



# **REMOVAL EVALUATION WORK PLAN CHURCH ROCK SITES 1 and 1E PHASE II**

Prepared For:

**Rio Algom Mining LLC**

Prepared By:

**SENES Consultants Limited**

Redlined Version - December 2010



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CHURCH ROCK SITES 1 AND 1E  
PHASE II**

**Prepared for:**

**Rio Algom Mining LLC**

**Prepared by:**

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## ACRONYMS AND ABBREVIATIONS

AOC	Administrative Order on Consent
bgs	below ground surface
Bi-214	bismuth-214
BLM	Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	U.S. Code of Federal Regulations
CR	Church Rock
COC	constituents of concern
C-O-C	chain of custody
cpm	counts per minute
DCGL	derived concentration guideline level
DOE	Department of Energy
DQA	data quality assurance
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
HSEC	Health, Safety, Environment & Community
IDW	investigation derived waste
IRA	Interim Removal Action
RSE	Removal Site Evaluation
MARSSIM	Multi-Agency Radiation Site and Survey Investigation Manual
MDC	minimum detectable concentration
MDL	method detection limit
NaI	sodium iodide
NMED	New Mexico Environmental Division
NMMA	New Mexico Mining Act
NNEPA	Navajo Nation Environmental Protection Agency
NPDES	National Pollutant Discharge Elimination System
OSC	On Scene Coordinator
PAL	Preliminary Action Level
pCi/g	picocuries per gram
POLREP	U.S. EPA Pollution Report
PPE	personal protection equipment
QA/QC	quality assurance / quality control
QAPP	Quality Assurance Project Plan
Ra-226	radium-226
RAML	Rio Algom Mining LLC
RSE	Removal Site Evaluation
RSO	Radiation Safety Officer
RWPR	Red Water Pond Road
SOP	Standard Operating Procedure
SOW	Scope of Work
<a href="#">SWPPP</a>	<a href="#">Storm Water Pollution Prevention Plan</a>
UMTRCA	Uranium Mill Tailings Radiation Control Act
UNC	United Nuclear Corporation
VOC	Volatile Organic Chemical

## 1.0 INTRODUCTION

This Removal Site Evaluation (RSE) Phase II Work Plan (Work Plan) describes the objectives, scope of work and methods for conducting an RSE at Church Rock Sites 1 and 1E. The Work Plans have been prepared in two phases in accordance with the provisions of the United States Environmental Protection Agency (EPA) Administrative Order on Consent (AOC) (CERCLA Docket No. 2010-13) and the associated Scope of Work (SOW) into which they have been incorporated by reference. The AOC and SOW were previously provided as Exhibits A and B respectively of the Phase I Work Plan. The Phase I Work Plan was provided on August 26, 2010 (RAML, 2010).

This document represents the Phase II Work Plan.

### 1.1 SITE BACKGROUND

The former Quivira Church Rock sites are located approximately 16 miles northeast of Gallup, McKinley County, New Mexico, as shown on Figure 1.1, General Location and *Site Plan*. The Church Rock 1 and 1E sites are reclaimed and closed uranium mine sites.

From the late 1960's into early 1986, Kerr-McGee Corporation conducted exploration and the development of two underground mines at Church Rock 1 and Church Rock 1E in Section 35, T17N, R16W and Section 36, T17N, R16W, respectively of McKinley County. The land on Navajo Tribal Uranium Leases 14-20-0603-9987 and 14-20-0603-9988 respectively were leased by Kerr-McGee Corporation.

Church Rock 1 was a former underground mine where ore was hoisted to surface via a shaft and temporally stockpiled prior to truck haulage to the Quivira Ambrosia Lake milling operation. Mine water was pumped to surface and discharged to a series of holding ponds where the water was treated prior to release to the receiving environment.

A number of surface structures existed during the operating years that consisted of shaft collar and head frame, ventilation raises and ore stockpile area; office, hoist house, maintenance shops and warehousing complex; mobile equipment repair shop, fuel and oil storage facilities, main electrical transformer & switch gear, explosive storage area, internal roads and water drainage to divert water from the waste areas and rock storage areas. The areal extent of the leased area of Church Rock 1 is estimated at approximately 43 acres.

Production at Church Rock 1 ceased in 1983 and Quivira Mining Company submitted an Abandonment and Reclamation Plan to BLM in January 1987. Records indicate that the mine had been placed in standby mode on January 31, 1985. The Abandonment and Reclamation Plan

was reviewed by the BLM, Navajo Tribal Government and Bureau of Indian Affairs as part of the Department of Interiors trust responsibilities and was approved by the BLM. On September 5, 1990, a “Finding of No Significant Impact” and a final Record of Decision by the U.S. Bureau of Land Management (BLM) was issued that allowed for the reclamation of Church Rock I and IE in accordance with the stipulated conditions.

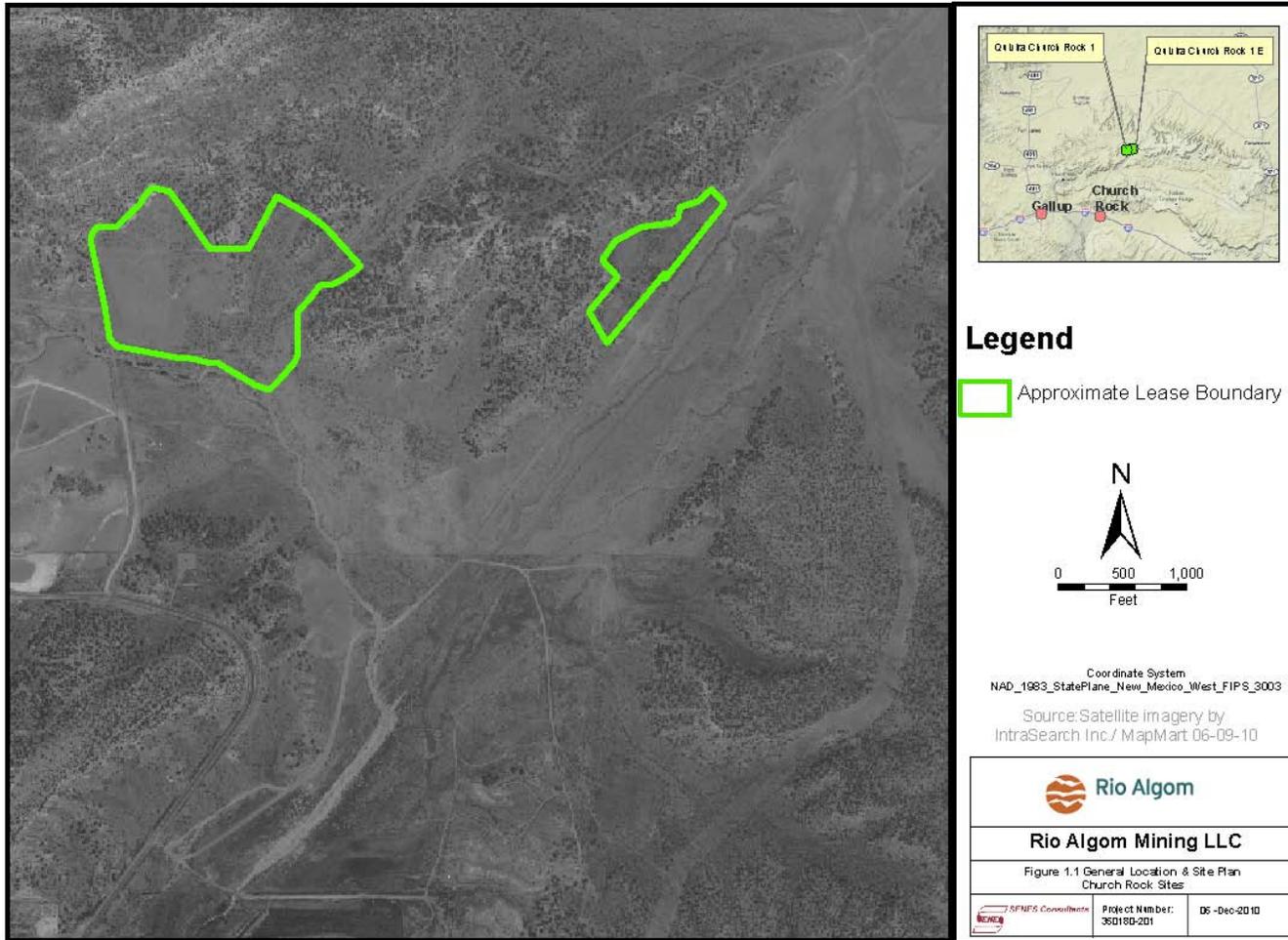
According to the plan and conditional approval, mine dewatering pumps were removed from Church Rock 1 in January 1986. Additional work outlined in the plan and approval included the following. Mine equipment to include hoists, compressors, headframes, and generators were to be removed from the site. Buildings were to be removed and foundations destroyed. Sediments from the mine water ponds were excavated and placed in shaft and ventilation raises. Pond sediments and waste rock were deposited in these underground openings. Grizzlies were to be placed over all shaft openings and monitored for 1 year for subsidence and backfilled as needed. These mining openings were then capped with a 4 foot concrete cap. Final land reclamation to include reseeding to the native landscape was to be done. Mine excavation waste piles and all disturbed areas were to be covered with a minimum of 1 foot of topsoil and reseeded with a seed mixture recommended by BIA for the Church Rock area. Bore hole foundations supporting the casing wall were to remain in place, but surface ventilation fans, transformers, switches, ductwork, electrical cables, and fences were to be removed from the bore hole area.

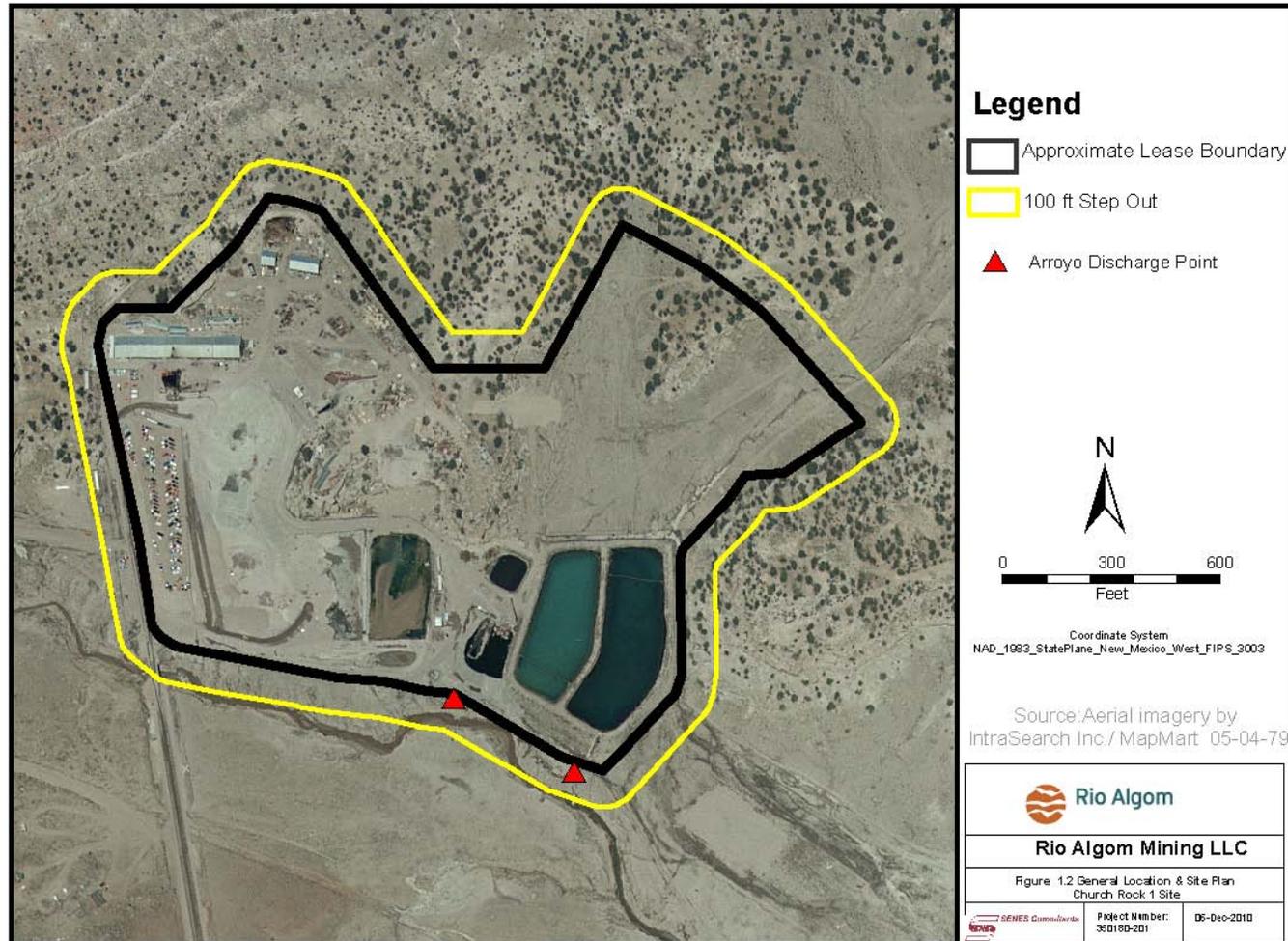
In addition, the ponds used as settling basins for mine solids and radium treatment facility were to be drained and allowed to dry. All sludge and settled solids were to be scraped from the sides and bottoms of the ponds and the material used to backfill the mine shafts and ventilation raises.

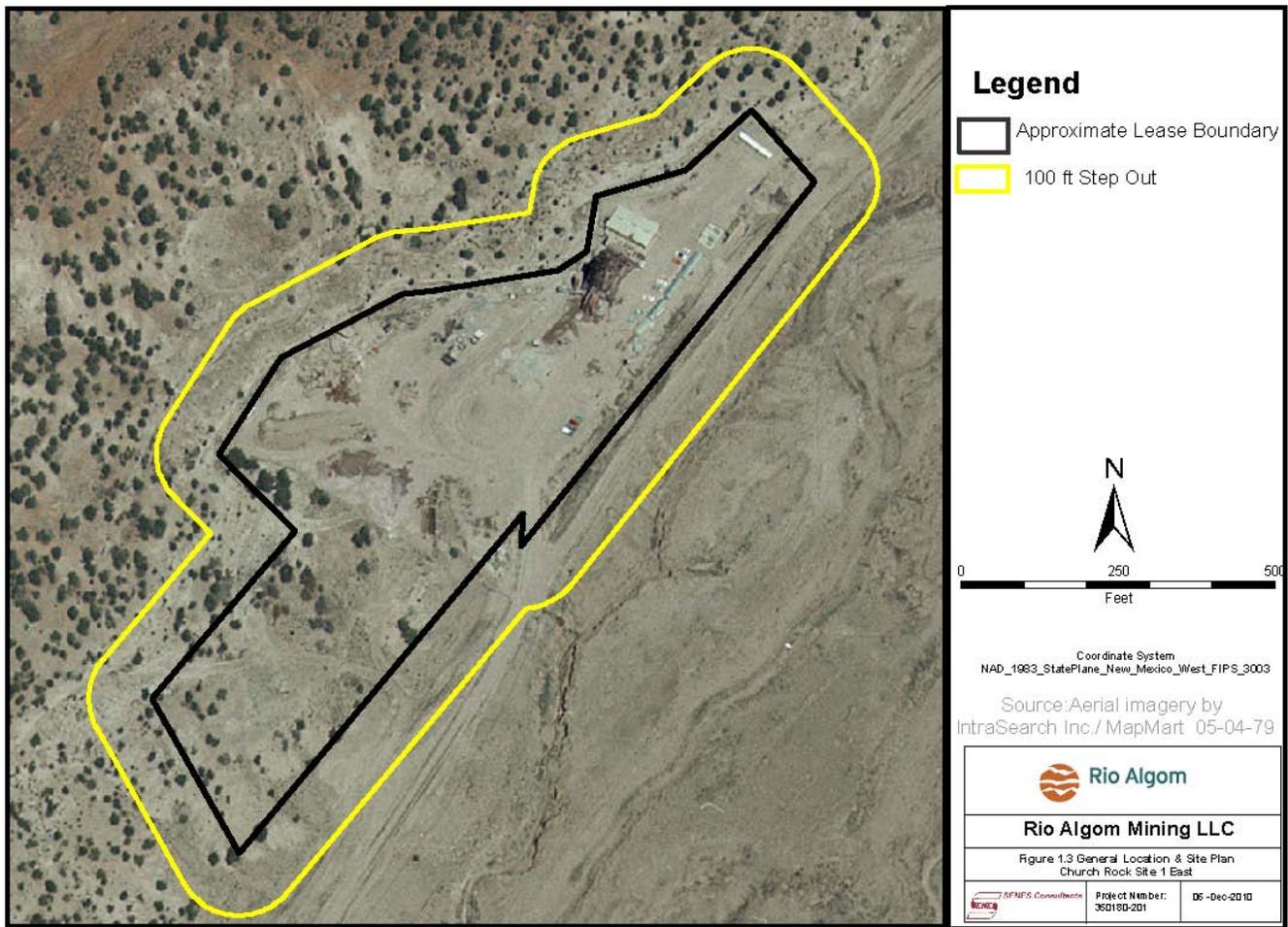
Church Rock 1E consisted of similar structures but on a much smaller scale. The leased area for Church Rock 1E is approximately 10 acres. Requirements for this site are addressed the same manner as for Church Rock 1 in the abandonment and reclamation document. Thus, material use at Church Rock 1E was likely to be on a smaller scale than at Church Rock 1.

Historical aerial photographs of Church Rock I (circa 1979) as shown in Figure 1.2 depict the industrial infrastructure as generally presented in the northern part of the site, the waste rock site is located on the west side of the property, and the mine water sedimentation ponds to the south and the SE sector of the property. The final clarification pond, discharges to the “unnamed” arroyo which is located in the south-eastern corner of site.

Church Rock 1E shown in Figure 1.3 is smaller but has a similar mixture of site activities. These historical photographs provide site process knowledge that is useful in the survey planning and interpretation.







### 1.1.1 Physical Setting

The Site is located in the southeastern part of the Colorado Plateau Physiographic Province. A detailed discussion of the physiography is presented in the Phase I Work Plan.

The nearest meteorological station is in Gallup. The average temperature in Gallup, 16 miles south of the Site, ranges between an average of 29 degrees Fahrenheit in January to an average of 68 degrees Fahrenheit in July. Daily extremes reach as high as 100 degrees Fahrenheit in summer and as low as -34 degrees Fahrenheit in winter. Gallup receives a total annual average precipitation of 11 inches.

Currently, areas of the Site have supported a variety of native vegetation but revegetation of some areas has had little success due to livestock grazing.

## 1.2 OBJECTIVES OF THE REMOVAL SITE EVALUATION

This Work Plan addresses Phase II activities of the Scope of Work for Administrative Order on Consent Interim Removal Action (IRA) (EPA, 2010). Phase II activities include characterization of the lateral and vertical extent of contamination in surface and subsurface soils at the following areas: Church Rock 1 and Church Rock 1E, along the “unnamed” arroyo in a southeasterly direction from Church Rock 1 and extending 100 feet beyond the Red Water Pond Road bridge crossing, and offsite areas (Step Outs) adjacent to the site boundary in which materials may have been carried by wind and water transport. [This Work Plan](#) would investigate [potential material that may have been transported via mine water discharges to the Unnamed Arroyo #2 and to the Pipeline Canyon Arroyo.](#)

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### 1.2.1 Documentation

The overriding objective of all activities is to implement the work in a safe manner that is protective of site personnel as well as nearby residents. The Field Sampling Plan previously submitted as Appendix A of the Ph I IRA Work Plan has been modified to reflect the additional activities proposed for the Phase II Work Plan. Similarly, the Quality Assurance Project Plan (QAPP) previously submitted as Appendix B in the Phase I IRA Work Plan has also been updated to reflect the range of contaminants to be sampled in Phase II.

The Health and Safety Plan and the Phase I SOP's originally provided to the EPA [for the Phase I Work Plan](#) were updated to reflect the field work proposed during Phase II and were submitted to the EPA on September 24 as part of RAML's Response to EPA's Comment Letter dated Sept. 10, 2010. [These Phase I SOPs plus the additional SOPs](#) required to support Phase II investigations are provided in [their entirety as Volume 3 of these plans.](#)

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## **1.2.2 Phase II Activities**

This Phase II Work Plan addresses the program for the characterization of surface soil and subsurface areas of Church Rock (CR) Sites 1 and 1E and along the “unnamed” arroyo above and below the CR Site 1 as reflected in Figure 1.1. A detailed discussion of this planned characterization is outlined subsequent sections of this Work Plan.

Agronomic characterization will be conducted to assess the density and diversity of current vegetative cover. Parameters will be determined as described in the SOW to help with evaluation of long-term mitigation options.

## 2.0 PROJECT MANAGEMENT

### 2.1 PROJECT TEAM

The responsibilities and contact information for key project personnel as of September 30, 2010 are listed in Table 2.1 and further defined in the following sections.

**Table 2.1 Site Contact Personnel**

Point of Contact	Title	E-mail Address	Phone Number
Ken Black	Program Director	<a href="mailto:ken.black@bhpbilliton.com">ken.black@bhpbilliton.com</a>	520-247-1080 (mobile)
Scott Johnsen <a href="#">Tony Baus</a>	Site Manager <a href="#">Site Manager</a>	<a href="mailto:scott.l.johnsen@bhpbilliton.com">scott.l.johnsen@bhpbilliton.com</a> <a href="mailto:Tony.AR.Baus@bhpbilliton.com">Tony.AR.Baus@bhpbilliton.com</a>	520.419-2383 <a href="tel:520.208.1014">520.208.1014</a>
Doug Chambers	SENES Project Manager	<a href="mailto:dchambers@senes.ca">dchambers@senes.ca</a>	905-764-9380 (office)
Krista Wenzel	Health Physicist	<a href="mailto:kwenzel@senes.ca">kwenzel@senes.ca</a>	307-315-2249 (mobile)
Bill Mckay	Field Supervisor	<a href="mailto:william.m.mckay@bhpbilliton.com">william.m.mckay@bhpbilliton.com</a>	520-419-0778 (mobile)
Frank Molina	Health and Safety	<a href="mailto:frank.molina@phpbilliton.com">frank.molina@phpbilliton.com</a>	520-302-9753 (mobile)
Chuck Wentz	RSO	<a href="mailto:chuck.wentz@bhpbilliton.com">chuck.wentz@bhpbilliton.com</a>	505-287-8851 (office)

#### 2.1.1 Rio Algom Mining LLC (RAML) Representative

Mr. Ken Black is the Project Director for Rio Algom Mining LLC. He is responsible for overall program execution and quality, and has overall responsibility for the execution of the Work Plan activities. He will continue to take the lead on all agency communications for RAML and will be responsible for the activities of the Consultants (SENES). Mr. Black reports to the President of Rio Algom Mining LLC on this matter.

The Site Manager, Mr. Scott Johnsen, is responsible for managing all activities of the Work Plan that are associated with coordination of the field work. [Mr. Tony Baus will replace Mr. Johnsen on an interim basis and](#) will be responsible for contractor activities associated with drilling. He will also coordinate access to the Site.

RAML will appoint a health and safety representative for project execution. Mr. Chuck Wentz will act as the Project Radiation Safety Officer. Mr. Frank Molina will act as the Health and Safety Officer. William McKay is the construction field supervisor.

### **2.1.2 SENES Consultants Limited**

The SENES Consultants Limited Project Manager, Dr. Doug Chambers, and Senior Health Physicist, Ms. Krista Wenzel, will be responsible for all activities related to chemistry, geochemistry, radiation and health physics. Dr. Chambers will have overall responsibility for coordinating the sampling and surveys, defining areas of contamination, quality of the data collected and interpretation of the data that will be presented in the investigation report, and document preparation and review.

The reporting relationships are shown in Figure 2.1. Details of signing authorities and related business confidential information are documented in RAML project files.

### **2.1.3 Regulatory Oversight**

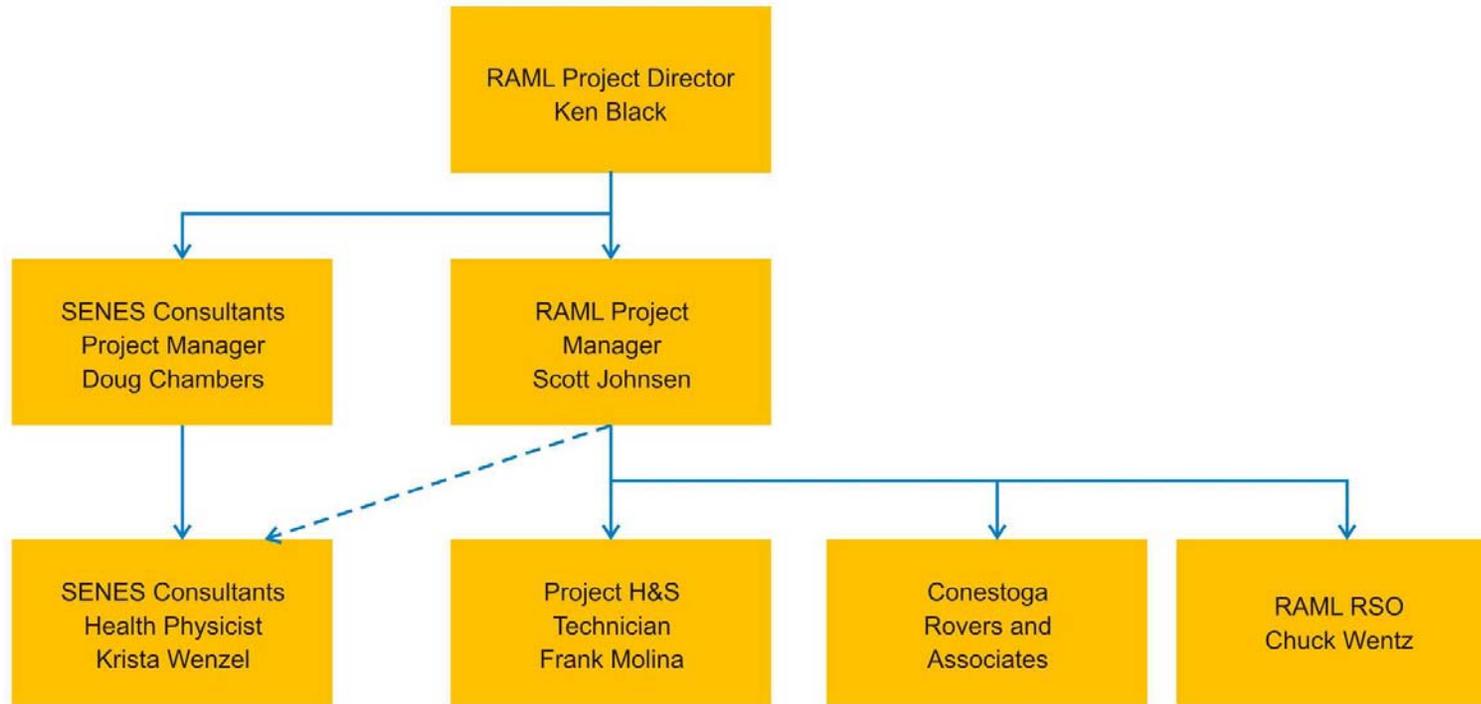
Information provided by the EPA on the regulatory oversight comprises:

- EPA Region 9 will oversee the work.
- The EPA Region 9 Remedial Project Manager (RPM) Mr. Andrew Bain is the On-Scene EPA Coordinator.

To date the specific responsibilities and authorities of the On-Scene coordinator have not been provided to RAML. All communication of approval or direction by the EPA must be provided in writing to RAML.

The role of the Navajo EPA representative(s) has not yet been defined to RAML. The Navajo EPA representative is Michele Dineyazhe.

Figure 2.1 RAML Project Team



**2.2 DELIVERABLES**

Within the number of working days (a day other than Saturday, Sunday and Federal Holidays) specified below, RAML will submit to EPA with a copy to NNEPA, as provided in the AOC, the following deliverables in accordance with the requirements of this Work Plan and the AOC. Unless otherwise agreed to by EPA, all submittals required by this Work Plan will be subject to 10-day EPA review and approval. Key deliverables are show in Table 2.2.

**Table 2.2 Deliverables**

Action/Document	Deadline
Proposed Phase I Overall Removal Action Work Plan, including: - Work Plan Outline - Construction Work Plan - Health and Safety Plan - Field Sampling Plan - Quality Assurance Project Plan	24 August 2010
Project Initiation for Phase I field activities	4 October 2010 (extended by agreement)
Completion of Phase I field activities	1 November 2010
Interim Report, including: - Phase I field activities - Sampling Report - Report using EPA pollution report (POLREP)	90 days after field work is complete  monthly
Submit Phase II Overall Removal Action Work Plan, including: - Commencement of Phase II field activities - Completion of Phase II field activities	<u>To be Arranged</u>  <u>To be Arranged</u> <u>To be Arranged</u>
Comprehensive Final Report, including: - Phase I and II - Proposed post-removal site control	90 days after analytical results from the RSE are received

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In addition to the hard copies and an electronic copy on a CD or DVD as specified in the AOC, an electronic copy of all deliverables created pursuant to this Work Plan should be provided electronically to the following email addresses:

Andrew Bain: [Bain.Andrew@epa.gov](mailto:Bain.Andrew@epa.gov)  
 Michele Dineyazhe: [dineyazhe.michele@epa.gov](mailto:dineyazhe.michele@epa.gov)

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### 3.0 PHASE II WORK PLAN

#### 3.1 BASIS OF PHASE II WORK PLAN

The Quivira Church Rock Phase II Work Plan as defined by U.S. EPA scope of work in the AOC and SOW issued August 2010, CERCLA Docket No. 2010-13 (EPA, 2010). This work consists of the site characterization of the Church Rock 1 and Church Rock 1E sites and includes the following activities:

1. Characterization of the lateral and vertical extent of contamination in surface and subsurface soils and sediments at the Church Rock 1 and Church Rock 1E, along the “unnamed” arroyo in a southeasterly direction from Church Rock 1 and along a segment of the Pipeline Canyon Arroyo from the Church Rock 1 E site.
2. Conduct Traditional Cultural Inventory Report on the “Step Out” segments around Church Rock I and Church Rock IE.

Characterization of existing soil and vegetative cover was completed in Phase I to support agronomical assessment of the density and diversity of the vegetative cover, conduct soil analyses and to provide recommendation for cover seed mixture to be added to the vegetative plan.

The stated performance objective and specific requirements for this task is outlined in the Scope of Work for the Time-Critical Removal Action of the Administrative Order on Consent as provided in Exhibit B of the Phase I Work Plan.

For purposes of developing and executing this work plan, RAML assumes that:

- Approved, access will be assured by EPA and Navajo EPA;
- In addition to the scope of the characterization program proposed by RAML, four additional sites are to be determined by the EPA for characterization. In consultation with EPA, Navajo EPA and their agents RAML agreed to propose locations of this investigation as part of the Phase II Work Plan. RAML will investigate the nature and extent of the operating activities upon receipt of its FOIA request for operating information and propose siting locations for these additional sites. The locations of the four sites will be provided at least 2 weeks prior to field execution in the spring 2011 program;

This phase of work has been divided into two main tasks and the numbering sequence follows the approach taken in Section 3.2 of the Phase I Work Plan.

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*Task 4a: Scope of the Characterization Studies*

The SOW requires that RAML characterize surface and subsurface soils and sediments from Church Rock 1 and Church Rock 1E. The characterization work covers about 43 acres at Church Rock 1 and about 10 acres at Church Rock 1E not including Step Out areas that add approximately another 10% of the area. The tasks required include characterization of the lateral and vertical extent of contamination in surface and subsurface soils and sediments at the Church Rock Sites 1 and 1E, along the “unnamed” arroyo located south of Church Rock 1 and any “Step Out” areas. This includes static and scan surveys of these areas as well as subsurface sampling to native soil in the Church Rock 1 and Church Rock 1E areas. [Subsequently, EPA has requested characterization of the Pipeline Arroyo located near the Church Rock 1E Site.](#)

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[RAML believes a “Step Out” area of 100 feet is adequate for initial assessment and meet the intent of the SOW and RSE. A survey of the existing background area used by UNC with RAML equipment will be conducted. “Step Out” surveys may extend until values are reached subject to physical limitations such as the arroyo to the south or in the cases where there is no apparent gradient \(i.e., no further changes in gamma measurement/or as appropriate, in concentrations\) thereby reflecting a potentially higher background. In addition, other background areas will be considered and surveyed as necessary. \[Reference: RAML Response Letter –Nov. 30, 2010\]. In addition some “Step Out” boundary limits will be constrained by known cultural resource properties that were identified in the recent cultural resource assessment conducted during Phase I work \(Cultural Resource Inventory Report DCRM 2010-37\).](#)

The scope of the sampling program will include:

- (a) waste rock areas;
- (b) former mine sedimentation ponds;
- (c) discharge point(s) into the arroyo;
- (d) mixed waste disposal areas, and;
- (e) “Step Outs” areas that are adjacent to the site boundary in which wind and water transport may carry material.

Based on historical studies and reviews, there are no known mixed waste disposal areas. Other described areas are likely to have been used at the site.

In addition, four sites are to be chosen by the EPA will be screened for a full suite of contaminants. [In accordance with SOW requirements, the EPA will determine the locations of the four samples based on past operational history.](#)

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[RAML and consultants will select the locations for detailed analyses. The work plan will add a discussion of impacts that are known or suspected \(also in Appendix A\). Locations of sub-](#)

surface/borings will be chosen based on historical data and areas that have a reasonable likelihood of determining if impacts from past operations are present. At this time, the recommended suite of parameters for analysis includes Ra-226 activity, total uranium, stable metals concentrations, volatile organic compounds, semi-volatile organic compounds and total petroleum hydrocarbons.

Sub-surface sampling of the streambed to a limited depth is reasonable; however sampling the steep walls may not be completed safely in all parts of the arroyo and certainly not at depth. Surface sampling of the bank would be limited by safety considerations and are not considered for the program except for, potentially, very limited judgmental locations. .

*Task 4b: Characterization of Subsurface Soils*

Sampling and analysis surface and sub-surface soils in the areas described will be conducted in accordance with the field sampling plan in Appendix A and the Quality Assurance Project Plan. Depth sampling techniques may incorporate auger drilling, trenching and down-the-hole drilling methods to determine the extent of waste limits and the chemical or physical characterization of the waste materials. Drilling will be employed where the native soils are too deep to intercept by other methods.

The schedule for this characterization work is dependent on the following factors:

- a. Receipt of written approval of this Work Plan by EPA, after consultation with NNEPA;
- b. Mobilization by the contractor at the Site;
- c. Subsurface drilling during the winter conditions will be weather dependent.

The contractor is to provide a schedule for completion of the characterization work. RAML expects characterization field work would be completed in less than one month from the start of the work.

Upon approval by EPA, after consultation of the Navajo Nation EPA (NNEPA), this characterization plan will be carried out by SENES Consultants. The specific schedule for subsurface sampling will be provided by the contractor.

*Task 5: Characterization of the Existing Soil and Vegetative Cover*

Agronomist field work was completed as part of Phase I Work Plan. This study assessed current conditions of the vegetative cover, develop vegetative maps of the type, density and diversity of the cover material and to make recommendations to enhance the vegetative cover that will minimize erosion of soils.

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EPA will determine the four locations upon submittal of the Field Sampling Plan/Quality Assurance Project Plan (FSP/QAPP) work plans based on site operational history and probable usage of solvents, acids, bases and other materials. At this time, the recommended suite of parameters for analysis includes Ra-226 activity, total uranium, stable metals concentrations, volatile organic compounds, semi-volatile organic compounds and total petroleum hydrocarbons (see Section 3.2.4). ¶  
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Agronomic sampling to characterize existing soils and vegetation was done along with other characterization field work. In addition to sampling, current vegetation was inventoried and mapped. The soils were sampled at locations based on the soil type and amount of previous disturbance, and analyzed for typical agronomic parameters important for revegetation to include: pH, texture, organic matter, available nutrients, sodium adsorption ratio (SAR), cation exchange capacity (CEC) and electrical conductivity (EC). Vegetation was sampled for types and major species on the natural and revegetated portions of the site, and mapped at an appropriate scale.

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### 3.2 FIELD SAMPLING PLAN

The following sections describe in detail the sampling for the above listed three tasks.

#### 3.2.1 Sampling Plan

The field radiological stationary measurements and scans will consist of direct gamma radiation level measurements using a scintillation detector coupled with a single-channel rate meter and a GPS. Use of GPS will facilitate development of a site survey map with radiological isopleth contours in various ranges of uncorrected raw data and [estimated](#) Ra-226 concentrations in soil.

A static gamma radiation measurement grid based on a random origin in accordance with MARSSIM (EPA, 2000a) guidance and will have an 80 foot triangular grid. A relationship between gamma radiation and the soil sample Ra-226 concentration will be developed to predict surface soil concentrations at locations without soil samples. In addition, a roving gamma survey will be conducted of the site between these stationary points.

The sampling plan for the sites and "Step Out" areas based on an 80-foot triangular grid has been established for the two areas and this extends to adjacent "Step Out" locations just outside the areas as shown in Figure 3.1. The triangular grid is cast on a random origin in accordance with MARSSIM (EPA, 2000a) guidance documents. Static gamma radiation measurements will be collected at all these points located on the map. Locations that interfere with buried water lines, fencing or overhead power lines will be relocated in the field to the nearest offset.

[In response to EPA's Nov. 10, 2010 letter RAML believes the "Step Out" area of 100 feet is adequate and meets the intent of the SOW and RSE. A survey of the existing background area used by UNC with RAML equipment will be conducted. The surveys in the Step Out areas may extend until a value is reached subject to physical limitations such as the arroyo to the south or in the cases where there is no apparent gradient \(i.e., no further changes in gamma measurement/or as appropriate, in concentrations\) thereby reflecting a potentially higher background. In](#)

addition, other background areas will be considered and surveyed as necessary. The suitability of these will be reviewed with the EPA prior to use in the analyses of site characterization data.

A discussion of comparing static gamma readings to background readings has been added to the work plan. A background gamma radiation level will be established from the UNC background site and be considered in the field studies and evaluation of the Phase II work. Additional background work is planned for the soils up-gradient from the CR1 site which may reflect baseline conditions of the alluvium material that is common in this area that may differ in Ra-226 concentrations and gamma radiation from those soils at the UNC site. In addition, other background areas will be considered and surveyed as necessary.

Table 3.1 summarizes the locations of the potential background surveys and these are shown in Figure 3.1. All potential locations, with the exception of B1 are more than 1,000 feet from the sites and all potential locations are up-gradient relative to transport by water. Investigation of these locations will require cooperation of the landowners. Locations B1, B2 and B3 are proximal to both Church Rock 1 and Church Rock 1E sites with B4 and B5 further removed.

**Deleted:** locations and a brief description on the rationale is provided in Table x.x. ¶

**Table 3.1 Potential Background Areas for Investigation**

	<u>Area and Rationale</u>
B1	<u>Borrow Area; Cover material for the sites may have come from these alluvial deposits and therefore these could represent the background for the leased areas. Although located in close proximity and a typical downwind location, the surface materials that may have been contaminated in the past have been removed. Further contamination following remediation is likely negligible.</u>
B2	<u>Likely similar material as Borrow 1 but, is about 1000 feet removed from Church Rock 1</u>
B3	<u>Upstream Pipeline Canyon Arroyo</u>
B4	<u>Upstream Pipeline Canyon Arroyo</u>
B5	<u>Located up-gradient with respect to water and not in the typical wind direction from Church Rock 1</u>

Samples for waste rock boring will be discrete samples taken from approximately 6 inches of material at 5 foot intervals to native soil. Sampling in the treatment pond areas requiring sampling at depth will be taken at 2.5 foot intervals to native soil. Spacing may be less when changes in soil are noticed. The plan will make clear that the depth to native soil will be recorded as consideration will be given to a method to determine undisturbed soils based on geological conditions. For sub-surface samples collected with auger the same depths as used in Phase I will be used (18-24" and 30-36"). Hand auger subsurface sampling of the sediments

within the arroyo will be limited to 12'' depth as materials at deeper depths would be isolated from the environment.

Initial calibration for gamma radiation to surface Ra-226 measurements will be based on the Phase I work (as data is available) with final correlations based on Phase II work which may include additional background as required. As previously indicated, background is not a simple fixed value but rather variable depending on the variability in the characteristics of native soils. The calibration will be completed over the range of 0-10 pCi/g Ra-226 as available from field sampling so that field decisions relative to the PAL appropriate for the site can be accommodated.

MARSSIM guidance was used in part through subdividing the CR1 site into three major areas and sub-sampling from the 80 foot grid as was used by UNC. An initial estimate of the number of locations for surface and sub-surface sampling has been developed for these locations. A key to the surface characterization is the surface gamma radiation scans and survey which will be conducted at high density transects.

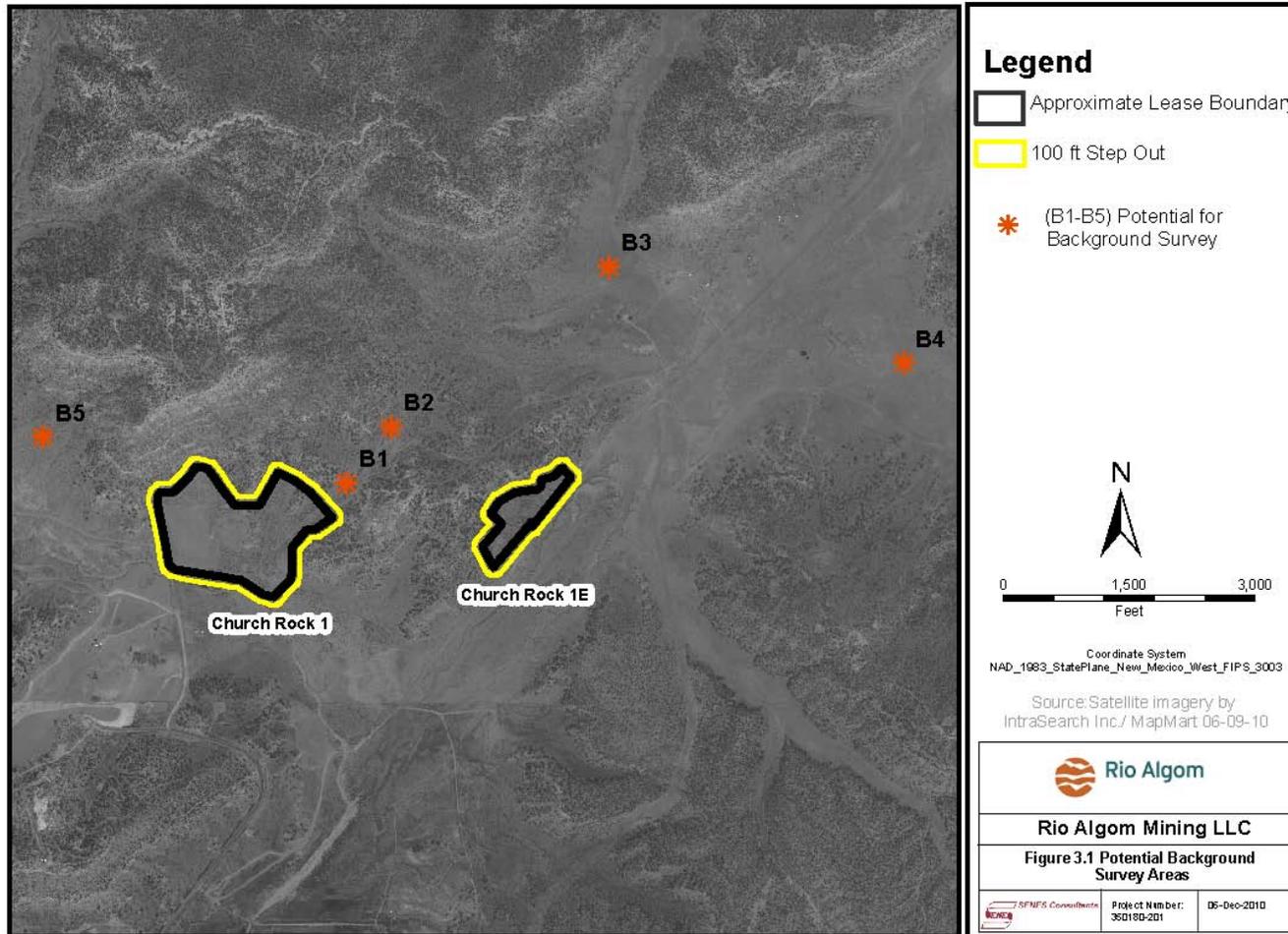


Table 3.2 provides the number of grid points considered in the project. Random soil sampling locations will be selected from these points and these are shown in the table.

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**Table 3.2 80 Foot Triangular Grid Points and Sample Locations**

<u>Site</u>	<u>Sub-Area</u>	<u>Static Gamma Locations</u>	<u>Surface and Shallow Sub-Surface</u>	<u>Auger /Boring Locations</u>
<u>Church Rock 1</u>	<u>Industrial</u>	<u>157</u>	<u>15</u>	<u>5</u>
	<u>Ponds &amp; Related Area</u>	<u>82</u>	<u>15</u>	<u>5</u>
	<u>Waste Rock</u>	<u>105</u>	<u>15</u>	<u>5</u>
	<u>Step Out</u>	<u>125</u>	<u>0</u>	<u>0</u>
	<u>Total</u>	<u>469</u>	<u>45</u>	<u>15</u>
<u>Church Rock 1E</u>	<u>Inside Fence</u>	<u>77</u>	<u>20</u>	<u>5</u>
	<u>Step Out</u>	<u>69</u>	<u>0</u>	<u>0</u>
	<u>Sub-Total</u>	<u>146</u>	<u>20</u>	<u>5</u>
	<u>Total</u>	<u>615</u>	<u>65</u>	<u>20</u>
<u>Arrovos</u>				
<u>Unnamed</u>		<u>39</u>	<u>39</u>	
<u>Pipeline</u>		<u>21</u>	<u>21</u>	
<u>Total Locations</u>		<u>675</u>	<u>125</u>	<u>20</u>

Surface and subsurface soil sampling will be conducted per Phase II of the SOW. Soil samples will be collected manually as grab samples and submitted to the laboratory and analyzed for COCs as outlined in Appendix A. Sample locations will be randomly selected from the gamma radiation stationary point locations that are shown in Figure 3.2.

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Surface soil sampling will be conducted at the survey areas as shown. Surface soil samples will be collected manually as grab samples at the surface (0-6 inches) as required by the SOW and submitted to the laboratory and analyzed. The surface soil samples will be collocated with the stationary gamma measurements.

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Trenching, down-the-hole drilling or portable auger techniques, as appropriate, will be used to support characterization of subsurface concentrations of COCs and delineate the extent of mine waste. Drilling will be employed when it is determined the sampling depth to native soil is deeper than can be reached using trenching or power auger.

Deep subsurface soil samples, which have been defined as soil samples that are taken by the use of a drill rig, will also be collected. Depth will vary by location, surface samples will be taken at 0 to 6 inches and every 5 feet to native soil. Shallower subsurface samples will be completed using a power auger mounted on a "bobcat".

The drill program targets may be guided by pre-mining and post-mining topographic survey data. The sampling program will be used to ascertain whether there is difference in concentrations with depth particularly for the waste rock area and the extent of the deposited materials.

Composite samples will be collected from four points determined by the EPA within the investigation area. As required by the SOW, the samples will be analyzed for Ra-226, total uranium stable metals concentration, volatile organic compounds, semi-volatile organic compounds and total petroleum hydrocarbons.

The Church Rock 1 site will be sub-divided into the following three areas; waste rock pile, ponds and related area, and the industrial site. Five potential random locations for subsurface sampling to native soil will be determined for each sub-area by random sampling from the surface sample locations for the waste rock and industrial areas of Church Rock 1. Five judgmental locations will be specified for the ponds and related area to ensure that the former ponds are measured. The final selection of auger / boring sample locations will draw on experience of the December program and this would include the selection of the four locations at which full laboratory analysis will conducted on the samples. Thus, there are a total of 15 locations proposed on the Church Rock 1 site where subsurface investigations will occur; however, native soil may be encountered during the sub-surface investigations at the 30 to 36" soil horizon and thus not require deeper boring.

Five random locations for subsurface sampling to native soil will be selected from the surface soil sampling locations at the Church Rock 1E site. The final selection of sample locations will draw on experience of the December program and this could include the selection of the four locations at which full laboratory analysis will conducted on the samples.

In total, there are a total of 20 auger /boring locations for the investigation. Other than the five samples in the area of the waste rock pile, it is anticipated that sampling can be done with the use of augers. Sample splits will be collected from 10% of the locations. Split samples (replicates) will be submitted to the EPA's laboratory for quality assurance purposes.

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The primary radionuclide of concern at the site is Ra-226, due to its decay into alpha-emitting radon progeny, which diffuse into the atmosphere and impose internal radiation exposure through inhalation, and gamma-emitting decay products from Ra-226 decay products remaining in the soil, which would pose a direct external radiation exposure. Thus determination of Ra-226 would provide the primary radiation hazard assessment associated with uranium ore and

impacted soils. Nevertheless, determination of Ra-226 content would also provide estimation of other radionuclide concentrations of concern (U-natural and Th-230) in soil derived from uranium ore because all of the radionuclides should be in secular equilibrium. However, Ra-226 may not be able to accurately estimate other radionuclide concentrations in processed waste materials since Ra-226 is likely to be in partial secular equilibrium.

Background reference locations will be investigated and, upon EPA site approval, be measured for gamma radiation and Ra-226 surface soil concentrations. Background areas exist from previous surveys; however, the locations may not be closely enough associated with the sites to provide adequate reference to compare to on-site levels of radionuclides. As described in MARSSIM (EPA, 2000), a site background reference area should have similar physical, chemical, geological, radiological and biological characteristics as the survey unit being evaluated. Background reference areas are normally selected from non-impacted areas, but are not limited to natural areas undisturbed by human activities.

As discussed in RAML response letter of Nov. 30, 2010, background is not a simple fixed value but rather variable depending on the variability in the characteristics of native soils. Thus, SENES/RAML reserves the right to consider the expected variability in natural background when evaluating the need for "Step Out" beyond the 100 foot buffer.

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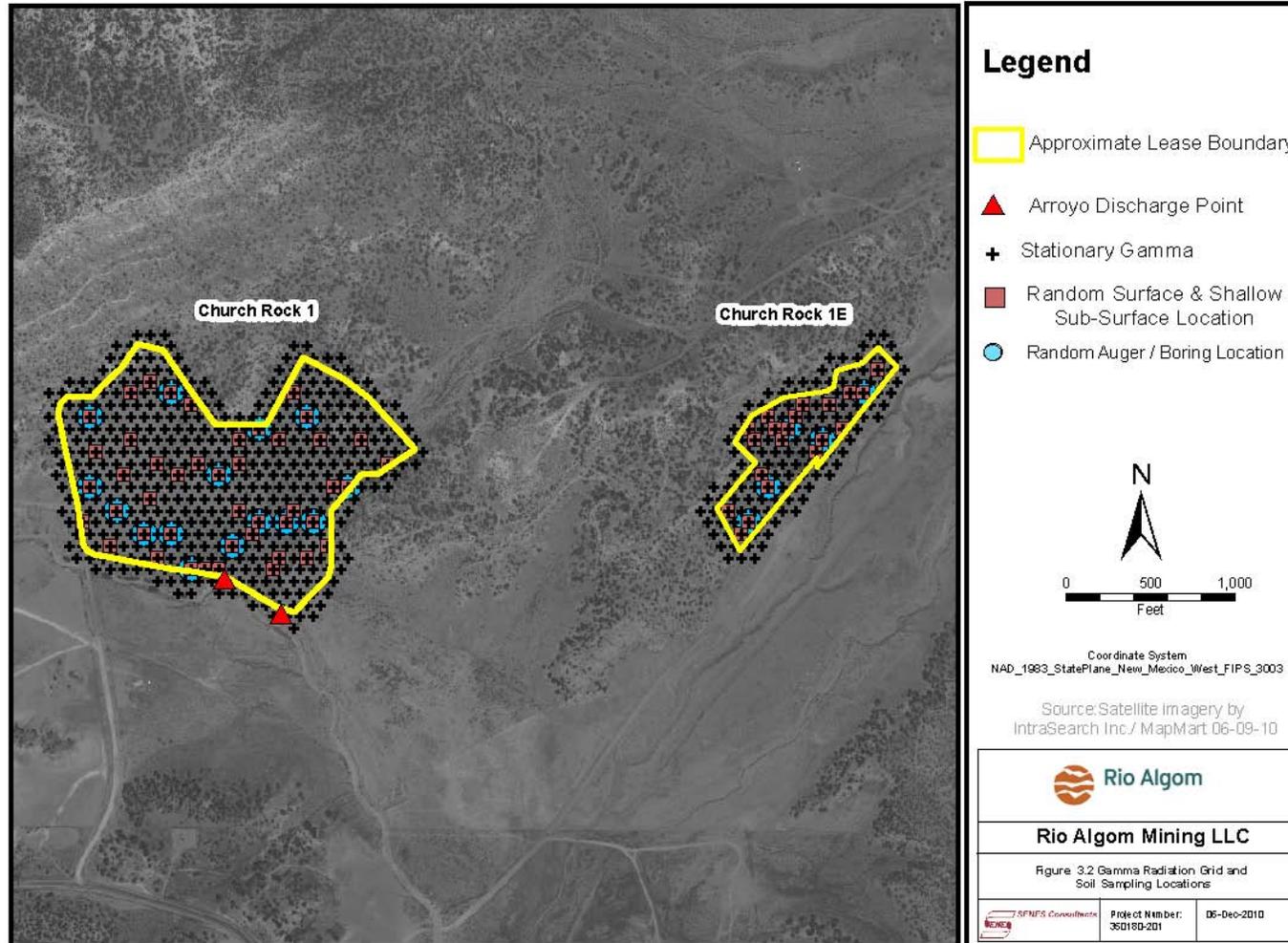
Some measurements will be collected from the UNC background site and other backgrounds mutually agreed by EPA and SENES/RAML will be investigated. Background can be variable depending on the source of the soils. A proposed sampling will be conducted to determine if some backgrounds in the area may be higher than 1.0 pCi/g in the alluvial deposits to the north of the CR1 site. Some consideration will be discussed about the use of unrestricted exposure scenario for a fenced site. Although the 2.24 pCi/g PAL may be appropriate for a residential site, it may not be applicable for the fenced sites with lower potential for dose and a higher background.

#### *Arroyo Sediment*

Arroyo sediment samples will be collected from transects along the streambed of Unnamed Arroyo from upstream of the confluence of the former UNC discharge with this Unnamed Arroyo to downstream above the confluence with the Pipeline Canyon Arroyo. The spacing of transects is closer along the boundary of the Church Rock 1 from the bridge to below the Church Rock 1 discharge point with a proposed seven locations in this area. The four upstream transects from the Church Rock 1 site will be above the UNC discharge point and two downstream sites prior to the confluence with the Pipeline Arroyo. The locations are indicated in Appendix A sample plan; however, the exact locations will be determined in the field.

Deleted: shown on Figure 4.2

Given the erosive nature of the run-off in the arroyo, it is likely that surface deposition (sedimentation) will be minimal. Survey below a depth of 1 foot is unlikely to find contamination. For present purposes and consideration of safety, samples will be collected, by hand auger, to the depths of 0-6" and 6-12" or refusal. Results from the current program will be reviewed prior to the spring program and planning for deeper investigations will be determined at that time.



Along each transect, three grab samples will be collected for laboratory analysis of Ra-226. The three samples will be evenly spaced across the ephemeral streambed of the arroyo. Static surveys will be done at each sample point and a scanning gamma radiation survey will also be performed longitudinally along the axis of the streambed channel.

### **3.2.2 Quality Assurance Program**

This section introduces the Quality Assurance Project Plan (QAPP) detailed in Appendix B of this document.

A Quality Assurance Project Plan (QAPP) was developed for the project and is presented in Appendix B. The QAPP was prepared to describe the project requirements for all field and Contract Laboratory activities and data assessment activities associated with this Work Plan. The QAPP presents in specific terms the policies, organization, functions, and quality assurance/quality control (QA/QC) requirements designed to meet the objectives for the sampling activities described in this Work Plan. Additionally, the QAPP provides guidance that establishes the analytical protocols and documentation requirements to ensure the data are collected, reviewed, and analyzed in a consistent manner. The QAPP was prepared in accordance with the document EPA Requirements for Quality Assurance Project Plans (EPA, 2001); the EPA guidance document Guidance for Quality Assurance Project Plans (EPA, 2002a) was also used.

Consistent with the QAPP, SENES will manage all data pertinent to this project by establishing data handling procedures and a centralized database management system. Appendix B provides details on the data management procedures that will be implemented during this project.

### **3.2.3 Data Evaluation**

At the four locations determined by the EPA, soil samples will be analyzed for Ra-226, total uranium, Th-230, TPH, VOC, SVOC, and stable metals (arsenic, molybdenum, selenium, and vanadium). The Ra-226 results will be compared to the PAL in the SOW to identify the extent and depth of materials above the PAL.

Mapping and summary of surface gamma radiation levels will be developed for both gamma radiation count rate and predicted Ra-226 concentrations. Statistical relationships between gamma radiation and surface soil concentrations will be developed to support this.

### 3.3 HEALTH, SAFETY, ENVIRONMENT AND SECURITY MANAGEMENT

The specific HSE management plans developed to date are provided in the Phase I Work Plan and RAML's Response Letter to EPA's Comments dated September 10, 2010. The plan is a living document and will be updated and amended from time to time as field work is initiated. Internal risk assessment and risk management plan will be completed for each aspect of project execution, once the contractors are selected. These specific components of the HSEC management plans include:

- Safety and health management roles and responsibilities.
- Environmental management roles and responsibilities.
- Hazard identification including applicable Fatal Risk Control Standards (FRCS), workplace and task-specific hazard assessment procedures, and project-specific hazards.
- Risk mitigation and controls including applicable established Risk Management risks and controls, project-specific risks and controls.
- Safety targets and objectives including required frequency for tool box meetings, work site inspections, job and critical task observations.
- Site specific training including radiation safety.
- Project safety tasks, designates and schedule.
- Contractor Health, Safety and Environment Plans.

As part of the qualification process, the contractor will provide RAML with evidence of a HSE program that considers the normal hazards and the contractor must be made familiar with the special nature of the Site conditions. These special conditions include the potential for incidental contact with residual materials from the Site operations as well as natural hazards such as wildlife. The Site's severe topographic relief imposes the need for experienced contractor personnel and the use of appropriate fall protection measures. The fence is readily accessible along the entire perimeter with safe access possible in all areas reviewed to date.

**Deleted:** involved with fencing installation and repair projects the activities required in this Work Plan and that is consistent with the RAML corporate HSEC requirements. As part of the qualification process, the contractor will also provide RAML with evidence of an environmental management program that considers management, dust control and containment of waste. In addition,

Prior to the initiation of work, RAML will provide the contractor employees with a health and safety and environment briefing an induction on HSEC and particularly regarding the Site background issues and current conditions. The topics will include potential exposure to radiation, management of hazardous or dangerous substances, and sharp or jagged metal debris. This briefing will identify areas at the Site to avoid. The Radiation Safety Officer (RSO) will also provide a briefing on radiation hazards, controls and monitoring.

RAML and the contractor will establish a communication system (satellite phone, cell phones or radios) so that emergency medical help can be summoned, if necessary. All work will be conducted in teams of at least two persons because of the remote location of the work.

Prior to field work being initiated RAML will review the Emergency Response Plan (ERP) as part of induction for all contractors and subcontractors.

RAML has met with the community, EPA and other interested parties on September 28 to discuss the background to planned remedial activities at the Church Rock sites.

### **3.4 EXECUTION AND CONTRACTING STRATEGY**

#### **3.4.1 Project Team**

The responsibilities and contact information for key project personnel as described in Section 2 and listed in Table 2.1.

#### **3.4.2 Reporting Relationships and Authority Levels**

The reporting relationships are shown in Section 2. Details of signing authorities and related business confidential information are documented in RAML project files.

#### **3.4.3 Licences, Permits and Statutory Approvals**

RAML has been informed by the EPA that no licenses, permits or statutory approvals are required to execute the work described herein, since this work is defined by the EPA as a Time Critical Removal Action under an U.S. EPA Administrative Order on Consent dated August 2010 (EPA, 2010). RAML will submit a permit application to the NWDOT for any work that is conducted in the highway ROW. This permit will be in place prior to the commencement of chip sealing.

### **3.5 STORM WATER POLLUTION PREVENTION PLAN**

#### **3.5.1 Implementation and Planning**

Best Management Practice (BMP) have been developed to stabilize the waste rock pile for the winter in preparation of additional work next year. A SWPPP is currently being drafted by Ajax Engineering and will be reviewed by Chuck Baltzer. Comments about the plan and long-term plans for controlling storm water runoff, including ongoing periodic inspections in accordance with NPDES Construction General Permit will be addressed in a separate submittal to EPA.

An evaluation of storm water management was performed at the Northeast Church Rock No. 1 and No. 1 East to identify maintenance items and near-term improvements to the existing erosion and sediment controls. Several thousand feet of earthen berms were repaired and extended to better direct "run-on" storm water safely around the facility and to direct potentially impacted

“run-off” storm water to sediment traps and evaporation basins located onsite. One new trap was installed while a few others were deepened or enlarged to increase capacity. Erosion rills in the soil cover were repaired on a portion of the reclaimed slope, which was further stabilized with sediment logs. To arrest the migration of sediment, sediment logs were installed in select locations of channelized flow and silt fencing was installed in select areas of sheet flow along the perimeter of the facility. In addition, a portion of the access road was treated with a soil stabilizer, while another portion was paved with a chip seal treatment. A storm water pollution protection plan has been drafted to maintain the practices employed at the site. RAML will continue to conduct inspection and maintenance activities, as appropriate.

### **3.6 PROJECT CONTROL**

#### **3.6.1 Logistics**

The project manager is responsible for all logistics. The project manager will be supported, as required, by staff from the RAML Ambrosia Lake site and by the Project Director.

All logistics will be defined by the site project manager. For logistical arrangements that directly affect the local residents, these arrangements will be defined in consultation with the Navajo EPA representative and, if required, a local representative of the residents. RAML values the communities in which we work and will make every effort to complete the works without disturbing the local residents.

At this time, it is envisioned that:

- Contractors and site personnel will be lodged in Gallup.
- The project manager or his designate will be present in the field throughout the project execution.
- A staging area will be required where contractors can place vehicles and materials during field activities. If safe access can be provided, preferably this would be located on the former Quivira property. Advice will be sought by the Project Manager from the local representative on an appropriate staging area.

#### **3.6.2 Contracts**

Fair bidding processes will be employed by RAML for any services. RAML has contracted with an expert consultant, SENES Consultants for advice on the radiological and erosion management practices. Field drilling management will be provided by RAML staff and, if required, a third party contractor experienced in RAML requirements and practices.

### **3.6.3 Materials and Procurement**

Fair bidding processes will be employed by RAML for all goods and services. Where possible, preference will be given to qualified local suppliers for services and materials. Procurement is the responsibility of the RAML project team, with advice from SENES Consultants on specialized matters related to radiation control.

### **3.6.4 Site Management**

Site management is being conducted by RAML and this team will provide oversight to SENES Consulting and [Conestoga-Rovers & Associates \(CRA\)](#). However, if specialized services are required in the final work plan, other components of management may be subcontracted to the successful bidder.

### **3.6.5 QA/QC and Performance Monitoring**

A QA/QC plan will be required of the contractor. This plan will be approved by RAML prior to execution.

### **3.6.6 Reporting and Closeout**

The project reporting schedule is defined in Table 2.2 regarding project deliverables. During the project, the project manager will be responsible for:

- daily and weekly reporting from the contractors and consultants on progress, costs and safety performance, issues and exceptions;
- regular reporting to the Project Director; and
- preparation of information for any required reporting to the EPA (this has not yet been defined).

RAML will also define a reporting process to the local stakeholders – either a formal or informal process, as defined within our community consultation program.

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**APPENDIX A**

**FIELD SAMPLING PLAN**

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**APPENDIX A: FIELD SAMPLING PLAN**

**A.1 SURFACE SOIL, SHALLOW SUBSURFACE & SEDIMENT SAMPLING**

The sampling plan for the sites and "Step Out" areas based on an 80-foot triangular grid has been established for the two areas and this extends to adjacent "Step Out" locations just outside the areas as shown in Figure A.1 [and A.2](#). The triangular grid is cast on a random origin in accordance with MARSSIM (EPA, 2000a) guidance. Static gamma radiation measurements will be collected at all these points. Table A.1 provides the number of grid points considered in the project. Random soil sampling locations will be selected from these points [within Church Rock 1 and Church Rock 1E sites and these are also shown in the table.](#)

**Table A.1 80 Foot Triangular Grid Points [and Sample Locations](#)**

<u>Site</u>	<u>Sub-Area</u>	<u>Static Gamma Locations</u>	<u>Surface and Shallow Sub-Surface</u>	<u>Auger/Boring Locations</u>
<a href="#">Church Rock 1</a>	<a href="#">Industrial</a>	<a href="#">157</a>	<a href="#">15</a>	<a href="#">5</a>
	<a href="#">Ponds &amp; Related Area</a>	<a href="#">82</a>	<a href="#">15</a>	<a href="#">5</a>
	<a href="#">Waste Rock</a>	<a href="#">105</a>	<a href="#">15</a>	<a href="#">5</a>
	<a href="#">Step Out</a>	<a href="#">125</a>	<a href="#">0</a>	<a href="#">0</a>
	<a href="#">Total</a>	<a href="#">469</a>	<a href="#">45</a>	<a href="#">15</a>
<a href="#">Church Rock 1 E</a>	<a href="#">Inside Fence</a>	<a href="#">77</a>	<a href="#">20</a>	<a href="#">5</a>
	<a href="#">Step Out</a>	<a href="#">69</a>	<a href="#">0</a>	<a href="#">0</a>
	<a href="#">Sub-Total</a>	<a href="#">146</a>	<a href="#">20</a>	<a href="#">5</a>
	<a href="#">Total</a>	<a href="#">615</a>	<a href="#">65</a>	<a href="#">20</a>
<a href="#">Arroyos</a>				
<a href="#">Unnamed</a>		<a href="#">39</a>	<a href="#">39</a>	
<a href="#">Pipeline Canyon</a>		<a href="#">21</a>	<a href="#">21</a>	
<b><a href="#">Total Locations</a></b>		<b><a href="#">675</a></b>	<b><a href="#">125</a></b>	<b><a href="#">20</a></b>

Arroyo sediment samples will be collected from transects along the Unnamed Arroyo from upstream of the UNC discharge to downstream above the confluence with the Pipeline Canyon Arroyo [and along the Pipeline Canyon Arroyo](#). The spacing of transects [for the Unnamed Arroyo are](#) closer along the boundary of the Church Rock 1 from the bridge to below the Church

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Rock 1 discharge point with a proposed seven locations in this area. The four upstream transects from the Church Rock 1 site include side arroyos above the UNC discharge point. There are two downstream sites prior to the confluence with the Pipeline Canyon Arroyo. The locations are shown on Figure A.3; however, the exact locations will be determined in the field. The spacing of transects in the Pipeline Canyon Arroyo is shown on Figure A.4.

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Along each transect, three grab samples will be collected for laboratory analysis of Ra-226. The three samples will be evenly spaced across the ephemeral streambed of the arroyo and will be taken from 0-6" and 6-12". Static surveys will be done at each sample point and a scanning gamma radiation survey will also be performed longitudinally along the axis of the channel.

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Surface and subsurface soil sampling will be conducted per Phase II of the SOW. These samples will be used to characterize Ra-226. Soil samples will be collected manually at surface, the 18 to 24" soil horizon and the 30-36" soil horizon at each surface soil sampling location.

Subsurface samples will be collected for characterization of concentrations below the 30-36" horizon samples from the surface soil program where native soil has not been reached by that depth. Samples will be collected every 5 feet of depth until native soil is reached. Subsurface samples will be collected using auger or drilling as required. At this time, it is anticipated that augers can be used to collect subsurface programs other than for the investigation at the waste rock piles. The program will be used to ascertain whether there is difference in concentrations with depth particularly for the waste rock pile. The depths of material will be primarily defined using the differences in topography between current conditions and before mining activity (e.g. 1962); however, the subsurface investigation program will confirm these depths.

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Soil grab samples from the subsurface program to be collected from the surface from 0 to 6 inches and from the subsurface every five feet from the ground surface to native soil. If the depth to native soil is less than five feet from the surface or from the previous sample, one soil grab sample will be collected from the mid-depth of the non-native material in addition to a native soil sample.

The surface and subsurface soil samples are co-located with stationary gamma measurements. The field radiological stationary measurements and scans will consist of direct gamma radiation level measurements using a scintillation detector coupled with a single-channel rate meter and a GPS. Use of GPS will facilitate development of a site survey map with radiological isopleth contours in various ranges of uncorrected raw data and Ra-226 concentrations in soil.

Four, 5-point composite samples will be collected from points determined by the EPA within the investigation area. As required by the SOW, the samples will be analyzed for Ra-226, total

uranium stable metals concentration, volatile organic compounds, semi-volatile organic compounds and total petroleum hydrocarbons.

## A.2 ANALYTICAL PROGRAM

Locations for surficial and near-surface sampling were selected from the triangular grid of gamma radiation static points. The principles of MARSSIM and similarity to the UNC program have been used in the characterization plan for Church Rock 1 and Church Rock 1E. The fences areas have been divided into four survey units:

- industrial area of Church Rock 1;
- former ponds and related area of Church Rock 1;
- waste rock pile of Church Rock 1; and
- Church Rock 1E.

**Deleted:** The target number is 30 sample locations from Church Rock 1 and 20 samples from Church Rock 1E and these are shown in Figure A.1. There will be 10 samples from outside the lease boundary for each Mine Area that will be selected based on Step Out investigations. These are randomly selected and result in 80 sample locations where surface, 18 to 24" and 30 to 36" soil samples will be collected resulting in a total of 240 soil samples.¶

The UNC program had selected a minimum of 13 samples for each survey unit based on a MARSSIM comparison to background. A decision error of 0.05 was specified for the alpha error and a decision error of 0.10 was specified for the beta error with a relative shift of 1.6. These were considered applicable to the Church Rock sites as these had also been previously remediated. The target number of 13 from the UNC was increased to 15 for the Church Rock 1 site and to 20 for the Church Rock 1E site to improve statistical decision making. This was applied for surface and shallow sub-surface sampling.

Depending on daily review of site gamma radiation measurements, judgmental sample locations may be specified to investigate anomalies (e.g. in the Step Out area).

Correlation between surface Ra-226 concentrations and gamma radiation levels will consider all samples collected during the program. A suitable range and area specification (e.g. the waste rock pile may have a different relationship than the Church Rock 1E area) will be used to develop the relationships.

**Deleted:** Drilling will be used to collect sample locations at some of the surface locations; however, surface sample locations may reach native soil in the 30 to 36" soil horizon and therefore drilling will not be required at these locations.

Five (5) potential auger /boring locations will be sub-sampled from the surface sample locations from each of these subareas. As required, judgmental locations will be assigned to the ponds and related areas not measured by the random sampling. There are a total of 15 locations from a combination of random and judgmental locations proposed on Church Rock 1 where auger/boring will occur; however, native soil may be encountered during the sub-surface investigations at the 30 to 36" soil horizon and drilling will not be required at those sites.

**Deleted:** The Church Rock 1 site was be sub-divided into the following three areas; waste rock pile, pond area and industrial site.

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Five random locations will be selected from the surface soil sampling locations at the Church Rock 1E site. An estimate of the total number of samples is difficult since it is not clear whether native soil will already have been met from the surface program. Drilling is not intended for locations outside the lease boundary. The potential grid locations are shown in Figure A.1. Should the random location be on an inaccessible area (e.g. the slope of the waste rock pile, field decisions will relocate these drilling locations to a safe position.

**Deleted:** Assuming that 12 locations have native soil deeper than 30 to 36" bgs and the average depth to native soil is 20 feet, this suggests that 60 samples may be collected from the deep drilling program.

A map of the surface sample locations for Church Rock 1 is shown in Figure A.1, and the Church Rock 1E locations are shown in Figure A.2. The locations for the Arroyo and Pipeline Arroyos are shown in Figure A.3 and A.4, respectively.

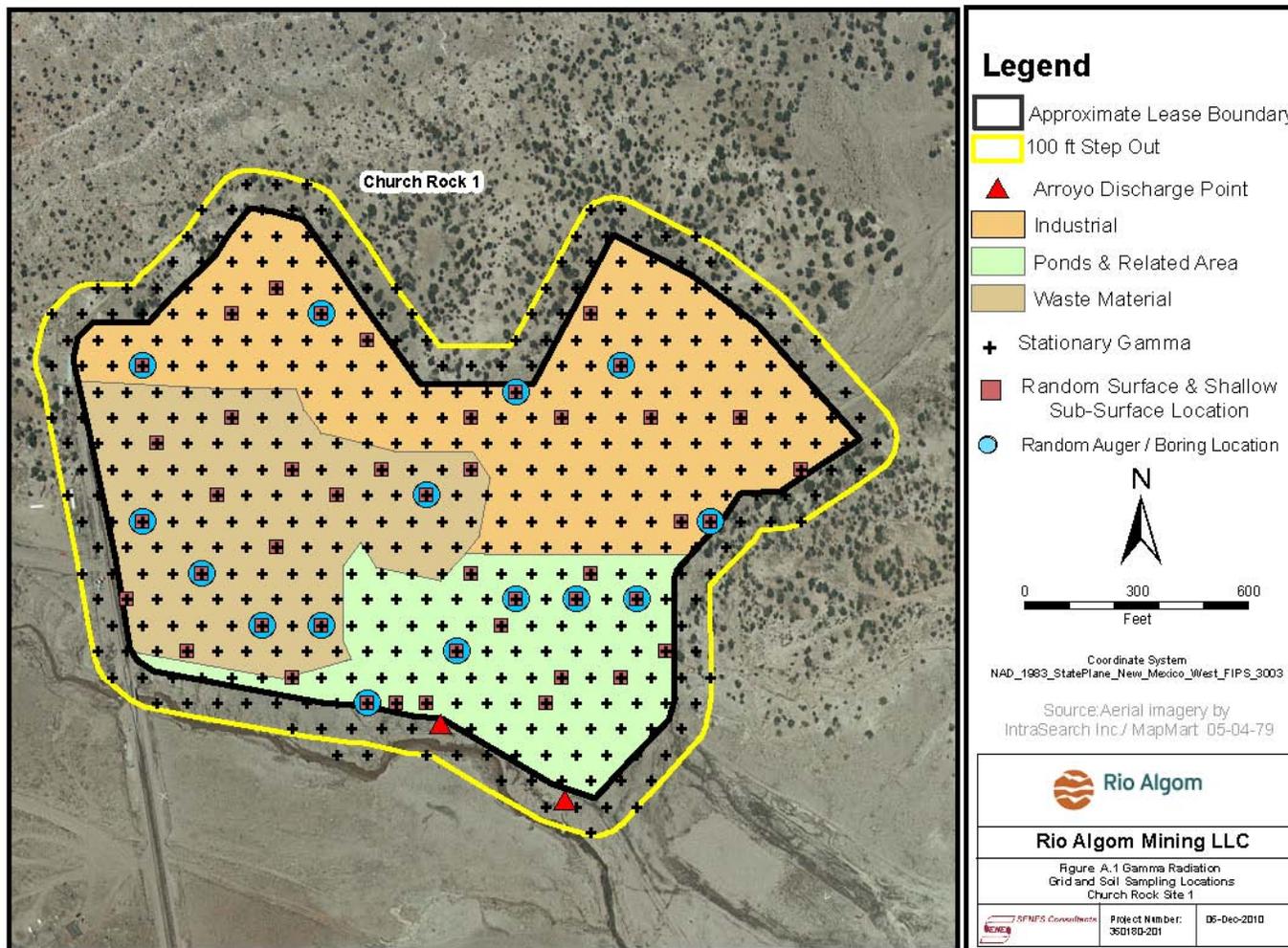
**Deleted:** A total of more than 300 soil samples, plus associated QA/QC samples may be collected for laboratory analysis from within the areas. Another 60 samples (20 locations with three depths for each location) are planned for the Step Out Areas.

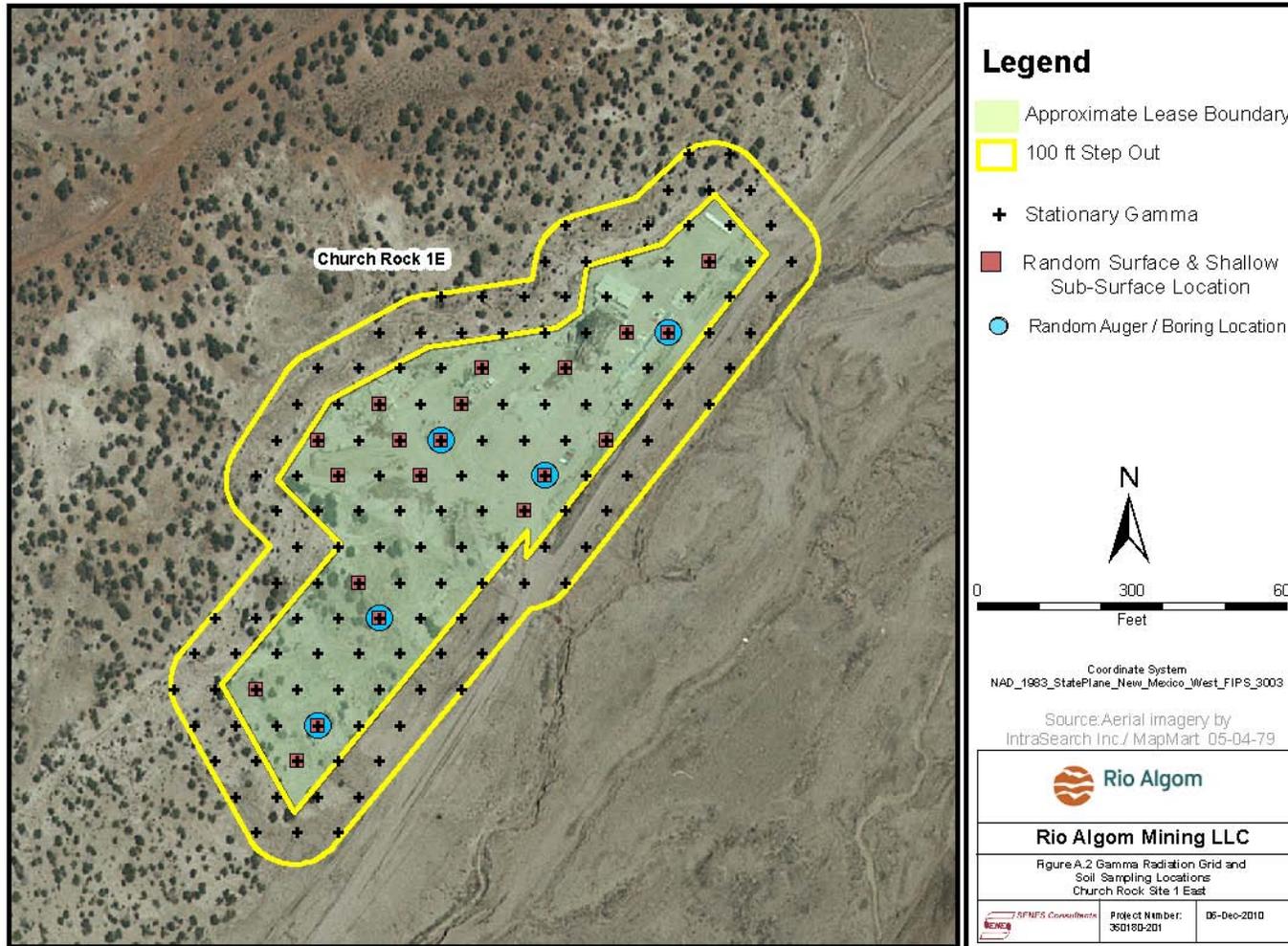
Background sample locations may include another 25 surface (0 to 6") samples plus QA/QC for each background area selected.

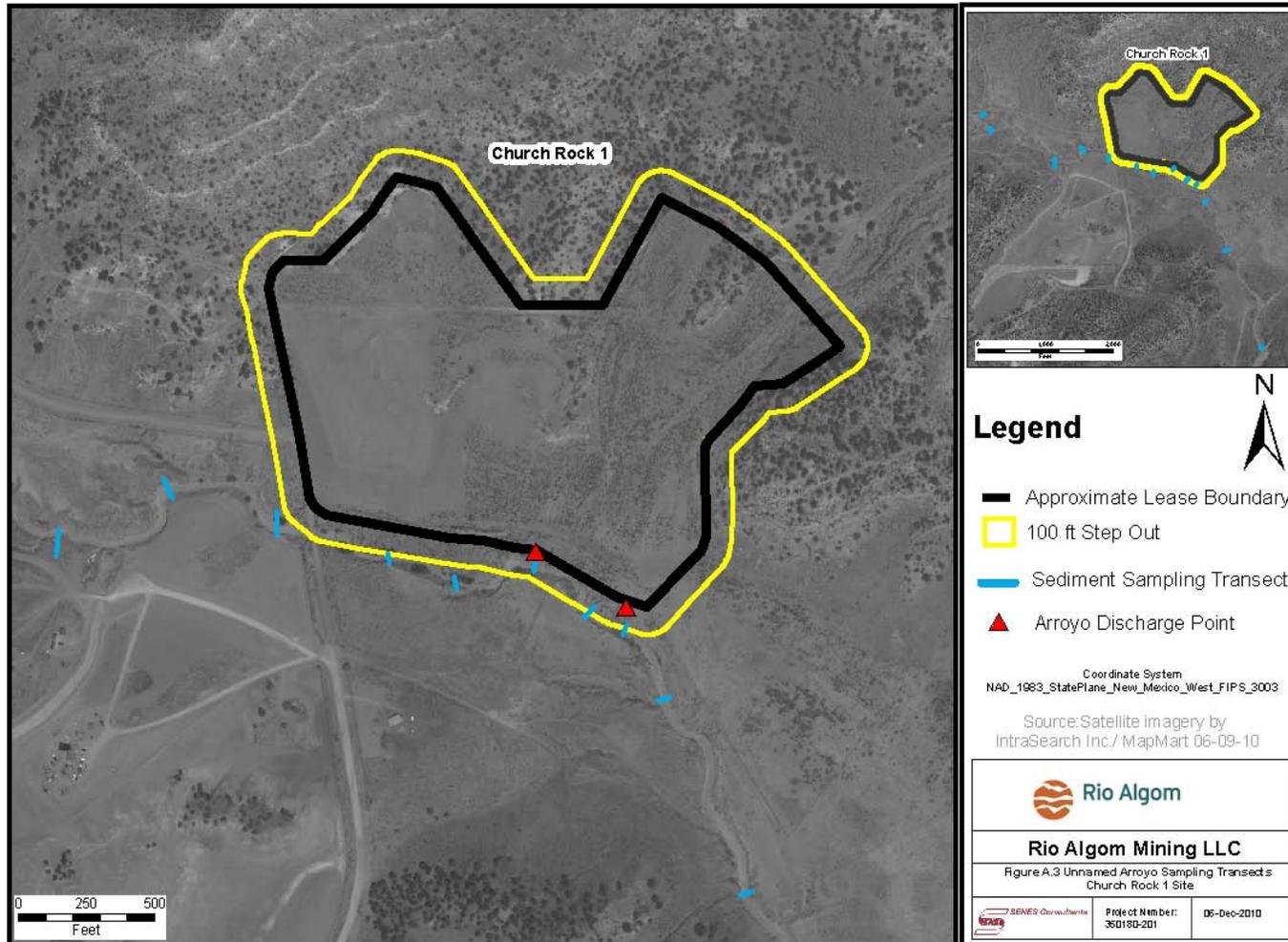
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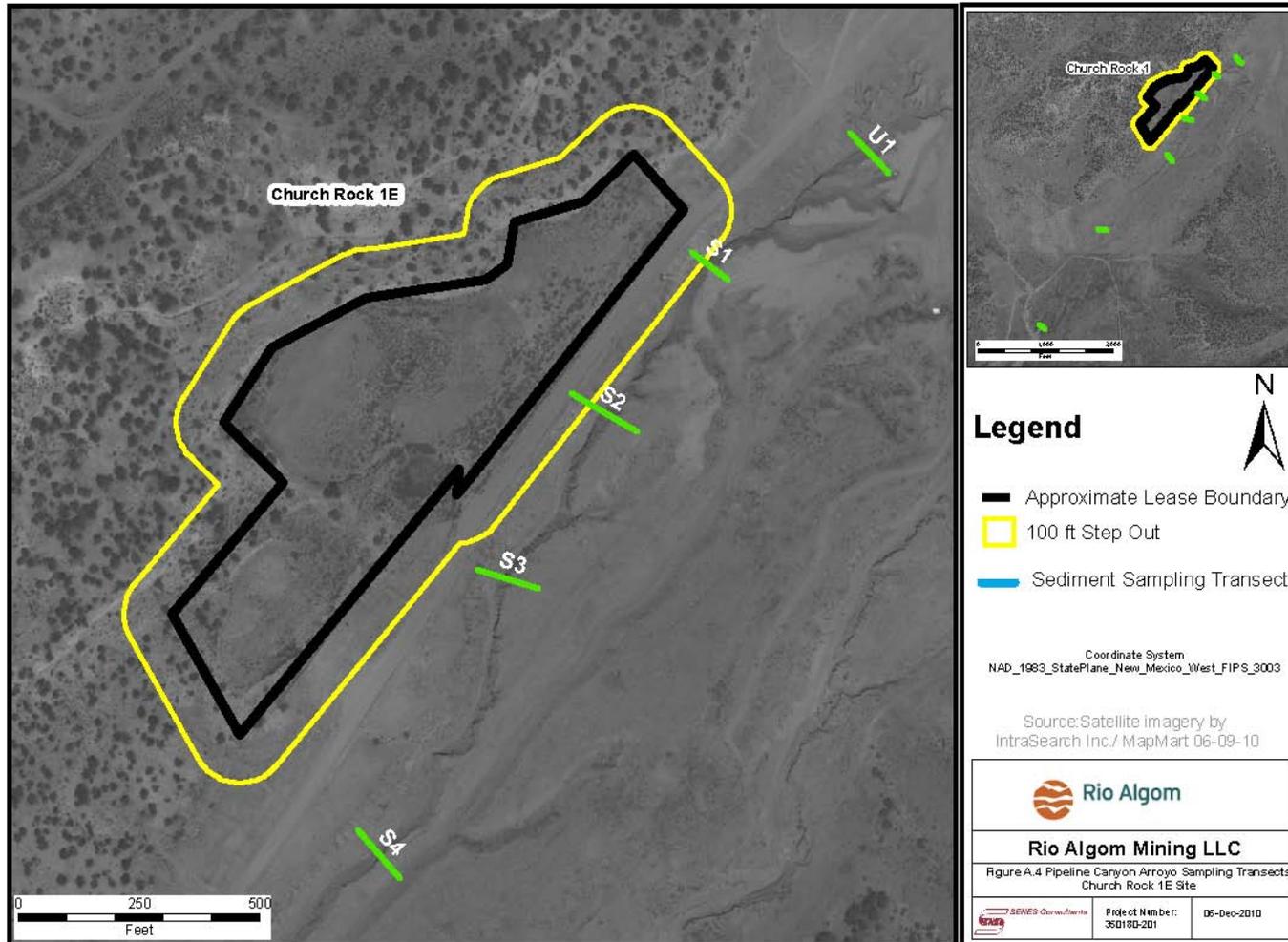
**Deleted:** The arroyo program will have 80 samples based on 13 transects times 3 locations per transect plus related QA/QC measurements.

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## A.2.1 Analyses

### A.2.1.1 Radionuclide Analyses

Ra-226 will be performed on all soil samples, Ra-226 will be analyzed by EPA Method 901.1 and metals by SW-846 6020 as shown in Table B.1. This table is also a summary of pertinent field sampling information (i.e., sample containers, preservative and holding times).

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### A.2.1.2 Stable Metals

Analysis for stable metals including arsenic, selenium, molybdenum, and vanadium will be performed on soil samples to characterize the type and quantity of COCs. They will be analyzed by SW-846 6010 as shown in Table B.1. This table is also a summary of pertinent field sampling information (i.e., sample containers, preservative and holding times).

### A.2.1.3 Volatile Organic Compounds (VOC) and Semi-Volatile Organic Compounds (SVOC)

VOC and SVOC analysis will be performed on soil samples at EPA-determined locations based on operational history of the sites as shown in Figure 2.2 to characterize the type and quantity of COCs. VOC will be analyzed by EPA Method SW-846 8260B and SVOC by SW-846 8270C as shown in Table B.1. This table is also a summary of pertinent field sampling information (i.e., sample containers, preservative and holding times).

### A.2.1.4 Total Petroleum Hydrocarbons (TPH)

TPH analysis will be performed on soil samples to characterize the type and quantity of COCs. TPH will be analyzed by EPA Method SW-846 8015M as shown in Table B.1. This table is also a summary of pertinent field sampling information (i.e., sample containers, preservative and holding times).

### A.2.1.5 Agronomic Analysis

Agronomic analysis were carried out for the following features:

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- pH;
- Electrical conductivity;
- Saturation percentage;
- Texture;
- Rock Fragment Percentage;
- Sodium Adsorption Rate (SAR);
- Nitrate;

- Phosphorus;
- Potassium;
- Chloride;
- Sulfate;
- Organic Carbon.

Table B.2 provides further information on analytical methods and procedures.

## **A.2.2 Field Methods and Procedures**

### ***A2.2.1 Surface Soil, Shallow Subsurface, and Sediment Samples***

Surface soil grab samples will be collected by carefully removing the top layer of soil or debris to the desired sample depth with a decontaminated spade, shovel, or equivalent. Samples collected from the area may contain large grain sizes (e.g., gravel and cobbles). An attempt will be made to select locations in the area that are free of any particularly large pieces. Shallow subsurface samples will be collected with a hand auger, shovel, or power auger, depending on soil conditions. Unless instructed otherwise, samples received by the laboratory will be analyzed "as received." Therefore, extraneous material (e.g., rocks greater than 2-inch in diameter, leaves, sticks) will be removed at the time of sample collection.

Each soil sample will be recorded on the Surface Soil Sample Log Form provided in SOP 7, Surface and Shallow Subsurface Soil Sampling. Samples will be labelled and handled following the sample preservation and chain-of-custody protocols described in this section, SOP 4, Field Documentation, and SOP 6, Sampling Handling and Shipping. Sampling equipment will be decontaminated as described in SOP 5, Equipment Decontamination. Samples for VOCs will be handled in accordance with SOP 8, Soil Sampling for VOC Analysis.

### ***A2.2.2 Deep Subsurface Soil Samples***

Deep subsurface samples (collected with the use of a drill rig) will be collected. Once the desired interval is reached, a 6-inch interval of material will be collected.

Each subsurface soil sample will be recorded on as required by SOP 9, Deep Subsurface Soil Sampling. Samples will be labelled and handled following the sample preservation and chain-of-custody protocols described in this section, SOP 4, Field Documentation, and SOP 6, Sampling Handling and Shipping. Sampling equipment will be decontaminated as described in SOP 5, Equipment Decontamination.

### **A2.2.3 Radiological Field Gamma Radiation Measurements**

Gamma radiation measurements are related to the amount of radioactivity in the soil are efficiently collected at a large number of points using standard methods supported by MARSSIM. The gamma radiation program will include stationary measurements at static points including soil sampling locations and with a roving survey and scan approach. A site-specific predictive relationship will be developed between the gamma radiation levels and the surface Ra-226 concentration using statistical methods.

#### **A2.2.3.1 Field Direct Gamma Radiation Level Correlation for Surface Soil**

The radiological characterization for the surface soil consists of stationary direct gamma radiation level measurements as well as scans for additional characterization of the survey area and boundaries. The gamma radiation survey methods with the Ra-226 concentrations from soil sampling will provide the aerial extent of Ra-226 contamination in the top six-inch soil layer that will allow greater characterization of the Site compared to relying on surface soil sampling alone. Ra-226 is primarily an alpha-emitting radionuclide with a gamma radiation emission of 186 keV at about 4% intensity. Field measurement of alpha radiation from soil using radiation detection instruments is an inadequate technique due to its short range and self-absorption. The low energy and intensity of Ra-226 gamma radiation emission makes field determination of Ra-226 by gamma radiation measurement a difficult task. However, Ra-226 content in soil can be determined by measuring gamma radiation levels of its decay products Bi-214 and Pb-214. These radionuclides emit higher energy and more frequent gamma emissions that which are easily detected and quantified by a sodium iodide (NaI) scintillation detector. The field survey consisting of direct gamma radiation level measurement is consistent with the flow diagram for selection of field survey instrumentation for direct measurements presented in Figure 4.2 of the MARSSIM (EPA, 2000a).

The direct gamma radiation measurements, using a NaI scintillation detector, provide radiation levels in counts per unit time. The counts per unit time for a given radioactivity depend on the efficiency of the detector. Therefore, a site-specific correlation between direct gamma radiation levels and Ra-226 soil concentrations, as discussed in Section 6.6.2 of the MARSSIM (EPA, 2000a), may be used to convert the counts per minute (cpm) readings to the Ra-226 soil concentration in pCi/g. The conversion factor, pCi/g per cpm, is dependent upon several factors, as described below.

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- Efficiency of a particular detector. The 2-inch x 2-inch NaI scintillation detector provides a high efficiency for gross gamma radiation level measurements in the field.
- The direct gamma radiation level survey for Ra-226 in soil is a surrogate for gamma measurement of Bi-214, similar to the measurement described in Section 4.3.2 of the

MARSSIM. Bi-214 is a decay product of Ra-226 through Rn-222, a gaseous form, some of which emanates from soil. This phenomenon results in activity disequilibrium between Ra-226 and Bi-214 in the soil. The fraction of Rn-222 emanation varies with different geometric characteristics of a particular soil. Therefore, a site-specific calibration is necessary.

- Other gamma-emitting naturally occurring radionuclides in soil, such as potassium-40 and Th-232 decay series, and cosmic gamma rays will be included in this gross gamma radiation level measurement. Therefore, this contribution to gross gamma count needs to be corrected. These interferences are generally constant and allow for the use of linear regression to determine the correlation with the intercept term describing the contribution from other radionuclides.

Prior to conducting the gamma radiation measurements, the operating high voltage levels of the NaI detector will be established in accordance with manufacturer instructions. The operating high voltage that will yield the lowest noise, optimum efficiency and least sensitivity to voltage fluctuations in the field will be established by determining the high voltage plateau of the detector.

The field gamma radiation correlations, static measurements, and scans for Ra-226 content in soil will be performed using a Ludlum 2221 Ratemeter/Scaler. The Ratemeter/Scaler is connected to a 2-inch by 2-inch NaI crystal scintillation detector (Ludlum 44-10), which detects gamma radiation emitted from Bi-214 and Pb-214 which are decay products of Ra-226 in the soil.

Soil samples for the correlation will be collected using the surface soil sampling SOP. The sampling locations will be marked with flags. Each sample bag will be marked and labelled with appropriate sample identification. Soil sampling equipment will be decontaminated between each sampling location using the SOP. All soils samples will be shipped to the radioanalytical laboratory for Ra-226 on a dry basis using EPA gamma spectroscopy method 901.1.

The selection of soil sample locations will also include background samples. Background areas will be investigated and two or more sites may be chosen as reference background areas per MARSSIM (EPA, 2000). These areas would be chosen for population statistical tests for comparison to sampling areas to include the sites as well as the arroyo. Sample locations will be determined using an equally spaced triangular grid, cast on a random origin.

Radiation level surveys will be generally performed using a detector with lead collimator to minimize the interference. This is consistent with the technique described in Section 6.4.1.1 of MARSSIM (EPA, 2000a).

**Deleted:** A five-point composite sample at a depth of 0" to 2" and 2" to 6" will be collected from each of the gamma radiation level measurement location. One soil sample aliquot point will be from the center point directly under the detector, and the other four aliquots from four points that are 18 inches from the center points in four directions (90 degrees apart). Each soil sample aliquot will be approximately 200 grams, collected by using the hand scoop method if soil texture is loose, or a hand auger if soil texture is sufficiently compacted.

**Deleted:** The five 200-gram soil sample aliquots will be combined (total of 1000 gram) in a mixing bowl, homogenized and placed in a sample bag.

To determine the correlation between gamma radiation level counts and corresponding Ra-226 concentration in soil content (i.e. to determine a calibration factor) a linear regression analysis will be performed on the sample Ra-226 concentration in pCi/gm, and the associated gamma radiation count rate (cpm) from all the sample locations. A relationship should be developed for the paired Model 2221 rate meter and Model 44-10 detector system.

#### **A2.2.3.2 Field Direct Gamma Radiation Level Measurements for Surface Soil**

NaI scintillation detectors will be used for stationary direct radiation level measurements and scans for determining Ra-226 content in surface soils for the characterization survey. A 2-inch by 2-inch NaI detector is an appropriate detector for this type of survey (Section 6.7.2 of MARSSIM [EPA, 2000a]).

The 2-inch by 2-inch NaI detector will be connected to a single-channel rate meter, which provides necessary' operating voltage to the detector. [The probe will be used with a lead collimator for greater consistency among measurements as it reduces \(but does not eliminate\) the low energy gamma radiation from other areas impacting the detector. The low energy gamma artificially increases the count rate attributed to a specific location and are especially important at these low levels.](#) The rate meter receives signals from the detector and reports in terms of counts of radiation detected per minute. The rate meter will be setup to report gross counts, as recommended in Section 4.7.3 of the MARSSIM (EPA, 2000a). A GPS will be used to establish systematic grids. The GPS coordinates will be referenced to the New Mexico [West](#) State Plane Coordinate System.

[Review of UNC documentation and surveys of background levels will provide a gamma radiation level indicative of contamination within the Step Out area. Additional judgmental gamma radiation and soil sampling will be conducted in these areas.](#)

#### **Stationary Measurements**

Static surveys will be performed at specified grid nodes within survey areas or other locations, such as correlation sampling points as needed in the field. The grid nodes were determined using a 80-foot triangular grid cast on a random origin. The 80-foot triangular grid will be extended beyond the initial survey area boundary to assist with the boundary delineation evaluation. Figure A.1 shows the stationary measurement locations.

A technician will hold the detector at approximately 18 inches from the ground surface above the desired survey point to obtain a one minute integrated count. The technician will perform the static (stationary) gamma radiation survey according to the methods detailed in the SOP.

#### **Scan Surveys**

Scan radiation surveys (walkthrough surveys) will be performed by walking at a rate of about three feet per second with the detector at about 18 inches above the ground surface. Scan surveys will be performed hot spots by walking in serpentine shape along transects. The distance between transects of an area will be determined based on the static survey of the grid nodes in that survey area and will be no further than 30 feet apart within the area.

The scan radiation surveys will also be performed at survey area boundaries to delineate lateral extent of Ra-226 contamination. This scan survey will be performed by walking along the 80-foot spacing transects perpendicular to the initial perimeter of each survey area. These transects would run between the most outer 80-foot static grid node inside the initial boundary to the next 80-foot grid node outside the survey area boundary. There will be additional transects outside the area boundaries to explore the “step-out” areas.

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For the scan surveys, the Ludlum 2221 with external RS-232 output connector will be coupled to a Trimble XRT Pro mapping grade GPS receiver/data logger (or similar model) to collect and store the survey data. The GPS receiver will store in the electronic data file the gamma radiation count rate and its corresponding location coordinates. This configuration can provide a gamma radiation intensity level in counts per minute (cpm) at approximately every three feet along the scan path based on a scan rate of three feet per second and reporting of count rate every second. The GPS receiver/antenna will be carried in a backpack. At the end of each survey day, the field data will be downloaded to a laptop computer for processing.

#### **A2.2.4 Surveying**

Surveyed locations will include stationary and scan gamma measurements, surface soil samples, soil borings, excavations and other physical features, such as roads and survey area boundaries. It is anticipated that the surveying will be completed using a backpack GPS unit.

All measurements will be referenced to the State Plane Coordinate System New Mexico West, North American Datum 1983 and North American Vertical Datum 1988. Each sampling location will be marked with a wooden stake, a wooden lath or pin flag, and will have the corresponding sample identification number written on the marker. During surveying, the northing, easting and elevation will be stored in the GPS unit and downloaded onto a computer. In addition, the northing, easting and elevation will be recorded in a bound field notebook.

The GPS unit will be checked daily for accuracy at a control point or benchmark with a known northing and easting. The northing and easting will be recorded on a field form. Other information reported on the GPS Benchmark Elevation Form, located in Appendix B, will include date, time, weather, problems, repairs and comments.

### ***A2.2.5 Field Quality Control Samples***

Equipment rinsate samples and field replicates will be collected for all soil sampling events. Field replicate soil samples will be collected at a rate of five percent for the primary laboratory and at a rate of 10 percent for the EPA's secondary laboratory. The field replicate soil samples will be splits of the original grab sample.

To the extent possible and practical, dedicated sampling equipment will be used. However, equipment rinsate blanks will be prepared at the Site by passing laboratory-provided reagent water of known quality through decontaminated non-dedicated sampling equipment. At the end of each day, the sampling team will take one equipment rinsate sample from each set of non-dedicated sampling equipment just before its final use.

- The field log will identify the team members, date, and sampling area. This identification procedure will associate the equipment rinsate samples with a specific team's field decontamination procedure on each day. The rinsate sample sets from the team will be submitted each day along with the field samples. Equipment rinsate samples will be collected at a frequency of one each day per analysis type. It is assumed that the non-disposable sampling equipment may include stainless steel bowls, hand trowels, shovels, split-spoon samplers, excavator bucket, and auger flights. Collection of rinsate blanks is summarized as follows: Rinsate blanks will be collected by pouring contaminant-free reagent-grade water directly over decontaminated sample collection equipment and into sample containers. The sample containers used for rinsate blanks are summarized in the QAPP location in Appendix A. Rinsate blanks will be labeled and transported to the analytical laboratory using the same procedures used for primary samples. Rinsate blanks will be analyzed for the same analytes that are specified for associated field samples.
- The laboratory will conduct the analyses of rinsate blanks in an identical fashion to the associated field samples (i.e. aqueous rinsate blank samples for soil samples will be prepared and analyzed as soil samples and reported accordingly).

Whenever rinsate blanks are sampled for VOCs and SVOCs, trip blanks will accompany the samples to the laboratory and analyzed for VOCs and SVOCs.

In addition to the rinsate samples, sample replicates (splits) of all of the surface and subsurface soil samples will be collected at a rate of 10%. The EPA will prepare an in-house split sampling plan to describe who in the EPA would verify the sampling and splitting procedures and selection. The samples will be submitted to EPA's laboratory for analysis.

### ***A2.2.6 Decontamination Procedures***

All soil sampling equipment will be cleaned and decontaminated prior to use at each location. Additional details on decontamination procedures are located in SOP 5, Equipment Decontamination. Large equipment such as drill rigs, augers and the backhoe bucket will be decontaminated using a pressure washer, if possible. Smaller equipment such as trowels and shovels will be decontaminated as follows:

- Wash the equipment in low- or non-phosphate detergent (e.g., Alconox® or Liqui-Nox® solutions made as directed by the manufacturer);
- Rinse twice with potable water;
- Rinse once with de-ionized or distilled water; and
- Rinse water will be handled as IDW.

### **A.3 SAMPLE CONTAINERS AND STORAGE**

After collection, samples will be properly stored to prevent degradation of the integrity of the sample prior to its analysis. As applicable, this includes analyzing the sample within prescribed holding times. Where practicable, personnel may electronically document sample handling and storage. Holding times are to be maintained from the time of sampling until the time of analysis.

All samples designated for off-site laboratory analysis will be packaged and shipped in accordance with applicable U.S. Department of Transportation regulations. Samples will be sealed in the appropriate sampling container. A chain-of-custody seal will be placed on the sample container. The samples will be packed securely in an ice chest and samples will be preserved in accordance with the specifications set forth in Table 6.2 through Table 6.4.

Samples collected for SPLP analysis will be collected in accordance with the above description of soil and sediment sampling procedures in 6.4.1. Soils collected for SPLP analysis do not require preservation or refrigeration. Once collected and placed in the sample container, it will be catalogued and properly labeled to be shipped to the laboratory accompanied with the necessary chain of custody.

#### **A.3.1 Disposal of Investigation Derived Waste**

Generation of IDW such as equipment decontamination wastewater, rinsate, soil cuttings, sample containers, and personal protective equipment (PPE) will be minimal. Soil cuttings generated from excavation will be put back into the pit once excavation is complete at each location. Any residual will be evenly spread on the ground surface on top of the pit or drill hole from which they came.

Decontamination wastewater, rinsate sample containers, and PPE will be characterized, as necessary, and disposed of in accordance with State and Federal Regulations.

#### **A.4 SAMPLE DOCUMENTATION AND SHIPMENT**

##### **A.4.1 Field Notes**

The on-site geologist/environmental scientist will use a weather-resistant, bound, survey-type field logbook with numbered, non-removable pages to record in black or blue indelible ink all field activities including soil sampling, trenching, drilling, etc. Daily information entered in the logbook will include:

- Dates and times;
- Name and location of the work activities;
- Weather conditions;
- Personnel, subcontractors and visitors on site;
- Sample locations and methods (including sampling equipment);
- Time of sample collection, and sample depths;
- Samples submitted to the laboratory for analyses;
- Sample type (e.g., soil, rinsate water, co-located, or trip blanks);
- Name of carrier transporting the sample (e.g., name of laboratory and shipping carrier);
- Photograph numbers and descriptions (if applicable);
- Description of decontamination activities;
- Schematic drawings of sample locations (if not done on field forms);
- Any deviations from the field sampling plan;
- Health & Safety meetings, including topics discussed and attendees;
- Accidents, including near misses;
- Other relevant observations as the field work progresses;
- Problems and corrective actions;
- Field equipment calibration methods;
- Investigation Derived Waste.

At the end of each field day, the project field book will be dated and signed by the field person who took notes during the day. If the entire page is not used a line will be drawn through the unused portion of the page. If pages are accidentally skipped, a line will be drawn through the entire page. All corrections will be made by drawing a line through the erroneous information and initialing the change.

If electronic record-keeping systems are employed, procedures will ensure that:

- All original entries recorded are sufficiently backed up to avoid loss;
- A system that preserves both the original record and any changes to the record, inclusive of the identification of the individual making the change, exists and will be implemented;

- An archived record of all data entries will be protected to prevent unauthorized access or amendment of the electronic data;
- Entries will be complete enough to allow for the historical reconstruction of all records;
- The review of the records will be documented.

Additional details for the project field books are located in the SOPs.

#### A.4.2 Sample Identification

All samples will be labeled in a clear, precise way for proper identification in the field and for tracking in the laboratory. The samples will have identifiable and unique numbers. Detailed sampling handling procedures are provided in the SOPs, Sample Handling and Shipping, located in Appendix C. At a minimum, the sample labels will contain the following information:

- Facility name;
- Sample number;
- Sample depth;
- Date of collection;
- Time of collection;
- Initials or name of person(s) collecting sampling;
- Analytical parameter(s);
- Method of sample preservation.

##### A.4.2.1 Labeling

The sample designation will be recorded on the sample label and logbook, and will comprise three parts or fields.

Samples will be numbered sequentially for each type of sample collected (i.e., surface sampling, soil boring, field gamma measurement).

- Part 1 will be designated as the survey area.
  - ~~CIL1, CILP, CILW and CISO~~ for ~~Church Rock 1 industrial, ponds and related area, and the waste rock area~~, and Step Out, respectively
  - ~~CELA, CESO~~ for ~~Church Rock 1E lease and Step Out areas~~, respectively
  - BKG1, BKG2, ... respectively for background areas.
- Part 2 will be a field that begins with alphabetic characters that identify the type of sample. Sample-type codes include the following:
  - ER = equipment rinsate blank
  - SS = surface soil

- Deleted: INQ1MI,
- Deleted: Q1
- Deleted: O
- Deleted: Quivira Mine Site
- Deleted: Q1EM
- Deleted: QI
- Deleted: ES
- Deleted: Quivira Mine Site 1E

- SSSa = shallow subsurface soil, 18-24 inches
- SSSb = shallow subsurface soil, 30-36 inches
- SBS = Subsurface soil
- TB = trip blank
- GM = gamma measurement
- Part 3 will be three digits that follow the alphabetic character(s) and will be sequential (e.g., "001" for the first sample location collected, "002" for the second sample location collected, "003" for the third sample collected). In the case of a soil sample at depth, Part 2 will end with depth interval, referenced to below ground surface (bgs) in parentheses. The depth will be in feet for subsurface soil and inches as required for the surface samples.

As an example, sample designation C1LI-SS004(0-2) is the 4<sup>th</sup> surface soil sample collected from 0 to 2 inches below ground surface from the industrial area of Mine Site 1. Replicate samples will be hidden from the laboratory by using a "200" identifier in the sample designation.

Deleted: Q1EM

The replicate sample designation for the example described above would be C1LI-SS204(0-2).

Deleted: Q

Deleted: EM

#### A.4.2.2 Chain-of-Custody

Samples should be treated in accordance with SOP 6, Sample Handling and Shipping. Each sample and/or measurement will be properly documented to facilitate timely, accurate, and complete analysis of data. The documentation system is used to identify, track, and monitor each sample from the point of collection through final data reporting. Where practicable, this documentation system may be electronic. Chain-of-custody protocol will be implemented and followed for all samples. A sample is considered to be in a person's custody if it is: 1) in a person's physical possession, 2) in view of the person after taking possession, or 3) secured by that person so that no one can tamper with it.

Deleted: 12

Chain-of-custody forms will be used to ensure that the integrity of samples is maintained. Each form will include the following information:

- Sample number;
- Date of collection;
- Time of collection;
- Sample depth;
- Analytical parameter;
- Method of sample preservation;
- Number of sample containers;
- Shipping arrangements and airbill number, as applicable;
- Recipient laboratories;
- Signatures of parties relinquishing and receiving the sample at each transfer point.

Whenever a change of custody takes place, both parties will sign and date the chain-of-custody form, with the relinquishing person retaining a copy of the form. The party that accepts custody will inspect the custody form and all accompanying documentation to ensure that the information is complete and accurate. Any discrepancies will be noted on the chain-of-custody form.

#### A.4.2.3 Packaging and Shipment

All packaging will be in accordance with SOP 6, Sample Handling and Shipping. After collection, samples will be properly stored to prevent degradation of the integrity of the sample prior to its analysis. As applicable, this includes adding the appropriate chemical preservative to the sample, storing the sample in a refrigerated environment, and analyzing the sample within prescribed holding times. Where practicable, SENES may electronically document sample handling, preservation, and storage. Sample preservation and holding times are to be maintained from the time of sampling until the time of analysis.

Deleted: 12

All samples designated for off-site laboratory analysis will be packaged and shipped in accordance with applicable U.S. Department of Transportation regulations. Samples will be sealed in the appropriate sampling container. Sample containers will be placed in clean protective foam or bubble pack sleeves. The caps of all sample bottles shall be checked for tightness to prevent sample leakage during transport. Care will be taken to prevent over-tightening and breakage of bottle caps.

The samples will be packed securely in a cooler or other appropriate container, and samples will be preserved in accordance with the specification. For those samples requiring preservation at 4°C, the samples will be placed on ice in coolers in the field. Sufficient water ice (not "blue ice" or similar products) will be utilized to cool the samples during shipment. Sufficient ice shall be placed in each cooler such that: 1) some ice is still present upon arrival at the laboratory, and 2) the samples are cooled to 4 °C or below. The ice will be double wrapped in resalable plastic bags. Sufficient packing material will be placed in each ice chest to minimize the potential for sample bottles to shift and become damaged or broken during shipment. Packing material may include bubble pack or foam material. Samples should be thoroughly cooled before placing in packing material so the packing material serves to insulate the pre-cooled sample. Each cooler will contain a temperature blank consisting of a 40 millimeter vial. The drain plug on the shipping container will be closed and sealed on the inside and outside with duct tape.

Sampling personnel will inventory the sample bottles from the Site prior to shipment to ensure that all samples listed on the chain-of-custody form are present. All bottles collected from a specific sampling interval will be packed and shipped together in the same shipping container. The originals of the analysis request and chain-of-custody forms will be sealed in a waterproof plastic bag and firmly attached to the lid of the container. The cooler will be taped shut using strapping tape over the hinges and custody seals placed across the top and sides of the cooler lid.

Custody seals will be used to preserve the integrity of each sample container and cooler from the time the sample is collected until it is opened by the laboratory. A custody seal will be placed over the opening of the cooler. Clear tape will be placed over the custody seals to prevent inadvertent damage during shipping. The tape should not allow the seals to be lifted off with the tape and then reattach without breaking the seal.

**APPENDIX B**

**QUALITY ASSURANCE PROJECT PLAN**

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## ATTACHMENTS

Attachment 1 Analytical Procedures

Attachment 2 Laboratory Quality Assurance Plan (LQAP) of ALS Laboratory Group (PDF file)

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## ACRONYMS AND ABBREVIATIONS

%D	percent difference
%R	percent recovery
AALA	Association of Laboratory Accreditation
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
C-O-C	chain-of-custody
CRADA	Cooperative Research and Development Agreement
°C	degrees Celsius
DOT	department of transportation
DQOs	data quality objectives
EPA	U.S. Environmental Protection Agency
ICB/CCB	initial calibration blank/continuing calibration blank
ICP	inductively coupled plasma
ICS	interference check sample
LCS	laboratory control sample
LIMS	laboratory information management system
LQMP	laboratory quality management plan
MD	matrix duplicate
MDA	minimum detectable activity
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
NECR	Northeast Church Rock
NIST	National Institute of Standards and Technology
	precision, accuracy, representativeness, completeness,
PARCC	comparability
PCBs	polychlorinated biphenyls
PRGs	preliminary remediation goals
QAPP	Quality Assurance Project Plan
QA	quality assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QC	Quality Control
RCA	recommendations for corrective action
RL	reporting limit
RER	replicate error ratio
RFs	response factors RPD relative percent difference
SOP	standard operating procedure SSL soil screening level
UNC	United Nuclear Corporation
USDA	United States Department of Agriculture

## **APPENDIX B: QUALITY ASSURANCE PROJECT PLAN**

### **B.1.0 INTRODUCTION**

This Quality Assurance Project Plan (QAPP) is a component of the Removal Site Evaluation Work Plan prepared by Rio Algom Mining LLC (RAML) specific to the Church Rock Site. This QAPP was prepared to describe the project requirements for all field and Contract Laboratory activities and data assessment activities associated with the Work Plan. This QAPP presents in specific terms the policies, organization, functions, and quality assurance/quality control (QA/QC) requirements designed to meet the objectives for the sampling activities described in the Work Plan. Additionally, this QAPP provides guidance that establishes the analytical protocols and documentation requirements to ensure the data are collected, reviewed, and analyzed in a consistent manner.

This QAPP is based on the following:

- EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, EPA QA/R-5 (U.S. EPA, 2001).
- Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA/240/B-06/001. (EPA, 2006).
- EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846; U.S. EPA Third Edition, Final Update III, December 1996).
- EPA 100-400 - Series Methods for the Determination of Inorganic Substances in Environmental Samples (U.S. EPA/600R-93-100, August, 1999a).
- Prescribed Procedures for Measurement of Radioactivity in Drinking Water (U.S. EPA/600/4-80-032, August, 1980).
- Methods of Soil Analysis (American Society of Agronomy, 1982).
- United States Department of Agriculture (USDA), Handbook No. 60, (USDA, 1954).

This Quality Assurance Project Plan (QAPP) is a component of the Removal Site Evaluation Work Plan prepared for RAML specific to the Church Rock Site. The Work Plan contains a description of the Site, Site background, constituents of concern, proposed sampling activities and this QAPP, and is intended to describe the project requirements for all field, sample analysis, and data assessment activities associated with this project.

This QAPP presents in specific terms the policies, organization, functions, and quality assurance/quality Control (QA/QC) requirements to meet the project-specific objectives associated with soil sample collection and analysis. Detailed field procedures for soil sample collection and field analysis are also described in the Work Plan.

### **B.1.1 QAPP Objectives**

The specific objective of this QAPP is to provide the guidance that will be followed for chemical analysis of soil samples to ensure that the data are of sufficient quality to support the project objectives and the data end uses. This QAPP also presents the project organization and QA/QC procedures to be followed by the Contract Laboratory for all sample analysis.

### **B.1.2 Document Organization**

The remainder of this QAPP is organized as follows: Section B 2.0 Project Organization. This section describes the organization for this project.

- Section B 3.0 Quality Assurance Objectives for Measurement Data. This section presents the field and Contract Laboratory analytical procedures that will be followed to ensure that all measurement data collected during this project meet the project quality assurance objectives. This section also includes the procedures for instrument calibration for all anticipated analyses performed by the Contract Laboratory.
- Section B 4.0 Sampling Procedures. This section references back to the Work Plan.
- Section B 5.0 Sample Custody. This section presents the Contract Laboratory chain-of-custody (C-O-C) procedures. Field C-O-C procedures are defined in the Work Plan.
- Section B 6.0 Analytical Procedures. The analytical procedures to be used by the Contract Laboratory are presented in this section.
- Section B 7.0 Internal Quality Control Checks. The SENES and Contract Laboratory internal QC checks are presented in this section.
- Section B 8.0 Data Reduction, Reporting, Verification, and Validation. The procedures for reducing, reporting, verifying, and validating field and chemical data are defined in this section.
- Section B 9.0 Performance and Systems Audits. The SENES and Contract Laboratory procedures for performance and systems audits are presented in this section.
- Section B10.0 Preventative Maintenance Procedures. The preventative maintenance procedures that will be followed by the Contract Laboratory are detailed in this section. General procedures for field-related tasks are presented in this section; specific details will be included in the Work Plan.
- Section B 11.0.O Corrective Actions. This section defines the corrective actions that will be implemented in the event of field or Contract Laboratory non-conformances.
- Section B12.0 Quality Assurance Reports to Management. The quality assurance reporting requirements for this project are presented in this section.
  1. Attachment 1 Quality Control Procedures. This attachment includes the following information for all methods included in Table B.1:
  2. Control limits that will be used for matrix spike (MS), matrix spike duplicate (MSD), and laboratory control sample (LCS) - standard assessment.

3. Method specific calibration requirements, QC sample analysis frequency, and corrective action procedures.
4. Method specific reporting limit (RL) requirements.

The specific criteria that will be used for data assessment are as follows:

- Control Limits. The control limits for this project are based on the referenced analytical method or current industry standards.
- Calibration Requirements, QC Sample Analysis Frequency, and Corrective Action Procedures. The analytical methods listed in Section 4 were used as the source for establishing instrument calibration, QC sample analysis frequency, and corrective action requirements for this project.
- Reporting Limits. The RLs for this project will reflect the RLs established by the Contract Laboratory.

## **B.2.0 ORGANIZATION**

At the direction of the RAML or their appointed representative, SENES will have the overall responsibility for the implementation of this project. SENES responsibilities include preparing the project plans and conducting the field activities. Descriptions of the responsibilities and authorities for the key positions as they relate to project QA and QC are provided below. In addition, the organization of the Contract Laboratory is provided in the attached ALS Quality Laboratory Assurance Plan.

### **B.2.1 RAML**

The RAML Representative and Site Manager have the overall responsibility for the successful completion of the sampling program. They are responsible for:

- Developing scopes of work.
- Defining project objectives and schedules.
- Reviewing and analyzing overall task performance with respect to planned requirements and authorizations.
- Interfacing with the federal and state regulatory agencies. Approving all reports (deliverables) before their submission to the federal and state regulatory agencies.

### **B.2.2 LS Laboratory Group Staff**

ALS Laboratory Group staff involved with sample preparation and analysis will consist of experienced professionals who possess the degree of specialization and technical competence to perform the required work in an effective and efficient manner.

### **B.2.3 ALS Laboratories Training Requirements**

ALS Laboratory Group staff associated with the project will have sufficient training to safely, effectively, and efficiently perform their assigned tasks. Training records are available in the LQAP (Attachment 2).

## **B.3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA**

Data quality refers to the level of reliability associated with a particular data set or data point. The data quality associated with environmental measurement data is a function of the sampling plan rationale, the sample collection procedures, and the analytical methods and instrumentation used in making the measurements. The overall QA objective is to develop and implement procedures for field sampling, C-O-C, Contract Laboratory analysis, and data reporting that will provide data that meet task-specific objectives and that are legally defensible. Objectives are qualitative and quantitative statements that specify the field and Contract Laboratory data quality necessary to support specific decisions or regulatory actions. The objectives describe which data are needed, why the data are needed, and how the data are to be used to meet the needs of this sampling program. Objectives also establish numeric limits for the data to allow the data user (or reviewers) to determine whether the data collected are of sufficient quality for their intended use.

The objectives for this project are included in Section 3.0 of the Work Plan. The objectives were developed in accordance with the Guidance for the Objectives Process, EPA QA/G-4 (U.S. EPA, 2000). The remainder of this section defines how the data will be assessed to meet the task-specific objectives and the criteria that will be used to define acceptable limits of uncertainty.

### **B.3.1 Data Types**

The data types required for this project are based on the task-specific objectives, the end-use of the analytical data, and the level of documentation. Both screening and definitive data will be collected. The specific type of data that will be collected for each sampling task are defined in the Work Plan. Whether data are considered screening or definitive is based on the method of sample collection, preparation, and analysis. Definitive data include data that are collected using standard sampling methodology and analytical methodology of known precision and accuracy. Screening data include data that are collected using non-standard sampling methodology or

collected using rapid, less precise methods of analysis with less rigorous sample preparation or quality control as compared to analytical methods from which definitive data are generated. For this project all data from the Contract Laboratory are considered definitive.

### **B.3.2 Data Quality Definition and Measurement**

To determine the overall quality of definitive data, the results of QC sample analysis will be evaluated in terms of the precision, accuracy, representativeness, completeness, and comparability (PARCC) objectives established in this QAPP. The QC samples that will be used to assess the quality of both the field and Contract Laboratory data (prepared both in the laboratory and in the field) are described later in this section.

#### ***B.3.2.1 Precision***

Precision is the reproducibility of measurements under a given set of conditions. For large data sets, precision is expressed as the variability of a group of measurements compared to their average value (i.e., standard deviation).

#### ***B.3.2.2 Accuracy***

Accuracy is the degree of agreement of a measurement or an average of measurements with an accepted reference or "true" value, and is a measure of bias in the system. The accuracy of a measurement system is affected by errors introduced through the sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and analytical techniques.

Contract Laboratory Accuracy. Contract Laboratory accuracy will be assessed quantitatively through the analysis of MS/MSD samples LCS, interference check samples (metals analysis only), post digestion spikes, and response factors for calibration standards, and internal standard recoveries.

#### ***B.3.2.3 Representativeness***

Representativeness is a qualitative expression of the degree to which sample data accurately and precisely represent a characteristic of a population, a sampling point, or an environmental condition. Representativeness is maximized by ensuring that, for a given task, the number and location of sampling points and the sample collection and analysis techniques are appropriate for the specific investigation, and that the sampling and analysis program provides information that reflects "true" site conditions.

Contract laboratory data will be evaluated for representativeness by assessing whether the laboratory followed the specified analytical criteria in this QAPP and their standard operating procedures (SOPs). In addition representativeness will be evaluated by assessing compliance with sample preservation and holding time criteria, and the results of method and instrument blank sample results, ICB/CCB results (metals analysis only), trip blanks, equipment rinsate blanks, source water blanks, and field replicate sample analyses.

#### ***B.3.2.4 Comparability***

Comparability is a qualitative parameter that expresses the confidence with which one data set may be compared to another. Comparability is dependent on similar QA objectives and is achieved through the use of standardized methods for sample collection and analysis, the use of standardized units of measure, normalizing results to standard conditions, and the use of standard and comprehensive reporting formats as defined by this QAPP.

Contract laboratory data comparability is dependent on the use of similar sampling and analytical methodology and standard units of measure between different tasks at a specific site. For this project, chemical data will be collected using standard sampling and analyses procedures. Data comparability will also be assessed by comparing investigative sample data to QA or QC sample data.

#### ***B.3.2.5 Completeness***

Completeness is the measure of the amount of valid data obtained from a measurement system relative to the amount of data scheduled for collection under correct, normal conditions. Completeness measures the effectiveness of the overall investigation in collecting the required samples, completing the required analyses, and producing valid results.

Contract laboratory data completeness is a quantitative measure of the percentage of valid data for all analytical data as determined by the precision, accuracy, and holding time criteria evaluation. Completeness will be calculated using the completeness equation by dividing the total number of valid data points by the total number of data points. The Contract Laboratory completeness goal for data collected under this QAPP is 95 percent.

If the 95 percent completeness goal is not met for field or laboratory data, the RAML Project Manager will be immediately notified. The determination regarding the need for corrective action will be based upon how critical the data are to the project objectives and will be made by the SENES and the RAML Project Managers in conjunction with federal and state regulatory agencies Project Manager.

### **B.3.3 Method Detection Limits, Reporting Limits, and Instrument Calibration Requirements**

#### ***B.3.3.1 Method Detection Limits***

The MDL is an empirically derived value that is used to estimate the lowest concentration a method can detect in a matrix-free environment. The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero.

The Contract Laboratory will at a minimum perform MDL studies during initial method setup, annually, or whenever the basic chemistry of a procedure is changed. The MDLs will be method specific and include any cleanup method used. The MDLs will be established for all target analytes in an interference-free matrix using the procedures in 40 Code of Federal Regulations (CFR), Part 136, Appendix B, or an equivalent statistical approach. To ensure that the valid MDL values are determined, the laboratory will analyze an MDL check sample by spiking an interference-free matrix with all target analytes at approximately two times the calculated MDL. The MDL check sample will be taken through all the preparatory and determinative steps used to establish the calculated MDL values to verify a response is detected. If any of the target analytes are not detected, then the concentration will be increased in another MDL check sample, and the analysis repeated until the failed target analytes are detectable. The detectable target analyte concentrations will be used in lieu of the calculated MDL values to establish the lowest detected concentration for samples taken through all appropriate method\* procedures. The laboratory may demonstrate continued method detection capability by analyzing the check sample on a quarterly basis, in lieu of the annual MDL study. When multiple instruments or confirmation columns are used for the same method, separate MDL studies may be replaced by the analysis of an MDL check sample on all instruments/columns. The MDL check sample will be analyzed after major instrument maintenance or changes in instrumentation or instrumental conditions to verify the current sensitivity of the method.

#### ***B.3.3.2 Reporting Limits***

The RL is the lowest concentration that can be reliably achieved within limits of precision and accuracy during routine operating conditions and is based on the MDL for each analyte. The RL is established at a factor of five to ten times the MDL, but no lower than three times the MDL for any target analyte. For example RLs for the analytical methods included in this QAPP are presented in Attachment 2. The laboratory-specific RLs for each method included in this QAPP will be back checked against the project objectives to ensure that data usability goals are met. Data reporting requirements are described in Sections B7.0 and B9.0 of the QAPP.

### **B.3.4 Instrument Calibration**

The following sub-section describes the procedures that will be used for instrument calibration by the Contract Laboratory. The procedures that will be followed for field meter or instrument calibration are detailed in the Work Plan. Analytical quality control requirements, evaluation criteria, acceptance criteria, preventative maintenance, and corrective actions are discussed later in this QAPP.

#### ***B.3.4.1 Contract Laboratory Instrument Calibration Procedures***

Instrument calibration is necessary to ensure that the analytical system is operating correctly and functioning at the proper sensitivity to meet the required RLs. Calibration establishes the dynamic range of an instrument, establishes response factors to be used to quantify results, and demonstrates instrument sensitivity. Criteria for calibration are specific to the instrument and the analytical method. The following paragraphs describe procedures that will be followed by the Contract Laboratory for instrument calibration.

Standard/Reagent Preparation. All instruments will be calibrated in accordance with the Contract Laboratory's SOPs. To ensure the highest quality standard, primary reference standards will be used by the Contract Laboratory and will be obtained from the National Institute of Standards and Technology (NIST), EPA Cooperative Research and Development Agreement (CRADA) vendors, American Association of Laboratory Accreditation (AALA) vendors, or other reliable commercial sources. When standards are received at the Contract Laboratory, the date received, supplier, lot number, purity, concentration, and expiration date will be recorded in a standards logbook. Vendor certifications for the standards will be retained in the files and made available upon request. Standards will be obtained in their pure form or in a stock or working standard. Dilutions will be made from the vendor standards. All records regarding standards will unambiguously trace their preparation, use in calibration, expiration dates, and quantification of sample results. All standards will be given a standard identification number, and the following information recorded in the appropriate file (standards logbook): source of standard, the initial concentration of the standard, the final concentration of the standard, the volume of the standard that was diluted, the solvent and the source and lot number of the solvent used for standard preparation, the expiration date of the standard, and the preparer's initials. All standards will be verified prior to use.

After preparation and before routine use, the identity and concentration of the standards will be verified. Verification procedures include verification of the standard's concentration by comparing its response to a standard of the same analyte prepared or obtained from a different source. Reagent purity will be assessed by analyzing an aliquot of the reagent lot using the analytical method in which it will be used; for example, every lot of laboratory grade water is

analyzed for undesirable contaminants prior to use in the laboratory. Standards will be routinely checked for signs of deterioration (e.g., discoloration, formation of precipitates, and changes in concentration), and will be discarded if deterioration is suspected or the expiration date has passed. Expiration dates will be taken from the vendor recommendation, the analytical methods, or from internal research.

Instrument Calibration. Criteria for calibration are specific to the instrument and the analytical method. Each instrument will be calibrated according to the analytical methods following manufacturer's guidelines and using standard solutions appropriate to the type of instrument and the linear range established for the method. All reported analytes will be present in both initial and continuing calibrations, which must meet the acceptance criteria specified in the analytical method. The instrument calibration will be from lowest to the highest calibration standard and the lowest calibration standard concentration will be at the RL for each target analyte.

Multipoint calibrations will contain the minimum number of calibration points specified in the method with all points used for the calibration being contiguous. If more than the minimum number of standards is analyzed for the initial calibration, all of the standards analyzed will be included in the initial calibration. The only exception is the dropping of a standard from the calibration that has been statistically determined as an outlier, providing that the requirement for the minimum number and RL standard criteria are met.

All instrument calibration information will be documented, and at a minimum include the equipment to be calibrated, the reference standards used for calibration, the calibration techniques, actions, acceptable performance tolerances, frequency of calibration, and calibration documentation format. The Contract Laboratory will maintain records of standard preparation and instrument calibration. Calibration records will include daily checks using standards prepared independently of the calibration standards, and instrument response will be evaluated against established criteria. The analysis logbook, maintained for each analytical instrument, will include at a minimum the date and time of calibration, the initials of the person performing instrument calibration, and the calibrator reference number and concentration.

### **B.3.5 Contract Laboratory Batch Quality Control Logic**

The frequency of instrument calibration and QC sample analysis for the analytical methods are batch controlled. All sample data for this project will be associated with sample batch QC samples that were extracted or prepared concurrently with the site samples and analyzed in the same analytical batch (analyzed on the same instrument relative to the primary sample results). The identity of each preparation or analytical batch will be unambiguously reported with the analyses so that a reviewer can identify the QC samples and the associated environmental samples. The following paragraphs define sample and instrument batches.

**Sample Batch.** For this project, a sample batch is a group of twenty or less environmental samples of the same matrix which are extracted or prepared within the same time period (concurrently) or in limited continuous sequential time periods with the same lot of reagents. Keeping batches "open" for more than two hours will not be accepted; samples and their associated QC samples (method blank, LCS, MD, and MS/MSD) will be prepared in a continuous process. The sample batch will be analyzed sequentially on a single instrument (as practicable).

**Analytical Batch.** The analytical batch is a group of 20 or less environmental samples that are analyzed together within the same analytical run sequence as defined by the method calibration criteria or in continuous sequential time periods. Samples in each batch will be of similar matrix, will be treated in a similar manner, and will use the same reagents.

### **B.3.6 Elements of Quality Control**

The quality control parameters and samples that will be used to evaluate analytical data in terms of the PARCC criteria are described in this section. These include QC samples prepared both in the field and by the Contract Laboratory. Method specific quality control procedures, frequency of QC sample analysis, acceptance criteria (control limits), and corrective action procedures are included in Attachment 2.

#### ***B.3.6.1 Field Elements of Quality Control***

For field sampling, quality control samples are used to assess sample collection techniques and to assess environmental conditions during sample collection and transport. For this project, field QC samples will include temperature blanks and field replicate samples (samples that are submitted blind to the laboratory).

**Temperature Blanks and Cooler Temperature:** Temperature blanks will be used to evaluate the internal temperature of the cooler and assess whether the sample temperature criterion of 4°C + 2 degrees Celsius (°C) was met during sample shipment when applicable. The temperature of the blank is measured at the time the samples are received by the Contract Laboratory and recorded on the C-O-C. Temperatures that exceed the temperature criterion indicate that the samples may not have been handled or transported properly.

**Trip Blanks:** Trip blanks will be analyzed for VOCs to detect any potential cross-contamination of samples that may occur from sample containers, during sample transit to the laboratory, or during sample storage at the laboratory. Trip blanks will be prepared by the laboratory and consist of 40 milliliter (ml) amber glass vials filled with acidified reagent-grade water and then sealed with a cap with a Teflon™ septum. The trip blanks samples will accompany the empty

sample bottles from the laboratory to the Site. One set of trip blank samples will be placed in the sample cooler at the start of each day of sampling and remain in the cooler throughout the day. The trip blanks will then be shipped with the samples to the laboratory. Trip blanks will not be submitted with soil samples.

**Equipment Rinseate Blank Samples:** Equipment rinseate blank samples will be used to evaluate representativeness and will be prepared in the field (after decontamination of sampling equipment is complete) by collecting the final rinse water into the appropriate sample container. Equipment rinseate blanks will be collected on a daily basis for groundwater or surface water samples when non-dedicated equipment is used for sampling.

**Field Replicate Samples:** Field replicate samples are soil samples that are submitted blind to the Contract Laboratory to assess variability in the sample media and to assess sampling and analytical precision. A field replicate sample is a single grab sample that is replicated into two samples during collection. For each field replicate sample pair, one of the samples is labeled with the correct sample identification and the other is labeled with fictitious sample identification. This replicate sample pair is then submitted to the same Contract Laboratory as two separate samples. Precision will be evaluated by calculating the RPD between the field replicate sample pairs for all analytes detected at or above the RL. RPD calculations will not be performed when either one or both of the sample results for the field replicate sample pairs are reported as less than the RL.

Although the RPD will be calculated between field replicate samples, the results will not be used as a basis for qualifying data or accepting or rejecting data. The RPD and actual results will be evaluated qualitatively to assess precision of field sample collection procedures. An RPD within  $\pm 30$  percent will be used as an indication of good agreement between the parent and replicate sample results and that good field procedures were followed.

### ***B.3.6.2 Contract Laboratory Elements of Quality Control***

The Contract Laboratory will, as a minimum, analyze internal QC samples at the frequency specified by the analytical method and in this QAPP. Method-specific quality control procedures, frequency of QC sample analysis, acceptance criteria (control limits), and corrective actions are provided in Attachment 2. The following paragraphs discuss holding time and the QC samples that will be used to assess laboratory data quality.

**Sample Holding Time:** Sample holding time reflects the length of time that a sample or sample extract remains representative of environmental conditions. For methods that do not require sample extraction one holding time will be evaluated, the length of time from sample collection to analysis. For methods that require sample extraction prior to analysis two holding times will

be evaluated; the length of time from sample collection until sample extraction, and the length of time from sample extraction to sample analysis. These holding times will be compared to the holding times specified by the respective analytical method. The holding times for each analytical method included in this QAPP are listed in Attachment 1. Samples will not be analyzed outside of the specified method holding times without approval by the SENES Project Manager.

**Method Blanks:** Method blanks will be used to monitor the Contract Laboratory preparation and analytical systems for interferences and contamination from glassware, reagents, sample manipulations, and the general laboratory environment. The method blank is an analyte-free matrix (reagent grade water or laboratory grade sand) to which all reagents will be added in the same volumes or proportions as used in sample processing. Method blanks will be taken through the entire sample preparation/extraction and analytical process. Method blanks will be prepared and analyzed with each analytical or preparation batch of environmental samples up to a maximum of 20 samples of a similar matrix. No analytical data will be corrected for the presence of analytes in blanks.

Internal Standards. Internal standards are compounds that behave similarly to the target analytes during analysis and will be used to assess accuracy for gas chromatography/mass spectroscopy (GC/MS) analysis. Internal standards will be prepared and added to the initial calibration standard (ICAL), the continuing calibration verification standard (CVS), and all samples (field and QC) prior to analysis. Internal standard data will be reviewed for compliance with the analytical method acceptance criteria.

Surrogate Spikes. Surrogate spikes will be used to evaluate the accuracy of analytical instrument performance for all organic analysis. Surrogate spikes will be added to each sample for organic compound analysis, including QC samples, prior to extraction as specified in the laboratory's standard operating procedure (SOP). The percent recovery of each surrogate spike will be calculated and compared to the project acceptance criteria (Attachment 2).

Initial and Continuing Calibration Blanks. Initial and continuing calibration blank (ICB/CCB) samples are analyzed with each sample batch with method SW-846 6020 (ICP) to determine whether metals are introduced into samples during preparation by the laboratory. The same criteria that used to evaluate method are used to evaluate the ICB/CCB and associated sample data.

Laboratory Control Samples. Laboratory control samples will be used to measure laboratory accuracy in the absence of matrix interference. Laboratory control samples are prepared in the laboratory and consist of samples of a known matrix (reagent grade water or laboratory grade sand) spiked with a known quantity of specific target analytes at a level less than or equal to the

midpoint of the calibration curve for each analyte. The midpoint is defined as the median point in the curve, not the middle of the range. These samples are taken through the entire sample preparation and analytical process. LCSs will be prepared and analyzed with each analytical or preparation batch of environmental samples up to a maximum of 20 samples of a similar matrix. If more than one LCS is analyzed in an analytical batch, results from all LCSs analyzed will be reported.

Matrix Spikes and Matrix Spike Duplicates. Matrix spikes measure matrix-specific method performance and will be used to assess accuracy and precision. Unlike LCSs, MS/MSD samples will be used to assess the influence of the sample media (media interference) on sample analysis. Samples for MS/MSD analysis will be collected from each sampling location and will be media specific (e.g., sediment, sludge, and groundwater). A minimum of one MS/MSD sample pair will be analyzed with every batch of RAML samples in a sample delivery group of up to 20 field samples. Each MS/MSD sample will be spiked with the compounds specified by this QAPP prior to sample extraction or analysis at a concentration less than or equal to the midpoint of the calibration curve for each analyte. The samples scheduled for MS/MSD analyses will be designated on the C-O-C form.

Matrix Duplicate Samples. Matrix duplicate samples are identical to field replicates, except that the duplicate sample does not have a false identification. Precision will be evaluated by calculating the RPD between the MD and parent sample pairs for all analytes detected at or above the RL. RPD calculations will not be performed when either one or both results is less than the RL.

Interference Check Sample. The interference check sample (ICS), used in inductively coupled plasma (ICP) analyses only, contains both interfering and analyte elements of known concentrations and is analyzed at the beginning and end of each run sequence. The ICS is used to verify background and interelement correction factors.

Serial Dilution. Serial dilutions are conducted for metals analysis to assess positive or negative interferences when the concentration of a metal detected in a sample is ten times greater than the instrument detection limit (after sample dilution). A five-fold dilution of the sample is analyzed and compared to the results of the original analysis. If the difference between the original and diluted sample results is greater than 10 percent, a chemical or physical interference is suspected.

Field Replicates. As discussed previously, field replicates will be used to assess both sampling and analytical precision. The purpose of submitting samples "blind" to the Contract Laboratory is to assess the consistency or precision of the laboratory's analytical system. Precision will be evaluated by calculating the RPD between the parent and field replicate samples.

As discussed previously, although the RPD will be calculated between field replicate samples, the results will not be used as a basis for qualifying data or accepting or rejecting data. The RPD and actual results will be evaluated qualitatively as additional evidence to support data comparability and quality. An RPD within + 30 will be used as an indication of good agreement between the parent and duplicate sample results and that good laboratory procedures were followed.

#### **B.4.0 SAMPLING PROCEDURES**

##### **B.4.1 Sample Collection Procedures**

The sample collection procedures are defined in Appendix A of the Work Plan.

#### **B.5.0 SAMPLE CUSTODY AND SHIPPING**

To ensure that samples are identified correctly and remain representative of the environment, the sample documentation and custody procedures outlined in this section will be used during the sampling program to maintain and document sample integrity during collection, transportation, storage, and analysis. Field sampling personnel will be responsible for ensuring that proper documentation and custody procedures are initiated at the time of sample collection, and that individual samples can be tracked from the time of sample collection until custody of the samples is transferred to the Contract Laboratory. The Contract Laboratory will be responsible for maintaining sample custody and documentation from the time the laboratory receives the samples until final sample disposition.

##### **B.5.1 Chain-of-Custody**

C-O-C procedures provide an accurate written record of the possession of each sample from the time it is collected in the field through laboratory analysis. A sample is considered in custody if one of the following applies:

- It is in an authorized person's immediate possession.
- It is in view of an authorized person after being in physical possession.
- It is in a secure area after having been in an authorized person's physical possession.
- It is in a designated secure area, restricted to authorized personnel only.

##### ***B.5.1.1 Contract Laboratory Chain-of-Custody Procedures***

Upon receipt by the Contract Laboratory, the integrity of the shipping container will be checked by verifying that the custody seals are not broken. The cooler will be opened and examined for

evidence of proper cooling and the presence of temperature blanks when applicable. The individual sample containers will be checked for breakage, damage, or leakage. The contents of the shipping container will then be verified against the C-O-C. If any problems are found, they will be documented on the sample custody form(s) and the SENES Project Manager will be notified immediately. The shipping receipts will be placed with the C-O-C records and stored in the project files.

If the samples and documentation are acceptable, each sample container will be assigned a unique laboratory identification number and entered into the laboratory's sample tracking system. Sample tracking will be documented in the LIMS, or other appropriate tracking system. Other information that will be recorded includes date and time of sampling, sample description, due dates, and required analytical tests.

The Contract Laboratory will follow their SOPs for sample log-in, storage, tracking, and control (Attachment 2). Sample custody will be maintained within the laboratory's secure facility until the samples are disposed. The Contract Laboratory will be responsible for sample disposal, which will be conducted in accordance with all applicable local, state, and federal regulations. All sample disposals will be documented and the records maintained by the Contract Laboratory in the project file.

### **B.5.2 Sample Packaging and Shipping Procedures**

All samples will be shipped in accordance with all applicable State and Federal Department of Transportation (DOT) requirements. The following paragraphs describe general sample packaging requirements.

All samples will be packaged and shipped to Fort Collins, Colorado within two business days of sample collection via a commercial carrier according to SOP [6](#) "Sample Handling and Shipping" and by using the following procedures:

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- Sample labels will be completed and attached to sample containers.
- The samples will be placed upright in a waterproof metal or equivalent strength plastic ice chest or cooler.
- Wet ice in double Ziploc™ bags (to prevent leakage) will be placed around, among, and on top of the sample bottles when applicable. Enough ice will be used so that the samples will be chilled and maintained at  $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$  during transport to the laboratory.
- To prevent the sample containers from shifting inside the cooler, the remaining space in cooler will be filled with inert cushioning material, such as shipping peanuts, additional bubble pack, or cardboard dividers.
- The original copy of the completed C-O-C Form will be placed in a waterproof plastic bag and taped to the inside of the cooler lid.

- The lid will be secured by wrapping strapping tape completely around the cooler in two locations.
- "This Side Up" labels will be placed on two sides of the cooler.
- Custody seals will be placed in two locations (the front right and back left of the cooler) across the cooler closure to ensure that any tampering is detected. The date and initials of the sampler will be written on the custody seal.
- A copy of the C-O-C record and the signed air bill will be retained for the project files.
- The samples will be shipped priority to:

ALS Laboratory Group / 225 Commerce Drive / Fort Collins, CO 80524  
ph: (970) 490-1511 / toll free (800) 443-1511 / fax: (970) 490-1522

### **B.5.3 Final Project Files Custody Procedures**

The final project files will be maintained by SENES and will be under the custody of the Project Manager in a secured area. At a minimum, the project file will contain all relevant records including:

- Field logbooks
- Field data and data deliverables
- Photographs
- All original field logs
- Clean container certifications from laboratory.
- Contract Laboratory data deliverables.
- Data verification reports.
- Data assessment reports.
- Progress reports, QA reports, interim study reports, etc
- All custody documentation (tags, forms, airbills, etc.).

### **B.6.0 ANALYTICAL PROCEDURES**

This section describes the analytical procedures that will be used for the acquisition of chemical data and includes the relevant aspects of field and Contract Laboratory procedures (sample preparation and extraction procedures, and instrumentation). Analytical quality control requirements, evaluation criteria, acceptance criteria, calibration procedures, preventative maintenance, and corrective actions are discussed in following sections.

## **B.6.1 Contract Laboratory Analytical Procedures**

### ***B.6.1.1 Analytical Methodology***

The specific analytical methods for this project are from the following:

- EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846; U.S. EPA Third Edition, Final Update III, December 1996).
- EPA 100-400 - Series Methods for the Determination of Inorganic Substances in Environmental Samples (U.S. EPA/600R-93-100, August, 1999a).
- Prescribed Procedures for Measurement of Radioactivity in Drinking Water (U.S. EPA/600/4-80-032, August, 1980)
- Methods of Soil Analysis (American Society of Agronomy, 1982).
- United States department of Agriculture (USDA), Handbook No. 60, (USDA, 1954)

The analytical methods are briefly described in Attachment 1. All samples will be prepared and analyzed in accordance with this QAPP, the referenced analytical method, and in accordance with the Contract Laboratory's SOPs.

### ***B.6.1.2 Data Reporting Requirements***

The following criteria for reporting data will apply for all samples:

- MDLs and sample results will be reported to one decimal place more than the corresponding RL, unless the appropriate number of significant figures for the measurement dictates otherwise.
- All target compound non-detections will be reported (at a minimum) as less than the RL.
- If target analytes are detected at or above the RL, they will be reported as quantified.

Additional Reporting Requirements for Definitive Data. The Project Manager will be notified immediately regarding the failure of sample data to meet the RL to assess potential corrective action. The decision to implement corrective action will be based on whether there are any analytical alternatives or clean up steps that would improve the reporting limit and whether the elevated reporting limits will adversely affect data use. Any data that do not meet the MDLs or RLs due to sample dilution will be included in the case narrative and the supporting documentation (chromatograms) will be included in the data packages.

## **B.7.0 INTERNAL QUALITY CONTROL CHECKS**

Internal quality control checks are used to evaluate whether field measurements and sampling procedures and laboratory analytical method performance is within acceptable limits of precision and accuracy. The following sections describe the internal QC that will be followed for both field and Contract Laboratory activities.

### **B.7.1 Sample Collection**

The accuracy and precision of the field sampling procedures will be assessed as described in Section B3.0 of this QAPP. Sample representativeness will be assessed by the analysis of field replicate samples.

### **B.7.2 Contract Laboratory Analysis**

The general objectives of the internal Contract Laboratory QC program are to:

- Ensure that all procedures are documented, including any changes in administrative and/or technical procedures.
- Ensure that all analytical procedures are validated and conducted according to method guidelines and laboratory SOPs.
- Monitor the performance of the laboratory using a systematic inspection program.
- Ensure that all data are properly reported and archived.

The Contract Laboratory will conduct internal quality control checks for analytical methods in accordance with their SOPs, the individual method requirements, and this QAPP. The Contract Laboratory will notify the Project Manager in writing before making significant changes resulting from corrective actions to this QAPP or analytical methodology. The SENES Project Manager and the RAML Project Managers will be notified if the data impacts the task specific objectives.

Contract Laboratory quality control consists of two distinct components, a laboratory component and a matrix component. The laboratory component measures the performance of the laboratory analytical process during sample analyses, while the matrix component measures the effects of a specific media on the method performance. The QC samples that will be used to assess the laboratory component and the media component of analysis are described Section B3.0 of this QAPP. The criteria against which the QC data will be evaluated are listed in Attachment 2. Corrective actions for instrument calibrations or QC sample data out of compliance are listed in the corrective action summary tables included in Attachment 2.

## **B.8.0 DATA REDUCTION, REVIEW, REPORTING, VERIFICATION, VALIDATION, AND RECORD-KEEPING**

The data reduction, review, reporting, verification, and validation procedures are described in this section to ensure that; (1) complete documentation is maintained, (2) transcription and data reduction errors are minimized, (3) the data are reviewed and documented, and (4) the reported results are qualified if necessary. Laboratory data reduction and verification procedures are required to ensure the overall objectives of analysis and reporting meet method and project specifications.

### **B.8.1 Data Reduction**

#### ***B.8.1.1 Contract Laboratory Data Reduction***

The Contract Laboratory will reduce all analytical data (both screening and definitive) in accordance with the analytical methods and the guidance presented in Sections B3.0 of this QAPP. Refer to Section B3.0 of this QAPP for equations that will be used by the Contract Laboratory to assess precision and accuracy, and refer to Section B3.0 and Attachment 2 regarding instrument calibration and target analyte quantitation.

### **B.8.2 Data Review**

#### ***B.8.2.1 Contract Laboratory Data Review***

Prior to the release of data to SENES, the Contract Laboratory will perform in-house data review under the direction of the Contract Laboratory Project Manager and/or the laboratory QAO and will prepare and retain full analytical and QC documentation. In general, the Contract Laboratory data review will be conducted as described in the following paragraphs.

The bench analyst will conduct the initial data review based on established protocols specified in laboratory SOPs and analytical method and this QAPP. At a minimum, this review will include the following:

- An assessment of sample preparation procedures and documentation for accuracy and completeness.
- An assessment of sample analysis procedures and documentation for accuracy and completeness.
- Assessments of whether the appropriate SOPs were followed.
- Assessment analytical results for accuracy and completeness.
- An assessment of whether QC samples are within established control limits and method blank data are acceptable.

- An assessment of whether documentation is complete (e.g., all anomalies in the preparation and analysis have been documented, out-of-control forms, if required, are complete, holding times are documented, etc.).

The calculations that will be used to evaluate precision and accuracy are defined in Section B3.0 of this QAPP. The acceptance criteria for calibration, precision, and accuracy assessment and the corrective action summaries are provided in Attachment 2.

When an analysis of a QC sample (blank, spike, or similar sample) indicates that the analysis of that batch of samples is not in control, the analyst will immediately bring the matter to the attention of the appropriate designated Contract Laboratory QC staff (QAO, Project Manager, Section Leader, etc.). This individual will determine whether the analysis can proceed, or if selected samples should be rerun, or specific corrective action needs to be taken before analyzing additional samples. Out-of-control analyses and information justifying accuracy or precision outside acceptance criteria will be documented. A Nonconformance Report will be prepared for all Contract Laboratory analysis out of control events that require documentation. The SENES Project Manager will be notified as soon as feasibly possible to determine the appropriate corrective action for out-of-control events resulting in unacceptable data.

After this review is complete, the analyst will sign the applicable control documentation associated with the analytical batch and forward to the appropriate reviewer. This reviewer (department manager, QAO, etc.) will be responsible for review and approval of the analytical control documentation associated with each analytical batch, as well as any corrective action explanations provided by the analyst. This individual will also be responsible for determining whether the analytical data meet quality control criteria established by the analytical methods and by this QAPP and for identifying QC problems that require further resolution. A permanent record of any corrective actions will be maintained in the Contract Laboratory files.

The Contract Laboratory Project Manager will provide the final review and approval of the analytical data that have been approved by the analyst and other designated reviewer. The Contract Laboratory Project Manager will also be responsible for reviewing all final data reports for proper format and reporting consistency prior to release of the reports to the SENES. This review will include the following as a minimum:

- Contract Laboratory name and address.
- Sample information (includes unique sample identification, sample collection date and time, date of sample receipt, and date(s) of sample preparation and analysis).
- Analytical results reported with an appropriate number of significant figures.
- Reporting limits reflecting dilutions, interferences, and corrections for dry weight as applicable.

- Method references.
- Appropriate QC results and correlations for sample batch traceability and documentation.
- Data qualifiers with appropriate references and narrative on the quality of results. Confirmation that QAPP requirements have been met.

The Contract Laboratory Project Manager and/or QAO will also be responsible for qualifying any data that may be unreliable. Data qualifications will be based on the analytical method, and this QAPP.

### **B.8.3 Data Reporting**

#### ***B.8.3.1 Contract Laboratory Data***

The Contract Laboratory will provide an electronic deliverable report in a format as specified by SENES. The Contract Laboratory will provide the electronic deliverable via electronic mail or compact disk.

### **B.8.4 Data Management**

The individuals responsible for data management for this project include all personnel responsible for identifying, reporting, and documenting activities affecting data quality. In general, the qualifications of the individuals associated with data management activities will be commensurate with the level of expertise necessary to ensure the intended level of evaluation.

All project files will provide a traceable record for all data management activities. The Contract Laboratory will maintain a project file that includes but is not limited to the following; formulas used for data reduction, computer programs, which data transfers are electronic or manual, data review protocol, raw data files, etc. All data acquired electronically will be transferred and manipulated electronically to reduce errors inherent in manual data manipulation. Data entered, transferred or calculated by hand will be spot checked for accuracy by someone who did not perform the original entries or calculations.

The Contract Laboratory will preserve all electronic and hardcopy records sufficient to recreate each analytical event conducted pursuant to this project. The minimum records the Contract Laboratory will keep include the following:

- C-O-C forms.
- Initial and continuing calibration records including standards preparation traceable to the original material and lot number.
- Instrument tuning records (as applicable).

- Method blank results
- Spike and spike duplicate records and results
- Laboratory records.
- Raw data, including instrument printouts.
- Bench work sheets, and/or chromatograms with compound identification and quantification reports.
- Corrective action reports.
- Other method and project required QC samples and results.
- Laboratory-specific written SOPs for each analytical method.
- QA/QC function in place at the time of analysis of project samples.

Computer acquired data will also be stored on magnetic tape, disks, or other media, that can be accessed using industry-standard hardware and software for data processing, retrieval, or reporting. The laboratory will maintain all data collected for this project sampling for a minimum of seven years following submission of the data reports.

### **B.9.0 PERFORMANCE AND SYSTEM AUDITS**

Technical systems and performance audits will be performed as independent assessments of sample collection and analysis procedures. Audit results will be used to evaluate the ability of the Contract Laboratory to:

- (1) produce data that fulfill the objectives established for this project,
- (2) comply with the QC criteria presented in this QAPP, and
- (3) identify any areas requiring corrective action.

The systems audit is a qualitative review of the overall sampling or measurement system, while the performance audit is a quantitative assessment of a measurement system, and includes both internal and external audits. SENES personnel will conduct internal audits. External audits are the responsibility of federal and state regulatory agencies. Definitive data verification and validation is also a quantitative check of the analytical process, where documentation and calculations are evaluated and verified.

### **B.9.1 Laboratory Performance and Systems Audits**

In-house and regulatory agency audits of laboratory systems and performance will be a regular part of the laboratory's QA program. Internal audits will be conducted by the laboratory's QAO or designee, and consist of a review of the entire laboratory system and at a minimum include: examination of sample receiving, log-in, storage, and chain-of-custody documentation

procedures; sample preparation and analysis; and instrumentation procedures.

An internal audit of the laboratory may be performed by SENES, at the discretion of the RAML Representative, within six months of field investigation start up and will include a review of the following items:

- Sample custody procedures.
- Calibration procedures and documentation.
- Completeness of data forms, notebooks, and other reporting requirements.
- Data review and verification procedures.
- Data storage, filing, and record keeping procedures.
- QC procedures, tolerances, and documentation
- Operating conditions of facilities and equipment
- Documentation of training and maintenance activities.
- Systems and operations overview.
- Security of laboratory automated systems.

Electronic audits involve the examination of the electronic media used by the Contract Laboratory to collect, analyze, report, and store data. These audits are used to assess the authenticity of the data generated, and assess the implementation of good automated laboratory practices. The SENES Project Manager may perform electronic audits of the Contract Laboratory if warranted by on-site audit results.

SENES will forward audit results to appropriate management and the RAML Representative. Deficiencies and corrective action procedures will be clearly documented in the audit report.

External field audits are the responsibility of the federal and state regulatory agencies. Field audits will be conducted at any time during the field operations and will be based upon the information presented in the Work Plan and this QAPP. The audits may or may not be announced, at the discretion of the auditing agency.

#### **B.10.0 PREVENTIVE MAINTENANCE PROCEDURES**

A preventive maintenance program will be in place to promote the timely and effective completion of a measurement effort. The preventive maintenance program is designed to minimize the downtime of crucial sampling and/or analytical equipment due to unexpected component failure. In implementing this program, efforts will be focused in three primary areas: (1) establishment of maintenance responsibilities, (2) establishment of maintenance schedules for major and/or critical instrumentation and apparatus, and (3) establishment of an adequate inventory of critical spare parts and equipment.

### **B.10.1 Contract Laboratory Equipment**

Preventive maintenance of all laboratory equipment and instruments is essential to ensure the quality of the analytical data produced. The objective of preventive maintenance is to ensure instrument operation is appropriate for both task-specific and method objectives. The Contract Laboratory has a routine preventive maintenance program to minimize the occurrence of instrument failure and other system malfunctions and will have designated individuals who perform routine scheduled maintenance for each instrument system and required support activity. The following paragraphs focus on maintenance responsibilities, maintenance schedules, record keeping, and inventory of spare parts and equipment.

Maintenance Responsibilities. Maintenance responsibilities for Contract Laboratory equipment will be assigned to designated personnel. These individuals establish maintenance procedures and schedules for each major equipment item. The instrument manufacturer service engineers will perform instrument maintenance and repair, as scheduled/needed. The analysts will perform other routine preventive maintenance tasks. Only qualified individuals will perform any maintenance activities.

Maintenance Schedules. Maintenance schedules are based on the manufacturers' recommendations and/or sample load. Maintenance activities for each instrument will be documented in a maintenance logbook, as described below.

Record Keeping. All instrument maintenance will be documented in instrument-specific bound logbooks, which are kept with the instrument. The date, initials of the individual performing the maintenance and the type of maintenance will be recorded in this logbook. Receipts from routine maintenance performed by the manufacturer's representative will be filed in the appropriate laboratory department (e.g., ion chromatograph maintenance receipts are stored in the organic section). This logbook will serve as a permanent record that documents any routine preventive maintenance performed, as well as any service performed by external individuals such as manufacturers' service representatives. In addition, all receipts from routine maintenance performed by manufacturers' representatives will be maintained in the laboratory's file. These records will be made available upon request during external audits.

Spare Parts. An adequate inventory of spare parts is maintained to minimize equipment down time. This inventory will include those parts (and supplies) which are subject to frequent failure, have limited useful lifetimes, or cannot be obtained in a timely manner.

Contingency Plan. In the event of instrument failure, every effort will be made to analyze samples by an equivalent alternate means within holding times. If the redundancy in equivalent instrumentation is insufficient to handle the affected samples, SENES will be immediately notified and the corrective action to be taken will be determined by the SENES Project Manager and RAML Project Manager (as applicable).

## **B.11.0 CORRECTIVE ACTIONS**

### **B.11.1 Corrective Action Requirements**

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out of control performance that may affect data quality. All proposed and implemented corrective action will be documented in the regular quality assurance reports to the appropriate project management as defined in Section 2.0 of this QAPP. The SENES Project Manager or designee will implement corrective action only after approval. If immediate corrective action is required, approvals secured by telephone from the RAML Project Manager will be documented in an additional memorandum.

For each incidence of noncompliance, a formal corrective action program will be established and implemented at the time the problem is identified. The individual who identifies the problem will be responsible for notifying the SENES Project Manager, who in turn will notify other applicable personnel. Implementation of corrective action will be confirmed in writing as described previously.

Any nonconformance with the established QC procedures specified in the Work Plan or this QAPP will be identified and corrected in accordance with the QAPP. Corrective actions will be implemented and documented in the field logbook. No staff member will initiate corrective action without prior communication of findings through the proper channels.

#### ***B.11.1.1 Contract Laboratory Corrective Action***

Corrective actions are required whenever unreliable analytical results prevent the quality control criteria from being met, as specified by the analytical method; the Contract Laboratory's SOPs, or this QAPP. The corrective action taken depends on the analysis and the nonconformance. A summary of corrective actions that will be undertaken for problems associated with specific laboratory analyses is provided in Attachment 2 of this QAPP.

Corrective action will be undertaken if one of the following occurs:

- Blanks consistently contain target analytes above acceptance levels.
- Undesirable trends are detected in spike recoveries, spike recoveries are outside the QC limits, or RPDs between duplicate analyses are consistently outside QC limits.
- There are unusual changes in RLs.
- Deficiencies are detected during QA audits.
- Inquiries concerning data quality are received from the SENES Project Manager.

The analyst who reviews the sample preparation or extraction procedures, and performs the instrument calibration and analysis will handle corrective actions at the bench level (primarily). If the problem persists or its cause cannot be identified, the matter will be referred to the department supervisor or QA department for further investigation. Once resolved, full documentation of the corrective action procedure will be filed with the appropriate Contract Laboratory QA department. A summary of the corrective actions will be included in the data reports.

#### ***B.11.1.2 Data Verification Corrective Actions***

Corrective action may be initiated during data verification or data assessment. Potential types of corrective action include resampling by the field team or reanalysis of samples by the Contract Laboratory.

Corrective actions that will be taken are dependent upon the ability to mobilize the field team, how critical the data are to the task-specific objectives, and whether the samples are still within holding time criteria. When a corrective action situation is identified by the SENES Health Physicist, the SENES Project Manager will have responsibility for authorizing the implementation of the corrective action, including resampling and documenting the corrective action and notifying the RAML Project Manager for authorization.

#### **B.11.2 Corrective Action System**

A system for issuing, tracking, and documenting completion of formal Recommendations for Corrective Action (RCA) exists for addressing significant and systematic problems. Recommendations for corrective actions are issued only by a member of the QA group, or a designee in a specific QA role. Each RCA addresses a specific problem or deficiency, usually identified during QA audits of Contract Laboratory or project operations. An RCA requires a written response from the party to whom the RCA was issued. A summary of unresolved RCAs is included in the monthly QA report to management. The report lists all RCAs that have been issued, the manager responsible for the work area, and the current status of each RCA. An RCA requires verification by the QA group that the corrective action has been implemented before the RCA is considered to be resolved. In the event there is no response to an RCA within 30 days, or if the proposed corrective action is disputed, the recommendation and/or conflict is pursued to successively higher management levels until the issue is resolved.

### **B.12.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT**

Deliverables associated with this project will contain separate QA sections in which data quality information collected during specific tasks is summarized. Deliverables include reports that summarize the sampling program findings. Submission of these reports is the responsibility of the SENES Project Manager. Quality assurance sections will identify all QA samples collected and the corresponding primary samples and will report accuracy, precision, and completeness of the data as well as the results of the performance and system audits, and any corrective action needed or taken during the project.

### **B.13.0 DATA MANAGEMENT**

Data management will be achieved using a standard relational database format. Database fields will encompass standard sample and analytical information, including:

- Sample identifications;
- Matrices;
- Analytical methods;
- Dates & times;
- Chain-of-custody information;
- Analytical results;
- Detection limits and reporting limits;
- Quality control results;
- Coordinate information.

Horizontal coordinate information will be referenced to the State Plane Coordinate System, New Mexico West, North American Datum of 1983. Vertical coordinates will be referenced to the North American Vertical Datum of 1988.

The database will serve as a central repository for data from many different project tasks. It is one foundation for making project decisions. Making sure the data are technically accurate, complete and correctly represented in the database is referred to as "data integrity." Project staff will assume that data within the database are correct and ready to use in analyses, reports, graphics, geographic information system (GIS), modeling and for other purposes. Therefore, the Database Manager will ensure that the following tasks have been applied to all data in the database:

- Data will be received from the laboratory using an electronic data deliverable (EDD) format compatible with the project database format;
- Data will be assembled and reviewed by the person compiling the data for completeness and technical accuracy;

- Data will have been validated using procedures presented in the QAPP; no draft or preliminary (i.e., unvalidated and unqualified) data will be put into the master database;
- Data will be transcribed accurately from any hard copies during data entry (100% error free transcription); and
- Data are converted and imported accurately from any electronic files (spreadsheets, ASCII files, and HDDs).

The Database Manager will also ensure that all data products (report summary tables, appendices, programs and files exported to other applications) represent the data in the database accurately.

#### **B.14.0 ASSESSMENT AND OVERSIGHT**

Program assessment and oversight will be performed by the Project Manager and/or designee and will include assessments and response actions, reports to management, as well as nonconformance and corrective action training. All personnel are responsible for ensuring that the program is implemented in accordance with this Work Plan and applicable professional standards. All personnel are also expected to stop and take appropriate action when it is determined that conditions adversely affecting the quality of the data have occurred (e.g., an instrument is not working properly). Work may be stopped to determine what further action is needed to meet the quality objectives of this study.

##### **B.14.1 Assessments and Response Actions**

Program assessment and oversight will include surveillance/audit of field sampling activities, the analytical program, and program records. Surveillance of sampling activities will focus on adherence to procedures outlined in this Work Plan and will include observation of sampling procedures and selected documentation (e.g., field logbooks).

Review of program records will include both sampling and laboratory records. Review of the laboratory data will serve as verification that the quality program as described in this Work Plan and the laboratory QAPP is being implemented, thus allowing for the collection of data that support the objectives.

##### **B.14.2 Nonconformance and Corrective Action**

All of the individuals involved in this program will follow a formalized process for documenting non-conformances. The nonconformance process consists of the following:

- Identification of the nonconformance;

- Determination of the immediate actions to be taken as a result of the nonconformance;
- Root cause analysis and identification of real root cause(s);
- Proposed action to prevent recurrence of the nonconformance and implementation of the correction; and
- Follow-up and verification of the effectiveness of the corrective action.

Any deviations from the specifications described in this Work Plan, field sampling protocols, held measurement SOPs, or laboratory quality system will be documented and addressed. A signed corrective action or field change request (see Appendix B) form will be submitted to the EPA for their approval prior to proceeding with the affected task. A prompt response from the EPA will be required to prevent delays in the execution of field activities. The form(s) will be forwarded to the RAML Project Manager and SENES Project Manager.

#### **B.14.3 Data Validation and Usability**

Data verification is used to ensure that the requirements stated in the planning documents are implemented as prescribed. Data validation is used to ensure that the results of the data collection activities support the objectives of the survey as documented in the QAPP, or permit a determination that these objectives should be modified. Data quality assessment is the scientific and statistical evaluation of data to determine if the data are of the right type, quality, and quantity to support their intended.

This plan specifies the QC checks that are to be performed during sample collection, handling, and analysis. These include calibration and analyses of check standards, blanks, spikes, and replicates, which provide indications of the quality of data being produced by specific steps of the measurement process. Data validation should document any corrective actions that were taken, which samples were affected, and the potential effect of the actions on the validity of the data. When issues are identified in the verification and validation process, the validator will make appropriate comments and/or assign data flags to alert the data user to potential limitations on the usability of the data.

#### **B.14.4 Reconciliation with User Requirements**

Data collected during the field activities will be reconciled with the requirements of the data user. There are five steps in the DQA Process:

1. Review the objectives and survey designs;
2. Conduct a preliminary data review;
3. Select the statistical test;
4. Verify the assumptions of the statistical test;
5. Draw conclusions from the data.

These five steps are presented in a linear sequence, but the DQA process is applied in an iterative fashion much like the DQO process. The strength of the DQA process is that it is designed to promote an understanding of how well the data will meet their intended use by progressing in a logical and efficient manner.

#### **B.15.0 REFERENCES**

American Society of Agronomy, 1982, Methods of Soil Analysis.

U.S. Environmental Protection Agency, 1986. EPA Test Methods for Evaluating Solid Waste. Physical/Chemical Methods (SW-846; U.S. EPA Third Edition, Final Update III, December 1996).

U.S. Environmental Protection Agency, 1999. EPA 100-400 - Series Methods for the Determination of Inorganic Substances in Environmental Samples. EPA/600R-93-100.

U.S. Environmental Protection Agency, 1980. Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA/600/4-80-032.

U.S. Environmental Protection Agency, 2000. Guidance for the Data Quality Objectives Process, EPA QA/G-4. EPA/600/R-96/055.

U.S. Environmental Protection Agency, 2001. EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, EPA QA/R-5.

United States department of Agriculture (USDA), 1954. Handbook No. 60.

**ATTACHMENT 1 TO APPENDIX B**

**Analytical Procedures**

**Appendix B, Attachment 1**

**Table B.1  
Quality Control Procedures  
Radionuclide and Total Metals Analyses**

Analyte	Analytical Method	Sample Container	Preservation	Holding Time	Unit of Measure	Reporting Limit	Method/ Analytical Procedure
Ra-226	EPA 901.1	Gallon ziploc bag	None	180 days	pCi/g	0.5	A homogeneous aliquot of sample is put into a standard geometry for gamma counting, and set aside for 21 day in-growth period. Samples are counted long enough to meet the required sensitivity of measurement.
Uranium	SW-846 6020A	1-8-oz glass wide-mouth jar with Teflon-lined cap	None	180 days	mg/kg	0.15	Metals in solution are analyzed using an ICP/Mass Spectrometer.
Th-230	ASTM 3972-90M	Gallon ziploc bag or 1-8 oz glass wide-mouth jar with Teflon-lined cap	None	180 days	pCi/g	0.1	A homogeneous aliquot of sample is put into a standard geometry for gamma counting. Samples are counted long enough to meet the sensitivity of measurement.
Stable Metals Arsenic	SW-846 6010	1-8-oz glass wide-mouth jar with Teflon-lined cap	None	180 days	ppb	1000.0	Metals in solution are analyzed using an ICP/Mass Spectrometer.
Stable Metals Molybdenum	SW-846 6010	1-8-oz glass wide-mouth jar with Teflon-lined cap	None	180 days	ppb	0.5	Metals in solution are analyzed using an ICP/Mass Spectrometer.
Stable Metals Selenium	SW-846 6010	1-8-oz glass wide-mouth jar with Teflon-lined cap	None	180 days	ppb	500.0	Metals in solution are analyzed using an ICP/Mass Spectrometer.

*Church Rock 1 and 1E Removal Site Evaluation Phase II Work Plan*

Analyte	Analytical Method	Sample Container	Preservation	Holding Time	Unit of Measure	Reporting Limit	Method/ Analytical Procedure
Stable Metals Vanadium	SW-846 6010	1-8-oz glass wide-mouth jar with Teflon-lined cap	None	180 days	ppb	1000.0	Metals in solution are analyzed using an ICP/Mass Spectrometer.
Volatile Organic Compounds	SW-846 8260B	2, 40 mL amber glass bottles with Teflon septum cap and no head space	HCl; pH < 2 Chill to 4°C	14 days	ppb	5.0	Volatile compounds are introduced onto a 30-meter capillary column in a gas chromatograph (GC), temperature programmed to separate the analytes, which are then detected with a mass spectrometer (MS) interfaced with the GC. Quantification is accomplished by comparing the response of a major ion relative to an internal standard using a 5-point calibration curve.
Semi-Volatile Organic Compounds	SW-846 8270C	1 L amber glass bottle with a Teflon Cap	Chill to 4°C	7 days collection to extraction, 40 days extraction to analysis	ppb	333.3333	Semi-volatile compounds are introduced onto a 30-meter capillary column in a gas chromatograph (GC), temperature programmed to separate the analytes, which are then detected with a mass spectrometer (MS) interfaced with the GC. Quantification is accomplished by comparing the response of a major ion relative to an internal standard using a 5-point calibration curve.
Petroleum Hydrocarbons	SW-846 8015M	1-4oz. glass jar-Teflon lined cap	Chill to 4°C	14 days	ppb	500	Determines the concentrations of various nonhalogenated volatile organic compounds and semivolatile organic compounds by gas chromatography.

References:

EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846), (U.S. EPA Third Edition, September 1986; Final Update III, December 1996).  
 EPA Methods for the Determination of Inorganic Substances in Environmental Samples (EPA 100-400 Series) (EPA/600R-93/100, August 1993).

Abbreviations:

SW = Solid Waste  
 EPA = Environmental Protection Agency  
 pCi/g = picocuries/gram  
 mg/kg = milligrams per kilogram  
 ICP = inductively coupled plasma  
 ppb= parts per billion

**Table B.2**  
**Quality Control Procedures**  
**Agronomic Sampling**

<b>Agronomic Analyses</b>	<b>Analytical Method</b>	<b>Method/ Analytical Procedure</b>
pH	ASA No.9 Method 10-3.2	A saturated paste is made by mixing the soil with water in a 1:1 ratio. pH is measured with a calibrated pH probe
Electrical Conductivity	ASA No. 9 Method 10-3.3	A saturated paste is made by mixing the soil with water in a 1:1 ratio. Electrical conductivity is measured using a calibrated conductivity meter.
Saturation Percentage	USDA Handbook 60, Method 27A	A portion of the saturated pastes is collected and dried at 105°C. The loss of water weight divided by the dry weight of the soil is expressed in percent
Texture	ASA No. 9, Method 15-5	Texture is determined by mixing a weighted portion of the sample with enough water to bring the volume to 1L. After mixing density is measured using a hydrometer at 7 timed intervals as the sample settles.
Rock Fragment Percentage	ASA No. 9, Method 15-5	A weighed amount of sample is sent through a series of sieves and percentage is determined by weighting the amount of samples left on each sieve.
Sodium Adsorption Ratio (SAR)	ASA No. 9, Method 10-3.4 / SW6010B	A saturated paste is made by mixing the soil with water in a 1:1 ratio. The liquid portion is then analyzed for potassium using ICP.
Nitrate	ASA No. 9, Method 33-3.1 / EPA 353.2	Nitrate is extracted from soil using a 2M potassium chloride solution. Extract is then analyzed for nitrate by colorimetry
Phosphorus	ASA No. 9, Method 24-5.1 / EPA 365.1	Phosphorus is extracted from soil using a solution consisting of 0.03 N ammonium fluoride and 0.025 N hydrochloric acid. The extract is analyzed for phosphorus by colorimetry.
Potassium	ASA No. 9, Method 13-3.5 / SW6010B	A saturated paste is made by mixing soil with water in a 1:1 ratio. The liquid portion is then analyzed for potassium using ICP
Chloride	ASA No. 9, Method 10-2.3.2 / EPA300	Chloride is extracted from soil using distilled water. Extract is analyzed for chloride by ion chromatography.
Sulfate	ASA No. 9, Method 28-5.1	Sulfate is extracted from soil using distilled water. Extract is analyzed for sulfate by ion chromatography.
Organic Carbon	ASA No. 9, Method 29.3.5.2	Walkley-Black was developed specifically for soils and consists of a wet oxidation method using potassium dichromate, which is back-titrated with iron <sup>+2</sup> This method targets organic matter in soil which is the primary source of organic carbon in soil.

**ATTACHMENT 2 TO APPENDIX B**

**Laboratory Quality Assurance Plan (LQAP)**

**ALS Laboratory Group, Environmental Division**

**APPENDIX C**

**STANDARD OPERATING PROCEDURES**

## **Phase II SOPs**

### **Provided Under Separate Cover as Volume 3**

- SOP 1 - Environmental Particulate Air Sampling
- SOP 2 - Gamma Ray Intensity to Ra-226 Soil Concentration Correlation
- SOP 3 - Field Gamma Radiation Surveys
- SOP 4 - Field Documentation for General and Soil Boring Activities
- SOP 5 - Equipment Decontamination
- SOP 6 - Sample Handling and Shipping
- SOP 7 - Surface and Shallow Subsurface Soil Sampling
- SOP 8 - Soil Sampling for Semi-Volatile and Volatile Organic  
Compound Analysis
- SOP 9 - Deep Subsurface Soil Sampling
- SOP 10 - Daily Operational Health Physics