Appendix A

Changes and Additions to the Vegetation Sampling and Analysis Plan, Fugitive Dust Study, Red Dog Mine, Alaska
Changes and Additions to the Vegetation Sampling and Analysis Plan
Fugitive Dust Study, Red Dog Mine, Alaska

Sample Collection

- Exact coordinates of sampling locations differed slightly, and occasionally significantly, from the coordinates reported in the vegetation sampling and analysis plan (Exponent 2001). For example, transect 5 was shifted about 450 m south of the original location, from a region with very little *H. splendens* to one with more abundant moss. Four alternate port site locations were selected in the field, because the original sites were inaccessible or had no moss. The original coordinates for HR-06-04 and HR-07-04 fell on ridges with very little vegetation, so new sites were chosen from the air and were located as close to the originals as feasible.

- As described in the sampling plan, forage species were chosen in the field based on availability, ecological significance, and subsistence use. These included *Peltigera aphthosa* (lichen), *Salix pulchra* (willow), and *Rubus chamaemorus* (salmonberry or cloudberry).

- In total, 50 moss samples, 13 willow samples, 12 lichen samples, and 7 berry samples were collected during the event (see Table A-1). Moss was collected at all designated sites except spill site 29, which did not have enough for a sample. In accordance with the sampling plan, willow samples were collected at all points along haul road transects 2, 3, and 7, and lichen was also collected at all four points along transect 7.

- *Peltigera aphthosa* and other lichen samples were rare at 3-m sites and uncommon at 10-m sites, so no other full transects of lichen were collected. Instead, lichen was collected where available, including samples from HR-01-02, HR-02-02, HR-02-03, HR-03-03, and HR-05-03.
• Salmonberries tended to be more common along the road than away from it, and samples were collected at 3-m and 100-m sites along haul road transects 1 and 4. However, there were not enough berries at 1,000-m sites to complete the transects. Salmonberries were also scarce at transects 6 and 7, so no berry collections were made at transects closest to the mine.

• Due to changes made to the sampling plan while sampling was occurring, three samples each of willow, lichen, and salmonberries were collected at the port, rather than the four samples of each species recommended in the plan.

• The sampling plan does not describe vegetation collection methods in detail. *Hylocomium splendens* (moss) and *Peltigera aphthosa* (lichen) samples were collected by hand using powderless latex gloves and stored in labeled, gallon-size Ziploc® storage bags. *Salix pulchra* (willow) branches were clipped with stainless steel scissors and stored in labeled Ziploc® storage bags. Ripe *Rubus chamaemorus* berries (salmonberries) were collected by hand using powderless latex gloves and deposited directly into pre-cleaned, labeled 8-ounce glass jars. Berry samples from HR-01-01 and HR-04-02 began to mildew after a few days on ice, so HR-01-01-B was replaced with a new collection from the same site, and all berry samples were frozen until shipment to slow decomposition. A second berry collection was attempted at HR-04-02, but plants had turned brown, and there were too few ripe berries left to take a sample.

**Sample Processing, Storage, and Shipping**

• The following precautions were taken to avoid sample contamination in the processing (clean) tent: At the onset of sample processing, the floor of the clean tent was swept and the interior walls wiped down with damp paper towels. Sample coolers were washed out with 1 percent Alconox solution and tap water, and all chairs, tables, and cooler exteriors were washed with Alconox and rinsed before they were moved into the clean tent. At the beginning of each day of processing, tables were wiped down with 1 percent Alconox solution and rinse water and covered with fresh paper, and the tarp beneath the tables was also wiped down with damp paper towels. At least two Whatman 41 paper filters were hung
inside the tent each day to monitor ambient air dust levels. Field crew members wore boot covers at all times inside the processing tent and handled samples with powderless latex gloves. Unwrapped gloves and bags were stored in doubled Ziploc® bags.

- *Hylocomium splendens* samples were processed in the clean tent using methods similar to those adopted by the National Park Service (NPS) in its studies. Before beginning the sampling effort, training on the NPS methods was provided to the sampling team by Brett Wolk, who had previously worked on the NPS program. One deviation from the NPS methods is that samples were not dried in the field prior to shipping. Essentially, moss samples were processed in plastic bowls using stainless steel forceps and powderless latex gloves. The moss was picked clean of debris, and clumps of mud were removed from the moss using forceps, although samples were not washed or dusted off. The last 3 to 5 years’ of moss growth was clipped with forceps and saved for analysis.

- Lichen and willow samples were processed similarly. Plant material, clumps of dirt, and dead tissue were removed from lichen samples, but samples were not washed or dusted off. Willow leaves were removed from the stems by plucking the leaves at the base with forceps; stipules and buds were discarded. Green leaves were selected whenever possible, though willow leaves were turning yellow both on trees and in the Ziploc® bags over the course of the sampling event. Between samples, bowls and forceps were washed with 1 percent Alconox, rinsed with tap water, rinsed again with deionized water, and dried with paper towels. Fresh gloves were used for every sample.

- Moss, willow, and lichen samples from the haul road, port area, and spill sites were all double bagged, labeled, logged into a field notebook, and stored in coolers on blue ice until shipment. Unprocessed moss samples from the mine site were stored on blue ice and transported back to Exponent’s Bellevue office, where they were processed in a clean environment using NPS methods. To ease future identification of specimens, voucher samples were saved for all moss, willow, and lichen samples.
Reference

Tables
Table A-1. Summary of vegetation sampling for the haul road fugitive dust study

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of Sample Transects (or grid locations)</th>
<th>Number of Locations per Transect</th>
<th>H. Hylocomium</th>
<th>Willow</th>
<th>Lichen</th>
<th>Berry</th>
<th>Analytes</th>
<th>All Other Plant Species</th>
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<td>4</td>
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<td>Pb, Zn, Cd, Ca</td>
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<td>13</td>
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<tr>
<td>(including duplicates)</td>
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Appendix B

Summary Statistics for Analytical Samples Results
### Table B-1. Summary statistics for road surface samples

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<th>Mean Undetected Value</th>
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<td>&gt;15 μm</td>
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<td>1–5 μm</td>
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Table B-2. Summary statistics for road core samples

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<tr>
<td>Aluminum</td>
<td>mg/kg</td>
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<td>1</td>
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<td>12,100</td>
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<tr>
<td>Arsenic</td>
<td>mg/kg</td>
<td>dry</td>
<td>29</td>
<td>28</td>
<td>1.3</td>
<td>11.3</td>
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Table B-3. Summary statistics for road core samples, 0–4 in.

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Table B-4. Summary statistics for road core samples, 4–8 in.

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<td>dry</td>
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<td>9</td>
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<td>11.1</td>
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Table B-6. Summary statistics for road shoulder fines

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<th>Number of</th>
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### Table B-8. Summary statistics for material sites surface water samples

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**Note:** All results reported in $\mu g/L$, unfiltered.
Table B-9. Summary statistics for dustfall samples

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**Note:** Samples were collected from August 22 to September 21 (30 days) in collectors with a diameter of 0.0206 m². Deposition rates were calculated using detected values.
Table B-10. Summary statistics for moss (*Hylocomium splendens*) samples

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**Note:** All results reported in mg/kg, dry weight.

Summary statistics include haul road transects, spill sites, and port site samples.
Table B-11. Summary statistics for lichen (*Peltigera aphthosa*) samples

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**Note:** All results reported in mg/kg, dry weight. Summary statistics include haul road transects and port site samples.
Table B-12. Summary statistics for willow (*Salix pulchra*) samples

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**Note:** All results reported in mg/kg, dry weight.

Summary statistics include haul road transects and port site samples.
Table B-13. Summary statistics for salmonberry (*Rubus chamaemorus*) samples

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<td>Dry weight of tissue %</td>
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<td>13.1</td>
<td>16.4</td>
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<tr>
<td>Cadmium</td>
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<td>dry</td>
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<td>0.49</td>
<td>1.58</td>
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<td>mg/kg</td>
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<td></td>
<td>mg/kg</td>
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<td>7</td>
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<td>485</td>
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<td>Lead</td>
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<td>dry</td>
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<td>7</td>
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<td>13.5</td>
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<td>mg/kg</td>
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<td></td>
<td>mg/kg</td>
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<td>7</td>
<td>1.86</td>
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**Note:** Summary statistics include haul road transects and port site samples.
### Table B-14. Summary statistics for surface water samples

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<th>Analyte</th>
<th>Number of Analyses</th>
<th>Number of Detected Values</th>
<th>Minimum Detected Value</th>
<th>Mean Detected Value</th>
<th>Maximum Detected Value</th>
<th>Minimum Undetected Value</th>
<th>Mean Undetected Value</th>
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<td>49</td>
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<td>89</td>
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<td>55</td>
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<td>210</td>
<td>1,310</td>
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<td>5,000</td>
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<tr>
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<td>34.4</td>
<td>2</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

**Note:** All results reported in \( \mu \text{g/L}, \) unfiltered.
Appendix C

Quality Assurance Review:
Soil, Water, Dust, and
Vegetation Sampling
Quality Assurance Review: Soil, Water, Dust, and Vegetation Sampling

Introduction

A quality assurance review was completed by Exponent for metals and grain size analyses in soil, surface water, dust, and vegetation samples collected during the Haul Road Fugitive Dust Study at the Red Dog Mine, Alaska site. Samples were collected from July 11 to October 18, 2001. A modified U.S. Environmental Protection Agency Level 3 data validation was completed.

Analyses of metals in soil, water, and dust were performed by Columbia Analytical Services, Inc., Kelso, Washington. Additional analyses of metals in water were performed by CT & E Environmental Services, Inc., Anchorage, Alaska. Analyses of metals in vegetation were performed by Battelle Marine Sciences Laboratory, Sequim, Washington. Analyses of grain size were performed by PTS Laboratories, Inc., Santa Fe Springs, California.

Completeness

Results reported by the laboratory were 100-percent complete.

Holding Times and Sample Preservation

Holding time constraints were met for all samples.

Instrument Performance

The performance of the analytical instruments, as documented by the laboratory, was acceptable.
Initial and Continuing Calibration

Initial and continuing calibrations, as documented by the laboratory, were completed for all applicable target analytes and met the laboratory criteria for acceptable performance and frequency of analysis. There were no continuing calibration exceedances that resulted in sample qualification.

Initial and Continuing Calibration Blanks

The initial and continuing calibration blank analyses, as documented by the laboratory, met the laboratory criteria for acceptable performance.

Laboratory Blank Analyses

No analytes were detected in the laboratory blanks, with the following exception. Low levels of calcium, cadmium, iron, magnesium, lead, and zinc were detected in blanks associated with the vegetation analyses. None of the metals were detected at concentrations which required qualification of sample data.

Graphite Furnace Atomic Absorption Quality Control Checks

One graphite furnace atomic absorption spectrometry quality control analytical spike recovery for arsenic was below control limits. The arsenic result for this one soil sample was qualified as estimated (J).

Accuracy

The accuracy of the analytical results is evaluated in the following sections in terms of analytical bias (matrix spike, standard reference material [SRM], and laboratory control sample [LCS] recoveries) and precision (duplicate sample analyses).
Matrix Spike Recoveries

The recoveries reported by the laboratory for matrix spike and duplicate matrix spike analyses, and the frequency of analysis, met the laboratory’s criteria for acceptable performance, with the exception of the recovery of aluminum in surface water sample delivery group (SDG) K2106565, which exceeded the control limit. All associated aluminum results were qualified as estimated ($J$).

Standard Reference Material Sample Recoveries

The recoveries reported by the laboratory for vegetation SRM analyses, and the frequency of analysis, met the laboratory’s criteria for acceptable performance, with the following exceptions. The SRM recoveries from SRM Moss M3 (1136) for zinc in SDGs 110601 and 110701 and for aluminum in SDGs 110601, 110701, and 110801 exceeded control limits. Associated sample results were qualified as estimated ($J$). The SRM recoveries from SRM Moss M3 (1136) for lead in SDGs 110601 and 110701 and the SRM recovery from SRM Tomato Leaf (NIST 1573) for zinc in SDG 110701 exceeded control limits, but data qualification was not required since there was no data of a similar matrix and/or analyte associated with these SRMs.

Laboratory Control Sample Recoveries

The recoveries reported by the laboratory for all LCS, and the frequency of analysis, met the laboratory’s criteria for acceptable performance.

Precision

Results for all duplicate sample analyses and the frequency of analysis met the laboratory’s criteria for acceptable performance, with the following exception for soil samples. The duplicate relative percent difference for lead in “MS-” samples in SDG K2106399 exceeded control limits. All associated lead results in “MS-” samples were qualified as estimated. The
relative percent difference for lead in the pair of duplicate samples for “RS-” and “RF-” samples in SDG K2106399 was in control, and no qualification of “RS-” or “RF-” samples was required.

Field Quality Control Sample

Field quality control samples consisted of field duplicate samples, filter blank samples (to assess ambient dust levels), equipment rinsate blanks, and distilled water blanks. Three zinc, one lead, and five iron results in surface water were restated as undetected ($U$) because of detection of these metals in field blanks. The precision of all target analytes detected in the field duplicates was acceptable.