REVISED SAMPLING AND ANALYSIS PLAN

COVE WASH WATERSHED ASSESSMENT SITE

Navajo Nation, Cove Chapter, Apache County, Arizona

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U.S. Environmental Protection Agency, Region 9

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ABBREVIATIONS AND ACRONYMS

$\delta^{18}O$	$^{18}O/^{16}O$
AOC	area(s) of concern
AUM	abandoned uranium mine
bgs	below ground surface
°C	degrees Celsius
COC	constituent (s) of concern
cpm	counts per minute
DMP	Data Management Plan
DQI	Data Quality Indicators
DQO	Data Quality Objectives
EPA	U. S. Environmental Protection Agency
ERT	Environmental Response Team
GIS	geographic information system
GPS	Global Positioning System
IDW	investigation-derived waste(s)
KPA	Kinetic Phosphorous Analysis
LCS	Laboratory Control Samples
MCL	Maximum Contaminant Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
µg/L	micrograms per literµm micrometer
NNEPA	Navajo Nation Environmental Protection Agency
NNSWQS	Navajo Nation Surface Water Quality Standards
pCi/g	picocuries per gram
PE	Performance Evaluation
PM	Project Manager
PPE	personal protective equipment
QA	quality assurance
QC	quality control

Abbreviations and Acronyms, CONT.

RPD	relative percent difference
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SD	standard deviation
SOP	Standard Operating Procedures
START	Superfund Technical Assessment and Response Team
TAL	Target Analyte List
TDD	Technical Direction Document
TM	Task Monitor
USGS	U. S. Geological Survey
WESTON	Weston Solutions, Inc.

1. INTRODUCTION

The U. S. Environmental Protection Agency (EPA) tasked Weston Solutions, Inc.'s (WESTON®) Superfund Technical Assessment and Response Team (START) to conduct a watershed assessment at the Cove Wash Watershed Sites in the Cove Chapter of the Navajo Nation, Apache County, Arizona.

The watershed assessment includes sampling of surface water and sediment samples to delineate the source(s) contributing to the contamination in drainages throughout the watershed. Water parameters such as temperature and conductivity will be measured at each surface water sampling point. Additionally, the flow at each surface water sampling point will be estimated. Waste volumes will be determined by measuring surface areas and elevations of mine waste located in the drainages of the Cove Wash. Ground surface gamma radiation surveys will be conducted within Cove Wash watershed drainages to identify areas of high gamma activity. Groundwater wells, seeps, and springs will be sampled in order to assess potential impacts of historical uranium mining in the Cove Wash watershed.

This revised Sampling and Analysis Plan (SAP) describes the project and data use objectives, data collection rationale, data quality assurance (QA) goals, and requirements for sampling and analysis activities. It also defines the sampling and data collection methods that will be used for this project. This SAP is intended to accurately reflect the planned data-gathering activities for this task; however, site conditions, budget, and additional EPA direction may warrant modifications. All significant changes will be documented in site records.

The specific field sampling and chemical analysis information in this SAP was prepared according to the following EPA documents: *EPA Requirements for Quality Assurance Project Plans, EPA QA/R 5, EPA/240/B 01/003 (EPA 2001b); Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G 4, EPA/240/B-06/001 (EPA 2006); Guidance on Choosing a Sampling Design for Environmental Data Collection, EPA QA/G 5S, EPA/240/R02/005 (EPA 2002a); and Uniform Federal Policy for Implementing Environmental Quality System, EPA/505/F-03/001 (EPA 2005).*

1.1 PROJECT ORGANIZATION

The following is a list of project personnel and their responsibilities.

EPA Federal Task Monitor **(TM)—**The TM is Edwin Poalinelli. Mr. Poalinelli. is the primary decision-maker and will direct the project, specify tasks, and ensure that the project is proceeding on schedule and within budget. Additional duties include coordination of all preliminary and final reporting and communication with the Navajo Nation Environmental Protection Agency (NNEPA), START Project Manager (PM), EPA Environmental Response Team (ERT), EPA QA Office, and community residents. The EPA TM is also responsible for access to each property to be investigated.

START PM—The START PM is Ms. Tara Fitzgerald. The START PM is responsible for implementing the SAP, coordination of project tasks and field sampling, project management, and completion of all preliminary and final reporting.

Principal Data Users—Data generated during the implementation of this SAP will be utilized by the EPA FOSC to make decisions regarding further action at the site, if necessary.

Analytical Laboratory Support—The START-contracted laboratories are ALS and Isotech Laboratories, Inc.. The laboratories are responsible for sample analyses by definitive analytical methodologies. START is responsible for field data analysis and data validation of laboratory-generated data.

1.2 DISTRIBUTION LIST

Copies of the SAP will be distributed to the following persons and organizations:

- Edwin Poalinelli, EPA Region 9 TM
- WESTON START Field Team
- WESTON START Project Files

1.3 STATEMENT OF THE SPECIFIC PROBLEM

A total of 50 abandoned uranium mines (AUMs) are located within the Cove Wash watershed. Twenty-six of the AUMs were historically operated by Kerr McGee, which became Tronox. Previous studies have identified uranium and other constituents of concerns (COCs), including arsenic and molybdenum, within surface water, groundwater, and sediments (Lameman-Austin 2012, NNEPA 2014). Previous gamma screenings conducted in 2008 by WESTON identified elevated levels in the AUMs throughout the watershed and within surveyed drainages below. Additionally, unreclaimed mining waste has been identified within Cove Wash drainages during previous investigations. Due to the large number of AUMs present within the Cove Wash watershed, it is not clear which AUMs are contributing to the elevated concentrations of COCs. The watershed assessment will collect samples throughout the watershed, downstream of each AUM if possible, in order to determine the source(s) of COCs.

2. SITE BACKGROUND

2.1 SITE LOCATION AND DESCRIPTION

The Site consists of the Cove Wash watershed, which includes 50 of the 70 AUMs within the Lukachukai Mountains. The Cove Wash watershed is located within the Navajo Nation and extends at the highest elevations in the Lukachukai Mountains and downstream to Cove, Arizona. The watershed contains approximately 52 miles of tributaries and is defined by the U.S. Geological Survey (USGS) as Hydrologic Unit Code 140801050903. Annual precipitation averages 12 to 16 inches throughout the watershed. The site location is shown in Figure 1. AUMs located in the Cove Wash watershed are shown in Figure 2.

The Cove Wash watershed is not a known drinking water source, but may have been historically used by residents before drinking water was provided by a municipal source 20 years ago. However, it is not entirely clear if residents are not currently using surface water and/or groundwater wells for drinking water (Lameman-Austin 2012, NNEPA 2014). Additionally, the Cove Wash watershed is used extensively for drinking water for grazing livestock. Livestock is dependent on surface water and groundwater for drinking.

2.2 SITE HISTORY

Uranium outcrops were discovered within the Cove Wash watershed in the late 1940s. In the late 1940s Dan Phillips obtained a 528-acre lease and Koley Black obtained a 640-acre lease. Mr. Phillips and Mr. Black assigned a 75% interest in their leases to F.A. Sutton, Inc. Uranium and vanadium ore shipments from the watershed began in 1950 (NNEPA 2004). The mine sites were situated along mesas throughout the watershed. Uranium and vanadium mining ceased in the 1960s and the mine sites were abandoned. The Navajo Nation reclaimed AUMs in the 1990s, but inaccessible mine waste remains present throughout the watershed (Lameman-Austin 2012).

2.3 SITE SPECIFIC THREATENED AND ENDANGERED PROTECTIVE MEASURES

The U.S. Fish and Wildlife Service reviewed the Biological Assessment Report for the Cove Wash Radiological Survey and concurred with the EPA's determination that planned sampling activities may affect, but not adversely affect the Mexican spotted owl, Navajo sedge and Zuni fleabane (EPA 2014; USFWS 2014). The following describes protective measure that will be conducted to minimize impacts from the sampling teams to the threatened and endangered species.

The canyon areas of the Cove Wash watershed are suitable nesting habitats for the Mexican spotted owl from spring to summer. During June 2015 sampling activities, Mexican spotted owls were visually observed within a drainage running in between Mesa I and Mesa II. In November 2015, a Navajo Nation Fish & Wildlife Service conducted reconnaissance activities within the three main drainages of the Cove Wash watershed and determined that suitable habitat was located for the Mexican spotted owl. Care should be taken during field activities in the canyons to ensure that Mexican spotted owl nests are avoided. In the event Mexican spotted owl nests are

observed during watershed assessment activities, sampling team members will be notified and the time to pass the nesting areas will be kept to a minimum and personal will not linger or disturb the Mexican spotted owl if they are encountered.

Wet or moist sediments and soil along the Cove Wash watershed provide aquatic habitats for plants including the Navajo sedge. Upland Areas along mine roads in the watershed may be habitat for the Zuni fleabane. The sampling team members will avoid trampling on vegetation while traversing the streams and upland areas. Sediment samples will be collected at locations that will not impact vegetation.

2.4 PREVIOUS INVESTIGATIONS

In 1999, the EPA collected surface water and groundwater samples within the Cove Wash watershed and analyzed the samples for metals and radionuclides. Uranium and other metals exceeded EPA Maximum Contaminant Levels (MCLs) for drinking water in some samples collected during the investigation. Of the 21 water samples collected, 12 water samples contained COCs in exceedance of EPA MCLs for at least one COC, including arsenic, uranium, selenium, and vanadium (Lameman-Austin 2012).

In 2008, WESTON conducted AUM screenings throughout the Lukachukai Mountains, including AUMs located within the Cove Wash watershed. The AUM screenings consisted of gamma radiation screenings in the vicinity of a majority of AUMs in the watershed. Gamma readings two to three times background were detected at multiple AUMs during the 2008 AUM screenings.

In 2011, Terri Lameman-Austin conducted a study of the uranium distribution throughout the Cove Wash watershed as part of a Master's Degree fulfillment requirement with the assistance of the USGS. A total of seven surface water, three groundwater, and 26 sediment, rock, and soil samples were collected and analyzed for metals, including uranium and other trace metals. Uranium concentrations exceeded the EPA MCL of 30 micrograms per liter (µg/L) in all surface water samples collected during the study. Arsenic was detected in one surface water sample collected within the Cove Wash watershed above the EPA MCL of 10 µg/L. Uranium was detected above the MCL in one well sample (Ellison Well).

Surface water and groundwater samples were also analyzed for major cations and anions, alkalinity, and stable oxygen isotopes (^{16}O and ^{18}O) in order to determine the ratio of $^{18}O/^{16}O$ ($\delta^{18}O$). As ^{16}O has a lower vapor pressure that ^{18}O, the $\delta^{18}O$ results can be used to determine additional information about surface water sources and the study report recommends that future investigations analyze water samples for $\delta^{18}O$. The study report also noted that uranium isotope (^{234}U and ^{238}U) concentrations in water samples can be used to evaluate groundwater residence times. Selected samples will be analyzed for stable oxygen isotopes. All water samples collected during this watershed assessment will be submitted for uranium isotope analysis, ^{234}U and ^{238}U.

The NNEPA completed a Surface Water Quality Assessment Report (Integrated 305(b) Report (pending revision) and 303(d) Listing) in 2014 (NNEPA 2014). The report summarized water quality sampling events conducted at two locations downgradient of historical mining activity in the Cove Wash watershed. Data used for the assessment were from a 2001 sampling event for

one sampling location, and from 2011 and 2012 for the second sampling location. The NNEPA compared concentrations of COCs found at the two locations to Navajo Nation Surface Water Quality Standards (NNSWQS) adopted by the Navajo Nation in 2013 and pending approval by the EPA. Sampling results for the surface water location sample results in 2001 did not meet NNSWQS standards for gross alpha radioactivity, chlorine, and selenium. Sampling results for the surface water samples in 2011 and 2012 did not meet NNSWQS standards for gross alpha radioactivity, aluminum, and dissolved oxygen. The assessment recommended that the Cove Wash watershed be designated as impaired per the U.S. Clean Water Act Sections 305(b) and 303(d). The assessment also recommends that a total maximum daily load for gross alpha radioactivity be developed for the Cove Wash watershed.

In June 2015, the first sampling event was conducted within the Cove Wash Watershed. Sampling results for the June 2015 sampling event will be discussed in a watershed assessment report that includes 2016 sampling event results.

3. PROJECT OBJECTIVES

3.1 DATA USE OBJECTIVES

START will collect surface water, groundwater, and sediment samples, as well as conduct gamma radiation surveys in order to further characterize drinking water contamination and delineate the source/sources contributing to the contamination in the watershed. The analytical data collected as part of this watershed assessment will be used to answer the following site-specific study questions:

A. What is the extent of COC concentrations in surface water, groundwater, and sediments throughout the Cove Wash watershed?

B. Are the concentrations of COCs in surface water and groundwater present at concentrations above the MCL for drinking water?

C. Are the concentrations of COCs in sediments present at concentrations above the EPA Regional Screening Levels (RSLs) for protection of groundwater?

D. Is waste rock present within Cove Wash watershed drainages contributing to elevated concentrations of COCs within the watershed?

E. What are potential sources of contamination contributing to elevated concentrations of COCs within the watershed?

3.2 PROJECT TASKS AND SAMPLING OBJECTIVES

The EPA tasked START to prepare this SAP to support the environmental data collection activities needed to document implementation and completion of the removal assessment. The purpose of data collection procedures presented in this SAP is to determine the number, location, and type of proposed sampling; field sample collection and laboratory analytical methods and procedures; and data quality assurance and validation procedures. The primary objectives for this assessment are to delineate AUM sources of contamination to the Cove Wash watershed and characterize contamination within the watershed. The data collected will be utilized to:

1. Determine the potential threat to human health or the environment from COCs originating from AUM waste within the Cove Wash watershed drainages which exceed the proposed action level protective of human health;
2. Determine the lateral ground surface boundaries where elevated gamma radiation activity is present within the Cove Wash watershed drainages;
3. Identify waste rock boundaries within Cove Wash watershed drainages;
4. Determine current COC concentrations within groundwater from wells throughout the Cove Wash watershed.

3.3 ENVIRONMENTAL SCREENING LEVELS

The screening levels for surface water and groundwater are MCLs for drinking water. Screening levels for sediments are EPA RSLs for the protection of groundwater. These screening levels will serve as evaluation tools to help determine whether further characterization or other actions are recommended for the Site. Screening levels are presented in Tables 3-1 and 3-2 in Section 3.5.

3.4 DATA QUALITY OBJECTIVES (DQO)

The DQO process, as set forth in the EPA Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA/240/B-06/001) (EPA 2006), was followed to establish the DQOs for this project. The DQOs and the outputs for this project are included in Appendix A.

3.5 DATA QUALITY INDICATORS (DQI)

Measurement Quality Objectives are criteria established to assess the viability and usability of data. These are based on both field and laboratory protocols that examine whether the DQIs meet the established criteria for this project. DQI goals for this project were developed using the guidelines provided in *EPA Guidance for Quality Assurance Project Plans,* EPA QA/G-5 (EPA 2002b).

All sampling will be guided by procedures detailed in Sections 4.0 and 6.0 as well as Standard Operating Procedures (SOPs) to ensure representativeness of sampling results. Tables 3-1 and 3-2. Approved EPA methods and standard reporting limits will be used. All data not rejected will be considered complete.

Table 3-1 Screening Levels and DQI Goals for Surface Water and Groundwater

Analyte	Screening Level*	Reporting Limit (µg/L)	Accuracy (Percent Recovery for LCS)	Precision (RPD for MSD and duplicates)	Percent Complete
Arsenic	10 µg/L	10 µg/L	75-100	≤ 35%	≥90
Selenium	5 µg/L	5 µg/L	75-100	≤ 35%	≥90
Uranium	30 µg/L	1 µg/L	75-100	≤ 35%	≥90
Combined Radium - 226+228	5 pCi/L	1 pCi/L	75-100	≤ 35%	≥90
Gross-alpha radiation	15 pCi/L	5 pCi/L	75-100	≤ 35%	≥90

Notes:
* EPA Maximum Contaminant Level
≥ = greater than or equal to
≤ = less than or equal to
µg/L = micrograms per liter
LCS = laboratory control sample
MS/MSD = Matrix Spike/Matrix Spike Duplicate
pCi/L = picocuries per liter
RPD = relative percent difference

Table 3-2 Screening Levels and DQI Goals for Sediment

Analyte	Screening Level* (mg/kg)	Reporting Limit	Accuracy (Percent Recovery for LCS)	Precision (RPD for MS/MSD and duplicates)	Percent Complete
Arsenic	0.29	0.260mg/kg**	75-100	≤ 35%; ≤ 50% for field duplicates	≥90
Selenium	0.26	0.158mg/kg***	75-100	≤ 35%; ≤ 50% for field duplicates	≥90
Uranium	14	0.1 mg/kg	75-100	≤ 35%; ≤ 50% for field duplicates	≥90
Combined Radium - 226+228	Not Applicable	1 pCi/g	75-100	≤ 35%; ≤ 50% for field duplicates	≥90

Notes:
* EPA Regional Screening Level (RSL) - Protection of groundwater Soil Screening Level (mg/kg)
** The Reporting Limit for arsenic is 1 mg/kg, which exceeds the screening level. Therefore, the method detection limit will be used to evaluate arsenic concentrations in sediment.
** The Reporting Limit for selenium is 0.5 mg/kg, which exceeds the screening level. Therefore, the method detection limit will be used to evaluate arsenic concentrations in sediment.
≥ = greater than or equal to
≤ = less than or equal to
LCS = laboratory control sample
mg/kg – milligrams per kilogram
MS/MSD = Matrix Spike/Matrix Spike Duplicate
pCi/g = picocuries per gram
RPD = relative percent difference

3.6 SCHEDULE OF FIELD ACTIVITIES

Field activities are anticipated to take place over three events to document seasonal variance of site conditions:

- Spring Snowmelt – Anticipated to begin on March 21, 2016 and continue for up to 20 days.
- Monsoon Season – Anticipated to begin on May 2, 2016 and continue for up to 20 days.
- Low Flow - Anticipated to begin on May 2, 2016 and continue for up to 20 days.

A total of six to nine START personnel will conduct field activities during the watershed assessment.

3.7 SPECIAL TRAINING REQUIREMENTS/CERTIFICATIONS

The operation of the field analytical instruments requires specialized training that will be administered, prior to mobilization, to all START personnel scheduled to be on Site.

Data validation requires specialized training and experience. START will determine and verify a qualified data validation resource prior to data validation.

Field sampling personnel have experience with soil sampling at hazardous waste sites while wearing appropriate personal protective equipment (PPE).

At least one field sampler will be trained and familiar with Global Positioning System (GPS) data collection and SCRIBE software. All sampling personnel must have appropriate training that complies with 29 Code of Federal Regulations 1910.120. The site-specific health and safety plan for this project is to be appended to this plan by START (Appendix B).

4. SAMPLING RATIONALE AND DESIGN

START reviewed available site information including previously collected gamma radiation data, and the EPA's objectives for this removal assessment, to determine a specific sampling design. The following sections describe the specific sampling designs that will be implemented during this removal assessment. The number of samples to be collected and the analyses to be performed are presented in Section 5.2 in Tables 5-1 and 5-2. Sample locations were chosen in order to obtain information on site conditions various temporal conditions including monsoon, spring snow melt, and arid seasons.

4.1 DETERMINATION OF BACKGROUND

Sampling and analysis of background samples for gamma radiation, metals (including uranium), and selected radioisotopes are required to determine naturally-occurring gamma radiation and COC concentrations in an area with similar geology and no known or suspected impacts from mining. The background area will be selected in the field according to the Background Location Selection Criteria (NNEPA and EPA 2010). The background area will be easily accessible, an appropriate distance from the Site, and historically undeveloped based on visual observation. Background locations determined during the 2012 watershed study by Teri Lameman-Austin (Lameman-Austin 2012) will be sampled during the watershed assessment. Although historical contamination from AUMs is already established in the Cove Wash watershed, background concentrations remain important in understanding the contributions of individual abandoned mines to the concentrations of COCs in the watershed. Background sampling locations collected in June 2015 are shown in Figure 3.

4.1.1 Background Gamma Radiation Investigation Level

A gamma radiation survey unit measuring 50-feet by 50-feet will be established in the selected background location. Gamma radiation in surface soil will be measured using a GPS assisted portable ratemeter and detector. The background survey unit will consist of transects spaced 5-feet apart, which will provide 99-100% characterization of the Site. The transect width is based on the field-of-view of the detector which is about 3-feet in diameter. The surveyor will walk at a pace of 3-feet per second. The mean and standard deviation (SD) of the gamma radiation measurements in the background surface soil will be calculated to develop the investigation level for gamma radiation at the site. An acceptable background area will have a low mean and SD. In the event poor satellite reception prevents the GPS from recording positions, the approximate sampling area location will be identified on a printed aerial image or topographic map in the field. The GPS continues to log gamma radiation measurements from the ratemeter at 1-second intervals without satellite reception.

4.1.2 Background Surface Water and Sediment Sampling

Surface water and sediment samples collected from locations in June 2015 upstream of historical mining activity in the Cove Wash watershed as shown in Figure 3. Surface water will be collected at all background locations collected in June 2015 pending surface water presence.

4.1.3 Stationary Gamma Measurements

Stationary 1-minute gamma measurements will be collected at selected suspect locations across the Site, identified by the gamma-scanning data. The stationary measurements will be more accurate than scanning measurements because they are integrated over 1-minute intervals versus 1-second intervals for the gamma scanning measurements. Stationary measurements will be made with the same type of instrumentation, and at the same height (6-inches) above ground surface as the gamma-scanning measurements. The precise height above ground surface is not critical during scanning measurements, but should be consistently set at 6-inches for each stationary measurement. These measurements will be collected using the same type of instrument and GPS system, though a second instrument set may be required for these measurements at suspect areas in order to efficiently conduct the required measurements in the time allotted.

4.1.4 Gamma Scanning

The 1-minute stationary gamma measurements described in Section 4.1.3 will likely depict a representation gamma activity at areas of specific concern. However, these 1-minute measurements may not coincide with the overall Site conditions. Gamma scanning will be employed to locate the spots with the maximum gamma activity.

Gamma scanning does not provide a quantitative assessment of Site conditions but is an excellent tool to assess the relative gamma activity of the area. The scanning procedure allows rapid assessment of a large area, sensitive detection of gamma radiation levels in excess of the background value, reasonably accurate delineation of areas where gamma radiation levels are elevated, and identification of small areas with the highest gamma count rates that have the highest potential for an observed release. The gamma scanning results will be presented on maps using geographic information system (GIS) software to illustrate areas of elevated gamma activity and to identify where additional measurements and sampling efforts should be placed.

Gamma scanning will be performed in Cove Wash drainages containing visible waste rock from upstream AUMs. The field team member will walk the area around the points where the highest 1-minute measurements were collected, attempting to locate the spot of maximum gamma count rate. When performing this scan, 100% of the hot spot should be surveyed.

Gamma scanning will be conducted using a GPS assisted portable ratemeter and detector. The detector will be hand-held approximately 6-inches above the soil surface. The instrument will be set with an open window to allow detection of the broad spectrum of gamma energies associated with the naturally occurring radionuclides. Gamma activity measurements are recorded at 1-second intervals by the GPS with corresponding positional data. The field-of-view for this detector system is roughly a circle of about 3-feet in diameter.

Gamma activity is recorded by the GPS in units of gamma counts per minute (cpm). The data are collected in 1-second intervals and the ratemeter calculates the gamma counts as cpm. Any slight variation in the collected count rate is magnified by this automated conversion and individual readings will be more variable than those from the 1-minute gamma measurements. Individual

gamma scan measurements will include occasional statistical outliers that do not indicate elevated gamma activity.

Because of this statistical variation, these gamma-scanning data are not used for comparison to the observed release criteria for gamma measurements. These data are used to qualitatively evaluate the Site and identify areas where sediment samples should be collected and stationary gamma measurements made.

4.1.5 Surface Water and Sediment Sampling

An estimated 50 surface water samples, including up to eight background samples, may be collected from the Cove Wash watershed at locations at or downstream of AUMs within the Cove watershed. The locations will include previous investigation sampling locations and June 2015 watershed assessment sampling locations. A total of 20 surface water/sediment sampling locations will correspond with previous investigation sampling locations (Lameman-Austin 2012, NNEPA 2014). Surface water and sediment sampling locations are located directly downgradient of historical uranium mines and directly downstream of where drainages converge. The sampling locations are meant to delineate potential sources of COCs to the Cove Wash watershed. Additionally, up to 10 additional surface water and sediment sampling locations may be collected in depositional areas (areas in drainages with sediment accumulation) at field determined locations. Additional samples may be collected based on field observation and gamma scanning. It is likely that many sampling locations will not contain surface water during the sampling event. In the case that surface water is not present, sediment samples will still be collected at each sampling location.

A sample volume of approximately 8.25 liters will be collected at each surface water location. Approximately 4.25 liters of surface water will be filtered using 0.45 micrometer filter before analysis. The samples will be filtered on site. As the criteria to which these results will be compared are the EPA's drinking water standards, all mud and other material must be removed before analysis. Otherwise, entrained mud and sediments which contain uranium and radium will influence the analytical result of the water. Approximately 1-gallon of collected surface water will be submitted for all analyses without filtering in order to determine total concentrations of COCs. Gamma spectrometry analysis is not recommended for water samples as the sensitivity of the analysis is not adequate to meet the EPA drinking water criteria. The laboratory will be requested to perform gross alpha analysis on each sample. Isotopic and total uranium analysis will be conducted, preferably by Kinetic Phosphorous Analysis (KPA), and radium isotopes (Ra-226 / Ra-228) analysis. The suite of metals to be analyzed in each surface water sample includes aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium (total), cobalt, copper, iron, lead, lithium, manganese, magnesium, molybdenum, nickel, potassium, phosphorous, selenium, silver, sodium, strontium, thallium, total uranium, vanadium, and zinc.

Alkalinity, ammonia, and major anions (including chloride, fluoride, nitrate and nitrite as total nitrogen, and sulfate anions) will be measure for all filtered surface water samples only. Additional metals, alkalinity, ammonia, and major anions were added in the revised SAP based on review of June 2015 sampling results and additional input from Terri Lameman-Austin and the USGS.

In addition, $\delta^{18}O$ and the activity ratio of $^{234}U/^{238}U$ in water samples can be used to evaluate the residence time of surface water and groundwater within the subsurface. Therefore, selected surface water samples will be analyzed for stable isotopes ^{16}O and ^{18}O. The concentrations of uranium isotope ^{234}U will be determined as part of the isotopic uranium analysis for all water samples.

A sample mass of approximately 1 kilogram will be collected all sediment sampling locations from a depth of 0 to 6-inches using a dedicated disposable plastic trowel or hand auger, and will be homogenized. Rocks of greater than approximately 0.25-inch diameter should be discarded, as should any biological material such as grass or twigs.

Sediment samples will be analyzed by gamma spectrometry for radium and uranium isotopes. The suite of metals to be analyzed in each sediment sample include the modified TAL metals, total uranium and molybdenum.

4.1.6 Groundwater Sampling

Well-construction information is not available for the seven groundwater wells to be sampled. Groundwater samples collected in 2011 during the uranium distribution study conducted by Terri Lameman-Austin were sampled by purging wells for 1 to 2 minutes and collecting the groundwater sample before the well went dry. Water level readings could not be collected as the wells are surrounded by a stone masonry box. The groundwater wells will be sampled after purging the well fully dry and allowing enough time for water to refill the well. As the water level reading cannot be ascertained in order to determine the level of refill in the well, the wells will be purged, and the wells will be sampled after a minimum of 30 minutes to permit groundwater to recharge. Groundwater sampling locations collected in June 2015 are shown in Figure 4. When possible, additional well construction data will be collected at each well.

A sample volume of approximately 8.25 liters will be collected at each surface water location. Approximately 4.25 liters of surface water will be filtered using 0.45 micrometer filter before analysis. The samples will be filtered on site. As the criteria to which these results will be compared are the EPA's drinking water standards, all mud and other material must be removed before analysis. Otherwise, entrained mud and sediments which contain uranium and radium will influence the analytical result of the water. Approximately 1-gallon of collected surface water will be submitted for all analyses without filtering in order to determine total concentrations of COCs. Gamma spectrometry analysis is not recommended for water samples as the sensitivity of the analysis is not adequate to meet the EPA drinking water criteria. The laboratory will be requested to perform gross alpha analysis on each sample. Isotopic and total uranium analysis will be conducted, preferably by Kinetic Phosphorous Analysis (KPA), and radium isotopes (Ra-226 / Ra-228) analysis. The suite of metals to be analyzed in each surface water sample includes aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium (total), cobalt, copper, iron, lead, lithium, manganese, magnesium, molybdenum, nickel, potassium, phosphorous, selenium, silver, sodium, strontium, thallium, total uranium, vanadium, and zinc.

Alkalinity, ammonia, and major anions (including chloride, fluoride, nitrate and nitrite as total nitrogen, and sulfate anions) will be measure for all filtered surface water samples only. Additional metals, alkalinity, ammonia, and major anions were added in the revised SAP based

on review of June 2015 sampling results and additional input from Terri Lameman-Austin and the USGS.

In addition, $\delta^{18}O$ and the activity ratio of $^{234}U/^{238}U$ in water samples can be used to evaluate the residence time of surface water and groundwater within the subsurface. Therefore, selected surface water samples will be analyzed for stable isotopes ^{16}O and ^{18}O. The concentrations of uranium isotope ^{234}U will be determined as part of the isotopic uranium analysis for all water samples.

4.1.7 Subsurface Sediment Sampling

In addition to two subsurface background samples, up to eight subsurface samples (up to 10% of sediment locations) will be collected within mining waste deposited in Cove Wash watershed drainages using a hand auger or dedicated plastic trowel. Subsurface samples will be collected in order to further characterize mine waste that has migrated into the watershed. The depth of subsurface sediment samples will be determined in the field and will range from 6 to 18-inches.

4.2 CONTAMINANTS OF CONCERN

Analytes detected during previous surface water sampling events at concentrations above the EPA MCL are COCs, including arsenic, selenium, uranium, radium 226, and gross-alpha radioactivity.

5. REQUEST FOR ANALYSES

Gamma radiation will be measured at the selected background locations, and at locations of mine waste in Cove Wash watershed drainages. Up to 45 surface water locations and 10 groundwater locations will be sampled. Surface and groundwater samples will be submitted for metals, alkalinity, ammonia, major anions, uranium and radium isotopes, gross-alpha radiation, and stable isotopes analysis. Up to 45 sediment locations will be sampled. Sediment samples will be submitted for metals, uranium and radium isotopes, and gross-alpha radiation analysis. All samples will be submitted to a START contracted laboratory.

5.1 FIELD ANALYSIS

5.1.1 Water Quality Measurements

Field measurements will be collected at each surface water sampling location including pH, temperature, conductivity, oxidation-reduction potential, and turbidity. Flow measurements will be collected at each surface water sampling location where flow is fast enough to measure. Flow will be estimated in the field. Visual observation of each surface water sample will be recorded.

5.1.2 Gamma Radiation in Surface Soils

Gamma radiation in surface soil will be measured in the field using a GPS assisted ratemeter and detector. Operational checks will be conducted on the paired meter and detector combinations before the field activities using a check source with 1 or 5 microcuries of Cobalt-60. The optimal high voltage setting for the instrument will be set using a Fluke voltage meter.

To provide quality control (QC) for the field analytical effort, the following measures will be utilized:

- Analytical precision and sensitivity of the gamma radiation survey equipment will be established before beginning the field measurements and will be verified throughout the field survey event through operational and background checks.
- Whenever possible, the same paired GPS-linked meter and detector used to establish the relationship between gamma radiation activity and Ra-226 concentrations in soil will be used for all surveys conducted at the Site.

5.2 LABORATORY ANALYSIS

5.2.1 Surface water and Groundwater Analyses

Surface and groundwater samples will be submitted for metals, alkalinity, ammonia, major anions, uranium and radium isotopes, gross-alpha radiation, and stable isotopes analysis. Sediment samples will be submitted for metals, uranium and radium isotopes, and gross-alpha radiation analysis. ALS Environmental and Isotech Laboratories. Sample containers,

preservatives, holding times, and estimated number of soil confirmation and QC samples are summarized in Table 5-1.

To provide QC for the analytical program, the following samples will be collected/analyzed:

- Duplicate samples will be collected from 10 percent of the soil sampling locations or one per sample design group. Duplicate soil samples will be collected as a 50/50 split of the sample after collection and homogenization.
- If non-dedicated sampling equipment is used to collect soil samples at the site, a rinsate blank will be collected at a rate of one per day to evaluate decontamination procedures. The rinsate blank will be collected by pouring deionized water over the decontaminated sample collection device (e.g., trowel or hand auger) and capturing the water in the specified sample container.

Table 5-1. Surface Water and Groundwater Sampling and Analysis Summary

Method	Metals by EPA 200.7 and 200.8	Uranium Isotopes by EPA 908.0	Ra-226 by EPA 903.0 and Ra-228 by EPA 904.0	Alkalinity by EPA 310.0, Ammonia by EPA 350.1, and Major Ions by EPA 300.0	Gross Alpha Radiation by EPA 900.1	Stable isotopes by CRDS
Sample Container	500-mL poly	1-gallon poly	1-gallon poly	250 mL	1-gallon poly	125 mL poly
Preservation	HNO_3	None	None	None	None	None
Analysis Holding Time	28–180 days	180 days	180 days	28 days	180 days	None
Estimated Number of Unique Discrete Samples	55	55	55	55	55	30
Estimated Number of Duplicate Samples	6	6	6	6	6	3
Minimum Total Site Sample Analyses	61	61	61	61	61	33
Equipment Rinse Blanks (if non-dedicated equipment is used for groundwater sampling						
Sample Container	500 milliliter plastic bottle/1-gallon poly					
Preservation	HNO_3 and 4 °C					
Analysis Holding Time	28-180 days					
Number of Samples	As needed for groundwater sampling					

Sample ID	Description	Sample ID	Description
CW-GW-01	Red Point Dug Well	CW-SW-58	TBD
CW-SW-01	Cove Wash	CW-SW-59	TBD
CW-SW-02	Cove Wash	CW-SW-60	TBD
CW-SW-04	Background	CW-SW-61	TBD

Sample ID	Description	Sample ID	Description
CW-SW-05	Historical Sample - Area 1 - Dam Surf	CW-SW-62	TBD
CW-SW-07	Historical Sample - W07 - Cove Wa	CW-SW-63	TBD
CW-SW-10	Cottonwood Spring	CW-SW-64	TBD
CW-SW-11	Cove Wash North	CW-SW-65	TBD
CW-SW-12	Cove Wash Middle 3	CW-SW-66	TBD
CW-SW-13	Cove Wash Middle 3	CW-SW-67	TBD
CW-SW-14	Cove Wash Middle 3E	CW-SW-68	TBD
CW-SW-18	Background - Cove Wash Middle 1 B	CW-SW-69	TBD
CW-SW-21	Background - Mesa IV Springs	CW-SW-70	TBD
CW-SW-22	Duplicate of SW-21	CW-SW-71	TBD
CW-SW-26	Historical Sample - W006 - Cove Wa	CW-SW-72	TBD
CW-SW-36	Historical Sample - W005 - Cove Wa	CW-SW-73	TBD
CW-SW-37	Historical Sample - W004 - Middle	CW-SW-74	TBD
CW-SW-38	Historical Sample Area 4 - Cove Wa	CW-SW-75	TBD
CW-SW-39	Cove Wash Middle 2	CW-SW-76	TBD
CW-SW-40	Duplicated of SW-39	CW-SW-77	TBD
CW-SW-46	Pine Water Springs	CW-SW-78	TBD
CW-SW-48	Cove Wash Middle 3	CW-SW-79	TBD
CW-SW-49	Duplicate of SW-05	CW-SW-80	TBD
CW-SW-50	Cove Wash Middle 1	CW-SW-81	TBD
CW-SW-51	Cove Wash Middle 1A	CW-SW-82	TBD
CW-SW-53	Cove Wash Middle 1	CW-SW-83	TBD
CW-SW-54	Cove Wash Middle 1B	CW-SW-84	TBD
CW-SW-55	TBD	CW-SW-85	TBD
CW-SW-56	TBD	CW-SW-86	TBD
CW-SW-57		CW-SW-87	TBD

Notes:
°C = degree Celsius
CRDS = cavity ring-down spectroscopy
NA = Not Applicable
TBD = To Be Decided

5.2.2 Sediment Analyses

Sediment samples will be analyzed for metals, uranium and radium isotopes, gross-alpha radiation. Sediment samples will be submitted to Test America - St. Louis and Eberline Laboratories. Sample containers, preservatives, holding times, and estimated number of soil confirmation and quality control samples are summarized in Table 5-2.

To provide quality control for the analytical program, the following measures will be utilized:

- Duplicate samples will be collected from 10% of the soil sampling locations or one per sample design group. Duplicate soil samples will be collected as a 50/50 split of the sample after collection and homogenization.
- If non-dedicated sampling equipment is used to collect soil samples at the site, a rinsate blank will be collected at a rate of one per day to evaluate decontamination procedures. The rinsate blank will be collected by pouring deionized water over the decontaminated sample collection device (e.g., trowel or hand auger) and capturing the water in the specified sample container.

Table 5-2. Sediment Sampling and Analysis Summary

Method	Metals by EPA 6010B	Uranium Isotopes by EPA 908.0 Modified	Ra-226/Ra-228 by EPA 901.1 Modified	Gross Alpha Radiation by EPA 900.0 Modified
Sample Container	4-ounce glass jar	4-ounce glass jar	8 ounce plastic soil 4-ounce glass jar	4-ounce glass jar
Preservation	4 °C	None	None	None
Analysis Holding Time	180 days	180 days	180 days	
Estimated Number of Unique Discrete Samples	58	58	58	58
Estimated Number of Duplicate Samples	6	6	6	6
Minimum Total Site Sample Analyses	64	64	64	64
Equipment Rinse Blanks (if non-dedicated equipment is used for groundwater sampling				
Sample Container	500 milliliter plastic bottle/1-gallon poly cube			
Preservation	HNO_3 and 4 °C			
Analysis Holding Time	14 days			
Number of Samples	As needed			

Sample ID	Sample Depth	Description	Sample ID	Sample Depth	Description
CW-SS-01	Surface	Cove Wash	CW-SS-30	Surface	Background
CW-SS-02	Surface	Cove Wash	CW-SS-31	Surface	Background
CW-SS-03	Surface	Cove Wash North	CW-SS-32	Surface	Cove Wash Middle 1E
CW-SS-04	Surface	Background	CW-SS-36	Surface	Historical Sample - W005 - Cove Wash Middle 2
CW-SS-05	Surface	Historical Sample - Area 1 - Dam Surface Sample - Cove	CW-SS-37	Surface	Historical Sample - W004 - Middle 2
CW-SS-06	Surface	Cove Wash	CW-SS-38	Surface	Historical Sample Area 4 - Cove Wash Middle
CW-SS-07	Surface	Historical Sample - W07 - Cove Wash Middle	CW-SS-39	Surface	Cove Wash Middle 2

Sample ID	Sample Depth	Description	Sample ID	Sample Depth	Description
CW-SS-08	Surface	Background	CW-SS-41	Surface	Cove Wash Middle 1
CW-SS-09	Surface	Cove Wash North	CW-SS-42-14	Subsurface	Irrigation Ditch Subsurface - Cove Middle
CW-SS-10	Surface	Cottonwood Springs	CW-SS-43-12	Subsurface	Dam Subsurface - Cove Middle
CW-SS-11	Surface	Cove Wash North	CW-SS-44	Surface	Pine Water Springs Drainage
CW-SS-12	Surface	Cove Wash Middle 3	CW-SS-45	Surface	Background - Deer Springs Drainage
CW-SS-13	Surface	Cove Wash Middle 3	CW-SS-46	Surface	Pine Water Springs
CW-SS-14	Surface	Cove Wash Middle 3E	CW-SS-46-14	Surface	Pine Water Springs Subsurface
CW-SS-15	Surface	Cove Wash North	CW-SS-47	Surface	Cove Wash Middle 3F
CW-SS-16	Surface	Cove Wash North	CW-SS-48	Surface	Cove Wash Middle 3F
CW-SS-17	Surface	Cove Wash South	CW-SS-49	Surface	Duplicate of CW-SS-10
CW-SS-18	Surface	Background - Cove Wash Middle 1 BKG	CW-SS-50	Surface	Cove Wash Middle 1
CW-SS-19	Surface	Historical Sample - Cove Mesa 2	CW-SS-51	Surface	Cove Wash Middle 1A
CW-SS-19-12	Subsurface	Cove Wash Middle 3B Subsurface	CW-SS-52	Surface	Cove Wash Middle 1G
CW-SS-20	Surface	Cove Wash Middle 3C	CW-SS-53	Surface	Cove Wash Middle 1
CW-SS-21	Surface	Background - Mesa IV Springs	CW-SS-54	Surface	Cove Wash Middle 1B
CW-SS-21-12	Subsurface	Background - Mesa IV Springs Subsurface	CW-SS-55	Surface	Cove Wash Middle 1C
CW-SS-26	Surface	Cove Wash Middle 2B	CW-SS-56	Surface	Cove Wash Middle 3A
CW-SS-27	Surface	Cove Wash Middle 2B	TBD	TTBD	Duplicate Sample TPBD
CW-SS-28	Surface	Duplicate of CW-SS-27	TBD	TBD	Duplicate Sample TBD
CW-SS-29	Surface	Cove Wash Middle 2C	TBD	TBD	Duplicate Sample TBD

Notes:
°C = degree Celsius
NA = Not Applicable
TBD = To Be Decided
1 Subsurface depths will be determined based on field observations

6. FIELD METHODS AND PROCEDURES

6.1 FIELD PROCEDURES

The following sections describe field procedures and equipment used during the site activities.

6.1.1 Equipment

The equipment listed below may be utilized to obtain environmental data from the respective media according to the following sampling SOPs or their equivalent:

- Ludlum Model 44-20 3-inch by 3-inch sodium iodide detector
- Ludlum Model 2241 Meter
- Trimble GeoXT 6000 GPS
- ERT SOP #2012 Soil Sampling
- ERT SOP #2006 Sample Decontamination

The following is a partial list of equipment that may come in contact with samples:

- Dedicated plastic scoops
- Dedicated plastic sample jars or sealable plastic bags
- Non-dedicated hand auger
- Disposable nitrile gloves

6.1.2 Equipment Maintenance

Field instrumentation for the collection of samples will be operated, maintained, and have operational checks conducted by the sampling team according to the SOPs listed in Section 6.1.1 or their equivalent. Field instrumentation utilized for health and safety purposes will be operated, maintained, and have operational checks conducted by the sampling team according to the manufacturer's instruction. Operational checks and field use data will be recorded in the instrument or field logbooks.

6.1.3 Inspection/Acceptance Requirements for Supplies and Consumables

There are no project-specific inspection/acceptance criteria for supplies and consumables. It is standard operating procedure that personnel will not use broken or defective materials; items will not be used past their expiration date; supplies and consumables will be checked against order and packing slips to verify the correct items were received; and the supplier will be notified of any missing or damaged items.

6.1.4 Field Logbooks

Field logbooks will document where, when, how, and from whom any vital project information was obtained. Logbook entries will be complete and accurate enough to permit reconstruction of field activities. Logbooks are bound with consecutively numbered pages. Each page will be

dated and the time of entry noted in military time. All entries will be legible, written in ink, and signed by the individual making the entries. Language will be factual, objective, and free of personal opinions. The following information will be recorded, if applicable, during the collection of each sample:

- Sampling location and description
- Property sketch showing sampling, removal excavations, and in-place capping locations with measured distances
- Sampler's and documenter's name(s)
- Date and time sample collection, removal excavation, and in-place capping occurred
- Type of samples, excavated, or capped material
- Type of sampling equipment used and matrix
- Field observations and details (e.g., rain, odors, etc.)
- Field instrument reading
- Shipping arrangements (air bill numbers)
- Receiving laboratory(ies)

START members will be on site performing different duties related to sample collection, processing, and analysis. Each logbook will document the information relevant to the site radiation activity, and at a minimum will include:

- Team members and their responsibilities
- Time of activities
- Deviations from sampling plans, site safety plans, and SAP procedures
- Levels of safety protection
- Calibration information
- Analytical data

6.1.5 Photographs

Photographs will be taken at representative sampling locations and at other areas of interest on site. They will serve to verify information entered in the field logbook. When a photograph is taken, the following information will be recorded in the appropriate field logbook or field computer tablet:

- Time, date, location, and, if appropriate, weather conditions
- Description of the subject photographed
- Name of person taking the photograph

6.1.6 Electronic Sample Logging

The sampling team may utilize field management software to prepare sample labels and chain-of-custody forms. Blank sample labels and chain-of-custody forms will also be available. The following information should be entered for each sample after collection:

- Sample name
- Sample date and time
- Number of Sample bottles
- Type of Preservation
- Analyses

In addition to these items, the software may also be used to keep track of other information such as sample depth, field measurements, and split samples. The field team will generate chain-of-custody forms for each cooler of samples packaged and sent to a laboratory. Each chain-of-custody form will refer to the shipping method and tracking number. Printed chain-of-custody forms will be submitted to the laboratory with the samples. The use of field management software will require that the field team have access to a computer, a printer, computer paper, and labels while in the field. The field data manager will be responsible for implementing the software.

The Data Management Plan (DMP) is included as Appendix D.

6.1.7 Mapping Equipment

Sampling points and site features will be located and documented with a GPS unit. The GPS will be used to assign precise geographic coordinates to sampling locations on the site. GPS mapping will be done by personnel trained in the use of the equipment and will be completed according to the manufacturer's instructions. Expected output from the use of GPS mapping will be site maps with sampling locations and major site features. Sampling locations and gamma survey areas will be identified on a printed aerial image or topographic map at locations of poor GPS satellite reception.

6.2 BACKGROUND LOCATION SURVEY PROCEDURES

The background location will be selected in the field according to the Background Location Selection Criteria (NNEPA and EPA 2010) as follows:

- Similar elevation as the Site
- Similar geology as the Site
- Upwind (gradient, stream) from the Site
- Undisturbed with natural vegetation
- Not in drainage or area impacted by flooding
- Distance to residential structures (structures should be within range of vision)
- Accessible (by vehicle and equipment)

- Should not be near a mine site or similar contaminant source
- If possible, avoid anthills and rodent holes
- Ask nearby residents about area history

6.2.1 Background Gamma Radiation Sampling

A gamma radiation survey unit measuring 50-feet by-50 feet will be established in the selected background location. Gamma radiation in surface soil will be measured using GPS assisted ratemeter and detector described in section 6.3. The detector will be positioned 6-inches above the ground surface. The background survey unit will consist of transects spaced 3-feet apart, which will provide 99-100% characterization of the site. The transect width is based on the field-of-view of the detector which is 3-feet in diameter. The surveyor will walk at a pace of 3-feet per second. The mean and SD of the gamma radiation measurements in the background surface soil will be calculated to develop the investigation level for gamma radiation at the site. An acceptable background area will have a low mean and SD.

6.2.2 Background Surface Water and Groundwater Sampling

In general, background surface water locations should be collected directly upstream of potentially contaminated areas of concern. However, based on a sampling event conducted in 2011, sampling location surface water may not be present upstream of all AUMs due to their locations at the top of the Lukachukai Mountain range. Background surface water samples will be collected upstream of areas of concern (AOC) whenever possible. In the event that surface water is not present, background surface water samples will be collected in other Cove Wash drainages that are upstream of any AOC.

Groundwater wells present within the watershed are mostly downgradient of historical mining activities in the watershed. Seeps are present within the Cove Wash watershed, and they may also be used as background groundwater sample locations as necessary.

6.3 SURFACE GAMMA RADIATION SURVEY PROCEDURES

The survey equipment for measuring gamma radiation consists of a paired Ludlum Model 2241 meter and Model 44-20 (3-inch by 3-inch sodium iodide) detector in conjunction with a Trimble GeoXT 6000 GPS which will have operational checks conducted before field activities. Performance of the radiation survey equipment will be verified throughout the field activities through operational checks and background checks as necessary. Whenever possible, the same paired gamma activity survey system will be used for all surveys conducted at the site.

The detector will be carried at approximately 6-inches above ground surface. The Trimble will be used for geospatial information collection and analysis. Real-time in situ surface soil survey will consist of transects spaced 5-feet apart covering 99-100% of the mine waste located in drainages at a pace of 3-feet per second. If an immovable obstruction is encountered during the survey, the scanning survey will be performed around the feature.

If gamma radiation measurements along the perimeter of the Site exceed the investigation level, lateral step-out delineation will continue beyond the current site boundary until the recorded

gamma radiation measurements are below the investigation level. Co-located static one-minute gamma radiation counts at surface soil sampling locations will be used to establish the relationship between gamma radiation measurements in cpm and Ra-226 concentration in soil.

6.4 SEDIMENT SAMPLING PROCEDURES

Sediment samples will be collected from the Cove Wash watershed from surface locations (0 to 6 inches below ground surface [bgs]) and subsurface locations (depth to be determined in field). Additional samples may be collected from floodplain terraces if identified in the field.

6.4.1 Surface Sediment

In addition to the eight background surface soil samples detailed in Section 4.1.2, up to 48 surface soil samples will be collected at selected sampling locations. Surface soil samples will be co-located with one-minute static gamma radiation counts to establish a relationship between Ra-226 concentrations and gamma radiation measurements in cpm in soil. Surface soil samples will be collected using a disposable trowel and placed into a dedicated 8-ounce plastic sample jar or plastic sealable bag. If present, non-soil material including rocks larger than approximately 0.25 inch median diameter will be removed from the soil sample. Sample jars will be stored in a cooler according to the laboratory requirements in Table 5-1. Non-dedicated sampling equipment will be decontaminated after every sample according to Section 6.6.

Surface soil samples will be collected from 0 to 6-inches. All sample information will be logged in the electronic data collection device, photographed, and marked with a GPS.

Nine duplicate samples (or 10% of total samples) will be collected and given false sample IDs for the purposed of QA/QC. Additional surface soil samples may be collected based on field observations.

All sampling locations will be recorded in an electronic data collection device as sampling is completed. Each field sampling team will document each individual sampling location in the device, which includes: the site name, where the sample was collected with a representative sketch of the area, GPS coordinates of the sample location, date, time, sample identification, sampling team members, and photographs taken.

6.4.2 Subsurface Soil

In addition to the two background subsurface soil samples detailed in Section 4.1.2, up to eight subsurface soil samples will be collected at site and analyzed for Ra-226 by EML HASL 300 4.5.2.3 method. Subsurface sample locations will be co-located with the surface sample locations at locations determined in the field. One subsurface sample will be collected from the surface water diversion dam.

Subsurface soil samples will be collected using a hand auger and/or shovel.

One duplicate sample (or 10% of total samples) will be collected and given a false sample ID for the purposed of QA/QC. Additional subsurface soil samples may be collected based on field observations.

6.5 FIELD DECONTAMINATION PROCEDURES

Decontamination activities will be conducted by START in accordance with ERT SOP #2006. All surface soil samples will be collected using dedicated equipment. All shallow sub-surface soil samples will be collected using a hand auger or shovel and a plastic scoop. The hand auger or shovel is the only non-dedicated sampling equipment that will come into contact with the soil sample. The hand auger or shovel will be decontaminated between each sub-surface sampling location. Decontamination of sampling equipment must be conducted consistently to assure the quality of samples collected. Dedicated equipment intended for one-time use will not be decontaminated, but will be packaged for appropriate disposal. Decontamination will occur prior to and after each use of a piece of non-dedicated equipment. All non-dedicated sampling devices used will be decontaminated using the following procedures. All non-dedicated sample handling devices will be decontaminated according to the following procedure:

- Non-phosphate detergent and tap water wash using a brush to scrub solids from the surface;
- Tap water rinse; and
- Triple deionized/distilled water rinse.

In order to ensure that water and sediment with elevated concentrations of COCs is not transported offsite, a G-M pancake probe may be utilized to determine that alpha, beta, and gamma radiation levels remain at background (offsite within Cove, Az) on personnel and sampling equipment as needed. Personnel health and safety equipment such as waders will be scanned using the G-M pancake probe before leaving the site. In addition, any remaining sediment on personnel or sampling equipment will be removed prior to leaving the site each day by dry washing or using water obtained from offsite.

7. DISPOSAL OF INVESTIGATION-DERIVED WASTE (IDW)

In the process of collecting environmental samples at the Site, several different types of potentially contaminated IDW will be generated, including the following:

- Used PPE
- Disposable sampling equipment
- Decontamination fluids

The EPA's National Contingency Plan requires that management of IDW generated during site investigations comply with all relevant or appropriate requirements to the extent practicable. This SAP will follow the U.S. EPA Office of Emergency and Remedial Response Management of Investigation-Derived Wastes during Site Inspections (Directive 9345.3-02), May 1991 (EPA 1991), which provides the guidance for management of IDW during site investigations. Listed below are the procedures that will be followed for handling IDW. The procedures are flexible enough to allow the site investigation team to use its professional judgment on the proper method for the disposal of each type of IDW generated at each sampling location.

- Used PPE and disposable sampling equipment will be double bagged in plastic trash bags and disposed of in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a municipal landfill. Any PPE or dedicated equipment that is to be disposed of that can still be reused will be rendered inoperable before disposal.
- Decontamination fluids will consist of water with residual contaminants and/or non-phosphate detergent. These fluids will be left onsite to evaporate.

8. SAMPLE IDENTIFICATION, DOCUMENTATION AND SHIPMENT

8.1 SAMPLE NOMENCLATURE

A unique, identifiable name will be assigned to each soil sample. Soil samples will be identified according to the following nomenclature:

[Sample Site][Sample Description]-[Sample Number]-[Sample Depth]

Where:

Sample Site – "CW" will designate the samples as collected from Cove Wash.

Sample Description – "SW" will designate surface water, "GW" will designate groundwater samples, and "SS" will designate sediment samples.

Sample Number – Number representing the specific sampling location where the sample was collected starting with 01.

Sample Depth – In the case of sediment, subsurface samples will be identified with a number indicating the sample depth sequence, where "#" indicates the depth of the subsurface sample in inches.

For example, a subsurface sediment sample labeled CW-SS-94-12 would be collected at 12 inches bgs. Surface water samples will not be identified with a depth.

For example, the first surface water sample collected will be identified as follows: CW-SW-01.

Field duplicate samples will be given a false location identifier.

8.2 CONTAINER, PRESERVATION, AND HOLDING TIME REQUIREMENTS

All sample containers will be delivered to START in a pre-cleaned condition. Container, preservation, and holding time requirements are summarized in Tables 5-1 and 5-2.

8.3 SAMPLE LABELING, PACKAGING, AND SHIPPING

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. Sample labels will be affixed to the sample containers and will contain the following information:

- Sample number
- Date and time of collection
- Site name
- Analytical parameter and method of preservation

- Samples will be stored in a secure location onsite pending analysis and shipment to the laboratory. Sample coolers will be retained in the custody of site personnel at all times or secured so as to deny access to anyone else.
- The procedures for shipping soil samples are:
  - If ice is used, it will be packed in double sealable plastic bags.
  - The drain plug of the cooler will be sealed with tape to prevent melting ice from leaking.
  - The bottom of the cooler will be lined with bubble wrap to prevent breakage during shipment.
  - Screw caps will be checked for tightness.
  - Containers will have custody seals affixed so as to prevent opening of the container without breaking the seal.
  - All glass sample containers will be wrapped in bubble wrap.
  - All containers will be sealed in plastic bags.
  - All samples will be placed in coolers with the appropriate chain-of-custody forms. All forms will be enclosed in plastic bags and affixed to the underside of the cooler lid. If samples require refrigeration during shipment then bags of ice will be placed on top of and around samples. Empty space in the cooler will be filled with bubble wrap or Styrofoam peanuts to prevent movement and breakage during shipment. Each ice chest will be securely taped shut with strapping tape, and custody seals will be affixed to the front, right, and back of each cooler.
- Samples will be shipped for immediate delivery to the laboratory. Upon shipping, the laboratory will be notified of:
  - Sampling contractor's name.
  - Site name.
  - Shipment date and expected delivery date.
  - Total number of samples, by matrix and the relative level of contamination for each sample (i.e., low, medium, or high).
  - Carrier; air bill number(s), method of shipment (e.g., priority).
  - Irregularities or anticipated problems associated with the samples.
  - Whether additional samples will be sent; whether this is the last shipment.

8.4 CHAIN-OF-CUSTODY FORMS AND QA/QC SUMMARY FORMS

A chain-of-custody form will be maintained for all samples to be submitted for analysis, from the time the sample is collected until its final deposition. Every transfer of custody must be noted and a signature affixed. Corrections on sample paperwork will be made by drawing a single line through the mistake and initialing and dating the change. The correct information will be entered above, below, or after the mistake. When samples are not under the direct control of the

individual responsible for them, they must be stored in a locked container sealed with a custody seal. The chain-of-custody form must include the following:

- Sample identification numbers
- Identification of sample to be used for MS/MSD purposes
- Site name
- Sample date
- Number and volume of sample containers
- Required analyses
- Signature and name of samplers
- Signature(s) of any individual(s) with control over samples
- Airbill number
- Note(s) indicating special holding times and/or detection limits

The chain-of-custody form will be completed and sent with the samples for each laboratory and each shipment. Each sample cooler should contain a chain-of-custody form for all samples within the sample cooler.

A sample summary form will be completed for each method and each matrix of the sampling event. The sample number for all blanks, reference samples, laboratory QC samples (MS/MSDs), and duplicates will be documented on this form. This form is not sent to the laboratory. The original form will be sent to the reviewer who is validating and evaluating the data; a photocopy of the original will be made for the START project file.

9. QUALITY ASSURANCE AND CONTROL (QA/QC)

9.1 QUALITY CONTROL/QUALITY ASSURANCE SAMPLES

QA/QC samples to be collected during this sampling are listed in Table 5-1 and described in the following subsections. QA/QC described in the following sections pertains to samples collected for laboratory analysis to obtain definitive data and do not pertain to field measurements. QA/QC relevant to field measurement data is discussed in section 5.1.

9.1.1 Equipment Blank Samples

For non-dedicated equipment such as hand augers, to collect samples equipment rinsate blanks will be collected at a rate of one per day to evaluate field decontamination procedures. An equipment rinsate blank consists of a sample of analyte-free water passed through or over a decontaminated sampling device into a 500 milliliter plastic bottle.

9.1.2 Assessment of Sample Variability

Duplicate soil samples will be collected at selected sampling locations. These locations will be chosen randomly in the field and will be collected at a rate of one for every 10 field samples. The duplicate sample will be obtained by splitting the homogenized sample collected from the soil location. The duplicate sample will be placed in an 8-ounce plastic jar and labeled accordingly.

9.1.3 Laboratory Quality Control Samples

Analyses for radioisotopes do not typically have MS/MSD requirements; therefore, none will be performed.

9.2 ANALYTICAL AND DATA PACKAGE REQUIREMENTS

It is required that all samples be analyzed according to the methods listed in Tables 5-1 and 5-2. The laboratory is required to supply documentation to demonstrate that their data meet the requirements specified in the method. Ra-226 determination requires a 21-day ingrowth period prior to analysis. Therefore, the preliminary results will be delivered to START within four (4) weeks of sample delivery. A complete analytical data package will be required from the analytical laboratory 30 working days after sample delivery. The laboratory will also provide all data electronically in a Microsoft Excel-compatible format or delimited text file in the format specified for SCRIBE. The data validator will provide a full validation data package to the START PM within 15 days after receipt of the complete analytical data package from the laboratory.

All field measurements and QA/QC information will be documented in logbooks, field forms, and spreadsheets, or may be directly downloaded into a database.

Deliverables for this project must meet the guidelines in EPA Region 9s Laboratory Documentation Requirements for Data Evaluation, R9/QA/00.4.1 (EPA 2001a). The following

data requirements specify and emphasize general documentation requirements and are not intended to supersede or change requirements of each method.

- A copy of the chain-of-custody, sample log-in records, and a case narrative describing the analyses and methods used.
- Analytical data (results) for up to three significant figures for all samples, method blanks, MS/MSD, Laboratory Control Samples (LCS), duplicates, Performance Evaluation (PE) samples, and field QC samples.
- QC summary sheets/forms that summarize the following:
- MS/MSD/LCS recovery summary
- Method/preparation blank summary
- Initial and continuing calibration summary (including retention time windows)
- Sample holding time and analytical sequence (i.e., extraction and analysis)
- Calibration curves and correlation coefficients
- Duplicate summary
- Detection limit information
- Analyst bench records describing dilution, sample weight, percent moisture (solids), sample size, sample extraction and cleanup, final extract volumes, and amount injected.
- Standard preparation logs, including certificates of analysis for stock standards.
- Detailed explanation of the quantitation and identification procedure used for specific analyses, giving examples of calculations from the raw data.
- The final deliverable report will consist of sequentially numbered pages.

9.3 DATA MANAGEMENT

Data collected during the removal assessment will consist of field and laboratory data. Field activities and sample information will be documented in a logbook as discussed in Section 6.1.4. Field and laboratory data including gamma radiation measurements, Ra-226 sample results, and location coordinates, will be loaded in SCRIBE. All data including logbook, complete analytical and validation data packages, photographs, and electronic data will be archived by START. The laboratory data summary and validation reports will be included in the final report submitted to EPA. The DMP is included as Appendix D.

9.4 DATA VALIDATION

Data validation will be performed by START or their subcontractor according to the EPA Region IX Superfund Data Evaluation/Validation Guidance R9QA/006.1 (EPA 2001a). The standard data quality review requirements of a Tier 2 validation of 100%of the data (as defined in Requirements for Quality Assurance Project Plans [EPA 2001b]) will satisfy the data quality requirements for this portion of the project. Upon completion of validation, data will be

classified as one of the following: acceptable for use without qualifications, acceptable for use with qualifications, or unacceptable for use. If during or after the evaluation of the project's analytical data it is found that the data contain excess QA/QC problems or if the data do not meet the DQI goals, then the independent reviewer may determine that additional data evaluation is necessary. Additional evaluation may include EPA Region IX Superfund Data Evaluation/Validation Guidance R9QA/006.1 for evaluation Tier 3.

To meet evaluation and project requirements, the following criteria will be evaluated during a Tier 2 evaluation:

- Data package completeness
- Laboratory QA/QC summaries
- Holding times
- Blank contamination
- Matrix related recoveries
- Field duplicates
- Random data checks
- Preservation and holding times
- Blank analyses
- Interference check samples
- Laboratory control samples
- Duplicate sample analysis
- Matrix spike sample analyses
- Sample serial dilution
- Field duplicate/replicate
- Overall assessment of data

Upon completion of evaluation, an analytical data evaluation Tier 2 review report will be delivered to the PM, and the data will be classified within the report as one of the following:

- Acceptable for use without qualifications
- Acceptable for use with qualifications
- Unacceptable for use

The data with applicable qualifications will be attached to the report. Unacceptable data may be more thoroughly examined to determine whether corrective action could mitigate data usability.

9.5 FIELD VARIANCES

As conditions in the field may vary, it may become necessary to implement minor modifications to this plan. When appropriate, the START QA Coordinator and the EPA FOSC will be notified of the modifications and a verbal approval obtained before implementing the modifications. Modifications to the original plan will be recorded in Site records and documented in the final report.

9.6 ASSESSMENT OF PROJECT ACTIVITIES

9.6.1 Assessment Activities

The following assessment activities will be performed by the START:

- All project deliverables (SAP, Data Summaries, Data Validation Reports, Removal Assessment Report) will be peer-reviewed by START prior to submission to EPA. In time-critical situations, the peer review may be concurrent with the release of a draft document to EPA.
- The START QA Coordinator will review project documentation such as logbooks and chain-of-custody forms to ensure the SAP was followed and that sampling activities were adequately documented. The START QA Coordinator will document deficiencies, and the START PM will be responsible for corrective actions.

9.6.2 Project Status Reports to Management

It is standard procedure for the START PM to report to the FOSC any issues, as they occur, that arise during the course of the project that could affect data quality, data use objectives, the project objectives, or project schedules. As requested by EPA, START will provide unvalidated data as they are received from the laboratory.

9.6.3 Reconciliation of Data with DQOs

Assessment of data quality is an ongoing activity throughout all phases of a project. The following outlines the methods to be used by the START for evaluating the results obtained from the project.

Review of the DQO outputs and the sampling design will be conducted by the START QA Coordinator prior to sampling activities. The reviewer will submit comments to the START PM for action, comment, or clarification. This process will be iterative.

A preliminary data review will be conducted by START. The purpose of this review is to look for problems or anomalies in the implementation of the sample collection and analysis procedures and to examine QC data for information to verify assumptions underlying the DQOs and the SAP. When appropriate to sample design, basic statistical quantities will be calculated and the data will be graphically represented. When appropriate to the sample design and if specifically tasked to do so by the FOSC, START will select a statistical hypothesis test and identify assumptions underlying the test.

10. REFERENCES

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FIGURES

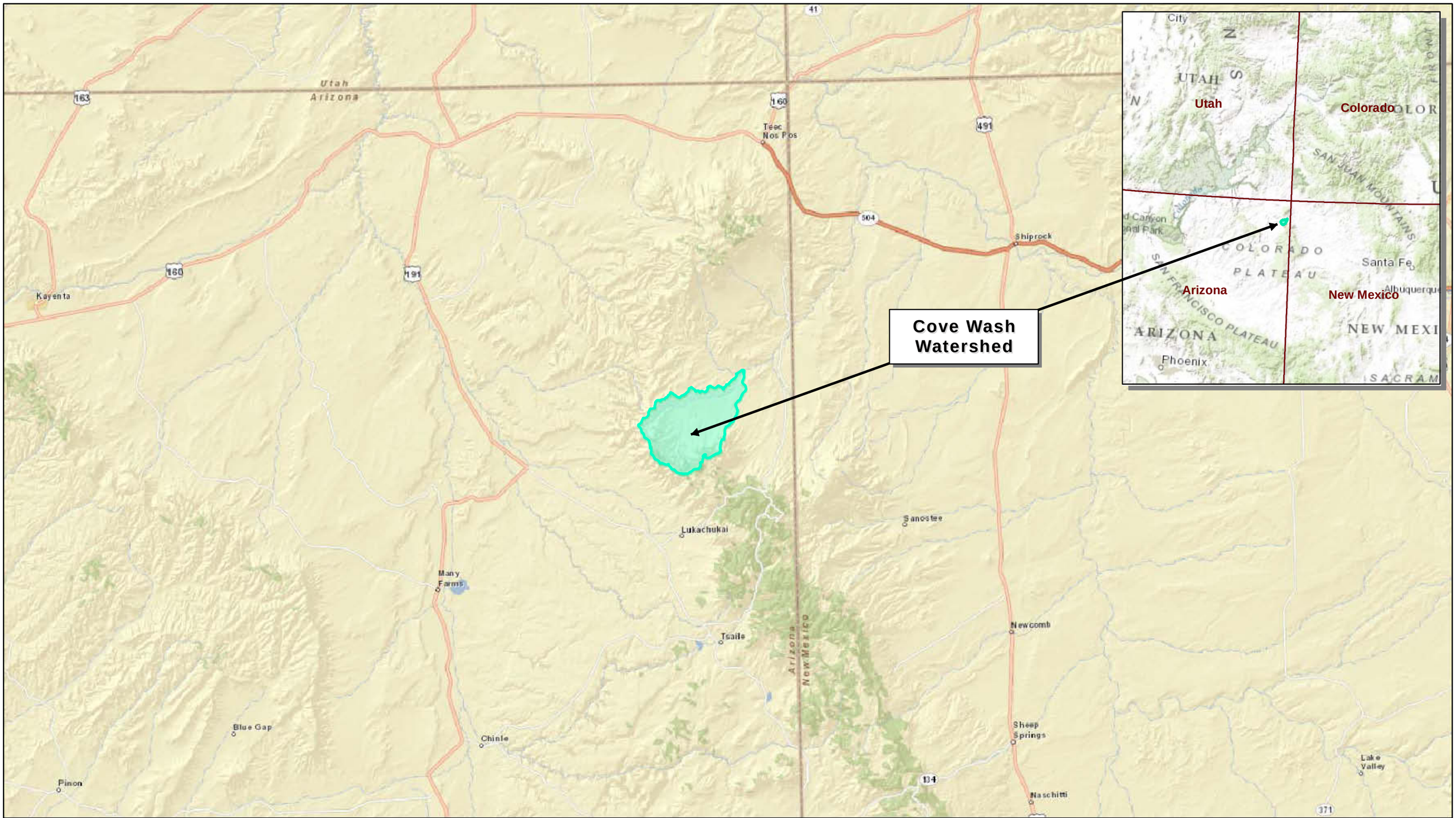

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FIGURE #1
SITE LOCATION
Cove Wash Watershed Assessment
Cove Chapter, Navajo Nation, AZ

Contract: EP-S5-13-02; **TDD:** 0011/1302-T11-R9-15-03-0001

Document Control Numberr: 0047-08-AAEX

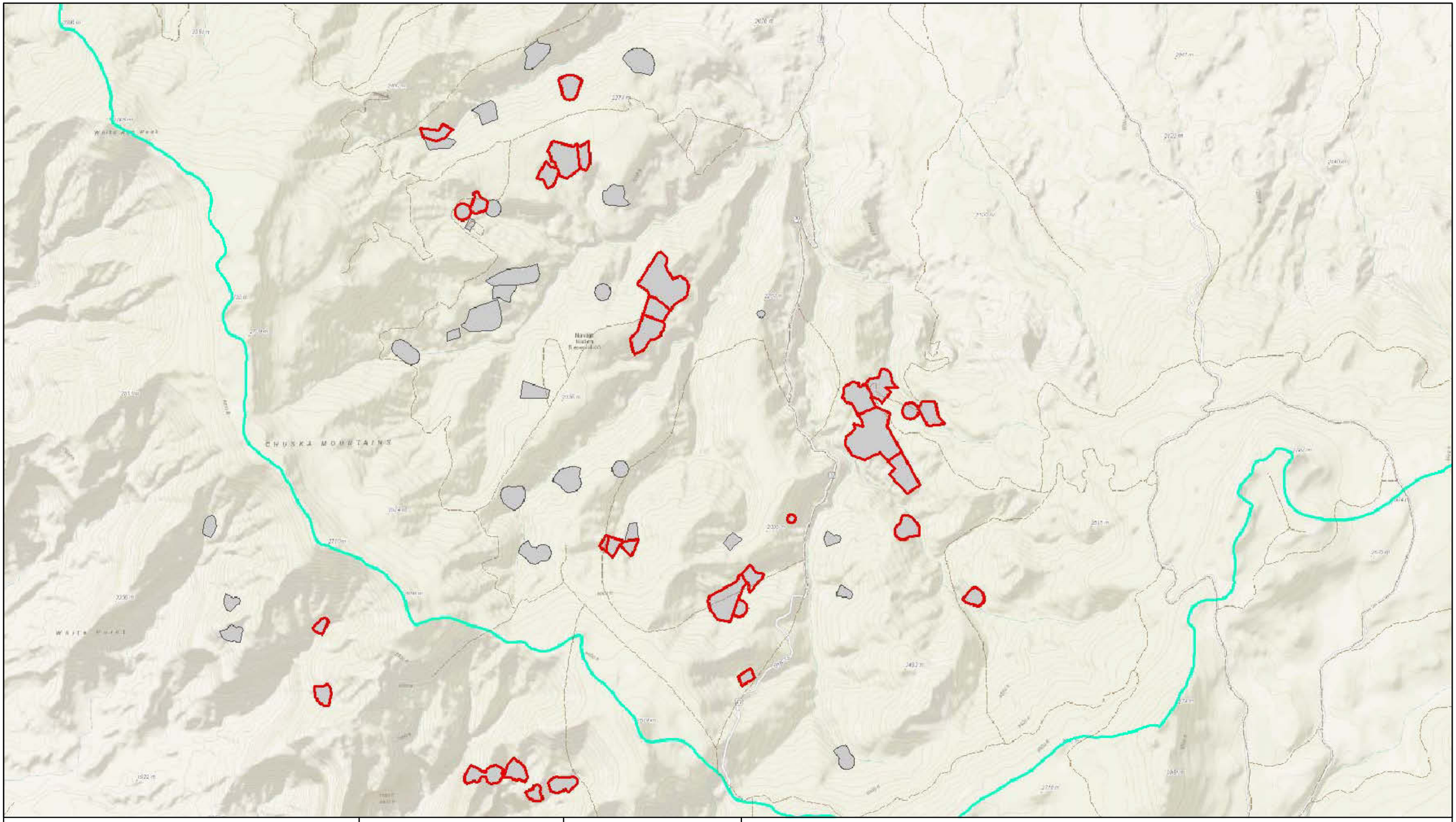

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FIGURE #2
ANANDONED URANIUM MINES
Cove Wash Watershed Assessment
Cove Chapter, Navajo Nation, AZ

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Legend

- Sediment Sample
- Surface Water Sample
- Approximate Location of Owl Sighting
- Cove Drainage
- Tronox Mine Site
- Mine Site
- Cove Wash Watershed

SW/SS-02
SW-01
SS-01
SS-06
SS-17
SS-08
GW-03
SW-10
SS-09
SS-03
SW/SS-07
SS-30
SW/SS-11
SS-15
SW/SS-04
SS-16
SW/SS-18
SW-05
SW-39
SW/SS-51
SW/SS-50
SW/SS-48
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SS-45
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FIGURE #3
SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS
Cove Wash Watershed Assessment
Cove Chapter, Navajo Nation, AZ

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Document Control Numberr: 0047-08-AAEX

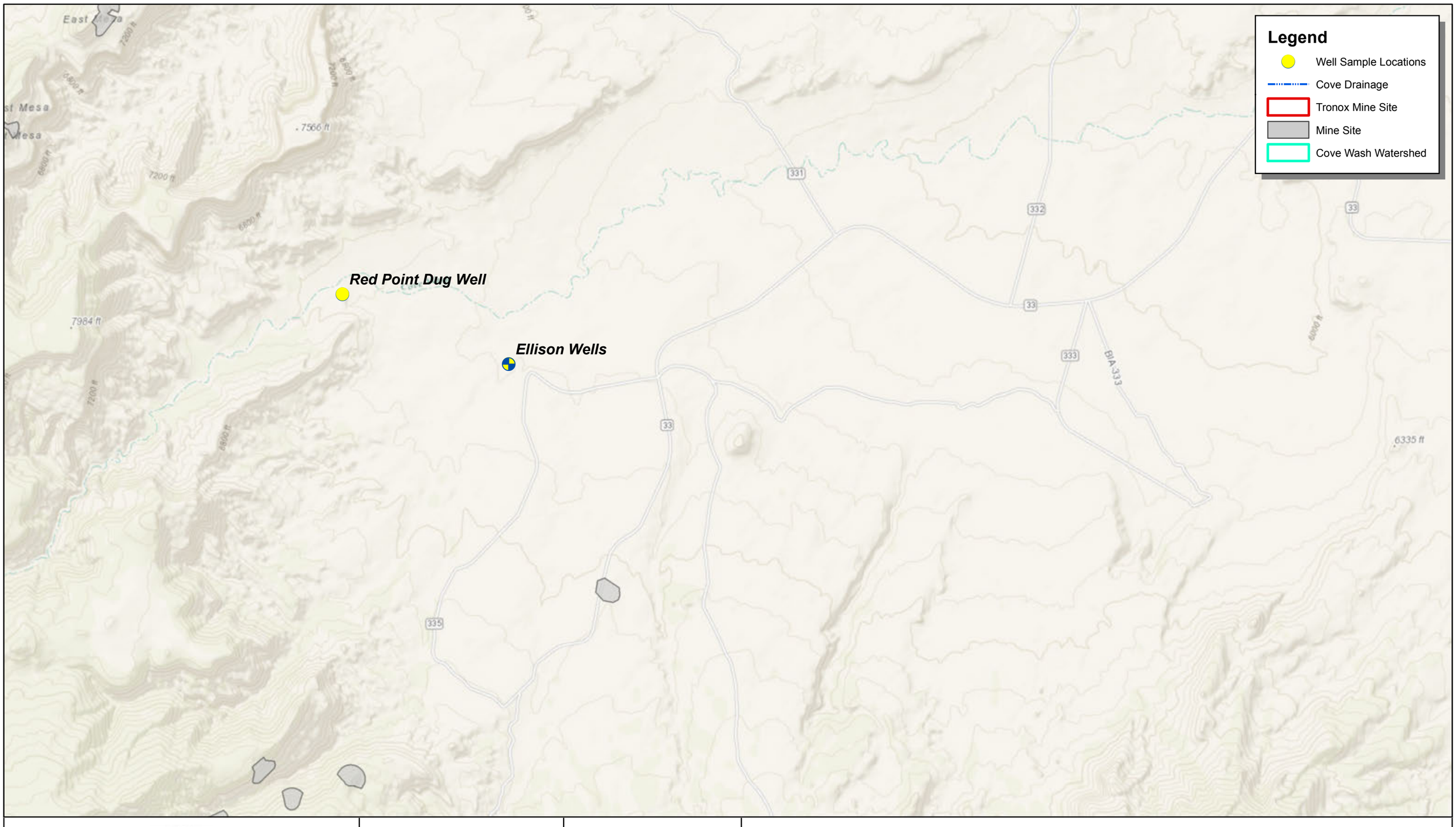

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FIGURE #4
GROUNDWATER SAMPLE LOCATIONS
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