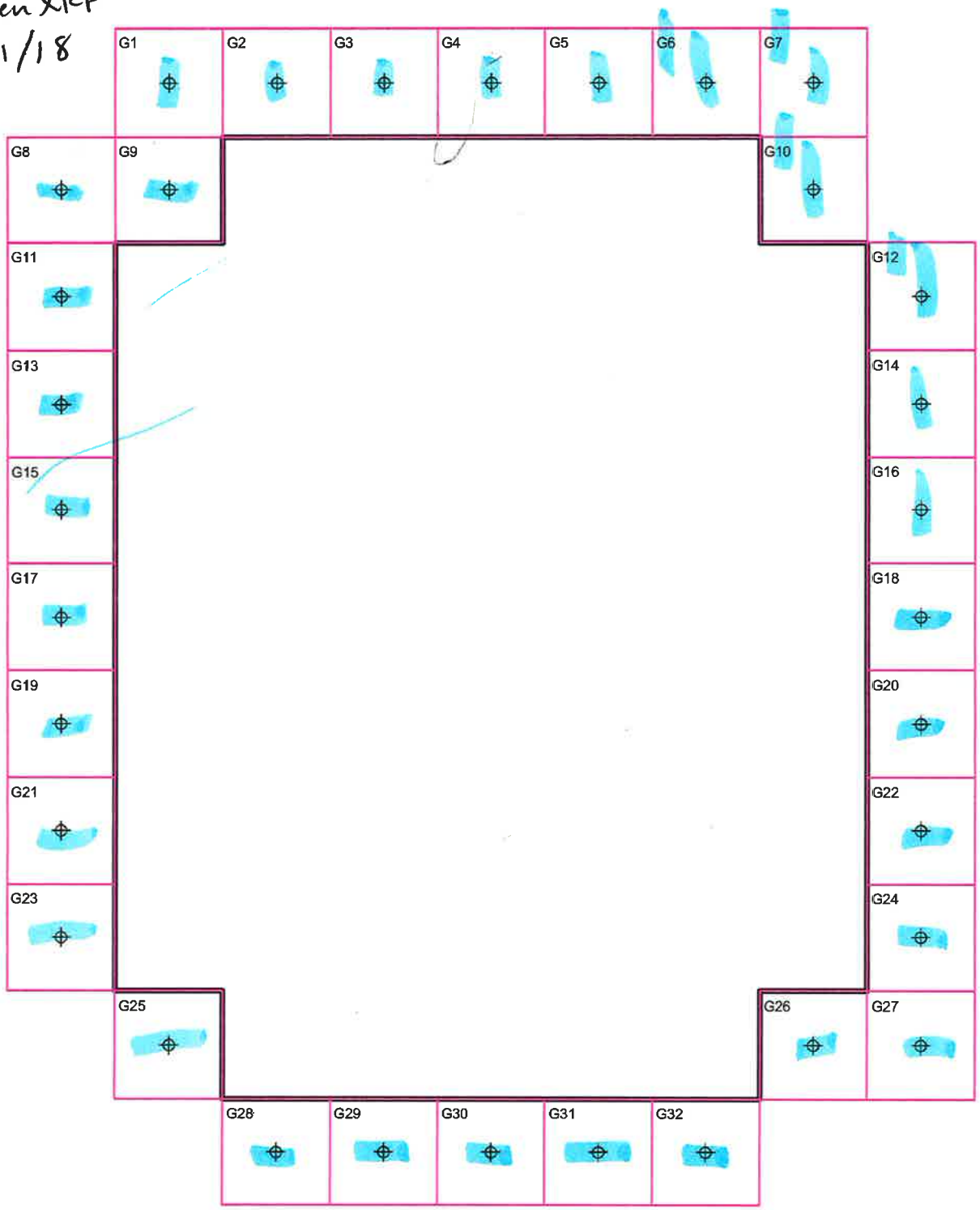
Example Sample ID: M1-XS1-01-042218
Example Duplicate ID: M1-XS1-02-042218

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
X7	5/24/18	1423	N	V 57 U 6		N				R=61
X6	5/24/18	1426	N	V 27 U 8		N				R=62
X13	5/24/18	1428	N	V 60 U 12		N				
X14	5/24/18	1430	N	V 34 U 7		N				
X15	5/24/18	1432	N	V 61 U 6		N				
X16	5/24/18	1434	N	V 52 U 5		N				
X17	5/24/18	1437	N	V 53 U 4		N				
X18	5/24/18	1438	N	V 66 U 6		N				R=68
X19	5/24/18	1440	N	V 60 U 7		N				
X	5/24/18	14		V U		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 SURVEY GRID MAP

Green XRF
9/11/18



Type: Non-AUM Target **Site Name: M5-07 Non-AUM Target**	**TT ID: T24** **Subarea Group: F**	0 20 40 Feet N

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XRF Field Form

Site Type: Target
AUM Site: M5-07
Tetra Tech ID: T24
Sampling team: KR, CA, AS
XRF Color: Green

Date: 9/11/18
Weather:

Page No.: 1 / 4
GPS Color: Green

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
G18	9/11/18	1027	No	V 43 U 4	V 41 U <3	No	—	No	—	VOID #59
G20	|	1032	No	V 43 U <2	—	No	—	No	—	
G22	|	1034	No	V 59 U 10	—	No	—	No	—	
G24	|	1037	No	V 15 U <3	—	No	—	No	—	
G27	|	1038	No	V 28 U 3	—	No	—	No	—	
G26	|	1040	No	V 30 U 3	V 32 U <3	Yes	T24-XS-G26-01-091118	No	—	In trimble called G26 Duplicate ST=1045
G32	|	1044	No	V 33 U 3	—	No	—	No	—	
G31	|	1046	No	V 25 U 3	—	No	—	No	—	
G30	|	1047	No	V 30 U 5	—	No	—	No	—	Entered As G3 *
G29	|	1050	No	V 63 U 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.

XRF Field Form

Site Type: Target
AUM Site: M5-07
Tetra Tech ID: T24
Sampling team: KR, CA, VS
XRF Color: Green

Date: 9/11/18
Weather:

Page No.: 2/4
GPS Color: Green

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
G 28	9/11/18	1052	No	V 49 U 4	—	No	—	No	—	
G 25		1054	No	V 50 U 6	—	No	—	No	—	
G 23		1055	No	V 57 U 12	—	No	—	No	—	
G 21		1100	No	V 54 U 6	—	No	—	No	—	
G 19		1102	No	V 34 U 3	—	No	—	No	—	
G 17		1104	No	V 20 U 3	—	No	—	No	—	
G 15		1105	No	V 42 U 5	—	No	—	No	—	
G 13		1107	No	V 36 U 7	—	No	—	No	—	On the Road
G 11		1108	No	V 39 U 5	—	No	—	No	—	
G 8		1110	No	V 39 U <33	—	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: Target
AUM Site: MS-07
Tetra Tech ID: T24
Sampling team: ILR, CA, MS
XRF Color: Green

Date: 9/11/18
Weather:

Page No.: 3/4
GPS Color: Green

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
G9	9/11/18	1112	No	V 31 U 3	—	No	—			
G1	|	1114	No	V 35 U 3	—	~~Yes~~ No	~~T24-X862-01-091118~~ —	No		
G2	|	1115	No	V 43 U 4	V 36 U 4	Yes	T24-X862-01-091118	No	—	ST = 1120
G3	|	1121	No	V 21 U 7	—	No	—	No	—	
G4	|	1123	No	V 37 U 4	—	No	—	No	—	On the Road
G5	|	1125	No	V 41 U 5	—	No	—	No	—	
G6	|	1127	No	V 53 U 4	—	No	—	No	—	
G7	|	1128	No	V 46 U 7	—	No	—	No	—	
G10	|	1130	No	V 73 U <3	—	No	—	No	—	
G12	V	1132	No	V 43 U <3	—	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: Target
AUM Site: MS-07
Tetra Tech ID: T24
Sampling team: KR, CM, MB
XRF Color: Green

Date: 9/11/18
Weather:
Page No.: 4/4
GPS Color: Green

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

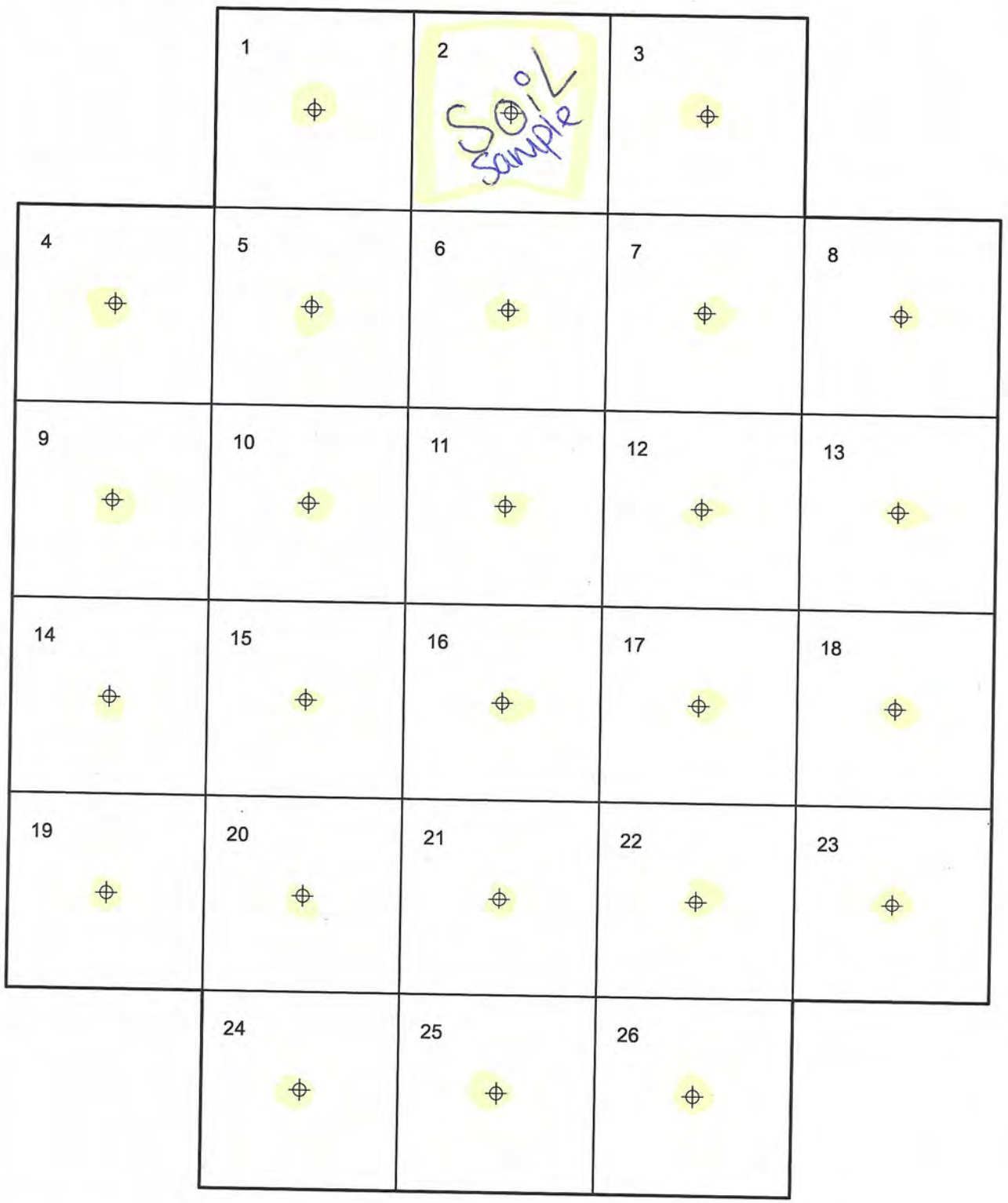
XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
G14	9/11/18	1134	Yes	V 44 U 5	—	NO	—	No	—	OFF set SE due to Grant Dead Tree
G16	"	1136	No	V 52 U 6	—	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.

TARGET T25

FIELD FORMS

XRF SURVEY GRID MAP



Type: Target Site **Site Name: M5-08**	**TT ID: T25** **Subarea Group: F**	0 10 20 Feet N

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XRF Field Form

(1)

Site Type: Target
Site Name: T25
Tetra Tech ID:
Sampling team: AD, CL, LS
XRF Color: blue

Date: 6/6/18
Weather: Sunny, high 80°s
Page No.: 1
GPS Color: Pink

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
X9	6/6/18	1448	Y	42/<4	-	N				Slope
X13	↓	1450	N	42/<3	-	↓				
X18		1452	N	45/<3	-					
X23		1454	N	45/3	-					
X26		1456	Y	33/5	-					Drainage
X22		1459	Y	48/3	-					Thick brush
X17		1502	Y	51/3	-					Thick brush
X12		1504	Y	48/3	-					slope
X7		1506	Y	41/3	-					Slope
X3	↓	1509	N	28/4	-	↓				

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.

XRF Field Form

(2)

Site Type: Target
Site Name: I-25
Tetra Tech ID:
Sampling team: AD, LS, CL
XRF Color: blue

Date: 6/6/18
Weather: Sunny, High 80's
Page No.: 2
GPS Color: Pink

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
x2	6/6/18	1511	N	33/4	41/5	Yes	T25-XS2-01-060618	No	—	Sample @ 1515
x1	↓	1519	Y	59/3	-	N				Slope
x6		1521	Y	32/3	-					Slope
x11		1523	Y	28/5	-					Slope
x16		1527	Y	38/3	-					Thick brush
x21		1529	N	42/4	-					
x25		1531	N	52/3	-					
x24		1533	N	65/6	-					
x20		1535	N	48/4	-					
x15	↓	1537	N	39/3	-	↓				

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: Target
Site Name: T25
Tetra Tech ID:
Sampling team: AO, CL, LS
XRF Color: blue

Date: 6/6/18
Weather: Sunny, high 80's

Page No.: 3
GPS Color: pink

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
X10	6/6/18	1529 ~~1547~~	N	48/4	-	N				
X5		1541 ~~1544~~	Y	56/3	-					Slope
X4		1542 ~~1547~~	N	39/3	-					
X9		1544	Y	50/5	-					Slope
X14		1547	Y	46/4	-					Slope
X19		1549	Y	46/6	-					Thick brush
	Note: Target Site 25 was located in an area with steep slopes around it, which impacted Trimble accuracy due to poor Sattelite communication. Therefore, when taking a point, it could re-adjust and become slightly offcentered from grid point.									

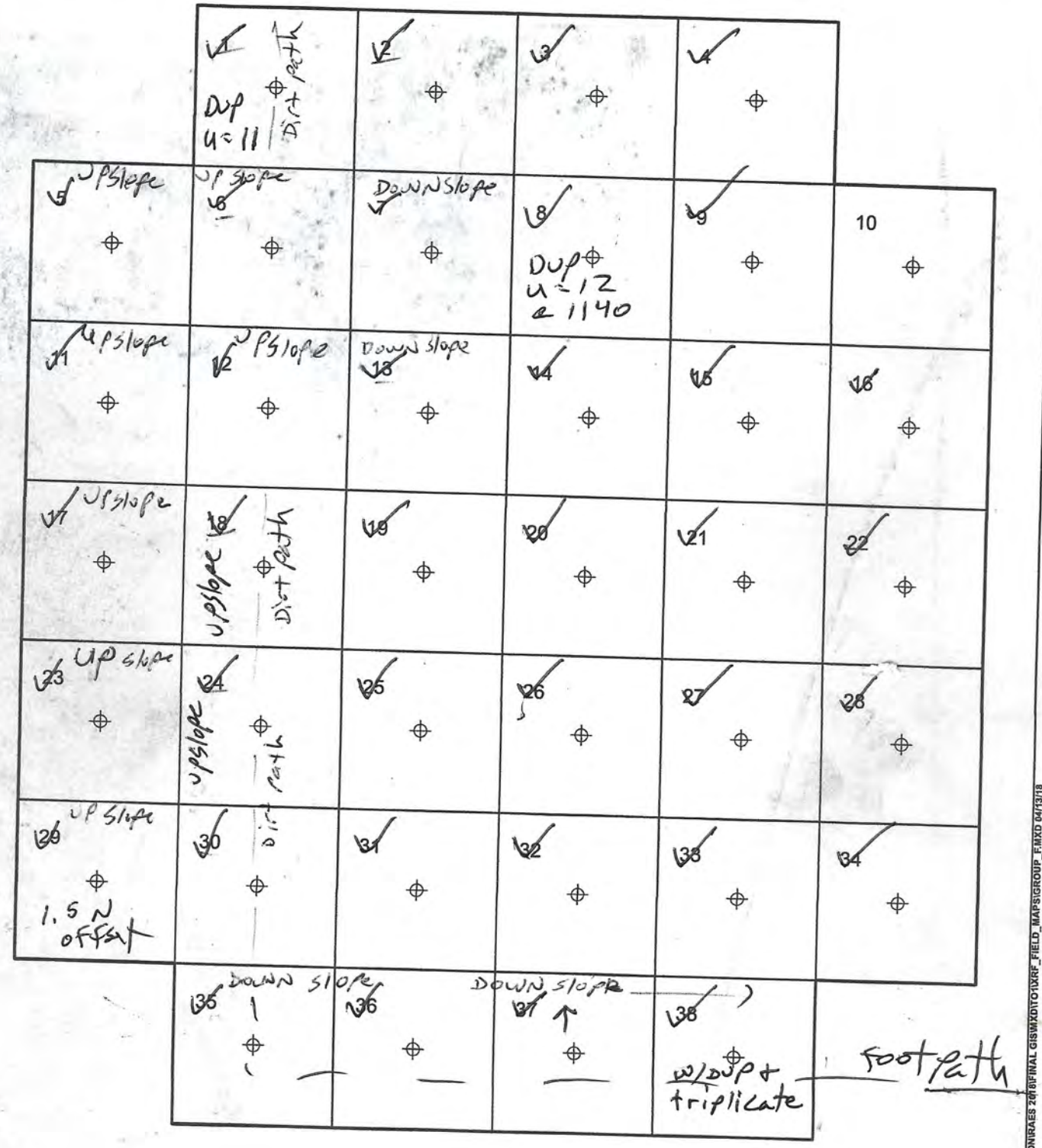
Notes to field team:
If the location of an in situ XRF measurement is adjusted by more than 1 foot, make a note of the direction of the adjustment in the notes seciton and record new coordinates in the GPS.
If a grid cannot be accessed, make a note and describe the reason.
XRF confirmation samples are 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.

TARGET T26

FIELD FORMS

6-10-18

XRF SURVEY GRID MAP



Type: Target Site **Site Name: M5-09**	**TT ID: T26** **Subarea Group: F**	0 12.5 25 Feet N

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XRF Form

Site Type: Target
AUM Site: M5-09
Tetra Tech ID: 126
Sampling team: DW, MB, NB
XRF Color: Blue

Date: 6-10-18
Weather: 72°F ☀

Page No.: 1
GPS Color: Pink

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
X38	6/10/18	9:19	offset ~1m East	V=30 U=<3.0	V=19 U=<3	N	—	N	—	offset due to GPS signal in trees
X37	↓	9:28	offset ~2M South	V=27 U=<3.0	—	N	—	N	—	offset due to trees & GPS accuracy
X36		9:31	Yes	V=34 U=<3.0	—	N	—	N	—	offset 2m E due to trees blocking GPS signal
X35		9:34	Y	V=29 U=<3.0	—	N	—	N	—	offset 1m W; GPS accuracy in trees is 1.5m
X30		9:37	N	V=44 U=<3.0	—	N	—	N	—	just downslope of foot path
X29		9:42	Y	V=36 U=<3.0	—	N	—	N	—	offset 1.5 N due to Trees on slope
X23		9:52	N	V=17 U=4.0	—	N	—	N	—	Heavily treed upper slope from foot path
X17		9:56	N	V=18 U=<4.0	—	N	—	N	—	clearing on slope
X11		9:58	N	V=33 U=<3.0	—	N	—	N	—	clearing area on slope
X5	↓	10:01	N	V=40 U=5.0	—	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 Form

Site Type: Target
AUM Site: M2-09
Tetra Tech ID: T26
Sampling team: DW, MB, NB
XRF Color: Blue

Date: 6-10-18
Weather: 75°F + ☀
Page No.: 2
GPS Color: PINK

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
X6	6/10/18	10:04	N	V=42 U≤5.0	—	N	—	N	—	~20 ft E. of sandstone outcrop; possible Nesting Area
X12	↓	10:07	Y	V=46 U=<3.0	—	N	—	N	—	offset 1m N, due to GPS signal, atop S.S outcrop
X1		10:11	N	V=75 U=12	V=78 U=~~11~~ Revised	N	T26-XS1-01-061018 @ ~~10:17~~ 10:17	N	—	Adj to foot path, atop DOWNSlope
X2		10:22	N	V=73 U=14	~~—~~	N	—	N	—	Just downslope of foot path
X7		1024	N	V=227 U=15	—	N	—	N	—	Just downslope of foot path
X18		1027	N	V=27 U=<3.0	—	N	—	N	—	Just upslope of foot path below treeline
X19		1029	Y	V=36 U=<3.0	—	N	—	N	—	offset 80cm W, due to steep drop off
X13		1032	N	V=34 U=5.0	—	N	—	N	—	Just downslope of foot path
X24		1035	N	V=38 U=<3.0	—	N	—	N	—	Just upslope of foot path
X25	↓	1037	N	V=50 U=5.0	—	N	—	N	—	Just downslope of foot path

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 Form

Site Type: Target
AUM Site: MZ-09
Tetra Tech ID: T26
Sampling team: DW, MB, NB
XRF Color: Blue

Date: 6-10-18
Weather: 80°F

Page No.: 3
GPS Color: PINK

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
X31	6/10/18	1041	N	V=41 U=4.0	—	N	—	N	—	Downslope of foot path
X32	"	1047	N	V=40 U=<3.0	—	N	—	N	—	Downslope, S. slope heavily vegetated
X33	"	1050	N	V=31 U=3.0	—	N	—	N	—	" " "
X34	"	1053	N	V=41 U=<3.0	—	N	—	N	—	" " "
X28	"	1059	N	V=38 U=4.0	—	N	—	N	—	S. slope, 1 row further down slope
X27	"	1100	N	V=37 U=<5.0	—	N	—	N	—	" " "
X26	"	1103	N	V=29 U=<3.0	—	N	—	N	—	" " "
X20	"	1105	N	V=29 U=<3.0	—	N	—	N	—	downslope, W. slope
X21	"	1107	N	V=31 U=<3.0	—	N	—	N	—	downslope, ~~south~~ west slope
X22	"	1110	N	V=39 U=<3.0	—	N	—	N	—	Down slope, S. slope

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 Form

Site Type: Target
AUM Site: M2-09
Tetra Tech ID: T26
Sampling team: DW, MB, NB
XRF Color: Blue

Date: 6-10-18
Weather: 83°F & ☀

Page No.: 4
GPS Color: pink

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
X16	6/10/18	1115	Y	V=16 U=5.0	—	N	—	N	—	offset 2m S. due to down tree on S. slope
X15	↓	1125	Y	V=51 U=6.0	—	N	—	N	—	Meter accuracy = 90cm offset 3m North due to steep slope w/ down trees
X14	↓	1131	N	V=45 U=4.0	—	N	—	N	—	DownSlope, w. Slope, heavy vegetation
X8	↓	1135	N	V=84 U=12	V=85 U=13	Y	T26-XS8-01-061018 @ 11:40	~~YES~~ NO	—	DownSlope, w. Slope
X3	↓	1146	N	V=56 U=5	—	N	—	N	—	DownSlope w. Slope
X4	↓	1150	N	V=53 U=8	—	N	—	N	—	" " " "
X9	↓	1152	N	V=94 U=12	—	N	—	N	—	" " " "
X10	↓	1154	N	V=80 U=10	—	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 SURVEY GRID MAP

= Soil sample taken
= XRF-only sample



Type: Non-AUM Target Site Name: M5-09 Non-AUM Target	TT ID: T26 Subarea Group: F	0 20 40 Feet N

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XRF Field Form

Site Type: Non-AUM Target
AUM Site: MS-09 non-AUM target
Tetra Tech ID: TZ6
Sampling team: CB, RJ, AB
XRF Color: Blue

Date: 9/15/18
Weather: Sunny, warm
Page No.: 1 of 3
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
* G19	9/15/18	09:00	Y IN	V: 32 u: >3	V: 26 u: 3	N	—	N	—	offset due to slope & low GPS accuracy * lift lost 1st shot
* G20		0912	Y	V 21 u 4	—	N	—	N	—	offset due to low accuracy
* G17		0916	Y	V 27 u 5	—	N	—	N	—	offset due to low accuracy
* G16		0920	Y	V 30 u 5	—	N	—	N	—	offset due to low accuracy (ODLA)
* G13		0924	Y	V 29 u >3	—	N	—	N	—	ODLA
* G11		0927	Y	V 40 u 25	—	N	—	N	—	ODLA
* G9		0929	Y	V 44 u >3	V 39 u 3		~~MS-09~~ T26-XS09-01-091518	N	—	ODLA ST 1034 silty grey sand
* G8		0945	Y	V 27 u 7	—	N	—	N	—	ODLA
G5		0952	Y	V 47 u 4	—	N	—	N	—	
G4		0956	Y	V 46 u 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.

* G19 - G8 Heat was not entered in XRF

XRF Field Form

Site Type: Non AUM Target
AUM Site: MS-09 Non AUM target
Tetra Tech ID: T26
Sampling team: CB RJ AB
XRF Color: Blue

Date: 9/15/18
Weather: Sunny
Page No.: 2 of 3
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
G3	9/15/18	0959	Y	U 45 U 5	—	~~N~~	—	N	—	ODLA
G2		~~1007~~ 1002 CB	Y	V 62 U 6	V 74 U 5	Y	T26XSG2-01-091518	N	—	ODLA ST. 1007
G1		1009	Y	V 41 U 9	—	N	—	N	—	ODLA
G7		1012	Y	V 40 U >3	—	N	—	N	—	ODLA
G6		1015	Y	V 40 U 3	—	N	—	N	—	ODLA
G10		1019	Y	V 26 U 4	—	N	—	N	—	ODLA *Done 2x Edg#1, 27+28
G12		1021	N	V 41 U 4	—	N	—	N	—	
G14		1023	N	V 32 U >5	—	N	—	N	—	
G15		1026	N	V 37 U 7	—	N	—	N	—	
G18	↓	1024	Y	V 37 U 3	—	N	—	N	—	ODLA

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.

* ODLA: Offset due to low accuracy.

XRF Field Form

Site Type: Non AMU Target
AUM Site: MS-09 Non AUM target
Tetra Tech ID:
Sampling team: TTE CB, RJ, AB
XRF Color: Blue

Date: 9/15/18
Weather: Sunny
Page No.: 3 of 3
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
G22	9/15/18	1030	N	V: 40 U: <7	—	N	—	N	—	
G21		1035	Y	V 51 U 4	—	N	—	N	—	ODLA Rdg #34 Mislabled as "G23"
G23		1038	N	V: 28 U: 4	—	N	—	N	—	Rdg # 35
	↓									

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.

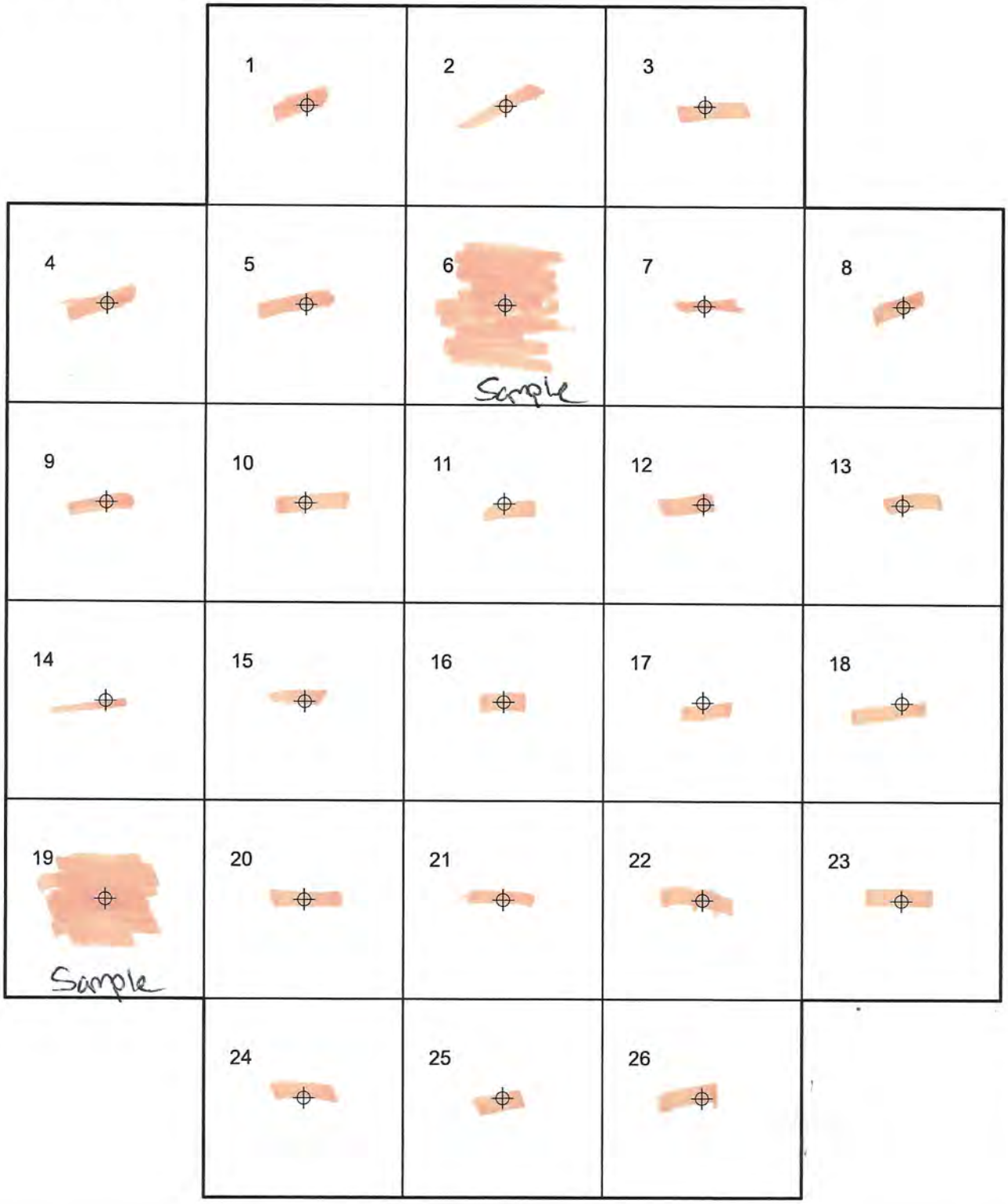
* ODLA - offset due to low accuracy

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TARGET T27

FIELD FORMS

XRF SURVEY GRID MAP



Type: Target Site **Site Name: M4-02**	**TT ID: T27** **Subarea Group: G**	0 10 20 Feet N

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XRF Field Form

Site Type: Target Site
Site Name: M4-02
Tetra Tech ID: T27
Sampling team: Mark, John, Cora
XRF Color: Purple

Date: 6/10/18
Weather: Sunny, 86°F, winds
Page No.: 1 of 3
GPS Color: orange

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
X13	6/10/18	14:33	NO	40/4	~~NO~~	NO	—	—	—	—
X18	"	14:35	NO	44/LOD<7	—	~~NO~~	—	—	—	—
X23	"	14:38	NO	44/LOD<3	—	NO	—	—	—	
X26	"	14:41	NO	LOD=32/LOD<5	—	NO	—	—	—	
X22	"	14:43	NO	LOD=30/LOD<4	—	NO	—	—	—	
X25	"	14:45	NO	39/LOD<3	—	NO	—	—	—	• reading 69 was accidental • reading 70 here
X24	"	14:48	NO	47/4	—	NO	—	—	—	
X21	"	14:51	NO	35/5	—	NO	—	—	—	
X17	"	14:53 ~~14:58~~	NO	41/LOD<4	—	NO	—	—	—	
X8	"	14:57	NO	LOD=40/LOD<6	—	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: Target Site
Site Name: ~~HH-02~~ ~~M402~~ M4-02
Tetra Tech ID: T27
Sampling team: John, Mark, Cora
XRF Color: purple

Date: 6/10/18
Weather: Sunny, 86° F, windy
Page No.: 2 of 3
GPS Color: orange

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
X12	6/10/18	15:01	NO	LOD=30/LOD<3	—	NO	—	—	—	
X16		15:03	NO	35/LOD<4	—	NO	—	—	—	
X20		1505	No	34/LOD<3	-	No	-	-	-	
X19		1507	No	41/4	20/LOD=3	yes ~~No~~	T27-XS19-01-0610~~2018~~18	-	-	Sample Time 15:11
X15		1522	Yes 1.5m	42/4	-	No	-	-	-	GPS offset- due to oak shrubs.
X11		1524	No	33/LOD<3	-	No	-	-	-	
X7		1528	Yes 2m ~~No~~	39/LOD<3	-	No	-	-	-	GPS off ~~a~~ 2 meter due to oak shrubs.
X3		1530	No	54/LOD<3	-	No	-	-	-	
X6		1532	No	57/4	58/5	yes ~~No~~	T27-XS6-01 061018	-	-	Sample time 15:36
X10		1547	No	39/3						

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.

John ring on - 14:30 → ring off : 15:04
Cora ring on : 15:04 → ring off : 15:48

XRF Field Form

Site Type: Target Site
Site Name: M4-02
Tetra Tech ID: T27
Sampling team: Mark, John, Cora
XRF Color: purple

Date: 6/10/18
Weather: Sunny, 86°F, windy
Page No.: 3 of 3
GPS Color: orange

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

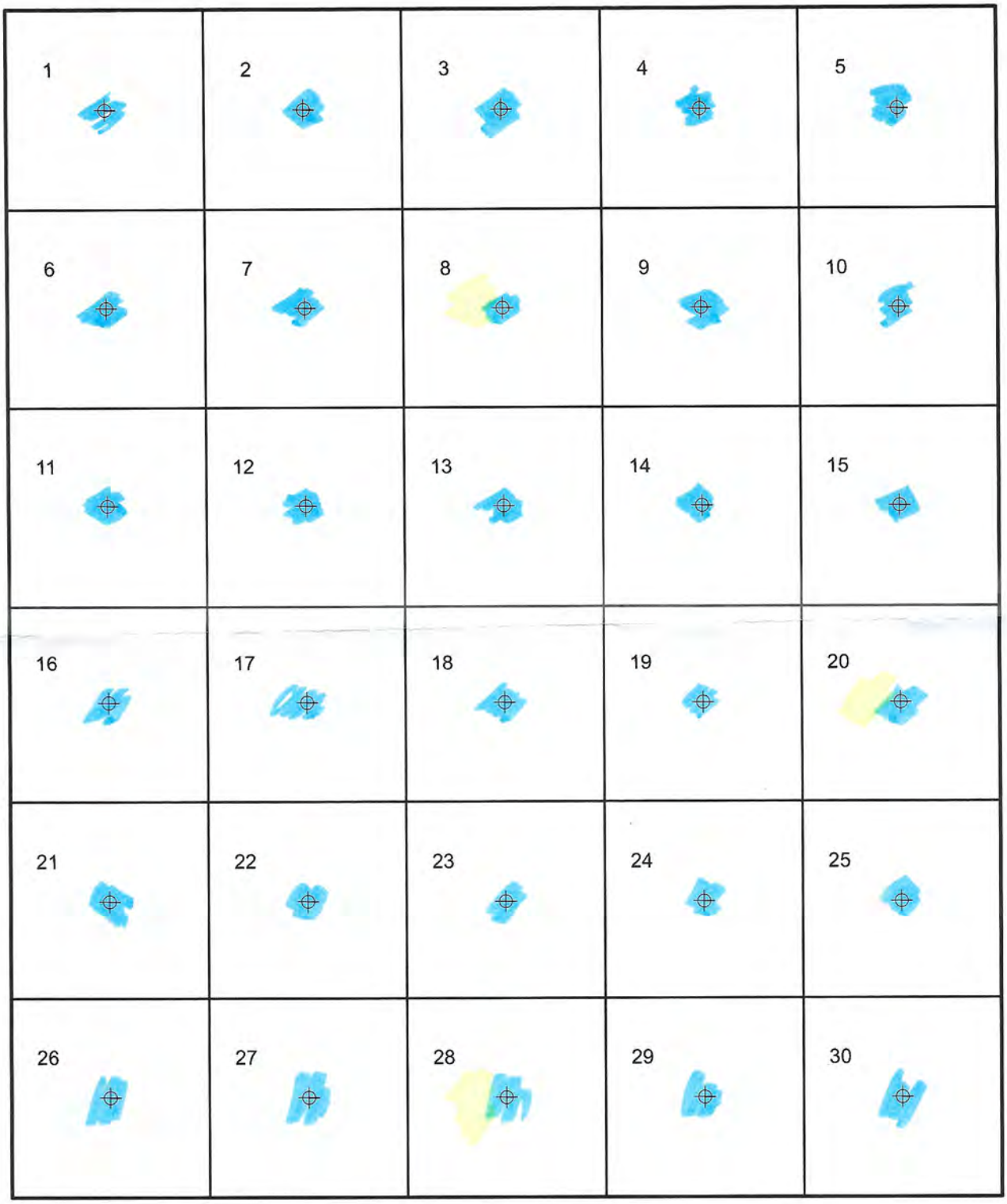
XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
X14	6/10/18	1549	No	44/5	—	No	—	—		
X9	"	1551	No	38/4	—	No	—	—		
X4	"	1553	No	42/LOD<3	—	No	—	—		
X5	"	1555	No	34/LOD<3	—	No	—	—		
X1	"	1557	No	26/LOD<3	—	No	—	—		
X2	"	1558	No	44/LOD<3	—	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.

TARGET T30

FIELD FORMS

XRF SURVEY GRID MAP



Type: Target Site **Site Name: M1-07**	**TT ID: T30** **Subarea Group: H**	0 10 20 Feet N

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3 conf. samples

XRF (white) on 9/25/18

Soil collected 9/25/18

XRF Field Form

T30 file not loaded in Orange trimble so using green Mesa to find grids (still marking point in orange trimble)

Site Type: Target
AUM Site: M1-67
Tetra Tech ID: T30
Sampling team: MP, SK, CA
XRF Color: White

Date: 9/25/18
Weather: Sunny, 75
Page No.: 1/3
GPS Color: Orange

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
X30	9/25/18	1115	N SEE	V 42 U 6	—	No	—	No	—	R=26
X29		1119	Notes About	V 48 U 5	—	No	—	No	—	Reading #27
X28		1121	XRF Location	V 46 U 4	V 43 U 5	Yes	T30-XS28-01-092518	No	—	ST=1125
X27		1129		V 49 U 7	—	No	—	No	—	Reading #30
X26		1131		V 53 U 7	—	No	—	No	—	Brushy slope
X21		1134		V 41 U 4	—	No	—	No	—	Reading #32
X22		1137		V 37 U 4	—	No	—	No	—	Brushy slope with moderate vegetation. Some light tan SS outcrops
X23		1139		V 34 U 4	—	No	—	No	—	
X24		1142		V 36 U 7	—	No	—	No	—	Reading #35
X25	↓	1144	↓	V 41 U 5	—	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: Target
AUM Site: M1-07
Tetra Tech ID: T30
Sampling team: MP, SK, CA
XRF Color: White

Date: 9/25/18
Weather:

Page No.: 2/3
GPS Color: Orange

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
X20	9/25/18	1146	–	V 36 U 4	V 41 U 3	Yes	T30-XS20-01-042518	NO	–	ST = 1150
X19		1154	–	V 34 U 5	–	No	–	No	–	Reading #39
X18		1156	–	V 37 U 5	–	No	–	No	–	
X17		1158	–	V 41 U 7	–	NO	–	No	–	
X16		1201	–	V 42 U 4	–	No	–	No	–	Next to light tan ss outcrop on brushy slope
X11		1204	–	V 34 U 7	–	NO	–	No	–	Reading #43
X12		1206	–	V 45 U 4	–	No	–	No	–	
X13		1208	–	V 37 U 5	–	No	–	NO	–	Reading #46
X14		1211	–	V 37 U < 3	–	No	–	No	–	
X15	↓	1213	–	V 40 U 6	–	No	–	No	–	#48

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: Target
AUM Site: M1-07
Tetra Tech ID: T30
Sampling team: MP, SK, CA
XRF Color: white

Date: 9/25/18
Weather:

Page No.: 3/3
GPS Color: Orange

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

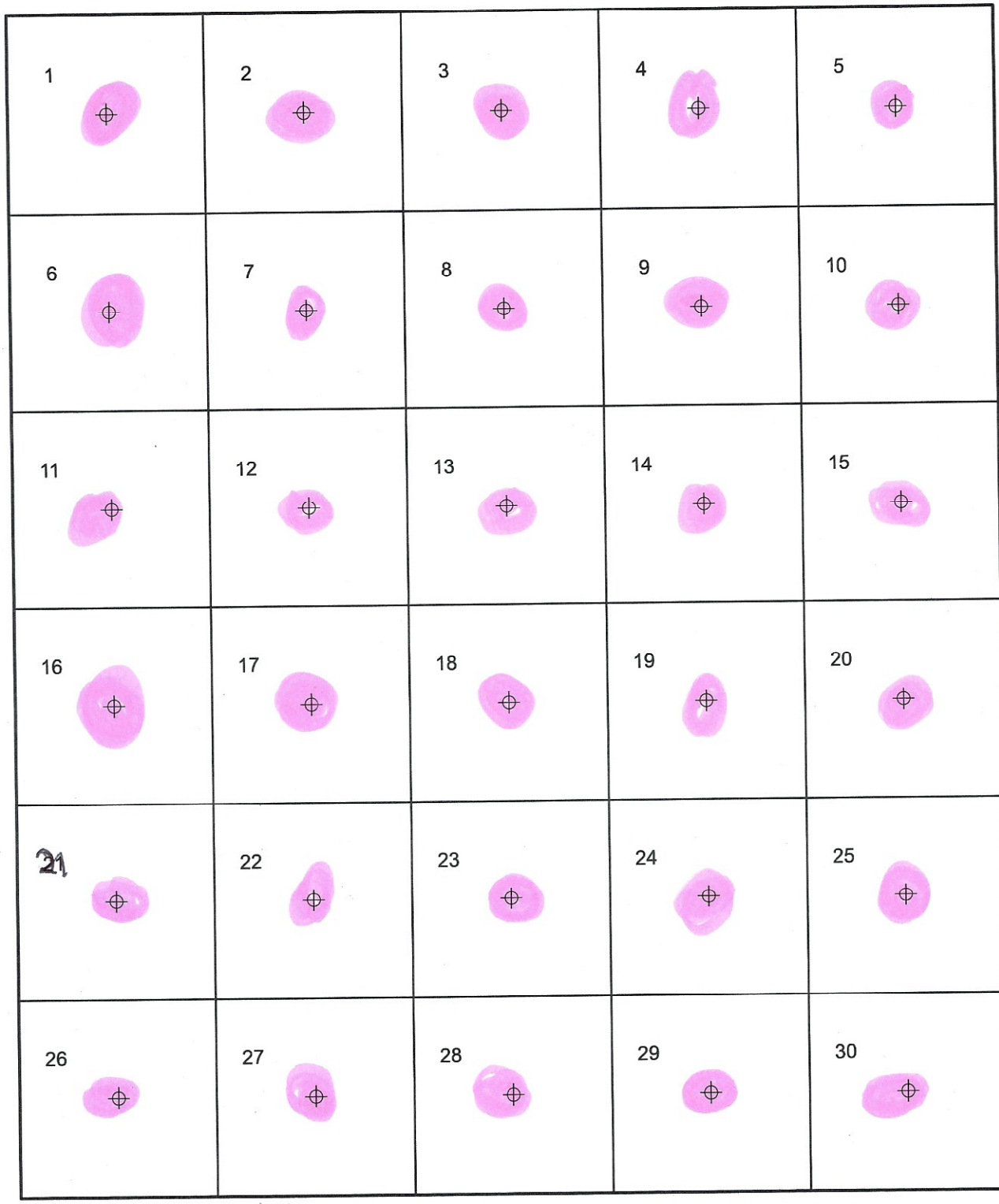
XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
X10	9/25/18	1215	-	V 38 U 6	—	NO	—	NO	—	#49
X5		1217	-	V 39 U 6	—	NO	—	NO	—	#51
X4		1220	-	V 39 U 5	—	NO	—	NO	—	Reading #52
X9		1222	-	V 53 U 6	—	NO	—	NO	—	#53
X8		1225	-	V 33 U <3	V 32 U 4	~~YES~~ NO CA	T30-XS8-01-092518 —	NO	—	ST = 1230
X3		1232	-	V 55 U 4	—	NO	—	NO	—	#57
X2		1237	-	V 45 U 5	—	NO	—	NO	—	#58
X7		1239	-	V 46 U 3	—	NO	—	NO	—	
X6		1241	-	V 45 U 4	-	NO	—	NO	—	
X1	↓	1243	-	V 37 U <3	—	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.

TARGET T31

FIELD FORMS

XRF SURVEY GRID MAP



7/17/18 - purple XRF
MS, CL, MW

Type: Target Site **Site Name: M1-08**	**TT ID: T31** **Subarea Group: H**	0 10 20 Feet N

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XRF Field Form

Site Type: Target
Site Name: M1-08
Tetra Tech ID: T31
Sampling team: MS, CL, MW
XRF Color: purple

Date: 7/17/18
Weather: clear, 90°F, slight breeze
Page No.: 1 of 3
GPS Color: green

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
X1	7/17/18	1314	N	V 46 W 5	—	N	—	N	—	western on slope
X2	7/17/18	1315	N	V 48 W 5	—	N	—	N	—	western slope
X3	7/17/18	1318	N	V 34 W <3	—	N	—	N	—	western slope slope
X4	7/17/18	1321	N	V <25 W <3	—	N	—	N	—	bottom of hill between W + E slope
X5	7/17/18	1322	N	V 22 W <3	—	N	—	N	—	Eastern slope
X10	7/17/18	1324	N	V 67 W <4	—	N	—	N	—	Eastern slope
X9	7/17/18	1327	N	V 37 W 6	—	N	—	N	—	bottom of W + E slope
X8	7/17/18	1329	N	V 41 W 3	—	N	—	N	—	western slope
X7	7/17/18	1331	N	V 48 W 4	—	N	—	N	—	western slope
X6	7/17/18	1333	N	V 55 W 4	—	N	—	N	—	western slope

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: Target
Site Name: M1-08
Tetra Tech ID: T31
Sampling team: MS, CL, MW
XRF Color: purple

Date: 7/17/18
Weather: clear 90°F, slight breeze
Page No.: 2 of 3
GPS Color: green

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
X11	7/17/18	1336	N	V 40 U 4	—	N	—	N	—	Western Slope
X12	7/17/18	1338	N	V 44 U 4	—	N	—	N	—	Western slope
X13	7/17/18	1341	N	V 45 U 5	—	N	—	N	—	western slope
X14	7/17/18	1343	N	V 41 U 4	—	N	—	N	—	eastern slope
X15	7/17/18	1347 ~~1345~~ MS	N	V 34 U <3	—	N	—	N	—	**void Reading #106 eastern Slope
X20	7/17/18	1350	~~X N~~ MS	V 31 U 4	—	N	—	N	—	offset ~2m due to tree/bushes western slope
X25 ~~X19~~ MS	7/17/18	1353	N	V <20 U <3	—	N	—	N	—	western slope
X30	7/17/18	1404	N	V 18 U <4	—	N	—	N	—	western slope
X29	7/17/18	1407 ~~1406~~ MS	N	V 29 U <3	—	N	—	N	—	**void Reading #111 + 112 near bottom of W + E slope
X24	7/17/18	1409	N	V 23 U <3	—	N	—	N	—	near bottom of W + E slope in drainage

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: Target
Site Name: M1-08
Tetra Tech ID: T31
Sampling team: ~~CL~~ MS, MW
XRF Color: ~~CL~~ purple

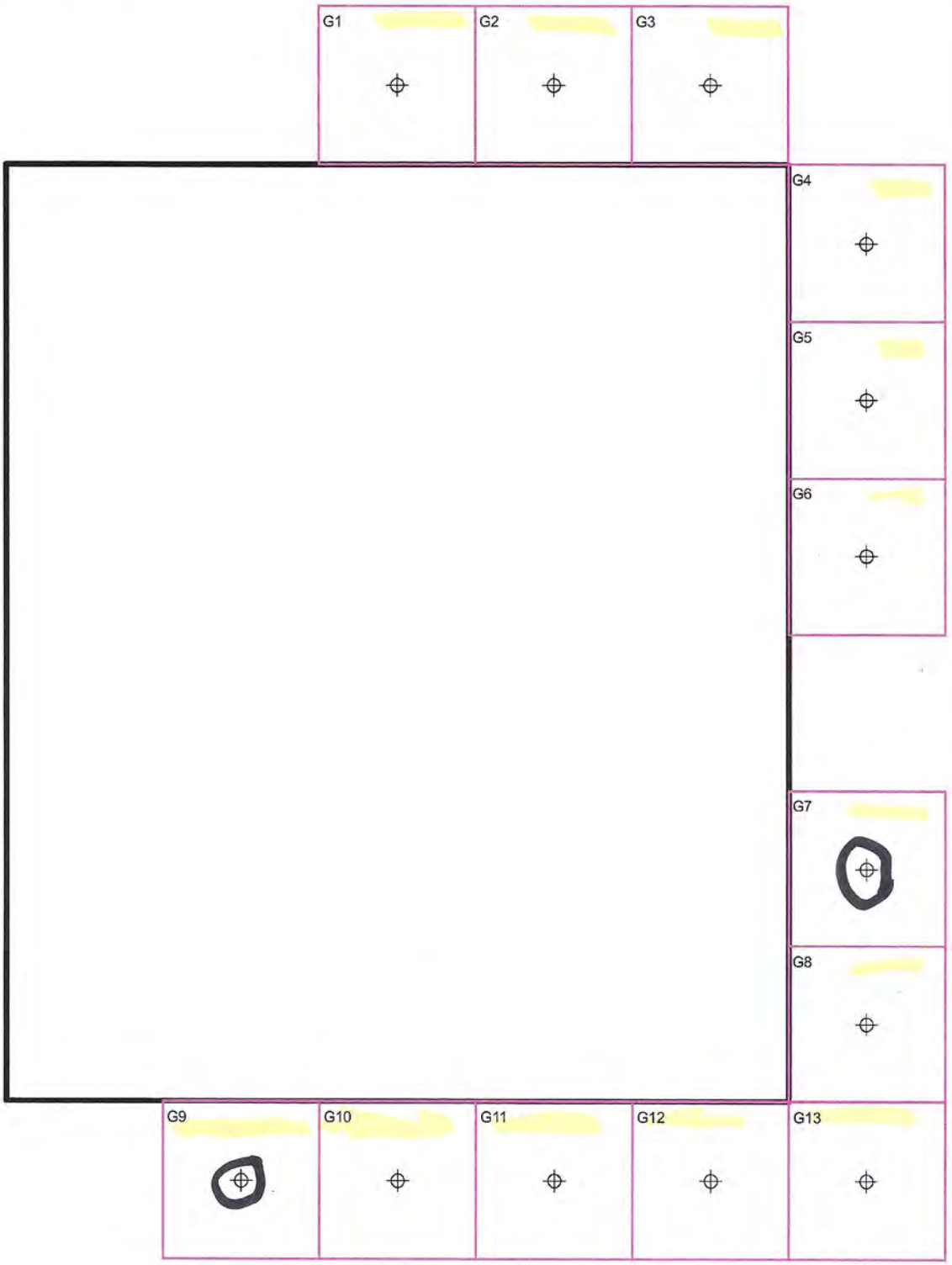
Date: 7/17/18
Weather: 90°F, clear, slight breeze
Page No.: 3 of 3
GPS Color: green

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
X19	7/17/18	1414 ~~1413~~ MS	N	V <17 W <3	—	N	—	N	—	Western slope near drainage
X18	7/17/18	1416	N	V 30 W <3	—	N	—	N	—	western slope
X17	7/17/18	1418	N	V 35 W <3	—	N	—	N	—	western slope
X16	7/17/18	1420	N	V 57 W 5	—	N	—	N	—	western slope
X21	7/17/18	1422	N	V <19 W <3	—	N	—	N	—	western slope
X22	7/17/18	1425	N	V 39 W <3	—	N	—	N	—	western slope
X23	7/17/18	1428	Y	V 50 W <3	—	N	—	N	—	off set ~2m due to slope + down trees, western slope
X28	7/17/18	1430	N	V 44 W 5	—	N	—	N	—	western slope
X27	7/17/18	1432	N	V 40 W 6	~~V~~ MS — ~~W~~ MS —	N	—	N	—	western slope
X26	7/17/18	1436	N	V 40 W 6	V 52 W 5	N	—	N	—	western slope

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 GOBACK SURVEY MAP



9/29/18

Soil samples

XRF'd

Type: Non-AUM Target **Site Name: M1-08 Non-AUM Target**	**TT ID: T31** **Subarea Group: H**	0 15 30 Feet N

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2 conf. samples

XRF Field Form

Site Type: TARGET
AUM Site: M1-05
Tetra Tech ID: T31
Sampling team: MP, SK, LA
XRF Color: White

Date: 9/25/18
Weather: CLEAR, 60°, CALM

Page No.: 1/2
GPS Color: Orange

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
G9	9/25/18	0919	N	V 30 U 5	V 34 U 5	Y	T31-XSG9-01-092518	N		*R3 IS BOGUS* READING (R) = 4 TO R=10 SOIL SAMPLE 09:25
G10	"	0935	N	V 43 U 7		N		N		R=11
G11	"	0938	N	V 31 U 5		N		N		R=13
G12	"	0942	N	V 24 U 7		N		N		R=14
G13	"	0950	N	V 27 U 4		N		N		R=15
G8	"	0955	N	V 33 U C		N		N		R=16
G7	"	0957	N	V 39 U 5	V 28 U <3	Y	T31-XSG7-01-092518	N		R=17 R=18 ST at 1000
G6	"	1008	N	V 20 U 4		N		N		
G5	"	1012	N	V 40 U 6		N		N		
G4	↓	1014	N	V 32 U 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: TARGET
AUM Site: M1-08
Tetra Tech ID: T31
Sampling team: MPSK, CA
XRF Color: WHITE

Date: 9/25/18
Weather: – SEE PAGE 1
Page No.: 2/2
GPS Color: ORANGE

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

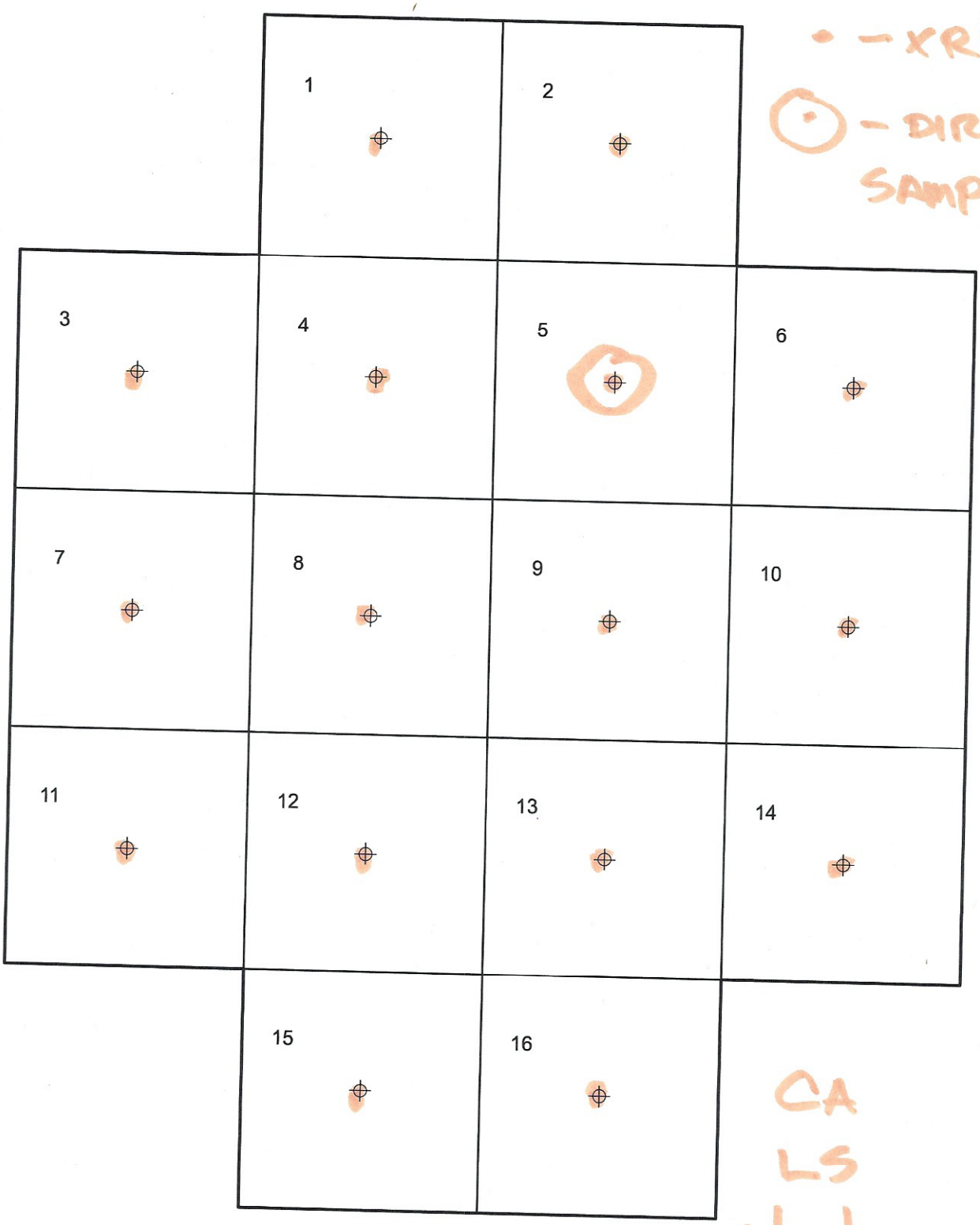
XRF Sample ID	Date (M/D/Y)	Time (MST)	Adjusted Location by >1 ft? (Yes or No)	Metal Concentration* (In Situ XRF Measurement, ppm)	Duplicate Metal Concentration (In Situ XRF Measurement, ppm)	Lab Sample Collected? (Yes or No)	Lab Sample ID	Lab Sample Duplicate Collected? (Yes or No)	Duplicate ID	Notes
G3	9/25/18	1018		V 20 U 24						R=22
G2	9/25/18	1023		V 27 U 4						
G1	9/25/18	1025		V 37 U 4						OFFSET STEEP/UNSTABLE SLOPE

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.

TARGET T32

FIELD FORMS

XRF SURVEY GRID MAP



• - XRF

⊙ - DIRT SAMPLE

CA
LS
6/20/18

Type: Target Site **Site Name: M2-01**	**TT ID: T32** **Subarea Group: H**	0 10 20 Feet N

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XRF Field Form

Site Type: Target
Site Name: M2-01
Tetra Tech ID: T32
Sampling team: LS, CA
XRF Color: Purple

Date: 6/20/18
Weather: Sunny, 70s
Page No.: 1
GPS Color: Orange

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
X14	6/20/18	1048	No	V= 36 U= 4	V= 43 U= 4					SLOPE
X16	6/20/18	1057	NO	V= 51 U= 6						SLOPE
X15	6/20/18	1100	NO	V= 54 U= <3						SLOPE
X11	6/20/18	1102	NO	V= 43 U= <3						SLOPE
X12	6/20/18	1104	NO	V= 50 U= 3						SLOPE
X13	6/20/18	1107	NO	V= 51 U= 5						SLOPE
X10	6/20/18	1110	NO	V= 45 U= <3						SLOPE
X9	6/20/18	1114	NO	V= 48 U= 3						SLOPE
X8	6/20/18	1117	NO	V= 50 U= <3						SLOPE (OFFSET - BRUSH)
X7	6/20/18	1119	NO	V= 48 U= 4						SLOPE

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:
Site Name:
Tetra Tech ID:
Sampling team:
XRF Color:

Date:
Weather:

Page No.: 2
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
X3	6/20/18	1123	NO	V = 52 U = 4						MINE ROAD
X4	6/20/18	1125	NO	V = 39 U = 4						MINE ROAD
X5	6/20/18	1129	NO	V = 50 U = 4	V = 50 U = 5	Yes	T32-XS5-01-062018	NO	-	MINE ROAD SOIL SAMPLE TIME: 1132
X6	6/20/18	1138	NO	V = 53 U = <3						MINE ROAD
X2	6/20/18	1140	YES	V = 58 U = 4						TOP OF SLOPE OFFSET - BRUSH
X1	6/20/18	1142	NO	V = 53 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.

TARGET T33

FIELD FORMS

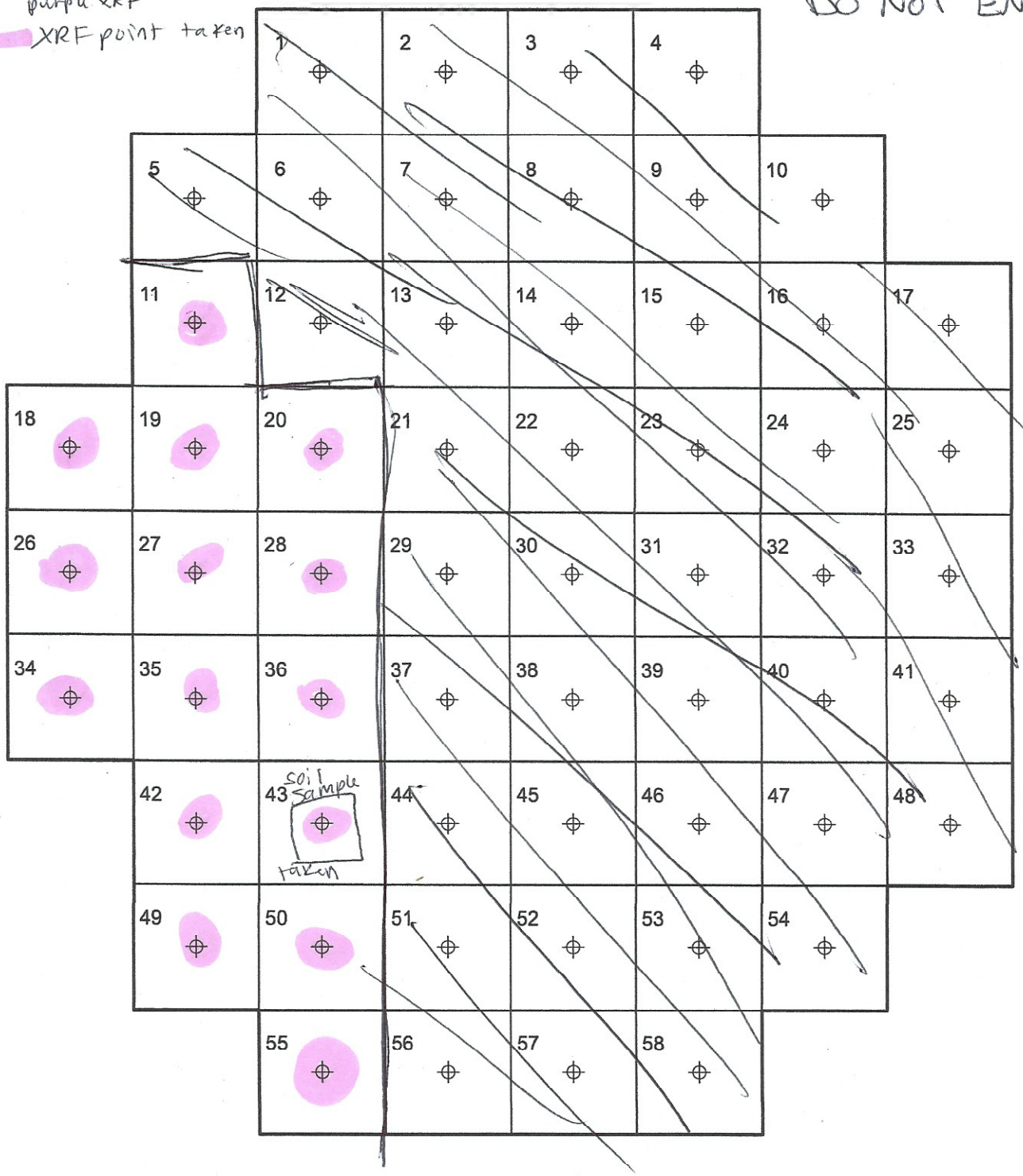
XRF SURVEY GRID MAP

7/17/18 MS, CA, MW

purple XRF

XRF point taken

// = Hazard Do Not Enter



Type: Target Site **Site Name: KE-01**	**TT ID: T33** **Subarea Group: I**	0 15 30 Feet N

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XRF Field Form

Site Type: Target
Site Name: KE-01
Tetra Tech ID: T33
Sampling team: MS, MW, CA
XRF Color: purple

Date: 7/17/18
Weather: 85°F, slight overcast, no breeze
Page No.: 1 of 2
GPS Color: green

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
X55	7/17/18	1116	N	V 34 W 5	—	N	—	N	—	slope
X50	7/17/18	1118	N	V 28 W 6	—	N	—	N	—	slope
X49	7/17/18	1120	N	V 56 W 9	—	N	—	N	—	slope
X42	7/17/18	1122	N	V 49 W 12	—	N	—	N	—	slope
X43	7/17/18	1124	N	V 63 W 13	V 62 W 13	Y	~~M~~ MS T33-XS43-d-071718	N	—	slope above cliff sample time: 1130
X36	7/17/18	1134	N	V 58 W 6	—	N	—	N	—	slope
X35	7/17/18	1137	N	V 32 W 6	—	N	—	N	—	slight slope
X28	7/17/18	1139	N	V 41 W 9	—	N	—	N	—	slight slope
X20	7/17/18	1141	N	V 80 W 13	—	N	—	N	—	abovecliff
X11	7/17/18	1143	N	V 33 W 5	—	N	—	N	—	slight slope

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: Target
Site Name: KE-01
Tetra Tech ID: T33
Sampling team: MS, CA, MW
XRF Color: purple

Date: ~~7/18~~ MS 7/17/18
Weather: 85°F, slight overcast, slight breeze
Page No.: 2 of 2
GPS Color: green

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
X19	7/17/18	~~1144~~	N	V 27 W 4	—	N	—	N	—	flat
X27	7/17/18	1146	N	V 33 W 4	—	N	—	N	—	slight slope
X34	7/17/18	1149	N	V 42 W 9	—	N	—	N	—	Slope near potential waste pile (5FT X 6FT)
X26	7/17/18	1151	N	V 50 W 9	—	N	—	N	—	Slope
X18	7/17/18	1153	N	V 63 W 13	—	N	—	N	—	slope

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.

ATTACHMENT I3

VALIDATED XRF DATA

Attachment I3
Validated XRF Data Tables

Table

I3-1 Validated XRF Field Survey Results for Non-AUM Target BR-01 (T1)

I3-3 Validated XRF Field Survey Results for Non-AUM Target BR-03 (T3)

I3-4 Validated XRF Field Survey Results for Non-AUM Target BR-04 (T4)

I3-5 Validated XRF Field Survey Results for Non-AUM Target BR-05 (T5)

I3-6 Validated XRF Field Survey Results for Non-AUM Target BR-06 (T6)

I3-7 Validated XRF Field Survey Results for Non-AUM Target BK-01 (T7)

I3-8 Validated XRF Field Survey Results for Non-AUM Target BK-02 (T8)

I3-10 Validated XRF Field Survey Results for Non-AUM Target CT-01 (T10)

I3-11 Validated XRF Field Survey Results for Non-AUM Target CT-02 (T11)

I3-12 Validated XRF Field Survey Results for Non-AUM Target CT-03 (T12)

I3-13 Validated XRF Field Survey Results for Non-AUM Target M1-01 (T13)

I3-14 Validated XRF Field Survey Results for Non-AUM Target M1-02 (T14)

I3-15 Validated XRF Field Survey Results for Non-AUM Target M1-03 (T15)

I3-18 Validated XRF Field Survey Results for Non-AUM Target M5-01 (T18)

I3-19 Validated XRF Field Survey Results for Non-AUM Target M5-02 (T19)

I3-20 Validated XRF Field Survey Results for Non-AUM Target M5-03 (T20)

I3-21 Validated XRF Field Survey Results for Non-AUM Target M5-05 (T21)

I3-22 Validated XRF Field Survey Results for Non-AUM Target M5-06 (T22)

I3-24 Validated XRF Field Survey Results for Non-AUM Target M5-07 (T24)

I3-25 Validated XRF Field Survey Results for Non-AUM Target M5-08 (T25)

I3-26 Validated XRF Field Survey Results for Non-AUM Target M5-09 (T26)

I3-27 Validated XRF Field Survey Results for Non-AUM Target M4-02 (T27)

I3-30 Validated XRF Field Survey Results for Non-AUM Target M1-07 (T30)

I3-31 Validated XRF Field Survey Results for Non-AUM Target M1-08 (T31)

I3-32 Validated XRF Field Survey Results for Non-AUM Target M2-01 (T32)

I3-33 Validated XRF Field Survey Results for Non-AUM Target KE-01 (T33)

Table I3-1. Validated XRF Field Survey Results for Non-AUM Target BR-01 (T1)

Grid ID	Unique_X	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
G1	T1G1	8/19/18	2.8		7831		5.0		201		< 0.038	QU	2.0		< 0.08	QU	< 16	QU	17.9	
G10	T1G10	8/19/18	< 1.8	QU	8085		7.5		184		< 0.038	QU	2.0		< 0.08	QU	< 16	QU	18.6	
G11	T1G11	8/19/18	< 1.8	QU	4470		6.6		182		1.586		2.3		1.74		< 16	QU	18.6	
G12	T1G12	8/19/18	< 1.8	QU	4681		5.5		193		1.783		1.3		3.37		< 16	QU	19.8	
G13	T1G13	8/19/18	< 1.8	QU	7047		4.5		162		< 0.038	QU	1.6		< 0.08	QU	< 16	QU	17.2	
G14	T1G14	8/19/18	3.3		8892		3.7		160		1.024		1.3		< 0.08	QU	< 16	QU	17.3	
G15	T1G15	8/19/18	2.5		3494		4.0		153		< 0.038	QU	1.5		1.05		< 16	QU	15.0	
G16	T1G16	8/19/18	2.6		8847		4.0		219		1.387		2.2		0.11	QL	< 16	QU	17.6	
G17	T1G17	8/19/18	< 1.8	QU	4605		6.8		186		< 0.038	QU	2.4		1.46		< 16	QU	18.3	
G18	T1G18	8/19/18	< 1.8	QU	2879		3.1		132		< 0.038	QU	1.4		0.39		< 16	QU	14.2	
G19	T1G19	8/19/18	< 1.8	QU	6858		0.4	QL	117		1.250		1.1		< 0.08	QU	< 16	QU	10.4	
G2	T1G2	8/19/18	< 1.8	QU	4646		6.1		197		< 0.038	QU	1.4		0.87		< 16	QU	18.4	
G20	T1G20	8/19/18	< 1.8	QU	9851		4.9		104		1.690		1.4		0.75		< 16	QU	16.6	
G21	T1G21	8/19/18	< 1.8	QU	5266		7.1		207		0.388		1.9		1.12		< 16	QU	18.7	
G22	T1G22	8/19/18	2.1		6121		8.3		222		1.015		3.2		3.42		< 16	QU	22.3	
G23	T1G23	8/19/18	< 1.8	QU	2817		2.5		89	QL	< 0.038	QU	1.1		0.68		< 16	QU	11.8	
G24	T1G24	8/19/18	< 1.8	QU	5863		6.2		250		0.911		1.6		1.78		< 16	QU	22.3	
G25	T1G25	8/19/18	5.7		9401		6.1		187		1.209		2.2		0.73		< 16	QU	17.4	
G26	T1G26	8/19/18	< 1.8	QU	7910		1.1	QL	169		0.638		2.0		< 0.08	QU	< 16	QU	15.8	
G27	T1G27	8/19/18	< 1.8	QU	4966		8.1		204		< 0.038	QU	2.1		1.19		< 16	QU	19.4	
G28	T1G28	8/19/18	2.5		7518		4.4		198		< 0.038	QU	1.6		< 0.08	QU	< 16	QU	15.2	
G29	T1G29	8/19/18	2.4		5220		6.2		204		1.494		2.1		1.11		< 16	QU	20.2	
G3	T1G3	8/19/18	< 1.8	QU	8772		6.5		224		2.689		1.4		< 0.08	QU	< 16	QU	18.8	
G30	T1G30	8/19/18	< 1.8	QU	3745		3.9		120		< 0.038	QU	1.3		1.83		< 16	QU	12.9	
G31	T1G31	8/19/18	< 1.8	QU	7969		6.2		180		1.289		2.1		1.25		< 16	QU	18.7	
G32	T1G32	8/19/18	< 1.8	QU	7580		0.8	QL	119		0.581		1.2		< 0.08	QU	< 16	QU	14.4	
G33	T1G33	8/19/18	3.4		6139		7.0		284		< 0.038	QU	2.6		1.42		< 16	QU	21.8	
G34	T1G34	8/19/18	2.7		4010		2.7		130		< 0.038	QU	1.4		0.69		< 16	QU	14.2	
G35	T1G35	8/19/18	2.6		8919		4.3		199		1.615		1.7		< 0.08	QU	< 16	QU	19.5	
G36	T1G36	8/19/18	3.1		7924		4.9		191		< 0.038	QU	2.0		< 0.08	QU	< 16	QU	17.6	
G37	T1G37	8/19/18	2.2		6936		2.5		125		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	12.8	
G38	T1G38	8/19/18	2.0		5934		6.8		244		< 0.038	QU	2.7		1.31		< 16	QU	21.5	
G39	T1G39	8/19/18	< 1.8	QU	6635		3.6		137		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	13.8	
G4	T1G4	8/19/18	< 1.8	QU	5048		5.6		211		< 0.038	QU	2.8		2.62		< 16	QU	18.3	
G40	T1G40	8/19/18	< 1.8	QU	4148		3.9		161		0.364		1.1		2.07		< 16	QU	15.6	
G41	T1G41	8/19/18	< 1.8	QU	9468		6.1		166		1.212		1.2		0.15		< 16	QU	16.3	
G42	T1G42	8/19/18	3.1		3715		2.7		123		< 0.038	QU	1.7		2.75		< 16	QU	14.9	
G43	T1G43	8/19/18	< 1.8	QU	5338		6.2		199		0.397		2.3		1.57		< 16	QU	19.4	
G44	T1G44	8/19/18	< 1.8	QU	7660		5.2		189		< 0.038	QU	1.9		< 0.08	QU	< 16	QU	16.6	
G45	T1G45	8/19/18	2.4		7120		2.1		127		< 0.038	QU	< 1	QU	0.46		< 16	QU	13.3	
G46	T1G46	8/19/18	5.7		9789		3.6		236		< 0.038	QU	2.6		3.19		< 16	QU	20.5	
G47	T1G47	8/19/18	< 1.8	QU	6517		9.1		261		0.248		3.2		2.66		< 16	QU	20.8	
G48	T1G48	8/19/18	3.3		7634		2.1		140		< 0.038	QU	1.8		1.07		< 16	QU	17.7	
G49	T1G49	8/19/18	10.5		5606		6.1		203		2.653		2.0		9.48		< 16	QU	18.6	
G49A	T1G49A	8/19/18	7.9		10748		1.1		128		4.694		< 1	QU	4.57		< 16	QU	21.3	
G5	T1G5	8/19/18	3.7		9818		4.4		240		2.430		1.8		29.67		< 16	QU	17.0	
G50	T1G50	8/19/18	2.0		8539		6.1		215		< 0.038	QU	1.4		< 0.08	QU	< 16	QU	20.0	
G51	T1G51	8/19/18	< 1.8	QU	5351		7.5		228		< 0.038	QU	2.7		0.75		< 16	QU	18.8	
G52	T1G52	8/19/18	< 1.8	QU	8478		5.8		188		1.017		2.4		< 0.08	QU	< 16	QU	16.2	
G53	T1G53	8/19/18	< 1.8	QU	4219		5.8		152		2.550		1.8		2.83		< 16	QU	18.7	
G54	T1G54	8/19/18	2.3		4395		2.1		118		0.689		1.5		2.22		< 16	QU	16.6	
G55	T1G55	8/19/18	< 1.8	QU	4413		5.1		161		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	15.9	

Table I3-1. Validated XRF Field Survey Results for Non-AUM Target BR-01 (T1)

Grid ID	Unique_X	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
G56	T1G56	8/19/18	< 1.8	QU	7128		3.1		161		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	16.8	
G57	T1G57	8/19/18	2.9		7775		4.1		134		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	13.5	
G58	T1G58	8/19/18	3.6		6636		1.6		319		< 0.038	QU	4.5		5.89		< 16	QU	21.9	
G5A	T1G5A	8/19/18	3.3		9265		< 0.27	QU	143		1.557		2.2		< 0.08	QU	< 16	QU	15.8	
G6	T1G6	8/19/18	< 1.8	QU	5488		5.8		219		< 0.038	QU	2.1		1.62		< 16	QU	19.0	
G7	T1G7	8/19/18	< 1.8	QU	8381		5.3		156		3.551		2.4		< 0.08	QU	< 16	QU	16.8	
G8	T1G8	8/19/18	< 1.8	QU	4304		5.6		207		< 0.038	QU	1.8		0.73		< 16	QU	16.8	
G9	T1G9	8/19/18	< 1.8	QU	4528		6.8		178		< 0.038	QU	2.0		1.93		< 16	QU	16.4	
X1	T1X1	5/13/2018	2.4		5306		5.6		203		1.761		2.0		1.98		< 16	QU	17.1	
X10	T1X10	5/13/2018	3.3		4927		4.7		199		< 0.038	QU	2.1		1.11		< 16	QU	14.5	
X100	T1X100	5/13/2018	< 1.8	QU	4281		5.5		181		1.629		1.7		1.00		< 16	QU	14.6	
X101	T1X101	5/13/2018	< 1.8	QU	3746		2.9		153		< 0.038	QU	1.7		0.31		< 16	QU	13.7	
X102	T1X102	5/13/2018	< 1.8	QU	4063		7.4		171		0.380		2.0		0.23		< 16	QU	11.4	
X103	T1X103	5/13/2018	< 1.8	QU	3791		4.2		155		< 0.038	QU	2.2		< 0.08	QU	< 16	QU	11.8	
X104	T1X104	5/13/2018	6.9		17288		9.6		202		< 0.038	QU	4.9		9.67		22.6		35.0	
X11	T1X11	5/13/2018	2.1		4661		5.3		204		< 0.038	QU	2.7		1.36		< 16	QU	14.7	
X12	T1X12	5/13/2018	< 1.8	QU	4340		6.5		174		0.833		2.0		< 0.08	QU	< 16	QU	13.8	
X13	T1X13	5/13/2018	2.2		5234		6.1		230		0.847		2.6		4.62		< 16	QU	17.7	
X13A	T1X13A	8/19/2018	< 1.8	QU	5842		8.1		243		0.565		2.8		4.87		< 16	QU	18.8	
X14	T1X14	5/13/2018	< 1.8	QU	4405		5.2		186		0.742		1.8		0.53		< 16	QU	14.9	
X14A	T1X14A	8/19/2018	4.9		8758		4.6		230		< 0.038	QU	1.5		4.65		< 16	QU	18.8	
X15	T1X15	5/13/2018	< 1.8	QU	4621		6.0		212		< 0.038	QU	2.2		1.17		< 16	QU	16.2	
X16	T1X16	5/13/2018	< 1.8	QU	4334		5.6		186		< 0.038	QU	1.7		1.63		< 16	QU	13.5	
X17	T1X17	5/13/2018	< 1.8	QU	4078		4.5		209		1.125		2.1		< 0.08	QU	< 16	QU	13.2	
X18	T1X18	5/13/2018	< 1.8	QU	3888		5.2		182		0.211		2.0		2.20		< 16	QU	12.3	
X19	T1X19	5/13/2018	< 1.8	QU	3750		4.7		189		0.573		1.4		0.56		< 16	QU	11.5	
X2	T1X2	5/13/2018	< 1.8	QU	4900		5.7		186		0.327		2.2		< 0.08	QU	< 16	QU	15.4	
X20	T1X20	5/13/2018	4.8		6184		3.2		221		0.310		3.2		4.16		< 16	QU	17.6	
X21	T1X21	5/13/2018	< 1.8	QU	4784		6.7		206		< 0.038	QU	2.8		1.60		< 16	QU	15.0	
X22	T1X22	5/13/2018	2.1		4498		4.7		183		< 0.038	QU	2.4		1.82		< 16	QU	14.6	
X23	T1X23	5/13/2018	2.1		4647		5.4		206		0.341		2.1		0.75		< 16	QU	13.9	
X24	T1X24	5/13/2018	2.2		4012		3.3		198		0.166		1.5		1.51		< 16	QU	11.9	
X25	T1X25	5/13/2018	< 1.8	QU	4156		5.4		167		< 0.038	QU	1.7		1.17		< 16	QU	12.9	
X26	T1X26	5/13/2018	2.7		5235		5.6		224		0.045		2.4		1.31		< 16	QU	17.1	
X27	T1X27	5/13/2018	2.6		5330		4.1		206		< 0.038	QU	2.9		0.98		< 16	QU	16.3	
X28	T1X28	5/13/2018	< 1.8	QU	5000		6.1		214		< 0.038	QU	1.9		1.30		< 16	QU	16.6	
X29	T1X29	5/13/2018	< 1.8	QU	4454		4.5		246		0.461		2.2		1.31		< 16	QU	14.1	
X3	T1X3	5/13/2018	< 1.8	QU	5357		7.6		227		< 0.038	QU	2.8		1.09		< 16	QU	15.7	
X30	T1X30	5/13/2018	2.2		2644		1.2		236		< 0.038	QU	1.4		1.11		< 16	QU	8.9	
X31	T1X31	5/13/2018	2.0		4501		4.0		203		< 0.038	QU	1.9		1.24		< 16	QU	13.9	
X32	T1X32	5/13/2018	< 1.8	QU	4003		3.2		165		< 0.038	QU	1.7		1.02		< 16	QU	11.7	
X33	T1X33	5/13/2018	< 1.8	QU	3611		2.5		132		0.522		1.2		0.73		< 16	QU	10.7	
X34	T1X34	5/13/2018	< 1.8	QU	4901		6.2		198		< 0.038	QU	2.4		1.74		< 16	QU	16.5	
X35	T1X35	5/13/2018	< 1.8	QU	5182		8.4		206		1.089		2.4		2.22		< 16	QU	15.2	
X36	T1X36	5/13/2018	4.3		4861		5.1		193		< 0.038	QU	2.9		2.39		< 16	QU	16.7	
X37	T1X37	5/13/2018	2.5		2247		2.0		272		< 0.038	QU	1.5		3.55		< 16	QU	8.1	
X38	T1X38	5/13/2018	2.4		3365		4.1		324		< 0.038	QU	1.5		5.31		< 16	QU	10.1	
X39	T1X39	5/13/2018	< 1.8	QU	3927		3.8		159		< 0.038	QU	2.0		1.25		< 16	QU	11.7	
X4	T1X4	5/13/2018	2.2		4241		4.3		177		0.547		1.7		0.69		< 16	QU	14.4	
X40	T1X40	5/13/2018	< 1.8	QU	2327		3.0		83	QL	0.264		< 1	QU	< 0.08	QU	< 16	QU	8.0	
X41	T1X41	5/13/2018	< 1.8	QU	3843		5.7		151		< 0.038	QU	1.7		< 0.08	QU	< 16	QU	13.6	
X42	T1X42	5/13/2018	< 1.8	QU	5394		6.4		261		1.356		2.2		1.56		< 16	QU	17.4	

Table I3-1. Validated XRF Field Survey Results for Non-AUM Target BR-01 (T1)

Grid ID	Unique_X	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
X43	T1X43	5/13/2018	< 1.8	QU	5612		6.4		213		0.572		2.3		2.80		< 16	QU	17.1	
X44	T1X44	5/13/2018	2.6		4458		4.4		233		< 0.038	QU	2.3		1.92		< 16	QU	13.0	
X45	T1X45	5/13/2018	1.9		4366		4.8		209		< 0.038	QU	1.9		1.79		< 16	QU	13.7	
X46	T1X46	5/13/2018	2.4		5587		4.3		241		1.170		2.6		2.90		< 16	QU	16.0	
X47	T1X47	5/13/2018	< 1.8	QU	4063		3.8		184		< 0.038	QU	1.2		0.81		< 16	QU	12.5	
X48	T1X48	5/13/2018	2.0		3823		3.2		154		< 0.038	QU	1.8		1.57		< 16	QU	10.6	
X49	T1X49	5/13/2018	< 1.8	QU	3402		1.7		134		< 0.038	QU	2.2		3.10		< 16	QU	10.8	
X5	T1X5	5/13/2018	< 1.8	QU	4441		5.6		185		< 0.038	QU	2.4		0.41		< 16	QU	14.8	
X50	T1X50	5/13/2018	< 1.8	QU	4190		5.8		209		< 0.038	QU	2.1		1.19		< 16	QU	15.3	
X51	T1X51	5/13/2018	2.2		4130		4.5		172		< 0.038	QU	1.5		1.06		< 16	QU	14.9	
X52	T1X52	5/13/2018	2.4		4835		5.8		186		< 0.038	QU	2.3		1.24		< 16	QU	15.5	
X53	T1X53	5/13/2018	2.7		5345		4.9		263		< 0.038	QU	1.9		2.76		< 16	QU	15.7	
X54	T1X54	5/13/2018	2.0		5445		7.3		254		< 0.038	QU	2.4		14.60		< 16	QU	17.0	
X55	T1X55	5/13/2018	< 1.8	QU	3464		2.2		242		< 0.038	QU	1.1		1.59		< 16	QU	9.2	
X56	T1X56	5/13/2018	< 1.8	QU	2436		2.7		304		< 0.038	QU	1.6		0.36		< 16	QU	8.0	
X57	T1X57	5/13/2018	< 1.8	QU	4552		6.0		202		< 0.038	QU	2.1		9.06		< 16	QU	14.3	
X58	T1X58	5/13/2018	< 1.8	QU	2495		2.9		< 81	QU	0.795		1.4		1.06		< 16	QU	< 7.8	QU
X59	T1X59	5/13/2018	2.8		4453		5.2		196		< 0.038	QU	2.3		1.54		< 16	QU	14.1	
X6	T1X6	5/13/2018	< 1.8	QU	4455		4.9		187		1.074		1.8		0.62		< 16	QU	14.6	
X60	T1X60	5/13/2018	3.3		5067		5.7		196		0.389		2.7		1.13		< 16	QU	16.9	
X61	T1X61	5/13/2018	3.1		6204		5.9		260		0.466		3.3		6.23		< 16	QU	17.9	
X62	T1X62	5/13/2018	< 1.8	QU	2653		3.4		268		< 0.038	QU	1.0		0.97		< 16	QU	9.3	
X63	T1X63	5/13/2018	2.9		7423		6.6		214		< 0.038	QU	2.6		7.92		< 16	QU	22.2	
X64	T1X64	5/13/2018	3.2		3067		2.1		171		< 0.038	QU	1.2		2.60		< 16	QU	10.2	
X65	T1X65	5/13/2018	5.2		3705		2.8		265		< 0.038	QU	1.6		4.11		< 16	QU	11.0	
X66	T1X66	5/13/2018	3.5		6221		6.6		252		< 0.038	QU	3.2		10.97		16.1		20.5	
X67	T1X67	5/13/2018	< 1.8	QU	3290		3.2		138		0.251		1.3		< 0.08	QU	< 16	QU	10.1	
X68	T1X68	5/13/2018	2.7		5214		4.6		203		1.501		1.8		0.99		< 16	QU	15.6	
X69	T1X69	5/13/2018	3.8		7383		6.6		328		0.713		2.6		20.42		< 16	QU	22.0	
X7	T1X7	5/13/2018	2.0		5104		5.8		221		0.541		2.1		2.27		< 16	QU	14.5	
X70	T1X70	5/13/2018	4.8		7351		7.8		314		< 0.038	QU	3.0		7.87		< 16	QU	22.3	
X71	T1X71	5/13/2018	4.6		6072		5.7		241		< 0.038	QU	2.8		7.71		< 16	QU	18.1	
X72	T1X72	5/13/2018	< 1.8	QU	3592		2.6		229		< 0.038	QU	1.3		1.62		< 16	QU	11.3	
X73	T1X73	5/13/2018	< 1.8	QU	4571		5.3		185		< 0.038	QU	2.1		0.96		< 16	QU	15.1	
X74	T1X74	5/13/2018	< 1.8	QU	3960		3.6		148		< 0.038	QU	1.6		0.58		< 16	QU	12.4	
X75	T1X75	5/13/2018	2.8		5414		5.2		139		< 0.038	QU	2.2		5.62		< 16	QU	15.4	
X76	T1X76	5/13/2018	< 1.8	QU	5162		6.6		221		0.526		2.4		< 0.08	QU	< 16	QU	17.2	
X77	T1X77	5/13/2018	3.7		5130		5.2		219		0.400		2.3		3.41		< 16	QU	16.6	
X78	T1X78	5/13/2018	3.9		8860		9.0		343		1.924		4.1		7.64		< 16	QU	30.2	
X79	T1X79	5/13/2018	1.9		6095		8.2		272		2.444		2.4		13.12		22.2		18.4	
X8	T1X8	5/13/2018	2.2		5057		6.6		200		< 0.038	QU	2.8		1.02		< 16	QU	14.7	
X80	T1X80	5/13/2018	3.3		7183		7.1		283		1.824		2.6		4.38		< 16	QU	21.7	
X81	T1X81	5/13/2018	3.1		4338		3.1		232		1.776		1.9		4.77		< 16	QU	12.9	
X82	T1X82	5/13/2018	< 1.8	QU	3514		3.2		130		< 0.038	QU	1.1		0.53		< 16	QU	10.6	
X83	T1X83	5/13/2018	4.4		8201		14.0		238		< 0.038	QU	3.4		32.98		33.7		29.5	
X83A	T1X83A	8/19/2018	5.6		12422		8.1		160		< 0.038	QU	1.8		6.39		< 16	QU	24.5	
X84	T1X84	5/13/2018	< 1.8	QU	5342		6.0		234		3.523		2.4		0.65		< 16	QU	17.5	
X85	T1X85	5/13/2018	1.8		4776		5.2		190		0.458		2.4		1.94		< 16	QU	16.3	
X86	T1X86	5/13/2018	2.7		6311		6.6		266		1.004		2.3		5.07		< 16	QU	19.2	
X87	T1X87	5/13/2018	3.5		6156		4.6		212		3.035		2.1		2.79		< 16	QU	19.9	
X88	T1X88	5/13/2018	< 1.8	QU	5190		6.1		220		0.183		1.7		1.01		< 16	QU	14.5	
X89	T1X89	5/13/2018	< 1.8	QU	2834		1.4		126		3.430		1.5		1.05		< 16	QU	9.6	

Table I3-1. Validated XRF Field Survey Results for Non-AUM Target BR-01 (T1)

Grid ID	Unique_X	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
X9	T1X9	5/13/2018	1.9		4411		5.0		195		1.244		1.5		1.76		< 16	QU	15.3	
X90	T1X90	5/13/2018	< 1.8	QU	3557		2.8		135		2.690		1.4		1.98		< 16	QU	11.6	
X91	T1X91	5/13/2018	2.6		6371		5.0		229		< 0.038	QU	2.0		3.66		24.9		17.6	
X92	T1X92	5/13/2018	< 1.8	QU	4798		5.8		181		2.558		1.1		1.36		< 16	QU	14.7	
X93	T1X93	5/13/2018	3.4		5853		5.9		226		1.716		3.0		1.30		< 16	QU	19.8	
X94	T1X94	5/13/2018	< 1.8	QU	4185		4.4		160		3.004		2.5		1.14		< 16	QU	12.7	
X95	T1X95	5/13/2018	< 1.8	QU	4181		4.8		179		2.271		2.1		1.40		< 16	QU	14.5	
X96	T1X96	5/13/2018	< 1.8	QU	2706		5.0		132		< 0.038	QU	1.0		< 0.08	QU	< 16	QU	11.1	
X97	T1X97	5/13/2018	10.8		6554		7.2		363		< 0.038	QU	3.5		72.38		60.1		24.2	
X98	T1X98	5/13/2018	< 1.8	QU	4817		7.1		186		< 0.038	QU	2.0		0.40		< 16	QU	16.7	
X99	T1X99	5/13/2018	2.1		4286		5.4		161		3.422		2.4		1.20		< 16	QU	14.4	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-3. Validated XRF Field Survey Results for Non-AUM Target BR-03 (T3)

Grid ID	Unique_X	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
X1	T3X1	5/13/2018	1.9		4216		5.6		181		< 0.038	QU	1.8		0.81		< 16	QU	13.7	
X10	T3X10	5/12/2018	< 1.8	QU	4474		6.7		192		0.394		2.3		1.25		< 16	QU	15.0	
X11	T3X11	5/13/2018	< 1.8	QU	3968		6.1		213		< 0.038	QU	1.1		0.44		< 16	QU	12.9	
X12	T3X12	5/13/2018	< 1.8	QU	4264		4.4		154		< 0.038	QU	1.6		0.95		< 16	QU	14.4	
X13	T3X13	5/13/2018	< 1.8	QU	3892		5.1		129		< 0.038	QU	1.1		1.08		< 16	QU	13.5	
X14	T3X14	5/13/2018	< 1.8	QU	4383		6.3		166		< 0.038	QU	2.1		0.17		< 16	QU	13.7	
X15	T3X15	5/13/2018	3.2		4163		5.4		178		< 0.038	QU	1.9		0.80		< 16	QU	14.0	
X16	T3X16	5/12/2018	< 1.8	QU	4030		4.9		182		0.757		2.1		0.11	QL	< 16	QU	13.5	
X17	T3X17	5/12/2018	< 1.8	QU	3443		3.7		140		< 0.038	QU	1.5		0.61		< 16	QU	10.1	
X18	T3X18	5/13/2018	< 1.8	QU	3986		5.0		149		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	13.7	
X19	T3X19	5/13/2018	< 1.8	QU	4320		5.6		208		< 0.038	QU	1.4		0.92		< 16	QU	14.8	
X2	T3X2	5/13/2018	3.5		5898		5.0		166		< 0.038	QU	2.5		0.79		< 16	QU	18.7	
X20	T3X20	5/13/2018	< 1.8	QU	4599		5.8		203		< 0.038	QU	2.2		1.46		< 16	QU	16.3	
X3	T3X3	5/12/2018	2.6		3035		2.4		135		< 0.038	QU	< 1	QU	< 0.08	QU	30.7		10.8	
X4	T3X4	5/12/2018	< 1.8	QU	3671		4.1		214		< 0.038	QU	1.5		0.24		< 16	QU	12.3	
X5	T3X5	5/12/2018	< 1.8	QU	3902		5.8		149		< 0.038	QU	1.9		1.24		< 16	QU	12.3	
X6	T3X6	5/12/2018	< 1.8	QU	3337		3.1		151		< 0.038	QU	1.3		0.62		< 16	QU	11.9	
X7	T3X7	5/13/2018	2.4		4255		3.3		181		< 0.038	QU	1.9		0.62		< 16	QU	13.1	
X8	T3X8	5/13/2018	< 1.8	QU	3545		3.7		149		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	11.0	
X9	T3X9	5/13/2018	< 1.8	QU	4055		4.8		147		< 0.038	QU	1.4		1.65		< 16	QU	11.9	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-4. Validated XRF Field Survey Results for Non-AUM Target BR-04 (T4)

Grid ID	Unique_X	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
G1	T4G1	8/19/2018	< 1.8	QU	4376		5.7		176		< 0.038	QU	1.3		1.54		< 16	QU	14.9	
G10	T4G10	8/19/2018	< 1.8	QU	3540		4.8		143		< 0.038	QU	< 1	QU	5.27		< 16	QU	14.9	
G11	T4G11	8/19/2018	2.1		4088		5.7		153		< 0.038	QU	1.8		1.35		< 16	QU	16.1	
G12	T4G12	8/19/2018	< 1.8	QU	4313		5.8		204		0.690		2.1		0.54		< 16	QU	16.4	
G12A	T4G12A	8/19/2018	< 1.8	QU	4837		5.5		226		< 0.038	QU	2.4		1.24		< 16	QU	16.0	
G13	T4G13	8/19/2018	4.7		3820		2.4		152		< 0.038	QU	1.6		1.87		< 16	QU	10.4	
G14	T4G14	8/19/2018	< 1.8	QU	4263		4.3		182		< 0.038	QU	1.7		5.90		< 16	QU	12.9	
G15	T4G15	8/19/2018	1.9		4419		5.5		174		< 0.038	QU	1.5		2.14		< 16	QU	14.8	
G16	T4G16	8/19/2018	2.6		4943		5.0		200		< 0.038	QU	1.4		0.76		< 16	QU	15.0	
G17	T4G17	8/19/2018	< 1.8	QU	4456		5.5		175		< 0.038	QU	1.6		11.73		17.4		16.8	
G18	T4G18	8/19/2018	3.1		5881		5.8		238		< 0.038	QU	2.2		1.22		< 16	QU	20.9	
G19	T4G19	8/19/2018	< 1.8	QU	3900		4.5		164		1.538		1.6		3.90		< 16	QU	20.6	
G19A	T4G19A	8/19/2018	2.7		4311		3.5		200		< 0.038	QU	1.8		1.77		< 16	QU	12.8	
G2	T4G2	8/19/2018	2.9		6625		4.7		205		< 0.038	QU	2.1		4.97		< 16	QU	20.0	
G20	T4G20	8/19/2018	< 1.8	QU	3767		4.2		177		< 0.038	QU	2.0		1.79		< 16	QU	12.5	
G21	T4G21	8/19/2018	< 1.8	QU	4339		6.9		157		< 0.038	QU	2.3		1.88		< 16	QU	14.3	
G22	T4G22	8/19/2018	4.0		5899		5.3		232		< 0.038	QU	2.9		1.53		< 16	QU	18.0	
G23	T4G23	8/19/2018	6.2		6824		6.8		271		< 0.038	QU	2.8		2.09		18.2		21.4	
G24	T4G24	8/19/2018	1.9		4139		5.7		157		< 0.038	QU	2.6		0.84		< 16	QU	14.6	
G25	T4G25	8/19/2018	< 1.8	QU	6078		4.6		220		< 0.038	QU	1.5		3.53		71.0		18.7	
G26	T4G26	8/19/2018	5.2		9283		6.4		239		< 0.038	QU	3.4		4.36		< 16	QU	28.3	
G27	T4G27	8/19/2018	3.7		2483		3.0		96		< 0.038	QU	1.1		4.31		< 16	QU	11.5	
G27A	T4G27A	8/19/2018	2.0		3651		4.8		165		< 0.038	QU	1.6		0.88		< 16	QU	11.8	
G28	T4G28	8/19/2018	3.4		4894		5.1		158		< 0.038	QU	1.2		3.35		< 16	QU	14.6	
G29	T4G29	8/19/2018	2.6		4276		4.5		172		< 0.038	QU	2.5		< 0.08	QU	< 16	QU	14.2	
G3	T4G3	8/19/2018	< 1.8	QU	4725		2.7		129		3.378		2.4		3.08		< 16	QU	18.9	
G30	T4G30	8/19/2018	< 1.8	QU	3174		6.0		110		< 0.038	QU	< 1	QU	9.78		50.2		14.4	
G31	T4G31	8/19/2018	< 1.8	QU	5933		5.0		225		0.837		1.9		1.88		18.0		21.5	
G32	T4G32	8/19/2018	< 1.8	QU	4627		2.8		209		1.271		1.6		0.67		< 16	QU	18.2	
G32A	T4G32A	8/19/2018	2.0		4852		4.5		183		< 0.038	QU	2.1		0.86		< 16	QU	16.5	
G33	T4G33	8/19/2018	2.7		4018		3.8		175		< 0.038	QU	2.5		1.14		< 16	QU	12.6	
G34	T4G34	8/19/2018	9.1		6545		4.1		285		< 0.038	QU	1.0		7.02		21.6		18.7	
G35	T4G35	8/19/2018	3.4		8215		3.7		158		< 0.038	QU	2.8		5.90		22.4		22.6	
G36	T4G36	8/19/2018	< 1.8	QU	3759		4.4		172		< 0.038	QU	1.6		< 0.08	QU	< 16	QU	12.7	
G37	T4G37	8/19/2018	< 1.8	QU	2319		1.4		163		< 0.038	QU	1.0		< 0.08	QU	< 16	QU	9.2	
G38	T4G38	8/19/2018	< 1.8	QU	3666		3.3		124		0.040		< 1	QU	1.32		< 16	QU	13.7	
G39	T4G39	8/19/2018	< 1.8	QU	2978		4.4		113		< 0.038	QU	< 1	QU	1.97		< 16	QU	14.4	
G4	T4G4	8/19/2018	< 1.8	QU	3373		4.9		170		< 0.038	QU	1.1		2.00		< 16	QU	13.2	
G40	T4G40	8/19/2018	5.3		15132		6.2		326		< 0.038	QU	4.4		5.55		29.8		42.1	
G40A	T4G40A	8/19/2018	4.3		5826		8.4		248		< 0.038	QU	2.7		2.77		20.4		18.4	
G41	T4G41	8/19/2018	3.6		5148		3.4		203		< 0.038	QU	1.7		1.30		< 16	QU	16.3	
G42	T4G42	8/19/2018	< 1.8	QU	3879		4.5		151		< 0.038	QU	1.4		3.99		38.0		15.8	
G43	T4G43	8/19/2018	4.2		12419		5.4		188		< 0.038	QU	4.1		3.57		43.5		34.2	
G44	T4G44	8/19/2018	< 1.8	QU	5262		7.1		229		< 0.038	QU	2.5		2.09		< 16	QU	18.6	
G44A	T4G44A	8/19/2018	3.0		5756		5.0		208		< 0.038	QU	2.1		3.05		17.4		17.2	
G45	T4G45	8/19/2018	4.9		3236		3.4		187		< 0.038	QU	1.4		1.84		< 16	QU	12.0	
G46	T4G46	8/19/2018	< 1.8	QU	4809		6.1		227		< 0.038	QU	< 1	QU	1.36		< 16	QU	15.6	
G47	T4G47	8/19/2018	< 1.8	QU	4160		4.5		154		< 0.038	QU	2.4		0.94		< 16	QU	14.6	
G48	T4G48	8/19/2018	< 1.8	QU	2933		3.0		131		< 0.038	QU	1.3		0.58		< 16	QU	9.6	
G49	T4G49	8/19/2018	< 1.8	QU	3262		2.8		< 81	QU	0.758		1.7		< 0.08	QU	36.8		11.5	
G5	T4G5	8/19/2018	4.9		4634		3.9		156		0.485		1.7		12.54		< 16	QU	16.3	
G50	T4G50	8/19/2018	3.0		18586		4.7		250		0.679		5.8		20.81		109.3		60.6	QH

Table I3-4. Validated XRF Field Survey Results for Non-AUM Target BR-04 (T4)

Grid ID	Unique_X	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
G50A	T4G50A	8/19/2018	4.1		14520		3.0		267		0.134		3.7		13.24		80.2		43.9	
G51	T4G51	8/19/2018	< 1.8	QU	4463		5.1		176		< 0.038	QU	1.9		2.03		< 16	QU	17.7	
G52	T4G52	8/19/2018	3.2		5924		3.7		144		1.049		1.9		3.10		< 16	QU	20.9	
G53	T4G53	8/19/2018	2.0		5124		6.4		205		< 0.038	QU	2.7		0.89		< 16	QU	24.9	
G6	T4G6	8/19/2018	< 1.8	QU	5207		3.4		133		< 0.038	QU	2.1		6.72		< 16	QU	18.3	
G7	T4G7	8/19/2018	2.0		4022		1.7		159		1.318		1.4		5.48		< 16	QU	13.7	
G8	T4G8	8/19/2018	< 1.8	QU	3548		5.9		160		< 0.038	QU	2.2		4.30		< 16	QU	17.0	
G9	T4G9	8/19/2018	< 1.8	QU	4259		5.2		163		< 0.038	QU	1.6		4.37		40.7		18.2	
X1	T4X1	5/13/2018	5.3		8316		9.7		168		< 0.038	QU	2.0		13.06		21.0		25.8	
X10	T4X10	5/13/2018	< 1.8	QU	4736		2.7		136		< 0.038	QU	2.1		4.52		< 16	QU	14.3	
X11	T4X11	5/13/2018	4.1		6794		4.4		247		< 0.038	QU	2.2		6.15		< 16	QU	19.1	
X12	T4X12	5/13/2018	< 1.8	QU	3935		3.5		128		< 0.038	QU	1.1		4.25		< 16	QU	11.9	
X13	T4X13	5/13/2018	2.2		4779		3.7		301		< 0.038	QU	1.2		3.36		< 16	QU	13.5	
X14	T4X14	5/13/2018	2.6		4310		3.8		162		< 0.038	QU	1.5		2.92		< 16	QU	13.1	
X15	T4X15	5/13/2018	4.3		5968		7.5		219		< 0.038	QU	2.5		5.75		< 16	QU	17.9	
X15A	T4X15A	8/19/2018	16.2		12203		16.1		226		< 0.038	QU	5.3		52.13		42.4		51.3	
X16	T4X16	5/13/2018	< 1.8	QU	5654		9.8		256		< 0.038	QU	1.9		3.45		< 16	QU	19.3	
X17	T4X17	5/13/2018	4.6		4746		4.6		201		< 0.038	QU	1.6		2.94		< 16	QU	15.4	
X18	T4X18	5/13/2018	4.0		5186		6.9		185		< 0.038	QU	1.7		20.39		45.2		16.6	
X19	T4X19	5/13/2018	< 1.8	QU	4253		4.0		157		< 0.038	QU	1.2		6.57		30.5		11.9	
X2	T4X2	5/13/2018	7.7		18330		5.2		252		< 0.038	QU	8.0		4.63		27.2		44.2	
X20	T4X20	5/13/2018	< 1.8	QU	2027		0.5	QL	137		< 0.038	QU	< 1	QU	9.64		42.6		< 7.8	QU
X21	T4X21	5/13/2018	2.8		6533		6.7		172		< 0.038	QU	2.3		8.21		16.3		19.2	
X22	T4X22	5/13/2018	2.6		4199		5.4		153		< 0.038	QU	2.3		3.07		< 16	QU	12.0	
X23	T4X23	5/12/2018	< 1.8	QU	3391		3.8		127		< 0.038	QU	2.0		3.55		< 16	QU	11.9	
X24	T4X24	5/14/2018	2.4		4540		5.2		165		< 0.038	QU	1.6		2.69		< 16	QU	14.0	
X25	T4X25	5/14/2018	2.4		5017		6.0		177		< 0.038	QU	2.9		1.95		< 16	QU	16.4	
X26	T4X26	5/14/2018	3.6		5353		4.9		221		< 0.038	QU	2.4		2.92		< 16	QU	16.0	
X27	T4X27	5/14/2018	4.7		5603		6.0		248		< 0.038	QU	2.7		3.19		< 16	QU	16.7	
X28	T4X28	5/14/2018	4.0		5046		5.0		183		< 0.038	QU	2.2		3.34		< 16	QU	15.2	
X29	T4X29	5/14/2018	8.2		5429		6.3		205		< 0.038	QU	1.9		3.49		17.2		14.3	
X2A	T4X2A	8/19/2018	4.6		13145		5.6		290		< 0.038	QU	3.4		4.23		18.9		35.8	
X3	T4X3	5/13/2018	< 1.8	QU	4290		5.8		194		< 0.038	QU	2.3		1.84		< 16	QU	12.6	
X30	T4X30	5/13/2018	< 1.8	QU	3772		4.2		168		< 0.038	QU	1.1		2.51		22.8		12.1	
X31	T4X31	5/13/2018	< 1.8	QU	4589		6.2		174		< 0.038	QU	1.8		1.90		20.1		15.3	
X32	T4X32	5/12/2018	< 1.8	QU	3306		3.8		131		< 0.038	QU	1.2		5.66		103.5		10.5	
X33	T4X33	5/13/2018	3.2		4888		5.3		155		< 0.038	QU	2.2		6.03		24.6		15.4	
X34	T4X34	5/13/2018	15.2		3837		5.6		163		0.205		1.7		5.98		< 16	QU	13.3	
X35	T4X35	5/13/2018	1.9		3895		5.0		135		< 0.038	QU	1.6		6.91		< 16	QU	13.8	
X36	T4X36	5/14/2018	3.0		4736		4.2		200		< 0.038	QU	1.8		3.22		< 16	QU	15.2	
X37	T4X37	5/14/2018	26.7		7429		10.4		194		< 0.038	QU	2.0		11.53		16.8		22.0	
X38	T4X38	5/14/2018	2.2		6695		7.3		261		< 0.038	QU	3.1		2.98		< 16	QU	18.6	
X39	T4X39	5/14/2018	4.3		7602		5.0		215		< 0.038	QU	2.2		3.34		< 16	QU	19.7	
X4	T4X4	5/13/2018	4.4		7744		7.0		279		< 0.038	QU	2.7		10.40		20.4		20.3	
X40	T4X40	8/19/2018	< 1.8	QU	3146		2.7		< 81	QU	< 0.038	QU	1.5		< 0.08	QU	40.8		11.8	
X41	T4X41	8/19/2018	< 1.8	QU	1934		0.3	QL	< 81	QU	0.450		1.4		< 0.08	QU	26.1		7.9	
X42	T4X42	5/13/2018	4.8		5081		4.9		185		< 0.038	QU	1.5		3.18		16.5		14.9	
X43	T4X43	5/12/2018	19.0		4069		9.9		137		3.465		2.4		20.44		< 16	QU	12.0	
X44	T4X44	5/13/2018	1.9		6241		6.0		203		< 0.038	QU	2.6		3.26		< 16	QU	19.0	
X45	T4X45	5/13/2018	42.6		5456		8.5		162		0.582		2.0		4.84		< 16	QU	10.8	
X46	T4X46	5/13/2018	2.6		6691		4.6		196		< 0.038	QU	2.4		3.49		< 16	QU	19.2	
X47	T4X47	5/13/2018	< 1.8	QU	4364		5.1		181		< 0.038	QU	1.9		1.16		< 16	QU	12.4	

Table I3-4. Validated XRF Field Survey Results for Non-AUM Target BR-04 (T4)

Grid ID	Unique_X	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
X48	T4X48	5/13/2018	< 1.8	QU	6665		5.4		185		< 0.038	QU	2.5		2.91		< 16	QU	18.6	
X5	T4X5	5/13/2018	2.4		6862		6.6		250		< 0.038	QU	2.5		6.44		< 16	QU	22.8	
X50	T4X50	5/13/2018	< 1.8	QU	3512		2.4		152		< 0.038	QU	1.7		0.89		< 16	QU	12.6	
X51	T4X51	5/13/2018	2.2		5885		4.1		163		< 0.038	QU	2.6		2.55		< 16	QU	16.4	
X52	T4X52	5/13/2018	< 1.8	QU	4321		5.5		166		< 0.038	QU	1.9		4.10		< 16	QU	13.7	
X6	T4X6	5/13/2018	2.7		6145		5.7		208		< 0.038	QU	1.9		2.52		< 16	QU	17.7	
X7	T4X7	5/13/2018	2.7		4861		4.8		200		< 0.038	QU	2.6		3.89		< 16	QU	15.3	
X8	T4X8	5/13/2018	2.7		3077		2.4		129		< 0.038	QU	1.2		0.83		< 16	QU	10.0	
X9	T4X9	5/13/2018	2.0		5332		4.0		209		0.630		1.9		6.45		18.2		17.6	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-5. Validated XRF Field Survey Results for Non-AUM Target BR-05 (T5)

Grid ID	Unique_X	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
G1	T5G1	9/28/2018	2.0		3895		4.6		149		< 0.038	QU	1.4		2.25		< 16	QU	10.5	
G10	T5G10	8/19/2018	24.5		6274		10.1		239		< 0.038	QU	2.4		14.31		< 16	QU	19.0	
G11	T5G11	9/28/2018	4.3		3921		4.8		158		< 0.038	QU	< 1	QU	2.98		< 16	QU	9.3	
G12	T5G12	8/19/2018	< 1.8	QU	4622		6.7		215		< 0.038	QU	1.8		0.86		< 16	QU	13.5	
G13	T5G13	9/28/2018	5.5		4202		5.8		156		0.561		1.6		0.79		< 16	QU	9.3	
G14	T5G14	9/28/2018	< 1.8	QU	5140		7.0		202		< 0.038	QU	2.0		2.80		< 16	QU	13.4	
G15	T5G15	9/28/2018	3.6		5133		7.0		219		0.365		2.0		1.20		< 16	QU	12.1	
G16	T5G16	9/28/2018	6.6		4168		7.2		179		0.218		1.2		3.24		< 16	QU	12.2	
G17	T5G17	9/28/2018	< 1.8	QU	3477		4.3		177		< 0.038	QU	1.4		2.57		< 16	QU	9.6	
G2	T5G2	9/28/2018	< 1.8	QU	4604		7.8		190		< 0.038	QU	2.2		3.20		< 16	QU	12.8	
G3	T5G3	9/28/2018	2.4		4430		6.8		205		< 0.038	QU	2.4		2.50		< 16	QU	13.0	
G4	T5G4	9/28/2018	< 1.8	QU	4284		6.9		157		< 0.038	QU	1.5		2.58		< 16	QU	12.9	
G5	T5G5	8/19/2018	2.1		4238		4.4		182		< 0.038	QU	2.0		0.99		< 16	QU	13.9	
G6	T5G6	8/19/2018	< 1.8	QU	4756		5.0		183		< 0.038	QU	1.6		1.28		< 16	QU	16.2	
G7	T5G7	8/19/2018	4.4		7470		6.2		214		< 0.038	QU	2.0		2.90		18.9		17.8	
G8	T5G8	8/19/2018	2.8		4940		5.2		200		< 0.038	QU	2.2		3.36		< 16	QU	13.7	
G9	T5G9	9/28/2018	2.0		4822		6.8		193		< 0.038	QU	1.6		1.66		< 16	QU	13.9	
X1	T5X1	5/14/2018	2.2		4959		4.9		220		< 0.038	QU	2.0		3.70		< 16	QU	16.7	
X10	T5X10	5/14/2018	< 1.8	QU	2755		3.2		137		< 0.038	QU	1.2		1.11		< 16	QU	9.4	
X11	T5X11	5/14/2018	2.8		3957		3.7		168		< 0.038	QU	1.7		2.78		< 16	QU	13.0	
X12	T5X12	5/14/2018	< 1.8	QU	4275		6.2		187		< 0.038	QU	1.5		3.21		< 16	QU	14.2	
X13	T5X13	5/14/2018	2.6		3496		4.8		167		< 0.038	QU	1.3		1.80		< 16	QU	13.4	
X14	T5X14	5/14/2018	5.1		4692		5.4		201		< 0.038	QU	1.9		2.55		< 16	QU	14.9	
X15	T5X15	5/14/2018	2.5		4836		7.3		224		< 0.038	QU	2.3		4.00		< 16	QU	15.5	
X16	T5X16	5/14/2018	2.4		3331		2.4		143		< 0.038	QU	1.8		2.96		< 16	QU	12.1	
X17	T5X17	5/14/2018	3.0		3418		3.5		152		< 0.038	QU	1.5		1.79		< 16	QU	12.3	
X18	T5X18	5/14/2018	2.0		3189		5.0		126		< 0.038	QU	1.1		2.01		< 16	QU	13.2	
X19	T5X19	5/14/2018	7.4		5630		1.3		118		< 0.038	QU	2.5		6.38		< 16	QU	16.9	
X2	T5X2	5/14/2018	2.1		3608		4.2		161		< 0.038	QU	1.6		1.20		< 16	QU	12.1	
X20	T5X20	5/14/2018	6.2		9994		3.4		200		< 0.038	QU	3.2		4.01		26.3		27.9	
X21	T5X21	5/14/2018	4.8		4304		4.0		165		< 0.038	QU	1.3		0.98		< 16	QU	14.7	
X22	T5X22	5/14/2018	2.5		3402		3.9		166		< 0.038	QU	1.4		3.67		< 16	QU	13.1	
X23	T5X23	5/14/2018	< 1.8	QU	3886		4.2		169		< 0.038	QU	< 1	QU	1.68		< 16	QU	11.8	
X24	T5X24	5/14/2018	2.3		4099		7.4		184		< 0.038	QU	1.6		2.46		< 16	QU	13.6	
X25	T5X25	5/14/2018	3.3		3886		5.1		151		< 0.038	QU	1.6		2.15		< 16	QU	13.0	
X26	T5X26	5/14/2018	2.0		3089		3.3		151		< 0.038	QU	1.8		1.82		< 16	QU	10.6	
X27	T5X27	5/14/2018	1.9		3517		4.8		189		< 0.038	QU	1.1		< 0.08	QU	< 16	QU	11.6	
X3	T5X3	5/14/2018	< 1.8	QU	3085		3.3		148		< 0.038	QU	1.5		1.55		< 16	QU	10.0	
X4	T5X4	5/14/2018	3.8		4242		5.4		166		< 0.038	QU	2.6		2.98		< 16	QU	12.7	
X5	T5X5	5/14/2018	< 1.8	QU	3470		3.0		197		0.348		1.4		0.57		< 16	QU	10.8	
X6	T5X6	5/14/2018	2.0		2962		3.8		133		< 0.038	QU	< 1	QU	0.44		< 16	QU	11.1	
X7	T5X7	5/14/2018	2.3		3633		4.0		149		< 0.038	QU	1.2		2.78		< 16	QU	12.2	
X8	T5X8	5/14/2018	2.9		4041		3.6		172		< 0.038	QU	2.2		3.75		< 16	QU	13.2	
X9	T5X9	5/14/2018	4.2		6427		4.6		179		< 0.038	QU	2.3		6.64		21.2		17.7	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-6. Validated XRF Field Survey Results for Non-AUM Target BR-06 (T6)

Grid ID	Unique_X	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
G1	T6G1	8/19/2018	< 1.8	QU	4166		5.7		152		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	10.8	
G10	T6G10	8/19/2018	< 1.8	QU	2177		3.2		103		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	< 7.8	QU
G11	T6G11	8/19/2018	< 1.8	QU	2667		3.7		144		< 0.038	QU	2.0		< 0.08	QU	< 16	QU	8.1	
G12	T6G12	8/19/2018	< 1.8	QU	2983		3.9		139		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	< 7.8	QU
G13	T6G13	8/19/2018	< 1.8	QU	3371		6.8		147		< 0.038	QU	1.7		0.90		< 16	QU	8.9	
G14	T6G14	8/19/2018	< 1.8	QU	2728		4.0		136		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	< 7.8	QU
G15	T6G15	8/19/2018	< 1.8	QU	3039		4.8		141		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	8.2	
G16	T6G16	8/19/2018	< 1.8	QU	3919		4.8		203		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	10.9	
G17	T6G17	8/19/2018	< 1.8	QU	2165		3.6		95		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	< 7.8	QU
G18	T6G18	8/19/2018	< 1.8	QU	4167		5.6		168		< 0.038	QU	1.4		< 0.08	QU	< 16	QU	8.6	
G19	T6G19	8/19/2018	< 1.8	QU	3155		4.1		147		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	8.1	
G2	T6G2	8/19/2018	< 1.8	QU	3011		5.3		144		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	< 7.8	QU
G20	T6G20	8/19/2018	< 1.8	QU	2983		3.4		123		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	8.2	
G3	T6G3	8/19/2018	< 1.8	QU	3441		3.6		146		< 0.038	QU	< 1	QU	0.63		< 16	QU	< 7.8	QU
G4	T6G4	8/19/2018	< 1.8	QU	2262		2.7		98		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	< 7.8	QU
G5	T6G5	8/19/2018	< 1.8	QU	2166		2.7		110		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	< 7.8	QU
G6	T6G6	8/19/2018	< 1.8	QU	2441		2.1		123		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	< 7.8	QU
G7	T6G7	8/19/2018	< 1.8	QU	2775		4.9		121		< 0.038	QU	1.0		< 0.08	QU	< 16	QU	< 7.8	QU
G8	T6G8	8/19/2018	< 1.8	QU	2900		4.2		131		< 0.038	QU	1.2		0.23		< 16	QU	8.7	
G9	T6G9	8/19/2018	< 1.8	QU	2606		4.3		128		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	< 7.8	QU
X1	T6X1	5/12/2018	< 1.8	QU	3710		4.1		159		< 0.038	QU	2.8		3.98		< 16	QU	10.4	
X10	T6X10	5/12/2018	< 1.8	QU	2643		3.7		121		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	< 7.8	QU
X11	T6X11	5/12/2018	< 1.8	QU	3939		4.0		169		< 0.038	QU	2.0		1.02		< 16	QU	10.7	
X12	T6X12	5/12/2018	< 1.8	QU	2827		3.0		114		0.184		1.4		< 0.08	QU	< 16	QU	8.7	
X13	T6X13	5/12/2018	< 1.8	QU	3683		4.0		136		< 0.038	QU	2.0		0.53		< 16	QU	11.2	
X14	T6X14	5/12/2018	< 1.8	QU	5009		5.6		199		< 0.038	QU	2.6		< 0.08	QU	< 16	QU	13.5	
X15	T6X15	5/12/2018	< 1.8	QU	3938		4.2		167		< 0.038	QU	2.2		< 0.08	QU	< 16	QU	10.1	
X16	T6X16	5/12/2018	< 1.8	QU	3506		3.8		141		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	10.2	
X17	T6X17	5/12/2018	< 1.8	QU	3565		4.2		150		< 0.038	QU	1.7		< 0.08	QU	< 16	QU	10.3	
X18	T6X18	5/12/2018	< 1.8	QU	3323		6.3		150		< 0.038	QU	1.6		< 0.08	QU	< 16	QU	10.8	
X19	T6X19	5/12/2018	< 1.8	QU	3375		3.8		126		< 0.038	QU	1.5		1.30		< 16	QU	8.6	
X2	T6X2	5/12/2018	< 1.8	QU	3127		3.8		120		< 0.038	QU	1.9		< 0.08	QU	< 16	QU	8.1	
X20	T6X20	5/12/2018	< 1.8	QU	2811		2.9		121		0.054		< 1	QU	< 0.08	QU	< 16	QU	8.7	
X21	T6X21	5/12/2018	< 1.8	QU	3476		3.8		135		< 0.038	QU	2.1		1.12		< 16	QU	12.5	
X22	T6X22	5/12/2018	< 1.8	QU	4110		6.3		161		0.175		1.8		1.00		< 16	QU	12.8	
X23	T6X23	5/12/2018	< 1.8	QU	4725		4.4		201		< 0.038	QU	2.6		0.54		< 16	QU	12.8	
X24	T6X24	5/12/2018	< 1.8	QU	3339		4.3		110		< 0.038	QU	1.7		< 0.08	QU	< 16	QU	11.0	
X25	T6X25	5/12/2018	< 1.8	QU	3386		2.5		135		< 0.038	QU	2.2		< 0.08	QU	< 16	QU	9.0	
X26	T6X26	5/12/2018	< 1.8	QU	3235		2.5		138		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	10.1	
X27	T6X27	5/12/2018	< 1.8	QU	3390		3.1		150		< 0.038	QU	2.0		< 0.08	QU	< 16	QU	9.7	
X28	T6X28	5/12/2018	< 1.8	QU	3391		5.0		140		< 0.038	QU	1.6		0.14		< 16	QU	10.4	
X29	T6X29	5/12/2018	< 1.8	QU	3203		2.3		114		0.073		2.3		< 0.08	QU	< 16	QU	9.9	
X3	T6X3	5/12/2018	< 1.8	QU	3011		3.6		124		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	10.0	
X30	T6X30	5/12/2018	< 1.8	QU	3914		4.8		178		0.313		1.9		< 0.08	QU	< 16	QU	11.4	
X31	T6X31	5/12/2018	< 1.8	QU	3637		3.9		184		< 0.038	QU	1.2		0.54		< 16	QU	9.8	
X32	T6X32	5/12/2018	< 1.8	QU	3544		3.9		137		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	9.9	
X33	T6X33	5/12/2018	< 1.8	QU	2761		1.4		111		< 0.038	QU	1.6		< 0.08	QU	< 16	QU	8.5	
X34	T6X34	5/12/2018	2.3		3501		2.3		110		< 0.038	QU	1.8		< 0.08	QU	< 16	QU	11.3	
X35	T6X35	5/12/2018	2.1		4769		3.5		221		< 0.038	QU	2.1		< 0.08	QU	< 16	QU	13.1	
X36	T6X36	5/12/2018	< 1.8	QU	3934		2.8		219		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	11.5	
X37	T6X37	5/12/2018	< 1.8	QU	3564		5.1		126		< 0.038	QU	1.2		1.45		< 16	QU	11.0	
X4	T6X4	5/12/2018	< 1.8	QU	3490		3.2		129		< 0.038	QU	1.4		< 0.08	QU	< 16	QU	11.1	

Table I3-6. Validated XRF Field Survey Results for Non-AUM Target BR-06 (T6)

Grid ID	Unique_X	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
X5	T6X5	5/12/2018	< 1.8	QU	3303		4.4		160		< 0.038	QU	1.7		< 0.08	QU	< 16	QU	10.2	
X6	T6X6	5/12/2018	< 1.8	QU	3851		3.1		171		< 0.038	QU	1.6		< 0.08	QU	< 16	QU	10.2	
X7	T6X7	5/12/2018	< 1.8	QU	3417		4.4		152		0.343		1.9		< 0.08	QU	< 16	QU	9.7	
X8	T6X8	5/12/2018	< 1.8	QU	3191		4.7		162		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	11.2	
X9	T6X9	5/12/2018	< 1.8	QU	3716		2.7		156		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	10.9	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-7. Validated XRF Field Survey Results for Non-AUM Target BK-01 (T7)

Grid ID	Unique_X	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
X1	T7X1	4/24/2018	< 1.8	QU	2763		2.1		152		< 0.038	QU	1.4		< 0.08	QU	< 16	QU	9.7	
X10	T7X10	4/24/2018	< 1.8	QU	3132		3.6		143		0.273		1.4		0.12	QL	< 16	QU	11.7	
X11	T7X11	4/24/2018	< 1.8	QU	3772		3.5		208		< 0.038	QU	1.7		< 0.08	QU	< 16	QU	11.8	
X12	T7X12	4/24/2018	< 1.8	QU	3315		2.1		147		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	10.4	
X13	T7X13	4/24/2018	< 1.8	QU	3046		4.1		140		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	10.4	
X14	T7X14	4/24/2018	< 1.8	QU	3340		3.6		137		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	12.2	
X15	T7X15	4/24/2018	< 1.8	QU	3296		3.7		154		< 0.038	QU	1.1		< 0.08	QU	< 16	QU	11.5	
X16	T7X16	4/24/2018	< 1.8	QU	3329		3.7		147		< 0.038	QU	1.3		0.15		< 16	QU	10.7	
X17	T7X17	4/24/2018	< 1.8	QU	3420		5.0		161		0.534		1.7		< 0.08	QU	< 16	QU	12.3	
X18	T7X18	4/24/2018	1.8		4021		4.6		170		0.429		1.3		< 0.08	QU	< 16	QU	12.4	
X19	T7X19	4/24/2018	< 1.8	QU	3074		3.8		141		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	9.3	
X2	T7X2	4/24/2018	< 1.8	QU	3820		3.7		151		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	11.8	
X20	T7X20	4/24/2018	< 1.8	QU	3646		3.4		145		< 0.038	QU	1.7		1.48		< 16	QU	12.4	
X21	T7X21	4/24/2018	< 1.8	QU	2967		3.9		150		< 0.038	QU	2.3		< 0.08	QU	< 16	QU	10.6	
X22	T7X22	4/24/2018	2.2		3145		2.7		141		1.506		1.7		0.77		< 16	QU	8.7	
X23	T7X23	4/24/2018	< 1.8	QU	3173		2.9		136		0.543		2.1		< 0.08	QU	< 16	QU	10.3	
X24	T7X24	4/24/2018	2.6		3509		2.6		139		0.757		1.7		0.35		< 16	QU	11.2	
X25	T7X25	4/24/2018	< 1.8	QU	2911		2.5		129		1.747		1.4		< 0.08	QU	< 16	QU	9.8	
X26	T7X26	4/24/2018	< 1.8	QU	3370		3.1		183		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	12.3	
X27	T7X27	4/24/2018	< 1.8	QU	3697		4.8		159		0.278		1.6		0.27		< 16	QU	11.8	
X28	T7X28	4/24/2018	< 1.8	QU	3898		3.1		152		1.355		1.8		0.15		< 16	QU	11.5	
X29	T7X29	4/24/2018	< 1.8	QU	3603		3.8		143		< 0.038	QU	1.9		< 0.08	QU	< 16	QU	10.9	
X3	T7X3	4/24/2018	< 1.8	QU	3278		2.9		130		1.114		1.3		0.41		< 16	QU	9.4	
X30	T7X30	4/24/2018	< 1.8	QU	3825		4.0		158		1.416		1.6		< 0.08	QU	< 16	QU	11.9	
X31	T7X31	4/24/2018	< 1.8	QU	3212		2.6		133		0.959		1.2		< 0.08	QU	< 16	QU	12.5	
X32	T7X32	4/24/2018	< 1.8	QU	3159		2.2		148		0.472		1.6		< 0.08	QU	< 16	QU	10.4	
X33	T7X33	4/24/2018	< 1.8	QU	3004		4.1		138		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	10.7	
X34	T7X34	4/24/2018	< 1.8	QU	3764		3.5		151		0.616		1.4		0.23		< 16	QU	11.1	
X35	T7X35	4/24/2018	< 1.8	QU	3026		4.4		131		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	11.7	
X36	T7X36	4/24/2018	< 1.8	QU	3043		4.4		136		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	10.5	
X37	T7X37	4/24/2018	< 1.8	QU	3485		4.1		135		< 0.038	QU	1.8		0.27		< 16	QU	11.5	
X38	T7X38	4/24/2018	< 1.8	QU	3880		4.0		163		0.661		2.0		0.15		< 16	QU	12.2	
X39	T7X39	4/24/2018	< 1.8	QU	3573		3.9		183		0.840		1.9		0.54		< 16	QU	10.6	
X4	T7X4	4/24/2018	< 1.8	QU	3878		4.1		152		0.322		1.1		< 0.08	QU	< 16	QU	12.6	
X40	T7X40	4/24/2018	2.7		4144		3.5		180		1.163		2.1		2.58		< 16	QU	11.4	
X41	T7X41	4/24/2018	< 1.8	QU	3524		4.5		165		< 0.038	QU	1.1		0.43		< 16	QU	11.2	
X42	T7X42	4/24/2018	< 1.8	QU	3084		4.6		132		< 0.038	QU	2.3		< 0.08	QU	< 16	QU	10.7	
X43	T7X43	4/24/2018	< 1.8	QU	3694		4.1		145		< 0.038	QU	1.6		< 0.08	QU	< 16	QU	11.5	
X44	T7X44	4/24/2018	< 1.8	QU	3340		4.4		146		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	10.0	
X45	T7X45	4/24/2018	< 1.8	QU	3553		4.2		138		< 0.038	QU	1.9		< 0.08	QU	< 16	QU	9.8	
X46	T7X46	4/24/2018	< 1.8	QU	3016		4.1		147		< 0.038	QU	1.3		0.36		< 16	QU	10.5	
X47	T7X47	4/24/2018	< 1.8	QU	2833		2.8		125		< 0.038	QU	1.2		0.31		< 16	QU	11.7	
X48	T7X48	4/24/2018	2.0		3523		3.3		137		0.941		1.9		0.79		< 16	QU	11.4	
X49	T7X49	4/24/2018	< 1.8	QU	2328		1.0	QL	106		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	< 7.8	QU
X5	T7X5	4/24/2018	< 1.8	QU	3595		4.4		175		1.143		1.6		< 0.08	QU	< 16	QU	11.7	
X50	T7X50	4/24/2018	< 1.8	QU	3335		3.9		151		1.345		1.5		< 0.08	QU	< 16	QU	11.0	
X51	T7X51	4/24/2018	< 1.8	QU	3352		3.4		138		3.030		2.2		1.05		< 16	QU	12.5	
X52	T7X52	4/24/2018	< 1.8	QU	3483		3.4		141		0.518		2.0		0.58		< 16	QU	11.5	
X53	T7X53	4/24/2018	< 1.8	QU	3329		2.6		133		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	10.5	
X54	T7X54	4/24/2018	2.6		3783		4.1		167		0.466		2.5		0.33		< 16	QU	12.3	
X55	T7X55	4/24/2018	< 1.8	QU	2731		3.4		116		0.455		1.2		< 0.08	QU	< 16	QU	8.9	
X56	T7X56	4/24/2018	< 1.8	QU	3238		4.0		116		0.848		1.8		< 0.08	QU	< 16	QU	10.8	

Table I3-7. Validated XRF Field Survey Results for Non-AUM Target BK-01 (T7)

Grid ID	Unique_X	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
X57	T7X57	4/24/2018	< 1.8	QU	2222		1.7		85	QL	1.835		1.2		1.13		< 16	QU	< 7.8	QU
X58	T7X58	4/24/2018	3.9		4769		4.4		171		< 0.038	QU	2.3		0.79		< 16	QU	13.2	
X59	T7X59	4/24/2018	< 1.8	QU	2575		2.7		119		0.669		1.1		< 0.08	QU	< 16	QU	8.8	
X6	T7X6	4/24/2018	< 1.8	QU	2776		1.9		126		< 0.038	QU	1.1		< 0.08	QU	< 16	QU	8.6	
X60	T7X60	4/24/2018	< 1.8	QU	3045		3.8		126		0.672		1.2		0.15		< 16	QU	10.4	
X61	T7X61	4/24/2018	< 1.8	QU	3600		4.5		154		0.388		2.0		< 0.08	QU	< 16	QU	11.0	
X62	T7X62	4/24/2018	< 1.8	QU	3316		3.9		168		1.189		1.7		< 0.08	QU	< 16	QU	11.0	
X63	T7X63	4/24/2018	< 1.8	QU	4104		4.6		184		< 0.038	QU	1.7		0.25		< 16	QU	13.2	
X64	T7X64	4/24/2018	< 1.8	QU	3415		3.7		154		0.303		1.8		1.70		< 16	QU	10.0	
X65	T7X65	4/24/2018	< 1.8	QU	3310		3.0		150		< 0.038	QU	2.1		< 0.08	QU	< 16	QU	11.5	
X66	T7X66	4/24/2018	< 1.8	QU	2631		3.8		127		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	9.8	
X67	T7X67	4/24/2018	< 1.8	QU	3789		5.0		152		0.058		1.6		< 0.08	QU	< 16	QU	10.3	
X68	T7X68	4/24/2018	< 1.8	QU	3311		2.2		143		1.445		1.5		< 0.08	QU	< 16	QU	10.1	
X69	T7X69	4/24/2018	< 1.8	QU	4365		5.8		207		1.475		2.1		< 0.08	QU	< 16	QU	15.5	
X7	T7X7	4/24/2018	< 1.8	QU	2600		2.7		96		1.148		1.2		< 0.08	QU	< 16	QU	8.4	
X70	T7X70	4/24/2018	< 1.8	QU	3690		4.7		156		0.590		1.9		< 0.08	QU	< 16	QU	11.2	
X71	T7X71	4/24/2018	< 1.8	QU	3914		4.2		159		< 0.038	QU	1.5		0.15		< 16	QU	11.4	
X72	T7X72	4/24/2018	< 1.8	QU	2425		1.2		109		1.216		< 1	QU	< 0.08	QU	< 16	QU	< 7.8	QU
X73	T7X73	4/24/2018	< 1.8	QU	2395		3.0		106		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	8.2	
X74	T7X74	4/24/2018	< 1.8	QU	3990		5.3		157		1.144		1.7		0.30		< 16	QU	12.8	
X75	T7X75	4/24/2018	< 1.8	QU	3252		4.5		134		1.340		1.1		< 0.08	QU	< 16	QU	9.3	
X76	T7X76	4/24/2018	< 1.8	QU	3592		3.6		137		< 0.038	QU	1.9		< 0.08	QU	< 16	QU	9.7	
X77	T7X77	4/24/2018	< 1.8	QU	2834		1.8		120		1.297		1.4		< 0.08	QU	< 16	QU	8.6	
X78	T7X78	4/24/2018	< 1.8	QU	2392		2.7		135		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	8.6	
X79	T7X79	4/24/2018	< 1.8	QU	2493		2.3		116		0.135		1.3		< 0.08	QU	< 16	QU	8.7	
X8	T7X8	4/24/2018	< 1.8	QU	3451		3.8		146		0.557		1.6		< 0.08	QU	< 16	QU	12.4	
X80	T7X80	4/24/2018	< 1.8	QU	2770		3.4		118		0.600		1.5		< 0.08	QU	< 16	QU	9.3	
X81	T7X81	4/24/2018	< 1.8	QU	3452		4.4		147		1.146		1.4		< 0.08	QU	< 16	QU	11.0	
X82	T7X82	4/24/2018	< 1.8	QU	3057		4.8		136		< 0.038	QU	1.7		< 0.08	QU	< 16	QU	10.1	
X83	T7X83	4/24/2018	< 1.8	QU	2788		2.9		108		< 0.038	QU	1.4		0.13	QL	< 16	QU	< 7.8	QU
X84	T7X84	4/24/2018	< 1.8	QU	2048		0.7	QL	116		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	< 7.8	QU
X85	T7X85	4/24/2018	< 1.8	QU	3014		2.1		111		0.587		1.0		< 0.08	QU	< 16	QU	8.4	
X9	T7X9	4/24/2018	2.9		4151		4.3		189		0.570		2.1		1.56		< 16	QU	11.9	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-8. Validated XRF Field Survey Results for Non-AUM Target BK-02 (T8)

Grid ID	Unique_X	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
G1	T8G1	8/19/2018	< 1.8	QU	4457		6.5		196		< 0.038	QU	2.0		1.64		< 16	QU	17.9	
G10	T8G10	8/19/2018	< 1.8	QU	4561		5.7		180		< 0.038	QU	1.3		1.32		< 16	QU	17.9	
G10A	T8G10A	8/19/2018	1.9		4329		5.1		174		< 0.038	QU	1.6		< 0.08	QU	< 16	QU	15.9	
G12	T8G12	8/19/2018	1.9		7426		2.7		197		0.641		1.3		< 0.08	QU	< 16	QU	14.1	
G14	T8G14	8/19/2018	2.0		3664		4.0		166		1.385		1.1		3.22		< 16	QU	17.7	
G16	T8G16	8/19/2018	2.0		7873		3.9		165		1.321		2.2		< 0.08	QU	< 16	QU	17.3	
G18	T8G18	8/19/2018	< 1.8	QU	4371		6.3		183		< 0.038	QU	1.6		1.21		< 16	QU	18.6	
G19	T8G19	8/19/2018	< 1.8	QU	4660		4.1		195		< 0.038	QU	1.9		0.64		< 16	QU	17.4	
G2	T8G2	8/19/2018	2.2		7658		3.4		185		1.378		1.4		< 0.08	QU	< 16	QU	14.6	
G20	T8G20	8/19/2018	< 1.8	QU	7965		3.2		187		1.146		1.4		< 0.08	QU	< 16	QU	17.6	
G21	T8G21	8/19/2018	< 1.8	QU	7790		6.7		193		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	19.3	
G22	T8G22	8/19/2018	< 1.8	QU	4855		6.9		183		< 0.038	QU	1.6		1.78		< 16	QU	18.3	
G23	T8G23	8/19/2018	2.4		5164		4.6		206		< 0.038	QU	1.8		1.71		< 16	QU	19.2	
G24	T8G24	8/19/2018	< 1.8	QU	8334		5.0		200		0.602		1.8		< 0.08	QU	< 16	QU	16.0	
G25	T8G25	8/19/2018	< 1.8	QU	4407		4.1		196		< 0.038	QU	2.2		1.72		< 16	QU	17.9	
G26	T8G26	8/19/2018	< 1.8	QU	7301		4.5		193		< 0.038	QU	2.0		< 0.08	QU	< 16	QU	14.9	
G3	T8G3	8/19/2018	< 1.8	QU	3631		4.3		178		< 0.038	QU	1.6		0.90		< 16	QU	13.9	
G4	T8G4	8/19/2018	2.1		7729		4.2		210		< 0.038	QU	1.4		< 0.08	QU	< 16	QU	16.0	
G5	T8G5	8/19/2018	< 1.8	QU	6504		4.4		159		< 0.038	QU	1.1		< 0.08	QU	< 16	QU	14.7	
G6	T8G6	8/19/2018	< 1.8	QU	6364		4.7		154		< 0.038	QU	2.0		< 0.08	QU	< 16	QU	12.2	
G7	T8G7	8/19/2018	2.4		4370		4.3		179		< 0.038	QU	1.4		< 0.08	QU	< 16	QU	17.3	
G8	T8G8	8/19/2018	< 1.8	QU	4175		5.6		174		< 0.038	QU	< 1	QU	0.15		< 16	QU	20.3	
G9	T8G9	8/19/2018	2.5		7543		3.8		183		2.122		1.6		< 0.08	QU	< 16	QU	16.1	
X1	T8X1	4/24/2018	2.4		4387		5.7		185		< 0.038	QU	2.3		0.60		< 16	QU	13.3	
X10	T8X10	4/24/2018	< 1.8	QU	4443		6.1		182		0.619		1.1		1.36		< 16	QU	14.2	
X11	T8X11	4/24/2018	< 1.8	QU	3992		4.4		196		< 0.038	QU	1.4		< 0.08	QU	< 16	QU	14.6	
X12	T8X12	4/24/2018	< 1.8	QU	3897		4.1		158		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	14.5	
X13	T8X13	4/24/2018	< 1.8	QU	4063		5.3		185		< 0.038	QU	2.1		< 0.08	QU	< 16	QU	16.2	
X14	T8X14	4/24/2018	< 1.8	QU	4785		4.5		187		< 0.038	QU	1.6		1.61		< 16	QU	17.1	
X15	T8X15	4/24/2018	< 1.8	QU	4389		4.4		183		< 0.038	QU	1.7		0.77		< 16	QU	15.5	
X16	T8X16	4/24/2018	1.9		4503		5.4		203		< 0.038	QU	1.9		0.59		< 16	QU	16.4	
X17	T8X17	4/24/2018	< 1.8	QU	4573		6.4		170		< 0.038	QU	2.0		1.02		< 16	QU	16.8	
X18	T8X18	4/24/2018	< 1.8	QU	3889		5.3		136		< 0.038	QU	1.6		0.17		< 16	QU	17.9	
X19	T8X19	4/24/2018	< 1.8	QU	3869		5.8		159		< 0.038	QU	< 1	QU	0.57		< 16	QU	13.9	
X2	T8X2	4/24/2018	< 1.8	QU	3277		4.4		143		0.369		1.0		< 0.08	QU	< 16	QU	11.2	
X20	T8X20	4/24/2018	< 1.8	QU	4565		5.1		191		< 0.038	QU	1.2		0.51		< 16	QU	14.8	
X21	T8X21	4/24/2018	< 1.8	QU	4199		6.9		163		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	14.2	
X22	T8X22	4/24/2018	1.9		4213		4.4		170		< 0.038	QU	1.3		0.49		< 16	QU	13.3	
X23	T8X23	4/24/2018	< 1.8	QU	4861		5.7		222		< 0.038	QU	1.7		0.91		< 16	QU	15.5	
X24	T8X24	4/24/2018	< 1.8	QU	3700		5.1		162		< 0.038	QU	< 1	QU	0.38		< 16	QU	13.5	
X25	T8X25	4/24/2018	< 1.8	QU	4219		4.8		197		< 0.038	QU	1.3		0.69		< 16	QU	14.2	
X26	T8X26	4/24/2018	2.1		4744		4.9		186		< 0.038	QU	1.1		1.52		< 16	QU	18.8	
X27	T8X27	4/24/2018	< 1.8	QU	3999		6.4		165		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	15.6	
X28	T8X28	4/24/2018	2.5		5478		5.2		216		< 0.038	QU	1.9		0.87		< 16	QU	16.6	
X29	T8X29	4/24/2018	< 1.8	QU	3981		5.5		190		< 0.038	QU	1.2		0.66		< 16	QU	14.3	
X3	T8X3	4/24/2018	< 1.8	QU	3973		5.2		185		< 0.038	QU	1.9		0.08	QL	< 16	QU	13.4	
X30	T8X30	4/24/2018	< 1.8	QU	4084		4.9		157		< 0.038	QU	< 1	QU	0.46		< 16	QU	15.3	
X31	T8X31	4/24/2018	< 1.8	QU	4145		4.2		199		< 0.038	QU	< 1	QU	0.61		< 16	QU	14.6	
X32	T8X32	4/24/2018	< 1.8	QU	3856		5.1		174		< 0.038	QU	< 1	QU	0.70		< 16	QU	14.6	
X33	T8X33	4/24/2018	2.0		4837		5.3		187		0.395		1.2		1.82		< 16	QU	14.9	
X34	T8X34	4/24/2018	2.3		4140		4.1		170		< 0.038	QU	1.1		< 0.08	QU	< 16	QU	13.9	
X35	T8X35	4/24/2018	< 1.8	QU	4318		5.2		160		< 0.038	QU	1.6		0.71		< 16	QU	14.2	

Table I3-8. Validated XRF Field Survey Results for Non-AUM Target BK-02 (T8)

Grid ID	Unique_X	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
X36	T8X36	4/24/2018	< 1.8	QU	4410		3.9		190		< 0.038	QU	1.4		0.54		< 16	QU	12.9	
X37	T8X37	4/24/2018	< 1.8	QU	4333		5.1		183		< 0.038	QU	1.0		0.10	QL	< 16	QU	15.2	
X38	T8X38	4/24/2018	< 1.8	QU	3698		4.6		176		< 0.038	QU	1.1		< 0.08	QU	< 16	QU	13.4	
X39	T8X39	4/24/2018	< 1.8	QU	3399		4.6		149		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	14.4	
X4	T8X4	4/24/2018	< 1.8	QU	3877		4.9		189		< 0.038	QU	1.1		< 0.08	QU	< 16	QU	13.4	
X40	T8X40	4/24/2018	< 1.8	QU	4232		5.1		196		< 0.038	QU	1.1		< 0.08	QU	< 16	QU	14.9	
X41	T8X41	4/24/2018	2.0		4563		4.5		184		< 0.038	QU	2.0		< 0.08	QU	< 16	QU	16.2	
X42	T8X42	4/24/2018	< 1.8	QU	4143		5.6		161		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	15.5	
X43	T8X43	4/24/2018	< 1.8	QU	4417		5.5		165		< 0.038	QU	1.1		< 0.08	QU	< 16	QU	12.5	
X44	T8X44	4/24/2018	< 1.8	QU	3652		5.3		152		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	14.9	
X45	T8X45	4/24/2018	< 1.8	QU	3451		4.4		156		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	12.1	
X46	T8X46	4/24/2018	< 1.8	QU	3672		5.4		162		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	12.5	
X47	T8X47	4/24/2018	< 1.8	QU	3389		3.6		138		< 0.038	QU	1.6		< 0.08	QU	< 16	QU	11.5	
X48	T8X48	4/24/2018	< 1.8	QU	3594		3.5		159		< 0.038	QU	1.4		< 0.08	QU	< 16	QU	14.3	
X49	T8X49	4/24/2018	< 1.8	QU	3797		4.2		155		< 0.038	QU	< 1	QU	0.28		< 16	QU	13.7	
X5	T8X5	4/24/2018	< 1.8	QU	3906		5.8		170		< 0.038	QU	1.3		0.31		< 16	QU	13.7	
X50	T8X50	4/24/2018	2.3		4323		3.4		184		< 0.038	QU	1.8		0.18		< 16	QU	14.7	
X51	T8X51	4/24/2018	< 1.8	QU	4031		6.7		177		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	14.7	
X52	T8X52	4/24/2018	2.2		5168		4.6		208		< 0.038	QU	1.9		0.39		< 16	QU	15.2	
X53	T8X53	4/24/2018	< 1.8	QU	3823		5.2		139		< 0.038	QU	1.7		0.29		< 16	QU	13.8	
X54	T8X54	4/24/2018	< 1.8	QU	3923		4.5		171		< 0.038	QU	1.8		0.64		< 16	QU	14.2	
X55	T8X55	4/24/2018	2.1		3382		3.9		180		< 0.038	QU	1.4		0.85		< 16	QU	14.4	
X56	T8X56	4/24/2018	2.3		5096		5.1		203		< 0.038	QU	1.8		0.62		< 16	QU	17.6	
X57	T8X57	4/24/2018	2.9		4724		5.5		196		< 0.038	QU	2.0		0.16		< 16	QU	15.0	
X58	T8X58	4/24/2018	< 1.8	QU	4807		5.3		185		< 0.038	QU	1.6		0.22		< 16	QU	14.6	
X59	T8X59	4/24/2018	< 1.8	QU	4499		6.2		182		< 0.038	QU	1.1		0.52		< 16	QU	14.4	
X6	T8X6	4/24/2018	< 1.8	QU	3552		3.6		126		< 0.038	QU	1.1		0.17		< 16	QU	11.4	
X7	T8X7	4/24/2018	1.9		3544		3.6		160		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	12.6	
X8	T8X8	4/24/2018	< 1.8	QU	4317		4.8		176		< 0.038	QU	1.7		< 0.08	QU	< 16	QU	14.1	
X9	T8X9	4/24/2018	< 1.8	QU	3691		4.1		140		< 0.038	QU	< 1	QU	0.70		< 16	QU	14.0	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-10. Validated XRF Field Survey Results for Non-AUM Target CT-01 (T10)

Grid ID	Unique_X	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
G1	T10G1	8/18/2018	< 1.8	QU	6151		8.7		284		< 0.038	QU	2.6		2.34		18.8		19.8	
G2	T10G2	8/18/2018	2.7		8185		8.8		444		< 0.038	QU	4.0		3.82		27.7		94.8	QH
G3	T10G3	8/18/2018	< 1.8	QU	3959		4.3		200		< 0.038	QU	1.3		0.97		< 16	QU	22.4	
X1	T10X1	4/25/2018	2.1		6486		8.5		311		2.190		2.7		1.45		18.3		19.6	
X10	T10X10	4/25/2018	< 1.8	QU	4419		5.5		209		3.003		2.5		1.34		< 16	QU	16.0	
X100	T10X100	5/14/2018	< 1.8	QU	5831		9.9		282		< 0.038	QU	1.9		2.99		16.9		21.1	
X101	T10X101	4/25/2018	2.9		6501		7.3		285		< 0.038	QU	2.8		1.76		22.2		20.1	
X103	T10X103	5/14/2018	2.4		6579		5.7		304		3.121		2.4		1.29		26.8		19.3	
X104	T10X104	5/14/2018	2.9		6555		9.8		280		< 0.038	QU	2.6		2.25		20.6		17.3	
X105	T10X105	5/14/2018	2.1		5896		8.9		261		0.903		2.2		0.99		< 16	QU	17.6	
X106	T10X106	5/14/2018	< 1.8	QU	5401		8.1		273		1.170		1.7		1.91		22.7		15.4	
X107	T10X107	5/14/2018	< 1.8	QU	6495		9.2		317		2.086		1.7		2.46		22.3		24.2	
X108	T10X108	4/25/2018	< 1.8	QU	4666		5.0		203		1.390		2.1		1.77		< 16	QU	15.9	
X11	T10X11	4/25/2018	< 1.8	QU	5800		7.0		263		1.713		2.4		1.30		< 16	QU	19.4	
X12	T10X12	4/25/2018	< 1.8	QU	3855		6.9		192		1.276		2.0		1.08		< 16	QU	21.7	
X13	T10X13	4/25/2018	< 1.8	QU	5140		7.3		285		< 0.038	QU	2.7		0.57		< 16	QU	17.2	
X14	T10X14	4/25/2018	3.0		4449		4.5		219		< 0.038	QU	2.3		< 0.08	QU	< 16	QU	15.8	
X15	T10X15	4/25/2018	2.6		7193		7.0		321		1.947		3.4		0.92		< 16	QU	20.6	
X16	T10X16	4/25/2018	2.6		6807		6.3		287		1.074		3.0		2.13		16.7		20.4	
X17	T10X17	4/25/2018	2.0		5993		7.0		259		< 0.038	QU	2.8		1.53		< 16	QU	18.3	
X18	T10X18	4/25/2018	< 1.8	QU	4285		5.0		203		3.166		2.8		0.27		< 16	QU	15.8	
X19	T10X19	4/25/2018	< 1.8	QU	5270		7.4		287		1.550		2.6		0.52		< 16	QU	15.7	
X2	T10X2	4/25/2018	2.0		6904		8.6		331		< 0.038	QU	2.8		1.82		< 16	QU	23.1	
X20	T10X20	4/25/2018	< 1.8	QU	6269		6.9		281		1.167		2.8		0.52		17.2		18.8	
X21	T10X21	4/25/2018	2.3		6764		8.4		338		0.910		2.5		2.44		25.9		20.4	
X22	T10X22	4/25/2018	< 1.8	QU	5464		8.4		290		0.335		2.5		2.39		< 16	QU	17.4	
X23	T10X23	4/25/2018	< 1.8	QU	5182		6.9		278		1.143		2.2		< 0.08	QU	< 16	QU	24.8	
X24	T10X24	4/25/2018	< 1.8	QU	4508		5.8		200		0.160		3.0		3.35		< 16	QU	13.1	
X25	T10X25	4/25/2018	3.1		7559		8.2		324		< 0.038	QU	3.4		1.13		17.3		23.9	
X26	T10X26	4/25/2018	2.1		6325		6.5		276		< 0.038	QU	3.9		1.63		19.8		19.2	
X27	T10X27	4/25/2018	3.2		7982		8.6		344		< 0.038	QU	3.7		2.33		< 16	QU	24.2	
X28	T10X28	4/25/2018	3.3		6597		8.8		307		1.066		2.7		2.16		< 16	QU	20.2	
X29	T10X29	4/25/2018	2.9		7298		7.3		302		< 0.038	QU	3.3		2.85		21.1		22.7	
X3	T10X3	4/25/2018	< 1.8	QU	5317		8.2		228		1.918		2.6		0.63		< 16	QU	17.3	
X30	T10X30	4/25/2018	2.5		6483		6.6		294		2.453		2.9		0.27		< 16	QU	21.8	
X31	T10X31	4/25/2018	2.0		6550		8.7		279		< 0.038	QU	3.6		1.40		< 16	QU	19.4	
X32	T10X32	4/25/2018	< 1.8	QU	4622		6.3		249		0.115		2.5		0.43		< 16	QU	14.0	
X33	T10X33	4/25/2018	< 1.8	QU	5538		7.1		268		< 0.038	QU	3.2		1.56		< 16	QU	19.7	
X34	T10X34	4/25/2018	< 1.8	QU	5103		3.6		265		< 0.038	QU	2.0		2.13		< 16	QU	14.3	
X35	T10X35	4/25/2018	3.2		6823		6.6		319		< 0.038	QU	2.9		< 0.08	QU	< 16	QU	18.9	
X36	T10X36	4/25/2018	2.8		7135		9.8		319		< 0.038	QU	3.1		3.49		< 16	QU	21.6	
X37	T10X37	4/25/2018	2.9		7040		7.1		315		0.819		3.2		2.08		< 16	QU	21.2	
X38	T10X38	4/25/2018	3.3		7010		7.5		329		0.998		3.8		1.10		16.4		19.6	
X39	T10X39	4/25/2018	3.2		6511		6.3		338		< 0.038	QU	3.0		1.67		< 16	QU	19.0	
X4	T10X4	4/25/2018	2.3		5294		7.2		297		2.579		2.2		1.09		< 16	QU	21.6	
X40	T10X40	4/25/2018	2.7		6439		7.3		287		< 0.038	QU	2.7		2.39		< 16	QU	19.1	
X41	T10X41	4/25/2018	< 1.8	QU	5784		6.8		258		< 0.038	QU	2.7		0.97		< 16	QU	18.2	
X42	T10X42	4/25/2018	2.7		6912		8.5		306		0.706		2.9		1.53		< 16	QU	20.3	
X43	T10X43	4/25/2018	< 1.8	QU	5210		8.5		246		0.273		2.8		1.58		< 16	QU	23.0	
X44	T10X44	4/25/2018	3.5		6743		6.1		314		0.291		2.3		1.93		< 16	QU	19.8	
X45	T10X45	4/25/2018	3.5		7564		8.2		332		1.788		3.2		1.74		< 16	QU	24.8	
X46	T10X46	4/25/2018	4.2		6760		7.7		313		< 0.038	QU	2.8		2.30		< 16	QU	20.0	

Table I3-10. Validated XRF Field Survey Results for Non-AUM Target CT-01 (T10)

Grid ID	Unique_X	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
X47	T10X47	4/25/2018	2.6		6235		5.7		262		1.487		3.2		2.31		19.0		22.2	
X48	T10X48	4/25/2018	3.6		8159		7.6		386		0.605		2.8		1.48		25.1		23.8	
X49	T10X49	4/25/2018	2.3		7068		8.7		312		1.067		2.9		1.74		< 16	QU	19.9	
X5	T10X5	4/25/2018	< 1.8	QU	5549		6.9		311		1.732		2.9		0.68		23.6		20.1	
X50	T10X50	4/25/2018	< 1.8	QU	6213		7.2		279		< 0.038	QU	2.9		1.86		< 16	QU	16.5	
X51	T10X51	4/25/2018	2.6		6006		7.7		289		< 0.038	QU	2.9		2.15		< 16	QU	19.8	
X52	T10X52	4/25/2018	3.1		6207		6.9		279		2.819		2.8		2.77		< 16	QU	18.6	
X53	T10X53	4/25/2018	2.2		5494		5.5		272		1.388		2.4		2.20		16.1		22.5	
X54	T10X54	4/25/2018	3.1		7509		7.3		337		0.394		2.3		2.05		< 16	QU	22.3	
X55	T10X55	4/25/2018	3.7		8619		8.1		422		< 0.038	QU	3.8		1.72		21.4		25.0	
X56	T10X56	4/25/2018	3.1		7761		6.5		356		1.941		3.5		3.04		20.8		22.9	
X57	T10X57	4/25/2018	4.1		7113		7.2		336		< 0.038	QU	2.9		1.68		< 16	QU	21.9	
X58	T10X58	4/25/2018	3.4		7435		8.2		321		< 0.038	QU	3.0		3.11		< 16	QU	20.8	
X59	T10X59	4/25/2018	< 1.8	QU	6454		7.3		342		< 0.038	QU	3.3		0.76		< 16	QU	21.1	
X6	T10X6	4/25/2018	2.0		7408		8.9		369		1.703		3.4		1.88		< 16	QU	26.4	
X60	T10X60	4/25/2018	2.2		6436		7.8		293		< 0.038	QU	3.5		2.34		< 16	QU	18.9	
X61	T10X61	4/25/2018	3.8		6912		6.7		319		< 0.038	QU	3.7		1.75		< 16	QU	20.9	
X62	T10X62	4/25/2018	< 1.8	QU	5646		9.6		283		< 0.038	QU	2.5		2.23		< 16	QU	18.7	
X63	T10X63	4/25/2018	2.2		4885		4.6		236		1.755		2.3		1.37		< 16	QU	20.2	
X64	T10X64	8/18/2018	< 1.8	QU	3766		3.8		186		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	22.7	
X65	T10X65	4/25/2018	2.9		7054		8.9		361		0.304		3.9		0.55		< 16	QU	21.0	
X66	T10X66	4/25/2018	2.3		6881		9.3		313		< 0.038	QU	2.9		3.78		< 16	QU	20.4	
X67	T10X67	4/25/2018	2.8		6942		6.5		302		2.177		3.0		2.44		< 16	QU	18.5	
X68	T10X68	4/25/2018	3.3		8587		7.7		384		0.270		3.9		1.94		< 16	QU	24.1	
X69	T10X69	4/25/2018	2.1		7146		7.1		320		0.259		2.6		1.45		< 16	QU	19.1	
X7	T10X7	4/25/2018	< 1.8	QU	5017		5.6		234		3.060		2.7		< 0.08	QU	< 16	QU	17.0	
X70	T10X70	4/25/2018	< 1.8	QU	6145		9.0		340		< 0.038	QU	2.8		1.37		< 16	QU	19.6	
X71	T10X71	4/25/2018	2.2		6362		8.3		271		< 0.038	QU	3.3		2.22		< 16	QU	18.7	
X72	T10X72	4/25/2018	< 1.8	QU	5515		7.1		262		2.815		2.3		2.65		20.2		22.7	
X73	T10X73	4/25/2018	< 1.8	QU	5092		5.7		195		1.284		1.8		2.17		< 16	QU	18.0	
X75	T10X75	4/25/2018	2.9		6836		7.3		331		0.605		3.0		0.61		< 16	QU	18.6	
X76	T10X76	4/25/2018	3.1		6539		8.3		319		< 0.038	QU	2.5		1.07		< 16	QU	19.4	
X77	T10X77	4/25/2018	1.9		7242		7.8		318		< 0.038	QU	3.0		2.19		17.0		22.8	
X78	T10X78	4/25/2018	2.2		7261		7.1		333		1.226		3.8		2.35		27.4		20.8	
X79	T10X79	4/25/2018	2.2		6143		5.8		276		1.651		2.5		1.99		< 16	QU	19.3	
X8	T10X8	4/25/2018	2.3		5989		6.9		279		1.292		2.6		1.60		< 16	QU	18.4	
X80	T10X80	4/25/2018	2.1		6824		7.0		333		1.427		2.7		0.95		< 16	QU	18.5	
X81	T10X81	4/25/2018	< 1.8	QU	6973		10.2		340		0.551		3.2		5.46		25.6		23.7	
X82	T10X82	4/25/2018	< 1.8	QU	5645		7.8		284		< 0.038	QU	2.5		3.12		16.3		23.7	
X83	T10X83	4/25/2018	2.1		6182		6.3		342		< 0.038	QU	2.2		2.20		19.2		24.7	
X84	T10X84	8/18/2018	< 1.8	QU	7082		10.9		318		< 0.038	QU	3.5		3.42		< 16	QU	29.9	
X85	T10X85	5/14/2018	< 1.8	QU	7531		9.0		319		2.896		2.5		1.68		19.9		21.9	
X86	T10X86	5/14/2018	< 1.8	QU	6376		6.9		301		4.152		2.8		< 0.08	QU	< 16	QU	17.1	
X87	T10X87	5/14/2018	1.9		7456		8.1		341		1.189		2.7		0.62		22.2		20.7	
X88	T10X88	5/14/2018	2.0		6183		7.6		278		1.765		2.4		2.16		< 16	QU	16.7	
X89	T10X89	5/14/2018	< 1.8	QU	5646		5.9		274		2.944		2.3		1.99		< 16	QU	16.2	
X9	T10X9	4/25/2018	2.8		6163		6.7		289		< 0.038	QU	3.6		1.82		< 16	QU	19.2	
X90	T10X90	4/25/2018	< 1.8	QU	6015		7.4		320		1.182		3.0		0.52		< 16	QU	17.7	
X91	T10X91	4/25/2018	< 1.8	QU	5369		7.8		265		1.506		2.0		3.59		20.0		17.1	
X92	T10X92	4/25/2018	2.3		5449		6.1		255		1.081		2.2		2.91		16.3		19.1	
X93	T10X93	4/25/2018	2.6		7659		7.3		333		< 0.038	QU	2.7		2.91		< 16	QU	28.0	
X94	T10X94	5/14/2018	3.9		10472		11.8		413		0.779		3.1		2.72		22.9		18.0	

Table I3-10. Validated XRF Field Survey Results for Non-AUM Target CT-01 (T10)

Grid ID	Unique_X	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
X95	T10X95	5/14/2018	< 1.8	QU	6045		6.7		264		3.247		1.9		0.68		< 16	QU	17.8	
X96	T10X96	5/14/2018	2.0		7214		8.4		307		1.466		3.1		0.71		18.1		18.0	
X97	T10X97	5/14/2018	3.0		6705		7.2		294		< 0.038	QU	2.5		0.73		< 16	QU	19.2	
X98	T10X98	5/14/2018	1.9		5679		5.8		289		< 0.038	QU	2.5		0.84		< 16	QU	16.3	
X99	T10X99	5/14/2018	2.6		6405		8.0		322		1.865		1.8		3.13		16.7		17.7	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-11. Validated XRF Field Survey Results for Non-AUM Target CT-02 (T11)

Grid ID	Unique_X	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
X1	T11X1	4/25/2018	4.0		7712		7.6		334		< 0.038	QU	3.7		1.31		18.5		24.2	
X10	T11X10	4/25/2018	< 1.8	QU	4240		7.3		232		< 0.038	QU	1.7		1.43		< 16	QU	14.3	
X11	T11X11	4/25/2018	2.8		6732		6.8		270		< 0.038	QU	3.3		0.46		< 16	QU	19.1	
X12	T11X12	4/25/2018	3.6		7313		6.7		309		< 0.038	QU	3.8		1.53		< 16	QU	18.7	
X13	T11X13	4/25/2018	2.4		7412		8.7		366		< 0.038	QU	3.5		1.31		< 16	QU	21.4	
X14	T11X14	4/25/2018	3.5		6981		7.2		390		< 0.038	QU	3.4		0.59		22.2		19.4	
X15	T11X15	4/25/2018	< 1.8	QU	3859		9.2		350		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	9.4	
X17	T11X17	4/25/2018	< 1.8	QU	4417		6.7		226		< 0.038	QU	1.6		0.41		< 16	QU	17.2	
X18	T11X18	4/25/2018	2.2		5528		6.6		277		< 0.038	QU	3.2		1.16		< 16	QU	16.3	
X19	T11X19	4/25/2018	2.6		6795		8.8		289		< 0.038	QU	3.2		2.10		< 16	QU	19.0	
X2	T11X2	4/25/2018	2.5		7927		9.3		395		< 0.038	QU	4.1		0.63		< 16	QU	22.7	
X20	T11X20	4/25/2018	3.6		7945		8.3		338		< 0.038	QU	4.0		1.52		< 16	QU	22.8	
X21	T11X21	4/25/2018	2.1		7261		8.1		299		< 0.038	QU	2.9		0.88		< 16	QU	20.4	
X22	T11X22	4/25/2018	3.1		7033		8.3		320		< 0.038	QU	3.2		0.59		< 16	QU	19.1	
X23	T11X23	4/25/2018	< 1.8	QU	5202		6.0		216		< 0.038	QU	2.4		1.87		< 16	QU	12.8	
X25	T11X25	4/25/2018	< 1.8	QU	4796		8.5		276		< 0.038	QU	2.1		0.68		< 16	QU	17.0	
X26	T11X26	4/25/2018	2.1		5919		6.4		257		< 0.038	QU	3.4		2.26		< 16	QU	14.1	
X27	T11X27	4/25/2018	2.1		6371		7.8		289		< 0.038	QU	3.0		< 0.08	QU	< 16	QU	18.1	
X28	T11X28	4/25/2018	2.9		7650		9.2		377		< 0.038	QU	4.0		2.46		< 16	QU	21.9	
X29	T11X29	4/25/2018	3.0		6770		6.9		273		< 0.038	QU	3.0		2.91		< 16	QU	20.7	
X3	T11X3	4/25/2018	2.4		5564		5.7		409		< 0.038	QU	2.3		0.93		< 16	QU	10.2	
X30	T11X30	4/25/2018	< 1.8	QU	4487		7.6		217		< 0.038	QU	4.9		1.10		< 16	QU	12.7	
X32	T11X32	4/25/2018	< 1.8	QU	5542		6.7		382		< 0.038	QU	2.3		1.29		< 16	QU	26.3	
X33	T11X33	4/25/2018	< 1.8	QU	4687		6.8		216		< 0.038	QU	1.9		0.63		< 16	QU	15.1	
X34	T11X34	4/25/2018	< 1.8	QU	4769		5.4		253		< 0.038	QU	1.9		0.43		< 16	QU	12.1	
X35	T11X35	4/25/2018	< 1.8	QU	7219		8.3		293		< 0.038	QU	3.0		1.43		< 16	QU	20.2	
X36	T11X36	4/25/2018	1.9		7020		9.1		291		< 0.038	QU	3.4		1.34		< 16	QU	20.4	
X37	T11X37	4/25/2018	3.0		6186		7.9		252		< 0.038	QU	3.5		< 0.08	QU	< 16	QU	18.1	
X38	T11X38	4/25/2018	< 1.8	QU	4389		6.5		216		0.784		1.8		< 0.08	QU	< 16	QU	11.0	
X4	T11X4	4/25/2018	6.7		7835		13.3		507	QH	0.656		5.5		4.52		16.5		40.0	
X40	T11X40	4/25/2018	2.1		5184		6.9		269		< 0.038	QU	2.8		0.48		< 16	QU	14.5	
X41	T11X41	4/25/2018	3.1		5514		5.8		253		< 0.038	QU	2.4		1.94		< 16	QU	14.2	
X42	T11X42	4/25/2018	< 1.8	QU	4427		5.3		195		< 0.038	QU	1.6		< 0.08	QU	< 16	QU	12.7	
X43	T11X43	4/25/2018	< 1.8	QU	6117		8.3		234		< 0.038	QU	3.3		2.23		< 16	QU	17.5	
X44	T11X44	4/25/2018	< 1.8	QU	4941		5.3		237		< 0.038	QU	1.8		0.73		< 16	QU	15.0	
X45	T11X45	4/25/2018	< 1.8	QU	4566		5.9		325		< 0.038	QU	2.2		< 0.08	QU	< 16	QU	10.0	
X47	T11X47	4/25/2018	2.8		5109		5.5		288		< 0.038	QU	2.4		< 0.08	QU	< 16	QU	11.4	
X48	T11X48	4/25/2018	< 1.8	QU	5612		6.4		256		< 0.038	QU	2.8		1.79		16.4		16.6	
X49	T11X49	4/25/2018	< 1.8	QU	4449		6.5		173		< 0.038	QU	2.6		1.70		< 16	QU	11.7	
X5	T11X5	4/25/2018	3.5		7186		7.0		330		< 0.038	QU	2.8		0.26		< 16	QU	20.8	
X50	T11X50	4/25/2018	< 1.8	QU	5195		6.7		325		< 0.038	QU	2.1		0.16		< 16	QU	14.3	
X51	T11X51	4/25/2018	2.2		5921		6.2		264		< 0.038	QU	2.5		1.88		< 16	QU	17.5	
X53	T11X53	4/25/2018	3.1		5635		4.5		258		< 0.038	QU	2.0		0.57		< 16	QU	18.1	
X55	T11X55	4/25/2018	< 1.8	QU	5198		6.8		221		< 0.038	QU	2.2		0.20		< 16	QU	17.0	
X56	T11X56	4/25/2018	< 1.8	QU	5155		8.2		258		< 0.038	QU	1.7		0.18		< 16	QU	14.4	
X57	T11X57	4/25/2018	< 1.8	QU	6396		6.0		285		< 0.038	QU	3.3		0.37		< 16	QU	18.2	
X58	T11X58	4/25/2018	< 1.8	QU	5568		7.0		272		< 0.038	QU	2.9		2.00		< 16	QU	15.4	
X59	T11X59	4/25/2018	2.1		5700		6.9		295		< 0.038	QU	3.1		1.80		< 16	QU	20.8	
X6	T11X6	4/25/2018	2.5		7864		9.4		345		< 0.038	QU	3.4		1.24		< 16	QU	24.5	
X60	T11X60	4/25/2018	< 1.8	QU	3002		4.3		144		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	8.6	
X7	T11X7	4/25/2018	2.1		7058		8.8		305		< 0.038	QU	4.0		1.16		16.8		18.8	
X8	T11X8	4/25/2018	< 1.8	QU	4908		7.1		155		< 0.038	QU	3.3		2.15		< 16	QU	11.7	

Table I3-11. Validated XRF Field Survey Results for Non-AUM Target CT-02 (T11)

Grid ID	Unique_X	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

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-12. Validated XRF Field Survey Results for Non-AUM Target CT-03 (T12)

Grid ID	Unique_X	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
X1	T12X1	5/14/2018	3.6		8652		8.7		356		0.935		4.3		1.16		29.3		25.6	
X10	T12X10	5/14/2018	1.9		6012		9.6		358		< 0.038	QU	2.5		0.35		< 16	QU	21.5	
X11	T12X11	5/14/2018	2.1		6001		5.9		328		1.276		2.4		0.93		< 16	QU	19.8	
X12	T12X12	5/14/2018	< 1.8	QU	7950		9.2		329		< 0.038	QU	3.2		1.95		< 16	QU	21.9	
X2	T12X2	5/14/2018	3.5		8934		13.4		517	QH	< 0.038	QU	3.4		1.83		23.5		31.4	
X3	T12X3	5/14/2018	2.2		8102		9.2		364		1.451		2.2		0.30		16.1		34.8	
X4	T12X4	5/14/2018	3.2		6718		11.0		382		0.501		2.8		0.42		16.9		25.0	
X5	T12X5	5/14/2018	3.0		8090		10.5		410		0.310		2.8		1.57		17.4		28.8	
X6	T12X6	5/14/2018	2.6		7500		9.1		393		0.926		3.3		1.89		18.6		29.8	
X7	T12X7	5/14/2018	4.5		7918		11.0		380		0.154		2.5		1.85		< 16	QU	26.4	
X8	T12X8	5/14/2018	2.0		8421		9.5		417		0.905		3.2		1.22		17.6		26.9	
X9	T12X9	5/14/2018	2.2		6928		8.3		292		1.872		2.5		0.75		17.6		23.7	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-13. Validated XRF Field Survey Results for Non-AUM Target M1-01 (T13)

Grid ID	Unique_X	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
G1	T13G1	8/16/2018	3.7		6042		22.3		584	QH	< 0.038	QU	2.9		0.97		< 16	QU	28.0	
G10	T13G10	8/16/2018	< 1.8	QU	7348		7.3		433		1.891		3.3		0.17		23.4		22.1	
G11	T13G11	8/16/2018	< 1.8	QU	6188		8.2		215		< 0.038	QU	2.9		1.46		< 16	QU	15.8	
G12	T13G12	8/16/2018	< 1.8	QU	6013		9.6		349		1.158		2.4		3.01		< 16	QU	20.5	
G13	T13G13	8/16/2018	< 1.8	QU	5017		8.7		280		< 0.038	QU	2.8		1.80		< 16	QU	12.6	
G14	T13G14	8/16/2018	< 1.8	QU	4527		8.1		206		< 0.038	QU	2.3		1.92		< 16	QU	13.6	
G15	T13G15	8/16/2018	2.3		7382		13.9		468	QH	< 0.038	QU	2.9		3.75		32.0		23.4	
G16	T13G16	8/16/2018	< 1.8	QU	5883		18.8		276		3.160		3.0		1.87		23.2		31.8	
G17	T13G17	8/16/2018	< 1.8	QU	6833		17.6		328		< 0.038	QU	3.3		3.32		< 16	QU	26.5	
G18	T13G18	8/16/2018	2.2		6643		9.4		387		< 0.038	QU	3.2		2.67		< 16	QU	18.2	
G19	T13G19	8/16/2018	3.4		6476		19.3		442		< 0.038	QU	3.4		2.12		< 16	QU	29.8	
G2	T13G2	8/16/2018	< 1.8	QU	5523		6.9		269		0.531		3.4		1.44		< 16	QU	12.2	
G20	T13G20	8/16/2018	2.1		7392		9.0		316		< 0.038	QU	3.1		4.13		25.0		16.8	
G21	T13G21	8/16/2018	3.3		8295		20.9		550	QH	< 0.038	QU	3.5		2.62		23.0		27.9	
G22	T13G22	8/16/2018	3.3		7012		14.2		578	QH	< 0.038	QU	3.8		1.81		27.1		22.4	
G23	T13G23	8/16/2018	2.1		6706		11.9		367		< 0.038	QU	4.0		1.46		< 16	QU	15.8	
G24	T13G24	8/16/2018	< 1.8	QU	5583		9.0		270		< 0.038	QU	2.6		2.96		< 16	QU	19.3	
G25	T13G25	8/16/2018	3.6		4923		5.4		324		< 0.038	QU	2.8		1.68		< 16	QU	17.1	
G26	T13G26	8/16/2018	2.1		7969		15.2		503	QH	< 0.038	QU	4.0		3.50		28.8		26.5	
G27	T13G27	8/16/2018	< 1.8	QU	8216		17.4		439		< 0.038	QU	5.2		5.37		28.8		25.2	
G28	T13G28	8/16/2018	3.7		11449		11.9		428		< 0.038	QU	12.5		7.49		41.8		28.5	
G29	T13G29	8/16/2018	< 1.8	QU	5844		16.3		331		< 0.038	QU	4.8		3.75		< 16	QU	27.2	
G3	T13G3	8/16/2018	5.9		9859		28.4		622	QH	< 0.038	QU	3.7		4.80		22.6		50.8	
G30	T13G30	8/16/2018	3.3		7784		9.8		288		< 0.038	QU	8.1		3.65		16.4		23.1	
G31	T13G31	8/16/2018	< 1.8	QU	5453		8.0		244		< 0.038	QU	3.7		2.64		20.1		18.0	
G4	T13G4	8/16/2018	2.7		6433		9.0		427		< 0.038	QU	2.6		3.61		22.6		18.1	
G5	T13G5	8/16/2018	3.3		6943		14.5		302		1.019		3.4		2.76		21.4		23.7	
G6	T13G6	8/16/2018	< 1.8	QU	7137		17.1		374		< 0.038	QU	2.4		0.80		21.6		24.5	
G7	T13G7	8/16/2018	5.4		7617		15.8		662	QH	0.729		3.4		0.66		21.7		21.8	
G8	T13G8	8/16/2018	2.1		6607		12.6		283		< 0.038	QU	2.7		2.36		18.4		14.4	
G9	T13G9	8/16/2018	2.8		7788		14.8		501	QH	< 0.038	QU	3.0		3.40		22.5		22.4	
X1	T13X1	5/8/2018	1.9		5432		8.1		280		1.598		2.5		2.10		< 16	QU	17.1	
X10	T13X10	5/8/2018	1.9		5481		6.2		366		1.769		2.5		1.19		< 16	QU	25.2	
X11	T13X11	5/8/2018	2.1		5649		8.8		336		< 0.038	QU	2.8		1.52		< 16	QU	16.0	
X12	T13X12	5/8/2018	4.1		8311		10.9		608	QH	< 0.038	QU	3.7		3.05		20.2		24.3	
X13	T13X13	5/8/2018	2.0		5815		9.7		303		0.382		2.8		3.20		< 16	QU	16.9	
X14	T13X14	5/8/2018	< 1.8	QU	4524		7.5		274		4.535		2.6		1.47		< 16	QU	29.0	
X15	T13X15	5/8/2018	< 1.8	QU	6170		9.6		326		0.610		3.6		0.76		< 16	QU	16.0	
X16	T13X16	5/8/2018	< 1.8	QU	4753		9.0		259		< 0.038	QU	2.1		0.12	QL	< 16	QU	12.3	
X17	T13X17	5/8/2018	< 1.8	QU	5608		9.3		413		< 0.038	QU	3.3		< 0.08	QU	< 16	QU	16.1	
X18	T13X18	5/8/2018	< 1.8	QU	4995		8.2		211		< 0.038	QU	2.1		1.61		< 16	QU	12.6	
X19	T13X19	5/8/2018	3.6		5871		12.7		545	QH	1.207		2.6		1.83		< 16	QU	20.3	
X2	T13X2	5/8/2018	2.7		5236		14.2		445		5.161		2.6		3.84		< 16	QU	64.7	QH
X20	T13X20	5/8/2018	4.2		6185		10.6		378		0.521		3.7		0.16		< 16	QU	22.3	
X21	T13X21	5/8/2018	2.7		6067		11.8		405		0.882		3.0		2.29		< 16	QU	20.3	
X22	T13X22	5/8/2018	3.3		7692		9.5		490	QH	< 0.038	QU	4.6		3.68		< 16	QU	22.3	
X23	T13X23	5/8/2018	< 1.8	QU	4564		8.1		242		< 0.038	QU	2.3		< 0.08	QU	< 16	QU	13.7	
X24	T13X24	5/8/2018	< 1.8	QU	3751		3.1		206		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	16.5	
X25	T13X25	5/8/2018	2.6		6566		8.5		316		< 0.038	QU	2.9		1.22		< 16	QU	15.6	
X26	T13X26	5/8/2018	2.9		7064		8.1		396		< 0.038	QU	4.1		1.00		< 16	QU	18.2	
X27	T13X27	5/8/2018	< 1.8	QU	5661		8.3		337		< 0.038	QU	2.3		1.60		< 16	QU	22.6	
X28	T13X28	5/8/2018	< 1.8	QU	5145		12.1		485	QH	< 0.038	QU	2.6		1.54		< 16	QU	13.2	

Table I3-13. Validated XRF Field Survey Results for Non-AUM Target M1-01 (T13)

Grid ID	Unique_X	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
X29	T13X29	5/8/2018	< 1.8	QU	5535		13.9		342		< 0.038	QU	2.7		0.86		< 16	QU	23.7	
X3	T13X3	5/8/2018	2.5		5597		5.5		346		0.211		3.0		0.64		< 16	QU	17.0	
X30	T13X30	5/8/2018	3.5		6781		13.1		434		< 0.038	QU	3.3		2.47		< 16	QU	23.7	
X31	T13X31	5/8/2018	< 1.8	QU	5418		7.4		285		< 0.038	QU	2.3		1.19		< 16	QU	13.7	
X32	T13X32	5/8/2018	< 1.8	QU	7472		9.1		346		< 0.038	QU	5.1		1.48		< 16	QU	18.4	
X33	T13X33	5/8/2018	2.7		5979		6.6		421		0.405		2.8		1.67		< 16	QU	30.6	
X34	T13X34	5/8/2018	< 1.8	QU	6855		12.8		459		< 0.038	QU	3.4		0.50		< 16	QU	21.5	
X35	T13X35	5/8/2018	< 1.8	QU	5709		9.2		427		0.089		2.6		2.74		< 16	QU	27.0	
X36	T13X36	5/8/2018	< 1.8	QU	5923		9.1		349		< 0.038	QU	2.8		1.13		< 16	QU	19.5	
X37	T13X37	5/8/2018	2.3		6776		16.8		375		< 0.038	QU	3.1		2.28		< 16	QU	30.2	
X38	T13X38	5/8/2018	2.9		5470		9.0		374		< 0.038	QU	3.4		3.44		< 16	QU	22.2	
X39	T13X39	5/8/2018	2.5		8272		13.0		486	QH	< 0.038	QU	4.5		0.39		16.3		24.1	
X4	T13X4	5/8/2018	2.5		6272		17.0		523	QH	2.448		3.0		2.58		< 16	QU	39.1	
X40	T13X40	5/8/2018	< 1.8	QU	5509		8.6		355		< 0.038	QU	3.4		1.85		< 16	QU	16.8	
X41	T13X41	5/8/2018	< 1.8	QU	4823		6.8		240		< 0.038	QU	3.4		1.02		< 16	QU	11.2	
X42	T13X42	5/8/2018	2.4		6094		12.2		461		< 0.038	QU	3.0		1.45		< 16	QU	22.4	
X43	T13X43	5/8/2018	1.9		6315		8.8		259		< 0.038	QU	4.2		1.02		< 16	QU	26.6	
X44	T13X44	5/8/2018	3.4		6893		16.7		515	QH	1.339		2.9		2.70		< 16	QU	26.7	
X5	T13X5	5/8/2018	< 1.8	QU	6115		9.7		296		< 0.038	QU	2.9		0.31		< 16	QU	16.9	
X6	T13X6	5/8/2018	5.3		6712		10.9		356		1.577		2.5		2.28		< 16	QU	26.9	
X7	T13X7	5/8/2018	3.7		6240		13.8		387		0.918		3.1		2.18		< 16	QU	27.4	
X8	T13X8	5/8/2018	2.4		6590		12.4		401		< 0.038	QU	3.7		1.53		< 16	QU	20.7	
X9	T13X9	5/8/2018	< 1.8	QU	4516		3.9		255		1.022		2.2		< 0.08	QU	< 16	QU	18.2	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-14. Validated XRF Field Survey Results for Non-AUM Target M1-02 (T14)

Grid ID	Unique_X	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
X1	T14X1	5/8/2018	< 1.8	QU	4826		8.5		251		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	12.5	
X10	T14X10	5/8/2018	3.2		5679		8.4		237		0.507		3.1		1.84		< 16	QU	24.3	
X11	T14X11	5/8/2018	3.7		7098		10.2		553	QH	0.923		2.8		1.51		< 16	QU	33.6	
X12	T14X12	5/8/2018	1.9		6989		9.4		404		< 0.038	QU	3.0		2.09		< 16	QU	18.5	
X13	T14X13	5/8/2018	< 1.8	QU	4104		8.6		263		4.914		2.6		2.97		< 16	QU	22.4	
X14	T14X14	5/8/2018	3.1		5734		9.2		353		1.301		2.8		< 0.08	QU	< 16	QU	17.8	
X15	T14X15	5/8/2018	2.3		6782		12.0		342		< 0.038	QU	2.6		1.62		< 16	QU	19.1	
X16	T14X16	5/8/2018	< 1.8	QU	5043		8.5		303		< 0.038	QU	2.5		0.99		< 16	QU	25.4	
X17	T14X17	5/8/2018	< 1.8	QU	6347		9.5		311		< 0.038	QU	3.0		2.24		< 16	QU	17.5	
X18	T14X18	5/8/2018	2.5		6797		11.2		383		< 0.038	QU	3.0		1.40		< 16	QU	20.4	
X19	T14X19	5/8/2018	< 1.8	QU	5418		8.9		308		0.089		2.2		< 0.08	QU	< 16	QU	17.6	
X2	T14X2	5/8/2018	< 1.8	QU	6686		8.3		375		< 0.038	QU	3.4		1.35		16.4		17.0	
X20	T14X20	5/8/2018	< 1.8	QU	5545		7.6		234		< 0.038	QU	3.5		< 0.08	QU	< 16	QU	15.8	
X21	T14X21	5/8/2018	< 1.8	QU	4702		9.7		292		2.126		2.2		0.54		< 16	QU	18.6	
X22	T14X22	5/8/2018	1.9		6386		11.0		391		< 0.038	QU	3.2		0.53		< 16	QU	20.1	
X23	T14X23	5/8/2018	2.1		6203		6.7		262		< 0.038	QU	2.1		< 0.08	QU	< 16	QU	14.5	
X24	T14X24	5/8/2018	2.6		4711		6.3		230		0.170		1.9		1.41		< 16	QU	12.8	
X25	T14X25	5/8/2018	< 1.8	QU	6295		10.1		314		< 0.038	QU	2.6		0.73		< 16	QU	18.3	
X26	T14X26	5/8/2018	< 1.8	QU	4308		3.8		268		3.755		2.0		1.17		< 16	QU	33.9	
X27	T14X27	5/8/2018	1.9		5829		6.8		281		< 0.038	QU	2.2		5.63		< 16	QU	15.2	
X28	T14X28	5/8/2018	2.2		7303		11.7		354		1.086		3.0		1.70		< 16	QU	18.3	
X29	T14X29	5/8/2018	< 1.8	QU	5224		8.2		239		< 0.038	QU	2.8		1.60		< 16	QU	15.0	
X3	T14X3	5/8/2018	3.5		6001		10.5		328		< 0.038	QU	2.6		1.24		< 16	QU	15.9	
X30	T14X30	5/8/2018	< 1.8	QU	5321		4.9		245		< 0.038	QU	1.7		0.23		< 16	QU	16.1	
X31	T14X31	5/8/2018	< 1.8	QU	5751		7.7		226		1.337		2.6		0.84		< 16	QU	23.2	
X32	T14X32	5/8/2018	3.1		6803		11.8		396		< 0.038	QU	3.2		1.44		< 16	QU	26.8	
X33	T14X33	5/8/2018	2.1		6446		10.1		285		< 0.038	QU	3.4		0.30		< 16	QU	17.2	
X34	T14X34	5/8/2018	1.9		6039		6.3		270		< 0.038	QU	2.8		0.60		< 16	QU	14.6	
X35	T14X35	5/8/2018	2.3		6309		8.0		360		0.636		2.8		1.31		< 16	QU	17.6	
X36	T14X36	5/8/2018	< 1.8	QU	5750		6.8		219		< 0.038	QU	3.1		1.30		< 16	QU	15.2	
X37	T14X37	5/8/2018	1.9		5942		7.5		308		< 0.038	QU	1.7		0.77		< 16	QU	14.8	
X38	T14X38	5/8/2018	< 1.8	QU	4914		6.9		213		< 0.038	QU	2.1		< 0.08	QU	< 16	QU	17.2	
X39	T14X39	5/8/2018	< 1.8	QU	5805		7.2		325		0.483		2.7		< 0.08	QU	< 16	QU	19.0	
X4	T14X4	5/8/2018	< 1.8	QU	6544		14.5		390		< 0.038	QU	2.4		0.59		< 16	QU	19.9	
X40	T14X40	5/8/2018	< 1.8	QU	5737		7.5		280		< 0.038	QU	2.2		1.00		< 16	QU	13.5	
X41	T14X41	5/8/2018	< 1.8	QU	5629		6.9		363		0.940		2.5		0.76		< 16	QU	15.3	
X42	T14X42	5/8/2018	< 1.8	QU	4806		6.6		243		< 0.038	QU	1.8		0.73		< 16	QU	13.0	
X43	T14X43	5/8/2018	3.1		6408		6.9		330		1.587		3.0		1.64		< 16	QU	16.9	
X44	T14X44	5/8/2018	2.2		5815		9.3		325		< 0.038	QU	2.8		< 0.08	QU	< 16	QU	16.4	
X5	T14X5	5/8/2018	2.4		5817		9.3		331		< 0.038	QU	2.2		0.40		< 16	QU	16.0	
X6	T14X6	5/8/2018	< 1.8	QU	5555		8.4		291		0.202		2.8		1.61		< 16	QU	16.0	
X7	T14X7	5/8/2018	2.3		5565		6.5		260		< 0.038	QU	4.1		< 0.08	QU	< 16	QU	13.1	
X8	T14X8	5/8/2018	< 1.8	QU	6256		11.2		315		< 0.038	QU	2.5		1.15		< 16	QU	17.5	
X9	T14X9	5/8/2018	2.0		5342		6.2		468	QH	1.702		2.5		1.84		< 16	QU	29.9	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-15. Validated XRF Field Survey Results for Non-AUM Target M1-03 (T15)

Grid ID	Unique_X	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
G1	T15G1	8/17/2018	3.9		8124		11.2		385		< 0.038	QU	4.0		0.89		19.5		22.1	
G10	T15G10	8/17/2018	1.9		6682		9.5		388		< 0.038	QU	3.0		1.25		< 16	QU	26.3	
G11	T15G11	8/17/2018	4.0		6520		9.3		322		< 0.038	QU	4.0		1.05		< 16	QU	17.5	
G12	T15G12	8/17/2018	1.9		4884		12.4		392		3.335		2.7		3.24		< 16	QU	39.5	
G13	T15G13	8/17/2018	3.6		6204		6.8		428		< 0.038	QU	2.3		0.45		22.9		21.8	
G14	T15G14	8/17/2018	3.7		10807		7.7		580	QH	< 0.038	QU	3.7		0.49		17.5		28.5	
G2	T15G2	8/17/2018	2.4		6165		8.9		199		< 0.038	QU	2.8		0.58		< 16	QU	17.1	
G3	T15G3	8/17/2018	< 1.8	QU	6453		9.3		303		< 0.038	QU	3.3		1.20		< 16	QU	17.6	
G4	T15G4	8/17/2018	< 1.8	QU	6935		8.8		640	QH	1.122		3.3		2.24		< 16	QU	22.4	
G5	T15G5	8/17/2018	1.9		6370		8.5		253		0.520		2.5		2.83		< 16	QU	16.9	
G6	T15G6	8/17/2018	4.1		6452		7.0		322		< 0.038	QU	2.7		1.66		18.6		16.9	
G7	T15G7	8/17/2018	2.0		5041		8.5		216		0.506		2.8		< 0.08	QU	< 16	QU	14.3	
G8	T15G8	8/17/2018	3.2		5858		9.0		319		< 0.038	QU	2.1		1.49		< 16	QU	17.1	
G9	T15G9	8/17/2018	2.6		6451		7.9		292		< 0.038	QU	2.4		1.45		< 16	QU	18.4	
X1	T15X1	5/8/2018	2.9		6422		9.9		374		1.429		3.2		2.63		< 16	QU	27.0	
X10	T15X10	5/8/2018	2.0		6160		8.8		190		< 0.038	QU	3.4		< 0.08	QU	< 16	QU	19.1	
X11	T15X11	5/8/2018	2.2		8735		10.9		254		< 0.038	QU	4.7		2.74		< 16	QU	22.8	
X12	T15X12	5/8/2018	< 1.8	QU	3911		5.8		168		< 0.038	QU	1.8		< 0.08	QU	< 16	QU	12.2	
X13	T15X13	8/17/2018	3.4		4930		6.6		198		< 0.038	QU	2.3		0.33		< 16	QU	16.1	
X14	T15X14	5/8/2018	3.3		5334		8.3		332		0.664		3.0		1.67		< 16	QU	16.9	
X15	T15X15	5/8/2018	2.3		6788		9.3		422		0.540		3.0		2.68		< 16	QU	19.9	
X16	T15X16	5/8/2018	3.5		6497		8.2		342		0.126		3.6		1.57		< 16	QU	19.6	
X17	T15X17	5/8/2018	2.6		6620		7.7		335		0.945		3.4		1.80		< 16	QU	20.4	
X18	T15X18	5/8/2018	3.0		7132		8.2		446		< 0.038	QU	3.7		1.78		19.2		19.1	
X19	T15X19	5/8/2018	4.1		6954		8.8		410		0.324		3.0		3.51		< 16	QU	24.0	
X2	T15X2	5/8/2018	2.7		6653		8.6		251		1.053		3.7		1.93		< 16	QU	18.1	
X20	T15X20	8/17/2018	3.2		3780		5.9		148		< 0.038	QU	2.0		< 0.08	QU	< 16	QU	11.3	
X21	T15X21	8/17/2018	3.4		5765		9.1		259		< 0.038	QU	2.7		2.03		< 16	QU	18.2	
X22	T15X22	5/8/2018	2.7		7090		10.3		335		0.068		4.2		3.64		< 16	QU	23.8	
X23	T15X23	5/8/2018	2.5		5572		6.1		256		2.159		3.3		2.41		< 16	QU	27.2	
X24	T15X24	5/8/2018	3.1		5813		12.0		368		1.224		3.1		2.57		< 16	QU	30.0	
X25	T15X25	5/8/2018	3.4		7424		7.3		653	QH	2.952		2.8		2.21		26.3		29.3	
X26	T15X26	5/8/2018	< 1.8	QU	6478		13.8		349		< 0.038	QU	3.2		2.60		< 16	QU	20.2	
X27	T15X27	8/17/2018	< 1.8	QU	3721		7.6		180		< 0.038	QU	1.8		< 0.08	QU	< 16	QU	12.2	
X28	T15X28	8/17/2018	2.8		7558		8.8		290		< 0.038	QU	5.0		2.10		27.8		17.1	
X29	T15X29	5/8/2018	3.2		6347		10.8		252		< 0.038	QU	3.2		1.80		< 16	QU	19.7	
X3	T15X3	5/8/2018	< 1.8	QU	5691		7.9		204		< 0.038	QU	2.7		1.87		< 16	QU	15.5	
X30	T15X30	5/8/2018	3.3		6323		9.6		259		< 0.038	QU	2.7		1.60		< 16	QU	19.5	
X31	T15X31	5/8/2018	4.1		6601		16.9		312		< 0.038	QU	2.5		3.47		< 16	QU	25.7	
X32	T15X32	5/8/2018	< 1.8	QU	6219		8.5		263		< 0.038	QU	2.7		< 0.08	QU	< 16	QU	19.5	
X33	T15X33	5/8/2018	2.8		7664		9.8		299		< 0.038	QU	3.6		2.89		< 16	QU	18.3	
X34	T15X34	5/8/2018	7.6		5104		7.3		247		< 0.038	QU	2.0		< 0.08	QU	< 16	QU	12.9	
X35	T15X35	5/8/2018	< 1.8	QU	4964		10.1		212		< 0.038	QU	2.5		< 0.08	QU	< 16	QU	15.7	
X36	T15X36	5/8/2018	3.6		6824		8.1		209		< 0.038	QU	3.6		1.01		< 16	QU	17.0	
X37	T15X37	5/8/2018	< 1.8	QU	5671		8.7		255		0.150		2.7		1.89		< 16	QU	18.0	
X38	T15X38	5/8/2018	< 1.8	QU	5379		6.9		276		0.993		1.9		0.87		< 16	QU	20.7	
X39	T15X39	5/8/2018	4.0		5710		9.3		258		< 0.038	QU	2.7		1.14		< 16	QU	18.3	
X4	T15X4	5/8/2018	2.8		5751		10.0		266		< 0.038	QU	3.6		2.23		< 16	QU	20.6	
X40	T15X40	5/8/2018	< 1.8	QU	5762		9.4		280		< 0.038	QU	2.7		0.42		< 16	QU	22.9	
X41	T15X41	5/8/2018	2.0		4007		5.2		167		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	9.7	
X42	T15X42	5/8/2018	3.7		4238		6.2		175		< 0.038	QU	1.7		0.40		< 16	QU	11.2	
X43	T15X43	5/8/2018	2.4		5831		9.4		186		< 0.038	QU	2.8		2.30		< 16	QU	21.7	

Table I3-15. Validated XRF Field Survey Results for Non-AUM Target M1-03 (T15)

Grid ID	Unique_X	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
X44	T15X44	5/8/2018	< 1.8	QU	5777		8.1		246		< 0.038	QU	2.6		0.62		< 16	QU	15.3	
X45	T15X45	5/8/2018	2.9		5866		7.6		204		< 0.038	QU	3.2		1.13		< 16	QU	18.5	
X46	T15X46	5/8/2018	2.2		5769		6.5		195		< 0.038	QU	2.3		7.13		< 16	QU	14.7	
X47	T15X47	5/8/2018	3.2		6974		10.1		312		0.247		3.2		2.62		< 16	QU	18.7	
X48	T15X48	5/8/2018	2.2		5725		8.4		290		< 0.038	QU	2.2		< 0.08	QU	< 16	QU	15.6	
X49	T15X49	5/8/2018	< 1.8	QU	3563		4.1		173		< 0.038	QU	1.9		4.75		< 16	QU	10.9	
X5	T15X5	5/8/2018	2.7		5766		9.6		267		0.169		2.9		5.12		< 16	QU	15.9	
X50	T15X50	5/8/2018	3.2		5785		5.9		188		< 0.038	QU	3.0		0.53		< 16	QU	15.9	
X51	T15X51	5/8/2018	2.1		5506		6.5		176		< 0.038	QU	2.8		0.62		< 16	QU	14.7	
X52	T15X52	5/8/2018	3.5		4056		6.1		185		< 0.038	QU	2.5		< 0.08	QU	< 16	QU	11.1	
X6	T15X6	5/8/2018	3.9		4119		4.6		206		0.178		1.9		< 0.08	QU	< 16	QU	12.5	
X7	T15X7	5/8/2018	2.7		5076		7.8		245		1.020		3.8		1.23		< 16	QU	18.1	
X8	T15X8	5/8/2018	4.4		6238		9.3		303		1.567		4.0		1.07		< 16	QU	22.1	
X9	T15X9	5/8/2018	3.2		5394		4.2		148		< 0.038	QU	2.7		1.28		< 16	QU	14.1	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-18. Validated XRF Field Survey Results for Non-AUM Target M5-01 (T18)

Grid ID	Unique_X	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
G1	T18G1	9/15/2018	< 1.8	QU	4628		4.1		172		< 0.038	QU	1.8		0.38		< 16	QU	12.4	
G10	T18G10	9/15/2018	< 1.8	QU	4681		4.7		168		< 0.038	QU	2.0		< 0.08	QU	< 16	QU	12.0	
G11	T18G11	9/15/2018	< 1.8	QU	5051		5.9		230		< 0.038	QU	2.4		< 0.08	QU	< 16	QU	14.4	
G12	T18G12	9/15/2018	2.7		6215		4.7		276		< 0.038	QU	2.5		1.20		17.0		17.1	
G13	T18G13	9/15/2018	< 1.8	QU	5401		5.9		247		< 0.038	QU	2.1		< 0.08	QU	< 16	QU	15.4	
G14	T18G14	9/15/2018	< 1.8	QU	4899		4.7		168		< 0.038	QU	2.1		< 0.08	QU	18.7		13.1	
G2	T18G2	9/15/2018	< 1.8	QU	7489		6.6		227		< 0.038	QU	3.2		< 0.08	QU	< 16	QU	20.9	
G3	T18G3	9/15/2018	< 1.8	QU	5449		5.0		218		< 0.038	QU	2.2		< 0.08	QU	16.3		15.3	
G4	T18G4	9/15/2018	2.4		6606		4.2		233		0.059		2.6		1.92		17.5		20.0	
G5	T18G5	9/15/2018	< 1.8	QU	4206		4.7		150		0.467		2.0		< 0.08	QU	< 16	QU	12.5	
G7	T18G7	9/15/2018	< 1.8	QU	6844		6.2		230		< 0.038	QU	2.5		1.04		< 16	QU	19.3	
G8	T18G8	9/15/2018	2.8		5260		4.4		180		< 0.038	QU	2.5		< 0.08	QU	< 16	QU	15.6	
G9	T18G9	9/15/2018	< 1.8	QU	5647		6.0		243		< 0.038	QU	2.0		2.60		19.9		14.0	
X1	T18X1	6/10/2018	< 1.8	QU	6395		6.3		215		0.043		3.1		1.14		< 16	QU	22.9	
X10	T18X10	6/11/2018	< 1.8	QU	5657		4.6		200		< 0.038	QU	1.9		0.33		< 16	QU	15.2	
X11	T18X11	6/11/2018	2.2		7436		4.1		322		< 0.038	QU	2.4		< 0.08	QU	< 16	QU	17.0	
X12	T18X12	9/15/2018	2.0		6497		4.6		190		< 0.038	QU	3.2		0.66		< 16	QU	17.8	
X13	T18X13	6/11/2018	2.6		6954		5.1		228		< 0.038	QU	2.5		< 0.08	QU	< 16	QU	18.8	
X14	T18X14	6/11/2018	< 1.8	QU	6281		4.8		230		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	15.0	
X15	T18X15	6/11/2018	< 1.8	QU	4699		4.6		182		< 0.038	QU	1.9		< 0.08	QU	< 16	QU	13.1	
X16	T18X16	6/11/2018	< 1.8	QU	4457		5.0		190		< 0.038	QU	1.7		0.23		< 16	QU	13.9	
X17	T18X17	6/11/2018	< 1.8	QU	3532		4.7		120		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	11.5	
X18	T18X18	9/15/2018	< 1.8	QU	7425		6.3		225		0.297		3.5		0.67		< 16	QU	20.8	
X19	T18X19	6/11/2018	2.7		5626		3.9		207		< 0.038	QU	2.4		< 0.08	QU	< 16	QU	16.4	
X2	T18X2	6/10/2018	< 1.8	QU	4257		3.7		169		< 0.038	QU	2.0		< 0.08	QU	< 16	QU	13.6	
X20	T18X20	6/11/2018	< 1.8	QU	3059		3.3		128		< 0.038	QU	1.1		< 0.08	QU	< 16	QU	10.5	
X21	T18X21	6/11/2018	< 1.8	QU	4217		4.0		206		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	12.0	
X22	T18X22	6/11/2018	< 1.8	QU	6776		6.5		224		< 0.038	QU	2.4		0.79		< 16	QU	18.2	
X23	T18X23	6/11/2018	< 1.8	QU	3961		5.3		219		< 0.038	QU	1.6		< 0.08	QU	< 16	QU	13.2	
X24	T18X24	6/11/2018	< 1.8	QU	5302		4.8		222		< 0.038	QU	1.5		1.49		< 16	QU	16.6	
X24A	T18X24A	9/15/2018	< 1.8	QU	4953		5.0		201		< 0.038	QU	1.3		0.91		< 16	QU	13.7	
X25	T18X25	6/11/2018	< 1.8	QU	5711		6.4		180		< 0.038	QU	1.9		1.15		< 16	QU	16.9	
X26	T18X26	6/11/2018	2.7		5378		4.0		185		< 0.038	QU	2.0		1.33		< 16	QU	20.4	
X27	T18X27	6/11/2018	< 1.8	QU	3362		3.1		148		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	9.9	
X28	T18X28	6/11/2018	< 1.8	QU	3768		7.0		207		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	13.2	
X29	T18X29	6/11/2018	< 1.8	QU	5106		5.4		148		< 0.038	QU	1.9		< 0.08	QU	< 16	QU	16.1	
X3	T18X3	6/10/2018	< 1.8	QU	6171		7.3		214		< 0.038	QU	2.3		< 0.08	QU	< 16	QU	19.7	
X30	T18X30	6/11/2018	< 1.8	QU	5052		5.6		182		< 0.038	QU	1.5		0.87		< 16	QU	15.1	
X31	T18X31	6/11/2018	2.2		5784		6.1		319		< 0.038	QU	1.6		1.84		< 16	QU	16.5	
X31A	T18X31A	9/15/2018	2.7		6167		6.1		351		< 0.038	QU	2.8		0.35		< 16	QU	17.7	
X32	T18X32	6/11/2018	< 1.8	QU	5105		7.2		224		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	14.4	
X33	T18X33	6/11/2018	< 1.8	QU	4672		6.3		174		< 0.038	QU	1.4		1.38		< 16	QU	13.2	
X4	T18X4	6/10/2018	2.2		6236		6.0		236		< 0.038	QU	2.5		< 0.08	QU	< 16	QU	19.1	
X5	T18X5	6/10/2018	2.0		4457		5.1		168		< 0.038	QU	1.6		0.62		< 16	QU	16.0	
X6	T18X6	6/10/2018	< 1.8	QU	5662		5.5		173		0.173		2.5		0.81		< 16	QU	16.6	
X7	T18X7	6/10/2018	< 1.8	QU	4236		3.4		151		< 0.038	QU	2.0		0.53		< 16	QU	14.2	
X8	T18X8	6/10/2018	< 1.8	QU	3117		2.4		137		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	12.9	
X9	T18X9	6/10/2018	< 1.8	QU	4058		3.2		166		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	12.2	

Notes:

mg/kg Milligrams per kilogram

QH Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).

Table I3-18. Validated XRF Field Survey Results for Non-AUM Target M5-01 (T18)

Grid ID	Unique_X	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

QL Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).

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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.

XRF X-ray fluorescence

Table I3-19. Validated XRF Field Survey Results for Non-AUM Target M5-02 (T19)

Grid ID	Unique_X	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
G1	T19G1	9/11/2018	< 1.8	QU	4834		3.9		326		< 0.038	QU	1.6		< 0.08	QU	28.5		10.3	
G10	T19G10	9/11/2018	5.1		7455		9.7		373		< 0.038	QU	2.5		2.39		78.1		21.3	
G11	T19G11	9/11/2018	2.9		6493		8.2		372		0.176		3.0		1.21		72.6		27.2	
G12	T19G12	9/11/2018	5.2		5868		5.7		280		< 0.038	QU	2.0		0.34		111.4		15.6	
G12A	T19G12A	5/22/2018	3.6		6841		9.9		384		1.961		2.9		1.98		64.9		20.7	
G13	T19G13	9/11/2018	4.3		7059		12.6		574	QH	0.926		2.6		1.56		60.5		20.1	
G14	T19G14	9/11/2018	6.3		6869		5.0		351		2.239		2.5		2.34		74.6		20.0	
G15	T19G15	9/11/2018	4.7		6938		10.0		602	QH	< 0.038	QU	2.9		1.15		84.7		27.7	
G16	T19G16	9/11/2018	< 1.8	QU	5055		3.4		261		2.435		2.0		0.83		127.8		14.4	
G17	T19G17	9/11/2018	3.7		5576		6.0		277		< 0.038	QU	2.3		1.52		86.3		12.9	
G18	T19G18	9/11/2018	6.4		6162		4.8		521	QH	< 0.038	QU	2.3		6.24		202.2		13.3	
G19	T19G19	9/11/2018	< 1.8	QU	4425		5.1		190		< 0.038	QU	1.6		1.28		104.8		13.5	
G2	T19G2	9/11/2018	4.3		6055		6.5		410		2.702		2.5		0.98		34.8		15.2	
G20	T19G20	9/11/2018	3.4		7578		6.2		464		1.049		2.6		1.35		153.5		27.7	
G21	T19G21	9/11/2018	2.1		4309		3.6		180		< 0.038	QU	1.6		5.36		272.2		11.1	
G3	T19G3	9/11/2018	1.9		5308		6.7		250		6.195		2.0		2.86		27.1		18.5	
G4	T19G4	9/11/2018	< 1.8	QU	3966		6.9		181		3.599		2.1		< 0.08	QU	20.5		9.7	
G5	T19G5	9/11/2018	< 1.8	QU	6728		8.2		293		0.973		2.8		1.93		63.2		17.2	
G6	T19G6	9/11/2018	2.7		4505		4.8		220		0.097		2.3		< 0.08	QU	39.6		9.4	
G7	T19G7	9/11/2018	4.7		5820		5.1		229		< 0.038	QU	2.2		< 0.08	QU	59.1		13.7	
G8	T19G8	9/11/2018	< 1.8	QU	5635		8.2		262		1.742		1.9		1.15		40.8		16.6	
G9	T19G9	9/11/2018	3.4		6668		6.9		337		1.213		2.8		1.29		72.9		18.4	
X1	T19X1	5/22/2018	2.3		5206		5.4		236		< 0.038	QU	2.3		0.69		44.9		15.8	
X10	T19X10	6/10/2018	5.6		7105		16.5		344		0.360		3.6		2.82		23.3		22.4	
X11	T19X11	6/10/2018	6.3		8261		10.0		308		0.190		2.7		2.23		78.0		23.6	
X12	T19X12	6/10/2018	3.2		5038		4.9		208		0.791		2.6		2.51		56.3		16.1	
X13	T19X13	6/10/2018	< 1.8	QU	5463		7.0		233		< 0.038	QU	2.5		1.18		67.1		14.1	
X14	T19X14	5/22/2018	< 1.8	QU	3593		5.3		162		< 0.038	QU	1.4		0.20		67.3		10.8	
X15	T19X15	5/22/2018	2.2		5528		3.0		272		< 0.038	QU	1.1		< 0.08	QU	110.1		14.2	
X16	T19X16	5/22/2018	7.2		7075		4.8		323		< 0.038	QU	2.5		3.07		88.8		18.2	
X17	T19X17	5/22/2018	4.4		7252		6.5		446		1.166		2.9		2.53		126.9		21.2	
X18	T19X18	5/22/2018	< 1.8	QU	6305		7.6		326		0.820		2.7		2.77		112.2		20.1	
X19	T19X19	5/22/2018	3.6		5949		10.4		303		0.291		2.6		2.47		58.0		22.0	
X2	T19X2	6/10/2018	2.4		5752		6.9		288		< 0.038	QU	2.3		1.04		53.4		16.0	
X20	T19X20	5/22/2018	4.9		6068		6.6		253		1.224		2.7		2.85		94.3		18.5	
X21	T19X21	5/22/2018	4.3		6171		5.2		253		< 0.038	QU	2.1		1.15		179.3		15.5	
X3	T19X3	6/10/2018	2.2		5590		5.6		223		0.064		2.2		< 0.08	QU	54.2		13.7	
X4	T19X4	5/22/2018	4.2		6975		6.2		308		< 0.038	QU	3.3		1.31		56.0		20.2	
X5	T19X5	6/10/2018	4.1		7088		7.7		350		1.027		3.0		2.09		38.9		24.7	
X6	T19X6	6/10/2018	< 1.8	QU	6679		8.3		319		0.158		2.7		0.86		35.4		19.3	
X7	T19X7	6/10/2018	3.8		5928		5.6		278		< 0.038	QU	2.2		0.23		45.1		15.5	
X8	T19X8	6/10/2018	< 1.8	QU	6095		7.7		374		0.680		2.3		2.51		38.4		18.8	
X9	T19X9	9/11/2018	3.3		6710		8.2		351		1.107		2.5		2.22		60.7		19.8	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-20. Validated XRF Field Survey Results for Non-AUM Target M5-03 (T20)

Grid ID	Unique_X	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
G1	T20G1	9/11/2018	3.3		6640		7.5		278		3.050		2.2		< 0.08	QU	71.3		19.9	
G2	T20G2	9/11/2018	3.5		7797		10.5		457		0.200		2.4		5.98		103.2		29.5	
G3	T20G3	9/11/2018	< 1.8	QU	4902		7.5		176		0.085		1.3		< 0.08	QU	18.0		12.5	
X1	T20X1	5/22/2018	2.4		7373		9.2		790	QH	2.431		2.3		1.24		26.2		34.8	
X10	T20X10	5/22/2018	2.6		6245		6.7		346		< 0.038	QU	1.7		0.95		27.9		17.6	
X11	T20X11	5/22/2018	< 1.8	QU	5482		10.2		226		< 0.038	QU	2.6		1.05		< 16	QU	18.5	
X12	T20X12	5/22/2018	< 1.8	QU	6317		7.7		278		< 0.038	QU	1.5		0.94		< 16	QU	17.6	
X13	T20X13	5/22/2018	< 1.8	QU	5088		6.6		200		< 0.038	QU	1.0		< 0.08	QU	< 16	QU	13.0	
X14	T20X14	5/22/2018	2.8		6562		6.3		243		< 0.038	QU	2.4		< 0.08	QU	18.7		14.6	
X15	T20X15	5/22/2018	< 1.8	QU	6118		9.6		268		< 0.038	QU	1.7		1.43		25.7		17.4	
X16	T20X16	5/22/2018	2.0		6295		10.2		306		< 0.038	QU	2.5		1.51		< 16	QU	18.3	
X17	T20X17	5/22/2018	< 1.8	QU	4817		5.3		248		< 0.038	QU	1.0		< 0.08	QU	33.9		11.5	
X18	T20X18	5/22/2018	2.0		6784		8.3		547	QH	< 0.038	QU	1.8		1.17		40.5		16.5	
X19	T20X19	5/22/2018	3.5		5758		6.0		337		0.274		1.5		2.09		28.3		19.4	
X2	T20X2	5/22/2018	< 1.8	QU	5704		8.6		429		< 0.038	QU	2.4		1.50		< 16	QU	24.8	
X20	T20X20	5/22/2018	3.3		6880		7.7		368		< 0.038	QU	2.8		0.35		18.3		17.2	
X3	T20X3	5/22/2018	2.6		5178		10.3		359		3.207		2.5		3.59		< 16	QU	26.8	
X4	T20X4	5/22/2018	< 1.8	QU	3708		4.2		329		< 0.038	QU	< 1	QU	< 0.08	QU	149.2		12.4	
X5	T20X5	5/22/2018	4.4		5734		5.3		384		< 0.038	QU	1.4		1.76		17.6		21.2	
X6	T20X6	5/22/2018	< 1.8	QU	5130		6.4		334		< 0.038	QU	1.6		1.75		< 16	QU	22.7	
X7	T20X7	5/22/2018	< 1.8	QU	6202		7.1		250		< 0.038	QU	2.3		0.65		20.0		15.8	
X8	T20X8	5/22/2018	< 1.8	QU	6036		8.1		242		< 0.038	QU	2.4		0.44		25.6		14.9	
X9	T20X9	5/22/2018	3.6		5976		7.2		277		< 0.038	QU	2.9		1.93		35.1		14.7	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-21. Validated XRF Field Survey Results for Non-AUM Target M5-05 (T21)

Grid ID	Unique_X	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
G1	T21G1	9/11/2018	< 1.8	QU	4624		8.1		212		< 0.038	QU	2.3		1.70		17.2		13.6	
G10	T21G10	9/11/2018	< 1.8	QU	4406		7.3		265		2.042		2.2		0.57		< 16	QU	14.6	
G11	T21G11	9/11/2018	< 1.8	QU	7306		13.4		452		< 0.038	QU	3.3		5.56		29.8		20.4	
G12	T21G12	9/11/2018	2.1		5244		7.6		278		< 0.038	QU	2.6		1.77		< 16	QU	14.0	
G13	T21G13	9/11/2018	2.5		6467		10.3		404		< 0.038	QU	2.9		4.57		35.7		22.1	
G14	T21G14	9/11/2018	2.9		5915		8.4		443		< 0.038	QU	2.8		3.37		20.2		18.0	
G15	T21G15	9/11/2018	3.2		6492		12.5		415		0.668		2.8		10.82		53.9		20.7	
G16	T21G16	9/11/2018	2.6		5263		8.9		335		< 0.038	QU	2.2		3.42		33.3		15.4	
G17	T21G17	9/11/2018	2.3		6579		11.9		432		< 0.038	QU	2.0		9.83		< 16	QU	21.2	
G18	T21G18	9/11/2018	2.0		4602		8.8		266		< 0.038	QU	1.9		1.21		< 16	QU	13.9	
G19	T21G19	9/11/2018	< 1.8	QU	5442		10.2		343		< 0.038	QU	2.7		10.00		35.3		17.1	
G2	T21G2	9/11/2018	< 1.8	QU	5814		11.7		375		0.577		2.7		5.26		27.6		18.4	
G20	T21G20	9/11/2018	< 1.8	QU	6191		9.0		347		< 0.038	QU	2.3		2.46		18.6		18.5	
G21	T21G21	9/11/2018	< 1.8	QU	6213		8.8		302		< 0.038	QU	2.4		1.11		17.8		14.6	
G22	T21G22	9/11/2018	2.5		6240		10.1		436		< 0.038	QU	3.0		4.92		27.5		25.2	
G23	T21G23	9/11/2018	2.2		5412		8.5		297		< 0.038	QU	1.6		5.70		25.8		17.2	
G24	T21G24	9/11/2018	2.0		5730		11.7		445		< 0.038	QU	2.8		3.98		27.3		20.3	
G25	T21G25	9/11/2018	2.8		5990		9.0		298		0.294		1.6		8.28		66.0		18.7	
G26	T21G26	9/11/2018	< 1.8	QU	4940		7.7		296		< 0.038	QU	2.1		1.01		18.7		13.6	
G27	T21G27	9/11/2018	4.6		6183		7.5		311		< 0.038	QU	2.3		23.80		88.0		21.0	
G28	T21G28	9/11/2018	3.5		6395		9.9		288		< 0.038	QU	2.1		31.47		95.0		25.8	
G29	T21G29	9/11/2018	6.1		9848		6.7		270		< 0.038	QU	3.4		2.67		34.5		22.2	
G3	T21G3	9/11/2018	2.3		6970		13.7		553	QH	2.398		2.7		13.61		47.3		44.8	
G30	T21G30	9/11/2018	3.3		8138		11.6		358		0.372		3.0		9.39		65.7		20.4	
G31	T21G31	9/11/2018	1.9		7042		10.5		272		< 0.038	QU	2.4		7.45		46.7		19.9	
G32	T21G32	9/11/2018	< 1.8	QU	4089		4.5		217		6.743		1.6		7.76		23.9		30.0	
G4	T21G4	9/11/2018	< 1.8	QU	4143		5.9		174		1.631		1.8		0.84		< 16	QU	9.4	
G5	T21G5	9/11/2018	< 1.8	QU	5054		5.2		165		0.825		2.3		0.26		< 16	QU	12.7	
G6	T21G6	9/11/2018	2.6		5084		6.9		279		< 0.038	QU	1.8		3.39		25.5		14.9	
G7	T21G7	9/11/2018	< 1.8	QU	4797		8.4		273		< 0.038	QU	2.3		0.17		< 16	QU	13.0	
G8	T21G8	9/11/2018	4.2		6881		15.8		391		2.175		2.8		24.07		69.8		42.9	
G9	T21G9	9/11/2018	< 1.8	QU	4576		7.8		236		< 0.038	QU	2.2		0.93		16.3		11.6	
X1	T21X1	5/21/2018	< 1.8	QU	5432		8.7		375		0.083		2.5		6.37		30.5		19.4	
X10	T21X10	5/21/2018	< 1.8	QU	6173		13.2		324		< 0.038	QU	2.2		11.31		50.8		19.2	
X11	T21X11	5/21/2018	4.5		7456		15.7		599	QH	0.694		2.8		10.71		55.1		22.4	
X12	T21X12	5/21/2018	2.2		5296		9.2		330		< 0.038	QU	2.0		3.44		< 16	QU	14.7	
X13	T21X13	5/21/2018	< 1.8	QU	4621		6.4		281		< 0.038	QU	1.7		1.82		< 16	QU	14.6	
X14	T21X14	5/21/2018	< 1.8	QU	5260		9.1		404		< 0.038	QU	1.8		3.20		16.2		21.8	
X15	T21X15	5/21/2018	3.2		7074		9.0		381		0.866		2.1		3.89		32.2		20.8	
X16	T21X16	5/21/2018	< 1.8	QU	7059		10.1		506	QH	< 0.038	QU	1.9		4.92		34.5		19.6	
X17	T21X17	5/21/2018	3.7		6707		9.7		352		< 0.038	QU	2.6		7.18		35.4		19.7	
X18	T21X18	5/21/2018	< 1.8	QU	4734		8.8		253		0.137		1.8		3.26		< 16	QU	12.4	
X19	T21X19	5/21/2018	3.2		9066		11.0		654	QH	< 0.038	QU	3.3		7.66		40.9		29.1	
X2	T21X2	5/21/2018	2.0		5619		9.2		269		< 0.038	QU	2.1		5.23		26.7		17.8	
X20	T21X20	5/21/2018	< 1.8	QU	4998		7.0		291		< 0.038	QU	1.4		1.02		< 16	QU	13.2	
X21	T21X21	5/21/2018	2.1		5130		8.4		314		< 0.038	QU	1.9		2.89		18.6		16.6	
X22	T21X22	5/21/2018	< 1.8	QU	5922		8.2		308		0.181		1.8		4.91		30.0		22.9	
X23	T21X23	5/21/2018	3.2		5829		7.4		395		< 0.038	QU	2.1		6.23		29.6		19.7	
X24	T21X24	5/21/2018	2.7		6488		7.6		333		< 0.038	QU	2.3		1.83		< 16	QU	18.3	
X25	T21X25	5/21/2018	3.7		6770		11.9		490	QH	< 0.038	QU	2.2		13.49		58.4		20.5	
X26	T21X26	5/21/2018	2.0		5240		7.8		399		0.978		1.3		9.73		35.0		32.6	
X27	T21X27	5/21/2018	< 1.8	QU	5873		9.1		340		< 0.038	QU	2.0		4.59		21.0		16.6	

Table I3-21. Validated XRF Field Survey Results for Non-AUM Target M5-05 (T21)

Grid ID	Unique_X	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
X28	T21X28	5/21/2018	< 1.8	QU	4737		9.2		237		< 0.038	QU	1.7		6.41		28.4		16.5	
X29	T21X29	5/21/2018	2.6		7149		14.4		544	QH	< 0.038	QU	2.4		12.51		55.4		29.9	
X3	T21X3	5/21/2018	2.0		7863		14.1		533	QH	< 0.038	QU	3.7		7.44		42.9		25.0	
X30	T21X30	5/21/2018	< 1.8	QU	6151		9.4		339		0.414		2.1		1.18		< 16	QU	17.1	
X31	T21X31	5/21/2018	3.6		6887		12.7		553	QH	1.044		3.0		24.50		64.5		35.0	
X32	T21X32	5/21/2018	2.2		6503		10.2		404		< 0.038	QU	2.5		6.64		31.9		20.5	
X33	T21X33	5/21/2018	< 1.8	QU	6796		10.9		360		< 0.038	QU	2.9		6.43		39.2		19.9	
X34	T21X34	5/21/2018	2.2		5605		8.8		361		0.342		2.0		11.52		35.9		18.9	
X35	T21X35	5/21/2018	4.4		6819		13.3		415		1.235		2.6		19.80		84.5		22.7	
X36	T21X36	5/21/2018	< 1.8	QU	5652		8.9		289		< 0.038	QU	1.8		4.56		30.0		16.5	
X37	T21X37	5/21/2018	2.2		5905		9.6		326		< 0.038	QU	2.3		7.06		25.7		17.2	
X38	T21X38	5/21/2018	< 1.8	QU	5706		8.8		398		< 0.038	QU	1.9		3.31		26.3		18.0	
X39	T21X39	5/21/2018	2.8		5494		9.0		411		< 0.038	QU	1.9		8.02		39.8		17.2	
X4	T21X4	5/21/2018	< 1.8	QU	5115		9.0		332		< 0.038	QU	1.3		2.78		16.8		17.0	
X40	T21X40	5/21/2018	< 1.8	QU	6124		8.3		302		< 0.038	QU	2.7		4.26		27.2		15.9	
X41	T21X41	5/21/2018	2.5		6081		10.4		322		0.388		2.0		11.25		60.6		20.3	
X42	T21X42	5/21/2018	4.8		6143		9.9		383		< 0.038	QU	2.7		10.38		43.6		22.5	
X43	T21X43	5/21/2018	2.0		6893		8.5		326		< 0.038	QU	3.4		2.45		21.6		19.2	
X44	T21X44	5/21/2018	2.3		6402		9.3		525	QH	0.846		2.3		10.96		42.8		33.1	
X45	T21X45	5/21/2018	4.0		5910		9.6		333		< 0.038	QU	2.5		8.33		48.0		17.5	
X46	T21X46	5/21/2018	3.8		5741		10.1		323		< 0.038	QU	1.9		5.64		27.7		20.9	
X47	T21X47	5/21/2018	< 1.8	QU	6485		11.0		367		< 0.038	QU	1.7		10.37		46.7		20.0	
X48	T21X48	5/21/2018	3.2		6085		11.2		364		0.999		2.1		20.29		71.2		27.4	
X49	T21X49	5/21/2018	2.1		6430		8.8		321		< 0.038	QU	2.5		10.70		41.0		18.5	
X5	T21X5	5/21/2018	< 1.8	QU	5240		11.2		276		< 0.038	QU	1.1		4.84		25.5		15.9	
X50	T21X50	5/21/2018	2.0		5678		10.1		262		< 0.038	QU	2.1		9.56		44.7		19.6	
X51	T21X51	5/21/2018	3.1		5604		9.6		315		1.556		2.5		7.80		51.4		18.9	
X52	T21X52	5/21/2018	< 1.8	QU	5519		9.9		298		< 0.038	QU	2.3		4.90		26.0		18.6	
X53	T21X53	5/21/2018	2.3		5961		10.9		299		< 0.038	QU	2.6		4.73		26.1		18.6	
X54	T21X54	5/21/2018	3.0		6001		9.9		385		< 0.038	QU	2.2		6.84		41.3		19.8	
X55	T21X55	5/21/2018	2.3		5899		9.4		302		0.179		2.0		8.88		45.3		18.1	
X56	T21X56	5/21/2018	4.8		7343		10.9		430		< 0.038	QU	2.4		22.11		79.8		24.1	
X57	T21X57	5/21/2018	3.5		5416		7.1		260		< 0.038	QU	2.4		6.37		27.0		16.6	
X58	T21X58	5/21/2018	3.2		6886		8.3		273		< 0.038	QU	2.8		< 0.08	QU	24.5		18.2	
X59	T21X59	5/21/2018	2.7		5650		9.4		275		< 0.038	QU	1.9		12.92		39.8		22.3	
X6	T21X6	5/21/2018	< 1.8	QU	5583		11.2		266		< 0.038	QU	1.7		5.48		30.1		16.7	
X60	T21X60	5/21/2018	2.6		6498		11.0		388		< 0.038	QU	2.6		13.28		63.7		22.5	
X61	T21X61	5/21/2018	< 1.8	QU	6768		10.8		436		0.590		2.0		3.52		41.3		20.1	
X62	T21X62	5/21/2018	2.2		5810		10.4		386		< 0.038	QU	1.4		5.99		42.3		19.1	
X63	T21X63	5/21/2018	3.3		6173		12.3		567	QH	2.104		2.2		35.05		111.5		44.9	
X64	T21X64	5/21/2018	2.1		6158		8.9		343		< 0.038	QU	1.7		12.80		52.8		19.7	
X65	T21X65	5/21/2018	2.7		6366		7.2		333		< 0.038	QU	2.2		8.02		44.6		22.1	
X66	T21X66	5/21/2018	2.1		6579		12.4		248		1.559		2.0		24.21		68.1		27.2	
X67	T21X67	5/21/2018	6.1		7363		13.5		436		0.769		2.5		19.88		78.9		26.1	
X68	T21X68	5/21/2018	3.0		5660		10.9		295		< 0.038	QU	2.3		4.74		35.3		16.2	
X7	T21X7	5/21/2018	< 1.8	QU	6693		9.4		485	QH	0.992		2.3		3.16		25.8		20.8	
X8	T21X8	5/21/2018	2.8		6306		10.9		381		< 0.038	QU	2.4		5.42		29.2		17.9	
X9	T21X9	5/21/2018	2.9		5120		7.8		283		< 0.038	QU	2.2		5.91		28.9		18.6	

Notes:

mg/kg Milligrams per kilogram

QH Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).

Table I3-21. Validated XRF Field Survey Results for Non-AUM Target M5-05 (T21)

Grid ID	Unique_X	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

QL Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).

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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.

XRF X-ray fluorescence

Table I3-22. Validated XRF Field Survey Results for Non-AUM Target M5-06 (T22)

Grid ID	Unique_X	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
G1	T22G1	9/11/2018	2.5		5750		7.3		281		0.270		2.8		< 0.08	QU	< 16	QU	15.9	
G10	T22G10	9/11/2018	3.3		6792		9.7		340		< 0.038	QU	3.2		1.80		21.2		19.0	
G11	T22G11	9/11/2018	2.9		6145		6.4		345		< 0.038	QU	2.7		0.83		18.6		18.8	
G12	T22G12	9/11/2018	2.6		9606		12.6		631	QH	< 0.038	QU	3.8		2.86		38.7		29.8	
G13	T22G13	9/11/2018	3.1		6904		8.5		394		0.543		2.7		1.86		19.6		19.1	
G14	T22G14	9/11/2018	2.8		6077		10.8		356		< 0.038	QU	3.5		3.66		24.5		20.5	
G15	T22G15	9/11/2018	2.6		7719		8.3		382		< 0.038	QU	2.9		0.47		24.1		19.1	
G16	T22G16	9/11/2018	2.5		5813		7.8		515	QH	0.064		2.4		3.00		16.9		22.9	
G17	T22G17	9/11/2018	< 1.8	QU	6854		17.2		431		< 0.038	QU	2.9		2.41		33.3		26.3	
G18	T22G18	9/11/2018	< 1.8	QU	4890		8.0		380		1.337		1.9		1.05		16.8		24.6	
G19	T22G19	9/11/2018	< 1.8	QU	5713		35.4		263		0.226		3.0		2.09		21.3		18.7	
G2	T22G2	9/11/2018	< 1.8	QU	4526		6.9		193		0.483		1.6		< 0.08	QU	< 16	QU	10.7	
G20	T22G20	9/11/2018	< 1.8	QU	6103		11.3		291		1.300		2.1		3.55		21.8		20.2	
G21	T22G21	9/11/2018	3.4		7989		11.7		575	QH	0.622		3.0		5.91		31.4		24.9	
G22	T22G22	9/11/2018	3.2		8121		8.2		243		0.887		2.7		0.93		16.9		24.2	
G23	T22G23	9/11/2018	2.5		7189		12.9		481	QH	< 0.038	QU	2.7		4.73		42.3		22.6	
G24	T22G24	9/11/2018	2.9		6677		8.2		299		< 0.038	QU	3.3		2.02		19.9		17.6	
G25	T22G25	9/11/2018	2.2		5650		10.7		326		0.119		2.4		2.54		21.5		18.2	
G26	T22G26	9/11/2018	4.0		6739		6.9		326		0.296		2.6		1.43		21.9		23.0	
G27	T22G27	9/11/2018	< 1.8	QU	5032		8.5		255		< 0.038	QU	1.9		2.30		16.2		14.4	
G28	T22G28	9/11/2018	2.9		7524		7.9		243		< 0.038	QU	3.2		< 0.08	QU	20.3		18.1	
G29	T22G29	9/11/2018	< 1.8	QU	5255		10.5		395		0.555		2.1		2.54		< 16	QU	18.4	
G3	T22G3	9/11/2018	< 1.8	QU	3078		3.7		167		< 0.038	QU	1.4		< 0.08	QU	< 16	QU	< 7.8	QU
G30	T22G30	9/11/2018	5.2		8062		7.5		324		< 0.038	QU	3.0		2.29		27.2		19.8	
G31	T22G31	9/11/2018	4.6		7214		6.6		217		< 0.038	QU	2.7		0.15		25.1		16.5	
G32	T22G32	9/11/2018	5.3		7176		6.9		220		0.685		2.4		0.09	QL	30.5		18.4	
G33	T22G33	9/11/2018	3.8		7012		10.5		564	QH	1.303		3.2		5.62		27.9		34.5	
G34	T22G34	9/11/2018	2.1		5731		8.4		262		< 0.038	QU	2.3		1.72		17.2		19.4	
G35	T22G35	9/11/2018	2.3		5695		9.0		299		< 0.038	QU	2.1		1.37		22.5		17.6	
G36	T22G36	9/11/2018	4.6		6785		12.5		418		1.023		2.7		7.63		39.3		23.8	
G4	T22G4	9/11/2018	2.1		5425		5.3		241		0.481		2.4		< 0.08	QU	< 16	QU	13.3	
G5	T22G5	9/11/2018	2.6		6208		9.0		320		< 0.038	QU	2.5		1.05		19.5		17.8	
G6	T22G6	9/11/2018	2.4		4971		7.9		274		0.257		2.1		1.41		16.6		17.0	
G7	T22G7	9/11/2018	< 1.8	QU	3905		6.2		183		< 0.038	QU	1.9		< 0.08	QU	< 16	QU	9.1	
G8	T22G8	9/11/2018	2.0		6224		8.5		260		< 0.038	QU	2.1		1.12		< 16	QU	13.9	
G9	T22G9	9/11/2018	3.7		6909		18.5		414		0.461		2.7		5.57		35.5		30.8	
X1	T22X1	5/21/2018	< 1.8	QU	5016		7.9		304		< 0.038	QU	2.0		1.79		< 16	QU	15.3	
X10	T22X10	5/21/2018	< 1.8	QU	6282		7.6		328		0.101		3.0		1.17		< 16	QU	17.3	
X11	T22X11	5/21/2018	< 1.8	QU	6087		8.6		299		< 0.038	QU	3.8		2.33		< 16	QU	18.4	
X12	T22X12	5/21/2018	2.9		6320		7.1		370		2.530		2.5		4.02		20.7		29.9	
X13	T22X13	5/21/2018	3.1		6498		8.6		407		2.823		2.8		3.63		23.6		28.8	
X14	T22X14	5/21/2018	3.9		7925		15.8		553	QH	0.696		3.9		12.15		62.4		26.4	
X15	T22X15	5/21/2018	2.6		7057		12.3		509	QH	0.956		3.1		6.54		33.0		27.8	
X16	T22X16	5/21/2018	2.7		6650		7.9		382		1.997		3.3		2.17		18.4		20.1	
X17	T22X17	5/21/2018	< 1.8	QU	5639		8.7		289		< 0.038	QU	2.2		1.16		< 16	QU	16.6	
X18	T22X18	5/21/2018	2.7		6271		8.1		336		0.641		2.4		1.91		18.4		17.5	
X19	T22X19	5/21/2018	< 1.8	QU	5022		8.2		301		0.486		2.6		1.28		< 16	QU	17.0	
X19A	T22X19A	5/21/2018	2.2		6388		9.2		346		0.664		2.2		2.71		< 16	QU	19.5	
X2	T22X2	5/21/2018	< 1.8	QU	7428		9.7		516	QH	1.608		2.9		3.19		30.4		25.9	
X20	T22X20	9/11/2018	2.7		6169		8.8		274		0.350		3.1		0.83		< 16	QU	14.2	
X21	T22X21	5/21/2018	< 1.8	QU	4848		8.6		253		< 0.038	QU	2.1		2.08		< 16	QU	17.0	
X22	T22X22	5/21/2018	3.2		5241		6.8		294		< 0.038	QU	2.9		0.73		18.5		17.8	

Table I3-22. Validated XRF Field Survey Results for Non-AUM Target M5-06 (T22)

Grid ID	Unique_X	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
X23	T22X23	5/21/2018	< 1.8	QU	6524		13.1		381		0.442		2.9		5.72		29.7		23.5	
X24	T22X24	5/21/2018	2.6		6458		11.4		416		0.076		2.8		4.69		24.3		23.4	
X25	T22X25	5/21/2018	4.2		8567		10.4		513	QH	0.754		3.5		3.26		21.6		28.1	
X26	T22X26	5/21/2018	2.4		5177		4.9		277		3.246		3.1		2.53		< 16	QU	16.5	
X27	T22X27	5/21/2018	2.5		6701		10.3		472	QH	1.143		2.5		2.67		< 16	QU	24.0	
X28	T22X28	5/21/2018	3.8		7492		11.8		460		2.230		2.2		6.39		22.3		28.2	
X29	T22X29	5/21/2018	3.9		6630		8.8		454		< 0.038	QU	2.5		3.28		25.3		20.5	
X3	T22X3	5/21/2018	1.9		6290		8.1		381		1.805		2.8		3.05		19.3		18.9	
X30	T22X30	5/21/2018	2.3		5856		8.4		309		< 0.038	QU	2.5		2.84		28.6		20.1	
X31	T22X31	5/21/2018	3.4		7286		10.7		547	QH	0.465		3.1		4.28		28.0		27.8	
X32	T22X32	5/21/2018	3.8		4913		5.5		293		< 0.038	QU	2.1		2.71		< 16	QU	15.7	
X33	T22X33	5/21/2018	1.8		6173		9.0		483	QH	2.772		2.2		3.89		24.0		27.4	
X34	T22X34	5/21/2018	< 1.8	QU	6051		8.3		410		1.247		2.9		3.04		< 16	QU	21.2	
X35	T22X35	5/21/2018	< 1.8	QU	5913		6.4		240		0.668		2.2		0.31		17.6		18.8	
X36	T22X36	5/21/2018	1.9		5764		6.8		288		< 0.038	QU	1.8		0.89		16.1		15.0	
X37	T22X37	5/21/2018	2.9		6537		8.3		500	QH	0.120		3.0		4.14		26.1		26.0	
X38	T22X38	5/21/2018	< 1.8	QU	5899		9.1		419		3.419		3.3		3.69		22.5		21.6	
X39	T22X39	5/21/2018	< 1.8	QU	6442		9.5		520	QH	2.565		2.8		3.53		24.3		26.0	
X4	T22X4	5/21/2018	< 1.8	QU	5582		8.4		404		< 0.038	QU	2.3		3.14		20.6		18.2	
X40	T22X40	5/21/2018	5.5		8161		10.4		347		1.979		2.7		4.40		< 16	QU	23.9	
X41	T22X41	5/21/2018	3.4		5856		7.9		436		1.481		3.5		3.34		< 16	QU	23.7	
X42	T22X42	5/21/2018	< 1.8	QU	5755		9.4		386		0.941		2.7		4.80		17.5		20.6	
X43	T22X43	5/21/2018	2.8		6566		8.3		405		< 0.038	QU	2.8		5.76		19.5		21.3	
X44	T22X44	5/22/2018	3.1		6416		7.6		315		< 0.038	QU	3.0		1.18		18.1		18.2	
X45	T22X45	5/22/2018	< 1.8	QU	5860		5.6		273		0.125		1.8		1.24		< 16	QU	20.6	
X46	T22X46	5/22/2018	< 1.8	QU	4060		6.4		211		< 0.038	QU	2.3		0.89		< 16	QU	12.4	
X47	T22X47	5/22/2018	< 1.8	QU	5930		11.0		330		< 0.038	QU	2.6		6.79		24.1		19.0	
X48	T22X48	5/22/2018	< 1.8	QU	6462		11.5		366		< 0.038	QU	2.4		5.96		39.0		20.1	
X49	T22X49	5/22/2018	2.5		5615		10.1		309		0.260		2.6		2.92		24.0		16.7	
X5	T22X5	5/21/2018	2.4		5181		6.7		317		< 0.038	QU	2.5		0.53		< 16	QU	21.4	
X50	T22X50	5/21/2018	2.5		5494		9.3		320		0.266		2.6		5.55		25.0		21.4	
X51	T22X51	5/21/2018	3.6		6366		7.4		383		2.011		2.6		2.64		24.6		26.8	
X52	T22X52	5/21/2018	< 1.8	QU	5411		7.2		279		0.826		2.5		0.44		< 16	QU	18.5	
X53	T22X53	5/21/2018	4.0		6253		7.6		387		1.575		2.8		4.73		27.2		23.7	
X54	T22X54	5/22/2018	3.3		6132		5.9		261		< 0.038	QU	2.7		1.54		21.0		16.8	
X55	T22X55	5/22/2018	< 1.8	QU	5748		7.6		208		< 0.038	QU	2.1		0.59		< 16	QU	14.9	
X56	T22X56	5/22/2018	3.2		5973		8.6		302		< 0.038	QU	1.9		1.55		18.3		17.5	
X57	T22X57	5/22/2018	2.6		6538		11.6		364		0.042		2.4		6.41		36.7		24.5	
X58	T22X58	5/22/2018	2.2		6131		10.1		335		< 0.038	QU	2.5		4.59		23.8		18.6	
X59	T22X59	5/22/2018	2.6		5881		10.6		315		< 0.038	QU	2.1		3.89		20.9		17.1	
X6	T22X6	5/21/2018	2.0		5817		8.8		378		0.315		2.5		3.77		34.1		20.6	
X60	T22X60	5/22/2018	< 1.8	QU	6575		11.7		368		< 0.038	QU	2.7		4.12		31.6		22.3	
X61	T22X61	5/22/2018	2.3		4928		6.6		252		< 0.038	QU	2.2		2.63		< 16	QU	15.9	
X62	T22X62	5/22/2018	< 1.8	QU	5941		8.1		387		< 0.038	QU	1.8		1.42		21.4		20.9	
X63	T22X63	5/22/2018	2.3		5948		10.4		323		< 0.038	QU	1.9		4.86		30.3		18.1	
X64	T22X64	5/22/2018	< 1.8	QU	6647		8.8		254		< 0.038	QU	1.6		0.79		22.2		17.6	
X65	T22X65	5/22/2018	2.9		6492		8.2		338		< 0.038	QU	2.3		3.05		34.5		21.4	
X66	T22X66	5/22/2018	2.7		7062		12.6		855	QH	1.836		2.1		4.22		24.2		31.7	
X67	T22X67	5/22/2018	3.4		5356		8.7		277		< 0.038	QU	2.0		3.49		29.6		15.6	
X68	T22X68	5/22/2018	2.0		6674		7.4		313		< 0.038	QU	1.9		2.20		26.4		17.6	
X69	T22X69	5/22/2018	< 1.8	QU	6392		12.2		424		< 0.038	QU	2.2		4.56		26.0		21.8	
X7	T22X7	5/21/2018	< 1.8	QU	4431		5.9		294		3.674		2.2		2.65		< 16	QU	16.8	

Table I3-22. Validated XRF Field Survey Results for Non-AUM Target M5-06 (T22)

Grid ID	Unique_X	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
X70	T22X70	5/22/2018	2.5		6670		9.4		361		< 0.038	QU	2.5		3.21		20.3		20.3	
X71	T22X71	5/22/2018	2.2		5623		9.3		321		< 0.038	QU	1.6		1.52		19.5		17.8	
X72	T22X72	5/22/2018	3.9		7013		8.7		280		< 0.038	QU	2.2		3.18		26.5		20.4	
X73	T22X73	5/22/2018	2.6		6108		8.4		355		< 0.038	QU	2.7		3.20		23.0		20.0	
X74	T22X74	5/22/2018	< 1.8	QU	5766		8.9		244		< 0.038	QU	2.1		< 0.08	QU	17.8		16.1	
X75	T22X75	5/22/2018	2.6		6169		5.9		229		< 0.038	QU	2.2		1.48		19.7		16.3	
X76	T22X76	5/22/2018	1.9		5813		9.3		303		< 0.038	QU	2.6		1.65		17.3		18.0	
X77	T22X77	5/22/2018	< 1.8	QU	5957		7.4		350		< 0.038	QU	2.3		1.69		19.3		24.4	
X78	T22X78	5/22/2018	< 1.8	QU	5878		10.8		451		< 0.038	QU	1.8		5.09		22.1		22.2	
X79	T22X79	5/22/2018	1.9		5875		8.5		269		< 0.038	QU	2.9		2.12		18.6		19.1	
X8	T22X8	5/21/2018	< 1.8	QU	6457		11.3		316		0.248		3.0		3.15		17.8		18.5	
X80	T22X80	5/22/2018	3.0		5799		10.1		390		< 0.038	QU	2.4		3.65		32.8		19.3	
X81	T22X81	5/22/2018	< 1.8	QU	5305		10.1		295		< 0.038	QU	1.6		1.87		20.8		16.1	
X82	T22X82	5/22/2018	3.5		7353		11.5		516	QH	< 0.038	QU	2.6		3.54		36.0		23.1	
X83	T22X83	5/22/2018	2.3		7812		7.3		247		< 0.038	QU	2.6		2.10		16.7		18.1	
X84	T22X84	5/22/2018	4.5		7467		11.6		640	QH	< 0.038	QU	2.2		8.43		42.2		31.9	
X85	T22X85	5/22/2018	< 1.8	QU	4953		9.0		256		0.349		1.5		1.52		21.1		16.5	
X86	T22X86	5/22/2018	3.0		6329		9.1		328		0.931		2.6		4.54		22.5		21.4	
X87	T22X87	5/22/2018	< 1.8	QU	5261		9.2		312		< 0.038	QU	1.5		3.73		23.4		17.5	
X88	T22X88	5/22/2018	2.7		5958		9.8		308		< 0.038	QU	1.7		1.56		24.9		18.2	
X89	T22X89	5/22/2018	2.2		6468		11.0		341		0.590		2.1		4.76		26.3		21.8	
X9	T22X9	5/21/2018	< 1.8	QU	5682		8.0		291		0.811		3.1		1.89		< 16	QU	16.9	
X90	T22X90	5/22/2018	< 1.8	QU	5607		11.1		349		< 0.038	QU	1.9		3.76		35.5		19.2	
X91	T22X91	5/22/2018	4.1		6766		9.0		279		< 0.038	QU	2.1		4.36		40.8		18.6	
X92	T22X92	5/22/2018	< 1.8	QU	5241		7.7		278		< 0.038	QU	1.3		2.80		31.4		20.0	
X93	T22X93	5/22/2018	2.9		5871		9.6		312		< 0.038	QU	2.2		4.28		25.3		19.8	
X94	T22X94	5/22/2018	2.1		5222		8.7		259		< 0.038	QU	1.9		1.81		22.6		16.0	
X95	T22X95	5/22/2018	3.9		6152		7.9		524	QH	< 0.038	QU	2.0		4.51		25.5		26.9	
X96	T22X96	5/22/2018	< 1.8	QU	4667		5.1		761	QH	1.968		2.0		4.91		20.1		42.4	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-24. Validated XRF Field Survey Results for Non-AUM Target M5-07 (T24)

Grid ID	Unique_X	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
G1	T24G1	9/11/2018	< 1.8	QU	5945		9.3		372		< 0.038	QU	2.9		0.90		< 16	QU	18.0	
G10	T24G10	9/11/2018	2.7		9063		8.2		426		0.925		3.2		0.24		40.6		23.2	
G11	T24G11	9/11/2018	3.7		7846		8.1		275		< 0.038	QU	2.4		1.99		< 16	QU	15.3	
G12	T24G12	9/11/2018	< 1.8	QU	7010		5.8		292		1.844		2.3		0.57		20.2		16.3	
G13	T24G13	9/11/2018	8.8		8016		8.8		237		< 0.038	QU	2.6		3.98		< 16	QU	19.9	
G14	T24G14	9/11/2018	4.4		7296		7.5		388		3.463		2.6		1.98		17.4		29.1	
G15	T24G15	9/11/2018	7.2		11943		7.4		366		0.041		3.7		1.88		< 16	QU	29.2	
G16	T24G16	9/11/2018	< 1.8	QU	7474		9.4		389		< 0.038	QU	2.3		2.67		23.9		22.3	
G17	T24G17	9/11/2018	2.3		3605		4.6		160		0.072		1.7		0.31		< 16	QU	7.9	
G18	T24G18	9/11/2018	2.5		7105		6.7		329		< 0.038	QU	2.3		0.96		16.7		18.6	
G19	T24G19	9/11/2018	2.5		7311		7.7		235		< 0.038	QU	2.2		0.20		< 16	QU	19.6	
G2	T24G2	9/11/2018	2.0		5067		7.0		288		1.221		2.7		1.30		< 16	QU	14.3	
G20	T24G20	9/11/2018	2.8		6563		8.4		253		< 0.038	QU	2.8		< 0.08	QU	16.5		19.8	
G21	T24G21	9/11/2018	10.3		11793		7.6		412		1.410		3.4		3.17		25.2		23.9	
G22	T24G22	9/11/2018	11.0		12363		11.9		441		1.898		4.7		6.56		29.1		38.4	
G23	T24G23	9/11/2018	23.0		13831		10.6		386		< 0.038	QU	5.9		7.99		27.1		32.8	
G24	T24G24	9/11/2018	2.2		3115		2.1		100		< 0.038	QU	1.2		< 0.08	QU	< 16	QU	9.1	
G25	T24G25	9/11/2018	11.0		9534		7.6		216		1.928		2.8		3.29		22.1		26.2	
G26	T24G26	9/11/2018	2.7		4212		3.3		142		1.277		1.9		0.23		< 16	QU	11.0	
G27	T24G27	9/11/2018	< 1.8	QU	3603		5.4		131		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	12.7	
G28	T24G28	9/11/2018	9.1		7208		7.3		197		< 0.038	QU	2.4		1.37		21.1		17.6	
G29	T24G29	9/11/2018	27.6		16887		11.4		286		< 0.038	QU	5.7		6.07		32.6		41.2	
G3	T24G3	9/11/2018	< 1.8	QU	3076		9.4		277		4.918		1.7		3.99		< 16	QU	25.8	
G30	T24G30	9/11/2018	7.6		5905		4.5		174		0.060		1.6		1.79		< 16	QU	15.0	
G31	T24G31	9/11/2018	5.8		5413		4.4		157		1.139		1.5		0.57		< 16	QU	13.5	
G32	T24G32	9/11/2018	4.2		4877		3.9		173		< 0.038	QU	1.7		0.89		< 16	QU	13.2	
G4	T24G4	9/11/2018	2.3		5966		7.8		323		1.419		2.5		0.99		< 16	QU	13.8	
G5	T24G5	9/11/2018	2.8		6929		7.5		230		< 0.038	QU	1.9		2.43		< 16	QU	16.9	
G6	T24G6	9/11/2018	3.8		8364		6.9		483	QH	< 0.038	QU	3.0		1.06		24.1		19.8	
G7	T24G7	9/11/2018	3.3		6482		11.3		313		0.155		2.7		3.47		18.8		29.1	
G8	T24G8	9/11/2018	3.9		6639		5.8		228		< 0.038	QU	2.1		0.28		< 16	QU	15.1	
G9	T24G9	9/11/2018	2.3		5398		8.6		208		0.850		1.6		0.67		< 16	QU	13.7	
X1	T24X1	5/24/2018	5.5		7989		9.1		245		< 0.038	QU	3.7		2.91		< 16	QU	20.4	
X10	T24X10	5/24/2018	7.1		10886		7.9		285		< 0.038	QU	4.1		4.26		33.2		27.0	
X11	T24X11	5/24/2018	2.2		6854		10.1		666	QH	1.574		3.2		6.49		19.5		33.7	
X12	T24X12	5/24/2018	< 1.8	QU	8232		3.8		331		< 0.038	QU	2.8		0.55		18.6		23.6	
X13	T24X13	5/24/2018	7.7		10551		8.5		259		< 0.038	QU	3.5		7.68		29.9		28.4	
X14	T24X14	5/24/2018	< 1.8	QU	4657		3.6		304		4.697		2.4		3.81		< 16	QU	28.3	
X15	T24X15	5/24/2018	3.1		6830		8.2		323		< 0.038	QU	3.2		2.56		31.0		20.8	
X16	T24X16	5/24/2018	4.4		7240		9.4		398		< 0.038	QU	3.1		2.30		23.5		23.8	
X17	T24X17	5/24/2018	< 1.8	QU	6581		8.8		315		< 0.038	QU	2.2		1.74		24.6		19.7	
X18	T24X18	5/24/2018	6.8		15373		7.2		407		< 0.038	QU	5.0		2.83		34.6		42.8	
X19	T24X19	5/24/2018	< 1.8	QU	8255		7.6		456		2.879		2.6		4.09		29.7		29.4	
X2	T24X2	5/24/2018	1.9		6200		7.4		262		< 0.038	QU	2.9		1.60		< 16	QU	19.2	
X20	T24X20	5/24/2018	2.5		6413		7.9		403		< 0.038	QU	2.1		< 0.08	QU	< 16	QU	18.2	
X21	T24X21	5/24/2018	3.4		7726		8.1		294		1.447		3.6		3.46		26.7		20.4	
X22	T24X22	5/24/2018	5.0		8700		15.4		468	QH	< 0.038	QU	3.7		4.99		33.1		31.3	
X23	T24X23	5/24/2018	3.5		8995		11.4		420		< 0.038	QU	4.2		3.30		23.1		26.1	
X24	T24X24	5/24/2018	2.8		7133		7.6		306		< 0.038	QU	2.3		3.04		23.3		23.0	
X25	T24X25	5/24/2018	2.0		6879		3.4		579	QH	< 0.038	QU	2.4		0.87		24.5		20.8	
X26	T24X26	5/24/2018	4.1		12051		9.4		484	QH	< 0.038	QU	3.6		4.00		37.5		31.5	
X27	T24X27	5/24/2018	6.2		8725		7.4		258		0.483		2.4		3.50		25.4		21.3	

Table I3-24. Validated XRF Field Survey Results for Non-AUM Target M5-07 (T24)

Grid ID	Unique_X	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
X28	T24X28	5/24/2018	6.7		11414		10.5		456		< 0.038	QU	3.7		2.60		35.0		30.7	
X29	T24X29	5/24/2018	4.3		8582		8.6		423		< 0.038	QU	3.2		3.55		27.7		25.8	
X3	T24X3	5/24/2018	3.0		7635		7.3		267		< 0.038	QU	2.9		2.37		35.4		20.5	
X30	T24X30	5/24/2018	3.1		7920		9.4		470	QH	< 0.038	QU	2.7		3.98		25.5		20.9	
X31	T24X31	5/24/2018	4.5		8243		8.0		364		< 0.038	QU	3.4		2.44		28.8		20.4	
X32	T24X32	5/24/2018	2.7		6760		7.1		362		< 0.038	QU	3.0		1.95		< 16	QU	24.9	
X33	T24X33	5/24/2018	2.4		5968		6.0		412		0.908		2.0		2.26		18.4		34.1	
X34	T24X34	5/24/2018	3.1		7572		6.1		346		< 0.038	QU	2.4		1.32		17.8		20.7	
X35	T24X35	5/24/2018	3.5		7888		7.3		466		0.474		2.7		2.28		22.5		25.3	
X36	T24X36	5/24/2018	< 1.8	QU	5826		9.1		520	QH	2.194		2.3		5.21		23.4		42.8	
X37	T24X37	5/24/2018	< 1.8	QU	6112		7.3		500	QH	< 0.038	QU	2.1		1.43		19.5		17.8	
X38	T24X38	5/24/2018	3.0		6900		6.7		336		< 0.038	QU	2.8		1.11		< 16	QU	22.0	
X39	T24X39	5/24/2018	3.3		6413		9.4		259		< 0.038	QU	3.0		2.34		30.9		20.8	
X4	T24X4	5/24/2018	3.0		6607		7.4		415		0.601		2.5		2.98		< 16	QU	37.3	
X40	T24X40	5/24/2018	6.1		7952		16.5		412		< 0.038	QU	3.1		6.69		36.7		35.1	
X41	T24X41	5/24/2018	4.6		7112		10.5		329		< 0.038	QU	2.8		1.94		20.3		23.8	
X42	T24X42	5/24/2018	< 1.8	QU	4617		6.4		175		< 0.038	QU	1.3		1.24		< 16	QU	11.0	
X43	T24X43	5/24/2018	4.6		7047		13.1		377		< 0.038	QU	2.7		3.76		20.4		27.6	
X44	T24X44	5/24/2018	< 1.8	QU	5120		8.1		284		1.778		2.5		3.30		< 16	QU	43.6	
X45	T24X45	5/24/2018	4.6		7001		13.7		476	QH	< 0.038	QU	2.9		4.76		27.5		37.8	
X46	T24X46	5/24/2018	2.5		6465		10.4		339		< 0.038	QU	3.0		3.98		17.0		22.9	
X47	T24X47	5/24/2018	3.0		6205		10.4		375		< 0.038	QU	3.0		3.22		23.7		26.9	
X48	T24X48	5/24/2018	22.8		14435		6.7		252		< 0.038	QU	3.5		9.28		38.4		34.6	
X49	T24X49	5/24/2018	4.8		9387		9.1		367		< 0.038	QU	3.7		2.88		23.2		24.4	
X5	T24X5	5/24/2018	4.1		8747		7.5		502	QH	1.308		2.9		1.04		23.7		22.7	
X50	T24X50	5/24/2018	2.4		4965		6.7		210		< 0.038	QU	1.9		1.19		< 16	QU	16.3	
X51	T24X51	5/24/2018	3.7		6685		12.6		265		< 0.038	QU	2.8		5.39		33.6		24.9	
X52	T24X52	5/24/2018	< 1.8	QU	6672		9.9		294		< 0.038	QU	3.2		2.42		26.5		19.6	
X53	T24X53	5/24/2018	6.1		7613		11.1		319		< 0.038	QU	3.6		5.26		38.3		25.5	
X54	T24X54	5/24/2018	3.6		6824		8.2		305		< 0.038	QU	2.7		2.84		< 16	QU	22.6	
X55	T24X55	5/24/2018	12.5		17781		9.5		247		< 0.038	QU	8.1		4.63		34.6		39.4	
X56	T24X56	5/24/2018	10.2		12272		7.0		308		< 0.038	QU	3.8		4.50		37.3		27.1	
X57	T24X57	5/24/2018	5.6		7656		8.7		401		< 0.038	QU	3.0		3.37		25.1		20.9	
X58	T24X58	5/24/2018	7.1		7656		8.2		270		< 0.038	QU	2.8		2.26		20.0		20.5	
X59	T24X59	5/24/2018	6.0		8344		11.9		300		< 0.038	QU	3.4		5.70		24.3		27.0	
X6	T24X6	5/24/2018	< 1.8	QU	4623		7.3		246		2.154		2.4		4.46		< 16	QU	29.2	
X7	T24X7	5/24/2018	5.0		8647		6.8		321		< 0.038	QU	4.0		3.09		27.1		23.4	
X8	T24X8	5/24/2018	3.4		7683		11.2		271		< 0.038	QU	2.2		2.79		27.0		21.2	
X9	T24X9	5/24/2018	4.9		9239		18.3		674	QH	0.042		3.7		5.71		32.6		42.2	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-25. Validated XRF Field Survey Results for Non-AUM Target M5-08 (T25)

Grid ID	Unique_X	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
X1	T25X1	6/6/2018	< 1.8	QU	9312		8.0		625	QH	< 0.038	QU	3.9		0.74		28.9		21.5	
X10	T25X10	6/6/2018	< 1.8	QU	8006		6.2		277		< 0.038	QU	3.6		0.35		20.5		20.1	
X11	T25X11	6/6/2018	< 1.8	QU	5533		7.6		234		< 0.038	QU	2.1		< 0.08	QU	< 16	QU	12.3	
X12	T25X12	6/6/2018	< 1.8	QU	6867		6.0		363		< 0.038	QU	3.9		0.09	QL	20.4		14.8	
X13	T25X13	6/6/2018	< 1.8	QU	6258		6.0		346		< 0.038	QU	2.5		< 0.08	QU	< 16	QU	15.3	
X14	T25X14	6/6/2018	< 1.8	QU	11212		7.4		373		< 0.038	QU	3.4		0.67		20.4		21.5	
X15	T25X15	6/6/2018	< 1.8	QU	7407		3.8		406		< 0.038	QU	2.3		0.42		< 16	QU	18.3	
X16	T25X16	6/6/2018	< 1.8	QU	6562		6.0		295		< 0.038	QU	2.4		< 0.08	QU	< 16	QU	20.0	
X17	T25X17	6/6/2018	< 1.8	QU	8417		7.4		314		< 0.038	QU	2.4		0.29		23.0		20.4	
X18	T25X18	6/6/2018	< 1.8	QU	6246		5.8		375		0.610		2.7		< 0.08	QU	18.1		14.9	
X19	T25X19	6/6/2018	< 1.8	QU	6742		5.7		256		< 0.038	QU	2.7		< 0.08	QU	18.9		16.1	
X2	T25X2	6/6/2018	< 1.8	QU	6865		6.9		365		< 0.038	QU	2.2		1.34		< 16	QU	14.8	
X20	T25X20	6/6/2018	< 1.8	QU	7600		6.3		390		< 0.038	QU	2.3		1.51		20.0		18.2	
X21	T25X21	6/6/2018	< 1.8	QU	7196		7.9		327		< 0.038	QU	2.9		1.25		< 16	QU	16.5	
X22	T25X22	6/6/2018	< 1.8	QU	7750		5.7		394		0.686		2.3		0.58		19.9		15.8	
X23	T25X23	6/6/2018	< 1.8	QU	6719		6.6		301		< 0.038	QU	2.7		0.11	QL	18.0		19.1	
X24	T25X24	6/6/2018	< 1.8	QU	6241		4.1		281		0.470		2.0		< 0.08	QU	33.6		12.0	
X25	T25X25	6/6/2018	< 1.8	QU	8925		7.6		359		< 0.038	QU	3.6		< 0.08	QU	23.4		19.6	
X26	T25X26	6/6/2018	< 1.8	QU	4724		4.5		260		< 0.038	QU	2.3		< 0.08	QU	< 16	QU	12.2	
X3	T25X3	6/6/2018	< 1.8	QU	5977		4.7		322		< 0.038	QU	2.1		< 0.08	QU	< 16	QU	12.8	
X4	T25X4	6/6/2018	< 1.8	QU	7800		6.1		407		< 0.038	QU	3.7		0.30		< 16	QU	19.4	
X5	T25X5	6/6/2018	< 1.8	QU	8957		9.1		337		0.413		2.6		0.64		26.6		20.7	
X6	T25X6	6/6/2018	< 1.8	QU	4834		5.3		219		< 0.038	QU	2.3		< 0.08	QU	< 16	QU	11.6	
X7	T25X7	6/6/2018	< 1.8	QU	5641		6.2		333		< 0.038	QU	1.8		0.17		< 16	QU	13.0	
X8	T25X8	6/6/2018	< 1.8	QU	6822		8.6		295		1.080		2.7		< 0.08	QU	< 16	QU	16.3	
X9	T25X9	6/6/2018	2.0		7353		5.0		531	QH	1.720		2.5		1.76		21.6		26.5	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-26. Validated XRF Field Survey Results for Non-AUM Target M5-09 (T26)

Grid ID	Unique_X	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
G1	T26G1	9/15/2018	5.4		6738		5.5		903	QH	6.047		2.7		4.96		< 16	QU	29.5	
G10	T26G10	9/15/2018	< 1.8	QU	3954		6.1		352		1.961		2.7		1.16		< 16	QU	18.6	
G11	T26G11	9/15/2018	4.8		5967		3.4		145		< 0.038	QU	2.2		2.33		< 16	QU	12.8	
G12	T26G12	9/15/2018	5.0		6906		15.6		699	QH	< 0.038	QU	2.4		1.55		< 16	QU	30.9	
G13	T26G13	9/15/2018	2.3		4355		2.7		118		< 0.038	QU	1.4		< 0.08	QU	< 16	QU	9.3	
G14	T26G14	9/15/2018	3.2		3941		3.6		249		< 0.038	QU	2.1		< 0.08	QU	< 16	QU	10.1	
G15	T26G15	9/15/2018	3.3		4645		5.9		219		< 0.038	QU	1.8		3.80		< 16	QU	9.7	
G16	T26G16	9/15/2018	6.0		4358		1.8		120		< 0.038	QU	< 1	QU	2.34		< 16	QU	9.1	
G17	T26G17	9/15/2018	5.7		5846		3.8		206		1.832		2.6		1.77		< 16	QU	18.0	
G18	T26G18	9/15/2018	3.8		4874		5.7		272		< 0.038	QU	2.2		0.67		< 16	QU	13.4	
G19	T26G19	9/15/2018	2.3		4435		4.8		150		< 0.038	QU	1.3		< 0.08	QU	< 16	QU	8.7	
G2	T26G2	9/15/2018	3.8		3882		1.1		135		< 0.038	QU	1.1		2.77		31.8		9.8	
G20	T26G20	9/15/2018	1.8		4063		2.5		214		6.157		2.1		1.15		< 16	QU	31.8	
G21	T26G21	9/15/2018	2.4		5932		4.7		201		< 0.038	QU	4.4		1.05		22.4		13.7	
G22	T26G22	9/15/2018	5.4		4008		1.5		170		3.291		< 1	QU	< 0.08	QU	< 16	QU	11.1	
G23	T26G23	9/15/2018	1.9		4061		4.9		153		< 0.038	QU	2.3		1.33		< 16	QU	9.5	
G3	T26G3	9/15/2018	2.7		5973		6.7		295		< 0.038	QU	2.3		1.80		17.8		13.5	
G4	T26G4	9/15/2018	4.3		5506		5.0		312		0.252		2.1		1.49		18.5		16.4	
G5	T26G5	9/15/2018	3.0		6501		5.1		334		3.468		2.2		1.07		19.7		19.2	
G6	T26G6	9/15/2018	< 1.8	QU	5612		9.9		490	QH	< 0.038	QU	2.8		0.58		< 16	QU	17.1	
G7	T26G7	9/15/2018	< 1.8	QU	4828		2.3		180		< 0.038	QU	2.5		0.48		< 16	QU	11.8	
G8	T26G8	9/15/2018	3.6		6246		3.3		201		0.410		2.1		3.57		< 16	QU	16.9	
G9	T26G9	9/15/2018	1.9		6575		2.4		188		< 0.038	QU	3.6		0.45		17.0		16.4	
X1	T26X1	6/10/2018	5.2		6108		4.9		244		0.822		2.2		7.58		42.1		16.3	
X10	T26X10	6/10/2018	5.7		5733		3.3		207		3.949		1.2		6.55		45.9		14.8	
X11	T26X11	6/10/2018	4.1		6637		10.2		383		< 0.038	QU	3.0		0.42		< 16	QU	18.8	
X12	T26X12	6/10/2018	4.5		5229		2.9		133		< 0.038	QU	2.2		< 0.08	QU	18.5		10.9	
X13	T26X13	6/10/2018	6.0		5148		2.9		166		1.255		1.9		2.22		< 16	QU	13.0	
X14	T26X14	6/10/2018	5.4		7271		11.8		545	QH	< 0.038	QU	2.7		1.45		17.9		18.3	
X15	T26X15	6/10/2018	4.6		6504		11.3		455		1.844		2.4		2.86		22.4		23.0	
X16	T26X16	6/10/2018	< 1.8	QU	3898		5.7		157		< 0.038	QU	2.7		2.52		< 16	QU	11.0	
X17	T26X17	6/10/2018	< 1.8	QU	2191		< 0.27	QU	91		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	< 7.8	QU
X18	T26X18	6/10/2018	2.3		4025		2.3		89	QL	< 0.038	QU	1.3		< 0.08	QU	< 16	QU	11.3	
X19	T26X19	6/10/2018	4.9		4304		2.8		131		< 0.038	QU	1.8		0.25		< 16	QU	11.3	
X2	T26X2	6/10/2018	8.7		4983		4.2		174		4.920		2.0		9.32		40.0		12.5	
X20	T26X20	6/10/2018	4.5		4795		2.9		194		< 0.038	QU	1.9		0.12	QL	< 16	QU	10.3	
X21	T26X21	6/10/2018	< 1.8	QU	3715		4.7		200		< 0.038	QU	1.6		0.22		< 16	QU	28.0	
X22	T26X22	6/10/2018	2.6		4056		2.6		154		0.617		1.8		< 0.08	QU	< 16	QU	12.1	
X23	T26X23	6/10/2018	4.7		4826		18.4		293		2.154		1.9		1.01		< 16	QU	17.9	
X24	T26X24	6/10/2018	5.5		5103		4.1		148		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	11.0	
X25	T26X25	6/10/2018	7.5		5783		3.0		166		1.402		2.2		2.23		21.9		14.4	
X26	T26X26	6/10/2018	2.3		4113		5.6		220		< 0.038	QU	3.0		0.29		< 16	QU	11.6	
X27	T26X27	6/10/2018	2.7		4489		4.8		242		< 0.038	QU	2.2		< 0.08	QU	< 16	QU	14.2	
X28	T26X28	6/10/2018	7.3		5591		3.2		168		< 0.038	QU	1.9		1.69		< 16	QU	13.4	
X29	T26X29	6/10/2018	3.4		5159		4.2		190		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	12.8	
X3	T26X3	6/10/2018	5.9		5549		4.5		215		< 0.038	QU	1.5		2.22		26.9		11.8	
X30	T26X30	6/10/2018	4.2		4663		2.9		140		< 0.038	QU	1.6		0.34		17.5		12.4	
X31	T26X31	6/10/2018	7.0		5234		2.6		181		3.404		1.6		1.59		< 16	QU	12.7	
X32	T26X32	6/10/2018	< 1.8	QU	5144		7.8		244		1.379		2.3		< 0.08	QU	< 16	QU	15.2	
X33	T26X33	6/10/2018	3.0		5171		6.5		191		< 0.038	QU	2.0		0.47		< 16	QU	14.6	
X34	T26X34	6/10/2018	5.5		5355		2.6		144		< 0.038	QU	1.8		< 0.08	QU	< 16	QU	13.3	
X35	T26X35	6/10/2018	< 1.8	QU	3856		4.9		165		< 0.038	QU	2.0		0.55		< 16	QU	11.9	

Table I3-26. Validated XRF Field Survey Results for Non-AUM Target M5-09 (T26)

Grid ID	Unique_X	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
X36	T26X36	6/10/2018	3.2		4619		2.8		245		< 0.038	QU	1.9		< 0.08	QU	< 16	QU	18.0	
X37	T26X37	6/10/2018	< 1.8	QU	3555		5.3		173		< 0.038	QU	1.9		0.18		< 16	QU	10.9	
X38	T26X38	6/10/2018	6.6		5384		4.6		156		< 0.038	QU	1.6		< 0.08	QU	< 16	QU	10.0	
X4	T26X4	6/10/2018	4.3		5816		5.8		299		2.745		2.0		4.74		23.9		30.8	
X5	T26X5	6/10/2018	2.7		6052		18.9		482	QH	1.206		3.1		1.87		< 16	QU	24.6	
X6	T26X6	6/10/2018	5.3		6999		7.9		378		< 0.038	QU	2.7		1.76		< 16	QU	25.2	
X7	T26X7	6/10/2018	5.4		6660		4.4		196		< 0.038	QU	1.6		10.09		162.9		14.8	
X8	T26X8	6/10/2018	6.6		6224		4.1		216		5.088		1.4		7.71		49.0		14.8	
X9	T26X9	6/10/2018	7.0		5909		3.0		198		2.392		1.2		8.16		57.1		13.6	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-27. Validated XRF Field Survey Results for Non-AUM Target M4-02 (T27)

Grid ID	Unique_X	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
X1	T27X1	6/10/2018	< 1.8	QU	3408		6.0		179		< 0.038	QU	1.8		< 0.08	QU	< 16	QU	15.7	
X10	T27X10	6/10/2018	< 1.8	QU	3954		10.1		413		0.821		1.8		0.77		< 16	QU	22.5	
X11	T27X11	6/10/2018	< 1.8	QU	4292		8.1		225		< 0.038	QU	2.6		0.74		< 16	QU	17.1	
X12	T27X12	6/10/2018	< 1.8	QU	4173		5.3		202		4.464		1.7		0.22		< 16	QU	19.6	
X13	T27X13	6/10/2018	< 1.8	QU	6524		7.2		283		2.136		2.6		1.58		18.8		21.4	
X14	T27X14	6/10/2018	< 1.8	QU	5237		10.4		365		0.518		2.9		2.08		17.1		21.1	
X15	T27X15	6/10/2018	< 1.8	QU	3810		8.3		207		< 0.038	QU	2.0		1.24		< 16	QU	17.3	
X16	T27X16	6/10/2018	< 1.8	QU	3813		6.6		213		4.110		2.7		< 0.08	QU	< 16	QU	19.7	
X17	T27X17	6/10/2018	< 1.8	QU	2862		2.0		152		1.161		1.0		< 0.08	QU	< 16	QU	24.5	
X18	T27X18	6/10/2018	< 1.8	QU	5869		3.8		146		1.642		2.4		< 0.08	QU	16.9		25.4	
X19	T27X19	6/10/2018	< 1.8	QU	4395		7.4		285		< 0.038	QU	2.8		1.29		< 16	QU	18.9	
X2	T27X2	6/10/2018	< 1.8	QU	3751		6.5		218		0.853		1.3		0.24		17.5		17.3	
X20	T27X20	6/10/2018	< 1.8	QU	3163		5.5		182		1.518		1.4		< 0.08	QU	< 16	QU	17.4	
X21	T27X21	6/10/2018	< 1.8	QU	5344		7.2		263		2.059		2.7		1.78		< 16	QU	21.8	
X22	T27X22	6/10/2018	< 1.8	QU	3072		2.8		148		3.028		< 1	QU	< 0.08	QU	< 16	QU	20.9	
X23	T27X23	6/10/2018	< 1.8	QU	4480		5.7		178		1.283		2.4		< 0.08	QU	17.0		15.3	
X24	T27X24	6/10/2018	< 1.8	QU	3265		2.6		387		5.339		< 1	QU	1.36		19.5		28.3	
X25	T27X25	6/10/2018	< 1.8	QU	5360		6.8		214		1.223		2.1		0.19		< 16	QU	18.6	
X26	T27X26	6/10/2018	< 1.8	QU	3618		3.6		219		2.947		< 1	QU	< 0.08	QU	< 16	QU	19.2	
X3	T27X3	6/10/2018	< 1.8	QU	4567		8.5		375		0.747		1.5		0.55		25.1		20.4	
X4	T27X4	6/10/2018	< 1.8	QU	3417		6.6		196		0.648		1.2		< 0.08	QU	< 16	QU	14.7	
X5	T27X5	6/10/2018	< 1.8	QU	4611		7.3		210		< 0.038	QU	1.7		< 0.08	QU	< 16	QU	19.0	
X6	T27X6	6/10/2018	2.2		5647		15.3		416		< 0.038	QU	2.9		1.55		27.3		24.1	
X7	T27X7	6/10/2018	< 1.8	QU	4559		7.9		527	QH	3.974		2.4		0.63		< 16	QU	27.7	
X8	T27X8	6/10/2018	< 1.8	QU	2474		1.4		199		4.172		< 1	QU	< 0.08	QU	< 16	QU	32.9	
X9	T27X9	6/10/2018	< 1.8	QU	5109		9.8		440		0.691		1.5		1.44		< 16	QU	20.0	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-30. Validated XRF Field Survey Results for Non-AUM Target M1-07 (T30)

Grid ID	Unique_X	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
X1	T30X1	9/25/2018	< 1.8	QU	5567		10.1		314		3.032		2.0		< 0.08	QU	< 16	QU	16.9	
X10	T30X10	9/25/2018	2.5		5712		11.1		322		0.785		2.8		3.15		< 16	QU	36.7	
X11	T30X11	9/25/2018	2.4		5444		9.1		312		0.970		3.0		4.01		< 16	QU	26.9	
X12	T30X12	9/25/2018	3.2		7000		7.7		353		0.517		3.1		1.58		17.9		17.6	
X13	T30X13	9/25/2018	2.5		5459		10.8		368		< 0.038	QU	2.7		2.02		< 16	QU	24.0	
X14	T30X14	9/25/2018	2.3		6347		6.5		291		1.857		2.6		0.25		< 16	QU	16.4	
X15	T30X15	9/25/2018	3.6		7351		10.7		375		< 0.038	QU	3.2		2.81		< 16	QU	19.9	
X16	T30X16	9/25/2018	3.2		6107		9.9		327		0.693		2.3		1.43		< 16	QU	21.7	
X17	T30X17	9/25/2018	< 1.8	QU	6069		10.5		380		< 0.038	QU	2.6		3.57		< 16	QU	22.1	
X18	T30X18	9/25/2018	2.1		6018		9.6		271		< 0.038	QU	2.1		2.18		< 16	QU	25.1	
X19	T30X19	9/25/2018	< 1.8	QU	5671		8.7		247		0.377		2.6		2.12		< 16	QU	16.3	
X2	T30X2	9/25/2018	3.4		6343		12.7		344		< 0.038	QU	2.8		1.99		17.5		21.6	
X20	T30X20	9/25/2018	< 1.8	QU	6019		10.8		320		< 0.038	QU	2.5		1.61		< 16	QU	18.7	
X21	T30X21	9/25/2018	< 1.8	QU	5704		12.7		304		0.577		2.2		1.29		< 16	QU	20.1	
X22	T30X22	9/25/2018	3.0		6366		12.7		503	QH	1.763		3.2		1.74		< 16	QU	28.1	
X23	T30X23	9/25/2018	2.3		6110		10.6		275		0.044		4.4		1.32		< 16	QU	18.9	
X24	T30X24	9/25/2018	3.1		5756		11.0		278		< 0.038	QU	2.6		4.06		< 16	QU	25.0	
X25	T30X25	9/25/2018	3.6		6430		16.6		340		0.628		3.0		2.12		< 16	QU	23.5	
X26	T30X26	9/25/2018	3.4		6666		9.9		410		2.338		2.8		3.38		24.3		20.7	
X27	T30X27	9/25/2018	3.1		7210		11.5		371		< 0.038	QU	3.3		3.54		21.0		22.9	
X28	T30X28	9/25/2018	2.2		6258		9.8		329		0.544		2.6		0.99		18.4		22.7	
X29	T30X29	9/25/2018	1.9		6153		12.1		307		1.444		3.4		1.87		20.5		19.4	
X3	T30X3	9/25/2018	4.3		7636		10.8		295		3.024		3.4		1.57		25.9		22.6	
X30	T30X30	9/25/2018	2.6		6181		12.0		332		0.960		3.4		3.00		< 16	QU	21.9	
X4	T30X4	9/25/2018	2.6		7218		12.9		439		< 0.038	QU	2.6		1.85		< 16	QU	25.3	
X5	T30X5	9/25/2018	< 1.8	QU	5358		7.6		307		2.022		2.5		2.87		< 16	QU	17.8	
X6	T30X6	9/25/2018	< 1.8	QU	5515		11.3		283		< 0.038	QU	2.6		1.65		17.9		23.0	
X7	T30X7	9/25/2018	2.0		6211		7.8		300		< 0.038	QU	2.5		0.78		18.7		16.9	
X8	T30X8	9/25/2018	< 1.8	QU	4276		6.5		147		< 0.038	QU	1.9		0.17		< 16	QU	14.5	
X9	T30X9	9/25/2018	2.4		6578		7.0		381		1.310		2.3		2.57		24.4		21.6	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-31. Validated XRF Field Survey Results for Non-AUM Target M1-08 (T31)

Grid ID	Unique_X	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
G1	T31G1	9/25/2018	3.2		6784		9.4		372		< 0.038	QU	2.8		1.57		< 16	QU	21.2	
G10	T31G10	9/25/2018	< 1.8	QU	5701		13.4		457		< 0.038	QU	2.4		3.92		16.1		21.3	
G11	T31G11	9/25/2018	2.0		5367		10.7		270		0.063		2.3		2.32		< 16	QU	14.8	
G12	T31G12	9/25/2018	4.4		4352		4.9		383		7.310		2.4		3.96		< 16	QU	34.3	
G13	T31G13	9/25/2018	< 1.8	QU	5017		9.2		349		< 0.038	QU	3.0		1.13		< 16	QU	16.1	
G2	T31G2	9/25/2018	< 1.8	QU	4563		6.4		202		< 0.038	QU	1.2		1.16		< 16	QU	15.2	
G3	T31G3	9/25/2018	< 1.8	QU	4404		10.3		232		3.117		1.8		1.03		< 16	QU	18.7	
G4	T31G4	9/25/2018	< 1.8	QU	5104		8.3		353		< 0.038	QU	2.3		0.98		< 16	QU	16.0	
G5	T31G5	9/25/2018	< 1.8	QU	5012		9.7		235		0.445		2.9		3.05		< 16	QU	17.2	
G6	T31G6	9/25/2018	< 1.8	QU	4676		6.6		295		< 0.038	QU	2.5		0.99		< 16	QU	12.9	
G7	T31G7	9/25/2018	< 1.8	QU	4681		8.8		213		< 0.038	QU	2.7		2.50		< 16	QU	17.3	
G8	T31G8	9/25/2018	< 1.8	QU	4800		5.5		464		11.192		2.5		3.18		< 16	QU	54.6	
G9	T31G9	9/25/2018	< 1.8	QU	5150		12.3		302		< 0.038	QU	2.3		2.47		< 16	QU	18.8	
X1	T31X1	7/17/2018	3.5		5314		13.8		455		< 0.038	QU	2.9		2.09		18.8		28.9	
X10	T31X10	7/17/2018	< 1.8	QU	7547		6.4		427		1.381		3.8		0.24		35.4		33.8	
X11	T31X11	7/17/2018	2.5		4644		13.4		429		< 0.038	QU	3.0		1.63		< 16	QU	20.3	
X12	T31X12	7/17/2018	< 1.8	QU	4726		9.1		263		< 0.038	QU	2.0		1.24		17.4		22.0	
X13	T31X13	7/17/2018	2.3		5185		10.1		437		3.587		2.0		2.09		17.8		31.3	
X14	T31X14	7/17/2018	2.4		4047		5.0		222		2.411		1.6		1.46		< 16	QU	18.4	
X15	T31X15	7/17/2018	< 1.8	QU	3859		8.0		229		0.128		1.3		0.12	QL	< 16	QU	19.8	
X16	T31X16	7/17/2018	4.5		5240		20.7		573	QH	2.565		2.4		2.37		27.6		26.6	
X17	T31X17	7/17/2018	< 1.8	QU	3809		8.7		309		< 0.038	QU	1.7		< 0.08	QU	< 16	QU	17.0	
X18	T31X18	7/17/2018	< 1.8	QU	3268		8.2		244		< 0.038	QU	1.5		< 0.08	QU	< 16	QU	16.8	
X19	T31X19	7/17/2018	< 1.8	QU	2103		5.1		134		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	12.6	
X2	T31X2	7/17/2018	3.5		5598		14.5		331		1.558		2.4		2.11		19.9		26.6	
X20	T31X20	7/17/2018	< 1.8	QU	3230		4.2		326		3.658		1.5		1.43		< 16	QU	18.3	
X21	T31X21	7/17/2018	< 1.8	QU	3089		9.8		313		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	18.0	
X22	T31X22	7/17/2018	< 1.8	QU	3480		7.3		257		< 0.038	QU	1.7		0.15		< 16	QU	16.3	
X23	T31X23	7/17/2018	< 1.8	QU	4354		7.5		287		1.341		1.9		0.40		21.5		20.0	
X24	T31X24	7/17/2018	< 1.8	QU	2539		4.3		151		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	12.6	
X25	T31X25	7/17/2018	< 1.8	QU	2278		4.8		175		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	16.5	
X26	T31X26	7/17/2018	2.6		5837		11.4		531	QH	3.395		2.9		3.08		29.6		29.8	
X27	T31X27	7/17/2018	3.5		5837		15.2		545	QH	0.743		2.9		3.02		< 16	QU	28.1	
X28	T31X28	7/17/2018	< 1.8	QU	4155		7.0		287		0.610		3.0		2.49		17.4		19.5	
X29	T31X29	7/17/2018	< 1.8	QU	2567		2.6		123		< 0.038	QU	< 1	QU	< 0.08	QU	< 16	QU	12.3	
X3	T31X3	7/17/2018	2.2		5344		10.9		364		< 0.038	QU	2.7		0.60		< 16	QU	24.0	
X30	T31X30	7/17/2018	< 1.8	QU	4467		3.9		193		< 0.038	QU	1.8		< 0.08	QU	< 16	QU	16.8	
X4	T31X4	7/17/2018	< 1.8	QU	3024		4.4		164		1.189		1.3		0.41		< 16	QU	16.0	
X5	T31X5	7/17/2018	< 1.8	QU	6299		7.1		298		< 0.038	QU	3.3		< 0.08	QU	< 16	QU	23.6	
X6	T31X6	7/17/2018	2.3		5852		18.4		375		1.799		2.4		1.34		25.9		37.9	
X7	T31X7	7/17/2018	< 1.8	QU	5389		13.1		292		1.341		2.7		1.43		19.9		23.0	
X8	T31X8	7/17/2018	< 1.8	QU	4389		8.4		389		< 0.038	QU	1.3		0.72		< 16	QU	23.9	
X9	T31X9	7/17/2018	< 1.8	QU	3858		5.6		526	QH	4.202		1.6		3.14		< 16	QU	30.0	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-32. Validated XRF Field Survey Results for Non-AUM Target M2-01 (T32)

Grid ID	Unique_X	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
X1	T32X1	6/20/2018	3.7		6431		6.3		244		< 0.038	QU	2.9		0.95		24.6		24.1	
X10	T32X10	6/20/2018	< 1.8	QU	4367		8.8		628	QH	0.241		2.2		< 0.08	QU	17.5		19.8	
X11	T32X11	6/20/2018	1.9		5678		7.5		336		< 0.038	QU	3.2		< 0.08	QU	16.1		22.3	
X12	T32X12	6/20/2018	< 1.8	QU	5572		10.7		355		< 0.038	QU	2.3		0.80		22.1		21.9	
X13	T32X13	6/20/2018	< 1.8	QU	5858		8.2		827	QH	3.980		2.1		2.23		23.1		29.9	
X14	T32X14	6/20/2018	< 1.8	QU	4738		5.9		412		2.587		1.9		1.29		< 16	QU	27.7	
X15	T32X15	6/20/2018	2.2		5325		6.7		236		0.238		1.8		< 0.08	QU	24.8		21.9	
X16	T32X16	6/20/2018	2.7		4682		8.3		284		4.141		2.3		2.74		22.3		29.4	
X2	T32X2	6/20/2018	< 1.8	QU	6185		6.4		247		< 0.038	QU	1.8		1.41		28.1		21.7	
X3	T32X3	6/20/2018	< 1.8	QU	4913		6.2		280		0.800		1.4		1.43		23.3		22.6	
X4	T32X4	6/20/2018	< 1.8	QU	3349		4.2		157		4.369		< 1	QU	1.01		< 16	QU	18.0	
X5	T32X5	6/20/2018	< 1.8	QU	5287		7.2		256		3.138		1.6		1.49		21.6		21.3	
X6	T32X6	6/20/2018	< 1.8	QU	5993		6.7		265		< 0.038	QU	2.7		< 0.08	QU	24.6		22.8	
X7	T32X7	6/20/2018	< 1.8	QU	4451		5.6		328		0.870		1.2		1.06		20.5		21.2	
X8	T32X8	6/20/2018	2.0		5673		6.3		263		< 0.038	QU	2.7		0.59		22.0		22.7	
X9	T32X9	6/20/2018	< 1.8	QU	5206		7.0		246		< 0.038	QU	1.9		0.72		20.6		20.8	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

Table I3-33. Validated XRF Field Survey Results for Non-AUM Target KE-01 (T33)

Grid ID	Unique_X	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
X11	T33X11	7/17/2018	< 1.8	QU	2609		1.1		88	QL	< 0.038	QU	< 1	QU	1.80		< 16	QU	15.1	
X18	T33X18	7/17/2018	32.5		7767		6.8		272		< 0.038	QU	2.8		8.73		32.1		30.0	
X19	T33X19	7/17/2018	< 1.8	QU	2574		1.5		134		1.402		< 1	QU	1.48		< 16	QU	12.8	
X20	T33X20	7/17/2018	< 1.8	QU	6983		6.0		279		< 0.038	QU	2.0		8.23		45.9		26.1	
X26	T33X26	7/17/2018	26.1		6885		6.2		270		0.503		2.6		5.61		22.3		28.3	
X27	T33X27	7/17/2018	< 1.8	QU	3098		4.2		165		< 0.038	QU	< 1	QU	1.59		< 16	QU	16.0	
X28	T33X28	7/17/2018	< 1.8	QU	5712		8.2		251		< 0.038	QU	3.0		5.53		< 16	QU	28.7	
X34	T33X34	7/17/2018	13.7		5529		3.7		203		2.340		2.5		5.65		< 16	QU	28.3	
X35	T33X35	7/17/2018	< 1.8	QU	3932		4.8		178		0.600		1.1		2.57		< 16	QU	18.6	
X36	T33X36	7/17/2018	< 1.8	QU	6334		5.0		235		0.781		2.3		3.21		28.3		29.1	
X42	T33X42	7/17/2018	14.6		7772		4.3		199		2.728		2.0		7.53		20.9		26.1	
X43	T33X43	7/17/2018	4.3		9239		8.0		293		< 0.038	QU	4.2		8.35		32.0		38.6	
X49	T33X49	7/17/2018	9.6		6108		8.1		284		< 0.038	QU	2.7		5.36		26.3		23.3	
X50	T33X50	7/17/2018	< 1.8	QU	3519		3.6		259		< 0.038	QU	< 1	QU	2.69		< 16	QU	18.2	
X55	T33X55	7/17/2018	3.3		4097		2.9		232		3.115		1.5		2.02		< 16	QU	18.3	

Notes:

mg/kg	Milligrams per kilogram
QH	Qualifier is given to a reported value where the XRF reported value is detected but is greater than the maximum XRF value used in the correlation (XRF_{MAX}).
QL	Qualifier is given to a reported value where the XRF reported value is detected but is less than the minimum XRF value used in the correlation (XRF_{MIN}) but greater than the XRF value which would equal a zero laboratory concentration (XRF_{O}).
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 no nondetect and reported as the maximum observed laboratory MDL for that analyte.
XRF	X-ray fluorescence

ATTACHMENT I4

LIST OF TABLES

LIST OF TABLES

Executive Summary

I-ES-1 COPC Screening Summary at Non-AUM Targets Addressed in Report
I-ES-2 NORM/TENORM Screening Summary at Non-AUM Targets Addressed in Report

Sections 1 to 3

I-1 Summary of Regions and Subarea Groups
I-2 Subgroup AUMs and Targets
I-3 Baseline Study Data Quality Objective Roadmap
I-4 Detection Systems Used in the Non-AUM Target Gamma Radiation Surveys
I-5 Summary of Detection Equipment and Calibration Information
I-6 High Pressure Ionization Chamber Equipment Usage Summary
I-7 Non-AUM Target Groups Addressed in Report
I-8 Previous Investigations at Non-AUM Targets Address in Report
I-9 Summary of Geologic Formations
I-10 Applied Background Threshold Value Summary Table

Section 4

I1-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target BR-01 (T1)
I1-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BR-01 (T1)
I1-3 Summary of Surface Soil Sample Locations at Non-AUM Target BR-01 (T1)
I1-4 Summary of Subsurface Soil Sample Locations at Non-AUM Target BR-01 (T1)
I1-5 Summary of Analytical Methods for Metals in Surface and Subsurface Soil Samples at Non-AUM Target BR-01 (T1)
I1-6 Summary of Analytical Methods for Select Radionuclides in Surface and Subsurface Soil Samples at Non-AUM Target BR-01 (T1)
I1-7 Summary of Geochemical Analytical Methods for Metals in Surface and Subsurface Soil Samples at Non-AUM Target BR-01 (T1)
I1-8 Summary of Geochemical Analytical Methods for Radionuclides in Surface and Subsurface Soil Samples
I1-9 Applied Background Threshold Value for Non-AUM Target BR-01 (T1)
I1-10 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target BR-01 (T1)
I1-11 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BR-01 (T1)

LIST OF TABLES (CONTINUED)

I1-12 Laboratory Analytical Results for Surface and Subsurface Soil Samples at Non-AUM Target BR-01 (T1)

I1-13 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target BR-01 (T1)

I1-14 Laboratory Analytical Results for Surface Soil Geochemical Parameters at Non-AUM Target BR-01 (T1)

I1-15 All Analytes Greater Than Background Threshold Values at Non-AUM Target BR-01 (T1)

I3-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target BR-03 (T3)

I3-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BR-03 (T3)

I3-3 Applied Background Threshold Value for Non-AUM Target BR-03 (T3)

I3-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target BR-03 (T3)

I3-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BR-03 (T3)

I3-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target BR-03 (T3)

I3-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target BR-03 (T3)

I4-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target BR-04 (T4)

I4-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BR-04 (T4)

I4-3 Applied Background Threshold Value for Non-AUM Target BR-04 (T4)

I4-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target BR-04 (T4)

I4-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BR-04 (T4)

I4-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target BR-04 (T4)

I4-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target BR-04 (T4)

LIST OF TABLES (CONTINUED)

I5-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target BR-05 (T5)

I5-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BR-05 (T5)

I5-3 Applied Background Threshold Value for Non-AUM Target BR-05 (T5)

I5-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target BR-05 (T5)

I5-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BR-05 (T5)

I5-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target BR-05 (T5)

I5-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target BR-05 (T5)

Section 5

I6-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target BR-06 (T6)

I6-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BR-06 (T6)

I6-3 Applied Background Threshold Value for Non-AUM Target BR-06 (T6)

I6-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target BR-06 (T6)

I6-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BR-06 (T6)

I6-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target BR-06 (T6)

I6-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target BR-06 (T6)

I7-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target BK-01 (T7)

I7-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BK-01 (T7)

I7-3 Applied Background Threshold Value for Non-AUM Target BK-01 (T7)

I7-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target BK-01 (T7)

I7-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BK-01 (T7)

I7-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target BK-01 (T7)

LIST OF TABLES (CONTINUED)

I7-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target BK-01 (T7)

I8-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target BK-02 (T8)

I8-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target BK-03 (T8)

I8-3 Applied Background Threshold Value for Non-AUM Target BK-02 (T8)

I8-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target BK-02 (T8)

I8-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target BK-02 (T8)

I8-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target BK-02 (T8)

I8-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target BK-02 (T8)

Section 6

I10-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target CT-01 (T10)

I10-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target CT-01 (T10)

I10-3 Applied Background Threshold Value for Non-AUM Target CT-01 (T10)

I10-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target CT-01 (T10)

I10-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target CT-01 (T10)

I10-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target CT-01 (T10)

I10-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target CT-01 (T10)

I11-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target CT-02 (T11)

I11-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target CT-02 (T11)

I11-3 Applied Background Threshold Value for Non-AUM Target CT-02 (T11)

I11-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target CT-02 (T11)

LIST OF TABLES (CONTINUED)

I11-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target CT-02 (T11)

I11-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target CT-02 (T11)

I11-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target CT-02 (T11)

I12-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target CT-03 (T12)

I12-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target CT-03 (T12)

I12-3 Applied Background Threshold Value for Non-AUM Target CT-03 (T12)

I12-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target CT-03 (T12)

I12-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target CT-03 (T12)

I12-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target CT-03 (T12)

I12-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target CT-03 (T12)

Section 7

I13-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M1-01 (T13)

I13-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M1-01 (T13)

I13-3 Applied Background Threshold Value for Non-AUM Target M1-01 (T13)

I13-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M1-01 (T13)

I13-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M1-01 (T13)

I13-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M1-01 (T13)

I13-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M1-01 (T13)

I14-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M1-02 (T14)

LIST OF TABLES (CONTINUED)

I14-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M1-02 (T14)

I14-3 Applied Background Threshold Value for Non-AUM Target M1-02 (T14)

I14-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M1-02 (T14)

I14-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M1-02 (T14)

I14-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M1-02 (T14)

I14-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M1-02 (T14)

I15-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M1-03 (T15)

I15-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M1-03 (T15)

I15-3 Applied Background Threshold Value for Non-AUM Target M1-03 (T15)

I15-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M1-03 (T15)

I15-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M1-03 (T15)

I15-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M1-03 (T15)

I15-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M1-03 (T15)

Section 8

I18-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-01 (T18)

I18-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-01 (T18)

I18-3 Applied Background Threshold Value for Non-AUM Target M5-01 (T18)

I18-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-01 (T18)

I18-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-01 (T18)

LIST OF TABLES (CONTINUED)

I18-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-01 (T18)

I18-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-01 (T18)

I19-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-02 (T19)

I19-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-02 (T19)

I19-3 Applied Background Threshold Value for Non-AUM Target M5-02 (T19)

I19-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-02 (T19)

I19-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-02 (T19)

I19-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-02 (T19)

I19-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-02 (T19)

I20-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-03 (T20)

I20-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-03 (T20)

I20-3 Applied Background Threshold Value for Non-AUM Target M5-03 (T20)

I20-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-03 (T20)

I20-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-03 (T20)

I20-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-03 (T20)

I20-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-03 (T20)

I21-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-05 (T21)

I21-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-05 (T21)

LIST OF TABLES (CONTINUED)

I21-3 Applied Background Threshold Value for Non-AUM Target M5-05 (T21)

I21-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-05 (T21)

I21-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-05 (T21)

I21-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-05 (T21)

I21-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-05 (T21)

I22-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-06 (T22)

I22-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-06 (T22)

I22-3 Applied Background Threshold Value for Non-AUM Target M5-06 (T22)

I22-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-06 (T22)

I22-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-06 (T22)

I22-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-06 (T22)

I22-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-06 (T22)

I24-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-07 (T24)

I24-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-07 (T24)

I24-3 Applied Background Threshold Value for Non-AUM Target M5-07 (T24)

I24-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-07 (T24)

I24-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-07 (T24)

I24-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-07 (T24)

I24-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-07 (T24)

LIST OF TABLES (CONTINUED)

I25-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-08 (T25)

I25-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-08 (T25)

I25-3 Applied Background Threshold Value for Non-AUM Target M5-08 (T25)

I25-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-08 (T25)

I25-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-08 (T25)

I25-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-08 (T25)

I25-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-08 (T25)

I26-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M5-09 (T26)

I26-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M5-09 (T26)

I26-3 Applied Background Threshold Value for Non-AUM Target M5-09 (T26)

I26-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M5-09 (T26)

I26-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M5-09 (T26)

I26-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M5-09 (T26)

I26-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M5-09 (T26)

Section 9

I27-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M4-02 (T27)

I27-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M4-02 (T27)

I27-3 Applied Background Threshold Value for Non-AUM Target M4-02 (T27)

I27-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M4-02 (T27)

LIST OF TABLES (CONTINUED)

I27-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M4-02 (T27)

I27-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M4-02 (T27)

I27-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M4-02 (T27)

Section 10

I30-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M1-07 (T30)

I30-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M1-07 (T30)

I30-3 Applied Background Threshold Value for Non-AUM Target M1-07 (T30)

I30-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M1-07 (T30)

I30-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M1-07 (T30)

I30-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M1-07 (T30)

I30-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M1-07 (T30)

I31-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M1-08 (T31)

I31-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M1-08 (T31)

I31-3 Applied Background Threshold Value for Non-AUM Target M1-08 (T31)

I31-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M1-08 (T31)

I31-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M1-08 (T31)

I31-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M1-08 (T31)

I31-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M1-08 (T31)

LIST OF TABLES (CONTINUED)

I32-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target M2-01 (T32)

I32-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target M2-01 (T32)

I32-3 Applied Background Threshold Value for Non-AUM Target M2-01 (T32)

I32-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target M2-01 (T32)

I32-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target M2-01 (T32)

I32-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target M2-01 (T32)

I32-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target M2-01 (T32)

Section 11

I33-1 Summary of XRF Confirmation Soil Sample Locations at Non-AUM Target KE-01 (T33)

I33-2 Summary of Analytical Methods for XRF Confirmation Soil Samples at Non-AUM Target KE-01 (T33)

I33-3 Applied Background Threshold Value for Non-AUM Target KE-01 (T33)

I33-4 Summary Statistics for Gamma Radiation Survey Results at Non-AUM Target KE-01 (T33)

I33-5 Laboratory Analytical Results for XRF Confirmation Soil Samples at Non-AUM Target KE-01 (T33)

I33-6 XRF Field Survey Results for Selected Analytes of Concern at Non-AUM Target KE-01 (T33)

I33-7 All Analytes Greater Than Background Threshold Values at Non-AUM Target KE-01 (T33)

ATTACHMENT I5

LIST OF FIGURES

LIST OF FIGURES

Sections 1 to 3

I-1 Regional Overview
I-2 Tse Tah Region AUM and Target Map
I-3 Cove Valley and Lukachukai Mountains Regions AUM and Target Map
I-4 Gamma Count Rate Versus Exposure Rate
I-5 Group A AUMs and Non-AUM Targets
I-6 Group B AUMs and Non-AUM Targets
I-7 Group C AUM-Related Targets and Non-AUM Targets
I-8 Group D AUMs and Non-AUM Targets
I-9 Group F AUMs and Non-AUM Targets
I-10 Group G AUMs and Non-AUM Targets
I-11 Group H AUMs and Non-AUM Targets
I-12 Group I AUMs and Non-AUM Targets
I-13 Geologic Map for Group A Non-AUM Targets
I-14 Soils Map for Group A Non-AUM Targets
I-15 Geologic Map for Group B Non-AUM Targets
I-16 Soils Map for Group B Non-AUM Targets
I-17 Geologic Map for Group C Non-AUM Targets
I-18 Soils Map for Group C Non-AUM Targets
I-19 Idealized Stratigraphic Profile of Lukachukai Mountains
I-20 Geologic Map for Group D Non-AUM Targets
I-21 Soils Map for Group D Non-AUM Targets
I-22 Geologic Map for Group F Non-AUM Targets
I-23 Soils Map for Group F Non-AUM Targets
I-24 Geologic Map for Group G Non-AUM Targets
I-25 Soils Map for Group G Non-AUM Targets
I-26 Geologic Map for Group H Non-AUM Targets
I-27 Soils Map for Group H Non-AUM Targets
I-28 Geologic Map for Group I Non-AUM Targets
I-29 Soils Map for Group I Non-AUM Targets

Section 4

I1-1 Non-AUM Target BR-01 (T1) Location and Access Map
I1-2 Non-AUM Target BR-01 (T1) Topographic Map
I1-3 Non-AUM Target BR-01 (T1) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I1-4 Non-AUM Target BR-01 (T1) XRF Field Survey Map
I1-5 Non-AUM Target BR-01 (T1) Surface and Subsurface Soil Sample Location Map

LIST OF FIGURES (CONTINUED)

I1-6 Individual Value Plot of Raw Gamma Radiation Levels at Target BR-01 (T1) and BSA-2 (Qa)
I1-7 Box Plot of Raw Gamma Radiation Levels at Target BR-01 (T1) and BSA-2 (Qa)
I1-8 Non-AUM Target BR-01 (T1) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I1-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target BR-01 (T1) and BSA-2 (Qa)
I1-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target BR-01 (T1) and BSA-2 (Qa)
I1-11 Non-AUM Target BR-01 (T1) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I1-12 Individual Value Plot for Target BR-01 (T1) and BSA-2 (Qa) Arsenic Soil Concentrations
I1-13 Box Plot for Target BR-01 (T1) and BSA-2 (Qa) Arsenic Soil Concentrations
I1-14 Non-AUM Target BR-01 (T1) Surface Soil Arsenic Concentration Map
I1-15 Individual Value Plot for Target BR-01 (T1) and BSA-2 (Qa) Lead Soil Concentrations
I1-16 Box Plot for Target BR-01 (T1) and BSA-2 (Qa) Lead Soil Concentrations
I1-17 Non-AUM Target BR-01 (T1) Surface Soil Lead Concentration Map
I1-18 Individual Value Plot for Target BR-01 (T1) and BSA-2 (Qa) Thorium Soil Concentrations
I1-19 Box Plot for Target BR-01 (T1) and BSA-2 (Qa) Thorium Soil Concentrations
I1-20 Non-AUM Target BR-01 (T1) Surface Soil Thorium Concentration Map
I1-21 Individual Value Plot for Target BR-01 (T1) and BSA-2 (Qa) Uranium Soil Concentrations
I1-22 Box Plot for Target BR-01 (T1) and BSA-2 (Qa) Uranium Soil Concentrations
I1-23 Non-AUM Target BR-01 (T1) Surface Soil Uranium Concentration Map
I1-24 Individual Value Plot for Target BR-01 (T1) and BSA-2 (Qa) Vanadium Soil Concentrations
I1-25 Box Plot for Target BR-01 (T1) and BSA-2 (Qa) Vanadium Soil Concentrations
I1-26 Non-AUM Target BR-01 (T1) Surface Soil Vanadium Concentration Map

I3-1 Non-AUM Target BR-03 (T3) Location and Access Map
I3-2 Non-AUM Target BR-03 (T3) Topographic Map
I3-3 Non-AUM Target BR-03 (T3) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I3-4 Non-AUM Target BR-03 (T3) XRF Field Survey Map
I3-5 Non-AUM Target BR-03 (T3) Surface Soil Sample Location Map
I3-6 Individual Value Plot of Raw Gamma Radiation Levels at Target BR-03 (T3) and BSA-1 (Jms)
I3-7 Box Plot of Raw Gamma Radiation Levels at Target BR-03 (T3) and BSA-1 (Jms)

LIST OF FIGURES (CONTINUED)

I3-8 Non-AUM Target BR-03 (T3) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I3-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target BR-03 (T3) and BSA-1 (Jms)
I3-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target BR-03 (T3) and BSA-1 (Jms)
I3-11 Non-AUM Target BR-03 (T3) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I3-12 Individual Value Plot for Target BR-03 (T3) and BSA-1 (Jms) Arsenic Soil Concentrations
I3-13 Box Plot for Target BR-03 (T3) and BSA-1 (Jms) Arsenic Soil Concentrations
I3-14 Non-AUM Target BR-03 (T3) Surface Soil Arsenic Concentration Map
I3-15 Individual Value Plot for Target BR-03 (T3) and BSA-1 (Jms) Lead Soil Concentrations
I3-16 Box Plot for Target BR-03 (T3) and BSA-1 (Jms) Lead Soil Concentrations
I3-17 Non-AUM Target BR-03 (T3) Surface Soil Lead Concentration Map
I3-18 Individual Value Plot for Target BR-03 (T3) and BSA-1 (Jms) Thorium Soil Concentrations
I3-19 Box Plot for Target BR-03 (T3) and BSA-1 (Jms) Thorium Soil Concentrations
I3-20 Non-AUM Target BR-03 (T3) Surface Soil Thorium Concentration Map
I3-21 Individual Value Plot for Target BR-03 (T3) and BSA-1 (Jms) Uranium Soil Concentrations
I3-22 Box Plot for Target BR-03 (T3) and BSA-1 (Jms) Uranium Soil Concentrations
I3-23 Non-AUM Target BR-03 (T3) Surface Soil Uranium Concentration Map
I3-24 Individual Value Plot for Target BR-03 (T3) and BSA-1 (Jms) Vanadium Soil Concentrations
I3-25 Box Plot for Target BR-03 (T3) and BSA-1 (Jms) Vanadium Soil Concentrations
I3-26 Non-AUM Target BR-03 (T3) Surface Soil Vanadium Concentration Map

I4-1 Non-AUM Target BR-04 (T4) Location and Access Map
I4-2 Non-AUM Target BR-04 (T4) Topographic Map
I4-3 Non-AUM Target BR-04 (T4) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I4-4 Non-AUM Target BR-04 (T4) XRF Field Survey Map
I4-5 Non-AUM Target BR-04 (T4) Surface Soil Sample Location Map
I4-6 Individual Value Plot of Raw Gamma Radiation Levels at Target BR-04 (T4) and BSA-1 (Jms)
I4-7 Box Plot of Raw Gamma Radiation Levels at Target BR-04 (T4) and BSA-1 (Jms)
I4-8 Non-AUM Target BR-04 (T4) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I4-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target BR-04 (T4) and BSA-1 (Jms)

LIST OF FIGURES (CONTINUED)

I4-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target BR-04 (T4) and BSA-1 (Jms)
I4-11 Non-AUM Target BR-04 (T4) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I4-12 Individual Value Plot for Target BR-04 (T4) and BSA-1 (Jms) Arsenic Soil Concentrations
I4-13 Box Plot for Target BR-04 (T4) and BSA-1 (Jms) Arsenic Soil Concentrations
I4-14 Non-AUM Target BR-04 (T4) Surface Soil Arsenic Concentration Map
I4-15 Individual Value Plot for Target BR-04 (T4) and BSA-1 (Jms) Lead Soil Concentrations
I4-16 Box Plot for Target BR-04 (T4) and BSA-1 (Jms) Lead Soil Concentrations
I4-17 Non-AUM Target BR-04 (T4) Surface Soil Lead Concentration Map
I4-18 Individual Value Plot for Target BR-04 (T4) and BSA-1 (Jms) Thorium Soil Concentrations
I4-19 Box Plot for Target BR-04 (T4) and BSA-1 (Jms) Thorium Soil Concentrations
I4-20 Non-AUM Target BR-04 (T4) Surface Soil Thorium Concentration Map
I4-21 Individual Value Plot for Target BR-04 (T4) and BSA-1 (Jms) Uranium Soil Concentrations
I4-22 Box Plot for Target BR-04 (T4) and BSA-1 (Jms) Uranium Soil Concentrations
I4-23 Non-AUM Target BR-04 (T4) Surface Soil Uranium Concentration Map
I4-24 Individual Value Plot for Target BR-04 (T4) and BSA-1 (Jms) Vanadium Soil Concentrations
I4-25 Box Plot for Target BR-04 (T4) and BSA-1 (Jms) Vanadium Soil Concentrations
I4-26 Non-AUM Target BR-04 (T4) Surface Soil Vanadium Concentration Map

I5-1 Non-AUM Target BR-05 (T5) Location and Access Map
I5-2 Non-AUM Target BR-05 (T5) Topographic Map
I5-3 Non-AUM Target BR-05 (T5) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I5-4 Non-AUM Target BR-05 (T5) XRF Field Survey Map
I5-5 Non-AUM Target BR-05 (T5) Surface Soil Sample Location Map
I5-6 Individual Value Plot of Raw Gamma Radiation Levels at Target BR-05 (T5) and BSA-1 (Jms)
I5-7 Box Plot of Raw Gamma Radiation Levels at Target BR-05 (T5) and BSA-1 (Jms)
I5-8 Non-AUM Target BR-05 (T5) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I5-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target BR-05 (T5) and BSA-1 (Jms)
I5-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target BR-05 (T5) and BSA-1 (Jms)
I5-11 Non-AUM Target BR-05 (T5) Grid Averaged Gamma Radiation Levels and Radium-226 Results

LIST OF FIGURES (CONTINUED)

I5-12 Individual Value Plot for Target BR-05 (T5) and BSA-1 (Jms) Arsenic Soil Concentrations
I5-13 Box Plot for Target BR-05 (T5) and BSA-1 (Jms) Arsenic Soil Concentrations
I5-14 Non-AUM Target BR-05 (T5) Surface Soil Arsenic Concentration Map
I5-15 Individual Value Plot for Target BR-05 (T5) and BSA-1 (Jms) Lead Soil Concentrations
I5-16 Box Plot for Target BR-05 (T5) and BSA-1 (Jms) Lead Soil Concentrations
I5-17 Non-AUM Target BR-05 (T5) Surface Soil Lead Concentration Map
I5-18 Individual Value Plot for Target BR-05 (T5) and BSA-1 (Jms) Thorium Soil Concentrations
I5-19 Box Plot for Target BR-05 (T5) and BSA-1 (Jms) Thorium Soil Concentrations
I5-20 Non-AUM Target BR-05 (T5) Surface Soil Thorium Concentration Map
I5-21 Individual Value Plot for Target BR-05 (T5) and BSA-1 (Jms) Uranium Soil Concentrations
I5-22 Box Plot for Target BR-05 (T5) and BSA-1 (Jms) Uranium Soil Concentrations
I5-23 Non-AUM Target BR-05 (T5) Surface Soil Uranium Concentration Map
I5-24 Individual Value Plot for Target BR-05 (T5) and BSA-1 (Jms) Vanadium Soil Concentrations
I5-25 Box Plot for Target BR-05 (T5) and BSA-1 (Jms) Vanadium Soil Concentrations
I5-26 Non-AUM Target BR-05 (T5) Surface Soil Vanadium Concentration Map

I6-1 Non-AUM Target BR-06 (T6) Location and Access Map
I6-2 Non-AUM Target BR-06 (T6) Topographic Map
I6-3 Non-AUM Target BR-06 (T6) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I6-4 Non-AUM Target BR-06 (T6) XRF Field Survey Map
I6-5 Non-AUM Target BR-06 (T6) Surface Soil Sample Location Map
I6-6 Individual Value Plot of Raw Gamma Radiation Levels at Target BR-06 (T6) and BSA-4 (Js)
I6-7 Box Plot of Raw Gamma Radiation Levels at Target BR-06 (T6) and BSA-4 (Js)
I6-8 Non-AUM Target BR-06 (T6) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I6-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target BR-06 (T6) and BSA-4 (Js)
I6-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target BR-06 (T6) and BSA-4 (Js)
I6-11 Non-AUM Target BR-06 (T6) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I6-12 Individual Value Plot for Target BR-06 (T6) and BSA-4 (Js) Arsenic Soil Concentrations
I6-13 Box Plot for Target BR-06 (T6) and BSA-4 (Js) Arsenic Soil Concentrations

LIST OF FIGURES (CONTINUED)

I6-14 Non-AUM Target BR-06 (T6) Surface Soil Arsenic Concentration Map
I6-15 Individual Value Plot for Target BR-06 (T6) and BSA-4 (Js) Lead Soil Concentrations
I6-16 Box Plot for Target BR-06 (T6) and BSA-4 (Js) Lead Soil Concentrations
I6-17 Non-AUM Target BR-06 (T6) Surface Soil Lead Concentration Map
I6-18 Individual Value Plot for Target BR-06 (T6) and BSA-4 (Js) Thorium Soil Concentrations
I6-19 Box Plot for Target BR-06 (T6) and BSA-4 (Js) Thorium Soil Concentrations
I6-20 Non-AUM Target BR-06 (T6) Surface Soil Thorium Concentration Map
I6-21 Individual Value Plot for Target BR-06 (T6) and BSA-4 (Js) Uranium Soil Concentrations
I6-22 Box Plot for Target BR-06 (T6) and BSA-4 (Js) Uranium Soil Concentrations
I6-23 Non-AUM Target BR-06 (T6) Surface Soil Uranium Concentration Map
I6-24 Non-AUM Target BR-06 (T6) Surface Soil Vanadium Concentration Map

Section 5

I7-1 Non-AUM Target BK-01 (T7) Location and Access Map
I7-2 Non-AUM Target BK-01 (T7) Topographic Map
I7-3 Non-AUM Target BK-01 (T7) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I7-4 Non-AUM Target BK-01 (T7) XRF Field Survey Map
I7-5 Non-AUM Target BK-01 (T7) Surface Soil Sample Location Map
I7-6 Individual Value Plot of Raw Gamma Radiation Levels at Target BK-01 (T7) and BSA-5 (Qa)
I7-7 Box Plot of Raw Gamma Radiation Levels at Target BK-01 (T7) and BSA-5 (Qa)
I7-8 Non-AUM Target BK-01 (T7) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I7-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target BK-01 (T7) and BSA-5 (Qa)
I7-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target BK-01 (T7) and BSA-5 (Qa)
I7-11 Non-AUM Target BK-01 (T7) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I7-12 Individual Value Plot for Target BK-01 (T7) and BSA-5 (Qa) Arsenic Soil Concentrations
I7-13 Box Plot for Target BK-01 (T7) and BSA-5 (Qa) Arsenic Soil Concentrations
I7-14 Non-AUM Target BK-01 (T7) Surface Soil Arsenic Concentration Map
I7-15 Individual Value Plot for Target BK-01 (T7) and BSA-5 (Qa) Lead Soil Concentrations
I7-16 Box Plot for Target BK-01 (T7) and BSA-5 (Qa) Lead Soil Concentrations
I7-17 Non-AUM Target BK-01 (T7) Surface Soil Lead Concentration Map

LIST OF FIGURES (CONTINUED)

I7-18 Individual Value Plot for Target BK-01 (T7) and BSA-5 (Qa) Thorium Soil Concentrations
I7-19 Box Plot for Target BK-01 (T7) and BSA-5 (Qa) Thorium Soil Concentrations
I7-20 Non-AUM Target BK-01 (T7) Surface Soil Thorium Concentration Map
I7-21 Individual Value Plot for Target BK-01 (T7) and BSA-5 (Qa) Uranium Soil Concentrations
I7-22 Box Plot for Target BK-01 (T7) and BSA-5 (Qa) Uranium Soil Concentrations
I7-23 Non-AUM Target BK-01 (T7) Surface Soil Uranium Concentration Map
I7-24 Non-AUM Target BK-01 (T7) Surface Soil Vanadium Concentration Map

I8-1 Non-AUM Target BK-02 (T8) Location and Access Map
I8-2 Non-AUM Target BK-02 (T8) Topographic Map
I8-3 Non-AUM Target BK-02 (T8) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I8-4 Non-AUM Target BK-02 (T8) XRF Field Survey Map
I8-5 Non-AUM Target BK-02 (T8) Surface Soil Sample Location Map
I8-6 Individual Value Plot of Raw Gamma Radiation Levels at Target BK-02 (T8) and BSA-5 (Qa)
I8-7 Box Plot of Raw Gamma Radiation Levels at Target BK-02 (T8) and BSA-5 (Qa)
I8-8 Non-AUM Target BK-02 (T8) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I8-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target BK-02 (T8) and BSA-5 (Qa)
I8-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target BK-02 (T8) and BSA-5 (Qa)
I8-11 Non-AUM Target BK-02 (T8) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I8-12 Individual Value Plot for Target BK-02 (T8) and BSA-5 (Qa) Arsenic Soil Concentrations
I8-13 Box Plot for Target BK-02 (T8) and BSA-5 (Qa) Arsenic Soil Concentrations
I8-14 Non-AUM Target BK-02 (T8) Surface Soil Arsenic Concentration Map
I8-15 Individual Value Plot for Target BK-02 (T8) and BSA-5 (Qa) Lead Soil Concentrations
I8-16 Box Plot for Target BK-02 (T8) and BSA-5 (Qa) Lead Soil Concentrations
I8-17 Non-AUM Target BK-02 (T8) Surface Soil Lead Concentration Map
I8-18 Individual Value Plot for Target BK-02 (T8) and BSA-5 (Qa) Thorium Soil Concentrations
I8-19 Box Plot for Target BK-02 (T8) and BSA-5 (Qa) Thorium Soil Concentrations
I8-20 Non-AUM Target BK-02 (T8) Surface Soil Thorium Concentration Map
I8-21 Individual Value Plot for Target BK-02 (T8) and BSA-5 (Qa) Uranium Soil Concentrations

LIST OF FIGURES (CONTINUED)

I8-22 Box Plot for Target BK-02 (T8) and BSA-5 (Qa) Uranium Soil Concentrations
I8-23 Non-AUM Target BK-02 (T8) Surface Soil Uranium Concentration Map
I8-24 Non-AUM Target BK-02 (T8) Surface Soil Vanadium Concentration Map

Section 6

I10-1 Non-AUM Target CT-01 (T10) Location and Access Map
I10-2 Non-AUM Target CT-01 (T10) Topographic Map
I10-3 Non-AUM Target CT-01 (T10) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I10-4 Non-AUM Target CT-01 (T10) XRF Field Survey Map
I10-5 Non-AUM Target CT-01 (T10) Surface Soil Sample Location Map
I10-6 Individual Value Plot of Raw Gamma Radiation Levels at Target CT-01 (T10) and Trc Regional
I10-7 Box Plot of Raw Gamma Radiation Levels at Target CT-01 (T10) and Trc Regional
I10-8 Non-AUM Target CT-01 (T10) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I10-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target CT-01 (T10) and Trc Regional
I10-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target CT-01 (T10) and Trc Regional
I10-11 Non-AUM Target CT-01 (T10) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I10-12 Individual Value Plot for Target CT-01 (T10) and Trc Regional Arsenic Soil Concentrations
I10-13 Box Plot for Target CT-01 (T10) and Trc Regional Arsenic Soil Concentrations
I10-14 Non-AUM Target CT-01 (T10) Surface Soil Arsenic Concentration Map
I10-15 Individual Value Plot for Target CT-01 (T10) and BSA-7 (Trc) Lead Soil Concentrations
I10-16 Box Plot for Target CT-01 (T10) and BSA-7 (Trc) Lead Soil Concentrations
I10-17 Non-AUM Target CT-01 (T10) Surface Soil Lead Concentration Map
I10-18 Individual Value Plot for Target CT-01 (T10) and BSA-7 (Trc) Thorium Soil Concentrations
I10-19 Box Plot for Target CT-01 (T10) and BSA-7 (Trc) Thorium Soil Concentrations
I10-20 Non-AUM Target CT-01 (T10) Surface Soil Thorium Concentration Map
I10-21 Individual Value Plot for Target CT-01 (T10) and Trc Regional Uranium Soil Concentrations
I10-22 Box Plot for Target CT-01 (T10) and Trc Regional Uranium Soil Concentrations
I10-23 Non-AUM Target CT-01 (T10) Surface Soil Uranium Concentration Map
I10-24 Individual Value Plot for Target CT-01 (T10) and Trc Regional Vanadium Soil Concentrations

LIST OF FIGURES (CONTINUED)

I10-25 Box Plot for Target CT-01 (T10) and Trc Regional Vanadium Soil Concentrations
I10-26 Non-AUM Target CT-01 (T10) Surface Soil Vanadium Concentration Map

I11-1 Non-AUM Target CT-02 (T11) Location and Access Map
I11-2 Non-AUM Target CT-02 (T11) Topographic Map
I11-3 Non-AUM Target CT-02 (T11) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I11-4 Non-AUM Target CT-02 (T11) XRF Field Survey Map
I11-5 Non-AUM Target CT-02 (T11) Surface Soil Sample Location Map
I11-6 Individual Value Plot of Raw Gamma Radiation Levels at Target CT-02 (T11) and Trc Regional
I11-7 Box Plot of Raw Gamma Radiation Levels at Target CT-02 (T11) and Trc Regional
I11-8 Non-AUM Target CT-02 (T11) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I11-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target CT-02 (T11) and Trc Regional
I11-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target CT-02 (T11) and Trc Regional
I11-11 Non-AUM Target CT-02 (T11) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I11-12 Individual Value Plot for Target CT-02 (T11) and Trc Regional Arsenic Soil Concentrations
I11-13 Box Plot for Target CT-02 (T11) and Trc Regional Arsenic Soil Concentrations
I11-14 Non-AUM Target CT-02 (T11) Surface Soil Arsenic Concentration Map
I11-15 Individual Value Plot for Target CT-02 (T11) and BSA-7 (Trc) Lead Soil Concentrations
I11-16 Box Plot for Target CT-02 (T11) and BSA-7 (Trc) Lead Soil Concentrations
I11-17 Non-AUM Target CT-02 (T11) Surface Soil Lead Concentration Map
I11-18 Individual Value Plot for Target CT-02 (T11) and BSA-7 (Trc) Thorium Soil Concentrations
I11-19 Box Plot for Target CT-02 (T11) and BSA-7 (Trc) Thorium Soil Concentrations
I11-20 Non-AUM Target CT-02 (T11) Surface Soil Thorium Concentration Map
I11-21 Individual Value Plot for Target CT-02 (T11) and Trc Regional Uranium Soil Concentrations
I11-22 Box Plot for Target CT-02 (T11) and Trc Regional Uranium Soil Concentrations
I11-23 Non-AUM Target CT-02 (T11) Surface Soil Uranium Concentration Map
I11-24 Individual Value Plot for Target CT-02 (T11) and Trc Regional Vanadium Soil Concentrations
I11-25 Box Plot for Target CT-02 (T11) and Trc Regional Vanadium Soil Concentrations
I11-26 Non-AUM Target CT-02 (T11) Surface Soil Vanadium Concentration Map

LIST OF FIGURES (CONTINUED)

I12-1 Non-AUM Target CT-03 (T12) Location and Access Map
I12-2 Non-AUM Target CT-03 (T12) Topographic Map
I12-3 Non-AUM Target CT-03 (T12) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I12-4 Non-AUM Target CT-03 (T12) XRF Field Survey Map
I12-5 Non-AUM Target CT-03 (T12) Surface and Subsurface Soil Sample Location Map
I12-6 Individual Value Plot of Raw Gamma Radiation Levels at Target CT-03 (T12) and Trc Regional
I12-7 Box Plot of Raw Gamma Radiation Levels at Target CT-03 (T12) and Trc Regional
I12-8 Non-AUM Target CT-03 (T12) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I12-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target CT-03 (T12) and Trc Regional
I12-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target CT-03 (T12) and Trc Regional
I12-11 Non-AUM Target CT-03 (T12) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I12-12 Individual Value Plot for Target CT-03 (T12) and BSA-8 (Trc) Arsenic Soil Concentrations
I12-13 Box Plot for Target CT-03 (T12) and BSA-8 (Trc) Arsenic Soil Concentrations
I12-14 Non-AUM Target CT-03 (T12) Surface Soil Arsenic Concentration Map
I12-15 Individual Value Plot for Target CT-03 (T12) and BSA-8 (Trc) Lead Soil Concentrations
I12-16 Box Plot for Target CT-03 (T12) and BSA-8 (Trc) Lead Soil Concentrations
I12-17 Non-AUM Target CT-03 (T12) Surface Soil Lead Concentration Map
I12-18 Individual Value Plot for Target CT-03 (T12) and BSA-8 (Trc) Thorium Soil Concentrations
I12-19 Box Plot for Target CT-03 (T12) and BSA-8 (Trc) Thorium Soil Concentrations
I12-20 Non-AUM Target CT-03 (T12) Surface Soil Thorium Concentration Map
I12-21 Individual Value Plot for Target CT-03 (T12) and BSA-8 (Trc) Uranium Soil Concentrations
I12-22 Box Plot for Target CT-03 (T12) and BSA-8 (Trc) Uranium Soil Concentrations
I12-23 Non-AUM Target CT-03 (T12) Surface Soil Uranium Concentration Map
I12-24 Individual Value Plot for Target CT-03 (T12) and BSA-8 (Trc) Vanadium Soil Concentrations
I12-25 Box Plot for Target CT-03 (T12) and BSA-8 (Trc) Vanadium Soil Concentrations
I12-26 Non-AUM Target CT-03 (T12) Surface Soil Vanadium Concentration Map

LIST OF FIGURES (CONTINUED)

Section 7

I13-1 Non-AUM Target M1-01 (T13) Location and Access Map
I13-2 Non-AUM Target M1-01 (T13) Topographic Map
I13-3 Non-AUM Target M1-01 (T13) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I13-4 Non-AUM Target M1-01 (T13) XRF Field Survey Map
I13-5 Non-AUM Target M1-01 (T13) Surface Soil Sample Location Map
I13-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M1-01 (T13) and BSA-11 (Jse)
I13-7 Box Plot of Raw Gamma Radiation Levels at Target M1-01 (T13) and BSA-11 (Jse)
I13-8 Non-AUM Target M1-01 (T13) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I13-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M1-01 (T13) and BSA-11 (Jse)
I13-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M1-01 (T13) and BSA-11 (Jse)
I13-11 Non-AUM Target M1-01 (T13) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I13-12 Individual Value Plot for Target M1-01 (T13) and BSA-11 (Jse) Arsenic Soil Concentrations
I13-13 Box Plot for Target M1-01 (T13) and BSA-11 (Jse) Arsenic Soil Concentrations
I13-14 Non-AUM Target M1-01 (T13) Surface Soil Arsenic Concentration Map
I13-15 Individual Value Plot for Target M1-01 (T13) and BSA-11 (Jse) Lead Soil Concentrations
I13-16 Box Plot for Target M1-01 (T13) and BSA-11 (Jse) Lead Soil Concentrations
I13-17 Non-AUM Target M1-01 (T13) Surface Soil Lead Concentration Map
I13-18 Individual Value Plot for Target M1-01 (T13) and Jse Regional Thorium Soil Concentrations
I13-19 Box Plot for Target M1-01 (T13) and Jse Regional Thorium Soil Concentrations
I13-20 Non-AUM Target M1-01 (T13) Surface Soil Thorium Concentration Map
I13-21 Individual Value Plot for Target M1-01 (T13) and BSA-11 (Jse) Uranium Soil Concentrations
I13-22 Box Plot for Target M1-01 (T13) and BSA-11 (Jse) Uranium Soil Concentrations
I13-23 Non-AUM Target M1-01 (T13) Surface Soil Uranium Concentration Map
I13-24 Individual Value Plot for Target M1-01 (T13) and BSA-11 (Jse) Vanadium Soil Concentrations
I13-25 Box Plot for Target M1-01 (T13) and BSA-11 (Jse) Vanadium Soil Concentrations
I13-26 Non-AUM Target M1-01 (T13) Surface Soil Vanadium Concentration Map

LIST OF FIGURES (CONTINUED)

I14-1 Non-AUM Target M1-02 (T14) Location and Access Map
I14-2 Non-AUM Target M1-02 (T14) Topographic Map
I14-3 Non-AUM Target M1-02 (T14) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I14-4 Non-AUM Target M1-02 (T14) XRF Field Survey Map
I14-5 Non-AUM Target M1-02 (T14) Surface Soil Sample Location Map
I14-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M1-02 (T14) and Jml Regional
I14-7 Box Plot of Raw Gamma Radiation Levels at Target M1-02 (T14) and Jml Regional
I14-8 Non-AUM Target M1-02 (T14) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I14-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M1-02 (T14) and Jml Regional
I14-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M1-02 (T14) and Jml Regional
I14-11 Non-AUM Target M1-02 (T14) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I14-12 Individual Value Plot for Target M1-02 (T14) and Jml Regional Arsenic Soil Concentrations
I14-13 Box Plot for Target M1-02 (T14) and Jml Regional Arsenic Soil Concentrations
I14-14 Non-AUM Target M1-02 (T14) Surface Soil Arsenic Concentration Map
I14-15 Individual Value Plot for Target M1-02 (T14) and Jml Regional Lead Soil Concentrations
I14-16 Box Plot for Target M1-02 (T14) and Jml Regional Lead Soil Concentrations
I14-17 Non-AUM Target M1-02 (T14) Surface Soil Lead Concentration Map
I14-18 Individual Value Plot for Target M1-02 (T14) and Jml Regional Thorium Soil Concentrations
I14-19 Box Plot for Target M1-02 (T14) and Jml Regional Thorium Soil Concentrations
I14-20 Non-AUM Target M1-02 (T14) Surface Soil Thorium Concentration Map
I14-21 Individual Value Plot for Target M1-02 (T14) and Jml Regional Uranium Soil Concentrations
I14-22 Box Plot for Target M1-02 (T14) and Jml Regional Uranium Soil Concentrations
I14-23 Non-AUM Target M1-02 (T14) Surface Soil Uranium Concentration Map
I14-24 Individual Value Plot for Target M1-02 (T14) and Jml Regional Vanadium Soil Concentrations
I14-25 Box Plot for Target M1-02 (T14) and Jml Regional Vanadium Soil Concentrations
I14-26 Non-AUM Target M1-02 (T14) Surface Soil Vanadium Concentration Map

LIST OF FIGURES (CONTINUED)

I15-1 Non-AUM Target M1-03 (T15) Location and Access Map
I15-2 Non-AUM Target M1-03 (T15) Topographic Map
I15-3 Non-AUM Target M1-03 (T15) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I15-4 Non-AUM Target M1-03 (T15) XRF Field Survey Map
I15-5 Non-AUM Target M1-03 (T15) Surface Soil Sample Location Map
I15-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M1-03 (T15) and Jml Regional
I15-7 Box Plot of Raw Gamma Radiation Levels at Target M1-03 (T15) and Jml Regional
I15-8 Non-AUM Target M1-03 (T15) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I15-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M1-03 (T15) and Jml Regional
I15-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M1-03 (T15) and Jml Regional
I15-11 Non-AUM Target M1-03 (T15) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I15-12 Individual Value Plot for Target M1-03 (T15) and BSA-9 (Jml) Arsenic Soil Concentrations
I15-13 Box Plot for Target M1-03 (T15) and BSA-9 (Jml) Arsenic Soil Concentrations
I15-14 Non-AUM Target M1-03 (T15) Surface Soil Arsenic Concentration Map
I15-15 Individual Value Plot for Target M1-03 (T15) and BSA-9 (Jml) Lead Soil Concentrations
I15-16 Box Plot for Target M1-03 (T15) and BSA-9 (Jml) Lead Soil Concentrations
I15-17 Non-AUM Target M1-03 (T15) Surface Soil Lead Concentration Map
I15-18 Individual Value Plot for Target M1-03 (T15) and Jml Regional Thorium Soil Concentrations
I15-19 Box Plot for Target M1-03 (T15) and Jml Regional Thorium Soil Concentrations
I15-20 Non-AUM Target M1-03 (T15) Surface Soil Thorium Concentration Map
I15-21 Individual Value Plot for Target M1-03 (T15) and Jml Regional Uranium Soil Concentrations
I15-22 Box Plot for Target M1-03 (T15) and Jml Regional Uranium Soil Concentrations
I15-23 Non-AUM Target M1-03 (T15) Surface Soil Uranium Concentration Map
I15-24 Individual Value Plot for Target M1-03 (T15) and BSA-9 (Jml) Vanadium Soil Concentrations
I15-25 Box Plot for Target M1-03 (T15) and BSA-9 (Jml) Vanadium Soil Concentrations
I15-26 Non-AUM Target M1-03 (T15) Surface Soil Vanadium Concentration Map

LIST OF FIGURES (CONTINUED)

Section 8

I18-1 Non-AUM Target M5-01 (T18) Location and Access Map
I18-2 Non-AUM Target M5-01 (T18) Topographic Map
I18-3 Non-AUM Target M5-01 (T18) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I18-4 Non-AUM Target M5-01 (T18) XRF Field Survey Map
I18-5 Non-AUM Target M5-01 (T18) Surface Soil Sample Location Map
I18-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M5-01 (T18) and BSA-19 (Jse)
I18-7 Box Plot of Raw Gamma Radiation Levels at Target M5-01 (T18) and BSA-19 (Jse)
I18-8 Non-AUM Target M5-01 (T18) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I18-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-01 (T18) and BSA-19 (Jse)
I18-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-01 (T18) and BSA-19 (Jse)
I18-11 Non-AUM Target M5-01 (T18) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I18-12 Individual Value Plot for Target M5-01 (T18) and BSA-19 (Jse) Arsenic Soil Concentrations
I18-13 Box Plot for Target M5-01 (T18) and BSA-19 (Jse) Arsenic Soil Concentrations
I18-14 Non-AUM Target M5-01 (T18) Surface Soil Arsenic Concentration Map
I18-15 Individual Value Plot for Target M5-01 (T18) and BSA-19 (Jse) Lead Soil Concentrations
I18-16 Box Plot for Target M5-01 (T18) and BSA-19 (Jse) Lead Soil Concentrations
I18-17 Non-AUM Target M5-01 (T18) Surface Soil Lead Concentration Map
I18-18 Individual Value Plot for Target M5-01 (T18) and BSA-19 (Jse) Thorium Soil Concentrations
I18-19 Box Plot for Target M5-01 (T18) and BSA-19 (Jse) Thorium Soil Concentrations
I18-20 Non-AUM Target M5-01 (T18) Surface Soil Thorium Concentration Map
I18-21 Individual Value Plot for Target M5-01 (T18) and BSA-19 (Jse) Uranium Soil Concentrations
I18-22 Box Plot for Target M5-01 (T18) and BSA-19 (Jse) Uranium Soil Concentrations
I18-23 Non-AUM Target M5-01 (T18) Surface Soil Uranium Concentration Map
I18-24 Individual Value Plot for Target M5-01 (T18) and BSA-19 (Jse) Vanadium Soil Concentrations
I18-25 Box Plot for Target M5-01 (T18) and BSA-19 (Jse) Vanadium Soil Concentrations
I18-26 Non-AUM Target M5-01 (T18) Surface Soil Vanadium Concentration Map

LIST OF FIGURES (CONTINUED)

I19-1 Non-AUM Target M5-02 (T19) Location and Access Map
I19-2 Non-AUM Target M5-02 (T19) Topographic Map
I19-3 Non-AUM Target M5-02 (T19) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I19-4 Non-AUM Target M5-02 (T19) XRF Field Survey Map
I19-5 Non-AUM Target M5-02 (T19) Surface Soil Sample Location Map
I19-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M5-02 (T19) and BSA-19 (Jse)
I19-7 Box Plot of Raw Gamma Radiation Levels at Target M5-02 (T19) and BSA-19 (Jse)
I19-8 Non-AUM Target M5-02 (T19) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I19-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-02 (T19) and BSA-19 (Jse)
I19-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-02 (T19) and BSA-19 (Jse)
I19-11 Non-AUM Target M5-02 (T19) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I19-12 Individual Value Plot for Target M5-02 (T19) and BSA-19 (Jse) Arsenic Soil Concentrations
I19-13 Box Plot for Target M5-02 (T19) and BSA-19 (Jse) Arsenic Soil Concentrations
I19-14 Non-AUM Target M5-02 (T19) Surface Soil Arsenic Concentration Map
I19-15 Individual Value Plot for Target M5-02 (T19) and BSA-19 (Jse) Lead Soil Concentrations
I19-16 Box Plot for Target M5-02 (T19) and BSA-19 (Jse) Lead Soil Concentrations
I19-17 Non-AUM Target M5-02 (T19) Surface Soil Lead Concentration Map
I19-18 Individual Value Plot for Target M5-02 (T19) and BSA-19 (Jse) Thorium Soil Concentrations
I19-19 Box Plot for Target M5-02 (T19) and BSA-19 (Jse) Thorium Soil Concentrations
I19-20 Non-AUM Target M5-02 (T19) Surface Soil Thorium Concentration Map
I19-21 Individual Value Plot for Target M5-02 (T19) and BSA-19 (Jse) Uranium Soil Concentrations
I19-22 Box Plot for Target M5-02 (T19) and BSA-19 (Jse) Uranium Soil Concentrations
I19-23 Non-AUM Target M5-02 (T19) Surface Soil Uranium Concentration Map
I19-24 Individual Value Plot for Target M5-02 (T19) and BSA-19 (Jse) Vanadium Soil Concentrations
I19-25 Box Plot for Target M5-02 (T19) and BSA-19 (Jse) Vanadium Soil Concentrations
I19-26 Non-AUM Target M5-02 (T19) Surface Soil Vanadium Concentration Map

LIST OF FIGURES (CONTINUED)

I20-1 Non-AUM Target M5-03 (T20) Location and Access Map
I20-2 Non-AUM Target M5-03 (T20) Topographic Map
I20-3 Non-AUM Target M5-03 (T20) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I20-4 Non-AUM Target M5-03 (T20) XRF Field Survey Map
I20-5 Non-AUM Target M5-03 (T20) Surface Soil Sample Location Map
I20-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M5-03 (T20) and Jml Regional
I20-7 Box Plot of Raw Gamma Radiation Levels at Target M5-03 (T20) and Jml Regional
I20-8 Non-AUM Target M5-03 (T20) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I20-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-03 (T20) and Jml Regional
I20-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-03 (T20) and Jml Regional
I20-11 Non-AUM Target M5-03 (T20) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I20-12 Individual Value Plot for Target M5-03 (T20) and Jml Regional Arsenic Soil Concentrations
I20-13 Box Plot for Target M5-03 (T20) and Jml Regional Arsenic Soil Concentrations
I20-14 Non-AUM Target M5-03 (T20) Surface Soil Arsenic Concentration Map
I20-15 Individual Value Plot for Target M5-03 (T20) and BSA-21 (Jml) Lead Soil Concentrations
I20-16 Box Plot for Target M5-03 (T20) and BSA-21 (Jml) Lead Soil Concentrations
I20-17 Non-AUM Target M5-03 (T20) Surface Soil Lead Concentration Map
I20-18 Individual Value Plot for Target M5-03 (T20) and BSA-21 (Jml) Thorium Soil Concentrations
I20-19 Box Plot for Target M5-03 (T20) and BSA-21 (Jml) Thorium Soil Concentrations
I20-20 Non-AUM Target M5-03 (T20) Surface Soil Thorium Concentration Map
I20-21 Individual Value Plot for Target M5-03 (T20) and Jml Regional Uranium Soil Concentrations
I20-22 Box Plot for Target M5-03 (T20) and Jml Regional Uranium Soil Concentrations
I20-23 Non-AUM Target M5-03 (T20) Surface Soil Uranium Concentration Map
I20-24 Individual Value Plot for Target M5-03 (T20) and Jml Regional Vanadium Soil Concentrations
I20-25 Box Plot for Target M5-03 (T20) and Jml Regional Vanadium Soil Concentrations
I20-26 Non-AUM Target M5-03 (T20) Surface Soil Vanadium Concentration Map

LIST OF FIGURES (CONTINUED)

I21-1 Non-AUM Target M5-05 (T21) Location and Access Map
I21-2 Non-AUM Target M5-05 (T21) Topographic Map
I21-3 Non-AUM Target M5-05 (T21) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I21-4 Non-AUM Target M5-05 (T21) XRF Field Survey Map
I21-5 Non-AUM Target M5-05 (T21) Surface Soil Sample Location Map
I21-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M5-05 (T21) and BSA-22 (Jml)
I21-7 Box Plot of Raw Gamma Radiation Levels at Target M5-05 (T21) and BSA-22 (Jml)
I21-8 Non-AUM Target M5-05 (T21) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I21-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-05 (T21) and BSA-22 (Jml)
I21-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-05 (T21) and BSA-22 (Jml)
I21-11 Non-AUM Target M5-05 (T21) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I21-12 Individual Value Plot for Target M5-05 (T21) and BSA-22 (Jml) Arsenic Soil Concentrations
I21-13 Box Plot for Target M5-05 (T21) and BSA-22 (Jml) Arsenic Soil Concentrations
I21-14 Non-AUM Target M5-05 (T21) Surface Soil Arsenic Concentration Map
I21-15 Individual Value Plot for Target M5-05 (T21) and BSA-22 (Jml) Lead Soil Concentrations
I21-16 Box Plot for Target M5-05 (T21) and BSA-22 (Jml) Lead Soil Concentrations
I21-17 Non-AUM Target M5-05 (T21) Surface Soil Lead Concentration Map
I21-18 Individual Value Plot for Target M5-05 (T21) and BSA-22 (Jml) Thorium Soil Concentrations
I21-19 Box Plot for Target M5-05 (T21) and BSA-22 (Jml) Thorium Soil Concentrations
I21-20 Non-AUM Target M5-05 (T21) Surface Soil Thorium Concentration Map
I21-21 Individual Value Plot for Target M5-05 (T21) and BSA-22 (Jml) Uranium Soil Concentrations
I21-22 Box Plot for Target M5-05 (T21) and BSA-22 (Jml) Uranium Soil Concentrations
I21-23 Non-AUM Target M5-05 (T21) Surface Soil Uranium Concentration Map
I21-24 Individual Value Plot for Target M5-05 (T21) and BSA-22 (Jml) Vanadium Soil Concentrations
I21-25 Box Plot for Target M5-05 (T21) and BSA-22 (Jml) Vanadium Soil Concentrations
I21-26 Non-AUM Target M5-05 (T21) Surface Soil Vanadium Concentration Map

LIST OF FIGURES (CONTINUED)

I22-1 Non-AUM Target M5-06 (T22) Location and Access Map
I22-2 Non-AUM Target M5-06 (T22) Topographic Map
I22-3 Non-AUM Target M5-06 (T22) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I22-4 Non-AUM Target M5-06 (T22) XRF Field Survey Map
I22-5 Non-AUM Target M5-06 (T22) Surface Soil Sample Location Map
I22-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M5-06 (T22) and BSA-22 (Jml)
I22-7 Box Plot of Raw Gamma Radiation Levels at Target M5-06 (T22) and BSA-22 (Jml)
I22-8 Non-AUM Target M5-06 (T22) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I22-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-06 (T22) and BSA-22 (Jml)
I22-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-06 (T22) and BSA-22 (Jml)
I22-11 Non-AUM Target M5-06 (T22) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I22-12 Individual Value Plot for Target M5-06 (T22) and BSA-22 (Jml) Arsenic Soil Concentrations
I22-13 Box Plot for Target M5-06 (T22) and BSA-22 (Jml) Arsenic Soil Concentrations
I22-14 Non-AUM Target M5-06 (T22) Surface Soil Arsenic Concentration Map
I22-15 Individual Value Plot for Target M5-06 (T22) and BSA-22 (Jml) Lead Soil Concentrations
I22-16 Box Plot for Target M5-06 (T22) and BSA-22 (Jml) Lead Soil Concentrations
I22-17 Non-AUM Target M5-06 (T22) Surface Soil Lead Concentration Map
I22-18 Individual Value Plot for Target M5-06 (T22) and BSA-22 (Jml) Thorium Soil Concentrations
I22-19 Box Plot for Target M5-06 (T22) and BSA-22 (Jml) Thorium Soil Concentrations
I22-20 Non-AUM Target M5-06 (T22) Surface Soil Thorium Concentration Map
I22-21 Individual Value Plot for Target M5-06 (T22) and BSA-22 (Jml) Uranium Soil Concentrations
I22-22 Box Plot for Target M5-06 (T22) and BSA-22 (Jml) Uranium Soil Concentrations
I22-23 Non-AUM Target M5-06 (T22) Surface Soil Uranium Concentration Map
I22-24 Individual Value Plot for Target M5-06 (T22) and BSA-22 (Jml) Vanadium Soil Concentrations
I22-25 Box Plot for Target M5-06 (T22) and BSA-22 (Jml) Vanadium Soil Concentrations
I22-26 Non-AUM Target M5-06 (T22) Surface Soil Vanadium Concentration Map

LIST OF FIGURES (CONTINUED)

I24-1 Non-AUM Target M5-07 (T24) Location and Access Map
I24-2 Non-AUM Target M5-07 (T24) Topographic Map
I24-3 Non-AUM Target M5-07 (T24) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I24-4 Non-AUM Target M5-07 (T24) XRF Field Survey Map
I24-5 Non-AUM Target M5-07 (T24) Surface Soil Sample Location Map
I24-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M5-07 (T24) and BSA-22 (Jml)
I24-7 Box Plot of Raw Gamma Radiation Levels at Target M5-07 (T24) and BSA-22 (Jml)
I24-8 Non-AUM Target M5-07 (T24) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I24-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-07 (T24) and BSA-22 (Jml)
I24-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-07 (T24) and BSA-22 (Jml)
I24-11 Non-AUM Target M5-07 (T24) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I24-12 Individual Value Plot for Target M5-07 (T24) and BSA-22 (Jml) Arsenic Soil Concentrations
I24-13 Box Plot for Target M5-07 (T24) and BSA-22 (Jml) Arsenic Soil Concentrations
I24-14 Non-AUM Target M5-07 (T24) Surface Soil Arsenic Concentration Map
I24-15 Individual Value Plot for Target M5-07 (T24) and BSA-22 (Jml) Lead Soil Concentrations
I24-16 Box Plot for Target M5-07 (T24) and BSA-22 (Jml) Lead Soil Concentrations
I24-17 Non-AUM Target M5-07 (T24) Surface Soil Lead Concentration Map
I24-18 Individual Value Plot for Target M5-07 (T24) and BSA-22 (Jml) Thorium Soil Concentrations
I24-19 Box Plot for Target M5-07 (T24) and BSA-22 (Jml) Thorium Soil Concentrations
I24-20 Non-AUM Target M5-07 (T24) Surface Soil Thorium Concentration Map
I24-21 Individual Value Plot for Target M5-07 (T24) and BSA-22 (Jml) Uranium Soil Concentrations
I24-22 Box Plot for Target M5-07 (T24) and BSA-22 (Jml) Uranium Soil Concentrations
I24-23 Non-AUM Target M5-07 (T24) Surface Soil Uranium Concentration Map
I24-24 Individual Value Plot for Target M5-07 (T24) and BSA-22 (Jml) Vanadium Soil Concentrations
I24-25 Box Plot for Target M5-07 (T24) and BSA-22 (Jml) Vanadium Soil Concentrations
I24-26 Non-AUM Target M5-07 (T24) Surface Soil Vanadium Concentration Map

LIST OF FIGURES (CONTINUED)

I25-1 Non-AUM Target M5-08 (T25) Location and Access Map
I25-2 Non-AUM Target M5-08 (T25) Topographic Map
I25-3 Non-AUM Target M5-08 (T25) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I25-4 Non-AUM Target M5-08 (T25) XRF Field Survey Map
I25-5 Non-AUM Target M5-08 (T25) Surface Soil Sample Location Map
I25-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M5-08 (T25) and BSA-17 (Jml)
I25-7 Box Plot of Raw Gamma Radiation Levels at Target M5-08 (T25) and BSA-17 (Jml)
I25-8 Non-AUM Target M5-08 (T25) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I25-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-08 (T25) and BSA-17 (Jml)
I25-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-08 (T25) and BSA-17 (Jml)
I25-11 Non-AUM Target M5-08 (T25) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I25-12 Individual Value Plot for Target M5-08 (T25) and BSA-17 (Jml) Arsenic Soil Concentrations
I25-13 Box Plot for Target M5-08 (T25) and BSA-17 (Jml) Arsenic Soil Concentrations
I25-14 Non-AUM Target M5-08 (T25) Surface Soil Arsenic Concentration Map
I25-15 Individual Value Plot for Target M5-08 (T25) and Jml Regional Lead Soil Concentrations
I25-16 Box Plot for Target M5-08 (T25) and Jml Regional Lead Soil Concentrations
I25-17 Non-AUM Target M5-08 (T25) Surface Soil Lead Concentration Map
I25-18 Individual Value Plot for Target M5-08 (T25) and Jml Regional Thorium Soil Concentrations
I25-19 Box Plot for Target M5-08 (T25) and Jml Regional Thorium Soil Concentrations
I25-20 Non-AUM Target M5-08 (T25) Surface Soil Thorium Concentration Map
I25-21 Individual Value Plot for Target M5-08 (T25) and BSA-17 (Jml) Uranium Soil Concentrations
I25-22 Box Plot for Target M5-08 (T25) and BSA-17 (Jml) Uranium Soil Concentrations
I25-23 Non-AUM Target M5-08 (T25) Surface Soil Uranium Concentration Map
I25-24 Individual Value Plot for Target M5-08 (T25) and BSA-17 (Jml) Vanadium Soil Concentrations
I25-25 Box Plot for Target M5-08 (T25) and BSA-17 (Jml) Vanadium Soil Concentrations
I25-26 Non-AUM Target M5-08 (T25) Surface Soil Vanadium Concentration Map

LIST OF FIGURES (CONTINUED)

I26-1 Non-AUM Target M5-09 (T26) Location and Access Map
I26-2 Non-AUM Target M5-09 (T26) Topographic Map
I26-3 Non-AUM Target M5-09 (T26) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I26-4 Non-AUM Target M5-09 (T26) XRF Field Survey Map
I26-5 Non-AUM Target M5-09 (T26) Surface Soil Sample Location Map
I26-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M5-09 (T26) and BSA-16 (Tc)
I26-7 Box Plot of Raw Gamma Radiation Levels at Target M5-09 (T26) and BSA-16 (Tc)
I26-8 Non-AUM Target M5-09 (T26) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I26-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M5-09 (T26) and BSA-16 (Tc)
I26-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M5-09 (T26) and BSA-16 (Tc)
I26-11 Non-AUM Target M5-09 (T26) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I26-12 Individual Value Plot for Target M5-09 (T26) and BSA-16 (Tc) Arsenic Soil Concentrations
I26-13 Box Plot for Target M5-09 (T26) and BSA-16 (Tc) Arsenic Soil Concentrations
I26-14 Non-AUM Target M5-09 (T26) Surface Soil Arsenic Concentration Map
I26-15 Individual Value Plot for Target M5-09 (T26) and BSA-16 (Tc) Lead Soil Concentrations
I26-16 Box Plot for Target M5-09 (T26) and BSA-16 (Tc) Lead Soil Concentrations
I26-17 Non-AUM Target M5-09 (T26) Surface Soil Lead Concentration Map
I26-18 Individual Value Plot for Target M5-09 (T26) and BSA-16 (Tc) Thorium Soil Concentrations
I26-19 Box Plot for Target M5-09 (T26) and BSA-16 (Tc) Thorium Soil Concentrations
I26-20 Non-AUM Target M5-09 (T26) Surface Soil Thorium Concentration Map
I26-21 Individual Value Plot for M5-09 (T26) and BSA-16 (Tc) Uranium Soil Concentrations
I26-22 Box Plot for Target M5-09 (T26) and BSA-16 (Tc) Uranium Soil Concentrations
I26-23 Non-AUM Target M5-09 (T26) Surface Soil Uranium Concentration Map
I26-24 Individual Value Plot for Target M5-09 (T26) and BSA-16 (Tc) Vanadium Soil Concentrations
I26-25 Box Plot for Target M5-09 (T26) and BSA-16 (Tc) Vanadium Soil Concentrations
I26-26 Non-AUM Target M5-09 (T26) Surface Soil Vanadium Concentration Map

LIST OF FIGURES (CONTINUED)

Section 9

I27-1 Non-AUM Target M4-02 (T27) Location and Access Map
I27-2 Non-AUM Target M4-02 (T27) Topographic Map
I27-3 Non-AUM Target M4-02 (T27) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I27-4 Non-AUM Target M4-02 (T27) XRF Field Survey Map
I27-5 Non-AUM Target M4-02 (T27) Surface Soil Sample Location Map
I27-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M4-02 (T27) and BSA-27 (Jml)
I27-7 Box Plot of Raw Gamma Radiation Levels at Target M4-02 (T27) and BSA-27 (Jml)
I27-8 Non-AUM Target M4-02 (T27) 2018 Removal Site Evaluation vs. Weston Site Screening Gamma Radiation Levels Survey Map
I27-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M4-02 (T27) and BSA-27 (Jml)
I27-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M4-02 (T27) and BSA-27 (Jml)
I27-11 Non-AUM Target M4-02 (T27) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I27-12 Non-AUM Target M4-02 (T27) Surface Soil Arsenic Concentration Map
I27-13 Individual Value Plot for Target M4-02 (T27) and BSA-27 (Jml) Lead Soil Concentrations
I27-14 Box Plot for Target M4-02 (T27) and BSA-27 (Jml) Lead Soil Concentrations
I27-15 Non-AUM Target M4-02 (T27) Surface Soil Lead Concentration Map
I27-16 Individual Value Plot for Target M4-02 (T27) and BSA-27 (Jml) Thorium Soil Concentrations
I27-17 Box Plot for Target M4-02 (T27) and BSA-27 (Jml) Thorium Soil Concentrations
I27-18 Non-AUM Target M4-02 (T27) Surface Soil Thorium Concentration Map
I27-19 Individual Value Plot for M4-02 (T27) and BSA-27 (Jml) Uranium Soil Concentrations
I27-20 Box Plot for Target M4-02 (T27) and BSA-27 (Jml) Uranium Soil Concentrations
I27-21 Non-AUM Target M4-02 (T27) Surface Soil Uranium Concentration Map
I27-22 Individual Value Plot for Target M4-02 (T27) and BSA-27 (Jml) Vanadium Soil Concentrations
I27-23 Box Plot for Target M4-02 (T27) and BSA-27 (Jml) Vanadium Soil Concentrations
I27-24 Non-AUM Target M4-02 (T27) Surface Soil Vanadium Concentration Map

Section 10

I30-1 Non-AUM Target M1-07 (T30) Location and Access Map
I30-2 Non-AUM Target M1-07 (T30) Topographic Map
I30-3 Non-AUM Target M1-07 (T30) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map

LIST OF FIGURES (CONTINUED)

I30-4 Non-AUM Target M1-07 (T30) XRF Field Survey Map
I30-5 Non-AUM Target M1-07 (T30) Surface Soil Sample Location Map
I30-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M1-07 (T30) and BSA-30 (Jml)
I30-7 Box Plot of Raw Gamma Radiation Levels at Target M1-07 (T30) and BSA-30 (Jml)
I30-8 Non-AUM Target M1-07 (T30) 2018 Removal Site Evaluation Gamma Radiation Levels Survey Map
I30-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M1-07 (T30) and BSA-30 (Jml)
I30-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M1-07 (T30) and BSA-30 (Jml)
I30-11 Non-AUM Target M1-07 (T30) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I30-12 Individual Value Plot for Target M1-07 (T30) and BSA-30 (Jml) Arsenic Soil Concentrations
I30-13 Box Plot for Target M1-07 (T30) and BSA-30 (Jml) Arsenic Soil Concentrations
I30-14 Non-AUM Target M1-07 (T30) Surface Soil Arsenic Concentration Map
I30-15 Individual Value Plot for Target M1-07 (T30) and BSA-30 (Jml) Lead Soil Concentrations
I30-16 Box Plot for Target M1-07 (T30) and BSA-30 (Jml) Lead Soil Concentrations
I30-17 Non-AUM Target M1-07 (T30) Surface Soil Lead Concentration Map
I30-18 Individual Value Plot for Target M1-07 (T30) and Jml Regional Thorium Soil Concentrations
I30-19 Box Plot for Target M1-07 (T30) and Jml Regional Thorium Soil Concentrations
I30-20 Non-AUM Target M1-07 (T30) Surface Soil Thorium Concentration Map
I30-21 Individual Value Plot for Target M1-07 (T30) and BSA-30 (Jml) Uranium Soil Concentrations
I30-22 Box Plot for Target M1-07 (T30) and BSA-30 (Jml) Uranium Soil Concentrations
I30-23 Non-AUM Target M1-07 (T30) Surface Soil Uranium Concentration Map
I30-24 Individual Value Plot for Target M1-07 (T30) and BSA-30 (Jml) Vanadium Soil Concentrations
I30-25 Box Plot for Target M1-07 (T30) and BSA-30 (Jml) Vanadium Soil Concentrations
I30-26 Non-AUM Target M1-07 (T30) Surface Soil Vanadium Concentration Map

I31-1 Non-AUM Target M1-08 (T31) Location and Access Map
I31-2 Non-AUM Target M1-08 (T31) Topographic Map
I31-3 Non-AUM Target M1-08 (T31) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I31-4 Non-AUM Target M1-08 (T31) XRF Field Survey Map
I31-5 Non-AUM Target M1-08 (T31) Surface Soil Sample Location Map

LIST OF FIGURES (CONTINUED)

I31-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M1-08 (T31) and BSA-30 (Jml)
I31-7 Box Plot of Raw Gamma Radiation Levels at Target M1-08 (T31) and BSA-30 (Jml)
I31-8 Non-AUM Target M1-08 (T31) 2018 Removal Site Evaluation Gamma Radiation Levels Survey Map
I31-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M1-08 (T31) and BSA-30 (Jml)
I31-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M1-08 (T31) and BSA-30 (Jml)
I31-11 Non-AUM Target M1-08 (T31) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I31-12 Individual Value Plot for Target M1-08 (T31) and BSA-30 (Jml) Arsenic Soil Concentrations
I31-13 Box Plot for Target M1-08 (T31) and BSA-30 (Jml) Arsenic Soil Concentrations
I31-14 Non-AUM Target M1-08 (T31) Surface Soil Arsenic Concentration Map
I31-15 Individual Value Plot for Target M1-08 (T31) and BSA-30 (Jml) Lead Soil Concentrations
I31-16 Box Plot for Target M1-08 (T31) and BSA-30 (Jml) Lead Soil Concentrations
I31-17 Non-AUM Target M1-08 (T31) Surface Soil Lead Concentration Map
I31-18 Individual Value Plot for Target M1-08 (T31) and Jml Regional Thorium Soil Concentrations
I31-19 Box Plot for Target M1-08 (T31) and Jml Regional Thorium Soil Concentrations
I31-20 Non-AUM Target M1-08 (T31) Surface Soil Thorium Concentration Map
I31-21 Individual Value Plot for Target M1-08 (T31) and BSA-30 (Jml) Uranium Soil Concentrations
I31-20 Box Plot for Target M1-08 (T31) and BSA-30 (Jml) Uranium Soil Concentrations
I31-23 Non-AUM Target M1-08 (T31) Surface Soil Uranium Concentration Map
I31-24 Individual Value Plot for Target M1-08 (T31) and BSA-30 (Jml) Vanadium Soil Concentrations
I31-25 Box Plot for Target M1-08 (T31) and BSA-30 (Jml) Vanadium Soil Concentrations
I31-26 Non-AUM Target M1-08 (T31) Surface Soil Vanadium Concentration Map

I32-1 Non-AUM Target M2-01 (T32) Location and Access Map
I32-2 Non-AUM Target M2-01 (T32) Topographic Map
I32-3 Non-AUM Target M2-01 (T32) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I32-4 Non-AUM Target M2-01 (T32) XRF Field Survey Map
I32-5 Non-AUM Target M2-01 (T32) Surface Soil Sample Location Map
I32-6 Individual Value Plot of Raw Gamma Radiation Levels at Target M2-01 (T32) and BSA-30 (Jml)
I32-7 Box Plot of Raw Gamma Radiation Levels at Target M2-01 (T32) and BSA-30 (Jml)

LIST OF FIGURES (CONTINUED)

I32-8 Non-AUM Target M2-01 (T32) 2018 Removal Site Evaluation Gamma Radiation Levels Survey Map
I32-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target M2-01 (T32) and BSA-30 (Jml)
I32-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target M2-01 (T32) and BSA-30 (Jml)
I32-11 Non-AUM Target M2-01 (T32) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I32-12 Individual Value Plot for Target M2-01 (T32) and BSA-30 (Jml) Arsenic Soil Concentrations
I32-13 Box Plot for Target M2-01 (T32) and BSA-30 (Jml) Arsenic Soil Concentrations
I32-14 Non-AUM Target M2-01 (T32) Surface Soil Arsenic Concentration Map
I32-15 Individual Value Plot for Target M2-01 (T32) and BSA-30 (Jml) Lead Soil Concentrations
I32-16 Box Plot for Target M2-01 (T32) and BSA-30 (Jml) Lead Soil Concentrations
I32-17 Non-AUM Target M2-01 (T32) Surface Soil Lead Concentration Map
I32-18 Individual Value Plot for Target M2-01 (T32) and Jml Regional Thorium Soil Concentrations
I32-19 Box Plot for Target M2-01 (T32) and Jml Regional Thorium Soil Concentrations
I32-20 Non-AUM Target M2-01 (T32) Surface Soil Thorium Concentration Map
I32-21 Individual Value Plot for Target M2-01 (T32) and BSA-30 (Jml) Uranium Soil Concentrations
I32-22 Box Plot for Target M2-01 (T32) and BSA-30 (Jml) Uranium Soil Concentrations
I32-23 Non-AUM Target M2-01 (T32) Surface Soil Uranium Concentration Map
I32-24 Individual Value Plot for Target M2-01 (T32) and BSA-30 (Jml) Vanadium Soil Concentrations
I32-25 Box Plot for Target M2-01 (T32) and BSA-30 (Jml) Vanadium Soil Concentrations
I32-26 Non-AUM Target M2-01 (T32) Surface Soil Vanadium Concentration Map

Section 11

I33-1 Non-AUM Target KE-01 (T33) Location and Access Map
I33-2 Non-AUM Target KE-01 (T33) Topographic Map
I33-3 Non-AUM Target KE-01 (T33) 2018 Removal Site Evaluation and ASPECT Gamma Radiation Levels Survey Map
I33-4 Non-AUM Target KE-01 (T33) XRF Field Survey Map
I33-5 Non-AUM Target KE-01 (T33) Surface Soil Sample Location Map
I33-6 Individual Value Plot of Raw Gamma Radiation Levels at Target KE-01 (T33) and BSA-32 (Jste)
I33-7 Box Plot of Raw Gamma Radiation Levels at Target KE-01 (T33) and BSA-32 (Jste)
I33-8 Non-AUM Target KE-01 (T33) 2018 Removal Site Evaluation Gamma Radiation Levels Survey Map

LIST OF FIGURES (CONTINUED)

I33-9 Individual Value Plot of Grid Averaged Gamma Radiation Levels at Target KE-01 (T33) and BSA-32 (Jste)
I33-10 Box Plot of Grid Averaged Gamma Radiation Levels at Target KE-01 (T33) and BSA-32 (Jste)
I33-11 Non-AUM Target KE-01 (T33) Grid Averaged Gamma Radiation Levels and Radium-226 Results
I33-12 Individual Value Plot for Target KE-01 (T33) and BSA-32 (Jste) Arsenic Soil Concentrations
I33-13 Box Plot for Target KE-01 (T33) and BSA-32 (Jste) Arsenic Soil Concentrations
I33-14 Non-AUM Target KE-01 (T33) Surface Soil Arsenic Concentration Map
I33-15 Individual Value Plot for Target KE-01 (T33) and BSA-32 (Jste) Lead Soil Concentrations
I33-16 Box Plot for Target KE-01 (T33) and BSA-32 (Jste) Lead Soil Concentrations
I33-17 Non-AUM Target KE-01 (T33) Surface Soil Lead Concentration Map
I33-18 Individual Value Plot for Target KE-01 (T33) and BSA-32 (Jste) Thorium Soil Concentrations
I33-19 Box Plot for Target KE-01 (T33) and BSA-32 (Jste) Thorium Soil Concentrations
I33-20 Non-AUM Target KE-01 (T33) Surface Soil Thorium Concentration Map
I33-21 Individual Value Plot for Target KE-01 (T33) and BSA-32 (Jste) Uranium Soil Concentrations
I33-22 Box Plot for Target KE-01 (T33) and BSA-32 (Jste) Uranium Soil Concentrations
I33-23 Non-AUM Target KE-01 (T33) Surface Soil Uranium Concentration Map
I33-24 Individual Value Plot for Target KE-01 (T33) and BSA-32 (Jste) Vanadium Soil Concentrations
I33-25 Box for Target KE-01 (T33) and BSA-32 (Jste) Vanadium Soil Concentrations
I33-26 Non-AUM Target Ke-01 (T33) Surface Soil Vanadium Concentration Map