Exponent®

Draft

Quality Assurance Project Plan

Haul Road Fugitive Dust Study

Red Dog Mine, Alaska

Prepared for

Teck Cominco Alaska Inc.
Anchorage, Alaska

Exponent®

Draft

Quality Assurance Project Plan

Haul Road Fugitive Dust Study

Red Dog Mine, Alaska

Prepared for

Teck Cominco Alaska Inc.
Red Dog Operations
3105 Lakeshore Drive
Building A, Suite 101
Anchorage, AK 99517

Prepared by

Exponent
15375 SE 30th Place, Suite 250
Bellevue, WA 98007

August 2001

Doc. No.: 8601997.001 0201 0801 DP16

Quality Assurance Project Plan

Haul Road Fugitive Dust Study

Red Dog Mine, Alaska

Prepared by: Exponent
August 2001

Prepared for: Teck Cominco Alaska Inc.

Approvals:

Jim Kulas, Teck Cominco Alaska Inc. Project Manager

Walt Shields, Exponent Project Manager

Dan Peek, Exponent QA/QC Coordinator

Distribution List

Copies of this quality assurance project plan, and any subsequent revisions, will be sent to the following:

Teck Cominco Alaska Inc.
Red Dog Operations
3105 Lakeshore Drive
Building A, Suite 101
Anchorage, AK 99517
(907) 266-4567

A copy of this quality assurance project plan will also be provided to all contractors hired by Teck Cominco Alaska, Inc. to complete any phase of the sampling, including field sampling crews and testing laboratories.

Contents

List of Tables

Tables are located at the end of the main text.

Acronyms and Abbreviations

COC/SAR	chain-of-custody/sample analysis request
Cominco	Teck Cominco Alaska Inc.
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
GPS	global positioning system
LCS	laboratory control sample
MQO	measurement quality objective
MS/MSD	matrix spike/matrix spike duplicate
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
RPD	relative percent difference
SAP	sampling and analysis plan
SDG	sample delivery group
SOP	standard operating procedure

1 Introduction

This quality assurance project plan (QAPP) describes the quality assurance and quality control (QA/QC) procedures that will be used to support the analytical data generated from dust, soil, water, and vegetation sampling to be conducted at Teck Cominco Alaska Inc.'s (Cominco) Delong Mountain Transportation System Road. These QA/QC procedures ensure that the data generated during this sampling are representative of actual field conditions and meet the project's quality objectives. This QAPP was developed using guidance provided by the U.S. Environmental Protection Agency (EPA) (U.S. EPA 1998, 1999).

A complete description of the project, including rationale for the current sampling specifications, tentative dates for the fieldwork, and the intended end use of the data acquired from this field effort is provided in the road and vegetation study sampling and analysis plans (SAPs) (Exponent 2001a,b).

This QAPP contains the following sections:

- Section 1. Introduction
- Section 2. Project Management
- Section 3. Data Acquisition
- Section 4. Assessment and Oversight
- Section 5. Data Verification, Validation, and Usability
- Section 6. References.

2 Project Management

Well-defined project management procedures, QA/QC procedures, and quality assessment checkpoints are instrumental in the execution of a successful field effort and the generation of well-documented, high-quality data. This section of the QAPP includes descriptions of the project structure and management procedures that relate to project quality assurance.

2.1 Project Organization

Exponent will be responsible for planning and managing the sampling program. Table 1 identifies the personnel responsible for planning and implementing field and laboratory operations and QA/QC procedures for this project and describes each individual's tasks for project management and quality assurance. Laboratory quality assurance officers, also described in Table 1, will be identified at each contract laboratory to ensure that appropriate procedures are followed during sample analysis and preparation of the data packages and electronic deliverables. The laboratory quality assurance officers will be identified prior to submittal of samples.

Each laboratory may, at Exponent's request, be required to provide its quality assurance manual for review and approval by the project QA/QC coordinator. The manuals will include a description of the laboratory organization, personnel, and responsibilities; facilities and equipment; analytical methods and QA/QC protocols; and routine procedures for sample custody and data handling. The laboratory quality assurance manuals will be provided if requested.

No changes in the QAPP procedures will be permitted without written justification and a detailed explanation of the intended change. All changes are subject to approval by the Exponent QA/QC coordinator and project manager, and the Cominco project manager. A description of all changes, with justification, will be included in applicable quality assurance or data reports generated for this project.

2.2 Project Description

The details of the design of the fugitive dust study and vegetation study sampling are presented in the SAPs (Exponent 2001a,b).

2.3 Quality Objectives and Criteria for Measurement Data

The primary quality objective for measurement data is to obtain results that are of known and acceptable quality and are representative of the conditions present at the site. The sampling plans for the fugitive dust and vegetation studies have been developed to ensure the collection of sufficient samples from appropriate locations to provide statistically significant and representative data for chemical concentrations and physical measurements. Field sampling procedures will include safeguards to ensure that the samples provided to the laboratories are intact and representative of field conditions, as described in the SAPs (Exponent 2001a,b).

Measurement quality objectives (MQOs) have been established for this project to ensure that chemical and physical data are of known and sufficiently high quality to support the project objectives. Quantitative MQOs are provided in Table 2. To confirm that project MQOs for precision and accuracy are achieved, analytical results for field and laboratory quality control samples will be evaluated, as discussed in the sections below. The equations used to assess precision, accuracy, and completeness are provided in Section 5.2 of this QAPP. Quality control results that do not meet target values will be qualified during data validation, and their limitations will be noted in the data quality and usability report for the project, as discussed in Section 5.2 of this QAPP. To ensure comparability and representativeness of the laboratory data, standard instrumentation will be used for the analyses and the instruments will be properly calibrated and maintained.

2.4 Special Training and Certification

Procedures to be completed for this study are, for the most part, routine. Standard procedures will be used to collect the dust, soil, water, and vegetation samples and to complete laboratory

analyses. All Exponent field personnel will have completed the 40-hour Hazardous Waste Operations and Emergency Response training with annual refresher courses as required by the Occupational Safety and Health Administration. No other special personnel or requirements are identified in the SAPs (Exponent 2001a,b).

2.5 Documents and Records

Procedures, observations, and test results will be documented for all sample collection, laboratory analysis and reporting, and data validation activities. In addition to data reports provided by the laboratories, reports will be prepared that address data quality and usability, and provide tabulated laboratory and field data. Internal and external reporting procedures for this study are described in this section.

2.5.1 Field Records

Field records will be maintained during all stages of sample collection and preparation for shipment to the laboratories. Field records will include the following items:

- Field logbook to record daily sampling activities and conditions
- Combined station/sample log to document station locations and the date and time of collection
- Sample labels
- Combined chain-of-custody forms/sample analysis request (COC/SAR) forms
- Custody seals to monitor cooler security during shipment
- Photographic documentation (if any).

Detailed descriptions of the information that will be documented during the field work are provided in the SAPs (Exponent 2001a,b).

In addition to the standard field records, the following reports may be completed if a deviation from the SAPs (Exponent 2001a,b) or QAPP is encountered or to document an audit:

- Corrective action reports documenting any problems encountered during field activities and corrective actions taken
- System and performance audit reports completed during the investigation
- A summary of any changes made to documented procedures and the rationale for the changes.

2.5.2 Laboratory Data Reports

The laboratories will perform data reduction as described in each test method for this project (Table 2) and submit a complete data package with full documentation for all analyses or other determinations. The laboratory quality assurance officer is responsible for reviewing the laboratory data packages and checking data reduction prior to submittal to Exponent. Any transcription or computation errors identified during this review will be corrected by the laboratory.

The analytical laboratories will provide all information (as appropriate for the specific analyses) required for a complete quality assurance review, including the following:

- A cover letter discussing analytical procedures and any difficulties that were encountered
- A summary of analyte concentrations (to two significant figures, unless otherwise justified) and method reporting limits

- Laboratory data qualifier codes appended to analyte concentrations, as appropriate, and a summary of code definitions
- Initial and continuing calibration data, including instrument printouts and quantification summaries for all analytes
- Results for method and calibration blanks
- Results for all QA/QC checks, including laboratory control samples (LCSs), matrix spike samples, duplicate matrix spike samples, and laboratory duplicate or triplicate samples
- Original data quantification reports for all analyses and samples
- All laboratory worksheets and standards preparation logs (data include final dilution volumes, sample sizes, wet-to-dry ratios, and spiking and standards preparation procedures for all analyses).

2.5.3 Data Quality and Usability Report

A data quality and usability report will be prepared in conjunction with a data report for each monitoring event. The data quality report will summarize the results of the data validation and data quality review and will describe any significant quality assurance problems that were encountered. The report will include the following items:

- Executive summary of overall data quality and recommendations for data use and limitations
- Description of sample collection and shipping, including chain-of-custody and holding time documentation
- Description of analytical methods and detection limits
- Description of data reporting
- Description of completeness relative to QAPP objectives

- Description of precision relative to QAPP objectives, including results for field and laboratory replicate analyses
- Description of accuracy relative to QAPP objectives, including results of matrix spikes and LCSs
- Description of any contamination in field and laboratory blanks and implications for bias of the data or false positives
- Identification of all cases where MQOs were not met and a summary of the significance of these deviations.

All data and any qualifiers applied to the data as a result of the quality assurance review will be reported in the final data report.

2.5.4 Location of Records and Reports

The electronic and hard copy data generated for this study will be retained at Exponent's office in the custody of the project data manager. Field logs, sample records, and chain-of-custody records will be kept with the Exponent project files for reference purposes.

3 Data Acquisition

3.1 Sampling Design

The details of the design of the haul road fugitive dust study sampling program are presented in the SAPs (Exponent 2001a,b).

3.2 Sampling Methods

Detailed descriptions of field methods and related quality assurance procedures are provided in the SAPs (Exponent 2001a,b), including the following:

- Identifying and documenting the location of sampling stations
- Decontaminating equipment and work surfaces prior to sample collection, between samples, and between sampling events
- Collection of samples for chemical and physical testing
- Preparing composite samples and collecting subsamples for laboratory testing.

Requirements for sample containers, preservation, and holding times, as well as the sample mass required by the laboratory for each analysis, are summarized in Table 3. New I-Chem® 300 series or equivalent sample containers, with certificates of analysis, will be provided by the laboratories. Procedures for labeling, processing, and shipping samples are described in SAPs (Exponent 2001a,b).

3.3 Sample Handling and Custody

A continuous record of the possession and proper handling of samples must be documented so that sample custody and handling is traceable from the time of sample collection until the analytical data have been validated and accepted for use.

3.3.1 Field Sampling Operations

Sample custody documentation is initiated in the field as each sample is collected. A designated sampler assumes custody of the samples as soon as they are collected. A sample label is attached to each sample container as it is filled in the field. An example of a sample label is included in the SAPs (Exponent 2001a,b). The sample information will be recorded by the field samplers at the time of collection. Sample identifiers will consist of coded information as described in the SAPs (Exponent 2001a,b).

At the end of each day and prior to shipping or storage, COC/SAR forms will be completed for all samples. The information on the sample labels will be rechecked and verified against field logbook entries and the COC/SAR forms. Any necessary changes to COC/SAR forms, sample container labels, or the field logbook will be made by striking out the error with one line and reentering the correct information. The new entries will be initialed and dated.

3.3.2 Shipping

All samples will be accompanied by COC/SAR forms (provided in the SAPs [Exponent 2001a,b]) during shipment. The custodial sampler provides the first signature on the COC/SAR form when relinquishing custody to another member of the field team for documentation or packing or to the shipping company or laboratory courier. The COC/SAR forms will be generated using computer spreadsheet software. Sample information from the COC/SAR forms will be transferred electronically into the database. Paper copies of completed COC/SAR forms will be provided by the laboratories with the data packages and will be stored with the data by the project data manager.

When samples are shipped, the sample containers will be securely packed inside the shipping coolers and placed on ice as specified in Standard Operating Procedure (SOP) 2 for shipping samples (see the SAPs [Exponent 2001a,b] for SOP 2). All glass containers will be wrapped in bubble wrap. The original COC/SAR forms will be enclosed in a plastic bag and taped to the inside lid of the cooler. The cooler will be taped closed by wrapping fiber tape completely around it. "This End Up" labels and "Fragile—Glass" labels, as well as any other required shipping labels, will be attached to the cooler, and the cooler will be sealed with two custody seals on adjacent sides of the lid. Packaging will conform to U.S. Department of Transportation regulations.

The field personnel will be responsible for sample custody and appropriate sample storage prior to shipment, as well as for packing and shipping samples in a manner that allows the laboratory sufficient time to meet holding time requirements. The technical field personnel will also contact the laboratory project manager and the project manager to notify them of the sample shipment.

3.3.3 Laboratory Operations

The laboratory project manager will verify receipt of each sample shipment and will contact the sample manager to provide notification that all samples were received and to relay any concerns or observations regarding sample integrity or documentation. The laboratory project manager will also be responsible for ensuring that laboratory chain-of-custody forms and tracking records are completed upon receipt of the samples and maintained through all stages of laboratory analysis. Storage information must be maintained until disposal of the samples. The sample tracking records must show the date of sample extraction or preparation and the date of instrument analysis for each analytical procedure. These records will be used to determine compliance with holding time requirements.

The laboratories will maintain daily temperature logs for all refrigerators and freezers that contain samples for this project. These logs will be stored at the laboratory and copies will be

provided to Cominco if requested. The laboratory project manager will notify the project QA/QC coordinator if storage temperatures deviate from those specified in Table 3.

3.4 Analytical Methods

Chemical and physical testing will be completed using American Society for Testing and Materials (ASTM 2001), EPA SW-846 (U.S. EPA 1996), and API (API 1998) or other approved or recommended methods by EPA when available and will include all associated QA/QC procedures recommended in each method. All laboratories for this study will have established protocols and quality assurance procedures that meet or exceed any applicable EPA guidelines. Laboratory procedures for chemical and physical analyses are summarized below.

3.4.1 Chemical Analyses

Chemical analyses of dust, soil, water, and vegetation samples will be completed for aluminum, arsenic, cadmium, calcium, iron, magnesium, lead, and zinc. The target method reporting limits for chemical analyses are provided in Table 2. These reporting limits can reasonably be expected from a competent laboratory. The actual detection limits attained during this site investigation may be elevated with respect to target detection limits if interferences are encountered because of the sample matrices.

For soil, dirt, and water samples collected as part of the road sampling plan, analysis for aluminum, arsenic, cadmium, calcium, iron, magnesium, lead, and zinc will be completed using inductively coupled plasma-atomic emission spectrometry in accordance with EPA SW-846 Method 6010A (U.S. EPA 1996). Analysis for lead will be completed using graphite furnace atomic absorption spectrometry in accordance with EPA SW-846 Method 7421 (U.S. EPA 1996). Dust samples will be collected in accordance with ASTM Method D4464 (ASTM 2001), in which dust is trapped in water. In the laboratory, in accordance with the method, the suspended dust will be collected on a filter paper and dried prior to digestion and analysis. Dust, soil, and vegetation samples will be digested with nitric acid and peroxide in accordance

with EPA SW-846 Method 3050A (U.S. EPA 1996). Water samples will be digested with nitric acid and hydrochloric acid in accordance with EPA Method 3005A (U.S. EPA 1996).

All metals analyses for vegetation samples will be performed using EPA Method 6020 (inductively coupled plasma-mass spectrometry). Moss, willow, and lichen sample results will be reported by dry weight and berry sample results will be reported both by wet weight and dry weight.

3.4.2 Physical Analyses

Physical analyses of soil samples will be completed for particle size and particle density according to the methods indicated in Table 2.

3.5 Quality Control

Quality control samples and procedures are used to obtain quantitative information regarding the execution of field sampling and laboratory testing activities. Quality control results may be used to estimate the magnitude of bias and level of precision inherent in the test data. A variety of quality control samples will be collected in the field and initiated by the laboratories for every test.

3.5.1 Field Quality Control

Field quality control samples will include equipment rinsate blanks and field duplicate samples. These quality control samples will be collected or prepared by sampling personnel in the field and submitted to the laboratory as natural samples. Equipment rinsate blanks will be used to identify possible contamination from the sampling environment or from sampling equipment. These blanks will be collected by pouring deionized and distilled water over the decontaminated sampling equipment and into a sample jar. One equipment rinsate blank for dust samples will

be collected during the monitoring period, and one equipment rinsate blank for road/source samples will be collected for each sampling event.

Field duplicate samples will be collected to assess the homogeneity of the samples collected in the field and the precision of the sampling process. Field duplicates will be prepared by collecting two aliquots of sample from the homogenization bowl and submitting them for analysis as separate samples. Field duplicates for each matrix will be collected at frequencies specified in the SAPs (Exponent 2001a,b).

3.5.2 Laboratory Quality Control

Each analytical protocol used in this investigation (Table 2) includes specific instructions for analysis of quality control samples and completion of quality control procedures during sample analysis. These quality control samples and procedures verify that the instrument is calibrated properly and remains in calibration throughout the analytical sequence and that the sample preparation procedures have been effective and have not introduced contaminants into the samples. Additional quality control samples are used to identify and quantify positive or negative interference caused by the sample matrix. Each method protocol provides control limits that indicate acceptable conditions for analysis of samples as well as unacceptable conditions that would necessitate reanalysis of samples.

The following laboratory quality control procedures are required for chemical and physical analyses:

- **Calibration and Verification—**Initial calibration of instruments will be performed at the start of the project and when any ongoing calibration does not meet control criteria. The number of points used in the initial calibration is defined in each analytical method. Continuing calibration will be performed as specified in the analytical methods to track instrument performance. In the event that a continuing calibration does not meet control limits, analysis of project samples will be suspended until the source of the

control failure is either eliminated or reduced to within control specifications. Any project samples analyzed while the instrument was out of calibration will be reanalyzed.

- **Method Blanks—**Method blanks are used to assess possible laboratory contamination of samples during all stages of preparation and analysis. Blank corrections will not be applied by the laboratories to the original data. For metals analyses a minimum of 1 method blank will be analyzed for every sample preparation group or 1 for every 20 samples, whichever is more frequent.

- **Laboratory Control Samples—**LCSs (reference material or spiked blanks) will be used as a check on overall method performance. For metals analyses, an LCS will be analyzed for every sample delivery group (SDG) or for every 20 samples, whichever is more frequent.

- **Matrix Spike Samples—**Matrix spike samples are used to assess the effects of the sample matrix on the accuracy of analytical measurements. For metals a minimum of 1 matrix spike will be analyzed for each SDG or for every 20 samples, whichever is more frequent.

- **Laboratory Duplicates and Triplicates—**Replicate laboratory analyses are indicators of laboratory precision. For metals and physical analyses, 1 laboratory duplicate will be analyzed for every SDG or for every 20 samples, whichever is more frequent. Triplicate analyses will be completed for grain size distribution for one sample in every SDG.

3.6 Instrument and Equipment Testing, Inspection, and Maintenance

Preventive maintenance of field equipment and laboratory instruments is essential if project resources are to be used in a cost-effective manner. Preventive maintenance will take two forms: 1) a schedule of preventive maintenance activities to minimize downtime and ensure the

accuracy of measurement systems and 2) availability of critical spare parts and backup systems and equipment. The performance of these maintenance procedures will be documented in field and laboratory notebooks.

The field team leader will be responsible for ensuring that routine preventive maintenance is performed and documented for all field instrumentation and equipment (e.g., global positioning system [GPS] and sampling gear).

The laboratory quality assurance officers will be responsible for ensuring that routine preventive maintenance is performed and documented for each analytical instrument and that spare parts or additional instruments are available in case of instrument breakdown or failure. Instrument quality control procedures (e.g., initial and continuing calibration, LCSs, calibration blanks) will be used to verify the continuing acceptable performance of each instrument. Details are provided in the referenced method descriptions (Table 2) and the laboratory SOPs and quality assurance manuals.

3.7 Instrument and Equipment Calibration

Initial and continuing calibration procedures for laboratory instruments will be performed in accordance with the cited analytical method for each analysis (Table 2). The method descriptions for each analysis specify acceptance criteria for initial and continuing calibration and state the conditions where recalibration is necessary.

All primary chemical standards and standard solutions used in this project will be traceable to the National Institute of Standards and Technology or other documented, reliable, commercial sources. At the laboratories, standards are validated prior to use to verify their accuracy by comparison with an independent standard. Reagents are examined for purity by performing method blank analyses.

Field instruments (e.g., GPS) will be calibrated according to and at the frequency specified in the manufacturers' instructions.

3.8 Inspection and Acceptance of Supplies and Consumables

Supplies and consumables are required for sample collection and laboratory activities. During sample collection, the most critical supplies affecting data quality are those used for decontamination of the sampling equipment. Supplies of appropriate, documented purity will be used for sample collection and decontamination. Acceptance for all supplies will require an intact seal upon receipt, maintenance at appropriate temperature, and use only prior to the expiration date. This method of documentation allows any contamination problem to be traced to its source and will enable identification of related samples that may have been affected. Acceptance requirements will include a basic inspection of all containers received and rejection of unacceptable supplies.

Reagents of appropriate purity and suitably cleaned equipment must be used for all stages of laboratory analyses. In addition, the laboratories must ensure that the concentrations of calibration and spiking standard are accurate and that instrumentation is functioning properly. The lot numbers of all standards are routinely tracked by the laboratories, from purchase of stock standards to preparation of secondary and working calibration standards. All calibration and spiking standards are checked against standards from another source. LCS results provide an additional check for accuracy. Details for acceptance requirements for supplies and consumables at the laboratories are provided in the laboratory SOPs and quality assurance manuals.

3.9 Non-direct Measurements

As part of a separate task on this project, available data and previous consultant reports will be reviewed. The quality of data available from these sources will be evaluated, and results for the current study will be grouped with existing data for statistical evaluation, where possible. Interpretation of monitoring results may also rely on a base of knowledge established by scientific papers published in peer-reviewed journals regarding arctic forage plants, lichens, and moss, as well as plants and berries used by native residents.

3.10 Data Management

Computerized systems will be used to record, store, and sort the technical data that will be generated to support the monitoring program. Automated data handling increases data integrity by reducing errors, omissions, and ambiguities that can be introduced by manual procedures. In addition, automated procedures will be used by the laboratories to capture and summarize analytical results. In this case, electronic data files can be imported directly from the laboratory to the project database, minimizing both data entry effort and opportunities for error. Sampling location coordinates will be entered into the database to enable the generation of maps and figures using appropriate software.

Field logbooks and COC/SAR forms are prepared by the field team while sample collection activities are in progress. Sample information from the field is entered manually into the database in Exponent's office. Each data record will include a unique sample code, station ID, sample type (matrix), analyte, analyte concentration, and concentration units. Data from the laboratories are entered directly from the electronic disk deliverables. A small portion of the laboratory data may be entered manually if electronic data cannot be supplied. Electronic data summaries are produced to support data validation procedures. Data qualifiers are entered into the database when validation is completed and verified, and the data set is approved as final. All manual and electronic entries are verified by the data manager or validation personnel.

Project data tables and reports are prepared using customized retrievals that filter and sort the data according to criteria specified by the user. The data are automatically formatted for direct use with statistics software packages and various geographic information system software. The maintenance of a single authoritative database prevents the proliferation of multiple versions of data and the introduction and proliferation of errors.

4 Assessment and Oversight

4.1 Assessment Activities

Assessment activities for each sampling event may include readiness reviews prior to commencement of each phase of project work and surveillance while work is in progress. In addition, a technical systems audit may be conducted if problems are encountered during sample collection or analysis.

Readiness reviews are completed to ensure that the components of a project are in place so that work can be completed efficiently. Generally, two readiness reviews are conducted, one prior to the initiation of fieldwork and the other prior to data interpretation activities for each monitoring event.

The field team leader will verify that the following conditions are met prior to field sampling:

- All of the field equipment is ready and available, and shipment to the sampling site has been arranged
- The field sampling team has been scheduled, and transportation has been arranged
- Subcontractors have been contracted and scheduled.

The data manager, at the project manager's direction, will finalize the project data after all results have been received from the laboratory, data validation has been completed, and data qualifiers have been entered into the database. This process constitutes the readiness review for data use. The project manager will be responsible for addressing any deficiencies in the readiness review. No report will be prepared.

Project surveillance may be conducted throughout the course of each monitoring event to ensure that every phase of work (fieldwork, laboratory analysis, data review/validation, data

interpretation, and report preparation) follows the quality assurance procedures outlined in this QAPP. The project manager will be responsible for conducting surveillance with the assistance of the field sampling director, data validation manager, laboratory quality assurance officers, and lead technical personnel. Technical problems will be noted in the field sampling or quality assurance report if appropriate. Any non-compliance issues will be addressed as described below in Section 4.2.

Technical system audits may be conducted if problems are encountered during sampling and analysis operations. If completed, these audits will be conducted by the project QA/QC coordinator or designee or by the laboratory quality assurance officer. These audits may consist of onsite reviews of field activities or laboratory analyses. Technical system audits may include, but are not limited to, the following components:

- Field and laboratory personnel, facilities, and equipment
- Chain-of-custody procedures and records
- Instrument calibration and maintenance procedures and records
- Standards preparation and verification procedures and records
- Documentation of analytical methods
- Sample storage conditions
- Data reduction, processing, and reporting procedures
- Documentation of control procedures.

All personnel engaged in sampling and analysis tasks will have appropriate training and required certifications. All laboratories are required to have written procedures addressing internal QA/QC; if requested, these procedures must be submitted to Exponent and will be reviewed by the project QA/QC coordinator to ensure compliance with this QAPP. The QA/QC coordinator will discuss any serious problems with the project manager and the Cominco project

manager will be notified of the situation. Any problems identified during the course of the project that affect data quality will be discussed in the quality assurance report.

4.2 Response Actions

While the entire quality assurance program is designed and implemented to avoid problems, it also serves to identify unexpected or unavoidable problems that may be encountered during sample collection and analysis. An important part of any quality assurance program is a well-defined policy that can effectively correct these problems after they have been identified.

4.2.1 Short-Term Corrective Action

Short-term corrective actions fall into two categories: 1) handling analytical instrument or field equipment malfunctions, and 2) handling nonconformance or noncompliance with the quality assurance requirements that have been established for the project.

During field operations and sampling procedures, the field team leader will be responsible for correcting equipment malfunctions. Acceptable equipment operating parameters and control limits are specified in the operating instructions and SOPs. If any piece of equipment fails to meet established quality control criteria or cannot be properly repaired, it will be replaced. All equipment malfunctions and subsequent corrective measures will be documented in the field log.

The laboratory quality assurance officers are responsible for ensuring that laboratory results comply with project, method, and laboratory quality control requirements and that all analytical instruments and laboratory equipment are properly maintained. Acceptable instrument operating parameters, control limits for quality control results, and required corrective actions are specified in the laboratory SOPs, method protocols, and manufacturers' instructions provided with laboratory instruments. Control limit specifications are designed to help analysts detect the need for corrective action. Often an analyst's experience will be most valuable in identifying suspicious data or malfunctioning equipment. Immediate corrective action must be

taken by the laboratory if any phase of the sample preparation and analysis process is considered suspect. Any corrective actions will be noted in the laboratory notebooks and, if appropriate, discussed in the case narratives for all affected sample sets.

4.2.2 Long-Term Corrective Action

In addition to short-term corrective actions taken by field and laboratory personnel, a mechanism is required to address long-term, systemic corrective actions. The need for long-term corrective action may be identified by an overview of compliance with standard quality control procedures, control charts, and performance or system audits. Any quality control problem that cannot be solved by immediate corrective action falls into this long-term category. The long-term system will be used to ensure that the condition is reported to the person who is responsible for the corrective action and follow-up plan.

The required corrective actions will vary, depending on the nature of the problem; however, the essential steps in the closed-loop, long-term corrective action system are as follows:

- Identify the problem
- Assign responsibility for investigating the problem
- Investigate and determine the cause of the problem
- Determine a corrective action to eliminate the problem
- Establish responsibility for implementing the corrective action and implement the corrective action
- Verify that the corrective action has eliminated the problem
- Document the complete process of establishing and implementing the corrective action in a project memorandum that specifies the problem areas requiring corrective action and how they were detected, the individual initiating corrective action, the samples concerned, the acceptable data range,

the measures taken to correct the problems, and the individual approving the corrective action.

The QA/QC coordinator, who has the authority to enforce necessary corrective measures, will routinely review the documentation of corrective actions.

4.3 Reports to Management

Reports will be prepared for any condition that requires corrective action and for technical system audits (if conducted). The reports will be prepared by the individual who conducted the audit, approved by the project QA/QC coordinator, and provided to Cominco and Exponent.

Prior to inclusion or presentation of any of the data in a report, a data quality report will be prepared that will include the following items:

- A discussion of sampling procedures and any anomalies encountered during sample collection
- A discussion of laboratory procedures
- A discussion of quality control procedures and data validation results
- A description and discussion of any other conditions that may have affected the quality of the data
- A summary of the quality of the project data
- A description of the data usability and limitations for the project.

The data quality report will be prepared by or under the direction of the field activities manager (for discussions related to fieldwork) and the QA/QC coordinator (for data quality evaluation).

5 Data Verification, Validation, and Usability

Data verification and validation are conducted to establish the data quality and usability for the project. Data verification is the process of determining whether samples have been collected and analyzed according to procedures prescribed in the SAPs (Exponent 2001a,b), SOPs and method descriptions, and this QAPP. Data verification includes checking for compliance of procedures with the project plan, correctness of protocols used in the field and at the laboratory, comparability of the data collection and analysis procedures, and completeness of the data set and supporting documentation. Data validation is the process of evaluating the technical quality of the verified data with respect to the project data quality objectives (DQOs). Data validation and verification criteria and procedures are described below in Sections 5.1 and 5.2. Procedures for determining data usability are provided in Section 5.3.

5.1 Data Verification and Validation Requirements

Requirements for field and laboratory procedures and data quality are described in this section. Adherence to these procedures by field and laboratory personnel will be verified as described in Section 5.2.

5.1.1 Requirements for Verification of Field Procedures

Field procedures will be followed as described in this QAPP, the SAPs (Exponent 2001a,b), and the SOPs. All protocols related to sample collection, storage, shipping, and handling include requirements for quality assurance procedures and documentation of activities. Any deviations from specified procedures should be documented in detail in the field logbook and fully justified. Specific requirements include, but are not limited to, the following:

- Sampling locations must be fully documented and correct. Errors in the sampling location (e.g., as the result of malfunction of the GPS unit) may result in the rejection of data.

- Sample collection, compositing, and homogenization procedures must be completed as planned and fully documented. Difficulties encountered during sampling that may affect the representativeness of the sample should be minimized.

- Sample shipping and handling procedures must be completed as described in the SAPs (Exponent 2001a,b). Maintaining appropriate sample temperatures during field activities and shipping is particularly important.

- Results for field quality control samples should meet control limits. The MQO for precision (Table 2) will be used as the control limit for field duplicates. Equipment rinsate blank contamination will result in the qualification of related data as described in the functional guidelines (U.S. EPA 1994).

Failure to meet these requirements may result in qualification or rejection of data during data validation (see Section 5.2).

5.1.2 Requirements for Verification of Laboratory Procedures

Laboratory procedures should be followed as described in this QAPP, the method descriptions cited in Table 2, and the laboratory quality assurance plan and SOPs. Any deviations from the specified procedures should be documented in detail and fully justified in the case narrative for the data package.

Chemical data will be evaluated according to criteria specified in the functional guidelines for data validation (U.S. EPA 1994). Physical data will be evaluated according to the same criteria, as appropriate. Data may be qualified as estimated or rejected if any of the following quality control samples and procedures do not meet control limits:

- Sample holding times (specified in Table 3 of this QAPP)

- Method of analysis

- Initial and continuing instrument calibration
- Calibration and method blanks
- LCSs
- Matrix spike samples
- Matrix duplicates
- Surrogate recovery
- Analyte identification and quantification.

5.2 Verification and Validation Methods

Verification procedures will be completed in the field during sample collection and in the laboratory during sample analysis and testing. In addition, verification and validation of all field and laboratory documentation and reports will be conducted after the analyses and tests are completed. The data will be released for interpretation only after validation has been completed and all qualifiers have been correctly entered into the database.

5.2.1 Field Procedures

The conformance of field activities to specifications in the sampling plan will be verified by the field team leader on an ongoing basis while field activities are in progress. Additional verification will be provided through oversight of the field activities by the project manager. Verification procedures will include the review of any deviation from prescribed sampling procedures described in the field logbook.

Planned sampling locations are described in the SAPs (Exponent 2001a,b). If a sample cannot be collected as planned, the project manager will be notified and an alternate location or sampling method will be selected, if possible. The review process will include immediate

evaluation of any sampling difficulties so that an alternate field procedure or location may be established quickly, if necessary.

Sample completeness will be verified at the end of each sampling day and again when samples are packed for shipment to the laboratory. Laboratory personnel will provide an additional completeness check when the samples are received and logged in and checked against the COC/SAR forms.

Sample identification information in the sample logs and COC/SAR forms will be verified by the data manager or sampling personnel when the field data are entered into the database. Station location information will be verified by the project manager or designee when station coordinates are used to generate project maps. Any discrepancies will be brought to the attention of the field team leader, who will be responsible for resolving the issue. Any deviations that affect data quality or completeness will be discussed in the data quality report, and data will be qualified or rejected, as appropriate.

5.2.2 Chemical and Physical Analyses

Verification and validation of chemical and physical data will be completed at the laboratories and by Exponent. The laboratory will be responsible for verifying data quality during and after sample analyses. Any nonconformance issues identified during the laboratory's quality assurance checks will be corrected and noted by the laboratory. Close contact will be maintained between the project QA/QC coordinator and the laboratory project manager so that any quality issues can be resolved in a timely manner. Any data quality deviations will be discussed in the laboratory case narrative, including the direction or magnitude of any bias to the data, if possible.

Data validation and verification will be completed by Exponent prior to finalization of the data and release of the data set for interpretation. Chemical and physical data will be validated according to EPA Level 3 criteria. Level 3 validation includes evaluation of the results for quality control samples (i.e., surrogate recoveries, calibration and method blanks, matrix spikes

and matrix spike duplicates, and LCSs) with respect to control limits. Initial and continuing calibration results will be reviewed, but calculations and transcriptions will not be checked. For chemical analyses, qualifiers will be applied to the results according to procedures described in the EPA Contract Laboratory Program national functional guidelines for data review (U.S. EPA 1994), as applicable, with modifications made as appropriate to accommodate method-specific quality control requirements. For physical analyses, qualifiers will be applied when the quality control results do not meet MQOs (Table 2).

5.2.2.1 Algorithms to Assess Quality Control Results

Data verification includes checking that quality control procedures were included at the required frequencies and that the quality control results meet control limits defined in the method descriptions or by the project MQOs. The equations that will be used to determine whether measurement targets for project MQOs were met for each quality control procedure are provided below.

Duplicate Analyses—Precision for duplicate chemical analyses will be calculated as the relative percent difference (RPD) between the duplicate samples. The formula that will be used to assess precision for both laboratory and field duplicate samples is as follows:

$$\text{RPD} = \frac{D_1 - D_2}{(D_1 + D_2)/2} \times 100$$

where:

D1 = sample value

D2 = duplicate sample value.

Matrix Spikes Recoveries—Spiked samples provide an indication of the bias of the analysis system. The recovery of matrix spikes will be calculated as the ratio of the recovered spike concentration to the known spiked quantity:

$$\%R = \frac{A - B}{C} \times 100$$

where:

A = the analyte concentration determined experimentally from spiked sample

B = the background level determined by a separate analysis of the unspiked sample

C = the amount of the spike added.

Completeness—Completeness will be calculated for each sample type by dividing the number of valid measurements (all measurements except rejected data) actually obtained by the number of valid measurements that were planned:

$$\%\text{Completeness} = \frac{\text{Valid Data Obtained}}{\text{Total Data Planned}} \times 100$$

To be considered complete, the data sets must also contain all quality control check analyses that verify the precision and accuracy of the results.

5.2.2.2 Detection and Quantification Limits

The detection limit of the sample preparation and analysis process is defined as "the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte is greater than zero" (40 CFR 136B). In other words, it is the point at which qualitative, not quantitative, identification can be made. In practice, the limit of detection is defined as three times the standard deviation of the blank or background response adjusted for the amount of sample typically extracted and the final extract volume of the method.

Best professional judgment is used to adjust the limit of detection upward in cases where high instrument precision (i.e., low variability) results in a calculated limit of detection and equivalent instrument response less than the absolute sensitivity of the analytical instrument. The actual reporting limit for environmental samples is generally higher than the instrument detection limit because the sample matrix tends to contribute to fluctuations in the instrument's background signal. Laboratory personnel will determine reporting limits based on their

experience with samples of similar matrix to those collected for this study and on the response of each instrument to samples for this study. The method reporting limits will be verified during data validation.

5.3 Reconciliation with User Requirements

The goal of data validation is to determine the quality of each data point and to identify data points that do not meet the project DQOs. Nonconforming data may be qualified as estimated or rejected as unusable during data validation if criteria for data quality are not met. Rejected data will be flagged as unreportable in the project database and will automatically be excluded from all data retrievals. These data will not be used for any purpose. An explanation of the rejected data will be included in the data validation report. If the rejected data are needed to make a decision, then it may be necessary to resample. Any decision to resample will be based on discussions among the project management team (Cominco and Exponent).

Data qualified as estimated (*J*) are less precise or less accurate than unqualified data but are still acceptable for use. The data users and the Exponent project manager are responsible for assessing the effect of the inaccuracy or imprecision of the qualified data on statistical procedures and other data uses. The data quality report will include all available information regarding the direction or magnitude of bias or the degree of imprecision for qualified data to facilitate the assessment of data usability. The monitoring report will include a discussion of data limitations and their effect on data interpretation activities.

6 References

API. 1998. Recommended practices for core analysis. Second Edition. API document number API 40. American Petroleum Institute, Washington, DC.

ASTM. 2001. Standard test method for particle size distribution of catalytic material by laser light scattering. ASTM D4464. American Society for Testing and Materials, Philadelphia, PA.

Exponent. 2001a. Road sampling and analysis plan, haul road fugitive dust study, Red Dog Mine, Alaska. Prepared for Teck Cominco Alaska Inc., Anchorage, AK. Exponent, Bellevue, WA.

Exponent. 2001b. Vegetation sampling and analysis plan, haul road fugitive dust study, Red Dog Mine, Alaska. Prepared for Teck Cominco Alaska Inc., Anchorage, AK. Exponent, Bellevue, WA.

U.S. EPA. 1994. Laboratory data validation: functional guidelines for evaluating inorganics analysis. Prepared by U.S. Environmental Protection Agency Work Group. U.S. Environmental Protection Agency, Hazardous Site Evaluation Division, Washington, DC.

U.S. EPA. 1996. Test methods for evaluating solid waste—physical/chemical methods, SW-846. Revised methods. Update II. U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA. 1998. EPA guidance for quality assurance project plans, EPA QA/G-5. EPA/600/R-98/018. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC.

U.S. EPA. 1999. EPA requirements for quality assurance project plans. EPA QA/R-5. Interim Final. U.S. Environmental Protection Agency, Quality Staff (2811R), Washington, DC.

Tables

Table 1. Project personnel and responsibilities

Personnel	Responsibilities
Jim Kulas Teck Cominco Project Manager	Overall responsibility for Teck Cominco activities. Oversee all program activities to ensure compliance; perform technical oversight and consultation on major quality assurance problems; provide final approval of all necessary actions and adjustments for activities to accomplish project objectives.
Walt Shields Exponent Project Manager	Oversee all investigation activities under Teck Cominco's direction to ensure appropriate quality control review; provide technical oversight; implement necessary actions and adjustments for activities to accomplish project objectives.
Dan Peek Exponent QA/QC Coordinator	Provide technical quality assurance assistance; oversee quality assurance activities to ensure compliance with QAPP; coordinate and supervise data validation and data quality report preparation; review and submit quality assurance reports.
Scott Shock/Liz Maier Exponent Field Team Coordinators	Coordinate and supervise field activities; ensure field procedures are completed in accordance with SAPs and QAPP; authorize and document minor adjustments to the sampling plan in response to field conditions, as necessary, and notify project manager and QA/QC coordinator; track submittal and receipt of samples at the laboratory; verify COC/SAR forms.
Database Administrator	Organize and maintain project database. Ensure that the data are stored in accordance with the QAPP. Supervise data management personnel.
Laboratory Quality Assurance Officers	Ensure that sample receipt and custody records are properly handled and data are reported within specified turnaround times: calibrate and maintain instruments as specified; perform internal quality control measures and analytical methods as required; take appropriate corrective action as necessary; notify the QA/QC coordinator when problems occur; report data and supporting quality assurance information as specified in this QAPP.

Note: ADEC - Alaska Department of Environmental Conservation
COC/SAR - chain-of-custody/sample analysis request (form)
QA/QC - quality assurance and quality control
QAPP - quality assurance project plan
SAP - sampling and analysis plan

Table 2. Summary of measurement quality objectives

Analysis	Method Reference	Media	Units	Method Reporting Limit	Bias (percent)	Precision (RPD)	Completeness (percent)
Aluminum, arsenic, cadmium, calcium, iron, magnesium, zinc	EPA SW-846 6010A	Dust/soil	mg/kg	1–10	75–125	±30	100
	EPA SW-846 6010/6020 (ICM-MS)	Vegetation[a]	mg/kg	0.05–1	75–125	± 25	
		Water	µg/L	4–50	75–125	±20	
Lead	EPA SW-846 7421	Dust/soil	mg/kg	1	60–130	±30	100
	EPA SW-846 6010/6020 (ICM-MS)	Vegetation[a]	mg/kg	0.05	75–125	±25	
		Water	µg/L	2	75–125	±20	
Particle density	API-RP40	Soil	mg/cm^3	--	75–125	±35	100
Grain size	ASTM D4464-00	Soil	percent	0.01	75–125	±35	100

Note: -- - not applicable
API - American Petroleum Institute
ASTM - American Society for Testing and Materials
EPA - U.S. Environmental Protection Agency
ICP-MS - inductively coupled plasma-mass spectrometry
RPD - relative percent difference

[a] Moss, willow, and lichen sample results will be reported by dry weight and berry sample results will be reported both by wet weight and dry weight.

Table 3. Sample preservation and holding time requirements

Analyte	Approximate Laboratory Subsample	Container	Preservation and Handling	Maximum Holding Time (from date of collection)
Soil				
Metals	1–5 g	250-mL wide-mouth glass or polyethylene jar; Teflon®-lined lid	4°C	180 days
Particle size	100 g	250-mL wide-mouth glass or polyethylene jar; Teflon®-lined lid	4°C (do not freeze)	28 days
Particle density	25 g	250 mL wide-mouth glass or polyethylene jar; Teflon®-lined lid	4°C	Not established
Water				
Metals	200 mL	500-mL polyethylene bottle; Teflon®-lined lid	HNO3 to pH<2; 4°C	180 days
Vegetation (except berries)				
Metals	10 g[a]	Ziploc™ bag	4°C	180 days
Berries				
Metals	10–50 g[a]	Wide-mouth glass or polyethylene jar; Teflon®-lined lid	4°C (do not freeze)	180 days

[a] Wet weight.