

Appendix F

Data Quality Review for the Phase II Sampling Program for the DMTS Fugitive Dust Risk Assessment

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Introduction

On behalf of Teck Cominco Alaska Incorporated, Exponent conducted field sampling and analysis in support of Phase II of the DeLong Mountain Regional Transportation System (DMTS) fugitive dust risk assessment. This data quality report describes the results of a quality assurance review of laboratory procedures and data for metals analyses and physical characteristic determinations (i.e., grain size distribution and total solids) completed on the sediment and tundra soil samples, and metals and total solids analyses completed on biota samples, collected during sampling events completed in June through September 2004. Appendix E describes the sample collection, and Appendix G provides a tabulation of the data.

Overall, the data reported for the Phase II DMTS fugitive dust risk assessment are of good quality. A total of 5,538 results were reported. Of these results, 594 (10.7 percent) were qualified as estimated (*J*) and 201 (3.6 percent) were restated as undetected (*U*). No results required rejection (*R*). A summary of the qualified data (by matrix) is summarized in Table 1.

The quality assurance review was conducted to verify that laboratory quality assurance and quality control (QA/QC) procedures were completed and documented as required. In addition, the quality assurance review was conducted to verify the quality of the data is sufficiently high to support their use in estimating possible risks to humans and other receptors posed by current and future exposure to metals in soil, water, sediments, and biota surrounding the DMTS, and to determine what additional measures may be needed to reduce those risks. Data that did not meet quality control measurement limits for were qualified as estimated (*J*) during the review. All data that were qualified as estimated (*J*) have an acceptable degree of uncertainty and represent data of good quality and reasonable confidence (U.S. EPA 1989; 1996). These qualified results are acceptable for their intended use. No data were rejected (*R*) as unusable for this investigation.

The remainder of this data quality report includes a summary of samples and analyses for the sampling program; descriptions of data validation procedures; and descriptions of QA/QC procedures and data quality for the environmental samples.

Samples and Analyses

Sediment samples, tundra soil samples, biota samples, equipment rinsate blanks, and a sample of the deionized/distilled water provided by the laboratory to complete the equipment rinsate blanks were collected during sampling events completed in June through September 2004. A summary of samples (by matrix) and the number of samples collected is provided in Table 1 and a summary of the analyses completed is provided in Table 2. Additional samples were collected and placed into archived storage at -20°C at the laboratory. Archived samples that were not analyzed are not addressed in this report. Details regarding sample locations and field sampling

procedures are described in the *Phase II Field Sampling and Analysis Plan for the DMTS Fugitive Dust Risk Assessment* (Exponent 2004).

Metals analyses and physical characteristic determinations were completed by Columbia Analytical Services, Inc. (CAS) located in Kelso, Washington. CAS submitted the data in 21 sample delivery groups (SDGs).

Data Validation Procedures

Data validation procedures included evaluating the sample results and applicable quality control results reported by the laboratory. The metals data were validated in accordance with guidance specified by the *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (U.S. EPA 2002). The U.S. Environmental Protection Agency (EPA) has not yet prepared national functional guidelines for the validation of grain size distribution and total solids data; therefore, these data were validated following the general evaluation procedures specified in U.S. EPA (2002) and in the context of method-specific quality control requirements and laboratory-established control limits (as are applicable to the analytical method).

The following laboratory deliverables (as applicable to the analyses completed) were evaluated during data validation:

- Case narratives discussing analytical problems (if any) and procedures
- Chain-of-custody documentation to verify completeness of the data set
- Sample preparation logs or laboratory summary result forms to verify analytical holding time constraints were met (all analyses)
- Results for instrument tuning, initial calibrations, and continuing calibrations to assess instrument performance (metals only)
- Results for method blanks and equipment rinsate blanks to determine whether an analyte reported as detected in any sample was the result of possible contamination at the laboratory or contamination during field sampling, respectively (metals only)
- Results for internal standards performance to ensure that instrument sensitivity and response were stable during the analysis of the samples (metals only)
- Results for laboratory control sample (LCS) (i.e., blank spikes), duplicate LCS, matrix spike, and matrix spike duplicate recoveries for metals to assess analytical accuracy (metals only)
- Results for duplicate samples (all analyses) or triplicate samples (grain size distribution only), duplicate LCSs (metals only), and MSD analyses (metals only), as applicable, to assess analytical precision

- Instrument printouts and bench sheets to assess the validity of analyte identification as either detected or undetected and to verify quantification of sample results (all analyses)
- Laboratory summaries of analytical results.

In addition, results for the field duplicate samples were evaluated to provide additional information in support of the quality assurance review.

Data qualifiers were assigned during the quality assurance review when control limits were not met, in accordance with U.S. EPA (2002). Data were qualified as estimated (*J*) when one or more quality control measurements (e.g., matrix spike recoveries and duplicate sample measurements) did not meet applicable control limits. All data qualified as estimated (*J*) have an acceptable degree of uncertainty and represent data of good quality and reasonable confidence (U.S. EPA 1989, 1996). No data were rejected (*R*).

Data Quality and Usability

Overall, the data reported for the Phase II DMTS fugitive dust risk assessment are of good quality. A total of 5,538 results were reported. Of these results, 594 (10.7 percent) were qualified as estimated (*J*) and 201 (3.6 percent) were restated as undetected (*U*). No results required rejection (*R*). A summary of the qualified data (by matrix type) is summarized in Table 1. All data are of sufficiently high quality for their intended purposes. The quality control results reviewed during the quality assurance review are summarized below.

Completeness

Completeness for metals and conventional analyses was 100 percent. The laboratory provided results for all requested analyses, and no data required rejection (*R*) during the quality assurance review.

Holding Times and Sample Preservation

The analytical holding time constraints and sample preservation requirements specified in the quality assurance project plan (QAPP) (Exponent 2004, Appendix A) and the applicable analytical methods were met for all samples and analyses.

Instrument Performance

The performance of the analytical instruments was acceptable. No changes in instrument performance that would have resulted in the degradation of data quality were indicated during any analysis sequence.

Mass Spectrometer Tuning

For the analysis of metals by inductively coupled plasma-mass spectrometry (ICP-MS), mass spectrometer tuning checks were completed as required to assess the sensitivity and precision of the instrument. Method-specific quality control requirements for mass spectrometer tuning checks were met.

Instrument Calibration

Initial calibration and continuing calibration verification (CCV) were completed, as required, for the metals analyses. Instrument calibrations met the criteria for acceptable performance in all cases.

Laboratory and Field Blanks

Laboratory blanks (i.e., method blanks, initial calibration blanks [ICBs], and continuing calibration blanks [CCBs]) are analyzed to check for contamination during sample preparation and analysis. Equipment rinsate blanks were collected to determine the effectiveness of equipment decontamination procedures in the field. Deionized and distilled water (supplied by CAS) that was used to prepare the equipment rinsate blanks was analyzed to determine whether this water was free of target analytes. The results of laboratory blanks, equipment rinsate blanks, and the laboratory deionized and distilled water are summarized below.

Method blanks were prepared and analyzed with each sample batch for the analysis of metals, as required by the analytical method. Initial calibration blanks and CCBs were analyzed for metals, as required by the analytical method, at the required frequency. Five equipment rinse blanks were collected and included the following:

- Sample EB0001, associated with the lagoon sediment samples
- Sample EB0002, associated with the marine sediment samples
- Sample EB003, associated with the terrestrial invertebrate samples
- Sample EB004, associated with the vegetation samples
- Sample EB-0002, associated with the second set of marine sediment samples collected in September 2004.

The equipment rinsate blanks were collected to determine the effectiveness of equipment decontamination procedures completed in the field. In addition, two samples (Samples DB0001 and DI-0002) of deionized and distilled water used for the field program were analyzed to determine whether this water was free of target analytes.

Selected metals were detected in some of the method blanks, ICBs, CCBs, equipment rinsate blanks, and the deionized and distilled water at a concentration above the method detection limit (MDL), but below the method reporting limit (MRL). Following data validation guidance (U.S. EPA 2002), results for selected metals required restatement as undetected (*U*) at the

concentration reported because they were present in the associated samples at a concentration less than 5 times the concentration in the associated blanks. The following results required restatement as undetected (*U*):

- Ten cadmium and nine silver results associated with the marine sediment samples
- One lead and one silver result associated with the tundra soil samples
- Twenty-two antimony, 17 chromium, 1 molybdenum, 1 thallium, and 5 vanadium results associated with the willow leaf samples
- One aluminum, 45 antimony, 21 chromium, 1 lead, 1 mercury, 6 thallium, and 7 vanadium results associated with the sedge samples
- Six antimony, 17 chromium, 2 molybdenum, and 10 vanadium results associated with the lichen samples
- Four antimony, 5 chromium, 1 molybdenum, and 1 thallium results associated with the birch leaf samples
- Two antimony results associated with the tufted hair grass samples
- Two mercury results associated with the mammal samples
- Two antimony results associated with the ptarmigan samples.

Accuracy

The accuracy (i.e., bias) of the analytical results is reflected by the performance of applicable internal standards, matrix spike recoveries, LCS recoveries, and serial dilution analyses. Results for these quality control procedures are described below.

Internal Standard Performance

Internal standards were added to all samples for the analysis of metals by ICP-MS to assess the existence and magnitude of instrument drift and physical interferences on a sample-by-sample basis. Method-specific criteria for internal standards performance were met.

Matrix Spike Recoveries

Matrix spikes are added to field samples to determine the analytical accuracy for samples from the study site. The recoveries of matrix spikes provide a measure of accuracy in the presence of matrix interferences. Matrix spike samples are required at a frequency of one per batch for all metals analyses only.

Matrix spike recoveries generally met laboratory-established control limits. In some instances, however, recoveries of selected metals in some matrix spikes were either below or above

laboratory-established control limits that required qualification of selected data as estimated (*J*). The following selected metals results required qualification as estimated (*J*):

- One lead result reported as detected in a marine sediment sample
- Thirteen antimony, 16 barium, 16 lead, and 52 manganese, and 32 zinc results reported as detected in tundra soil samples
- Six aluminum, 6 barium, and 9 zinc results reported as detected, and 1 aluminum and 4 chromium results reported as undetected, in willow leaf samples
- Ten aluminum, 6 barium, 1 chromium, and 10 zinc results reported as detected, and 1 aluminum and 3 chromium results reported as undetected, in sedge samples
- Thirteen aluminum, 8 barium, 3 chromium, and 14 zinc results reported as detected, and 4 chromium results reported as undetected, in lichen samples
- Two aluminum and 1 zinc results reported as detected, and 1 chromium result reported as undetected, in birch leaf samples
- Six lead and 6 zinc results reported as detected in stream invertebrate samples
- Five lead and 5 zinc results reported as detected in lagoon invertebrate samples
- Six antimony, 8 barium, 8 lead, and 8 zinc results reported as detected, and 2 antimony results reported as undetected, in soil invertebrate samples.

Laboratory Control Sample Recoveries

LCSs provide a control for the entire analytical system, including sample preparation as well as instrumental analysis. The recoveries of LCSs provide a measure of accuracy in the absence of matrix interferences. An LCS must be included with every sample batch for all metals analyses.

LCS recoveries generally met the data validation control limits of 75–125 percent (U.S. EPA 2002) and generally met laboratory-established control limits, with the following five exceptions:

- In one SDG associated with the analysis of terrestrial invertebrate samples, a recovery of 121 percent was reported in an LCS for aluminum. This recovery is within the data validation control limit of 75-125 percent (U.S. EPA 2002), but is above the upper laboratory-established control limit of 120 percent.
- In another SDG associated with the analysis of terrestrial invertebrate samples, recoveries of 140 percent and 125 percent were reported in an LCS for lead and zinc, respectively. The recovery for lead is above the upper data

validation control limit of 125 percent (U.S. EPA 2002) and is above the upper laboratory-established control limit of 137 percent. The recovery of zinc is within the data validation control limit of 75–125 percent (U.S. EPA 2002), but above the upper laboratory-established control limit of 124 percent.

- In two separate SDGs associated with the analysis of tundra soil samples, recoveries of 64 percent and 67 percent were reported for antimony. Both of these recoveries are below the lower data validation control limit of 75 percent (U.S. EPA 2002), but are within the laboratory-established control limits.

No data required additional qualification for any of the LCS exceedances noted above either because the affected metals were previously qualified for other quality control reasons (e.g., matrix spike recovery or precision exceedances) or because the LCS exceedance was only slightly outside the applicable control limit.

ICP Serial Dilution Analyses

ICP serial dilution analyses are completed to determine whether significant physical or chemical interferences exist due to sample matrix. An ICP serial dilution analysis must be performed on a sample from each group of samples with a similar matrix and concentration, or for each sample delivery group, whichever is more frequent. The control limit for serial dilution is 10 percent difference between the undiluted sample and the diluted sample (after adjustment for the dilution).

Serial dilution results for the sample analyses, and the frequency of analysis, typically met the criteria for acceptable performance. The 10-percent difference control limit was not met for the following metals and matrices:

- Barium associated with the analysis of selected willow leaf samples. Three results reported as detected were qualified as estimated (*J*).
- Barium, chromium, and vanadium associated with the analysis of selected sedge samples. Two results reported as detected for barium, two results reported as detected for chromium, one result reported as detected for vanadium, one result reported as undetected for chromium, and one result reported as undetected for vanadium were qualified as estimated (*J*).
- Barium, chromium, and vanadium associated with the analysis of selected lichen samples. One result reported as detected for barium, one result reported as detected for chromium, and two results reported as detected for vanadium were qualified as estimated (*J*).
- Barium associated with the analysis of selected birch leaf samples. One result reported as detected for barium was qualified as estimated (*J*).

- Chromium associated with the analysis of selected tufted grass samples. Two results reported as detected for chromium were qualified as estimated (*J*).
- Chromium associated with the analysis of selected mammal samples. Seven results reported as detected for chromium were qualified as estimated (*J*).

Precision

Laboratory duplicate samples are used to determine the precision of analyses for metals and total solids and laboratory triplicate samples for grain size distribution determinations are used to determine the precision of analyses for grain size distribution.

The results for applicable laboratory duplicates generally met the laboratory-established control limits. The results for applicable laboratory triplicates met the laboratory-established control limits. The required frequency of analysis of laboratory duplicates and triplicates was met. In some instances, however, the relative percent difference of selected metals in some duplicate sample analyses was above the laboratory-established control limit, requiring qualification of the following selected metals results as estimated (*J*):

- Sixteen antimony, 36 barium, 16 cadmium, 36 cobalt, 16 copper, 16 lead, 36 manganese, 16 mercury, 49 molybdenum, 36 vanadium, and 16 zinc results reported as detected in tundra soil samples
- One antimony and 10 chromium results reported as undetected in willow leaf samples
- Two antimony and 1 chromium results reported as detected, and 3 antimony and 9 chromium results reported as undetected in sedge samples
- Five antimony and 7 chromium results reported as detected, and 6 chromium results reported as undetected in lichen samples
- Two antimony and 1 chromium results reported as undetected for birch leaf samples
- Six lead results reported as detected in stream invertebrate samples
- Five lead results reported as detected in lagoon invertebrate samples
- Eight lead results reported as detected in soil invertebrate samples
- Twenty antimony results reported as detected in sour dock samples
- Twenty barium and four cadmium results reported as detected in ptarmigan samples.

Identification and Quantification of Analytes

Identification requirements for the analyses completed are provided in each method description. Quantification of analyte concentrations involves calculation of concentrations with respect to standards; correction for sample weights or volumes, dilutions, and moisture content in the samples; and determination and correct calculation of MDLs and MRLs for each analyte in each sample type and dilution level (if completed). Verification of analyte quantification and identification were the responsibility of the laboratory and were assessed during the quality assurance review. All criteria for identification and quantification, as specified in the applicable analytical methods, were met.

Method Detection Limits and Method Reporting Limits

The MDLs and MRLs provided by the laboratory met project method quality objectives. MDLs and MRLs varied with moisture content of the samples. Dilutions were necessary for some samples analyzed for metals due to relatively high concentrations of specific metals in the affected samples.

Field Duplicate Quality Control Samples

The field duplicates collected are collocated samples. They provide information regarding variability in analyte concentration in the area from which they were collected, are not used to assess laboratory precision, and are generally not used to qualify sample data.

The number of field duplicates collected during this investigation included three for the marine sediment samples; one for the lagoon sediment samples; one for the stream sediment samples; three for the tundra soil samples; two for the willow leaf samples; two for the lichen samples; four for the sedge samples; one for the lagoon invertebrate samples; two for the salmonberry samples; and two for the sour dock samples.

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Table F1-1. Summary of qualified data

Matrix	Analyte	Total No. Samples	Total No. Results Reported	Total No. Results Qualified Estimated (<i>J</i>)	Total No. Results Restated Undetected (<i>U</i>)	Total No. Results Rejected (<i>R</i>)	
Marine sediment	Total solids	62	62	0	0	0	
	Percent clay	62	62	0	0	0	
	Percent silt	62	62	0	0	0	
	Phi class 3.00+ to 4.00	62	62	0	0	0	
	Phi class 2.00+ to 3.00	62	62	0	0	0	
	Phi class 1.00+ to 2.00	62	62	0	0	0	
	Phi class 0.00+ to 1.00	62	62	0	0	0	
	Phi class -1.00+ to 0.00	62	62	0	0	0	
	Phi class -2.00+ to -1.00	62	62	0	0	0	
	Phi class -3.00+ to -2.00	62	62	0	0	0	
	Cadmium	62	62	0	10	0	
	Copper	21	21	0	0	0	
	Lead	62	62	1	0	0	
	Mercury	21	21	0	0	0	
	Silver	21	21	0	9	0	
	Zinc	62	62	0	0	0	
	Total count	62	869	1	19	0	
Lagoon sediment	Total solids	7	7	0	0	0	
	Percent clay	7	7	0	0	0	
	Percent silt	7	7	0	0	0	
	Phi class 3.00+ to 4.00	7	7	0	0	0	
	Phi class 2.00+ to 3.00	7	7	0	0	0	
	Phi class 1.00+ to 2.00	7	7	0	0	0	
	Phi class 0.00+ to 1.00	7	7	0	0	0	
	Phi class -1.00+ to 0.00	7	7	0	0	0	
	Phi class -2.00+ to -1.00	7	7	0	0	0	
	Phi class -3.00+ to -2.00	7	7	0	0	0	
	Arsenic	7	7	0	0	0	
	Cadmium	7	7	0	0	0	
	Lead	7	7	0	0	0	
	Mercury	7	1	0	0	0	
	Zinc	7	7	0	0	0	
		Total count	7	99	0	0	0
Stream sediment	Total solids	6	6	0	0	0	
	Percent clay	6	6	0	0	0	
	Percent silt	6	6	0	0	0	
	Phi class 3.00+ to 4.00	6	6	0	0	0	
	Phi class 2.00+ to 3.00	6	6	0	0	0	
	Phi class 1.00+ to 2.00	6	6	0	0	0	
	Phi class 0.00+ to 1.00	6	6	0	0	0	
	Phi class -1.00+ to 0.00	6	6	0	0	0	
	Phi class -2.00+ to -1.00	6	6	0	0	0	
	Phi class -3.00+ to -2.00	6	6	0	0	0	
	Cadmium	6	6	0	0	0	
	Lead	6	6	0	0	0	
	Mercury	6	6	0	0	0	
	Zinc	6	6	0	0	0	
		Total count	6	84	0	0	0

Table F1-1. (cont.)

Matrix	Analyte	Total No. Samples	Total No. Results Reported	Total No. Results Qualified Estimated (<i>J</i>)	Total No. Results Restated Undetected (<i>U</i>)	Total No. Results Rejected (<i>R</i>)
Tundra soil	Total solids	65	65	0	0	0
	Antimony	65	65	29	0	0
	Arsenic	65	65	0	0	0
	Barium	65	65	36	0	0
	Cadmium	65	65	16	0	0
	Cobalt	65	65	36	0	0
	Copper	65	65	16	0	0
	Lead	65	65	16	1	0
	Manganese	65	65	52	0	0
	Mercury	65	65	16	0	0
	Molybdenum	65	65	49	0	0
	Selenium	65	65	0	0	0
	Silver	65	65	0	1	0
	Thallium	65	65	0	0	0
	Vanadium	65	65	36	0	0
	Zinc	65	65	32	0	0
	pH	65	65	0	0	0
		Total count	65	1,105	334	2
Willow leaves	Total solids	30	30	0	0	0
	Aluminum	30	30	7	0	0
	Antimony	30	30	1	22	0
	Arsenic	30	30	0	0	0
	Barium	30	30	9	0	0
	Cadmium	30	30	0	0	0
	Chromium	30	30	10	17	0
	Cobalt	30	30	0	0	0
	Lead	30	30	0	0	0
	Mercury	30	30	0	0	0
	Molybdenum	30	30	0	1	0
	Selenium	30	30	0	0	0
	Thallium	30	30	0	1	0
	Vanadium	30	30	9	5	0
	Zinc	30	30	0	0	0
		Total count	30	450	36	46
Sedge	Total solids	61	61	0	0	0
	Aluminum	61	61	11	1	0
	Antimony	61	61	5	45	0
	Arsenic	61	61	0	0	0
	Barium	61	61	8	0	0
	Cadmium	61	61	0	0	0
	Chromium	61	61	13	21	0
	Cobalt	61	61	0	0	0
	Lead	61	61	0	1	0
	Mercury	61	61	0	1	0
	Molybdenum	61	61	0	0	0
	Selenium	61	61	0	0	0
	Thallium	61	61	0	6	0
	Vanadium	61	61	2	7	0
	Zinc	61	61	10	0	0
	Total count	61	915	49	82	0

Table F1-1. (cont.)

Matrix	Analyte	Total No. Samples	Total No. Results Reported	Total No. Results Qualified Estimated (<i>J</i>)	Total No. Results Restated Undetected (<i>U</i>)	Total No. Results Rejected (<i>R</i>)
Lichen	Total solids	34	34	0	0	0
	Aluminum	34	34	14	0	0
	Antimony	34	34	5	6	0
	Arsenic	34	34	0	0	0
	Barium	34	34	9	0	0
	Cadmium	34	34	0	0	0
	Chromium	34	34	14	17	0
	Cobalt	34	34	0	0	0
	Lead	34	34	0	0	0
	Mercury	34	34	0	0	0
	Molybdenum	34	34	0	2	0
	Selenium	34	34	0	0	0
	Thallium	34	34	0	0	0
	Vanadium	34	34	2	10	0
	Zinc	34	34	14	0	0
	Total count	34	510	58	35	0
	Birch leaves	Total solids	6	6	0	0
Aluminum		6	6	2	0	0
Antimony		6	6	2	4	0
Arsenic		6	6	0	0	0
Barium		6	6	1	0	0
Cadmium		6	6	0	0	0
Chromium		6	6	1	5	0
Cobalt		6	6	0	0	0
Lead		6	6	0	0	0
Mercury		6	6	0	0	0
Molybdenum		6	6	0	1	0
Selenium		6	6	0	0	0
Thallium		6	6	0	1	0
Vanadium		6	6	0	0	0
Zinc		6	6	1	0	0
Total count		6	90	7	11	0
Tufted hair grass		Total solids	2	2	0	0
	Aluminum	2	2	0	0	0
	Antimony	2	2	0	2	0
	Arsenic	2	2	0	0	0
	Barium	2	2	0	0	0
	Cadmium	2	2	0	0	0
	Chromium	2	2	2	0	0
	Cobalt	2	2	0	0	0
	Lead	2	2	0	0	0
	Mercury	2	2	0	0	0
	Molybdenum	2	2	0	0	0
	Selenium	2	2	0	0	0
	Thallium	2	2	0	0	0
	Vanadium	2	2	0	0	0
	Zinc	2	2	0	0	0
	Total count	2	30	2	2	0

Table F1-1. (cont.)

Matrix	Analyte	Total No. Samples	Total No. Results Reported	Total No. Results Qualified Estimated (J)	Total No. Results Restated Undetected (U)	Total No. Results Rejected (R)
Stream invertebrates	Total solids	6	6	0	0	0
	Cadmium	6	6	0	0	0
	Lead	6	6	6	0	0
	Mercury	6	6	0	0	0
	Zinc	6	6	6	0	0
	Total count	6	30	12	0	0
Lagoon invertebrates	Total solids	5	5	0	0	0
	Antimony	1	1	0	0	0
	Arsenic	1	1	0	0	0
	Barium	1	1	0	0	0
	Cadmium	5	5	0	0	0
	Cobalt	1	1	0	0	0
	Lead	5	5	5	0	0
	Molybdenum	1	1	0	0	0
	Selenium	1	1	0	0	0
	Thallium	1	1	0	0	0
	Zinc	5	5	5	0	0
	Total count	5	27	10	0	0
	Soil invertebrates	Total solids	18	18	0	0
Aluminum		18	18	0	0	0
Antimony		18	18	6	0	0
Arsenic		18	18	0	0	0
Barium		18	18	10	0	0
Cadmium		18	18	0	0	0
Chromium		18	18	0	0	0
Cobalt		18	18	0	0	0
Lead		18	18	8	0	0
Mercury		18	18	0	0	0
Molybdenum		18	18	0	0	0
Selenium		18	18	0	0	0
Thallium		18	18	0	0	0
Vanadium		18	18	0	0	0
Zinc		18	18	8	0	0
Total count		18	270	32	0	0
Salmonberry	Total solids	34	34	0	0	0
	Antimony	34	34	0	0	0
	Barium	34	34	2	0	0
	Cadmium	34	34	0	0	0
	Lead	34	34	0	0	0
	Thallium	34	34	0	0	0
	Zinc	34	34	0	0	0
	Total count	34	238	2	0	0
Sour Dock	Total solids	34	34	0	0	0
	Antimony	34	34	20	0	0
	Barium	34	34	0	0	0
	Cadmium	34	34	0	0	0
	Lead	34	34	0	0	0
	Thallium	34	34	0	0	0
	Zinc	34	34	0	0	0
	Total count	34	238	20	0	0

Table F1-1. (cont.)

Matrix	Analyte	Total No. Samples	Total No. Results Reported	Total No. Results Qualified Estimated (J)	Total No. Results Restated Undetected (U)	Total No. Results Rejected (R)
Small mammal	Total solids	23	23	0	0	0
	Aluminum	23	23	0	0	0
	Antimony	23	23	0	0	0
	Arsenic	23	23	0	0	0
	Barium	23	23	0	0	0
	Cadmium	23	23	0	0	0
	Chromium	23	23	7	0	0
	Cobalt	23	23	0	0	0
	Lead	23	23	0	0	0
	Mercury	23	23	0	2	0
	Molybdenum	23	23	0	0	0
	Selenium	23	23	0	0	0
	Thallium	23	23	0	0	0
	Vanadium	23	23	0	0	0
	Zinc	23	23	0	0	0
	Total count	23	345	7	2	0
Ptarmigan	Total solids	24	24	0	0	0
	Antimony	24	24	0	2	0
	Barium	24	24	20	0	0
	Cadmium	24	24	4	0	0
	Lead	24	24	0	0	0
	Thallium	24	24	0	0	0
	Zinc	24	24	0	0	0
		Total count	24	168	24	2
Equipment rinsate blank EB0001	Arsenic	1	1	0	0	0
	Cadmium	1	1	0	0	0
	Lead	1	1	0	0	0
	Zinc	1	1	0	0	0
		Total count	1	4	0	0
Equipment rinsate blank EB0002	Cadmium	1	1	0	0	0
	Copper	1	1	0	0	0
	Lead	1	1	0	0	0
	Mercury	1	1	0	0	0
	Silver	1	1	0	0	0
	Zinc	1	1	0	0	0
	Total count	1	6	0	0	0
Equipment rinsate blank EB0003	Aluminum	1	1	0	0	0
	Antimony	1	1	0	0	0
	Arsenic	1	1	0	0	0
	Barium	1	1	0	0	0
	Cadmium	1	1	0	0	0
	Chromium	1	1	0	0	0
	Cobalt	1	1	0	0	0
	Lead	1	1	0	0	0
	Mercury	1	1	0	0	0
	Molybdenum	1	1	0	0	0
	Selenium	1	1	0	0	0
Thallium	1	1	0	0	0	

Table F1-1. (cont.)

Matrix	Analyte	Total No. Samples	Total No. Results Reported	Total No. Results Qualified Estimated (<i>J</i>)	Total No. Results Restated Undetected (<i>U</i>)	Total No. Results Rejected (<i>R</i>)
Equipment rinsate blank EB0003 (cont.)	Vanadium	1	1	0	0	0
	Zinc	1	1	0	0	0
	Total count	1	14	0	0	0
Equipment rinsate blank EB0004	Aluminum	1	1	0	0	0
	Antimony	1	1	0	0	0
	Arsenic	1	1	0	0	0
	Barium	1	1	0	0	0
	Cadmium	1	1	0	0	0
	Chromium	1	1	0	0	0
	Cobalt	1	1	0	0	0
	Lead	1	1	0	0	0
	Mercury	1	1	0	0	0
	Molybdenum	1	1	0	0	0
	Selenium	1	1	0	0	0
	Thallium	1	1	0	0	0
	Vanadium	1	1	0	0	0
	Zinc	1	1	0	0	0
Total count	1	14	0	0	0	
Laboratory DI water DB0001	Aluminum	1	1	0	0	0
	Antimony	1	1	0	0	0
	Arsenic	1	1	0	0	0
	Barium	1	1	0	0	0
	Cadmium	1	1	0	0	0
	Chromium	1	1	0	0	0
	Cobalt	1	1	0	0	0
	Copper	1	1	0	0	0
	Lead	1	1	0	0	0
	Manganese	1	1	0	0	0
	Mercury	1	1	0	0	0
	Molybdenum	1	1	0	0	0
	Selenium	1	1	0	0	0
	Silver	1	1	0	0	0
	Thallium	1	1	0	0	0
	Vanadium	1	1	0	0	0
	Zinc	1	1	0	0	0
Total count	1	17	0	0	0	
Laboratory DI water DI-0002	Cadmium	1	1	0	0	0
	Copper	1	1	0	0	0
	Lead	1	1	0	0	0
	Mercury	1	1	0	0	0
	Silver	1	1	0	0	0
	Zinc	1	1	0	0	0
Total count	1	6	0	0	0	

Table F1-1. (cont.)

Matrix	Analyte	Total No. Samples	Total No. Results Reported	Total No. Results Qualified Estimated (<i>J</i>)	Total No. Results Restated Undetected (<i>U</i>)	Total No. Results Rejected (<i>R</i>)
Equipment rinsate	Cadmium	1	1	0	0	0
blank EB-0002	Copper	1	1	0	0	0
	Lead	1	1	0	0	0
	Mercury	1	1	0	0	0
	Silver	1	1	0	0	0
	Zinc	1	1	0	0	0
	Total count	1	6	0	0	0
	OVERALL TOTALS	424	5,538	594	201	0
	Percentage	--	--	10.7	3.6	0

Table F1-2. Summary of analytical methods

Matrix	Analyte	Method
Marine sediment	Total solids	EPA Method 160.3 M
	Grain size distribution	ASTM D422
	Cadmium	EPA Method 200.8 by ICP-MS
	Copper	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7471A by CVAA
	Silver	EPA Method 200.8 by ICP-MS
	Zinc	EPA Method 200.8 by ICP-MS
Lagoon sediment	Total solids	EPA Method 160.3 M
	Grain size distribution	ASTM D422
	Arsenic	EPA Method 200.8 by ICP-MS
	Cadmium	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7471A by CVAA
	Zinc	EPA Method 200.8 by ICP-MS
Stream sediment	Total solids	EPA Method 160.3 M
	Grain size distribution	ASTM D422
	Cadmium	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7471A by CVAA
	Zinc	EPA Method 200.8 by ICP-MS
Tundra soil	Total solids	EPA Method 160.3 M
	Antimony	EPA Method 200.8 by ICP-MS
	Arsenic	EPA Method 200.8 by ICP-MS
	Barium	EPA Method 200.8 by ICP-MS
	Cadmium	EPA Method 200.8 by ICP-MS
	Cobalt	EPA Method 200.8 by ICP-MS
	Copper	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Manganese	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7471A by CVAA
	Molybdenum	EPA Method 200.8 by ICP-MS
	Selenium	EPA Method 200.8 by ICP-MS
	Silver	EPA Method 200.8 by ICP-MS
	Thallium	EPA Method 200.8 by ICP-MS
	Vanadium	EPA Method 200.8 by ICP-MS
Zinc	EPA Method 200.8 by ICP-MS	
Willow leaves	Total solids	EPA Method 160.3 M
	Aluminum	EPA SW-846 Method 6010B by ICP-AES
	Antimony	EPA Method 200.8 by ICP-MS
	Arsenic	EPA Method 200.8 by ICP-MS
	Barium	EPA Method 200.8 by ICP-MS and EPA SW-846 Method 6010B by ICP-AES
	Cadmium	EPA Method 200.8 by ICP-MS
	Chromium	EPA SW-846 Method 6010B by ICP-AES
	Cobalt	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7471A by CVAA
	Molybdenum	EPA Method 200.8 by ICP-MS
	Selenium	EPA Method 200.8 by ICP-MS
	Thallium	EPA Method 200.8 by ICP-MS

Table F1-2. (cont.)

Matrix	Analyte	Method
Willow leaves (cont.)	Vanadium	EPA SW-846 Method 6010B by ICP-AES
	Zinc	EPA Method 200.8 by ICP-MS and EPA SW-846 Method 6010B by ICP-AES
Sedge	Total solids	EPA Method 160.3 M
	Aluminum	EPA SW-846 Method 6010B by ICP-AES
	Antimony	EPA Method 200.8 by ICP-MS
	Arsenic	EPA Method 200.8 by ICP-MS
	Barium	EPA Method 200.8 by ICP-MS and EPA SW-846 Method 6010B by ICP-AES
	Cadmium	EPA Method 200.8 by ICP-MS
	Chromium	EPA SW-846 Method 6010B by ICP-AES
	Cobalt	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7471A by CVAA
	Molybdenum	EPA Method 200.8 by ICP-MS
	Selenium	EPA Method 200.8 by ICP-MS
	Thallium	EPA Method 200.8 by ICP-MS
	Vanadium	EPA SW-846 Method 6010B by ICP-AES
	Zinc	EPA Method 200.8 by ICP-MS and EPA SW-846 Method 6010B by ICP-AES
	Lichen	Total solids
Aluminum		EPA SW-846 Method 6010B by ICP-AES
Antimony		EPA Method 200.8 by ICP-MS
Arsenic		EPA Method 200.8 by ICP-MS
Barium		EPA Method 200.8 by ICP-MS and EPA SW-846 Method 6010B by ICP-AES
Cadmium		EPA Method 200.8 by ICP-MS
Chromium		EPA SW-846 Method 6010B by ICP-AES
Cobalt		EPA Method 200.8 by ICP-MS
Lead		EPA Method 200.8 by ICP-MS
Mercury		EPA SW-846 Method 7471A by CVAA
Molybdenum		EPA Method 200.8 by ICP-MS
Selenium		EPA Method 200.8 by ICP-MS
Thallium		EPA Method 200.8 by ICP-MS
Vanadium		EPA SW-846 Method 6010B by ICP-AES
Zinc		EPA Method 200.8 by ICP-MS and EPA SW-846 Method 6010B by ICP-AES
Birch leaves		Total solids
	Aluminum	EPA SW-846 Method 6010B by ICP-AES
	Antimony	EPA Method 200.8 by ICP-MS
	Arsenic	EPA Method 200.8 by ICP-MS
	Barium	EPA SW-846 Method 6010B by ICP-AES
	Cadmium	EPA Method 200.8 by ICP-MS
	Chromium	EPA SW-846 Method 6010B by ICP-AES
	Cobalt	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7471A by CVAA
	Molybdenum	EPA Method 200.8 by ICP-MS
	Selenium	EPA Method 200.8 by ICP-MS
	Thallium	EPA Method 200.8 by ICP-MS
	Vanadium	EPA SW-846 Method 6010B by ICP-AES
Zinc	EPA SW-846 Method 6010B by ICP-AES	

Table F1-2. (cont.)

Matrix	Analyte	Method
Tufted hair grass	Total solids	EPA Method 160.3 M
	Aluminum	EPA SW-846 Method 6010B by ICP-AES
	Antimony	EPA Method 200.8 by ICP-MS
	Arsenic	EPA Method 200.8 by ICP-MS
	Barium	EPA Method 200.8 by ICP-MS
	Cadmium	EPA Method 200.8 by ICP-MS
	Chromium	EPA SW-846 Method 6010B by ICP-AES
	Cobalt	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7471A by CVAA
	Molybdenum	EPA Method 200.8 by ICP-MS
	Selenium	EPA Method 200.8 by ICP-MS
	Thallium	EPA Method 200.8 by ICP-MS
	Vanadium	EPA SW-846 Method 6010B by ICP-AES
	Zinc	EPA Method 200.8 by ICP-MS
Stream invertebrates	Total solids	EPA Method 160.3 M
	Cadmium	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7471A by CVAA
	Zinc	EPA Method 200.8 by ICP-MS
Lagoon invertebrates	Total solids	EPA Method 160.3 M
	Antimony	EPA Method 200.8 by ICP-MS
	Arsenic	EPA Method 200.8 by ICP-MS
	Barium	EPA Method 200.8 by ICP-MS
	Cadmium	EPA Method 200.8 by ICP-MS
	Cobalt	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Molybdenum	EPA Method 200.8 by ICP-MS
	Selenium	EPA Method SW-846 7740 by GFAA
	Thallium	EPA Method 200.8 by ICP-MS
	Zinc	EPA Method 200.8 by ICP-MS
Soil invertebrates	Total solids	EPA Method 160.3 M
	Aluminum	EPA SW-846 Method 6010B by ICP-AES
	Antimony	EPA Method 200.8 by ICP-MS
	Arsenic	EPA Method 200.8 by ICP-MS
	Barium	EPA Method 200.8 by ICP-MS
	Cadmium	EPA Method 200.8 by ICP-MS
	Chromium	EPA SW-846 Method 6010B by ICP-AES
	Cobalt	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7471A by CVAA
	Molybdenum	EPA Method 200.8 by ICP-MS
	Selenium	EPA Method SW-846 7740 by GFAA
	Thallium	EPA Method 200.8 by ICP-MS
	Vanadium	EPA SW-846 Method 6010B by ICP-AES
Zinc	EPA SW-846 Method 6010B by ICP-AES	
Salmonberry	Total solids	EPA Method 160.3 M
	Antimony	EPA Method 200.8 by ICP-MS
	Barium	EPA Method 200.8 by ICP-MS
	Cadmium	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS

Table F1-2. (cont.)

Matrix	Analyte	Method
Salmonberry (cont.)	Thallium	EPA Method 200.8 by ICP-MS
	Zinc	EPA Method 200.8 by ICP-MS
Sour Dock	Total solids	EPA Method 160.3 M
	Antimony	EPA Method 200.8 by ICP-MS
	Barium	EPA Method 200.8 by ICP-MS
	Cadmium	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Thallium	EPA Method 200.8 by ICP-MS
	Zinc	EPA Method 200.8 by ICP-MS
Small mammal	Total solids	EPA Method 160.3 M
	Aluminum	EPA SW-846 Method 6010B by ICP-AES
	Antimony	EPA Method 200.8 by ICP-MS
	Arsenic	EPA Method 200.8 by ICP-MS
	Barium	EPA Method 200.8 by ICP-MS
	Cadmium	EPA Method 200.8 by ICP-MS
	Chromium	EPA SW-846 Method 6010B by ICP-AES
	Cobalt	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7471A by CVAA
	Molybdenum	EPA Method 200.8 by ICP-MS
	Selenium	EPA Method SW-846 7740 by GFAA
	Thallium	EPA Method 200.8 by ICP-MS
	Vanadium	EPA SW-846 Method 6010B by ICP-AES
Zinc		
Ptarmigan	Total solids	EPA Method 160.3 M
	Antimony	EPA Method 200.8 by ICP-MS
	Barium	EPA Method 200.8 by ICP-MS
	Cadmium	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Thallium	EPA Method 200.8 by ICP-MS
	Zinc	EPA Method 200.8 by ICP-MS
Equipment rinsate blank EB0001	Arsenic	EPA Method 200.8 by ICP-MS
	Cadmium	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Zinc	EPA Method 200.8 by ICP-MS
Equipment rinsate blank EB0002	Cadmium	EPA Method 200.8 by ICP-MS
	Copper	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7470A by CVAA
	Silver	EPA Method 200.8 by ICP-MS
	Zinc	EPA Method 200.8 by ICP-MS
Equipment rinsate blank EB0003	Aluminum	EPA Method 200.8 by ICP-MS
	Antimony	EPA Method 200.8 by ICP-MS
	Arsenic	EPA Method 200.8 by ICP-MS
	Barium	EPA Method 200.8 by ICP-MS
	Cadmium	EPA Method 200.8 by ICP-MS
	Chromium	EPA Method 200.8 by ICP-MS
	Cobalt	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7470A by CVAA

Table F1-2. (cont.)

Matrix	Analyte	Method
Equipment rinsate blank EB0003 (cont.)	Molybdenum	EPA Method 200.8 by ICP-MS
	Selenium	EPA Method 200.8 by ICP-MS
	Thallium	EPA Method 200.8 by ICP-MS
	Vanadium	EPA Method 200.8 by ICP-MS
	Zinc	EPA Method 200.8 by ICP-MS
Equipment rinsate blank EB0004	Aluminum	EPA Method 200.8 by ICP-MS
	Antimony	EPA Method 200.8 by ICP-MS
	Arsenic	EPA Method 200.8 by ICP-MS
	Barium	EPA Method 200.8 by ICP-MS
	Cadmium	EPA Method 200.8 by ICP-MS
	Chromium	EPA Method 200.8 by ICP-MS
	Cobalt	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7470A by CVAA
	Molybdenum	EPA Method 200.8 by ICP-MS
	Selenium	EPA Method 200.8 by ICP-MS
	Thallium	EPA Method 200.8 by ICP-MS
	Vanadium	EPA Method 200.8 by ICP-MS
Zinc	EPA Method 200.8 by ICP-MS	
Laboratory DI water DB0001	Aluminum	EPA Method 200.8 by ICP-MS
	Antimony	EPA Method 200.8 by ICP-MS
	Arsenic	EPA Method 200.8 by ICP-MS
	Barium	EPA Method 200.8 by ICP-MS
	Cadmium	EPA Method 200.8 by ICP-MS
	Chromium	EPA Method 200.8 by ICP-MS
	Cobalt	EPA Method 200.8 by ICP-MS
	Copper	EPA Method 200.8 by ICP-MS
	Lead	EPA Method 200.8 by ICP-MS
	Manganese	EPA Method 200.8 by ICP-MS
	Mercury	EPA SW-846 Method 7470A by CVAA
	Molybdenum	EPA Method 200.8 by ICP-MS
	Selenium	EPA Method 200.8 by ICP-MS
	Silver	EPA Method 200.8 by ICP-MS
	Thallium	EPA Method 200.8 by ICP-MS
	Vanadium	EPA Method 200.8 by ICP-MS
Zinc	EPA Method 200.8 by ICP-MS	

Note: AES - atomic emission spectrometry
 ASTM - American Society for Testing and Materials
 CVAA - cold vapor atomic absorption
 EPA - U.S. Environmental Protection Agency
 GFAA - graphite furnace atomic absorption spectrometry
 ICP - inductively coupled plasma
 MS - mass spectrometry

**Data Quality Review of
Benthic Macroinvertebrate
Data**

Data Quality Review of Benthic Macroinvertebrate Data

Introduction

This report documents the results of the quality assurance/quality control (QA/QC) review of the data generated on benthic macroinvertebrate drift assemblages that were collected from six streams near the Red Dog Mine in Alaska. Three streams were located near the DeLong Mountain Regional Transportation System (DMTS) road (i.e., site streams) and the remaining three streams were located in a reference area (i.e., reference streams). The benthic macroinvertebrate evaluations were conducted by Mr. Steve Peek of Bug Sleuth in Fairbanks, Alaska. Exponent conducted the quality assurance review to ensure that the methods used to collect the benthic macroinvertebrate assemblage data were consistent with the specifications of the statement of work (SOW) and that the data are acceptable for their intended use in future stages of the Red Dog Mine ecological evaluation.

The quality assurance review consisted of an evaluation of the following major elements of the benthic macroinvertebrate evaluations:

- **Field Methods**—Were the major specifications of the field sampling procedures followed, as described in the field sampling and analysis plan (Exponent 2004)?
- **Laboratory System and Testing Methods**—Were the major specifications of the laboratory testing procedures followed, as described in the laboratory SOW prepared by Exponent? Were the specified field and laboratory methods (i.e., .S. EPA 1997; Scannell and Ott 2001) followed and were any modifications adequately justified and documented?
- **Taxonomic Accuracy**—Were taxonomic identifications conducted by experienced taxonomists using the appropriate literature?

The following sections of this report present the results of the QA/QC evaluation of the data for the benthic macroinvertebrate assemblages. QA/QC considerations are then summarized, and conclusions are presented in the final section.

Review of Methods

In this section, the methods used for field sampling, laboratory analyses, and QA/QC procedures are reviewed.

Field Methods

Overall, the field methods used to conduct the benthic macroinvertebrate evaluations were consistent with U.S. EPA (1997) and Scannell and Ott (2001). All field sampling was conducted by Exponent staff between July 22 and 25, 2004. For each stream, a single station was selected for analysis. Each station consisted of a 45–95 m stream segment. For the three site streams, the stream segments were located immediately downstream from the DMTS Road. The segments in all three site streams were high-gradient environments with substrates composed primarily of cobble and gravel. The three reference streams were selected so that their physical characteristics were as similar as possible to those of the site streams.

Aquatic macroinvertebrates were sampled using drift nets set within riffle habitats. Five drift nets (mesh size = 363 μm) were installed as replicate samples at random locations within each stream segment. The dimensions of each drift net were 28 cm (11 in.) in height and 47 cm (18.5 in.) in width. In all cases, drift nets were deployed in water approximately 28 cm deep, so that the nets sampled the entire water column. Water velocity and depth were measured at the mouth of each drift net to determine the volume of water sampled, so that macroinvertebrate abundances could be standardized to water volume (i.e., m^3). Each drift net was deployed for a sampling period of approximately an hour (i.e., 55–83 minutes). Water velocity was measured at the mouth of each drift net using a flow meter at the beginning and end of each sampling period.

At the end of sampling, each drift net was removed and the retained material was rinsed into the end cup using site water, rinsing from the outside of the net. The end cup was then detached from the net, and the retained material was transferred to a sample container and preserved with a 10 percent formalin solution.

Laboratory Methods

Overall, the recommended laboratory protocols were followed closely during testing. In the taxonomic laboratory, each sample was transferred to a pan that was subdivided into quarters. All material was spread out in the pan and, in most cases, a one-quarter subsample was randomly selected for taxonomic analysis. In some cases, when macroinvertebrate densities were relatively low, taxonomic analysis was conducted on the entire sample. Subsampling procedures were specified by Exponent in a supplement to the laboratory SOW after the field sampling was completed and it was found that many samples included large numbers of organisms.

All taxonomic determinations were made by Mr. Steve Peek, a qualified taxonomic expert who has conducted similar evaluations for streams near the Red Dog Mine for the Alaska Department of Fish and Game. All taxonomic determinations were made using a binocular microscope. Most insects were identified to the genus level, if possible. However, chironomids were identified only to the family level. All other taxonomic groups were identified to higher taxonomic levels (usually class or order).

Terrestrial invertebrates that were incidentally captured by the drift nets were identified to higher taxonomic levels and enumerated. However, the terrestrial invertebrates were not used in the comparisons of the site and reference streams.

All macroinvertebrates were preserved in labeled vials and transferred to Exponent for archiving.

QA/QC Procedures

Taxonomic identifications were made by Mr. Steve Peek, a qualified taxonomic expert. As a check on the identifications during this QA/QC review, all taxonomic names were verified by consulting standard references (Pennak 1953; Usinger 1956; Merritt and Cummins 1978). No taxonomic discrepancies were found. However, in several cases, the number of individuals of a particular taxon was inadvertently omitted from the laboratory data sheet. In such cases, Exponent determined the number of individuals using the archived specimens for the project.

Based on the review of taxonomic accuracy, it was concluded that the taxonomic identifications were made with acceptable accuracy.

Summary of QA/QC Considerations

Based on the review of field sampling methods, laboratory procedures and taxonomic accuracy described above, all of the results of the benthic macroinvertebrate evaluations are determined to be acceptable for use in the DMTS ecological evaluation.

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**Data Quality Review of
Lagoon Sediment Toxicity
Test Data**

Data Quality Review of Lagoon Sediment Toxicity Test Data

Introduction

This report documents the results of the quality assurance/quality control (QA/QC) review of the data generated from the 10-day amphipod (i.e., *Hyalella azteca*) toxicity test performed on six sediment samples collected from coastal lagoons near the port facility of Red Dog Mine in Alaska. These tests were conducted by MEC Analytical Systems, Inc., in Carlsbad, California. Exponent conducted the quality assurance review to ensure that the toxicity testing was consistent with the specifications of the statement of work (SOW) and that the data are acceptable for their intended use in future stages of the DeLong Mountain Regional Transportation System (DMTS) fugitive dust risk assessment.

The quality assurance review consisted of an evaluation of the following major elements for the bioaccumulation test:

- **Field Methods**—Were the major specifications of the field sampling procedures followed, as described in the field sampling and analysis plan (Exponent 2004)?
- **Laboratory System and Testing Methods**—Were the major specifications of the laboratory testing procedures followed, as described in the laboratory's SOW? Were the specified methods (i.e., U.S. EPA 2000) followed and were any modifications adequately justified and documented?
- **Sediment Holding Time**—Was each sediment sample analyzed within the specified holding time after collection?
- **Water Quality Conditions**—Were water quality conditions monitored adequately during testing and were the measured conditions within the specified ranges for each test chamber?
- **Negative Control Responses**—Were the responses in the negative controls (i.e., clean sediment) within specified limits?
- **Positive Control Responses**—Did the positive controls (i.e., reference toxicant) indicate that the test organisms were suitably responsive for testing?

Throughout this report, the term “replicate” refers to one of the eight replicates of homogenized sediment collected at each station.

The following section of this report presents the results of the QA/QC evaluation for the sediment toxicity test. QA/QC considerations are then summarized, and conclusions are presented in the final section.

Quality Assurance and Quality Control Evaluation

Field Methods

From June 28 to July 4, 2004, sediment samples were collected from six coastal lagoon stations near the port facility of Red Dog Mine in Alaska. At each station, surface sediment was collected using either an Ekman grab sampler or a petite-ponar grab sampler. Multiple grabs were taken from a depth interval of 0–2 cm and then composited and homogenized into a single sediment sample. Sediment from the homogenized sample was used for both the amphipod survival and growth test and for the chemical analyses to ensure that the toxicity test and the chemical analyses were related as closely as possible.

Sediment sampling was conducted according to the procedures and plans described in the field sampling and analysis plan (Exponent 2004).

Laboratory System

Reconstituted water was used for the toxicity testing program. The laboratory performed the toxicity test in one batch. Sediments were stored at 4°C in the dark until used. All testing was conducted in close adherence to the good laboratory practice requirements as defined in the EPA/TSCA Good Laboratory Practice regulations revised August 17, 1989 (40 CFR 792).

Amphipod Survival and Growth Test

This toxicity test measured amphipod survival and growth using the amphipod *Hyaletta azteca* following a 10-day exposure to the test sediments.

Test Organism and Acclimation

The *H. azteca* test organisms used in these toxicity tests were obtained from Aquatic Indicators in St. Augustine, Florida. The test organisms were maintained in the laboratory in the same sediments in which they were reared at Aquatic Indicators. Pretest survival of test organisms was not documented. However, only healthy, juvenile organisms of similar size and life history stage were used for the toxicity test.

Test Methods

Overall, the recommended protocols were followed closely during testing. All biological testing was in compliance with U.S. EPA (2000). Samples were collected and stored properly. The toxicity test was initiated on July 16, 2004. The test initiation date for the majority of the samples was within the specified 14-day holding time. However, sediment samples collected prior to July 2 were tested outside the 14-day holding time. Due to the remoteness of the site and sporadic shipping schedule from the site due to weather delays, prior approval was provided by the Alaska Department of Environmental Conservation (ADEC) to waive the holding period for this study. All organisms used in the test were from the same source (see above discussion).

Eight toxicity test replicate samples were conducted for each station. For each toxicity test replicate, 10 amphipods were exposed to 200 mL of bedded test sediment in a 1-L chamber filled with 950 mL of deionized overlying water. This is a departure from U.S. EPA (2000), which stipulates that 100 mL of bedded test sediment will be placed in a 300-mL chamber that will be filled with 175 mL of acceptable overlying water. Overlying water was renewed at a rate of 400 mL of water per day (i.e., 0.42 volumes per day) throughout the 10-day exposure period. This is also a departure from U.S. EPA (2000), which stipulates that overlying water will be replaced at two volume additions per day.

On Day 10, the surviving amphipods in all test chambers were carefully sieved from the sediment, counted, and weighed. Percent survival was determined relative to the total of 10 individuals added to each chamber at the beginning of the test. The biomass of the pooled survivors was determined to the nearest 0.01 mg after drying to constant weight at 60°C for 24 hours, which is a departure from Exponent's SOW that stipulated a drying temperature of 80°C, but which is not outside the range of drying temperatures provided in the test protocol (U.S. EPA; 60–90°C).

Water Quality Measurements

Water quality was monitored during the amphipod test. Measurements of the overlying water in one replicate for each station were taken just prior to the introduction of the test organisms into the other test replicate chambers, then at the same time each day until the conclusion of the test. This monitoring consisted of the following measurements:

- Temperature was measured in the overlying water of each water quality replicate daily. The daily mean test temperature should be $23 \pm 1^\circ\text{C}$ and the instantaneous temperature must always be within $\pm 3^\circ\text{C}$ of 23°C . Temperatures measured during the testing period ranged from 21.0°C to 22.4°C , which is within the recommended range of $20\text{--}26^\circ\text{C}$. Dissolved oxygen was measured in the overlying water of each water quality replicate daily. Dissolved oxygen concentrations should be greater than or equal to 3.4 mg/L throughout the study in all control and test water quality replicates. The lowest dissolved oxygen concentration was 2.2 mg/L. The dissolved oxygen levels ranged from 2.2 to 8.4 mg/L. The dissolved oxygen levels that were less than 3.4 mg/L were observed in two of the water quality replicates on Day 1 of the test and corrective action was taken immediately by the laboratory (i.e., all of the test chambers were aerated using trickle-flow aeration). Dissolved oxygen levels remained within acceptable limits throughout the rest of the test.
- Values of pH were measured in the overlying water in each water quality replicate daily. Values for pH ranged from 6.9 to 8.3, which is slightly outside the recommended range of 6–8 pH units.
- Salinity was to be measured in the pore water of the composite of each sediment sample prior to subsampling and in one replicate beaker of each sample on Day 10. The salinity in the pore water prior to test initiation

ranged from 0 to 4.7 ppt. The salinity in the pore water at test termination (i.e., Day 10) was 0 ppt.

- Ammonia was to be measured in the pore water of the composite of each sediment sample prior to subsampling and in one replicate beaker of each sample on Days 5 (sacrificial) and 10. These measurements were not collected.
- Total dissolved sulfides were measured in the pore water of the composite of each sediment sample prior to subsampling and in one replicate beaker of each sample on Days 5 (sacrificial) and 10. All of the sulfide concentrations were undetected (<0.5 mg/L), except for sulfide concentrations in Sample SD0001 (Station PLNL) which had sulfide concentrations ranging from <0.5 to 0.6 mg/L.
- Additional water quality parameters (i.e., conductivity, hardness, and alkalinity) were to be analyzed in overlying water in one replicate beaker on Days 0 and 10 (i.e., test initiation and termination). Hardness was 88 mg/L and alkalinity was 92 mg/L on Day 0. Conductivity was not measured on Day 0. Conductivity, hardness, and alkalinity measurements were not collected on Day 10.

Controls

A negative control consisting of #16 silica sand from Oglebay Norton Industrial Sands was used in each analytical group. Mean survival for the control sediment was 90 percent. Mean survival for sediment from the three reference area samples was 97.5, 98.8, and 95 percent, respectively. These results suggest that the test organisms were sufficiently healthy for testing.

A positive control was tested using cadmium chloride as the reference toxicant. The positive control exhibited a 96-hour LC50 value of 0.31 mg Cu/L, which is within the testing laboratory's control chart warning limits for this test (i.e., 0.0–0.41 mg Cu/L). The observed LC50 value suggests that the test organisms were suitably sensitive for testing.

Summary of Quality Assurance and Quality Control Considerations

Mean survival in the negative control was 90 percent. Mean growth was 0.10 mg with a standard deviation of 0.01. For the testing to be considered acceptable, a minimum mean survival of 80 percent must occur in the negative controls. These results meet the performance standards set for the *H. azteca* survival and growth test (U.S. EPA 2000).

During the testing period, there were seven inconsistencies with the specifications provided in the SOW:

- Pretest survival of test organisms was not documented.

- For each toxicity test replicate, the test amphipods were exposed to a sediment/water ratio of 0.22, which is less than the sediment/water ratio of 0.57 that is stipulated in the test protocol (U.S. EPA 2000). The addition of extra water to each test chamber could have affected the results of the toxicity test by diluting the possible chemical contamination in the test sediment and increasing the number of survivors in the toxicity test.
- For each toxicity test replicate, overlying water was renewed at a rate of 400 mL of water per day throughout the exposure period. This is less than the renewal rate of two volume additions per day that is stipulated in U.S. EPA (2000). Because the dissolved oxygen levels remained within the limits stipulated in the test protocol, this deviation is not expected to have affected the results.
- In all test treatments, pH was slightly above acceptable limits. However, pH for all treatments was within 0.3 pH units of the acceptable limits. Because the test results of all treatments exceeded the controls for survival and growth, the deviations are not expected to have affected the results.
- During the testing period, both interstitial ammonia and ammonia in the overlying water were supposed to be measured in each sample. These measurements were not collected. Failure to collect these water quality measurements is not expected to have affected the quality of the results, and because the test results of all treatments exceeded the controls for survival and growth, it did not affect the interpretation of the results.
- During the testing period, both hardness and alkalinity in the interstitial and overlying water were supposed to be measured in each sample. These measurements were not collected at test termination. Failure to collect these water quality measurements is not expected to have affected the quality of the results, and because the test results of all treatments exceeded the controls for survival and growth, it did not affect the interpretation of the results.

The deviations in water quality did not appear to have an effect on test results as all test treatments exceeded the controls for both survival and growth. Therefore, the data are determined to be acceptable for use in the DMTS fugitive dust risk assessment.

References

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