2004 PRELIMINARY ASSESSMENT/SITE INSPECTION REPORT

ROSS ADAMS URANIUM MINE

PRINCE OF WALES ISLAND, ALASKA

PREPARED FOR

U.S.D.A. FOREST SERVICE, ALASKA REGION

SUBMITTED: DECEMBER 30, 2004

KSI Project No: 25-10

KENT & SULLIVAN, INC.

Environmental Consultants

Table of Contents

Table of Contents (cont'd)

Table of Contents (cont'd)

Table of Contents (cont'd)

Appendices

Tables

Table of Contents (cont'd)

Figures

Acronyms and Abbreviations

~	approximately
µR/hr	micro roentgens per hour
Ac	actinium
ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
agl	above ground level
As	arsenic
Bi	bismuth
bgl	below ground level
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 as amended by the Superfund Amendments and Reauthorization Act of 1986
CFR	Code of Federal Regulations
cfs	cubic feet per second
Ci	Curie
Climax	Climax Molybdenum Company
cy	cubic yard
DO	dissolved oxygen
DQO	data quality objectives
DRO	diesel-range organics
GPS	global positioning system
HRS	hazard ranking score
KBMC	Kendrick Bay Mining Company
KSI	Kent & Sullivan, Inc.
LDC	Laboratory Data Consultants, Inc.
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MSL	mean sea level
NCP	National Contingency Plan
Newmont	Newmont Exploration, Ltd
ORP	oxygen-reduction potential
OSA	ore staging area
Pa	protactinium
PA	CERCLA preliminary assessment
Pb	lead
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter
POW	Prince of Wales
PPE	probably point of entry
ppm	parts per million

Acronyms and Abbreviations (cont'd)

QA/QC	quality assurance/quality control
Ra	radium
REE	rare earth elements
Rn	radon
RPA	Removal Preliminary Assessment Report [24]
RRO	residual-range organics
SCDM	Superfund Chemical Data Matrix
SI	CERCLA site inspection
SQL	sample quantitation level
SSLR	soil screening level for radionuclides
Standard	Standard Metals Corporation
TDL	target distance limit
TAL	target analyte list
Th	thorium
TNF	Tongass National Forest
TOC	total organic carbon
U	uranium
USBLM	U.S. Bureau of Land Management
USDA	U.S. Department of Agriculture
USDOD	U.S. Department of Defense
USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency
USFS	U.S.D.A. Forest Service, Alaska Region
USGS	U.S. Geological Society
West Arm	West Arm, Kendrick Bay

Selected CERCLA Glossary [34]

Actual Contamination in the Air Migration Pathway: A target population is subject to actual contamination if a sample location within its distance category meets the criteria for an observed release. Targets located within distance categories closer to the source than the distance category where the observed release is established are also subject to actual contamination. Targets located within distance categories beyond the most distant category containing an observed release, but within the 4 - mile target distance limit, are subject to potential contamination.

Actual Contamination for the Surface Water Pathway: A portion of a surface water body is considered subject to actual contamination if it meets criteria for an observed release. Sampling data from aqueous, sediments, or essentially sessile, benthic organisms may be used to establish actual contamination. However, the requirements for establishing actual contamination vary by threat.

Area of Observed Contamination: Evaluated only in the soil exposure pathway and established based on sampling locations as follows:

- Generally, for contaminated soil, the area lying between sampling locations that indicate observed contamination is considered an area of observed contamination unless information indicates otherwise.
- For sources other than contaminated soil, the entire source is considered to be an area of observed contamination if any sample taken from the source indicates observed contamination.
- If an area of observed contamination (or a portion of such an area) is covered by a permanent, or otherwise maintained, essentially impenetrable material (e.g., asphalt), the covered area is excluded from the area of observed contamination. However, asphalt or other impenetrable materials contaminated by site - related hazardous substances may be considered areas of observed contamination.

Aquifer: One or more strata of rock or sediment that is saturated and sufficiently permeable to yield economically significant quantities of water to wells or springs. An aquifer includes any geologic material that is currently used or could be used as a source of water (for drinking or other purposes) within the target distance limit. All geologic materials combined into one aquifer are referred to as a single hydrologic unit.

Background Level: The concentration of a hazardous substance that provides a defensible reference point with which to evaluate whether or not a release from the site has occurred. The background level should be reflective of the concentration of the hazardous substance in the medium of concern for the environmental setting on or near the site. Background level does not necessarily represent pre-release conditions, nor conditions in the absence of influence from source(s) at the site. Background level may or may not be less than the detection limit, but if it is greater than the detection limit, it should account for variability in local concentrations. Background level need not be established by chemical analysis.

Note: The term background reference is used in this report to refer to the concentration, activity, or gamma radiation level above which signifies observed contamination or an observed release. The criteria used to establish a background reference based on laboratory analyses are listed in Section 5.1.1.

CERCLA Hazardous Substances: Hazardous substance as defined by statute in CERCLA section 101(14); the list of CERCLA hazardous substances having reportable quantities is found in 40 CFR 302 in Table 302.4.

CERCLA Pollutant or Contaminant: Section 101(33) of CERCLA states that: "pollutant or contaminant shall include, but not be limited to, any element, substance, compound, or mixture, including disease - causing agents, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical deformations, in such organisms or

Selected CERCLA Glossary [34] (cont'd)

their offspring; except that the term "pollutant or contaminant" shall not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under subparagraphs (A) through (F) of paragraph (14) and shall not include natural gas, liquefied natural gas, or synthetic gas of pipeline quality (or mixtures of natural gas and such synthetic gas)."

Chemical Waste Pile: A pile consisting primarily of discarded chemical products (whether marketable or not), by-products, radioactive wastes, or used or unused feedstocks.

Contaminated Soil (excluding land treatment): Soil onto which available evidence indicates a hazardous substance was spilled, spread, disposed, or deposited.

Evidence of Hazardous Substance Migration: Chemical analyses and/or visual evidence that demonstrate hazardous substances attributable to a source have migrated away from that source into the surrounding soil, groundwater, surface water, or air (e.g., leachate containing hazardous substances coming out of the source; stained or contaminated soil that can be attributed to migration from the source; evidence of the overflow from a surface impoundment containing hazardous substances).

Fishery: Any area of a surface water body from which human food chain organisms are taken or could be taken for human consumption on a commercial, recreational, or subsistence basis. Food chain organisms include fish, shellfish, crustaceans, amphibians, and amphibious reptiles. Fisheries are delineated by changes in dilution weights, level of contamination, or annual production.

Hazardous Constituent Quantity: The mass (in pounds) of CERCLA hazardous substances allocated to a source (with certain exceptions for RCRA wastes).

Hazardous Substances: Hazardous substances consist of CERCLA hazardous substances, pollutants, and contaminants as defined in CERCLA sections 101(14) and 101(33), except as otherwise specifically noted in the HRS.

Hazardous Substance Migration Path: The path that hazardous substances travel (or would travel) overland from a source to surface water (overland segment) and within surface water to the target distance limit (in-water segment). In certain cases (e.g., sites consisting only of contaminated sediments, sites where sources are located in surface water bodies), the hazardous substance migration path consists of only an in-water segment.

In-water Segment: Portion of the hazardous substance migration path from the probable point of entry (PPE) to the target distance limit. For tidally-influenced rivers, the in-water segment may include portions of surface water bodies upstream from the PPE to the extent that the in-water migration path is reversed by tides. For contaminated sediments with no identified source, the in-water segment begins at the upstream boundary (for streams and rivers) or center of the area of contaminated sediments (for water bodies with no direction of flow).

Level I Concentrations for the Air Migration Pathway: Level I concentrations are established at sampling locations where the concentration of at least one hazardous substance that meets the criteria for an observed release is at or above its health-based benchmark for air. Benchmarks for air include National Ambient Air Quality Standards (NAAQs), National Emission Standards for Hazardous Air Pollutants (NESHAPs), screening concentrations for cancer, and screening concentrations for non-cancer toxicological responses.

Level II Concentrations for the Air Migration Pathway: Level II concentrations are established at sampling locations where the concentration of at least one hazardous substance meets the criteria for an observed release, but the conditions for Level I concentrations are not met. In addition, Level II is assigned to observed releases established by direct observation.

Selected CERCLA Glossary [34] (cont'd)

Level I Concentration for the Surface Water Pathway: Level I concentrations are established in samples in which the concentration of a hazardous substance that meets the criteria for an observed release is at or above its specific health-based benchmark for the surface water threats, with certain exceptions for the human food chain threat. Targets also may be subject to Level I concentrations if multiple hazardous substances that meet the criteria for an observed release are present below their respective benchmarks. Benchmarks for the surface water pathway include maximum contaminant level (MCLs), non-zero maximum contaminant level goals (MCLGs), Food and Drug Administration advisory levels (FDAAL) for fish or shellfish, ambient water quality criteria (AWQC) for protection of aquatic life, ambient aquatic life advisory concentrations (AALAC), and screening concentrations for cancer and chronic non-cancer effects.

Level II Concentration for the Surface Water Pathway: Level II concentrations are established in samples in which the concentration of at least one hazardous substance meets the criteria for an observed release, but the conditions for Level I concentrations are not met, with certain exceptions for the food chain threat. In addition, Level II concentrations are assigned to observed releases established by direct observation.

Listed Sensitive Environment: Areas that are evaluated as one or more of the sensitive environments listed in HRS Table 4-23, even if these areas (or portions of these areas) also are being evaluated as a wetland. The distinction is necessary because a wetland that is also a listed sensitive environment (e.g., a wetland area that also is habitat known to be used by an endangered species) would be evaluated as two separate sensitive environments.

Observed Contamination: Observed contamination is established for the soil exposure pathway only by chemical analysis. The minimum requirements for establishing observed contamination in the soil exposure pathway are (1) analytical data that the concentration of at least one hazardous substance attributable to the site is significantly above background level, (2) information that some portion of that increase is attributable to the site, and (3) the hazardous substance is present at the surface or is covered by two feet or less of cover material (e.g., soil) other than an essentially impenetrable material (e.g., asphalt).

Observed Release: An observed release is established for the ground water, surface water, or air migration pathway either by chemical analysis or by direct observation. The minimum requirements for establishing an observed release by chemical analysis are analytical data demonstrating the presence of a hazardous substance in the medium significantly above background level, and information that some portion of that increase is attributable to the site. The minimum criterion for establishing an observed release by direct observation is evidence that the hazardous substance was placed into or has been seen entering the medium.

Overland Segment: Portion of the hazardous substance migration path from a source to a surface water body.

Probable Point of Entry (PPE): Point at which the overland segment of a hazardous substance migration path intersects with surface water. A site may have multiple PPEs. The PPE is assigned as the point at which entry of the hazardous substances to surface water is most likely. [Note: In the Ross Adams 2004 SI report, a single PPE is assigned to each source at the most likely upstream location that hazardous substances could migrate to surface water.]

Source: An area where a hazardous substance may have been deposited, stored, disposed, or placed. Also, soil that may have become contaminated as a result of hazardous substance migration. In general, however, the volumes of air, ground water, surface water, and surface water sediments that may have become contaminated through migration are not considered sources.

Tailings Pile: A pile consisting primarily of any combination of overburden from a mining operation and tailings from a mineral mining, beneficiation, or processing operation.

Selected CERCLA Glossary [34] (cont'd)

Target Distance Categories: Concentric rings (not necessarily circular) with radii 1/4, 1/2, 1, 2, 3, and 4 miles from the sources at the site. These distance categories are used to group the wells subject to potential contamination for distance weighting.

Target Distance Limit for the Air Migration Pathway: Distance over which population and other targets are evaluated. The target distance limit generally is a four-mile radius from the sources at the site. However, if a sampling point meeting the criteria for an observed release is located beyond the four-mile radius, that point defines the outer boundary of the target distance limit. For example, if an observed release is established six miles from the source, the target distance limit is six miles.

Target Distance Limit for the Ground Water Migration Pathway: The target distance limit is the distance over which targets are evaluated. For the ground water pathway, the target distance limit is generally a four-mile radius from the sources at the site, except: Any drinking water well with an observed release attributed to the site is evaluated, regardless of its distance from the source.

Target Distance Limit (TDL) for the Surface Water Migration Pathway: Distance over which the in-water segment of the hazardous substance migration path is evaluated. The target distance limit extends 15 miles from the PPE in the direction of flow (or radially in lakes, oceans, or coastal tidal waters) or to the most distant sample point establishing an observed release, whichever is greater. In tidally-influenced surface water bodies, an upstream target distance limit is also determined. For some sites (e.g., sites with multiple PPEs), an overall target distance of greater than 15 miles may result.

Terrestrial Sensitive Environment: A terrestrial sensitive environment is defined as any area that meets the criteria listed in HRS Table 5-5. No other areas are considered terrestrial sensitive environments.

Watershed: The region drained by, or contributing water to, a surface water body. Watershed evaluations are performed in two areas.

- Drainage Area: Portion of the watershed upgradient of sources at the site.
- Watershed: Portion of the watershed downgradient of the site. The watershed includes the surface water bodies between the PPEs and the target distance limit (i.e., the in-water segment of the hazardous substance migration path). A single watershed includes all in-water segments that intersect within the target distance limit. A site is in two or more watersheds if two or more hazardous substance migration paths from the sources do not reach a common point within the target distance limit. In these cases, each distinct watershed is evaluated separately.

Wetlands: Generally includes swamps, marshes, bogs, and similar areas. As defined in 40 CFR 230.3 and the HRS, wetlands are those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Such areas can be natural or constructed. Only areas that meet this definition are eligible to be evaluated as wetlands for HRS purposes. Wetlands identified using other definitions (e.g., the Food Security Act of 1985, the wetlands classification system of the U.S. Fish and Wildlife Service, the 1989 Federal Manual for Identifying and Delineating Jurisdictional Wetlands) are not eligible unless they also meet the 40 CFR 230.3 definition. Additionally, for HRS purposes, isolated wetlands and wetlands contiguous to rivers, lakes, and coastal tidal waters are defined as surface water bodies.

Executive Summary

This report presents the results of a Comprehensive Environmental Response, Compensation, and Liability Act of 1980 as amended by the Superfund Amendments and Reauthorization Act of 1986 (CERCLA) Preliminary Assessment and Site Inspection conducted at the Ross Adams uranium mine located ~38 miles southwest of Ketchikan in southern southeast Alaska. The mine produced ~94,500 tons of uranium ore between 1955 and 1971, initially from an open pit (the 900-foot level) and subsequently from underground workings accessed through two haulage adits (the 700-foot and 300-foot levels). A haul road connects the mine levels to a sea-level staging area and a former ore barge loading dock on the West Arm of Kendrick Bay. All of the ore was shipped off site and milled outside Alaska. The majority of the ore was produced by Climax Molybdenum Company[1] (1957), Standard Metals Corporation[2] (1961 to 1964), and Newmont Exploration, Ltd. (1971).

A Removal Preliminary Assessment (RPA) of the mine area was performed by the U.S. Bureau of Land Management (USBLM) in 1995 and 1997. This work identified nine acres of waste rock dumps and road system segments with gamma radiation levels greater than 100 micro roentgens per hour (µR/hr) compared to background levels of 13 to 44 µR/hr. Gamma radiation levels greater than 1,000 µR/hr were identified on the four main waste rock dumps. Two waste rock samples were collected and contained elevated total uranium and Ra-226 activities. Surface water sampling indicated that the mine drainage and streams below two waste rock dumps contain elevated gross alpha and gross beta radiation levels compared to background surface water. Air samples in the mine contained elevated radon activities between 212.3 and 540.5 picoCuries per liter (pCi/L) compared with the residential air benchmark of 4 pCi/L.

The 2004 Site Inspection (SI) field work was performed in May 2004. Potential sources of hazardous substances associated with the mine and potential targets associated with the migration of hazardous substances from sources to the surface water and air pathways were evaluated. The groundwater pathway was not evaluated because groundwater is not used within the four-mile groundwater pathway target distance limit (TDL) and potential exposure to groundwater at the site occurs only through the surface water pathway. A total of 81 characterization samples were collected, including 21 waste rock and soil source samples, six surface water samples, seven stream sediment samples, six marine sediment samples, 13 radon detector samples (air), and 28 background samples representative of each of these media and the geologic settings where they were collected. The samples were selectively analyzed for radon, metals, and radionuclides in the natural thorium (Th) and uranium (U) decay series (Th-232, U-235, and U-238). Background reference concentrations or activities for each analyte, media, and geologic setting were established based on the background sample results. For detected metals, background references are three times the maximum concentration, and for detected radionuclides, background references are two standard deviations above the mean activity. Background references for gamma radiation are two times the mean background readings taken three feet above the ground surface. Sample results or gamma radiation readings that exceed a background reference are evidence of actual contamination. The principal findings of the SI are summarized below.

[1] In partnership with Kendrick Bay Mining Company
[2] In partnership with Bay West, Inc.

Hazardous substances. Waste rock, soil, stream sediment, and marine sediment samples contained the following analytes in concentrations that exceed background references:

- Arsenic
- Lead
- Total uranium
- Numerous radionuclides in the U-235, U-238, and Th-232 decay chains.

Surface water samples contained the following analytes in concentrations or activities that exceed the background references:

- Total uranium
- Ra-226
- Ra-228.

Sources. The areas listed below are discrete sources of observed contamination.

- 900-foot level dumps
- 700-foot level dump
- 300-foot level dump
- Ore staging area (OSA)
- Mine road
- Haul road
- 700/900-foot level soil
- OSA soil
- Underground mine workings.

The mine dumps, OSA, and roads contain an estimated 45,000 cubic yards (cy) of mine waste rock and the contaminated soil adjacent to the waste rock sources cover at least 3.3 acres. Soil is treated as a source in this report in accordance with CERCLA guidance although it is recognized that soil contamination has resulted from the migration of hazardous substances from waste rock sources. The mine waste rock and soil sources are direct exposure routes to human and terrestrial receptors via direct contact, ingestion, inhalation, external radiation, and food-chain exposure routes and have also resulted in observed releases to the surface water and air pathways.

The underground mine workings are a source of metals and radioactivity with direct exposure routes to human and terrestrials receptors via inhalation of radon emissions and has resulted in observed releases to the surface water and air pathways.

Observed contamination. Actual contamination was documented in the surface water, soil, and air exposure pathways as described below.

- **Surface water pathway**. Portions of the mine dumps are cut by fresh water streams and a portion of the OSA is within the intertidal zone. Surface water, stream sediment, and marine sediment samples demonstrate that contaminants have been and continue to be released to the surface water pathway. Releases impact the lower 5,750 feet of Kendrick Creek from probable points of contaminant entry at the 300-foot level dump to the stream outlets as well as part of the Kendrick Creek delta in West Arm. Short sections of Mine Fork Creek and 700 Level Creek also have actual contamination as do marine sediments.

- **Soil exposure pathway**. Observed waste rock and soil contamination cover a minimum of ~8.4 acres of land including the haul road, ore staging area, mine dumps, and mine workings which are available for use areas by recreational visitors. The activities of radium isotopes Ra-226 and Ra-228 exceed background references in nearly all SI source rock and surface soil samples. Most source samples also contain numerous other radionuclides as well as arsenic, lead, and total uranium at activities/concentrations that exceed the background references. Gamma radiation exceeds the background reference over most of the waste rock sources with maximum radiation levels of 2,200 to 5,000 µR/hr.

- **Air pathway**. The underground mine workings and waste rock piles are sources of radon emissions to the atmosphere. Radon activities range between 24 and 396 pCi/L in air outside four mine openings and between 10 and 105 pCi/L above the waste rock dump sources.

Targets. The targets listed below are current populations with actual or potential on-site exposures:

- One family, the Dotsons, occasionally, and possibly seasonally, occupies a cabin to work mining claims in the area.
- Site visitors include recreational users, such as fishers, hunters, hikers, berry pickers, etc.; commercial fishers; government employees; and minerals exploration personnel.
- A drinking water intake on Cabin Creek services the Dotson cabin. Contaminated sections of the haul rock are in the Cabin Creek watershed, although a water sample collected at the intake did not exceed surface water benchmarks or background references.
- The other clear water creeks in the Kendrick Creek drainage are available drinking water sources for site visitors. Surface water samples demonstrate actual contamination of ~6,750 feet of the creeks, and drinking water benchmarks are exceeded in the 300-foot level mine drainage and in the 700 Level Creek.
- Approximately 6,470 linear feet of wetlands border stream reaches with actual contamination. Approximately 88 acres of wetlands are within areas considered exposed to actual radon contamination (within 0.25 miles of radon sources).
- Kendrick Creek is a designated anadromous fish stream.

- The range of Steller sea lions, a Federally-designated threatened species, includes marine waters with actual marine sediment and radon contamination. If present, sea lions are expected to be transient visitors to these waters.

Continuous off-site human exposures are currently unlikely since towns or known permanent residences are not present within the 15-mile surface water TDL or 4-mile air TDL. Potential off-site targets include:

- Commercial, subsistence, and recreational fishers target waters in the 15-mile surface water TDL and 4-mile air TDL. A significant commercial salmon fishery occurs in Kendrick Bay and commercial shrimp, sea cucumber, and red urchin fishing also occur in these waters.
- Recreational users, such as hunters, hikers, berry pickers, etc.; government employees; and minerals exploration personnel visit lands within the 4-mile air TDL.
- In addition to Kendrick Creek, 18 designated anadromous fish streams empty into marine waters within the 15-mile surface water TDL, and 16 watersheds host designated anadromous fish streams within the 4-mile air TDL.
- Approximately 6,110 feet of wetlands border surface water outside the site area but within the 15-mile surface water TDL. Approximately 27,300 acres of wetlands are outside the areas of actual contamination but within the 4-mile air TDL.
- Part of the South Prince of Wales Wilderness is within the 4-mile air TDL.
- The range of Federally-designated endangered species (humpback and fin whales) and Federally-designated threatened species (Steller sea lion) are within the 15-mile surface water TDL and the range of humpback whales and sea lions are within the 4-mile air TDL. Major sea lion rookeries and haulouts are not present in the air or surface water TDLs, and the presence of any of these species within the TDLs is expected to be transient.

Removal action assessment. One or more CERCLA reportable quantity limits for arsenic, lead, natural uranium in secular equilibrium with its daughters, and natural thorium in secular equilibrium with its daughters are exceeded in each of the waste rock and soil sources. The sources contain a total of ~15.3 Curies (Ci) natural uranium and 7.0 Ci natural thorium compared to reportable quantities of 0.052 and 0.011 Ci, respectively.

The data collected during the SI show that the site meets the requirements for a removal action as defined by 40 CFR 300.415. Site conditions meet four specific factors relevant to initiating a removal action under CERCLA: 1) actual or potential exposure to nearby human populations, animals, and the food chain has been documented to occur via the surface water, soil exposure, and air pathways; 2) actual or potential contamination of drinking water supplies and sensitive ecosystems has been documented; 3) high levels of natural uranium and thorium and their daughter products occur in waste rock and soil at or near the surface and have been demonstrated to migrate, and 4) high average annual precipitation and high two-year, 24-hour probable maximum precipitation amounts at the site are conducive to contaminant migration by stream erosion, sediment transport, and overland transport.

1.0 Introduction

This document is submitted to the United States Department of Agriculture (USDA) Forest Service, Alaska Region (USFS) by Kent & Sullivan, Inc. (KSI) under contract 53-0109-0-00543, task order 08. The document contains the results of preliminary assessment/site inspection (PA/SI) activities performed in general accordance with workplans [13] approved by the USFS and the U.S. Environmental Protection Agency (USEPA) regarding the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 and applicable portions of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) [31].

1.1 OBJECTIVES

The PA/SI objectives and approach for this project were established in the project workplan [13] are listed below.

1. *Characterize potential sources of contamination and radioactive substances.* This was accomplished by:
    - Collecting and analyzing mine waste rock and surface soil samples for natural uranium and thorium and their decay products, and metals
    - Evaluating the mean and maximum concentrations for each radionuclide and metal in four waste rock sources
    - Collecting and analyzing samples from background reference areas to characterize the natural background concentration range for each source-related radionuclide and metal
    - Mapping source dimensions and calculating waste rock volumes.
2. *Identify areas of observed contamination.* This was accomplished by:
    - Collecting and analyzing samples from background reference areas in each medium for source-related radionuclides and metals
    - Collecting and analyzing samples in the surface water and air pathways for source-related radionuclides and metals
    - Evaluating the significance of each source-related radionuclide and metal in these media.
3. *Identify levels of contamination at specific targets.* This was accomplished by using published, media-specific benchmarks for radionuclides and other contaminants to assess the significance of observed contamination.

4. *Assess whether a removal/remedial response is warranted under CERCLA*. This was accomplished by determining the CERCLA hazardous substances that exceed reportable quantity limits in site sources and reviewing the SI results in relation to the criteria contained in 40 CFR 300.415.

5. *Provide sufficient environmental data to allow USEPA to score the site using the Hazard Ranking System (HRS)*. This was accomplished by using EPA guidance [28, 30] for performing PAs and SIs, including the specific instructions for radioactive sites. The work was performed primarily as an "expanded SI" because much of the required PA information had been largely collected and the remoteness of the site dictates that as much information as practicable should be collected during a single mobilization to the site. A previous investigation by the U.S. Bureau of Land Management (USBLM, [21]) titled *Removal Preliminary Assessment, Bokan Mountain Mine* (referred to herein as the RPA), identifies areas of potential human and environmental exposure to gamma radiation and radionuclides associated with the Ross Adams mine. The 2004 SI provides additional information concerning the nature of the sources, evaluates pathways and targets not previously examined, and assesses background concentrations in potentially impacted media. The SI sampling program objectives focused on filling data gaps and confirming previous sampling results needed to complete the HRS score.

To the extent practicable, the 2004 SI was performed to address objectives that are specific to a scoping survey performed under MARSSIM [28]. The following objectives for a scoping survey listed in Section 5 of MARSSIM were incorporated into the 2004 SI as follows:

- *Perform a preliminary hazard assessment*. This was accomplished in the Health and Safety Plan contained in the PA/SI Workplan [13].
- *Optimize the survey for use in the future characterization and/or final status surveys.* This was addressed by analyzing samples for many of the daughter products in the Th-228, U-235, and U-238 decay chains. The information from these data could be utilized in the future to assess statistically significant progenitor-to-daughter ratios, minimize future analytical costs, and to help establish site cleanup goals.
- *Provide data to complete the CERCLA site prioritization scoring process (HRS scoring).* This was addressed as explained in a previous paragraph.
- *Provide input to the characterization survey design if appropriate.* This was addressed by assessing maximum and mean concentrations of four radioactive sources and estimating the volume of contaminated waste rock and soil sources.

1.2 REPORT ORGANIZATION

Section 2 of this report provides general site background information. Section 3 explains the field and analytical procedures that were used during the SI, and Section 4 summarizes the overall quality and usability of the data obtained during the SI. Section 5 explains the process for evaluating the significance of the analytical data and summarizes the background reference data. Section 6 summarizes the data pertaining to potential sources, and Section 7 summarizes the data pertaining to

potential migration pathways and targets. Section 8 provides removal action assessment of the site based on the SI results. Section 9 discusses the conceptual site model and lists important site characterization data gaps.

Supporting references are numbered and listed in Appendix A; they are referred to in the text by their number in brackets, e.g. "[1]" refers to the first reference listed in Appendix A. Appendix A also contains a copy of the reference cover, article (if not readily available), or a printout of the on-line data source.

Photographs are numbered and printed in Appendix B; they are referred to in the text using the appropriate photograph number.

A completed SI Data Summary (Appendix B in [28]) is contained in Appendix C.

Worksheet calculations are numbered and contained in Appendix D; they are referenced in the text using the appropriate worksheet number.

A CD ROM containing an electronic copy of this report, drawings, database, and the laboratory reports and data packages is contained in Appendix E.

The data validation summary report is provided in Appendix F.

Printed copies of the laboratory reports are provided in Appendix G.

2.0 Site Background

2.1 SITE DESCRIPTION AND BACKGROUND

The Ross Adams mine is in the Bokan Mountain uranium-thorium area in southern southeast Alaska. The mine produced ~94,500 tons of ore averaging ~0.8 percent uranium oxide (U_3O_8) from mining operations between 1957 and 1971 [7, 39]. Production was from open pit and underground workings. The ore was barged to Washington where it was shipped for processing at the Dawn Mining Company mill in Ford, Washington or the Mexican Hat Mill in Utah [40].

2.1.1 Site Location

The mine is located in the Tongass National Forest (TNF) near the southern end of Prince of Wales (POW) Island, ~38 miles from Ketchikan (Figure 1). The mine is on the southeast flank of Bokan Mountain in the Kendrick Creek watershed. A haul road runs from the mine to a former barge loading facility at the west end of West Arm, Kendrick Bay (West Arm). Kendrick Bay is a five-mile long fiord that opens onto Clarence Straight on the east side of POW Island. The nearest towns are Metlakatla, 28 miles to the northeast across Clarence Straight, and Hydaburg, 33 miles to the northwest on the west side of POW Island.

2.1.2 Topographic Map Quadrangle

Map coverage for the site is provided by the United States Geological Survey (USGS) 15-minute quadrangle map titled Dixon Entrance (D-1), Alaska. The mine, haul road, and loading facility are located in Sections 22, 26, and 27, Township 80 South, Range 88 East of the Copper River Meridian (Figure 2).

2.1.3 Latitude, Longitude, and Elevation

The site latitude and longitude in the NAD 1983 (Alaska) datum measured by global positioning system (GPS) at the 900-foot level Mine Fork Creek bridge (Figure 3) are:

Latitude: 54° 54' 37.65" North

Longitude: 132° 8' 21.33" West

Elevation: 965 feet mean sea level (MSL).

2.1.4 Access

Access to the site is unrestricted but requires a boat, aircraft, or long overland approach on foot. The site is not on the POW road network and TNF roads do not extend into the Bokan Mountain area. The haul road can be used by foot traffic, four-wheel-drive vehicles, or recreational all-terrain vehicles. Access to the waste rock dumps is unrestricted, and the mine portals at all three levels are open. The

USFS has posted signs at numerous locations across the site to warn visitors of radiation and mine hazards.

2.2 MINE DESCRIPTION

The Ross Adams mine was initially developed by open-pit mining and later by underground operations from two haulage adits (Figure 4). The mine area is divided based on the approximate elevations of the workings into the "900-foot level", "700-foot level", and "300-foot level" (Figures 3 and 4). A haul road runs from the 900-foot level to the north shore of West Arm where the ore staging area (OSA) and loading dock were located. The haul road branches ~0.8 miles inland from the OSA with the lower branch serving the 300-foot level. Road access to the 700-foot level is via a switch-back road from the 900-foot level referred to as the mine road. Drill roads extend down the slope below the 700-foot level waste rock dump. Figure 5 is a 1971 aerial photograph of the site showing the roads and mine workings, and Photos 1 and 2 show the area between West Arm and the mine workings.

2.2.1 900-Foot Level

The ore body cropped out at an elevation of ~970 feet on a broad bench with gently rolling local topography (Photos 3, 4). The ore body was mined in 1957 from an open pit ~380 feet long (north to south), 60 to 160 feet wide, and 25 to 40 feet deep (Figure 3). An estimated 20,000 to 30,000 cubic yards (cy) of rock was removed from the pit. At the south end of the pit, the ore body turns abruptly to the west and is down-faulted which prevented further open pit mining. A stope from the 700-foot level breaks through to the surface at the south end of the open pit, and an air shaft serving the underground workings is located ~150 feet south of the open pit. Truck access to the pit was from the north, and the pit floor slopes gently to the south. Sub-ore-grade material (<0.5 percent U_3O_8) crops out on the pit walls and occurs as slough on the pit bottom [39].

Waste rock at the 900-foot level occurs in piles located north and east of the open pit (Figure 3). The largest waste rock pile is located on the north side of Mine Fork Creek and is referred to as the north dump. A smaller pile (the south dump) borders the south side of Mine Fork Creek northeast of the pit. Small waste rock piles are present in the area east of the pit.

The remains of a shop or storage building is located east of the north dump (Photo 5, 6), and a small building remains standing at the edge of the south dump. The remnants of the mine camp including a drill core shack are present northwest of the open pit.

2.2.2 700-Foot Level and Mine Road

The ore body was worked from the 700-foot level between 1961 and 1964. The area is on a moderately steep, south-facing slope south of the 900-foot level. A haulage adit was driven ~390 feet through granite to intercept the ore body south of the open pit. The adit is approximately 9 by 7 feet and involved removing ~1,000 cy of development rock. A waste rock dump ~230 feet wide is located at the adit portal and forms an extensive fan down-slope from the portal. USBLM [24] reports that the 700-

foot level is flooded by water two feet deep within 19 feet of the portal. Surface water flow from the adit was not observed during the SI, but a continuous flow from the adit and onto the waste rock dump was observed in November 2004 [15]

The mine road between the 700-foot and 900-foot levels appears to be constructed in part with waste rock, probably from the 900-foot level dumps, as evidenced by gamma radiation levels of 500 to 2,000 micro roentgens per hour (µR/hr) along most of the road bed [24].

2.2.3 300-Foot Level

The remainder of the ore body was mined in 1971 from the 300-foot level. A 13- by 16-foot haulage adit was driven ~1,300 feet through quartz monzonite and granite to below the ore body which terminated at an elevation of ~430 feet. The ore was reached by several raises from the end of the adit. Approximately 10,000 cy of waste rock were removed from the 300-foot level adit in addition to an unknown quantity of material removed from the raises and drifts used to access the ore body.

The adit portal is 100 feet west of Mine Fork Creek and 115 feet north of Kendrick Creek. A bridge across Mine Fork Creek provided access to the portal. Waste rock was brought to the opposite side of the bridge and dumped along Mine Fork Creek and Kendrick Creek in an area ~200 feet wide and 330 feet long. All that remained of the bridge in October 2003 were two logs, and it was impassable even on foot. Two buildings, two trailers, and a large pile of drill core remain at the 300-foot level (Photos 7, 8).

2.2.4 Haul Road

A haul road connects the mine to the OSA and former barge loading facility. The haul road to the 900-foot level was presumably constructed as part of the initial development work on the mine and was used during mining of the 900- and 700-foot levels. The haul road to the 300-foot level branches off the original road ~ 0.8 miles from the OSA. Gamma emissions exceed 100 µR/hr in 17 areas totaling ~3,000 linear feet along the haul road [24].

2.2.5 Ore Staging Area (OSA) and Floating Dock

Ore was stockpiled at the OSA prior to loading onto barges. The OSA is on a gently-sloped area on the north side of West Arm ~0.25 miles east of the head of the arm (Photos 9, 10). The area cleared for the staging area was approximately 200 by 280 feet and covers ~1 acre. A dike approximately three-foot high diverts run-on surface water to the east of the main staging area. A residual amount of ore material remains primarily in a 160- by 200-foot area on the southwest side of the dike and adjacent to the ramp leading to the former dock.

A small floating dock, a cabin, and a generator shed line the north shore of West Arm west of the OSA (Photos 11, 12). The head of the dock is within an area of gamma radiation emissions greater 1,000 µR/hr.

2.2.6 Former Loading Dock

An ore loading dock extended ~200 feet into West Arm from the OSA as shown in the 1971 aerial photograph (Figure 5). Barges tied up to the dock and were loaded from the ore stockpile.

2.3 OPERATION AND OWNERSHIP HISTORY

2.3.1 Past and Present Use and Years of Operation

The Ross Adams Mine was actively mined on a discontinuous basis between 1957 and 1971 and produced between 87,632 and 93,530 tons of high-grade uranium ore [7]. All of the ore was shipped off site and milled outside Alaska. The mining history of the area is briefly summarized below.

- **1955** Don Ross, Keldon Adams, and Bill Easton plus 13 other Ketchikan residents form a prospecting syndicate named U-55 and file the original mining claims (the "Cub Group"). U-55 and Climax Molybdenum Company (Climax) form the Kendrick Bay Mining Company (KBMC) with. Climax retaining 75 percent interest and U-55 retaining 25 percent interest.
- **1955-58** Climax and KBMC develop the mine and produce ~15,000 tons of uranium ore with grades over 1 percent from the 900-foot level open pit.
- **1958** Climax sells its interest to Standard Metals Corporation (Standard). Standard now holds 75 percent interest in KBMC.
- **1959-60** Jott Mining Company leases the mine and produces 1,000 tons of ore.
- **1961-64** Bay West, Inc. forms partnership with Standard, drives the 700-foot level adit, and produces ~19,700 tons of high-grade ore.
- **1964-68** Mine is inactive.
- **1968-70** Newmont Exploration, Ltd. (Newmont) obtains a lease from KBMC, reopens the mine, and conducts detailed exploration of the deposit. Numerous subcontractors are used to conduct exploratory activities such as core drilling and geophysical surveys. The claims are subleased to Dawn Mining, a subsidiary of Newmont, which begins development work in 1970.
- **1971** CM, Inc., under subcontract to Newmont, constructs the 300-foot level haulage adit and produces ~55,000 tons of ore. Dawn Mining closes the mine in September 1971 and removes all of the mining equipment. The generator building, generator, living quarters, motor boat, and trailer are left on site.
- **1972-1984** Standard and/or KBMC continue exploratory work and annual assessment work, including activities such as core drilling, trenching, road maintenance, geophysical and radiometric surveys, and geochemical sampling.
- **1985 to 2000** Minor to no annual assessment work conducted.

Western Miner [40] provides a detailed description of the Newmont operations. Ore was loaded directly from the underground workings into 35-ton Caterpillar trucks and brought 1.5 miles to the OSA adjacent to the barge-loading ramp. One Caterpillar 966 loader and one Caterpillar D-7 dozer were used to load and level barges to an average cargo of 4,500 tons. Photographs suggest that the barges were kept ~100 feet off-shore and were connected to shore by a ramp placed perpendicular to the shore. Barges were tied up perpendicular to the ramp. One man was involved in barge loading and leveling, and a single barge load took ~54 hours to complete.

Exploratory drilling was performed by several companies in 1977, but further mining has not been performed. The claims covering the Ross Adams mine site do not appear to be active [25], although other claims in the area are active (see Section 2.4.2).

2.3.2 Materials Stored or Disposed on Site

USBLM [24] reports the following materials were observed at the site in 1995:

- Waste rock, waste ore piles, surface mine workings, and ore-bearing outcrops
- Underground mine workings
- Mine road constructed with sub-grade ore material between the 700- and 900-foot levels and portions of the haul road below the 700-foot level
- Two buildings (buildings 1 and 2) and two dilapidated trailers (buildings 3 and 4) near the 300-foot level dump
- Petroleum-contaminated soil beneath the generator at the 300-foot level workings
- 55-gallon drums of diesel fuel, diesel engine, generator, oil cans, and transmission fluid at the 300-foot level dump (these wastes have been subsequently removed)
- Two lead-acid car batteries at the 900-foot level pit; 1.5-gallon container of battery acid, a freezer potentially containing Freon, 11 pint bottles of Truog, 6 pull-wire fuse lighters, antifreeze, and unlabeled bottles containing unknown chemicals at the 300-foot level workings (these wastes have been subsequently removed).

2.4 LAND USE AND POPULATIONS

2.4.1 Site Uses

The site and nearby areas are used occasionally during warmer months by recreational visitors for hiking, camping, hunting, fishing, and boating. Commercial salmon and other fisheries occur in West Arm [36, 37]. Mining claimants conduct work in the area and use a cabin located near the OSA under the terms of a USFS Special Use Permit.

The cabin is a wooden structure built on wooden pilings (Photo 13). USFS personnel report that the cabin is owned by the Dotson family of Ketchikan. Family members were present during the SI, and

they report that the cabin is occupied by family members (including children) and family friends seasonally for periods of time that vary year-to-year. A flexible plastic pipe carries water from a Kendrick Creek tributary (referred to as Cabin Creek) to the cabin. A floating dock is located near the OSA (Photo 14).

2.4.2 Active Mining Claims

USBLM records [25] indicate that four individuals hold mining claims in the area (sections 21to 23and 26 to 28, T80S, R88E) as of March 2004. The claims generally cover rare earth element (REE) occurrences, and it does not appear that the Ross Adams mine is currently claimed. The CUB claims, staked over the discovery outcrop in May 1955, were dropped after the 2000 assessment year. The currently active claims are summarized below.

Summary of Current Claim Holdings in Project Area (Sections 21-23, 26-28)

Claim Holder	Claim Name	Claim Holder	Claim Name
Raymond Dotson	I and L #3	Mary Anderson	Atom Bobby
Ketchikan, AK	I and L #4	Ketchikan, AK	Atom Del
	I and L #5		Atom Don
Irene and Robert Dotson	Atom Irene #3		Atom Florence #5
Ketchikan, AK	Atom Gayle		Atom Harl
	Atom Marietta #4		Atom Joe #9
	Atom Pete		Atom Maxine #10
	Atom Rose		Atom Mike
	Fraction Rosemary		Irene D
	Little Maryrose #7		Little Pete Fraction
	Little Ray #1	Troy C. Erwin	Gray Sea No.1
	Little Sue #1	Gig Harbor, WA	Gray Sea No.2
	Little Red #2		Shy Anne #1

2.4.3 Surrounding Land Use

The site is located within the Eudora roadless area of the TNF [27] (Figure 6). The South POW Wilderness Area is located on the west side of POW Island within ~3 miles of the 900-foot level workings. A roughly square mile of land approximately three miles east of the OSA is owned by the State of Alaska. The POW Island Area Plan [4] designates the state land in Kendrick Bay for development of a small community although residential land development is not planned within the 20-year period the plan is designed to cover.

People fly into nearby lakes for fishing, hunting, and alpine hiking opportunities [10]. The USFS has issued permits to the following individuals for activities that include the Kendrick Bay area:

- Larry McQuarrie. The Sportsmen Cove Lodge fishes the southeast side of POW Island, including Kendrick Bay.

- Hallco Inc. The motor vessel Sumdum conducts guided hiking, freshwater fishing, and wildlife viewing tours in southern POW Island, including Kendrick Bay.
- Erik Johnson. EA Enterprises conducts guided bear hunts in the area.

Kendrick Bay is used for commercial and recreational fishing and recreational boating. A commercial aquiculture facility owned by the Southern Southeast Regional Aquiculture Association is located in Kendrick Bay (Photo 15). The facility was moved in 1993 from a location on the south shore between West Arm and Short Arm to a bite on the east side of South Arm. The facility consists of juvenile salmon holding pens and is part of a terminal fishery for chum salmon.

2.5 ECOLOGICAL SETTING

The site area is within the South POW Granitics Ecological Subsection of the Dixon Entrance Lowlands Ecological Section [27]. The subsection is characterized by granitic outcrops and glacially scoured areas of volcanics and metasediments. The landscape is mostly rolling hills and lowlands spotted with hundreds of lakes and ponds. The well-drained soils on the hill slopes support moderately productive forests, and the poorly drained soils of the lowlands support forested and non-forested wetlands.

2.5.1 Vegetation

Coastal Western hemlock and Sitka spruce forest surround the site whereas alder predominates in the disturbed mining areas. Moss covers much of the ground and lichens drape many of the trees. Muskegs and small ponds are common around the 900-foot level and above the beach waste ore pile. Alpine tundra is present above the 900-foot level, and Bokan Mountain is bare, steep, and rocky.

2.5.2 Drainage and Surface Water Bodies

Kendrick Creek and its main tributaries, Mine Fork Creek and Cabin Creek, drain approximately 2.2 square miles on the east side of Bokan Mountain including the Ross Adams mine area. There are no gauging stations on the streams. Average stream flow is estimated from a comparison to three relatively similar mountain streams in southeast Alaska [36]: a) Staney Creek located in central POW Island north of the site, b) Fish Creek located on southern Revillagigedo Island east of the site, and c) the Harding River located on the mainland east of Wrangell, Alaska. The average flow in these streams was calculated to be 10.5 cubic feet per second (cfs) per square mile of watershed. This factor is applied to the Kendrick Creek watershed as a whole and to the main tributaries to obtain average flow estimates. Worksheet 1 (Appendix D) shows the calculations and the results are summarized in the following table.

Estimated Average Flow Rates in Site Streams

Stream	Location	Watershed Area ($mile^2$)	Average Flow/Area ($cfs/mile^2$)	Average Flow (cfs)	Average Annual Peak Flow (apprx.) (times average flow)	Average Annual Peak Flow (apprx.[1]) (cfs)
Gauged streams in southern SE Alaska						
Staney Ck.	POW I.	50.6	7.3	368	32	11,800 (15 events in 14 years)
Fish Ck.	Revillagigedo I.	32.1	13.1	422	na	na
Harding R.	Mainland	67.4	11.0	742	9.6	7,100 (30 events in 32 years)
Kendrick Creek watershed						
Mine Fork Ck.	At 900-foot level	0.32	10.5 (2)	3.4	--	--
Mine Fork Ck.	Above Kendrick Ck. confluence	0.40	10.5	4.2	--	--
700 Level Ck.	Above Kendrick Ck. confluence	0.04	10.5	0.4	--	--
Kendrick Ck.	Above Mine Fork confluence	0.34	10.5	3.6	--	--
Cabin Ck.	Above Kendrick Ck. confluence	0.78	10.5	8.2	--	--
Kendrick Ck.	Mouth	2.2	10.5	23	9.6 to 32	220 to 740

na. Not applicable. Fish Creek data are not used for estimating peak flow because three large lakes on the drainage significantly dampen peak flow events compared to streams without lakes such as Kendrick Creek.
1. Based on number of peak flow events as indicated (0.9 to 1.1 per year).
2. Average flow per square mile watershed in gauged streams equals 10.5 $cfs/mile^2$.

Mine Fork Creek rises as two branches west of the 900-foot level, and small ponds and a wetland area are present along the creek upstream of the 900-foot level. The creek flows through the northern part of the 900-foot level and then turns south where it enters Kendrick Creek at the 300-foot level. An ~60-feet high water fall is present on Mine Fork Creek just upstream of the 300-foot level. Water draining from the 300-foot level adit enters the Mine Fork just upstream of the Kendrick Creek confluence. The mine drainage is estimated to have been 10 to 15 gallons per minute (0.2 to 0.3 cfs) during November 2003 and during the 2004 SI (May 2004). Two culverts carry a portion of the Mine Fork flow under the 300-foot level dump (Photo 16) and the remainder flows along the west side of the dump.

The 700-foot level and most of the mine road is in a watershed situated west and south of the Mine Fork Creek drainage. It is drained by a small, apparently perennially-flowing stream referred to as the 700 Level Creek. The 700 Level Creek flows south through an area of overgrown drill roads between the 700-foot and 300-foot levels. It is thought to enter Kendrick Creek 300 to 500 feet upstream of the 300-foot level dump but was not traced to the confluence during the SI. Water periodically drains from the 700-foot level adit and flows onto the waste rock dump.

The Kendrick Creek stream bed at and above the 300-foot level consists of boulders and cobbles with little accumulation of sand-sized and finer sediments. The stream gradient decreases somewhat downstream of the 300-foot level, but the stream bed remains predominantly cobbles, boulders, and areas of bedrock outcrop with only a few areas of sand and gravel accumulation (Photos 17, 18). Cabin Creek enters Kendrick Creek ~500 feet inland from West Arm. Below Cabin Creek, the main stem is 15

to 30 feet wide, generally 6 to 12 inches deep, and has a cobble bottom with abundant sand. The creek enters West Arm in two branches and flows across an intertidal delta 300 to 400 feet wide (Photo 6). The delta sediments are predominantly sand and gravel with small proportions of cobble- and boulder-sized material. The delta deposits drop off abruptly to depths of 50 to 60 feet and bottom sediments become "fine-grained, organic-rich" material [39].

The OSA is outside the Kendrick Creek drainage. A small stream drains out of the wetlands located on the hillside north of the OSA. A dike was constructed northeast of the OSA waste rock pile to divert the stream east of the pile. The stream carried approximately two gallons per minute in November 2003 and a somewhat lower flow during the SI (May 2004). The stream flow diminishes and disappears completely in the forested area east of the OSA. The dike allows a small amount of up-slope water to drain across the western part of the OSA. Small rivulets were observed in this area in November 2003 but not during the SI. Greater surface flow likely occurs during periods of rain and snow melt, and the surface flow is coupled with shallow groundwater flow through the ore staging pile. A small groundwater seep was observed during the SI in the intertidal zone down-slope from where the stream disappears, but the majority of the surface water from the OSA discharges to West Arm subtidally.

The streams on the site were observed in fair weather conditions in November 2003 and for the duration of the SI. Higher flows than those observed are likely during major rainfall events as indicated by the 50- to 130-foot wide flood channel along Kendrick Creek below the 300-foot level (Photo 17) and the paucity of sand-sized and finer sediment in the streams (Photo 18). A comparison of peak to average flows in Staney Creek and the Harding River provide a basis for estimating peak flows in Kendrick Creek (see above table and Worksheet 1). Fifteen past crests (>7,000 cfs) are recorded in Stanley Creek since 1989 with an average crest flow of 11,800 cfs or 32 times the average flow [16]. Thirty crests in the Harding River exceeded 4,000 cfs between 1970 and 2002 with an average crest flow of 7,800 cfs; 9.6 time the average flow. Site streams are expected to experience variations between average and peak flows of similar magnitude and frequency such that the average annual peak flows at the mouth of Kendrick Creek are estimated to be from 220 to 740 cfs.

2.5.3 Wetlands

The National Wetlands Inventory [35] identifies extensive areas of wetlands at the site and in the surrounding area. The wetlands that likely meet the HRS wetland definition (i.e., those with a prevalence of rooted, emergent hydrophytes) are shown on Figure 7. These include forest palustrine wetlands present along parts of Kendrick Creek, and forest, shrub, and emergent palustrine wetlands in the upland portions of the area (Photo 19). Intertidal estuarine wetlands are mapped along most of the Kendrick Bay shoreline (Photo 20), however, these wetlands are unlikely to meet the HRS wetland definition because they generally lack emergent hydrophytes.

2.5.4 Wildlife

The southeast portion of POW Island area supports populations of Sitka black-tailed deer, black bear, wolves, river otter, marten, mink, bald eagles, loons, and common waterfowl. The American peregrine

falcon may migrate through the area. Trumpeter swans, marbled murrelets, osprey, and Peale's peregrine falcons, as well as the Queen Charlotte goshawk, may occur in the area [27].

USBLM [24] describes observing sea otters and seals just offshore of the site, fish carcasses half-eaten by bears along Kendrick Creek, and deer tracks between the beach and the 900-foot level. Wildlife observed during the SI include a bear and bear scat, deer and deer scat, seals, a salamander, Canadian geese, several types of song birds including kinglets and jays, and starfish, crab, mussels, and abundant clam shells in shallow marine waters (Photos 21 to 26).

Marine waters at the head of West Arm are relatively unproductive because of restricted circulation [37], but several species of clams, red rock and Dungeness crab, chiton, star fish, nudibranchs, anemone, and sea cucumber are likely present. West Arm is open to commercial sea cucumber harvesting on a three-year cycle.

2.5.5 Sensitive Populations

The federally listed threatened or endangered species likely to occur within or adjacent to the site are humpback and fin whales (endangered) and the Steller sea lion (threatened). These species are found in adjacent marine waters [37, 6]. Three USFS Sensitive Species are suspected or known to occur within the area: the trumpeter swan, Peale's peregrine falcon, and the Queen Charlotte goshawk. Trumpeter swans nest in the lowlands on small lakes and along large rivers and winter in ice-free areas throughout the TNF. Peale's peregrine falcons nest on cliff faces and islands and feed primarily on seabirds. Inhabitants of late seral forests, Queen Charlotte goshawks are closely associated with productive old growth. In addition, nine sensitive plant species are known or suspected to occur in the Craig Ranger District [27]. The southeast Alaska populations of peregrine falcons and goshawks are listed as Species of Special Concern by the State of Alaska [1].

2.6 GEOLOGY AND HYDROGEOLOGY

2.6.1 Soil Types

The 900-foot level, 700-foot level, and mine road are in an area of rock outcrop, colluvium, and patches of poorly drained soils that typifies most of the southeast flank of Bokan Mountain to elevations as low as 700 feet. USBLM [24] identifies three soil types in the forested region south and east of this area. Kaikli soils are present north of the 900-foot level and along the haul road to near the intersection with the 300-foot level haul road. These soils are moderately deep and are characterized by very poorly drained red and black mucky peat with a high organic content [26]. Tonowek soils are present in the OSA, along the eastern third of the haul road and at the 300-foot level. This classification type is moderately to well drained, and supports Sitka spruce, Western hemlock, devils club and alder [26]. Helm soils are found between the Kaikli and Tonowek soil areas and are generally thin, moderately to poorly drained, and consist of un-decomposed and decomposed forest litter over loam.

2.6.2 Geology

Geologic maps of the Bokan Mountain area have been produced by MacKevett [14], Warner and Barker [39], and Brew [5]. Figure 8 shows the bedrock geology of the Ross Adams mine area compiled from these sources. The West Arm and Bokan Mountain area is underlain by Late Ordovician and Silurian plutonic and metasedimentary rocks that are intruded by the Jurassic Bokan Mountain granite. The Ordovician and Silurian plutonic rocks are part of the Cape Chacon plutonic province and consist of quartz diorite intruded by quartz monzonite. Quartz diorite underlies the eastern part of the area including most of the West Arm shoreline. Quartz monzonite occurs west and northwest of the quartz diorite and underlies most of the area between the Ross Adams mine and West Arm. Descon Formation metasedimentary rocks are intruded by the quartz monzonite pluton.

The Bokan Mountain granite is comprised of rare rock types and is unique in southeast Alaska. It is a concentrically-zone peralkaline (sodium + potassium > aluminum) stock 1.7 to 2 miles in diameter intruding quartz monzonite and Descon Formation metasedimentary rocks. The stock consists of border-zone pegmatites discontinuously surrounding a narrow ring of aegirine (sodic clinopyroxene) granite that occurs around a core of riebeckite (sodic amphibole) – aegirine granite. Aplite occurs as irregularly-shaped bodies on the southeast and northwest sides of the stock. Quartz monzonite and quartz diorite within about 1.5 miles of the stock is typically albitized and locally silicified.

2.6.2.1 Ross Adams Mine Mineralization

The Ross Adams mine is developed on a southward-plunging, crudely pipe-like zone within the riebeckite–aegirine granite phase of the Bokan Mountain granite. The ore-grade (greater than ~0.5 percent U_3O_8 or ~1,400 picoCuries per gram (pCi/g) total uranium) portion of the pipe was up to 50 feet in diameter and was surrounded by a sub-ore-grade zone two to 20 feet thick.

MacKevett [14] describes the mineralogy and geochemistry of the ore body exposed in the open pit. Uranothorite ($(Th,U)SiO_4$) and uranoan thorianite ($(Th,U)O_2$) are the principle ore minerals with minor amounts of coffinite ($U(SiO_4)_{1-x}(OH)_{4x}$). Weathering formed minor amounts of secondary uranium minerals including gummite, sklodowskite, beta-uranophane, bassetite, and novacekite. The primary ore minerals are disseminated in altered granite as crystals up to 2 mm in diameter. Veinlets containing hematite, hydrous iron oxides, calcite, fluorite, pyrite, and galena radiate from the uranium-thorium minerals. Alteration of the granite host rock leached potassium and enriched thorium, uranium, iron, fluorine, lead, aluminum, niobium, and some rare earth elements relative to unaltered granite. The zone of thorium, uranium, and fluorine enrichment extends well beyond the ore body.

Much of the material mined from the open pit contained greater than 1 percent U_3O_8 with localized areas up to 3 percent U_3O_8. The thorium to uranium ratio was typically somewhat greater than 1:1. MacKevett [14] states that the degree of iron staining provides a visual indication of uranium and thorium content with higher grade ore colored reddish-brown from abundant hematite and iron hydroxide. Lower grade material is light brown and the rock color grades to white or buff away from the ore body.

2.6.2.2 Other Mineralization Occurrences

Rare-earth elements (REE), niobium, yttrium, zirconium, and other uranium-thorium deposits are associated with the Bokan Mountain granite. Within the SI area, this suite of mineralization occurs in the I & L vein-dike system and associate deposits including the Wennie, Dotson, and Dotson shear zone deposits (Figure 8). The vein-dike system trends at least 1.5 mile east-southeast from the outer part of the Bokan Mountain stock to West Arm. Uranium and thorium are most highly enriched in the western part of the system where Warner and Barker [39] reported localized occurrences up to 5.5 percent uranium and 13.9 percent thorium. Elevated gamma radiation and enrichment of uranium and thorium above 500 parts per million (ppm) is widespread along en echelon and cross-cutting vein-dikes and shear zones in this area. Uranium and thorium concentrations decrease away from the stock, but the vein-dike system remains radioactive.

2.6.3 Groundwater

Site observations suggest that groundwater in upland areas is likely to occur discontinuously in the thin soil and colluvium developed over bedrock and continuously within bedrock fractures. Flow patterns probably conform to topography except in the mine area where the workings, blasting-related fractures, and drill holes likely act as preferential flow pathways that channel groundwater through the mine, primarily to the 300-foot level. As such, the continuous drainage from the 300-foot level adit and periodic drainage from the 700-foot level adit is representative, at least in part, of groundwater in the mine area. Groundwater probably discharges to Kendrick Creek along most or all of the reach below the 300-foot level as well as to portions of the 700 Level Creek and Mine Fork Creek. Significant groundwater flow probably also occurs in the Kendrick Creek valley in coarse-grained, valley-fill sediments. This water discharges primarily subtidally to West Arm. Groundwater flow through the OSA also discharges to West Arm primarily in the subtidal zone.

2.7 CLIMATE DATA

The nearest climatological data station to the site is located on Annette Island, south of Ketchikan, and the following chart provides monthly temperature and precipitation averages for the period between 9/1/49 to 3/31/2004 [41].

Climate Data for Annette Island (Sept 1949 through March 2004)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	39.0	41.9	44.2	49.5	55.7	60.7	64.1	64.5	59.7	51.6	44.4	40.6	51.3
Average Min. Temperature (F)	29.8	32.2	33.6	37.3	42.7	48.2	52.1	52.4	48.2	41.9	35.4	32.0	40.5
Average Total Precipitation (in.)	10.22	8.79	8.42	7.82	6.42	4.96	4.66	7.25	9.94	15.75	12.69	12.0	108.91
Average Total Snow Fall (in.)	11.4	9.3	7.6	2.1	0.1	0.0	0.0	0.0	0.0	0.0	3.2	9.7	43.6

The 2-year, 24-hour probable maximum precipitation at the site is ~5 inches [17].

2.8 SITE CHARACTERIZATION

2.8.1 Mineral Resource Studies

The unusual nature of the Bokan Mountain stock and the associated mineralization has prompted numerous studies since discovery of the Ross Adams deposit. Individual studies and the information they provide that are relevant to the PA/SI are summarized in the following paragraphs. Sample locations from these studies are shown on Figure 3 where possible.

MacKevett [14] describes the geology and mineral deposits of the Bokan Mountain area. He provides a geologic map of the Bokan Mountain granite and surrounding area and describes more than 13 uranium-thorium occurrences that had been discovered in the area by the early 1960s. The field work was conducted during mining at the Ross Adams 900-foot level open pit. The description of the deposit mineralogy and petrology provided in Section 2.6.2.1 of this report is summarized primarily from MacKevett.

Eakins [9] sampled plant material, stream sediments, algae in streams, and soil near the Ross Adams mine as part a geobotonical prospecting experiment. Plant and algae samples (371 total) were ashed prior to analyses. The results showed significant uranium uptake in some large plant species with up to ~2,400 ppm in lodgepole pine, ~2,100 ppm in cedar, and ~900 ppm in hemlock. Uranium uptake into plants used as human food sources varied by species: blueberry bushes contained low or undetectable uranium whereas the small number of crowberry plants sampled contained up to ~830 ppm uranium near the orebody outcrop. Thirteen algae samples were collected, primarily from the Mine Fork upstream of the 900-foot level, and the results indicate algae is in enriched in uranium even in areas with relatively low bedrock uranium concentrations. Nine stream sediment samples were collected and show that uranium concentrations in Mine Fork sediments near the 900-foot level are low (<33 ppm) but that sediments in the ephemeral 700-foot level drainage and in Kendrick Creek have elevated uranium levels ranging from 554 ppm near the toe of the 700-foot level dump to 77 ppm in the lower part of Kendrick Creek. Table 1 summarizes the stream sediment data from this study and the approximate sample locations are shown on Figure 3. Eakins obtained gamma radiation readings on the open pit walls and surrounding area which can be used to confirm and supplement other gamma survey results.

Staatz [23] investigated the I & L (or Dotson) vein-dike system north of the Ross Adams mine. Staatz provides quantitative and semi-quantitative analytical results from 25 samples analyzed for 36 elements including uranium and thorium. He reports uranium concentrations from 0.005 to 2.8 percent and thorium concentrations from 0.0033 to greater than 10 percent. The access road to the 900-foot level is partly on the vein-dike system trend.

Warner and Barker [39] evaluate niobium and REE resources in the Bokan Mountain area and compile geologic maps of the Bokan Mountain area and Ross Adams mine workings. Fourteen samples from four phases of the Bokan Mountain granite stock were analyzed to characterize trace element composition trends and rock type associations. The samples were collected from unaltered areas and as such appear to represent background conditions in the granite, but sample location information is not provided. These data are summarized in Table 2. The samples contained an average of 10.2 ppm

uranium and ~33.7 ppm thorium. The average activities of uranium and thorium were approximately equal (3.55 pCi/g uranium and ~3.7 pCi/g thorium). Twenty-seven rock samples from the Ross Adams open pit and drill cores that intercepted the Ross Adams deposit at depth were analyzed for uranium, thorium, niobium, yttrium, zirconium and REE. Table 3 summarizes these data, and Figure 3 shows the drill hole locations. The samples contained maximum concentrations of 3,560 ppm (1,230 pCi/g) uranium and 3,700 ppm (407 pCi/g) thorium.

Philpotts, et. al. [22] collected rock samples along a 1.9-mile exposure of vein-dikes (the I & L and associated systems) variably enriched in REE, yttrium, zirconium, niobium, uranium, and thorium southeast of the Bokan Mountain stock. The samples were tested for 51 analytes including major rock-forming elements, metals and REE. Several of the samples are representative of the major rock types in the area (including the Bokan Mountain granite) and provide information on background rock compositions. Table 4 summarizes these data, and Figure 3 shows the approximate sample locations. Four samples from the main portion of the Bokan Mountain stock (including two samples of float) contained an average of 8.2 ppm (2.8 pCi/g) uranium and 49.3 ppm (5.4 pCi/g) thorium. Samples of aplite and pegmatite associated with the vein-dikes (seven samples) were somewhat enriched in uranium and thorium with average concentrations of 94 ppm (33 pCi/g) uranium and 147 ppm (16 pCi/g) thorium. Philpotts, et. al. summarize other work on the regional and local geology including the tectonic setting of southern POW Island, detailed geologic mapping, petrography, ore genesis, and geochronology studies.

2.8.2 Previous Environmental Site Investigations

The USBLM [24] inventoried physical and chemical hazards at the Ross Adams mine in 1995 and performed the RPA in 1997. The work involved reviewing records, compiling regional data, and performing the following field activities:

- Examining underground and surface mine workings and structures for imminent physical hazards
- Collecting and analyzing surface water samples for metals and radiological contamination
- Performing a gamma radiation survey over the main deposit, waste dumps, ore staging area, haul road, and mine road using a µR/hr meter at centers ranging from 25 feet to 100 feet at 3 feet above ground level (agl) and preparing radiation contour maps
- Collecting 5-day alpha-track radon monitoring data from the 300-foot and 700-foot underground mine working
- Collecting and analyzing rock samples for total uranium, thorium-230 (Th-230), and radium-226 (Ra-226).

The RPA report summarizes climatic data, operational history, regional and local geology, soil data, surface hydrology, ecological setting, and previous investigations. The following sections summarize the analytical results from that study.

2.8.2.1 Background

USBLM [24] collected and analyzed two background samples from the principal rock types underlying the site at the locations shown on Figure 3. The adjacent table summarizes the analytical results.

Country Rock Analytical Results [21]

Analyte	Granodiorite (Sample SO02)	Granite (Sample SO04)
Gamma @ gl	13 µR/hr	44 µR/hr
Total uranium	1.72 ± 0.11	0.14 ± 0.11
Th-230	<0.05	<0.09
Ra-226	1.54 ± 0.37	4.47 ± 0.79

Results in pCi/g except for gamma readings.

USBLM also collected three background water samples from Kendrick Creek upstream from the mine workings and analyzed them for gross alpha, gross beta, and 13 priority pollutant metals (samples WA03, WA04, and WA05 on Figure 3). Table 5 summarizes sample data and shows that the samples contained between 0.2 and 4.2 picoCuries per liter (pCi/L) gross alpha, 2.0 and 3.8 pCi/L gross beta, 0 to 0.8 pCi/L total radium, and trace to non-detectable metal concentrations.

2.8.2.2 Source, Nature, and Extent of Contamination

The sources and areas of contamination evaluated in the RPA include the mine workings, waste rock piles, waste rock or ore spillage along the road, OSA, and surface water.

Mine radiation levels. The underground mine workings are sources of gamma radiation and radon emitted from wall rocks. USBLM gamma radiation readings in the mine workings were:

- 485 to 10,900 µR/hr in the 300-foot level adit,
- 280 to 1,200 µR/hr in the 700-foot level adit
- greater than 5,000 µR/hr throughout the 900-foot level stope.

Reported air radon activities in the workings were measured with alpha-track samples placed at the location shown on Figure 4. The results were:

- 540.4 pCi/L in the 300-foot level,
- 212.3 pCi/L in the 700-foot level
- 260.9 pCi/L in the 900-foot level stope.

Waste rock. Most of the waste rock in the 900-foot and 700-foot areas have gamma radiation levels greater than 500 µR/hr with significant areas exceeding 1,000 µR/hr (Figure 9). Gamma radiation on the 300-foot level waste rock dump generally exceeds 100 µR/hr, and areas exceeding 500 µR/hr cover only ~25 percent of the dump. Analytical results from two 900-foot level waste rock samples are summarized in the adjacent table.

900-Foot Level Waste Rock Analytical Results [21]

Analyte	Sample SO01	Sample SO03
Gamma readings @ gl	257 µR/hr	4,575 µR/hr
Total uranium	2.6 ± 0.3	1,304 ± 3
Th-230	<0.14	<1.0
Ra-226	81.8 ± 9.1	1,506 ± 220

Results in pCi/g.

Haul roads. The haul roads from West Arm to the 300-foot and 900-foot levels were surveyed for gamma radiation. Approximately 3,000 feet of road exceed 100 µR/hr at three feet agl (Figure 9).

Ore staging area. A gamma survey was performed across the OSA and adjacent intertidal zone. Gamma radiation readings between 1,000 and 9,000 µR/hr occur in a 1.1-acre portion of the area adjacent to the ramp serving the former loading dock (Figure 9). The RPA describes clearly discernable waste rock in a 1.6-acre area surrounding this zone having gamma radiation levels between 100 and 1,000 µR/hr. Approximately 500 feet of the intertidal zone adjacent to the staging area contains gamma radiation levels greater than 100 µR/hr.

Total Ra-226 content. USBLM estimates the total Ra-226 content of the principal sources to be between 43.2 x 10^{12} and 68.6 x 10^{12} pCi by averaging gamma measurements taken at ground level and assuming a uniform gamma:Ra-226 ratio of 3.1.

Surface water. USBLM collected four surface water samples from within the site area for gross alpha, gross beta, total radium and 13 metals analyses (Table 5). The samples with the highest activities were collected near the 300-foot level adit and below the 300-foot dumps where up to 256 pCi/L gross alpha and 71.6 pCi/L gross beta were detected. A third sample collected downstream from the 900-foot level and the fourth from the mouth of Kendrick Creek contained activities at or below background surface water (gross alpha less than 4.2 pCi/L). Metals were generally not detectable or present in only trace amounts.

3.0 Field Activities Sampling and Analytical Protocols

The SI sampling event was performed in general accordance with *PA/SI Workplan, Ross Adams (Bokan Mountain) Uranium Mine, Prince of Wales Island, Alaska* [13]. The workplan and supporting plans describe the SI sampling rationale, sampling procedures, and analytical program. Significant changes from the planned activities or protocols are summarized in Table 6 and noted below, as appropriate.

The SI was conducted between May 3 and May 8, 2004 using the USFS owned and operated 66-foot motor vessel *Tongass Ranger* to support the field work. One day of the scheduled project field time was lost due to rough seas that prevented departure from Ketchikan. Some planned sampling tasks were therefore eliminated because the vessel's schedule could not be changed and re-mobilization to the site was not feasible.

3.1 SAMPLING METHODOLOGY

The SI field program sampled waste rock and soil sources and targets in air, fresh water sediments, marine sediments, and fresh surface water. Background reference areas for the source and target areas were also sampled. A total of 81 samples were collected (excluding QA samples) by the methods described in the workplan and further detailed in the following sections. Table 7 identifies the sample containers and preservatives used, and Tables 8 and 9 summarize the laboratory analyses performed for each sample. Table 10 provides the sample descriptions, and Figures 10 and 11 show sample locations.

3.1.1 Sample Numbering Scheme

Rock samples were given identification numbers with prefixes that identify the sample area followed by sequential numbers for each sample and duplicate sample collected in the area. Prefixes *300-, 700-,* and *900-* refer to the three mine levels, *OSA-* to the ore staging area, *HR-* and *MR-* to the haul and mine roads, and *GR-* and *QM-* to the granite and quartz monzonite background samples. For example, 900-03 identifies the third rock sample collected at the 900-foot level, and GR-01 identifies the first granite background sample.

Radon samples have an *R* at the beginning of the area prefix plus a suffix indicating the hours of exposure (e.g. *R700-01-44.3* signifies the first radon sample collected from the 700-foot level which was exposed for 44.3 hours). At locations where multiple radon detectors were deployed at different heights, the distance above ground is indicated as the third item in the sample identification (e.g. *ROSA-01-0.5-108.4* identifies a radon detector at the OSA set at a height of 0.5 feet agl and exposed for 108.4 hours).

Samples of other matrices have identification numbers with prefixes that indicate their matrix (e.g., *SSED-* for stream sediment, *MSED-* for marine sediment, *SW-* for surface water, and *SOIL-* for surface soil samples). Four surface soil samples have a prefix of *GEN-* since they were collected at the generator shack at the 300-foot level. Samples from each matrix are then numbered sequentially.

3.1.2 Rock Samples

A total of 25 rock samples, including 13 mine waste samples and 12 background rock samples were collected in the project area. Background rock samples are chip samples of bedrock outcrops. To the extent possible, rock chips with unweathered surfaces were collected.

Three types of waste rocks were collected: high-grades, composites, and grabs. High-grade rock samples were collected at each of the mine levels and at the OSA from the locations with the highest gamma radiation level at 3 feet agl. Composite rock samples were also collected from each mine level and the OSA at randomly selected grid locations. One of the planned composite samples at the 900-foot level south dump was changed to a high-grade sample due to time constraints. Two grab samples were collected on the mine road and one on the haul road at locations with elevated gamma radiation levels. Two haul road samples were not collected as planned due to time constraints.

All waste rock samples (high-grade, grab, and composite sub-samples) were collected from 0 to between 4 and 6 inches below ground level (bgl) using pre-decontaminated trowels. Hard material was loosened with a rock hammer where necessary, and sub-samples from large rocks were obtained by chipping off material with a rock hammer.

Composite sub-samples were collected at previously determined random grid points [13]. The sample grids were laid out by establishing a convenient base line extending across the length or width of a waste rock dump and then measuring to a grid point sample location perpendicular from the baseline using a tape and compass. Grid point sample locations were not used if they fell outside a waste rock pile in which case an alternate pre-selected random grid point was used. Additional grid points were randomly generated in the field for the OSA area because all pre-selected points and alternate points were either used or rejected before the planned number of sub-samples were collected. The 700-foot level dump differed significantly from the layout of the sampling grid. The grid needed to be shortened on the west side of the dump and extended on the east. Even with this change, the eastern part of the 700-foot level dump is underrepresented in the composite sample. Approximately equal amounts of material were collected for each sub-sample, and the gamma radiation emissions from each sub-sample were measured in an area just outside the site contaminant reduction zone where gamma radiation was low (< 10 µR/hr) (Figure 10, Table 11). The composite samples were prepared by thoroughly mixing each sub-sample, weighing out equal portions of each sub-sample, and then thoroughly mixing the composite set of samples. A split of the composite sample material was then placed in a sample container and the gamma radiation emissions of the container measured (Table 12).

3.1.3 Surface Soil Samples

Ten surface soil samples were collected, including four in the OSA, one at the 900-foot level, two at the 700-foot level, and three at the 300-foot level. The soil samples were collected with dedicated, pre-decontaminated trowels from the uppermost 0 to 6 inches of mineral soil immediately below any forest duff or vegetation mat that was present. The forest duff layer in old-growth forest around the OSA was deep and difficult to penetrate with hand tools as planned (Photo 27). One sample location was

therefore selected where mineral soil was exposed below an overturned tree and one was selected where the forest duff was relatively thin. A third planned sample was eliminated due to time constraints. Opportunity samples in the 900-foot and 700-foot levels were selected at apparently undisturbed soil locations based on professional judgment. Three samples were collected from petroleum-stained soil near the generator shed at the 300-foot level and analyzed for total extractable hydrocarbons. Table 12 provides the gamma radiation readings at the soil sample locations and of the sample containers.

3.1.4 Fresh Surface Water Samples

Surface water samples were collected at eight locations including three locations on Mine Fork Creek, two on Kendrick Creek, and one each on the 700 Level Creek, the 300-foot level mine drainage, Cabin Creek, and the OSA stream (Photos 28 though 35). Surface water samples were collected before any co-located stream sediment samples were collected. In-situ measurements of temperature, pH, conductivity, salinity, dissolved oxygen (DO), and oxidation-reduction potential (ORP) were made using a YSI® Model 556 probe, and these data are summarized on Table 13. Samples were collected directly into containers (not filtered) using a decontaminated Teflon dipper and preserved with nitric acid, as required (Table 7).

3.1.5 Beach Seeps/Pore Water Samples

The beach area below and north of the OSA was inspected for beach seeps during a low tide. Three seeps were identified north of the OSA area and one excavation to groundwater was dug. Field parameters (pH, temperature, etc.) were measured at each seep, the pore water, and Kendrick Bay, but samples were not collected because the waters were saline (11 to 25 percent salinity) (Table 13) and did not yield sufficient water for samples.

3.1.6 Stream Sediment Samples

Nine stream sediment samples were collected in the Kendrick Creek drainage system, including three from Mine Fork Creek, one from the 700 Level Creek, four from Kendrick Creek, and one from Cabin Creek (Photos 36 to 38). Stream beds in the drainage are comprised predominantly of cobble- and boulder-sized sediments with significant reaches of bedrock. Sand-sized sediments are uncommon, and silt- and clay-sized sediment accumulations were not observed. Samples were collected from the largest sand and gravel accumulations and most probable salmon spawning sites in the lower mile of Kendrick Creek.

Samples were collected from the upper 4 to 6 inches of sediment below 2 to 12 inches of water. A 5-gallon plastic bucket with the bottom removed was used to still water at the sample locations. Dedicated, pre-decontaminated trowels were used to collect the samples. Material larger than ~1 inch was excluded from the samples.

3.1.7 Marine Gamma Surveys and Sediment Samples

A submarine gamma radiation survey was conducted to assess the extent of potential contamination caused by ore spillage in the former ore barge dock area. The survey was performed using a Ludlum Model 12 rate meter and Model 133-2-1 submersible gamma detector. It covered a 410- by 360-foot area encompassing the circa 1971 ore dock area and extending ~230 feet seaward (south) of the dock (Photo 39). Bottom elevations in the survey area are between approximately -12 and -63 feet MSL. A uniform survey grid could not be achieved because of current and wind conditions. Gamma levels at the sediment-water interface were measured at 58 scattered locations with the largest number of measurements taken in the immediate vicinity of the dock location (Table 14).

A gamma screening survey was performed during a low tide over the intertidal sediments within ~165 feet of the mouth of Kendrick Creek using the Ludlum meter at 3 feet agl.

A total of nine marine sediment samples were collected from intertidal and subtidal zones: three at a background location outside the West Arm of Kendrick Bay, two on the Kendrick Creek delta (Photo 40), and four in the former ore barge dock area (Figure 11). Five of the samples were collected from submerged locations using a Ponar® dredge and the remaining samples were collected at emergent locations using dedicated sampling equipment. The samples were collected from the top 3 to 6 inches of sediment. Except in the Kendrick Creek delta, gravel- to boulder-sized sediment was common at the sample locations which made dredge sampling difficult. The large grains frequently prevented any recovery or did not allow the dredge to fully close resulting in wash-out of finer material. Sample locations were not moved because similar conditions appeared to exist throughout the background and former dock areas. The sampling difficulty has several consequences including: 1) dredged samples were composited from 2 to 5 sub-samples collected at the same location, 2) the boat drifted in a 6- to 12-foot diameter area during the collection of the sub-samples, and 3) some fine-grained material was probably lost from some of the sub-samples used for samples MSED-01 and MSED-06.

3.1.8 Air Samples

A total of 19 alpha track detectors were deployed to measure radon activities in air at the mine openings, above waste rock piles, and at background reference locations. Model AT-100 detectors supplied by AccuStar Labs of Medway, MA were used for the project.

Radon detectors were not placed in the Dotson cabin as planned because the cabin was occupied during the SI. The value of an indoor air sample would have been negligible because doors and windows were frequently opened during this period.

Wind speed and direction were not measured during the SI because: 1) detectors were placed near the center of waste rock piles such that wind direction would have limited impact on the sample results, and 2) detectors were placed just outside the mine workings to evaluate average radon activity at the mine portals and not radon flux. This approach provides adequate HRS information at low cost. Evaluating air flow out of the underground workings and wind direction across the site may be useful in fully evaluating radon migration from the source areas.

The detectors were set at ~4 feet agl in the middle of the 300-foot and 700-foot adit portals on wires stretched just outside the entrances (Photos 41 to 43). The detector at the 900-foot level stope was suspended on a line lowered 27.3 feet from the edge of the open pit to approximately the middle of the stope opening (Photo 44), and the detector at the 900-foot level air shaft was attached to an existing wire fencing placed over the shaft. The detectors in background reference areas were set ~3 feet agl using either a stake or existing vegetation (Photo 45). Detectors in the waste rock dumps were set on stakes at 3 feet agl and, with the exception of the 900-foot level south dump, at 0.5 feet agl (Photos 46 to 48). The detectors in all cases were oriented with the cup side down to prevent moisture accumulation. The detectors were collected at the end of the field investigation or after a designated exposure time and placed in laboratory-supplied ziplock bags for shipment to the laboratory.

3.2 GAMMA RADIATION MEASUREMENTS

Ludlum® model 19 microR meter was used to measure gamma radiation levels at waste rock and soil sample locations. The meter is equipped with an internal 1-inch by 1-inch sodium iodide scintillator detector. The meter was factory calibrated on November 24, 2003. Calibration was checked at least daily with a NIST-traceable Cs-137 source.

A Ludlum® model 12 rate meter equipped with a model 133-2-1 waterproof Geiger-Mueller detector and 80-foot cable was used to measure gamma radiation levels at marine sediment sample locations. The meter was factory calibrated on April 24, 2004. Calibration was checked daily during the submarine survey with a NIST-traceable Cs-137 source.

3.3 ANALYTICAL PROTOCOLS

The analytical methods used for this project are listed below. All analyses were performed by Paragon Analytics in Fort Collins, Colorado, except for radon alpha tracks which were performed by AccuStar Laboratory in Medway Massachusetts. Paragon's in-house SOPs for the methods are shown in parentheses.

Gross alpha and beta	EPA method 900.0/9310 (724R8)
Protactinium 231, radium 228 (soil)	EPA method 901.1M (713R8)
Radium 226	EPA method 903.1 (783R5)
Radium 228 (water)	EPA method 9320 (724R8)
Lead 210	Paragon Analytics method RAD-A013
Thorium 228/230/232	ASTM D3972-90M (714R8 and R9)
Uranium 234/235/238 and actinium 227	ASTM D3972-90M (714R8 and R9)
Target Analyte List (TAL) metals plus uranium	EPA methods 6010 and 6020
Mercury	EPA methods 7470 and 7471
Diesel-range and residual-range organics	SW8015M
Radon	alpha track
Alkalinity	310.1
Total organic carbon (TOC)	Walkley-Black

Paragon's gamma spectroscopy laboratory reports list activities for many isotopes that are not naturally occurring as well as naturally-occurring potassium 40 and a few short-lived (<5 minutes) natural isotopes, and they are not discussed in this report. The reports also list U-235 activities which are included on this report's data tables as method 713 results. However, the U-235 background and reportable quantity activities are based on the results of the ASTM D3972-90M (714) analysis only.

3.4 GLOBAL POSITIONING SYSTEM (GPS) SURVEY

The coordinates and elevations of the samples, composite sub-samples, and other survey points were measured using a Trimble® GeoXT™ or Trimble® ProXR™ GPS receiver (Photo 49, 50). The field data were differentially corrected (code only) based on base station data collected at the Annette Island continuously operating reference station (CORS AIS1). The corrected coordinates and elevations are provided in on Table 15 for each measurement point. The coordinates are in UTM zone 8 north and are in units of meters. The elevation datum is NAD-27 (Alaska) mean sea level, and elevations are provided in feet.

3.5 INVESTIGATION-DERIVED WASTE

Approximately ten gallons of personnel and equipment decontamination water and excess material from the composite rock samples were disposed near the center of the OSA waste rock pile. Disposable personnel protective equipment, used sample containers, towels, and other potentially contaminated investigation-derived wastes were bagged and placed in a 55-galllon steel drum. The drum and non-disposable investigation equipment (digging tools, decontamination equipment, hand cart, etc.) were placed in a locked storage shed ~0.5 miles up the haul road from the OSA (Photo 51, 52).

4.0 Quality Assurance/Quality Control

All metals, isotopic, and hydrocarbon analyses from the Paragon laboratory were reviewed by a chemist with Laboratory Data, Inc. (LDC) located in Carlsbad, California. 10% Level 4 Data qualifiers were applied by the chemist as necessary according to statements of work and the following guidance:

- *U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* [32].
- *U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* [29].

Copies of the data validation report are included in Appendix D.

4.1 SATISFACTION OF DATA QUALITY OBJECTIVES

The overall data quality achieved during field sample collection and sample analyses conducted at the laboratories satisfies the data quality objectives (DQOs) established in the workplan [13]. Elevated RPDs in the laboratory and field duplicates is the reason most metals and isotopic data were qualified in the rock, sediment, and soil data.

4.2 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Samples were collected or processed in the field to assist analysis of QA/QC measures. QA samples included rinsate blank samples for samples collected using re-usable equipment and temperature blank samples in each sample shipping cooler. QC samples included matrix spike/matrix spike duplicate MS/MSD) for organic samples and a matrix spike/duplicate (MS/DUP) for inorganic samples at a rate of one per 20 or less organic or inorganic samples respectively.

4.3 PROJECT-SPECIFIC DATA QUALITY OBJECTIVES

The following sections describe the laboratory's ability to meet project DQOs for precision, accuracy, and completeness, and the overall success of the field team and the laboratories to meet the project DQOs for representativeness and comparability. The laboratories and the field team were able to meet DQOs for the project with the exceptions noted below. Table 16 presents a summary of data qualifications by the LDC Chemist and/or the laboratory.

4.3.1 Precision

Precision refers to the reproducibility of measurements under a given set of conditions and is generally reported as relative percent difference (RPD)[3]. Analytical precision was assessed using matrix

[3] RPD = the difference between duplicate results divided by the average of the duplicate results.

$$RPD = \frac{\text{(Sample Result -- Duplicate Result)}}{\text{(Sample Result + Duplicate Result)/2}}$$

spike/matrix spike duplicate samples, laboratory control laboratory control duplicate samples, and/or laboratory duplicates. Precision in the field was assessed using field duplicates or field replicates.

The RPD values were reviewed for all field and laboratory duplicate samples. The precision DQOs for this project were met for all analyses, except those listed below:

- High RPDs between surface water field duplicates for aluminum; between rock field duplicates for uranium, arsenic, and lead; between marine sediment field duplicates for arsenic, lead, manganese, and uranium, between stream sediment field duplicates for lead and uranium; and between soil field duplicates for aluminum and manganese. Duplicate values are qualified as estimates.
- High RPDs between marine sediment field duplicates for Bi-214, Pb-212, Pb-214, Ra-226, Ra-228, Th-227, Th-228, Th-230, Th-232, U-234, U-235, and U-238; between soil field duplicates for Ra-228; between rock field duplicates for R-226, Th-228, Th-230, Th-232, U-234, U-235, and U-238; and between stream sediment field duplicates for Ra-226, Th-228, Th-230, Th-232, U-234, U-235, and U-238. Duplicate values are qualified as estimates.
- High Th-232 RPD in a lab duplicate sample associated with five rock samples; high Ac-227 RPD in a lab duplicate sample associated with one marine sediment sample, high U-234 RPD in a laboratory duplicate sample associated with ten marine sediment samples, and high lead and aluminum RPDs for a lab duplicate sample associated with nine soil samples. Data associated with the laboratory duplicates are qualified as estimates.

4.3.2 Accuracy

Accuracy represents the measure of bias from a set of measurements relative to a known or true value. Data accuracy was measured using various quality control samples and procedures that include:

- Maximum sample holding times
- Instrument calibration and performance checks
- Preparation, calibration, trip, temperature, and rinsate blank analyses
- Interference check sample, serial dilution, and laboratory control sample analyses (metals only)
- Surrogate spike analyses (organics only)
- Matrix spike analyses.

Accuracy DQOs for this project were met with the exceptions noted below.

- Elevated receiving temperatures for soil samples to be analyzed for total hydrocarbon analyses. Values are qualified as estimates.
- Holding time exceedances for analysis of four rock samples for mercury. Values are qualified as estimates.

- High recovery of iron and uranium in a matrix spike duplicate sample associated with 18 rock samples. Values are qualified as estimates.
- High recovery of an internal standard associated with total uranium analysis for one rock and one marine sediment samples. Values are qualified as estimates.
- The laboratory used the known barium concentration for carrier recovery calculations due to low barium concentration measurements prior to chemical separation for Ra-228 in water samples. Ra-228 activities for all water samples are qualified as estimates.

Pb-214 and Bi-214 activities are included on Paragon's gamma spectroscopy reports but were not requested. The lab notes that a significant low bias is associated with these analyses when using a mixed nuclide gamma source for efficiency calibrations. They estimate the bias to be ~32 percent for Bi-214 and 23 percent for Pb-214 and they report the data with a "J" qualifier.

4.3.3 Completeness

Data completeness is measured as the percentage of usable data relative to the total possible data. The laboratory data were reviewed for data validation and usability, and the data are 100 percent useable, meeting the project completeness goal.

4.3.4 Representativeness

Data representativeness is the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or environmental condition. The appropriateness of the number and location of samples were verified in the field and are considered to account for site variations and sample matrices.

4.3.5 Comparability

Comparability represents the ability to evaluate one set of data with another. This project addressed the need to produce comparable data by using approved field and consistent sampling techniques, consistent analytical methods, standard units of measurement, and required data reporting formats.

5.0 Analytical Results Reporting and Background Samples

This section identifies the methods used to evaluate the significance of the analytical data and describes the locations and analytical results from background reference samples.

5.1 SIGNIFICANCE CRITERIA AND ANALYTICAL RESULTS REPORTING

5.1.1 Background Reference Concentrations/Activities

Samples with significant and elevated concentrations or activities relative to background are identified in this report using the procedures defined by USEPA [28]. The concentration or activity must be:

- Equal to or greater than the sample quantification limit (SQL), and
- Equal to or greater than the background sample's SQL when the background sample concentration/activity is below detection limits, or
- Equal to or greater than three times the maximum detected background concentration of metals including total uranium, or
- Equal to or greater than two standard deviations above the mean activity of radionuclides including radon (Worksheet 2).

Background references for different media and geologic settings are equal to the concentrations or activities for each analyte calculated based on the above criteria. Gamma radiation background references for different bedrock types are equal to two times the mean background gamma radiation level measured at 3-feet agl.

5.1.2 Benchmark Concentrations/Activities

The preliminary screening criteria proposed in the project workplan [13] were revised to include published benchmark data that can be used to evaluate contamination under the CERCLA Hazard Ranking System. Analytical results collected during the SI are compared to published benchmarks contained in the *Superfund Chemical Data Matrix* (SCDM) [33] as appropriate and soil screening levels for radiation exposures (SSLR) contained in the *Soil Screening Guidance for Radionuclides* [21]. The benchmarks that were used are shown on Tables 17 and 18 and are applied to the SI data as follows:

- Rock samples. Isotope data are compared to SSLRs since the SCDM benchmarks for the soil, air, and water matrices do not apply to a rock matrix. The metals data are not compared to published benchmarks for the same reason.
- Soil samples. Isotope data are compared to the lower of the SCDM soil benchmark or SSLRs. Metals data are compared to the SCDM soil benchmark. Hydrocarbon data are compared to Alaska state soil criteria contained in 18 AAC 75.341 since federal hydrocarbons benchmarks are not available.

- Surface water samples. Isotope and metals data are compared to maximum contaminant levels (MCLs) or maximum contaminant level goals (MCLGs), or if neither an MCL or MCLG is established, the SCDM cancer risk benchmark.
- Sediment samples. Isotope benchmarks for sediments have not been published. Metals data are compared to the SCDM environmental benchmarks.
- Air samples. Radon data are compared to the SCDM Rn-222 air benchmark.

5.1.3 Analytical Results Reporting

Tables 19 through 38 summarize all of the laboratory analytical data, and Appendix G contains printed copies of the laboratory reports. The laboratory data deliverables are included on the CD ROM contained in Appendix E. The data tables show detected analytes in bold type, and analytes in source and target samples that exceed their background references (Section 5.1.1) are in red bold font and underlined. Analyte concentrations that exceed applicable benchmarks (Section 5.1.2) are enclosed in a box. The applicable background references and media benchmarks are generally shown in the second and third columns of the analytical data tables. Duplicate sample results are not discussed in the text or used to calculate background references or total analyte quantities.

The analytical results for common earth crust elements (e.g., aluminum, calcium, iron, magnesium, manganese, potassium, and sodium) are shown on the data tables, but are not included in discussions that compare sample concentrations to background reference concentrations or matrix benchmarks. The significance of these data is beyond the scope of this report.

5.1.4 Isotopic Equilibrium

MARSSIM protocol encourages determining the ratios between the individual isotopes at sites with multiple isotopes present. Establishing statistically significant ratios between isotopes can help reduce analytical costs in the future and are important in developing site cleanup goals. If the activities of all the radionuclides in a decay series are equal, the isotopes are in secular equilibrium and the progenitor-to-daughter ratios will be ~1.

The SI data are not sufficient to assess isotopic ratios in the U-235 series, but the range of progenitor-to-daughter ratios, excluding apparent outliers, in the Th-232 and U-238 decay series are calculated on Worksheet 3. The significance of ratios other than 1 cannot be determined at the present time since apparent depletion or enrichment could indicate either natural enrichment/depletion processes or an analytical artifact. Very high progenitor-to-daughter ratios do not occur indicating that unreported, short-lived daughters in the decay chains are present at activities similar to their immediate progenitors.

5.2 BACKGROUND REFERENCE SAMPLES

Background reference samples were collected from the following media:

1. Rock in areas underlain by the Bokan Mountain granite
2. Rock and soil in areas underlain by quartz monzonite
3. Soil in the shoreline area
4. Fresh surface water in the Kendrick Creek drainages
5. Stream sediment
6. Marine sediment
7. Radon in areas underlain by quartz monzonite and in areas underlain by the Bokan Mountain granite

Background soil, rock, and sediment samples were analyzed only for metals that exceeded the preliminary screening concentrations [13] in high-grade source rocks (arsenic, lead, manganese, and uranium) and background fresh surface water samples were analyzed only for metals that were detected in the 300-foot level adit drainage and/or the OSA creek samples (cadmium, lead, and uranium). All background samples except surface water samples were analyzed for long-lived radionuclides in the Th-232, U-235, and U-238 decay chains (the laboratory also reported concentrations for numerous non-naturally occurring and several short-lived naturally-occurring isotopes that were detectable by gamma spectrometry). Surface water samples were analyzed for gross alpha and gross beta activities plus selected isotopes from the Th-235 and U-238 decay chains if the gross alpha activities exceeded 5 pCi/L.

The following sections summarize the background sample results, primarily the maximum detected metals concentrations and the mean detected activities for the head of the Th-232 and U-238 decay series. U-235 activity is not discussed because it occurs in a nearly constant ratio to U-238. Analytes in background samples that exceed benchmarks are identified.

5.2.1 Granite Background

5.2.1.1 Sample Locations

Ten samples of Bokan Mountain granite bedrock were collected to characterize background concentrations of metals and radionuclides in the granite stock in which the Ross Adams ore body occurs. Seven samples (GR-01 to GR-07) were collected at ~160-foot intervals from undisturbed aegirine granite outcrops in an east-west transect passing just south of the 900-foot level open pit (Figure 12, Photo 4). Gamma radiation levels at 3 feet agl ranged from 21 to 180 µR/hr. These samples provide a background reference that directly represents pre-mining conditions in the 900-foot and 700-foot source areas. The locations are appropriate for background samples because mining operations would not impact the chemical composition of bedrock.

The project workplan called for three additional samples (10 total) to be taken on the east-west transect, but these sample locations (GR-08 to GR-10) were moved to an area 980 to 1,070 feet west of the open pit (Figure 10) to provide additional background reference data from outside the mine area. The samples were also collected from undisturbed outcrops (Photo 45). Sample GR-08 was collected in the riebeckite granite zone, and the remaining samples were collected in the aegirine granite zone. Gamma radiation levels at 3 feet agl ranged from 16 to 30 µR/hr. The mean gamma radiation level at the 10

granite background sample locations is 58 µR/hr. The gamma radiation background reference level in granite terrain is 116 µR/hr.

5.2.1.2 Sample Results

Tables 19 and 20 summarize the analytical data for the background granite samples. The maximum arsenic, lead, and uranium concentrations are 2.8, 24, and 19 mg/Kg respectively.

The mean Th-232 and U-238 activities are 2.96 and 3.8 pCi/g, respectively. Four Th-232 decay daughters and six U-238 decay daughters were detected in most of the samples. The background references for the detected radionuclides range from 7.5 to 9 pCi/g in the Th-232 series and from 8.6 to 14.8 pCi/g in the U-238 series. Four radionuclides (U-238, Ra-226, Ra-228, and Th-228) exceed SSLR activity benchmarks in all of the samples, and U-235 exceeds the SSLR activity benchmark in one sample.

The granite background results for Th-232 and U-238 are similar to those reported by Warner and Barker [39] and Philpotts et. al. [22] for granite background samples (Tables 2 and 4). However, the uranium activity reported by USBLM [24] in a single background granite sample is more than an order of magnitude less (0.14 pCi/g) than the mean activity in the SI samples.

5.2.2 Quartz Monzonite Background

5.2.2.1 Sample Locations

Two samples of quartz monzonite bedrock (QM-01 and QM-02) were collected as background references for sources underlain by quartz monzonite, including the 300-foot level and haul road samples. The background samples were collected from outcrops located ~2,000 feet east of the open pit (Figure 10). The quartz monzonite in this area appears to have undergone weak albitization and chloritic alteration. Gamma radiation levels at the sample locations are 5 and 6 µR/hr at 3 feet agl. Combined with gamma radiation readings at the three quartz monzonite radon sample locations (see Section 5.2.7), the mean background gamma level in quartz monzonite terrain is 5 µR/hr. The gamma radiation background reference level in quartz monzonite terrain is 10 µR/hr.

5.2.2.2 Sample Results

Background quartz monzonite bedrock analytical data are summarized on Tables 23 and 24. Lead and uranium were detected in the quartz monzonite background samples at maximum concentrations of 1.9 and 0.6 mg/Kg respectively.

The mean activities of Th-232 and U-238 are 0.76 and 0.43 pCi/g, respectively. Four Th-232 decay daughters and six U-238 decay daughters were detected in most of the samples. Three radionuclides (Ra-226, Ra-228, and Th-228) exceed the SSLR activity benchmark in all of the samples. The mean uranium activity in the SI samples is less than that reported by USBLM [24] in a single background quartz

monzonite sample (1.72 pCi/g total uranium). The SI results are, however, similar to those reported by Philpotts et. al. [22] for a granodiorite background sample (Table 4).

5.2.3 Shoreline-Area Soil Background

5.2.3.1 Sample Locations

Two soil samples (SOIL-01 and SOIL-02) were collected from old-growth forested areas as background references for soil samples in the OSA source area. The samples are of mineral soil developed over quartz monzonite bedrock in old-growth forest. Sample SOIL-01 was collected ~100 feet east of the OSA, and sample SOIL-02 was collected ~100 feet west of the OSA (Figure 15). Gamma radiation levels at both sample locations were 30 µR/hr at 3 feet agl.

5.2.3.2 Sample Results

Background shoreline soil data are summarized on Tables 30 and 31. The maximum lead and uranium concentrations are 31 and 210 mg/Kg, respectively, and the uranium concentrations in both samples exceed the soil benchmark.

The mean activities of Th-232 and U-238 are 14.6 and 17.3 pCi/g, respectively. Four Th-232 decay daughters and six U-238 decay daughters were detected in most of the samples. Both samples exceed the SSLR activity benchmarks for eight radionuclides.

Radionuclide activities in the shoreline background soil samples are substantially greater than in background quartz monzonite rock samples discussed in Section 5.2.2. The difference may reflect enrichment in soil, differences in bedrock concentrations between the two locations, or dispersal of contaminants from the OSA into the surrounding undisturbed forest soils.

5.2.4 Fresh Surface Water Background

5.2.4.1 Sample Locations

Surface water samples SW-01and SW-02 were collected as background references for Kendrick Creek and its tributaries. The sample locations are on branches of Mine Fork Creek upstream of the 900-foot level and are co-located with stream sediment samples SSED-02 and SSED-01, respectively (Figure 10). Sample SW-03 was to have been collected from Kendrick Creek upstream of the 300-foot level, but the sample was not collected due to time constraints.

5.2.4.2 Sample Results

Tables 32 and 33 summarize the background analytical results for fresh surface water. Cadmium and uranium were detected in the background surface water samples at maximum concentrations of 0.3 and 0.11 µg/L, respectively. The maximum cadmium concentration exceeds the surface water benchmark of0.09 µg/L.

Gross alpha and gross beta radiation were detected at mean concentrations of 1.06 and 1.05 pCi/L, respectively. Ra-226 and Ra-228 were not detected in the samples.

The surface water gross alpha background activities from the SI are similar to or lower than those reported by USBLM [24] (0.2 to 4.2 pCi/L) but the gross beta background activities are lower than USBLM (2.0 to 3.8 pCi/L).

5.2.5 Stream Sediment Background

5.2.5.1 Sample Locations

Two stream sediment samples (SSED-01 and SSED-02) were collected as background references for the Kendrick Creek drainages. The samples were collected from the two main branches of Mine Fork Creek 500 to 650 feet upstream (west) of the 900-foot level north dump (Figure 10). These streams primarily drain areas underlain by the riebeckite granite zone of the Bokan Mountain stock. Sample SSED-02 was to have been collected from Kendrick Creek upstream of the 300-foot level, but the location was changed due to time constraints.

5.2.5.2 Sample Results

Tables 34 and 35 summarize the analytical results for background stream sediments. Arsenic, lead, and uranium were detected in the stream sediment background samples at maximum concentrations of 10, 16 and 3 mg/Kg respectively. The maximum background arsenic concentration exceeds the sediment benchmark of 8.2 mg/Kg.

The mean Th-232 and U-238 activities are 1.57 and 1.36 pCi/g, respectively. Four Th-232 decay daughters and six U-238 decay daughters were detected in most of the samples.

5.2.6 Marine Sediment Background

5.2.6.1 Sample Locations

Marine sediment samples MSED-01 to MSED-03 were collected from an un-named bay ~1.9 miles southeast of the OSA (Figure 11) as background references for marine sediment samples collected in the Kendrick Creek delta and former dock areas. The samples were collected at elevations between -3 and -46.5 feet off the mouth of a small stream draining an area underlain by quartz monzonite and quartz diorite. Gamma radiation levels at the sediment surface were between 4 and 7 µR/hr and average 5 µR/hr.

5.2.6.2 Sample Results

Tables 36 and 37 summarize the analytical results for background marine sediments. Arsenic, lead, and uranium were detected in the marine sediment background samples at maximum concentrations of 13, 4.2, and 5.4 mg/Kg respectively. Arsenic exceeds the benchmark concentration of 8.2 mg/Kg in one sample.

The mean activities of Th-232 and U-238 are 0.15 and 0.69 pCi/g, respectively. Four Th-232 decay daughters and five U-238 decay daughters were detected in most of the samples.

5.2.7 Radon in Air Background

5.2.7.1 Sample Locations

Alpha track detectors were deployed at three background locations within areas underlain by quartz monzonite and three locations underlain by Bokan Mountain granite (Figure 10). Samples RQM-01 and RQM-02 were approximately co-located with background rock sample QM-01 and QM-02, respectively. The third sample location is ~210 feet northwest of sample RQM-02. Samples RGR-01, RGR-02, and RGR-03 were co-located with background rock samples GR-10, GR-09, and GR-08, respectively. The exposure duration was ~100 hours for the quartz monzonite area detectors and ~95 hours for the granite area detectors.

5.2.7.2 Sample Results

Table 9 summarizes the background analytical results for radon. All of the detected radon activities exceed the air benchmark of 6.3×10^{-4} pCi/L. The average radon activity detected over quartz monzonite bedrock was higher than that detected over granite bedrock even though radium activity is higher in the granite bedrock. This may result from higher radon flux from quartz monzonite; migration of radon from the Ross Adams mine working, waste rock dumps or other areas of radium mineralization during the sampling period; or an unrecognized process.

6.0 Sources

Mining activities created several sources in the mine area, along the haul road, and in the OSA. This section describes the sources and the source area sampling that was conducted as part of the 2004 SI.

6.1 WASTE ROCK SOURCES

Mining waste rock containing ore, sub-ore, and development rock is present in the mine dumps, road bed material, and the remnants of the OSA ore pile. Six discrete waste rock sources have been identified:

Source 1: 900-foot level waste rock dumps

Source 2: 700-foot level waste rock dump

Source 3: 300-foot level waste rock dump

Source 4: OSA

Source 5: Mine road

Source 6: Haul road.

The following sections describe the sample locations, summarize analytical results, and estimate the area and volume of each potential source.

6.1.1 Sample Locations

Discrete, high-grade rock samples were collected from each waste rock dump (sources 1 through 4) where the maximum gamma radiation levels were observed, on the mine road (source 5) at two locations with elevated gamma radiation, and on the haul road (source 6) between the 300-foot level and OSA where the maximum gamma radiation was measured. The sample locations are shown on Figure 10 and Figures 12 to 15. The samples are intended to characterize the maximum metal concentrations and radionuclide activities in the waste rock sources. The high-grade samples all contained hematitic granite characteristic of Ross Adams ore (Photo 53) [14]. The high-grade sample at the 300-foot level dump was collected within a 10- to 15-foot diameter area on the top of the dump containing abundant hematitic granite which is uncommon on the remainder of the dump. In contrast, hematitic granite is ubiquitous on all of the other mine dumps and on the mine road. Hematitic granite was observed in all of the areas of elevated gamma radiation on the haul road, and is common at the location of haul road sample HR-01.

The haul road high-grade sample (HR-01) was collected ~740 feet east of the 300-foot level dump in an area where hematitic granite was observed on 80 to 100 feet of road bed. Two additional haul road waste rock samples were not collected due to time constraints, but observations along both branches of the haul road indicate that gamma radiation anomalies greater than 100 µR/hr result from the presence of hematitic granite characteristic of Ross Adams mine ore and sub-ore. Relatively small quantities of

granite (such as would have been spilled from haul trucks) appear to account for most of the gamma anomalies, but in two locations along the haul road to the 900-foot level larger quantities of granite waste rock suggest that the material was used for road bed repairs. Gamma radiation anomalies associated with in-situ vein-dike mineralization in the quartz monzonite were not observed.

Composite waste rock samples were collected from each of the waste rock dumps (sources 1 through 4) to estimate the mean metal concentrations and radionuclide activities across the dump surfaces. These samples were composited from 15 to 25 sub-samples. The number of sub-samples was chosen with the goal of achieving specified relative errors and confidence levels of the true mean concentrations and activities for each dump [13]. The goal of the OSA composite sample was a 20 percent relative error at a 90 percent confidence level, and the goal of the other samples was 30 percent relative error with an 80 percent confidence level. The sub-sample size was calculated based on area-averaged gamma radiation levels provided in the RPA report [24]. The actual relative error achieved by the composite samples was evaluated based on the gamma radiation readings made on each sub-sample using the following expression modified from Gilbert [11]:

$$d_r = \frac{Z_{1-\alpha/2}\eta}{(n_1)^{0.5}}$$

where: d_r = relative error

n = number of sub-samples

α = probability of exceeding the relative error (confidence level = 1-α)

$Z_{1-\alpha/2}$ = standard normal deviate (obtained from standard statistical tables)

η = relative standard deviation estimated by σ/μ where σ is the standard deviation and μ is the true mean of the population of interest

Table 11 provides the sub-sample gamma radiation readings and the relative error of the mean calculated for each composite sample. Better than planned estimates of mean concentrations/activities were achieved for the 900-foot level north dump and 700-foot level dump composite samples (respectively, 16 percent and 25 percent estimated relative errors at 80 percent confidence levels) whereas poorer than planned results were achieved for the 300-foot level dump and OSA waste rock pile (respectively, 36 percent and 34 percent estimated relative errors at 80 percent confidence levels). The larger relative errors associated with the 300-foot level and OSA composite samples may reflect greater heterogeneity resulting from the mix of ore-grade material and unmineralized quartz monzonite or quartz monzonite-derived soil present on these waste rock piles.

6.1.2 Sample Results

The sampling results from the 900- and 700-foot levels are compared to the granite background references and are summarized in Table 21 (metals) and Table 22 (radionuclides). The results from the 300-foot level and OSA are compared to the quartz monzonite background references and are summarized in Table 23 (metals) and Table 24 (radionuclides).

The analytical results are discussed in the following paragraphs, and the maximum and composite (mean) analytical results for each source are summarized in the table below.

Summary of Analytical Data from Rock Sources 1 though 6

	As *(mg/kg)*		**Pb** *(mg/kg)*		**U** *(mg/kg)*		**Th-232** *(pCi/g)*		**U-235** *(pCi/g)*		**U-238** *(pCi/g)*	
	Max	*Comp*	*Max*	*Comp*	*Max*	*Comp*	*Max*	*Comp*	*Max*	*Comp*	*Max*	*Comp*
Benchmark	**NE**		**NE**		**NE**		**326**		**0.206**		**0.979**	
Granite Reference	**2.8**		**24**		**19**		**7.5**		**1**		**13.6**	
900-Level (source 1)	25	3.4	470	62	10,000	490	252 [A]	119 [A]	149	9	2,880	171
700-Level (source 2)	61	8.9	410	190	10,000	1,400	212 [A]	244 [A]	180	22	3,220	420
Mine Road (source 5)	5.5	--	82	--	1,100	--	60 [A]	--	18	--	326	--
Quartz Monzonite Reference	**1 U**		**1.9**		**0.6**		**1.1**		**0.1**		**0.45**	
300-Level (source 3)	15	3.3	330	62	8,200	120	175 [A]	57 [A]	117	1.92	2,350	42
OSA (source 4)	8.8	9.9	470	240	7,800	2,200	158 [A]	64 [A]	110	32.2	2,280	670
Haul Road (source 6)	2	--	300	--	590	--	136 [A]	--	10.3	--	207	--

Underlined — Concentration/activity exceeds either the granite (GR) or quartz monzonite (QM) background reference, as appropriate.
Shaded — Activity exceeds published benchmark shown in first row of this table.
-- Not analyzed.
A Isotopes further down in the decay chain exceed their benchmarks.
Comp Composite sample concentration.
Max Maximum concentration.
NE Not established.

Three high-grade samples (900-01, 700-01, and OSA-01) were analyzed for the 24 TAL metals and contained detectable concentrations of 14 to 16 analytes (Tables 21 and 22). All of the samples exceed the background references for arsenic, lead, and uranium with maximum concentrations of 61, 470, and 10,000 mg/Kg, respectively. The remaining six high-grade samples were analyzed for a subset of six metals. All of the samples exceed the lead and uranium background references, and all but the two mine road samples exceed the arsenic background reference. The composite samples all exceed the uranium background reference, and all but sample 900-04 exceed the arsenic and lead background references. In addition, the 700-foot level samples all exceed the manganese background reference.

The high-grade samples contain 60 to 252 pCi/g Th-232 and 190 to 3,220 pCi/g U-238. Three to four Th-232 daughters and five to seven U-238 daughters are detected in the high-grade samples. The mine road and haul road samples have lower radionuclide concentrations than the dump samples.

In the high-grade samples, the combined uranium isotope activities are equivalent to between 580 and 9,800 mg/Kg total uranium or to between 0.07 and 1.15 percent U_3O_8 compared to an average ore grade of ~0.8 percent U_3O_8. The combined thorium activities are equivalent to between 550 and 2,300 mg/Kg total thorium.

The composite samples from the 900-foot level north dump, 700-foot level, and OSA waste rock pile contain 57 to 244 pCi/g Th-232 and 41.8 to 670 pCi/g U-238. The lowest activities are in the 300-foot level sample.

Most of the detected radionuclides in the waste rock samples exceed the background references, and 5 to 16 radionuclides exceed the SSLR radiation benchmarks. The Ra-226, Ra-228, Th-228, U-235, and U-

238 activities in all of the samples exceed the background references and SSLR benchmarks. The Ra-226 and Ra-228 activities exceed the SSLR benchmark by 2 to 5 orders of magnitude.

The Ra-226 activities reported by USBLM [24] in two 900-foot level waste rock samples are within the range of results from the SI waste rock samples as is the uranium activity in a sample (sample SO03, Figure 3) collected east of the open pit. The uranium activity in USBLM sample SO01 from the north dump is, however, significantly lower than any SI waste rock sample result.

In accordance with MARSSIM [31] guidance, correlations between analytes and between analytes and gamma radiation measurements were evaluated to assess useful proxies that could be used to decrease analytical costs in future investigations. The correlations and descriptive statistics using SI data from all solid matrixes are shown on Worksheet 4 and summarized below:

- U-238 and Th-232 activities do not appear to be either normally or log-normally distributed.
- The ratio of U-238 to Th-232 activity varies with the uranium content. The average ratio is 1.2 at U-238 activities below 200 pCi/g and U-238 and Th-232 activities are strongly correlated (r^2 = 0.84). However, at higher U-238 activities, the U-238 to Th-232 ratio progressively increases to values greater than 15. This complicates use of uranium as a proxy for Th-232.
- The results of the chemical uranium and isotopic U-238 analyses are strongly correlated (r^2 = 0.99) indicating the chemical uranium analysis is a useful proxy for isotopic analysis.
- Lead concentrations and U-238 activities are strongly correlated (r^2 = 0.78) whereas the correlation between arsenic and U-238 is weaker (r^2 = 0.33). The results suggest that lead may be a useful uranium proxy.
- Total uranium (U-238 plus U-235) and gamma radiation readings taken on bag samples are strongly correlated (r^2 = 0.92) when considering the entire SI data set. The correlation is poorer (r^2 = 0.32) for samples with lower total uranium activity. In this case, gamma readings 3 feet agl at the sample locations correlate better to total uranium activity (r^2 = 0.55).

6.1.3 Estimated Waste Rock Volume and Mass

The waste rock area and mass estimates were calculated based on the SI GPS survey data. The calculations are shown on Worksheet 5 and are summarized on Table 38. Dump mass is calculated based on an estimated waste rock density of 117.9 lbs/ft^3 (1.89 g/cm^3) [8]. A margin of error of approximately ±30 percent is applied to the volume and mass estimates to account for GPS elevation error and uncertainty in the topography underlying the dumps.

The 900-foot level waste rock dumps cover ~1.3 acres and contain an estimated 12,000 cy (19,000 tons) of material with ~90 percent of the waste rock occurring in the north dump. The north dump volume estimate is based on an average dump thickness of 7 feet derived from GPS elevation measurements. In addition to other uncertainties impacting the waste rock volume estimate, the thickness estimate is

uncertain because of the irregular surface of the dump which appears to have been bulldozed into piles and partly excavated after its original placement. The south dump contains ~700 cy of waste rock. The estimate is based on the average cross-sectional thickness of the wedge-shaped dump multiplied by the dump area. Other waste rock piles in the area east of the open pit contain ~550 cy of material based on the mapped extent and observation-based average waste rock thickness.

The 700-foot level dump covers ~0.43 acres on the slope south of the adit portal. The dump volume estimate is based on the dump surface profile surveyed by GPS along the sub-sample grid baseline. The average dump thickness along the baseline is 6.3 feet assuming that the dump was placed on a uniform slope. Multiplying the average thickness and dump area gives an estimated dump volume of 4,400 cy and mass of 7,100 tons.

Waste rock removed from the 300-foot level was hauled across Mine Fork Creek and dumped in an approximately one-acre area east of the confluence with Kendrick Creek. The dump volume estimate is based on the dump surface profile surveyed by GPS along the sub-sample grid baseline. The average dump thickness along the baseline is 14.8 feet assuming that the dump was placed on a uniform slope. Multiplying the average thickness and dump area gives an estimated dump volume of 23,000 cy and mass of 37,000 tons. Additional rock fill is present between the adit mouth and Mine Fork Creek but is not included in the area and volume estimates because it appears to be comprised primarily of quartz monzonite development rock.

The remnant of the OSA pile covers ~0.69 acres within a larger formerly cleared area of ~1 acre. The thickness of the waste rock is uncertain but is estimated to average ~2.5 feet based on site observations. The pile does not have a pronounced topographic expression except in the southern portion where it merges into the bulkhead of the former dock. The pile margins in this area are 1 to 3 feet high. Elsewhere, the pile merges into the surrounding ground without an elevation change. Although hand borings in the pile met refusal within waste rock at depths of 1.5 to 2 feet, a bedrock outcrop near the center of the pile suggests that the pile thickness is not substantially greater than the depth of these borings. The pile is estimated to contain 2,800 cy and 4,400 tons of waste rock based on an assumed average thickness of 2.5 feet.

The mine road covers a length of ~1,600 feet and an area of ~0.83 acres between the south end of the 900-foot level open pit and the east end of the 700-foot level dump (Figure 10). The road bed appears to have been constructed with soil and rock obtained along the road alignment mixed with variable amounts of development and sub-ore waste rock. Fill material was used along the entire road (Photo 54), and the six largest fill areas were mapped during the SI as shown in Figure 13 in order to estimate the total volume of waste rock. The waste rock volume in each area was estimated assuming a 20-foot wide wedge-shaped road bed was placed over a uniform slope. Fill thickness was estimated from GPS survey data and field observations. The six main fill areas contain an estimated 2,400 cy and 3,800 tons of material, and the remainder of the road contains 400 to 500 cy of fill (~710 tons) assuming an average fill depth of one foot.

The land area of the haul road containing mine waste rock is estimated based on the gamma survey results [24]. Gamma radiation levels exceed 100 µR/hr along ~3,000 feet of road bed. Assuming an average road width of 12 feet, the total area is ~0.8 acres. The volume of road bed material impacted by mine waste rock is not estimated.

6.2 SOIL SOURCES

Soil along overland transport paths from waste rock sources may be impacted by contamination. In addition, vehicle traffic in the OSA may have spread contaminants from the ore stockpile into surrounding soil. Three potential soil sources were assessed during the SI:

Source 3: soil in and near the generator shed located on the 300-foot level dump

Source 7: soil between the 700- and 900-foot levels

Source 8: soil adjacent to the OSA.

Soil samples were collected to assess the potential for contamination in these three areas. The results of samples collected in soils developed over granite bedrock (source 7) are compared to the granite rock background reference, and the results of a sample collected in an area underlain by quartz monzonite (source 3) are compared to the quartz monzonite background reference. The results of samples collected in the OSA (source 9) are compared to the shoreline background soil references.

Lead-acid battery plate and casing fragments were observed during the 2004 SI on the surface of soil east of the 900-foot level north dump at the location shown on Figure 10. The observed battery material covers a ~10- by 15-foot area of unvegetated soil (Photo 55, 56). The soil at this location was not sampled.

6.2.1 Sample Locations

Three soil samples (SOIL-07, SOIL-08, and SOIL-10) were collected in the 900-foot and 700-foot level areas at locations underlain by granite. Sample SOIL-07 was collected in an apparently undisturbed location ~115 feet southeast of the open pit to assess potential contaminant migration associated with mining activities in this area. The sample is sand with clumps of silt collected below low-growing alpine tundra vegetation.

Sample SOIL-08 was collected ~65 feet south of the 700-foot level dump from apparently undisturbed, grass- and sedge-covered, saturated, silty sand. Washouts and debris on the hillside below the dump suggest that overland flow spreads contaminants down-slope from the dump and sample SOIL-08 is located to assess the potential impacts from this process.

Sample SOIL-10 is located ~65 feet southeast and down-slope of the mine road. Runoff from a 230- to 300-foot long section of the road funnels into the swale where the sample is located. The sample is of grass-covered, saturated, gravely sand and assesses the potential impacts of overland contaminant migration from the road.

Three soil samples (GEN-01 to GEN-03) were collected from 0 to 2-inches below ground surface near the generator building at the 300-foot level (Photo 57, 58). The samples were analyzed for diesel-range organics (DRO), residual-range organics (RRO), and TOC to assess impacts from possible fuel or oil spills. One sample (GEN-02) was also analyzed for metals and radionuclides to assess impacts to soil at the margin of the 300-foot level dump. The samples are sand and gravel with variable silt content collected from 0 to 2-inches below ground surface. Samples GEN-01 and GEN-02 are stained black with apparent diesel fuel.

Two soil samples (SOIL-04 and SOIL-05) were collected near the OSA waste rock pile to assess potential migration of contaminants from the pile into surrounding soil. Contaminants may have spread from the waste rock pile to soil by vehicle traffic, overland flow, or blowing dust. The samples were collected beneath the duff layer and are comprised of sandy organic silt mixed with gravel.

6.2.2 Results

The results for samples collected in the granite terrain (source 7) are summarized on Tables 25 and 26, in the quartz monzonite terrain on Tables 27, 28, and 29, and in the shoreline area on Tables 30 and 31. The results are discussed in the following paragraphs, and the maximum concentrations for each source are summarized on the table below.

Summary of Analytical Data from Contaminated Soil Sources

	As *(mg/kg)* *Max*	**Pb** *(mg/kg)* *Max*	**U** *(mg/kg)* *Max*	**Th-232** *(pCi/g)* *Max*	**U-235** *(pCi/g)* *Max*	**U-238** *(pCi/g)* *Max*
Benchmark	**0.43**	**400**	**46.9**	**3.4**	**0.206**	**0.979**
QM Reference	**1 U**	**1.9**	**0.6**	**1.1**	**0.1**	**0.45**
300 Level Soil (source 3)	2.1	15	22	4.38	0.245	6.4
GR Reference	**2.8**	**24**	**19**	**7.5**	**1**	**13.6**
700/900 Level Soil (source 7)	16	290	1,900	120	19.7	278
Shoreline Soil Reference	**3.1 U**	**31**	**210**	**24.3**	**1.35**	**26.6**
OSA Soil (source 8)	3.7	87	2,600	84	41	557

Underlined: Concentration/activity exceeds background reference.
Concentration/activity exceeds published soil benchmark shown in first row of table.

Arsenic concentrations in the soil samples are from <1 to 16 mg/Kg. All samples except SOIL-05 exceed the arsenic soil benchmark, and samples SOIL-04, -08, -10 and GEN-2 exceed their relevant arsenic background reference. All of the samples contain lead concentrations between 15 and 290 mg/Kg which is below the lead soil benchmark but exceeds the relevant background reference in three samples. Uranium concentrations range from 11 to 2,600 mg/Kg, and all soil samples except GEN-2 and SOIL-7 exceed the uranium soil benchmark. Samples GEN-2, SOIL-4, SOIL-8 and SOIL-10 exceed the relevant uranium background reference.

Th-232 activities in soil samples range from 4.38 to 120 pCi/g, and U-238 activities from 4.83 to 557 pCi/g. All of the samples except sample SOIL-7 exceed the established soil benchmarks for Th-232, U-238, and U-235 and their decay products. Eight to 16 isotopes exceed the relevant background references in all but sample SOIL-07 which did not exceed background references in the U-235 and U-238 decay chains.

Surface soil samples from the 300-foot level generator building (Table 29) contained 1,200 to 12,000 mg/Kg DRO and 4,700 to 43,000 mg/Kg RRO. TOC concentrations in the samples range from 14,000 to 71,000 mg/Kg including petroleum hydrocarbons. The average TOC concentration exclusive of hydrocarbons is ~7,600 mg/Kg (0.0076 g/g, Table 29). The Alaska Department of Environmental Conservation (ADEC) on-line Method 3 Calculator (Worksheet 6) was used to derive alternative (site-specific) DRO and RRO cleanup levels for protection of groundwater of 1,700 and 22,000 mg/Kg, respectively, based on the adjusted TOC concentration. The lowest RRO cleanup level, however, is 8,300 mg/Kg based on the ingestion pathway.

6.2.3 Estimated Land Area

Soil samples SOIL-07, SOIL-08, and SOIL-10 exceed a background reference for at least one radionuclide and are located on the hillside adjacent to and below the mine road and 700-foot level dump. As such, the samples define ~3.3 acres of contamination that is likely associated with overland transport of contaminants from the mine road and 700-foot level waste rock sources. The land area included in this estimate does not include the waste rock areas, which are accounted for separately, or bedrock outcrops which are estimated to cover 30 percent of the total area. A smaller area of soil contamination covering ~0.06 acres (2,800 ft^2) defined by sample SOIL-04 and SOIL-05 is adjacent to the OSA pile.

6.3 MINE WORKINGS SOURCE

The underground mine workings are a source (source 9) of radon gas and contaminated surface water.

Rock surfaces and air within the underground workings are a source radon gas[4]. The radon gas can vent to ground surface via mine air flow driven by pressure differences between the interior and exterior of the mine. Downward flow with venting at the 300-foot level, and to a lesser extent at the 700-foot level, likely dominates when the exterior temperature exceeds the interior temperature. Warm air entering the upper mine openings is cooled and becomes increasingly dense driving downward flow. Significant flow out of the 300-foot level adit was observed during the SI which was performed during warm weather. Upward flow with venting from the air shaft and 900-foot level stope probably occurs during cold weather when the workings are warmer than exterior air but was not observed during the SI. Other factors that may influence air flow rate and direction include wind speed and direction and rate of barometric pressure change. Air flow rates through the mine have not been measured.

[4] Radon is produced by the alpha decay of radium which occurs in the U-238, U-235, and Th-232 decay chains. Recoil from the alpha particle emission can eject the radon atom from a mineral grain into the air where it occurs as a gas. Radon isotope half-lives are 3.8 days for Rn-222 in the U-238 decay chain, 56 seconds for Rn-220 in the Th-232 decay chain, and 4 seconds for Rn-219 in the U-235 decay chain.

Air measurements inside the mine were not collected during the SI. Alpha track radon detectors were deployed by USBLM [24] to sample radon activities inside the 900-foot level stope, at approximately the mid-point of the 700-foot level adit, and at the end of the 300-foot level adit. Detected concentrations were between 212.3 and 540.5 pCi/L with the highest concentrations in the 300-foot level adit.

Small volumes of surface water were observed flowing into the 900-foot level open pit where it and precipitation that falls in the open pit presumably enters the underground workings though the stope opening. The mine itself probably acts as a drain for groundwater occurring in the bedrock surrounding the mine area. These water sources combine and drain continuously to surface water through the 300-foot level adit. Periodic drainage also occurs from the 700-foot level adit. The infiltrating surface water and groundwater is impacted by contact with mineralized rock.

7.0 Migration/Exposure Pathways and Targets

This section describes the potential migration pathways and targets associated with the nine potential sources described in Section 6.

7.1 GROUNDWATER MIGRATION PATHWAY

Groundwater at the site was not sampled during the SI because groundwater is not used within four miles of the site. Potential exposure to the groundwater pathway occurs via surface water. Groundwater discharges to surface water in the following areas:

- Groundwater probably discharges to site streams in many areas including Kendrick Creek along most of the reach below the 300-foot level, along the upper 500 to 600 feet of the 700 Level Creek, and along parts of Mine Fork Creek and Cabin Creek.
- Groundwater and surface water interact in wetland areas of the site.
- The surface water drainage from the 300-foot level adit and periodic drainage from the 700-foot level adit is in part groundwater collected by the mine workings and by the drill holes and blasting-related fractures around the mine. The mine discharge also includes precipitation and overland flow into the open pit which enters the mine through the 900-foot stope [24].
- Groundwater flow in coarse-grained, valley-fill sediments in the lower Kendrick Creek valley discharges primarily subtidally to West Arm.
- Groundwater flow through the OSA discharges to West Arm primarily in the subtidal zone since little to no seepage was observed in the intertidal area below the OSA.

7.2 SURFACE WATER MIGRATION PATHWAY

7.2.1 Pathway Description

Surface water runoff and eroded waste rock and soil sources enter Kendrick Creek drainage and the West Arm of Kendrick Bay at several locations. Nine probable points of entry (PPEs) to surface water are designated as described in the following paragraphs and shown on Figure 16. PPEs for each source are located at the most upstream point on a watershed where an overland transport path from a source enters surface water or where source contamination is observed in surface water.

PPE-1 is the most upstream point where contamination could enter the watershed. It is located on Mine Fork Creek where the 900-foot level north waste rock dump (source 1) was observed in the north branch of the creek during the SI (Photo 59). The toe of the 900-foot level south dump was also observed in the creek during the SI (Photo 60).

Both dumps are subject to direct erosion and annual flooding. Surface runoff can enter the creek directly from the dumps. The up-slope drainage area for the north dump is estimated to be ~0.75 acres.

The south dump is situated such that it has almost no up-slope drainage. Mine Fork Creek passes just north of the open pit where a heavily overgrown dike prevents the creek from flowing into the pit. A breach in the dike could result in a breakout of debris from the lower levels of the mine; however, significant erosion of the dike was not observed during the SI.

PPE-2 is the most upstream point for surface runoff to enter the 700 Level Creek and is where the creek was observed during the SI to emerge as a spring from the east end of the 700-foot level dump. Runoff from the eastern part of the 700-foot level dump (source 2) can enter the creek directly. Runoff from the western part of the dump travels via overland flow through the sample SOIL-08 location and enters the creek ~410 feet downstream of its origin. Runoff from the mine road (source 5) and soil (source 7) must also flow overland before entering the creek. Overland flow paths for most of the mine road are such that they also cross the 700-foot level dump and have the same PPEs. The up-slope drainage area for the 700-foot level dump is estimated to be ~5.5 acres.

The overland flow paths for the mine road on the lower switchback, however, do not cross the 700-foot dump. Sample SOIL-10 is on this overland path, but the path to the 700 Level Creek below this sample was not mapped during the SI and cannot be accurately estimated from the site topographic map.

PPE-3 is where Mine Fork Creek first intersects the toe of the 300-foot level dump. The dump abuts both Mine Fork and Kendrick Creeks, and part of Mine Fork Creek passes through the dump via two culverts. Dump material was observed in Mine Fork Creek during the SI, and the toe of the dump appears to have been significantly eroded by Kendrick Creek flood events. Surface runoff can enter the creeks directly from the dump. The up-slope drainage area for the 300-foot level dump is estimated to be ~1 acre, but the estimate is uncertain because of the steep hillside above the dump.

PPE-4 is where mine drainage from the 300-foot level adit (source 9) enters Mine Fork Creek just upstream of the Kendrick Creek confluence.

PPE-5 is located on Kendrick Creek south of the 300-foot dump where the uppermost overland flow path from the haul road (source 6) intersects the creek. The haul road sources in the Kendrick Creek watershed are 720 to 1,050 feet from the creek via overland flow paths.

PPE-6 is located on Cabin Creek where the uppermost overland flow path from the haul road (source 6) intersects the creek. The haul road sources are 1,150 to 2,450 feet from the creek via the overland flow paths, and PPE-8 is located ~3,600 feet upstream of the confluence with Kendrick Creek.

PPE-7 is located on the creek northeast of the OSA where overland flow through sample SOIL-05 enters the creek.

PPE-8 is at the south edge of the OSA waste rock pile at approximately the high tide line (Photo 61). Surface runoff from the waste rock pile can directly enter the West Arm marine environment.

PPE-9 is at the edge of the former loading dock where ore was spilled into West Arm. This is the furthest downstream PPE that has been identified at the site.

The 15-mile target distance limit (TDL) starts at PPE-1 and continues ~1.6 miles downstream to its confluence with Kendrick Creek (Figure 7). The TDL encompasses the 700 Level Creek, Kendrick Creek below the 700 Level Creek, and the lower 0.7 miles of Cabin Creek. The TDL extends 15 miles from the OSA and encompasses all of Kendrick Bay. The TDL extends ~9.5 miles into Clarence Straight and along the east shore of POW Island from Rip Point on the north to Huaji Cliff on the south. The inner portions of two fiords along this coastline (Ingraham Bay and Mc Lean Arm) are outside the TDL.

7.2.2 Targets

One known surface water intake for drinking water is located within the 15-mile TDL. The intake is on Cabin Creek and serves the Dotson cabin located west of the OSA. Dotson family members occupy the cabin intermittently and perhaps seasonally. Four people were present during the SI. The surface water intake is ~670 feet upstream of the Kendrick Creek confluence and 2,950 feet below PPE-7.

State land located on the north side of Kendrick Bay is within the 15-mile TDL and may be developed for residential use in the future [4].

Kendrick Creek and its main tributaries are clear-water streams that may be convenient drinking water sources for area visitors, such as commercial fishers, minerals exploration personnel, state and federal government workers, and recreational users (hunters, fishers, boaters, hikers, etc.).

Kendrick Creek from its mouth to near the headwaters ~9,480 feet (1.8 miles) inland has been designated by the state of Alaska as an important stream for the spawning or rearing of anadromous fish under Alaska Statute 41.14.870. Coho, pink, and chum salmon have been sighted in the stream [3]. Eighteen other designated streams flow into marine waters within the 15-mile TDL [3]. These streams host one or more of the salmon species present in Kendrick Creek, and one unnamed stream draining into Stone Rock Bay hosts sockeye salmon.

National Wetlands Inventory [35] data show that ~12,580 linear feet (2.4 miles) of wetlands are present within the upper 4.2 miles of the 15-mile TDL[5]. National Wetlands Inventory data for the remainder of the TDL have not been published, and no wetlands are mapped on the 15-minute topographic maps covering the remainder of the TDL. Of the total length of mapped wetlands, 10,230 feet are along the freshwater portion of the surface water migration pathway and 2,350 feet are along the Kendrick Bay coastline. Approximately 6,470 linear feet of wetlands border Kendrick Creek between its mouth and PPE-5 at the 300-foot level.

Commercial fishing operations in the 15-mile TDL harvest salmon, rock fish, halibut, sea cucumber, red urchin, shrimp [38]. The average annual salmon harvest in Kendrick Bay between 1994 and 2003 was 130,459 chum, 9,767 pink, 869 sockeye, and 454 coho [2]. The chum salmon are primarily produced by the Southern Southeast Regional Aquiculture Association terminal fisheries operation. The holding pens and release point for the terminal fishery are within the TDL. Harvest amounts for other

[5] Wetland distances and areas were estimated with the topology functions provided in AutoCAD™ Map using the published wetland shape files [35]. Figure WS-1in Appendix D shows wetland areas and lengths along streams in the Kendrick Creek drainage.

commercial fisheries and areas in the TDL are not known. Recreational fishers within the TDL harvest the species targeted by commercial fisheries. In addition, recreational harvest of Dungeness crab occurs in shallow waters near the heads of bays within the TDL [38]. Kendrick Creek is open for recreational fishing.

The marine waters within the TDL are in the range of the humpback whale (*Megapter novaeangliae*) and fin whale (*Balaenoptera physalus*), Federally-listed endangered species, and of eastern population of Steller sea lions (*Eumetopias jubatus*) which is a Federally-listed threatened species [6]. Fin whales are unlikely to enter the inner portion of the bays and humpback whales and sea lions are probably transient or incidental visitors to the inner bays [6]. Critical habitat for the Steller sea lion (major haul-outs and rookeries) have not been designated within the TDL, and the nearest critical habitat is Forrester Island located ~50 miles west of the site [19].

7.2.3 Sample Locations

Water, stream sediment, and marine sediment samples were collected to evaluate potential contamination along the surface water migration pathway. The sample locations are shown on Figures 15 and 16.

Fresh surface water samples were collected at six locations including five samples from the Kendrick Creek drainages and one sample from the OSA creek as follows:

- Sample SW-04 was collected in Cabin Creek at the drinking water intake for the Dotson's cabin. Mineralization associated with the I and L vein-dike system occurs in the Cabin Creek watershed as do contaminated sections of the haul road (source 6).
- Samples SW-05, SW-08, SW-09, and SW-10 were collected adjacent to or short distances downstream of PPE-8, PPE-4/PPE-5, PPE-3, and PPE-2, respectively.
- Sample SW-06 was collected at the mouth of Kendrick Creek where it enters the marine environment and shows the significance of contamination from all PPEs in the Kendrick Creek watershed.
- Sample SW-07 was collected from the 300-foot level mine drainage at the adit portal and shows the contribution of the mine drainage to Kendrick Creek contaminant concentrations. The flow rate at the time of sampling was estimated to be 10 to 15 gpm.

Stream sediment samples were collected from six locations in the Kendrick Creek drainage as follows:

- Sample SSED-03 was collected from Cabin Creek ~650 feet upstream of its confluence with Kendrick Creek. The sample location is 6 feet downstream of the cabin water supply line intake and shows the significance of contamination from PPE-7 and other PPEs associated with the haul road.
- Sample SSED-04 was collected at the mouth of Kendrick Creek and shows the significance of contamination from all PPEs in the Kendrick Creek watershed.

- Samples SSED-05 through SSED-07 show the significance of contamination from PPEs in Kendrick Creek above the Cabin Creek confluence.
- Sample SSED-08 was collected from the 700 Level Creek and is co-located with surface water sample SW-09. It shows the significance of contamination from PPE-3 and other PPEs associated with the 700-foot level dump (source 2), the mine road (source 5), and soil (source 7).
- Sample SSED-09 was collected from Mine Fork Creek and is co-located with surface water sample SW-10. It shows the significance of sediment contamination from PPE-1 and PPE-2 associated with the north and south 900-foot level dumps.

Marine sediment samples were collected from six locations during the SI as follows:

- Samples MSED-04 and MSED-05 were collected from the intertidal zone on the Kendrick Creek delta (Photo 12, 62) and show the significance of possible contaminant migration from the Kendrick Creek watershed to the marine environment.
- Samples MSED-06 to MSED-09 were collected in the intertidal and subtidal zones in the area of the former ore loading dock to show the significance of contamination from PPE-9 and PPE-10 associated with the OSA and former ore loading dock. These samples were collected at locations with gamma radiation levels at the sediment surface of 25 to 270 µR/hr identified during the submarine gamma survey (Section 3.1.7).

7.2.4 Results

Water sample results are summarized on Tables 13, 32, and 33, and stream sediment sample results are summarized in Tables 34 and 35. Tables 36 and 37 summarize marine sediment sample results, and Table 14 provides the submarine gamma survey results. The following sections discuss the analytical results and the maximum concentration for surface water, stream sediments, and marine sediments are summarized in the table below.

Summary of Analytical Data from Surface Water Pathway

	As *Max*	Pb *Max*	U *Max*	Gross Alpha *Max*	Gross Beta *Max*	Ra-228 *Max*	Ra-226 *Max*	Th-232 *Max*	U-235 *Max*	U-238 *Max*
SW Benchmark	**10**	**0.5**	**30**	**15**	**20**	**5**	**5**	**15**	**--**	**--**
SW Reference	**--**	**0.5 U**	**0.11**	**1.63**	**3.01**	**0.53**	**0.11**	**--**	**--**	**--**
Surface Water *(µg/L or pCi/L)*	10 U	0.5	42	34.6	19.1	2.18	2.68	0.284	--	--
Stream Sediment Benchmark	**8.2**	**47**	**NE**	**--**	**--**	**NE**	**NE**	**NE**	**NE**	**NE**
Stream Sediment Reference	**10**	**16**	**3**	**--**	**--**	**3.65**	**3.2**	**2.31**	**0.38**	**1.9**
Stream Sediments *(mg/kg or pCi/g)*	10	48	180	--	--	34.1	67	33.2	3.04	60.8
Marine Sediment Benchmark	**8.2**	**47**	**NE**	**--**	**--**	**NE**	**NE**	**NE**	**NE**	**NE**
Marine Sediment Reference	**13**	**4.2**	**5.4**	**--**	**--**	**0.38**	**0.49**	**0.2**	**0.14**	**1.35**
Marine Sediments *(mg/kg or pCi/g)*	49	43	390	--	--	32.6	64	117	8.7	137

Underlined Concentration/activity exceeds background reference.
Concentration/activity exceeds published soil benchmark.
-- Not analyzed.
Max Maximum concentration.
NE Not established.
TI Tentative identification.
U Not detected.

7.2.4.1 Kendrick Creek

Water sample SW-06 collected at the mouth of Kendrick Creek and sample SW-08 collected from Kendrick Creek downstream of the 300-foot level exceed the background reference for uranium. Neither sample exceeds the uranium surface water benchmark, but sample SW-08 also exceeds the background references for gross alpha, gross beta, and Ra-226. The contamination in sample SW-08 is attributable to impacts from PPE-3 (at the 300-foot level dump) and PPE-4 (from the adit drainage) located ~260 feet upstream. Combined, the results demonstrate the presence of actual contamination along a stream reach extending ~5,750 feet (1.1 miles) upstream from the mouth.

Stream sediment samples SSED-04 to SSED-07 collected from Kendrick Creek and marine sediment samples MSED-04 and MSED-05 collected from the intertidal sediments at the mouth of Kendrick Creek demonstrate actual contamination of sediments along the same in-water segment of the pathway. Total uranium and a minimum of 4 radionuclides in the Th-232, U-235, and U-238 decay series meet or exceed background references in samples SSED-05, SSED-07, MSED-04 and MSED-05. In addition, the lead concentration in sample MSED-05 exceeds the background reference.

Water sample SW-07 collected from the 300-foot level adit drainage contained a total uranium concentration and gross alpha and Pb-210 activities that exceed the background references and surface water benchmarks. The gross beta, Ra-226, and Ra-228 activities exceed the background references. The results demonstrate actual contamination of the mine drainage. The mine drainage water is slightly acidic (pH of 5.74, Table 13) and has low conductivity (38 µmhos/cm) indicating that water flow through the mine does not generate an acid leachate.

7.2.4.2 Cabin Creek

Water sample SW-04 collected from Cabin Creek did not contain analytes that exceed background references or surface water benchmarks. This demonstrates that Cabin Creek below PPE-7 is subject only to potential contamination.

7.2.4.3 700 Level Creek

Surface water sample SW-09 collected from 700 Level Creek exceeds the background references for total uranium, gross alpha, gross beta, Ra-228, and Ra-226 and the surface water benchmark for gross alpha. Co-located stream sediment sample SSED-08 exceeds the background references for uranium and 13 radionuclides in the Th-232, U-235, and U-238 decay series. Actual contamination of the upper ~410 feet of the stream is demonstrated by these results and by the presence of source 2 (700-foot level dump) in the water at PPE-3. Potential contamination exists from the sample location to the confluence with Kendrick Creek and along Kendrick Creek to its confluence with Mine Fork Creek, a distance of ~920 feet.

7.2.4.4 Mine Fork Creek

Surface water sample SW-10 collected from Mine Fork Creek exceeds the background reference for total uranium but none of the surface water benchmarks. Co-located stream sediment sample SSED-09

exceeds the background references for uranium and 12 radionuclides in the Th-232 and U-238 decay series. The analytical results and observation of source 1 (900-foot level dump) in the north branch of the creek at PPE-1 demonstrate actual contamination along ~590 feet of the creek. Potential contamination exists from the sample location downstream to PPE-5, a distance of ~2,450 feet.

7.2.4.5 OSA and Former Dock Area

Sample SW-05 from the OSA creek exceeds the background benchmark for uranium, gross alpha, and Ra-226. Surface water benchmarks are not exceeded.

The four marine sediment samples collected in the former loading dock area exceed the background references for between 7 and 16 radionuclides in the Th-232, U-235, and U-238 decay series. Samples MSED-07 to MSED-09 also exceed the lead and total uranium background references, and sample MSED-09 exceeds both the arsenic background reference and sediment benchmark. The analytical results demonstrate that an ~0.45-acre area in the intertidal and subtidal zones exceeds background references, whereas the sediment surface gamma readings exceed the background gamma readings (5 µR/hr) in an ~1.3-acre area (Worksheet 5). Most of the exceedances and the points with the greatest exceedances are clustered near the dock bulkhead and below the former dock.

7.3 SOIL AND WASTE ROCK EXPOSURE PATHWAY

7.3.1 Pathway Description

Ra-228 exceeds the background reference in all of the waste rock and soil source samples (Section 6.2.1), and Ra-226 exceeds the background reference in all but sample SOIL-07. The radium isotopes are also the radionuclides with the lowest screening levels. Uranium and numerous radionuclides in the Th-232 and U-238 decay series exceed the background references in most waste rock and soil samples, and arsenic and lead concentrations also frequently exceed the background references.

The total land area in the site covered by waste rock and soil that exceeds at least one background reference is ~330,000 square feet (~7.6 acres). Worksheet 5 shows the area calculations, and Table 38 lists the estimated extent of impacted land in each source.

7.3.2 Targets

Access to the site and all areas of observed contamination is unrestricted. The Dotson cabin is ~450 feet west of the observed contamination in the OSA, and there are no other residences in the area. The Dotson cabin is occupied intermittently and perhaps seasonally by the Dotson family. Four people were present during the SI. Commercial fishers, minerals exploration personnel, state and federal government workers, and recreational users (hunters, fishers, boaters, hikers, etc.) visit the area periodically.

The USFS manages the area for commercial wood production, and some contaminated portions of the haul road are in mapped areas of suitable timber [27].

Wetlands and areas of commercial agriculture have not been identified in the areas of observed soil and waste rock contamination [27, 4]. The range of two state-designated species of special concern, the peregrine falcon (*Falco peregrinus anatum*) and northern goshawk (*Accipiter gentilis laingi*), includes the areas of observed contamination [1].

7.4 AIR PATHWAY

7.4.1 Pathway Description

The prevailing wind direction in southeast Alaska is southeast with northerly winds common during periods of high pressure [18]. The strongest winds are from the south and southeast and are associated with low pressure systems moving inland from the Gulf of Alaska. These strong systems are typically accompanied by significant precipitation. Conversely, warm and dry conditions often accompany the northerly winds associated with high pressure systems.

Wind speed and direction at the site are probably strongly influenced by orographic effects because of the mountain and fiord topography of the area. The orographic effects are likely to be most pronounced at lower elevations and along the West Arm of Kendrick Bay. As such, the dominant wind directions across the site are not known.

Radon is a gas (vapor pressure 760 Torr, density 9.7×10^{-3} g/mL [33]) produced by the alpha decay of radium. Rn-222 in the U-238 decay chain has a half-life of 3.8 days and as such can migrate a substantial distance from the source. Rn-220 in the Th-232 decay chain has a shorter half-life (56 seconds) and will migrate a comparatively shorter distance and is a potential concern in the immediate vicinity of the source. The U-235 daughter, Rn-219, has a half-life of 4 seconds and is therefore not of concern in the air pathway. Radon in the air pathway was sampled in the SI.

The potential for blowing particulates at the site is low because of common year-round precipitation. However, the waste rock piles are sparsely vegetated in large part and could be sources of blowing dust during the occasional dry periods. The SI was performed during warm, dry weather, but blowing dust was not observed. Samples of air-borne particulates were not collected during the SI.

7.4.2 Targets

Permanent residences are not located within the 4-mile TDL of the site. The Dotson cabin located 450 feet west of the OSA is occupied intermittently and perhaps seasonally by the Dotson family. Four people were present during the SI. Commercial fishers, minerals exploration personnel, state and federal government workers, and recreational users (hunters, fishers, boaters, hikers, etc.) visit the area periodically. State land located on the north side of Kendrick Bay is within the 4-mile TDL and may be developed for residential use in the future.

Approximately 27,400 acres of wetlands are present within the 4-mile TDL (see footnote 2). Of the total, 87.6 acres of wetlands are within 0.25 miles of the radon sample locations.

Kendrick Creek from its mouth to near the headwaters ~9,480 feet (1.8 miles) inland has been designated by ADFG as an important stream for the spawning or rearing of anadromous fishes under Alaska Statute 41.14.870 [3]. The stream supports coho, pink, and chum salmon. Seventeen other watersheds within the 4-mile TDL also contain designated anadromous fish streams. In addition to the species present in Kendrick Creek, five streams host sockeye salmon and two host steelhead trout.

The western two thirds of Kendrick Bay, the South Arm of Moira Sound, and the heads of Ingraham and Hidden Bays lie within the 4-mile TDL. Commercial and recreational fishers operate in these waters [38]. The holding pens and release point for the Southern Southeast Regional Aquiculture Association terminal fisheries operation are located just outside the TDL, but fishing vessels targeting the returning fish operate within and outside of the TDL [20].

The marine waters within the TDL are in the range of the endangered humpback whale (*Megapter novaeangliae*) and threatened Steller sea lion (*Eumetopias jubatus*) [6]. These animals are probably transient or incidental visitors to the waters within the TDL [6]. Critical habitat for the Steller sea lion (major haul-outs and rookeries) have not been designated within the TDL [19]. The TDL is within the range of two state-designated species of special concern, the peregrine falcon (*Falco peregrinus anatum*) and northern goshawk (*Accipiter gentilis laingi*) [1].

The nearest boundary of the South POW Wilderness area is 3.3 miles southwest of the mine area.

7.4.3 Sample Locations and Exposure Durations

Alpha track detectors were set at sampling locations just outside the four mine openings to show the significance of radon contamination from the underground workings (source 9). Detectors were set above waste rock dumps at the 900-foot level (source 1), 700-foot level (source 2), and OSA (source 4) to assess radon gas emissions from the sources. Detectors were set at 0.5 and 3 feet agl at the 900-foot level north dump, 700-foot level dump, and OSA sample locations. The 900-foot and 700-foot level radon samples are compared to the radon granite background reference, and the 300-foot level and OSA samples are compared to the radon quartz monzonite background reference.

All of the detectors were deployed on May 3, 2004, and most were exposed between approximately 94 and 108 hours. Potential variability in radon emissions from the mine was evaluated by setting multiple detectors at the 700-and 300-foot level adit locations and exposing the detectors for different durations. Detectors at the 700-foot level adit were exposed for approximately 44 and 95 hours, and 300-foot level adit detectors were exposed for approximately 48, 72, and 96 hours. The radon detectors are true time-integrated samplers which provide results which are the average radon activity over the exposure duration.

7.4.4 Sample Results

Radon activities detected at the mine entrances were between 24 and 396 pCi/L (Table 9) and exceed the background reference and air benchmark at all locations. Activities progressively increased from the

upper to lower levels of the mine. Air at the 900-foot level stope and air shaft portals contained 24 and 40 pCi/L, respectively compared to 80 to 87 pCi/L at the 700-foot level adit portal and 322 to 396 pCi/L at the 300-foot level adit portal. These results are consistent with downward airflow through the mine. The results show actual contamination of the air pathways near the underground mine source.

The results from detectors deployed for different durations at the 700- and 300-foot level adits indicate that radon activities were not constant between May 3 and May 7. The data from the 300-foot level adit shows that the radon activity averaged 396 pCi/L over the first ~48 hours of the total sampling time (sample R300-01-48). The radon activity decreased to ~200 pCi/L over the next 24 hours resulting in an overall 72-hour average activity of 336 pCi/L (sample R300-01-72). Similarly the activity was ~250 pCi/L over the last 24 hours resulting in a 96-hour average activity of 322 pCi/L (sample R300-01-96). The radon activity at the 700-foot level adit averaged ~105 pCi/L over the first 44 hours and ~60 pCi/L over the subsequent 55 hours of the total sampling time.

Radon activities in air above waste rock sources were 10 to 35 pCi/L at three feet agl and 31 to 105 pCi/L at 0.5 feet agl. Samples from the 900-foot level north dump (source 1) detected the highest radon activities. The radon background references and air benchmark is exceeded by all samples but one.

8.0 Removal Action Assessment

The data collected during the SI are used in this section to assess if:

- CERCLA hazardous substances have been released
- Reportable quantities have been exceeded
- Alaska state hydrocarbon cleanup criteria have been exceeded
- The site meets the standards for initiating a removal action under CERCLA.

8.1 CERCLA RELEASES

A total of 37 analytes were detected in one or more SI samples. The potential for each of these analytes to be considered a CERCLA release based on: 1) listing on 40 CFR Table 302.4 or Appendix B to Table 302.4 and 2) one or more exceedance of a site background reference concentration or activity is summarized below.

- Aluminum, calcium, iron, magnesium, manganese, potassium, sodium, and vanadium are not CERCLA hazardous substances.
- Barium, beryllium, cadmium, chromium, cobalt, copper, silver, and zinc are detected hazardous substances but the detected concentrations did not exceed background references.
- Arsenic and lead are hazardous substances that were detected at concentrations that exceed background references in one or more waste rock, soil, stream sediment, and marine sediment sample.
- Th-232 and five daughter radionuclides (Ra-228, Th-228, Pb-212, and Bi-212) are hazardous substances that were detected at activities that exceed background references in one or more waste rock, soil, stream sediment, and marine sediment sample. Ra-228 also exceeds the surface water background reference in two samples.
- U-235 and two daughter radionuclides (Ac-227 and Th-227) are detected hazardous substances. A background reference for Ac-227 was not established, but U-235 and Th-227 were detected at activities that exceed background references in one or more waste rock, soil, stream sediment, and marine sediment sample.
- U-238 and eight daughter radionuclides (Th-234, U-234, Th-230, Ra-226, Pb-214, Bi-214, and Pb-210) are detected hazardous substances. A background reference for Pb-210 was not established, but U-238 and the other daughters were detected at activities that exceed background references in one or more waste rock, soil, stream sediment, and marine sediment sample. Ra-226 also exceeds the surface water background reference in three samples.
- Radon was detected in air at concentrations that exceed background references.

8.2 REPORTABLE QUANTITIES

The quantities of hazardous substances present in the eight waste rock and soil sources associated with the Ross Adams mine are summarized in Table 39. The reportable quantities (RQs) of arsenic and lead are one pound and 10 pounds, respectively (40 CFR 302.4). Galena (lead sulfide) is reported in the Ross Adams ore [14] and may be the main form of lead in waste rock and soil. The SI sampling results indicate that arsenic and lead exceed RQ limits in all of the sources with the exception of the 900-foot level waste rock dumps (source 1) and OSA soil (source 8) where the metals were not present above background reference levels. In addition, the arsenic level in mine road waste rock (source 5) did not exceed the background reference. A total of ~570 pounds of arsenic and ~13,900 pounds of lead are estimated to be present in the sources in excess of background levels.

RQs of radionuclide mixtures consisting of Th-232 in secular equilibrium with its daughters and natural uranium (U-235 and U-238) in secular equilibrium with their daughters are 0.011 and 0.052 Ci, respectively. Secular equilibrium conditions have not been demonstrated; however, a qualitative review of progenitor to daughter ratios shows that values are close to one in many SI samples. As such, secular equilibrium is assumed for the purpose of assessing RQs. Natural uranium exceeds the RQ in all of the soil and waste rock sources, and the estimated total activity for the entire site is 15.3 Ci. Th-232 exceeds RQ in all of the soil and waste rock sources except in OSA soil (source 8). The total estimated Th-232 activity for the entire site is 7.0 Ci.

8.3 REPORTABLE HYDROCARBON RELEASES

Comparison of the data from the 300-foot level generator building soil samples to the State of Alaska Method 3 soil criteria (18 AAC 75.351) show that DRO concentrations exceed the cleanup level in two samples and RRO concentrations exceed the cleanup level in one sample.

8.4 THREAT TO THE ENVIRONMENT

The data collected during the SI document that a removal action is appropriate at the site as defined by 40 CFR 300.415(b)(2) paragraphs (i) through (viii). The specific factors that apply to this site are:

(i) Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants.

Transient or seasonal occupants of the Dotson cabin are within 0.25 miles of the OSA source and are potentially exposed to arsenic, lead, and natural uranium, thorium and their daughter products including radon.

The OSA, mine dumps, and mine workings are attractive sites for recreational visitors. Those visitors that ignore posted hazard signs and enter these areas are exposed to elevated gamma radiation levels and radon gas concentrations as well as to arsenic, lead, and natural uranium, thorium and their daughter products in waste rock.

Actual contamination by arsenic, lead, and natural uranium, thorium and their daughter products occurs in intertidal and subtidal marine sediments in the Kendrick Creek delta and at the former ore loading dock. This contamination exposes or potentially exposes crab, clams, sea cucumber, urchin, other invertebrates, and groundfish. Humans consuming these organisms may be exposed to arsenic, lead, and radionuclides that are accumulated or concentrated in the organisms.

(ii) Actual or potential contamination of drinking water supplies or sensitive ecosystems.

The drinking water intake for the Dotson cabin is in an area of potential contamination associated with the in-water migration pathway of contaminated parts of the haul road. Water and stream sediment samples collected at the intake during the SI, however, showed that contaminant concentrations/activities at this location were below drinking water benchmarks and background references.

Kendrick Creek, Mine Fork Creek and the 700 Level Creek are clear water streams that are convenient drinking water sources for site visitors. Actual contamination impacts ~6,750 feet of these streams but drinking water benchmarks are not exceeded in the SI samples. Drinking water benchmarks are exceeded only in the 300-foot level mine drainage stream.

Wetlands border ~6,470 linear feet of Kendrick Creek containing actual contamination and ~87.6 acres of wetlands are within areas impacted by actual radon contamination.

The range of two Federal endangered species (humpback and fin whales) and one Federal threatened species (Steller sea lion) are in potentially contaminated marine waters. Sea lions may also enter areas of actual contamination at the former loading dock area.

(iv) High levels or hazardous substances or pollutants or contamination in soils largely at or near the surface, that may migrate.

Waste rock dumps at the 900-foot, 700-foot, and 300-foot levels were observed in streams during the SI. Dump material, particularly at the 300-foot level, appears to have been eroded by the streams.

The dump and waste rock material on the mine and haul roads are uncontained and subject to erosion and overland transport. Soil adjacent to the OSA waste rock pile and down-slope from the mine road and 700-foot level dump appears to be impacted by contaminants that have migrated from original waste rock sources.

The mine portals are open and waste rock piles are not capped allowing radon produced in these sources to migrate.

(v) Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.

The site is subject to high average annual precipitation and high 2-year, 24-hour probable maximum precipitation. Contaminants in the uncontained waste rock sources are susceptible to flooding and erosion under these conditions. The sampling data show that contaminant migration occurs by overland and stream sediment transport, especially in the 700-foot level dump and mine road areas. Elevated levels of arsenic, lead, and natural uranium, thorium and their daughter products are present in soil and stream sediment down-slope from these waste rock sources.

9.0 Conceptual Site Model and Data Gaps

The conceptual site model is illustrated in Figure 18 and summarizes the principal sources, contaminant release mechanisms, migration pathways, exposure routes, and potential current and future receptors at the site. The results of the SI are summarized in this section within the framework of the conceptual site model. The data gaps that exist in the characterization of the site are also listed in the following sections.

The conceptual site model considers contaminated soil both as a source in accordance with HRS and as a result of contaminant release by erosion of the waste rock sources. Deposition of fugitive dust derived from the waste rock sources may also contribute to soil contamination.

The contaminant release mechanism to the groundwater pathway is leaching of waste rock and soil sources. The groundwater pathway was not evaluated in the SI because groundwater is not used at or near the site and potential exposures to contaminated groundwater are through the surface water pathway.

The contaminant release mechanisms to the surface water pathway are runoff to surface water, erosion to stream and marine sediments, and to a lesser extent, by discharge of groundwater to surface water. Observed releases of contaminants to the surface water pathway were demonstrated by the SI surface water, stream sediment, and marine sediment sampling results and by observations of waste rock in streams and marine waters.

Contaminants are released to the air pathway by radon and fugitive dust emissions. Observed releases to the air pathway were demonstrated by the SI radon sampling results, but fugitive dust was not observed or sampled during the SI.

9.1 SOURCES

9.1.1 SI Results Summary

An estimated 45,000 cy of mine waste rock forms six discrete sources of metals and radioactivity at the site. Three waste rock sources consists of development rock, sub-ore-grade rock, and small amounts of ore-grade rock that were disposed on the mine dumps, two sources consist of waste rock that was used to build or repair roads or was spilled from ore trucks, and one source consists of the remnants of the OSA pile. The waste rock sources exceed the gamma radiation background reference, and contain arsenic, lead, total uranium, and numerous radionuclides in the natural uranium and thorium decay chains in concentrations or activities that exceed background references. Most of the radionuclides exceed the SSLR benchmarks. These sources impact the surface water pathway via surface water runoff and erosion and the air pathway via radon emissions. The sources potentially impact the groundwater pathway via leaching and the air pathway via fugitive dust emissions. Observed releases and actual contamination have been demonstrated for the surface water and air pathways.

An estimated 3.3 acres of contaminated soil adjacent to the waste rock sources contain significant metal concentrations and radionuclide activities in two additional sources: the OSA and 700-foot/mine road areas. A third area of contaminated soil identified on the 300-foot dump is combined with the 300-foot dump source for the purpose of calculating the potential extent of contamination. These contaminated soil sources were probably created largely by erosion and transport of contaminants from the waste rock sources described in the previous paragraph. Like the waste rock sources, the contaminated soil sources contain arsenic, lead, total uranium, and numerous natural radionuclides in concentrations or activities that exceed background references. Arsenic, total uranium, and many of the radionuclides exceed soil benchmarks. These contaminated soil sources potentially impact the groundwater pathway via leaching, the surface water pathway via surface water runoff and erosion, and the air pathway via radon and fugitive dust emissions.

The underground mine workings is a source of metals and radionuclides that impacts the surface water pathway via groundwater discharge from the 300-foot level adit and 700-foot level adit and the air pathway via radon emissions at the four mine openings. The source also potentially impacts the groundwater pathway via leaching. Observed releases from the underground workings have been demonstrated for the surface water and air pathways.

9.1.2 Data Gaps

- The SI sampling results show that contaminants have migrated from waste rock sources into soil in the OSA, mine road, and 700-foot level areas, but the full extent of soil contamination in these areas is not delineated. In addition, the potential for soil contamination down-slope from the 300-foot level dump and contaminated sections of the haul road have not been assessed.

- The volume of the OSA waste rock pile is uncertain because hand borings designed to assess the thickness of the pile during the SI met refusal at shallow depths within waste rock.

- The average contaminant levels of the OSA and 300-foot level waste rock piles are uncertain because the composite samples collected at these locations during the SI have high estimated relative errors of the mean.

- The extent and levels of contamination on the haul road are incompletely delineated.

- The gamma radiation levels across the waste rock and soil source areas are incompletely surveyed. Gamma survey maps produced by USBLM match poorly with the GPS mapping completed during the SI so the location of gamma isochors is uncertain. Furthermore, the delineation of background gamma isochors in the mine area has not been completed.

- The background reference for OSA soil is uncertain because anomalously high background sample results suggest that the locations may have been impacted by contaminant migration from the OSA pile. In addition, a specific background reference for soil developed over granite bedrock has not been defined.

9.2 GROUNDWATER PATHWAY

The groundwater pathway at the site has not been assessed because groundwater is not used within the four-mile groundwater TDL. Potential exposure to the groundwater pathway occurs via discharge to surface water. Discharge to surface water occurs continuously at the 300-foot level adit and periodically at the 700-foot level adit. In addition, groundwater discharge or connection to surface water likely occurs at many locations along the streams and wetlands in the Kendrick Creek watershed and at West Arm via subtidal seeps.

9.3 SURFACE WATER PATHWAY

9.3.1 SI Results Summary

Observed contamination in the surface water pathway includes source 1 (900-foot level north and south dumps) material in Mine Fork Creek, source 2 (700-foot level dump) material in the 700 Foot Creek, source 3 (300-foot level dump) material in Mine Fork Creek, and Source 4 (OSA) material in the intertidal waters of West Arm. Surface water, stream sediment, and marine sediment samples contained metal and radionuclide concentrations/activities exceeding background references and demonstrate that contaminants have been and continue to be released to the surface water pathway. Releases impact the lower 5,750 feet of Kendrick Creek and part of the Kendrick Creek delta in West Arm. Shorter sections of Mine Fork Creek and 700 Level Creek also have actual contamination as do marine sediments in West Arm near the OSA source and former ore loading dock.

9.3.2 Targets and Exposure Routes

Potential receptors of contamination in the surface water pathway include fishers in nearby waters; area visitors; and terrestrial, fresh water and marine biota. Current human exposure routes are through ingestion, direct contact, and food-chain exposure to contaminants in surface water and sediments. Humans are also potentially exposed to gamma radiation from radionuclides in contaminated sediments. The same exposure routes impact potential future on-site workers or residents as well as biota in the surface water pathway.

A significant commercial salmon fishery based on an aquiculture facility located in Kendrick Bay occurs within the 15-mile surface water TDL. The waters are also used for commercial shrimp, sea cucumber, and red urchin fishing. Recreational and subsistence fishers also use waters within the surface water TDL. Towns or known permanent residences are not present within the surface water TDL. The Dotson cabin west of the OSA is occupied occasionally and possibly seasonally by the owners of mining claims in the area and their family members. Drinking water for the cabin is obtained from an intake on Cabin Creek located 1,150 to 2,450 feet downstream of PPEs associated with the haul road source (source 6). A water sample collected at the creek did not exceed surface water benchmarks or background references.

Approximately 6,470 linear feet of wetlands border stream reaches with actual contamination. An additional 6,110 feet of wetlands border surface water within the mapped portion of the 15-mile TDL.

Kendrick Creek is designated as an important anadromous fish stream. The waters are in the range and are used by humpback and fin whales which are Federally-designated endangered species and by sea lions which is a Federally-designated threatened species.

As shown on Figure 18, plant and animal uptake of contaminants from surface water, stream sediments, and marine sediments may occur and impact human and biota receptors by ingestion of the contaminated plants and animals. This exposure route has not been evaluated and is a data gap as discussed in the following section.

9.3.3 Data Gaps

- A background sample on Kendrick Creek upstream from the 300-foot level has not been collected. Data from this location is important for confirming the surface water and stream sediment background references.

- The sampling results show that contamination in the upper part of 700 Level Creek exceeds background and benchmark concentrations. The extent of contamination in the creek has not been defined nor has the creek been followed to its confluence with either Kendrick Creek or Mine Fork Creek. In addition, the impact of ephemeral drainage from the 700-foot level adit on 700 Level Creek water quality has not been evaluated.

- Surface water samples were collected during a dry period with low stream flows. The effect of precipitation runoff and higher stream flows on contaminant levels is not known.

- The SI sampling results show that marine sediment contamination is present in the Kendrick Creek delta, but the seaward extent of contamination in the delta is not known.

- The possible biological effects of the stream and marine sediment contamination identified in the SI have not been evaluated. The toxicity of the contaminants at the detected concentrations/activities is not known. In addition, the potential uptake and biomagnification of contaminants are not known.

9.4 SOIL AND WASTE ROCK EXPOSURE PATHWAY

9.4.1 SI Results Summary

Observed waste rock and soil contamination covers ~8.4 acres of land. The activities of radium isotopes Ra-226 and Ra-228 exceed background references in nearly all SI source rock and surface soil samples. Most source samples also contain numerous other radionuclides as well as arsenic, lead, and total uranium at activities/concentrations that exceed the background references. Gamma radiation exceeds the background reference over most of the waste rock source areas with maximum radiation levels of 2,200 to 5,000 µR/hr.

9.4.2 Targets and Exposure Routes

Current site visitors, potential future site workers and residents, and terrestrial biota are potential receptors of contaminants in the soil and waste rock sources. Exposures can occur via ingestion, direct contact, external irradiation, and food-chain exposure. Signs warning of radiation hazard are posted near the OSA, waste rock dumps, and mine workings. The Dotson family may be considered occasional visitors or seasonal residents. Other site visitors are primarily occasional recreational users. The haul road, OSA, mine dumps, and mine workings are attractive use areas for recreational visitors.

Plant and animal uptake of contaminants from soil may occur and impact human and biota receptors by ingestion of the contaminated plants and animals. This exposure route was not evaluated in the SI and is a data gap as discussed in the following section.

9.4.3 Data Gaps

- The possible biological effects of soil contamination have not been evaluated. The toxicity of the contaminants to terrestrial flora and fauna at the detected concentrations/activities, and the potential uptake and biomagnification of contaminants are not known.

9.5 AIR PATHWAY

9.5.1 SI Results Summary

The underground mine workings and waste rock piles are sources of radon emissions to the atmosphere. Radon activities range between 24 and 396 pCi/L in air outside four mine openings and between 10 and 105 pCi/L above the waste rock dump sources. The radon activities exceed the background reference and air benchmark in all but one sample.

9.5.2 Targets and Exposure Routes

Current receptors of radon and fugitive dust in the air pathway include fishers in nearby waters, area visitors, terrestrial biota, and marine mammals. Potential future receptors include both on-site and off-site workers and residents. Exposure occurs through inhalation.

Towns or known permanent residences are not present within the four-mile air TDL but state land ~2.5 miles east of the site may be developed in the future for residential use. The Dotson cabin is within 0.25 miles of the OSA source where a radon release to air is documented. The cabin is occupied occasionally or seasonally. Approximately 87.6 acres of wetlands are located within 0.25 miles of radon sample locations at mine openings or waste rock sources. The South POW Wilderness, several commercial fisheries, and ~27,300 additional wetland acres are present within four miles of the site.

Air particulate levels have not been evaluated. However, blowing dust was not observed during the SI and the potential risk associated with the human or biota inhalation of fugitive dust may be low because

the high rainfall in the area limits the potential for blowing dust from the waste rock piles. As such, the lack of air particulate sampling is not considered an important data gap.

9.5.3 Data Gaps

- The background reference for radon over quartz monzonite bedrock is uncertain because the background sample locations may have been impacted by radon migration from the Ross Adams mine area.
- The SI identified elevated radon levels adjacent to the waste rock and mine workings sources, but radon migration from the sources and the extent of radon contamination in air that exceeds background concentrations across the site has not been evaluated.
- Air flow rates and the associated radon flux from the mine portals have not been measured so the effects of mine venting on radon plume distribution cannot be assessed.
- Radon flux from the waste rock piles has not been evaluated and radon activities adjacent to the waste rock sources have only been evaluated during warm, dry weather. As such, the variability of radon emissions cannot be assessed.

Table 1
Historical Analytical Data: Stream Sediment Samples
Ross Adams Uranium Mine PA/SI Report

Sample ID	Sample Date	U (ppm)	U (pCi/g)[1]	V (ppm)	Mo (ppm)	As (ppm)	Cu (ppm)	Mn (%)	Zn (%)
SS-1	~1970	7	2.4	30 U	2 U	2	2 U	0.1 U	0.003
SS-2	~1970	8	2.8	30 U	2 U	2	2 U	0.1	0.001
SS-3	~1970	33	11.4	30 U	2 U	2	2 U	0.1 U	0.003
SS-4	~1970	554	192	30 U	2 U	5	2 U	0.1 U	0.002
SS-5	~1970	315	109	30 U	2 U	3	2 U	0.1 U	0.003
SS-6	~1970	253	87.5	30 U	2 U	2	2 U	0.1 U	0.002
SS-7	~1970	291	101	30 U	2 U	3	2 U	0.1	0.004
SS-8	~1970	198	68.4	30 U	2 U	4	2 U	0.1 U	0.003
SS-9	~1970	77	26.6	100	2 U	6	4	0.1 U	0.005

Data from Eakins [9].
[1] Calculated from mass concentration assuming 99.72% U-238, 0.72% U-235 and 0.0055% U-234

Table 2
Historical Analytical Data Summary: Bokan Mountain Stock Bedrock
Ross Adams Uranium Mine PA/SI Report

	Phase of Bokan Mountain Granite (number of samples)							
	Biotite Aplite (1)		Aegirine Granite (4)		Riebeckite Granite (7)		Riebeckite Aplite (2)	
Element	*X*	*R*	*X*	*R*	*X*	*R*	*X*	*R*
U (ppm)	14	NA	10.9	8.6 - 13	10	7.9 - 15.2	7.5	6.4 - 8.5
(pCi/g)[1]	4.8	NA	3.8	3.0 - 4.5	3.5	2.7 - 5.3	2.6	2.2 - 2.9
Th (ppm)	45	NA	39.5	12 - 90	28.8	ND - 80	30 U	NA
(pCi/g)[2]	4.9	NA	4.3	1.3 - 9.9	3.2	ND - 8.8	3.3 U	NA
Nb (ppm)	120	NA	100	60 - 150	79	40 - 140	50	ND - 100
Y (ppm)	D	NA	115	ND - 240	80	ND - 240	ND	NA
Zr (%)	0.02	NA	0.11	0.02 - 0.17	0.08	0.02 - 0.16	0.1	0.05 - 0.16
Total REE (ppm)	D	NA	305	100 - 500	250	100 - 360	200	200 - 300

Data from Warner & Barker [39].

[1] Calculated from mass concentration assuming 99.72% U-238, 0.72% U-235 and 0.0055% U-234

[2] Calculated from mass concentration assuming 100% Th-232

D Detected

NA Not applicable

R Range

X Mean

REE Rare-earth elements, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu were analyzed

Table 3
Historical Analytical Data: Open Pit and Core Samples
Ross Adams Uranium Mine PA/SI Report

Sample ID	Sample Type[1]	Sample Length or Depth Interval (feet)	U (ppm)	U (pCi/g)[2]	Th (ppm)	Th (pCi/g)[3]	Nb (ppm)	Y (ppm)	Zr (%)	Total REE[4]	CPS[5]	Description
I-1	C	5	3,560	1,231	1,040	114	150	300	0.20	510	20,000	Silicic, hematitic syenite dike
I-2	Ch	3	120	41	350	38	290	100	0.01	20	--	Aegerine granite, minor fluorite
I-3	Ch	6	156	54	810	89	280	900	0.20	520	--	Syenite dike, fluorite, smokey quartz
I-4	Ch	6	72	25	370	41	130	100	0.03	250	6,000	Granite
I-5	Ch	6	172	59	440	48	60	100	0.04	50	14,000	Granite
I-6	Ch	6	145	50	2,320	255	nd	40	0.02	20	15,000	Granite minor chlorite on fractures
I-7	Ch	6	156	54	1,125	124	50	40	0.02	20	15,000	Granite, minor chlorite on fractures
I-8	Ch	6	92	32	430	47	85	100	0.05	50	10,000	Granite, moderate chlorite
I-9	Ch	6	45	16	1,030	113	65	100	0.02	50	11,000	Granite, mod. chlorite, minor hematite
I-10	Ch	6	86	30	1,125	124	100	100	0.04	100	11,000	Granite, mod. chlorite, minor hematite
I-11	Ch	6	550	190	1,040	114	90	100	0.1	100	20,000	Granite, abundant chlorite, hematite
I-12	Ch	6	1,235	427	1,270	140	nd	100	0.1	50	20,000	Granite with pyrite and pervasive chlorite
I-13	Ch	6	1,020	353	1,270	140	100	100	0.05	50	20,000	Granite with pyrite and pervasive chlorite
I-14	Ch	6	215	74	645	71	85	20	0.2	20	6,000	Granite with chlorite alteration
I-15	Ch	6	15	5.2	60	7	65	20	0.06	10	2,500	Granite
I-16	Ch	6	12	4.1	95	10	70	40	0.02	10	1,400	Granite
I-17	Cr	175-187	17	5.9	84	9	120	470	0.38	549	--	Granite with mod. hematite, some fluorite
I-18	Cr	188-204	17	5.9	160	18	130	230	0.15	482	--	Granite, mod. chlorite, minor hematite
I-19	Cr	205-220	448	155	590	65	nd	8,600	0.22	1,229	--	"Ore zone" chlorite-altered, galena, hematite, MnO_x, uraninite (?)
I-20	Cr	220-230	99	34	3,000	330	nd	960	0.29	570	--	"Ore zone" chlorite and hematite altered granite
I-21	Cr	230.5-241.5	102	35	1,400	154	nd	2,200	0.08	388	--	Chlorite altered granite with minor hematite (footwall of ore)
I-22	Cr	242.5-257.9	1	0.35	24	3	50	200	0.24	17	--	Granite, analtered
I-23	Cr	20-30	767	265	540	59	nd	60	0.25	579	--	Aegirine syenite, unaltered except local chlorite
I-24	Cr	30-36	17	5.9	1,100	121	nd	90	0.24	323	--	Aegirine syenite, hematite increases downhole
I-25	Cr	36-47	1,200	415	840	92	nd	60	0.28	623	--	Hematite-chlorite altered syenite, galena, pyrite, uraninite (?)
I-26	Cr	47-65	79	27	44	5	50	60	0.31	154	--	Leucocratic syenite, some fluorite
I-27	Cr	38.5-46	350	121	3,700	407	nd	1,200	0.18	642	--	"Ore zone" chlorite altered granite, some hematite, pyrite

Data from Warner & Barker [39].

[1] C: channel, Ch: chip, Cr: random chip.

[2] Calculated from mass concentration assuming 99.72% U-238, 0.72% U-235 and 0.0055% U-234

[3] Calculated from mass concentration assuming 100% Th-232.

[4] Rare-earth elements, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu were analyzed

[5] CPS: counts per second on Mount Sorpris model SC-132 gamma ray scintillometer

nd Not detected.

-- Not measured.

Table 4
Historical Analytical Data: Country Rock Samples
Ross Adams Uranium Mine PA/SI Report

Sample Numbers and Rock Types

Element	5 Country rock meta-basalt	6 Qtz Ab aplite	7 Country rock meta-basalt dike	8 Country rock granodiorite	11 S.E. stock, aeg. granite	13 S.E. stock, amph. granite	15A Border zone, float granite porphyry	15C Border zone, float granite	17 Qtz feld pegmatite	19-5 Qtz feld pegmatite	19-6 Qtz feld pegmatite	21A Ab granite	21B Qtz feld pegmatite	23 Qtz ab aplite
As	--	--	--	1.2	--	2	1.2	2	--	--	--	--	--	--
Ba	200	35	240	1,100	24	34	19	34	79	53	57	90	150	96
Be	--	130	--	--	6	8	5	7	30	25	24	7	49	120
Co	29	1.6	59	6.9	0.11	0.12	0.16	0.14	0.56	0.4	0.3	1.4	--	4.9
Cr	170	12	150	19	--	3	3	1.7	7	--	19	5	--	3
Cs	0.4	0.3	0.2	0.12	0.97	0.77	0.6	1	0.65	0.55	0.6	0.56	2	0.55
Cu	6	16	87	23	--	2	1	1	1	2	10	3	19	19
Ga	18	35	19	18	40	40	42	41	44	28	42	19	45	31
Hf	1.9	105	2.4	2.5	32	11.5	43.7	25	430	537	420	11.2	290	9.8
Li	5	2	13	--	88	120	2	160	9	11	10	60	4	510
Mo	--	6.4	--	--	1.5	2.2	1.2	2.5	1.7	--	1.8	--	1.8	4.7
Nb	1.9	2,100	1.9	1.8	51	130	32	60	77	69	600	100	630	1,700
Ni	48	3	140	10	--	--	--	--	--	2	--	4	3	5
Pb	--	130	--	6	25	23	16	18	44	400	1,000	130	200	2,300
Rb	27.5	16	13	37	250	230	82	180	290	260	310	41	740	150
Sb	0.35	8.3	0.13	0.15	0.1	0.24	0.15	0.22	2.4	1.9	2	0.18	1.3	0.9
Sc	36	0.75	33.6	5.2	0.35	0.33	0.18	0.34	1.9	1.67	1.16	3.3	1.8	3.5
Sn	--	82	--	--	10	11	--	--	--	120	110	--	--	24
Sr	380	76	300	840	2	6	3	5	5	15	50	58	40	200
Ta	0.16	112	0.16	0.17	4.2	9.9	2.7	4.4	10.4	7.2	57.3	14.5	48	113
Th	1.71	217	0.21	3.86	19.5	137	12.3	28.4	86	30	116	48	490	41
Th (pCi/g)[1]	*0.2*	*23.9*	*0.0*	*0.4*	*2.1*	*15.1*	*1.4*	*3.1*	*9.5*	*3.3*	*12.8*	*5.3*	*53.9*	*4.5*
U	0.63	141	--	1.26	7.2	11.6	8.04	6.1	64	95	98	19.4	148	95
U (pCi/g)[2]	*0.2*	*48.7*		*0.4*	*2.5*	*4.0*	*2.8*	*2.1*	*22.1*	*32.8*	*33.9*	*6.7*	*51.2*	*32.8*
V	270	11	220	52	--	--	4	--	8	3	--	4	--	44
Y	23	2,100	23	5	19	70	40	28	140	1,800	2,200	530	18,000	380
Zn	108	220	107	28	235	320	140	280	170	620	610	310	220	1,600
Zr	--	5,600	110	90	1,100	390	1,600	920	19,000	24,000	19,000	450	15,000	330
La	9	1,200	2.9	17.4	200	290	20	26	102	41	540	230	3,200	1,140
Ce	19.6	2,420	9.1	31	390	620	44	56	270	78	1,130	390	5,900	1,950
Nd	11	780	9.8	12	170	240	22	20	110	60	530	150	2,450	710
Sm	3.1	237	3.4	2.3	21	48	6.5	5	33	28	186	47	770	198
Eu	1.04	22.6	1.2	0.63	1.1	3.2	0.66	0.4	4.3	4.9	18.7	4.85	79	16.4
Tb	0.63	51.3	0.72	0.21	0.89	3.6	1.62	0.94	18	24.6	49.6	13.8	295	19.6
Ho	0.75	140	1.4	--	--	--	4	2.6	60	90	110	20	500	--
Yb	2.5	190	2.6	0.65	17.3	16.6	16	14	335	490	390	52	1,360	12.2
Lu	0.36	22.2	0.37	0.085	2.8	2.3	2.67	2.28	46	67	52.6	5.6	153	0.99

Data from Philpotts, et al, [22].

Results in ppm by weight except as indicated.

-- Not analyzed.

[1] Calculated from mass concentration assuming 99.72% U-238, 0.72% U-235 and 0.0055% U-234

[2] Calculated from mass concentration assuming 100% Th-232.

Mineralogy abbreviations

Ab:	albite	Feld:	feldspar
Aeg:	aegirine	Qtz:	quartz
Amph:	amphibole		

Table 5
Historical Analytical Data: Surface Water Samples
Ross Adams Uranium Mine PA/SI Report

Analyte	Units	**WA01 (R01)** Kendrick Ck below 300 dump	**WA02 (R02)** downstream of 900 level dumps	**WA03 (R03)** background	**WA04 (R04)** background	**WA05 (R05)** background	**WA06 (R06)** 300 level adit discharge	**WA07 (R07)** Kendrick Ck at Kendrick Bay
Antimony	(ug/L)	ND	ND	ND	ND	ND	ND	ND
Arsenic	(ug/L)	ND	ND	ND	ND	ND	ND	ND
Beryllium	(ug/L)	ND	ND	ND	ND	ND	ND	ND
Cadmium	(ug/L)	ND	**0.85**	ND	ND	ND	ND	ND
Chromium	(ug/L)	ND	ND	ND	ND	ND	ND	ND
Copper	(ug/L)	ND	ND	ND	ND	ND	**2.4**	ND
Lead	(ug/L)	ND	ND	ND	ND	ND	ND	ND
Mercury	(ug/L)	ND	ND	ND	ND	ND	ND	ND
Nickel	(ug/L)	ND	ND	ND	ND	ND	ND	ND
Selenium	(ug/L)	ND	ND	ND	ND	ND	ND	ND
Silver	(ug/L)	ND	ND	ND	ND	ND	ND	ND
Thallium	(ug/L)	ND	ND	ND	ND	ND	ND	ND
Zinc	(ug/L)	ND	ND	ND	ND	ND	**35**	ND
Hardness	(mg/L)	ND	ND	ND	ND	ND	**21**	**31**
Gross alpha	(pCi/L)	**13.7**	**4.4**	**1.2**	**0.2**	**4.2**	**256**	-0.1
Gross beta	(pCi/L)	**5.0**	**1.4**	**3.8**	**2.0**	**3.3**	**71.6**	**2.7**
Total radium	(pCi/L)	0.0	0.0	**0.8**	--	0.0	**0.4**	--
Flow	(cfs)	0.7	0.45	0.2	0.2	0.9	<0.1	1.0 to 1.5

Data from USBLM [24].

BOLD The analyte was detected.

-- Not analyzed.

ND Not detected.

Table 6
Changes to Workplan
Ross Adams Uranium Mine PA/SI Report

No.	WP Section	Change	Reason for Change
1	Table SAP-1	Duplicate surface water sample was collected from location SW-06 rather than SW-10.	To eliminate the logistics of transporting the duplicate sample from the 900-ft level.
2	Section 6.5.2	Cabin radon samples were omitted.	The cabin was occupied during the field program which would invalidate the sample results.
3	Section 6.3.2	The fourth soil sample at the generator shed was omitted.	The spill area was too small to warrant four samples.
4	Section 6.3.1	Soil samples in the cabin area were not collected.	The cabin was occupied and pervasive septic-type leakage covered the surrounding ground.
5	Section 6.4.5	Beach seeps and/or beach pore-space water samples were not collected.	Beach seeps and groundwater were largely saline (salinity > ~15%).
6	Table SAP-1	Surface water sample SW-3 was not collected.	Insufficient time.
8	Section 6.2.5	Two haul road samples were not collected.	Insufficient time.
9	Sections 6.3.3 and 6.6.1	Two surface soil and one background surface soil in the OSA area were not collected.	Insufficient time.
10	Table SAP-1	Duplicate marine sediment sample was collected from location MSED-08 rather than MSED-06.	Sample collection at location MSED-06 was difficult.
11	Section 6.5.1	Alpha track samples were collected at 0.5 feet agl (in addition to samples at 3 feet agl) at the 700- and 900-ft level dumps.	To ensure that detectable data were collected even though the field program was shortened by one day due to weather.
12	Section SAP 13.5.1	Rock chip samples and all of the composite samples other than OSA-02 were stored in large plastic bags rather than bottles.	To ensure sufficient material was available to the laboratory and to reduce altering sample results by eliminating large rock chips from the composite samples.
13	Section 6.2.3	Sample 900-03 was changed from a composite of the south 900-ft dump to a discrete high grade sample.	Insufficient time to collect a composite sample.
14	Section 6.7.2	The 50uR/hr contour was not surveyed between the 700- and 900-ft levels.	Insufficient time.
15	Section 6.5.1	Some radon sample exposure times were decreased.	Necessitated due to loss of one field day.
16	Section 6.6.3	Granite background sample locations were revised. Seven samples were collected along the transect near the open pit and three were collected ~1000 feet west-southwest of the pit.	To address USEPA/USFS comment concerning appropriate granite background locations.

Table 7
Sample Containers, Preservation, and Holding Times
Ross Adams Uranium Mine PA/SI Report

Matrix	Parameter List	Containers	Preservation	Holding Time
Air	Radon	alpha-track detector	None	na
Rock	Radionuclides and metals	3 x 16-oz HDPE jars or large plastic bag	4± 2° C	180 days for metals; 28 days for mercury
Sediment	Radionuclides and metals	3 x 16-oz HDPE jars	4± 2° C	180 days for metals; 28 days for mercury
Soil	Radionuclides and metals	3 x 16-oz HDPE jars	4± 2° C	180 days for metals; 28 days for mercury
Soil	Diesel- and residual-range hydrocarbons	2 x 8-oz glass jars	4± 2° C	14 days to extraction; 40 days to analysis
Water	Alkalinity	250-ml HDPE	4± 2° C	na
Water	Metals + hardness	1-liter HDPE	4± 2° C, HNO3	180 days for metals; 28 days for mercury
Water	Isotopic Thorium	2 x 1-liter HDPE	4± 2° C, HNO3	na
Water	Radium 226/228	2 x 1-gal HDPE cube	4± 2° C, HNO3	na
Water	Lead 210	1-gal HDPE cube	4± 2° C, HNO3	na
Water	Gross alpha/beta	1-liter HDPE	4± 2° C, HNO3	na

º C Degrees centigrade.
gal Gallon.
HDPE High density polyethylene.
na Not applicable.
oz Ounce.

Table 8
Solids and Water Sample Numbers and Requested Analyses
Ross Adams Uranium Mine PA/SI Report

Sample Area	Sample ID	Lab ID	Sample Type	Matrix	Sample Prep	Uranium - isotopic	Thorium - Isotopic	Radium 226/228	Actinium 227/Protactinium 231/Lead 210	TAL Metals	10 Metals	Gross alpha/beta	Hydrocarbon + TOC	Alkalinity/Hardness
Ore Staging	OSA-01	0405097-14	Discrete HG	Rock	x	x	x	x	x	x	•	•	•	•
Ore Staging	‡OSA-02	0405097-15	Composite	Rock	x	x	x	x	•	•	x	•	•	•
Ore Staging	OSA-03	0405097-16	OSA-02-Dup	Rock	x	x	x	x	•	•	x	•	•	•
300-ft dump	300-01	0405097-17	Discrete HG	Rock	x	x	x	x	•	•	x	•	•	•
300-ft dump	300-02	0405097-18	Composite	Rock	x	x	x	x	•	•	x	•	•	•
700-ft dump	‡700-01	0405097-19	Discrete HG	Rock	x	x	x	x	x	x	•	•	•	•
700-ft dump	‡700-02	0405097-20	Composite	Rock	x	x	x	x	•	•	x	•	•	•
700-ft dump	700-03	0405097-21	700-01-Dup	Rock	x	x	x	x	x	x	•	•	•	•
700-ft dump	700-04	0405097-22	700-02-Dup	Rock	x	x	x	x	•	•	•	•	•	•
900-ft dump	900-01	0405097-23	Discrete HG	Rock	x	x	x	x	x	x	•	•	•	•
900-ft dump	900-02	0405097-24	Discrete HG	Rock	x	x	x	x	•	•	x	•	•	•
900-ft dump	900-03	0405097-25	Discrete HG	Rock	x	x	x	x	•	•	x	•	•	•
900-ft dump	‡900-04	0405097-26	Composite	Rock	x	x	x	x	•	•	x	•	•	•
900-ft dump	900-05	0405097-27	900-04-Dup	Rock	x	x	x	x	•	•	x	•	•	•
BG-Granite	Gr-01	0405097-4	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
BG-Granite	Gr-02	0405097-5	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
BG-Granite	Gr-03	0405097-6	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
BG-Granite	Gr-04	0405097-7	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
BG-Granite	Gr-05	0405097-8	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
BG-Granite	Gr-06	0405097-9	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
BG-Granite	Gr-07	0405097-10	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
BG-Granite	Gr-08	0405097-11	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
BG-Granite	Gr-09	0405097-12	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
BG-Granite	Gr-10	0405097-13	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
BG-QM	‡QM-01	0405097-14	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
BG-QM	QM-02	0405097-15	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
BG-QM	QM-03	0405097-16	QM-01-Dup	Rock	x	x	x	x	•	•	x	•	•	•
Mine Road	MR-01	0405097-2	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
Mine Road	MR-02	0405097-3	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
Haul Road	HR-01	0405097-1	Discrete	Rock	x	x	x	x	•	•	x	•	•	•
BG-OSA	Soil-01	0405096-25	Discrete	Soil	•	x	x	x	•	•	x	•	•	•
BG-OSA	Soil-02	0405096-26	Discrete	Soil	•	x	x	x	•	•	x	•	•	•
Ore Staging	Soil-04	0405096-27	Discrete	Soil	•	x	x	x	•	•	x	•	•	•
Ore Staging	Soil-05	0405096-28	Discrete	Soil	•	x	x	x	•	•	x	•	•	•
Opportunity	‡Soil-07	0405096-29	Discrete	Soil	•	x	x	x	•	•	x	•	•	•
Opportunity	Soil-08	0405096-30	Discrete	Soil	•	x	x	x	•	•	x	•	•	•
Opportunity	Soil-09	0405096-31	Soil-07-Dup	Soil	•	x	x	x	•	•	x	•	•	•
Opportunity	Soil-10	0405096-32	Discrete	Soil	•	x	x	x	•	•	x	•	•	•
Generator	Gen-01	0405096-21	Discrete	Soil	•	•	•	•	•	•	•	•	x	•
Generator	‡Gen-02	0405096-22	Discrete	Soil	•	x	x	x	•	•	x	•	x	•
Generator	Gen-03	0405096-23	Discrete	Soil	•	•	•	•	•	•	•	•	x	•
Generator	Gen-04	0405096-24	Gen-02-Dup	Soil	•	x	x	x	•	•	x	•	x	•

Table 8
Solids and Water Sample Numbers and Requested Analyses
Ross Adams Uranium Mine PA/SI Report

Sample Area	Sample ID	Lab ID	Sample Type	Matrix	Sample Prep	Uranium - isotopic	Thorium - Isotopic	Radium 226/228	Actinium 227/Protactinium 231/Lead 210	TAL Metals	10 Metals	Gross alpha/beta	Hydrocarbon + TOC	Alkalinity/Hardness
BG-MF	SSed-01	0405096-11	Discrete	SSed	•	x	x	x	•	•	x	•	•	•
BG-KC	SSed-02	0405096-12	Discrete	SSed	•	x	x	x	•	•	x	•	•	•
Cabin Creek	SSed-03	0405096-13	Discrete	SSed	•	x	x	x	•	•	x	•	•	•
KC-Mouth	SSed-04	0405096-14	Discrete	SSed	•	x	x	x	•	•	x	•	•	•
KC	SSed-05	0405096-15	Discrete	SSed	•	x	x	x	•	•	x	•	•	•
KC	‡SSed-06	0405096-16	Discrete	SSed	•	x	x	x	•	•	x	•	•	•
KC-300 level	SSed-07	0405096-17	Discrete	SSed	•	x	x	x	•	•	x	•	•	•
MF-700 level	SSed-08	0405096-18	Discrete	SSed	•	x	x	x	•	•	x	•	•	•
MF-900 level	SSed-09	0405096-19	Discrete	SSed	•	x	x	x	•	•	x	•	•	•
KC	SSed-10	0405096-20	SSed-06-Dup	SSed	•	x	x	x	•	•	x	•	•	•
BG	MSed-01	0405096-01	Discrete	MSed	•	x	x	x	•	•	x	•	•	•
BG	MSed-02	0405096-02	Discrete	MSed	•	x	x	x	•	•	x	•	•	•
BG	MSed-03	0405096-03	Discrete	MSed	•	x	x	x	•	•	x	•	•	•
KC-Mouth	MSed-04	0405096-04	Discrete	MSed	•	x	x	x	x	•	x	•	•	•
KC-Mouth	MSed-05	0405096-05	Discrete	MSed	•	x	x	x	•	•	x	•	•	•
KB-Dock	MSed-06	0405096-06	Discrete	MSed	•	x	x	x	•	•	x	•	•	•
KB-Dock	MSed-07	0405096-07	Discrete	MSed	•	x	x	x	•	•	x	•	•	•
KB-Dock	‡MSed-08	0405096-08	Discrete	MSed	•	x	x	x	•	•	x	•	•	•
KB-Dock	MSed-09	0405096-09	Discrete	MSed	•	x	x	x	•	•	x	•	•	•
KB-Dock	MSed-10	0405096-10	MSed-08-Dup	MSed	•	x	x	x	•	•	x	•	•	•
BG-MF	SW-01	0405095-01	Discrete	SW	•	•	•	x	•	•	x	x	•	x
BG-MF	SW-02	0405095-02	Discrete	SW	•	•	•	x	•	•	x	x	•	x
Cabin Creek	SW-04	0405095-03	Discrete	SW	•	•	•	x	•	•	x	x	•	x
OSA	SW-05	0405095-04	Discrete	SW	•	•	x	x	**- B -**	x	•	x	•	x
KC-mouth	‡SW-06	0405095-05	Discrete	SW	•	•	•	**- A -**	•	•	x	x	•	x
KC-300 level	SW-07	0405095-06	Discrete	SW	•	•	x	x	**- B -**	x	•	x	•	x
KC-300 level	SW-08	0405095-07	Discrete	SW	•	•	•	**- A -**	•	•	x	x	•	x
MF-700 level	SW-09	0405095-08	Discrete	SW	•	•	•	**- A -**	•	•	x	x	•	x
MF-900 level	SW-10	0405095-09	Discrete	SW	•	•	•	**- A -**	•	•	x	x	•	x
MF-900 level	SW-11	0405095-10	SW-06-Dup	SW	•	•	•	**- A -**	•	•	x	x	•	x
Field Rinsate	FR-01	0405095-11	QC	Water	•	•	•	x	•	•	x	x	•	•
Field Rinsate	FR-02	0405095-12	QC	Water	•	•	•	x	•	•	x	x	•	•

QC samples shown in red.

‡ Duplicate sample associated with this sample.

- A - The analysis was performed only if gross alpha is > 5 pC/L.

- B - Analyzed only for Pb-210.

BG	Background	Gr	Granite	MF	Mine Fork Creek
C	Cabin	GW	Groundwater	MSed	Marine sediment
CC	Cabin Creek	HG	High grade	OSA	Ore-staging area
Comp	Composite	KB	Kendrick Bay	QM	Quartz monzonite
Dup	Duplicate	KC	Kendrick Creek	SSed	Stream sediment
				SW	Surface water

Table 9
Alpha Track Radon Detector Sample Results
Ross Adams Uranium Mine PA/SI Report

Location	Feet Above Ground Level	Sample ID	Lab ID	Start Time *(day - time)*	End Time *(day - time)*	Total Time *(hrs - min)*	Track Count	Tracks per Hour	Radon *(pCi/L)*
900 Level									
North dump	3	R900-01-3-98	117791	5/3/2004 15:05	5/7/2004 17:27	98:22	145	1.47	35
North dump	0.5	R900-01-0.5-98	117792	5/3/2004 15:06	5/7/2004 17:28	98:22	384	3.90	105
Stope	3	R900-02-96	117785	5/3/2004 15:35	5/7/2004 15:20	95:45	108	1.13	24
Vent Shaft	0	R900-03-96	117780	5/3/2004 15:52	5/7/2004 15:26	95:34	164	1.72	40
South Dump	3	R900-04-98	117775	5/3/2004 15:20	5/7/2004 17:23	98:03	121	1.23	28
700 Level									
Adit	3	R700-01-44	117772	5/3/2004 17:23	5/5/2004 13:43	44:20	174	3.92	87
Adit	3	R700-01-95	117779	5/3/2004 17:20	5/7/2004 15:55	94:35	299	3.16	80
Dump	3	R700-02-3-95	117773	5/3/2004 17:04	5/7/2004 16:04	95:00	79	0.83	16
Dump	0.5	R700-02-0.5-95	117786	5/3/2004 17:05	5/7/2004 16:02	94:57	340	3.58	92
300 Level									
Adit	3	R300-01-48	117774	5/3/2004 18:35	5/5/2004 18:25	47:50	687	14.36	396
Adit	3	R300-01-72	117778	5/3/2004 18:35	5/6/2004 18:40	72:05	860	11.93	336
Adit	3	‡R300-01-96	117783	5/3/2004 18:35	5/7/2004 18:45	96:10	1078	11.21	322
Adit (dup)	3	R300-02-96	117788	5/3/2004 18:36	5/7/2004 18:48	96:12	892	9.27	262
Adit (blank)	3	R300-03-96	117789	5/3/2004 18:36	5/7/2004 18:55	96:19	45	0.47	5.9
Ore Staging Area									
Dump	3	‡ROSA-01-3-108	117771	5/3/2004 19:14	5/8/2004 7:37	108:23	70	0.65	10
Dump	0.5	ROSA-01-0.5-108	117793	5/3/2004 19:14	5/8/2004 7:39	108:25	158	1.46	31
Dump (dup)	3	ROSA-02-108	117781	5/3/2004 19:15	5/8/2004 7:34	108:19	48	0.44	1.7
Granite Background									
Outcrop	3	RGR-01-95	117784	5/3/2004 16:12	5/7/2004 15:47	95:35	32	0.33	2.1
Outcrop	3	RGR-02-95	117782	5/3/2004 16:20	5/7/2004 15:30	95:10	13	0.14	0.4 U
Outcrop	3	RGR-03-95	117776	5/3/2004 16:27	5/7/2004 15:15	94:48	23	0.14	0.4 U
Quart Monzonite Background									
Outcrop	3	RQM-01-100	117794	5/3/2004 13:35	5/7/2004 18:04	100:29	22	0.14	0.4 U
Outcrop	3	RQM-02-100	117787	5/3/2004 14:00	5/7/2004 17:56	99:56	40	0.40	4.4
Outcrop	3	RQM-03-100	117777	5/3/2004 14:15	5/7/2004 18:07	99:52	43	0.43	5.3
Control Blank[1]									
Blank	na	R1000-01	117790	na	na	na	27	na	0.6

Note: All samples and the detection limit exceed the 10-6 cancer risk Rn-222 criterion of 6.3*10-4 pCi/L [27].

[1]Detector accompanied all shipment and handling but was not deployed in the field.

QC samples are shown in red.

‡ Duplicate sample collected at this location.

☐ Activity exceeds background comparison criteria (2.9 pCi/L in granite terrain, 8.6 pCi/L in quartz monzonite terrain).

na Not applicable.

U Not detected at sample concentration shown in the table.

Table 10
Sample Objectives and Descriptions
Ross Adams Uranium Mine PA/SI Report

Matrix	Sample ID	Depth *(in bgs)*	Lab ID	Sample Type	Objective	Description
Rock	OSA-01	0 - 2	0405097-14	Discrete HG	Characterize maximum concentration in OSA.	Loose, medium brown SAND with 20 to 30 percent coarse gravel, wet, no odor.
Rock	‡OSA-02	0 - 4	0405097-15	Composite	Characterize average concentration in OSA.	Sand, gravel, and rock chips.
Rock	OSA-03	0 - 4	0405097-16	OSA-02-Dup	Field QC	Same as OSA-02.
Rock	300-01	0 - 2	0405097-17	Discrete HG	Characterize maximum concentration in 300-foot dump.	Dump material comprised of gravel-sized rock chips with 15 to 20 percent sand. Pervasively hematitic Jgr, weakly chloritized.
Rock	300-02	0 - 4	0405097-18	Composite	Characterize average concentration in 300-foot dump.	Medium orangish-brown, medium to coarse SAND with 30 to 40 percent fine to coarse gravel.
Rock	‡700-01	0 - 2	0405097-19	Discrete HG	Characterize maximum concentration in 700-foot dump.	Medium brown, fine to coarse SAND with 10 to 20 percent fine gravel and 10 percent silt, slightly moist, no odor.
Rock	‡700-02	0 - 4	0405097-20	Composite	Characterize average concentration in 700-foot dump.	Medium brown, medium to coarse SAND with 30 to 40 percent fine to coarse gravel.
Rock	700-03	0 - 2	0405097-21	700-01-Dup	Field QC.	Same as sample 700-01.
Rock	700-04	0 - 4	0405097-22	700-02-Dup	Field QC.	Same as sample 700-02.
Rock	900-01	0 - 2	0405097-23	Discrete HG	Resample BLM sample location SO-03.	Collected near old flagging believed to be location of BLM sample SO-03. Loose, medium yellowish brown, very fine to coarse SAND with trace silt and 5 to 10 percent gravel, barely damp, no odor.
Rock	900-02	0 - 2	0405097-24	Discrete HG	Characterize maximum concentration in north 900-foot dump.	Dump material comprised of dark reddish- and greenish-gray rock fragments. Jgr with weak to moderate pervasive hematite and jaresite (?) fracture coatings.
Rock	900-03	0 - 2	0405097-25	Discrete HG	Characterize maximum concentration in south 900-foot dump.	Dump material comprised of medium to coarse sand, fine to coarse gravel, and cobbles. Jgr, hemtitic red to reddish orange.
Rock	‡900-04	0 - 4	0405097-26	Composite	Characterize average concentration in north 900-foot dump.	Medium orangish-brown fine to coarse SAND with 15 to 20 percent fine to coarse gravel.
Rock	900-05	0 - 4	0405097-27	900-04-Dup	Field QC.	Same as 900-04.
Rock	GR-01	0 - 2	0405097-4	Discrete	Characterize granite background.	Light orange, fine to medium grained phaneritic Jgr.
Rock	GR-02	0 - 2	0405097-5	Discrete	Characterize granite background.	Light gray, fine to medium grained phaneritic Jgr.

Table 10
Sample Objectives and Descriptions
Ross Adams Uranium Mine PA/SI Report

Matrix	Sample ID	Depth *(in bgs)*	Lab ID	Sample Type	Objective	Description
Rock	GR-03	0 - 2	0405097-6	Discrete	Characterize granite background.	Medium greenish-gray, medium-grained phaneritic Jgr.
Rock	GR-04	0 - 2	0405097-7	Discrete	Characterize granite background.	Very light gray, fine to medium-grained phaneritic Jgr, appears bleached, possible clay alteration.
Rock	GR-05	0 - 2	0405097-8	Discrete	Characterize granite background.	Light gray, medium-grained, phaneritic Jgr.
Rock	GR-06	0 - 2	0405097-9	Discrete	Characterize granite background.	Light orangish-gray, medium-grained phaneritic Jgr, possible weak albitization.
Rock	GR-07	0 - 2	0405097-10	Discrete	Characterize granite background.	Very light gray, fine- to medium-grained, phaneritic Jgr, weak to moderate albitization.
Rock	GR-08	0 - 2	0405097-11	Discrete	Characterize granite background.	Medium greenish-gray, coarse-grained, phaneritic Jgr.
Rock	GR-09	0 - 2	0405097-12	Discrete	Characterize granite background.	Light gray, medium-grained phaneritic Jgr.
Rock	GR-10	0 - 2	0405097-13	Discrete	Characterize granite background.	Light gray and orangish-gray, medium-grained phaneritic Jgr.
Rock	‡QM-01	0 - 2	0405097-14	Discrete	Characterize quartz monzonite background.	Coarse-grained phaneritic quartz monzonite, weak to moderate albitization and chloritic alteration.
Rock	QM-02	0 - 2	0405097-15	Discrete	Characterize quartz monzonite background.	Coarse-grained phaneritic quartz monzonite, weak albitization (?) and chloritic alteration.
Rock	QM-03	0 - 2	0405097-16	QM-01-Dup	Field QC.	Same as QM-01.
Rock	MR-01	0 - 4	0405097-2	Discrete	Characterize mine road.	Loose, medium brown, very fine to coarse SAND with 5 to 10 percent silt and 10 to 20 percent gravel, moist, no odor.
Rock	MR-02	0 - 4	0405097-3	Discrete	Characterize mine road.	Loose, medium brown, fine to coarse SAND with 20 to 30 percent gravel, moist, no odor. Large gravel and cobbles excluded from sample.
Rock	HR-01	0 - 4	0405097-1	Discrete	Characterize haul road.	Road bed material comprised of well-graded fine to coarse SAND and fine to coarse GRAVEL with cobbles. Mix of 60 to 70 percent quartrz monzonite, 15 percent granite, and ~15 percent hematitic granite.
Soil	SOIL-01	0 - 6	0405096-25	Discrete	Characterize OSA background.	Very dark brown SILT with 20 to 30 percent fine to medium sand and 10 to 20 percent coarse gravel, wet, no odor.
Soil	SOIL-02	0 - 4	0405096-26	Discrete	Characterize OSA background.	Dark brown CLAY with fine sand and fine to coarse angular gravel and abundant rootlets, moist, no odor. Collected below uprooted tree stump.

Table 10
Sample Objectives and Descriptions
Ross Adams Uranium Mine PA/SI Report

Matrix	Sample ID	Depth *(in bgs)*	Lab ID	Sample Type	Objective	Description
Soil	SOIL-04	0 - 4	0405096-27	Discrete	Characterize soil near OSA.	Dark brown organic SILT with 30 to 40 percent coarse rounded gravel and 5 to 10 percent fine sand, moist, no odor.
Soil	SOIL-05	0 - 4	0405096-28	Discrete	Characterize soil near OSA.	Dark brown organic SILT with 15 to 20 percent fine sand and 10 to 15 percent coarse gravel, moist, no odor. Collected on top of OSA berm.
Soil	‡SOIL-07	0 - 4	0405096-29	Discrete	Characterize soil near 900-foot level.	Medium tan, fine to medium SAND with 5 to 10 percent silt, 5 to 10 percent gravel, 5 to 10 percent coarse sand, abundant rootlets, and occasional clumps of light gray silt, moist, no odor. Upper one inch is medium brown with organic material.
Soil	SOIL-08	6 - 9	0405096-30	Discrete	Characterize soil between 700- and 900-foot levels.	Light to medium gray, fine to medium SAND with trace coarse sand and 10 to 15 percent silt, saturated, abundant grass roots.
Soil	SOIL-09	0 - 4	0405096-31	Soil-07-Dup	Field QC.	Same as sample Soil-07.
Soil	SOIL-10	2 - 6	0405096-32	Discrete	Characterize soil between 700- and 900-foot levels.	Medium reddish-brown, medium to coarse SAND with 10 to 20 percent fine gravel, saturated, iron surface coatings, some grass roots.
Soil	‡GEN-01	0 - 2	0405096-21	Discrete	Characterize soil near 300-foot level.	Upper 0.25 inch is black-stained organic soil, then organish-yellow silty sand and gravel, no odor.
Soil	GEN-02	0 - 2	0405096-22	Discrete	Characterize diesel spill.	Loose, black-stained SAND and GRAVEL, diesel odor.
Soil	GEN-03	0 - 2	0405096-23	Discrete	Characterize diesel spill.	Loose, olive brown silty SAND with fine to medium gravel, no odor.
Soil	GEN-04	0 - 2	0405096-24	Gen-01-Dup	Field QC.	Same as sample GEN-02.
SSed	SSED-01	0 - 6	0405096-11	Discrete	Characterize background stream sediments.	Black and white with occasional yellowish orange staining, fine to coarse GRAVEL and 20 to 30 percent coarse sand, wet, no odor.
SSed	SSED-02	0 - 6	0405096-12	Discrete	Characterize background stream sediments.	Black and white, medium to coarse SAND with 20 to 30 percent coarse gravel and trace fine sand, no odor.
SSed	SSED-03	0 - 6	0405096-13	Discrete	Characterize stream sediments next to water intake.	Medium brown, fine to coarse SAND with 5 to 10 percent fine angular gravel, no odor.
SSed	SSED-04	0 - 6	0405096-14	Discrete	Characterize stream sediments at mouth of Kendrick Ck.	Light brownish-gray coarse SAND with 15 to 25 percent fine gravel and trace fine to medium sand. Sample collected below cut bank on southern creek branch at mean higher high water level.

Table 10
Sample Objectives and Descriptions
Ross Adams Uranium Mine PA/SI Report

Matrix	Sample ID	Depth *(in bgs)*	Lab ID	Sample Type	Objective	Description
SSed	SSED-05	0 - 6	0405096-15	Discrete	Characterize stream sediments in Kendrick Ck.	Light grayish-brown corase SAND with some fine to medium sand and 20 to 25 percent fine gravel. Some small cobbles excluded from the sample. Collected from a gravel bar in mid-stream below sveral hundred feet long area of quartz monzonite bedrock forming most of streambed.
SSed	‡SSED-06	0 - 6	0405096-16	Discrete	Characterize stream sediments in Kendrick Ck.	Light to medium brown, medium to coarse SAND with 30 to 40 percent fine gravel (up to 8 mm). Collected where stream is 15 feet wide and 4 to 6 inches deep.
SSed	SSED-07	0 - 6	0405096-17	Discrete	Characterize stream sediments below 300-foot level.	Medium brown, fine to coarse SAND with 5 to 10 percent fine gravel. Sample collected in calm eddy at south side of broad, shallow pool. No evidence of egg nest. At 10 feet below sample location the creek is 22 feet wide and 2 to 6 inches deep in a single channel.
SSed	SSED-08	0 - 6	0405096-18	Discrete	Characterize stream sediments below 700-foot level.	Yellowish brown, 50 percent coarse SAND and 50 percent fine GRAVEL, angular grains, no odor.
SSed	SSED-09	0 - 6	0405096-19	Discrete	Characterize stream sediments below 900-foot level.	Light yellowish tan, fine to coarse GRAVEL with 10 to 20 percent coarse sand, angular grains, no odor.
SSed	SSED-10	0 - 6	0405096-20	SSed-06-Dup	Field QC.	Same as sample SSED-06.
MSed	MSED-01	0 - 6	0405096-01	Discrete	Characterize background marine sediment quality.	Medium brown, fine to medium SAND with 35 to 45 percent fine to coarse gravel, 15 to 20 percent shell material, including mussel and barnacle fragments.
MSed	MSED-02	0 - 6	0405096-02	Discrete	Characterize background marine sediment quality.	Dark brown, fine to medium SAND with 10 percent coarse sand and 10 percent silt and organic material.
MSed	MSED-03	0 - 6	0405096-03	Discrete	Characterize background marine sediment quality.	Medium brownish gray, fine to coarse SAND with 15 to 20 percent fine gravel, clam shells common.
MSed	MSED-04	0 - 4	0405096-04	Discrete	Characterize intertidal sediments near Kendrick Ck.	Loose, medium brown, fine to medium SAND with trace coarse sand and fine gravel, occasional cobbles (excluded), grass rootlets and woody debris, wet, no odor.
MSed	MSED-05	0 - 4	0405096-05	Discrete	Characterize intertidal sediments near Kendrick Ck.	Loose, medium brown, fine to coarse SAND with trace gravel, cobbles (excluded), clumps of mud, grass rootlets, woody debris, mussel shells, possible salmon fin, moist, no odor.
MSed	MSED-06	0 - 6	0405096-06	Discrete	Characterize marine sediments near former dock.	Fine to coarse GRAVEL with 2 to 3 cobbles and 10 percent fine to coarse sand. Rock types: quartz monzonite, slightly hematitic granite, and dark gray aphanitic rock. Fines were possibly washed out of sample during retrieval.

Table 10
Sample Objectives and Descriptions
Ross Adams Uranium Mine PA/SI Report

Matrix	Sample ID	Depth *(in bgs)*	Lab ID	Sample Type	Objective	Description
MSed	MSED-07	0 - 6	0405096-07	Discrete	Characterize marine sediments near former dock.	Medium to dark gray, fine to coarse GRAVEL with 20 to 30 percent medium to coarse sand, abundant seaweed and twig debris, barnacle and shell fragments common. Collected on dock abuttment at low tide.
MSed	‡MSED-08	0 - 6	0405096-08	Discrete	Characterize marine sediments near former dock.	Medium gray, fine to coarse GRAVEL (predominantly fine gravel) with 5 to 10 percent medium to coarse sand, common clam and/or barnacle shell fragments. Collected at base of dock embankment at low tide.
MSed	MSED-09	0 - 6	0405096-09	Discrete	Characterize marine sediments near former dock.	Dark gray, fine to medium SAND with 35 to 40 percent silt and 15 to 20 percent fine to coarse gravel.
MSed	MSED-10	0 - 6	0405096-10	MSed-08-Dup	Field QC.	Same as MSED-08.
SW	SW-01	--	0405095-01	Discrete	Characterize background surface water quality.	Unfiltered, field-preserved sample.
SW	SW-02	--	0405095-02	Discrete	Characterize background surface water quality.	Unfiltered, field-preserved sample.
SW	SW-04	--	0405095-03	Discrete	Characterize surface water quality at drinking water intake.	Unfiltered, field-preserved sample.
SW	SW-05	--	0405095-04	Discrete	Characterize surface water quality near OSA.	Unfiltered, field-preserved sample.
SW	‡SW-06	--	0405095-05	Discrete	Characterize surface water quality below 300-foot level.	Unfiltered, field-preserved sample.
SW	SW-07	--	0405095-06	Discrete	Characterize surface water quality below 300-foot level.	Unfiltered, field-preserved sample.
SW	SW-08	--	0405095-07	Discrete	Characterize surface water quality below 700-foot level.	Unfiltered, field-preserved sample.
SW	SW-09	--	0405095-08	Discrete	Characterize surface water quality below 700-foot level.	Unfiltered, field-preserved sample.
SW	SW-10	--	0405095-09	Discrete	Characterize surface water quality below 900-foot level.	Unfiltered, field-preserved sample.
SW	SW-11	--	0405095-10	SW-06-Dup	Field QC.	Unfiltered, field-preserved sample.
Water	FR-01		0405095-11	QC	Field QC.	De-ionized water collected from decontaminated dipper.
Water	FR-02		0405095-12	QC	Field QC.	De-ionized water collected from decontaminated trowel.

‡ Duplicate sample collected from this location.
bgs Below ground surface.
Jgr Bokan Mountain granite.
OSA Ore staging area.

Table 11
Sub-Sample Gamma Readings and Relative Error Estimates
Ross Adams Uranium Mine PA/SI Report

Sample OSA-02		
	Gamma g (µR/hr)	
Grid No.	*3-feet agl*	*Sample bag*
10	500	55
12	800	130
16	975	110
17	550	75
39	500	80
42	540	40
44	340	38
46	1,750	170
53	1,700	200
60	1,150	90
61	2,000	900
67	500	55
68	300	55
73	1,780	120
74	2,100	300
88	1,880	700
91	690	120
95	2,700	300
97	1,200	190
113	950	100
Mean χ		191
Std. Dev.		224
γ		1.17
d_r (α = 0.2)		34%
d_r (α = 0.1)		43%

Target: relative error ☯ 20% at 90% confidence limit.
Result: not met

Sample 300-02		
	Gamma g (µR/hr)	
Grid No.	*3-feet agl*	*Sample bag*
10	90	270
23	130	30
26	85	25
43	550	25
50	270	55
61	150	27
69	280	60
77	90	25
79	270	30
87	220	35
90	160	40
95	370	50
99	140	30
118	170	23
120	120	25
Mean χ		50
Std. Dev.		62
γ		1.24
d_r (α = 0.2)		36%
d_r (α = 0.1)		46%

Target: relative error ☯ 30% at 80% confidence limit.
Result: not met

Sample 700-02		
	Gamma g (µR/hr)	
Grid No.	*3-feet agl*	*Sample bag*
17	165	30
28	1,150	30
30	2,500	400
57	2,500	350
73	2,100	105
75	2,900	350
100	650	35
114	580	45
115	1,120	50
118	880	40
130	2,100	125
135	1,350	150
157	770	75
160	450	50
163	620	65
170	750	200
176	510	35
179	630	60
180	480	140
184	1,100	160
187	850	65
188	850	80
196	600	300
211	650	75
229	590	165
Mean χ		127
Std. Dev.		111
γ		0.87
d_r (α = 0.2)		25%
d_r (α = 0.1)		32%

Target: relative error ☯ 30% at 80% confidence limit.
Result: met

Sample 900-04		
	Gamma g (µR/hr)	
Grid No.	*3-feet agl*	*Sample bag*
31	350	55
43	620	105
51	300	40
63	150	30
81	400	45
121	800	85
126	1,000	110
150	950	100
159	250	30
160	550	40
170	200	30
198	800	50
201	350	30
226	220	25
238	230	45
Mean χ		55
Std. Dev.		30
γ		0.55
d_r (α = 0.2)		16%
d_r (α = 0.1)		20%

Target: relative error ☯ 30% at 80% confidence limit.
Result: met

agl	Above ground level.
h	Relative standard deviation.
d_r	Relative error.
a	Probability of exceeding d_r.
1-a	Confidence limit.

Table 12
Rock, Soil, and Sediment Field Parameters
Ross Adams Uranium Mine PA/SI Report

Sample No.	Sample Date	Gamma (3-feet agl)	Gamma (individual sample containers)					Average (sample container)
OSA-01	5/6/2004	5,000	1,100	1,200	1,200	--	--	1,167
‡OSA-02	5/6/2004	1,145	15	--	--	--	--	15
OSA-03	5/6/2004	1,145	10	--	--	--	--	10
300-01	5/4/2004	2,200	1,000	--	--	--	--	1,000
300-02	5/7/2004	206	45	--	--	--	--	45
‡700-01	5/7/2004	5,000	950	1,000	1,100	--	--	1,017
‡700-02	5/7/2004	1,074	250	--	--	--	--	250
700-03	5/7/2004	5,000	800	850	900	--	--	850
700-04	5/7/2004	1,074	450					450
900-01	5/7/2004	2,200	110	110	140	--	--	120
900-02	5/7/2004	1,350	1,400	--	--	--	--	1,400
900-03	5/7/2004	1,600	300	--	--	--	--	300
‡900-04	5/7/2004	478	95	--	--	--	--	95
900-05	5/7/2004	478	100	--	--	--	--	100
Gr-01	5/7/2004	37	25	--	--	--	--	25
Gr-02	5/7/2004	32	11	--	--	--	--	11
Gr-03	5/7/2004	40	15	--	--	--	--	15
Gr-04	5/7/2004	185	12	--	--	--	--	12
Gr-05	5/7/2004	160	15	--	--	--	--	15
Gr-06	5/7/2004	32	30	--	--	--	--	30
Gr-07	5/7/2004	21	25	--	--	--	--	25
Gr-08	5/7/2004	16*	25	--	--	--	--	25
Gr-09	5/7/2004	24*	25	--	--	--	--	25
Gr-10	5/7/2004	28*	20	--	--	--	--	20
‡QM-01	5/3/2004	6	10	--	--	--	--	10
QM-02	5/3/2004	4	15	--	--	--	--	15
QM-03	5/3/2004	6	10	--	--	--	--	10
MR-01	5/7/2004	750	70	80	60	--	--	70
MR-02	5/7/2004	800	85	85	85	--	--	85
HR-01	5/6/2004	480	130	--	--	--	--	130
Soil-01	5/6/2004	30	15	15	15	--	--	15
Soil-02	5/6/2004	30	15	15	20	--	--	17
Soil-04	5/6/2004	100	15	20	40	--	--	25
Soil-05	5/6/2004	100	20	20	30	--	--	23
‡Soil-07	5/7/2004	90	25	20	15	--	--	20
Soil-08	5/7/2004	110	40	45	40	--	--	42
Soil-09	5/7/2004	90	20	20	20	--	--	20
Soil-10	5/7/2004	125	20	20	20	--	--	20

Table 12
Rock, Soil, and Sediment Field Parameters
Ross Adams Uranium Mine PA/SI Report

Sample No.	Sample Date	Gamma (3-feet agl)	Gamma (individual sample containers)					Average (sample container)
‡Gen-01	5/7/2004	90	28	28	--	--	--	28
Gen-02	5/7/2004	40	10	15	15	29	30	20
Gen-03	5/7/2004	70	20	22	--	--	--	21
Gen-04	5/7/2004	40	25	22	--	--	--	24
MSed-01	5/6/2004	4[b]	20	20	--	--	--	20
MSed-02	5/6/2004	7[b]	15	15	15	--	--	15
MSed-03	5/6/2004	4[b]	20	20	20	--	--	20
MSed-04	5/6/2004	15[b]	15	15	20	--	--	17
MSed-05	5/6/2004	10[b]	10	10	15	--	--	12
MSed-06	5/7/2004	50[b]	8	--	--	--	--	8
MSed-07	5/7/2004	110[b]	35	25	25	--	--	28
‡MSed-08	5/7/2004	190[b]	75	30	20	--	--	42
MSed-09	5/7/2004	25[b]	15	300	20	--	--	112
MSed-10	5/7/2004	190[b]	40	25	30	--	--	32
SSed-01	5/5/2004	NA	10	10	15	--	--	12
SSed-02	5/5/2004	NA	15	15	20	--	--	17
SSed-03	5/4/2004	NA	15	15	15	--	--	15
SSed-04	5/4/2004	NA	10	15	15	--	--	13
SSed-05	5/4/2004	NA	10	15	20	--	--	15
‡SSed-06	5/4/2004	NA	20	20	15	--	--	18
SSed-07	5/4/2004	NA	5	10	15	--	--	10
SSed-08	5/5/2004	NA	20	25	30	--	--	25
SSed-09	5/5/2004	NA	15	15	15	--	--	15
SSed-10	5/4/2004	NA	10	15	20	--	--	15

Gamma readings in uR/hr.
* Reading collected with Ludlum 16.
[b] Reading taken from top of sediment layer.
-- Not applicable.
‡ Duplicate sample collected from this location.
agl Above ground level.
NA Not available.

Table 13

General Chemistry Data - Surface Water Samples

Ross Adams Uranium Mine PA/SI Report

Sample No	Sample Date	Bicarbonate *(ug/L CaCO3)*	Carbonate *(ug/L CaCO3)*	Alkalinity *(ug/L CaCO3)*	Hardness *(mg/L CaCO3)*	Field pH *(standard units)*	Field Temperature *(deg. C)*	Field Conductivity *(umhos/cm))*	Field DO *(mg/L)*	Field ORP *(mV)*	Field Salinity *(percent)*
Kendrick Bay	5/6/2004	--	--	--	--	7.17	11.72	40,000	13.3	-44.5	25.57
Pore water-1	5/6/2004	--	--	--	--	7.19	11.27	23,989	3.28	-25.4	14.56
Seep-1	5/6/2004	--	--	--	--	7.66	13.27	28,379	10.44	-61.5	17.52
Seep-2	5/6/2004	--	--	--	--	7.17	16.64	18,671	6.23	-58.8	11.12
Seep-3	5/6/2004	--	--	--	--	6.79	17.21	18,586	5.45	-49.3	11.06
SW-01	5/5/2004	5000 U	5000 U	5000 U	< 7.063	6.56	10.65	27	11.7	26.5	0.01
SW-02	5/5/2004	5000 U	5000 U	5000 U	< 7.063	6.8	9.28	20	10.01	27	0.01
SW-04	5/4/2004	**8100**	5000 U	**8100**	< 11.1888	6.28	7.65	20	11.2	102.6	0.01
SW-05	5/6/2004	5000 U	5000 U	5000 U	< 7.063	8.22	7.96	61	10.75	-69.2	0.03
SW-06	5/6/2004	**6900**	5000 U	**6900**	**14.1869**	8.25	7.04	98	12.07	-58.4	0.05
SW-07	5/3/2004	**8500**	5000 U	**8500**	< 10.3047	6.05	7.69	38	12.1	101.7	0.02
SW-08	5/3/2004	5000 U	5000 U	5000 U	< 7.063	5.74	7.46	19	12.57	129.8	0.01
SW-09	5/5/2004	5000 U	5000 U	5000 U	< 7.063	7.08	12.42	21	10.03	20.4	0.01
SW-10	5/5/2004	5000 U	5000 U	5000 U	< 7.063	6.95	10.21	23	10.28	28.7	0.02

BOLD The analyte was detected.

< Concentration is less than the indicated value.

-- Not analyzed.

U Not detected.

Table 14

Marine Sediment Gamma Survey Data

Ross Adams Uranium Mine PA/SI Report

Point ID	Date	Time	Gamma Reading *microR/hr*	Depth *feet*	Northing *meters*	Easting *meters*	GPS Elevation *feet MSL*	Tide Elevation[1] *feet MSL*	Bottom Elevation *feet MSL*
37	5/6/2004	9:53:32	12	52	6087373.7	685772.9	-11.7	-6.6	-58.5
38	5/6/2004	10:01:22	5	nm	6087374.3	685762.6	-7.2	-6.0	nm
39	5/6/2004	10:05:02	6	nm	6087373.0	685756.8	-12.3	-5.7	nm
40	5/6/2004	10:08:32	4	43	6087369.7	685747.5	-12.1	-5.5	-48.5
41	5/6/2004	10:12:37	8	nm	6087369.6	685740.2	-2.8	-5.1	nm
42	5/6/2004	10:16:12	15	41.5	6087369.6	685732.0	-7.9	-4.9	-46.5
43	5/6/2004	10:20:52	8	nm	6087371.8	685724.2	-2.1	-4.5	nm
44	5/6/2004	10:33:07	3	nm	6087374.6	685716.5	6.2	-3.5	nm
45	5/6/2004	10:38:22	18	43	6087373.9	685707.8	-1.4	-3.1	-46.0
46	5/6/2004	10:41:32	4	nm	6087368.6	685698.9	3.3	-2.9	nm
47	5/6/2004	10:46:12	3	50	6087367.2	685692.6	-7.1	-2.5	-52.5
48	5/6/2004	10:51:07	4	nm	6087366.2	685685.0	-7.2	-2.1	nm
49	5/6/2004	10:55:17	3	nm	6087368.8	685672.5	-14.5	-1.7	nm
50	5/6/2004	10:58:57	5	48	6087366.9	685667.8	-4.1	-1.5	-49.5
51	5/6/2004	11:03:27	9	nm	6087367.1	685658.6	-9.3	-1.1	nm
52	5/6/2004	11:07:32	9	47	6087367.3	685651.8	-5.3	-0.8	-48.0
56	5/6/2004	15:49:17	2	66	6087429.4	685771.1	5.0	4.0	-62.0
57	5/6/2004	15:54:02	4	nm	6087424.9	685763.1	14.6	3.7	nm
58	5/6/2004	15:56:22	2	nm	6087421.8	685756.6	14.6	3.6	nm
59	5/6/2004	16:00:17	15	nm	6087426.8	685748.8	6.7	3.4	nm
60	5/6/2004	16:02:37	15	63.5	6087423.3	685741.6	1.3	3.2	-60.5
61	5/6/2004	16:07:12	10	nm	6087436.5	685736.2	6.4	3.0	nm
62	5/6/2004	16:21:57	12	62	6087406.9	685711.5	4.0	2.0	-60.0
63	5/6/2004	16:25:57	4	nm	6087415.2	685715.3	3.2	1.8	nm
64	5/6/2004	16:29:37	12	59	6087424.4	685719.4	5.9	1.5	-57.5
65	5/6/2004	16:33:47	50	nm	6087435.1	685722.5	5.7	1.3	nm
66	5/6/2004	16:39:42	25	44	6087443.8	685730.2	12.1	0.9	-43.0
67	5/6/2004	16:43:02	15	38	6087451.2	685730.4	10.2	0.7	-37.5
68	5/6/2004	16:46:22	7	30.5	6087457.7	685732.6	7.5	0.4	-30.0
69	5/6/2004	16:49:22	25	nm	6087465.6	685726.9	8.2	0.2	nm
70	5/6/2004	16:52:52	180	15	6087472.4	685721.2	35.8	0.0	-15.0
71	5/6/2004	16:56:02	115	7.5	6087475.1	685716.9	0.8	-0.2	-7.5
72	5/6/2004	17:09:32	20	53	6087435.6	685692.9	2.7	-1.1	-54.0
73	5/6/2004	17:14:37	9	51.5	6087435.8	685701.0	-0.5	-1.5	-53.0
74	5/6/2004	17:17:52	15	nm	6087438.4	685704.8	-5.3	-1.7	nm
75	5/6/2004	17:20:22	20	51	6087435.2	685710.4	-4.0	-1.9	-53.0
76	5/6/2004	17:24:02	45	43	6087446.7	685693.3	-1.5	-2.1	-45.0
77	5/6/2004	17:26:47	10	37.5	6087453.2	685694.6	1.3	-2.3	-40.0

Table 14

Marine Sediment Gamma Survey Data

Ross Adams Uranium Mine PA/SI Report

Point ID	Date	Time	Gamma Reading *microR/hr*	Depth *feet*	Northing *meters*	Easting *meters*	GPS Elevation *feet MSL*	Tide Elevation[1] *feet MSL*	Bottom Elevation *feet MSL*
78	5/6/2004	17:30:17	12	32	6087456.5	685697.6	4.6	-2.5	-34.5
79	5/6/2004	17:33:02	10	28	6087463.5	685696.9	-18.9	-2.7	-30.5
80	5/6/2004	17:35:57	30	23	6087467.8	685698.7	-18.8	-2.8	-26.0
81	5/6/2004	17:39:02	270	17	6087469.6	685700.8	-12.2	-3.0	-20.0
82	5/6/2004	17:42:12	90	9	6087475.6	685703.4	-23.7	-3.2	-12.0
83	5/7/2004	7:34:32	9	33	6087455.0	685653.5	-11.0	-11.0	-44.0
84	5/7/2004	7:37:37	7	25	6087456.1	685677.8	-9.3	-11.1	-36.0
85	5/7/2004	7:40:42	10	44.5	6087421.3	685687.8	-3.6	-11.2	-55.5
86	5/7/2004	7:43:02	4	45.5	6087405.9	685667.9	-9.9	-11.2	-56.5
87	5/7/2004	7:45:47	12	48	6087397.7	685701.1	-11.8	-11.3	-59.5
88	5/7/2004	7:48:12	10	52	6087394.4	685733.9	-19.2	-11.4	-63.5
89	5/7/2004	7:50:32	2	51	6087402.1	685758.9	-7.1	-11.4	-62.5
90	5/7/2004	7:53:47	10	51	6087401.3	685726.1	-9.3	-11.5	-62.5
91	5/7/2004	7:56:12	2	51.5	6087413.1	685736.5	-10.4	-11.5	-63.0
92	5/7/2004	7:59:27	5	33	6087447.8	685749.2	-4.1	-11.6	-44.5
93	5/7/2004	8:01:22	10	15	6087462.0	685744.6	-5.8	-11.6	-26.5
94	5/7/2004	8:09:47	25	nm	6087466.6	685685.2	-7.6	-11.7	nm
95	5/7/2004	8:11:52	12	5	6087469.2	685674.5	-10.7	-11.7	-16.5
96	5/7/2004	8:16:12	4	17	6087464.6	685759.2	-10.1	-11.8	-29.0
97	5/7/2004	8:18:07	10	22	6087460.6	685772.1	-9.0	-11.8	-34.0
MSED-01	5/6/2004	13:00:00	4	9	6085485.4	687989.5	-8.2	6.1	-3.0
MSED-02	5/6/2004	13:40:00	7	20.5	6085466.4	688040.3	7.2	7.1	-13.5
MSED-03	5/6/2004	15:20:00	4	52	6085462.3	688077.8	3.4	5.5	-46.5
MSED-04	5/6/2004	9:10:00	15	nm	6087410.2	685307.3	14.3	-9.2	nm
MSED-05	5/6/2004	9:20:00	10	nm	6087395.6	685344.0	10.5	-8.7	nm
MSED-06	5/7/2004	8:30:00	50	37	6087437.7	685723.5	-8.4	-11.8	-49.0
MSED-07	5/7/2004	9:00:00	110	0.25	6087470.7	685703.6	-12.0	-11.4	-11.5
MSED-08	5/7/2004	9:15:00	190	0	6087471.0	685721.0	-8.1	-10.9	-11.0
MSED-09	5/7/2004	10:10:00	25	17	6087465.8	685686.4	-6.5	-8.4	-25.5

Tide elevation calculated from polynomial fits to Ketchikan, Alaska NOAA station observations uncorrected for Kendrick Bay West Arm location.

May 6 polynominal fit: $y = 6271.6x^4 - 14464x^3 + 11887x^2 - 4081.5x + 488.08$

May 7 polynominal fit: $y = -6123.7x^4 + 8474.6x^3 - 3735.4x^2 + 550.84x - 18.436$

MSL Mean sea level.

nm Not measured.

Table 15
Sample and Subsample Survey Data
Ross Adams Uranium Mine PA/SI Report

Sample ID	Sub-Sample ID	Easting (meters)	Northing (meters)	Elevation (feet MSL)
Composite Samples				
300-02	10	683782.2	6087751.6	353
	23	683793.8	6087753.9	361
	26	683792.4	6087733.1	354
	43	683813.8	6087736.6	344
	50	683810.4	6087726.6	350
	61	683828.9	6087737.9	353
	69	683827.2	6087727.1	345
	77	683826.6	6087715.6	336
	79	683836.5	6087723.9	334
	87	683835.3	6087713.1	339
	90	683848.8	6087728.5	312
	95	683833.2	6087711.0	324
	99	683854.5	6087726.2	323
	118	683837.9	6087703.8	323
	120	683848.9	6087721.0	281
700-02	17	683505.1	6088042.9	739
	28	683509.5	6088039.7	745
	30	683515.6	6088040.5	744
	57	683518.8	6088034.7	730
	73	683521.6	6088031.4	730
	75	683528.5	6088032.7	732
	100	683512.7	6088027.4	728
	114	683509.6	6088022.5	721
	115	683513.5	6088023.2	730
	118	683521.0	6088023.6	725
	130	683513.0	6088020.1	720
	135	683527.3	6088021.0	726
	157	683545.9	6088020.3	718
	160	683507.3	6088015.5	720
	163	683516.1	6088016.4	717
	170	683536.6	6088017.0	719
	176	683507.6	6088012.7	710
	179	683516.5	6088013.0	708
	180	683520.2	6088013.5	702
	184	683531.2	6088013.1	713
	187	683540.8	6088015.7	703
	188	683543.2	6088015.6	701
	196	683520.7	6088011.6	696
	211	683517.7	6088008.3	694
	229	683519.7	6088004.8	687

Sample ID	Sub-Sample ID	Easting (meters)	Northing (meters)	Elevation (feet MSL)
Composite Samples				
900-04	31	683491.5	6088489.4	983
	43	683493.3	6088483.8	987
	51	683485.0	6088487.3	982
	63	683485.7	6088484.1	991
	81	683496.8	6088469.3	992
	121	683469.6	6088476.0	981
	126	683479.5	6088466.4	980
	150	683477.2	6088460.9	984
	159	683471.8	6088461.2	978
	160	683473.6	6088459.6	982
	170	683469.7	6088459.8	983
	198	683456.6	6088458.5	970
	201	683464.9	6088455.1	973
	226	683465.0	6088439.0	975
	238	683462.9	6088433.0	982
OSA-02	10	685704.5	6087557.2	84
	12	685711.1	6087566.2	46
	16	685686.9	6087555.9	41
	17	685692.3	6087554.3	56
	39	685675.1	6087545.7	43
	42	685696.6	6087545.1	46
	44	685703.5	6087548.5	41
	46	685714.1	6087549.3	67
	53	685673.4	6087537.4	51
	60	685717.9	6087546.1	42
	61	685722.0	6087540.9	90
	67	685683.0	6087536.8	48
	68	685686.1	6087536.5	27
	73	685716.3	6087536.8	51
	74	685723.5	6087538.0	54
	88	685724.5	6087529.8	78
	91	685680.9	6087524.6	24
	91	685681.0	6087523.8	25
	95	685705.2	6087526.5	34
	97	685714.6	6087523.9	61
	113	685717.4	6087508.4	36

Table 15 (cont'd)
Sample and Subsample Survey Data
Ross Adams Uranium Mine PA/SI Report

Sample ID	Sub-Sample ID	Easting (meters)	Northing (meters)	Elevation (feet MSL)
Rock Samples				
300-01		683816.0	6087730.5	349
700-01		683529.3	6088035.3	737
900-01		683510.0	6088335.0	975
900-02		683469.6	6088476.0	981
900-03		683506.8	6088386.8	977
GEN-01		683778.9	6087763.1	352
GR-01		683348.8	6088284.8	995
GR-02		683395.3	6088278.5	983
GR-03		683441.6	6088269.3	976
GR-04		683492.2	6088266.3	957
GR-05		683529.8	6088279.6	952
GR-06		683581.5	6088277.1	958
GR-07		683627.9	6088273.7	949
GR-08		683225.9	6088289.4	1082
GR-09		683184.5	6088208.3	1080
GR-10		683228.8	6088175.9	1035
HR-01		684008.0	6087763.0	385
MR-01		683442.2	6088149.7	883
MR-02		683500.9	6088125.0	824
OSA-01		685707.3	6087535.9	49
QM-01		684115.8	6088235.4	1085
QM-02		684149.9	6088295.7	1129
Marine Sediment Samples				
MSED-01		687989.5	6085485.4	-8
MSED-02		688040.3	6085466.4	7
MSED-03		688077.8	6085462.3	3
MSED-04		685307.3	6087410.2	14
MSED-05		685344.0	6087395.6	11
MSED-06		685723.5	6087437.7	-8
MSED-07		685703.6	6087470.7	-12
MSED-08		685721.0	6087471.0	-8
MSED-09		685686.4	6087465.8	-7
Soil Samples				
SOIL-01		685756.2	6087562.7	45
SOIL-02		685642.4	6087557.6	52
SOIL-04		685702.6	6087567.8	51
SOIL-05		685725.8	6087569.2	67
SOIL-07		683531.7	6088249.9	954
SOIL-08		683543.0	6087984.9	663
SOIL-10		683615.1	6088080.4	758
Stream Sediment Samples				
SSED-01		683264.6	6088376.3	1026
SSED-02		683324.9	6088565.4	1002
SSED-03		685140.6	6087728.5	86
SSED-04		685304.6	6087421.6	15
SSED-05		685133.5	6087551.1	22
SSED-06		684616.1	6087541.0	109
SSED-07		683970.4	6087486.6	222
SSED-08		683625.2	6087928.4	616
SSED-09		683546.2	6088407.5	957
Surface Water Samples				
SW-01		683324.5	6088565.6	1000
SW-02		683264.6	6088376.3	1026
SW-04		685139.1	6087733.2	92
SW-05		685735.0	6087573.6	59
SW-06		685304.6	6087421.6	15
SW-07		683750.7	6087765.9	337
SW-08		683801.0	6087699.2	308
SW-09		683625.9	6087927.6	616
SW-10		683546.2	6088407.5	957
Radon Samples				
R300-01		683743.9	6087773.5	334
R700-01		683530.0	6088073.5	737
R700-02		683529.3	6088034.8	753
R900-01		683459.9	6088476.9	962
R900-02		683472.6	6088274.2	937
R900-03		683467.7	6088227.6	948
R900-04		683506.6	6088388.1	971
RGR-01		683228.8	6088175.9	1035
RGR-02		683184.5	6088208.3	1080
RGR-03		683225.9	6088289.4	1082
ROSA-01		685706.5	6087535.0	60
RQM-01		684121.5	6088237.4	1091
RQM-02		684147.2	6088287.7	1118
RQM-03		684095.1	6088326.5	1125

MSL: mean sea level

Coordinate system is UTM, Zone 8 north.

Elevation datum is NAD 1927, mean sea level

Table 16
Summary of Data Qualifications
Ross Adams Uranium Mine PA/SI Report

Analysis	No. of Samples/Matrix (No. of Duplicate Samples)	Total No. of Data Values [a]	No. of Data Qualified (J or UJ)	Percent Data Qualified	Qualification Categories [b]
Total Metals	8 (1) Soil	54	22	40.7	Holding time exceedences (Hg); high
	18 (2) Sediment	252	59	23.4	RPDs in field and laboratory
	25 (5) Rock	120	12	10	duplicates; elevated recoveries in
	9 (1) Water	96	2	2.1	MSDs and in one internal standard.
Isotopes	8 (1) Soil	126	20	15.9	High RPDs in field and laboratory
	18 (2) Sediment	436	80	18.4	duplicates, poor carrier recovery
	25 (5) Rock	283	87	30.7	during chemical separation
	9 (1) Water	42	7	16.7	
Hydrocarbons	3 (1) Soil	8	8	100	Elevated receiving temperature.
Overall	73 Samples	1,417	297	21	

[a] The total number of chemical constituents multiplied by the number of samples

[b] See the text for additional information concerning the reasons for sample data qualification.

Table 17
Benchmarks for Metal Analyses
Ross Adams Uranium Mine PA/SI Report

Analyte	Surface Water Pathway (ug/L, water; mg/kg, sediment)							Soil Pathway (mg/kg) [a]
	Drinking Water (MCL / MCLG) [a]	Environmental		Hardness Adjusted Values		SW Screening Level [c]	Sediment	
		Acute [a]	Chronic [a]	Acute [b]	Chronic [b]		Ecotox [d]	
Aluminum	--	750	87	--	--	87	--	--
Antimony	6	--	--	--	--	6	--	31
Arsenic	10	340	150	--	--	10	8.2 [e]	0.43
Barium	2000	--	--	--	--	2000	--	5500
Beryllium	4	--	--	--	--	4	--	160
Cadmium	5	2	0.25	0.52	0.09	0.09	1.2	39
Chromium, total	100	570	74	183	24	24	81 [e]	230
Cobalt	--	--	--	--	--	--	--	--
Copper	1300	13	9	3.64	2.74	2.74	34	--
Lead	15	65	2.5	13.9	0.5	0.5	47	400
Manganese	--	--	--	--	--	--	--	--
Mercury	2	1.4	0.77	--	--	0.77	0.15 [e]	23
Nickel	--	470	52	145	16	16	21	1600
Selenium	50	--	5	--	--	5	--	390
Silver	--	3.2	--	0.30	--	0.3	--	390
Thallium	0.5	--	--	--	--	0.5	--	--
Uranium	30	--	--	--	--	30	--	46.9
Vanadium	260 [f]	--	--	--	--	260	--	550
Zinc	11000 [f]	120	120	36	36	36	150	23000

[a] Concentrations from on-line Superfund Chemical Data Matrix [33].
[b] Calculated assuming a hardness of 25 mg/L.
[c] The lowest of the available drinking water and environmental benchmarks.
[d] Ecotox threshold values from OSWER [21].
[e] Value is for all chemical forms.
[f] Based on non-cancer risk.
-- Not established.
MCL Maximum contaminant level.
MCLG Maximum contaminant level goal.

Table 18
Benchmarks for Radionuclide Analyses
Ross Adams Uranium Mine PA/SI Report

Isotope	Air Pathway [a] (pCi/L) SCDM	Surface Water Pathway [a] (pCi/L) MCL / MCLG	Soil Pathway (pCi/G) SCDM [a] (Ingestion)	Soil Pathway (pCi/G) SSLR [b] (Radiation Exposure)	Soil Pathway (pCi/G) SI Screening Level [c]	Rock (pCi/G) Radiation Exposure [d]
Ac-227	--	--	1.06	0.118	0.118	0.118
Bi-212	--	--	--	--	--	--
Bi-214	--	--	--	--	--	--
Gross Alpha	--	15	--	--	--	--
Gross Beta	--	20	--	--	--	--
Pa-231	--	--	2.12	0.803	0.803	0.803
Pb-210	--	0.037 [e]	0.3	40.8	0.3	40.8
Pb-212	--	--	--	--	--	--
Pb-214	--	--	--	--	--	--
Ra-226	--	5	1.1	0.0132	0.0132	0.0132
Ra-226 + Ra-228	--	5	--	--	--	--
Ra-228	--	5	0.35	0.0915	0.0915	0.0915
Rn-222	6.3E-04	--	--	--	--	-- --
Th-227	--	--	--	--	--	--
Th-228	--	15	0.98	0.157	0.157	0.157
Th-230	--	15	3.9	136	3.9	136
Th-232	--	15	3.4	326	3.4	326
Th-234	--	--	--	--	--	--
U-234	--	20	5.0	443	5.0	443
U-235	--	20	4.9	0.206	0.206	0.206
U-238	--	20	3.8	0.979	0.979	0.979

[a] Activities from on-line Superfund Chemical Data Matrix [33].

[b] Activities from generic soil screening levels [21].

[c] Lowest of the radiation and ingestion benchmarks.

[d] Radiation exposure level from Superfund Chemical Data Matrix (33).

[e] Based on cancer risk.

-- Not established.

MCL Maximum contaminant level.

MCLG Maximum contaminant level goal.

SCDM Superfund Chemical Data Matrix.

SSL Soil screening level.

Table 19

Granite Background Samples - Metals Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Background	Sample ID:	GR-01	GR-02	GR-03	GR-04	GR-05	GR-06	GR-07	GR-08	GR-09	GR-10
		Lab ID:	0405097-19	0405097-20	0405097-21	0405097-22	0405097-23	0405097-24	0405097-25	0405097-26	0405097-27	0405097-2
		Sample Date:	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04
		Sample Type:	Granite Background	Granite Background	Granite Background	Granite Background	Granite Background	Granite Background	Granite Background	Granite Background	Granite Background	Granite Background
Aluminum	**1200**		**830**	**540**	**470**	**510**	**310**	**410**	**250**	**300**	**550**	**1200**
Arsenic	**2.8**		1 U	**2.1**	1 U	1 U	1 U	1 U	1 U	**2.6**	**2.8**	**1.8**
Iron	**8900**		**8900**	**1800**	**860**	**490**	**660**	**850 J**	**500 J**	**740 J**	**2400 J**	**1500 J**
Lead	**24**		**22**	**14**	**8.7**	**3.2**	**19**	**8**	**3.2**	**11**	**18**	**24**
Manganese	**220**		**34**	**80**	**21**	**53**	**75**	**15**	**5.6**	**23**	**24**	**220**
Uranium	**19**		**8.9 J**	**7 J**	**3.6 J**	**19 J**	**4.6 J**	**3.5 J**	**1.1 J**	**1.4 J**	**4.8 J**	**6.1 J**

Concentrations are in mg/kg.

BOLD The analyte was detected.

Background Maximum background concentration.

J Estimated concentration.

U Not detected.

Table 20

Granite Background Samples - Isotopic Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Method	SSLR Benchmark	Back-ground	Sample ID: GR-01	GR-02	GR-03	GR-04	GR-05	GR-06	GR-07	GR-08	GR-09	GR-10
				Lab ID: 0405097-4	0405097-5	0405097-6	0405097-7	0405097-8	0405097-9	0405097-10	0405097-11	0405097-12	0405097-13
				Sample Date and Type: 5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04
				Field Gamma (3 ft agl): 37	32	40	185	160	32	21	16	24	28
				Granite Background	Granite Background	Granite Background	Granite Background	Granite Background	Granite Background	Granite Background	Granite Background	Granite Background	Granite Background
Th-232 Decay Chain													
Th-232	714	326	**7.5**	**6.8**	**2.19**	**1.39**	**7.5**	**1.07**	**2.85**	**1.58**	**1.32**	**2.54**	**2.32**
Ra-228	713	0.0915	**9**	**9.7**	**2.46**	**1.3**	**7.3**	**1.53**	**2.93**	**1.61**	**1.46**	**2.66**	**1.97**
Th-228	714	0.157	**8.5**	**8.7**	**2.41**	**1.73**	**7.5**	**1.37**	**2.68**	**1.54**	**1.88**	**3.08**	**2.14**
Pb-212	713	NE	**8.4**	**8.1**	**3.47**	**1.93**	**8**	**1.95**	**2.56**	**1.9**	**2**	**3.13**	**2.31**
Bi-212	713	NE	**9**	**8.1**	**7.7**	2.6 U	**6.4**	1.7 U	**4**	1.1 U	**3.3 TI**	2.3 U	2.5 U
U-235 Decay Chain													
U-235	714	0.206	**1**	**0.193**	**0.163**	**0.083**	**0.94**	0.048 U	0.064 U	**0.097**	**0.067**	**0.067**	**0.13**
	713	0.206	**1**	0.59 U	-0.3 U	0.01 U	1.21 U	-0.34 U	0.11 U	0.2 U	-0.22 U	0.48 U	0.43 U
Th-227	713	NE	**6.8**	8 U	-1 U	0.16 U	-3 U	-0.17 U	-6 U	0.15 U	-0.06 U	-0.9 U	-5 U
U-238 Decay Chain													
U-238	714	0.979	**13.6**	**5**	**3.34**	**1.44**	**17.3**	**1.73**	**2.37**	**1.4**	**1.03**	**1.98**	**2.71**
Th-234	713	NE	**14.8**	**10.2**	**4.3**	2.3 U	**16.9**	**5 TI**	**4.4 TI**	2.7 U	**3**	**4.4**	**5 TI**
U-234	714	443	**12.9**	**4.75**	**2.91**	**1.22**	**16.5**	**1.35**	**2.09**	**1.16**	**0.84**	**1.68**	**1.99**
Th-230	714	136	**13.2**	**4.64**	**3.24**	**2.34**	**16.8**	**2.23**	**2.39**	**1.21**	**1.07**	**2.13**	**2.29**
Ra-226	783R5	0.0132	**8.6**	**0.66**	**2.01**	**1.02**	**11.4**	**0.81**	**0.71**	**0.64**	**0.49**	**0.85**	**0.93**
Pb-214	713	NE	**12.5**	**4.95 J**	**3.47 J**	**2.17 J**	**15.4 J**	**3.09 J**	**2.8 J**	**2.22 J**	**2.94 J**	**5.4 J**	**2.86 J**
Bi-214	713	NE	**11**	**4.45 J**	**3.03 J**	**1.81 J**	**13.6 J**	**2.57 J**	**2.54 J**	**1.9 J**	**2.94 J**	**4.6 J**	**2.89 J**

Concentrations are in pCi/g.

-- Not analyzed.

BOLD The analyte was detected.

☐ Exceeds SSLR benchmark.

Background Two standard deviations above mean background concentration.

J Estimated concentration.

NE Not established.

SSLR Soil screening level for radiation exposure.

TI Nuclide identification is tentative.

U Not detected.

Table 21

Granite Samples - Metals Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Back-ground	Sample ID:	700-01	700-02	700-03	700-04	900-01	900-02	900-03	900-04	900-05	MR-01	MR-02
		Lab ID:	0405097-19	0405097-20	0405097-21	0405097-22	0405097-23	0405097-24	0405097-25	0405097-26	0405097-27	0405097-2	0405097-3
		Sample Date:	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04
		Sample Type:	Dump High Grade	Dump Composite	700-01 Duplicate	700-02 Duplicate	Dump High Grade	Dump High Grade	Dump High Grade	Dump Composite	900-04 Duplicate	Mine Road High Grade	Mine Road High Grade
Aluminum	**1200**		**2800**	**2300**	**3200**	**2500**	**2600**	**3300**	**1800**	**1900**	**2100**	**2000**	**2200**
Antimony	--		1.9 U	--	1.5 U	--	2 U	--	--	--	--	--	--
Arsenic	**2.8**		**61**	**8.9**	**59**	**7.8**	**24**	**15**	**25**	**3.4**	**3.6**	**3**	**5.5**
Barium	--		**150**	--	**170**	--	**15**	--	--	--	--	--	--
Beryllium	--		**3.7**	--	**3.5**	--	**0.57**	--	--	--	--	--	--
Cadmium	--		0.47 U	--	1.1 U	--	0.5 U	--	--	--	--	--	--
Calcium	--		**2700**	--	**3500**	--	100 U	--	--	--	--	--	--
Chromium	--		**13**	--	**13**	--	**9.9**	--	--	--	--	--	--
Cobalt	--		0.95 U	--	**0.78**	--	1 U	--	--	--	--	--	--
Copper	--		**38**	--	**41**	--	**11**	--	--	--	--	--	--
Iron	**8900**		**18000**	**14000 J**	**18000**	**14000 J**	**17000**	**16000 J**	**9100 J**	**11000 J**	**11000 J**	**13000**	**13000**
Lead	**24**		**410**	**190**	**440**	**210**	**110**	**470**	**110**	**62**	**58**	**78 J**	**82 J**
Magnesium	--		95 U	--	76 U	--	100 U	--	--	--	--	--	--
Manganese	**220**		**1700**	**930**	**1600**	**940**	**220**	**430**	**400**	**360**	**350**	**450**	**480**
Mercury	--		0.071 UJ	--	0.094 UJ	--	0.096 UJ	--	--	--	--	--	--
Nickel	--		1.9 U	--	1.5 U	--	2 U	--	--	--	--	--	--
Potassium	--		**230**	--	**300**	--	**200**	--	--	--	--	--	--
Selenium	--		0.47 U	--	1.1 U	--	0.5 U	--	--	--	--	--	--
Silver	--		0.95 U	--	**0.81**	--	**1.2**	--	--	--	--	--	--
Sodium	--		**200**	--	**260**	--	100 U	--	--	--	--	--	--
Thallium	--		1.9 U	--	2.3 U	--	1 U	--	--	--	--	--	--
Uranium	**19**		**10000 J**	**1400 J**	**10000 J**	**2200 J**	**1800 J**	**10000 J**	**1400 J**	**490 J**	**420 J**	**1100 J**	**700 J**
Vanadium	--		**9.1**	--	**9.5**	--	**5.9**	--	--	--	--	--	--
Zinc	--		**280**	--	**250**	--	**38**	--	--	--	--	--	--

Concentrations are in mg/kg.

-- Not analyzed.

BOLD The analyte was detected.

Underline Concentration exceeds three times maximum background concentration.

Background Maximum background concentration.

J Estimated concentration.

NA Not available.

U Not detected.

Table 22

Granite Samples - Isotopic Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Method	Radiation Benchmark	Back-ground	Sample ID:	700-01	700-02	700-03	700-04	900-01	900-02	900-03	900-04	900-05	MR-01	MR-02
				Lab ID:	0405097-19	0405097-20	0405097-21	0405097-22	0405097-23	0405097-24	0405097-25	0405097-26	0405097-27	0405097-2	0405097-3
				Sample Date and Type:	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04
				Field Gamma (3 ft agl):	5000	1074	5000	1074	2200	1350	1600	478	478	750	800
					Dump High Grade	Dump Composite	700-01 Duplicate	700-02 Duplicate	Dump High Grade	Dump High Grade	Dump High Grade	Dump Composite	900-04 Duplicate	Mine Road High Grade	Mine Road High Grade
Th-232 Decay Chain															
Th-232	714	326	**7.5**		212	244 J	218	61 J	63	252	69	119 J	116 J	60	60
Ra-228	713	0.0915	**9**		1150	249	1220	191	156	810	200	124	115	68	96
Th-228	714	0.157	**8.5**		225	248 J	292	75 J	76	292	82	120	124	61	65
Pb-212	713	NE	**8.4**		612	235	671	146	126	538	124	109	101	57	72
Bi-212	713	NE	**9**		750	264	680	50 U	130 U	530	260	116	117	94 U	100 U
U-235 Decay Chain															
U-235	713	0.206	**1**		148	22.5	90 U	61 U	19 U	152	38 U	8.9	8.8	-2 U	-4 U
	714	0.206	**1**		180	22 J	184	37.3 J	21.7	149	24	9	6.9	18	11
Pa-231	713	0.803	**--**		270 U	--	-20 U	--	-10 U	--	--	--	--	--	--
Ac-227	714	0.118	**--**		71	--	76	--	28.6	--	--	--	--	--	--
Th-227	713	NE	**6.8**		100 U	32.3	20 U	-333 U	0 U	1 U	19 U	10.1	7.3	-39 U	-96 U
U-238 Decay Chain															
U-238	714	0.979	**13.6**		3220	420 J	3390	660 J	452	2880	462	171	138	326	190
Th-234	713	NE	**14.8**		1830	469	1230	360 TI	250 U	1050	300	200	154	180 U	-80 U
U-234	714	443	**12.9**		3220	422 J	3390	650 J	415	2800	470	163	137	321	185
Th-230	714	136	**13.2**		472	491 J	473	159 J	202	740	169	225	214	135	105
Ra-226	783R5	0.0132	**8.6**		1960	368	2210	447	481	1470	274	131	160	234	179
Pb-214	713	NE	**12.5**		1060 J	342 J	1190 J	256 J	279 J	990 J	157 J	127 J	104 J	91 J	88 J
Bi-214	713	NE	**11**		950 J	323 J	970 J	232 J	242 J	920 J	161 J	113 J	97 J	72 J	52 J
Pb-210	704R6	40.8	**--**		3220	--	3040	--	520	--	--	--	--	--	--

Concentrations are in pCi/g.

BOLD The analyte was detected.

-- Not analyzed.

[ ] Concentration exceeds radiation exposure benchmark.

Underline Concentration exceeds background.

Background Two standard deviations above mean background concentration.

J Estimated concentration.

TI Nuclide identification is tentative.

U Not detected.

Table 23

Quartz Monzonite Samples - Metals Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Background	Sample ID:	QM-01	QM-02	QM-03	OSA-01	OSA-02	OSA-03	300-01	300-02	HR-01
		Lab ID:	0405097-14	0405097-15	0405097-16	0405097-28	0405097-29	0405097-30	0405097-17	0405097-18	0405097-1
		Sample Date:	5/3/04	5/3/04	5/3/04	5/6/04	5/6/04	5/6/04	5/4/04	5/7/04	5/6/04
		Sample Type:	QM Background	QM Background	QM-01 Duplicate	Dump High Grade	Dump Composite	OSA-02 Duplicate	Dump High Grade	Dump Composite	Haul Road High Grade
Aluminum	**2900**		**2900**	**2800**	**3200**	**1500**	**5600**	**5600**	**1200**	**2600**	**4000**
Antimony	--		--	--	--	1.7 U	--	--	--	--	--
Arsenic	1 U		1 U	1 U	1 U	**8.8**	**9.9 J**	**4.7 J**	**15**	**3.3**	**2**
Barium	--		--	--	--	**120**	--	--	--	--	--
Beryllium	--		--	--	--	**3.9**	--	--	--	--	--
Cadmium	--		--	--	--	**0.48**	--	--	--	--	--
Calcium	--		--	--	--	**2700**	--	--	--	--	--
Chromium	--		--	--	--	**14**	--	--	--	--	--
Cobalt	--		--	--	--	0.87 U	--	--	--	--	--
Copper	--		--	--	--	**38**	--	--	--	--	--
Iron	**7800**		**7100 J**	**7800 J**	**7900 J**	**11000**	**18000 J**	**16000 J**	**7600 J**	**12000 J**	**16000**
Lead	**1.9**		**0.94**	**1.9**	**1.3**	**470**	**240 J**	**130 J**	**330**	**62**	**300 J**
Magnesium	--		--	--	--	87 U	--	--	--	--	--
Manganese	**150**		**150**	**140**	**150**	**1400**	**750**	**670**	**1400**	**660**	**1000**
Mercury	--		--	--	--	0.091 UJ	--	--	--	--	--
Nickel	--		--	--	--	1.7 U	--	--	--	--	--
Potassium	--		--	--	--	**160**	--	--	--	--	--
Selenium	--		--	--	--	0.43 U	--	--	--	--	--
Silver	--		--	--	--	0.87 U	--	--	--	--	--
Sodium	--		--	--	--	**380**	--	--	--	--	--
Thallium	--		--	--	--	1.7 U	--	--	--	--	--
Uranium	**0.6**		**0.42 J**	**0.6 J**	**0.42 J**	**7800 J**	**2200 J**	**2200 J**	**8200 J**	**120 J**	**590 J**
Vanadium	--		--	--	--	**7.5**	--	--	--	--	--
Zinc	--		--	--	--	**280**	--	--	--	--	--

Concentrations are in mg/kg.

-- Not analyzed.

BOLD The analyte was detected.

Underline Concentration exceeds three times background.

Background Maximum background concentration.

J Estimated concentration.

U Not detected.

Table 24

Quartz Monzonite Samples - Isotopic Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Method	SSLR Benchmark	Back-ground	Sample ID:	QM-01	QM-02	QM-03	OSA-01	OSA-02	OSA-03	300-01	300-02	HR-01
				Lab ID:	0405097-14	0405097-15	0405097-16	0405097-28	0405097-29	0405097-30	0405097-17	0405097-18	0405097-1
				Sample Date and Type:	5/3/04	5/3/04	5/3/04	5/6/04	5/6/04	5/6/04	5/4/04	5/7/04	5/6/04
				Field Gamma (3 ft agl):	6	4	6	5000	1145	1145	2200	206	480
					QM Background	QM Background	QM-01 Duplicate	Dump High Grade	Dump Composite	OSA-02 Duplicate	Dump High Grade	Dump Composite	Haul Road High Grade
Th-232 Decay Chain													
Th-232	714	326	1.1		**0.6**	**0.91**	**0.77**	158	64 J	39.9 J	175	57 J	136 J
Ra-228	713	0.0915	0.7		**0.64**	**0.66**	0.71	1040	299	262	950	50.4	130
Th-228	714	0.157	0.9		**0.7**	**0.82**	**0.66**	192	72	55	208	59	142
Pb-212	713	NE	0.7		**0.62**	**0.53**	**0.52**	527	142	128	512	48.2	128
Bi-212	713	NE	1		0.65 U	0 U	0.08 U	440	20 U	260 U	450	54.3	125
U-235 Decay Chain													
U-235	713	0.206	0.1		-0.03 U	-0.15 U	-0.1 U	144	57 U	13 U	58 U	2.6	11.1
	714	0.206	0.1		0.025 U	0.017 U	**0.046**	110	32.2	33.3	117	1.92	10.3
Pa-231	713	0.803	--		--	--	--	-290 U	--	--	--	--	--
Ac-227	714	0.118	--		--	--	--	**58**	--	--	--	--	--
Th-227	713	NE	0.4		-0.09 U	0.19 U	-0.2 U	7 U	0 U	27 U	600 U	2.6 U	17.2
U-238 Decay Chain													
U-238	714	0.979	0.45		**0.42**	**0.44**	**0.43**	2280	670	630	2350	41.8	207
Th-234	713	NE	0.9		0.52 U	0.19 U	0.58 U	910	450	370	960	81	264
U-234	714	443	0.5		**0.49**	**0.45**	**0.49**	2370	650	630	2280	39.9	196
Th-230	714	136	1		**0.72**	**0.84**	**0.58**	328	126	93	347	69	315
Ra-226	783R5	0.0132	1.4		**1.07 J**	**0.46**	**0.36 J**	1650	498	482	1550	53.5	223
Pb-214	713	NE	0.7		**0.56 J**	**0.6 J**	**0.42 J**	970 J	314 J	287 J	830 J	46.7 J	201 J
Bi-214	713	NE	0.6		**0.44 J**	**0.57 J**	**0.46 J**	890 J	285 J	267 J	660 J	42.3 J	182 J
Pb-210	704R6	40.8	--		--	--	--	**2620**	--	--	--	--	--

Concentrations are in pCi/g.

-- Not analyzed.

BOLD The analyte was detected.

☐ Concentration exceeds the SSLR benchmark.

Underline Concentration exceeds background

Background Two standard deviations above the mean background concentration.

J Estimated concentration.

NE Not established.

SSLR Soil screening level for radiation exposure.

TI Nuclide identification is tentative.

U Not detected.

Table 25

Surface Soil Samples Underlain by Granite - Metals Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Soil Benchmark	Back-ground (Granite)	*Sample ID:*	SOIL-07	SOIL-08	SOIL-09	SOIL-10
			Lab ID:	0405096-29	0405096-30	0405096-31	0405096-32
			Sample Date:	5/7/04	5/7/04	5/7/04	5/7/04
			Sample Type:	Opportunity Sample	Opportunity Sample	Soil-07 Duplicate	Opportunity Sample
Aluminum	NE	**1200**		**1800 J**	9700	**1200 J**	5600
Arsenic	0.43	**2.8**		**1.7**	16	**1.7**	**8.1**
Iron	NE	**8900**		**7700**	**26000**	**6200**	36000
Lead	400	**24**		**28 J**	290 J	**26 J**	110 J
Manganese	NE	**220**		**31 J**	**230**	**46 J**	**580**
Uranium	46.9	**19**		**11 J**	1900 J	**9.4 J**	730 J

Concentrations are in mg/kg.

BOLD The analyte was detected.

Concentration exceeds the soil benchmark.

Underline Concentration is greater than three times the maximum background concentration.

-- Not analyzed.

Background Maximum background concentration

J Estimated concentration.

NE Not established.

U Not detected.

Table 26

Surface Soil Samples Underlain by Granite - Isotopic Data

Ross Adams Uranium Mine PA/SI Report

Isotope	Method	Soil Benchmark	Back - ground (Granite)	Sample ID:	SOIL-07	SOIL-08	SOIL-09	SOIL-10
				Lab ID:	0405096-29	0405096-30	0405096-31	0405096-32
				Sample Date:	5/7/04	5/7/04	5/7/04	5/7/04
				Field Gamma (3 ft agl):	90	110	90	125
				Sample Type:	Opportunity Sample	Opportunity Sample	Soil-07 Duplicate	Opportunity Sample
Th-232 Decay Chain								
Th-232	714	3.4	**7.5**		8.3	68	**6.9**	120
Ra-228	713	0.0915	**9**		12.8 J	65	9.1 J	122
Th-228	714	0.157	**8.5**		9.6	71	**8.2**	111
Pb-212	713	NE	**8.4**		12.8	67.2	10	125
Bi-212	713	NE	**9**		14.1	66	**7.8**	127
U-235 Decay Chain								
U-235	714	0.206	**1**		**0.33**	19.7	**0.16**	9.8
	713	0.206	**1**		0.43 U	14	0.34 U	9.6
Th-227	713	NE	**6.8**		0.17 U	**6.3 SI**	0.48 U	9.2 SI
U-238 Decay Chain								
U-238	714	0.979	**13.6**		**4.83**	278	**4.27**	176
Th-234	713	NE	**14.8**		**10.6**	309	**12.5**	107
U-234	714	5	**12.9**		**4.35**	295	**4.15**	164
Th-230	714	3.9	**13.2**		**5.6**	138	**5.08**	240
Ra-226	783R5	0.0132	**8.6**		**3.93**	126	**5.3**	221
Pb-214	713	NE	**12.5**		**6.18 J**	102 J	**7.24 J**	166 J
Bi-214	713	NE	**11**		**5.66 J**	93 J	**6.6 J**	152 J

Concentrations are in pCi/g.

-- Not analyzed.

BOLD The analyte was detected.

Concentration exceeds soil benchmark.

Underline Concentration exceeds background.

Background Two standard deviations above the mean background concentration.

J Estimated concentration.

NE Not established.

U Not detected.

Table 27

Surface Soil Samples Underlain by Quartz Monzonite - Metals Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Soil Benchmark	Back-ground (QM)	*Sample ID:* **GEN-02** *Lab ID:* 0405096-22 *Sample Date:* 5/7/04 *Sample Type:* Generator Building
Aluminum	NE	**2900**	**2000**
Arsenic	0.43	1 U	**2.1**
Iron	NE	**7800**	**8500**
Lead	400	**1.9**	**15 J**
Manganese	NE	**150**	**200**
Uranium	46.9	**0.6**	**22 J**

Concentrations are in mg/kg.

BOLD The analyte was detected.

Concentration exceeds the soil benchmark.

Underline Concentration exceeds three times maximum background concentration or, if background is ND, the analyte was detected in the characterization sample.

Background Maximum background concentration.

J Estimated concentration.

NE Not established.

QM Quartz monzonite.

U Not detected.

Table 28

Soil Samples Underlain by Quartz Monzonite - Isotopic Data

Ross Adams Uranium Mine PA/SI Report

Isotope	Method	Soil Benchmark	Back - ground (QM)	*Sample ID:*	**GEN-02**
				Lab ID:	0405096-22
				Sample Date:	5/7/04
				Field Gamma (3 ft agl):	40
				Sample Type:	Surface soil
Th-232 Decay Chain					
Th-232	714	3.4	**1.1**		**4.38**
Ra-228	713	0.0915	**0.7**		**6.6**
Th-228	714	0.157	**0.9**		**4.41**
Pb-212	713	NE	**0.7**		**6.71**
Bi-212	713	NE	**1**		**5.4**
U-235 Decay Chain					
U-235	714	0.206	**0.1**		**0.245**
	713	0.206	**0.1**		0.72 U
Th-227	713	NE	**0.4**		5 U
U-238 Decay Chain					
U-238	714	0.979	**0.45**		**6.4**
Th-234	713	NE	**0.9**		**13.6**
U-234	714	5	**0.5**		**6.2**
Th-230	714	3.9	**1**		**9**
Ra-226	783R5	0.0132	**1.4**		**5.7**
Pb-214	713	NE	**0.7**		**10.5 J**
Bi-214	713	NE	**0.6**		**8.7 J**

Concentrations are in pCi/g.

-- Not analyzed.

BOLD The analyte was detected.

Concentration exceeds soil benchmark.

Underline Concentration exceeds background.

Background Two standard deviations above the mean background concentration.

J Estimated concentration.

NE Not established.

QM Quartz monzonite.

U Not detected.

Table 29
Surface Soil Samples Underlain by Quartz Monzonite- Hydrocarbon Data
Ross Adams Uranium Mine PA/SI Report

Sample Source	Sample No	Sample Date	Units	DRO	RRO	TOC	TOC Excluding DRO+RRO
GEN-01	GEN-01	5/7/2004	MG/KG	12000 J	4700 J	15000	0
GEN-02	GEN-02	5/7/2004	MG/KG	12000 J	43000 J	71000	16000
GEN-02 DUP	GEN-04	5/7/2004	MG/KG	12000 J	46000 J	62000	--
GEN-03	GEN-03	5/7/2004	MG/KG	1200 J	5900 J	14000	6900
						Average TOC =	7633 or 0.0076%
		Method 2 Criteria:	*ingestion*	*8250*	*8300*		
			inhalation	*12500*	*22000*		
			MG	*230*	*9700*		
		Method 3 Criteria:	*ingestion*	*8300*	*8300*		
			inhalation	*12500*	*22000*		
			MG	*1700*	*22000*		

Concentrations are reported in mg/kg.

Method 3 criteria calculated using default parameters except for a TOC content of 0.0076 g/g.

Underline Exceeds one or more Method 3 criteria.

DRO Diesel-range organics.
MG Migration to groundwater.
RRO Residual-range organics.
TOC Total organic carbon.

Table 30

Surface Soil Samples in Shoreline Area - Metals Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Soil Benchmark	Back-ground (OSA Soil)	*Sample ID:*	SOIL-01	SOIL-02	SOIL-04	SOIL-05
			Lab ID:	0405096-25	0405096-26	0405096-27	0405096-28
			Sample Date:	5/6/04	5/6/04	5/6/04	5/6/04
			Sample Type:	OSA Background	OSA Background	OSA Area	OSA Area
Aluminum	NE	**14000**		**14000**	**11000**	**28000**	**11000**
Arsenic	0.43	3.1 U		3.1 U	1.9 U	**3.7**	1.7 U
Iron	NE	**33000**		**26000**	**33000**	**46000**	**38000**
Lead	400	**31**		**31 J**	**19 J**	**87 J**	**23 J**
Manganese	NE	**310**		**310**	**290**	**680**	**390**
Uranium	46.9	**210**		**210 J**	**73 J**	**2600 J**	**170 J**

Concentrations are in mg/kg.

BOLD The analyte was detected.

Concentration exceeds the soil benchmark.

Underline Concentration exceeds three times background concentration.

-- Not analyzed.

Background Maximum background concentration.

J Estimated concentration.

NE Not established.

OSA Ore staging area.

U Not detected.

Table 31

Surface Soil Samples in Shoreline Area - Isotopic Data

Ross Adams Uranium Mine PA/SI Report

Isotope	Method	Soil Benchmark	Back - ground	Sample ID:	SOIL-01	SOIL-02	SOIL-04	SOIL-05
				Lab ID:	0405096-25	0405096-26	0405096-27	0405096-28
				Sample Date:	5/6/04	5/6/04	5/6/04	5/6/04
				Field Gamma (3 ft agl):	30	30	100	100
				Sample Type:	OSA Background	OSA Background	OSA Area	OSA Area
Th-232 Decay Chain								
Th-232	714	3.4	**24.3**		**18**	**11.1**	84	**20.3**
Ra-228	713	0.0915	**20.7**		**15.4**	**9.6**	82	53.3
Th-228	714	0.157	**19.5**		**15.2**	**10.5**	100	24.3
Pb-212	713	NE	**18.3**		**14.8**	**11**	94	60.6
Bi-212	713	NE	**17.6**		**12.4**	**15.1**	82	51
U-235 Decay Chain								
U-235	714	0.206	**1.35**		**1.09**	**0.77**	41	1.65
	713	0.206	**1.35**		1.2 U	1.1 U	23.9	8.2 TI
Th-227	713	NE	**18.5**		7 U	13 U	21.2 SI	**5.7**
U-238 Decay Chain								
U-238	714	0.979	**26.6**		**20.6**	**14**	557	36.4
Th-234	713	NE	**39.6**		**30.4**	**20.3**	527	127
U-234	714	5	**26**		**20.1**	**13.6**	562	37
Th-230	714	3.9	**37.2**		**28.1**	**18.2**	223	**30.9**
Ra-226	783R5	0.0132	**13.6**		**11.7**	**12.7**	122	25
Pb-214	713	NE	**17.5**		**14 J**	**10.2 J**	159 J	63.8 J
Bi-214	713	NE	**15.7**		**12.5 J**	**9 J**	138 J	61.5 J

Concentrations are in pCi/g.

-- Not analyzed.

BOLD The analyte was detected.

Concentration exceeds soil benchmark.

Underline Concentration exceeds background.

Background Two standard deviations above mean background concentration.

J Estimated concentration.

NE Not established.

OSA Ore staging area.

SI Nuclide identification or concentration is tentative.

TI Nuclide identification is tentative.

U Not detected.

Table 32

Surface Water Samples - Metals Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Surface Water Benchmark	Back-ground	Sample ID:	SW-01	SW-02	SW-04	SW-05	SW-06	SW-07	SW-08	SW-09	SW-10	SW-11
			Lab ID:	0405095-1	0405095-2	0405095-3	0405095-4	0405095-5	0405095-6	0405095-7	0405095-8	0405095-9	0405095-10
			Sample Date:	5/5/04	5/5/04	5/4/04	5/6/04	5/6/04	5/3/04	5/3/04	5/5/04	5/5/04	5/6/04
			Sample Location	Mine Fork Background	Mine Fork Background	Cabin Creek	OSA Creek	Kendrick Ck Mouth Area	Kendrick Ck 300-Level	Kendrick Ck 300-Level	700 Level Creek	Mine Fork 900-Level	SW-06 Duplicate
Antimony	6	--		--	--	--	0.3 U	--	0.3 U	--	--	--	--
Arsenic	10	--		--	--	--	10 U	--	10 U	--	--	--	--
Aluminum	87	**130**		**94**	**130**	**88**	**290**	**100 J**	**130**	**120**	**130**	**98**	**130 J**
Barium	2000	--		--	--	--	100 U	--	100 U	--	--	--	--
Beryllium	4	--		--	--	--	1 U	--	1 U	--	--	--	--
Cadmium	0.09	**0.3**		0.3 U	**0.3**	0.3 U	**0.31**	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Calcium	NE	1000 U		1000 U	1000 U	**2400**	1000 U	**2300**	**2100**	1000 U	1000 U	1000 U	**2300**
Chromium	24	--		--	--	--	10 U	--	10 U	--	--	--	--
Cobalt	NE	--		--	--	--	10 U	--	10 U	--	--	--	--
Copper	2.74	--		--	--	--	2 U	--	2 U	--	--	--	--
Iron	NE	--		--	--	--	**630**	--	100 U	--	--	--	--
Lead	0.5	0.5 U		0.5 U	0.5 U	0.5 U	**0.5**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Manganese	NE	--		--	--	--	10 U	--	**15**	--	--	--	--
Mercury	0.77	--		--	--	--	0.2 U	--	0.2 U	--	--	--	--
Magnesium	NE	1000 U		1000 U	1000 U	1000 U	1000 U	**1800**	1000 U	1000 U	1000 U	1000 U	**1800**
Nickel	16	--		--	--	--	5 U	--	5 U	--	--	--	--
Potassium	NE	--		--	--	--	1000 U	--	1000 U	--	--	--	--
Selenium	5	--		--	--	--	5 U	--	5 U	--	--	--	--
Silver	0.3	--		--	--	--	0.1 U	--	0.1 U	--	--	--	--
Sodium	NE	--		--	--	--	**3500**	--	**2500**	--	--	--	--
Thallium	0.5	--		--	--	--	0.2 U	--	0.2 U	--	--	--	--
Uranium	30	**0.11**		0.1 U	**0.11**	**0.18**	**0.79**	**0.77**	**42**	**6.6**	**14**	**0.76**	**0.8**
Vanadium	260	--		--	--	--	10 U	--	10 U	--	--	--	--
Zinc	36	--		--	--	--	20 U	--	20 U	--	--	--	--

Concentrations are in ug/L.

BOLD The analyte was detected.

Concentration equals or exceeds surface water benchmark.

Underline Concentration exceeds three times background reference or, if benchmark is ND, the analyte was detected.

Background Maximum background concentration.

J Estimated concentration.

NE Not established.

U Not detected.

Table 33

Surface Water Samples - Isotopic Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Surface Water Benchmark	Back-ground	Sample ID:	SW-01	SW-02	SW-04	SW-05	SW-06	SW-07	SW-08	SW-09	SW-10	SW-11
			Lab ID:	0405095-1	0405095-2	0405095-3	0405095-4	0405095-5	0405095-6	0405095-7	0405095-8	0405095-9	0405095-10
			Sample Date:	5/5/04	5/5/04	5/4/04	5/6/04	5/6/04	5/3/04	5/3/04	5/5/04	5/5/04	5/6/04
			Sample Location:	Background	Background	Cabin Ck	OSA	KC-Mouth	Mine Drainage	KC 300-Level	700 Level Ck	MF 900-Level	SW-10 DUP
Gross Alpha/Beta													
Gross Alpha	15	**1.63**		**0.86**	**1.26**	0.09 U	**1.83**	**1.16**	**34.6**	**6.1**	**15.8**	**1.35**	**1.23**
Gross Beta	20	**3.01**		0.35 U	**1.74**	-0.15 U	**1.64**	**1.49**	**19.1**	**4.3**	**12.3**	**1.7**	**1.7**
Th-232 Decay Chain													
Th-232	15	--		--	--	--	**0.103**	--	**0.284**	--	--	--	--
Ra-228	5	**0.53**		0.17 UJ	0.36 UJ	0.23 UJ	0.46 UJ	--	**2.18 J**	**0.4 J**	**1.94 J**	--	--
Th-228	15	--		--	--	--	**0.174**	--	**0.91**	--	--	--	--
U-238 Decay Chain													
Th-230	15	--		--	--	--	**0.149**	--	**0.91**	--	--	--	--
Ra-226	5	**0.11**		0.03 U	0.07 U	0.09 U	**0.3**	--	**2.23**	**0.4**	**2.68**	--	--
Pb-210	0.037	--		--	--	--	0.23 U	--	**0.66**	--	--	--	--

Concentrations are in pCi/L.

BOLD The analyte was detected.

☐ Concentration exceeds surface water benchmark.

Underline Concentration exceeds background concentration.

-- Not analyzed.

Background Two standard deviations above the mean background concentration.

J Estimated concentration.

KC Kendrick Creek.

MF Mine Fork Creek.

NE Not established.

OSA Ore staging area.

U Not detected.

Table 34

Stream Sediment Samples - Metals Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Sediment Benchmark	Back-ground	Sample ID:	SSED-01	SSED-02	SSED-03	SSED-04	SSED-05	SSED-06	SSED-07	SSED-08	SSED-09	SSED-10
			Lab ID:	0405096-11	0405096-12	0405096-13	0405096-14	0405096-15	0405096-17	0405096-16	0405096-18	0405096-19	0405096-20
			Sample Date:	5/5/04	5/5/04	5/4/04	5/4/04	5/4/04	5/4/04	5/4/04	5/5/04	5/5/04	5/4/04
			Sample Location:	Mine Fork Background	Kendrick Ck Background	Cabin Creek	Kendrick Ck Mouth	Kendrick Creek	Kendrick Creek	Kendrick Ck 300-Level	700 Level Creek	Mine Fork 900-Level	SSED-06 Duplicate
Aluminum	NE	**960**		**960**	**680**	**13000**	**6600**	**8700**	**8100**	**12000**	**5200**	**1800**	**9400**
Arsenic	8.2	**10**		**1.9**	**10**	**2.3**	**1.9**	**1.8**	**2**	**3.2**	**6.3**	**2.2**	**2.4**
Iron	NE	**5600**		**5600**	**4900**	**31000**	**15000**	**19000**	**19000**	**27000**	**18000**	**8300**	**21000**
Lead	47	**16**		**16**	**9.8**	**6.7**	**5.7**	**7.6**	**6 J**	**14**	**48**	**16**	**9.1 J**
Manganese	NE	**86**		**86**	**39**	**1500**	**260**	**420**	**360**	**940**	**1400**	**170**	**470**
Uranium	NE	**3**		**2.5**	**3**	**3.2**	**2**	**14**	**3 J**	**11**	**180**	**24**	**23 J**

Concentrations are in mg/kg.

BOLD The analyte was detected.

Concentration exceeds sediment benchmark.

Underline Concentration equals or exceeds three times background concentration.

Background Maximum background concentration.

J Estimated concentration.

U Not detected.

Table 35

Stream Sediment Samples - Isotopic Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Method	Back-ground	Sample ID:	SSED-01	SSED-02	SSED-03	SSED-04	SSED-05	SSED-06	SSED-07	SSED-08	SSED-09	SSED-10
			Lab ID:	0405096-11	0405096-12	0405096-13	0405096-14	0405096-15	0405096-17	0405096-16	0405096-18	0405096-19	0405096-20
			Sample Date:	5/5/04	5/5/04	5/4/04	5/4/04	5/4/04	5/4/04	5/4/04	5/5/04	5/5/04	5/4/04
			Sample Type:	*Background*	*Background*	*Cabin Ck*	*KC-Mouth*	*Kendrick Ck*	*Kendrick Ck*	*KC - 300 Level*	*700 Level Ck*	*MF - 900 Level*	*SSED-06 DUP*
Th-232 Decay Chain													
Th-232	714	**2.31**		**1.3**	**1.83**	**0.75**	**0.59**	**2.23**	**0.74 J**	**1.25**	33.2	6	5.2 J
Ra-228	713	**3.65**		**2.27**	**0.76**	**0.99**	**0.96**	**1.03**	**2**	**2.1**	34.1	5.96	**1.73**
Th-228	714	**1.61**		**1.32**	**1**	**0.83**	**0.88**	2.36	**1.09**	**1.6**	26.9	4.16	5.7
Pb-212	713	**2.24**		**1.55**	**0.8**	**1.27**	**1.25**	**1.2**	**1.65**	**2.06**	26.8	5.46	**1.96**
Bi-212	713	**4.22**		2.6 U	**0.83**	1.2 U	1.6 U	1.6 U	0.6 U	1.8 U	32.7	7.2	**1.6**
U-235 Decay Chain													
U-235	714	**0.38**		**0.07**	**0.042**	0.034 U	**0.045**	**0.201**	**0.073 J**	**0.121**	3.04	**0.31**	**0.265 J**
	713	**0.38**		0.31 U	0.121 U	0.22 U	0.16 U	0.26 U	0.19 U	-0.13 U	3.4 TI	0.67 U	0.05 U
Th-227	713	**0.46**		-0.25 U	0.12 U	-0.45 U	0.03 U	-1.8 U	-1.75 U	0.24 U	19 U	5 U	0.17 U
U-238 Decay Chain													
U-238	714	**1.9**		**1.55**	**1.17**	**0.86**	**1.17**	4.15	**1.08 J**	2.3	60.8	7.1	5.42 J
Th-234	713	**2.66**		1.8 U	**2.25**	1.4 U	1.9 U	0.6 U	1.5 U	3.8	59.8	11.2	3.2 TI
U-234	714	**1.59**		**1.43**	**1.25**	**1.16**	**1.07**	3.93	**1.27 J**	2.55	56.8	5.97	5.18 J
Th-230	714	**2.03**		**1.85**	**1.65**	4.63	**0.96**	4.04	**0.98 J**	**1.99**	70	11	7.8 J
Ra-226	783R5	**3.2**		**1.99**	**0.67**	**1.49**	**1.6**	4.5	**0.78 J**	**1.44**	67	7.5	5.7 J
Pb-214	713	**3.4**		**2.35 J**	**1.2 J**	**2.16 J**	**1.82 J**	**1.57 J**	**2.4 J**	**3.39 J**	43.2 J	6.36 J	**2.87 J**
Bi-214	713	**2.55**		**1.86 J**	**1.1 J**	**2.04 J**	**1.37 J**	**1.38 J**	**2.01 J**	2.73 J	39.1 J	5.62 J	**2.33 J**

Concentrations are in pCi/g.

BOLD	The analyte was detected.	Background	Two standard deviations above the mean background concentration.	NA	Not available.
Underline	Concentration exceeds background.	J	Estimated concentration.	TI	Tentative identification.
--	Not analyzed.	KC	Kendrick Creek.	U	Not detected.

Table 36

Marine Sediment Samples - Metals Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Sediment Benchmark	Back-ground	Sample ID:	MSED-01	MSED-02	MSED-03	MSED-04	MSED-05	MSED-06	MSED-07	MSED-08	MSED-09	MSED-10
			Lab ID:	0405096-1	0405096-2	0405096-3	0405096-4	0405096-5	0405096-6	0405096-7	0405096-8	0405096-9	0405096-10
			Sample Date:	5/6/04	5/6/04	5/6/04	5/6/04	5/6/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04
			Sample Location:	Background	Background	Background	KC- Mouth	KC-Mouth	Dock Area	Dock Area	Dock Area	Dock Area	MSED-08 DUP
Aluminum	NE	**16000**		**7100**	**16000**	**9500**	**7700**	**11000**	**14000**	**7900**	**7100**	**23000**	**6000**
Arsenic	8.2	**13**		**3.9**	**13**	**5.8**	**2.5**	**5**	**1.6**	**7.7**	**4.7 J**	**49**	1.1 UJ
Iron	NE	**33000**		**14000**	**33000**	**16000**	**18000**	**25000**	**34000**	**21000**	**14000**	**51000**	**12000**
Lead	47	**4.2**		2.2 U	**4.2**	**2.5**	**9.7**	**20**	**1.6**	**20**	**14 J**	**43**	**8.4 J**
Manganese	NE	**350**		**430**	**350**	**200**	**440**	**860**	**540**	**330**	**370 J**	**550**	**230 J**
Uranium	NE	**5.4**		**1.2 E**	**5.4**	**1.6**	**5.4**	**17**	**0.78**	**290**	**390 J**	**210**	**74 J**

Concentrations are in mg/kg.

BOLD The analyte was detected.

Concentration exceeds sediment benchmark.

Underline Concentration exceeds three times background concentration.

Background Maximum background concentration.

E Estimated concentration due to interference.

J Estimated concentration.

KB Kendrick Bay.

KC Kendrick Creek.

U Not detected.

Table 37

Marine Sediment Samples - Isotopic Data

Ross Adams Uranium Mine PA/SI Report

Analyte	Method	Back-ground	Sample ID:	MSED-01	MSED-02	MSED-03	MSED-04	MSED-05	MSED-06	MSED-07	MSED-08	MSED-09	MSED-10
			Lab ID:	0405096-1	0405096-2	0405096-3	0405096-4	0405096-5	0405096-6	0405096-7	0405096-8	0405096-9	0405096-10
			Sample Date:	5/6/04	5/6/04	5/6/04	5/6/04	5/6/04	5/7/04	5/7/04	5/7/04	5/7/04	5/7/04
			Sample Type:	Background	Background	Background	KC-Mouth	KC-Mouth	Dock Area	Dock Area	Dock Area	Dock Area	MSED-8 DUP
Th-232 Decay Chain													
Th-232	714	**0.2**		**0.133**	**0.137**	**0.18**	2.25	4.32	0.65	79	117 J	20.2	34.6 J
Ra-228	713	**0.38**		0.25 U	**0.164**	**0.3**	1.74	3.44	0.77	32.6	2.84 J	17	45.4 J
Th-228	714	**0.17**		0.065 UJ	**0.157 J**	**0.14 J**	2.19 J	2.72 J	0.46 J	75 J	123 J	17.1 J	30 J
Pb-212	713	**0.26**		**0.111**	**0.208**	**0.159**	2.23	4.26	0.81	34.9	3.54 J	15.8	48.3 J
Bi-212	713	**0.54**		0.41 U	**0.45**	0.3 U	2.41	5	1.4 U	41	3.7 U	13.4	46.3
U-235 Decay Chain													
U-235	713	**0.14**		0.04 U	0.13 U	0.03 U	0.21	-0.16 U	0.04 U	2.4 U	0.16 UJ	1.2 U	5.6 J
	714	**0.14**		**0.037**	**0.069**	**0.011**	**0.125**	0.226	0.042 U	8.7	4.18 J	1.53	1.42 J
Pa-231	713	**--**		**--**	**--**	**--**	-0.2 U	**--**	**--**	**--**	**--**	**--**	**--**
Ac-227	714	**--**		**--**	**--**	**--**	**0.37 J**	**--**	**--**	**--**	**--**	**--**	**--**
Th-227	713	**0.92**		-0.37 U	**0.3 TI**	**0.37 TI**	**0.3**	0.07 U	-0.03 U	-0.4 U	0.34 UJ	16 U	4.6 J
U-238 Decay Chain													
U-238	714	**1.35**		**0.427**	**1.06**	**0.57**	2.83	4.1	**0.44**	137	86 J	25.9	28.6 J
Th-234	713	**1.73**		0.59 U	**1.36 TI**	0.63 U	3.16	8	0.73 U	63	4.6	29.7	121
U-234	714	**1.33**		**0.48 J**	**1.06 J**	**0.56 J**	2.8 J	4.32 J	**0.45 J**	132 J	84 J	25.3 J	26.8 J
Th-230	714	**0.36**		**0.211**	**0.284**	**0.3**	3.16	6.2	0.59	149	222 J	33.7	64 J
Ra-226	783R5	**0.49**		**0.38**	**0.137**	**0.17**	2.15	2.71	**0.19**	52.4	64 J	16.1	17.7 J
Pb-214	713	**0.43**		0.14 UJ	**0.339 J**	**0.197 J**	2.48 J	3.94 J	0.78 J	36.5 J	3.57 J	18.3 J	82 J
Bi-214	713	**0.36**		0.14 UJ	**0.23 J**	-0.01 UJ	2.26 J	3.4 J	0.63 J	31.1 J	2.97 J	15.8 J	75.2 J
Pb-210	704R6	**--**		**--**	**--**	**--**	**3.23**	**--**	**--**	**--**	**--**	**--**	**--**

Concentrations are in pCi/g.

BOLD The analyte was detected.

Underline Concentration exceeds background.

-- Not analyzed.

Background Two standard deviations above mean background concentration.

J Estimated concentration.

KC Kendrick Creek.

TI Tentative identification.

U Not detected.

Table 38

Observed Contamination Land Area, Volume, and Mass

Ross Adams Uranium Mine PA/SI Report

Area	Surface Area		Cross-Sectional Area[1]	Width at Section	Average Thickness[2]	Volume		Mass[3]
	ft^2	acres	ft^2	ft	ft	ft^3	yd^3	tons
900-Foot Level								
North Dump	41,800	0.96	nm	nm	7	290,000	11,000	17,000
South Dump	5,027	0.12	286	76	3.8	19,000	700	1,100
Soil with battery fragments	150	0.003	--	--	--	--	--	--
Other waste rock piles	9,900	0.23	nm	nm	*1.5* *	14,900	550	900
700-Foot Level								
Dump	18,550	0.43	857	135	6.3	120,000	4,400	7,100
Soil[4]	142,000	3.26	--	--	--	--	--	--
300-Foot Level								
Dump	42,400	0.97	2,950	200	14.8	630,000	23,000	37,000
Oar Staging Area								
Waste Rock Pile	30,100	0.69	nm	nm	*2.5* *	75,000	2,800	4,400
Soil	2,830	0.06	--	--	--	--	--	--
Mine Road Fill Areas (see Figure 15)								
I	6,135	0.14	210	65	3.2	20,000	740	1,200
II	2,690	0.06	150	51	2.9	7,900	290	470
III	4,410	0.10	110	40	2.8	12,000	440	710
IV	3,770	0.09	50	32	1.6	6,000	220	350
V	2,580	0.06	140	50	2.8	7,000	260	410
VI	4,410	0.10	120	46	2.6	12,000	440	710
Other mine road sections	12,200	0.28	nm	nm	*1* *	12,000	440	710
Haul Road								
Gamma > 100 µR/hr	36,000	0.83	--	--	--	--	--	--
Totals	**365,000**	**8.4**					**45,000**	**72,000**
					Range	+30%	59,000	94,000
						-30%	35,000	55,000

[1] Estimated area of vertical section through widest portion of dump or fill area.

[2] Distance-averaged thickness calculated by cross-sectional area over section width.

[3] Assuming waste rock pile density of 117.9 lbs/ft^3 [12].

[4] Area defined by SOIL-08, SOIL-10, SOIL-07, MR-01 and MR-02 excluding waste rock areas and estimated extent of bedrock outcrop (30%).

* Average thickness estimates based solely on site observations (no GPS data).

-- Not applicable.

nm Not measured.

Table 39
Reportable Quantities of Hazardous Substances
Ross Adams Uranium Mine PA/SI Report

Source	Data Source	Hazardous Substance	Activity/Concentration Above Background	Units	Density (lb/cf))	Volume (cy)	Hazardous Substance Quantity	Units
1. 900-Foot Level Dumps	900-04 composite	Th-232+D	111.5	pCi/g	117.9	12,250	1.97	Ci
		Natural uranium	165.4	pCi/g			2.93	Ci
		Arsenic	BNE	--			--	--
		Lead	BNE	--			--	--
2. 700-Foot Level Dump	700-02 composite	Th-232+D	236.5	pCi/g	117.9	4,400	1.50	Ci
		Natural uranium	427.4	pCi/g			2.72	Ci
		Arsenic	6.1	mg/Kg			85	Lbs
		Lead	166	mg/Kg			2320	Lbs
3. 300-Foot Level Dump	300-02 composite	Th-232+D	55.9	pCi/g	117.9	23,000	1.86	Ci
		Natural uranium	43.2	pCi/g			1.44	Ci
		Arsenic	2.8	mg/Kg			205	Lbs
		Lead	60.1	mg/Kg			4391	Lbs
4. OSA Waste Rock Pile	OSA-02 composite	Th-232+D	62.9	pCi/g	117.9	2,800	0.25	Ci
		Natural uranium	701.7	pCi/g			2.84	Ci
		Arsenic	9.4	mg/Kg			84	Lbs
		Lead	238.1	mg/Kg			2118	Lbs
5. Mine Road	Mean of road samples	Th-232+D	52.5	pCi/g	117.9	2,830	0.21	Ci
		Natural uranium	257.9	pCi/g			1.05	Ci
		Arsenic	BNE	--			--	--
		Lead	56	mg/Kg			503	Lbs
6. Haul Road	Mean of all dump composites and all road samples.	Th-232+D	101	pCi/g	117.9	2,700	0.39	Ci
		Natural uranium	297.2	pCi/g			1.16	Ci
		Arsenic	3.3	mg/Kg			29	Lbs
		Lead	130	mg/Kg			1118	Lbs
7. Soil - 700-Foot Level and Mine Road Area	Mean of samples SOIL-07, -08, and -10	Th-232+D	57.9	pCi/g	102	10,500	0.76	Ci
		Natural uranium	148.3	pCi/g			1.95	Ci
		Arsenic	5.8	mg/Kg			167	Lbs
		Lead	118.7	mg/Kg			3424	Lbs

Table 39
Reportable Quantities of Hazardous Substances
Ross Adams Uranium Mine PA/SI Report

Source	Data Source	Hazardous Substance	Activity/Concentration Above Background	Units	Density (lb/cf))	Volume (cy)	Hazardous Substance Quantity	Units
8. Soil - OSA	Mean of samples	Th-232+D	27.9	pCi/g	102	210	0.007	Ci
	SOIL-04 and -05	Natural uranium	290.1	pCi/g			1.19	Ci
		Arsenic	BNE	--			--	--
		Lead	BNE	--			--	--
TOTALS		Th-232+D	706.0				7.0	Ci
		Natural uranium	2331.2				15.3	Ci
		Arsenic	27.4				569	Lbs
		Lead	769.2				13,875	Lbs

Note 1: Quantities are calculated based on volume estimates provided in Table 38. Soil and haul road volume calculated assuming 2-foot thickness.

Note 2: Background reference concentration/activity is subtracted from reported results.

Note 3: Soil density assumed to be 102 lbs/ft^3 [8].

BNE Background not exceeded.

Th-232+D Thorium 232 in secular equilibrium with its daughters. Reportable quantity = 0.011 Ci.

Natural uranium Uranium 235 and 238 in secular equilibrium with their daughters. Reportable quantity = 0.052 Ci.

Arsenic Reportable quantity = 1 pound

Lead Reportable quantity = 10 pounds