Sampling and Analysis Plan for the Engineering Evaluation/Cost Analysis and Risk Assessment at the Ross-Adams Site, Tongass National Forest, Prince of Wales Island, Alaska

Revision 1

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ABBREVIATIONS

ADEC	Alaska Department of Environmental Conservation
ASAOC	Administrative Settlement Agreement and Order on Consent
BLM	U.S. Bureau of Land Management
BOM	U.S. Bureau of Mines
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chain of Custody
COPC	Contaminants of Potential Concern
CSM	Conceptual Site Model
DOT	Department of Transportation
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
ESI	Expanded Site Investigation
GW	Groundwater Samples
HDPE	High Density Polyethylene
HPIC	High Pressure Ion Chamber
IDW	Investigation Derived Wastes
KSI	Kent & Sullivan, Inc.
MS	Marine Sediment
NAD 83	Continental US 1983 Datum
NaI	Sodium Iodide
NELAP	National Environmental Laboratory Accreditation Program
PA/SI	Preliminary Assessment/Site Inspection
PARCC	Precision, Accuracy, Representativeness, Completeness and Comparability
POW	Prince of Wales
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
RAD	Radon Samples
REE	Rare Earth Elements
RPA	Removal Preliminary Assessment
SAP	Sampling Analysis Plan
SCR	Site Characterization Report
SOI	Soil Samples

SOP	Standard Operating Procedure
SOW	Statement of Work
SS	Stream Sediment Samples
SSHP	Site Safety and Health Plan
SW	Surface Water Samples
TAL	Target Analyte List
TNF	Tongass National Forest
Ucore	Ucore Uranium, Inc.
USDA	U.S. Department of Agriculture
USFS	U.S. Department of Agriculture Forest Service
XRF	X-ray fluorescence

1.0 INTRODUCTION

Tetra Tech developed this Sampling and Analysis Plan (SAP) for the Ross-Adams site (Site) Engineering Evaluation/Cost Analysis (EE/CA) project and associated risk assessment activities. The Ross-Adams site is a former uranium mine located in the Tongass National Forest (TNF) near the southern end of Prince of Wales Island (POW) approximately 38 miles southwest of Ketchikan, Alaska (Figure 1). The Site is located on the southeast flank of Bokan Mountain in the Kendrick Creek watershed (Figure 2). Major Site features are shown in Figure 2.

The purpose of this SAP is to assure that the applicable media are appropriately characterized to meet the project objectives (Section 3). Subsequent sections of this SAP describe the number, type and location of the samples to be collected, and the laboratory analyses planned to meet the requirements of the Statement of Work (SOW) (Appendix B of the Administrative Settlement Agreement and Order on Consent (ASAOC), USDA Forest Service (USFS), 2009). This SAP is intended to be used with these companion documents: Quality Assurance Project Plan (QAPP) (Tetra Tech, 2009a) and Site Safety and Health Plan (SSHP) (Tetra Tech, 2009b).

The information presented in this document is designed to address the elements of a SAP as described in EPA (1988). This SAP is organized thusly:

- Section 2: Site Background
- Section 3: Sampling Objectives
- Section 4: Sample Location and Frequency
- Section 5: Sample Designation
- Section 6: Sampling Equipment and Procedures
- Section 7: Sample Handling and Analysis

The Ecological Risk Assessment Work Plan and the Human Health Risk Assessment Work Plan required In the SOW (USFS, 2009) are presented in Appendices A and B, respectively. Standard Operating Procedures (SOPs) for data collection are provided in Appendix C.

2.0 SITE BACKGROUND

The Ross-Adams site is proceeding through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process as a non-time-critical removal action. Two preliminary site assessments (BLM, 1998; KSI, 2004) have been performed at the Site. The next step in the non-time-critical removal action process is to conduct an Engineering Evaluation/Cost Analysis (EE/CA), which will include ecological and human health risk assessments. This SAP and the companion QAPP (Tetra Tech, 2009a) provide the basis for collecting the data to conduct the EE/CA.

2.1 Site History

The Ross-Adams site is a former uranium mine located in the Tongass National Forest (TNF) near the southern end of Prince of Wales Island (POW) approximately 38 miles southwest of Ketchikan, Alaska (Figure 1). The Site is located on the southeast flank of Bokan Mountain in the Kendrick Creek watershed (Figure 2). The Ross-Adams site was initially developed as an open-pit mine in 1957, with subsequent underground mining occurring sporadically until about 1971. The mine has three major surface expressions named after their approximate elevation: the “900-foot level”, which includes the open pit; the “700-foot level; and the “300-foot level”. Between 1957 and 1971, ore from all levels was conveyed via haul roads to at least two staging areas on the north shore of the West Arm of Kendrick Bay. The Ore Staging Area and the former Ore Loading Dock were constructed in 1971 as documented in the aerial photographs and design documents made available to Tetra Tech. Details regarding the stockpiling and loading of ore on barges prior to the 1971 operations have not been made available and the specifics of these pre-1971 Site features are not known. For operations in 1971, a new ore stockpile area and floating dock were constructed. Stockpiled ore was loaded onto barges from a floating dock, which is no longer present. Major site features are shown in Figure 2. The Site, as defined in the SOW (USFS, 2009), includes the mine, haul roads, at least one ore staging area, two former barge loading areas, and downstream potentially impacted areas including the Kendrick Creek delta. An access road between the 900-Foot level and an adjacent exploration claim known as the I&L was constructed at some point during regional exploration using mine rock.

The Bokan Mountain region contains numerous areas of potentially economic uranium mineralization, some of which are expressed at the surface. The area continues to be actively explored for its potential mineral resources. Historic exploration activities have focused on uranium-thorium and rare-earth element-bearing deposits, though other minerals are also present. The Bokan Mountain region is currently being explored by Ucore Uranium, Inc. (Ucore). Ucore holds claims for several thousand acres on Bokan Mountain, including the Ross-Adams site, and reportedly drilled as many as 46 exploration holes throughout the region in 2007 and 2008 (Ucore, 2009). Mining at the Ross-Adams site focused on the relatively high grade uranium resources; however, the presence of rare earth element (REE) prospects has been noted. As described in BOM (1989) and more recently by Ucore (2009), REE mineralization has been characterized to be in an inverse relationship with uranium concentrations, with the best REE values found distal to the high grade uranium ore.

2.2 Previous Studies

Because of the mineralization present at Bokan Mountain, regional data are available from a variety of federal and state agencies and in the scientific literature (Eakins, 1970; MacKevvett, 1963; Philpotts, et al., 1998; Thompson, 1997; Warner and Barker, 1989). While some of these regional publications contain data specific to the Site, the majority of data evaluated during the preparation of this SAP and the associated QAPP (Tetra Tech, 2009a) and SSHP (Tetra Tech, 2009b) was obtained from a 2004 Preliminary Assessment/Site Inspection (PA/SI) report prepared by Kent & Sullivan, Inc. (KSI, 2004) for the USFS. Limited Site data are also contained in a Removal Preliminary Assessment (RPA) report published by the U.S. Bureau of Land Management (BLM, 1998).

The KSI (2004) PA/SI presented data on samples collected from these environmental media:

- Rock
- Surficial soil
- Stream sediment
- Marine sediment
- Surface water
- Air

Field gamma survey data were also presented in BLM (1998) and KSI (2004).

Laboratory data for 81 samples are presented in KSI (2004). These include: 21 mine rock and surficial soil samples; six surface water samples; seven stream sediment samples; six marine sediment samples and 13 radon detector samples (air). Additionally, data from a combined 28 “background” samples were also presented. The samples were analyzed for select metals and select daughter products in the thorium and uranium decay series. Metals analyzed were those on the EPA Target Analyte List (TAL) [aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium and zinc] plus uranium. Radionuclide analyses included the following: gross alpha and gross beta (water); protactinium 231; radium 226 and 228; lead 210; thorium 228, 230 and 232; uranium 234, 235 and 238; actinium 227; and radon in air (via alpha track detectors).

2.3 Conceptual Site Model

The Ross-Adams site consists of an open pit and underground mine workings. Mined materials from historical mining activities are located at the 900-, 700- and 300-foot mine levels. Mined materials are located adjacent to the mine workings, and were also used for construction of mine roads. Ore was stockpiled at ore staging areas prior to loading on barges for shipment from the Site. These locations are the primary sources of mine materials that remain on site. Migration from one or more of these sources may have occurred, and could potentially be occurring, via surface water, groundwater or air pathways[1]. A conceptual site model (CSM) developed in the PA/SI (KSI, 2004) identified these potential sources and the potential transport pathways (Figure 3). As shown on Figure 3, there are several pathways that require additional characterization including air, surface water, sediments and soil. Due to the hydrologic and geologic setting, groundwater has been characterized as occurring discontinuously in thin soil

[1] An October 12, 1971 letter from Dawn Mining Company (DMC) to the Alaska Department of Natural Resources provides information on areas cleaned-up by DMC at the conclusion of their mining. Subsequent to DMC’s Site activities, unknown parties have apparently re-entered the Site and placed ore at the former stockpile area and trailers and other debris at the 300-foot level. Both of these areas were left clean by DMC in 1971.

and colluvial deposits. The underground mine intercepts some limited inflow from bedrock fractures. Based on observations, groundwater at the site reports to the surface water. Remnant mine materials predominantly consist of development rock, sub-grade ore, and ore, which are collectively referred to as 'mine rock'. Mine rock may contain elevated levels of some ore-related metals and radionuclides, which pose potential current or future threats to human and/or ecological receptors.

Definition of localized background concentrations of the contaminants of potential concern (COPCs) is an objective to refine the CSM. Background in mineralized areas such as the Ross-Adams is often difficult to characterize because of the localized nature of relatively high grade mineralized material at the surface and the concentration of the mining impacts in the same areas. As discussed below, each media (air, surface water, soil and sediments) will be evaluated for localized background. Also, mineralized areas such as the Dotson Shear and I&L claim will be surveyed to characterize unmined areas of mineralization.

An Expanded Site Investigation (ESI) will be conducted in support of the ecological and human health risk assessments to provide data to characterize the potential sources of mine materials and to confirm the existence and importance of transport pathways. The ESI will include, at a minimum, three sampling events. These events are tentatively scheduled for June 2009, July 2009 and September 2009, with the potential for additional data collection in 2010. The general data collection activities planned for each event are summarized in Table 1. Detailed information on the sampling activities planned for each event are presented in Section 4. Data will be reviewed following each of the sampling events as described in the Ecological and Human Health Risk Assessment Work Plans (Appendices A and B, respectively). The CSM will be refined as data become available to ensure accurate characterization of the Site's potential impacts on human health and the environment.

Tetra Tech will summarize the data collected during the ESI in a Site Characterization Report (SCR). The ESI data, in conjunction with historical data, will then be used to conduct a draft and final EE/CA. The draft EE/CA will be used to refine the risk assessment work plan and subsequent data collection programs. The final draft EE/CA and final EE/CA will include the results of the risk assessment and recommend a removal action alternative. As described in the QAPP (Tetra Tech, 2009a), additional sampling and analyses will be performed in 2010 should the data collected during the ESI in 2009 not adequately address the potential receptors.

3.0 SAMPLING OBJECTIVES

The EE/CA process provides the framework to develop, evaluate and select removal alternatives to control the release, or the threat of release, of hazardous substances from a site. A sampling program has been developed to provide additional data required for site characterization and risk assessment in support of the EE/CA. The objectives of the sampling program are (1) to characterize the physical and chemical conditions of mine materials to support engineering development and evaluation of removal action alternatives, and (2) to characterize the ecological and human health exposure pathways and receptors to support risk assessment. The sampling program is described in detail in Section 4.

Based on the results of this site characterization process, Tetra Tech will develop a set of removal action alternatives designed to reduce the release or threat of release from the Site. The EE/CA report will provide feasibility level design and costing information for the alternatives, and evaluate each alternative with respect to its effectiveness, implementability and cost. The USFS will then propose one of these alternatives to the public as the final removal action for the Site.

3.1 Data Objectives

The data objectives for the project work were developed using the systematic seven-step planning process described in EPA (2006). The data objectives for the Ross-Adams EE/CA Project are detailed in the QAPP (Tetra Tech, 2009a). The preliminary sampling locations were identified in the SOW (USFS, 2009) and refined in this document. Minor changes to these sampling locations and media types may be necessary in the field due to access issues and sample availability; such variations will be documented in monthly progress reports and presented in the Site Characterization Report. Any changes in the sampling plan will be reviewed and approved by the Tetra Tech technical team.

3.2 Performance Criteria

The usability of the field and laboratory analytical data will be established through an evaluation of the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. The components of the data usability assessments are described, in detail, in the companion QAPP (Tetra Tech, 2009a). In general, the evaluation procedure utilizes the guidelines presented in U.S. EPA (2004). Guidance provided in specific analytical methods are also used in the assessment of data usability.

4.0 SAMPLE LOCATION AND FREQUENCY

The SOW requires an Expanded Site Investigation (ESI) to provide additional data to perform the EE/CA and the supporting ecological and human health risk assessment. The ESI will include three sampling events for 2009. The general data collection activities planned for each sampling event are summarized in Table 1 and described in detail in Section 4.2. The preliminary sampling locations, as identified in the SOW are illustrated in Figure 2. Additional sampling and analyses may be performed in 2010 should the data collected during the ESI in 2009 fail to adequately address the project goals.

4.1 Sampled Media

Tetra Tech will mobilize teams to the Site to perform sampling on three occasions during 2009. The following subsections describe the media that will be sampled in 2009; not all environmental media will be sampled during each of the three events. A description of the activities that will occur during each of the events is presented in Section 4.2.

4.1.1 Surface Water

Surface waters at the site include the freshwaters of Kendrick Creek, Mine Fork Creek, Cabin Creek, and drainage from the mine portals. Surface water samples will be collected from 18 locations both upstream and downstream of the Site and from other potential locations in the various drainages across the Site. The planned locations are:

Kendrick Creek (5 sample locations)

- Local background location: approximate 800 foot contour crossing
- 300-Foot Level: upstream of mine rock pile
- 300-Foot Level: downstream of mine rock pile
- Cabin Creek confluence: upstream
- Cabin Creek confluence: downstream

Mine Fork Creek (7 sample locations)

- Local background location: upstream of Camp Area and 900-foot mine rock pile
- Local background location: north tributary, upstream of 900-foot mine rock pile
- 900-Foot Level: north tributary, adjacent to mine rock pile, upstream of Mine Fork Creek
- 900-Foot Level: downstream of north and south mine rock piles
- 900-Foot Level: inflow into open pit
- 300-Foot Level: upgradient of mine rock pile in waterfall pool
- 300-Foot Level: adjacent to mine rock, upstream of Kendrick Creek

700-Foot Level Creek (2 sample locations)

- Downstream of mine rock pile
- Near end of discernable flow/upstream of Mine Fork Creek

Cabin Creek (1 sample location)

- Between Haul Road and Kendrick Creek

Portals (3 sample locations)

- 900-Foot Level (portal inflow)
- 700-Foot Level (portal discharge)
- 300-Foot Level (portal discharge)

Approximate sample locations are illustrated on Figure 4. Final locations will be access-dependent and will be determined during the initial sampling visit; significant departures from planned locations will be described in monthly progress reports and presented in the Site Characterization Report.

As described above, three local background sample locations are planned upstream of mining-related disturbances: one in Kendrick Creek at about the 800-foot topographic contour crossing and two in the Mine Fork Creek basin above the 900-foot level disturbances. These three sampling locations are potentially upstream of the mineralized zones but will provide water quality above mining impacted areas.

4.1.2 Stream Sediment

The Kendrick Creek watershed is a high-energy surface water environment. Consequently, locating sufficient "stream sediment" within the wetted channel at all proposed sample locations may be impractical. The EPA (2009) Method 3050B, *Acid Digestion of Sediments, Sludges, and Soils*, which will be employed by the laboratory to digest the stream, soil, and other solid sediments for analyses, includes sieving the samples using a USS #10 sieve (2 mm); only material passing the sieve (medium sand and finer) is retained for analysis. Analysis of medium sand and finer fractions will provide data on metals concentration due to gravity and sorption processes. Incorporation of larger fractions results in inconsistent results and dilution. Medium sand and finer fractions are also the most relevant for evaluation of ecological exposure and release pathways. As described in EPA (2001), sieving through a 10-mesh sieve is acceptable as a basis to discriminate between sediment and other materials. For the purposes of this project, stream sediment is operationally defined as (a) material within the wetted channel at the time of sampling, and (b) material passing through a USS #10 sieve. As described in the stream sediment sampling SOP (Appendix C), the wetted channel 25 feet upstream and downstream (50 feet total) will be sampled, using a USS # 10 sieve, for "stream sediment". If insufficient stream sediment is present to produce the required minimum mass for the laboratory analyses (Table 3), the sample location will be declared as free of stream sediment. The field team will also look for "opportunity" samples that will provide characterization value should sediment not be available in proposed locations. Where safely accessible, the Kendrick Creek and Mine Fork Creek streambeds will be walked and areas of sediment deposition will be qualitatively mapped.

Stream sediment samples will be collected at the surface water locations described in Section 4.1.1 plus three additional locations. Specifically, these 21 locations are:

Kendrick Creek (6 sample locations)

- Local background location: approximate 800 foot contour crossing
- 300-Foot Level: upstream of mine rock pile
- 300-Foot Level: downstream of mine rock pile

- Approximately 150-foot contour crossing
- Cabin Creek confluence: upstream
- Cabin Creek confluence: downstream

Mine Fork Creek (7 sample locations)

- Local background location: upstream of Camp Area and 900-foot mine rock pile
- Local background location: north tributary, upstream of 900-foot mine rock pile
- 900-Foot Level: north tributary, adjacent to mine rock pile, upstream of Mine Fork Creek
- 900-Foot Level: downstream of north and south mine rock piles
- 900-Foot Level: inflow into open pit
- 300-Foot Level: upgradient of mine rock pile in waterfall pool
- 300-Foot Level: adjacent to mine rock, upstream of Kendrick Creek

700-Foot Level Creek (2 sample locations)

- Downstream of mine rock pile
- Near end of discernable flow/upstream of Mine Fork Creek

Cabin Creek (1 sample location)

- Between Haul Road and Kendrick Creek

Portals (3 sample locations)

- 900-Foot Level (portal inflow)
- 700-Foot Level (portal discharge)
- 300-Foot Level (portal discharge)

Kendrick Creek Delta (2 sample locations)

- North drainage (within intertidal zone)
- South drainage (within intertidal zone)

Approximate sample locations are illustrated on Figure 4. Final locations will be access-dependent and will be determined during the initial sampling visit; significant departures from planned locations will be described in the monthly progress reports and presented in the Site Characterization Report.

As described above, three local background sample locations are planned upstream of mining-related disturbances: one in Kendrick Creek at about the 800-foot topographic contour crossing and two in the Mine Fork Creek basin above the 900-foot level disturbances. These three sampling locations are potentially upstream of the mineralized zones but will provide sediment quality above mining impacted areas.

4.1.3 Marine Sediment

Marine sediment sampling will be performed in the west arm of Kendrick Bay. Marine sediment sampling will be focused in the former loading dock area, along the shore on either side of the dock area, and the Kendrick Creek delta area. Thirty-one samples will be collected from these zones:

- Intertidal zone: 22 sample locations (4 around 1971 ore loading dock)
- Subtidal zone: 9 sample locations (6 around 1971 ore loading dock)

Approximate sample locations are illustrated on Figure 4. Final locations will be access-dependent and determined during the second sampling visit; the absence of appropriately sized sediment at the planned locations may necessitate the collection of "opportunity" samples at other locations. The use of an underwater camera will aid the evaluation and selection of sampling locations. Significant departures from planned locations will be described in the monthly progress reports and presented in the Site Characterization Report. The distribution of marine sediment samples has been designed to characterize the potential impacts of the ore staging and loading areas, and sediment loading from Kendrick Creek as well as sample locations outside of these potential influences. These samples outside the potential influence of the ore loading areas and Kendrick Creek delta will provide localized background quality. The number of localized background samples will depend on the in-field selection of sampling locations and availability of sediment.

4.1.4 Soil, Mine Rock & Ore Staging Area Sources

Sampling will be performed to characterize the nature and extent of mine rock, ore and soil contamination. Mine rock dumps and other mining disturbances have been previously characterized with respect to concentrations of radionuclides and metals, but the extent of any potential migration to adjacent areas has not been fully characterized. In addition, constituents in undisturbed soils and bedrock underlying and adjacent to disturbed areas have not been comprehensively characterized in previous site studies. These identified data gaps will be the primary focus of gamma survey and soil sampling activities for this project

The SOW (USFS, 2009) prescribes the use of gamma and XRF surveys for screening soils, mine rock and other solids at the Site. However, the accuracy of field XRF surveying is impaired by elevated soil moisture conditions. The reason for this is that X-rays from the XRF device are readily attenuated by water. Thus, the effectiveness of a portable XRF for *in-situ* measurement may be limited at the Site as high soil moisture conditions are expected to exist due to the high local precipitation. If this is found to be the case, samples would have to be collected and taken to a temporary laboratory, air dried, processed, and then scanned with the XRF. The time-intensiveness of this process may negate the benefit of the XRF. Additionally, review of the PA/SI data indicates that only four of the solid samples analyzed possessed arsenic concentrations above the XRF detection limit of approximately 25 mg/kg. Therefore, there would likely be minimal benefit in using the XRF to delineate potential arsenic contamination at the Site.

Gamma surveys offer an alternative to XRF to guide the field sampling, although XRF methods will also be evaluated during the first sampling event, as discussed below. Review of the PA/SI data (KSI, 2004) suggests a correlation between radium-226 (and associated short-lived gamma emitting decay products) and uranium (Figure 5), radium-226 and lead (Figure 6) concentrations in solids. Review of Ross-Adams mineralogy (MacKevett, 1963) indicates an association of the uranium (and thorium) minerals with sulfides (e.g., galena) which are the likely sources of the non-radioactive COPCs. Therefore, a relationship between gamma exposure rates and non-radioactive COPCs is plausible and will be evaluated from data generated during the first sampling event.

The GPS-based gamma radiation scanning will provide detailed information concerning the location and activity of gamma emitters on the site and will help define the limits of disturbance and/or radiological impacts from historical uranium mining. Scanning will be performed in areas impacted by mining and in adjacent areas that have not been influenced by mine activities. The latter will be used to establish “local background” gamma levels. The surficial concentrations of natural uranium and thorium (U-nat and Th-232), along with their decay products, will directly influence the spatial distribution of gamma survey readings. Gamma survey readings are thus expected to provide quantitative evidence of the spatial extent of radiological impacts from historic mining disturbances, and will be used to determine human health risk associated with gamma radiation exposure.

Existing radiological data from previous studies will be reviewed to evaluate the degree of correlation between U-238 and Th-232 and their decay products for the various rock types present across the Site. Soil samples will be taken to represent the range of the mapped gamma exposure rates. These soil samples will be analytically tested for uranium, thorium, radium and nonradioactive (nonrad) metals concentrations, which will allow evaluation of the degree of correlation between the various constituents of interest (i.e. U v. Th, U v. Ra, Th v. Ra, rads v. nonrads, etc.). A number of geologic studies (see Thompson, 1997) have been completed for the Ross-Adams site and indicated that metal sulfide mineralization occur within and adjacent to uranium-thorium mineralization. Because gamma radiation is associated with both the U-238 and Th-232 decay chains, the influence of the various gamma emitters on the correlations between gamma and metals (both rad and nonrad) will be evaluated. If reasonable relationships between gamma and metals cannot be developed, then more conventional methods (e.g., grid sampling) will be employed to measure COPC metals in soil.

Because of the potential for a high degree of small-scale spatial variability in soil radionuclide concentrations (e.g. large concentration differences within just a few feet), and because of the need to differentiate between natural mineralization and actual historical impacts in any areas where both may be present, a comprehensive high-density gamma survey is necessary. This survey will utilize state-of-the-art GPS-based radiological survey systems and characterization techniques, and if possible, will also include gamma-based characterizations of the spatial distributions of radionuclides and metals in surface soils. This information will be developed based on well-established correlation methods.

For this project, gamma surveys will utilize two GPS-based gamma scanning systems mounted on backpacks. Depending on the nature of terrain to be covered, each backpack will have one or two independent scanning systems coupled to a central data collection computer. The mounting system configuration may be modified to suit site conditions, but the functionality of the basic system will not change.

Wherever possible, the target areal ground coverage for gamma radiation survey measurements will be at least 50 percent. For surveys of this nature, these scanning systems are estimated to have an effective field of view of about 12 feet in diameter at the ground surface below the detector, meaning that a distance of about 25 feet between adjacent scan path trajectories should approximate this level of coverage. Areas of higher activity will be scanned at higher areal coverages, if necessary. The distances maintained between scan paths will depend on the ability of operators to safely negotiate targeted terrain with scanning system gear. Gamma survey paths will cross mine materials and continue away from these materials until gamma readings, in conjunction with visual observations, are sufficient to establish local baseline conditions. Gamma surveys will also be performed along the haul roads. This characterization will include quantitative evidence of background levels. Therefore, if a relationship between gamma radiation and metals concentration can be established, then the large database generated by the gamma survey can be employed to accurately define the limits of contamination (and therefore the extent of clean-up) for all COPCs.

Targeted gamma surveying and sampling of soil and rock in corresponding areas will be performed during the first sampling event. During this event, 15 soil and rock samples will be collected from areas representing the range of local background gamma readings, which may include mineralized areas beyond the limits of mining impact. This 'correlation' surveying and sampling will be performed on the haul roads, in undisturbed areas adjacent to the 900-, 700- and 300-foot levels, and adjacent to the ore staging area, and will have the following objectives:

- Confirm the validity of using gamma-scanning to guide site characterization
- Confirm the validity of using field XRF as a backup guide for site characterization
- Confirm or revise the COPC list identified in the Kent & Sullivan (2004) PA/SI report
- Characterize the haul road (identified as a data gap in Kent & Sullivan (2004), and
- Provide additional local background data at the 900-, 700- and 300-foot levels and the ore staging area (identified as data gaps in Kent & Sullivan (2004).

Using gamma surveying and/or XRF as a guide, a minimum of 25 samples of solid materials will be collected from the following areas during the second sampling event:

<u>900-Foot level (5 sample locations)</u>

- Shop area
- Camp Area
- North mine rock pile (2 samples)
- South mine rock pile

<u>700-Foot level (2 sample locations)</u>

- Mine rock pile (2 samples)

<u>300-Foot level (3 sample locations)</u>

- Generator shack (organics)
- Mine rock pile (2 samples)

<u>Ore Staging Areas (3 sample locations)</u>

- Within ore staging area (3 samples)

Mine Road and Haul Road, Including I&L Spur (6 sample locations)

Local Background Locations (6 sample locations).

With the exception of the samples collected in the vicinity of the Shop, Camp Area, and Generator Shack, these samples will be confirmatory samples. Either gamma surveying or XRF will be used to guide the confirmatory sample locations; consequently, these locations are not illustrated on Figure 4. However, the Shop, Camp Area, and Generator Shack soil locations are shown on Figure 4. Additional samples may be required in the event of poor correlation results.

The gamma surveys will provide detailed information on the extent of mining-related impacts and local background levels of gamma radiation. Should the gamma surveying and/or XRF field surveying fail to yield a reliable correlation for delineating non-radioactive metal removal action boundaries, then more conventional methods (e.g., grid sampling) will be employed to measure COPC metals in soil. Samples will be collected just outside the visual extent of mine rock accumulation; where this boundary is unclear, additional samples may be collected at a further distance.

4.1.5 Air

Radtrack® track-etch radon detectors will be deployed across the Site to characterize average radon concentrations. Radon monitoring stations will be established at thirty-three locations across the site to provide data on radon air concentrations at the sources, and at the mine portals. Additionally, 6 stations will be set up at source area boundaries (as determined by gamma surveys) to assess localized background conditions, Radon detectors at all locations will be deployed during the first sampling event and retrieved during third event. In addition, separate radon detectors will be deployed at mine portal locations only for the duration of the second sampling event to collect short term radon concentrations at these locations.

Additionally, at least three ambient air temperatures will be measured within the mine, via the portal entries or down drill core borings or air shafts, during all three sampling events to provide data for modeling and evaluation of air exchange in the underground workings. A ventilation model of the underground uranium mine to predict the ventilation flow quantities in relation to the surface air temperatures can be built using mine ventilation software such as VnetPC of VentSim®.

Radon detectors will be installed in the following areas:

- 900-Foot Level: Mine rock piles and background areas (6 sample locations)
- Open Pit: 900-Foot Level portal and in the pit (3 sample locations)
- 700-Foot Level: Mine rock pile and portal (5 sample locations)
- 300-Foot Level: Mine rock pile and portal (7 sample locations)
- Mine Road and Haul Road (4 sample locations)
- Dotson Cabin (3 sample locations)
- Ore staging area (5 sample locations)

Approximate sample locations are illustrated on Figure 4. Final locations will be access-dependent and determined during the first sampling visit; significant departures from planned locations will be described in the Site Characterization Report.

The potential for hazardous fugitive dusts or particulates in air associated with the mine rock piles and/or haul roads will be evaluated based on characterization of the materials for COPCs and grain size. If appropriate, modeling of the dust or particulates pathway will be evaluated to further characterize the risk considering climate, seasonal snow cover and particulate size. It is anticipated that the removal action alternatives evaluated in the EE/CA will include removal or isolation, as well as the topographic and vegetative conditions of the mine rock piles and road surfaces. Thus, the air transport pathway will either be eliminated or rendered incomplete.

4.1.6 Groundwater

As discussed in Section 2.3, groundwater reports to the portal discharges, to the surface water streams and locally in seeps and springs near the bay. Limited groundwater sampling focused on the shallow groundwater flow system presumed to be present in the Kendrick Creek alluvium will be performed. This sampling will be conducted by seeps and spring sampling and the installation of drive-point piezometers in the Kendrick Creek delta, if practicable; given the coarse nature of the alluvial delta deposits observed during the initial site visit, successfully driving piezometers several feet into the subsurface may be impractical. The groundwater sampling included in the SOW (USFS, 2009), includes the following eight sample locations:

- Drive-point piezometers near the mouth of Kendrick Creek (2 locations)
- Drive-point piezometers throughout the Kendrick Creek delta (5 locations)
- Seep/spring in the former ore staging area (1 location).

Approximate sample locations are illustrated on Figure 4. Final locations will be access-dependent and determined during the first sampling visit; significant departures from planned locations will be described in the Site Characterization Report. Localized background groundwater quality is not anticipated to be necessary and will not be collected as part of study due to the direct connection with surface water quality.

4.1.7 Engineering Assessment/Risk Assessment

Additional measurements will be performed to document and assess geotechnical aspects for the engineering analysis. These include:

- Potential sources of on-Site borrow material for possible use in removal action work, in terms of material type. This will require limited sampling and analysis for grain size and geotechnical parameters.
- Surveying to provide volume estimates of significant mine material piles and potential borrow sources.

For risk assessment purposes, a qualitative survey of the terrestrial, freshwater aquatic, and marine aquatic species (biota inventory) will be performed with an emphasis on those plants or animals that are important components of exposure routes to humans and ecological receptors.

4.2 Sampling Event Activities

The SOW (USFS, 2009) identifies three sampling events to be performed in 2009.

4.2.1 First Sampling Event

The first sampling event in will be performed in early June. Personnel and equipment will deploy to the Site through Ketchikan, where they will subsequently travel to the site aboard a vessel which will anchor in Kendrick Bay. Personnel will sleep and eat aboard ship, shuttling to and from shore each day. Some equipment may be transferred to shore on Day 1 where it may remain until it is scanned, decontaminated if necessary, and released on the final day during demobilization. Personnel and equipment routinely returning to the ship will follow scanning and decontamination procedures for each return trip as established in the SSHP (Tetra Tech, 2009b). Scanning and decontamination records will be retained in the project file.

The first sampling event will focus on media at the following locations:

- 900-foot Level: Radon; Surface water quality and flow
- Open Pit: Radon; Surface water quality and flow; Ambient air temperature
- 700-foot Level: Radon; Local background soil and rock correlation samples; Surface water quality and flow; Ambient air temperature
- 300-foot Level: Radon; Local background soil and rock correlation samples; Surface water quality and flow; Ambient air temperature
- Mine Road and Haul Road: Radon; soil and mine rock correlation samples
- Confluence of Kendrick Creek/Cabin Creek: Surface water quality and flow
- Kendrick Bay Delta: no sampling first sampling event
- Ore Staging Area: Radon; Local background soil and rock correlation samples
- Springs Sampling: Groundwater

Additionally, the first sampling event includes the collection of composite soil and mine material samples to (1) establish correlation between gamma radiation and metals content, and XRF and metals content, and (2) confirm COPC list (Section 4.1.4).

4.2.2 Second Sampling Event

The second sampling event will be performed in mid July. The second event is the most intensive sampling program and is timed to coincide with the New Moon (July 21), when maximum low tides will maximize access to the intertidal area. Personnel and equipment will deploy to the Site through Ketchikan, where they will subsequently travel to the site aboard a vessel which will anchor in Kendrick Bay. Personnel will sleep and eat aboard ship, shuttling to and from shore each day. Large equipment will be transferred to shore on Day 1 where it may remain until it is scanned, decontaminated if necessary, and released on the final day during demobilization. Personnel and equipment routinely returning to the ship will follow scanning and decontamination procedures for each return trip as established in the SSHP (Tetra Tech, 2009b). Scanning and decontamination records will be retained in the project file.

The second sampling event will focus on the following media:

- 900-foot Level: Surface water quality and flow; stream sediment; Gamma scanning and/or XRF scanning with confirmatory soil sampling
- Open Pit: Surface water quality and flow; stream sediment; Ambient air temperature; Gamma scanning
- I&L Access Road Spur: Gamma scanning and/or XRF scanning with confirmatory soil sampling
- 700-foot Level: Surface water quality and flow; stream sediment; Gamma scanning and/or XRF scanning with confirmatory soil sampling
- 300-foot Level: Surface water quality and flow; stream sediment; Ambient air temperature; Gamma scanning and/or XRF scanning with confirmatory soil sampling
- Mine Road and Haul Road: Gamma scanning and/or XRF scanning with confirmatory soil sampling
- Confluence of Kendrick Creek/Cabin Creek: Surface water quality and flow; stream sediment
- Kendrick Bay Delta: Stream sediment; Marine sediment; Drive-Point Piezometer; Gamma scanning and/or XRF scanning with confirmatory soil sampling
- Ore Staging Area: Gamma scanning and/or XRF scanning with confirmatory soil sampling
- Springs Sampling: Groundwater
- Cross calibrations of NaI detectors against the HPIC and/or micro-rem meter
- Portal radon monitoring station detector change-outs
- Borrow source reconnaissance
- Surveying

4.2.3 Third Sampling Event

The third sampling event will be performed in September. Personnel and equipment will deploy to the Site through Ketchikan, where they will travel to the site aboard a vessel which will anchor in Kendrick Bay. Personnel will sleep and eat aboard ship, shuttling to and from shore each day. Some equipment may be transferred to shore on Day 1 where it may remain until it is scanned, decontaminated if necessary, and released on the final day during demobilization. Personnel and equipment routinely returning to the ship will follow scanning and decontamination procedures for each return trip as established in the SSHP (Tetra Tech, 209b). Scanning and decontamination records will be retained in the project file.

The third sampling event will focus on the following media:

- 900-foot Level: Radon; Surface water quality and flow
- Open Pit: Radon; Surface water quality and flow
- 700-foot Level: Radon; Surface water quality and flow; Ambient air temperature
- 300-foot Level: Radon; Surface water quality and flow; Ambient air temperature
- Mine Road and Haul Road: Radon
- Confluence of Kendrick Creek/Cabin Creek: Surface water quality and flow

- Kendrick Bay Delta: no sampling third sampling event
- Ore Staging Area: Radon
- Springs Sampling: Groundwater
- Final collection of radon detectors from radon monitoring stations
- Collection of additional samples based on results of 1st & 2nd events.

5.0 SAMPLE DESIGNATION

The preliminary sampling locations shown on Figure 4 were identified in the SOW (USFS, 2009). Minor changes to these locations may be made due to access issues; such variations will be noted in the Site Characterization Report.

Sample labels will be supplied by the laboratory or container manufacturer. Sample labels will be completed with an indelible, waterproof marker. All samples will be labeled with date, time, sampler's initials and the sample ID. The sample ID includes the sample location, media type, and sample type. The sample IDs will be in the form of:

ZZZZ/YYY/##

Where: ZZZZ is the sample location code,
YYY is the environmental medium,
is sample type (01=primary, 02=duplicate, 03=blank),

Sample location codes are listed in Table 1. The designated environmental media are as follows: (GW) = Groundwater samples, (SW) = Surface water samples, (SS) = Stream Sediment samples, (MS) = Marine Sediment Samples, (SOI) = soil samples and (RAD) = radon. For example, a primary stream sediment sample, collected at the Open Pit would have the following sample ID: OP/SS/01.

6.0 SAMPLING EQUIPMENT AND PROCEDURES

The sampling equipment and procedures employed during the sampling events are designed to provide the type and quality of data consistent with the objectives of this project.

6.1 Sampling Procedures

Field sampling methods, equipment utilized, and decontamination procedures for this effort are documented in the SOPs provided in Appendix B. The following SOPs apply:

- SOP01 - Decontamination of Field Instrumentation and Equipment
- SOP02 - Field Logbook Keeping
- SOP03 - Sample Packaging and Shipment
- SOP04 - Stream Sediment Sampling
- SOP05 - Marine Sediment Sampling
- SOP06 - Stream Discharge Measurement
- SOP07 - Surface Water Sampling
- SOP08 - Groundwater Sampling and Low-flow Purging
- SOP09 - Soil Sampling
- SOP10 - Drive Point Piezometers Installation
- SOP11 - Radon Monitoring
- SOP12 - Direct Field Gamma Survey
- SOP13 - Field Portable X-ray Fluorescence (XRF) for Measurement of Metal Concentrations in Soils
- SOP14 - Low-Level Mercury Analysis Sample Collection

6.1.1 Surface Water Sampling

The Site surface water monitoring network (Section 4.1.1) is shown on Figure 4 and summarized in Table 1. Stream flow measurements will be made using a flow meter or portable flume per SOP06. Stream sample locations may be visited the day prior to sampling to prepare the streambed for flow measurements. Surface water quality samples will be collected per SOP07. Sample filtration, preservation and handling procedures are described in Section 7.

6.1.2 Stream Sediment Sampling

Stream sediments will be collected from the wetted stream channel using a decontaminated stainless steel or small plastic shovel, trowel or scoop (SOP04). Surficial sediments (i.e., the upper inch) will be targeted for the sampling. Sediments will be described in the field for textural properties, color, staining, etc. The sediments will be field-sieved using a USS #10 (2 mm) HDPE sieve to remove particles larger than medium grained sand. The stream sediment sampling locations are provided in Figure 4. The wetted streambed 25 feet upstream and downstream (total 50-foot reach) of the sampling station will be examined for sediment. Should insufficient sediment be present in the 50-foot reach to generate sufficient sample mass to complete all the required analyses (Table 3), the sample location will be declared "sediment-free". As discussed in Section 4.1.2, the Kendrick Creek and Mine Fork Creek streambeds will be walked, where safely accessible, and areas of sediment accumulation will be noted. Additional "opportunity" samples will be collected to augment the planned sample locations.

6.1.3 Marine Sediment Sampling

Marine sediments will be collected from the intertidal zone and the subtidal zone. Intertidal sediments will be collected using a decontaminated stainless steel or small plastic shovel, trowel or scoop following procedures for stream sediment sampling (SOP04). Surficial sediments (i.e., the upper inch) will be targeted for the sampling. Sediments will be described in the field for textural properties, color, staining, etc. The sediments will be field-sieved using a USS #10 (2 mm) HDPE sieve to remove particles larger than medium grained sand. Analysis of medium sand and finer fractions will provide data on metals concentration due to gravity and sorption processes. Incorporation of larger fractions results in inconsistent results and dilution. Medium sand and finer fractions are also the most relevant for evaluation of ecological exposure and release pathways. As described in EPA (2001), sieving through a 10-mesh sieve is acceptable as a basis to discriminate between sediment and other materials.

Subtidal samples will be collected using a van Veen bottom grab sampler following the procedures outlined in SOP05. Subtidal sampling efforts will focus on collecting material from the surficial "silty muck" layer noted in the BOM (1989) description of the Kendrick Bay placer deposit, if practical. Depending on the mass and grain size of the material recovered during the subtidal sampling, field sieving may not be performed; rather, the samples may be packaged and sent to the laboratory for processing. Where marine sediments at the proposed sampling locations are insufficient to generate the sample mass required to complete all the required analyses, those locations will be identified as sediment-free, and additional locations for "opportunity" samples will be sought to augment the planned sample locations. An underwater camera will be used during the second sampling event to assist in identifying marine sediment sampling locations, and also to attempt to visually identify potential ore spillage in the vicinity of the 1971 ore loading dock.

6.1.4 Soil, Mine Rock and Ore Staging Area Sampling

Soil and mine rock samples, and samples from the ore staging area will be collected based on the results of the gamma surveying (SOP12) and/or field XRF analysis (SOP13). Solid samples will be collected using a decontaminated stainless steel or small plastic shovel, trowel or scoop (SOP09). Surficial solids (i.e., the upper 15 cm) will be targeted for the sampling. Solids will be described in the field for textural properties, color, staining, etc. Composite bulk samples will be collected, homogenized, and split into 2 sub-samples for independent XRF (metals) and gamma (radionuclide) testing.

To evaluate gamma surveying and field XRF methods for their reliability in guiding site characterization efforts, up to 15 composite soil and mine rock samples will be collected during the first sampling visit. The composites will be generated from 10 sub-samples collected from within 100 square meter correlation plots to generate estimates of average concentrations of target solid sample analyte. Each correlation plot area will also be surveyed with gamma scanning equipment. The average gamma reading across each plot will be paired with results of the composite sample for each solid sample analyte (e.g. U-nat, Ra-226, Th-232, Pb, As, etc.) to evaluate potential statistical correlations between these parameters. In some cases, 100 m^2 plots with uniform gamma readings (a key plot selection criterion) may not be possible and plot dimensions may require adjustment. In all cases, professional judgment based on experience with correlation techniques will be used to ensure that mean gamma readings are likely to be adequately representative of mean analyte concentrations in corresponding solid terrestrial materials. Correlation plot sampling/measurement locations will be determined in the field based on the range of gamma readings observed in key areas such as haul roads and undisturbed locations adjacent to former mining areas.

The composite samples will be homogenized and split for independent XRF (metals) and gamma (radionuclide) scanning and analytical testing. The XRF sample will be contained in a zip lock bag, and will be scanned 3 times in the field at field moisture content using a portable XRF meter. The XRF sample will subsequently be processed through a USS No. 60 sieve and prepared in an XRF specimen cup for additional XRF testing, per EPA (2009) Method 6200. The specimen cups will then be sent to an analytical laboratory for measurement of lead and arsenic concentrations. Separate correlations will then be developed between both the XRF specimen cup sample and the analytical results, and between the XRF specimen cup and the field measurements. This method will facilitate evaluation of a correlation between field XRF tests and analytical testing. Depending on the results of the this correlation, field XRF testing can be used as a primary screening tool for metals during the second sampling visit, with 20 percent of the samples being submitted for confirmatory analytical testing of only confirmed COPCs. XRF samples will be retained in the laboratory for future analysis of other COPCs besides lead and arsenic if identified during site characterization.

Similarly, the gamma sample will also be scanned in the field with the XRF meter. The gamma sample will be submitted to an analytical laboratory and sampled for the radionuclides indicated in Table 5, as well as for arsenic and lead (the two metals identified in Kent & Sullivan (2004) as COPCs). Analytical testing for the radionuclides listed in Table 5 will be conducted on all 15 XRF and gamma samples. The relationship between terrestrial sources of Site gamma radiation levels and the concentrations of COPCs exceeding screening values will be evaluated. This evaluation will be completed in time for the second sampling event, during which comprehensive gamma surveying, and primary soil and mine waste sampling activities are scheduled to be performed.

Analysis for natural uranium will be performed using ICP-MS (inductively-coupled plasma - mass spectrometry). Natural uranium is approximately 99.3% U-238; thus, the ICP-MS analysis provides an accurate analysis of U-238 concentration. Laboratory analysis for Ra-226 will be performed by sealing soil samples in a container that is impermeable to radon. The Ra-226 decay products (daughters) will build into equilibrium activity within the sealed container over a period of 21 days or more, at which time the gamma radiation emitted by these daughter products (specifically, Pb-214 and Bi-214) is measured. The activity concentration of these surrogates is used to determine the concentration of radium in the soil sample, because the radionuclide activities are in near-equilibrium at 21 days.

The sub-sample for gamma (radionuclide) testing will be field-sieved using a USS 1” sieve to remove particles larger than coarse gravel. The larger fraction is used because the external radiation pathway includes both soil and rock-size material, in contrast to the exposure pathway for non-rad metals (e.g., lead), which is attributed to the smaller, soil-size fractions. The soil samples locations adjacent to the Shop and Generator Shack are provided in Figure 4; the gamma and/or XRF sample locations will be based on the results of the surveys (Section 4.1.4).

6.1.5 Air

Radtrack® Track-etch radon detectors will be deployed across the Site per the procedures described in SOP11. Radon detectors installed at the portals will be located as close as safety allows to the portal; radon detectors will be mounted to a driven fence post or tree (if conveniently located) at a height of approximately 3 feet. Radon detector locations are shown on Figure 4.

6.1.6 Groundwater Sampling

The Site groundwater monitoring network (Section 4.1.6) is shown on Figure 4 and summarized in Table 1. Groundwater samples will be collected from drive-point piezometers, if practical, and from a seep(s) present at the ore staging area. Drive-point piezometers will be installed per SOP10. Groundwater quality samples will be collected per SOP08. Sample filtration, preservation and handling procedures are described in Section 7.

6.2 Sampling Equipment Decontamination

Sampling equipment that comes in contact with environmental media will be thoroughly cleaned before use in the field and between sampling stations. Sampling equipment decontamination procedures are described in SOP01.

The cleaned sampling equipment will be bagged between sampling stations to avoid environmental contamination. Personnel involved in sampling equipment preparation and sample collection and processing will wear nitrile (or similar) gloves to protect themselves and to minimize the opportunity for sample contamination.

6.3 Investigation Derived Waste

Investigation derived wastes (IDW) will be generated during the course of the various field programs. IDW will be temporarily contained and/or disposed in accordance with the procedures outlined in the sections below. The means of waste handling and disposal is contingent on the types of IDW generated during each phase of the project. The sections below summarize the types of mine materials which will be generated and the methods of disposal to be employed by field personnel.

The types of IDW anticipated to be generated from the various sampling activities include:

- Decontamination water and materials.
- Purge water, excess sample water, and excess sediment from sampling activities.
- Personal protective equipment.
- Disposable sampling equipment

Handling/disposal of IDW will be completed as follows:

- Decontamination water: Decontamination waters will be disposed on mine rock piles removed from surface water bodies and Kendrick Bay.
- Decontamination materials: If sediment is present on the sampling equipment and cannot be easily removed by a spray bottle and a gloved hand, biodegradable towelettes may be used to remove the accumulated sediment. The towelettes will be placed bag in a biodegradable bag and disposed of in one of the mine rock piles [see SSHP (Tetra Tech, 2009b) for more information].

- Purge water from groundwater sampling and excess sediment: Purge water, excess sample water, and excess sediment samples will be discharged to the ground adjacent to the sampling location.
- Personal protective equipment (PPE): This is limited to gloves. Gloves will be cleaned of visible sediment and placed in plastic bags. The bags will be screened for radiation as described in the SSHP (Tetra Tech, 2009b), removed from the site, and disposed as solid waste.

6.4 Sample Location Surveying

All sample locations will be surveyed using a consumer-grade GPS unit. The GPS unit(s) will be set to measure the Continental U.S. 1983 datum (NAD 83). Sample locations will be reported in the UTM Coordinate System. Sample locations in and near areas to be surveyed will be marked by pin flags or stakes and surveyed.

7.0 SAMPLE HANDLING AND ANALYSIS

Proper sample preparation practices will be observed to minimize sample contamination and potential repeat analyses due to anomalous analytical results. Sample containers depend on sample type, and are described in Tables 2 and 3 for each individual sampling activity and media.

7.1 Sample Handling

7.1.1 Sample Filtration

Samples requiring dissolved analyte concentration analysis will be filtered at the time of sample collection using 0.45 µm disposable filters. Sample filtration methods for groundwater and surface water are covered in SOP07 and SOP08, respectively.

7.1.2 Sample Preservation

Samples are preserved through the addition of acids or bases to prevent or minimize chemical changes that could occur during transit and storage. Laboratories will supply new containers, pre-charged with the appropriate preservatives and clearly identified (e.g., color-coded) to identify the type of preservative. The project sample preservation and storage requirements are summarized in Tables 2 and 3.

7.1.3 Sample Preparation and Shipping

After collection, samples will be labeled and prepared as described in the previous discussions, and placed in an insulated cooler with ice for delivery to the laboratory. The ice in the cooler will be double-bagged. Chain-of-custody (COC) forms, listing those samples in the shipping container, and signed by the sampler to relinquish custody, will be placed in a re-closeable freezer-type plastic storage bag and taped to the inside lid of the cooler. Included with the COCs will be a copy of the sample analysis requirements (Tables 4 and 5). The coolers will be taped shut and chain-of-custody seals will be attached to the outside of the cooler to ensure that the cooler cannot be opened without breaking the seal. Samples will be shipped for laboratory receipt and analysis within the holding times specified in Tables 2 and 3.

Samples exceeding radiological field screening levels will follow sample packaging protocols according to SOP03. Solid samples will be surveyed to estimate U-nat concentrations to assure DOT exemption limits are not exceeded for regular shipping.

7.1.4 Chain of Custody

After samples have been collected, they will be maintained under chain-of-custody protocols. The field sampling personnel will complete a COC form for each shipping container (i.e., cooler, ice chest or other container) of samples to be delivered to the laboratory for analysis. COC forms will be provided by the laboratory. The sampler is responsible for initiating and filling out the COC form. The COC will be signed by the sampler when he or she relinquishes the samples to anyone else. The COC for a shipping container will list only those samples in that shipping container. When the samples are shipped by a common carrier, a Bill of Lading supplied by the carrier will be used to document the sample custody, and its identification number will be entered on the COC. Copies, receipts and carbons of Bills of Lading will be retained as part of the permanent documentation in the project file. It is not necessary for courier personnel to sign the COC. A detailed discussion of the custody process is provided in the QAPP. Copies of laboratory supplied COC forms are provided in the laboratory quality assurance plans appended to the QAPP (Tetra Tech, 2009a).

7.1.5 Holding Times

Sample holding times are established to minimize chemical changes in a sample prior to analysis and/or extraction. A holding time is defined as the maximum allowable time between sample collection and analysis and/or extraction, based on the nature of the analyte of interest and chemical stability factors. Samples will be shipped to the laboratory as soon as possible after collection or processing. Holding times for the chemical constituents for which samples will be analyzed are summarized in Tables 2 and 3.

7.2 Analytical Methods

The analytical parameters, analytical methods and required method detection limits for which the samples are to be analyzed for are summarized in Tables 4 and 5. The laboratories designated for the analytical support for the project are accredited under the National Environmental Laboratory Accreditation Program (NELAP). Additionally, the primary laboratories selected for this project are approved by Alaska Department of Environmental Conservation (ADEC) to analyze samples originated in Alaska. It is our understanding that the back-up laboratory for radionuclide analyses is in the process of filling its application with ADEC for inclusion in the approved list of laboratories.

Laboratories designated for analysis of environmental samples are:

- Columbia Analytical Services

  1317 South 13th Avenue
  Kelso, WA 98525
  360-577-7222

- ACZ Laboratories Inc.

  2773 Downhill Drive
  Steamboat Springs, CO 80487
  800-334-5493

- Paragon Analytics Inc.

  225 Commerce Drive
  Fort Collins, CO 80524
  970-490-1511

Tables 2 and 3 include holding times, preservation guidelines, and required sample amounts for all sample types. A copy of Tables 2, 3, 4, and 5, as appropriate, will be sent with each associated batch of samples submitted to the laboratory.

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TABLES

Table 1. Ross-Adams Site 2009 Sampling Event Description

2009 Event	Location	Location Code	Samples									
			Stream Water	Ground water	Sediment		Biota Inventory	Radon[2]	Soil[3]	Gamma Survey	XRF[5]	Ambient air temp
					Stream[1]	Marine						
1)	900-foot Level	900L	4					6	1			2
	Open Pit	OP	2					3				
	700-foot Level	700L	4					5	1			2
	300-foot Level	300L	5					7	1			2
	Mine and Haul Roads	MHR						3	10			
	Confluence of Kendrick Creek/Cabin Creek	CONF	3									
	Ore Staging Area	OSA						9[6]	2			
	Springs Sampling	SPR		1								
	All Locations									X	X	
2)	900-foot Level	900L	4		4		X	1	5	X	X	
	Open Pit	OP	2		2		X		1	X	X	2
	700-foot Level	700L	4		4		X	1	3	X	X	2
	300-foot Level	300L	5		5		X	1	4	X	X	2
	Mine and Haul Roads	MHR					X		7	X	X	
	Confluence of Kendrick Creek/Cabin Creek	CONF	3		4[7]		X					
	Kendrick Bay and Kendrick Creek Delta	KBD			2	22	X			X[4]	X	
	Ore Staging Area	OSA				9	X		5	X	X	
	Springs Sampling	SPR		1								
3)	900-foot Level	900L	4									
	Open Pit	OP	2									2
	700-foot Level	700L	4									2
	300-foot Level	300L	5									2
	Mine and Haul Roads	MHR										
	Confluence of Kendrick Creek/Cabin Creek	CONF	3									
	Ore Staging Area	OSA										
	Springs Sampling	SPR		1								

Notes:

[1] Stream flow will be measured at all stream water sampling locations.

[2] Event 2 activities include cross-calibrations of NaI detectors against the HPIC and/or micro-rem meter, and short-term radon monitoring at mine portals. Long-term radon monitoring apparatus to be set at all stations during first sampling event and retrieved during the third sampling event.

[3] Collection of composite soil and mine rock samples to (1) evaluate correlation between gamma radiation and metals content, and between XRF readings and metals content, and (2) confirm COPC list. Locations are to be determined in the field.

[4] Taken at intertidal zone at low tide.

[5] XRF characterizations to be evaluated during first sampling visit.

[6] Includes 4 samples in vicinity of Dotson Cabin.

[7] Includes 1 sample at the 150-foot contour crossing of Kendrick Creek

Table 2. Sample Containers, Preservation, and Holding Time Requirements for Water Samples

Analyte	Sampling Container	Filtration/ Preservation	Holding Time
Field Analysis			
pH, Specific Conductance, Temperature	Polyethylene	Unfiltered, Unpreserved	Analyze at time of sample collection
Laboratory Analysis			
Total Metals	250 ml Polyethylene	Unfiltered, HNO_3, Cool to 4°C	180 days*
Dissolved Metals and Dissolved Major Cations	250 ml Polyethylene	Filtered, HNO_3, Cool to 4°C	180 days*
Dissolved Major Anions (Sulfate, Chloride)	250 ml Polyethylene	Filtered, Unpreserved	28 days
Alkalinity (Bicarbonate, Carbonate)	500 ml Polyethylene	Unfiltered, Unpreserved, Cool to 4°C	14 days
TDS	500 ml Polyethylene	Filtered, Unpreserved, Cool to 4°C	7 days
TSS	500 ml Polyethylene	Unfiltered, Unpreserved, Cool to 4°C	7 days
Organic Carbon	125 ml Polyethylene	Unfiltered, H_2SO_4, Cool to 4°C	28 days
Dissolved Radiochemistry	2 each 4000 ml Polyethylene	Filtered, HNO_3, Cool to 4°C	180 days

* Mercury analysis required holding time is 28 days

Table 3. Sample Containers, Preservation, and Holding Time Requirements for Sediment/Soil Samples

Sample Media	Analysis	Sampling Container	Preservation/Prep	Minimum Sample Mass	Holding Time (days)
Sediment, Soil	Metals, paste pH, organic carbon, particle size	Quart–size freezer Zip-lock bags or glass jars	Cool at 4° C for transport, no preservation needed	500 g	180*
	PCBs	Quart–size freezer Zip-lock bags or glass jars	Cool at 4° C for transport, no preservation needed	200 g	7
	AVS	Quart–size freezer Zip-lock bags or glass jars	Cool at 4° C for transport, no preservation needed	100 g	14
	Radiochemistry	Quart–size freezer Zip-lock bags or glass jars	Cool at 4° C for transport, no preservation needed	500 g	180

* Mercury analysis required holding time is 28 days

Table 4. Water Sample Analysis Parameters, Methods, and Method Detection Limits

Analyte Group	*Constituent*	*U.S. EPA Method Number*	*Method Detection Limit (mg/L)*
Field Parameters	pH	150.1	0.1 (s.u.)
	Specific Conductance	120.1	1 (umhos/cm)
	Temperature	170.1	0.1 (°C)
Metals[1]	Aluminum	200.7 ICP	0.03
	Antimony	200.8 ICP-MS	0.0004
	Arsenic	200.7 ICP	0.04
	Barium	200.8 ICP-MS	0.0001
	Beryllium	200.8 ICP-MS	0.0001
	Cadmium	200.8 ICP-MS	0.0001
	Chromium	200.8 ICP-MS	0.0001
	Cobalt	200.8 ICP-MS	0.0001
	Copper	200.8 ICP-MS	0.0005
	Iron	200.7 ICP	0.02
	Lead	200.8 ICP-MS	0.0001
	Manganese	200.7 ICP	0.005
	Mercury	M1631	0.0002 (ug/L)
	Molybdenum	200.7 ICP	0.01
	Nickel	200.8 ICP-MS	0.0006
	Selenium	200.8 ICP-MS	0.0001
	Silver	200.8 ICP-MS	0.0001
	Thallium	200.8 ICP-MS	0.0001
	Uranium	200.8 ICP-MS	0.0001
	Vanadium	200.7 ICP	0.005
	Zinc	200.7 ICP	0.01
Radionuclides[2]	U-234, -235, -238	EiChrom ACW03	1 pCi/L
	Ra-226	903.1	0.4 pCi/L
	Ra-228	904.0	1.5 pCi/L
	Pb-210	EiChrom OTW01	1 pCi/L
	Po-210	HASL Po-01-RC	1 pCi/L
	Th-228, -230, -232	ESM 4506	0.3 pCi/L
Major Cations[2]	Calcium	200.7 ICP	0.2
	Potassium	200.7 ICP	0.3
	Magnesium	200.7 ICP	0.2
	Sodium	200.7 ICP	0.3
Major Anions[2]	Alkalinity	SM 2320B	2
	Chloride	300.0 Ion Chrom.	0.5
	Sulfate	375.3 Gravimetric	10
Miscellaneous[3]	Organic Carbon*	SM 5310B	1
	Total Dissolved Solids	160 Gravimetric	10
	Total Suspended Solids*	160.2 Gravimetric	5

NOTES:
1. Dissolved and total recoverable forms for surface water samples; dissolved form only for groundwater/seep samples
2. Dissolved form only
3. Parameters noted by asterisk "*" for surface water samples only

Table 5. Sediment/Soil Laboratory Parameters, Analysis Methods, and Method Detection Limits

Analyte Group	*Constituent*	*U.S. EPA Method Number*	*Method Detection Limit (mg/kg)*
Metals[1]	Aluminum	200.7 ICP	3
	Antimony	200.7 ICP	2
	Arsenic	200.8 ICP-MS	0.05
	Barium	200.7 ICP	0.3
	Beryllium	200.7 ICP	0.2
	Cadmium	200.7 ICP	0.5
	Chromium	200.7 ICP	1
	Cobalt	200.7 ICP	1
	Copper	200.7 ICP	1
	Iron	200.7 ICP	2
	Lead	200.7 ICP	4
	Manganese	200.7 ICP	0.5
	Mercury	CVAA	0.04
	Molybdenum	200.7 ICP	1
	Nickel	200.7 ICP	1
	Selenium	200.7 ICP	4
	Silver	200.7 ICP	1
	Thallium	200.7 ICP	30
	Uranium	200.8 ICP-MS	0.05
	Vanadium	200.7 ICP	0.5
	Zinc	200.7 ICP	1
Radionuclides	Pb-210	EiChrom OTW01	10 pCi/g
	Th-228, -230, -232	ESM 4506	0.3 pCi/g
	Gamma Spectroscopy (Ra-226, Ac-228, K-40 and other gamma emitting radionuclides)	901.1	0.4 pCi/g
Organics[2]	PCBs	M8082 GC/ECD	0.01-0.02
Miscellaneous[3]	Organic Carbon*	ASA No. 9 29-2,2,4 IC Combustion (leco)	0.1 %
	Acid Volatile Sulfides (AVS)*	EPA 08/09 Draft	
	Paste pH	USDA No. 60 (21a)	0.1 s.u.
	Particle size distribution	ASA No. 9 15-4.2.2	0.1 %

NOTES:
1. Initial sampling event. List may be reduced for other events.
2. Sample collected in the vicinity of the former generator shack at the 300-foot level.
3. Parameters noted by asterisk "*" for stream sediment samples only.

FIGURES

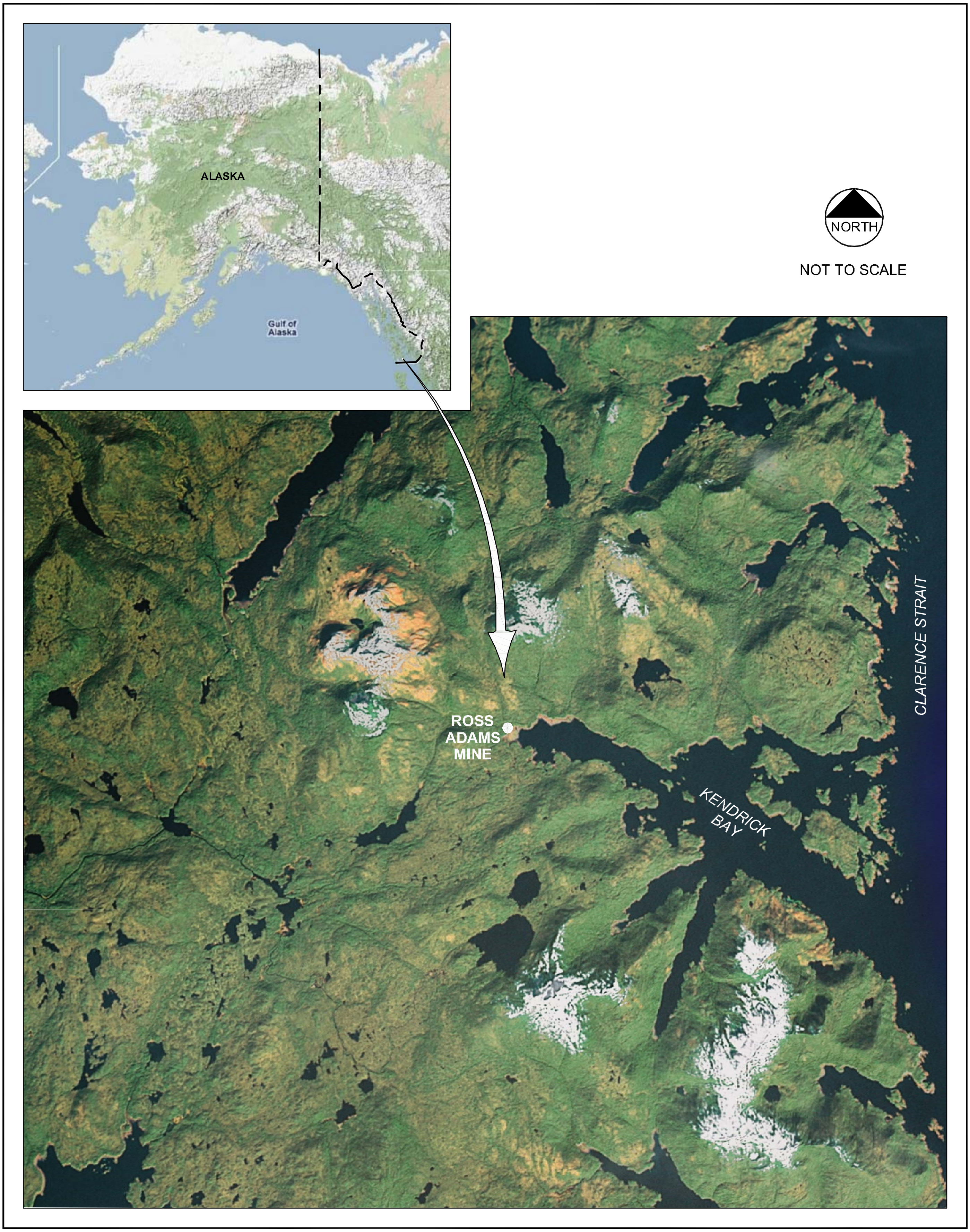

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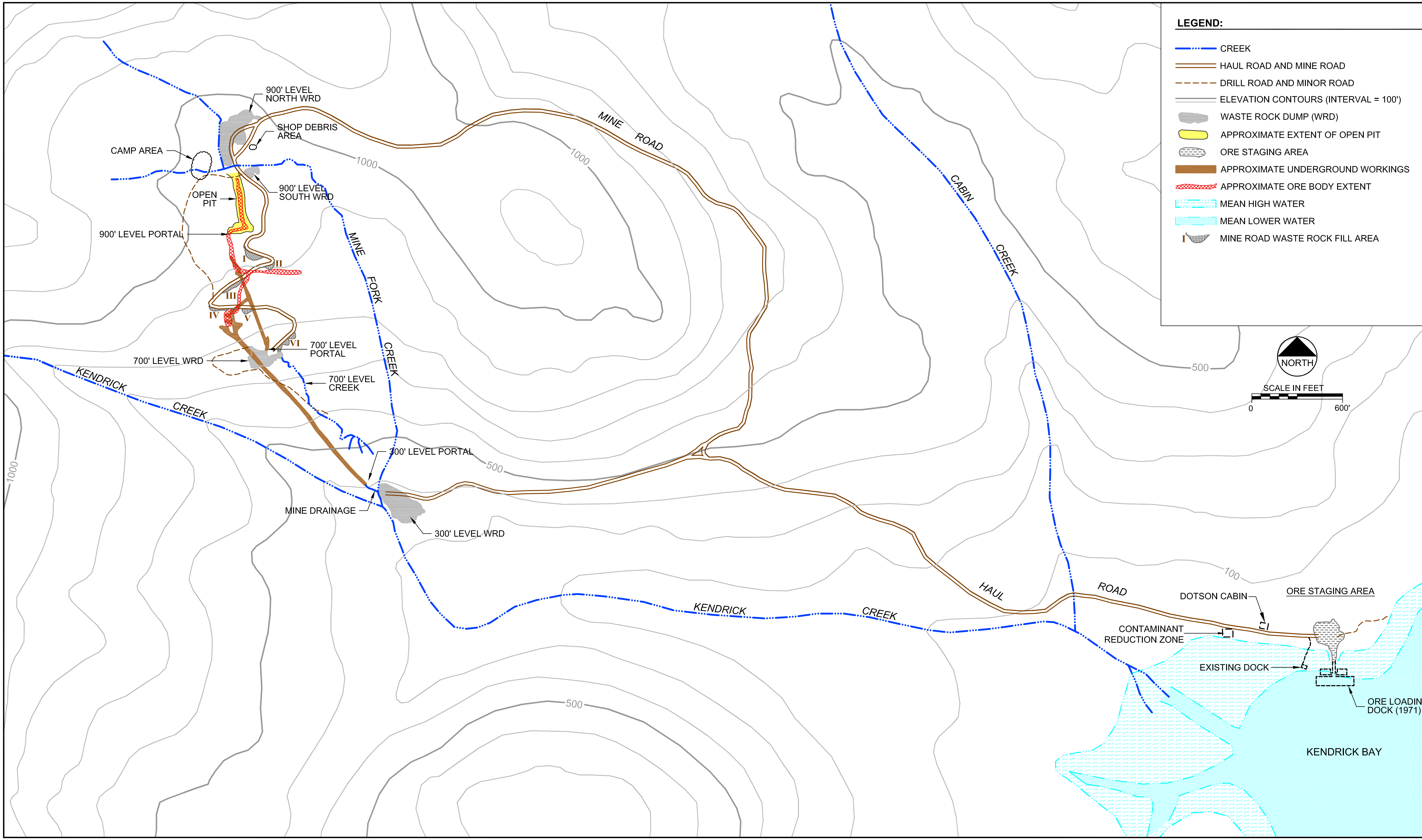
Figure 1
Ross-Adams Site Location



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Base Map Reproduced from Kent & Sullivan, 2004

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Figure 2
Ross-Adams Site
Major Site Features

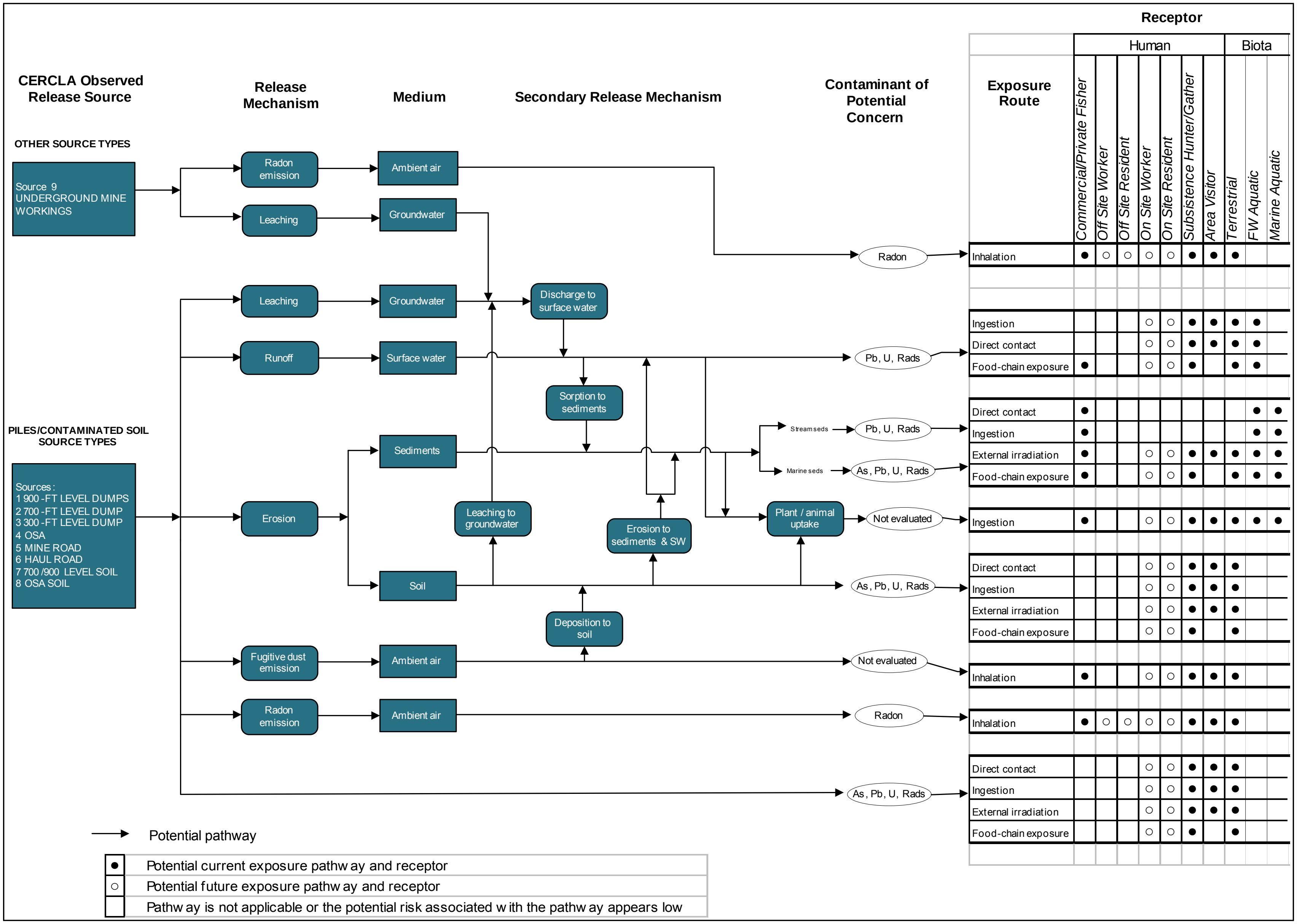

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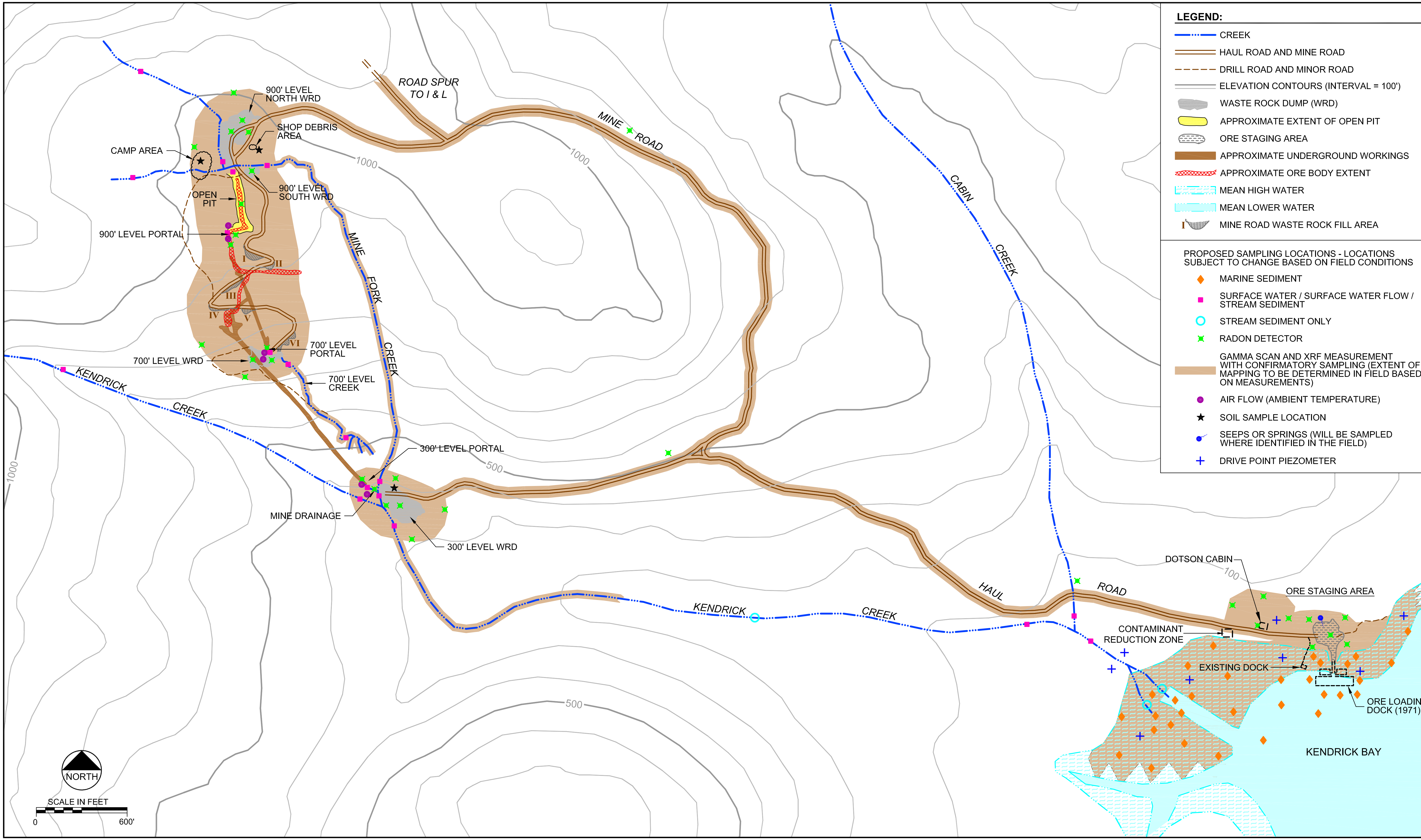
Figure 3
Ross-Adams Site
Preliminary Conceptual Site Model



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Note:
Final Sampling Locations will be Refined
by Field Reconnaissance.

Figure 4
Ross-Adams Site
Proposed Sampling Locations 2009

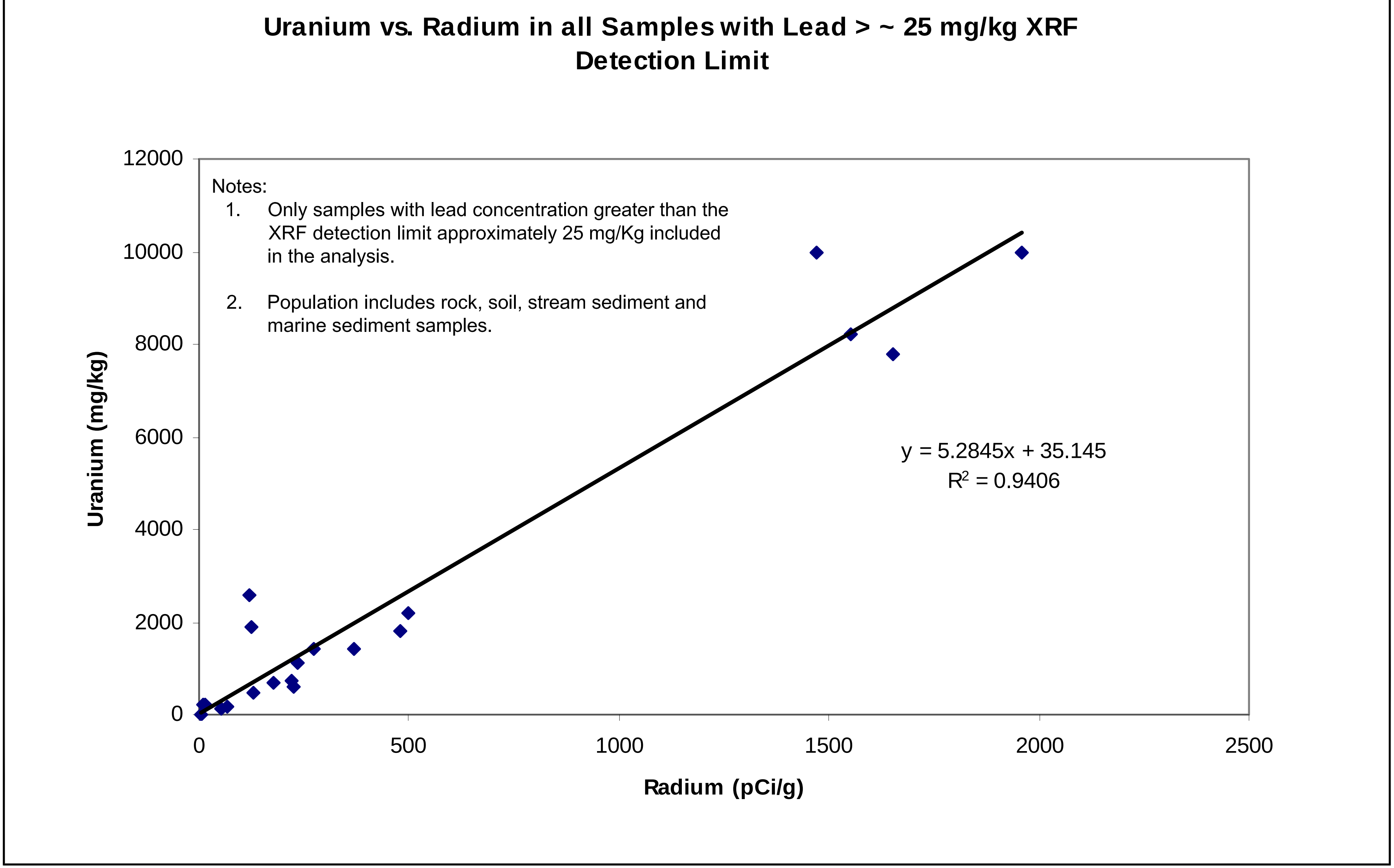

Figure 5
Ross-Adams Site
Uranium vs. Radium-226 in Select Solid Samples

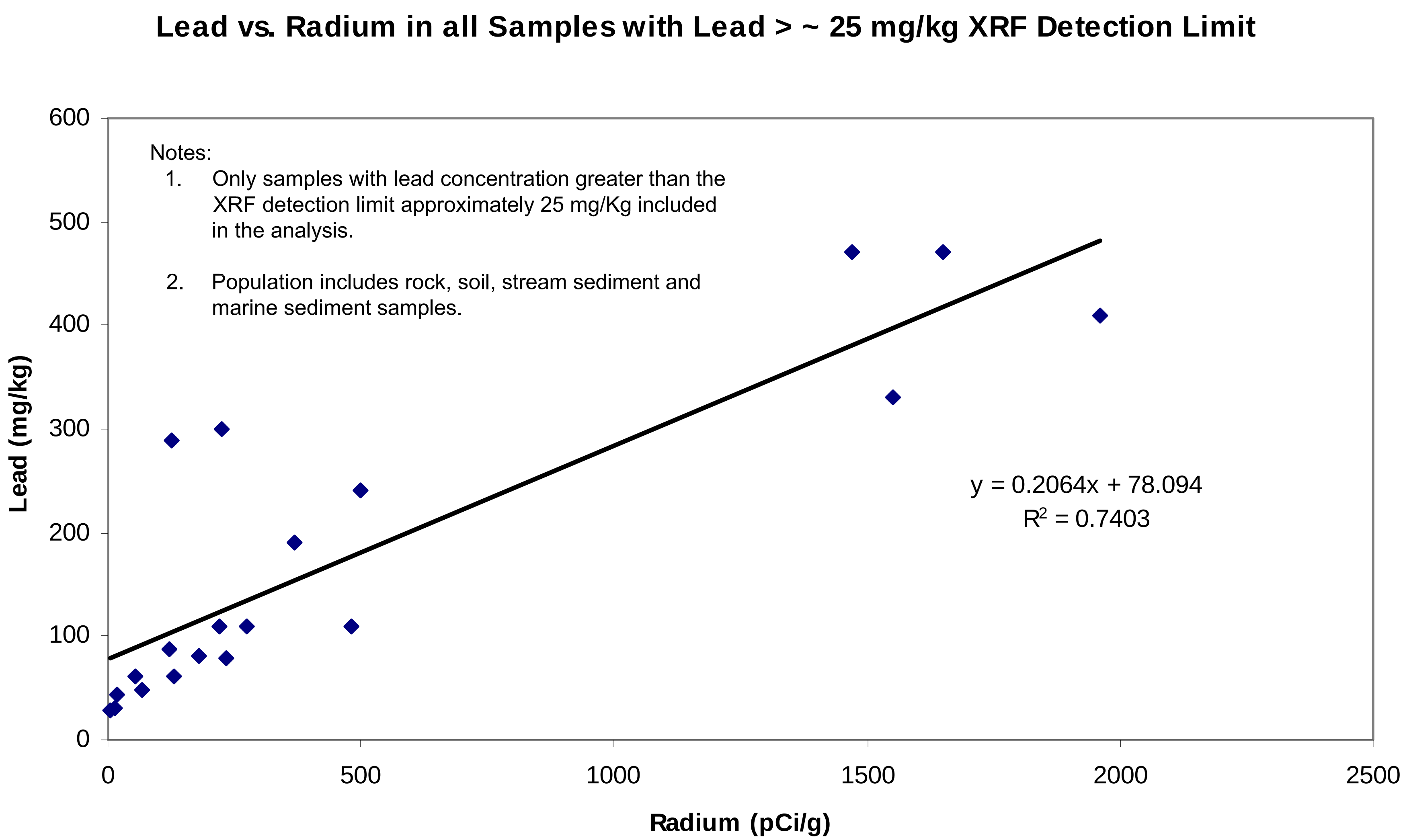

Figure 6
Ross-Adams Site
Lead vs. Radium-226 in Select Solid Samples