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**RADIOLOGICAL DATA COMPILATION  
YERINGTON MINE SITE**

**December 15, 2005**

**Prepared For:**

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**SECTION 1.0**  
**INTRODUCTION**

The Atlantic Richfield Company (“ARC”) has compiled available radiological data associated with recent (i.e., post-2003) testing, sampling and monitoring at the Yerington Mine Site (former Anaconda Copper Mine) in accordance with the Unilateral Administrative Order (“UAO”) issued by the U.S. Environmental Protection Agency (“EPA”). This Radiological Data Compilation (RDC) provides the basis for an evaluation of data completeness and relevance related to proper radiation investigation protocols as outlined in the Multi-Agency Radiation Survey and Site Investigation Manual (“MARSSIM”; EPA 402-R-97-016/NUREG-1575). This RDC will also provide the basis to determine data gaps, which may include areas where previous investigations have not been completed or the adequacy of existing data. Of particular importance is the need for the collection of background soil samples and laboratory analyses of these samples for selected radionuclides. The information presented in this RDC represents data collected by the EPA, the U.S. Bureau of Land Management (“BLM”), the Nevada Department of Environmental Protection (“NDEP”) and ARC.

During copper mining and process operations, the Anaconda Mining Company (“Anaconda”) investigated the possibility of recovering the naturally occurring uranium oxides in the copper ore as a by-product. Anaconda determined that the uranium concentrations were not economically viable. The occurrence of technically-enhanced naturally-occurring radioactive materials (“TENORM”) was described by EPA (1999) for copper ores in the southwestern United States. EPA evaluated TENORM at a number of copper mines in Arizona, and determined that: 1) copper beneficiation operations (e.g., milling and leaching) can concentrate radionuclides; and 2) concentrations above background occurred in soils and groundwater around these mines.

Pre-2003 investigations of the possible occurrence of TENORM at the Yerington Mine Site include: 1) an Environmental Survey conducted by Anaconda (1979) that included a gamma survey, vegetation samples, water samples and the sampling of tailings waste rock and ore

stockpiles around the mine site for radiological analyses; 2) a 1984 review of radiological analyses of groundwater samples prepared by Western Radiation Consultants, Inc.; 3) additional radiological analyses of groundwater samples collected by Applied Hydrology Associates in 1984; and 4) a geochemical investigation of groundwater that included radionuclide analyses prepared by Canonie Environmental in 1990. Copies of these earlier investigations are presented in Appendix A.

**SECTION 2.0**  
**RECENT INVESTIGATIONS**

Recent radiological investigations at the Yerington Mine Site are summarized in Table 2-1, which includes assigned document numbers for ease of reference throughout this RDC.

Table 2-1. Yerington Radiological Investigation Documents		
Document No.	Title	Source
RAD-DOC-01	December 17, 2003 Site Visit Summary and Phased Approach to Evaluating Technically Enhanced Naturally Occurring Radionuclides (TENORM) at the Anaconda Copper Mine Site, Yerington, Nevada	Jim Sickles, EPA
RAD-DOC-02	Yerington Mine Site Worker Radiological Dose Assessment	Foxfire Scientific for NDEP
RAD-DOC-03a	Yerington Mine Site Fugitive Dust Radiological Dose Assessment	Foxfire Scientific for NDEP
RAD-DOC-03b	Preliminary Gamma Survey Results for Yerington Mine Site Tailings and Evaporation Ponds Surface Characterization Work Plan	SRK for NDEP
RAD-DOC-03c	October 4, 2004 Request for Review and Formal Opinion Regarding "Yerington Mine Site Fugitive Dust Radiological Dose Assessment", dated September 19, 2004 by Foxfire Scientific, Inc.	Jim Sickles, EPA
RAD-DOC-04a	BLM Yerington Mine Health and Safety Plan, Appendix E: Data Currently Available From Site Sampling Events June/July 2004	BLM CCFO
RAD-DOC-04b	June 2004 BLM Radiological Survey of Process Areas at the Yerington Mine Site, Preliminary Data Evaluation	Walker & Assoc. for BLM
RAD-DOC-05	Review of Yerington Mine Characterization Activities	Technical Resource Group for BLM
RAD-DOC-06	EPA Radiation and Indoor Environments National Laboratory Scanner Van Survey of the Yerington Mine Site and Surrounding Areas	EPA
RAD-DOC-07	Final Radiological Monitoring Report, October 2004 to April 2005, Yerington Mine Site Investigation Operations	RMEC for ARC
RAD-DOC-08a	Data Summary Report for Process Areas Groundwater Conditions	Brown and Caldwell for ARC
RAD-DOC-08b	Data Summary Report for Process Areas Soil Investigation	Brown and Caldwell for ARC
RAD-DOC-08c	Split Sample Results, Yerington Process Area Investigation	TetraTech for EPA
RAD-DOC-09a	Yerington Mine Site 2 <sup>nd</sup> Quarter 2005 Air Quality Monitoring Report	Brown and Caldwell for ARC
RAD-DOC-09b	Addenda to First and Second Quarter 2005 Air Quality Monitoring Reports	Brown and Caldwell for ARC
RAD-DOC-10	On-site Monitor Wells and Off-site Domestic Well Water Quality Quarterly Results	AHI for ARC

Documents that refer to multiple data sets as part of a single investigation event have been assigned the same document number followed by a letter (e.g. RAD-DOC-03a, RAD-DOC-03b). The completed documents referenced in this RDC are provided electronically on compact disk in the Appendices section and relevant maps associated with each document are included as hardcopy. For documents with significant amounts of non-radiological data, only the radiological data have been included in the appendices. The investigations are generally described in chronological order in this section.

## 2.1 Summary of Recent Existing Documents and Data

As of December 2005, ten recent investigations relating to radiological occurrences at the Yerington Mine Site and surrounding areas have been conducted. A description of each of the documents presented is provided below.

*RAD-DOC-01: December 17, 2003 Site Visit Summary and Phased Approach to Evaluating Technically Enhanced Naturally Occurring Radionuclides (TENORM) at the Anaconda Copper Mine Site, Yerington, Nevada*

Source: Jim Sickles, EPA

Date: January 16, 2004

Brief Description: Letter from Jim Sickles (EPA) to Art Gravenstein (NDEP) regarding the results of the December 17 site visit by EPA.

Areas Covered: Unlined evaporation ponds ( 1 and 1A)

Media: General Rad activity (surface soil)

Investigation Method/Equipment Used: Gamma ray survey using (1) a Ludlum 2221 scalar/ratemeter with unshielded 3" x 3" sodium iodide detector for gamma ray counting in counts per minute (cpm); and (2) an Exploranium GR-130 Gamma Spectrum Analyzer for radionuclide identification.

Data: 27 locations with activity readings in cpm. Some information on radionuclides and isotopes detected. Locations are given as verbal description and map location (no coordinates).

Data/Document Format: This document is a 5 page letter-report with an additional 5 page investigation summary report attached including location maps and data table.

Summary: This letter provides (1) a summary of the EPA's Semi-Quantitative Gamma Ray Walkover Survey of Unlined Evaporation Ponds 1 and 1A which was conducted as part of the December 17, 2003 site visit, (2) EPA's recommendations regarding a phased approach to evaluating TENORM at the Site, and (3) EPA's recommendations for an Ambient Levels Work Plan.

Conclusions made by the gamma ray walkover survey indicate that radiation anomalies exist on the surface of Unlined Evaporation Ponds 1 and 1A, and that distribution of the anomalies in the surface sediments are not homogeneous and are concentrated more in the low lying areas, indicating potential transport by wind or water. The anomalous areas exhibit values up to 2X background on gross gamma counts and up to 3X background for radium.

EPA's recommendations for a phased approach include completing and initial Screening Level Radiation Assessment over the areas most suspected of potential radiation contamination including the Finger Evaporation Ponds and the Calcine Ditch. This should be followed by a Site-wide Comprehensive Radiation Investigation to evaluate tailings and waste rock areas, groundwater sampling, surface water sampling, and evaluation of areas where mine rock may have been used off-site for construction purposes.

The recommendation to prepare an Ambient Levels work Plan includes determining the background concentrations of metals and radionuclides for the Yerington area.

*RAD-DOC-02: Yerington Mine Site Worker Radiological Dose Assessment*

Source: Foxfire Scientific for NDEP

Date: February 26, 2004

Brief Description: The purpose of this report is to evaluate the exposure of SRK's site workers to potential radiological hazards caused by evaporation sprayers and wind blown dust.

Areas Covered:

1. Active heap leach ponds (Slot Pond, Phase I Pond, Phase II Pond, Mega Pond, Evaporation Basin 1A, VLT Pond)
2. VLT Heap Leach Pad (Enhanced Evaporative Area)

Media:

1. General Rad activity (surface).
2. Process solutions and solids.
3. Air (fugitive dust and mist).

Investigation Method/Equipment Used: (1) Gamma survey using hand held detector, readings in  $\mu\text{R/hr}$ . (2) Laboratory analysis of samples. (3) Modeling of airborne concentrations for employee exposure calculations.

Data:

1. 194 gamma readings ( $\mu\text{R/hr}$ ) taken around active ponds and evaporation area.
2. 6 composite analyses of precipitated salts from pond water evaporation and/or soil (analyzed for gross alpha, gross gamma, and gamma spec).
3. 1 grab sample of VLT pond water (U, Ra-226/228, gross alpha)

Data/Document Format: This document is a 25 page final report. Appendices include several sample location maps showing gamma readings at each location and original laboratory analytical reports for the 7 samples collected.

Summary:

This report addresses the potential exposure of on-site workers to airborne radiation or Rad metals through inhalation of suspended or "misted" droplets produced by the evaporative sprayers used to enhance evaporation of leach pad process solutions. An analysis of potential exposure is made based on laboratory results of process water and precipitated salts found in the active ponds on site.

The conclusions made be the report are that on-site workers are not receiving any significant radiation dose as a result of the evaporation sprayers. The calculated dose received by mine site workers is well below the acceptable dose for the general public (100 mrem/year) and inhalation exposure to uranium toxicity is well below the OSHA PEL of  $0.05 \text{ mg/m}^3$  for soluble uranium.

*RAD-DOC-03a: Yerington Mine Site Fugitive Dust Radiological Dose Assessment*

Source: Foxfire Scientific for NDEP

Date: September 19, 2004

Brief Description: Final report and evaluation based on SRK's data collected in June 2004 for the *Tailings and Evaporation Ponds Surface Characterization Work Plan*

Areas Covered:

1. Unlined Finger Evaporation Ponds
2. Unlined Evaporation Ponds (1 and 1A)
3. Lined Evaporation Ponds
4. Sulfide Tailings / Process Solution Recycling Ponds

Media:

1. General Rad activity (surface)
2. Soil (surface) – Evaporation Pond process waste solids
3. Air – fugitive dust exposure based on calculated model

Investigation Method/Equipment Used: (1) Gamma survey completed using a Ludlum Model 19 gamma radiation scintillation instrument held at 1 meter above land surface, readings recorded in  $\mu\text{R/hr}$ . (2) Laboratory analysis of process waste/soil samples from composite and individual grab samples. (3) Modeling of exposure levels to windblown dust at fence line.

Data:

1. approximately 1,375 gamma activity readings ( $\mu\text{R/hr}$ )
2. 26 composite soil samples and 33 individual grab sample analytical results. Samples were analyzed for particle size, moisture content, total metals, gross gamma, and uranium-234,-235,-238 and thorium-228,-230,-232 isotopes.

Data/Document Format: This document is a 22 page final report. Appendices include five sample location maps showing gamma readings at each location and original laboratory analytical reports for the 59 soil samples collected.

Summary:

The purpose of this report is to evaluate the data collected by SRK from the evaporation ponds and tailings areas and apply it to determining a potential radiological dose exposure to individuals on or off the site from fugitive (windblown) dust. This is done by finding the average concentration of all constituents that were analyzed from all samples collected to determine a representative value for soils that may leave the site through wind transport.

Dispersion of this dust off the site is calculated based on particle size, wind speed and direction. An individual's radiological dose is then calculated based on quantity of dust inhaled or ingested (based on standard assumptions of age and breathing rate) and the dose received from this material based on the isotopes found in the representative soil samples.

The conclusion made in this report is that the calculated doses received by individuals exposed to fugitive dusts from the evaporation ponds and tailings areas of the mine site are miniscule and well below the limit of 100 mrem per year allowed for public exposure to regulated radiation hazards. The calculated exposure, for an adult standing at the northeast edge of the study area for an entire year, is 0.0015 mrem.

*RAD-DOC-03b: Preliminary Gamma Survey Results for Yerington Mine Site Tailings and Evaporation Ponds Surface Characterization Work Plan*

Source: SRK for NDEP

Date: July 8, 2004

Brief Description: Maps showing gamma survey results, no text or discussion of results

Areas Covered: Same as RAD-DOC-03a

Media: General Rad activity (surface)

Investigation Method/Equipment Used: Gamma survey completed using a Ludlum Model 19 gamma radiation scintillation instrument held at 1 meter above land surface, readings recorded in micro-roentgens per hour ( $\mu\text{R/hr}$ ).

Data: approximately 1,375 gamma readings ( $\mu\text{R/hr}$ ). Data also presented in RAD-DOC-03a.

Data/Document Format: 5 maps showing locations and radiation activity values.

Summary: This is the same data that is presented in the Foxfire "Fugitive Dust Radiological Dose Assessment Report" and was circulated prior to the issuance of the final report. Detailed maps show the results of gamma surveys for the defined study areas, results are provided in  $\mu\text{R/hr}$ . A total of 6 transect lines were completed in the Unlined Evaporation Ponds, 5 transect lines in the Lined Evaporation Ponds, 5 transect lines in the Finger Evaporation Ponds, and 14 transect lines in the Sulfide Tailings Area. No summary of results or conclusions are included with this data.

*RAD-DOC-03c: October 4, 2004 Request for Review and Formal Opinion Regarding "Yerington Mine Site Fugitive Dust Radiological Dose Assessment", dated September 19, 2004 by Foxfire Scientific, Inc.*

Source: Jim Sickles, EPA

Date: July 11, 2005

Brief Description: Letter from Jim Sickles (EPA) to Robert Kelso (BLM) summarizing issues with the Foxfire Radiological Dose Assessment Report.

Areas Covered: Same as RAD-DOC-03a

Media: Same as RAD-DOC-03a

Investigation Method/Equipment Used: No field investigations completed

Data: None

Data/Document Format: 3 page letter-report.

Summary:

A request was made by BLM's State Director for Nevada, Robert Abbey, to the EPA Region 9 Administrator, Wayne Nastri, for the EPA to review and provide an opinion on the accuracy of the data and conclusions made by Foxfire Scientific in the referenced report. Concerns noted in the EPA response relate to (1) the representativeness of the data (or lack thereof) used in the modeling of off-site transport of dust; (2) the narrow focus and exclusion of other potential contaminants of concern; and (3) the lack of actual air monitoring data to assess the results of the modeling.

The EPA agrees that the data provided in the report is useful but does not agree with the broad conclusions of the report. The radiological data collected to date (both SRK's and BLM's) are not complete enough to be used for generating estimates of site-wide or off-site risk but are useful only for describing contaminant concentration in the limited areas sampled.

RAD-DOC-04a: *BLM Yerington Mine Health and Safety Plan, Appendix E: Data Currently Available From Site Sampling Events June/July 2004*

Source: BLM Carson City Field Office (CCFO)

Date: August 2004

Brief Description: Summary data tables and contour diagrams of soil sample results and Geiger counter readings taken by Walker and Assoc. included as an appendix of the BLM Health and Safety Plan (HASP).

Areas Covered:

1. Process Area
2. Unlined Evaporation Ponds
3. Finger Ponds
4. Sulfide Tailings

Media:

1. General Rad activity (surface)
2. Soil (surface)

Investigation Method/Equipment Used: (1) A handheld Geiger-Muller counter was used for a preliminary scan, readings were recorded in counts per minute (cpm) of total activity. (2) Laboratory analysis of soil samples.

Data:

1. 158 activity readings (cpm and mR/hr)
2. 119 laboratory soil results (gross alpha, gross beta, % solids)
3. 9 laboratory soil results (U, Th, Ra-226/228)

Data/Document Format: The 15 page appendix includes an analytical summary data table, sample location map, 3 comparison graphs, and 4 contour diagrams.

Summary:

A site radiation survey was completed by Walker and Associates at the request of the BLM CCFO for the purpose of defining potential radiation hazards at the mine site that personnel working on the site may be exposed to during the course of their work. This data was included in the BLM's HASP as Appendix E.

This document includes a complete summary table of the data collected by Walker/BLM for 158 locations around the mine site and includes the following information: GPS coordinates, gross alpha, gross beta, % solids, Ra-226, Ra-228, Thorium, uranium, and activity (CPM and mR/hr). In addition to the data tables, four color contour diagrams were prepared as an interpretation of the investigation results, including: 1) Gross Alpha radiation (pCi/g), and 2) radiation dose measurements (mR/hr).

This survey identified an area adjacent to the iron launder tanks in the process area that had elevated radiation activity readings measured at 1.92 mR/hr. Several other areas were identified as having activity levels greater than 2x background.

RAD-DOC-04b: *June 2004 BLM Radiological Survey of Process Areas at the Yerington Mine Site, Preliminary Data Evaluation*

Source: Walker and Associates for BLM CCFO

Date: September 2004

Brief Description: This document is an informal summary of radiation activity and soil results presented as a BLM "Fact Sheet". Supporting documentation of the original laboratory analytical reports make up the bulk of the document.

Areas Covered:

1. Process Area
2. Unlined Evaporation Ponds
3. Finger Ponds
4. Sulfide Tailings

Media: Soil (surface)

Investigation Method/Equipment Used: Laboratory analysis of soil samples

Data: 27 soil samples (U, Th, Ra-226/228, gross alpha, gross beta)

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Data/Document Format: The document includes a 2 page BLM fact sheet, sample location map, and the original laboratory reports for 27 soil samples (151 pages).

Summary:

This document includes the raw laboratory data reports for the soil samples collected in the process area and other areas of the mine site, as summarized in RAD-DOC-04a. Nine preliminary samples were analyzed for total uranium (mg/kg), total thorium (mg/kg), radium-226 and radium-228 (pCi/g), and gross alpha and gross beta (pCi/g). Only 18 of the remaining 90 samples were analyzed for uranium isotopes (234, 235, 238), thorium isotopes (228, 230, 232), radium-226, radium-228, gross alpha, gross beta, and gross gamma. Generalized maps indicate the locations of the collected samples.

The BLM CCFO prepared a brief 2 page "Fact Sheet" to provide a summary and interpretation of the results, including the range and average values of isotopes found in the soil samples and a comparison of these results to the OSHA worker standard of 5 rem/year, the NRC standard for public exposure or 25 mrem/year, and the EPA industrial PRG soil cleanup standard of 5 pCi/g . Date and distribution of the fact sheet is not documented.

RAD-DOC-05: Review of Yerington Mine Characterization Activities

Source: Technical Resources Group (TRG) for BLM Nevada State Office

Date: December 9, 2004 (with February 18, 2005 Addendum)

Brief Description: Summary of a site visit conducted by TRG/BLM on December 9, 2004 including discussion of real-time gamma measurements taken during the visit and soil sample analytical results included in Addendum 1 (Feb 2005).

Areas Covered:

1. Process Areas
2. Slot Pond

Media:

1. General Rad activity (surface)
2. Soil (surface)

Investigation Method/Equipment Used: Preliminary area radiation survey measurements were performed using a Ludlum 2241-3 handheld survey instrument coupled with a 1" x 1" sodium iodide scintillation detector, which measures total gamma activity in  $\mu\text{R/hr}$ . Surface contamination surveys were performed using the same Ludlum 2241-3 instrument with a pancake Geiger-Muller (GM) detector attached (Model 44-9), measured in counts per minute (cpm). Laboratory analysis of grab soil samples for radionuclides (U, Th, Ra).

Data:

1. Sixteen Rad activity readings ( $\mu\text{R/hr}$ ) with GPS locations.
2. Three soil samples (analyzed for Isotopic Uranium (total, U-234, 235, 238), Isotopic Thorium (total, Th-228, 230, 232), and Isotopic Radium (Ra-226, 228)).

Data/Document Format: This 15 page report includes photos and tables showing sample locations and radiation activity readings. The 15 page addendum includes tables and discussion of soil analytical results and original laboratory reports for 3 samples.

Summary:

Radiation surveys completed at the Slot Pond indicated radiation levels equivalent to background (19-20  $\mu\text{R/hr}$ ) and consistent with previous studies (SRK/Foxfire). Radiation surveys completed in the Process Area confirmed previously identified areas of elevated activity located near the Iron Launderers (80-4,000  $\mu\text{R/hr}$ ) and solution tanks. The surveys did not identify any unacceptable external radiation hazards for personnel working in the area but did observe several areas where elevated concentrations of natural radiation occurred.

Based on the isotopic analysis done on the three soil samples collected, it appears that the chemical separation of copper in the Anaconda process may have resulted in enhanced concentrations of Ra-226 relative to uranium, resulting in a disequilibrium of daughter product (Ra-226) to the original nuclide (U-238). The majority of elevated radiation levels found in the Process Area may be attributed to Ra-226 and the short lived Rn-222. For future characterization activities, it may be possible to develop a correlation between a measurable radiation exposure rate and an expected concentration of Ra-226 in soil. Also, it is not clear what the fate of the uranium in the processed ore may have been, whether it was never chemically separated from the ore, and therefore discarded with the VLT material, or whether it was leached and continued in solution to the evaporation ponds.

*RAD-DOC-06: EPA Radiation and Indoor Environments National Laboratory Scanner Van Survey of the Yerington Mine Site and Surrounding Areas*

Source: EPA

Date: April 18-26, 2005

Brief Description: This is a discussion of the results from the scanner van survey including maps showing survey locations and activity results.

Areas Covered:

1. Yerington Mine Site (process area, evaporation ponds, sulfide tailings, Arimetco plant site, W-3 waste rock, Phase IV Slot heap leach)
2. MacArthur pit and haul road
3. Wabuska rail spur

4. Yerington Paiute Indian Reservation
5. Mesa, Sunset Hills, Penrose, Luzier, Valley View Estates residential areas
6. Weed Heights, NV
7. Yerington, NV
8. Mason Valley, NV
9. Schurtz, NV

Media: General Rad activity (surface)

Investigation Method/Equipment Used: The R&IE scanner van uses a sodium iodide scintillation detector that is shielded to limit the field of view to the right side of the van. Readings are recorded in counts per second (cps) as the van drives along a road taking readings.

Data: Gamma activity results (cps) presented in color coded map format (no data tables).

Data/Document Format: 5 page report summarizes data results. 16 maps show graphical representation of data.

Summary:

Baseline activity (background) for the area was determined to be 264 cps. The highest activity encountered by the scanner van was in the previously identified location in the Process Area near the Iron Launderers (2700 cps). Other areas on the mine site with elevated readings were found near the solution tanks in the process area, the finger evaporation ponds, and the waste rock pile along the main Weed Heights road. Only minor activity was found along the MacArthur haul road and in the MacArthur pit. No significant activity (> 2x background) was found in any of the residential neighborhoods or Paiute reservation that may have received mine waste material used for surface gravel.

The readings from the van measure only a limited distance from the van which is not recorded in the report.

*RAD-DOC-07: Final Radiological Monitoring Report, October 2004 to April 2005, Yerington Mine Site Investigation Operations*

Source: RMEC Environmental for ARC

Date: October 10, 2005

Brief Description: This document is a summary of health and safety radiological monitoring completed during Brown and Caldwell's and Applied Hydrology's (AHI's) field investigations in the Process Area and pumpback wells between October 2004 and April 2005.

Areas Covered:

1. Process Area
2. Pumpback Wells

Media:

1. General Rad activity (surface)
2. Air (fugitive dust)

Investigation Method/Equipment Used: (1) Area radiological surveys using GM detectors and gamma ( $\mu\text{R}$ ) detectors; (2) personal and area radiological dosimetry badges; (3) personal and area air/dust monitoring using an Eberline RAS-1 air sampler; and (4) vehicle/equipment surveys using a Ludlum 2224 Ratemeter with an alpha/beta probe attached.

Data:

1. 37 locations gamma activity ( $\mu\text{R/hr}$ ), taken by AHI at monitor wells and pumpback wells
2. 315 locations gamma activity ( $\mu\text{R/hr}$ ), taken by Brown and Caldwell at Process Area sample locations.
3. 154 locations gamma activity ( $\mu\text{R/hr}$  and/or  $\text{mrem/hr}$ ), taken by Bartlett radiation control technician (RCT)
4. 5 months of personal and area dosimetry results ( $\text{mrem}$ )
5. 10 vehicle swipe surveys (alpha  $\text{dpm}$  and beta  $\text{dpm}$ )
6. 33 air samples (activity: alpha and beta in  $\mu\text{Ci/cc}$ )
7. 17 air samples (lab assay: isotope concentration as  $\mu\text{Ci/ml}$ )

Data/Document Format: The 19 page final report summarizes data and findings, plus 9 attachments to the report include data tables, lab reports, and photos (about 150 pages).

Summary:

Area radiological surveys were completed by AHI and Brown and Caldwell at all locations of ongoing field activities to determine if any areas presented a radiological hazard to the personnel. All work areas that were monitored were below the established radiation control levels for the project and did not require additional safety precautions. A radiation control technician (RCT) was on-site for part of the work and conducted additional area surveys to identify locations that exceeded the established radiation control level of 0.2  $\text{mrem/hr}$ . The previously identified area by the iron launders was confirmed with a reading of 0.8  $\text{mrem/hr}$  at waist height and 4.7  $\text{mrem/hr}$  at ground level. Other areas identified by the Walker/BLM survey (RAD-DOC-04) were confirmed as elevated above background but not greater than the radiation control level.

Personal dosimetry badges were worn by all personnel doing fieldwork on the site and were analyzed monthly. During the 5 months of dosimetry monitoring, personnel exposure was minimal; generally below detection or less than 1  $\text{mrem}$  per month, far below the ALARA ("as low as reasonably achievable") goal of 500  $\text{mrem}$  per year and the OSHA

allowable exposure of 5000 mrem/year (5 Rem/yr). Dosimetry badges were also stationed in several of the areas identified as "elevated" and were left there for 24 hrs/day for approximately one month. These badges were used to determine a worst case exposure level for personnel working in the areas. Only the badge located near the iron launders exceeded the ALARA goal of 0.2 mrem/hr with a recorded exposure level of 0.22 mrem/hr.

Personal and area air monitoring was completed in areas near the established radiation control area, areas near where field work was being done, and to monitor the breathing zone of field personnel working in these areas. Samples were typically collected for 2 to 8 hours and the filters were counted for alpha/beta activity within 30 minutes of collection and then read again 24 hours later. The activity decreased significantly within 24 hours indicating that radon decay products were likely responsible for initial activity detected. Total activity after 24 hours was generally very low. Selected filters were sent to a laboratory for analysis of isotopic uranium, radium and thorium. All results were typically below detection with the exception of Radium-226 which was occasionally detectable but still very low.

Equipment surveys were conducted to determine if vehicles were becoming contaminated after contact with the soils in the project area and potentially tracking that soil off the site. This was evaluated by swiping a filter over the vehicle and measuring the activity of the material that was removed and collected on the filter. Direct readings were also taken by moving a hand-held survey probe over the inside and outside of the vehicle. All equipment surveys indicated that the removable and non-removable residual surface radiation on pieces of equipment used during the site investigation (i.e. backhoe, drill rig, personal vehicles) were well within accepted criteria for unrestricted release of the equipment.

The final conclusion is that all radiological surveys conducted during this investigation have shown that worker internal and external radiation exposures have been negligible and well below the ALARA goal of 500 mRem/year.

*RAD-DOC-08a: Data Summary Report for Process Area Groundwater Conditions*

Date: September 23, 2005

Source: Brown and Caldwell for ARC

Brief Description: This is the final report for investigations of groundwater conditions in the Process Area completed by Atlantic Richfield in 2004-2005.

Areas Covered: Process Areas

Media: Groundwater

Investigation Method/Equipment Used: Laboratory analysis of groundwater samples collected by sonic drilling and retrieved by bailer and/or submersible pump in undeveloped boreholes, samples collected at top of water table.

Data: 30 groundwater samples (including duplicates) analyzed for U, Th, Ra-226, and Ra-228 plus other inorganic and organic analytes required by the work plan.

Data/Document Format: 41 page final report plus figures and appendices (lithologic logs, data summary tables, original laboratory reports, and Level IV data validation).

Summary:

Investigations of the Process Area groundwater were completed in the period between November 2004 and April 2005 as required by the *Process Areas Work Plan*. All samples collected were analyzed for a suite of potential contaminants of concern which included the radionuclides U, Th, and Ra.

A total of 30 groundwater samples were collected (including duplicates) from 27 locations. Of those samples: 0 (0%) exceeded the MCL for Ra-226, 3 (10%) exceeded the MCL for Ra-228, and 15 (50%) exceeded the MCL for uranium. Thorium was analyzed but does not have an established MCL for drinking water.

*RAD-DOC-08a: Data Summary Report for Process Areas Soils Conditions*

Date: November 1, 2005

Author: Brown and Caldwell for ARC

Brief Description: Final report for soils investigations in the process area completed in 2004-2005.

Areas Covered: Process Areas

Media: Soil (surface and subsurface)

Investigation Method/Equipment Used: Laboratory analysis of soil samples collected by sonic drilling, backhoe, and surface grab samples.

Data: 550 soil samples (including duplicates) analyzed for: total uranium (mg/kg), thorium-232 (mg/kg), radium-226 (pCi/g) and radium-228 (pCi/g).

Data/Document Format: This document is a 76 page final report plus figures and appendices (data summary tables, original laboratory reports, Level IV data validation reports, and photos).