Final
Quality Assurance Project Plan

Remedial Investigation/Feasibility Study
Red Devil Mine, Alaska

June 2011

Prepared for:

United States Department of the Interior
Bureau of Land Management
Anchorage Field Office
4700 BLM Road
Anchorage, Alaska 99507

Prepared by:

Ecology and Environment, Inc.
720 3rd Avenue, Suite 1700
Seattle, Washington 98104

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List of Abbreviations and Acronyms

%R	percent recovery
ARARs	applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
BLM	U.S Department of the Interior Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chain-of-custody
COPCs	contaminants of potential concern
DQO	data quality objective
E & E	Ecology and Environment, Inc.
EDDs	electronic data deliverable
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
FSP	Field Sampling Plan
GIS	geographic information system
GPS	global positioning system
HSO	Health and Safety Officer
HAZWOPER	Hazardous Waste Operations and Emergency Response
HHRA	Human Health Risk Assessment
LCSs	laboratory control samples
LCSDs	laboratory control sample duplicates
MSs	matrix spikes
MSDs	matrix spike duplicates
NCP	National Contingency Plan
NIST	National Institute of Standards and Technology
OSC	On-Scene Coordinator
PARCCS	precision, accuracy, representativeness, completeness, comparability, and sensitivity
PM	Project Manager
PPE	personal protective equipment
PQLs	practical quantitation limits
PRGs	preliminary remediation goals
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RBCs	risk-based criteria
RDM	Red Devil Mine
RI	Remedial Investigation
ROD	Record of Decision
RPD	relative percent difference
RSL	risk screening level
SHASP	Site-Specific health and safety plan
SOPs	standard operating procedures
XRF	x-ray fluorscence

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1 Project Management and Objectives

The U.S. Department of the Interior Bureau of Land Management (BLM) and Ecology and Environment, Inc. (E & E) have entered into a contract for a Remedial Investigation (RI)/Feasibility Study (FS) of the Red Devil Mine (RDM) site in a remote region of Alaska, approximately 250 air miles west of Anchorage. The purpose of the RI/FS is to determine the nature and extent of contamination associated with former mining and milling operations and to develop and evaluate remedial alternatives to support a Record of Decision (ROD). BLM is the lead agency as determined by the National Contingency Plan (NCP) to implement response actions under the NCP process. The NCP defines "lead agency" as the agency that provides the On-Scene Coordinator (OSC)/ Project Manager (PM) to plan and implement response actions under the NCP (BLM 2001).

The first phase of the RI is project scoping, which results in development of four plans: the project Work Plan, a Community Involvement Plan, a Site-Specific Health and Safety Plan (SHASP), and a Field Sampling Plan (FSP). An element of the FSP, the Quality Assurance Project Plan (QAPP) provides policies, procedures, specifications, standards, and documentation sufficient to produce data of quality adequate to meet project objectives and to minimize loss of data due to out-of-control conditions or malfunctions.

This QAPP pertains to the environmental sampling and analysis program to be conducted by E & E at the RDM site. The purpose of this QAPP is to provide guidance so that all environmentally related data collection procedures, and measurements are scientifically sound and of known, acceptable, and documented quality and the sampling activities are conducted in accordance with the requirements of this project.

1.1 Project/Task Organization

The BLM's PM will oversee the project and will be the primary contact for all project activities. The project organization is shown in Figure 1-1. Contact information is provided in Table 1-1. Roles and responsibilities of individual team members are described in the sections that follow.

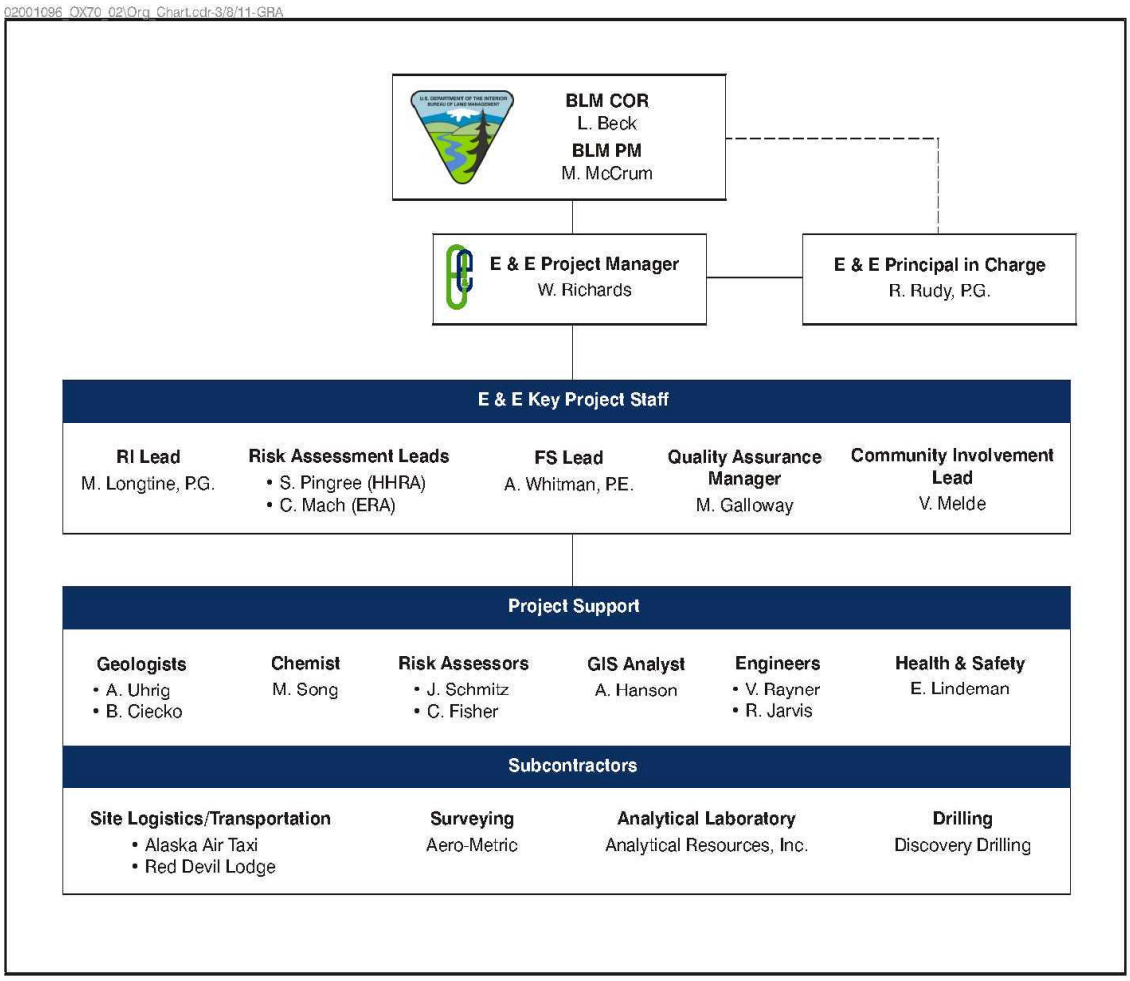

Figure 1 Project Organization

Table 1-1 Contact Information

Organization	Contact	Title	Telephone	Address
BLM	Mike McCrum	PM	(907) 271-4426	Anchorage Field Office 4700 BLM Road Anchorage, Alaska 99507
E & E	Bill Richards Marcia Galloway Mark Longtine Eric Lindeman	PM QA Manager RI Lead HSO	(206) 624-9537 ext. 3601 (716) 685-8080 (206) 794-9750 (206) 624-9537 ext. 4150	720 3rd Ave. Suite 1700 Seattle, Washington 98104
Analytical Resources, Inc. (contract laboratory)	Sue Dunnihoo	Director	(206) 695-6207	4611 S. 134th Place Tukwila, Washington 98168

1.1.1 BLM Project Manager

The BLM PM for the RDM RI/FS is Mr. Mike McCrum. He has overall responsibility for the project, including sampling activities at the site.

As the PM, Mr. McCrum is responsible for:

- Defining project objectives
- Establishing project policy and procedures to address the specific needs of the overall project and of each task
- Granting final approval of project plans and reports generated by E & E
- Assuring that plans are implemented according to schedule
- Committing the available resources necessary to meet project objectives and requirements
- Evaluating project staffing requirements and E & E resources as needed to ensure performance within budget and schedule constraints
- Informing E & E personnel about any special considerations
- Providing site access (if necessary)
- Reviewing work progress for each task to ensure budgets and schedules are met
- Reviewing and analyzing overall performance with respect to goals and objectives
- Implementing corrective actions resulting from staff observations, quality assurance/quality control (QA/QC) surveillance, and/or QA audits
- Reviewing and approving project-specific plans
- Directing the overall project QA program
- Maintaining QA oversight of the project
- Reviewing QA sections in project reports as applicable
- Reviewing QA/QC procedures applicable to this project
- Initiating, reviewing, and following up on response actions, as necessary
- Arranging performance audits of measurement activities, as necessary.

1.1.2 E & E Project Manager

E & E's PM is Mr. Bill Richards. Mr. Richards is responsible for the overall management and coordination of E & E's implementation of the RI/FS project, including collection of soil, sediment, water, and other samples from the RDM area. Mr. Richards will have overall responsibility for performing all appropriate procedures for sample collection. He will be assisted in this by the RI Lead. The E & E PM will be responsible for:

- Maintaining communications with BLM regarding the site work
- Assembling and supervising the project team
- Production and review of deliverables, including work plans and reports
- Tracking work progress against planned budgets and schedules
- Scheduling personnel and material resources
- Implementing all aspects of the RI/FS work plan and applicable guidance documents, including this QAPP, the monitoring plan, and other project documents
- Notifying the BLM of the fieldwork activities
- Gathering sampling equipment and field logbook(s)
- Maintaining communication with the analytical laboratory about the sampling schedule, delivery orders, and sample analysis
- Maintaining communication with the analytical laboratory about receipt of analytical results
- Ensuring that the quantity and location of all samples meet the requirements of appropriate work plans
- Identifying problems, resolving difficulties in consultation with QA staff, implementing and documenting corrective action procedures
- Maintaining proper chain-of-custody (COC) forms during sampling events
- Overall RI/FS implementation

1.1.3 E & E Quality Assurance Manager

Ms. Marcia Galloway will act as the E & E Quality Assurance Manager. As appropriate, she will:

- Assist the E & E PM in completing the data quality objective (DQO) selection process to assure project objectives are met
- Provide oversight on the review and approval by the project chemist of the use of laboratory data
- Direct the data validation activities and provide oversight for the preparation of data usability reports
- Identify the need for corrective actions and solutions to laboratory QC problems or nonconformance with QAPP criteria
- Provide appropriate direction and support to field sampling staff.

Ms. Galloway will also be responsible and accountable for selected project activities involving laboratory analyses, usability of analytical laboratory results, and data reports. As appropriate, she will be responsible for the following.

- Review and evaluate analytical data quality
- Perform or direct the performance of data validation activities and prepare data usability reports
- Identify the need for corrective actions and solutions for laboratory QC problems or nonconformance
- Inform the E & E PM of QA or QC deficiencies and work in cooperation to resolve program issues
- Help prepare QA/QC reports as requested by the E & E PM.

1.1.4 Remedial Investigation Lead

E & E's RI Lead is Mr. Mark Longtine. Mr. Longtine will be responsible for ensuring that all samples are collected and delivered to the analytical laboratory in accordance with the approved FSP and QAPP. He will report directly to the PM. As appropriate, he will be responsible for the following.

- Schedule and direct the activities of the various subcontractors at the site
- Assemble and supervise E & E field sampling teams
- Schedule personnel and material resources
- Track work progress against planned budgets and schedules
- Ensure, as directed by the project Health and Safety Officer (HSO), the SHASP is implemented and followed during sampling activities
- Implement all monitoring and field screening measurements called for in the FSP, QAPP, and SHASP
- Record all geologic observations, as directed by the FSP and QAPP
- Document all sample collection, sample handling, and sample delivery to the laboratory, as directed by the FSP and QAPP
- Review all boring logs, field instrumentation readings, and geologic observations in project reports.

1.1.5 Field Sampling Team

Field staff personnel are responsible for collecting samples under the direction of the RI Lead. This includes:

- Scheduling sampling activities and notifying the laboratory of sample delivery schedules
- Gathering the necessary sampling supplies, equipment, containers, preservatives, and forms
- Collecting samples in accordance with the FSP and applicable E & E standard operating procedures (SOPs)
- Ensuring that the quantity and location of all samples meet the requirements of appropriate work plans
- Measuring and recording required field screening data
- Documenting sampling activities such as completion of data collection forms, labeling of samples, and preparation of COC forms
- Maintaining proper COC forms during sampling events and delivery of the samples to the laboratory
- Reporting any problems encountered in the course of sampling to the RI Lead.

1.1.6 Project Health and Safety Officer

The project HSO will be Mr. Eric Lindeman. Mr. Lindeman will review the project SHASP, which is included in the RI/FS Work Plan, for the field crew to follow during all field activities. A site HSO will be responsible for ensuring that project personnel adhere to the site-specific SHASP during sampling activities. This officer will report to the PM. As appropriate, the project and site HSOs will:

- Evaluate safety plans and other submittals from subcontractors
- Provide project health and safety orientation and training for project staff and subcontractors
- Verify and maintain medical and safety training documentation
- Inspect work areas for hazards
- Evaluate appropriate personal protective equipment (PPE) and decontamination zone delineation
- Conduct safety monitoring, as needed
- Report and follow up on incident reports.

1.1.7 Contract Laboratories

Sampling activities for the RI/FS project will be implemented by E & E under contract to BLM. Previous sampling data and results are discussed in Section 3 of the Work Plan.

Analytical services for the RDM RI/FS will be provided by BLM-approved laboratories that have entered into a contract agreement with E & E. More than one contract laboratory may be responsible for analyzing samples for this project. Sediment, soil, and water samples will be taken during fieldwork and sent via COC protocol to professional laboratories that are licensed to perform the specific analysis requested.

The contracted laboratory will be responsible for laboratory and related QA/QC issues and keeping the analytical service uninterrupted. Additional responsibilities will include:

- Scheduling laboratory personnel and material resources
- Maintaining proper COC protocol and performing designated analytical services
- Preparing and delivering analytical reports to the E & E PM
- Identifying problems, resolving difficulties in consultation with QA staff, and implementing and documenting corrective action procedures
- Maintaining QA/QC for the laboratory.

1.2 Problem Definition/Background

Detailed descriptions of the RDM history, previous investigations, existing data quality, and identified data gaps are provided in the RI/FS Work Plan.

For the RI/FS, the RDM site has been organized into several historical source areas for investigation (see Figure 1-3 in the RI/FS Work Plan). Various conditions have been documented at these locations that will be addressed in the RI/FS. These conditions include the presence of mill tailings, calcines and mill processing chemicals, lined and unlined settling ponds and monofills, waste materials, demolished structures, open adits and mine shafts, and contaminants in sediment, water, and soil. Site contaminants generally include metals and other inorganic elements and petroleum hydrocarbons and related organic chemicals. Each area of investigation is described in greater detail in the RI/FS Work Plan.

1.3 Project Objectives and Related Sampling

The objectives of the RDM RI/FS project are to determine the nature and extent of contamination associated with former mining and milling operations, estimate potential risks to human health and ecological receptors, and evaluate remedial alternatives on a technical and cost basis. Human receptors in the RDM area include people who recreate on nearby BLM lands and potential future residents. The proposed investigation activities are designed to provide sufficient data to support risk management decisions and remedy selection related to the objectives.

The RDM sampling program is defined in the FSP (Appendix A of the RI/FS Work Plan). The approach involves collection of soil, sediment, surface water, and groundwater from the suspected sources and potential receptor areas. Detailed mapping of sample locations, site features, and designated source areas will allow for evaluations of the spatial distribution of contaminants. Both human health and ecological risk assessments will be performed using site data to evaluate risks associated with site contaminants.

1.4 Data Measurement Objectives

Together, the DQOs and data measurement objectives provide a means for control and review of the project so that environmentally related measurements and data collected by the field sampling teams are of known and acceptable quality. The DQO process and specific DQOs for the RI/FS are presented in Section 4 of the RI/FS Work Plan. This section describes only the data measurement objectives for the project.

Every reasonable attempt will be made to obtain an acceptable and high-quality set of usable field measurements and analytical data. If a measurement cannot be obtained or is unusable for any reason, the effect of the missing or invalid data will be evaluated. Precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS) are indicators of data quality. PARCCS goals are established to help assess data quality. The following paragraphs define PARCCS parameters associated with this project.

Precision

The precision of a measurement is an expression of mutual agreement among individual measurements of the same property taken under prescribed similar conditions. Precision is quantitative and most often expressed in terms of relative percent difference (RPD). Precision of the laboratory analysis will be assessed by comparing original and duplicate results. The RPD will be calculated for each pair of duplicate analyses using the following equation.

$$RPD = |S - D| \times 100 / ([S + D] / 2)$$

Where:
S = first sample value (original value)
D = second sample value (duplicate value)

Precision of reported results is a function of inherent field-related variability plus laboratory analytical variability, depending on the type of QC sample. Various measures of precision exist, depending upon "prescribed similar condition." Field duplicate samples will be collected to provide a measure of the contribution of field-related sources to overall variability. Acceptable RPD limits for field duplicate measurements will be less than or equal to 20% for aqueous matrices and less than or equal to 50% for other matrices. Contribution of laboratory-related sources to overall variability is measured through various laboratory QC samples. Acceptable RPD limits for laboratory measurements are specified in the source methods. Precision limits for the analyses to be run for the RI/FS are included in Table 1-2.

Accuracy

Accuracy is the degree of agreement of a measurement with an accepted reference or true value and is a measure of the bias in a system. Accuracy is quantitative and usually expressed as the percent recovery (%R) of a sample result. The %R is calculated as follows.

$$\%R = (SSR - SR / SA) \times 100$$

Where:
SSR = spiked sample result
SR = sample result
SA = spike added

Ideally, it is desirable for the reported concentration to equal the actual concentration present in the sample. Analytical data will be evaluated for accuracy. Matrix spikes (MSs) and/or laboratory control samples/laboratory control sample duplicates (LCSs/LCSDs) will be used, whichever is applicable. Accuracy criteria are as follows (EPA 1990):

Inorganic MSs = 75% -125% recovery
Organic MSs = 60% -140% recovery
LCS/LCSDs = 80% -120% recovery

Accuracy limits for the analyses to be run for RI/FS are included in Table 1-2.

Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the following:

- The characteristic being measured
- Parameter variations at a sampling point
- An environmental condition.

Representativeness is a qualitative and quantitative parameter that is most concerned with the proper design of the sample plan and the absence of cross-contamination of samples. Acceptable representativeness will be achieved through:

1. Careful, informed selection of sampling locations;
2. Selection of testing parameters and methods that adequately define and characterize the extent of possible contamination and meet the required parameter reporting limits;
3. Proper gathering and handling of samples to avoid interferences and prevent contamination and loss; and
4. Use of uncontaminated sample containers as the sample collection tool, eliminating the need for decontamination of sampling equipment and possible cross-contamination of samples.

Representativeness is a consideration that will be employed during all sample location and collection efforts. The representativeness will be assessed qualitatively by reviewing the procedures and design of the sampling event and quantitatively by reviewing the laboratory blank samples. If an analyte is detected in a field or laboratory blank, any associated positive result less than five times the detected concentration of the blank may be considered undetected.

Completeness

Completeness is a measure of the amount of usable data obtained from a measurement system compared with the amount that was expected to be obtained under correct normal conditions. Usability will be determined by evaluation of the PARCCs parameters, excluding completeness. Those data that are reviewed and need no qualification or are qualified as estimated or undetected are considered usable. Rejected data are not considered usable. Completeness will be calculated following data evaluation. Completeness is calculated using the following equation:

$$\% \text{ Completeness} = (DO/DP) \times 100$$

Where:
DO = data obtained and usable
DP = data planned to be obtained

A completeness goal of 90% is projected for the data set collected for this investigation. This goal will be assessed for the project as a whole as well as for individual parameters and study areas within the RDM site. If the completeness goal is not met, additional sampling may be necessary to adequately achieve project objectives.

Comparability

Comparability is a qualitative parameter. Consistency in the acquisition, handling, and analysis of samples is necessary for comparison of results. Data developed under this investigation will be collected and analyzed using standard U.S. Environmental Protection Agency (EPA) analytical methods and QC procedures to ensure comparability of results with other analyses performed in a similar manner. Data resulting from this field investigation may subsequently be compared with other data sets.

Comparability of the data collected at the RDM site will be achieved by following, to the extent possible, the same standard operating procedures for sample collection and analysis.

Sensitivity

Sensitivity is the achievement of method detection limits and depends on instrument sensitivity and sample matrix effects. Therefore, it is important to monitor the sensitivity of data-gathering instruments to ensure that data quality is met through constant instrument performance. Adequate sensitivity will be assured by selection of methods with method detection limits and practical quantitation limits (PQLs) that are at or below the potential applicable or relevant and appropriate requirements (ARARs) identified for this project. These ARARs are outlined in detail in Section 6 of the Work Plan. Required detection limits are presented in Table 1-2 at the end of this chapter.

Analytical methods for chemical analysis of solid waste, water, and other wastes will follow EPA-defined testing methods and protocols (EPA 1980, 1983). The specific EPA analytical methods for chemical analyses that have been selected for this project are also given in Table 1-2.

1.5 Special Training and Certifications

E & E will ensure that qualified, experienced, and trained staff perform or oversee all data collection and sampling tasks conducted under E & E's direction. The field staff, including subcontractors that perform work on the site, will have completed training that meets the requirements of 29 Code of Federal Regulations (CFR) 1910.120 (Hazardous Waste Operations and Emergency Response [HAZWOPER]) including up-to-date annual refresher training. Documentation and skills certification will be completed as described in 29 CFR 1910.120 and will be available for inspection upon request. Additional information is provided in the Site-Specific Health and Safety Plan (see Appendix D of the RI/FS Work Plan).

1.6 Documents and Records

This section summarizes the documents and records to be generated for the RDM RI/FS project.

1.6.1 Planning Documents

The following planning documents have been prepared or are anticipated for this project:

- FSP (Appendix A of the RI/FS Work Plan) – Defines sampling and data collection methods that will be used for the project. Includes sampling objectives, sample locations and frequency, sampling equipment and procedures, and sample handling and analysis. Documents procedures that will be used to ensure that sample collection activities are conducted in accordance with technically acceptable protocols and that data collected in the field meet the DQOs established during scoping.
- Risk Assessment Work Plan (Appendix B of the RI/FS Work Plan) – Defines the procedures and major assumptions that will be used in the human health and ecological risk assessment, including contaminants of potential concern (COPCs), exposure pathways and media, and receptors to be assessed for risk.
- QAPP – This QAPP has been prepared to describe the project objectives and organization, functional activities, and QA/QC protocols that will be used to achieve the desired DQOs.
- Site-Specific Health and Safety Plan (SHASP) (Appendix D of the RI/FS Work Plan) – The HSP specifies employee training, protective equipment, medical surveillance requirements, SOPs, and a contingency plan in accordance with 40 CFR 300.150 of the NCP and 29 CFR 1910.120 1(1) and (1)(2).

1.6.2 Reports

The reports that will be developed to document the results and identify potential future actions are described below.

Data collected during the RI will be reduced and tabulated for analysis. The data will be validated with respect to requirements outlined in the site-specific FSP and this QAPP. All usable data will be analyzed and mapped and compared with soil risk-based criteria (RBCs), and other potential preliminary remediation goals (PRGs) to determine whether the project objectives have been met. Any data gaps will be identified and discussed with the BLM PM. Any recommendations for additional work will be discussed during a meeting with the PM. If the RI requirements have been met, an RI report will be prepared.

Remedial Investigation Report: The RI will describe the site characteristics, such as media contaminated, extent of contamination, and physical boundaries of the contamination. The RI will also identify COPCs confirmed during the RI fieldwork based on persistence and mobility in the environment and the degree of hazard. The federal guide Risk Management Criteria for Metals at BLM Mining

Sites (BLM 2004) and the state-level guidance in 18AAC75.340 and Risk Assessment Procedures Manual (ADEC 2000) will be used to help risk managers develop screening criteria and levels for human health and ecological risk values. Existing standards and guidelines such as EPA's human health risk screening levels (RSL) and other criteria accepted by the BLM as appropriate will also be used to evaluate effects on human and ecological receptors. Any treatability data that may be necessary to support the FS will be discussed. The results and conclusions will be presented using maps, tables, and figures in a manner that will allow both technical and non-technical readers to understand the site conditions. Laboratory Data Review Checklists (ADEC 2010) will be completed for each analytical package and included with the report. The RI and risk assessment reports will be submitted under one cover. Draft reports as well as final versions that address comments from ADEC and EPA will be prepared.

Feasibility Study Report: Using the results presented in the RI, potential remedial alternatives will be evaluated. The evaluation will encompass, as appropriate, a range of alternatives in which treatment is used to reduce the toxicity, mobility, or volume of wastes. However, the alternatives will vary in the degree to which long-term management of residuals or untreated waste would be required and will include one or more alternatives involving containment with little or no treatment and a no action alternative. Alternatives that involve minimal efforts to reduce potential exposures (e.g., site fencing, deed restrictions) will be presented as "limited action" alternatives. In total, a screening-level analysis that identifies up to seven alternatives and one no further action alternative will be presented. These alternatives will be chosen on the basis of effectiveness, implementability, and cost.

A detailed evaluation of the retained alternatives will be performed according to all nine Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) criteria. The evaluation will include (1) a technical description of each alternative that outlines the waste management strategy involved and identifies the key ARARs associated with each alternative and (2) a discussion that profiles the performance of each alternative with respect to each of the evaluation criteria. Once the individual analyses are complete, the alternatives will be compared with one another with respect to each of the evaluation criteria. The results of the alternatives evaluation will be presented in a draft FS report. After incorporating BLM comments, a Final Feasibility Study Report will be produced.

Laboratory Reports: Each laboratory will submit its standard analytical data reports to the E & E PM. The analytical laboratory deliverables will include the following.

- Case narrative (including any problems encountered, protocol modifications, and/or corrective actions taken)
- Sample analytical and QA/QC results with units
- All protocols used during analyses

- Any protocol deviations from the approved sampling plan
- Surrogate recovery results
- Matrix spike/matrix spike duplicate (MS/MSD) results
- Laboratory duplicate/triplicate results
- Blank results
- Sample custody records (including original COC forms)

Field Records: A record of samples, analyses, and field events will be kept in a field logbook. A complete record of all field activities will be maintained. Field documentation will include permanently bound field logbooks, field forms, digital photographs, COC documents, and sample identification labels.

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Table 1-2 Analytes, Analytical Methods, Method Detection Limits, Screening Limits, and Risk Assessment Criteria

Matrix	Soil/Sediment
Analytical Group	Metals

	Analyte	Analytical Method	Analytical Method Reporting Limits (RLs)	Achievable Laboratory Method Detection Limits (MDLs)	Human Health SL	Eco SL (soil)	Eco SL (Sediment) [14]	Units
Total Metals	Mercury (low level)	EPA 7471A	0.05	0.0053	1400[1]	2[8]	.174	mg/kg
	Mercury	EPA 1631	0.15	0.05	NA	NA	NA	ng/g (wet)
	Aluminum	EPA 6010B	5	2.44	77000[2]	NA	NA	mg/kg
	Antimony (low level)	EPA 6020A(mass=121)	0.2	0.008	3[3]	0.27[9]	NA	mg/kg
		EPA 6020A (mass=123)	0.2	0.007	3[3]	0.27[9]	NA	mg/kg
	Antimony	EPA 6010B	5	0.41	NA	NA	NA	
	Arsenic (low level)	EPA 6020A	0.2	0.038	0.39[1]	18[10]	5.9	mg/kg
	Arsenic	EPA 6010B	5	0.31	NA	NA	NA	
	Barium	EPA 6020A (mass=135)	0.5	0.021	1100[2]	330[11]	NA	mg/kg
		EPA 6020A (mass=137)	0.5	0.028	1100[2]	330[11]	NA	mg/kg
	Beryllium	EPA 6020A	0.2	0.022	20[4]	21[9]	NA	mg/kg
	Cadmium	EPA 6020A (mass=111)	0.2	0.011	3[3]	0.36[9]	.596	mg/kg
		EPA 6020A (mass=114)	0.2	0.01	3[3]	0.36[9]	.596	mg/kg
	Calcium	EPA 6010B	50	0.83	NA	NA	NA	mg/kg
	Chromium	EPA 6020A (mass=52)	0.5	0.075	25[1]	75[15]	NA	mg/kg
		EPA 6020A (mass=53)	0.5	0.101	25[1]	75[15]	NA	mg/kg
	Cobalt	EPA 6020A	0.2	0.012	23[2]	13[10]	NA	mg/kg
	Copper	EPA 6020A (mass=63)	0.5	0.15	250[3]	28[12]	35.7	mg/kg
		EPA 6020A (mass=65)	0.5	0.127	250[3]	28[12]	35.7	mg/kg
	Iron	EPA 6010B	5	1.32	55000[2]	NA	NA	mg/kg
	Lead (low level)	EPA 6020A	1	0.298	40[4]	11[12]	35	mg/kg
	Lead	EPA 6010B	0.18	2	NA	NA	NA	mg/kg
	Magnesium	EPA 6010B	5	0.63	NA	NA	NA	mg/kg
	Manganese	EPA 6020A	0.5	0.026	960[3]	220[10]	NA	mg/kg
	Nickel	EPA 6020A (mass=60)	0.5	0.119	86[1]	38[10]	18	mg/kg
		EPA 6020A (mass=62)	0.5	0.208	86[1]	38[10]	18	mg/kg
	Potassium	EPA 6010B	50	11.68	NA	NA	NA	mg/kg
	Selenium	EPA 6020A (mass=82)	0.5	0.102	3.4[1]	0.52[10]	NA	mg/kg
		EPA 6020A (mass=78)	2	0.365	3.4[1]	0.52[10]	NA	mg/kg
	Silver	EPA 6020A	0.2	0.009	11.2[1]	4.2[12]	NA	mg/kg
	Sodium	EPA 6010B	50	15.06	NA	NA	NA	mg/kg
	Thallium	EPA 6020A	0.2	0.005	0.81[4]	1[15]	NA	mg/kg
	Vanadium	EPA 6020A	0.2	0.027	71[4]	7.8[12]	NA	mg/kg
	Zinc	EPA 6020A (mass=66)	4	0.637	2000[3]	46[12]	123	mg/kg
		EPA 6020A (mass=67)	4	0.567	2000[3]	46[12]	123	mg/kg
		EPA 6020A (mass=68)	4	0.621	2000[3]	46[12]	123	mg/kg
Methyl Mercury	Methyl Mercury	EPA 1630, modified	0.025	0.008	7800[2]	NA	NA	ng/g (wet)
Mercury Selective Sequential Extraction	Mercury	BRL SOP #BR-0013; Hg 5-step SSE and (www.epa.gov/esd/pdf-ecb/542asd95.pdf)	0.50 for F0, F1, and F2; 5.0 for F3, F4, F5, and F6	0.20 for F0, F1, and F2; 2.0 for F3, F4, F5, and F6	NA	NA	NA	ng/g (wet)
Arsenic Species	Arsenic Species	EPA 1632, modified As (inorganic)	0.1	0.03	0.39[2]	NA	NA	µg/kg
		EPA 1632, modified As (III)	0.1	0.03				
		EPA 1632, modified As (V)	0.1	0.03				

Table 1-2 Analytes, Analytical Methods, Method Detection Limits, Screening Limits, and Risk Assessment Criteria

Matrix	Soil/Sediment							
Analytical Group	Metals							
	Analyte	**Analytical Method**	**Analytical Method Reporting Limits (RLs)**	**Achievable Laboratory Method Detection Limits (MDLs)**	**Human Health SL**	**Eco SL (soil)**	**Eco SL (Sediment)**	**Units**
Synthetic Precipitation Leaching Procedure (SPLP) Metals	Aluminum	EPA 6010B	250	14.8	NA	NA	NA	ug/L
	Antimony	EPA 6010B	250	6.28	NA	NA	NA	ug/L
	Arsenic	EPA 6010B	250	7.21	NA	NA	NA	ug/L
	Barium	EPA 6010B	15	1.98	NA	NA	NA	ug/L
	Beryllium	EPA 6010B	5	0.24	NA	NA	NA	ug/L
	Cadmium	EPA 6010B	10	0.31	NA	NA	NA	ug/L
	Calcium	EPA 6010B	250	5.88	NA	NA	NA	ug/L
	Chromium	EPA 6010B	25	3.29	NA	NA	NA	ug/L
	Cobalt	EPA 6010B	15	0.51	NA	NA	NA	ug/L
	Copper	EPA 6010B	10	1.13	NA	NA	NA	ug/L
	Iron	EPA 6010B	250	7.15	NA	NA	NA	ug/L
	Lead	EPA 6010B	100	1.92	NA	NA	NA	ug/L
	Mercury	EPA 7470	0.1	0.0029	NA	NA	NA	ug/L
	Magnesium	EPA 6010B	250	10.81	NA	NA	NA	ug/L
	Manganese	EPA 6010B	5	0.85	NA	NA	NA	ug/L
	Nickel	EPA 6010B	50	5	NA	NA	NA	ug/L
	Potassium	EPA 6010B	2500	69.07	NA	NA	NA	ug/L
	Selenium	EPA 6010B	250	6.1	NA	NA	NA	ug/L
	Silver	EPA 6010B	15	0.55	NA	NA	NA	ug/L
	Sodium	EPA 6010B	2500	159.27	NA	NA	NA	ug/L
	Thallium	EPA 6010B	250	5.2	NA	NA	NA	ug/L
	Vanadium	EPA 6010B	15	0.61	NA	NA	NA	ug/L
	Zinc	EPA 6010B	50	3.94	NA	NA	NA	ug/L
Matrix	Soil/Sediment							
Analytical Group	Metals							
	Analyte	**Analytical Method**	**Analytical Method Reporting Limits (RLs)**	**Achievable Laboratory Method Detection Limits (MDLs)**	**Human Health SL**	**Eco SL (soil)**	**Eco SL (Sediment)**	**Units**
Toxicity Characteristic Leaching Procedure (TCLP) Metals	Arsenic	EPA 6010B	0.2	0.024	NA	NA	NA	mg/L
	Barium	EPA 6010B	0.02	0.0036	NA	NA	NA	mg/L
	Cadmium	EPA 6010B	0.01	0.00075	NA	NA	NA	mg/L
	Chromium	EPA 6010B	0.02	0.017	NA	NA	NA	mg/L
	Lead	EPA 6010B	0.1	0.0046	NA	NA	NA	mg/L
	Mercury	EPA 7470	0.0001	0.00004	NA	NA	NA	mg/L
	Selenium	EPA 6010B	0.2	0.024	NA	NA	NA	mg/L
	Silver	EPA 6010B	0.02	0.002	NA	NA	NA	mg/L

Table 1-2 Analytes, Analytical Methods, Method Detection Limits, Screening Limits, and Risk Assessment Criteria

Matrix	Groundwater/ Surface Water						
Analytical Group	Metals						
	Analyte	**Analytical Method**	**Analytical Method Reporting Limits (RLs)**	**Achievable Laboratory Method Detection Limits (MDLs)**	**Human Health SL**	**Eco SL[13]**	**Units**
Total and Dissolved Metals	Total Mercury (low level)	EPA 1631	0.4	0.15	100[5]	50	ng/L
	Aluminum	EPA 6010B	50	2.44	37000[6]	87	µg/L
	Antimony	EPA 6020A (mass=121)	0.2	0.003	0.2[5]	NA	µg/L
		EPA 6020A (mass=123)	0.2	0.01	0.2[5]	NA	µg/L
	Arsenic	EPA 6020A	0.2	0.02	0.045[6]	150	µg/L
	Barium	EPA 6020A (mass=135)	0.5	0.02	200[7]	NA	µg/L
		EPA 6020A (mass=137)	0.5	0.016	200[7]	NA	µg/L
	Beryllium	EPA 6020A	0.2	0.022	0.4[7]	NA	µg/L
	Cadmium	EPA 6020A (mass=111)	0.2	0.008	0.2[5]	0.25	µg/L
		EPA 6020A (mass=114)	0.2	0.004	0.2[5]	0.25	µg/L
	Calcium	EPA 6010B	50	11.612	NA	NA	µg/L
	Chromium	EPA 6020A (mass=52)	0.5	0.032	10[7]	74	µg/L
		EPA 6020A (mass=53)	0.5	0.086	10[7]	74	µg/L
	Cobalt	EPA 6020A	0.2	0.007	11[6]	NA	µg/L
	Copper	EPA 6020A (mass=63)	0.5	0.059	18[5]	9	µg/L
		EPA 6020A (mass=65)	0.5	0.065	18[5]	9	µg/L
	Iron	EPA 6010B	50	7.15	26000[6]	1000	µg/L
	Lead	EPA 6020A	1	0.127	1.5[7]	2.5	µg/L
	Magnesium	EPA 6010B	50	8.983	NA	NA	µg/L
	Manganese	EPA 6020A	0.5	0.265	2[5]	NA	µg/L
	Nickel	EPA 6020A (mass=60)	0.5	0.059	9[5]	52	µg/L
		EPA 6020A (mass=62)	0.5	0.15	9[5]	52	µg/L
	Potassium	EPA 6010B	500	5.081	NA	NA	µg/L
	Selenium	EPA 6020A (mass=82)	0.5	0.105	2[5]	5	µg/L
		EPA 6020A (mass=78)	2	0.814	2[5]	5	µg/L
	Silicon	EPA 6010B	0.06	0.00949	NA	NA	mg/L
	Silver	EPA 6020A	0.2	0.008	2[5]	3.2	µg/L
	Sodium	EPA 6010B	500	138.9	NA	NA	µg/L
	Thallium	EPA 6020A	0.2	0.003	0.2[7]	NA	µg/L
	Vanadium	EPA 6020A	0.2	0.022	26[7]	NA	µg/L
	Zinc	EPA 6020A (mass=66)	4	0.379	143[5]	118	µg/L
		EPA 6020A (mass=67)	4	0.429	143[5]	118	µg/L
		EPA 6020A (mass=68)	4	0.47	143[5]	118	µg/L
Methyl Mercury	Methyl Mercury	EPA 1630	0.05	0.02	3700[6]	NA	ng/L
Arsenic Speciation	Arsenic Species	EPA 1632, modified As (inorganic)	0.025	0.008	0.045[6]	NA	µg/L
		EPA 1632, modified As (III)	0.025	0.008	NA	NA	µg/L
		EPA 1632, modified As (V)	0.025	0.008	NA		µg/L

Table 1-2 Analytes, Analytical Methods, Method Detection Limits, Screening Limits, and Risk Assessment Criteria

Matrix	Soil/Sediment
Analytical Group	Petroleum

Analyte	Analytical Method	Analytical Method Reporting Limits (RLs)	Achievable Laboratory Method Detection Limits (MDLs)	Human Health SL	Eco SL (soil)	Eco SL (sediment)[14]	Units
Gasoline Range Organics	AK 101	5	2.95	NA	NA	NA	mg/kg
Diesel Range Organics	AK 102	5	0.64	250[1]	NA	200	mg/kg
Residual Range Organics	AK 103	10	0.665	10000[4]	NA	NA	mg/kg
Benzene	EPA 8021B	25	10.9	25[1]	NA	0.057	µg/kg
Toluene	EPA 8021B	25	10.6	6500[1]	200[16]	.89	µg/kg
Ethylbenzene	EPA 8021B	25	10	5400[2]	NA	4.8	µg/kg
m/p-Xylene	EPA 8021B	50	17.2	6300[4]	NA	0.025	µg/kg
o-Xylene	EPA 8021B	25	12.9	6300[4]	NA	.025	µg/kg

Matrix	Groundwater/ Surface Water
Analytical Group	Petroleum

Analyte	Analytical Method	Analytical Method Reporting Limits (RLs)	Achievable Laboratory Method Detection Limits (MDLs)	Human Health SL	Eco SL[13]	Units
Gasoline Range Organics	AK 101 (15.0 mL)	0.03	0.011	NA	NA	mg/L
	AK 101 (5.0 mL)	0.1	0.039	NA	NA	mg/L
Diesel Range Organics	AK 102	0.25	0.019	1.5[7]	NA	mg/L
Residual Range Organics	AK 103	0.5	0.03	1.1[7]	NA	mg/L
Benzene	EPA 8021B (15.0 mL)	0.08	0.019	0.41[6]	NA	µg/L
	EPA 8021B (5.0 mL)	0.25	0.139	0.41[6]	NA	µg/L
Toluene	EPA 8021B (15.0 mL)	0.08	0.016	100[7]	NA	µg/L
	EPA 8021B (5.0 mL)	0.25	0.077	100[7]	NA	µg/L
Ethylbenzene	EPA 8021B (15.0 mL)	0.08	0.019	1.5[6]	NA	µg/L
	EPA 8021B (5.0 mL)	0.25	0.149	1.5[6]	NA	µg/L
m/p-Xylene	EPA 8021B (15.0 mL)	0.16	0.036	200[6]	NA	µg/L
	EPA 8021B (5.0 mL)	0.5	0.109	200[6]	NA	µg/L
o-Xylene	EPA 8021B (15.0 mL)	0.08	0.013	200[6]	NA	µg/L
	EPA 8021B (5.0 mL)	0.25	0.143	200[6]	NA	µg/L

Matrix	Soil/Sediment
Analytical Group	Conventionals

Analyte	Analytical Method	Analytical Method Reporting Limits (RLs)	Achievable Laboratory Method Detection Limits (MDLs)	Units
Particle Size and Atterberg Limits	ASTM D2487	per method	per method	per method
Moisture Content	ASTM D2216	per method	per method	per method
Compaction (Proctor)	ASTM D1557	per method	per method	per method
Permeability	ASTM D2434	per method	per method	per method
Total Organic Carbon (TOC)	SW846 Method 9060 (modified)	per method	per method	%
Direct Shear	ASTM D3080	per method	per method	per method

Matrix	Groundwater/Surface Water
Analytical Group	Conventionals

Analyte	Analytical Method	Analytical Method Reporting Limits (RLs)	Achievable Laboratory Method Detection Limits (MDLs)	Units
Sulfate	EPA 300.0	0.1	0.059	mg/L
Chloride	EPA 300.0	0.1	0.019	mg/L
Fluoride	EPA 300.0	0.1	0.022	mg/L
Nitrate/Nitrite	EPA 353.2	0.01	0.005	mg/L
Carbonate, Bicarbonate	EPA 310.1	1	0.37	mg/L
Total Dissolved Solids (TDS)	EPA 160.1	5	NA	mg/L
Total Suspended Solids (TSS)	EPA 160.2	1	NA	mg/L

Matrix	Soil/Sediment
Analytical Group	SVOCs

Analyte	Analytical Method	Analytical Method Reporting Limits (RLs)	Achievable Laboratory Method Detection Limits (MDLs)	Units
SVOCs + TICs	EPA 8270D	per method	per method	ug/kg

Table 1-2 Analytes, Analytical Methods, Method Detection Limits, Screening Limits, and Risk Assessment Criteria

Matrix	Groundwater/Surface Water
Analytical Group	SVOCs

Analyte	Analytical Method	Analytical Method Reporting Limits (RLs)	Achievable Laboratory Method Detection Limits (MDLs)	Units
SVOCs + TICs	EPA 8270D	per method	per method	ug/L

Matrix	Tissue
Analytical Group	Metals

	Analyte	Analytical Method	Analytical Method Reporting Limits (RLs)	Achievable Laboratory Method Detection Limits (MDLs)	Eco SL Plant		Target Quantitation Limit for ERA Purposes (Eco SL Plant / 5)	Units	Precision and Accuracy
					Value	Basis			
	Mercury	EPA 7471A	0.02	0.002	0.37	NOAEL-based food	0.074	mg/kg	+ 35%
	Mercury (low level)	EPA 1631	1.0	0.3	370	NOAEL-based food	74	ng/g (wet)	+ 35%
	Aluminum	EPA 6010B	1	0.07	3.9	NOAEL-based food	0.780	mg/kg	+ 35%
	Antimony (low level)	EPA 6020A(mass=121)	0.05	0.02	0.25	NOAEL-based food	0.050	mg/kg	+ 35%
		EPA 6020A (mass=123)	0.05	0.02	0.25	NOAEL-based food	0.050	mg/kg	+ 35%
	Arsenic (low level)	EPA 6020A	0.5	0.04	0.25	NOAEL-based food benchmark for cottontail rabbit (herbivore) from Sample et al. (1996)	0.050	mg/kg	+ 35% 75% - 125%
	Barium	EPA 6020A (mass=135)	0.05	0.05	20	NOAEL-based food benchmark for cottontail rabbit (herbivore) from Sample et al. (1996)	4.000	mg/kg	+ 35% 75% - 125%
		EPA 6020A (mass=137)	0.05	0.05	20	NOAEL-based food benchmark for cottontail rabbit (herbivore) from Sample et al. (1996)	4.000	mg/kg	+ 35% 75% - 125%
	Beryllium	EPA 6020A	0.02	0.004	2.5	NOAEL-based food benchmark for cottontail rabbit (herbivore) from Sample et al. (1996)	0.500	mg/kg	+ 35% 75% - 125%
	Cadmium	EPA 6020A (mass=111)	0.02	0.005	3.6	NOAEL-based food benchmark for cottontail rabbit (herbivore) from Sample et al. (1996)	0.720	mg/kg	+ 35% 75% - 125%
		EPA 6020A (mass=114)	0.02	0.005	3.6	NOAEL-based food benchmark for cottontail rabbit (herbivore) from Sample et al. (1996)	0.720	mg/kg	+ 35% 75% - 125%
	Calcium	EPA 6010B	5	2	na	na	na	mg/kg	+ 35% 75% - 125%
	Chromium	EPA 6010B	0.2	0.08	0.83	NOAEL-based food benchmark for Amerian robin from Sample et al. (1996)	0.166	mg/kg	+ 35% 75% - 125%
	Cobalt	EPA 6020A	0.02	0.002	na	na	na	mg/kg	+ 35% 75% - 125%
	Copper	EPA 6020A (mass=63)	0.1	0.03	39	NOAEL-based food benchmark for Amerian robin from Sample et al. (1996)	7.800	mg/kg	+ 35% 75% - 125%
		EPA 6020A (mass=65)	0.1	0.03	39	NOAEL-based food benchmark for Amerian robin from Sample et al. (1996)	7.800	mg/kg	+ 35% 75% - 125%
Total Metals	Iron	EPA 6010B	2	0.4	na	na	na	mg/kg	+ 35% 75% - 125%
	Lead (low level)	EPA 6020A	0.02	0.005	0.94	NOAEL-based food benchmark for Amerian robin from Sample et al. (1996)	0.188	mg/kg	+ 35% 75% - 125%
	Magnesium	EPA 6010B	2	0.4	na	na	na	mg/kg	+ 35% 75% - 125%
	Manganese	EPA 6020A	0.5	0.03	327	NOAEL-based food benchmark for cottontail rabbit (herbivore) from Sample et al. (1996)	65.400	mg/kg	+ 35% 75% - 125%
	Nickel	EPA 6020A (mass=60)	0.2	0.02	148	NOAEL-based food benchmark for cottontail rabbit (herbivore) from Sample et al. (1996)	29.600	mg/kg	+ 35% 75% - 125%
		EPA 6020A (mass=62)	0.2	0.02	148	NOAEL-based food benchmark for cottontail rabbit (herbivore) from Sample et al. (1996)	29.600	mg/kg	+ 35% 75% - 125%
	Potassium	EPA 6010B	40	6	na	na	na	mg/kg	+ 35% 75% - 125%

Table 1-2 Analytes, Analytical Methods, Method Detection Limits, Screening Limits, and Risk Assessment Criteria

	Selenium	EPA 7742	0.1	0.05	0.33	NOAEL-based food benchmark for Amerian robin from Sample et al. (1996)	0.066	mg/kg	+ 35% 75% - 125%
	Silver	EPA 6020A	0.02	0.009	na	na	na	mg/kg	+ 35% 75% - 125%
	Sodium	EPA 6010B	20	4	na	na	na	mg/kg	+ 35% 75% - 125%
	Thallium	EPA 6020A	0.02	0.002	0.028	NOAEL-based food benchmark for cottontail rabbit (herbivore) from Sample et al. (1996)	0.006	mg/kg	+ 35% 75% - 125%
	Vanadium	EPA 6020A	0.2	0.02	0.725	NOAEL-based food benchmark for cottontail rabbit (herbivore) from Sample et al. (1996)	0.145	mg/kg	+ 35% 75% - 125%
	Zinc	EPA 6020A (mass=66)	0.5	0.08	12	NOAEL-based food benchmark for Amerian robin from Sample et al. (1996)	2.400	mg/kg	+ 35% 75% - 125%
		EPA 6020A (mass=67)	0.5	0.08	12	NOAEL-based food benchmark for Amerian robin from Sample et al. (1996)	2.400	mg/kg	+ 35% 75% - 125%
		EPA 6020A (mass=68)	0.5	0.08	12	NOAEL-based food benchmark for Amerian robin from Sample et al. (1996)	2.400	mg/kg	+ 35% 75% - 125%
Methyl Mercury	Methyl Mercury	EPA 1630, modified	10	4	5	NOAEL-based food benchmark for Amerian robin from Sample et al. (1996)	1.0	ug/kg	+ 35% 75% - 125%
Arsenic Species	Arsenic Species	EPA 1632, modified As (inorganic)	0.02	0.007	Not relevant for eco-risk assessment			mg/kg	+ 35% 75% - 125%
		EPA 1632, modified As (III)	0.04	0.02	Not relevant for eco-risk assessment				
		EPA 1632, modified As (V)	0.04	0.02	Not relevant for eco-risk assessment				

Key:
ERA = Ecological Risk Assessment
NOAEL = No Observed Avserse Effect Level
SL = Screening Level

Reference: Sample, B., D. Opresko, and G. Suter. 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision* . Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory. ES/ER/TM-86/R3.

2 Data Generation and Acquisition

2.1 Sampling Design

The sampling design for the RDM site is summarized in Section 7 of the RI/FS Work Plan and described in detail in the FSP (Appendix A of the RI/FS Work Plan).

2.2 Sampling Methods

Sampling methods are described in detail in the FSP, included as Appendix A of the RI/FS Work Plan.

2.3 Sample Handling and Custody

Sample handling and custody procedures are described in detail in the FSP, included as Appendix A of the RI/FS Work Plan.

2.4 Analytical Methods

Soil samples will be screened for field arsenic, mercury, antimony, and other metals with a portable, x-ray fluorescence (XRF). Methods for performing field screening are described in the FSP.

The laboratory analytical methods for soil, sediment, and water to be used for this project are summarized in Table 1-2 (located at the end of Chapter 1, above).

2.5 Quality Control

2.5.1 Field Quality Control

QC samples collected in the field will include field duplicates, rinseate blanks, and MS/MSDs. Each type of QA/QC sample is briefly described below.

Field Duplicates

A field duplicate sample is a second sample collected at the same time and location as the original sample. Field duplicate samples are collected simultaneously (an extra volume of one sample, which is then homogenized and split into equal aliquots) or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field such that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Duplicate sample results are used to

assess precision of the overall sample collection and analysis process. For soil, sediment, surface water, and groundwater, field duplicate samples will be collected at a minimum frequency of one field duplicate for every 10 regular samples for each matrix and sampling method and/or type of equipment used. A maximum RPD of 30% for waters and 50% for soil and sediment will be used for evaluation of field duplicate comparability. For vegetation samples, field duplicate samples will be collected at a rate of one field duplicate for every 20 regular samples by plant type.

Rinseate Blanks and Equipment Blanks

Rinseate blanks are used to assess the effectiveness of equipment decontamination procedures when non-dedicated sampling equipment is used. A rinseate blank is a sample of American Society for Testing and Materials (ASTM) Type II reagent grade water or equivalent (i.e., deionized), poured into or over the sampling device or pumped through it, collected in a sample container, and transported to the laboratory for analysis. Rinseate blanks will be collected immediately after the equipment has been decontaminated. The blank will be analyzed for all laboratory analyses requested for the environmental samples collected at the site. A minimum frequency of one rinseate blank per 20 field samples is required for each collection/decontamination method, by matrix and by sample type.

Equipment blanks are used to demonstrate that dedicated sampling equipment is adequately clean if a certificate is not available to demonstrate cleanliness. Equipment blanks will be analyzed for all laboratory analyses requested for the environmental samples collected at the site. One equipment blank sample for dedicated equipment will be collected at a rate of one for each set of dedicated equipment (i.e., bailers and sample tubing) of identical manufacturer's lot number.

Analyte concentrations in rinseate and equipment blanks must be below the applicable laboratory reporting limits. For common laboratory contaminants, the blank results may be up to five times the reporting limit.

Field Blanks

Field blanks are laboratory-provided, mercury-free water samples that are processed and treated as a regular sample in all respects, including contact with sampling devices, equipment, sampling site conditions, and analytical procedures. Field blanks are the best way to estimate how much mercury detected in a sample is from the site or can be attributed to contamination. Field blanks will be collected at a rate of one field blank for every 10 regular samples to be analyzed for low-level mercury.

Matrix Spikes/Matrix Spike Duplicates

MSs are used to assess the effect of the sample matrix on analyte recovery. An MS consists of an aliquot of a field sample to which the laboratory adds a known concentration of the analyte(s) of interest. An unspiked aliquot is also analyzed, and the %R for the spiked sample is calculated. Analysis of MSs requires

collection of a sufficient volume of sample to accommodate the number of aliquots to be analyzed. The sample(s) chosen for MSs should be representative of the sample matrix but should not contain excessive concentrations of analytes or interfering substances. MSs are analyzed at a frequency of one MS per 20 or fewer samples for each matrix and each sampling event. Control limits for MSs are provided in the source methods and in the laboratory quality assurance manuals.

2.5.2 Laboratory Quality Control

QC data are necessary to determine precision and accuracy and to demonstrate the absence of interferences and/or contamination of glassware and reagents. Each type of laboratory-based QC sample will be analyzed at a rate of 5% or one per batch (a batch is a group of up to 20 samples analyzed together), whichever is more frequent.

Method Blank

A method blank is a sample generated in the laboratory consisting of an analyte-free matrix (e.g., reagent water) that is taken through the entire sample preparation and analysis with the field samples. It is used to monitor for contamination that may be introduced into the samples during processing within the laboratory. Evaluation criteria are provided in the source methods and in the laboratory QA manuals.

Laboratory Duplicate

A laboratory duplicate consists of an aliquot of a field sample that is taken from the same container as the initial field sample and prepared and analyzed with the field samples. The laboratory duplicate is used to monitor the precision (in terms of RPD) of the analytical process. In conjunction with field duplicates, the sampling precision can then be inferred. Criteria for laboratory duplicates are provided in the source methods and in the laboratory QA manuals.

Laboratory Control Sample

An LCS consists of a laboratory-generated sample that contains the analytes of interest at known concentrations. It may be prepared by the laboratory or purchased from an outside source. The LCS is taken through the same preparation and analytical procedures as the field samples. Analyte recoveries indicate the accuracy of the analytical system. LCSs and MSs together allow the overall accuracy of the sampling and analytical process to be determined. Criteria for LCS evaluation are provided in the source methods and in the laboratory QA manuals.

Additional QC Samples

Certain analytical methods may require additional QC elements not described above. These may include surrogates, serial dilutions, and other elements. Specific requirements and evaluation criteria are provided in the source methods and laboratory QA manuals.

2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Field equipment will be maintained in accordance with manufacturers' instructions and the relevant field sampling SOPs.

All laboratory equipment will be maintained in accordance with the laboratory's SOPs.

2.7 Instrument/Equipment Calibration and Frequency

Field instruments will be calibrated immediately prior to use in accordance with manufacturers' instructions and the relevant field sampling SOPs. Calibrations will be verified periodically throughout each work day and at the end of the day. Records of field instrument calibrations will be kept in the field log books. Additional information is provided in the FSP.

Laboratory instruments will be calibrated in accordance with the source methods, laboratory SOPs, and laboratory QA manuals. In general, laboratory instrument calibration includes the following elements:

- Initial multi-point calibration to establish the working range of the instrument and response factors or calibration curve
- Verification of proper calibration using a standard from an independent source
- On-going calibration checks at a typical frequency of 10% throughout the analytical run and at the end of the run
- Depending on the analytical method, additional calibration elements may be required including tuning checks, interference check samples, and internal standards.

Records of initial calibration, continuing calibration and verification, repair, and replacement will be filed and maintained by the laboratory. Calibration records will also be included in data reporting packages.

2.8 Inspection/Acceptance of Supplies and Consumables

Prior to acceptance, all supplies and consumables will be inspected by the E & E sampling team or other contractors to ensure that they are in satisfactory condition and free of defects. Sample containers provided by the laboratory will be pre-cleaned to EPA specifications. Preservatives will be prepared from reagent-grade or higher chemicals. Calibration standards must be traceable to National Institute of Standards and Technology (NIST) or another recognized source.

2.9 Non-direct Measurements

Non-direct measurements and data that will be collected for this project include the following:

- Historical literature on mine operations and mine maps
- Sampling, analytical, and other data obtained from previous studies
- Global positioning system (GPS) survey of sample locations, mine features, and other relevant features on the site
- Survey data
- Monitoring well survey.

Where possible and appropriate, these data will be obtained from peer-reviewed literature or other reputable sources such as university libraries, state and federal agencies, and the U.S. Geological Survey. The PM and/or QA Manager will review all data for consistency and accuracy. A mining engineer or other qualified person will review mine literature and maps. Where necessary, information will be verified by ground truthing or consultation with independent sources.

Maps and associated geographic information system (GIS) data will be continually improved as new information is obtained. Geographic coordinates will be collected for all sample locations and included in the GIS project. All GPS data will be differentially corrected if needed. Data management discussed in Section 2.10 below provides details about recording site data and incorporating these data into the project database and GIS system.

2.10 Data Management

Daily field records constitute the primary documentation for field activities. Daily records are created using a combination of field logbooks and field data sheets. Field observations will be entered in field logbooks with enough detail to allow participants to accurately and objectively reconstruct events at a later time if necessary. Field logbooks will also document any deviations from the project scope, field protocols, or personal protection levels, as well as any changes in personnel. In all cases, deviations will be approved by the E & E PM and, where necessary, the BLM PM, prior to implementation in the field.

Logbooks will be bound with consecutively numbered pages; logbook pages cannot be removed, even if they are partially mutilated. Entries will be made in indelible ink using the time of day (24-hour clock) as entry headers. All logbooks will be returned to the project file at the end of the field tasks.

Each laboratory will provide the analytical results as electronic data deliverable (EDDs) and as paper reports. Following guidelines in the *Environmental Laboratory Data and Quality Assurance Requirements* (ADEC 2009) and following the Laboratory Data Review Checklist (ADEC 2010), all paper laboratory reports provided to E & E will be checked to verify they incorporate the following information:

- A report narrative discussing any out-of-control events, corrective actions, deviations from SOPs, and other observations pertaining to the analytical process
- A cross-reference of field sample IDs to laboratory sample IDs
- Dates of collection, receipt at laboratory, preparation, and analysis
- Data results for each sample with associated dilution factors and reporting limits
- Results for all laboratory QC samples (LCS, MS, MSD, duplicates), including acceptance limits
- Surrogate recoveries and acceptance limits for each sample
- A copy of the sample log-in checklist documenting sample condition, cooler temperatures, and so forth
- A copy of the completed COC form signed by the laboratory
- The raw data package, including initial and continuing calibration data, instrument performance checks, instrument run logs, and sample and blank data.

Each laboratory will maintain all original records relating to the analysis of the samples. These records will be maintained in such a way as to allow for complete reconstruction of the reported results by an independent party. These records will be available to E & E and/or the BLM upon request. The laboratory data reports will be maintained in the Master Records files at E & E.

3 Assessment and Oversight

Assessments and oversight reports are necessary to ensure that procedures are followed as required and that deviations from procedures are documented. These reports also address activities for assessing the effectiveness of the implementation of the project and associated QA and QC activities. These reports also keep management and the client current on field activities.

3.1 Assessments and Response Actions

3.1.1 Assessments

The E & E PM is responsible for overall quality and performance on this project; responsibilities include review of project activities to ensure that objectives are met on a day-to-day basis and that this QAPP and other project planning documents have been properly implemented. The E & E QA Manager will also assist in this capacity.

The BLM is responsible for overseeing the QC aspects of each of its contractors, including E & E. BLM or its representative is responsible for the overall QC assessment of the project and may perform system audits at any time.

3.1.2 Response Actions

Response actions will be implemented on a case-by-case basis to correct quality problems. All personnel involved in the project are responsible for discovering QA problems or deficiencies in their areas of responsibility. Any such deficiencies must be reported immediately to the PM. As soon as possible after discovery, the PM will also propose resolution action in cooperation with personnel in the area where the deficiency was found. The corrective action process has two components that must be addressed. The first component is the resolution of the immediate problem. The second component of the corrective action process is to prevent future occurrences of the problem. It is the responsibility of the PM to ensure that both components are addressed, and to finalize the action necessary to achieve resolution.

Results of the following QA activities may also initiate corrective actions:

- Performance audits
- Systems audits
- Failure to adhere to the approved QAPP or project work plan.

3.2 Reports to Management

Field teams will note any quality problems in the applicable logbook or other form of documentation. QA reports to the PM will be provided whenever quality problems are encountered.

The laboratory is responsible for providing a summary of quality issues to the PM with each data report.

Data validation reports will be provided to the PM by the data validation specialist. These reports will include a discussion of any significant quality problems that were observed and their effect on the use of the data.

Quality issues identified by the field team, laboratory, and data validation specialist will be incorporated into the data evaluation report(s) submitted to BLM. If significant problems are encountered, the PM will report these issues along with the results of the necessary response actions to BLM in a separate memorandum.

4 Data Validation and Usability

4.1 Data Review, Verification, and Validation

Each member of the field team will be responsible for reviewing his or her work for completeness and accuracy. The RI Lead will conduct an independent review of the field data to ensure that it meets the requirements of this QAPP and the FSP.

The subcontracted laboratory will be responsible for internal review of the data prior to issuance of reports. These review procedures are documented in the laboratory QA manuals.

Laboratory data packages will be reviewed by the QA Manager for completeness for compliance with project objectives and fulfillment of the Laboratory Data Review Checklist (ADEC 2010).

4.2 Verification and Validation Methods

The analytical results will be validated by an experienced E & E chemist. The data will be validated in accordance with the *National Functional Guidelines for Inorganic Data Review* (EPA 2010), *National Functional Guidelines for Organic Data Review* (EPA 2008), and *Guidelines for Data Reporting, Data Reduction, and Treatment of Non-Detect Values* (ADEC 2008) in conjunction with the QA/QC requirements specified in each specific analytical method and any project-specific QC defined in the QAPP.

Analytical data will be validated against criteria for:

- Holding times and sample integrity
- Instrument performance checks
- Initial and continuing calibrations
- Blank analyses
- Laboratory QC compounds and standards
- Field duplicates analyses
- Organic internal standard and surrogate performance
- Compound identification and compound quantification
- Reported detection limits
- System performance and overall assessment of data.

Laboratory data will be assessed for usability in accordance with the DQOs presented in this QAPP. Results that are less than the reporting limit but that exceed the method detection limit will be qualified as estimates and used in calculations as a detected value. Both laboratory and field QA/QC data are also assessed for precision, accuracy, representation of true nature, comparability, and completeness.

Other data that may be reviewed for verification of total sample integrity include:

- Sample handling and storage
- Field duplicates as identified to the reviewer
- Sample preparation logs
- Instrument standards (primary and secondary records)
- Run logs for each instrument.

All corrections and/or notations will be added to the project database.

4.3 Reconciliation with User Requirements

Data validation reports prepared by E & E will include an evaluation of the usability of the data. Precision, accuracy, representativeness, completeness, and comparability will be evaluated and compared with the project DQOs by the PM, in consultation with the QA Manager, as each data set is received. At the completion of the project, an overall assessment of data usability and compliance with project objectives will be conducted and documented in the RI report.

5 References

ADEC (Alaska Department of Environmental Conservation). 2010. Laboratory Data Review Checklist. January 2010.

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BLM (U.S. Department of the Interior Bureau of Land Management). 2004. *Risk Management Criteria for Metals at BLM Sites*. Technical Note 390.

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EPA (U.S. Environmental Protection Agency). 2010. *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*. January 2010 Version, EPA 540-R-10-011.

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