# PEBBLE PROJECT
# ENVIRONMENTAL BASELINE DOCUMENT
# 2004 through 2008

# APPENDIX G.
# QUALITY ASSURANCE PROJECT PLANS

PREPARED BY:

SHAW ALASKA, INC.

# APPENDIX G, QUALITY ASSURANCE PROJECT PLANS

As the name implies, the quality assurance project plans (QAPPs) were designed to document the people and procedures by which the Pebble Partnership (and its predecessor Northern Dynasty Mines Inc.) assured that the baseline studies for chemical characterization met rigid quality standards for sample handling and laboratory analysis. The QAPPs in this appendix address topics such as data quality parameters, precision, representativeness, sample preservation and handling, documentation and chain of custody, and analytical methods.

The five QAPPs in this appendix are for the consecutive years 2004 through 2008. The large majority of any variation between years is due to differences in the types of studies undertaken each year across this span. The following are the QAPPs completed for Pebble Project and provided in this appendix:

- Draft Environmental Baseline Studies, Proposed 2004 Quality Assurance Project Plan.
- Draft Environmental Baseline Studies, Proposed 2005 Quality Assurance Project Plan.
- Draft Environmental Baseline Studies, 2006 Quality Assurance Project Plan.
- Draft Environmental Baseline Studies, 2007 Quality Assurance Project Plan.
- Draft Environmental Baseline Studies, 2008 Quality Assurance Project Plan.

# APPENDIX

# DRAFT ENVIRONMENTAL BASELINE STUDIES
# PROPOSED 2004
# QUALITY ASSURANCE PROJECT PLAN

# Pebble Gold Copper Project

## DRAFT ENVIRONMENTAL BASELINE STUDIES PROPOSED 2004 QUALITY ASSURANCE PROJECT PLAN

Prepared For:

**State of Alaska Large Mine Permitting Team**
**Department of Natural Resources**

Prepared By:

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January 27, 2005

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# Acronyms

ADEC.....Alaska Department of Environmental Conservation
ADNR.....State of Alaska Department of Natural Resources
BEESC.....Bristol Environmental and Engineering Services Corporation
BTEX.....benzene, toluene, ethylbenzene, and xylenes
C.....Centigrade
CAS.....Columbia Analytical Services, Inc.
COC.....chain of custody
DRO.....diesel range organics
DQOs.....Data quality objectives
EPA.....United States Environmental Protection Agency
GRO.....gasoline range organics
GW.....groundwater
LCS.....laboratory control sample
LCSD.....laboratory control sample duplicate
MDL.....method detection limit
mg/kg.....milligrams per kilogram
mg/L.....milligrams per liter
mL.....milliliters
MRLs.....Method Reporting Limits
MS.....matrix spikes
MSD.....matrix spike duplicate
NA.....not applicable
NCA.....North Creek Analytical, Inc.
NDM.....Northern Dynasty Mines Inc.
NEPA.....National Environmental Policy Act
NIST.....National Institute for Standards and Technology
NDPES.....National Pollutant Discharge Elimination System
oz.....ounce
PARCC.....precision, accuracy, representativeness, comparability, and completeness
PE.....Performance Evaluation
Pebble Project....Pebble Gold Copper Project
QA.....Quality Assurance
QAM.....Quality Assurance Manual
QAPP.....Quality Assurance Project Plan
QAR.....Quality Assurance Report
QC.....Quality Control
QMP.....Quality Management Plan
RPD.....relative percent difference
RRO.....residual range organics
RSD.....relative standard deviation
SGS.....SGS Environmental Services, Inc.
Shaw.....Shaw Environmental, Inc.
SRMs.....Sample Reference Materials
SOP.....Standard Operating Procedure
SW.....surface water
tbd.....to be determined
ug/L.....micrograms per liter
umhos/cm.....micromhos per centimeter
USACE.....United States Army Corp of Engineers

# 1 Program Summary

## 1.1 Title and Approval Sheets

**Program Title**: Pebble Gold Copper Project, Environmental Baseline Studies

**Organization:** Northern Dynasty Mines Inc. (NDM)

| **NDM Personnel** | **Signature** | **Date** |
|---|---|---|
| Bruce Jenkins<br>Chief Operating Officer<br>E-mail: brucej@hdgold.com<br>Phone: 604-684-6365<br>**NDM** | _____ | |
| Ella Ede<br>Project Coordinator<br>E-mail: ellae@hdgold.com<br>Phone: 907-339-2600<br>**NDM** | _____ | |
| Loretta Ford<br>Trace Elements Study Manager<br>E-mail: LorettaF@hdgold.com<br>Phone: 604-684-6365<br>**NDM** | _____ | |
| Dennis Deans<br>Water Study Manager<br>E-mail: dennisd@hdgold.com<br>Phone: 604-684-6365<br>**NDM** | _____ | |
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| Jane Whitsett<br>Analytical QA/QC Manager<br>E-mail: jane.whitsett@shawgrp.com<br>Phone: 907-243-6300<br>**Shaw Environmental, Inc.** | _____ | |

| Agency Personnel | Signature | Date |
|---|---|---|
| William D. "Pete" McGee<br>Project Manager<br>E-mail: pete_mcgee@dec.state.ak.us<br>Phone: 907-451-2101<br>**Alaska Department of Environmental Conservation (ADEC)** | | |
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| Al Ott<br>Project Manager<br>E-mail: al_ott@dnr.state.ak.us<br>Phone: 907-459-7279<br>**ADNR** | | |
| Cindi Godsey<br>Project Manager<br>E-mail: godsey.cindi@epa.gov<br>Phone: 907-271-5083<br>**United States Environmental Protection Agency (EPA)** | | |

## 1.2 Distribution List

| Organization | No. Copies |
|---|---|
| ADEC | 1 |
| ADNR | 1 |
| EPA | 1 |
| NDM | 4 |
| Shaw Environmental, Inc. | 1 |
| HDR | 1 |
| BEESC | 1 |
| SLR | 1 |
| SGS Environmental Services, Inc. | 1 |
| Columbia Analytical Services, Inc. | 1 |
| North Creek Analytical, Inc. | 1 |

## 1.3 Project Organization

The Pebble Gold Copper Project (Pebble Project) is managed by Northern Dynasty Mines Inc. (NDM). NDM has commissioned highly experienced technical advisors for the environmental baseline studies including SLR Alaska Inc. (SLR), Bristol Environmental and Engineering Services Corporation (BEESC), HDR Alaska, Inc. (HDR) and Shaw Environmental, Inc. (Shaw). The project team will collect surface water, groundwater, surface soil, sediment, vegetation, and fish tissues from the mine and road/port areas.

The Pebble Project environmental baseline studies include collection of quality assurance (QA) and quality control (QC) samples at a frequency of 10 percent for all media and analyses. Primary and QC samples (field duplicate) are analyzed by the primary laboratories. QA samples (field triplicate) are analyzed by the QA laboratories. The QA laboratory analysis provides a check on the primary laboratory's accuracy and precision throughout the project. Primary and QA laboratories are identified in Table 1-1 by the parameters and media they are responsible for. Table 1-2 summarizes contact information for the Pebble Project laboratories. Field teams are responsible for collection of QA/QC samples in the field and shipment of samples to the appropriate laboratories.

Table 1-1
Summary of Primary and QA Analytical Laboratories for Environmental Baseline Studies

| Media | Parameters | Primary Laboratory | Location | QA Laboratory | Location |
|---|---|---|---|---|---|
| SW, GW, soil, sediment, marine sediment, MSW, MBW | Inorganics and trace metals | SGS | Anchorage | CAS | Kelso, WA |
| SW and GW | Low level mercury | CAS | Kelso, WA | NCA | Beaverton, OR |
| Fish tissue and invertebrate tissue | Trace metals, including Total Hg and MeHg | CAS | Kelso, WA | NCA | Beaverton, OR |
| Vegetation | Trace metals | CAS | Kelso, WA | NCA | Beaverton, OR |

CAS – Columbia Analytical Services, Inc. MSW - marine surface water
GW – groundwater MBW - marine bottom water
NCA – North Creek Analytical, Inc.
SGS – SGS Environmental Services, Inc.
SW – surface water
MeHg - methyl mercury

Table 1-2
Laboratory Contact Information

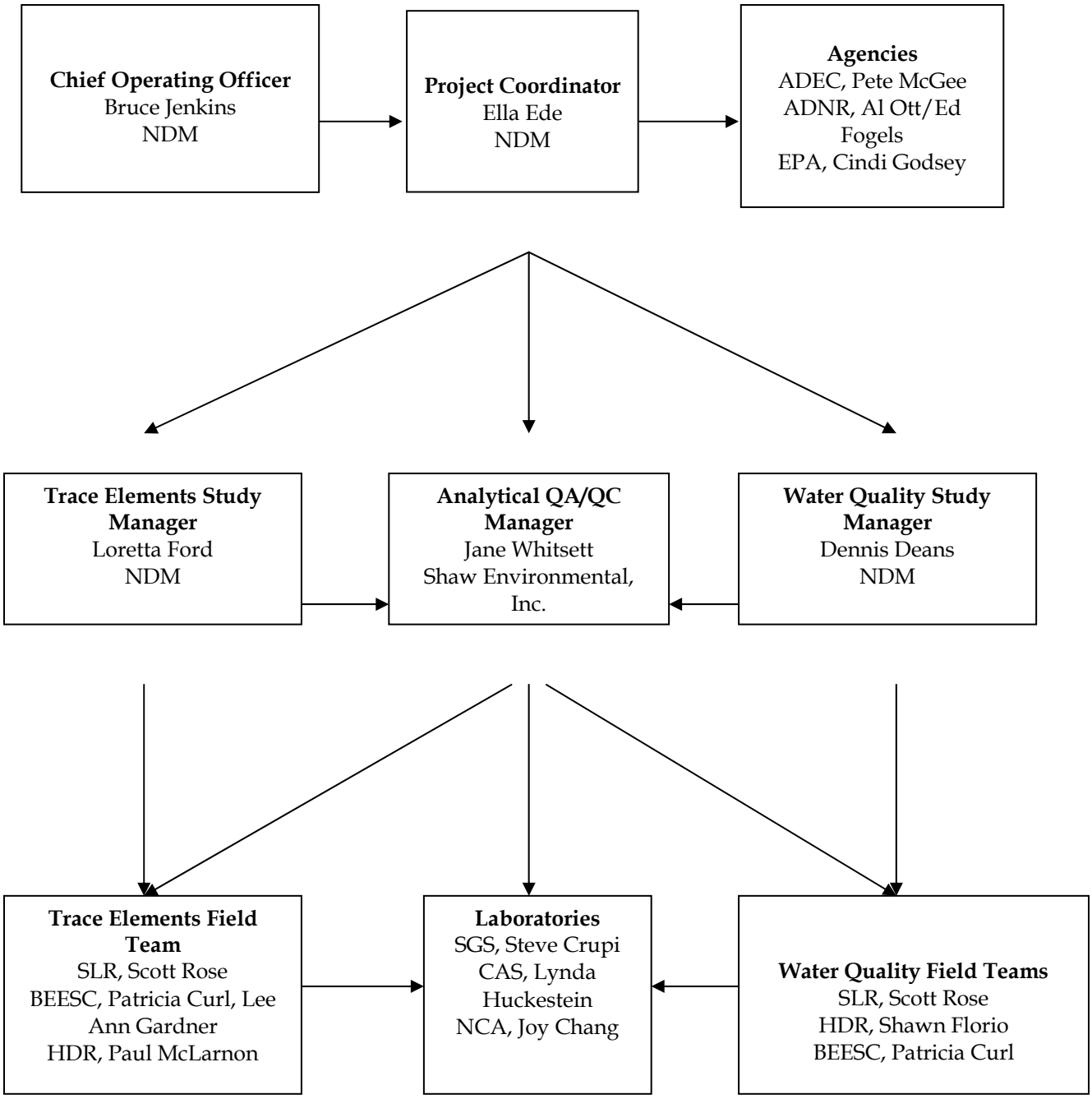
| | |
|---|---|
| Steve Crupi<br>SGS Environmental Services, Inc.<br>200 W. Potter Dr.<br>Anchorage, AK 99518<br>562-2343 phone 550-3213 direct<br>561-5301 fax<br>Steve_Crupi@sgs.com | Lynda Huckestein<br>1317 S. 13th Avenue<br>Kelso, WA 98626<br>360-501-3358 direct phone<br>360-636-1068 fax<br>lhuckestein@kelso.caslab.com |
| Joy Chang (primary contact)<br>North Creek Analytical, Inc.<br>9405 SW Nimbus Ave.<br>Beaverton, OR 97008<br>503-906-9234 direct phone<br>503-906-9210 fax<br>jchang@ncalabs.com | Mike Priebe (local contact)<br>North Creek Analytical, Inc.<br>2000 W. International Airport Road, Suite A10<br>Anchorage, Alaska 99502<br>563-9200 phone/317-3412 cell<br>563-9210 fax<br>mpriebe@ncalabs.com |

NDM has selected HDR and SLR for the Pebble Mine area studies and BEESC for the Road/Port area studies. These teams will collect all field samples for laboratory analysis. HDR has been selected to collect surface water, sediment and fish tissues for the mine area studies. SLR has been selected to collect soil, vegetation and groundwater samples from the mine area. BEESC has been selected to collect surface water, groundwater, sediment, soil and vegetation for the road/port area and conduct the marine studies. Shaw will provide analytical QA/QC management for the project. Key personnel and their roles are described below in Table 1-4 and identified in the organizational chart (Figure 1-1).

Table 1-4
Summary of Pebble Mine Key Personnel and Roles

| | |
|---|---|
| Northern Dynasty Mines Inc.<br>Bruce Jenkins, Chief Operating Officer<br><br>Ella Ede, Project Coordinator<br><br>Loretta Ford, Trace Elements Study Manager<br><br>Dennis Deans, Water and Aquatics Study Manager | • Responsible for development and execution of overall project scope and schedule.<br>• Provides oversight of project team, deliverables, and schedule.<br>• Responsible for sample collection and analysis of trace elements in surface soil, sediment, vegetation, and fish tissue.<br>• Responsible for sample collection and analysis of surface water, groundwater, and fish tissue samples. |
| Shaw Environmental, Inc.<br>Jane Whitsett, Analytical QA/QC Manager | • Preparation of Quality Assurance Project Plan (QAPP) and review of laboratory data and deliverables to ensure technical and quality requirements stipulated by regulatory agencies and NDM are met. |
| Field Teams<br>SLR, Scott Rose<br><br>HDR, Shawn Florio<br><br>BEESC, Patricia Curl, Lee Ann Gardner<br><br><br>HDR, Paul McLarnon | • Responsible for collection of groundwater, surface soil, sediment, and vegetation samples for the mine area.<br>• Responsible for collection of surface water for the mine area.<br>• Responsible for collection of surface water, groundwater, surface soil, sediment, and vegetation samples for the road/port area. Responsible for marine sampling in the port area.<br>• Responsible for collection of fish tissues for the mine area. |
| Laboratories<br>SGS Environmental Services, Inc.<br>Steve Crupi, Project Chemist<br><br>Columbia Analytical Services, Inc.<br>Lynda Huckestein, Project Chemist<br><br><br>North Creek Analytical Services, Inc.<br>Joy Chang, Project Chemist | • Responsible for executing and reporting laboratory scope of work for primary and QC samples collected by field teams.<br><br>• Responsible for executing and reporting laboratory scope of work for primary (fish and vegetation tissues and low level Hg in water) and QA samples collected by field teams.<br><br>• Responsible for executing and reporting laboratory scope of work for QA samples for lowlevel Hg is water, fish and vegetation tissues collected by field teams. |
| Agencies<br><br>ADEC<br>William “Pete” McGee<br>ADNR<br>Al Ott<br>Ed Fogels<br>EPA<br>Cindi Godsey | <br><br>• Project Manager<br><br>• Project Manager<br>• Acting Quality Assurance Manager<br><br>• Project Manager |

Figure 1-1
Pebble Project Organization Chart



## 1.4 Project Background and Objectives

Environmental baseline studies are being conducted to develop baseline data for comparison to future conditions (e.g., construction, operations and closure) for the Pebble Project, as outlined in the 2004 Proposed Study Plan (NDM, 2004).

### 1.4.1 Background

The Pebble Project is a proposed open pit mining operation of the gold, copper, molybdenum, and silver deposit located in southwestern Alaska. NDM has commenced extensive study programs to collect the engineering, environmental, and socioeconomic data necessary for a bankable feasibility study and the preparation of applications for state and federal permits.

NDM considers environmental stewardship as one of the cornerstones to pursuing the development of the Pebble Project. This involves diligent characterization of the existing conditions related to the environment of the project area and their incorporation into the project design and operation.

### 1.4.2 Objectives of the Program

NDM is in the process of evaluating the Pebble Gold Copper Project and is performing environmental baseline studies as part of this evaluation. Objectives of the environmental baseline studies include the following:

The overall objective is to collect data to establish the status of the environment in the mine and road/port area that will be potentially affected by development of the Pebble Project. Data will be collected for water quality and characterization of surface soil, sediment, vegetation, and fish tissues. These data will be used to establish existing baseline conditions for National Environmental Policy Act (NEPA) activities and permitting.

Specific objectives for water quality and trace elements for the mine and road/port area are as follows:

#### 1.4.3.1 Water Quality Objectives

Water chemistry baseline studies will include collection and analysis of surface water, groundwater, and water from seeps. The main objectives of this study are to:

- Collect baseline data to provide defensible documentation of the naturally occurring levels and variability of trace elements in surface water and ground water.
- Define the chemical characteristics of project area ground water used for drinking water.
- Evaluate sources that could be used for mine make-up water.
- Provide the database for the site water chemistry and site loading models for project design and environmental impact assessment.
- Develop the baseline for the evaluation of potential environmental impacts during construction, operation, and closure.
- Evaluation of site geochemistry.

This information is key to understanding current conditions and will provide a baseline for the evaluation of future potential environmental impacts during operation and closure. The baseline water chemistry data are also important for determining if site-specific water chemistry standards are required for water bodies in the project area.

### 1.4.2.2 Trace Element Objectives

Surface soil, sediment, vegetation, and fish tissues will be collected and analyzed for trace elements. The objectives of the trace elements study are as follows:

- Collect baseline data to provide defensible documentation of the natural levels of trace elements and anions in surface soil, sediments, and vegetation prior to mining operations.
- Evaluation of naturally occurring biogenic fingerprints in surface soil associated with petroleum hydrocarbon analysis to support long term site monitoring objectives.
- Determination of organic content in surface soils to support long term site monitoring objectives.
- Collect baseline data to provide defensible documentation of the natural levels of trace elements in fish tissue prior to mining operations.

This information is key to understanding current conditions and will provide a baseline for the evaluation of future potential environmental impacts to these media during operation and closure, and also to support long-term site monitoring objectives.

### 1.4.2.3 Marine Study Objectives

Marine environmental baseline studies will include collection and analysis of marine surface water (MSW), marine bottom water (MBW), marine sediment, fish tissues (muscle and liver) and invertebrate tissue. The main objectives of this study are to:

- Collect baseline data to provide defensible documentation of the naturally occurring levels and variability of trace elements and anions in the marine environment.
- Develop the baseline for the evaluation of potential environmental impacts during construction, operation, and closure.
- Evaluation of petroleum hydrocarbons in MSW, MBW, and marine sediments to support long term monitoring objectives.

Collect baseline data to provide defensible documentation of the natural levels of trace elements in fish tissue/invertebrates prior to mining operations.

This information is key to understanding the current conditions and will provide a baseline for the evaluation of future potential environmental impacts to these media during operation and closure, and also to support ling-term site monitoring objectives.

## 1.5 Project/Task Description and Schedule

This section provides a project description, summary of all work to be performed, products to be produced, and the schedule for implementation.

The Pebble Project is located in southwestern Alaska, about 230 miles from Anchorage, 18 miles North of Iliamna, and 60 miles from tidewater at Cook Inlet. The mine and road/port areas will be accessed by air from Iliamna for field tasks.

### 1.5.1 Task Descriptions

The tasks covered by this QAPP include field sampling, laboratory analysis and reporting, and data validation. Each task is discussed briefly below.

#### 1.5.1.1 Task 1–Field Sampling

NDM's sampling approach is discussed in the Pebble Gold Copper Project *Environmental Baseline Studies 2004 Proposed Study Plan* (NDM, 2004) and in this QAPP. Tables 1-4 and 1-5 summarizes sample quantities for each media.

#### 1.5.1.2 Task 2–Laboratory Analysis and Reporting

Samples collected from the mine and road/port areas will be analyzed for the parameters detailed in Table 1-6.

Laboratories will provide hardcopy and electronic reports to the Analytical QA/QC Manager. Reports will include data summaries, QC results, calibration data, and raw data. The Analytical QA/QC Manager will validate laboratory data. Analytical data will then be uploaded into the NDM database for access by data users.

#### 1.5.1.3 Task 3–Data Validation and Quality Assurance Reports

Laboratory data will be reviewed utilizing EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA, 1999); EPA Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review (EPA, 2001) and EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA, 2002) as the basis for review, with modifications as needed for the specific analytical methods being utilized. Quality Assurance Reports (QARs) will be prepared by the Analytical QA/QC Manager and submitted to NDM. These reports will discuss analytical QA/QC results and any impacts to the project based on the results of data validation.

### 1.5.2 Schedule

Field sampling for 2004 and 2005 will be conducted per the schedules in Table 1-7 and 1-8. Laboratory reports are due 30 days from sample receipt. Separate QAR reports will be prepared for samples collected in 2004 and 2005 for each media from the mine area and the road/port area. QAR reports for 2004 sampling will be completed by March 2005. QAR reports for 2005 sampling will be completed by July 2005.

## 1.6 Quality Objectives and Criteria

The principal objectives of the QA program are to maintain an acceptable level of quality for field activities, sample collection, sample handling, laboratory analysis, and data analysis and to document the quality of data at each processing level. This program clearly identifies major aspects of the project requiring specific quality control and demonstrates that quality control is a major focus for this project.

QA/QC requirements are established in this QAPP to achieve the project objectives for the data uses. Applicable QC procedures, quantitative target limits, and level of effort for assessing the data quality are dictated by the intended use of the data and the nature of the required field and analytical methods. The project objectives are to collect data of known and sufficient quality for NDM to rely upon as accurate and precise environmental baseline data.

Federal and state levels of concern (for example, ambient water quality criteria or maximum contaminant levels) exist for many of the parameters being analyzed in the environmental baseline study. Analytical methods will be specified that will allow detection of chemical constituents at or below levels of concern. A summary of field QA/QC samples is given in Table 1-9. Data quality objectives (DQOs) for the Pebble Project are listed in Tables 1-10 through 1-24.

### 1.6.1 Data Quality Parameters

The quality of laboratory data is measured by the precision, accuracy, representativeness, comparability, and completeness (PARCC) of the data. These parameters and the applicable quality control procedures and levels of effort are provided in Tables 1-10 through 1-24. A discussion of PARCC is presented below

Table 1-4
Pebble Project Terrestrial Sample Quantities Based on Draft Sample Plan

| Consultant | Area | Media | Sample Locations | Sampling Frequency | Primary Samples | MS/MSD Samples | QC Samples | Total Primary Lab Samples | QA Samples | QA MS/MSD Samples | Total QA Lab Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HDR | Mine | Surface Water | 35 | 9 | 315 | 32 | 32 | 379 | 32 | 4 | 36 |
| SLR | Mine | Groundwater (baseline) | 8 | 4 | 32 | 4 | 4 | 40 | 4 | 2 | 6 |
| SLR | Mine | Groundwater (non-baseline) | 15 | 1 | 15 | 2 | 2 | 19 | 2 | 2 | 4 |
| HDR | Mine | Seeps/Ponds | 18 | 2 | 36 | 4 | 4 | 44 | 4 | 2 | 6 |
| HDR | Mine | Stream Seepage Stations | 16 | 1 | 16 | 2 | 2 | 20 | 2 | 2 | 4 |
| BEESC | Road/Port | Surface Water | 16 | 8 | 128 | 13 | 13 | 154 | 13 | 2 | 15 |
| BEESC | Road/Port | Drinking Water Wells | 5 | 4 | 20 | 2 | 2 | 24 | 2 | 1 | 3 |
| | | | | | | | Subtotal | 680 | | Subtotal | 74 |
| SLR | Mine | Surface Soil | 84 | 1 | 84 | 9 | 9 | 102 | 9 | 2 | 11 |
| BEESC | Road/Port | Surface Soil | 26 | 1 | 26 | 3 | 3 | 32 | 3 | 2 | 5 |
| | | | | | | | Subtotal | 134 | | Subtotal | 16 |
| HDR | Mine | Sediment SW Locations | 35 | 4 | 140 | 14 | 14 | 168 | 14 | 2 | 16 |
| HDR | Mine | Sediment lakes/Ponds | 21 | 1 | 21 | 3 | 3 | 27 | 3 | 2 | 5 |
| BEESC | Road/Port | Sediment streams | 10 | 4 | 40 | 4 | 4 | 48 | 4 | 2 | 6 |
| BEESC | Road/Port | Sediment ponds | 10 | 1 | 10 | 2 | 1 | 13 | 1 | 2 | 3 |
| | | | | | | | Subtotal | 256 | | Subtotal | 30 |
| BEESC | Road/Port | Vegetation | 26 | 4 | 104 | 11 | 11 | 126 | 11 | 2 | 13 |
| SLR | Mine | Vegetation | 84 | 1 | 84 | 9 | 9 | 102 | 9 | 2 | 11 |
| | | | | | | | Subtotal | 228 | | Subtotal | 24 |
| HDR | Mine | Fish Tissues | 341 | 1 | 341 | | | 341 | 34 | | 34 |
| | | | | | | | Total | 1639 | | Total | 178 |

Table 1-5
Pebble Project Marine Sample Quantities Based on Draft Sample Plan

| Consultant | Site | Media | Sample Locations | Sampling Frequency | Primary Samples | MS/MSD Samples | QC Samples | Total Primary Lab Samples | QA Samples | QA MS/MSD Samples | Total QA Lab Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RWJ Consulting | Port #1-4 | Marine Surface Water | 4 | 3 | 12 | 2 | 2 | 16 | 2 | 2 | 4 |
| RWJ Consulting | Port #1-4 | Marine Bottom Water | 4 | 3 | 12 | 2 | 2 | 16 | 2 | 2 | 4 |
| RWJ Consulting | Cable Exit Points | Marine Surface Water | 2 | 3 | 6 | 2 | 1 | 9 | 1 | 2 | 3 |
| RWJ Consulting | Cable Exit Points | Marine Bottom Water | 2 | 3 | 6 | 2 | 1 | 9 | 1 | 2 | 3 |
| RWJ Consulting | 4 other opportunistic marine sites | Marine Surface Water | 4 | 3 | 12 | 2 | 2 | 16 | 2 | 2 | 4 |
| RWJ Consulting | 4 other opportunistic marine sites | Marine Bottom Water | 4 | 3 | 12 | 2 | 2 | 16 | 2 | 2 | 4 |
| Total metals AND dissolved metals (filtered), doubles number of samples for metals. | | | | | | | Subtotal | 82 | | Subtotal | 22 |
| Pentec | Intertidal Port #1-4 | Sediment | 4 | 5 | 20 | 2 | 2 | 24 | 2 | 2 | 4 |
| RWJ Consulting | Subtidal Port #1-4 | Sediment | 4 | 5 | 20 | 2 | 2 | 24 | 2 | 2 | 4 |
| Pentec | Intertidal Cable Exit Pts | Sediment | 2 | 5 | 10 | 2 | 1 | 13 | 1 | 2 | 3 |
| RWJ Consulting | Subtidal Cable Exit Points | Sediment | 2 | 5 | 10 | 2 | 1 | 13 | 1 | 2 | 3 |
| Pentec | 4 other opportunistic intertidal sites | Sediment | 4 | 5 | 20 | 2 | 2 | 24 | 2 | 2 | 4 |
| RWJ Consulting | 4 other opportunistic subtidal sites | Sediment | 4 | 5 | 20 | 2 | 2 | 24 | 2 | 2 | 4 |
| | | | | | | | Subtotal | 122 | | Subtotal | 22 |
| Pentec | Beach Seining | Fish/Invert. Tissues | 3 (bays) | 2 (for 3 species) | 18 | 2 | 2 | 22 | 2 | 2 | 4 |
| RWJ Consulting | Crab/Shrimp | Invert. Tissues | 3 (bays) | 3 (for 2 species) | 18 | 2 | 2 | 22 | 2 | 2 | 4 |

| Consultant | Site | Media | Sample Locations | Sampling Frequency | Primary Samples | MS/MSD Samples | QC Samples | Total Primary Lab Samples | QA Samples | QA MS/MSD Samples | Total QA Lab Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pots | | | | | | | | | | |
| Pentec | Onshore Hook and Line | Fish Tissues | 3 (bays) | 3 (for 2 species) | 18 | 2 | 2 | 22 | 2 | 2 | 4 |
| RWJ Consulting | Offshore Hook and Line | Fish Tissues | 3 (bays) | 3 (for 2 species) | 18 | 2 | 2 | 22 | 2 | 2 | 4 |
| Pentec | Try Net | Fish/Invert. Tissues | 3 (bays) | 2 (for 3 species) | 18 | 2 | 2 | 22 | 2 | 2 | 4 |
| RWJ Consulting | Try Net | Fish/Invert. Tissues | 3 (bays) | 2 (for 3 species) | 18 | 2 | 2 | 22 | 2 | 2 | 4 |
| | | | | | | | Total | 132 | | Total | 24 |

Table 1-6
Pebble Project Summary of Laboratory Analyses

| Parameter | Methods (Water) | Methods (Solids) | Media | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Surface Water(3) | Groundwater | Surface Soil | Sediment(3) | Vegetation | Fish Tissue(3) |
| Inorganics | | | | | | | | |
| pH[1] | E150.1 | | x | x | | | | |
| Conductivity[1] | SM 2510B, E120.1 | | x | x | | | | |
| Acidity | E305.2 | | x | x | | | | |
| Alkalinity | SM2320B | | x | x | | | | |
| Ammonia as N | SM4500NH3G, E350.1 | E350.3 | x | x | x | x | x | |
| Chloride | E300.0 | E300.0 | x | x | x | x | x | |
| Cyanide-total | SM4500CN | SM4500CN, E335.2 | x | x | x | x | x | |
| Cyanide-WAD | SM4500 | | x | x | | | | |
| Fluoride | E300.0 | E300.00 | x | x | x | x | x | |
| Hardness | Calculated from Ca and Mg | | x | x | | | | |
| Nitrate + Nitrite | E300.0, E353.2 | | x | x | | | | |
| Phosphorus-total | E365.3 | | x | x | | | | |
| Sulfate | E300.0 | E300.0 | x | x | x | x | x | |
| Thiocyanate(4) | Lab SOP | | x | x | | | | |
| Total dissolved solids | E160.1, SM2540C | | x | x | | | | |
| Total Suspended Solids | E160.2 | | x | X | | | | |
| Metals | | | | | | | | |
| Hexavalent chromium[1] | SW7196A | | x | X | | | | |
| Low level mercury | E1631 | E1631 | x | | | | | x |
| Mercury | E245.1 | SW7471A | | X | x | x | x | x |
| Metals[2] | E200.7/200.8 | SW6010B/6020/E200.8 | x | X | x | x | x | x |
| Organics | | | | | | | | |
| Fraction Organic Carbon | | ASTM D4129-82M | | | x | | | |
| GRO | AK101 | AK101 | x(marine only) | | | x(marine only) | | |
| BTEX | SW8260B | SW8260B | x(marine only) | | | x(marine only) | | |
| DRO/RRO | AK102/103 | AK102/103 | x(marine only) | | x | x(marine only) | | |
| Pesticides | E508.1 | | x | x | | | | |
| VOCs | SW8260B | | x | x | | | | |
| SVOCs | SW8270C | | x | x | | | | |

[1]Analysis for hexavalent chromium will only be conducted if total chromium exceeds 11 micrograms per liter (ug/L).

[2]Al, Sb, As, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Si (dissolved only), Ag, Na, Tl, Sn, V, Zn. Water samples are analyzed for total and dissolved metals.

3 fresh and marine media

4 fresh water only

5 BTEX- benzene, toluene, ethylbenzene, xylenes

Note: Sb, As, Cd, Cu, Pb, Ni, Se, Ag are planned for fish tissue.

Table 1-7
Pebble Project Field Sampling Schedule for 2004

| | | 2004 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Consultant | Media | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| HDR | Surface water | X | X | X | X | X | X | X | | |
| SLR | Groundwater | | | | | X | | X | | |
| | Sediment | | | | X | | X | | | |
| | Surface soil | | | | | X | | | | |
| | Vegetation | | | | | X | | | | |
| BEESC | Surface water | | | | X | X | X | X | | |
| | Groundwater | | | | X | | | X | | |
| | Sediment | | | | X | | X | | | |
| | Surface soil | | | | | X | | | | |
| | Vegetation | | | | | X | | | | |
| | Marine SW, Marine BW, sediment, fish/invertebrate tissues | | | | | X | | | | |
| HDR | Fish tissues | | | | | X | | | | |

Table 1-8
Pebble Project Field Sampling Schedule for 2005

| | | | 2005 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Consultant | Area | Media | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec |
| HDR | Mine | Surface water | X | | X | X | X | X | X | X | X | X | | |
| BEESC | Road | Surface water | | X | X | X | X | X | X | X | X | X | | |
| BEESC | Road | Groundwater | | | X | | X | | | X | | | X | |
| SLR | Mine | Groundwater | | | X | | X | | | X | | | X | |
| BEESC | Road | Sediment | | | | | X | | X | | X | | | |
| HDR | Mine | Sediment | | | | | X | | X | | X | | | |
| BEESC | Road | Surface soil | | | | | | | X | | X | | | |
| SLR | Mine | Surface soil | | | | | | | X | | X | | | |
| BEESC | Road | Vegetation | | | | | | | X | | X | | | |
| SLR | Mine | Vegetation | | | | | | | X | | X | | | |
| HDR | Mine/Road | Fish tissues | | | | | | | | X | | | | |

Table 1-9
Pebble Mine Summary of Field QA/QC Samples

| Type of Field QA/QC Sample | Analysis | Frequency | Sampling Events |
|---|---|---|---|
| Field Duplicate (QC sample) | All Parameters | 10 percent | All |
| Field Triplicate (QA sample) | All Parameters | 10 percent | All |
| DI water blank | Total Metals | 1 per sampling event | Surface water and groundwater |
| Equipment blank | Dissolved Metals | 5 percent | Surface water, groundwater, fish tissues (liver/muscle) |
| Trip blank | Low Level Hg and VOCs | 1 per cooler | Surface water and groundwater |

Table 1-10
SGS Data Quality Objectives–Water (Fresh)

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Inorganics | | | | | |
| pH[1] | NA | pH units | E150.1 | N/A | N/A |
| Conductivity[1] | 2 | umhos/cm | SM 2510B | N/A | 20 |
| Acidity | 10 | mg/L | E305.2 | N/A | 25 |
| Alkalinity | 10 | mg/L | SM2320B | N/A | 20 |
| Ammonia as N | 0.1 | mg/L | SM4500NH3F | 75-125 | 25 |
| Chloride | 0.2 | mg/L | E300.0 | 85-115 | 20 |
| Cyanide-total | 0.01 | mg/L | SM4500CN | 75-125 | 20 |
| Cyanide-WAD | 0.01 | mg/L | SM4500CN | 75-125 | 20 |
| Fluoride | 0.1 | mg/L | E300.0 | 85-115 | 20 |
| Hardness (total) | NA | mg/L | Calculated from Ca and Mg | N/A | N/A |
| Nitrate + Nitrite | 2.0 | mg/L | E300.0 | 90-110 | 20 |
| Phosphorus-total | 0.01 | mg/L | E365.3 | 75-125 | 25 |
| Sulfate | 0.2 | mg/L | E300.0 | 85-115 | 20 |
| Thiocyanate | 1 | mg/L | Lab SOP | 75-125 | 20 |
| TDS | 10 | mg/L | SM2540C | N/A | 25 |
| TSS | 5 | mg/L | E160.2 | N/A | 20 |
| Metals (Total and Dissolved) | | | | | |
| Hg (GW only) | 0.2 | ug/L | E245.1 | 85-115 | 15 |
| Al | 25 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Sb | 0.2 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| As | 0.5 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Ba | 0.3 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Be | 0.03 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Bi | 5 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| B | 10 | ug/L | ICP (E200.7) | 70-130 | 20 |
| Ca[1] | 50 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Cd | 0.1 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Co | 0.1 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Cr | 0.2 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Cu | 0.2 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Fe[1] | 20 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Pb | 0.2 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Mg[1] | 20 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Mn | 1 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Mo | 1 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Ni | 0.2 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| K[1] | 50 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Se | 1.0 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Si (Dissolved only) | 500 | ug/L | ICP (E200.7) | 70-130 | 20 |
| Ag | 0.02 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Na[1] | 100 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Tl | 0.05 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Sn | 1.0 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| V | 0.4 | ug/L | ICPMS (E200.8) | 70-130 | 20 |

Table 1-10
SGS Data Quality Objectives–Water (Fresh)

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Zn | 1.5 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| $Cr^{+6}$ | 10 | ug/L | SW7196A | 90-110 | 20 |
| Pesticides | | | | | |
| 4,4'-DDD | 0.005 | ug/L | SW8081 | 64-132 | 25 |
| 4,4'-DDE | 0.005 | ug/L | SW8081 | 52-129 | 25 |
| 4,4'-DDT | 0.008 | ug/L | SW8081 | 47-138 | 25 |
| Aldrin | 0.005 | ug/L | SW8081 | 38-127 | 25 |
| alpha-BHC | 0.005 | ug/L | SW8081 | 36-135 | 25 |
| beta-BHC | 0.007 | ug/L | SW8081 | 47-136 | 25 |
| Chlordane-alpha and gamma isomers | 0.10 | ug/L | SW8081 | 67-120 | 25 |
| delta-BHC | 0.005 | ug/L | SW8081 | 67-133 | 25 |
| Dieldrin | 0.005 | ug/L | SW8081 | 62-129 | 25 |
| Endosulfan I | 0.005 | ug/L | SW8081 | 50-120 | 25 |
| Endosulfan II | 0.007 | ug/L | SW8081 | 35-107 | 25 |
| Endosulfan sulfate | 0.006 | ug/L | SW8081 | 60-132 | 25 |
| Endrin | 0.006 | ug/L | SW8081 | 62-132 | 25 |
| Endrin aldehyde | 0.008 | ug/L | SW8081 | 55-155 | 25 |
| gamma-BHC (Lindane) | 0.005 | ug/L | SW8081 | 46-134 | 25 |
| Heptachlor | 0.006 | ug/L | SW8081 | 40-123 | 25 |
| Heptachlor epoxide | 0.006 | ug/L | SW8081 | 62-131 | 25 |
| Methoxychlor | 0.007 | ug/L | SW8081 | 60-140 | 25 |
| Toxaphene | 0.10 | ug/L | SW8081 | 41-126 | 25 |
| VOCS[2] | varies | ug/L | SW8260B | varies | varies |
| SVOCs[2] | varies | ug/L | SW82670C | varies | varies |

[1]may be analyzed by ICP (200.7)
[2] – Criteria is available for each parameter in the laboratory QA plan.
mg/L – milligrams per liter
SOP – Standard Operating Procedure
ug/L – micrograms per liter
umhos/cm – micromhos per centimeter
E – EPA 200 Series – Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91-010, June 1991 and EPA 100 – 400 Series – Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised march 1983.
SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition.
SW – EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), July 1992.

Table 1-11
SGS Data Quality Objectives–Water (Marine)

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Inorganics | | | | | |
| Ammonia as N | 0.1 | mg/L | SM4500NH3F | 75-125 | 25 |
| Chloride | 0.1 | mg/L | E300.0 | 85-115 | 20 |
| Cyanide-total | 0.005 | mg/L | SM4500CN | 85-115 | 20 |
| Fluoride | 0.1 | mg/L | E300.0 | 90-110 | 20 |
| Sulfate | 0.1 | mg/L | E300.0 | 85-115 | 20 |
| TSS | 5 | mg/L | E160.2 | N/A | 20 |
| Metals (Total and Dissolved) | | | | | |
| Al | 25 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Sb | 1 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| As | 5 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Ba | 3 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Be | 0.4 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Bi | tbd | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| B | tbd | ug/L | ICP (E200.7) | 70-130 | 20 |
| Ca[1] | 500 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Cd | 0.5 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Co | 4 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Cr | 1 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Cu | 1 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Fe[1] | 250 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Pb | 0.2 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Mg[1] | 50 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Mn | 1 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Mo | 10 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Ni | 2 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| K[1] | 500 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Se | 1.0 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Ag | 0.02 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Na[1] | 100 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Tl | 0.05 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Sn | 1.0 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| V | 0.4 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Zn | 1.5 | ug/L | ICPMS (E200.8) | 70-130 | 20 |
| Petroleum Hydrocarbons | | | | | |
| Gasoline Range Organics | 0.1 | mg/L | AK101 | 60-120 | 20 |
| Diesel Range Organics | 0.3 | mg/L | AK102 | 75-125 | 30 |
| Residual Range Organics | 0.5 | mg/L | AK103 | 60-120 | 30 |
| Benzene | 0.4 | ug/L | SW8260B | 88-117 | 20 |
| Toluene | 1 | ug/L | SW8260B | 87-115 | 20 |
| Ethlbenzene | 1 | ug/L | SW8260B | 80-120 | 20 |
| p&m-xylene | 2 | ug/L | SW8260B | 80-120 | 20 |
| o-xylene | 1 | ug/L | SW8260B | 90-120 | 20 |

[1]may be analyzed by ICP (200.7)
mg/L – milligrams per liter
ug/L – micrograms per liter
E – EPA 200 Series – Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91-010, June 1991 and EPA 100 – 400 Series – Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised march 1983.
SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition.
SW – EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), July 1992.

Table 1-12
SGS Data Quality Objectives–Soil/Sediment(Terrestrial)

| Parameter | Required Method Reporting Limit | Units | Suggested Method | Accuracy Limits | Precision Limits |
|---|---|---|---|---|---|
| Inorganics | | | | | |
| Cyanide (total) | 0.2 | mg/kg | SM4500-CN-I | 75-125 | 20 |
| Chloride | 1 | mg/kg | E300.0 | 75-125 | 20 |
| Fluoride | 2 | mg/kg | E300.0 | 75-125 | 20 |
| Sulfate | 2 | mg/kg | E300.0 | 75-125 | 20 |
| Ammonia as N | 0.2 | mg/kg | SM4500NH3 | 75-125 | 25 |
| Fraction Organic Carbon | 0.05 | Percent | Lab SOP | 75-125 | 25 |
| Petroleum Hydrocarbons | | | | | |
| GRO | 5 | mg/kg | AK101 | 60-120 | 20 |
| DRO | 20 | mg/kg | AK102 | 75-125 | 20 |
| RRO | 100 | mg/kg | AK103 | 60-120 | 20 |
| BTEX | 0.013Benzene / 0.05 TEX | mg/kg | SW8260B | varies | 20 |
| Metals | | | | | |
| Al | 2.0 | mg/kg | SW6020 | 80-120 | 20 |
| Sb | 0.05 | mg/kg | SW6020 | 80-120 | 20 |
| As | 0.5 | mg/kg | SW6020 | 80-120 | 20 |
| Ba | 0.05 | mg/kg | SW6020 | 80-120 | 20 |
| Be | 0.02 | mg/kg | SW6020 | 80-120 | 20 |
| Bi | tbd | mg/kg | SW6020 | 80-120 | 20 |
| B | 20 | mg/kg | SW6010B | 80-120 | 20 |
| Cd | 0.05 | mg/kg | SW6020 | 80-120 | 20 |
| Ca | 10 | mg/kg | SW6020 | 80-120 | 20 |
| Cr | 0.2 | mg/kg | SW6020 | 80-120 | 20 |
| Co | 0.02 | mg/kg | SW6020 | 80-120 | 20 |
| Cu | 0.1 | mg/kg | SW6020 | 80-120 | 20 |
| Fe | 4.0 | mg/kg | SW6020 | 80-120 | 20 |
| Pb | 0.05 | mg/kg | SW6020 | 80-120 | 20 |
| Mg | 4 | mg/kg | SW6020 | 80-120 | 20 |
| Mn | 0.05 | mg/kg | SW6020 | 80-120 | 20 |
| Hg | 0.02 | mg/kg | SW7471 | 83-118 | 20 |
| Mo | 0.05 | mg/kg | SW6020 | 80-120 | 20 |
| Ni | 0.2 | mg/kg | SW6020 | 80-120 | 20 |
| K | 400 | mg/kg | SW6020 | 80-120 | 20 |
| Se | 1.0 | mg/kg | SW6020 | 80-120 | 20 |
| Ag | 0.02 | mg/kg | SW6020 | 80-120 | 20 |
| Na | 20 | mg/kg | SW6020 | 80-120 | 20 |
| Tl | 0.02 | mg/kg | SW6020 | 80-120 | 20 |
| Sn | 1 | mg/kg | SW6020 | 80-120 | 20 |
| V | 0.2 | mg/kg | SW6020 | 80-120 | 20 |
| Zn | 0.5 | mg/kg | SW6020 | 80-120 | 20 |

Table 1-12
SGS Data Quality Objectives–Soil/Sediment(Terrestrial)

| Parameter | Required Method Reporting Limit | Units | Suggested Method | Accuracy Limits | Precision Limits |
|---|---|---|---|---|---|

mg/kg – milligrams per kilogram
SOP – Standard Operating Procedure
tbd – to be determined

1. E – 100 – 400 Series – Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983.
2. Adapted to soil matrices.
3. SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition. Adapted to soil matrices.

SW – EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), July 1992.

Table 1-13
SGS Data Quality Objectives– Marine Sediment

| Parameter | Method Reporting Limit (wet weight) | Units | Suggested Method | Accuracy Limits | Precision Limits |
|---|---|---|---|---|---|
| Inorganics | | | | | |
| Cyanide (total) | 0.06 | mg/kg | SM4500-CN C,E | 75-125 | 25 |
| Chloride | 1 | mg/kg | E300.0 | 75-125 | 30 |
| Fluoride | 2 | mg/kg | E300.0 | 75-125 | 30 |
| Sulfate | 2 | mg/kg | E300.0 | 75-125 | 30 |
| Ammonia as N | 0.2 | mg/kg | SM4500NH3 | 75-125 | 25 |
| Fraction Organic Carbon | 0.05 | Percent | Lab SOP | 75-125 | 25 |
| Petroleum Hydrocarbons | | | | | |
| GRO | 2.5 | mg/kg | AK101 | 60-120 | 20 |
| DRO | 20 | mg/kg | AK102 | 75-125 | 50 |
| RRO | 20 | mg/kg | AK103 | 60-120 | 50 |
| Benzene | 0.013 | mg/kg | SW8260B | 86-122 | 30 |
| Toluene | 0.05 | mg/kg | SW8260B | 80-123 | 30 |
| Ethylbenzene | 0.025 | mg/kg | SW8260B | 84-127 | 30 |
| m&p-xylene | 0.05 | mg/kg | SW8260B | 88-124 | 30 |
| o-xylene | 0.025 | mg/kg | SW8260B | 87-123 | 30 |
| Metals | | | | | |
| Al | 2.0 | mg/kg | SW6020 | 80-120 | 20 |
| Sb | 0.1 | mg/kg | SW6020 | 80-120 | 20 |
| As | 1.8 | mg/kg | SW6020 | 80-120 | 20 |
| Ba | 0.3 | mg/kg | SW6020 | 80-120 | 20 |
| Be | 0.1 | mg/kg | SW6020 | 80-120 | 20 |
| Bi | 0.2 | mg/kg | SW6020 | 80-120 | 20 |
| B | tbd | mg/kg | SW6010B | 80-120 | 20 |
| Cd | 0.2 | mg/kg | SW6020 | 80-120 | 20 |
| Ca | 30 | mg/kg | SW6020 | 80-120 | 20 |
| Cr | 0.4 | mg/kg | SW6020 | 80-120 | 20 |
| Co | 0.5 | mg/kg | SW6020 | 80-120 | 20 |
| Cu | 0.6 | mg/kg | SW6020 | 80-120 | 20 |
| Fe | 10 | mg/kg | SW6020 | 80-120 | 20 |
| Pb | 0.2 | mg/kg | SW6020 | 80-120 | 20 |
| Mg | 30 | mg/kg | SW6020 | 80-120 | 20 |
| Mn | 0.2 | mg/kg | SW6020 | 80-120 | 20 |
| Hg | 0.04 | mg/kg | SW7471 | 83-118 | 20 |
| Mo | 1 | mg/kg | SW6020 | 80-120 | 20 |
| Ni | 0.2 | mg/kg | SW6020 | 80-120 | 20 |
| K | 100 | mg/kg | SW6020 | 80-120 | 20 |
| Se | 0.5 | mg/kg | SW6020 | 80-120 | 20 |
| Ag | 0.1 | mg/kg | SW6020 | 80-120 | 20 |
| Na | 100 | mg/kg | SW6020 | 80-120 | 20 |
| Tl | 0.02 | mg/kg | SW6020 | 80-120 | 20 |
| Sn | tbd | mg/kg | SW6020 | 80-120 | 20 |
| V | 3 | mg/kg | SW6020 | 80-120 | 20 |

Table 1-13
SGS Data Quality Objectives– Marine Sediment

| Parameter | Method Reporting Limit (wet weight) | Units | Suggested Method | Accuracy Limits | Precision Limits |
|---|---|---|---|---|---|
| Zn | 1 | mg/kg | SW6020 | 80-120 | 20 |

mg/kg – milligrams per kilogram
SOP – Standard Operating Procedure
tbd – to be determined
E – 100 – 400 Series – Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983. Adapted to soil matrices.
SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition. Adapted to soil matrices.
SW – EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), July 1992.

Table1-14
CAS Data Quality Objectives–Water (fresh)

| Parameter | Method Reporting Limit | Lab MRL | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|---|
| Inorganics | | | | | | |
| pH (1) | NA | | pH units | E150.1 | | |
| Conductivity (1) | 2 | 2 | umhos/cm | E120.1 | NA | 20 |
| Acidity | NA | 2 | mg/L | E305.2 | NA | 20 |
| Alkalinity | 5 | 2 | mg/L | SM2320B/E310.1 | NA | 20 |
| Ammonia as N | 0.1 | 0.05 | mg/L | E350.1 | 85-115 | 20 |
| Chloride | 0.2 | 0.2 | mg/L | E300.0 | 90-110 | 20 |
| Cyanide-total | 0.01 | 0.01 | mg/L | SM4500CN | 85-115 | 20 |
| Cyanide-WAD | 0.01 | 0.01 | mg/L | SM4500CN | 85-115 | 20 |
| Fluoride | 0.1 | 0.2 | mg/L | E300.0 | 90-110 | 20 |
| Hardness | NA | 0.4 | mg/L | Calculated from Ca and Mg (SM2340B/ SW6010B) | NA | 20 |
| Nitrate + Nitrite | 0.1 | 0.2 | mg/L | E353.2 | 85-115 | 20 |
| Phosphorus-total | 0.01 | 0.01 | mg/L | E365.3 | 85-115 | 20 |
| Sulfate | 0.2 | 0.2 | mg/L | E300.0 | 90-110 | 20 |
| Thiocyanate | 0.1 | 0.1 | mg/L | Lab-SOP (SM4500M) | | |
| TDS | 5 | 5 | mg/L | E160.1 | NA | 20 |
| TSS | 5 | 5 | mg/L | E160.2 | NA | 20 |
| Metals (Total and Dissolved) | | | | | | |
| Hg (low level) (Total only) | 0.005 | 0.005 | ug/L | E1631 | 77-123 | 20 |
| Hg (GW only) | 0.2 | 0.2 | ug/L | E245.1 | 85-115 | 20 |
| Al | 2.0 | 1.0 | ug/L | E200.8 | 85-115 | 20 |
| Sb | 0.05 | 0.05 | ug/L | E200.8 | 85-115 | 20 |
| As | 0.5 | 0.5 | ug/L | E200.8 | 85-115 | 20 |
| Ba | 0.1 | 0.05 | ug/L | E200.8 | 85-115 | 20 |
| Be | 0.02 | 0.02 | ug/L | E200.8 | 85-115 | 20 |
| Bi | 5 | 0.1 | ug/L | E200.8 | 85-115 | 20 |
| B | 10 | 0.5 | ug/L | E200.8 | 85-115 | 20 |
| Cd | 0.1 | 0.02 | ug/L | E200.8 | 85-115 | 20 |
| Ca (2) | 50 | 50 | ug/L | E200.8 | 81-124 | 20 |
| Cr | 0.2 | 0.2 | ug/L | E200.8 | 85-115 | 20 |
| Co | 0.1 | 0.02 | ug/L | E200.8 | 85-115 | 20 |
| $Cr^{+6}$ | 10 | 10 | ug/L | SW7195 | 85-115 | 20 |
| Cu | 0.1 | 0.1 | ug/L | E200.8 | 85-115 | 20 |
| Fe(2) | 20 | 20 | ug/L | E200.7 | 85-115 | 20 |
| Pb | 0.2 | 0.02 | ug/L | E200.8 | 85-115 | 20 |
| Mg (2) | 20 | 20 | ug/L | E200.8 | 72-131 | 20 |
| Mn | 1 | 0.05 | ug/L | E200.8 | 85-115 | 20 |
| Mo | 1 | 0.05 | ug/L | E200.8 | 85-115 | 20 |
| Ni | 0.2 | 0.2 | ug/L | E200.8 | 85-115 | 20 |
| K (2) | 50 | 50 | ug/L | E200.8 | 91-117 | 20 |
| Se | 1.0 | 1.0 | ug/L | E200.8 | 85-115 | 20 |
| Si (Dissolved only) | 100 | tbd | ug/L | E200.8 | 85-115 | 20 |
| Ag | 0.02 | 0.02 | ug/L | E200.8 | 85-115 | 20 |
| Na (2) | 100 | 100 | ug/L | E200.8 | 81-127 | 20 |
| Tl | 0.02 | 0.01 | ug/L | E200.8 | 85-115 | 20 |
| Sn | 1.0 | 0.1 | ug/L | E200.8 | 85-115 | 20 |
| V | 0.2 | 0.2 | ug/L | E200.8 | 85-115 | 20 |
| Zn | 0.5 | 0.5 | ug/L | E200.8 | 85-115 | 20 |
| Pesticides | | | | | | |
| 4,4'-DDD | 0.005 | 0.005 | ug/L | E508.1 | 70-130 | 30 |
| 4,4'-DDE | 0.005 | 0.005 | ug/L | E508.1 | 70-130 | 30 |
| 4,4'-DDT | 0.008 | 0.008 | ug/L | E508.1 | 70-130 | 30 |
| Aldrin | 0.005 | 0.005 | ug/L | E508.1 | 70-130 | 30 |

Table1-14
CAS Data Quality Objectives–Water (fresh)

| Parameter | Method Reporting Limit | Lab MRL | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|---|
| alpha-BHC | 0.005 | 0.005 | ug/L | E508.1 | 70-130 | 30 |
| beta-BHC | 0.007 | 0.007 | ug/L | E508.1 | 70-130 | 30 |
| Chlordane | 0.10 | 0.10 | ug/L | E508.1 | 70-130 | 30 |
| delta-BHC | 0.005 | 0.005 | ug/L | E508.1 | 70-130 | 30 |
| Dieldrin | 0.005 | 0.005 | ug/L | E508.1 | 70-130 | 30 |
| Endosulfan I | 0.005 | 0.005 | ug/L | E508.1 | 70-130 | 30 |
| Endosulfan II | 0.007 | 0.007 | ug/L | E508.1 | 70-130 | 30 |
| Endosulfan sulfate | 0.006 | 0.006 | ug/L | E508.1 | 70-130 | 30 |
| Endrin | 0.006 | 0.006 | ug/L | E508.1 | 70-130 | 30 |
| Endrin aldehyde | 0.008 | 0.008 | ug/L | E508.1 | 70-130 | 30 |
| gamma-BHC (Lindane) | 0.005 | 0.005 | ug/L | E508.1 | 70-130 | 30 |
| Heptachlor | 0.006 | 0.006 | ug/L | E508.1 | 70-130 | 30 |
| Heptachlor epoxide | 0.006 | 0.006 | ug/L | E508.1 | 70-130 | 30 |
| Methoxychlor | 0.007 | 0.007 | ug/L | E508.1 | 70-130 | 30 |
| Toxaphene | 0.10 | 0.10 | ug/L | E508.1 | 70-130 | 30 |
| VOCS[1] | varies | varies | ug/L | SW8260B | varies | 30 |
| SVOCs[1] | varies | varies | ug/L | SW8270C | varies | 30 |

1 – Criteria is available for each parameter in the laboratory QA plan.
2 – samples may be analyzed by either E200.7 or E200.8.
mg/L – milligrams per liter
NA – not applicable
SOP – Standard Operating Procedure
ug/L – micrograms per liter

E – EPA 200 Series – Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91-010, June 1991 and EPA 100 – 400 Series – Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983.

E1631 – EPA Method 1631, Revision C – Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluoresence Spectrometry.
SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition.
SW – EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), July 1992.

Table 1-15
CAS Data Quality Objectives–Water (Marine)

| Parameter | Method Reporting Limit | Lab MRL | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|---|
| Inorganics | | | | | | |
| Ammonia as N | 0.1 | 0.05 | mg/L | E350.1 | 85-115 | 20 |
| Chloride | 0.2 | 0.2 | mg/L | E300.0 | 90-110 | 20 |
| Cyanide-total | 0.01 | 0.01 | mg/L | SM4500CN | 85-115 | 20 |
| Fluoride | 0.1 | 0.2 | mg/L | E300.0 | 90-110 | 20 |
| Sulfate | 0.2 | 0.2 | mg/L | E300.0 | 90-110 | 20 |
| TSS | 5 | 5 | mg/L | E160.2 | NA | 20 |
| Petroleum Hydrocarbons | | | | | | |
| Gasoline Range Organics | 0.1 | 0.1 | mg/L | AK101 | 60-120 | 20 |
| Diesel Range Organics | 0.3 | 0.3 | mg/L | AK102 | 75-125 | 30 |
| Residual Range Organics | 0.5 | 0.5 | mg/L | AK103 | 60-120 | 30 |
| Benzene | 0.4 | 0.4 | ug/L | SW8260B | 88-117 | 20 |
| Toluene | 1 | 1 | ug/L | SW8260B | 87-115 | 20 |
| Ethlbenzene | 1 | 1 | ug/L | SW8260B | 80-120 | 20 |
| p&m-xylene | 2 | 2 | ug/L | SW8260B | 80-120 | 20 |
| o-xylene | 1 | 1 | ug/L | SW8260B | 90-120 | 20 |
| Metals (Total and Dissolved) | | | | | | |
| Hg (low level) (Total only) | 0.005 | 0.005 | ug/L | E1631 | 77-123 | 20 |
| Al | 2.0 | 1.0 | ug/L | E200.8 | 85-115 | 20 |
| Sb | 0.05 | 0.05 | ug/L | E200.8 | 85-115 | 20 |
| As | 0.5 | 0.5 | ug/L | E200.8 | 85-115 | 20 |
| Ba | 0.1 | 0.05 | ug/L | E200.8 | 85-115 | 20 |
| Be | 0.02 | 0.02 | ug/L | E200.8 | 85-115 | 20 |
| Bi | 5 | 0.1 | ug/L | E200.8 | 85-115 | 20 |
| B | 10 | 0.5 | ug/L | E200.8 | 85-115 | 20 |
| Cd | 0.1 | 0.02 | ug/L | E200.8 | 85-115 | 20 |
| Ca (1) | 50 | 50 | ug/L | E200.8 | 85-115 | 20 |
| Cr | 0.2 | 0.2 | ug/L | E200.8 | 85-115 | 20 |
| Co | 0.1 | 0.02 | ug/L | E200.8 | 85-115 | 20 |
| Cu | 0.1 | 0.1 | ug/L | E200.8 | 85-115 | 20 |
| Fe(1) | 20 | 20 | ug/L | E200.7 | 85-115 | 20 |
| Pb | 0.2 | 0.02 | ug/L | E200.8 | 85-115 | 20 |
| Mg (1) | 20 | 20 | ug/L | E200.8 | 85-115 | 20 |
| Mn | 1 | 0.05 | ug/L | E200.8 | 85-115 | 20 |
| Mo | 1 | 0.05 | ug/L | E200.8 | 85-115 | 20 |
| Ni | 0.2 | 0.2 | ug/L | E200.8 | 85-115 | 20 |
| K (1) | 50 | 50 | ug/L | E200.8 | 85-115 | 20 |
| Se | 1.0 | 1.0 | ug/L | E200.8 | 85-115 | 20 |
| Ag | 0.02 | 0.02 | ug/L | E200.8 | 85-115 | 20 |
| Na (1) | 100 | 100 | ug/L | E200.8 | 85-115 | 20 |
| Tl | 0.02 | 0.01 | ug/L | E200.8 | 85-115 | 20 |
| Sn | 1.0 | 0.1 | ug/L | E200.8 | 85-115 | 20 |
| V | 0.2 | 0.2 | ug/L | E200.8 | 85-115 | 20 |
| Zn | 0.5 | 0.5 | ug/L | E200.8 | 85-115 | 20 |

1 – may be analyzed by E200.7 (ICP OES)
mg/L – milligrams per liter
NA – not applicable
ug/L – micrograms per liter
E – EPA 200 Series – Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91-010, June 1991 and EPA 100 – 400 Series – Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983.
E1631 – EPA Method 1631, Revision C – Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluoresence Spectrometry.
SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition.
SW – EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), July 1992.

Table 1-16
CAS Data Quality Objectives–Soil/Sediment (Terrestrial)

| Parameter | Required Method Reporting Limit (MRL) | Lab MRL | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|---|
| Inorganics | | | | | | |
| Cyanide (total) | 0.2 | 0.2 | mg/kg | E335.2 | 85-115 | 20 |
| Chloride | 1 | 1 | mg/kg | E300.0 | 90-110 | 20 |
| Fluoride | 2 | 2 | mg/kg | SM4500-F-C/E300.0 | 85-115 | 20 |
| Sulfate | 2 | 2 | mg/kg | E300.0 | 90-110 | 20 |
| Ammonia as N | 0.2 | 0.2 | mg/kg | E350.1/350.3 | 85-115 | 20 |
| Fraction Organic Carbon | 0.05 | 0.05 | Percent | ASTM D4129-82M | 85-115 | 20 |
| Petroleum Hydrocarbons | | | | | | |
| GRO | 5 | 5 | mg/kg | AK101 | 60-120 | 40 |
| DRO | 10 | 40 | mg/kg | AK102 | 75-125 | 40 |
| RRO | 100 | 100 | mg/kg | AK103 | 60-120 | 40 |
| Benzene | 0.005 | 0.005 | mg/kg | SW8260B | 78-124 | 40 |
| Toluene | 0.005 | 0.005 | mg/kg | SW8260B | 75-128 | 40 |
| Ethylbenzene | 0.005 | 0.005 | mg/kg | SW8260B | 89-124 | 40 |
| m&p-Xylenes | 0.005 | 0.005 | mg/kg | SW8260B | 89-126 | 40 |
| o-Xylene | 0.005 | 0.005 | mg/kg | SW8260B | 86-129 | 40 |
| Metals | | | | | | |
| Al | 2.0 | 2.0 | mg/kg | SW6020 | 70-130 | 30 |
| Sb | 0.05 | 0.05 | mg/kg | SW6020 | 70-130 | 30 |
| As | 0.5 | 0.5 | mg/kg | SW6020 | 70-130 | 30 |
| Ba | 0.05 | 0.05 | mg/kg | SW6020 | 70-130 | 30 |
| Be | 0.02 | 0.02 | mg/kg | SW6020 | 70-130 | 30 |
| Bi | tbd | tbd | mg/kg | SW6020 | tbd | tbd |
| B | 20 | 20 | mg/kg | SW6010B | 70-130 | 30 |
| Cd | 0.05 | 0.05 | mg/kg | SW6020 | 70-130 | 30 |
| Ca | 10 | 10 | mg/kg | SW6010B | 70-130 | 30 |
| Cr | 0.2 | 0.2 | mg/kg | SW6020 | 70-130 | 30 |
| Co | 0.02 | 0.02 | mg/kg | SW6020 | 70-130 | 30 |
| Cu | 0.1 | 0.1 | mg/kg | SW6020 | 70-130 | 30 |
| Fe | 4.0 | 4.0 | mg/kg | SW6010B | 70-130 | 30 |
| Pb | 0.05 | 0.05 | mg/kg | SW6020 | 70-130 | 30 |
| Mg | 4 | 4 | mg/kg | SW6010B | 70-130 | 30 |
| Mn | 0.05 | 0.05 | mg/kg | SW6020 | 70-130 | 30 |
| Hg | 0.02 | 0.02 | mg/kg | SW7471A | 55-137 | 30 |
| Mo | 0.05 | 0.05 | mg/kg | SW6020 | 70-130 | 30 |
| Ni | 0.2 | 0.2 | mg/kg | SW6020 | 70-130 | 30 |
| K | 400 | 400 | mg/kg | SW6010B | 70-130 | 30 |
| Se | 1.0 | 1.0 | mg/kg | SW6020 | 70-130 | 30 |
| Ag | 0.02 | 0.02 | mg/kg | SW6020 | 70-130 | 30 |
| Na | 20 | 20 | mg/kg | SW6010B | 70-130 | 30 |
| Tl | 0.02 | 0 | mg/kg | SW6020 | 70-130 | 30 |
| Sn | 1 | 10 | mg/kg | SW6010B/ SW6020 | 70-130 | 30 |

Table 1-16
CAS Data Quality Objectives–Soil/Sediment (Terrestrial)

| Parameter | Required Method Reporting Limit (MRL) | Lab MRL | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|---|
| V | 0.2 | 0.2 | mg/kg | SW6020 | 70-130 | 30 |
| Zn | 0.5 | 0.5 | mg/kg | SW6020 | 70-130 | 30 |

Mg/kg – milligrams per kilogram
tbd – to be determined
E – EPA 100 – 400 Series – Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983. Adapted to soil matrices.
SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition. Adapted to soil matrices.
SW – EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), July 1992.

Table 1-17
CAS Data Quality Objectives– Marine Sediment

| Parameter | Required Method Reporting Limit (MRL) | Lab MRL | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|---|
| Inorganics | | | | | | |
| Cyanide (total) | 0.2 | 0.2 | mg/kg | E335.2 | 85-115 | 20 |
| Chloride | 1 | 1 | mg/kg | E300.0 | 90-110 | 20 |
| Fluoride | 2 | 2 | mg/kg | SM4500-F-C | 85-115 | 20 |
| Sulfate | 2 | 2 | mg/kg | E300.0 | 90-110 | 20 |
| Ammonia as N | 0.2 | 0.2 | mg/kg | E350.3 | 85-115 | 20 |
| Fraction Organic Carbon | 0.05 | 0.05 | Percent | ASTM D4129-82M | 85-115 | 20 |
| Petroleum Hydrocarbons | | | | | | |
| GRO | 5 | 5 | mg/kg | AK101 | 60-120 | 40 |
| DRO | 10 | 40 | mg/kg | AK102 | 75-125 | 40 |
| RRO | 100 | 100 | mg/kg | AK103 | 60-120 | 40 |
| Benzene | 0.005 | 0.005 | mg/kg | SW8260B | 78-124 | 40 |
| Toluene | 0.005 | 0.005 | mg/kg | SW8260B | 75-128 | 40 |
| Ethylbenzene | 0.005 | 0.005 | mg/kg | SW8260B | 89-124 | 40 |
| m&p-Xylenes | 0.002 | 0.002 | mg/kg | SW8260B | 89-126 | 40 |
| o-Xylene | 0.002 | 0.002 | mg/kg | SW8260B | 86-129 | 40 |
| Metals | | | | | | |
| Al | 2.0 | 2.0 | mg/kg | E200.8 | 70-130 | 30 |
| Sb | 0.05 | 0.05 | mg/kg | E200.8 | 70-130 | 30 |
| As | 0.5 | 0.5 | mg/kg | E200.8 | 70-130 | 30 |
| Ba | 0.05 | 0.05 | mg/kg | E200.8 | 70-130 | 30 |
| Be | 0.02 | 0.02 | mg/kg | E200.8 | 70-130 | 30 |
| Bi | Tbd | tbd | mg/kg | E200.8 | tbd | tbd |
| B | 20 | 20 | mg/kg | E200.7 | 70-130 | 30 |
| Cd | 0.05 | 0.05 | mg/kg | E200.8 | 70-130 | 30 |
| Ca | 10 | 10 | mg/kg | E200.7 | 70-130 | 30 |
| Cr | 0.2 | 0.2 | mg/kg | E200.8 | 70-130 | 30 |
| Co | 0.02 | 0.02 | mg/kg | E200.8 | 70-130 | 30 |
| Cu | 0.1 | 0.1 | mg/kg | E200.8 | 70-130 | 30 |
| Fe | 4.0 | 4.0 | mg/kg | E200.7 | 70-130 | 30 |
| Pb | 0.05 | 0.05 | mg/kg | E200.8 | 70-130 | 30 |
| Mg | 4 | 4 | mg/kg | E200.7 | 70-130 | 30 |
| Mn | 0.05 | 0.05 | mg/kg | E200.8 | 70-130 | 30 |
| Hg | 0.001 | 0.001 | mg/kg | E1631 | tbd | 30 |
| Mo | 0.05 | 0.05 | mg/kg | E200.8 | 70-130 | 30 |
| Ni | 0.2 | 0.2 | mg/kg | E200.8 | 70-130 | 30 |
| K | 400 | 400 | mg/kg | E200.7 | 70-130 | 30 |
| Se | 1.0 | 1.0 | mg/kg | E200.8 | 70-130 | 30 |
| Ag | 0.02 | 0.02 | mg/kg | E200.8 | 70-130 | 30 |
| Na | 20 | 20 | mg/kg | E200.7 | 70-130 | 30 |
| Tl | 0.02 | 0 | mg/kg | E200.8 | 70-130 | 30 |
| Sn | 1 | 10 | mg/kg | E200.7 | 70-130 | 30 |

Table 1-17
CAS Data Quality Objectives– Marine Sediment

| Parameter | Required Method Reporting Limit (MRL) | Lab MRL | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|---|
| V | 0.2 | 0.2 | mg/kg | E200.8 | 70-130 | 30 |
| Zn | 0.5 | 0.5 | mg/kg | E200.8 | 70-130 | 30 |

Mg/kg – milligrams per kilogram
tbd – to be determined
E – EPA 100 – 400 Series – Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983. Adapted to soil matrices.
SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition. Adapted to soil matrices.
SW – EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), July 1992.

Table 1-18
CAS Data Quality Objectives–Vegetation

| Parameter | Required Method Reporting Limit (MRL) | Lab MRL | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|---|
| Inorganics | | | | | | |
| Cyanide (total) | 0.2 | NA | mg/kg | E335.2 | NA | NA |
| Chloride | 1 | NA | mg/kg | E300.0 | NA | NA |
| Fluoride | 2 | NA | mg/kg | SM4500-F-C | NA | NA |
| Sulfate | 2 | NA | mg/kg | E300.0 | NA | NA |
| Ammonia as N | 0.2 | NA | mg/kg | E350.3 | NA | NA |
| Metals | | | | | | |
| Al | 2.0 | 2.0 | mg/kg | SW6020 | 70-130 | 30 |
| Sb | 0.05 | 0.05 | mg/kg | SW6020 | 70-130 | 30 |
| As | 0.5 | 0.5 | mg/kg | SW6020 | 70-130 | 30 |
| Ba | 0.05 | 0.05 | mg/kg | SW6020 | 70-130 | 30 |
| Be | 0.02 | 0.02 | mg/kg | SW6020 | 70-130 | 30 |
| Bi | tbd | tbd | mg/kg | SW6020 | tbd | tbd |
| B | 20 | tbd | mg/kg | SW6010B | tbd | tbd |
| Cd | 0.05 | 0.02 | mg/kg | SW6020 | 70-130 | 30 |
| Ca | 10 | 10 | mg/kg | SW6010B | 70-130 | 30 |
| Cr | 0.2 | 0.5 | mg/kg | SW6020 | 75-125 | 30 |
| Co | 0.02 | 0.02 | mg/kg | SW6020 | 70-130 | 30 |
| Cu | 0.1 | 0.1 | mg/kg | SW6020 | 70-130 | 30 |
| Fe | 4.0 | 2 | mg/kg | SW6010B | 70-130 | 30 |
| Pb | 0.05 | 0.02 | mg/kg | SW6020 | 70-130 | 30 |
| Mg | 4 | 2 | mg/kg | SW6010B | 70-130 | 30 |
| Mn | 0.05 | 0.05 | mg/kg | SW6020 | 70-130 | 30 |
| Hg | 0.02 | 0.02 | mg/kg | SW7471 | 60-130 | 30 |
| Mo | 0.05 | 0.05 | mg/kg | SW6020 | 70-130 | 30 |
| Ni | 0.2 | 0.2 | mg/kg | SW6020 | 70-130 | 30 |
| K | 400 | 100 | mg/kg | SW6010B | 70-130 | 30 |
| Se | 1.0 | 1.0 | mg/kg | SW6020 | 60-130 | 30 |
| Ag | 0.02 | 0.02 | mg/kg | SW6020 | 70-130 | 30 |
| Na | 20 | 10 | mg/kg | SW6010B | 70-130 | 30 |
| Tl | 0.02 | 0.02 | mg/kg | SW6020 | 70-130 | 30 |
| Sn | 10 | 10 | mg/kg | SW6020 | 70-130 | 30 |
| V | 0.2 | 0.2 | mg/kg | SW6020 | 75-125 | 30 |
| Zn | 0.5 | 0.5 | mg/kg | SW6020 | 70-130 | 30 |

Mg/kg – milligrams per kilogram
tbd – to be determined
E – EPA 100 – 400 Series – Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983. Adapted to vegetation matrices.
SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition. Adapted to vegetation matrices.
SW – EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), July 1992.

Table 1-19
CAS Data Quality Objectives–Fish/Invertebrate Tissue

| Parameter | Required Method Reporting Limit | Lab MRLs | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|---|
| Metals | | | | | | |
| Sb | 0.05 | 0.05 | mg/kg | E200.8 | 70-130 | 30 |
| As | 0.5 | 0.5 | mg/kg | E200.8 | 70-130 | 30 |
| Cd | 0.02 | 0.02 | mg/kg | E200.8 | 70-130 | 30 |
| Cu | 0.1 | 0.1 | mg/kg | E200.8 | 70-130 | 30 |
| Pb | 0.02 | 0.02 | mg/kg | E200.8 | 70-130 | 30 |
| Hg | 0.001 | 0.001 | mg/kg | E1631 (CVAF) | 70-130 | 30 |
| Hg | 0.02 | 0.02 | mg/kg | SW7471 (CVAA) | 60-130 | 30 |
| Ni | 0.2 | 0.2 | mg/kg | E200.8 | 70-130 | 30 |
| Se | 1 | 1 | mg/kg | SW7740A | 60-130 | 30 |
| Ag | 0.02 | 0.02 | mg/kg | E200.8 | 70-130 | 30 |

mg/kg – milligrams per kilogram
NA – not available
E1631 – EPA Method 1631, Revision C – Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry.
SW – EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), July 1992.
E – EPA 100 – 400 Series – Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983. Adapted to solid matrices.

Table 1-20
NCA Data Quality Objectives–Water (Fresh)

| Parameter | Required Method Reporting Limit | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Hg (low level) (Total only) | 0.005 | ug/L | E1631 | 85-115 | 20 |

NCA – North Creek Analytical, Inc.
ug/L – micrograms per liter
E1631 – EPA Method 1631, Revision C – Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry.

Table 1-21
NCA Data Quality Objectives–Water (Marine)

| Parameter | Required Method Reporting Limit | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Hg (low level) (Total only) | 0.005 | ug/L | E1631 | 75-125 | 20 |

NCA – North Creek Analytical, Inc.
ug/L – micrograms per liter
E1631 – EPA Method 1631, Revision C – Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry.

Table 1-22
NCA Data Quality Objectives– Marine Sediment

| Parameter | Required Method Reporting Limit | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Hg (low level) (Total only) | 1.00 | ug/Kg | E1631 | 75-125 | 20 |

NCA – North Creek Analytical, Inc.
ug/L – micrograms per liter
E1631 – EPA Method 1631, Revision C – Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry.

Table 1-23
NCA Data Quality Objectives–Vegetation

| Parameter | Current NCA Reporting Limit | Required Reporting Limit | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|---|
| Inorganics | | | | | | |
| Cyanide (total) | 0.25 | 0.2 | mg/kg | E335.4 | 76-126 | 40 |
| Chloride | 5 | 1 | mg/kg | E300.0 | 76-126 | 40 |
| Fluoride | 5 | 2 | mg/kg | SM4500-F-C | 76-126 | 40 |
| Sulfate | 10 | 2 | mg/kg | E300.0 | 76-126 | 40 |
| Ammonia as N | 0.25 | 0.2 | mg/kg | E350.1 | 76-126 | 40 |
| Metals | | | | | | |
| Al | 2.0 | 2.0 | mg/kg | SW6020 | 76-126 | 40 |
| Sb | 0.05 | 0.05 | mg/kg | SW6020 | 76-126 | 40 |
| As | 0.5 | 0.5 | mg/kg | SW6020 | 76-126 | 40 |
| Ba | 0.05 | 0.05 | mg/kg | SW6020 | 76-126 | 40 |
| Be | 0.05 | 0.02 | mg/kg | SW6020 | 76-126 | 40 |
| Bi | tbd | tbd | mg/kg | SW6020 | tbd | tbd |
| B | 25 | 20 | mg/kg | SW6010B | 76-126 | 40 |
| Cd | 0.05 | 0.05 | mg/kg | SW6020 | 76-126 | 40 |
| Ca | 10 | 10 | mg/kg | SW6010B | 76-126 | 40 |
| Cr | 0.2 | 0.2 | mg/kg | SW6020 | 76-126 | 40 |
| Co | 0.02 | 0.02 | mg/kg | SW6020 | 76-126 | 40 |
| Cu | 0.1 | 0.1 | mg/kg | SW6020 | 76-126 | 40 |
| Fe | 10.0 | 4.0 | mg/kg | SW6010B | 76-126 | 40 |
| Pb | 0.05 | 0.05 | mg/kg | SW6020 | 76-126 | 40 |
| Mg | 10 | 4 | mg/kg | SW6010B | 76-126 | 40 |
| Mn | 0.05 | 0.05 | mg/kg | SW6020 | 76-126 | 40 |
| Hg | 0.02 | 0.02 | mg/kg | SW7471 | 76-126 | 40 |
| Mo | 0.25 | 0.05 | mg/kg | SW6020 | 76-126 | 40 |
| Ni | 0.2 | 0.2 | mg/kg | SW6020 | 76-126 | 40 |
| K | 400 | 400 | mg/kg | SW6010B | 76-126 | 40 |
| Se | 1.0 | 1.0 | mg/kg | SW6020 | 76-126 | 40 |
| Ag | 0.05 | 0.02 | mg/kg | SW6020 | 76-126 | 40 |
| Na | 20 | 20 | mg/kg | SW6010B | 76-126 | 40 |
| Tl | 0.05 | 0.02 | mg/kg | SW6020 | 76-126 | 40 |
| Sn | tbd | tbd | mg/kg | SW6020 | tbd | tbd |

Table 1-23
NCA Data Quality Objectives–Vegetation

| Parameter | Current NCA Reporting Limit | Required Reporting Limit | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|---|
| V | 0.2 | 0.2 | mg/kg | SW6020 | 76-126 | 40 |
| Zn | 0.5 | 0.5 | mg/kg | SW6020 | 76-126 | 40 |

g/kg – milligrams per kilogram
NCA – North Creek Analytical, Inc.
NA – not available
E – EPA 100 – 400 Series – Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983. Adapted to vegetation matrices.
SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition. Adapted to vegetation matrices.
SW – EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), July 1992.

Table 1-24
NCA Data Quality Objectives–Fish/Invertebrate Tissue

| Parameter | Required Method Reporting Limit | Units | Suggested Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Metals | | | | | |
| Sb | 0.05 | mg/kg | SW6020 (ICPMS) | 76-126 | 40 |
| As | 0.5 | mg/kg | SW6020 (ICPMS) | 76-126 | 40 |
| Cd | 0.05 | mg/kg | SW6020 (ICPMS) | 76-126 | 40 |
| Cu | 0.2 | mg/kg | SW6020 (ICPMS) | 76-126 | 40 |
| Pb | 0.05 | mg/kg | SW6020 (ICPMS) | 76-126 | 40 |
| Hg | 0.001 | mg/kg | E1631 (CVAF) | tbd | tbd |
| Hg | 0.02 | mg/kg | SW7471 (CVAA) | 76-126 | 40 |
| Ni | 0.2 | mg/kg | SW6020 (ICPMS) | 76-126 | 40 |
| Se | 1 | mg/kg | SW6020 (ICPMS) | 76-126 | 40 |
| Ag | 0.05 | mg/kg | SW6020 (ICPMS) | 76-126 | 40 |

NCA – North Creek Analytical Inc.
NA – not available
mg/kg – milligrams per kilogram
E1631 – EPA Method 1631, Revision C – Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluoresence Spectrometry.
SW – EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), July 1992.

### 1.6.2 Precision

Precision is a qualitative measure of the reproducibility of a measurement under a given set of conditions. For duplicate measurements, analytical precision can be expressed as the relative percent difference (RPD). The level of effort for precision will be at a minimum frequency of 1 in 20 (5 percent) or one per sampling batch, whichever is more frequent. Precision is calculated from field and laboratory duplicates.

If calculated from duplicate measurements:

$RPD = [(C_1 - C_2) \times 100\%] \div [(C_1 + C_2) / 2]$

RPD = relative percent difference

$C_1$ = larger of the two observed values

$C_2$ = smaller of the two observed values

If calculated from three or more replicates, use relative standard deviation (RSD) rather than RPD:

$RSD = (s / y) \times 100\%$

RSD = relative standard deviation

s = standard deviation

y = mean of replicate analysis

Standard deviation, S, is defined as follows:

$S = \{\Sigma n(y^i - y)^2 / (n-1)\}^{0.5}$

S = standard deviation

$y^i$ = measured value of the $i^{th}$ replicate

y = mean of replicate measurements

n = number of replicates

### 1.6.3 Accuracy

For samples processed by the analytical laboratory, accuracy will be evaluated with matrix spikes (MS), laboratory control samples (LCS), and performance evaluation (PE) samples to establish accuracy. MS will be analyzed at an overall frequency of 10 percent throughout the project duration. One PE sample will be submitted and analyzed during the 2004–2005 program.

For measurements where matrix spikes are used:

$\%R = 100\% \times [S-U/C_{SA}]$

%R = percent recovery

S = measured concentration in spiked aliquot

U = measured concentration in unspiked aliquot

$C_{SA}$ = actual concentration of spike added

For situations where a PE or LCS sample is used instead of or in addition to matrix spikes:

$\%R = 100\% \times [C_m/C_{srm}]$

%R = percent recovery

$C_m$ = measured concentration of PE or LCS sample

$C_{srm}$ = actual concentration of PE or LCS sample

The level of effort for precision and accuracy measurements is listed in Table 1-25.

Table 1-25
Precision and Accuracy Evaluation for the Pebble Project

| Parameter Group | Type of Test (precision/accuracy) | Level of Effort |
|---|---|---|
| Inorganic Analytes | PE sample[1] | 1 for 2004–2005 program |
| | Blind field duplicates (QC) | 10 percent |
| | Blind field triplicate(QA) | 10 percent |
| | Laboratory duplicates | 5 percent or 1 per analytical batch |
| | Laboratory control sample | 1 – 2 per analytical batch of 20 samples or fewer |
| | Matrix spike (not required for all analytes) | 5 percent of total samples submitted over project duration |
| Metals | PE sample[1] | 1 for 2004–2005 program |
| | Blind field duplicates (QC) | 10 percent |
| | Blind field triplicate (QA) | 10 percent |
| | Laboratory control sample | 1 per analytical batch of 20 samples or fewer |
| | Matrix spike/matrix spike duplicate | 5 percent of total samples submitted over project duration |
| Organics | PE sample[1] | 1 for 2004–2005 program |
| | Blind field duplicates (QC) | 10 percent |
| | Blind field triplicate (QA) | 10 percent |
| | Laboratory control sample | 2 per analytical batch of 20 samples or fewer |
| | Matrix spike/matrix spike duplicate (not required for all analytes) | 5 percent of total samples submitted over project duration |

[1]PE = Performance Evaluation Sample, issued by the National Institute for Standards and Technology (NIST). PE samples are certified for specific chemical or physical properties and are issued with certificates that report the results of the characterization and indicate the use of the material.

### 1.6.4 Representativeness

Representativeness is a measure of how closely the measured results reflect the actual concentration or distribution of the chemical compounds in the environment. Sampling plan design, sampling techniques, and sample handling protocols (for example, storage, preservation, and transportation) have been developed and are discussed in other sections of this document. Documentation will establish that protocols have been followed and sample identification and integrity assured. Field blanks and field duplicates will be used to assess field and transport contamination and sampling variation. Laboratory sample retrieval, storage, and handling procedures have also been developed and are discussed in other sections of this document. Laboratory method blanks will be run at the minimum frequency of 5 percent or one per analytical batch to assess laboratory contamination.

### 1.6.6 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement system. The target completeness objectives are 90 percent for each analytical parameter; the actual completeness can vary with the intrinsic nature of the samples. The completeness of the data will be assessed during the data review.

Completeness is defined as follows for all measurements:

$\%C = 100\% \times [V/n]$

%C = percent completeness
V = number of measurements judged valid
n = total number of measurements

### 1.6.7 Comparability

Comparability is the level of confidence with which one data set can be compared with another. This objective is met by selecting field sampling methods and laboratory analytical methods that are comparable throughout the baseline environmental studies. Changing sampling techniques or laboratory methods during the study may compromise comparability. The field sampling methods have been evaluated to ensure comparability among consultants collecting samples of the same media from the mine area and the road/ port area. The laboratory methods employed by the primary and QA laboratories have been evaluated to ensure methods used for primary, QC and QA samples are comparable. Comparability will also be maintained by the use of consistent units.

## 1.7 Special Training and Certification

The laboratories selected for the Pebble Project have obtained certifications and participate in periodic auditing programs that establish their level of performance. Table 1-26 summarizes state and federal certifications and accreditation programs that the Pebble Project laboratories participate in.

Table 1-26
Laboratory Certifications and Accreditation Programs

| Laboratory | Program |
|---|---|
| SGS Environmental Services, Inc. | Alaska Department of Environmental Conservation - Drinking Water and Contaminated Sites Certification |
| | Air Force Center for Environmental Excellence. |
| | National Environmental Laboratory Accreditation Program |
| | U.S Army Corps of Engineers |
| | US Navy (NAVSEA) |
| | U.S. Department of Agriculture |
| Columbia Analytical Services, Inc. | Alaska Department of Environmental Conservation – Contaminated Sites Certification |
| | Air Force Center for Environmental Excellence. |
| | National Environmental Laboratory Accreditation Program |
| | U.S Army Corps of Engineers |
| | US NAVY (NAVSEA) |
| North Creek Analytical, Inc. | Alaska Department of Environmental Conservation - Drinking Water and Contaminated Sites Certification |
| | National Environmental Laboratory Accreditation Program for Oregon |
| | US NAVY (NAVSEA) |
| | U.S Army Corps of Engineers |

## 1.8 Documents and Records

### 1.8.1 Quality Assurance Project Plan

The QAPP document will be controlled by the Analytical QA/QC Manager. Approved QAPPs will be provided to the parties presented in the Distribution List (Section 1.2). Should the QAPP require revision, the earlier version will be returned to the Analytical QA/QC Manager and updated versions subsequently distributed. The following document control information will be shown in the bottom right corner of each page.

### 1.8.2 Laboratory Reports

The minimum information that must be included in the hardcopy data report package is as follows:

1. Transmittal letter.
2. Case narrative to discuss at a minimum all issues that may negatively impact data quality including sample handling, preservation, holding times, sample matrix, and QC results.
3. Chain-of-custody documents.
4. Cooler receipt form documenting cooler temperatures, sample preservation, and condition upon receipt by the laboratory.
5. Custody seals.
6. Sample analytical results. Do not report results from multiple dilutions for a given parameter.
7. Method blank results.
8. Surrogate recovery results and acceptance criteria for applicable organic methods.
9. Dates of sample collection, receipt, preparation, and analysis for all tests.
10. Matrix spike result(s) with calculated recovery including associated acceptance criteria.
11. Duplicate or duplicate matrix spike result(s) (as appropriate to method), with calculated RPD and acceptance criteria.
12. LCS and or QC check sample result(s) with calculated recovery and associated acceptance criteria.
13. Calibration records and results of initial and continuing calibration verification standards with calculated recoveries and acceptance criteria.
14. Results of calibration blanks or solvent blanks (as appropriate to method).
15. Summary forms of associated QC and calibration parameters.
16. Copies of all raw data, including extraction/preparation bench sheets, chromatograms, and instrument printouts associated with the entire analytical sequence(s). Do not include sample results from other clients where possible.

For each report or sample delivery group, laboratories will submit the United States Army Corp of Engineers (USACE) COELT EDF v 1.2 electronic deliverables.

### 1.8.3 Quality Assurance Reports

QAR reports will assess the data and address corrective action related to field and laboratory activities. These reports will be prepared and controlled by the Analytical QA/QC Manager.

# 2 Data Generation and Acquisition

The generation, compilation, reporting, and archiving of data are critical components of field and laboratory operations. In order to generate data of known and acceptable quality, the QA/QC practices for data management must be complete and comprehensive and in keeping with the overall QA objectives of the project.

## 2.1 Sampling Process Design

Producing data of known quality that are considered representative of the sampling environment at an appropriate level of detail is achieved by establishing a QA program with specified data gathering protocols overseen by the Analytical QA/QC Manager. The main components of the proposed QA program include the following:

- Verification of use of proper sample containers and preservative
- Collection and analysis of blank/duplicate samples
- Specific procedures for handling, labeling, and shipping samples
- Field equipment calibration
- Equipment decontamination
- Field documentation
- Field corrective action

All field blanks/duplicates and triplicates will be noted on the chain of custody and field log books.

See Section 1.5 for the following information:

- Types and numbers of samples required
- Sampling frequency
- Sample matrices
- Parameters of interest

The Pebble Gold Copper Project *Environmental Baseline Studies 2004 Proposed Study Plan* (NDM, 2004) presents the sampling locations and rationale for the design.

## 2.2 Sampling Methods

General field sampling methods are contained in the Pebble Gold Copper Project *Environmental Baseline Studies 2004 Proposed Study Plan* (NDM, 2004) and in respective consultants' Field Work Plans and QA Plans. Corrective action is the responsibility of the Analytical QA/QC Manager and Project Managers for HDR, BEESC, and SLR. When a failure in the sampling system occurs, this management team will cooperate to investigate the failure and implement necessary corrective action(s).

For all field samples, containers will be provided by the laboratory conducting the analyses. Tables 2-1, 2-2, and 2-3 summarize the required containers, sample volumes, preservation, and maximum holding times for all parameters.

### 2.2.1 Sample Collection and Analysis

Sample collection, handling, and shipping procedures include the following:

- Field Collection
- Labeling

- Packaging
- Chain-of-custody forms
- Shipping

The Project Managers are responsible for implementing the following sample handling and shipping procedures. The Analytical QA/QC Manager will check for quality assurance measures on these activities.

### 2.2.2 Field Collection Procedures

In all cases, field collection procedures will be done to minimize contamination of samples, prevent cross-contamination between samples, and ensure sample validity by doing proper preservation and storage in the field according to the requirements specified in this QAPP.

Surface water samples will be collected for analysis in the following order:

- Mercury
- Total metals
- Dissolved metals
- Total suspended solids, total dissolved solids, etc.
- Settleable solids (Imhoff cones in the field)
- Miscellaneous parameters (ammonia, phosphorus, Cyanide WAD, etc.)

For mercury, many States are establishing new National Pollutant Discharge Elimination System (NPDES) limits at very low levels based on maintaining water quality standards in the receiving streams. The new limits may approach or even be less than the detection limit of routine analytical methods.

To ensure that reliable data are produced at these extremely low detection levels, additional emphasis must be placed on clean sampling and clean laboratory practices to minimize contamination. The following general field procedures are recommended by CAS, the laboratory that will perform mercury analysis for the Pebble Project.

Document sampling cleanliness through the use of trip blanks and field sampling blanks.

Use non-metallic sampling equipment and do not allow any metal object to come into direct or indirect contact with the sample or sample containers (storing samples at all times in properly cleaned and sealed containers (ice chests) can help prevent inadvertent contact with such objects, as well as prevent inadvertent contamination).

Use non-talc gloves and change gloves between sample collections.

Collect samples directly into sample containers that are documented clean at the levels of concern

Table 2-1
Sample Bottle Schedule and Sampling Parameters for Surface Water/Groundwater Collection

| Analytical Set | Bottle Type (SGS) | Bottle Type (CAS) | Analysis | Target Analytes | Lab Method | Preservative | Hold Time | Required Temp. | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (1) 1L HDPE<br><br>1 extra volume for MS/MSD | (1) 1L HDPE<br><br>No extra volume for MS/MSD | Total Hg<br><br>Total Metals | Hg<br><br>1 | E245.1<br><br>E200.8/ 200.7 | $HNO_3$<br><br>$HNO_3$ | 28 days<br><br>6 Months | 4 °C<br><br>None | Unfiltered |
| 2 | (1) 1L HDPE<br><br>1 extra volume for MS/MSD | (1) 1L HDPE<br><br>No extra volume for MS/MSD | Dissolved Hg (GW only)<br><br>Dissolved Metals | Hg<br><br>1 | E245.1<br><br>E200.8/ 200.7 | $HNO_3$<br><br>$HNO_3$ | 28 days<br><br>6 Months | 4 °C<br><br>None | Filtered |
| 3 | (2) 250 mL HDPE<br><br>No extra volume for MS/MSD | (1) 1L HDPE<br><br>No extra volume for MS/MSD | Cyanide Total | Cyanide Total | 4500CN | NaOH | 14 days | 4 °C | Unfiltered |
| | | | Cyanide (Weak Acid Dissociable) | Cyanide (Weak Acid Dissociable) | 4500CN | NaOH | 14 days | 4 °C | Unfiltered |
| 4 | 500 mL HDPE<br><br>No extra volume for MS/MSD | (1) 1L HDPE<br><br>No extra volume for MS/MSD | Ammonia as N | Ammonia as N | 4500-N , E350.1 | $H2SO_4$ | 28 days | 4 °C | Unfiltered |
| | | | Phosphorus Total | Phosphorus Total | E365.3 | $H2SO_4$ | 28 days | 4 °C | Unfiltered |
| | | | Nitrate-Nitrite Total | Nitrate-Nitrite Total | E300.0, E353.2 | $H2SO_4$ | 28 days | 4 °C | Unfiltered |
| 5 | (2) 1L HDPE<br><br>2 extra volumes for TDS/TSS lab duplicates<br><br>60 mL Nalgene* (*Cl, F, SO4 only)<br>1 extra volume for MS and 1 extra volume for lab | (2) 1L HDPE<br><br>No extra volume for MS/MSD | TDS | TDS | 2540C | None | 7 days | 4 °C | Unfiltered |
| | | | TSS | TSS | E160.2 | None | 7 days | 4 °C | Unfiltered |
| | | | Alkalinity | Alkalinity | 2320B | None | 14 days | 4 °C | Unfiltered |
| | | | Acidity | Acidity | 305.2 | None | 14 days | 4 °C | Unfiltered |
| | | | Conductivity | Conductivity | SM2510 B, E120.1 | None | 28 days | 4 °C | Unfiltered |
| | | | pH | PH | E150.1 | None | 24 hours | 4 °C | Unfiltered |
| | | | Chloride | Chloride | E300.0 | None | 28 Days | 4 °C | Unfiltered |
| | | | Fluoride | Fluoride | E300.0 | None | 28 Days | 4 °C | Unfiltered |
| | | | Sulfate | Sulfate | E300.0 | None | 28 Days | 4 °C | Unfiltered |

Table 2-1
Sample Bottle Schedule and Sampling Parameters for Surface Water/Groundwater Collection

| Analytical Set | Bottle Type (SGS) | Bottle Type (CAS) | Analysis | Target Analytes | Lab Method | Preservative | Hold Time | Required Temp. | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | duplicate | | | | | | | | |
| 6 | 250 mL HDPE<br><br>No extra volume for MS/MSD | 250 mL HDPE<br><br>No extra volume for MS/MSD | Thiocyanate | Thiocyanate | Lab SOP | $HNO_3$ | 28 days | 4 °C | Unfiltered |
| 7 | 500 mL Fluoropoly<br><br>No extra volume for MS/MSD | 500 mL Fluoropoly<br><br>No extra volume for MS/MSD | Low Level Hg | Hg | 1631 | HCl | 90 days | None | Unfiltered |
| 8 | See analytical set 4 above | 1L HDPE same bottle as analytical set 4 | Nitrate-Nitrite Total | Nitrate-Nitrite Total | E353.2 | $H2SO_4$ | 28 days | 4 °C | Unfiltered |
| 9 (Marine SW only) | (3) 40 ml VOA vial with Teflon septum lid<br><br>6 extra VOA vials for MS/MSD | (3) 40 ml VOA vial with Teflon septum lid<br><br>6 extra VOA vials for MS/MSD | GRO | GRO | AK101 | HCl | 14 days | 4 °C | Unfiltered |
| 10 (Marine SW only) | (2) 1- Liter Amber glass jar with Teflon cap<br><br>4 extra volumes for MS/MSD | (2) 1- Liter Amber glass jar with Teflon cap<br><br>4 extra volumes for MS/MSD | DRO/RRO | DRO/RRO | AK102/ 103 | HCl | 7 days to extraction; 40 days to analysis of extract | 4 °C | Unfiltered |
| 11 (SW only) | (3) 40 ml VOA vial with Teflon septum lid<br><br>6 extra VOA vials for MS/MSD | (3) 40 ml VOA vial with Teflon septum lid<br><br>6 extra VOA vials for MS/MSD | VOCs (or BTEX) | VOCs | SW826 0B | HCl | 14 days | 4 °C | Unfiltered |
| 12 (SW only) | (2) 1- Liter Amber glass jar | (2) 1- Liter Amber glass jar | SVOCs | SVOCs | SW827 0C | None | 7 days to extraction; 40 days to | 4 °C | Unfiltered |

Table 2-1
Sample Bottle Schedule and Sampling Parameters for Surface Water/Groundwater Collection

| Analytical Set | Bottle Type (SGS) | Bottle Type (CAS) | Analysis | Target Analytes | Lab Method | Preservative | Hold Time | Required Temp. | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | with Teflon cap<br><br>4 extra volumes for MS/MSD | with Teflon cap<br><br>4 extra volumes for MS/MSD | | | | | analysis of extract | | |
| 13(SW only) | (2) 1- Liter Amber glass jar with Teflon cap<br><br>4 extra volumes for MS/MSD | (2) 1- Liter Amber glass jar with Teflon cap<br><br>4 extra volumes for MS/MSD | Pesticides | Pesticides | SW8081 | None | 7 days to extraction; 40 days to analysis of extract | 4 °C | Unfiltered |

[1]Al, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, K, Ag, Na, Sb, V, Zn, As, Pb, Se, Sn, Tl, Hardness, B
[2]Al, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, K, Ag, Na, Sb, V, Zn, As, Pb, Se, Sn, Tl, B, Si
mL – milliliters
SOP – Standard Operating Procedure
SVOCs – semivolatile organic compounds
VOCs – volatile organic compounds

Table 2-2
Sample Bottle Schedule and Sampling Parameters for Soil/Sediment Collection

| Analytical Set | Bottle Type (SGS) | Bottle Type (CAS) | Analysis | Target Analytes | Lab Method | Preservative | Hold Time | Required Temp. | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (1) 8oz | (1) 8oz | Total Metals | 1 | SW6010B, SW6020, SW7471A, SW7196 | None | 6 Months | None | |
| 2 | (1) 4oz prewt'd amber | (1) 4oz prewt'd amber | GRO | Gasoline Range Organics | AK101 | MeOH w/ BFB | 28 days | 4 °C | 2nd 4oz % solids jar if no other analyses |
| 3 | (1) 4oz prewt'd amber | (1) 4oz prewt'd amber | BTEX | Benzene, toluene, ethylbenzene, and xylenes | SW8260B | MeOH w/ surrogate | 14 days | 4 °C | 2nd 4oz % solids jar if no other analyses |
| 4 | (1) 8oz | (1) 8oz | DRO/RRO | Diesel/residual range organics | AK102/103 | None | 14 days | 4 °C | |
| 5 | (1) 4oz | (1) 4oz | Cyanide | Cyanide Total | SM4500CN | None | (2) 28days | 4 °C | |
| 6 | (1) 4oz | (1) 4oz | Ammonia as N | Ammonia as N | SM4500NH3, E350.3 | None | 28 days | 4 °C | |
| 7 | (1) 4oz | (1) 4oz | Chloride | Chloride | E300.0 | None | 28 Days[3] | 4 °C | |
| | | | Fluoride | Fluoride | E300.0 | None | 28 Days[3] | 4 °C | |
| | | | Sulfate | Sulfate | E300.0 | None | 28 Days[3] | 4 °C | |
| 8 | (1) 4oz | (1) 4oz | Fraction Organic Carbon | Organic Carbon | ASTMD4129, LABSOP | None | 180 Days | 4 °C | |

[1]Al, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, K, Ag, Na, Sb, V, Zn, As, Pb, Se, Sn, Tl, B, Hg
oz – ounce prewt'd – reweighed and tared
[2] as per EPA methods factsheet titled- Total Petroleum Hydrocarbons, Reactive Cyanide, Reactive Sulfide, Ignitability, and Corrosivity
3Holding time is from the date of preparation

Table 2-3
Sample Bottle Schedule and Sampling Parameters for Tissue Collection

| Tissue Type | Bottle Type (CAS) | Bottle Type (NCA) | Analysis | Target Analytes | Lab Method | Preservative | Hold Time | Required Temp. |
|---|---|---|---|---|---|---|---|---|
| Vegetation | Ziploc Bag or Glass Jar | Ziploc Bag or Glass Jar | Total Metals | [1] | E200.8/200.7 - SW7471A | None | 6 Months | None |
| | | | Cyanide | Cyanide Total | SM4500CN-I | None | 14 days | 4 °C |
| | | | Ammonia as N | Ammonia as N | E350.3 | None | 28 days | 4 °C |
| | | | Chloride | Chloride | E300.0 | None | 28 Days[3] | 4 °C |
| | | | Fluoride | Fluoride | E300.0 | None | 28 Days[3] | 4 °C |
| | | | Sulfate | Sulfate | E300.0 | None | 28 Days[3] | 4 °C |
| Fish | Ziploc or similar plastic bag | Ziploc or similar plastic bag | Total Metals | [2] | SW6010B/6020 | None | 6 Months | Keep frozen (less than 0 °C ) |
| | | | Total Hg and MeHg | Total Hg and MeHg | SW7471A (CVAA) or E1631 (CVAF) | None | 6 Months | |

[1]Al, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, K, Ag, Na, Sb, V, Zn, As, Pb, Se, Sn, Tl, B, + Hg
[2]Sb, As, Cd, Cu, Pb, Ni, Se, Ag
[3]Holding time is from the date of preparation

Double bag all sample containers.

May need to designate one "clean hands" sampler to perform all operations involving direct contact with the sample, and one "dirty hands" sampler for all other operations (e.g., recordkeeping).

For fish being collected for contaminant analyses, fish collection procedures will follow many of the methods of Zhang et al. (2001) and Jewett et al. (2003). These include:

Total fish length and sex will be recorded for each specimen in the field; any necessary dissection to determine sex will be done using surgical sheets, powder-free latex gloves, and an acid-washed titanium knife or scalpel. The disposable gloves will be changed out between each dissection.

For smaller fish (e.g., < 6 inches total length), the entire animal will be placed in a Ziploc-type plastic bag and frozen immediately.

For larger fish (e.g, > 6 inches total length), immediate freezing of all tissues in an entire animal would be difficult under field conditions. Therefore, tissue dissections for muscle and liver samples will be done in the field as follows:

1. Immediately upon capture, fish will be placed in clean plastic bags and placed in a cooler with ice.
2. Dissection will occur inside at a clean site in Iliamna.
3. The cutting surface will be washed with soap and water and covered with heavy duty aluminum foil.
4. Either stainless steel disposable scalpels or stainless steel knives will be used for dissection. Knives will be washed with soap and water and rinsed with DI water between uses. Scalpels will be replaced between fish.

5. An approximate 25 g. sample of liver and muscle tissue will be extracted from each fish using powder free gloves and placed in an individually labeled Ziploc bag. Tissue samples will be immediately placed in a freezer.
6. An equipment blank will be prepared after each set of dissections by rinsing the cutting surface and the knives with DI water and collecting in an acid washed jar.
7. Frozen tissue samples will be packaged in a cooler and sent to the laboratory using packaging recommendations provided by the lab. Chain of custody procedures will be followed.
8. Each sample from an individual fish will be labeled with the sample ID number and include a suffix of "M" for muscle and "L" for liver tissue (see Section 2.3.1).
9. For the fish tissue samples from large fish, the muscle tissue will be collected immediately below the dorsal fin. When doing the tissue dissections at least 25g of tissue for each type of tissue sample, or about an 3x3x1 - inch piece of tissue will be collected.

For vegetation samples collect 50 grams from a representative plant in each plant class (tree, shrub, grass, forb, fern, moss, and lichen) within the plot. A two letter code for each species will be used as the suffix in the sample ID, for example 081604TE12TP001-Pm is a sample of picea mariana or black spruce at location TE12, collected on Aug 16, 2004. Refer to Table 2-4 for species names and codes

Table 2-4
Summary of Vegetation Species Names

| Species Name | Common Name |
|---|---|
| Trees | |
| Picea mariana (Pm) | black spruce |
| Picea glauca (Pg) | white spruce |
| Tsuga mertensiana (Tm) | mountain hemlock |
| Populus tremuloides (Pt) | quaking aspen |
| Betula papyrifera (Bp) | paper birch |
| Populus balsamifera (Pb) | balsam poplar |
| Shrubs | |
| Juniperus communis (Jc) | common juniper |
| Alnus crispa (Ac) | mountain alder |
| Rosa acicularis (Ra) | prickly rose |
| Potentilla fruticosa (Pf) | tundra rose |
| Ribes laxiflorum (Rl) | trailing black currant |
| Ribes triste (Rt) | northern red currant |
| Ribes glandulosum or hudsonianum (Rg)(Rh) | skunk or northern black currant |
| Vaccinium uliginosum (Vu) | bog blueberry |
| Vaccinium ovalifolium (Vo) | early blueberry |
| Salix alaxensis (Sa) | feltleaf willow |
| Salix brachycarpa (Sb) | barren-ground willow |
| Betula glandulosa or nana (Bg)(Bn) | shrub or dwarf birch |
| Ledum palustre (Lp) | narrow leaf labrador tea |
| Myrica gale (Mg) | sweet gale |
| Empetrum nigrum (En) | crowberry |
| Vaccinium vitis-idaea (Vv) | lingon berry (low bush cranberry) |
| Grasses | |

| Species Name | Common Name |
|---|---|
| Eriophorim scheuchzeri (Es) | alaska cotton or cotton grass |
| Calamagrostis sp.(Cs) | blue joint grass |
| Forbs | |
| Artemisia tilesii (At) | worm wood |
| Epilobium angustifolium (Ea) | fireweed |
| Rubus chamaemorus (Rc) | cloudberry |
| Iris setosa (Is) | iris |
| Heracleum lanatum (Hl) | cow parsnip (wild celery)(putchkie) |
| Rumex arcticus (Rar) | sour dock |
| Polygonum alaskanum (Pa) | wild rhubarb |
| Veratrum viride (Vvi) | false hellebore |
| Hedysarum alpinum (Ha) | wild potato |
| Hedysarum mackenzii (Hm) | wild sweet pea |
| Potentilla palustris (Pp) | marsh five finger |
| Polemonium pulcherrimum (Ppu) | beautiful jacobs ladder |
| Epilobium adenocaulon (Ead) | evening primrose sp. |
| Aconitum delphinifolium (Ad) | monkshood |
| Equisetum pratense (Ep) | horse tail |
| Ferns And Fern Allies | |
| Dryopteris dilatata (Dd) | spreading wood fern |
| Mosses | |
| Hylocomium splendens (Hs) | stair-step moss |
| Lichens | |
| Cladina rangiferina (Cr) | reindeer lichen or "caribou moss" |

### 2.2.3 Field Documentation

Field observations, field equipment calibration information, field measurements, and sample documentation, including sample identification, sample duplicates, and date and time the sample was collected, will be the responsibility of the entire sampling team. Field forms will be maintained for each task. Field forms will consist of waterproof bound pages, in ink, and every appropriate area marked. Blank pages will be marked as such with a diagonal line across the page, when appropriate.

Proper documentation for sample custody includes keeping records of all materials and procedures involved in sampling. Project field forms will be used to record field data. All information on the sampling station and respective samples and blanks collected at each site, including the positions of the station, will be recorded by the field crew. The field crew leader will review all data before leaving the sampling station. Completed field forms will be kept on file for future reference.

### 2.2.4 Corrections to Field Documentation

Unless weather conditions prevent it, all original data will be recorded with waterproof ink. No accountable documents will be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. If an error is made on an accountable document assigned to one person, that person must make corrections by drawing a line through the error, initialing and dating the lined-out item, and entering the correct information. The erroneous information is not to be obliterated, but must remain legible. Any subsequent error discovered on an accountable

document will be corrected by the person who made the entry. All such subsequent corrections will be initialed and dated.

## 2.3 Sample Handling and Custody

Sample handling and custody procedures are required in the field, laboratory, and during transport. The procedures take into account the nature of the samples, the maximum holding times, and shipping options from Iliamna to the laboratories.

### 2.3.1 Labeling

Each sample container will have a waterproof label large enough to contain the information needed to easily identify each sample. The information to be included on each label will include the project name, date, time, preservative (if added), sample code, analysis, and sampler's initials. Sample code will be formatted to indicate sample date (month and year), location, matrix, and number.

Each sampling location will be identified by the sampler on the field form. An example of sample identification is as follows:

0105CR199ASW001

Where:

0105 is the date as month/year
CR199A is the location ID
SW is the matrix code for surface water
001 is a sequential sample number

For field duplicates, the sequential sample number will be 201, and triplicates will be 301. The suffix 401 is used for field equipment rinse blanks. The suffix 501 is used for DI water blanks. The suffix 601 is used for trip blanks.

For trip blanks laboratory codes are used for the location ID. Laboratory codes are SGS, CASK and NCAP for SGS Environmental Services, Inc., Columbia Analytical Services, Inc. and North Creek Analytical Services, Inc. The date code is month and year only. A sample surface water trip blank ID for SGS may be 0105SGSTBSW601 for the first trip blank in January 2005. If more than one trip blank is used on the same date for the same matrix increase the sequential ID to 602.

Additional matrix codes are:

MS – marine surface water

MB – marine bottom water

MZ – marine sediment

SD – sediment

SL – soil

SP – seeps

SW – surface water

GW – groundwater

TF – fish tissue

TP – plant tissue

For large fish with analyses conducted on both muscle and liver tissue the sample ID will include a suffix of "M" for muscle and "L" for liver tissue. For example, fish liver tissue from location CR199A collected on August 20, 2004 would have the following sample ID 102004CR199ATF001L.

These samples IDs are defined to facilitate data management for the life of this project.

### 2.3.2 Packaging

Each analytical sample bottle will be packed to prevent breakage and placed in an iced cooler to keep the samples cooled to 4° Centigrade (C). One copy of the chain-of-custody form will be placed in a sealed plastic bag, and then will be placed on the inside of the cooler. In addition, the cooler lid will be sealed with tape and chain-of-custody seals will be attached to the outside of the cooler so that the seals must be broken if the cooler is opened.

To preserve water, soil, and sediment sample integrity from collection to receipt by laboratories, all shipments will adhere to the following requirements at a minimum:

1. Coolers will be packaged with 25 percent frozen blue ice and 75 percent samples. For water samples, avoid packing too much blue ice around any one sample to avoid freezing samples.
2. For fish tissue samples, ensure that the tissues are completely frozen before they are removed and placed into the iced cooler for shipment. Be sure that all samples are segregated from other freezer contents by being in an appropriate larger sealed container (including custody tape).
3. ALL samples in ALL coolers are to be shipped using Alaska Airlines GoldStreak (or other airport-to-airport equivalent). For samples sent to Columbia Analytical Services, Inc. (CAS) in Kelso, Washington, write on airbill "by way of Portland." CAS has daily courier service from Portland to their lab in Kelso. Samples may be shipped to Seattle without this instruction.
4. Each cooler will include a completed chainofcustody (COC) form for the samples contained in the cooler with all required analyses clearly specified.
5. Each cooler will include a bottle of water labeled Temperature Blank. The laboratory will measure and record the temperature from this bottle and the cooler air temperature.

### 2.3.3 Chain-of-Custody Form

COC forms will be used for all samples. Once collected, the samples will remain within sight of the sampler or will be secured until the samples are prepared for shipment. Each time the cooler changes hands, both the sender and the receiver will sign and date the chain-of-custody form. The laboratory will forward the original to the Analytical QA/QC Manager. The field sampling team(s) will verify all chain-of-custody forms before sample shipment and will make a copy of each to maintain a duplicate set of records. The following information is to be included on the chain-of-custody form:

- Sample identification code
- Signature of sampler
- Date and time of collection
- Project name
- Type of sample
- Number and type of containers
- Sample preservation
- Sample analysis requested

- Inclusive dates of possession
- Signature of receiver

The consulting company's name, address, and phone number is required on the COC. Instruct laboratories to invoice Northern Dynasty Mines Inc. and to mail reports to:

Jane Whitsett
Shaw Environmental, Inc.
2000 West International Airport Road,
Suite A-11
Anchorage, AK 99502

Other chain-of-custody components will include sample labels, field notebook, sample shipment receipts, and the laboratory logbook. The lab-specific lists of analytical parameters are presented in Tables 1-9 through 1- 23.

## 2.4 Laboratory Procedures and Analytical Methods

Laboratories will employ the following general procedures, especially when conducting low level detection analyses:

The laboratory should use ultra clean reagent, specially-cleaned glassware, and other precautions such as the use of laminar flow hoods for sample digestion and preparation.

Laboratory method detection limits (MDLs) should be significantly lower than the maximum compliance level specified.

Analytical methods selected for the Pebble Project are presented in Table 2-5 below. The instrument method is given for each parameter. The procedures are routine for the laboratories selected for this project and adhere to EPA methods for the analysis of water and solid samples. CAS and NCA will be conducting metals analysis on fish tissues and vegetation. These laboratories have established procedures for these matrices.

Table 2-5
Pebble Project Parameters, Methods, and Techniques/Instrumentation

| Parameter | Methods (Water) | Methods (Solids) | Technique/Instrumentation |
|---|---|---|---|
| Inorganics | | | |
| pH | E150.1 | NA | electrode |
| Conductivity | SM 2510B, E120.1 | NA | resistor network |
| Acidity | E305.2 | NA | titration |
| Alkalinity | SM2320B | MA | titration |
| Ammonia as N | SM4500NH3, E350.1 | SM4500NH3, E350.3 | ion selective electrode |
| Chloride | E300.0 | E300.0 | ion chromatography/ion selective electrode |
| Cyanide-total | SM4500CN | SM4500CN , E335.2 | spectroscopy (colorimetric) |
| Cyanide-WAD | E4500 | NA | spectroscopy (colorimetric) |
| Fluoride | E300.0 | E300.0 | ion chromatography/ion selective electrode |
| Hardness | Calculated from Ca and Mg | NA | Calculation |
| Nitrate + Nitrite | E300.0 | NA | ion chromatography |
| Nitrate + Nitrite | E353.2 | NA | spectrophotometer |
| Phosphorus-total | E365.3 | NA | spectroscopy (colorimetric, photometric) |
| Sulfate | E300.0 | E300.0 | ion chromatography |
| Thiocyanate | Lab SOP | NA | spectroscopy (colorimetric) |
| Total dissolved solids | E160.1, SM2540C | NA | gravimetric |
| Total Suspended Solids | E160.2 | NA | gravimetric |
| Metals | | | |
| Hexavalent chromium [1] | SW7196A | NA | colorimetric |
| Low level mercury | E1631 | E1631 | cold vapor atomic fluorescence spectrophotometer |
| Mercury | E245.1 | SW7471A | cold vapor atomic absorption |
| Metals [2] | E200.7/200.8 | SW6010B/6020 | inductively coupled plasma - atomic emission spectroscopy/mass spectrometry |
| Organics | | | |
| Fraction Organic Carbon | NA | ASTM D4129-82M, LAB SOP | combustion or oxidation |
| BTEX | SW8260B | SW8260B | gas chromatography/mass spectrometry |
| GRO/DRO/RRO | AK101/102/103 | AK101/102/103 | gas chromatography with flame ionization detector |
| Pesticides | E508.1, SW8081 | NA | gas chromatography with electron capture detection |
| VOCS | SW8260B | NA | gas chromatography/mass spectrometry |
| SVOCs | SW8270C | NA | gas chromatography/mass spectrometry |

[1]Analysis for hexavalent chromium will only be conducted if total chromium exceeds 11 ug/L.
[2]Al, Sb, As, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Si (dissolved only), Ag, Na, Tl, Sn, V, Zn. Water samples are analyzed for total and dissolved metals.
SOP – Standard Operating Procedure
NA – not applicable

## 2.5 Quality Control

The QAPP program consists of three components:

- Field QA identifies the procedures to be used in the field to verify that samples and field monitoring data are collected according to the requirements of the project. The objective of field QA is to produce data, both field measurements and samples collected for laboratory analyses, that can be demonstrated to be representative of the environment sampled and are of known and acceptable quality. The QA/QC Manager is responsible for reviewing at least 10 percent of the field data, and data review records will be kept in a log by the Project QA/QC Manager.
- Laboratory QA identifies the protocols to be used by the laboratories, demonstrating to NDM that project data are analyzed according to EPA acceptable methods and that reported values are accurate. SGS is the subcontracted lab and ADEC has SGS's Quality Management Plan on file. The objective of the laboratory QA/QC program is to produce data that will meet state and federal analytical requirements.
- Data QA identifies the protocols to be used to verify that laboratory and field data have been reported accurately. The objective of the data QA/QC program is to demonstrate that the data reported meet the project-specified requirements.

### 2.5.1 Data Uses and Data Quality Objectives

Quality assurance requirements are established in this QAPP program to achieve the project objectives for the data uses. Applicable quality control procedures, quantitative target limits, and level of effort for assessing the data quality are dictated by the intended use of the data and the nature of the required field and analytical methods. The project objectives are to collect data of known and sufficient quality for NDM to comply with the requirements of state and federal environmental regulations.

Federal and state levels of concern (e.g., ambient water quality criteria or maximum contaminant levels) exist for many of the parameters being analyzed in the baseline studies program. Analytical methods have been specified that will allow detection of chemical constituents at or below levels of concern.

Quality control procedures, detection limits, and data quality requirements are dictated by the intended use of the data and the nature of the analytical methods.

### 2.5.2 Data Quality Assurance/Quality Control Program

The proposed data QA/QC program serves four major functions:

- Maintenance of a duplicate record of all field data
- Sample tracking through laboratory analysis
- Data validation
- Oversight of data management

The second major component of the proposed data QA program is sample tracking throughout the laboratory analytical process. The QA/QC Manager will maintain close communications with all analytical laboratories to verify sample receipt, proper sample management, and strict adherence to sample holding times. The laboratories will immediately inform the QA/QC Manager of sample breakage, inadequate sample media to meet QA objectives, and other sample problems. The QA/QC

Manager will then notify the respective Field Team so that corrective action can be implemented as deemed necessary.

Following receipt of the analytical data package, the QA/QC Manager will verify that all sample parameter data have been received, will compare them to detection limits, and will compare preliminary results with previous results. Should major discrepancies be found, the QA/QC Manager will communicate these, where appropriate, to the respective Field Team. Possible corrective measures will then be evaluated as deemed necessary.

### 2.5.3 Laboratory Quality Assurance/Quality Control Program

Specific protocols to ensure laboratory data of known and consistent quality can be found in SGS, CAS, and NCA Quality Assurance Manuals on file in the Shaw Anchorage office. The QA/QC Manager and laboratory Project Chemists will oversee implementation of these protocols. Project specific criteria are provided in Tables 1-5 through 1-15.

Data validation will be conducted by Shaw. Any discrepancies will be noted and discussed with:

Mr. Crupi, Laboratory Project Chemist for this project with SGS or

Ms. Chang, Laboratory Project Chemist for this project with NCA or

Ms. Huckestein, Laboratory Project Chemist for this project with CAS.

## 2.6 Instrument/Equipment Testing, Inspection, and Maintenance

The Laboratory Project Chemists are responsible for all laboratory equipment maintenance decisions. In the event of equipment failure that will impact the analytical schedule, the laboratory operations manager will notify the QA/QC manager. Field Team Managers are responsible for field equipment maintenance decisions.

## 2.7 Inspection/Acceptance of Supplies and Consumables

All supplies and consumables (Sample Reference Materials [SRMs] and reagents) will be inspected and checked in by the Laboratory Project Chemist or the Quality Assurance Officer.

## 2.8 Data Management

### 2.8.1 Field Forms

All pertinent field survey and sampling information will be recorded on field forms during each day of the field effort and at each sample site. The field crew leader will be responsible for seeing that sufficient detail is recorded on the forms. No general rules can specify the extent of information that must be entered on the forms. However, they will contain sufficient information so that all field activity can be reconstructed without relying on the memory of the field crew. All entries will be made in indelible ink. All corrections will consist of initialed, single-line-out deletions.

Strict custody procedures will be maintained with the field forms used. While being used in the field, forms will remain with the field team and will be secured on a clip board or, at a minimum, with rubber bands AT ALL TIMES. Upon completion of the field effort, forms will be filed in an appropriately secure manner in a bound notebook labeled "original data." These forms will remain with the task manager. Photocopies of the original data will be used as working documents.

All data will be recorded in Excel$^{TM}$ spreadsheets and included for analysis in the year-end report. Computer transfer of laboratory data results to compact disc and then to spreadsheets will occur upon receipt of said results by the Analytical QA/QC Manager. The laboratories also send paper copies of analysis results to the Analytical QA/QC Manager.

# 3 Assessment and Oversight

## 3.1 Assessments and Response Actions

Field assessments will be discussed between the Analytical QA/QC Manager and the Field Team Manager. Any response actions will then be undertaken by the Analytical QA/QC Manager during regular field sampling/monitoring events. Internal assessment for the laboratory will be performed according to laboratory's Quality Management Plans (QMPs), which are kept on file in the Shaw Anchorage office.

## 3.2 Reports to Management

Following the receipt of the analytical data package by Shaw, the Analytical QA/QC Manager at Shaw will review the data with regard to the following:

1. Analytical methodology
2. Detection limits
3. Accuracy, precision, and adherence to holding times

The Analytical QA/QC Manager at Shaw will perform a review on at least 10 percent of field data and analysis results. These QA/QC checks of data will be kept on file at Shaw by the Analytical QA/QC Manager, and included in QA reports of the data. Where data do not meet the requirements specified in this QA/QC program, the data will be flagged with qualifiers. Should major discrepancies be found, the Analytical QA/QC Manager will communicate these to NDM's representative, Ella Ede. Possible corrective measures will then be evaluated as deemed necessary. These data reviews will be summarized and included in the QA reports by Shaw to NDM.

### 3.2.1 Reporting Procedures

The laboratory will include the following information in all data packages submitted for this project:

1. Transmittal letter
2. A case narrative outlining any problems encountered during sample analysis, corrective actions initiated (if applicable), and the outcome, and any data not meeting the quality control criteria listed in Tables 1-6 through 1-14.
3. Chain-of-custody forms and copies of sample receiving forms.
4. Cooler receipt form documenting cooler temperatures, sample preservation and condition upon receipt by the laboratory.
5. Custody seals
6. Sample data reports that cross-reference laboratory identification and identification assigned by field samplers, analyte and method, sample results, MRL and MDL, dilution factor, date prepared, date analyzed, data qualifiers, and definitions of qualifiers. Also, include results of field blanks and SRMs.
7. Surrogate recovery results and acceptance criteria for applicable organic methods.
8. Results of LCS/LCSD, spike level, sample result, percent recovery, recovery limits, and RPD.
9. Results of MS, including spike level, results, and percent recovery. Matrix spikes must be prepared and analyzed on 5 percent of the total number of samples submitted for the Pebble Project.

10. Duplicate or duplicate matrix spike result(s) (as appropriate to method), with calculated relative percent difference and acceptance criteria
11. Calibration records and results of initial and continuing calibration verification standards with calculated recoveries and acceptance criteria
12. Method blank results
13. Dates of sample collection, receipt, preparation and analysis for all tests.
14. Results of calibration blanks or solvent blanks (as appropriate to method)
15. Summary forms of associated QC and calibration parameters
16. Copies of all raw data, including extraction/preparation bench sheets, chromatograms and instrument printouts associated with the entire analytical sequence(s). Do not include sample results from other clients where possible.

# 4 Data Review, Validation and Usability

Data review and validation will be conducted on all data collected for the Pebble Project environmental baseline studies.

## 4.1 Data Review

Data generated for this project will be reviewed by both the laboratory and by Shaw. The laboratory has primary responsibility for correctly identifying and quantifying analytes and compounds of interest, for identifying matrix interferences, and for identifying, and correcting if possible, instrument anomalies. The laboratory is also responsible for the technical quality of the data and for meeting all quality control parameters by correctly following the analytical methods using instrumentation that is in proper working order for the given method.

The review process will be coordinated initially by the bench-level scientists who will review all data for accuracy and completeness. The bench-level scientist will also compare all QC sample results with control criteria outlined in Tables 1-6 through 1-14, and will initiate appropriate corrective action if criteria are not met.

Prior to summary reports, the data will be reviewed by the Laboratory QA/QC Manager to ensure that the data are representative, complete, and accurate.

## 4.2 Validation and Verification Methods

Data validation is the review process to screen data for anomalies and possible errors. Data accepted from the laboratory will be verified and validated by Shaw. The data validation process will include review of the following:

- Analytical methodology
- Detection limits
- Cross-contamination as indicated by blank data
- Laboratory accuracy and precision
- Adherence to holding times
- Sample preservation
- Initial and continuing calibration
- Field precision (QA/QC samples)
- Total metals vs. dissolved metals

Data will be validated in accordance with the following procedures:

U.S. Environmental Protection Agency (USEPA). 1999. *Contract Laboratory Program National Functional Guidelines for Organic Data Review*, OSWER 9240.1-05A-P, PB99-963506, EPA540/R-99/008, October.

USEPA. 2001. *Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review*, Final, OSWER 9240.1-34, EPA-540-R-00-006, June. [Not cited in report]

USEPA. 2002. *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, Final, OSWER 9240.1-35, EPA 540-R-01-008, July.

Field precision will be evaluated using criteria presented in Table 2-6. For samples that are in Disagreement or Major Disagreement field and laboratory data will be evaluated for any biases that may explain the disagreements. In some cases, associated samples may be qualified as estimates (J) or rejected (R) based on professional judgment.

Table 2-6
Criteria for Comparing Field QC and QA Sample Data

| Matrix | Parameter | Disagreement | Major Disagreement |
|---|---|---|---|
| All | All | >5x difference when one results is < MDL | >10x difference when one results is < MDL |
| All | All | >3x difference when on result is < MRL | >5x difference when one result is < MRL |
| Water | All except TPH | > 2x difference | > 3x difference |
| Soil, Sediment and Tissues | All except metals, VOCs, BTEX and TPH | > 4x difference | > 5x difference |
| Soil, Sediment and Tissues | Metals | > 2x difference | > 3x difference |
| Water, Soil and Sediment | TPH | Arbitrary (suggest >3x difference) | Arbitrary (suggest >3x difference) |
| Soil, Sediment and Tissues | VOCs and BTEX | Arbitrary (suggest >3x difference) | Arbitrary (suggest >3x difference) |

Reference: CRREL Special Report No. 96-9, "Comparison Criteria for Environmental Chemical Analyses of Split Samples Sent to Different Laboratories – Corps of Engineers Archived Data", Grant, C.G., Jenkins, T.F., Mudambi, A.R., USACE cold Regions & Environmental research Laboratory, Hanover, NH, May, 1996.

Evaluation of total and dissolved metals will involve comparison of results for instances where dissolved is greater than total. Sample results are acceptable if the following criteria are met.

1. Where both results are greater than 5x the MRL and the RPD between results is less than or equal to 20%.

2. Where the total metals result is less than or equal to 5x the MRL and the absolute value of the difference between the results is less than or equal to the MRL. If the total metals result is not detected at the MDL, then the value of the MDL will be used for the comparison.

3. Where both total and dissolved results are below the MRL.

For an individual sample where criteria are not met for up to 30% of the parameters, then the associated QC data (including method blanks and field blanks) will be evaluated for bias. Consequently, results may be qualified with a J as an estimate. If more than 30% of the parameters exceed the criteria, then both total and dissolved samples will be reanalyzed. If reanalysis does not eliminate the problem, then results will qualified with a J as an estimate (Zeiner, 1994).

Where data do not meet the requirements specified in this QAPP program, the data will be flagged with qualifiers. These reviews of data will be summarized and included in the QA report.

The following are validation flags that will be inserted into electronic format for upload into the Resource Development Inc. database:

R – The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.

U – The analyte was analyzed, but was not detected above the level of the reported sample quantitation limit.

J+ – The result is an estimated quantity, but the result may be biased high.

J- – The result is an estimated quantity, but the result may be biased low.

BQ – The result is associated with inorganic method blank contamination at a level less than or equal to five times the concentration in the blank for contaminants below the MRL (ten times for contaminants above the MRL). Result should be considered not detected at the concentration of the MRL for those results reported below it or as biased high for those reported above the MRL.

BQ1 – The result is associated with inorganic field blank (equipment blank, DI water blank or trip blank) contamination at a level less than or equal to five times the concentration in the blank for contaminants below the MRL (ten times for contaminants above the MRL). Result should be considered not detected at the concentration of the MRL for those results reported below it or as biased high for those reported above the MRL.

BQ2 – The result is associated with organic method blank contamination at a level less than or equal to five times the concentration in the blank (ten times for common laboratory contaminants). Result should be considered not detected at the concentration of the MRL or sample result, whichever is greater.

BQ3 – The result is associated with organic field blank (equipment blank, DI water blank or trip blank) contamination at a level less than or equal to five times the concentration in the blank (ten times for common laboratory contaminants). Result should be considered not detected at the concentration of the MRL or sample result, whichever is greater.

## 4.3 Reconciliation with User Requirements

A periodic review of the objectives of this project will be accomplished on a yearly basis to determine if user requirements have changed.

# 5 References

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# DRAFT ENVIRONMENTAL BASELINE STUDIES
# PROPOSED 2005
# QUALITY ASSURANCE PROJECT PLAN

# PEBBLE PROJECT

## DRAFT ENVIRONMENTAL BASELINE STUDIES
## PROPOSED 2005
## QUALITY ASSURANCE PROJECT PLAN

Prepared For:

**State of Alaska Large Mine Permitting Team**
**Department of Natural Resources**

Prepared By:

Pebble Project
NORTHERN DYNASTY MINES INC.

3201 C Street, Suite 604
Anchorage, AK 99503
(907) 339-2600

March 4, 2005

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# List of Tables and Figures

## Tables



## Figure

# Acronyms

ADEC..... Alaska Department of Environmental Conservation
ADNR ..... Alaska Department of Natural Resources
BEESC ..... Bristol Environmental and Engineering Services Corporation
BTEX ..... benzene, toluene, ethylbenzene, and xylenes
C..... Centigrade
CAS..... Columbia Analytical Services, Inc.
COC ..... chain-of-custody
DQAR ..... data quality assurance report
DRO ..... diesel range organics
DQOs ..... data quality objectives
EPA..... United States Environmental Protection Agency
EBS ..... environmental baseline studies
FSP..... field sampling plan
g ..... gram
GRO ..... gasoline-range organics
GW..... ground water
HDR ..... HDR Alaska, Inc.
ICP-MS ..... inductively coupled plasma-mass spectroscopy
LCS ..... laboratory control sample
L..... liters
MBW ..... marine bottom water
MDL..... method detection limit
mg/kg ..... milligrams per kilogram
mg/L..... milligrams per liter
ml ..... milliliters
MRLs ..... method reporting limits
MS..... matrix spikes
MSD..... matrix spike duplicate
MSW ..... marine surface water
N/A..... not applicable
NCA ..... North Creek Analytical, Inc.
NDM ..... Northern Dynasty Mines Inc.
NEPA ..... National Environmental Policy Act
NIST..... National Institute for Standards and Technology
NDPES..... National Pollutant Discharge Elimination System
NOAA ..... National Oceanic and Atmospheric Administration
oz..... ounce
PARCC ..... precision, accuracy, representativeness, comparability, and completeness
PCBs ..... polychlorinated biphenyls
PE..... performance evaluation
Pebble Project .... Pebble Project
PEL ..... probably effects level
QA..... quality assurance
QAPP ..... quality assurance project plan
QC..... quality control
QMP..... quality management plan
RPD..... relative percent difference

RRO ..... residual range organics
RSD..... relative standard deviation
SGS ..... SGS Environmental Services, Inc.
Shaw..... Shaw Environmental, Inc.
SLR ..... SLR Alaska, Inc.
SRMs ..... sample reference materials
SOP ..... standard operating procedure
SQRT ..... Screening Quick Reference Tables
SVOC..... semivolatile organic compound
SW ..... surface water
tbd ..... to be determined
TEL ..... threshold effects level
TKN ..... total kjeldahl nitrogen
TOC ..... total organic carbon
TSS..... total suspended solids
TDS..... total dissolved solids
µg/L..... micrograms per liter
µmhos/cm..... micromhos per centimeter
USACE ..... United States Army Corp of Engineers
VOC ..... volatile organic compound

# 1 Program Summary

## 1.1 Title and Approval Sheets

**Program Title**: Pebble Project, Environmental Baseline Studies

**Organization:** Northern Dynasty Mines Inc. (NDM)

| **NDM Personnel** | **Signature** | **Date** |
|---|---|---|
| Bruce Jenkins<br>Chief Operating Officer/<br>Environmental Study Director<br>E-mail: brucej@hdgold.com<br>Phone: 604-684-6365<br>**NDM** | _____ | |
| Dennis Deans<br>Asst. Environmental Study Director<br>E-mail: dennisd@hdgold.com<br>Phone: 604-684-6365<br>**NDM** | _____ | |
| Ella Ede<br>Environmental Project Manager<br>E-mail: ellae@northerndynasty.com<br>Phone: 907-339-2600<br>**NDM** | _____ | |
| Michael Smith<br>NEPA and Permitting Manager<br>E-mail: michaels@northerndynasty.com<br>Phone: 907-339-2606<br>**NDM** | _____ | |
| Jane Whitsett<br>Analytical QA/QC Manager<br>E-mail: jane.whitsett@shawgrp.com<br>Phone: 907-243-6300<br>**Shaw Environmental, Inc.** | _____ | |

| Agency Personnel | Signature | Date |
|---|---|---|
| William D. "Pete" McGee<br>Pebble Project Manager<br>E-mail: pete_mcgee@dec.state.ak.us<br>Phone: 907-451-2101<br>**Alaska Department of Environmental Conservation (ADEC)** | | |
| James Gendron Quality Assurance Officer<br>E-mail:<br>james_gendron@dec.stltg.ak.usPhone:<br>907-465-5305**Alaska Department of Environmental Conservation (ADEC)** | | |
| Cindi GodseyProject ManagerE-mail:<br>godsey.cindi@epa.govPhone: 907-271-6561**United States Environmental Protection Agency (EPA)** | | |

## 1.2 Distribution List

- ADEC
- ADNR
- EPA
- NDM
- Shaw Environmental, Inc.
- HDR Alaska, Inc.
- Bristol Environmental & Engineering Services Corp. BEESC
- SLR Alaska, Inc.
- SGS Environmental Services, Inc.
- Columbia Analytical Services, Inc.
- North Creek Analytical, Inc.

## 1.3 Project Organization

The Environmental Baseline Studies (EBS) for the Pebble Project (Pebble Project) are managed by Northern Dynasty Mines Inc. (NDM). NDM has commissioned highly experienced technical advisors for the environmental baseline studies. Those advisors include SLR Alaska Inc. (SLR), Bristol Environmental and Engineering Services Corporation (BEESC), HDR Alaska, Inc. (HDR) and Shaw Environmental, Inc. (Shaw). The project team will collect surface water, ground water, surface soil, sediment, vegetation, and fish tissues from the mine and road/port/transmission line areas. Marine sediment, water, and tissue samples will be collected from the port area at Cook Inlet.

The *Pebble Gold-Copper Project, Draft Environmental Baseline Studies, Proposed 2005 Quality Assurance Project Plan* (QAPP) provides the analytical quality assurance (QA)/quality control (QC) requirements for the project. The QAPP is applicable to the QA/QC aspects of field sampling and laboratory chemical analysis. The *Pebble Gold-Copper Project, Draft Environmental Baseline Studies, Proposed 2005 Study Plan* (NDM, 2005) provides a comprehensive description of the environmental baseline studies for agency and stakeholder review. Field sampling plans (FSPs) address the specifics of field sampling for each media undergoing chemical analysis. The program is divided into three disciplines, as follows.

| Discipline | Media | Senior Oversight |
|---|---|---|
| **Water Quality Studies** | Surface water and ground water (fresh water only) | Dennis Deans, NDM |
| **Trace Elements Studies** | Soil, sediment, vegetation, and fish tissues (fresh water only) | Jim Buell, Buell & Associates<br>Loretta Ford, NDM |
| **Marine Studies** | Marine water, sediment, and tissues | Jim Buell, Buell & Associates |

The Pebble Project EBS includes collection of QA/QC samples at a frequency of 10 percent for all media and analyses. Primary and QC samples (field duplicate) are analyzed by the primary laboratories. QA samples (field triplicate) are analyzed by the QA laboratories. The QA laboratory analysis provides a check on the primary laboratory's accuracy and precision throughout the project. Primary and QA laboratories and the media they are responsible for are identified in Table 1-1. Table 1-2 summarizes contact information for the Pebble Project laboratories. Field teams are responsible for collection of QA/QC samples in the field and shipment of samples to the appropriate laboratories.

**Table 1-1**
**Summary of Primary and QA Analytical Laboratories for Environmental Baseline Studies**

| Media | Primary Laboratory | QA Laboratory |
|---|---|---|
| SW and GW (all parameters except trace metals) | SGS – Anchorage, AK | CAS – Kelso, WA |
| SW and GW (trace metals only) | NCA – Portland, OR | CAS – Kelso, WA |
| Soil and sediment | SGS – Anchorage, AK | CAS – Kelso, WA |
| Marine water and sediment | CAS – Kelso, WA | NCA – Portland, OR |
| Fish tissue and invertebrate tissue | CAS – Kelso, WA | NCA – Portland, OR |
| Vegetation | CAS – Kelso, WA | NCA – Portland, OR |

CAS = Columbia Analytical Services, Inc.
GW = ground water
MBW - marine bottom water
NCA = North Creek Analytical, Inc.
SGS = SGS Environmental Services, Inc.
SW = surface water

**Table 1-2**
**Laboratory Contact Information**

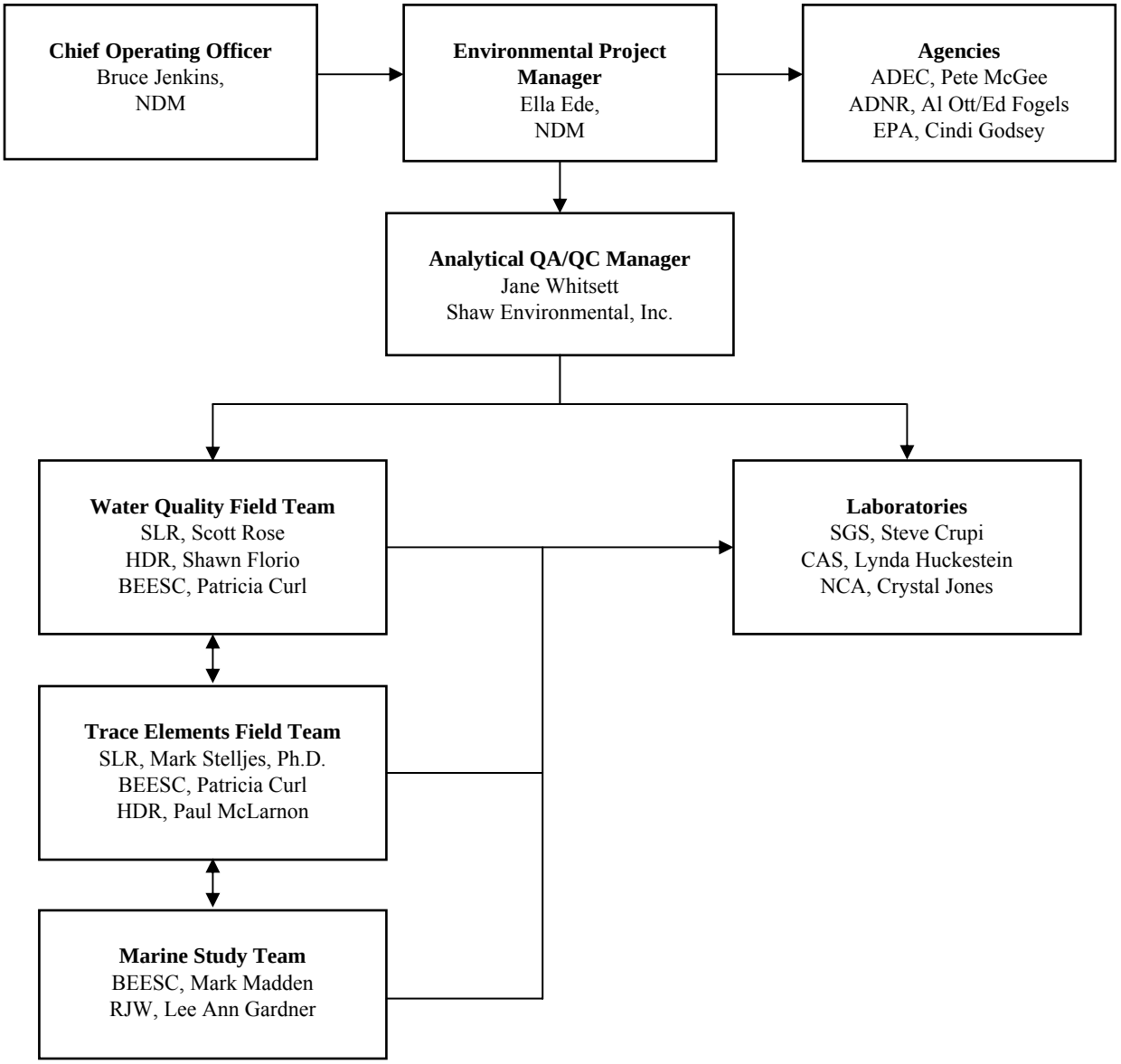
| | |
|---|---|
| **Steve Crupi**<br>SGS Environmental Services, Inc.<br>200 W. Potter Dr.<br>Anchorage, AK 99518<br>907-562-2343 phone, 907-550-3213 direct<br>907-561-5301 fax<br>Steve_Crupi@sgs.com | **Lynda Huckestein**<br>Columbia Analytical Services, Inc.<br>1317 S. 13th Avenue<br>Kelso, WA 98626<br>360-501-3358 direct phone<br>360-636-1068 fax<br>lhuckestein@kelso.caslab.com |
| **Crystal Jones**<br>North Creek Analytical, Inc.<br>9405 SW Nimbus Ave.<br>Beaverton, OR 97008<br>503-906-9234 direct phone<br>503-906-9210 fax<br>cjones@ncalabs.com | **Mike Priebe (local contact)**<br>North Creek Analytical, Inc.<br>2000 W. International Airport Road, Suite A10<br>Anchorage, Alaska 99502<br>907-563-9200 phone, 907-317-3412 cell<br>907-563-9210 fax<br>mpriebe@ncalabs.com |

NDM has selected HDR and SLR for the Pebble Project mine-area studies and BEESC for the road/port/transmission line-area and marine studies. These teams will collect all field samples for laboratory analysis. HDR has been selected to collect surface water, sediment, and fish tissues for the mine area studies. SLR has been selected to collect soil, vegetation, and groundwater samples from the mine area. BEESC has been selected to collect surface water, ground water, sediment, soil, and vegetation for the road/port area and to conduct the marine studies. Shaw will provide analytical QA/QC management for the project. Key personnel and their roles are described below in Table 1-3 and identified in the organizational chart (Figure 1-1).

**Table 1-3**
**Summary of Pebble Project EBS Key Personnel and Roles**

| Personnel | Responsibilities |
|---|---|
| **NORTHERN DYNASTY MINES INC.** | |
| Bruce Jenkins, Chief Operating Officer | Responsible for development and execution of overall project scope and schedule. |
| Ella Ede, Environmental Project Manager | Provides oversight of project team, deliverables, and schedule. |
| Jim Buell, Senior Fisheries Biologist | Responsible for sample collection and analysis of trace elements in surface soil, sediment, vegetation, and fish tissue. |
| Dennis Deans, Assistant Environmental Study Director | Responsible for sample collection and analysis of surface water and groundwater samples. |
| **SHAW ENVIRONMENTAL, INC.** | |
| Jane Whitsett, Analytical QA/QC Manager | Responsible for preparation of QAPP) and review of laboratory data and deliverables to ensure technical and quality requirements stipulated by regulatory agencies and NDM are met. |
| **FIELD TEAMS** | |
| **SLR**, Scott Rose | Responsible for collection of groundwater, surface soil and vegetation samples for the mine area. |
| **HDR**, Shawn Florio | Responsible for collection of surface water and sediment for the mine area. |
| **BEESC**, Patricia Curl, Lee Ann Gardner | Responsible for collection of surface water, groundwater, surface soil, sediment, and vegetation samples for the road/port area. Responsible for marine sampling in the port area. |
| **HDR**, Paul McLarnon | Responsible for collection of fish tissues for the mine and road/port area. |
| **LABORATORIES** | |
| **SGS Environmental Services, Inc.**<br>Steve Crupi, Project Chemist | Responsible for executing and reporting laboratory scope of work for primary and QC water (inorganics and organics), soil, and sediment samples collected by field teams. |
| **Columbia Analytical Services, Inc.**<br>Lynda Huckestein, Project Chemist | Responsible for executing and reporting laboratory scope of work for primary (fish and vegetation tissues) and QA water, soil, and sediment samples collected by field teams. |
| **North Creek Analytical Services, Inc.**<br>Crystal Jones, Project Chemist | Responsible for executing and reporting laboratory scope of work for primary water (metals only) and QA samples for fish and vegetation tissues collected by field teams. |
| **AGENCIES** | |
| **ADEC**<br>William “Pete” McGee<br>James Gendron | <br>Pebble Project Manager<br>Quality Assurance Officer |
| **ADNR**<br>Al Ott<br>Ed Fogels | <br>Manager, Office of Habitat Management and Permitting<br>Manager, Large Mine Planning Team |
| **EPA**<br>Cindi Godsey | <br>Project Manager |

**Figure 1-1**
**Pebble Project EBS Organization Chart**



# 1.4 Project Background and Objectives

Environmental baseline studies are being conducted to develop baseline data for comparison to future conditions (e.g., during construction, operations and closure) for the Pebble Project, as outlined in the Proposed 2004 Study Plan (NDM, 2004).

## 1.4.1 Background

The Pebble Project is a proposed open pit mining operation of a gold, copper, molybdenum, and silver deposit located in southwestern Alaska. NDM has commenced extensive study programs to collect the engineering, environmental, and socioeconomic data necessary for a bankable feasibility study and the preparation of applications for state and federal permits.

NDM considers environmental stewardship one of the cornerstones to pursuing the development of the Pebble Project. This involves diligent characterization of the existing conditions related to the environment of the project area and their incorporation into the project design and operation.

## 1.4.2 Objectives of the Program

NDM is in the process of evaluating the Pebble Project and is performing environmental baseline studies as part of this evaluation. The overall objective of the environmental baseline studies is to characterize the environment in the mine and road/port/transmission line areas that will be potentially affected by development of the Pebble Project. Data will be collected for water quality and for characterization of surface soil, sediment, vegetation, and fish tissues. These data will be used to establish existing baseline conditions for National Environmental Policy Act (NEPA) activities and permitting.

Specific objectives for the water quality and trace elements programs for the mine and road/port area are described below.

### 1.4.2.1 Water-Quality Objectives

Water-chemistry baseline studies will include collection and analysis of samples of surface water, ground water, and water from seeps. The main objectives of these studies are to:

- Collect baseline data to provide defensible documentation of the naturally occurring levels and spatial and temporal variability of trace elements in surface and ground water.
- Define the chemical characteristics of project-area ground water used for drinking water.
- Evaluate sources that could be used for mine make-up water.
- Provide the database for the site water chemistry and site loading models for project design and environmental impact assessment.
- Develop the baseline for the evaluation of potential environmental impacts during construction, operation, and closure.
- Evaluate site geochemistry.

This information is key to understanding current conditions and will provide a baseline for the evaluation of future potential environmental impacts during operation and closure. The baseline water-chemistry data are also important for determining if site-specific water-chemistry standards are required for water bodies in the project area.

#### 1.4.2.2 Trace-Element Objectives

Samples of surface soil, sediment, vegetation, and fish tissues will be collected and analyzed for trace elements. The objectives of the trace-elements study are as follows:

- Collect baseline data to provide defensible documentation of the natural levels of trace elements and spatial and temporal variability of anions in surface soil, sediments, and vegetation prior to mining operations.
- Evaluate naturally occurring biogenic fingerprints in surface soil associated with petroleum hydrocarbon analysis to support long-term site-monitoring objectives.
- Determination of organic content in surface soils to support long-term site-monitoring objectives.
- Collect baseline data to provide defensible documentation of the natural levels of trace elements in fish tissue prior to mining operations.

This information is key to understanding current conditions and will provide a baseline for the evaluation of future potential environmental impacts to these media during operation and closure, and also to support long-term site-monitoring objectives.

#### 1.4.2.3 Marine Study Objectives

Marine environmental baseline studies will include collection and analysis of samples of marine surface water (MSW), marine bottom water (MBW), marine sediment, fish tissues (muscle and liver), and invertebrate tissues. The main objectives of these studies are to:

- Collect baseline data to provide defensible documentation of the naturally occurring levels and spatial variability of trace elements and anions in the marine environment.
- Develop the baseline for the evaluation of potential environmental impacts during construction, operation, and closure.
- Evaluate petroleum hydrocarbons in MSW, MBW, and marine sediments to support long-term monitoring objectives.
- Collect baseline data to provide defensible documentation of the natural levels of trace elements in fish tissue/invertebrates prior to mining operations.

This information is key to understanding the current conditions and will provide a baseline for the evaluation of future potential environmental impacts to these media during operation and closure, and also to support long-term site-monitoring objectives.

## 1.5 Project/Task Description and Schedule

This section provides a project description, summary of all work to be performed, description of products to be produced, and the schedule for implementation.

The Pebble Project is located in southwestern Alaska, about 230 miles from Anchorage, 18 miles northwest of Iliamna, and 60 miles from tidewater at Cook Inlet. The mine and road/port areas will be accessed by air from Iliamna for field tasks.

### 1.5.1 Task Descriptions

The tasks covered by this QAPP include field sampling, laboratory analysis and reporting, and data validation. Each task is discussed briefly below.

#### 1.5.1.1 Task 1 — Field Sampling

NDM's sampling approach is discussed in the *Pebble Gold-Copper Project, Environmental Baseline Studies, Proposed 2004 Study Plan* (NDM, 2004) and in this QAPP. Tables 1-4 and 1-5 summarize sample quantities for terrestrial and marine samples respectively.

#### 1.5.1.2 Task 2 — Laboratory Analysis and Reporting

Samples collected from the mine and road/port areas will be analyzed for the parameters detailed in Table 1-6.

Laboratories will provide hardcopy and electronic reports to the Analytical QA/QC Manager. Reports will include data summaries, QC results, calibration data, and raw data. The Analytical QA/QC Manager will validate laboratory data. The validated analytical data will then be uploaded into the NDM database for access by data users.

#### 1.5.1.3 Task 3 — Data Validation and Data Quality Assurance Reports

Laboratory data will be reviewed using EPA *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA, 1999); *EPA Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review* (EPA, 2001), and *EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2002). These guidelines will be modified as needed for the specific analytical methods being used. Data quality assurance reports (DQARs) will be prepared by the Analytical QA/QC Manager and submitted to NDM. These reports will discuss analytical QA/QC results and potential impacts to the project based on the results of data validation.

### 1.5.2 Schedule

Field sampling for 2005 will be conducted according to the schedules in Table 1-7. Laboratory reports are due 30 days from sample receipt. Separate DQAR reports will be prepared for samples collected in 2005 for each media from the mine area and the road/port area. DQAR reports for 2004 sampling will be completed by March 2005. DQAR reports for 2005 sampling will be completed by February 28, 2006.

## 1.6 Quality Objectives and Criteria

The principal objectives of the QA program are to maintain an acceptable level of quality for field activities, sample collection, sample handling, laboratory analysis, and data analysis and to document the quality of data at each processing level. This program clearly identifies major aspects of the project requiring specific quality control and demonstrates that quality control is a major focus for this project..

**Table 1-4**
**Pebble Project EBS Terrestrial Sample Quantities**

| Consultant | Area | Media | Sample Locations | Sampling Frequency | Primary Samples | MS/MSD Samples | QC Samples | Total Primary Lab Samples | Total QA Lab Samples |
|---|---|---|---|---|---|---|---|---|---|
| HDR | Mine | Surface Water | 32 | 9 | 288 | 29 | 29 | 346 | 29 |
| HDR | Mine | Seeps | 60 | 1 | 60 | 6 | 6 | 72 | 6 |
| HDR | Road | Surface Water | 5 | 7 | 35 | 4 | 4 | 43 | 4 |
| SLR | Mine | Ground Water | 30 | 4 | 120 | 12 | 12 | 144 | 12 |
| SLR | Mine | Ground Water (new wells) | 15 | 2 | 30 | 3 | 3 | 36 | 3 |
| BEESC | Road/Port | Surface Water | 26 | 9 | 234 | 24 | 24 | 282 | 24 |
| BEESC | Road/Port | Drinking Water Wells | 5 | 4 | 20 | 2 | 2 | 24 | 2 |
| **Subtotal** | | | | | | | | **947** | **80** |
| SLR | Mine | Surface Soil | 85 | 2 | 170 | 17 | 17 | 204 | 17 |
| BEESC | Road/Port | Surface Soil | 28 | 1 | 28 | 3 | 3 | 34 | 3 |
| **Subtotal** | | | | | | | | **238** | **20** |
| HDR | Mine | Sediment (seeps) | 4 | 2 | 8 | 1 | 1 | 10 | 1 |
| HDR | Mine | Sediment (streams) | 16 | 3 | 48 | 5 | 5 | 58 | 5 |
| BEESC | Road/Port | Sediment (streams) | 26 | 3 | 78 | 8 | 8 | 94 | 8 |
| HDR | Mine | Sediment (lakes) | 6 | 1 | 6 | 2 | 1 | 9 | 1 |
| **Subtotal** | | | | | | | | **171** | **15** |
| BEESC | Road/Port | Vegetation | 190 | 2 | 380 | N/A | 38 | 418 | 38 |
| SLR | Mine | Vegetation | 90 | 2 | 180 | N/A | 18 | 198 | 18 |
| **Subtotal** | | | | | | | | **616** | **56** |
| HDR | Mine | Fish Tissues | 337 | 1 | 337 | N/A | 34 | 371 | 34 |
| **Total** | | | | | | | | **2243** | **205** |

MS = matrix spike
MSD = matrix spike duplicate
Note: vegetation and fish tissue QA/QC samples are prepared by the primary laboratory (CAS). CAS will ship QA samples to the QA laboratory (NCA) for these media.

## Table 1-5
### Pebble Project EBS Marine Sample Quantities

| Analytical Samples for 2005 — Primary Lab (CAS) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Task** | **Media** | **April** | **May** | **June** | **July** | **Aug** | **Sept** | **Total # of samples** |
| Trace Elements/Inorganics (1) | Surface water | | 8 | | | 8 | | 16 |
| Trace Elements/Inorganics (1) | Bottom water | | 8 | | | 8 | | 16 |
| Trace Elements/Inorganics (2) | Sediment | | 72 | | | 72 | | 144 |
| Grain Size/TOC/TKN (2) | Sediment | | 72 | | | 72 | | 144 |
| TSS Only | At-depth water (2 X) | 10 | 10 | 10 | 10 | 10 | 10 | 60 |
| **TOTAL** | | **10** | **170** | **10** | **10** | **170** | **10** | **380** |

| Analytical Samples for 2005 — Water and Sediment Organics, Tissues, and QA Lab (NCA) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Task** | **Media** | **April** | **May** | **June** | **July** | **Aug** | **Sept** | **Total # of samples** |
| Trace Elements/Inorganics (1) | Surface water | | 2 | | | 2 | | 4 |
| Trace Elements/Inorganics (1) | Bottom water | | 2 | | | 2 | | 4 |
| Trace Elements/Inorganics | Sediment | | 6 | | | 6 | | 12 |
| Organics | Surface water | | 8 | | | 8 | | 16 |
| Organics | Bottom water | | 8 | | | 8 | | 16 |
| Organics (2) | Sediment | | 72 | | | 72 | | 144 |
| Trace Elements (3) | Tissue — subtid./trawl | 0 | | | | 0 | | 0 |
| Trace Elements (3) | Tissue — intertid./seine | | 0 | | | 0 | | 0 |
| Grain Size/TOC/TKN | Sediment | | 6 | | | 6 | | 12 |
| TSS Only | At-depth water | 2 | 2 | 2 | 2 | 2 | 2 | 12 |
| **TOTAL** | | **2** | **106** | **2** | **2** | **106** | **2** | **220** |

1 — Total and dissolved metals - Al, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, K, Ag, Na, Sb, V, Zn, As, Pb, Se, Sn, Tl.
2 — Intertidal and subtidal.
3 — Sb, As, Be, Cd, Cr, Cu, Pb, Mo, Ni, Se, Ag, low level Hg and methyl mercury.
TKN = total kjeldahl nitrogen
TOC = total organic carbon
TSS = total suspended solids

**Table 1-6**
**Pebble Project EBS Summary of Laboratory Analyses**

| Parameter | Method (Water) | Method (Solids) | Media | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Surface Water (2) | Ground-water | Surface Soil | Sediment (3) | Vege-tation | Fish Tissue (3) |
| *Inorganics* | | | | | | | | |
| pH | E150.1 | | x | x | | | | |
| Specific Conductance | SM2510B | | x | x | | | | |
| Acidity | E305.2 | | x | x | | | | |
| Alkalinity | SM2320B | | x | x | | | | |
| Ammonia as N | SM4500NH3G | SM4500NH3G | x | x | x | x | x | |
| Chloride | E300.0 | E300.0 | x | x | x | x | x | |
| Cyanide, total | SM4500CN-E or E335.2 | SM4500CN or E335.2 | x | x | x | x | x | |
| Cyanide, WAD | SM4500-I | | x | x | | | | |
| Fluoride | E300.0 | E300.00 | x | x | x | x | x | |
| Hardness | SM2304B | | x | x | | | | |
| Nitrate + Nitrite | E300.0 | | x | x | | | | |
| Phosphorus, total | E365.3 | | x | x | | | | |
| Sulfate | E300.0 | E300.0 | x | x | x | x | x | |
| Thiocyanate | Lab SOP | | x | x | | | | |
| TDS | E160.1 or SM2540C | | x | x | | | | |
| TSS | E160.2 | | x | x | | | | |
| *Metals* | | | | | | | | |
| Low-level mercury | E1631 | E1631 | x | | | | | x |
| Mercury | E245.1 | SW7471A | | x | x | x | x | |
| Metals[1] | E200.7/200.8 | SW6010B/6020/7000/E200.8 | x | x | x | x | x | |
| *Organics* | | | | | | | | |
| Fraction Organic Carbon | | ASTM D4129-82M | | | x | | | |
| GRO | AK101 | AK101 | x (marine only) | | | x (marine only) | | |
| BTEX | SW8260B | SW8260B | x (marine only) | | | x (marine only) | | |
| DRO/RRO | AK102/103 | AK102/103 | x (marine only) | | x | x (marine only) | | |
| Pesticides/PCBs | E508 | SW8081/8082 | x | x | x | x | | x |
| VOCs | SW8260B | | x | x | | | | |
| SVOCs | SW8270C | | x | x | | | | |
| Methyl mercury | | E1630M | | | | | | x |

1 — Al, Sb, As, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Si (dissolved only), Ag, Na, Tl, Sn, V, Zn. Water samples are analyzed for total and dissolved metals. Sb, As, Be, Cd, Cr, Cu, Pb, Mo, Ni, Se, Ag are planned for fish tissue.
2 — Fresh and marine media
3 — Fresh water only
BTEX = benzene, toluene, ethylbenzene, xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
PCBs = polychlorinated biphenyls
RRO = residual-range organics
TDS = total dissolved solids
SOP = standard operating procedure
SVOCs = semivolatile organic compounds
VOCs = volatile organic compounds
E = EPA (1983, 1991 and 2001) M = modified SW = EPA (1993)SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition. 1998.

**Table 1-7**
**Pebble Project EBS Field Sampling Schedule for 2005**

| 2005 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Consultant | Area | Media | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec |
| HDR | Mine | Surface water | X | | X | X | X | X | X | X | X | X | | |
| BEESC | Road | Surface water | | X | X | X | X | X | X | X | X | X | | |
| BEESC | Road | Ground Water | | | X | | X | | | X | | | X | |
| SLR | Mine | Ground Water | | | X | | X | | | X | | | X | |
| BEESC | Road | Sediment | | | | | X | | | | X | | | |
| HDR | Mine | Sediment | | | | | X | | X | | X | | | |
| BEESC | Road | Surface soil | | | | | | | | | X | | | |
| SLR | Mine | Surface soil | | | | | | | X | | X | | | |
| BEESC | Road | Vegetation | | | | | | | | | X | | | |
| SLR | Mine | Vegetation | | | | | | | X | | X | | | |
| HDR | Mine/Road | Fish tissues | | | | | | | | X | | | | |

QA/QC requirements are established in this QAPP to achieve the project objectives for the data uses. Applicable QC procedures, quantitative target limits, and level of effort for assessing the data quality are dictated by the intended use of the data and the nature of the required field and analytical methods. The project objectives are to collect data of known and sufficient quality for NDM to rely upon as accurate and precise environmental baseline data

Federal and state levels of concern (for example, ambient water quality criteria or maximum contaminant levels) exist for many of the parameters being analyzed in the environmental baseline study. Analytical methods have been specified that will allow detection of chemical constituents at or below levels of concern wherever possible. A summary of field QA/QC samples is given in Table 1-8. The list of parameters and levels of concern for water and soil/sediment are summarized in Tables 1-9 and 1-10, respectively. Both EPA and ADEC standards were reviewed. The tables present the lowest criteria of the two standards. Parameters included in the environmental baseline study but not shown in this table do not have levels of concern.

**Table 1-8**
**Pebble Project EBS Summary of Field QA/QC Samples**

| Type of Field QA/QC Sample | Analysis | Frequency | Sampling Events |
|---|---|---|---|
| Field Duplicate (QC sample) | All Parameters | 10 percent | All |
| Field Triplicate (QA sample) | All Parameters | 10 percent | All |
| DI water blank | Total Metals | 1 per sampling event | Surface water and ground water |
| Equipment blank | Dissolved Metals | 5 percent | Surface water, ground water, soil, sediment, fish tissues (liver/muscle) |
| Trip blank | Low-Level Hg and VOCs | 1 per cooler | Surface water and ground water |

**Table 1-9**
**Levels of Concern in Water for the Environmental Baseline Studies**

| Analyte | Lowest Surface or Drinking Water Criteria |
|---|---|
| *Inorganics in Water (milligrams per liter — mg/L)* | |
| Alkalinity | 20000 |
| Ammonia as N | 0.885 |
| Chloride | 230 |
| Cyanide-total | 5.2 |
| Fluoride | 4 |
| Nitrate + Nitrite | 10 |
| Sulfate | 250 |
| TDS | 500 |
| TSS | 30 |
| *Volatile Organic Compounds (mg/L)* | |
| 1,1-Dichloroethylene | 0.007 |
| 1,1,1-Trichloroethane | 0.2 |
| 1,1,2-Trichloroethane | 0.005 |
| 1,2-Dichloroethane | 0.005 |
| 1,2-Dichloropropane | 0.005 |
| 1,2,4-Trichlorobenzene | 0.007 |
| Benzene | 0.005 |
| Carbon tetrachloride | 0.005 |
| Cis-1,2-Dichloroethylene | 0.07 |
| Dichloromethane | 0.005 |
| Ethylbenzene | 0.7 |
| Ethylene dibromide | 0.0002 |
| o-Dichlorobenzene | 0.6 |
| Para-Dichlorobenzene | 0.075 |
| Pentachlorophenol | 0.001 |
| Styrene | 0.1 |
| Tetrachlorobenzene | 0.005 |
| Toluene | 1.0 |
| Vinyl Chlorides | 0.002 |
| Total Xylenes | 10 |
| *Metals in Water (micrograms per liter — μg/L)* | |
| Al | 87 |
| Sb | 5.6 |
| As | 0.018 |
| Ba | 1000 |
| Be | 4 |
| Cd | 0.1 |
| Cr | 24 |
| Cr +6 (6) | 11 |
| Cu | 2.7 |
| Fe | 300 |
| Pb | 0.54 |

**Table 1-9**
**Levels of Concern in Water for the Environmental Baseline Studies**

| Analyte | Lowest Surface or Drinking Water Criteria |
|---|---|
| Mn | 50 |
| Hg | 0.05 |
| Mo | 10 |
| Ni | 16 |
| Se | 4.6 |
| Ag | 0.32 |
| Tl | 0.24 |
| V | 100 |
| Zn | 36 |
| *Pesticides (µg/L)* | |
| 4,4'-DDT | 0.001 |
| Aldrin | 3.0 |
| Chlordane | 0.0043 |
| Dieldrin | 0.056 |
| Endosulfan I | 0.056 |
| Endosulfan II | 0.056 |
| Endrin | 0.036 |
| Endrin aldehyde | 0.76 |
| gamma-BHC (Lindane) | 0.2 |
| Heptachlor | 0.0038 |
| Heptachlor epoxide | 0.0038 |
| Lindane | 0.0002 |
| Methoxychlor | 0.03 |
| Toxaphene | 0.0002 |
| *Semi Volatile Organic Compounds (mg/L)* | |
| Benzo[a]pyrene | 0.0002 |
| Di(2-ethylhexyl)adipate | 0.4 |
| Di(2-ethylhexyl)phthalate | 0.006 |
| Hexachlorobenzene | 0.001 |
| Hexachlorocyclopentadiene | 0.05 |

Levels of concern in water are based on the following references: ADEC (2003), USEPA (2003), and USEPA (2002a).

**Table 1-10**
**Levels of Concern in Soil and Sediment for the Environmental Baseline Studies**

| Analyte | Lowest Soil Criteria (milligrams/kilogram — mg/kg) | Lowest Sediment Criteria (mg/kg) |
|---|---|---|
| *Petroleum Hydrocarbons (Soil Only)* | | |
| Gasoline Range Organics | 300 | None |
| Diesel Range Organics | 250 | None |
| Residual Range Organics | 11000 | None |
| Benzene | 0.008 | None |
| Toluene | 5.4 | None |
| Ethylbenzene | 5.5 | 0.004 |
| Xylenes | 0.1 | 0.004 |
| *Inorganics* | | |
| Cyanide (Total) | 27 | None |
| *Metals* | | |
| Al | None | 18000 |
| Sb | 3.6 | 3 |
| As | 2 | 5.9 |
| Ba | 1100 | 48 |
| Be | 42 | None |
| Cd | 5 | 0.583 |
| Cr | $>10^6$ | 36.2 |
| Co | None | 10 |
| Cu | None | 18.7 |
| Fe | None | 40000 |
| Pb | 400 | 30.2 |
| Mn | None | 260 |
| Hg | 1.4 | 0.13 |
| Ni | 87 | 15.9 |
| Se | 3.5 | 1.0 |
| Ag | 21 | 0.73 |
| Sn | None | 3.4 |
| V | 3400 | 57 |
| Zn | 9100 | 89 |
| *Semivolatile Organic Compounds* | | |
| Naphthalene | 38 | 15 µg/kg |
| Fluorene | 240 | 10 µg/kg |
| Anthracene | 3900 | 10 µg/kg |
| Pyrene | 1400 | 44.27 µg/kg |
| Benzo(a)anthracene | 5.5 | 15.72 µg/kg |
| Acenaphthene | 190 | 290µg/kg |
| Chrysene | 550 | 26.83 µg/kg |
| Benzo(a)pyrene 2,4 | 2.4 | 31.9 µg/kg |
| Dibenzo(a,h)anthracene | 5 | 10 µg/kg |
| Benzo(b)fluoranthene | 17 | -- |

**Table 1-10**
**Levels of Concern in Soil and Sediment for the Environmental Baseline Studies**

| Analyte | Lowest Soil Criteria (milligrams/kilogram — mg/kg) | Lowest Sediment Criteria (mg/kg) |
|---|---|---|
| Benzo(k)fluoranthene | 170 | 27.2 µg/kg |
| Indeno(1,2,4-c,d)pyrene | 50 | 17.32 µg/kg |
| *Pesticides* | | |
| 4,4'-DDT | 2.4 | |
| Aldrin | 0.029 | 9.5 µg/kg |
| Chlordane | 1.6 | 0.5 µg/kg |
| Dieldrin | 0.03 | 0.02 µg/kg |
| Endosulfan I | 370 | — |
| Endosulfan II | | — |
| Endrin | 18 | 2.67 µg/kg |
| Endrin aldehyde | | |
| gamma-BHC (Lindane) | 0.44 | 0.32 µg/kg |
| Heptachlor | 0.11 | 0.3 µg/kg |
| Heptachlor epoxide | .053 | 0.6 µg/kg |
| Lindane | 0.44 | 0.32 µg/kg |
| Methoxychlor | 310 | |
| Toxaphene | 0.44 | — |

Em-dash (—) indicates that compound is listed in NOAA table but criterion is not established.
Blank cell indicates that compound is not listed in NOAA SQRT table.

Levels of concern in soil and sediment are based on the following references.

- Alaska Department of Environmental Conservation (ADEC) Soil Cleanup Levels, Under 40 Inch Zone, 18 AAC 75.

- National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQRT), Updated September 1999. Values in this table are the lowest among the threshold effects level (TEL), probable effects level (PEL), and upper effects level (UEL) for freshwater sediment and among TEL, effects range - low (ERL), PEL, effects range - medium (ERM), and apparent effects threshold (AET) for marine sediment.

Based on results from the 2004 environmental baseline studies conducted by NDM, total chromium in water was not detected above the Aquatic Life Criteria for Fresh Waters (11 µg/L). Therefore, hexavalent chromium in water is not included as a parameter of concern for the 2005 environmental baseline studies.

Data quality objectives (DQOs) for the Pebble Project EBS are listed in Tables 1-11 through 1-16.

### 1.6.1 Data Quality Parameters

The quality of laboratory data is measured by the precision, accuracy, representativeness, comparability, and completeness (PARCC) of the data. These parameters and the applicable quality control procedures

and levels of effort are provided in Tables 1-11 through 1-15. A discussion of PARCC is presented following the tables.

**Table 1-11**
**Data Quality Objectives — Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| *Inorganics* | | | | | |
| pH | N/A | pH units | E150.1 | N/A | N/A |
| Specific Conductance | 2 | µmhos/ cm | SM 2510B | N/A | 20 |
| Acidity | 10 | mg/L | E305.2 | N/A | 25 |
| Alkalinity | 10 | mg/L | SM2320B | N/A | 20 |
| Ammonia as N | 0.1 | mg/L | SM4500NH3-G | 75-125 | 25 |
| Chloride | 0.2 | mg/L | E300.0 | 85-115 | 20 |
| Cyanide-total | 0.01 | mg/L | SM4500CN-E | 75-125 | 20 |
| Cyanide-WAD | 0.01 | mg/L | SM4500CN-I | 75-125 | 20 |
| Fluoride | 0.1 | mg/L | E300.0 | 85-115 | 20 |
| Hardness (total) | N/A | mg/L | SM2340B | N/A | N/A |
| Nitrate + Nitrite | 0.1 | mg/L | E300.0 | 90-110 | 20 |
| Phosphorus-total | 0.01 | mg/L | E365.3 | 75-125 | 25 |
| Sulfate | 0.2 | mg/L | E300.0 | 85-115 | 20 |
| Thiocyanate | 1 | mg/L | Lab SOP | 75-125 | 20 |
| TDS | 10 | mg/L | E160.1 or SM2540C | N/A | 25 |
| TSS | 5 | mg/L | E160.2 | N/A | 20 |
| *Metals (Total and Dissolved)* | | | | | |
| Hg (low level) (Total only) | 0.005 | µg/L | E1631 | 77-123 | 20 |
| Hg (GW only) | 0.2 | µg/L | E245.1 | 85-115 | 20 |
| Al | 1.0 | µg/L | E200.8 | 85-115 | 20 |
| Sb | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| As | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Ba | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| Be | 0.02 | µg/L | E200.8 | 85-115 | 20 |
| Bi | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| B | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Cd | 0.02 | µg/L | E200.8 | 85-115 | 20 |
| Ca(1) | 50 | µg/L | E200.8 | 81-124 | 20 |
| Cr | 0.2 | µg/L | E200.8 | 85-115 | 20 |
| Co | 0.02 | µg/L | E200.8 | 85-115 | 20 |
| Cu | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| Fe(1) | 20 | µg/L | E200.7 | 85-115 | 20 |
| Pb | 0.02 | µg/L | E200.8 | 85-115 | 20 |
| Mg (1) | 20 | µg/L | E200.8 | 72-131 | 20 |
| Mn | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| Mo | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| Ni | 0.2 | µg/L | E200.8 | 85-115 | 20 |
| K (1) | 50 | µg/L | E200.8 | 91-117 | 20 |

**Table 1-11**
**Data Quality Objectives — Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Se | 1.0 | µg/L | E200.8 | 85-115 | 20 |
| Si (Dissolved only) | 100 | µg/L | E200.8 | 85-115 | 20 |
| Ag | 0.02 | µg/L | E200.8 | 85-115 | 20 |
| Na (1) | 100 | µg/L | E200.8 | 81-127 | 20 |
| Tl | 0.01 | µg/L | E200.8 | 85-115 | 20 |
| Sn | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| V | 0.2 | µg/L | E200.8 | 85-115 | 20 |
| Zn | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| *PCBs/Pesticides* | | | | | |
| 4,4'-DDD | 0.005 | µg/L | E508 | 64-132 | 25 |
| 4,4'-DDE | 0.005 | µg/L | E508 | 52-129 | 25 |
| 4,4'-DDT | 0.008 | µg/L | E508 | 47-138 | 25 |
| Aldrin | 0.005 | µg/L | E508 | 38-127 | 25 |
| alpha-BHC | 0.005 | µg/L | E508 | 36-135 | 25 |
| beta-BHC | 0.007 | µg/L | E508 | 47-136 | 25 |
| Chlordane-alpha and gamma isomers | 0.10 | µg/L | E508 | 67-120 | 25 |
| delta-BHC | 0.005 | µg/L | E508 | 67-133 | 25 |
| Dieldrin | 0.005 | µg/L | E508 | 62-129 | 25 |
| Endosulfan I | 0.005 | µg/L | E508 | 50-120 | 25 |
| Endosulfan II | 0.007 | µg/L | E508 | 35-107 | 25 |
| Endosulfan sulfate | 0.006 | µg/L | E508 | 60-132 | 25 |
| Endrin | 0.006 | µg/L | E508 | 62-132 | 25 |
| Endrin aldehyde | 0.008 | µg/L | E508 | 55-155 | 25 |
| gamma-BHC (Lindane) | 0.005 | µg/L | E508 | 46-134 | 25 |
| Heptachlor | 0.006 | µg/L | E508 | 40-123 | 25 |
| Heptachlor epoxide | 0.006 | µg/L | E508 | 62-131 | 25 |
| Methoxychlor | 0.007 | µg/L | E508 | 60-140 | 25 |
| Toxaphene | 0.10 | µg/L | E508 | 41-126 | 25 |
| Aroclor 1016 | 0.1 | µg/L | E508 | 53-107 | 25 |
| Aroclor 1221 | 0.1 | µg/L | E508 | N/A | 25 |
| Aroclor 1232 | 0.1 | µg/L | E508 | N/A | 25 |
| Aroclor 1242 | 0.1 | µg/L | E508 | N/A | 25 |
| Aroclor 1248 | 0.1 | µg/L | E508 | N/A | 25 |
| Aroclor 1254 | 0.1 | µg/L | E508 | N/A | 25 |
| Aroclor 1260 | 0.1 | µg/L | E508 | 56-116 | 25 |
| *Volatile Organic Compounds* | | | | | |
| 1,1,1,2-Tetrachloroethane | 0.5 | µg/L | SW5030/8260B | 90-116 | 20 |
| 1,1,1-Trichloroethane | 1 | µg/L | SW5030/8260B | 82-120 | 20 |
| 1,1,2,2-Tetrachloroethane | 0.5 | µg/L | SW5030/8260B | 63-128 | 20 |
| 1,1,2-Trichloroethane | 1 | µg/L | SW5030/8260B | 84-114 | 20 |
| 1,1-Dichloroethane | 1 | µg/L | SW5030/8260B | 85-125 | 20 |
| 1,1-Dichloroethene | 1 | µg/L | SW5030/8260B | 68-130 | 20 |

**Table 1-11**
**Data Quality Objectives — Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| 1,1-Dichloropropene | 1 | µg/L | SW5030/8260B | 87-123 | 20 |
| 1,2,3-Trichlorobenzene | 1 | µg/L | SW5030/8260B | 84-128 | 20 |
| 1,2,3-Trichloropropane | 1 | µg/L | SW5030/8260B | 73-124 | 20 |
| 1,2,4-Trichlorobenzene | 1 | µg/L | SW5030/8260B | 84-125 | 20 |
| 1,2,4-Trimethylbenzene | 1 | µg/L | SW5030/8260B | 87-117 | 20 |
| 1,2-Dibromo-3-chloropropane | 2 | µg/L | SW5030/8260B | 76-121 | 20 |
| 1,2-Dibromoethane | 1 | µg/L | SW5030/8260B | 86-119 | 20 |
| 1,2-Dichlorobenzene | 1 | µg/L | SW5030/8260B | 86-114 | 20 |
| 1,2-Dichloroethane | 0.5 | µg/L | SW5030/8260B | 82-122 | 20 |
| 1,2-Dichloropropane | 1 | µg/L | SW5030/8260B | 89-116 | 20 |
| 1,3,5-Trimethylbenzene | 1 | µg/L | SW5030/8260B | 87-118 | 20 |
| 1,3-Dichlorobenzene | 1 | µg/L | SW5030/8260B | 88-116 | 20 |
| 1,3-Dichloropropane | 0.4 | µg/L | SW5030/8260B | 86-118 | 20 |
| 1,4-Dichlorobenzene | 0.5 | µg/L | SW5030/8260B | 88-120 | 20 |
| 2,2-Dichloropropane | 1 | µg/L | SW5030/8260B | 70-135 | 20 |
| 2-Butanone (MEK) | 10 | µg/L | SW5030/8260B | 75-133 | 20 |
| 2-Chloroethyl Vinyl Ether | 10 | µg/L | SW5030/8260B | 71-133 | 20 |
| 2-Chlorotoluene | 1 | µg/L | SW5030/8260B | 86-116 | 20 |
| 2-Hexanone | 10 | µg/L | SW5030/8260B | 74-127 | 20 |
| 4-Chlorotoluene | 1 | µg/L | SW5030/8260B | 80-12 | 20 |
| 4-Isopropyltoluene | 1 | µg/L | SW5030/8260B | 86-121 | 20 |
| 4-Methyl-2-pentanone (MIBK) | 10 | µg/L | SW5030/8260B | 81-134 | 20 |
| Acetone | 10 | µg/L | SW5030/8260B | 40-135 | 20 |
| Benzene | 0.4 | µg/L | SW5030/8260B | 88-117 | 20 |
| Bromobenzene | 1 | µg/L | SW5030/8260B | 87-117 | 20 |
| Bromochloromethane | 1 | µg/L | SW5030/8260B | 87-126 | 20 |
| Bromodichloromethane | 0.5 | µg/L | SW5030/8260B | 86-112 | 20 |
| Bromoform | 1 | µg/L | SW5030/8260B | 81-126 | 20 |
| Bromomethane | 3 | µg/L | SW5030/8260B | 53-141 | 20 |
| Carbon disulfide | 2 | µg/L | SW5030/8260B | 57-146 | 20 |
| Carbon tetrachloride | 1 | µg/L | SW5030/8260B | 83-130 | 20 |
| Chlorobenzene | 0.5 | µg/L | SW5030/8260B | 89-115 | 20 |
| Chloroethane | 1 | µg/L | SW5030/8260B | 62-152 | 20 |
| Chloroform | 0.4 | µg/L | SW5030/8260B | 80-120 | 20 |
| Chloromethane | 1 | µg/L | SW5030/8260B | 56-131 | 20 |
| Cis-1,2-Dichloroethene | 1 | µg/L | SW5030/8260B | 87-114 | 20 |
| Cis-1,3-Dichloropropene | 0.5 | µg/L | SW5030/8260B | 90-122 | 20 |
| Dibromochloromethane | 0.5 | µg/L | SW5030/8260B | 88-119 | 20 |
| Dibromomethane | 1 | µg/L | SW5030/8260B | 89-119 | 20 |
| Ethylbenzene | 1 | µg/L | SW5030/8260B | 80-120 | 20 |
| Hexachlorobutadiene | 0.6 | µg/L | SW5030/8260B | 67-131 | 20 |

**Table 1-11**
**Data Quality Objectives — Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Isopropylbenzene (Cumene) | 1 | µg/L | SW5030/8260B | 80-120 | 20 |
| Methyl iodide | 1 | µg/L | SW5030/8260B | 67-137 | 20 |
| Methylene chloride | 1 | µg/L | SW5030/8260B | 78-124 | 20 |
| Methyl-t-butyl ether | 5 | µg/L | SW5030/8260B | 86-116 | 20 |
| Naphthalene | 1 | µg/L | SW5030/8260B | 75-131 | 20 |
| n-Butylbenzene | 1 | µg/L | SW5030/8260B | 85-122 | 20 |
| n-Propylbenzene | 1 | µg/L | SW5030/8260B | 86-121 | 20 |
| o-Xylene | 1 | µg/L | SW5030/8260B | 80-120 | 20 |
| p&m-Xylene | 2 | µg/L | SW5030/8260B | 80-120 | 20 |
| sec-Butylbenzene | 1 | µg/L | SW5030/8260B | 88-124 | 20 |
| Styrene | 1 | µg/L | SW5030/8260B | 80-120 | 20 |
| tert-Butylbenzene | 1 | µg/L | SW5030/8260B | 86-121 | 20 |
| Tetrachloroethene | 1 | µg/L | SW5030/8260B | 85-123 | 20 |
| Toluene | 1 | µg/L | SW5030/8260B | 87-115 | 20 |
| trans-1,2-Dichloroethene | 1 | µg/L | SW5030/8260B | 83-124 | 20 |
| trans-1,3-Dichloropropene | 1 | µg/L | SW5030/8260B | 85-119 | 20 |
| Trichloroethene | 1 | µg/L | SW5030/8260B | 72-119 | 20 |
| Trichlorofluoromethane | 1 | µg/L | SW5030/8260B | 57-129 | 20 |
| Vinyl chloride | 1 | µg/L | SW5030/8260B | 64-149 | 20 |
| *Semivolatile Organics* | | | | | |
| 1,2,4-Trichlorobenzene | 10 | µg/L | SW3510/8270C | 37-120 | 30 |
| 1,2-Dichlorobenzene | 10 | µg/L | SW3510/8270C | 33-120 | 30 |
| 1,3-Dichlorobenzene | 10 | µg/L | SW3510/8270C | 32-120 | 30 |
| 1,4-Dichlorobenzene | 10 | µg/L | SW3510/8270C | 32-120 | 30 |
| 2,4,5-Trichlorophenol | 10 | µg/L | SW3510/8270C | 49-120 | 30 |
| 2,4,6-Trichlorophenol | 10 | µg/L | SW3510/8270C | 49-126 | 30 |
| 2,4-Dichlorophenol | 10 | µg/L | SW3510/8270C | 48-120 | 30 |
| 2,4-Dimethylphenol | 10 | µg/L | SW3510/8270C | 43-101 | 30 |
| 2,4-Dinitrophenol | 70 | µg/L | SW3510/8270C | 32-110 | 30 |
| 2,4-Dinitrotoluene | 10 | µg/L | SW3510/8270C | 68-107 | 30 |
| 2,6-Dichlorophenol | 10 | µg/L | SW3510/8270C | 36-90 | 30 |
| 2,6-Dinitrotoluene | 10 | µg/L | SW3510/8270C | 62-107 | 30 |
| 2-Chloronaphthalene | 10 | µg/L | SW3510/8270C | 50-105 | 30 |
| 2-Chlorophenol | 10 | µg/L | SW3510/8270C | 37-120 | 30 |
| 2-Methyl-4,6-dinitrophenol | 50 | µg/L | SW3510/8270C | 42-116 | 30 |
| 2-Methylnaphthalene | 10 | µg/L | SW3510/8270C | 46-120 | 30 |
| 2-Methylphenol (o-Cresol) | 10 | µg/L | SW3510/8270C | 38-120 | 30 |
| 2-Nitroaniline | 10 | µg/L | SW3510/8270C | 54-110 | 30 |
| 2-Nitrophenol | 10 | µg/L | SW3510/8270C | 39-123 | 30 |
| 3&4-Methylphenol (p&m-Cresol) | 20 | µg/L | SW3510/8270C | 32-120 | 30 |
| 3,3-Dichlorobenzidine | 10 | µg/L | SW3510/8270C | 68-111 | 30 |

**Table 1-11**
**Data Quality Objectives — Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| 3-Methylphenol (m-Cresol) | 140 | µg/L | SW3510/8270C | 32-120 | 30 |
| 3-Nitroaniline | 10 | µg/L | SW3510/8270C | 62-11 | 30 |
| 4-Bromophenyl-phenylether | 10 | µg/L | SW3510/8270C | 52-94 | 30 |
| 4-Chloro-3-methylphenol | 10 | µg/L | SW3510/8270C | 48-95 | 30 |
| 4-Chloroaniline | 10 | µg/L | SW3510/8270C | 39-98 | 30 |
| 4-Chlorophenyl-phenylether | 10 | µg/L | SW3510/8270C | 53-105 | 30 |
| 4-Nitroaniline | 10 | µg/L | SW3510/8270C | 62-115 | 30 |
| 4-Nitrophenol | 50 | µg/L | SW3510/8270C | 13-51 | 30 |
| Acenaphthene | 10 | µg/L | SW3510/8270C | 47-120 | 30 |
| Acenaphthylene | 10 | µg/L | SW3510/8270C | 50-120 | 30 |
| Acetophenone | 10 | µg/L | SW3510/8270C | N/A | N/A |
| Aniline | 10 | µg/L | SW3510/8270C | 13-107 | 30 |
| Anthracene | 10 | µg/L | SW3510/8270C | 65-100 | 30 |
| Azobenzene | 10 | µg/L | SW3510/8270C | 53-105 | 30 |
| Benzo(a)Anthracene | 10 | µg/L | SW3510/8270C | 56-100 | 30 |
| Benzo[a]pyrene | 10 | µg/L | SW3510/8270C | 74-106 | 30 |
| Benzo[b]Fluoranthene | 10 | µg/L | SW3510/8270C | 64-113 | 30 |
| Benzo[g,h,i]perylene | 10 | µg/L | SW3510/8270C | 40-123 | 30 |
| Benzo[k]fluoranthene | 10 | µg/L | SW3510/8270C | 60-112 | 30 |
| Benzoic acid | 50 | µg/L | SW3510/8270C | 10-53 | 30 |
| Benzyl alcohol | 10 | µg/L | SW3510/8270C | 37-79 | 30 |
| Bis(2-Chloroethoxy)methane | 10 | µg/L | SW3510/8270C | 46-120 | 30 |
| Bis(2-Chloroethyl)ether | 10 | µg/L | SW3510/8270C | 37-120 | 30 |
| Bis(2-chloroisopropyl)ether | 10 | µg/L | SW3510/8270C | 30-88 | 30 |
| Bis(2-Ethylhexyl)phthalate | 10 | µg/L | SW3510/8270C | 68-119 | 30 |
| Butylbenzylphthalate | 10 | µg/L | SW3510/8270C | 65-113 | 30 |
| Chrysene | 10 | µg/L | SW3510/8270C | 71-105 | 30 |
| Dibenzo[a,h]anthracene | 10 | µg/L | SW3510/8270C | 42-127 | 30 |
| Dibenzofuran | 10 | µg/L | SW3510/8270C | 55-105 | 30 |
| Diethylphthalate | 10 | µg/L | SW3510/8270C | 41-120 | 30 |
| Dimethylphthalate | 10 | µg/L | SW3510/8270C | 25-125 | 30 |
| Di-n-butylphthalate | 10 | µg/L | SW3510/8270C | 66-105 | 30 |
| Di-n-Octylphthalate | 10 | µg/L | SW3510/8270C | 62-130 | 30 |
| Fluoranthene | 10 | µg/L | SW3510/8270C | 68-102 | 30 |
| Fluorene | 10 | µg/L | SW3510/8270C | 53-101 | 30 |
| Hexachlorobenzene | 10 | µg/L | SW3510/8270C | 64-105 | 30 |
| Hexachlorobutadiene | 10 | µg/L | SW3510/8270C | 27-120 | 30 |
| Hexachlorocyclopentadiene | 30 | µg/L | SW3510/8270C | 22-111 | 30 |
| Hexachloroethane | 10 | µg/L | SW3510/8270C | 30-95 | 30 |
| Indeno[1,2,3-c,d] pyrene | 10 | µg/L | SW3510/8270C | 46-125 | 30 |
| Isophorone | 10 | µg/L | SW3510/8270C | 50-110 | 30 |

**Table 1-11**
**Data Quality Objectives — Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Naphthalene | 10 | µg/L | SW3510/8270C | 40-100 | 30 |
| Nitrobenzene | 10 | µg/L | SW3510/8270C | 44-120 | 30 |
| N-Nitrosodimethylamine | 10 | µg/L | SW3510/8270C | 25-110 | 30 |
| N-Nitroso-di-n-propylamine | 10 | µg/L | SW3510/8270C | 38-95 | 30 |
| N-Nitrosodiphenylamine | 10 | µg/L | SW3510/8270C | 58-101 | 30 |
| Pentachlorophenol | 50 | µg/L | SW3510/8270C | 42-98 | 30 |
| Phenanthrene | 10 | µg/L | SW3510/8270C | 65-103 | 30 |
| Phenol | 10 | µg/L | SW3510/8270C | 15-41 | 30 |
| Pyrene | 10 | µg/L | SW3510/8270C | 64-111 | 30 |

1 — may be analyzed by ICP (200.7)
N/A = not applicable
SOP = standard operating procedure
µmhos/cm = micromhos per centimeter
E = EPA (1983, 1991 and 2001).
SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition. 1998.
SW = EPA (1993).

**Table 1-12**
**Data Quality Objectives — Soil/Sediment (Terrestrial)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits | Precision Limits |
|---|---|---|---|---|---|
| *Inorganics* | | | | | |
| Cyanide (total) | 0.2 | mg/kg | SM4500CN-E | 75-125 | 20 |
| Chloride | 1 | mg/kg | E300.0 | 75-125 | 20 |
| Fluoride | 2 | mg/kg | E300.0 | 75-125 | 20 |
| Sulfate | 2 | mg/kg | E300.0 | 75-125 | 20 |
| Ammonia as N | 0.2 | mg/kg | SM4500NH3 | 75-125 | 25 |
| Fraction Organic Carbon | 0.05 | Percent | E415.1 | 75-125 | 25 |
| *Petroleum Hydrocarbons* | | | | | |
| GRO | 5 | mg/kg | AK101 | 60-120 | 20 |
| DRO | 20 | mg/kg | AK102 | 75-125 | 20 |
| RRO | 100 | mg/kg | AK103 | 60-120 | 20 |
| Benzene | 0.013 | mg/kg | SW5035/8260B | 86-122 | 20 |
| Toluene | 0.050 | mg/kg | SW5035/8260B | 80-123 | 20 |
| Ethylbenzene | 0.025 | mg/kg | SW5035/8260B | 84-127 | 20 |
| p&m-xylenes | 0.050 | mg/kg | SW5035/8260B | 88-124 | |
| o-xylene | 0.050 | mg/kg | SW5035/8260B | 87-123 | 20 |
| *Metals* | | | | | |
| Al | 2.0 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Sb | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| As | 0.5 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Ba | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Be | 0.02 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Bi | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| B | 20 | mg/kg | SW3050/6010B | 80-120 | 20 |
| Cd | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Ca | 10 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Cr | 0.2 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Co | 0.02 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Cu | 0.1 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Fe | 4.0 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Pb | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Mg | 4 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Mn | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Hg | 0.02 | mg/kg | SW3050/7471 | 83-118 | 20 |
| Mo | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Ni | 0.2 | mg/kg | SW3050/6020 | 80-120 | 20 |
| K | 400 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Se | 1.0 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Ag | 0.02 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Na | 20 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Tl | 0.02 | mg/kg | SW3050/6020 | 80-120 | 20 |

**Table 1-12**
**Data Quality Objectives — Soil/Sediment (Terrestrial)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits | Precision Limits |
|---|---|---|---|---|---|
| Sn | 1 | mg/kg | SW3050/6020 | 80-120 | 20 |
| V | 0.2 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Zn | 0.5 | mg/kg | SW3050/6020 | 80-120 | 20 |
| *Pesticides/PCBs* | | | | | |
| 4,4'-DDD | 0.002 | mg/kg | SW3540/8081A | 62-136 | 30 |
| 4,4'-DDE | 0.002 | mg/kg | SW3540/8081A | 68-126 | 30 |
| 4,4'-DDT | 0.002 | mg/kg | SW3540/8081A | 54-131 | 30 |
| Aldrin | 0.0015 | mg/kg | SW3540/8081A | 59-144 | 30 |
| alpha-BHC | 0.0015 | mg/kg | SW3540/8081A | 62-125 | 30 |
| alpha-Chlordane | 0.0015 | mg/kg | SW3540/8081A | 63-121 | 30 |
| beta-BHC | 0.0015 | mg/kg | SW3540/8081A | 62-127 | 30 |
| delta-BHC | 0.0015 | mg/kg | SW3540/8081A | 57-130 | 30 |
| Dieldrin | 0.002 | mg/kg | SW3540/8081A | 67-125 | 30 |
| Endosulfan I | 0.0015 | mg/kg | SW3540/8081A | 54-127 | 30 |
| Endosulfan II | 0.002 | mg/kg | SW3540/8081A | 37-122 | 30 |
| Endosulfan sulfate | 0.002 | mg/kg | SW3540/8081A | 63-130 | 30 |
| Endrin | 0.002 | mg/kg | SW3540/8081A | 64-132 | 30 |
| Endrin aldehyde | 0.002 | mg/kg | SW3540/8081A | 37-147 | 30 |
| Endrin ketone | 0.002 | mg/kg | SW3540/8081A | 56-133 | 30 |
| gamma-BHC (Lindane) | 0.0015 | mg/kg | SW3540/8081A | 59-123 | 30 |
| gamma-Chlordane | 0.0015 | mg/kg | SW3540/8081A | 48-124 | 30 |
| Heptachlor | 0.002 | mg/kg | SW3540/8081A | 60-139 | 30 |
| Heptachlor epoxide | 0.002 | mg/kg | SW3540/8081A | 66-130 | 30 |
| Methoxychlor | 0.002 | mg/kg | SW3540/8081A | 63-129 | 30 |
| Toxaphene | 0.05 | mg/kg | SW3540/8081A | 31-136 | N/A |
| Aroclor-1016 | 0.05 | mg/kg | SW3540/8082 | 54-112 | 30 |
| Aroclor-1221 | 0.05 | mg/kg | SW3540/8082 | N/A | N/A |
| Aroclor-1232 | 0.05 | mg/kg | SW3540/8082 | N/A | N/A |
| Aroclor-1242 | 0.05 | mg/kg | SW3540/8082 | N/A | N/A |
| Aroclor-1248 | 0.05 | mg/kg | SW3540/8082 | N/A | N/A |
| Aroclor-1254 | 0.05 | mg/kg | SW3540/8082 | N/A | N/A |
| Aroclor-1260 | 0.05 | mg/kg | SW3540/8082 | 61-131 | 30 |

E = EPA (1983) Adapted to soil matrices.
SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition. Adapted to soil matrices.
SW = EPA (1993).

**Table 1-13**
**Data Quality Objectives — Vegetation**

| Parameter | Method Reporting Limit (MRL) | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| *Inorganics* | | | | | |
| Cyanide (total) | 0.2 | mg/kg | E335.2 | N/A | N/A |
| *Metals* | | | | | |
| Al | 2.0 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Sb | 0.05 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| As | 0.5 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Ba | 0.05 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Be | 0.02 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Bi | 0.05 | mg/kg | SW3050/6020 | 70-130 | 30 |
| B | 20 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Cd | 0.05 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Ca | 10 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Cr | 0.2 | mg/kg | SW3050/6010B | 75-125 | 30 |
| Co | 0.02 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Cu | 0.1 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Fe | 4.0 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Pb | 0.05 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Mg | 4 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Mn | 0.05 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| Hg | 0.02 | mg/kg | SW3050/7471 | 60-130 | 30 |
| Mo | 0.05 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Ni | 0.2 | mg/kg | SW3050/6020 | 70-130 | 30 |
| K | 400 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Se | 1.0 | mg/kg | SW3050/6020 | 60-130 | 30 |
| Ag | 0.02 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Na | 20 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Tl | 0.02 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Sn | 10 | mg/kg | SW3050/6010B | 70-130 | 30 |
| V | 0.2 | mg/kg | SW3050/6020 | 75-125 | 30 |
| Zn | 0.5 | mg/kg | SW3050/6010B | 70-130 | 30 |

E = EPA (1983 and 1991) Adapted to vegetation matrices.
SW = EPA (1993).

**Table 1-14**
**CAS Data Quality Objectives — Fish/Invertebrate Tissue**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| *Metals* | | | | | |
| Sb | 0.05 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| As | 0.5 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Be | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Cd | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Cr | 0.5 | mg/kg | PSEP/6010B | 70-125 | 30 |
| Cu | 0.1 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Pb | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Hg | 0.001 | mg/kg | E1631 | 70-130 | 30 |
| Mo | 0.05 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Ni | 0.2 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Se | 1 | mg/kg | PSEP/7740A | 60-130 | 30 |
| Ag | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Tl | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Zn | 0.5 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Methyl mercury | 0.0015 | mg/kg | E1630M | 65-135 | 35 |
| *Pesticides/PCBs* | | | | | |
| alpha-BHC | 5 | µg/kg | SW8081 | 54-128 | 40 |
| gamma-BHC (Lindane) | 5 | µg/kg | SW8081 | 58-125 | 40 |
| beta-BHC | 5 | µg/kg | SW8081 | 54-119 | 40 |
| Heptachlor | 5 | µg/kg | SW8081 | 48-117 | 40 |
| delta-BHC | 5 | µg/kg | SW8081 | 61-131 | 40 |
| gamma-Chlordane | 5 | µg/kg | SW8081 | 60-117 | 40 |
| alpha-Chlordane | 5 | µg/kg | SW8081 | 60-114 | 40 |
| Aldrin | 5 | µg/kg | SW8081 | 56-120 | 40 |
| Heptachlor Epoxide | 5 | µg/kg | SW8081 | 60-118 | 40 |
| Endosulfan I | 5 | µg/kg | SW8081 | 55-114 | 40 |
| 4,4'-DDE | 5 | µg/kg | SW8081 | 58-131 | 40 |
| Dieldrin | 5 | µg/kg | SW8081 | 61-122 | 40 |
| Endrin | 5 | µg/kg | SW8081 | 62-129 | 40 |
| 4,4'-DDD | 5 | µg/kg | SW8081 | 47-141 | 40 |
| Endosulfan II | 5 | µg/kg | SW8081 | 55-115 | 40 |
| 4,4'-DDT | 5 | µg/kg | SW8081 | 52-143 | 40 |
| Endrin Aldehyde | 5 | µg/kg | SW8081 | 10-109 | 40 |
| Endosulfan Sulfate | 5 | µg/kg | SW8081 | 57-121 | 40 |
| Methoxychlor | 5 | µg/kg | SW8081 | 60-128 | 40 |
| Toxaphene | 250 | µg/kg | SW8081 | N/A | 40 |
| Aroclor 1016 | 0.1 | mg/kg | SW8082 | 38-150 | 40 |
| Aroclor 1221 | 0.2 | mg/kg | SW8082 | N/A | 40 |

**Table 1-14**
**CAS Data Quality Objectives — Fish/Invertebrate Tissue**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Aroclor 1232 | 0.1 | mg/kg | SW8082 | N/A | 40 |
| Aroclor 1242 | 0.1 | mg/kg | SW8082 | N/A | 40 |
| Aroclor 1248 | 0.1 | mg/kg | SW8082 | N/A | 40 |
| Aroclor 1254 | 0.1 | mg/kg | SW8082 | N/A | 40 |
| Aroclor 1260 | 0.1 | mg/kg | SW8082 | 30-149 | 40 |

E = EPA (1983 and 2001)
M = modified
PSEP = Puget sound Estuary Program
SW = EPA (1993)

The following tables present the data quality objectives for the Marine Study. For these analyses CAS is the primary laboratory and NCA is the QA laboratory.

## Table 1-15
### Data Quality Objectives — Marine Water

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Ammonia as N | 0.05 | mg/L | E350.1 | 85-115 | 20 |
| Chloride | 0.2 | mg/L | E300.0 | 90-110 | 20 |
| Cyanide-total | 0.01 | mg/L | SM4500CN-E | 85-115 | 20 |
| Fluoride | 0.2 | mg/L | E300.0 | 90-110 | 20 |
| Sulfate | 0.2 | mg/L | E300.0 | 90-110 | 20 |
| Chemical Oxygen Demand | 5 | mg/L | E410.1 | 85-115 | 20 |
| Total Organic Carbon | 0.5 | mg/L | E415.1 | 85-115 | 20 |
| TSS | 5 | mg/L | E160.2 | N/A | 20 |
| *Petroleum Hydrocarbons* | | | | | |
| Gasoline Range Organics | 0.1 | mg/L | AK101 | 60-120 | 20 |
| Diesel Range Organics | 0.3 | mg/L | AK102 | 75-125 | 30 |
| Residual Range Organics | 0.5 | mg/L | AK103 | 60-120 | 30 |
| Benzene | 0.4 | µg/L | SW5030/8260B | 88-117 | 20 |
| Toluene | 1 | µg/L | SW5030/8260B | 87-115 | 20 |
| Ethlbenzene | 1 | µg/L | SW5030/8260B | 80-120 | 20 |
| p&m-xylene | 2 | µg/L | SW5030/8260B | 80-120 | 20 |
| o-xylene | 1 | µg/L | SW5030/8260B | 90-120 | 20 |
| *Metals (Total and Dissolved)* | | | | | |
| Hg (low level) (Total only) | 0.005 | µg/L | E1631 | 77-123 | 20 |
| Al | 1.0 | µg/L | Rpt/6010B | 85-115 | 20 |
| Sb | 0.05 | µg/L | Rpt/E200.8 | 85-115 | 20 |
| As | 0.5 | µg/L | Rpt/E200.8 | 85-115 | 20 |
| Ba | 0.05 | µg/L | Rpt/6010B | 85-115 | 20 |
| Be | 0.02 | µg/L | Rpt/E200.8 | 85-115 | 20 |
| Bi | 0.1 | µg/L | Rpt/E200.8 | 85-115 | 20 |
| B | 0.5 | µg/L | Rpt/6010B | 85-115 | 20 |
| Cd | 0.02 | µg/L | Rpt/E200.8 | 85-115 | 20 |
| Ca | 50 | µg/L | Rpt/6010B | 85-115 | 20 |
| Cr | 0.2 | µg/L | Rpt/E200.8 | 85-115 | 20 |
| Co | 0.02 | µg/L | Rpt/E200.8 | 85-115 | 20 |
| Cu | 0.1 | µg/L | Rpt/E200.8 | 85-115 | 20 |
| Fe | 20 | µg/L | Rpt/6010B | 85-115 | 20 |
| Pb | 0.02 | µg/L | Rpt/E200.8 | 85-115 | 20 |
| Mg | 20 | µg/L | Rpt/6010B | 85-115 | 20 |
| Mn | 0.05 | µg/L | Rpt/6010B | 85-115 | 20 |
| Mo | 0.05 | µg/L | Rpt/6010B | 85-115 | 20 |
| Ni | 0.2 | µg/L | Rpt/E200.8 | 85-115 | 20 |
| K | 50 | µg/L | Rpt/6010B | 85-115 | 20 |
| Se | 1.0 | µg/L | Rpt/SW7742 | 85-115 | 20 |
| Ag | 0.02 | µg/L | Rpt/E200.8 | 85-115 | 20 |
| Na | 100 | µg/L | Rpt/6010B | 85-115 | 20 |
| Tl | 0.01 | µg/L | Rpt/E200.8 | 85-115 | 20 |
| Sn | 0.1 | µg/L | Rpt/E200.8 | 85-115 | 20 |
| V | 0.2 | µg/L | Rpt/6010B | 85-115 | 20 |
| Zn | 0.5 | µg/L | Rpt/E200.8 | 85-115 | 20 |

Rpt = reductive precipitation.
SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition.
E = EPA (1983, 1991 and 2001).
SW = EPA (1993).

**Table 1-16**
**Data Quality Objectives — Marine Sediment**

| Parameter | Lab MRL | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| *Inorganics* | | | | | |
| Cyanide (total) | 0.2 | mg/kg | SM4500CN-E | 85-115 | 20 |
| Chloride | 1 | mg/kg | E300.0 | 90-110 | 20 |
| Fluoride | 2 | mg/kg | E300.0 | 85-115 | 20 |
| Sulfate | 2 | mg/kg | E300.0 | 90-110 | 20 |
| Ammonia as N | 0.2 | mg/kg | E350.1 | 85-115 | 20 |
| Total Kjeldahl Nitrogen | | mg/kg | E351.4 | 85-115 | 20 |
| Fraction Organic Carbon | 0.05 | Percent | ASTM D4129-82M | 85-115 | 20 |
| *Petroleum Hydrocarbons* | | | | | |
| GRO | 5 | mg/kg | AK101 | 60-120 | 40 |
| DRO | 40 | mg/kg | AK102 | 75-125 | 40 |
| RRO | 100 | mg/kg | AK103 | 60-120 | 40 |
| Benzene | 0.005 | mg/kg | SW5035/8260B | 78-124 | 40 |
| Toluene | 0.005 | mg/kg | SW5035/8260B | 75-128 | 40 |
| Ethylbenzene | 0.005 | mg/kg | SW5035/8260B | 89-124 | 40 |
| m&p-Xylenes | 0.002 | mg/kg | SW5035/8260B | 89-126 | 40 |
| o-Xylene | 0.002 | mg/kg | SW5035/8260B | 86-129 | 40 |
| *Metals* | | | | | |
| Al | 2.0 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Sb | 0.05 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| As | 0.5 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| Ba | 0.05 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| Be | 0.02 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| Bi | tbd | mg/kg | SW3050/E200.8 | tbd | tbd |
| B | 20 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Cd | 0.05 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| Ca | 10 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Cr | 0.2 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| Co | 0.02 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| Cu | 0.1 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| Fe | 4.0 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Pb | 0.05 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| Mg | 4 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Mn | 0.05 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Hg | 0.001 | mg/kg | E1631 | 30-70 | 30 |
| Mo | 0.05 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| Ni | 0.2 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| K | 400 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Se | 1.0 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| Ag | 0.02 | mg/kg | SW3050/E200.8 | 70-130 | 30 |

**Table 1-16**
**Data Quality Objectives — Marine Sediment**

| Parameter | Lab MRL | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Na | 20 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Tl | 0 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| Sn | 10 | mg/kg | SW3050/6010B | 70-130 | 30 |
| V | 0.2 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Zn | 0.5 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| *Pesticides/PCBs* | | | | | |
| alpha-BHC | 5 | µg/kg | SW3540/8081 | 64-135 | 40 |
| gamma-BHC (Lindane) | 5 | µg/kg | SW3540/8081 | 63-137 | 40 |
| beta-BHC | 5 | µg/kg | SW3540/8081 | 49-145 | 40 |
| Heptachlor | 5 | µg/kg | SW3540/8081 | 61-123 | 40 |
| delta-BHC | 5 | µg/kg | SW3540/8081 | 68-144 | 40 |
| gamma-Chlordane | 5 | µg/kg | SW3540/8081 | 63-127 | 40 |
| alpha-Chlordane | 5 | µg/kg | SW3540/8081 | 63-125 | 40 |
| Aldrin | 5 | µg/kg | SW3540/8081 | 59-127 | 40 |
| Heptachlor Epoxide | 5 | µg/kg | SW3540/8081 | 64-124 | 40 |
| Endosulfan I | 5 | µg/kg | SW3540/8081 | 55-124 | 40 |
| 4,4'-DDE | 5 | µg/kg | SW3540/8081 | 67-133 | 40 |
| Dieldrin | 5 | µg/kg | SW3540/8081 | 68-131 | 40 |
| Endrin | 5 | µg/kg | SW3540/8081 | 72-133 | 40 |
| 4,4'-DDD | 5 | µg/kg | SW3540/8081 | 67-139 | 40 |
| Endosulfan II | 5 | µg/kg | SW3540/8081 | 62-126 | 40 |
| 4,4'-DDT | 5 | µg/kg | SW3540/8081 | 68-144 | 40 |
| Endrin Aldehyde | 5 | µg/kg | SW3540/8081 | 48-120 | 40 |
| Endosulfan Sulfate | 5 | µg/kg | SW3540/8081 | 62-131 | 40 |
| Methoxychlor | 5 | µg/kg | SW3540/8081 | 65-140 | 40 |
| Toxaphene | 250 | µg/kg | SW3540/8081 | N/A | 40 |
| Aroclor 1016 | 0.1 | mg/kg | SW3540/8082 | 47-138 | 40 |
| Aroclor 1221 | 0.2 | mg/kg | SW3540/8082 | N/A | 40 |
| Aroclor 1232 | 0.1 | mg/kg | SW3540/8082 | N/A | 40 |
| Aroclor 1242 | 0.1 | mg/kg | SW3540/8082 | N/A | 40 |
| Aroclor 1248 | 0.1 | mg/kg | SW3540/8082 | N/A | 40 |
| Aroclor 1254 | 0.1 | mg/kg | SW3540/8082 | N/A | 40 |
| Aroclor 1260 | 0.1 | mg/kg | SW3540/8082 | N/A | 40 |

tbd = to be determined
E = EPA (1983, 1991 and 2001)
SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition. Adapted to soil matrices.
SW = EPA (1993)

### 1.6.2 Precision

Precision is a qualitative measure of the reproducibility of a measurement under a given set of conditions. For duplicate measurements, analytical precision can be expressed as the relative percent difference (RPD). The level of effort for laboratory precision will be at a minimum frequency of 1 in 20 (5 percent) or one per laboratory batch, whichever is more frequent. Laboratory precision is calculated from laboratory duplicates. Field precision will be at a minimum frequency of 1 in 20 field samples (10percent).

QC and QA samples are conducted on homogenized fish and vegetation tissues rather than collected in the field. The primary laboratory (CAS) will analyze 10 percent as QC samples and ship 10 percent of fish and vegetation tissue samples to NCA as QA homogenate samples.

If calculated from duplicate measurements:

$RPD = [(C_1 – C_2) \times 100\%] \div [(C_1 + C_2) / 2]$
RPD = relative percent difference
$C_1$ = larger of the two observed values
$C_2$ = smaller of the two observed values

If calculated from three or more replicates, relative standard deviation (RSD) rather than RPD is used:

$RSD = (s / y) \times 100\%$
RSD = relative standard deviation
s = standard deviation
y = mean of replicate analysis

Standard deviation, S, is defined as follows:

$S = [\Sigma n( y^i-y)^2 / (n-1)]^{0.5}$
S = standard deviation
$y^i$ = measured value of the $i^{th}$ replicate
y = mean of replicate measurements
n = number of replicates

### 1.6.3 Accuracy

For samples processed by the analytical laboratory, accuracy will be evaluated with matrix spikes (MS), laboratory control samples (LCS), and performance evaluation (PE) samples to establish accuracy. MS will be analyzed at an overall frequency of 10 percent throughout the project duration. One PE sample will be submitted and analyzed during the 2004-2005 program.

For measurements where matrix spikes are used:

$\%R = 100\% \times (S - U / C_{SA})$
%R = percent recovery
S = measured concentration in spiked aliquot
U = measured concentration in unspiked aliquot
$C_{SA}$ = actual concentration of spike added

For situations where a PE or LCS sample is used instead of or in addition to matrix spikes:

$\%R = 100\% \times (C_m / C_{srm})$
$\%R$ = percent recovery
$C_m$ = measured concentration of PE or LCS sample
$C_{srm}$ = actual concentration of PE or LCS sample

The level of effort for precision and accuracy measurements is listed in Table 1-17.

**Table 1-17**
**Precision and Accuracy Evaluation for the Pebble Project EBS**

| Parameter Group | Type of Test (precision/accuracy) | Level of Effort |
|---|---|---|
| Inorganic Analytes | *PE sample*[1] | *1 for 2004–2005 program* |
| | Field duplicates (QC) | 10 percent |
| | Field triplicate (QA) | 10 percent |
| | Laboratory duplicates | 5 percent or 1 per analytical batch |
| | Laboratory control sample | 1 to 2 per analytical batch of 20 samples or fewer |
| | Matrix spike (not required for all analytes) | 5 percent of total samples submitted over project duration |
| Metals | *PE sample*[1] | *1 for 2004–2005 program* |
| | Field duplicates (QC) | 10 percent |
| | Field triplicate (QA) | 10 percent |
| | Laboratory control sample | 1 per analytical batch of 20 samples or fewer |
| | Matrix spike/matrix spike duplicate | 5 percent of total samples submitted over project duration |
| Organics | *PE sample*[1] | *1 for 2004–2005 program* |
| | Field duplicates (QC) | 10 percent |
| | Field triplicate (QA) | 10 percent |
| | Laboratory control sample | 2 per analytical batch of 20 samples or fewer |
| | Matrix spike/matrix spike duplicate (not required for all analytes) | 5 percent of total samples submitted over project duration |

1 — Performance evaluation (PE) sample issued by the National Institute for Standards and Technology (NIST). PE samples are certified for specific chemical or physical properties and are issued with certificates that report the results of the characterization and indicate the use of the material.

### 1.6.4 Representativeness

Representativeness is a measure of how closely the measured results reflect the actual concentration or distribution of the chemical compounds in the environment. Sampling plan design, sampling techniques, and sample handling protocols (for example, storage, preservation, and transportation) have been developed and are discussed in other sections of this document. Documentation will establish that protocols have been followed and sample identification and integrity assured. Field blanks and field duplicates will be used to assess field and transport contamination and sampling variation. Laboratory sample retrieval, storage, and handling procedures have also been developed and are discussed in other sections of this document. Laboratory method blanks will be run at the minimum frequency of 5 percent or one per analytical batch to assess laboratory contamination.

### 1.6.5 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement system. The target completeness objectives are 90 percent for each analytical parameter; the actual completeness can vary with the intrinsic nature of the samples. The completeness of the data will be assessed during the data review.

Completeness is defined as follows for all measurements:

%C = 100% x (V / n)
%C = percent completeness
V = number of measurements judged valid
n = total number of measurements

### 1.6.6 Comparability

Comparability is the level of confidence with which one data set can be compared with another. This objective is met by selecting field sampling methods and laboratory analytical methods that are comparable throughout the baseline environmental studies. Changing sampling techniques or laboratory methods during the study may compromise comparability. The field sampling methods have been evaluated to ensure comparability among consultants collecting samples of the same media from the mine area and the road/port area. The laboratory methods employed by the primary and QA laboratories have been evaluated to ensure that methods used for primary, QC, and QA samples are comparable. Comparability will also be maintained by the use of consistent units.

## 1.7 Special Training and Certification

The laboratories selected for the Pebble Project EBS have obtained certifications and participate in periodic auditing programs that establish their level of performance. Table 1-18 summarizes state and federal certifications and accreditation programs that the Pebble Project laboratories participate in.

**Table 1-18**
**Laboratory Certifications and Accreditation Programs**

| Laboratory | Program |
|---|---|
| SGS Environmental Services, Inc. | Alaska Department of Environmental Conservation — Drinking Water and Contaminated Sites Certification |
| | Air Force Center for Environmental Excellence. |
| | National Environmental Laboratory Accreditation Program |
| | U.S. Army Corps of Engineers |
| | U.S. Navy (NAVSEA) |
| | U.S. Department of Agriculture |
| Columbia Analytical Services, Inc. | Alaska Department of Environmental Conservation – Contaminated Sites Certification |
| | Air Force Center for Environmental Excellence. |
| | National Environmental Laboratory Accreditation Program |
| | U.S. Army Corps of Engineers |
| | U.S. NAVY (NAVSEA) |

**Table 1-18**
**Laboratory Certifications and Accreditation Programs**

| Laboratory | Program |
|---|---|
| North Creek Analytical, Inc. | Alaska Department of Environmental Conservation — Drinking Water and Contaminated Sites Certification |
| | National Environmental Laboratory Accreditation Program for Oregon |
| | U.S. NAVY (NAVSEA) |
| | U.S Army Corps of Engineers |

## 1.8 Documents and Records

### 1.8.1 Quality Assurance Project Plan

The QAPP document will be controlled by the Analytical QA/QC Manager. Approved QAPPs and updated versions will be provided to the parties presented in the Distribution List (Section 1.2). Document control information (revision number and date) is shown in the bottom right corner of each page.

### 1.8.2 Laboratory Reports

The minimum information that must be included in the hardcopy data report package is as follows:

1. Transmittal letter.
2. Case narrative to discuss at a minimum all issues that may negatively impact data quality including sample handling, preservation, holding times, sample matrix, and QC results.
3. Chain-of-custody documents.
4. Cooler receipt form documenting cooler temperatures, sample preservation, and condition upon receipt by the laboratory.
5. Custody seals.
6. Sample analytical results. Do not report results from multiple dilutions for a given parameter.
7. Method blank results.
8. Surrogate recovery results and acceptance criteria for applicable organic methods.
9. Dates of sample collection, receipt, preparation, and analysis for all tests.
10. Matrix spike result(s) with calculated recovery including associated acceptance criteria.
11. Duplicate or duplicate matrix spike result(s) (as appropriate to method) with calculated RPD and acceptance criteria.
12. LCS and or QC check sample result(s) with calculated recovery and associated acceptance criteria.
13. Initial calibration results summary and continuing calibration verification-standard results with calculated recoveries and acceptance criteria.
14. Summary forms of associated QC and calibration parameters.
15. Run or sequence logs for each method.
16. Copies of all sample chromatograms with at least one calibration standard for fuels analyses.

For each report or sample delivery group, laboratories will submit the United States Army Corp of Engineers (USACE) COELT EDF v 1.2a electronic deliverables.

### 1.8.3 Data Quality Assurance Reports

DQAR reports will assess the data and address corrective action related to field and laboratory activities. These reports will be prepared and controlled by the Analytical QA/QC Manager.

# 2 Data Generation and Acquisition

The generation, compilation, reporting, and archiving of data are critical components of field and laboratory operations. In order to generate data of known and acceptable quality, the QA/QC practices for data management must be complete and comprehensive and in keeping with the overall QA objectives of the project.

## 2.1 Sampling Process Design

Producing data of known quality that are considered representative of the sampling environment at an appropriate level of detail is achieved by establishing a QA program with specified data gathering protocols overseen by the Analytical QA/QC Manager. The main components of the proposed QA program include the following:

- Verification of use of proper sample containers and preservative.
- Collection and analysis of blank/duplicate samples.
- Specific procedures for handling, labeling, and shipping samples.
- Field equipment calibration.
- Equipment decontamination.
- Field documentation.
- Field corrective action.

All field blanks/duplicates and triplicates will be noted on the chain-of-custody and field log books.

See Section 1.5 for the following information:

- Types and numbers of samples required.
- Sampling frequency.
- Sample matrices.
- Parameters of interest.

The *Pebble Gold-Copper Project*, Draft *Environmental Baseline Studies, Proposed 2004 Study Plan* (NDM, 2004) presents the sampling locations and rationale for the design.

## 2.2 Sampling Methods

General field sampling methods are contained in the *Pebble Gold-Copper Project*, Draft *Environmental Baseline Studies, Proposed 2004 Study Plan* (NDM, 2004) and in respective consultants' field sampling plans. Corrective action is the responsibility of the Analytical QA/QC Manager and Project Managers for HDR, BEESC, and SLR. When a failure in the sampling system occurs, this management team will cooperate to investigate the failure and implement necessary corrective action(s).

For all field samples, containers will be provided by the laboratory conducting the analyses. Tables 2-1, 2-2, and 2-3 summarize the required containers, sample volumes, preservation, and maximum holding times for all parameters.

**Table 2-1**
**Sample Bottle Schedule and Sampling Parameters for Surface Water/Groundwater Collection**

| Analytical Set | Bottle Type (SGS/ NCA) | Bottle Type (CAS) | Analysis | Lab Method | Preservative | Hold Time | Req. Temp. | Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | (1) 1L HDPE<br><br>1 extra volume for MS/MSD | (1) 1L HDPE<br><br>No extra volume for MS/MSD | Total Hg | E245.1 | $HNO_3$ | 28 days | 4 °C | Unfiltered |
| | | | Total Metals (1) | E200.8/200.7 | $HNO_3$ | 6 Months | None | |
| 2 | (1) 1L HDPE<br><br>1 extra volume for MS/MSD | (1) 1L HDPE<br><br>No extra volume for MS/MSD | Dissolved Hg (GW only) | E245.1 | $HNO_3$ | 28 days | 4 °C | Filtered |
| | | | Dissolved Metals (2) | E200.8/200.7 | $HNO_3$ | 6 Months | None | |
| 3 | (2) 250 ml HDPE<br><br>No extra volume for MS/MSD | (1) 1L HDPE<br><br>No extra volume for MS/MSD | Cyanide Total | 4500CN-E | NaOH | 14 days | 4 °C | Unfiltered |
| | | | Cyanide (Weak Acid Dissociable) | 4500CN-I | NaOH | 14 days | 4 °C | Unfiltered |
| 4 | 500 ml HDPE<br><br>No extra volume for MS/MSD | (1) 1L HDPE<br><br>No extra volume for MS/MSD | Ammonia as N | SM4500-NH3-G | $H2SO_4$ | 28 days | 4 °C | Unfiltered |
| | | | Phosphorus Total | E365.3 | $H2SO_4$ | 28 days | 4 °C | Unfiltered |
| | | | Nitrate-Nitrite Total | E300.0, E353.2 | $H2SO_4$ | 28 days | 4 °C | Unfiltered |
| 5 | (2) 1L HDPE<br><br>2 extra volumes for TDS/TSS lab duplicates<br><br>60 ml Nalgene* (*Cl, F, $SO_4$ only) 1 extra volume for MS and 1 extra volume for lab duplicate | (2) 1L HDPE<br><br>No extra volume for MS/MSD | TDS | E160.1 or SM2540C | None | 7 days | 4 °C | Unfiltered |
| | | | TSS | E160.2 | None | 7 days | 4 °C | Unfiltered |
| | | | Alkalinity | 2320B | None | 14 days | 4 °C | Unfiltered |
| | | | Acidity | 305.2 | None | 14 days | 4 °C | Unfiltered |
| | | | Specific Conductance | SM2510B | None | 28 days | 4 °C | Unfiltered |
| | | | pH | E150.1 | None | 24 hours | 4 °C | Unfiltered |
| | | | Chloride | E300.0 | None | 28 Days | 4 °C | Unfiltered |
| | | | Fluoride | E300.0 | None | 28 Days | 4 °C | Unfiltered |
| | | | Sulfate | E300.0 | None | 28 Days | 4 °C | Unfiltered |
| 6 | 250 ml HDPE<br><br>No extra volume for MS/MSD | 250 ml HDPE<br><br>No extra volume for MS/MSD | Thiocyanate | Lab SOP | $HNO_3$ | 28 days | 4 °C | Unfiltered |
| 7 | 500 ml Fluoropoly<br><br>No extra volume for MS/MSD | 500 ml Fluoropoly<br><br>No extra volume for MS/MSD | Low Level Hg | E1631 | HCl | 90 days | None | Unfiltered |
| 8 | See analytical Set 4 above | 1L HDPE same bottle as analytical Set 4 | Nitrate-Nitrite Total | E353.2 | $H2SO_4$ | 28 days | 4 °C | Unfiltered |
| 9 (Marine | (3) 40 ml VOA vial with | (3) 40 ml VOA vial with | GRO | AK101 | HCl | 14 days | 4 °C | Unfiltered |

**Table 2-1**
**Sample Bottle Schedule and Sampling Parameters for Surface Water/Groundwater Collection**

| Analyti-cal Set | Bottle Type (SGS/ NCA) | Bottle Type (CAS) | Analysis | Lab Method | Preser-vative | Hold Time | Req. Temp. | Comments |
|---|---|---|---|---|---|---|---|---|
| SW only) | Teflon septum lid<br><br>6 extra VOA vials for MS/MSD | Teflon septum lid<br><br>6 extra VOA vials for MS/MSD | | | | | | |
| 10 (Marine SW only) | (2) 1L amber glass jar with Teflon cap<br><br>4 extra volumes for MS/MSD | (2) 1L amber glass jar with Teflon cap<br><br>4 extra volumes for MS/MSD | DRO/RRO | AK102/103 | HCl | 7 days to extraction ; 40 days to analysis of extract | 4 °C | Unfiltered |
| 11 (SW only) | (3) 40 ml VOA vial with Teflon septum lid<br><br>6 extra VOA vials for MS/MSD | (3) 40 ml VOA vial with Teflon septum lid<br><br>6 extra VOA vials for MS/MSD | VOCs (or BTEX) | SW8260B | HCl | 14 days | 4 °C | Unfiltered |
| 12 (SW only) | (2) 1L amber glass jar with Teflon cap<br><br>4 extra volumes for MS/MSD | (2) 1L amber glass jar with Teflon cap<br><br>4 extra volumes for MS/MSD | SVOCs | SW8270C | None | 7 days to extraction ; 40 days to analysis of extract | 4 °C | Unfiltered |
| 13 (SW only) | (2) 1L amber glass jar with Teflon cap<br><br>4 extra volumes for MS/MSD | (2) 1L amber glass jar with Teflon cap<br><br>4 extra volumes for MS/MSD | Pesticides/ PCBs | SW508 | None | 7 days to extraction ; 40 days to analysis of extract | 4 °C | Unfiltered |

1 — Al, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, K, Ag, Na, Sb, V, Zn, As, Pb, Se, Sn, Tl, Hardness, B
2 — Al, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, K, Ag, Na, Sb, V, Zn, As, Pb, Se, Sn, Tl, B, Si
ml = milliliters
Low-level Hg by E1631 is only for surface water samples. Mercury by E245.1 is only for groundwater samples.

**Table 2-2**
**Sample Bottle Schedule and Sampling Parameters for Soil/Sediment Collection**

| Analytical Set | Bottle Type (SGS) | Bottle Type (CAS) | Analysis | Lab Method | Preservative | Hold Time | Required Temp. | Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | (1) 8oz | (1) 8oz | Total Metals (1) | SW6010B/6020/7471 (Hg) | None | 6 Months | None | |
| 2 | (1) 4 oz prewt'd amber | (1) 4 oz prewt'd amber | Gasoline Range Organics | AK101 | MeOH w/BFB | 28 days | 4 °C | 2nd 4 oz % solids jar if no other analyses |
| 3 | (1) 4 oz prewt'd amber | (1) 4 oz prewt'd amber | Benzene, toluene, ethylbenzene, and xylenes | SW8260B | MeOH w/surrogate | 14 days | 4 °C | 2nd 4 oz % solids jar if no other analyses |
| 4 | (1) 8 oz | (1) 8 oz | Diesel/residual range organics | AK102/103 | None | 14 days to extraction, 40 days to analysis of extract | 4 °C | |
| 5 | (1) 8 oz | (1) 8 oz | PCBs/ pesticides | SW8081/8082 | None | 14 days to extraction, 40 days to analysis of extract | 4 °C | |
| 6 | (1) 4 oz | (1) 4 oz | Cyanide | SM4500CN-E | None | 28 days (2) | 4 °C | |
| 7 | (1) 4 oz | (1) 4 oz | Ammonia as N | SM4500NH3 | None | 28 days | 4 °C | |
| 8 | (1) 4 oz | (1) 4 oz | Chloride | E300.0 | None | 28 Days (3) | 4 °C | |
| | | | Fluoride | E300.0 | None | 28 Days (3) | 4 °C | |
| | | | Sulfate | E300.0 | None | 28 Days (3) | 4 °C | |
| 9 | (1) 4 oz | (1) 4 oz | Fraction Organic Carbon | ASTMD4129, | None | 180 Days | 4 °C | |

1 — Al, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, K, Ag, Na, Sb, V, Zn, As, Pb, Se, Sn, Tl, B, Hg 2 — as per EPA methods factsheet titled “Total Petroleum Hydrocarbons, Reactive Cyanide, Reactive Sulfide, Ignitability, and Corrosivity”
3 — Holding time is from the date of preparation
oz = ounce
prewt'd = reweighed and tared

**Table 2-3**
**Sample Bottle Schedule and Sampling Parameters for Biological Tissue Collection**

| Tissue Type | Minimum Sample Amount, (grams) | Bottle Type (CAS/NCA) | Analysis | Lab Method | Shipping Preservation and Time | Hold Time | Required Laboratory Storage Temp. |
|---|---|---|---|---|---|---|---|
| Vegetation | 25 | Ziploc bag or glass jar | Hg | SW7471 | Cool on blue ice | 28 days | 4 °C |
| | | | Total Metals (1) | SW6010B/6020 E200.8 | | 6 Months | None |
| | | | Cyanide | SM4500CN-E | | 14 days | 4 °C |
| Fish | 25 | Ziploc or similar plastic bag | PCB/Pest | SW8081/8082 | Cool on blue ice or freeze on dry ice if shipping time will exceed 24 hours. Samples must arrive at the lab within 48 hours of shipment. | 1 year | Freeze at ≤ -20 °C |
| | | | Low-level Hg | E1631 | | 28 days | |
| | | | Total Metals (2) | SW6010B(Cr) E200.8 SW7740 (Se) SW6010B/6020 | | 6 Months | |
| | | | Methyl Mercury | E1630M | | 6 Months | |

1 — Al, Sb, As, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Tl, Sn, V, Zn
2 — Sb, As, Be, Cd, Cr, Cu, Pb, Mo, Ni, Se, Ag.

### 2.2.1 Sample Collection and Analysis

Sample collection, handling, and shipping procedures include the following:

- Field collection.
- Labeling.
- Packaging.
- Chain-of-custody forms.
- Shipping.

The Project Managers are responsible for implementing the following sample handling and shipping procedures. The Analytical QA/QC Manager will check for quality assurance measures on these activities.

### 2.2.2 Field Collection Procedures

In all cases, field collection procedures will be performed to minimize contamination of samples, prevent cross-contamination between samples, and ensure sample validity by conducting proper preservation and storage in the field according to the requirements specified in this QAPP.

Surface water samples will be collected for analysis in the following order:

1. Mercury.
2. Total metals.
3. Dissolved metals.
4. Total suspended solids, total dissolved solids, etc.
5. Settleable solids (Imhoff cones in the field).
6. Miscellaneous parameters (ammonia, phosphorus, Cyanide WAD, etc.).

For mercury, many states are establishing new National Pollutant Discharge Elimination System (NPDES) limits at very low levels based on maintaining water quality standards in the receiving streams. The new limits may approach or even be less than the detection limit of routine analytical methods. To ensure that reliable data are produced at these extremely low detection levels, additional emphasis must be placed on clean sampling and clean laboratory practices to minimize contamination. The following general field procedures are recommended by CAS, the laboratory that will perform mercury analysis for the Pebble Project EBS.

1. Sampling cleanliness will be documented through the use of trip blanks and field sampling blanks.
2. Only non-metallic sampling equipment will be used and no metal object will be allowed to come into direct or indirect contact with the sample or sample containers (storing samples at all times in properly cleaned and sealed containers [ice chests] can help prevent inadvertent contact with such objects, as well as prevent inadvertent contamination).
3. Only non-talc gloves will be used and gloves will be changed between sample collections.
4. Samples will be collected directly into sample containers that are documented clean at the levels of concern.
5. All sample containers will be double-bagged.
6. It may be necessary to designate one “clean hands” sampler to perform all operations involving direct contact with the sample and one “dirty hands” sampler for all other operations (e.g., record keeping).

For fish being collected for contaminant analyses, fish collection procedures will follow many of the methods of Zhang et al. (2001) and Jewett et al. (2003). These include:

1. Total fish length and sex will be recorded for each specimen in the field; any necessary dissection to determine sex will be done using surgical sheets, powder-free latex gloves, and an acid-washed titanium knife or scalpel. The disposable gloves will be changed out between each dissection.
2. For smaller fish (e.g., < 6 inches total length), the entire animal will be placed in a Ziploc-type plastic bag and frozen immediately.
3. For larger fish (e.g., > 6 inches total length), immediate freezing of all tissues in an entire animal would be difficult under field conditions. Therefore, tissue dissections for muscle and liver samples will be done in the field as follows:
    a. Immediately upon capture, fish will be placed in clean plastic bags and placed in a cooler with ice.
    b. Dissection will occur indoors at a clean site in Iliamna.

c. The cutting surface will be washed with soap and water and covered with heavy-duty aluminum foil.

d. Either stainless steel disposable scalpels or stainless steel knives will be used for dissection. Knives will be washed with soap and water and rinsed with DI water between uses. Scalpels will be replaced between fish.

e. An approximately 25-gram (g) sample of liver and muscle tissue will be extracted from each fish using powder free gloves and placed in an individually labeled Ziploc bag. Tissue samples will be immediately placed in a freezer.

f. An equipment blank will be prepared after each set of dissections by rinsing the cutting surface and the knives with DI water and collecting the rinse water in an acid-washed jar.

g. Frozen tissue samples will be packaged in a cooler and sent to the laboratory using packaging recommendations provided by the lab. Chain-of-custody procedures will be followed.

h. Each sample from an individual fish will be labeled with the sample ID number and include a suffix of "M" for muscle or "L" for liver tissue (see Section 2.3.1).

i. For the fish tissue samples from large fish, the muscle tissue will be collected immediately below the dorsal fin. When doing the tissue dissections, at least 25 grams of tissue for each type of tissue sample, or about a 3x3x1-inch piece of tissue, will be collected.

For vegetation samples collect 50 grams from a representative plant in each plant class (tree, shrub, grass, forb, fern, moss, and lichen) within the plot, if available.

Collect at least 75 grams for 10 percent of fish samples and 150 grams for 10 percent of vegetations samples. This will allow the preparation of QA/QC samples at the primary laboratory (CAS). CAS will ship QA samples to NCA for analysis.

### 2.2.3 Field Documentation

Field observations, field equipment calibration information, field measurements, and sample documentation, including sample identification, sample duplicates, and date and time the sample was collected, will be the responsibility of the entire sampling team. Field forms will be maintained for each task. Field forms will consist of waterproof bound pages with every appropriate area marked in waterproof ink. Blank pages will be marked as such with a diagonal line across the page, when appropriate.

Proper documentation for sample custody includes keeping records of all materials and procedures involved in sampling. Project field forms will be used to record field data. All information on the sampling station and respective samples and blanks collected at each site, including the positions of the station, will be recorded by the field crew. The field crew leader will review all data before leaving the sampling station. Completed field forms will be kept on file for future reference.

### 2.2.4 Corrections to Field Documentation

Unless weather conditions prevent it, all original data will be recorded with waterproof ink. No accountable documents will be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. If an error is made on an accountable document assigned to one person, that person must make corrections by drawing a line through the error, initialing and dating the lined-out item, and entering the correct information. The erroneous information is not to be

obliterated, but must remain legible. Any subsequent error discovered on an accountable document will be corrected by the person who made the entry. All such subsequent corrections will be initialed and dated.

## 2.3 Sample Handling and Custody

Sample handling and custody procedures are required in the field and the laboratory, and during transport. The procedures take into account the nature of the samples, the maximum holding times, and shipping options from Iliamna to the laboratories.

### 2.3.1 Labeling

Each sample container will have a waterproof label large enough to contain the information needed to easily identify each sample. The information to be included on each label will include the project name, date, time, preservative (if added), sample code, analysis, and sampler's initials. Sample code will be formatted to indicate sample date (month and year), location, matrix, and number.

Each sampling location will be identified by the sampler on the field form. An example of sample identification is as follows:

0105CR199ASW001

Where:

0105 is the date as month/year
CR199A is the location ID
SW is the matrix code for surface water
001 is a sequential sample number

For field duplicates, the sequential sample number is 201, and for triplicates, 301. The suffix 401 is used for field equipment rinse blanks. The suffix 501 is used for DI water blanks. The suffix 601 is used for trip blanks.

For trip blanks, laboratory codes are used for the location ID. Laboratory codes are SGS, CASK, and NCAP for SGS Environmental Services, Inc., Columbia Analytical Services, Inc., and North Creek Analytical Services, Inc., respectively. The date code is month and year only. A sample surface water trip blank ID for SGS may be 0105SGSTBSW601 for the first trip blank in January 2005. If more than one trip blank is used on the same date for the same matrix increase the sequential ID to 602.

Additional matrix codes are:

- MS – marine surface water
- MB – marine bottom water
- MZ – marine sediment
- SD – sediment
- SL – soil
- SP – seeps
- SW – surface water
- GW – ground water
- TF – fish tissue
- TP – plant tissue

For large fish with analyses conducted on both muscle and liver tissue, the sample ID will include a suffix of "M" for muscle or "L" for liver tissue. For example, fish liver tissue from location CR199A collected on August 20, 2004, would have the following sample ID 0804CR199ATF001L.

For vegetation samples, a two-letter code for each species will be used as the suffix in the sample ID. For example, 081604TE12TP001-Pm is a sample of *picea mariana* (black spruce) collected at location TE12 on Aug 16, 2004. Berry only samples are designated with a "B" at the end of the acronym. Refer to Table 2-4 for species names and codes.

**These samples IDs are defined to facilitate data management for the life of this project.**

**Table 2-4**
**Summary of Vegetation Species Names**

| Species Name | Common Name |
|---|---|
| *Trees* | |
| *Picea mariana* (Pm) | Black spruce |
| *Picea glauca* (Pg) | White spruce |
| *Tsuga mertensiana* (Tm) | Mountain hemlock |
| *Populus tremuloides* (Pt) | Quaking aspen |
| *Betula papyrifera* (Bp) | Paper birch |
| *Populus balsamifera* (Pb) | Balsam poplar |
| *Shrubs* | |
| *Juniperus communis* (Jc) | Common juniper |
| *Alnus crispa* (Ac) | Mountain alder |
| *Rosa acicularis* (Ra) | Prickly rose |
| *Potentilla fruticosa* (Pf) | Tundra rose |
| *Ribes laxiflorum* (Rl) | Trailing black currant |
| *Ribes triste* (Rt) | Northern red currant |
| *Ribes glandulosum* or *hudsonianum* (Rg or Rh) | Skunk or northern black currant |
| *Vaccinium uliginosum* (Vu) | Bog blueberry |
| *Vaccinium ovalifolium* (Vo) | Early blueberry |
| *Salix alaxensis* (Sa) | Feltleaf willow |
| *Salix brachycarpa* (Sb) | Barren-ground willow |
| *Betula glandulosa* or *nana* (Bg or Bn) | Shrub or dwarf birch |
| *Ledum palustre* (Lp) | Narrow-leaf Labrador tea |
| *Myrica gale* (Mg) | Sweet gale |
| *Empetrum nigrum* (En) | Crowberry |
| *Vaccinium vitis-idaea* (Vv) | Lingonberry (low bush cranberry) |
| *Grasses* | |
| *Eriophorim scheuchzeri* (Es) | Alaska cotton or cotton grass |
| *Calamagrostis* sp.(Cs) | Blue joint grass |
| *Forbs* | |
| *Artemisia tilesii* (At) | Worm wood |
| *Epilobium angustifolium* (Ea) | Fireweed |
| *Rubus chamaemorus* (Rc) | Cloudberry |
| *Iris setosa* (Is) | Iris |
| *Heracleum lanatum* (Hl) | Cow parsnip (wild celery, putchkie) |

**Table 2-4**
**Summary of Vegetation Species Names**

| Species Name | Common Name |
|---|---|
| *Rumex arcticus* (Rar) | Sour dock |
| *Polygonum alaskanum* (Pa) | Wild rhubarb |
| *Veratrum viride* (Vvi) | False hellebore |
| *Hedysarum alpinum* (Ha) | Wild potato |
| *Hedysarum mackenzii* (Hm) | Wild sweet pea |
| *Potentilla palustris* (Pp) | Marsh five finger |
| *Polemonium pulcherrimum* (Ppu) | Beautiful Jacobs ladder |
| *Epilobium adenocaulon* (Ead) | Evening primrose sp. |
| *Aconitum delphinifolium* (Ad) | Monkshood |
| *Equisetum pratense* (Ep) | Horse tail |
| *Ferns And Fern Allies* | |
| *Dryopteris dilatata* (Dd) | Spreading wood fern |
| *Mosses* | |
| *Hylocomium splendens* (Hs) | Stair-step moss |
| *Lichens* | |
| *Cladina rangiferina* (Cr) | Reindeer lichen or caribou moss |

### 2.3.2 Packaging

Each analytical sample bottle will be packed to prevent breakage and placed in an iced cooler to keep the samples cooled to 4° Centigrade (C). One copy of the chain-of-custody form will be placed in a sealed plastic bag and then will be placed inside of the cooler. In addition, the cooler lid will be sealed with tape and chain-of-custody seals will be attached to the outside of the cooler so that the seals must be broken if the cooler is opened.

To preserve the integrity of water, soil, and sediment samples from collection to receipt by laboratories, all shipments will adhere to the following requirements at a minimum:

1. Coolers will be packaged with 25 percent frozen blue ice and 75 percent samples. For water samples, avoid packing too much blue ice around any one sample to avoid freezing samples.
2. For fish tissue samples, ensure that the tissues are completely frozen before they are placed into the iced cooler for shipment. Be sure that all samples are segregated from other freezer contents by being placed in an appropriate larger sealed container (including custody tape).
3. ALL samples in ALL coolers are to be shipped using Alaska Airlines GoldStreak (or other airport-to-airport equivalent). For samples sent to Columbia Analytical Services, Inc. in Kelso, Washington, write on airbill "by way of Portland." CAS has daily courier service from Portland to their lab in Kelso. Samples may be shipped to Seattle without this instruction.
4. Each cooler will include a completed chain-of-custody (COC) form for the samples contained in the cooler with all required analyses clearly specified.
5. Each cooler will include a bottle of water labeled Temperature Blank. The laboratory will measure and record the temperature from this bottle and the air temperature in the cooler.

### 2.3.3 Chain-of-Custody Form

COC forms will be used for all samples. Once collected, the samples will remain within sight of the sampler or will be secured until the samples are prepared for shipment. Each time the cooler changes hands, both the sender and the receiver will sign and date the COC form. The laboratory will forward the original to the Analytical QA/QC Manager. The field sampling team(s) will verify all COC forms before sample shipment and will make a copy of each to maintain a duplicate set of records. The following information is to be included on the COC form:

- Sample identification code.
- Signature of sampler.
- Date and time of collection.
- Project name.
- Type of sample.
- Number and type of containers.
- Sample preservation.
- Sample analysis requested.
- Inclusive dates of possession.
- Signature of receiver.

The consulting company's name, address, and phone number are required on the COC form. Instruct laboratories to invoice Northern Dynasty Mines Inc. and to mail reports to:

> Jane Whitsett
> Shaw Environmental, Inc.
> 2000 West International Airport Road, Suite A-11
> Anchorage, AK 99502

Other COC components will include sample labels, field notebooks, sample shipment receipts, and the laboratory logbook. The lab-specific analytical parameters are presented in Tables 1-10 through 1- 15.

## 2.4 Laboratory Procedures and Analytical Methods

Laboratories will employ the following general procedures, especially when conducting low-level detection analyses.

The laboratory should use ultra-clean reagent, specially-cleaned glassware, and other precautions such as the use of laminar flow hoods for sample digestion and preparation. Soil, sediment, vegetation, and fish tissues will be reported on a dry-weight basis.

Analytical methods selected for the Pebble Project EBS are presented in Table 2-5 below. The instrument method is given for each parameter. The procedures are routine for the laboratories selected for this project and adhere to EPA methods for the analysis of water and solid samples. CAS and NCA will be conducting metals analysis on fish tissues and vegetation. These laboratories have established procedures for these matrices.

See Tables 1-11 through 1-16 for preparation methods. For metals in marine water, samples are prepared using reductive precipitation. This procedure incorporates a chemical separation to remove interfering

matrix components so final analysis can be performed using inductively coupled plasma-mass spectroscopy (ICP-MS). The separation uses reduction of certain target analytes to the elemental state and precipitation of others as the boride depending on reduction potentials and/or boride solubility. The precipitation is facilitated using elemental palladium and iron boride as carriers. Once separated from the seawater matrix via centrifugation, the precipitate is redissolved and analyzed using ICP-MS. Typically, this procedure is performed with the intention of including arsenic and chromium in the analyses. When these elements are not of concern, some improvement of sensitivity can be achieved by altering the dissolution acid used in the procedure.

**Table 2-5**
**Pebble Project EBS Parameters, Methods, and Techniques/Instrumentation**

| Parameter | Method (Water) | Method (Solids) | Technique/Instrumentation |
|---|---|---|---|
| *Inorganics* | | | |
| pH | E150.1 | N/A | Electrode |
| Specific Conductance | SM 2510B | N/A | Resistor network |
| Acidity | E305.2 | N/A | Titration |
| Alkalinity | SM2320B | MA | Titration |
| Ammonia as N | SM4500NH3 | SM4500NH3 | Ion selective electrode |
| Chloride | E300.0 | N/A | Ion chromatography/ion selective electrode |
| Cyanide, total | SM4500CN-E | SM4500CN -E | Spectroscopy (colorimetric) |
| Cyanide, WAD | SM4500CN-I | N/A | Spectroscopy (colorimetric) |
| Fluoride | E300.0 | N/A | Ion chromatography/ion selective electrode |
| Hardness | SM2340B | N/A | Calculation |
| Nitrate + Nitrite | E300.0 | N/A | Ion chromatography |
| Nitrate + Nitrite | E353.2 | N/A | Spectrophotometer |
| Phosphorus, total | E365.3 | N/A | Spectroscopy (colorimetric, photometric) |
| Sulfate | E300.0 | N/A | Ion chromatography |
| Thiocyanate | Lab SOP | N/A | Spectroscopy (colorimetric) |
| Total dissolved solids | E160.1, SM2540C | N/A | Gravimetric |
| Total suspended solids | E160.2 | N/A | Gravimetric |
| *Metals* | | | |
| Low level mercury | E1631 | E1631 | Cold vapor atomic fluorescence spectrophotometer |
| Mercury | E245.1 | SW7471A | Cold vapor atomic absorption |
| Metals 1 | E200.7/200.8 | E200.8<br>SW6010B/6020<br>SW7740 (Se)<br>SW7471 (Hg) | Inductively coupled plasma atomic emission spectroscopy<br>Inductively coupled plasma mass spectrometry<br>Graphite furnace atomic absorption |
| *Organics* | | | |
| Methyl mercury | N/A | E1630M | GC/cold vapor atomic fluorescence spectrophotometer |
| Fraction Organic Carbon | N/A | ASTM D4129-82M | Combustion or oxidation |
| BTEX | SW8260B | SW8260B | Gas chromatography/mass spectrometry |
| GRO/DRO/RRO | AK101/102/103 | AK101/102/103 | Gas chromatography with flame ionization detector |
| Pesticides/PCBs | E508.1 | SW8081/8082 | Gas chromatography with electron capture detection |
| VOCS | SW8260B | N/A | Gas chromatography/mass spectrometry |
| SVOCs | SW8270C | N/A | Gas chromatography/mass spectrometry |

1 — Al, Sb, As, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Si (dissolved only), Ag, Na, Tl, Sn, V, Zn. Water samples are analyzed for total and dissolved metals.

## 2.5 Quality Control

The QAPP program consists of three components:

- Field QA identifies the procedures to be used in the field to verify that samples and field monitoring data are collected according to the requirements of the project. The objective of field QA is to produce data, both field measurements and samples collected for laboratory analyses, that can be demonstrated to be representative of the environment sampled and are of known and acceptable quality. The QA/QC Manager is responsible for reviewing at least 10 percent of the field data, and data review records will be kept in a log by the Project QA/QC Manager.
- Laboratory QA identifies the protocols to be used by the laboratories, demonstrating to NDM that project data are analyzed according to EPA-accepted methods and that reported values are accurate. The objective of the laboratory QA/QC program is to produce data that will meet state and federal analytical requirements.
- Data QA identifies the protocols to be used to verify that laboratory and field data have been reported accurately. The objective of the data QA/QC program is to demonstrate that the data reported meet the project-specified requirements.

### 2.5.1 Data Uses and Data Quality Objectives

Quality assurance requirements are established in this QAPP to achieve the project objectives for the data uses. Applicable quality control procedures, quantitative target limits, and level of effort for assessing the data quality are dictated by the intended use of the data and the nature of the required field and analytical methods. The project objectives are to collect data of known and sufficient quality for NDM to comply with the requirements of state and federal environmental regulations.

Federal and state levels of concern (e.g., ambient water quality criteria or maximum contaminant levels) exist for many of the parameters being analyzed in the baseline studies program. Analytical methods have been specified that will allow detection of chemical constituents at or below levels of concern.

### 2.5.2 Data Quality Assurance/Quality Control Program

The proposed data QA/QC program serves four major functions:

- Maintenance of a duplicate record of all field data.
- Sample tracking through laboratory analysis.
- Data validation.
- Oversight of data management.

The second major component of the proposed data QA program is sample tracking throughout the laboratory analytical process. The QA/QC Manager will maintain close communications with all analytical laboratories to verify sample receipt, proper sample management, and strict adherence to sample holding times. The laboratories will immediately inform the QA/QC Manager of sample breakage, inadequate sample media to meet QA objectives, and other sample problems. The QA/QC Manager will then notify the respective field team so that corrective action can be implemented as deemed necessary.

Following receipt of the analytical data package, the QA/QC Manager will verify that all sample-parameter data have been received, will compare them to detection limits, and will compare preliminary results with previous results. Should major discrepancies be found, the QA/QC Manager will communicate these, where appropriate, to the respective field team. Possible corrective measures will then be evaluated as deemed necessary.

### 2.5.3 Laboratory Quality Assurance/Quality Control Program

Specific protocols to ensure laboratory data of known and consistent quality can be found in the SGS, CAS, and NCA quality assurance manuals, which are on file in the Shaw Anchorage office. The QA/QC Manager and laboratory Project Chemists will oversee implementation of these protocols. Project-specific criteria are provided in Tables 1-11 through 1-16.

Data validation will be conducted by Shaw. Any discrepancies will be noted and discussed with:

- Mr. Crupi, Laboratory Project Chemist for this project with SGS, or
- Ms. Jones, Laboratory Project Chemist for this project with NCA, or
- Ms. Huckestein, Laboratory Project Chemist for this project with CAS.

## 2.6 Instrument/Equipment Testing, Inspection, and Maintenance

The Laboratory Project Chemists are responsible for all laboratory equipment maintenance decisions. In the event of equipment failure that will impact the analytical schedule, the laboratory Operations Manager will notify the QA/QC Manager. Field Team Managers are responsible for field equipment maintenance decisions.

## 2.7 Inspection/Acceptance of Supplies and Consumables

All supplies and consumables (Sample Reference Materials [SRMs] and reagents) will be inspected and checked in by the Laboratory Project Chemist or the Quality Assurance Officer.

## 2.8 Data Management

### 2.8.1 Field Forms

All pertinent field survey and sampling information will be recorded on field forms during each day of the field effort and at each sample site. The field crew leader will be responsible for seeing that sufficient detail is recorded on the forms. No general rules can specify the extent of information that must be entered on the forms; however, they will contain sufficient information so that all field activity can be reconstructed without relying on the memory of the field crew. All entries will be made in indelible ink. All corrections will consist of initialed, single-line-out deletions.

Strict custody procedures will be maintained with the field forms used. While being used in the field, forms will remain with the field team and will be secured on a clip board or, at a minimum, with rubber bands AT ALL TIMES. Upon completion of the field effort, forms will be filed in an appropriately secure manner in a bound notebook labeled “original data.” These forms will remain with the task manager. Photocopies of the original data will be used as working documents.

Laboratory data results are received by electronic mail by the Analytical QA/QC Manager. The laboratories also send paper copies of analysis results to the Analytical QA/QC Manager. Laboratory data are validated by Shaw then uploaded to the NDM chemistry database

.

# 3 Assessment and Oversight

## 3.1 Assessments and Response Actions

Field assessments will be discussed between the Analytical QA/QC Manager and the Field Team Manager. Any response actions will then be undertaken by the Analytical QA/QC Manager during regular field sampling/monitoring events. Internal assessment for the laboratory will be performed according to laboratory's quality management plans (QMPs), which are kept on file in the Shaw Anchorage office.

## 3.2 Reports to Management

Following receipt of the analytical data package by Shaw, the Analytical QA/QC Manager at Shaw will review the data with regard to the following:

- Analytical methodology.
- Detection limits.
- Accuracy, precision, and adherence to holding times.

These QA/QC checks of data will be kept on file at Shaw by the Analytical QA/QC Manager and included in data quality assessment reports of the data. Where data do not meet the requirements specified in this QA/QC program, the data will be flagged with qualifiers. Should major discrepancies be found, the Analytical QA/QC Manager will communicate these to NDM's Environmental Project Manager, Ella Ede. Possible corrective measures will then be evaluated as deemed necessary. These data reviews will be summarized and included in the DQAR reports by Shaw to NDM.

Laboratory reports will include the elements presented in Section 1.8.2 of this QAPP.

# 4 Data Review, Validation, and Usability

Data review and validation will be conducted on all data collected for the Pebble Project environmental baseline studies.

## 4.1 Data Review

Data generated for this project will be reviewed by both the laboratory and by Shaw. The laboratory has primary responsibility for correctly identifying and quantifying analytes and compounds of interest, for identifying matrix interferences, and for identifying and, if possible, correcting instrument anomalies. The laboratory is also responsible for the technical quality of the data and for meeting all quality control parameters by correctly following the analytical methods using instrumentation that is in proper working order for the given method.

The review process will be coordinated initially by the bench-level scientists who will review all data for accuracy and completeness. The bench-level scientist will also compare all QC sample results with control criteria outlined in Tables 1-11 through 1-16 and will initiate appropriate corrective action if criteria are not met.

Prior to summary reports, the data will be reviewed by the Laboratory QA/QC Manager to ensure that the data are representative, complete, and accurate.

## 4.2 Validation and Verification Methods

Data validation is the review process to screen data for anomalies and possible errors. Data accepted from the laboratory will be verified and validated by Shaw. The data validation process will include review of the following:

- Analytical methodology
- Detection limits
- Cross-contamination as indicated by blank data
- Laboratory accuracy and precision
- Adherence to holding times
- Sample preservation
- Initial and continuing calibration
- Field precision (QA/QC samples)
- Total metals vs. dissolved metals

Data will be validated in accordance with the following procedures:

- *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (USEAP, 1999).
- *Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review* (USEPA, 2001).
- *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (USEPA, 2002)

Field precision will be evaluated using criteria presented in Table 4-1. Two sets of data are compared to each other for precision: the primary vs. duplicate sample sets and the primary vs. triplicate sample sets. For samples that are in the Disagreement or Major Disagreement columns, the duplicate or triplicate sample data and the associated laboratory data will be evaluated for any biases that may explain the disagreements. In some cases, associated samples may be qualified as estimates (J) or rejected (R) based on professional judgment.

**Table 4-1**
**Criteria for Comparing Field QC and QA Sample Data**

| Matrix | Parameter | Disagreement | Major Disagreement |
|---|---|---|---|
| All | All | >5x difference when one results is < MDL | >10x difference when one results is < MDL |
| All | All | >3x difference when one result is < MRL | >5x difference when one result is < MRL |
| Water | All except TPH | > 2x difference | > 3x difference |
| Soil, Sediment and Tissues | All except metals, VOCs, BTEX and TPH | > 4x difference | > 5x difference |
| Soil, Sediment, and Tissues | Metals | > 2x difference | > 3x difference |
| Water, Soil, and Sediment | TPH | Arbitrary (suggest >3x difference) | Arbitrary (suggest >3x difference) |
| Soil, Sediment, and Tissues | VOCs and BTEX | Arbitrary (suggest >3x difference) | Arbitrary (suggest >3x difference) |

Reference: Grant et al., 1996

Evaluation of total and dissolved metals will involve comparison of results for instances where dissolved is greater than total. Sample results are acceptable if the following criteria are met.

1. Where both results are greater than 5 times the MRL, and the RPD between results is less than or equal to 20 percent.
2. Where the total metals result is less than or equal to 5 times the MRL, and the absolute value of the difference between the results is less than or equal to the MRL. If the total metals result is not detected at the MDL, then the value of the MDL will be used for the comparison.
3. Where both total and dissolved results are below the MRL.

For an individual sample where criteria are not met for up to 30 percent of the parameters, then the associated QC data (including method blanks and field blanks) will be evaluated for bias. Consequently, results may be qualified with a J as an estimate. If more than 30 percent of the parameters exceed the criteria, then both total and dissolved samples will be reanalyzed. If reanalysis does not eliminate the problem, then results will qualified with a J as an estimate (Zeiner, 1994).

Aqueous samples are evaluated for ion balance by the laboratories. This is a QC check on results to identify any data that may be suspect. If ion balance criteria are not met the relevant data are evaluated to identify the cause for the poor balance.

Where data do not meet the requirements specified in this QAPP program, the data will be flagged with qualifiers. These reviews of data will be summarized and included in the QA report.

The following are validation flags that will be inserted into electronic format for upload into the NDM database:

R The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.

UJ The analyte was analyzed, but was not detected above the level of the reported sample quantitation limit. The MRL is an estimate.

J The result is an estimated quantity.

J+ The result is an estimated quantity, but the result may be biased high.

J- The result is an estimated quantity, but the result may be biased low.

BQ The result is associated with inorganic method-blank contamination at a level less than or equal to five times the concentration in the blank for contaminants below the MRL (ten times for contaminants above the MRL). Result should be considered not detected at the concentration of the MRL for those results reported below the MRL or as biased high for those reported above the MRL.

BQ1 The result is associated with inorganic field-blank (equipment blank, DI water blank, or trip blank) contamination at a level less than or equal to five times the concentration in the blank for contaminants below the MRL (ten times for contaminants above the MRL). Result should be considered not detected at the concentration of the MRL for those results reported below the MRL or as biased high for those reported above the MRL.

BQ2 The result is associated with organic method-blank contamination at a level less than or equal to five times the concentration in the blank (ten times for common laboratory contaminants). Result should be considered not detected at the concentration of the MRL or sample result, whichever is greater.

BQ3 The result is associated with organic field-blank (equipment blank, DI water blank or trip blank) contamination at a level less than or equal to five times the concentration in the blank (ten times for common laboratory contaminants). Result should be considered not detected at the concentration of the MRL or sample result, whichever is greater.

## 4.3 Reconciliation with User Requirements

A periodic review of the objectives of this project will be accomplished on a yearly basis to determine if user requirements have changed.

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# DRAFT ENVIRONMENTAL BASELINE STUDIES
# 2006
# QUALITY ASSURANCE PROJECT PLAN

# PEBBLE PROJECT

## ENVIRONMENTAL BASELINE STUDIES
## 2006
## QUALITY ASSURANCE PROJECT PLAN

Prepared For:

**State of Alaska Large Mine Permitting Team**
**Department of Natural Resources**

Prepared By:

Pebble Project
NORTHERN DYNASTY MINES INC.

3201 C Street, Suite 604
Anchorage, AK 99503
(907) 339-2600

July 12, 2006

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## Acronyms and Abbreviations

| | |
|---|---|
| 3PP | Three Parameters Plus, Inc. |
| ADEC | Alaska Department of Environmental Conservation |
| ADNR | Alaska Department of Natural Resources |
| AVC | Acid Volatile Sulfides |
| BEESC | Bristol Environmental & Engineering Services Corporation |
| C | Centigrade |
| CAS | Columbia Analytical Services, Inc. |
| COC | chain-of-custody |
| DQAR | data quality assurance report |
| DRO | diesel range organics |
| DQOs | data quality objectives |
| EPA | United States Environmental Protection Agency |
| EBS | environmental baseline studies |
| FSP | field sampling plan |
| g | gram |
| HDR | HDR Alaska, Inc. |
| ICP-MS | inductively coupled plasma-mass spectroscopy |
| LCS | laboratory control sample |
| L | liters |
| LOD | limit of detection |
| MDL | method detection limit |
| mg/kg | milligrams per kilogram |
| mg/L | milligrams per liter |
| ml | milliliters |
| MRLs | method reporting limits |
| MS | matrix spikes |
| MSD | matrix spike duplicate |
| N/A | not applicable |
| NCA | North Creek Analytical, Inc. |
| NDM | Northern Dynasty Mines Inc. |
| NEPA | National Environmental Policy Act |
| NIST | National Institute for Standards and Technology |
| NDPES | National Pollutant Discharge Elimination System |
| NOAA | National Oceanic and Atmospheric Administration |
| oz | ounce |
| PARCC | precision, accuracy, representativeness, comparability, and completeness |
| PE | performance evaluation |
| Pebble Project | Pebble Project |
| PEL | probably effects level |
| PSEP | Puget Sound Estuary Program |
| QA | quality assurance |
| QAPP | quality assurance project plan |
| QC | quality control |

## *Acronyms and Abbreviations (continued)*

| | |
|---|---|
| QMP | quality management plan |
| RPD | relative percent difference |
| RRO | residual range organics |
| RSD | relative standard deviation |
| SGS | SGS Environmental Services, Inc. |
| SEM | Simultaneously Extractable Metals |
| Shaw | Shaw Alaska, Inc. |
| SLR | SLR Alaska, Inc. |
| SRMs | sample reference materials |
| SOP | standard operating procedure |
| SQRT | Screening Quick Reference Tables |
| STL | Severn-Trent Laboratories, Inc. |
| SVOC | semivolatile organic compound |
| tbd | to be determined |
| TEL | threshold effects level |
| TKN | total kjeldahl nitrogen |
| TOC | total organic carbon |
| TSS | total suspended solids |
| TDS | total dissolved solids |
| µg/L | micrograms per liter |
| µmhos/cm | micromhos per centimeter |
| USACE | United States Army Corp of Engineers |
| WG | groundwater |
| WS | Surface water |

# 1.0 Program Summary

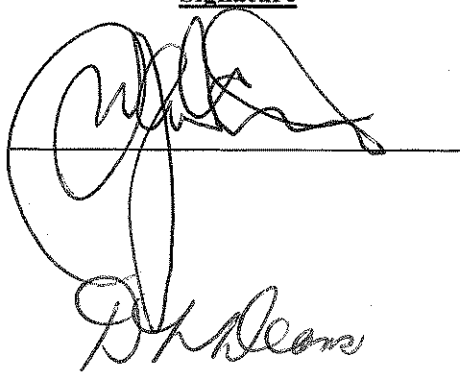
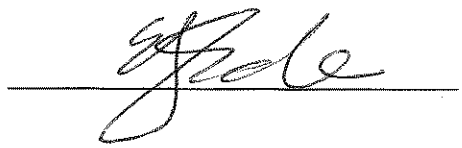
## 1.1 Title and Approval Sheets

**Program Title**

Pebble Project, Environmental Baseline Studies

**Organization**

Northern Dynasty Mines Inc. (NDM)

| NDM Personnel | Signature | Date |
|---|---|---|
| Bruce Jenkins<br>Chief Operating Officer/Environmental Study Director<br>**NDM**<br>E-mail: brucej@hdgold.com<br>Phone: 604-684-6365 |  | July 18/06 |
| Dennis Deans<br>Asst. Environmental Study Director<br>**NDM**<br>E-mail: dennisd@hdgold.com<br>Phone: 604-684-6365 |  | 18/07/06 |
| Ella Ede<br>Environmental Project Manager<br>**NDM**<br>E-mail: ellae@northerndynasty.com<br>Phone: 907-339-2600 |  | 7/18/06 |
| Michael Smith<br>NEPA and Permitting Manager<br>**NDM**<br>E-mail: michaels@northerndynasty.com<br>Phone: 907-339-2606 |  | 7/18/06 |

| NDM Personnel | Signature | Date |
|---|---|---|
| Jane Whitsett<br>Analytical QA/QC Manager<br>**Shaw Alaska, Inc.**<br>E-mail: jane.whitsett@shawgrp.com<br>Phone: 907-249-6333 | Jane Whitsett | 7/18/06 |

| Agency Personnel | Signature | Date |
|---|---|---|
| Pebble Project Manager to be determined (tbd)<br>**Alaska Department of Environmental Conservation (ADEC)**<br>E-mail: tbd<br>Phone: tbd | | |
| James Gendron<br>Quality Assurance Officer<br>**ADEC**<br>E-mail: james_gendron@dec.stltg.ak.us<br>Phone: 907-465-5305 | | |

## 1.2 Distribution List

- ADEC
- ADNR
- EPA
- NDM
- Shaw Alaska, Inc.
- Bristol Environmental & Engineering Services Corporation
- HDR Alaska, Inc.
- SLR Alaska, Inc.
- 3PP, Inc.

- SGS Environmental Services, Inc.
- Columbia Analytical Services, Inc.
- Test America, Inc.
- Severn Trent Laboratories, Inc.

## 1.3 Project Organization

The Environmental Baseline Studies (EBS) for the Pebble Project are managed by Northern Dynasty Mines Inc. (NDM). NDM has commissioned highly experienced technical advisors for the environmental baseline studies. Those advisors include SLR Alaska Inc. (SLR), Bristol Environmental & Engineering Services Corporation (BEESC), HDR Alaska, Inc. (HDR), Three Parameters Plus, Inc. (3PP), and Shaw Alaska, Inc. (Shaw). The project team will collect surface water, ground water, sediment, vegetation, and fish tissues from the mine area. Water, sediment and bivalve tissue samples will be collected from Lake Iliamna. Soil, surface water, vegetation, and sediment will be collected from the Transportation corridor.

The *Pebble Project, Environmental Baseline Studies, 2006 Quality Assurance Project Plan* (QAPP) provides the analytical quality assurance (QA)/quality control (QC) requirements for 2006. The QAPP is applicable to the QA/QC aspects of field sampling and laboratory chemical analysis. The *Pebble Project, Environmental Baseline Studies, Proposed 2005 Study Plan* and Addenda (NDM, 2005 and 2006) provides a comprehensive description of the environmental baseline studies for agency and stakeholder review. Field sampling plans (FSPs) address the specifics of field sampling for each media undergoing chemical analysis. The program is divided into two study disciplines, as follows.

| Discipline | Media | Study Manager |
|---|---|---|
| **Water Quality Studies** | Surface water and ground water (fresh water only) | Dennis Deans, NDM |
| **Trace Elements Studies** | Sediment, vegetation, bivalve and fish tissues (fresh water only) | Loretta Ford, NDM |

The Pebble Project EBS includes collection of QA/QC samples at a frequency of 10 percent for all media. Primary and QC samples (field duplicate) are analyzed by the primary laboratories. QA samples (field triplicate) are analyzed by the QA laboratories. The QA laboratory analysis provides a check on the primary laboratory's accuracy and precision throughout the project. Primary and QA laboratories and the media they are responsible for are identified in Table 1-1. Table 1-2 summarizes contact information for the Pebble Project laboratories. Field teams are responsible for collection of QA/QC samples in the field. Shaw is responsible for shipment of samples to the appropriate laboratories.

**Table 1-1**
**Summary of Primary and QA Analytical Laboratories for Environmental Baseline Studies**

| Media | Primary Laboratory | QA Laboratory |
|---|---|---|
| WS and WG (all parameters except low level Hg) | SGS – Anchorage, AK | CAS – Kelso, WA |
| WS and WG (low level Hg only) | NCA – Portland, OR | CAS – Kelso, WA |
| Sediment (1) | SGS – Anchorage, AK | CAS – Kelso, WA |
| Sediment (2,3) | CAS – Kelso, WA | STL – Pittsburg, PA (2) and Austin, TX (3) |
| Fish and Bivalve tissue | CAS – Kelso, WA | STL – Seattle, WA |
| Vegetation | CAS – Kelso, WA | STL – Seattle, WA |

*WS = surface water*
*WG = groundwater*
*CAS = Columbia Analytical Services, Inc.*
*NCA = North Creek Analytical, Inc. AKA; Test America, Inc.*
*SGS = SGS Environmental Services, Inc.*
*STL = Severn Trent Laboratories*
*1 = CN, Cl, F, $SO_4$, $NH_3$, Metals, Hg*
*2 = Acid volatile sulfides – simultaneously extractable metals (Cd, Cu, Pb, Ni, Zn, Hg)*
*3 = Total sulfur*

**Table 1-2**
**Laboratory Contact Information**

| | |
|---|---|
| Steve Crupi<br>SGS Environmental Services, Inc.<br>200 W. Potter Dr.<br>Anchorage, AK 99518<br>907-562-2343 phone, 907-550-3213 direct<br>907-561-5301 fax<br>Steve_Crupi@sgs.com | Lynda Huckestein<br>Columbia Analytical Services, Inc.<br>1317 S. 13th Avenue<br>Kelso, WA 98626<br>360-501-3358 direct phone<br>360-636-1068 fax<br>lhuckestein@kelso.caslab.com |
| Joy Chang<br>Test America (formerly North Creek Analytical, Inc.)<br>9405 SW Nimbus Ave.<br>Beaverton, OR 97008<br>503-906-9234 direct phone<br>503-906-9210 fax<br>jchang@ncalabs.com | Mike Priebe (local contact)<br>Test America (formerly North Creek Analytical, Inc.)<br>2000 W. International Airport Road, Suite A10<br>Anchorage, Alaska 99502<br>907-563-9200 phone, 907-317-3412 cell<br>907-563-9210 fax<br>mpriebe@ncalabs.com |
| Terri Torres<br>Severn Trent Laboratories - Seattle<br>5755 8th Street East<br>Tacoma, WA 98424<br>253-922-2310<br>ttorres@stl-inc.com | Neal Sacher<br>Severn Trent Laboratories - Austin<br>14050 Summit Drive, Suite A100<br>Austin, TX 78728<br>512-244-0855<br>nsalcher@stl-inc.com |
| Tara Martz<br>301 Alpha Drive<br>Severn Trent Laboratories - Pittsburgh<br>RIDC Park<br>Pittsburgh, PA 15238<br>412-963-7058<br>tmartz@stl-inc.com | |

NDM has selected HDR, SLR, BEESC and 3PP for the Pebble Project mine-area and transportation corridor area studies. These teams will collect all field samples for laboratory analysis. HDR has been selected to collect surface water, sediment, bivalve and fish tissues for the mine area/Lake Iliamna studies. SLR has been selected to collect sediment, soil, vegetation, and groundwater samples from the mine area. BEESC will collect surface water, sediment, soil, and vegetation from the transportation corridor area. Surface water and groundwater samples from small pools will be collected by 3PP in the mine area. Shaw will provide analytical QA/QC management for the project. Key personnel and their roles are described below in Table 1-3 and identified in the organizational chart (Figure 1-1).

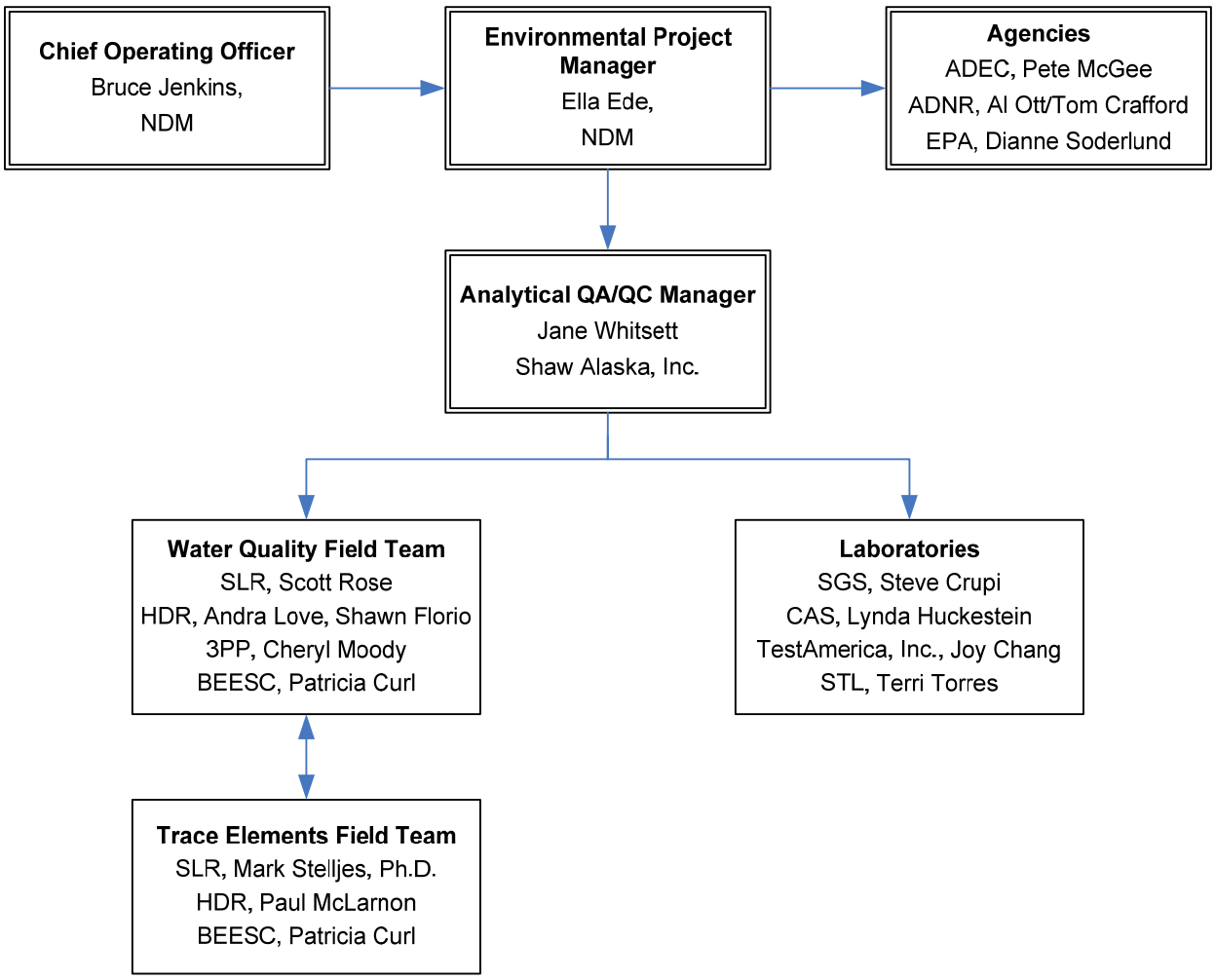
**Table 1-3**
**Summary of Pebble Project EBS Key Personnel and Roles**

| Personnel | Responsibilities |
|---|---|
| **NORTHERN DYNASTY MINES INC.** | |
| Bruce Jenkins, Chief Operating Officer | Responsible for development and execution of overall project scope and schedule. |
| Ella Ede, Environmental Project Manager | Provides oversight of project team, deliverables, and schedule. |
| Loretta Ford, Trace Elements Study Manager | Responsible for sample collection and analysis of trace elements in soil sediment, vegetation, bivalve and fish tissue. |
| Dennis Deans, Water/Aquatics Study Manager | Responsible for sample collection and analysis of surface water and groundwater samples. |
| **SHAW ALASKA, INC.** | |
| Jane Whitsett, Analytical QA/QC Manager | Responsible for preparation of QAPP and review of laboratory data and deliverables to ensure technical and quality requirements stipulated by regulatory agencies and NDM are met. |
| **FIELD TEAMS** | |
| **SLR**, Mark Stelljes, Scott Rose | General oversight of Trace Element Program (Mine Study Area and transportation corridor). Responsible for collection of groundwater, and vegetation samples for the mine area. |
| **HDR**, Andra Love | Responsible for collection of surface water and sediment for the mine area. |
| **HDR**, Paul McLarnon | Responsible for collection of fish tissues for the mine area. |
| **HDR**, Andra Love | Responsible for collection of bivalve tissues, sediment, and water samples from Lake Iliamna. |
| **BEESC,** Patricia Curl | Responsible for collection of surface water, sediment, soil, and vegetation samples from transportation corridor. |
| **3PP, Inc.,** Cheryl Moody | Responsible for small pools sampling in the mine area. |
| **LABORATORIES** | |
| **SGS Environmental Services, Inc.,** Steve Crupi, Project Chemist | Responsible for executing and reporting laboratory scope of work for primary and QC water (inorganics and organics), and sediment samples collected by field teams. |
| **Columbia Analytical Services, Inc.,** Lynda Huckestein, Project Chemist | Responsible for executing and reporting laboratory scope of work for primary (fish and vegetation tissues) and QA water and sediment samples collected by field teams. |
| **TestAmerica, Inc.** Joy Chang, Project Chemist | Responsible for executing and reporting laboratory scope of work for primary water (low level Hg). |
| **Severn Trent Laboratories** Terri Torres, Project Chemist | Responsible for executing and reporting laboratory scope of work for QA sediments (AVS – SEM, sulfur), QA fish tissue, and QA vegetation samples collected by field teams. |

**Table 1-3 (continued)**
**Summary of Pebble Project EBS Key Personnel and Roles**

| Personnel | Responsibilities |
|---|---|
| **AGENCIES** | |
| **ADEC** | |
| TBD | Pebble Project Manager |
| James Gendron | Quality Assurance Officer |
| **ADNR** | |
| Al Ott | Manager, Office of Habitat Management and Permitting |
| Tom Crafford | Manager, Large Mine Permitting Team |
| **EPA** | |
| Dianne Soderlund | Project Manager |

**Figure 1-1**
**Pebble Project EBS Organization Chart**



## 1.4 Project Background and Objectives

Environmental baseline studies are being conducted to develop baseline data for comparison to future conditions (e.g., during construction, operations and closure) for the Pebble Project, as outlined in the Proposed Study Plans and Addenda (NDM, 2005 and 2006).

### 1.4.1 Background

The Pebble Project is a proposed open pit mining operation of a copper, gold, molybdenum, and silver deposit located in southwestern Alaska. NDM has commenced extensive study programs to collect the engineering, environmental, and socioeconomic data necessary for a feasibility study and the preparation of applications for state and federal permits.

NDM considers environmental stewardship one of the cornerstones to pursuing the development of the Pebble Project. This involves diligent characterization of the existing conditions related to the environment of the project area and their incorporation into the project design and operation.

### 1.4.2 Objectives of the Program

NDM is in the process of evaluating the Pebble Project and is performing environmental baseline studies as part of this evaluation. The overall objective of the environmental baseline studies is to characterize the environment in the mine area that will be potentially affected by development of the Pebble Project. Data will be collected for water quality and for the characterization of surface soil, sediment, vegetation, bivalve and fish tissues. These data will be used to establish existing baseline conditions and provide data that can be used in the future in conjunction with future monitoring programs to evaluate long-term trends for National Environmental Policy Act (NEPA) activities and permitting.

Specific objectives for the water quality and trace elements for the mine and transportation corridor areas are described below.

#### 1.4.2.1 Water Quality Objectives

Water chemistry baseline studies will include collection and analysis of samples of surface water, ground water, and water from seeps and small pools. The main objectives of these studies are to:

- Collect baseline data to provide defensible documentation of the naturally occurring levels and spatial and temporal variability of trace elements in surface and ground water.
- Define the chemical characteristics of project-area ground water currently used for drinking water.
- Evaluate sources that could be used for mine make-up water.
- Provide the database for the site water chemistry and site loading models for project design and environmental impact assessment.

- Characterization of two proposed pool types: perched precipitation pools and groundwater flow through pools.
- Collect stage and hydraulic head measurements to evaluate pool hydrodynamics.
- Develop the baseline for the evaluation of potential environmental impacts during construction, operation, and closure.
- Provide data to compliment the evaluation of site geochemistry.

This information is key to understanding current conditions and trends. This will provide a baseline for the evaluation of future potential environmental impacts during operation and closure. The baseline water chemistry data are also important for determining if site-specific water chemistry standards are required for water bodies in the project area.

#### 1.4.2.2 Trace Element Objectives

Samples of surface soil, sediment, vegetation, bivalve and fish tissues (muscle) will be collected and analyzed for trace elements. The objectives of the trace elements study are as follows:

- Collect baseline data to provide defensible documentation of the natural levels of trace elements and spatial and temporal variability of anions in surface soil, sediments, and vegetation prior to mining operations.
- Evaluate naturally occurring biogenic fingerprints in surface soil associated with petroleum hydrocarbon analysis to support long-term site-monitoring objectives.
- Determination of organic content in surface soils to support long-term site-monitoring objectives.
- Collect baseline data to provide defensible documentation of the natural levels of trace elements in bivalve and fish tissue prior to mining operations.

This information is key to understanding current conditions and will provide a baseline for the evaluation of future potential environmental impacts to these media during operation and closure, and also to support long-term site-monitoring objectives.

## 1.5 Project/Task Description and Schedule

This section provides a project description, summary of all work to be performed, description of products to be produced, and the schedule for implementation.

The Pebble Project is located in southwestern Alaska, about 230 miles from Anchorage, 18 miles northwest of Iliamna, and 60 miles from tidewater at Cook Inlet. The mine area and transportation corridor area will be accessed by air from Iliamna for field tasks.

### 1.5.1 Task Descriptions

The tasks covered by this QAPP include field sampling, laboratory analysis and reporting, and data validation. Each task is discussed briefly below.

#### 1.5.1.1 Task 1 – Field Sampling

NDM's sampling approach is discussed in the *Pebble Project, Environmental Baseline Studies Proposed 2005 Study Plan* and Addenda (NDM, 2005 and 2006) and in this QAPP. Table 1-4 summarizes sample quantities planned for 2006.

#### 1.5.1.2 Task 2 – Laboratory Analysis and Reporting

Samples collected from the mine and transportation corridor areas will be analyzed for the parameters detailed in Table 1-5.

Laboratories will provide hardcopy and electronic reports to the Analytical QA/QC Manager. Reports will include data summaries, QC results, and calibration data. Shaw will validate laboratory data. The validated analytical data will then be uploaded into the NDM database for access by data users.

#### 1.5.1.3 Task 3 – Data Validation and Data Quality Assurance Reports

Laboratory data will be reviewed using EPA *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA, 1999); *EPA Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review* (EPA, 2001), and *EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2002). These guidelines will be modified as needed for the specific analytical methods being used. Data quality assurance reports (DQARs) will be prepared by the Analytical QA/QC Manager and submitted to NDM. These reports will discuss analytical QA/QC results and potential impacts to the project based on the results of data validation.

### 1.5.2 Schedule

Field sampling for 2006 will be conducted according to the schedules in Table 1-6. Laboratories have been contracted to deliver lab reports to Shaw within 30 days from sample receipt. Note that delays in this schedule may occur during peak field season. Separate Data Quality Assessment Reports (DQAR) will be prepared by Shaw for samples collected in 2006 for each media from the mine and transportation corridor areas.

## 1.6 Quality Objectives and Criteria

The principal objectives of the QA program are to maintain an acceptable level of quality for field activities, sample collection, sample handling, laboratory analysis, and data analysis and to document the quality of data at each processing level. This program clearly identifies major aspects of the project requiring specific quality control and demonstrates that quality control is a major focus for this project.

## Table 1-4
## Pebble Project EBS Sample Quantities

| Consultant | Area | Media | 2006 Sample Locations | Sampling Frequency | Primary Samples | MS/MSD Samples | 2006 QC Duplicate Samples | Total Primary Lab Samples | Total QA Lab Samples |
|---|---|---|---|---|---|---|---|---|---|
| HDR | Mine | Surface Water - Streams | 32 | 8 | 251 | 26 | 26 | 208 | 26 |
| HDR | Mine | Surface Water - Seeps | 28 | 5 | 140 | 14 | 14 | 168 | 14 |
| HDR | Mine | Surface Water - Ponds | 16 | 3 | 48 | 5 | 5 | 57 | 5 |
| HDR | Lk. Iliamna | Surface Water | 4 | 1 | 4 | 2 | 1 | 7 | 1 |
| SLR | Mine | Ground Water | 40 | 4 | 160 | 16 | 16 | 192 | 16 |
| 3PP | Mine | Surface and Ground Water - Small pools | 33 | 2 | 66 | 8 | 7 | 80 | 7 |
| **Subtotal** | | | | | | | | **712** | **69** |
| HDR | Lk. Iliamna | Sediment | 4 | 1 | 4 | 2 | 1 | 7 | 1 |
| HDR | Mine | Sediment – Streams | 8 | 1 | 8 | 2 | 1 | 11 | 1 |
| HDR | Mine | Sediment – Ponds | 12 | 1 | 12 | 2 | 2 | 14 | 2 |
| **Subtotal** | | | | | | | | **32** | **4** |
| SLR | MIne | Sediment – Pond | 27 | 1 | 27 | 4 | 3 | 34 | 3 |
| SLR | MIne | Soil | 46 | 1 | 46 | 6 | 5 | 57 | 5 |
| SLR | MIne | Aquatic Vegetation (Pond) | 68 | 3 | 68 | 8 | 7 | 83 | 7 |
| SLR | MIne | Terrestrial Vegetation[1] | 160 | 4 | 160 | 16 | 16 | 192 | 16 |
| **Subtotal** | | | | | | | | **366** | **31** |
| HDR | Mine | Fish Muscle | 2 | 1 | 50 | N/A | 5 | 55 | 5 |
| HDR | Lk. Iliamna | Bivalve Tissues (mussels) | 4 | 1 | 4 | N/A | 1 | 4 | 1 |
| **Subtotal** | | | | | | | | **59** | **6** |
| BEESC | Transportation Corridor | Surface Water | 4 | 1 | 4 | 2 | 1 | 7 | 1 |
| BEESC | Transportation Corridor | Soil | 7 | 1 | 7 | 2 | 1 | 10 | 1 |
| BEESC | Transportation Corridor | Terrestrial Vegetation | 42 | 1 | 42 | NA | 5 | 47 | 5 |
| BEESC | Transportation Corridor | Sediment | 4 | 1 | 4 | 2 | 1 | 7 | 1 |
| **Subtotal** | | | | | | | | **71** | **8** |
| **TOTAL** | | | | | | | | **1,240** | **118** |

*Key: MS = matrix spike; MSD = matrix spike duplicate; N/A = not applicable in matrix; na = not available for scheduling.*

*Note: Vegetation and fish tissue QA/QC samples are prepared by the primary laboratory (CAS). CAS will ship QA samples to the QA laboratory (TestAmerica, Inc.) for these media.*

*1 - Assumes four species per location, plus two berry samples per location.*

**Table 1-5**
**Pebble Project EBS Summary of Laboratory Analyses**

| Parameter | Method (Water) | Method (Solids) | Surface and Seep Water | Groundwater | Surface Soil | Sediment | Vegetation | Fish Tissue | Bivalve Tissue |
|---|---|---|---|---|---|---|---|---|---|
| ***Inorganics*** | | | | | | | | | |
| pH | E150.1 | | X | X | | | | | |
| Specific Conductance | SM2510B | | X | X | | | | | |
| Acidity | E305.2 | | X | X | | | | | |
| Alkalinity | SM2320B | | X | X | | | | | |
| Ammonia as N | SM4500NH3G | SM4500NHG3G | X | X | X | X | | | |
| AVS – SEM (2) | | Draft E1991/ SW6010B/SW7470A | | | | X | | | |
| Chloride | E300.0 | E300.0 | X | X | X | X | | | |
| Cyanide, total | SM4500CN-E or E335.2 | SM4500CN-E or E335.2 | X | X | X | X | X | | |
| Cyanide, WAD | SM4500-I | | X | X | | | | | |
| Cyanide, Available Low Level | E1677 | | X | X | | | | | |
| Fluoride | E300.0 | E300.0 | X | X | X | X | | | |
| Hardness | SM2304B | | X | X | | | | | |
| Nitrate + Nitrite, Nitrite, Nitrate | E353.2 | | X | X | | | | | |
| Orthophosphate | 365.2 | | X | | | | | | |
| Phosphorus, total | E365.3 | | X | X | | | | | |
| Sulfate | E300.0 | E300.0M | X | X | X | X | | | |
| Sulfur, Total | | EPA 300M | | | | X | | | |
| Thiocyanate | Lab SOP | | X | X | | | | | |

**Table 1-5 (continued)**
**Pebble Project EBS Summary of Laboratory Analyses**

| Parameter | Method (Water) | Method (Solids) | Surface and Seep Water | Groundwater | Surface Soil | Sediment | Vegetation | Fish Tissue | Bivalve Tissue |
|---|---|---|---|---|---|---|---|---|---|
| ***Inorganics*** | | | | | | | | | |
| TDS | E160.1 or SM2540C | | X | X | | | | | |
| TSS | E160.2 | | X | X | | | | | |
| ***Metals*** | | | | | | | | | |
| Low-level Mercury | E1631 | E1631 | X | X | | | | X | X |
| Mercury | | SW7471A | | | X | X | X | | |
| Metals[1] | E200.7/200.8 | SW6010B/6020 | X | X | X | X | X | X | X |
| ***Organics*** | | | | | | | | | |
| Total Organic Carbon | | ASTM D4129-82M | | | X | | | | |
| DRO/RRO | | AK102/103 | | | X | | | | |

*Notes:*

*1 - Al, Sb, As, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Si (dissolved only), Ag, Na, Tl, Sn, V, Zn.*
*Water samples are analyzed for total and dissolved metals.*
*Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Mo, Ni, Se, Ag, Tl, and Zn are planned for fish tissue.*

*2 - AVS – SEM Acid volatile sulfides – simultaneously extracted metals (Cd, Cu, Pb, Hg, Ni, Zn)*

*Key:*

*TDS = total dissolved solids.*

*SOP = standard operating procedure.*

*E = EPA (1983, 1991 and 2001).*

*M = modified.*

*SW = EPA (1993).*

*SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition. 1998.*

**Table 1-6**
**Pebble Project EBS Field Sampling Schedule for 2006**

| Consul-tant | Area | Media | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HDR | Mine | Surface Water – Streams | X | | X | X | X | X | X | X | X | X | | |
| HDR | Mine | Surface Water - Seeps | | | X | | | X | | X | | | | |
| HDR | Mine | Sediment | | | | | | | X | X | | | | |
| 3PP | Mine | Small Pools | | | | | | X | | | | X | | |
| HDR | Lake Iliamna | Water, Sediment, Mussel Tissues | | | | | | X | | | | | | |
| SLR | Mine | Groundwater | | | X | | X | | | X | | | X | |
| SLR | Mine | Vegetation, Soil, Sediment | | | | | | | X | X | | | | |
| HDR | Mine | Fish Tissues | | | | | | | | X | | | | |
| BEESC | Trans-portation Corridor | Surface Water, Sediment, Soil, Vegetation | | | | | | | | X | | | | |

QA/QC requirements are established in this QAPP to achieve the project objectives for the data users. Applicable QC procedures, quantitative target limits, and level of effort for assessing the data quality are dictated by the intended use of the data and the nature of the required field and analytical methods. The project objectives are to collect data of known and sufficient quality for NDM to rely upon as accurate and precise environmental baseline data.

Federal and state levels of concern (for example, ambient water quality criteria or maximum contaminant levels) are used as benchmark criteria in the QAPP. Analytical methods have been specified that will allow detection of chemical constituents at or below benchmark criteria wherever possible. Note that the benchmark criteria are not necessarily based on enforceable standards. A summary of field QA/QC samples is given in Table 1-7. The list of parameters and benchmark criteria for water, soil, and sediment are summarized in Tables 1-8 and 1-9, respectively. Both EPA and ADEC standards were reviewed. Benchmark criteria in water are based on the following references: Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances, May 15, 2003 (ADEC 2003); Factsheet: "Revised National Recommended Water Quality Criteria," December 2003 (USEPA 2003); and National Recommended Water quality Criteria, EPA-822-R-02-047, November 2002 (USEPA 2002a). The tables present the lowest criteria of the three standards. Parameters included in the environmental baseline study but not shown in this table do not have benchmark criteria.

**Table 1-7**
**Pebble Project EBS Summary of Field QA/QC Samples**

| Type of Field QA/QC Sample | Analysis | Frequency | Sampling Events |
|---|---|---|---|
| Field duplicate (QC sample) | All parameters | 10 percent | All |
| Field triplicate (QA sample) | All parameters | 10 percent | All |
| Deionized water blank | Total metals | 1 per sampling event | Surface water and groundwater |
| Equipment blank | Dissolved metals | 5 percent | Surface water, ground water, sediment, fish & bivalve tissues |
| Trip blank | Low-level Hg | 1 per cooler | Surface water and ground water |

**Table 1-8**
**Benchmark Criteria in Water for the Environmental Baseline Studies**

| Analyte | Lowest Surface or Drinking Water Criteria |
|---|---|
| *Inorganics in Water (milligrams per liter — mg/L)* | |
| Alkalinity | 20 |
| Ammonia as N | 0.18 |
| Chloride | 230 |
| Cyanide (Free) | 0.0052 |
| Fluoride | 1 |
| Nitrate + Nitrite | 10 |
| Nitrate | 10 |
| Nitrite | 1 |
| Sulfate | 250 |
| TDS | 500 |
| TSS | 30 |
| *Metals in Water (µg/L)* | |
| Al | 87 |
| Sb | 5.6 |
| As | 10 |
| Ba | 1,000 |
| Be | 4 |
| Cd | 0.1 |
| Cr | 24 |
| Cu | 2.7 |
| Fe | 300 |
| Pb | 0.54 |
| Mn | 50 |
| Hg | 0.05 |
| Mo | 10 |
| Ni | 16 |
| Se | 4.6 |
| Ag | 0.32 |
| Tl | 0.24 |
| V | 100 |
| Zn | 36 |

**Table 1-9**
**Benchmark Criteria in Soil and Sediment for the Environmental Baseline Studies**

| Analyte | Lowest Soil Criteria | Lowest Sediment Criteria |
|---|---|---|
| *Inorganics (mg/kg)* | | |
| Cyanide (free) | 27 | None |
| *Metals (mg/kg)* | | |
| Al | None | 18,000 |
| Sb | 3.6 | 3 |
| As | 2 | 5.9 |
| Ba | 1,100 | 48 |
| Be | 42 | None |
| Cd | 5 | 0.583 |
| Cr | $>10^6$ | 36.2 |
| Co | None | 10 |
| Cu | None | 18.7 |
| Fe | None | 40,000 |
| Pb | 400 | 30.2 |
| Mn | None | 260 |
| Hg | 1.4 | 0.13 |
| Ni | 87 | 15.9 |
| Se | 3.5 | 1.0 |
| Ag | 21 | 0.73 |
| Sn | None | 3.4 |
| V | 3,400 | 57 |
| Zn | 9,100 | 89 |
| ***Petroleum Hydocarbons (mg/kg)*** | | |
| Diesel Range Organics | 250 | None |
| Residual Range Organics | 11,000 | none |

Levels of concern in soil and sediment are based on the following references:

- Alaska Department of Environmental Conservation (ADEC) Soil Cleanup Levels, Under 40 Inch Zone, 18 AAC 75.
- National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQRT), Updated September 1999. Values in this table are the lowest among the threshold effects level (TEL), probable effects level (PEL), and upper effects level (UEL) for freshwater sediment and among TEL, effects range - low (ERL), PEL, effects range - medium (ERM).

Based on results from the 2004 environmental baseline studies conducted by NDM, total chromium was detected at 22.5 and 22.6 µg/L at groundwater locations MW2D and MW5S at the mine area. However, hexavalent chromium in water is not included as a parameter of concern for the 2006 environmental baseline studies due to the overall low values for total chromium and its short holding time of 24 hours. Data quality objectives (DQOs) for the Pebble Project EBS are listed in Tables 1-10 through 1-13.

### 1.6.1 Data Quality Parameters

The quality of laboratory data is measured by the precision, accuracy, representativeness, comparability, and completeness (PARCC) of the data. These parameters and the applicable quality control procedures and levels of effort are provided in Tables 1-10 through 1-13. A discussion of PARCC is presented following the tables.

**Table 1-10**
**Data Quality Objectives – Water (fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***Inorganics*** | | | | | |
| pH | N/A | pH units | E150.1 | N/A | N/A |
| Specific Conductance | 2 | µmhos/ cm | SM 2510B | N/A | 20 |
| Acidity | 10 | mg/L | E305.2 | N/A | 25 |
| Alkalinity | 10 | mg/L | SM2320B | N/A | 20 |
| Ammonia as N | 0.1 | mg/L | SM4500NH3-G | 75-125 | 25 |
| Chloride | 0.2 | mg/L | E300.0 | 85-115 | 20 |
| Cyanide - total | 0.01 | mg/L | SM4500CN-E | 75-125 | 20 |
| Cyanide - WAD | 0.01 | mg/L | SM4500CN-I | 75-125 | 20 |
| Low Level Cyanide - available | 0.0005 | mg/L | E1677 | 80-20 | 25 |
| Fluoride | 0.1 | mg/L | E300.0 | 85-115 | 20 |
| Hardness - total | N/A | mg/L | SM2340B | N/A | N/A |
| Nitrate + Nitrite, Nitrate, Nitrite | 0.1 | mg/L | E300.0 or E353.2 | 90-110 | 20 |
| Orthophosphate | 0.2 | mg/L | E365.2 | 75-125 | 25 |
| Phosphorus - total | 0.01 | mg/L | E365.3 | 75-125 | 25 |
| Sulfate | 0.2 | mg/L | E300.0 | 85-115 | 20 |
| Thiocyanate | 1 | mg/L | Lab SOP | 75-125 | 20 |
| TDS | 10 | mg/L | E160.1 or SM2540C | N/A | 25 |
| TSS | 5 | mg/L | E160.2 | N/A | 20 |
| ***Metals (Total and Dissolved)*** | | | | | |
| Hg (low level) (total only for surface water) | 0.005 | µg/L | E1631 | 77-123 | 20 |
| Al | 1.0 | µg/L | E200.8 | 85-115 | 20 |
| Sb | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| As | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Ba | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| Be | 0.02 | µg/L | E200.8 | 85-115 | 20 |

**Table 1–10 (continued)**
**Data Quality Objectives – Water (fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| *Metals (Total and Dissolved) (continued)* | | | | | |
| Bi | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| B | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Cd | 0.02 | µg/L | E200.8 | 85-115 | 20 |
| Ca[1] | 50 | µg/L | E200.8 | 81-124 | 20 |
| Cr | 0.2 | µg/L | E200.8 | 85-115 | 20 |
| Co | 0.02 | µg/L | E200.8 | 85-115 | 20 |
| Cu | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| Fe[1] | 20 | µg/L | E200.7 | 85-115 | 20 |
| Pb | 0.02 | µg/L | E200.8 | 85-115 | 20 |
| Mg[1] | 20 | µg/L | E200.8 | 72-131 | 20 |
| Mn | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| Mo | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| Ni | 0.2 | µg/L | E200.8 | 85-115 | 20 |
| K[1] | 50 | µg/L | E200.8 | 91-117 | 20 |
| Se | 1.0 | µg/L | E200.8 | 85-115 | 20 |
| Si (Dissolved only) | 100 | µg/L | E200.8 or E200.7 | 85-115 | 20 |
| Ag | 0.02 | µg/L | E200.8 | 85-115 | 20 |
| Na[1] | 100 | µg/L | E200.8 | 81-127 | 20 |
| Tl | 0.01 | µg/L | E200.8 | 85-115 | 20 |
| Sn | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| V | 0.2 | µg/L | E200.8 | 85-115 | 20 |
| Zn | 0.5 | µg/L | E200.8 | 85-115 | 20 |

*Notes:*

*1 - may be analyzed by ICP (200.7).*

*Key:*

*NA = not applicable*

*SOP = standard operating procedure.*

*µmhos/cm = micromhos per centimeter.*

*E = EPA (1983, 1991, and 2001).*

*SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1998.*

*SW – EPA (1993).*

**Table 1-11**
**Data Quality Objectives – Soil and Sediment (terrestrial)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***Inorganics*** | | | | | |
| Acid Volatile Sulfides (AVS) | 0.5 | mg/kg | Draft E1991 | 60-140 | 40 |
| Ammonia as N | 0.2 | mg/kg | SM4500NH3 | 75-125 | 25 |
| Cyanide (total) | 0.2 | mg/kg | SM4500CN-E | 75-125 | 20 |
| Chloride | 1 | mg/kg | E300.0 | 75-125 | 20 |
| Fluoride | 2 | mg/kg | E300.0 | 75-125 | 20 |
| Sulfate | 2 | mg/kg | E300.0 | 75-125 | 20 |
| Sulfur, total | 10 | mg/kg | E300M | 60-140 | 40 |
| ***Metals*** | | | | | |
| Al | 2.0 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Sb | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| As | 0.5 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Ba | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Be | 0.02 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Bi | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| B | 20 | mg/kg | SW3050/6010B | 80-120 | 20 |
| Cd | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Ca | 10 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Cr | 0.2 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Co | 0.02 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Cu | 0.1 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Fe | 4.0 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Pb | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Mg | 4 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Mn | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Hg | 0.02 | mg/kg | SW3050/7471A | 83-118 | 20 |
| Mo | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Ni | 0.2 | mg/kg | SW3050/6020 | 80-120 | 20 |
| K | 400 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Se | 1.0 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Ag | 0.02 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Na | 20 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Tl | 0.02 | mg/kg | SW3050/6020 | 80-120 | 20 |

**Table 1-11 (continued)**
**Data Quality Objectives – Soil and Sediment (terrestrial)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***Metals (continued)*** | | | | | |
| Sn | 1 | mg/kg | SW3050/6020 | 80-120 | 20 |
| V | 0.2 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Zn | 0.5 | mg/kg | SW3050/6020 | 80-120 | 20 |
| SEM - Cd | 0.2 | mg/kg | AVS-SEM/6010B | 60-140 | 40 |
| SEM - Cu | 0.4 | mg/kg | AVS-SEM/6010B | 60-140 | 40 |
| SEM - Pb | 3 | mg/kg | AVS-SEM/6010B | 60-140 | 40 |
| SEM - Ni | 0.5 | mg/kg | AVS-SEM/6010B | 60-140 | 40 |
| SEM - Zn | 0.4 | mg/kg | AVS-SEM/6010B | 60-140 | 40 |
| SEM - Hg | 0.01 | mg/kg | AVS-SEM/7471A | 60-140 | 40 |

*Key:*

*E = EPA (1983) adapted to soil matrices.*

*SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition. Adapted to soil matrices.*

*SW – EPA (1993).*

*AVS = Acid volatile sulfides*

*SEM = Simultaneously extractable metals (Cd, Cu, Pb, Hg, Ni, Zn)*

**Table 1-12**
**Data Quality Objectives – Vegetation**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***Inorganics*** | | | | | |
| Cyanide (total) | 0.2 | mg/kg | E335.2 | N/A | N/A |
| ***Metals*** | | | | | |
| Al | 2.0 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Sb | 0.05 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| As | 0.5 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Ba | 0.05 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Be | 0.02 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Bi | 0.05 | mg/kg | SW3050/6020 | 70-130 | 30 |
| B | 20 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Cd | 0.05 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Ca | 10 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Cr | 0.2 | mg/kg | SW3050/6010B | 75-125 | 30 |
| Co | 0.02 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Cu | 0.1 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Fe | 4.0 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Pb | 0.05 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Mg | 4 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Mn | 0.05 | mg/kg | SW3050/E200.8 | 70-130 | 30 |
| Hg | 0.02 | mg/kg | SW3050/7471A | 60-130 | 30 |
| Mo | 0.05 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Ni | 0.2 | mg/kg | SW3050/6020 | 70-130 | 30 |
| K | 400 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Se | 1.0 | mg/kg | SW3050/6020 | 60-130 | 30 |
| Ag | 0.02 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Na | 20 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Tl | 0.02 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Sn | 10 | mg/kg | SW3050/6010B | 70-130 | 30 |
| V | 0.2 | mg/kg | SW3050/6020 | 75-125 | 30 |
| Zn | 0.5 | mg/kg | SW3050/6010B | 70-130 | 30 |

*Key:*

*E = EPA (1983 and 1991) adapted to vegetation matrices.*

*SW = EPA (1993).*

**Table 1-13**
**Data Quality Objectives – Fresh Water Bivalves and Fish Tissue**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***Metals*** | | | | | |
| Sb | 0.05 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| As | 0.5 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Be | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Cd | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Cr | 0.5 | mg/kg | PSEP/6010B | 70-125 | 30 |
| Cu | 0.1 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Pb | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Hg | 0.001 | mg/kg | E1631 | 70-130 | 30 |
| Mo | 0.05 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Ni | 0.2 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Se | 1 | mg/kg | PSEP/7740A | 60-130 | 30 |
| Ag | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Tl | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Zn | 0.5 | mg/kg | PSEP/E200.8 | 70-130 | 30 |

*Key:*

*E = EPA (1983 and 2001).*

*PSEP = Puget Sound Estuary Program referencing "Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound" (1996).*

*SW = EPA (1993).*

### 1.6.2 Precision

Precision is a qualitative measure of the reproducibility of a measurement under a given set of conditions. For duplicate measurements, analytical precision can be expressed as the relative percent difference (RPD). The level of effort for laboratory precision will be at a minimum frequency of 1 in 20 (5 percent) or one per laboratory batch, whichever is more frequent. Laboratory precision is calculated from laboratory duplicates. Field precision will be at a minimum frequency of 1 in 20 field samples (10 percent).

QC and QA samples are conducted on homogenized fish and vegetation tissues rather than collected in the field. The primary laboratory (CAS) will analyze 10 percent as QC samples and ship 10 percent of fish and vegetation tissue samples to TestAmerica, Inc. as QA homogenate samples.

If calculated from duplicate measurements:

$$RPD = [(C_1 - C_2) \times 100\%] \div [(C_1 + C_2) / 2]$$

RPD = relative percent difference

$C_1$ = larger of the two observed values

$C_2$ = smaller of the two observed values

If calculated from three or more replicates, relative standard deviation (RSD) rather than RPD is used:

RSD = (s / y) x 100%

RSD = relative standard deviation

s = standard deviation

y = mean of replicate analysis

Standard deviation, S, is defined as follows:

$S = [\Sigma n( y^i-y)^2 / (n-1)]^{0.5}$

S = standard deviation

$y^i$ = measured value of the $i^{th}$ replicate

y = mean of replicate measurements

n = number of replicates

### 1.6.3 Accuracy

For samples processed by the analytical laboratory, accuracy will be evaluated with matrix spikes (MS), laboratory control samples (LCS), and performance evaluation (PE) samples to establish accuracy. MS will be analyzed at an overall frequency of 10 percent throughout the project duration.

For measurements where matrix spikes are used:

$\%R = 100\% \times (S - U / C_{SA})$

%R = percent recovery

S = measured concentration in spiked aliquot

U = measured concentration in unspiked aliquot

$C_{SA}$ = actual concentration of spike added

For situations where a PE or LCS sample is used instead of or in addition to matrix spikes:

$\%R = 100\% \times (C_m / C_{srm})$

%R = percent recovery

$C_m$ = measured concentration of PE or LCS sample

$C_{srm}$ = actual concentration of PE or LCS sample

**Table 1-14**
**Precision and Accuracy Evaluation for the Pebble Project EBS**

| Parameter Group | Type of Test (precision/accuracy) | Level of Effort |
|---|---|---|
| Inorganic Analytes | PE sample[1] | 1 for 2004–2006 program |
| | Field duplicates (QC) | 10 percent |
| | Field triplicate (QA) | 10 percent |
| | Laboratory duplicates | 5 percent or 1 per analytical batch |
| | Laboratory control sample | 1 to 2 per analytical batch of 20 samples or fewer |
| | Matrix spike (not required for all analytes) | 5 percent of total samples submitted over project duration |
| Metals | PE sample[1] | 1 for 2004–2006 program |
| | Field duplicates (QC) | 10 percent |
| | Field triplicate (QA) | 10 percent |
| | Laboratory control sample | 1 per analytical batch of 20 samples or fewer |
| | Matrix spike/matrix spike duplicate | 5 percent of total samples submitted over project duration |
| Organic Analytes | PE sample[1] | 1 for 2004–2006 program |
| | Field duplicates (QC) | 10 percent |
| | Field triplicate (QA) | 10 percent |
| | Laboratory control sample | 2 per analytical batch of 20 samples or fewer |
| | Matrix spike/matrix spike duplicate (not required for all analytes) | 5 percent of total samples submitted over project duration |

*Notes:*

*1 - Performance evaluation (PE) sample issued by the National Institute for Standards and Technology (NIST). PE samples are certified for specific chemical or physical properties and are issued with certificates that report the results of the characterization and indicate the use of the material.*

The level of effort for precision and accuracy measurements is listed in Table 1-16.

### 1.6.4 Representativeness

Representativeness is a measure of how closely the measured results reflect the actual concentration or distribution of the chemical compounds in the environment. Sampling plan design, sampling techniques, and sample handling protocols (for example, storage, preservation, and transportation) have been developed and are discussed in other sections of this document. Documentation will establish that protocols have been followed and sample identification and integrity assured. Field blanks and field duplicates will be used to assess field and transport contamination and sampling variation. Laboratory sample retrieval, storage, and handling procedures have also been developed and are discussed in other sections of this document. Laboratory method blanks will be run at the minimum frequency of 5 percent or one per analytical batch to assess laboratory contamination.

### 1.6.5 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement system. The target completeness objectives are 90 percent for each analytical parameter; the actual completeness can vary with the intrinsic nature of the samples. The completeness of the data will be assessed during the data review.

Completeness is defined as follows for all measurements:

$$\%C = 100\% \times (V / n)$$

%C = percent completeness

V = number of measurements judged valid

n = total number of measurements

### 1.6.6 Comparability

Comparability is the level of confidence with which one data set can be compared with another. This objective is met by selecting field sampling methods and laboratory analytical methods that are comparable throughout the baseline environmental studies. Changing sampling techniques or laboratory methods during the study may compromise comparability. The field sampling methods have been evaluated to ensure comparability among consultants collecting samples of the same media from the mine area and the road/port area. The laboratory methods employed by the primary and QA laboratories have been evaluated to ensure that methods used for primary, QC, and QA samples are comparable. Comparability will also be maintained by the use of consistent units.

## 1.7 Special Training and Certification

The laboratories selected for the Pebble Project EBS have obtained certifications and participate in periodic auditing programs that establish their level of performance. Table 1-17 summarizes state and federal certifications and accreditation programs that the Pebble Project laboratories participate in.

**Table 1-15**
**Laboratory Certifications and Accreditation Programs**

| Laboratory | Program |
|---|---|
| SGS Environmental Services, Inc. | Alaska Department of Environmental Conservation — Drinking Water and Contaminated Sites Lab Approval |
| | Air Force Center for Environmental Excellence. |
| | National Environmental Laboratory Accreditation Program |
| | U.S. Army Corps of Engineers |
| | U.S. Navy (NAVSEA) |
| | U.S. Department of Agriculture |
| Columbia Analytical Services, Inc. | Alaska Department of Environmental Conservation – Contaminated Sites Lab Approval |
| | Air Force Center for Environmental Excellence. |
| | National Environmental Laboratory Accreditation Program |
| | U.S. Army Corps of Engineers |
| | U.S. NAVY (NAVSEA) |
| TestAmerica, Inc. | Alaska Department of Environmental Conservation — Drinking Water and Contaminated Sites Lab Approval |
| | National Environmental Laboratory Accreditation Program for Oregon |
| | U.S. NAVY (NAVSEA) |
| | U.S Army Corps of Engineers |
| Severn Trent Laboratories | Alaska Department of Environmental Conservation – Contaminated Sites Lab Approval |
| | State of California Environmental Laboratory Accreditation Program |
| | U.S Army Corps of Engineers |
| | State of Washington Department of Energy |
| | Naval Facilities Engineering Service Center Quality Assurance Program |
| | State of Oregon Environmental Laboratory Accreditation Program |

## 1.8 Documents and Records

### 1.8.1 Quality Assurance Project Plan

The QAPP document will be controlled by the Analytical QA/QC Manager. Approved QAPPs and updated versions will be provided to the parties presented in the Distribution List (Section 1.2). Document control information (revision number and date) is shown in the bottom right corner of each page.

### 1.8.2 Laboratory Reports

The minimum information that must be included in the hardcopy data report package is as follows:

- Transmittal letter

- Case narrative to discuss at a minimum all issues that may negatively impact data quality including sample handling, preservation, holding times, sample matrix, and QC results
- Chain-of-custody documents
- Cooler receipt form documenting cooler temperatures, sample preservation, and condition upon receipt by the laboratory
- Custody seals
- Sample analytical results. Do not report results from multiple dilutions for a given parameter
- Method blank results
- Surrogate recovery results and acceptance criteria for applicable organic methods
- Dates of sample collection, receipt, preparation, and analysis for all tests
- Matrix spike result(s) with calculated recovery including associated acceptance criteria
- Duplicate or duplicate matrix spike result(s) (as appropriate to method) with calculated RPD and acceptance criteria
- LCS and/or QC check sample result(s) with calculated recovery and associated acceptance criteria
- Initial calibration results summary and continuing calibration verification-standard results with calculated recoveries and acceptance criteria
- Summary forms of associated QC and calibration parameters
- Run or sequence logs for each method

For each report or sample delivery group, laboratories will submit the United States Army Corp of Engineers (USACE) COELT EDF v 1.2a electronic deliverables.

### 1.8.3 Data Quality Assurance Reports

DQAR reports will assess the data and address corrective action related to field and laboratory activities. These reports will be prepared and controlled by the Analytical QA/QC Manager.

### 1.8.4 STORET Electronic Deliverables

All water quality data collected at the edge or outside of mixing zones that will be used to establish baseline conditions will be submitted to the ADEC permitter in the EPA water quality monitoring STORET database compatible format.

# 2.0 Data Generation and Acquisition

The generation, compilation, reporting, and archiving of data are critical components of field and laboratory operations. In order to generate data of known and acceptable quality, the QA/QC practices for data management must be complete and comprehensive and in keeping with the overall QA objectives of the project.

## 2.1 Sampling Process Design

Producing data of known quality that are considered representative of the sampling environment at an appropriate level of detail is achieved by establishing a QA program with specified data gathering protocols overseen by the Analytical QA/QC Manager. The main components of the proposed QA program include the following:

- Verification of use of proper sample containers and preservative
- Collection and analysis of blank/duplicate samples
- Specific procedures for handling, labeling, and shipping samples
- Field equipment calibration
- Equipment decontamination
- Field documentation
- Field corrective action

All field blanks/duplicates and triplicates will be noted on the chain-of-custody and field log books.

See Section 1.5 for the following information:

- Types and numbers of samples required
- Sampling frequency
- Sample matrices
- Parameters of interest

The *Pebble Project*, Draft *Environmental Baseline Studies and Monitoring, Proposed 2005 Study Plan* and Addenda (NDM, 2005 and 2006) presents the sampling locations and rationale for the design.

## 2.2 Sampling Methods

General field sampling methods are contained in the *Pebble Project*, Draft *Environmental Baseline Studies, Proposed 2005 Study Plan* and Addenda (NDM, 2005 and 2006) and in respective consultants' field sampling plans. Corrective action is the responsibility of the Analytical QA/QC Manager and Project

Managers for HDR, Pentec, and SLR. When a failure in the sampling system occurs, this management team will cooperate to investigate the failure and implement necessary corrective action(s).

For all field samples, containers will be provided by the laboratory conducting the analyses. Tables 2-1, 2-2, and 2-3 summarize the required containers, sample volumes, preservation, and maximum holding times for all parameters.

**Table 2-1**
**Sample Bottle Schedule and Sampling Parameters for Surface Water/Groundwater Collection**

| Sample Set | Bottle Type SGS | Bottle Type CAS/TestAmerica | Analysis | Lab Method | Preser-vative | Hold Time | Req. Temp. | Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | (1) 1L HDPE<br>1 extra volume for MS/MSD | (1) 1L HDPE (CAS) | Total Metals[1] | E200.8/200 .7 | $HNO_3$ | 6 months | None | Unfiltered |
| 2 | (1) 1L HDPE<br>(1) extra unpreserved container for dissolved metals collection<br>(1) 1L extra volume for MS/MSD | (1) 1L HDPE (CAS)<br>(1) extra unpreserved container for dissolved metals collection | Dissolved metals[2] | E200.8/200 .7 | $HNO_3$ | 6 months | None | Field Filtered |
| 3 | | (1) 500-ml fluoropoly (CAS)<br>(1) 250-ml fluoropoly (NCA)<br>No extra volume for MS/MSD | Low level Hg (total only) | E1631 | HCl | 90 days | None | Unfiltered |
| 4 (WG only) | | (2) 500-ml fluoropoly (CAS)<br>(2) 250-ml fluoropoly (NCA)<br>No extra volume for MS/MSD | Low level Hg (total and dissolved) | E1631 | HCl | 90 days | None | Unfiltered (total)<br>Filtered (dissolved) |
| 5 | (1) 250-ml Nalgene<br>No extra volume for MS/MSD | (1) 1L HDPE | Cyanide total | SM4500CN -E | NaOH | 14 days | 4°C | Unfiltered |
| | | | Cyanide (weak acid dissociable) | SM4500CN -I | NaOH | 14 days | 4°C | Unfiltered |
| | | | Cyanide, available (low level confirmation) | E1677 | NaOH | 14 days | 4°C | Unfiltered |
| 6 | (1) 500-ml HDPE<br>(1) 500-ml extra for MS/MSD | (1) 1L HDPE | Ammonia as N ($NH_3$) | SM4500-NH3-G | $H_2SO_4$ | 28 days | 4°C | Unfiltered |
| | | | Phosphorus total (P) | E365.3 | $H_2SO_4$ | 28 days | 4°C | Unfiltered |
| | | | Nitrate-nitrite total ($NO_3 + NO_2$) | E353.2 | $H_2SO_4$ | 28 days | 4°C | Unfiltered |

**Table 2-1 (continued)**
**Sample Bottle Schedule and Sampling Parameters for Surface Water/Groundwater Collection**

| Sample Set | Bottle Type SGS | Bottle Type CAS/TestAmerica | Analysis | Lab Method | Preser-vative | Hold Time | Req. Temp. | Comments |
|---|---|---|---|---|---|---|---|---|
| 7 | (2) 1L HDPE<br>(2) 1L extra volumes needed for MS/MSD | (1) 1L HDPE | TDS | E160.1 or SM2540C | None | 7 days | 4°C | Unfiltered |
| | | | TSS | E160.2 | None | 7 days | 4°C | Unfiltered |
| | | | Alkalinity | 2320B | None | 14 days | 4°C | Unfiltered |
| | | | Acidity | 305.2 | None | 14 days | 4°C | Unfiltered |
| | | | Specific Conductance | SM2510B | None | 28 days | 4°C | Unfiltered |
| | | | pH | E150.1 | None | 24 hours | 4°C | Unfiltered |
| 8 | 250 ml HDPE<br>No extra volume for MS/MSD | N/A | Nitrate | 353.2 | None | 48 hours | 4°C | Unfiltered |
| | | | Nitrite | 353.2 | None | 28 days | 4°C | Unfiltered |
| | | | Ortho-phosphorous | 365.2 | None | 48 hours | 4°C | Unfiltered |
| 9 | (1) 120-ml nalgene<br>(2) 120-ml nalgene extra volume for MS and lab duplicate | No separate sample needed -- analyzed from CAS sample set 7 | Chloride, fluoride, sulfate | E300.0 | None | 28 days | 4°C | Unfiltered |
| 10 | (1) 250-ml HDPE<br>No extra volume for MS/MSD | No separate sample needed -- analyzed from CAS sample set 1 | Thiocyanate | Lab SOP | HNO3 | 28 days | 4°C | Unfiltered |

*Notes:*

*1 - Total metals: Al, Sb, As, Ba, B, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Ag, Na, Se, Sn, Tl, V, Zn, and Hardness*

*2 - Dissolved Metals: Al, Sb, As, Ba, B, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Ag, Na, Se, Si, Sn, Tl, V, and Zn*

*Key:*

*L = liters.*

*ml = milliliters*

*N/A – Not applicable*

**Table 2-2**
**Sample Bottle Schedule and Sampling Parameters for Soil and Sediment Collection**

| Set | Bottle Type SGS | Bottle Type CAS | Bottle Type STL | Analysis | Lab Method | Preser-vative | Hold Time | Req. Temp. |
|---|---|---|---|---|---|---|---|---|
| 1 | (1) 8 oz glass | (1) 8 oz glass | | Total Metals[1] | SW6010B/ 6020/ 7471 (Hg) | None | 6 months | 4°C |
| | | | | Cyanide, Total | SM4500CN-E | None | 28 days[2] | 4°C |
| | | | | Ammonia as N | SM4500NH 3 | None | 28 days | 4°C |
| | | | | Chloride, fluoride, sulfate | E300.0 | None | 28 days[3] | 4°C |
| 2 | | (1) 2 oz glass (Zero headspace) | (1) 2 oz glass (Zero headspace) | Sulfur, total | E300 | None | 28 days | 4°C |
| | | | (1) 4 oz glass (Zero headspace) | AVS | Draft E1991 | None | 14 days | 4°C |
| | | | | SEM | SW6010B<br>SW7471A( Hg) | None<br>None | 6 months (SW6010B)<br>28 days (SW7471A) | Ambient<br>4°C |
| 3 (Soil Only) | (1) 4-oz glass | (1) 4-oz glass | | Total organic carbon | ASTM D4129-82M | None | 180 days | 4°C |
| 4 (Soil Only) | (1) 8-oz glass | (1) 8-oz glass | | Diesel/residual range organics | AK102/103 | None | 14 days to extraction, 40 days to analysis of extract | 4°C |

*Notes:*

*1 - Total metals: Al, Sb, As, Ba, B, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Ag, Na, Se, Sn, Tl, V, Zn, and Hg.*

*2 - Holding Time: per EPA methods fact sheet titled "Total Petroleum Hydrocarbons, Reactive Cyanide, Reactive Sulfide, Ignitability, and Corrosivity."*

*3 - Holding Time is from the date of preparation.*

*4 – For total metals there is no temperature requirement, with the exception of Hg, which requires storage at 4°C.*

*Key:*

*oz = ounce.*

*prewt'd = reweighed and tared*

*AVS = acid volatile sulfides*

*SEM =Simultaneously extractable metals (Cd, Cu, Pb, Ni, Zn, Hg)*

**Table 2-3**
**Sample Bottle Schedule and Sampling Parameters for Biological Tissue Collection**

| Tissue Type | Minimum Sample Amount (grams) | Bottle Type (CAS/STL) | Analysis | Lab Method | Shipping Preservation and Time | Hold Time | Required Laboratory Storage Temp. |
|---|---|---|---|---|---|---|---|
| Vegetation | 25 | Ziploc bag or glass jar | Hg | SW7471 | Cool on blue ice | 28 days | 4 °C |
| | | | Total Metals (1) | SW6010B/6020 E200.8 | | 6 months | None |
| | | | Cyanide | SM4500CN-E | | 14 days | 4 °C |
| Fish and Bivalves | 45 | Ziploc or similar plastic bag | Low-level Hg | E1631 | Cool on blue ice or freeze on dry ice if shipping time will exceed 24 hours. Samples must arrive at the lab within 48 hours of shipment. | 1 year | Freeze at ≤ -20 °C |
| | | | Total Metals (2) | SW6010B(Cr) E200.8 SW7740 (Se) SW6010B/6020 | | 12 months | |
| | | | PAHs (Lake Iliamna Bivalves) | SW8270C SIM | | 6 months | |

*Notes:*

*Total Metals 1 — Al, Sb, As, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Tl, Sn, V, Zn.*

*Total Metals 2 — Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Mo, Ni, Se, Ag, Tl, and Zn*

### 2.2.1 Sample Collection and Analysis

Sample collection, handling, and shipping procedures include the following:

- Field collection
- Labeling
- Packaging
- Chain-of-custody forms
- Shipping

The Project Managers are responsible for implementing the following sample handling and shipping procedures. The Analytical QA/QC Manager will check for quality assurance measures on these activities.

### 2.2.2 Field Collection Procedures

In all cases, field collection procedures will be performed to minimize contamination of samples, prevent cross-contamination between samples, and ensure sample validity by conducting proper preservation and storage in the field according to the requirements specified in this QAPP.

Surface water samples will be collected for analysis in the following order:

1. Mercury

2. Total metals
3. Dissolved metals
4. Total suspended solids, total dissolved solids, etc.
5. Settleable solids (Imhoff cones in the field)
6. Miscellaneous parameters (ammonia, phosphorus, Cyanide WAD, etc.)

For mercury, many states are establishing new National Pollutant Discharge Elimination System (NPDES) limits at very low levels based on maintaining water quality standards in the receiving streams. The new limits may approach or even be less than the detection limit of routine analytical methods. To ensure that reliable data are produced at these extremely low detection levels, additional emphasis must be placed on clean sampling and clean laboratory practices to minimize contamination. The following general field procedures are recommended by CAS, the laboratory that will perform mercury analysis for the Pebble Project EBS.

1. Sampling cleanliness will be documented through the use of trip blanks and field sampling blanks.
2. Only non-metallic sampling equipment will be used and no metal object will be allowed to come into direct or indirect contact with the sample or sample containers (storing samples at all times in properly cleaned and sealed containers [ice chests] can help prevent inadvertent contact with such objects, as well as prevent inadvertent contamination).
3. Only non-talc gloves will be used and gloves will be changed between sample collections.
4. Samples will be collected directly into sample containers that are documented clean at the levels of concern.
5. All sample containers will be double-bagged.
6. It may be necessary to designate one "clean hands" sampler to perform all operations involving direct contact with the sample and one "dirty hands" sampler for all other operations (e.g., record keeping).

**Smoking will not be allowed in the vicinity of any sampling activities or sampling equipment. Smokers must wash their hands thoroughly with soap and water before handling samples or sampling equipment.**

For fish being collected for contaminant analyses, fish collection procedures will follow many of the methods of Zhang et al. (2001) and Jewett et al. (2003). These include:

- Photo documentation of the specimen will occur before dissection to provide confirmation of species identification. A label will be placed beside the fish to identify the sample number in the photograph.
- Total fish length and sex will be recorded for each specimen in the field; any necessary dissection to determine sex will be done using surgical sheets, powder-free latex gloves, and an acid-washed titanium knife or scalpel. The disposable gloves will be changed between each dissection.

- For smaller fish (e.g., < 6 inches total length), the entire animal will be placed in a Ziploc-type plastic bag and frozen immediately.
- For larger fish (e.g., > 6 inches total length), immediate freezing of all tissues in an entire animal would be difficult under field conditions. Therefore, tissue dissections for muscle and liver samples will be done in the field as follows:
  - Immediately upon capture, the fish will be placed in clean plastic bags and placed in a cooler with ice. The fish is to be placed in the a clean plastic bag immediately upon being removed from the water and not be placed on any surface, such as the bottom of the boat, to avoid contamination.
  - Dissection will occur indoors at a clean site in Iliamna.
  - The cutting surface will be washed with soap and water and covered with heavy-duty aluminum foil.
  - Either stainless steel disposable scalpels or stainless steel knives will be used for dissection. Knives will be washed with soap and water and rinsed with deionized water between uses. Scalpels will be replaced between fish.
  - An approximately 25-gram (g) sample of liver and muscle tissue will be extracted from each fish using powder free gloves and placed in an individually labeled Ziploc bag. Tissue samples will be immediately placed in a freezer.
  - An equipment blank will be prepared after each set of dissections by rinsing the cutting surface and the knives with deionized water and collecting the rinse water in an acid-washed jar.
  - Frozen tissue samples will be packaged in a cooler and sent to the laboratory using packaging recommendations provided by the lab. Chain-of-custody procedures will be followed.
  - Each sample from an individual fish will be labeled with the sample ID number and include a suffix of "M" for muscle or "L" for liver tissue (see Section 2.3.1).
  - For the fish tissue samples from large fish, the muscle tissue will be collected immediately below the dorsal fin. When doing the tissue dissections, at least 25 grams of tissue for each type of tissue sample, or about a 3x3x1-inch piece of tissue, will be collected.

For vegetation samples collect 50 grams from a representative plant in each plant class within the sample location, if available.

Collect at least 75 grams for 10 percent of fish samples and 150 grams for 10 percent of vegetation samples. This will allow the preparation of QA/QC samples at the primary laboratory (CAS). CAS will ship QA samples to STL for analysis.

### 2.2.3 Field Documentation

Field observations, field equipment calibration information, field measurements, and sample documentation, including sample identification, sample duplicates, and date and time the sample was collected, will be the responsibility of the entire sampling team. Field forms will be maintained for each task. Field forms will consist of waterproof bound pages with every appropriate area marked in

waterproof ink. Blank pages will be marked as such with a diagonal line across the page, when appropriate.

Proper documentation for sample custody includes keeping records of all materials and procedures involved in sampling. Project field forms will be used to record field data. All information on the sampling station and respective samples and blanks collected at each site, including the positions of the station, will be recorded by the field crew. The field crew leader will review all data before leaving the sampling station. Completed field forms will be kept on file for future reference.

### 2.2.4 Corrections to Field Documentation

Unless weather conditions prevent it, all original data will be recorded with waterproof ink. No accountable documents will be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. If an error is made on an accountable document assigned to one person, that person must make corrections by drawing a line through the error, initialing and dating the lined-out item, and entering the correct information. The erroneous information is not to be obliterated, but must remain legible. Any subsequent error discovered on an accountable document will be corrected by the person who made the entry. All such subsequent corrections will be initialed and dated.

## 2.3 Sample Handling and Custody

Sample handling and custody procedures are required in the field and the laboratory, and during transport. The procedures take into account the nature of the samples, the maximum holding times, and shipping options from Iliamna to the laboratories.

### 2.3.1 Labeling

Each sample container will have a waterproof label large enough to contain the information needed to easily identify each sample. The information to be included on each label will include the project name, date, time, preservative (if added), sample code, analysis, and sampler's initials. Sample code will be formatted to indicate sample date (month and year), location, matrix, and number.

Each sampling location will be identified by the sampler on the field form. An example of sample identification is as follows:

0106CR199AWS001

Where:
- 0106 is the date as month/year
- CR199A is the location ID
- WS is the matrix code for surface water
- 001 is a sequential sample number

For field duplicates, the sequential sample number is 201, and for triplicates, 301. The suffix 401 is used for field equipment rinse blanks. The suffix 501 is used for DI water blanks. The suffix 601 is used for trip blanks.

For trip blanks, laboratory codes are used for the location ID. Laboratory codes are SGS, CASK, and TAM for SGS Environmental Services, Inc., Columbia Analytical Services, Inc., and Test America, Inc., respectively. The date code is month and year only. A sample surface water trip blank ID for SGS may be 0106SGSTBWS601 for the first trip blank in January 2006. If more than one trip blank is used in the same event for the same matrix increase the sequential ID to 602.

Additional matrix codes are:

- WO – marine water
- MS – marine sediment
- SE – sediment
- SL – surface soil
- SS – subsurface soil
- WS – surface water
- WG – ground water
- TF – fish tissue
- TP – plant tissue

For large fish with analyses conducted on both muscle and liver tissue, the sample ID will include a suffix of "M" for muscle or "L" for liver tissue. For example, fish liver tissue from location CR199A collected on August 20, 2004, would have the following sample ID: 0804CR199ATF001L.

For vegetation samples, a two or three-letter code for each species will be used as the suffix in the sample ID. For example, 0804TE12TP001-Pm is a sample of *picea mariana* (black spruce) collected at location TE12 on Aug 16, 2004. Berry only samples are designated with a "B" at the end of the acronym. Refer to Table 2-4 for species names and codes.

Samples collected from seep locations should be given the matrix code of WS or SE as applicable. The location IDs for seep samples should start with "SP" to indicate sample is from a seep location without regard to matrix type. Seep location IDs will contain a 2 to 3 digit sequential number to differentiate the locations and then end with a two digit number to indicate the year that the seep was first identified. For example, the first seep site to be identified in 2006 would be assigned location ID of SP00106. If a seep site is later samples in a subsequent year, the location ID should not be changed from that assigned the year the seep was first identified.

These samples IDs are defined to facilitate data management for the life of this project.

**Table 2-4**
**Summary of Vegetation Species Names**

| Plant Code | Latin Name | Common Name |
|---|---|---|
| | ***Aquatic*** | |
| Apa | Alisma plantago-aquatica | Broad-leaved water plantain |
| Cde | Ceratophyllum demersum | Coontail, hornwort |
| Cdo | Cucuta douglasii | Water hemlock |
| Cve | Callitriche verna | Vernal water-starwort |
| Hvu | Hippuris vulgaris | Mare's tail |
| La | Lycopodium annotinum | Stiff clubmoss |
| Lmi | Lemna minor | Common duckweed |
| Msp | Myriophyllum spicatum | Eurasian watermilfoil, spiked water-milfoil |
| Npo | Nuphar lutea ssp polysepala | Yellow pond-lily |
| Pam | Polygonum amphibium | Water smartweed |
| Pf | Potamogeton friesii | Flat-stalked pondweed |
| Pfi | Stuckenia filiformis ssp alpinus | Northern slender pondweed, thread-leaved pondweed |
| Ppe | Potamogeton perfoliatus | Clasping-leaf pondweed |
| Pta | Potamogeton sp. | Pondweeds, not keyed to sp. |
| Raq | Ranunculus aquatilis | Large-leaved white water-crowfoot |
| Rgm | Ranunculus gmelinii | Yellow water-crowfoot |
| San | Sparganium angustifolium | Narrow-leafed bur-reed |
| Scu | Sagittaria cuneata | Arum-leaved arrowhead |
| Seu | Sparganium eurycarpum | Giant bur-reed |
| Tla | Typha latifolia | Common cattail |
| Utr | Utricularia vulgaris (or minor, or intermedia) | Bladderwort |
| | ***Ferns & Allies*** | |
| Af | Athyrium filix-femina | Lady fern |
| Dd | Dryopteris expansa | Spreading wood fern |
| Ea | Equisetum arvense | Common horsetail, field horsetail |
| Ep | Equisetum pratense | Meadow horsetail |
| | ***Forbes*** | |
| Ab | Achillea borealis | Boreal yarrow |
| Ad | Aconitum delphinifolium | Monkshood |
| Ag | Angelica genuflexa | Kneeling angelica |
| At | Artemisia tilesii | Wormwood |
| Cha | Chamerion angustifolium | Fireweed |
| Cp | Comarum palustre | Marsh cinquefoil, marsh five finger |
| Ead | Epilobium ciliatum ssp ciliatum | Fringed willowherb |
| Ec | Epilobium ciliatum | Slender willowherb |
| Ha | Hedysarum alpinum | Wild potato, Eskimo potato, alpine sweetvetch |
| Hbm | Hedysarum boreale ssp mackenziei | Sweetvetch, wild sweet pea |
| Hmx | Heracleum maximum | Cow parsnip, wild celery, putchkie |
| Is | Iris setosa | Iris |
| Ln | Lupinus nootkatensis | Nootka lupine |
| Pa | Polygonum alpinum | Alaska wild rhubarb |
| Pfr | Petasites frigidus | Coltsfoot |
| Ppu | Polemonium pulcherrimum | Beautiful Jacob's ladder |

**Table 2-4 (continued)**
**Summary of Vegetation Species Names**

| Plant Code | Latin Name | Common Name |
|---|---|---|
| | ***Forbes (continued)*** | |
| Rar | Rumex arcticus | Arctic dock |
| Rr | Rhodiola integrifolia ssp integrifolia | Ledge stonecrop, sedum rosea |
| Sc | Sanguisorba canadensis | Canadian burnet |
| Sd | Solidago decumbens | Goldenrod |
| Vvi | Veratrum viride | False hellebore |
| | ***Grasses*** | |
| Csp | Calamagrostis sp. | Blue joint grass, reed grass, not keyed to sp. |
| Ear | Leymus arenarius | Lyme-grass |
| Es | Eriophorum scheuchzeri | Alaska cotton, cottongrass |
| | ***Woody Herbs*** | |
| CCu | Flavocetraria cucullata | Curled snow lichen |
| Cr | Cladina rangiferina | Reindeer lichen, caribou moss |
| Hs | Hylocomium splendens | Stair-step moss |
| Pcc | Ptilium crista-castrensis | Knight's plume moss |
| | ***Sedges*** | |
| Ca | Carex aquatilis | Water sedge |
| Cm | Carex microchaeta | Small-awned sedge |
| Cut | Carex utriculata | Common yellow lake sedge |
| Ss | Sedge sp. | Sedge, carex, not keyed to sp. |
| | ***Shrubs*** | |
| Ac | Alnus crispa | Mountain alder |
| Ap | Andromeda polifolia | Bog rosemary |
| Ar | Arctostaphylos rubra | Red bearberry |
| Avs | Alnus viridis ssp sinuata | Sitka alder |
| Bg | Betula glandulosa | Dwarf birch, resin birch |
| Bn | Betula nana | Arctic dwarf birch |
| Df | Dasiphora floribunda | Shrubby cinquefoil, potentilla, tundra rose |
| En | Empetrum nigrum | Crowberry |
| EnB | Empetrum nigrum | Crowberry |
| Jc | Juniperus communis | Common juniper |
| Lp | Ledum palustre | Narrow-leaf Labrador tea |
| Lpe | Luetkea pectinata | Partridgefoot |
| Mf | Menziesia ferruginea | Fool's huckleberry, false azalea |
| Mg | Myrica gale | Sweetgale |
| Oh | Oplopanax horridus | Devil's club |
| Ra | Rosa acicularis | Prickly rose |
| Rc | Rubus chamaemorus | Cloudberry |
| RcB | Rubus chamaemorus | Cloudberry |
| Rg | Ribes glandulosum | Skunk currant |
| Rh | Ribes hudsonianum | Northern black currant |

**Table 2-4 (continued)**
**Summary of Vegetation Species Names**

| Plant Code | Latin Name | Common Name |
|---|---|---|
| ***Shrubs (continued)*** | | |
| Rl | Ribes laxiflorum | Trailing black currant |
| Ro | Rosa sp. | Wild rose, not keyed to sp., (not tundra rose) |
| Rp | Rubus pedatus | Trailing raspberry |
| Rs | Rubus spectabilis | Salmonberry |
| Rt | Ribes triste | Northern red currant |
| Sa | Salix alaxensis | Felt-leaf willow |
| Sar | Salix arctica | Arctic willow, rock willow |
| Sb | Salix brachycarpa | Barrenground willow |
| Sba | Salix barclayi | Barclay's willow |
| Sg | Salix glauca | Glaucous willow, greyleaf willow |
| Sp | Salix planifolia | Planeleaf willow, diamondleaf willow |
| Sps | Spirea stevenii | Beauverd spirea |
| Sr | Sambucus racemosa | Elderberry |
| Srt | Salix reticulata | Netleaf willow, snow willow |
| Ssp | Salix sp. | Willow, not keyed to sp. |
| Sxs | Salix sitchensis | Sitka willow |
| Vo | Vaccinium ovalifolium | Ovalleaf blueberry or huckleberry, early blueberry |
| Vu | Vaccinium uliginosum | Bog blueberry |
| VuB | Vaccinium uliginosum | Bog blueberry |
| Vv | Vaccinium vitis-idaea | Lingonberry, low-bush cranberry |
| VvB | Vaccinium vitis-idaea | Lingonberry, low-bush cranberry |
| ***Trees*** | | |
| Bp | Betula papyrifera | Paper birch |
| Pb | Populus balsamifera | Cottonwood |
| Pg | Picea glauca | White spruce |
| Pm | Picea mariana | Black spruce |
| Pt | Populus tremuloides | Quaking aspen |
| Tm | Tsuga mertensiana | Mountain hemlock |
| ***Woody Herbs*** | | |
| Cc | Cornus canadensis | Bunchberry |
| CcB | Cornus canadensis | Bunchberry |

### 2.3.2 Packaging

Each analytical sample bottle will be packed to prevent breakage and placed in an iced cooler to keep the samples cooled to 4° Celsius (C). Gel ice packs for samples will be kept in dedicated freezers that are only used for the storage of ice or sample jars. One copy of the chain-of-custody form will be placed in a sealed plastic bag and then placed inside of the cooler. In addition, the cooler lid will be sealed with tape and chain-of-custody seals will be attached to the outside of the cooler so that the seals must be broken if the cooler is opened.

To preserve the integrity of water, soil, and sediment samples from collection to receipt by laboratories, all shipments will adhere to the following requirements at a minimum:

1. Coolers will be packaged with 25 percent frozen blue ice and 75 percent samples. For water samples, avoid packing too much blue ice around any one sample to avoid freezing samples.

2. For fish tissue samples, ensure that the tissues are completely frozen before they are placed into the iced cooler for shipment. Be sure that all samples are segregated from other freezer contents by being placed in an appropriate larger sealed container (including custody tape).

3. ALL samples in ALL coolers are to be shipped using Alaska Airlines GoldStreak (or other airport-to-airport equivalent). For samples sent to Columbia Analytical Services, Inc. in Kelso, Washington, write on airbill "by way of Portland." CAS has daily courier service from Portland to their lab in Kelso. Samples may be shipped to Seattle without this instruction.

4. Each cooler will include a completed chain-of-custody (COC) form for the samples contained in the cooler with all required analyses clearly specified.

5. Each cooler will include a bottle of water labeled Temperature Blank. The laboratory will measure and record the temperature from this bottle and the air temperature in the cooler.

### 2.3.3 Chain-of-custody Form

COC forms will be used for all samples. Once collected, the samples will remain within sight of the sampler or will be secured until the samples are prepared for shipment. Each time the cooler changes hands, both the sender and the receiver will sign and date the COC form. The laboratory will forward the original to the Analytical QA/QC Manager. The field sampling team(s) will verify all COC forms before sample shipment and will make a copy of each to maintain a duplicate set of records. The following information is to be included on the COC form:

- Sample identification code
- Signature of sampler
- Date and time of collection
- Project name
- Type of sample
- Number and type of containers
- Sample preservation
- Sample analysis requested
- Inclusive dates of possession
- Signature of receiver

The consulting company's name, address, and phone number are required on the COC form. Instruct laboratories to invoice Northern Dynasty Mines Inc. and to mail reports to:

Jane Whitsett
Shaw Environmental, Inc.
2000 West International Airport Road, Suite C-1
Anchorage, AK 99502

Other COC components will include sample labels, field notebooks, sample shipment receipts, and the laboratory logbook. The lab-specific analytical parameters are presented in Tables 1-10 through 1- 15.

## 2.4 Laboratory Procedures and Analytical Methods

Laboratories will employ the following general procedures, especially when conducting low-level detection analyses.

The laboratory should use ultra-clean reagent, specially-cleaned glassware, and other precautions such as the use of laminar flow hoods for sample digestion and preparation. Soil, sediment, vegetation, and fish tissues will be reported on a dry-weight basis.

Analytical methods selected for the Pebble Project EBS are presented in Table 2-5 below. The instrument method is given for each parameter. The procedures are routine for the laboratories selected for this project and adhere to EPA methods for the analysis of water and solid samples. CAS and STL will be conducting metals analysis on fish tissues following the Puget Sound Estuary Program (PSEP) "Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound" (1996). CAS will prepare vegetation samples following Standard Operating Procedure GEN-TISP dated 7/13/04. See Tables 1-11 through 1-16 for preparation methods.

**Table 2-5**
**Pebble Project EBS Parameters, Methods, and Techniques / Instrumentation**

| Parameter | Method (Water) | Method (Solids) | Technique/Instrumentation |
|---|---|---|---|
| | | ***Organics*** | |
| Total Organic Carbon | N/A | ASTM D4129-82M | Combustion or oxidation |
| DRO/RRO | N/A | AK102/103 | Gas chromatography with flame ionization detector |
| | | ***Inorganics*** | |
| pH | E150.1 | N/A | Electrode |
| Specific Conductance | SM 2510B | N/A | Resistor network |
| Acidity | E305.2 | N/A | Titration |
| Alkalinity | SM2320B | MA | Titration |
| Ammonia as N | SM4500NH3 | SM4500NH3 | Ion selective electrode |
| Chloride | E300.0 | N/A | Ion chromatography/ion selective electrode |
| Cyanide, total | SM4500CN-E | SM4500CN –E | Spectroscopy (colorimetric) |
| Cyanide, WAD | SM4500CN-I | N/A | Spectroscopy (colorimetric) |
| Cyanide, low level | E1677 | N/A | Ligand exchange / Amperometry |
| Fluoride | E300.0 | N/A | Ion chromatography/ion selective electrode |
| Hardness | SM2340B | N/A | Calculation |
| Nitrate + Nitrite, Nitrite, | E353.2 | N/A | Spectrophotometer |
| Phosphorus, total and | E365.3 | N/A | Spectroscopy (colorimetric, photometric) |
| Sulfate | E300.0 | N/A | Ion chromatography |
| Thiocyanate | Lab SOP | N/A | Spectroscopy (colorimetric) |
| Total dissolved solids | E160.1, SM2540C | N/A | Gravimetric |
| Total suspended solids | E160.2 | N/A | Gravimetric |
| | | ***Metals*** | |
| Low level mercury | E1631 | E1631 | Cold vapor atomic fluorescence spectrophotometer |
| Mercury | | SW7470 | Cold vapor atomic absorption |
| Metals (1) | E200.7/200.8 | E200.8<br>SW6010B/6020<br>SW7740 (Se) | Inductively coupled plasma atomic emission spectroscopy<br>Inductively coupled plasma mass spectrometry<br>Graphite furnace atomic absorption |
| Sulfur, total | N/A | E300M | Ion chromatography/ ion selective electrode |
| AVS | N/A | Draft E1991 | Colorimetric |
| SEM | N/A | SW6010B<br>7470A | Inductively coupled plasma atomic emission spectroscopy<br>Cold vapor atomic fluorescence spectrophotometer |

*Notes:*

*AVS = Acid volatile sulfides*

*SEM = Simultaneously extractable metals (Cd, Cu, Pb, Ni, Zn, Hg)*

*Metals (1) - Al, Sb, As, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Si (dissolved only), Ag, Na, Tl, Sn, V, Zn. Water samples are analyzed for total and dissolved metals.*

## 2.5 Quality Control

The QAPP program consists of three components:

1. Field QA identifies the procedures to be used in the field to verify that samples and field monitoring data are collected according to the requirements of the project. The objective of field QA is to produce data, both field measurements and samples collected for laboratory analyses, that can be demonstrated to be representative of the environment sampled and are of known and acceptable quality. The QA/QC Manager is responsible for reviewing at least 10 percent of the field data, and data review records will be kept in a log by the Project QA/QC Manager.

2. Laboratory QA identifies the protocols to be used by the laboratories, demonstrating to NDM that project data are analyzed according to EPA-accepted methods and that reported values are accurate. The objective of the laboratory QA/QC program is to produce data that will meet state and federal analytical requirements.

3. Data QA identifies the protocols to be used to verify that laboratory and field data have been reported accurately. The objective of the data QA/QC program is to demonstrate that the data reported meet the project-specified requirements.

### 2.5.1 Data Uses and Data Quality Objectives

Quality assurance requirements are established in this QAPP to achieve the project objectives for the data uses. Applicable quality control procedures, quantitative target limits, and level of effort for assessing the data quality are dictated by the intended use of the data and the nature of the required field and analytical methods. The project objectives are to collect data of known and sufficient quality for NDM to comply with the requirements of state and federal environmental regulations.

Federal and state levels of concern (e.g., ambient water quality criteria or maximum contaminant levels) exist for many of the parameters being analyzed in the baseline studies program. Analytical methods have been specified that will allow detection of chemical constituents at or below levels of concern.

### 2.5.2 Data Quality Assurance/Quality Control Program

The proposed data QA/QC program serves four major functions:

1. Maintenance of a duplicate record of all field data

2. Sample tracking through laboratory analysis

3. Data validation

4. Oversight of data management

The second major component of the proposed data QA program is sample tracking throughout the laboratory analytical process. The QA/QC Manager will maintain close communications with all analytical laboratories to verify sample receipt, proper sample management, and strict adherence to sample holding times. The laboratories will immediately inform the QA/QC Manager of sample breakage, inadequate sample media to meet QA objectives, and other sample problems. The QA/QC Manager will then notify the respective field team so that corrective action can be implemented as deemed necessary.

Following receipt of the analytical data package, the QA/QC Manager will verify that all sample-parameter data have been received, will compare them to detection limits, and will compare preliminary results with previous results. Should major discrepancies be found, the QA/QC Manager will communicate these, where appropriate, to the respective field team. Possible corrective measures will then be evaluated as deemed necessary.

### 2.5.3 Laboratory Quality Assurance/Quality Control Program

Specific protocols to ensure laboratory data of known and consistent quality can be found in the SGS, CAS, STL, and TestAmerica, Inc. quality assurance manuals, which are on file in the Shaw Anchorage office. The QA/QC Manager and laboratory Project Chemists will oversee implementation of these protocols. Project-specific criteria are provided in Tables 1-10 through 1-13.

Data validation will be conducted by Shaw. Any discrepancies will be noted and discussed with:

- Mr. Crupi, Laboratory Project Chemist for this project with SGS, or
- Ms. Chang, Laboratory Project Chemist for this project with TestAmerica, Inc., or
- Ms. Huckestein, Laboratory Project Chemist for this project with CAS, or
- Ms. Terri Torres, Laboratory Project Chemist for this project with STL.

## 2.6 Instrument/Equipment Testing, Inspection, and Maintenance

The Laboratory Project Chemists are responsible for all laboratory equipment maintenance decisions. In the event of equipment failure that will impact the analytical schedule, the laboratory Operations Manager will notify the QA/QC Manager. Field Team Managers are responsible for field equipment maintenance decisions.

## 2.7 Inspection/Acceptance of Supplies and Consumables

All supplies and consumables (Sample Reference Materials [SRMs] and reagents) will be inspected and checked in by the Laboratory Project Chemist or the Quality Assurance Officer.

## 2.8 Data Management

### 2.8.1 Field Forms

All pertinent field survey and sampling information will be recorded on field forms during each day of the field effort and at each sample site. The field crew leader will be responsible for seeing that sufficient detail is recorded on the forms. No general rules can specify the extent of information that must be entered on the forms. However, the objective is that the field forms contain sufficient information so that field activities can be reconstructed without relying on the memory of the field crew. All entries will be made in indelible ink. All corrections will consist of initialed, single-line-out deletions.

Strict custody procedures will be maintained with the field forms used. While being used in the field, forms will remain with the field team and will be secured on a clip board or, at a minimum, with rubber

bands AT ALL TIMES. Upon completion of the field effort, forms will be filed in an appropriately secure manner in a bound notebook labeled "original data." These forms will remain with the task manager. Photocopies of the original data will be used as working documents.

Laboratory data results are received by electronic mail by the Analytical QA/QC Manager. The laboratories also send paper copies of analysis results to the Analytical QA/QC Manager. Laboratory data are validated by Shaw then uploaded to the NDM chemistry database.

# 3.0 Assessment and Oversight

## 3.1 Assessments and Response Actions

Field assessments will be discussed between the Analytical QA/QC Manager and the Field Team Manager. Any response actions will then be undertaken by the Analytical QA/QC Manager during regular field sampling/monitoring events. Internal assessment for the laboratory will be performed according to laboratory's quality management plans (QMPs), which are kept on file in the Shaw Anchorage office.

## 3.2 Reports to Management

Following receipt of the analytical data package by Shaw, the Analytical QA/QC Manager at Shaw will review the data with regard to the following:

- Analytical methodology
- Detection limits
- Accuracy, precision, and adherence to holding times

These QA/QC checks of data will be kept on file at Shaw by the Analytical QA/QC Manager and included in data quality assessment reports of the data. Where data do not meet the requirements specified in this QA/QC program, the data will be flagged with qualifiers. Should major discrepancies be found, the Analytical QA/QC Manager will communicate these to NDM's Environmental Project Manager, Ella Ede. Possible corrective measures will then be evaluated as deemed necessary. These data reviews will be summarized and included in the DQAR reports by Shaw to NDM.

Laboratory reports will include the elements presented in Section 1.8.2 of this QAPP.

# 4.0 Data Review, Validation, and Usability

Data review and validation will be conducted on all data collected for the Pebble Project environmental baseline studies.

## 4.1 Data Review

Data generated for this project will be reviewed by both the laboratory and by Shaw. The laboratory has primary responsibility for correctly identifying and quantifying analytes and compounds of interest, for identifying matrix interferences, and for identifying and, if possible, correcting instrument anomalies. The laboratory is also responsible for the technical quality of the data and for meeting all quality control parameters by correctly following the analytical methods using instrumentation that is in proper working order for the given method.

The review process will be coordinated initially by the bench-level scientists who will review all data for accuracy and completeness. The bench-level scientist will also compare all QC sample results with control criteria outlined in Tables 1-11 through 1-16 and will initiate appropriate corrective action if criteria are not met.

Prior to summary reports, the data will be reviewed by the Laboratory QA/QC Manager to ensure that the data are representative, complete, and accurate.

## 4.2 Validation and Verification Methods

Data validation is the review process to screen data for anomalies and possible errors. Data accepted from the laboratory will be verified and validated by Shaw. The data validation process will include review of the following:

- Analytical methodology
- Detection limits
- Cross-contamination as indicated by blank data
- Laboratory accuracy and precision
- Adherence to holding times
- Sample preservation
- Initial and continuing calibration
- Field precision (QA/QC samples)
- Total metals vs. dissolved metals

Data will be validated in accordance with the following procedures:

- *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (USEAP, 1999)
- *Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review* (USEPA, 2001)
- *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (USEPA, 2002)

Field precision will be evaluated using criteria presented in Table 4-1. Two sets of data are compared to each other for precision: the primary vs. duplicate sample sets and the primary vs. triplicate sample sets. For samples that are in the Disagreement or Major Disagreement columns, the duplicate or triplicate sample data and the associated laboratory data will be evaluated for any biases that may explain the disagreements. In some cases, associated samples may be qualified as estimates (J) or rejected (R) based on professional judgment.

**Table 4-1**
**Criteria for Comparing Field QC and QA Sample Data**

| Matrix | Parameter | Disagreement | Major Disagreement |
|---|---|---|---|
| All | All | >5x difference when one results is < MDL | >10x difference when one results is < MDL |
| All | All | >3x difference when one result is < MRL | >5x difference when one result is < MRL |
| Water | All except TPH | > 2x difference | > 3x difference |
| Soil, Sediment and Tissues | All except metals, VOCs, BTEX and TPH | > 4x difference | > 5x difference |
| Soil, Sediment and Tissues | Metals | > 2x difference | > 3x difference |
| Water, Soil and Sediment | TPH | Arbitrary (suggest >3x difference) | Arbitrary (suggest >5x difference) |
| Soil, Sediment and Tissues | VOCs and BTEX | Arbitrary (suggest >5x difference) | Arbitrary (suggest >10x difference) |

Evaluation of total and dissolved metals will involve comparison of results for instances where dissolved is greater than total. Sample results are acceptable if the following criteria are met:

1. Where both results are greater than five times the MRL, and the RPD between results is less than or equal to 20 percent.
2. Where the total metals result is less than or equal to 5 times the MRL, and the absolute value of the difference between the results is less than or equal to the MRL. If the total metals result is not detected at the MDL, then the value of the MDL will be used for the comparison.
3. Where both total and dissolved results are below the MRL.

For an individual sample where criteria are not met for up to 30 percent of the parameters, then the associated QC data (including method blanks and field blanks) will be evaluated for bias. Consequently, results may be qualified with a J as an estimate. If more than 30 percent of the parameters exceed the criteria, then both total and dissolved samples will be reanalyzed. If reanalysis does not eliminate the problem, then results will be qualified with a J as an estimate (Zeiner, 1994).

Dissolved water samples are prepared in the field by filtering the sample with a peristaltic pump through tygon tubing with a disposable 0.45 micron filter in line. A comparison of the certified limits of detection (LOD) provided by the manufacturer (Voss Manufacturers) for their High Capacity Groundwater Capsule for filtering water samples is presented in Table 4-2. This table is intended to document the possible contribution of metals to dissolved water samples due to the filter. Note that Selenium is the only metal where the filter LOD is greater than the regulatory limit. Selenium has not been found in filtered samples at greater concentrations than total.

**Table 4-2**
**Summary of Metals Limit of Detection in Filters**

| Parameter | MRL, ug/L | Filter LOD, ug/L | Lowest EPA or ADEC Regulatory Limit | Filter LOD > MRL | Filter LOD > Regulatory Limit |
|---|---|---|---|---|---|
| Hg (low level) (total only) | 0.005 | 0.05 | 0.05 | Yes | No |
| Al | 1.0 | 0.2 | 87 | No | No |
| Sb | 0.05 | 0.1 | 5.6 | Yes | No |
| As | 0.5 | 0.2 | 10 | No | No |
| Ba | 0.05 | 0.1 | 1000 | Yes | No |
| Be | 0.02 | 0.04 | 4 | Yes | No |
| Bi | 0.1 | 0.04 | None | No | No |
| B | 0.5 | 5 | None | Yes | No |
| Cd | 0.02 | 0.03 | 0.1 | Yes | No |
| Co | 0.02 | 0.02 | None | No | No |
| Cu | 0.1 | 0.5 | 2.7 | Yes | No |
| Pb | 0.02 | 0.5 | 0.54 | Yes | No |
| Mn | 0.05 | 0.3 | 50 | Yes | No |
| Mo | 0.05 | 0.05 | 10 | No | No |
| Ni | 0.2 | 0.5 | 16 | Yes | No |
| Se | 1.0 | 7 | 4.6 | Yes | Yes |
| Si (Dissolved only) | 100 | Not reported | None | Not reported | No |
| Ag | 0.02 | 0.03 | 0.32 | No | No |
| Tl | 0.01 | 0.05 | 0.24 | Yes | No |
| Sn | 0.1 | 0.2 | None | Yes | No |

**Table 4-2 (continued)**
**Summary of Metals Limit of Detection in Filters**

| Parameter | MRL, ug/L | Filter LOD, ug/L | Lowest EPA or ADEC Regulatory Limit | Filter LOD > MRL | Filter LOD > Regulatory Limit |
|---|---|---|---|---|---|
| V | 0.2 | 0.03 | 100 | No | No |
| Zn | 0.5 | 1 | 36 | yes | No |

*Notes:*
*LOD – limit of detection*
*MRL – method of reporting limit*

Aqueous samples are evaluated for ion balance by the laboratories. This is a QC check on results to identify any data that may be suspect. If ion balance criteria are not met the relevant data are evaluated to identify the cause for the poor balance.

Where data do not meet the requirements specified in this QAPP program, the data will be flagged with qualifiers. These reviews of data will be summarized and included in the QA report.

The following are validation flags that will be inserted into electronic format for upload into the NDM database:

R The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.

UJ The analyte was analyzed, but was not detected above the level of the reported sample quantitation limit. The MRL is an estimate.

J The result is an estimated quantity.

J+ The result is an estimated quantity, but the result may be biased high.

J- The result is an estimated quantity, but the result may be biased low.

B Analyte was detected in the field blank.

U Analyte was not detected at the sample quantitation limit. Detections below this limit were attributed to associated blank contamination.

## 4.3 Reconciliation with User Requirements

A periodic review of the objectives of this project will be accomplished on a yearly basis to determine if user requirements have changed.

# 5.0 References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Zhang, X., Naidu, A.S., Kelly, J.J., Jewett, S.C., Dasher, D., Duffy, L.K. 2001. “Baseline concentrations of total mercury and methylmercury in salmon returning via the Bering Sea (1999-2000).” Marine Pollution Bulletin 43(10), 993-997.

# DRAFT ENVIRONMENTAL BASELINE STUDIES
# 2007
# QUALITY ASSURANCE PROJECT PLAN

# PEBBLE PROJECT

## DRAFT ENVIRONMENTAL BASELINE STUDIES 2007 QUALITY ASSURANCE PROJECT PLAN

Prepared For:

**State of Alaska Large Mine Permitting Team**
**Department of Natural Resources**

Prepared By:

Pebble Project
NORTHERN DYNASTY MINES INC.

3201 C Street, Suite 604
Anchorage, AK 99503
(907) 339-2600

September 2007

DRAFT

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# Acronyms and Abbreviations

| | |
|---|---|
| 3PP | Three Parameters Plus, Inc. |
| ABR | ABR, Inc. |
| ACZ | ACZ Laboratories, Inc. |
| ADEC | Alaska Department of Environmental Conservation |
| BEESC | Bristol Environmental & Engineering Services Corporation |
| BTEX | benzene, toluene, ethylbenzene, and xylenes |
| °C | degrees Celsius |
| CAS | Columbia Analytical Services, Inc. |
| COC | chain-of-custody |
| DOC | dissolved organic carbon |
| DQAR | data quality assurance report |
| DRO | diesel-range organics |
| DQOs | data quality objectives |
| EPA | United States Environmental Protection Agency |
| EBS | environmental baseline studies |
| HCl | hydrochloric acid |
| HDPE | high-density polyethylene |
| HDR | HDR Alaska, Inc. |
| $HNO_3$ | nitric acid |
| $H_2SO_4$ | sulfuric acid |
| LCS | laboratory control sample |
| L | liter(s) |
| LOD | limit of detection |
| MDL | method detection limit |
| µg/L | micrograms per liter |
| µmhos/cm | micromhos per centimeter |
| mg/kg | milligrams per kilogram |
| mg/L | milligrams per liter |
| ml | milliliter(s) |
| MRL | method reporting limit |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| N/A | not applicable |
| NDM | Northern Dynasty Mines Inc. |
| NEPA | National Environmental Policy Act |
| NDPES | National Pollutant Discharge Elimination System |
| NOAA | National Oceanic and Atmospheric Administration |
| oz | ounce(s) |
| PCBs | polychlorinated biphenyls |
| PE | performance evaluation |
| PEL | probably effects level |
| PSEP | Puget Sound Estuary Program |
| QA | quality assurance |
| QAPP | quality assurance project plan |

| | |
|---|---|
| QC | quality control |
| RPD | relative percent difference |
| RRO | residual-range organics |
| RSD | relative standard deviation |
| SGS | SGS Environmental Services, Inc. |
| Shaw | Shaw Alaska, Inc. |
| SLR | SLR Alaska |
| SRK | SRK Consulting (Canada) Inc. |
| STL | Severn-Trent Laboratories, Inc. |
| SVOC | semivolatile organic compound |
| TA | Test America Laboratories, Inc. |
| TDS | total dissolved solids |
| TEL | threshold effects level |
| TPH | total petroleum hydrocarbons |
| TOC | total organic carbon |
| TSS | total suspended solids |
| VOA | volatile organics analysis |
| VOC | volatile organic compound |
| WAD | weak acid dissociable |
| WG | groundwater |
| WS | surface water |

# 2007 QUALITY ASSURANCE PROJECT PLAN

# 1.0 Program Summary

## 1.1 Title and Approval Sheets

**Program Title**

Pebble Project, Environmental Baseline Studies

**Organization**

Northern Dynasty Mines Inc. (NDM)

| NDM Personnel | Signature | Date |
|---|---|---|
| Bruce Jenkins<br>Chief Operating Officer/Environmental Study Director<br>**NDM**<br>E-mail: brucejenkins@hdgold.com<br>Phone: 604-684-6365 | | |
| Loretta Ford<br>Environmental Study Director<br>**NDM**<br>E-mail: lorettaford@hdgold.com<br>Phone: 800-667-2114 | | |
| Michael Smith<br>NEPA and Permitting Manager<br>**NDM**<br>E-mail: michaels@northerndynasty.com<br>Phone: 907-339-2606 | | |
| Steven R. Crupi<br>Analytical QA/QC Manager<br>**Shaw Alaska, Inc.**<br>E-mail: steve.crupi@shawgrp.com<br>Phone: 907-249-6312 | | |

| Agency Personnel | Signature | Date |
|---|---|---|
| Environmental Program Manager<br>Sharmon Stambaugh<br>**Alaska Department of Environmental Conservation (ADEC)**<br>E-mail: sharmon.stambaugh@alaska.gov<br>Phone: 907-269-7565 | | |

## 1.2 Distribution List

- ABR, Inc.
- ACZ Laboratories, Inc.
- NDM
- Dana E. Stewart Information Technology
- Shaw Alaska, Inc.
- Bristol Environmental & Engineering Services Corporation
- HDR Alaska, Inc.
- SLR Alaska
- Three Parameters Plus, Inc.
- SGS Environmental Services, Inc.
- Columbia Analytical Services, Inc.
- Test America, Inc.
- Severn Trent Laboratories, Inc.
- SRK Consulting (Canada) Inc.

## 1.3 Project Organization

The environmental baseline study (EBS) for the Pebble Project is managed by Northern Dynasty Mines Inc. NDM has commissioned highly experienced technical advisors for the environmental baseline studies. Those advisors include SLR Alaska (SLR), Bristol Environmental & Engineering Services Corporation (BEESC), HDR Alaska, Inc. (HDR), Three Parameters Plus, Inc. (3PP), ABR, Inc. (ABR), SRK Consulting (Canada) Inc. (SRK), and Shaw Alaska, Inc. (Shaw). The project team will collect samples of surface water, groundwater, sediment, vegetation, and fish tissues from the mine study area. Water, sediment, and bivalve tissue samples will be collected from Iliamna Lake. Soil, surface water, vegetation, and sediment will be collected from the transportation corridor.

This quality assurance project plan (QAPP) provides the requirements for analytical quality assurance (QA) and quality control (QC) for 2007. The QAPP applies to the QA/QC aspects of field sampling and laboratory chemical analysis. The annual Pebble Project study plans (NDM, 2005, 2006, In press) provide a comprehensive description of the environmental baseline studies. Field sampling plans (FSPs) address the specifics of field sampling for each media undergoing chemical analysis. The QA/QC program is divided into two study disciplines:

| Discipline | Media | Study Director |
|---|---|---|
| **Water Quality Studies** | Surface water and groundwater | Loretta Ford, NDM |
| **Trace Elements Studies** | Sediment; vegetation; fish, bivalve, and mammal tissues | Loretta Ford, NDM |

The Pebble Project EBS includes collection of QA/QC samples at a frequency of 10 percent for all media. Primary and QC (field duplicate) samples are analyzed by the primary laboratories. QA (field triplicate) samples are analyzed by the designated QA laboratories. The QA laboratory analyses provide a check on the primary laboratories' accuracy and precision throughout the project. Primary and QA laboratories and the media they are responsible for are identified in Table 1-1. Table 1-2 summarizes contact information for the Pebble Project laboratories. Field teams are responsible for collection of QA/QC samples in the field. Shaw is responsible for shipment of samples to the appropriate laboratories.

**TABLE 1-1**
**Summary of Primary and QA Analytical Laboratories for Environmental Baseline Studies**

| Media | Primary Laboratories | QA Laboratories |
|---|---|---|
| Surface water and groundwater (all parameters except low-level mercury) | SGS – Anchorage, AK<br>ACZ – Steamboat Springs, CO [1] | CAS – Kelso, WA |
| Surface water and groundwater (low-level mercury only) | TA – Portland, OR | CAS – Kelso, WA |
| Sediment/soil [2] | SGS – Anchorage, AK<br>ACZ – Steamboat Springs, CO | CAS – Kelso, WA |
| Fish, bivalve, and mammalian tissue | CAS – Kelso, WA | STL – Tacoma, WA |
| Vegetation | CAS – Kelso, WA | STL – Tacoma, WA |

*Notes:*
*1. Surface water seep samples and leachate samples from in situ rock drainage study (SRK)*
*2. CN, Cl, F, SO4, NH3, metals, Hg*
*ACZ = ACZ Laboratories, Inc.*
*CAS = Columbia Analytical Services, Inc.*
*SGS = SGS Environmental Services, Inc.*
*STL = Severn Trent Laboratories*
*TA = Test America, Inc.*

**TABLE 1-2**
**Laboratory Contact Information**

| | |
|---|---|
| Karen Waak<br>SGS Environmental Services, Inc.<br>200 W. Potter Dr.<br>Anchorage, AK 99518<br>907-562-2343 phone, 907-550-3203 direct<br>907-561-5301 fax<br>Karen.Waak@sgs.com | Lynda Huckestein<br>Columbia Analytical Services, Inc.<br>1317 S. 13th Avenue<br>Kelso, WA 98626<br>360-501-3358 direct phone<br>360-636-1068 fax<br>lhuckestein@kelso.caslab.com |
| Crystal Jones<br>Test America, Inc.<br>9405 SW Nimbus Ave.<br>Beaverton, OR 97008<br>503-906-9233 direct phone<br>503-906-9210 fax<br>cjones@testamericainc.com | Mike Priebe (local contact)<br>Test America, Inc.<br>2000 W. International Airport Road, Suite A10<br>Anchorage, Alaska 99502<br>907-563-9200 phone, 907-317-3412 cell<br>907-563-9210 fax<br>mpriebe@testamericainc.com |
| Terri Torres<br>Severn Trent Laboratories—Seattle<br>5755 8th Street East<br>Tacoma, WA 98424<br>253-922-2310<br>terri.torres@testamericainc.com | Sue Webber<br>ACZ Laboratories, Inc.<br>2773 Downhill Drive<br>Steamboat Springs, CO 80487<br>800-334-5493, x110<br>suew@acz.com |

As described in Table 1-3, NDM's team of technical consultants will collect all field samples for laboratory analysis. HDR has been selected to collect surface water, sediment, bivalve, and fish tissues for the mine study area/Iliamna Lake studies. SLR has been selected to collect sediment, soil, vegetation, and groundwater samples from the mine study area. BEESC will collect surface water, sediment, soil, and vegetation from the transportation corridor. Surface water and groundwater samples from small pools in the mine study area will be collected by 3PP. ABR will collect mammalian tissue in the mine study area. Shaw will provide analytical QA/QC management for the project. Key personnel and their roles are described below in Table 1-3 and identified in the organizational chart (Figure 1-1).

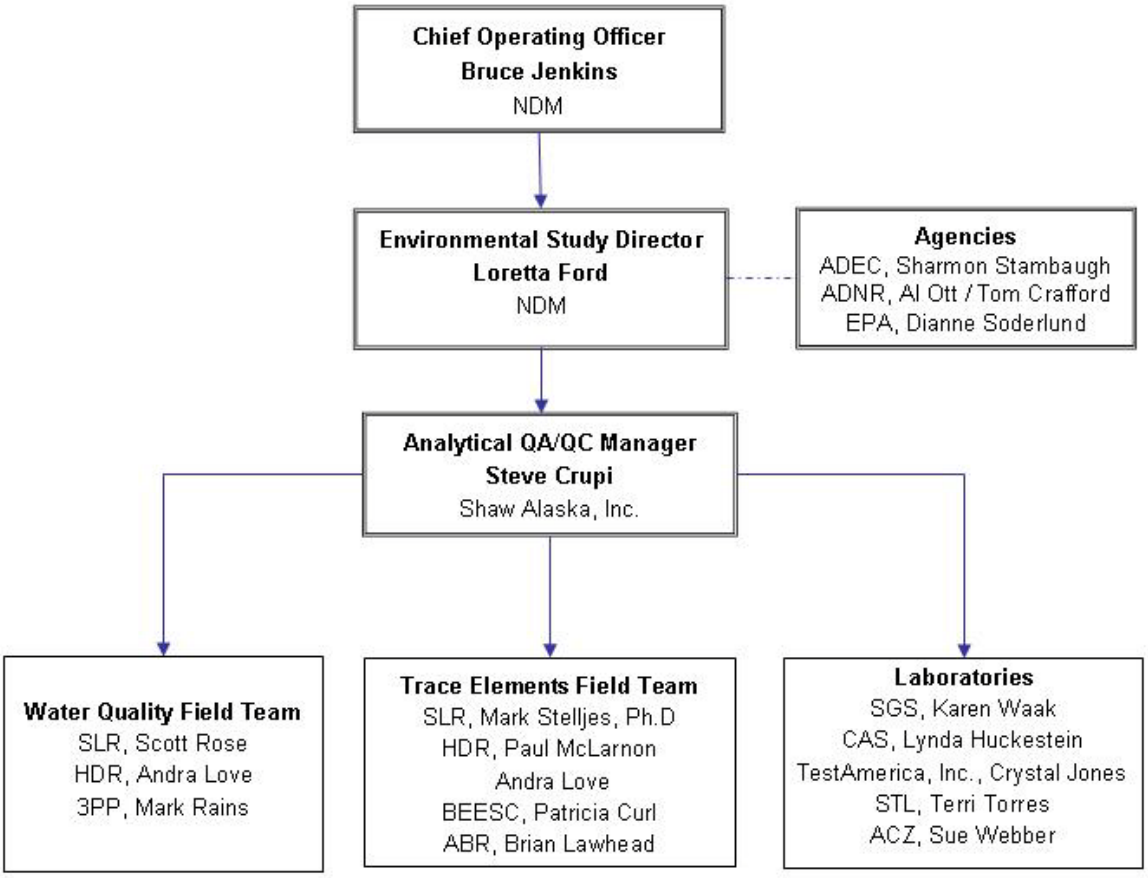
**TABLE 1-3**
**Summary of Pebble Project EBS Key Personnel and Roles**

| Personnel | Responsibilities |
|---|---|
| **NORTHERN DYNASTY MINES INC.** | |
| Bruce Jenkins, Chief Operating Officer | Responsible for development and execution of overall project scope and schedule. |
| Loretta Ford, Environmental Study Director, Trace Elements and Water/Aquatics Studies | Provides oversight of project team, deliverables, and schedule. Responsible for oversight of sample collection and analysis of all sampled media. |
| **SHAW ALASKA, INC.** | |
| Steven R. Crupi, Analytical QA/QC Manager | Responsible for preparation of QAPP and review of laboratory data and deliverables to ensure technical and quality requirements stipulated by regulatory agencies and NDM are met. |
| ***Field Teams*** | |
| **SLR**, Mark Stelljes, | General oversight of Trace Element Program (mine study area and transportation corridor), including collection of soil, sediment, and vegetation samples |
| **SLR**, Scott Rose | Responsible for collection of groundwater samples for the mine study area. |
| **HDR**, Andra Love | Responsible for collection of surface water and sediment for the mine study area. |
| **HDR**, Paul McLarnon | Responsible for collection of fish tissues for the mine study area. |
| **HDR**, Andra Love | Responsible for collection of bivalve tissues, sediment, and water samples from Iliamna Lake. |
| **BEESC**, Patricia Curl | Responsible for collection of surface water, sediment, soil, and vegetation samples from transportation corridor. |
| **3PP, Inc.**, Mark Rains | Responsible for small pools sampling in the mine study area. |
| **ABR**, Brian Lawhead | Responsible for oversight of the mammalian tissue collection activities. |
| ***Laboratories*** | |
| **SGS Environmental Services, Inc.,** Karen Waak, Project Chemist | Responsible for executing and reporting laboratory scope of work for primary and QC water (inorganics and organics) and sediment samples collected by field teams. |
| **ACZ Laboratories, Inc.,** Sue Webber, Project Chemist | Responsible for executing and reporting laboratory scope of work for primary and QC water (inorganics and organics) and sediment samples collected by field teams |
| **Columbia Analytical Services, Inc.,** Lynda Huckestein, Project Chemist | Responsible for executing and reporting laboratory scope of work for primary fish, bivalve, mammalian, and vegetation tissues and QA water and sediment samples collected by field teams. |
| **Test America, Inc.** Crystal Jones, Project Chemist | Responsible for executing and reporting laboratory scope of work for primary water (low level Hg) samples. |
| **Severn Trent Laboratories** Terri Torres, Project Chemist | Responsible for executing and reporting laboratory scope of work for QA fish, bivalve, mammalian, and vegetation samples collected by field teams. |

**TABLE 1-3**
**Summary of Pebble Project EBS Key Personnel and Roles**

| Personnel | Responsibilities |
|---|---|
| ***Agencies*** | |
| **ADEC**<br>Sharmon Stambaugh | <br>Environmental Program Manager III |
| **Alaska Dept. of Natural Resources**<br>Al Ott<br>Tom Crafford | <br>Manager, Office of Habitat Management and Permitting<br>Manager, Large Mine Permitting Team |
| **EPA**<br>Dianne Soderlund | <br>Project Manager |

**Figure 1-1**
**Pebble Project Analytical Chemistry Organization Chart**



## 1.4 Project Background and Objectives

Environmental baseline studies are being conducted to develop baseline data for comparison to future conditions (e.g., during construction, operations, and closure) for the Pebble Project, as outlined in the proposed study plans (NDM, 2005, 2006, In press).

### 1.4.1 Background

The Pebble Project is a proposed open-pit mining operation of a copper, gold, molybdenum, and silver deposit located in southwestern Alaska. NDM has commenced extensive study programs to collect engineering, environmental, and socioeconomic data necessary for a feasibility study and for the preparation of applications for state and federal permits.

NDM considers environmental stewardship one of the cornerstones to pursuing the development of the Pebble Project. This involves diligent characterization of the existing conditions related to the environment in the area of the project and their incorporation into the project design and operation.

### 1.4.2 Objectives of the Program

NDM is in the process of evaluating the Pebble Project and is performing environmental baseline studies as part of this evaluation. The overall objective of the environmental baseline studies is to characterize the environment in the area that will be potentially affected by development of the Pebble Project. The data collected also can be used in conjunction with future monitoring programs to evaluate long-term trends for National Environmental Policy Act (NEPA) activities and permitting.

Specific objectives for the water-quality and trace elements programs for the mine study area and transportation corridor are described below.

#### 1.4.2.1 Objectives of Water Quality Program

Water-chemistry baseline studies will include collection and analysis of samples of surface water, groundwater, and water from seeps and small pools. The main objectives of these studies are as follows:

- Collect baseline data to provide defensible documentation of the naturally occurring levels and spatial and temporal variability of trace elements in surface water and groundwater.
- Define the chemical characteristics of groundwater currently used for drinking water.
- Evaluate sources that could be used for make-up water.
- Provide a database for the site water chemistry and site loading models for project design and assessment of possible environmental effects.
- Characterize two types of pools—perched precipitation pools and groundwater flow-through pools—as part of the wetlands study.
- Collect stage and hydraulic-head measurements to evaluate pool hydrodynamics.
- Develop the baseline for the evaluation of possible environmental effects during construction, operation, and closure.
- Provide data to compliment the evaluation of site geochemistry.

This information is key to understanding current conditions and trends. The baseline water chemistry data also are important for determining if site-specific water-chemistry standards are required for waterbodies in the study areas.

#### 1.4.2.2 Objectives of Trace Elements Program

Samples of surface soil, sediment, vegetation, bivalve, and fish tissues (muscle) will be collected and analyzed for trace elements. The objectives of the trace elements study are as follows:

- Collect baseline data to provide defensible documentation of the natural levels of trace elements and spatial and temporal variability of anions in surface soil, sediments, and vegetation prior to mining operations.
- Evaluate naturally occurring biogenic fingerprints in surface soil associated with petroleum hydrocarbon analysis to support long-term site-monitoring objectives.
- Determine organic content in surface soils to support long-term site-monitoring objectives.
- Collect baseline data to provide defensible documentation of the natural levels of trace elements in bivalve and fish tissue prior to mining operations.
- Collect baseline data to provide defensible documentation of the natural levels of trace elements in mammalian tissue, hair, and blood prior to mining operations.

This information is key to understanding current conditions and also will support long-term site-monitoring objectives.

## 1.5 Project/Task Description and Schedule

This section provides a project description, a summary of all work to be performed, a description of products to be produced, and the schedule for implementation.

Pebble Project is located in southwestern Alaska, northwest of the community of Iliamna. Field teams will be transported to the study areas by air from Iliamna.

### 1.5.1 Task Descriptions

The tasks covered by this QAPP include field sampling, laboratory analysis and reporting, and data validation. Each task is discussed briefly below.

#### 1.5.1.1 Task 1—Field Sampling

NDM's sampling approach is discussed in the Pebble Project study plans (NDM, 2005, 2006, In press) and in this QAPP. Table 1-4 summarizes the number of sample planned for 2007.

#### 1.5.1.2 Task 2—Laboratory Analysis and Reporting

Samples collected from the mine study area and transportation corridor will be analyzed for the parameters detailed in Table 1-5. Laboratories will provide hardcopy and electronic reports to the Analytical QA/QC Manager. Reports will include data summaries, QC results, and calibration data. Shaw will validate the laboratory data. The validated data will then be uploaded into the NDM database for access by data users.

**TABLE 1-4**
**2007 Estimated Number of Samples**

| Consultant | Area | Media | Primary Samples | MS/MSD Samples | QC Duplicate Samples | QA Triplicate Samples | Total Primary Lab Samples | Total QA Lab Samples |
|---|---|---|---|---|---|---|---|---|
| HDR | Mine | Surface Water | 396 | 40 | 40 | 40 | 476 | 40 |
| HDR | Mine | Surface Water, Seeps | 398 | 40 | 40 | 40 | 478 | 40 |
| HDR | Mine | Surface Water, Ponds | 12 | 2 | 2 | 2 | 16 | 2 |
| HDR | Mine | Sediment, Ponds | 12 | 2 | 2 | 2 | 16 | 2 |
| HDR | Mine | Sediment | 33 | 4 | 4 | 4 | 41 | 4 |
| HDR | Mine | Fish[1] | 140 | 14 | 14 | 14 | 154 | 14 |
| HDR | Iliamna Lk. | Surface Water | 90 | 9 | 9 | 9 | 108 | 9 |
| HDR | Iliamna Lk. | Bivalve Tissue[1] | 3 | 1 | 1 | 1 | 5 | 1 |
| SLR | Mine | Groundwater | 166 | 17 | 17 | 17 | 200 | 17 |
| SLR | Mine | Sediment, Pond | 39 | 4 | 4 | 4 | 47 | 4 |
| SLR | Mine | Soil | 22 | 3 | 3 | 3 | 28 | 3 |
| SLR | Mine | Aquatic Vegetation, Pond[1] | 44 | 5 | 5 | 5 | 54 | 5 |
| SLR | Mine | Terrestrial Vegetation[1, 2] | 176 | 18 | 18 | 18 | 212 | 18 |
| BEESC | TC | Surface Water | 4 | 1 | 1 | 1 | 6 | 1 |
| BEESC | TC | Soil | 2 | 1 | 1 | 1 | 4 | 1 |
| BEESC | TC | Terrestrial Vegetation[1] | 18 | 2 | 2 | 2 | 22 | 2 |
| BEESC | TC | Sediment | 4 | 1 | 1 | 1 | 6 | 1 |
| SRK | Mine | Leachate Water (In Situ Rock Drainage Study) | 72 | 8 | 8 | 8 | 88 | 8 |
| 3PP | Mine | Surface Water and Groundwater, Small Pools | 206 | 11 | 21 | 21 | 238 | 21 |

*Key: MS = matrix spike; MSD = matrix spike duplicate; TC = transportation corridor.*

*1. Vegetation, fish, and bivalve QA/QC samples are prepared by the primary laboratory (CAS) which will ship QA samples to the QA laboratory (STL) for these media.*

*2. Assumes four species per location, plus two berry samples per location.*

**TABLE 1-5**
**2007 Summary of Laboratory Analyses**

| Parameter | Method (Water) | Method (Solids) | Surface and Seep Water | Groundwater | Surface Soil | Sediment | Vegetation | Fish/Bivalve/ Mammalian Tissue |
|---|---|---|---|---|---|---|---|---|
| ***Inorganics*** | | | | | | | | |
| pH | SM4500H+ B | | X | X | | | | |
| Specific Conductance | SM2510B | | X | X | | | | |
| Acidity | SM2310B | | X | X | | | | |
| Alkalinity | SM2320B | | X | X | | | | |
| Ammonia as N | SM4500NH3-G | SM4500NHG3G | X | X | X | X | | |
| Chloride | E300.0 | E300.0 | X | X | X | X | | |
| Cyanide, total | SM4500CN-E | SM4500CN-E | X | X | X | X | X | |
| Cyanide, WAD | SM4500-I | | X | X | | | | |
| Cyanide, Available Low-level | E1677 | | X | X | | | | |
| Fluoride | E300.0 | E300.0 | X | X | X | X | | |
| Hardness | SM2304C | | X | X | | | | |
| Nitrate + Nitrite | SM4500-NO3F | | X | X | | | | |
| Phosphorus, total | E365.3 | | X | X | | | | |
| Sulfate | E300.0 | E300.0M | X | X | X | X | | |
| Thiocyanate | SM4500CN-M | | X | X | | | | |
| TDS | SM2540C | | X | X | | | | |
| TSS | SM2540D | | X | X | | | | |
| ***Metals*** | | | | | | | | |
| Low-level Mercury | E1631 | E1631 | X | X | | | | X |
| Mercury | | SW7471A | | | X | X | X | X[1] |
| Metals[2] | E200.7/200.8 | SW6010B/6020 | X | X | X | X | X | X |

**TABLE 1-5**
**2007 Summary of Laboratory Analyses**

| Parameter | Method (Water) | Method (Solids) | Surface and Seep Water | Groundwater | Surface Soil | Sediment | Vegetation | Fish/Bivalve/ Mammalian Tissue |
|---|---|---|---|---|---|---|---|---|
| ***Organics[3]*** | | | | | | | | |
| TOC | | ASTM D4129-82M | | | X | | | |
| DOC | SM5310 | | X[4] | | | | | |
| DRO/RRO | AK102/103 | | X | | | | | |
| PCBs | E508 | | X | | | | | |
| VOCs | SW8260B | | X | | | | | |
| SVOCs | SW8270C | | X | | | | | |

*Notes:*
*1. Mercury for mammalian tissue samples will be analyzed by Method SW7471A*
*2. Target Analytes Lists:*
*For water samples analyzed for total and dissolved metals: Al, Sb, As, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Si (dissolved only), Ag, Na, Tl, Sn, V, Zn.*
*For fish, bivalve, and mammalian tissue: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Mo, Ni, Se, Ag, Tl, and Zn.*
*3. Iliamna Lake and streams sediment only*
*4. Stream samples only*

*Key:*
*DOC = dissolved organic carbon*
*DRO = diesel-range organics*
*E = EPA (1983, 1991 and 2001b)*
*M = modified*
*PCBs = polychlorinated biphenyls*
*RRO = residual-range organics*
*SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition. 1998*
*SVOCs = semivolatile organic compounds*
*SW = EPA (1993)*
*TDS = total dissolved solids*
*TOC = total organic carbon*
*TSS = total suspended solids*
*VOCs = volatile organic compounds*
*WAD = weak acid dissociable*

#### 1.5.1.3 Task 3—Data Validation and Data Quality Assurance Reports

Laboratory data will be reviewed using the U.S. Environmental Protection Agency's (EPA's) *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA, 1999); *Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review, Final* (EPA, 2001a), and *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, Final* (EPA, 2002a). These guidelines will be modified as needed for the specific analytical methods being used. Data quality assurance reports (DQARs) will be prepared by the Analytical QA/QC Manager and submitted to NDM. These reports will discuss analytical QA/QC results and potential effects to the project based on the results of data validation.

### 1.5.2 Schedule

Field sampling for 2007 will be conducted according to the schedule in Table 1-6. Laboratories have been contracted to deliver lab reports to Shaw within 30 days from sample receipt. Note that delays in this schedule may occur during the height of field season. Separate DQARs will be prepared by Shaw for samples collected in 2007 for each media from the mine study and transportation corridor areas.

## 1.6 Quality Objectives and Criteria

The principal objectives of the QA program are to maintain an acceptable level of quality for field activities, sample collection, sample handling, laboratory analysis, and data analysis and to document the quality of data at each processing level. This program clearly identifies major aspects of the project requiring specific quality control and demonstrates that quality control is a major focus for this project.

QA/QC requirements are established in this QAPP to achieve the project objectives for the data users. Applicable QC procedures, quantitative target limits, and level of effort for assessing the data quality are dictated by the intended use of the data and the nature of the required field and analytical methods. The intent is to collect data of known and sufficient quality to allow NDM to rely on accurate and precise environmental baseline data.

Federal and state levels of concern (for example, ambient water-quality criteria or maximum contaminant levels) are used as benchmark criteria. Analytical methods were selected to allow detection of chemical constituents at or below benchmark criteria wherever possible. Note that the benchmark criteria are not necessarily based on enforceable standards. Both EPA and Alaska Department of Environmental Conservation (ADEC) standards were reviewed. Benchmark criteria for water are based on the following references: *Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances*, May 15, 2003 (ADEC, 2003); EPA fact sheet *Revised National Recommended Water Quality Criteria*, December 2003 (EPA, 2003); and *National Recommended Water Quality Criteria*, November 2002 (EPA, 2002b). A summary of field QA/QC samples is given in Table 1-7. The list of parameters and the associated benchmark criteria for water and for soil and sediment are summarized in Tables 1-8 and 1-9, respectively. The tables present the lowest of the three water-quality standards. Parameters included in the environmental baseline study but not shown in the tables do not have benchmark criteria.

**TABLE 1-6**
**2007 Field Sampling Schedule**

| Consultant | Area | Media | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HDR | Mine | Surface Water (Streams) | X | X | X | X | X | X | X | X | X | X | X | X |
| HDR | Mine | Surface Water (Seeps) | | | X | | X | | X | | X | | X | |
| HDR | Mine | Surface Water/ Sediment (Ponds) | | | | | | | X | | | | | |
| HDR | Mine | Sediment | | | | | | X | | | | | | |
| HDR | Mine | Fish Tissue | | | | | | | | X | | | | |
| HDR | Iliamna Lk | Water | | | | | X | X | X | X | X | X | | |
| HDR | Iliamna Lk | Bivalve Tissue | | | | | | X | | | | | | |
| SLR | Mine | Groundwater | | | X | | X | | | X | | | X | |
| SLR | Mine | Soil | | | | | | | X | | | | | |
| SLR | Mine | Vegetation, Terrestrial | | | | | | | X | X | | | | |
| SLR | Mine | Vegetation, Aquatic | | | | | | | X | X | | | | |
| SLR | Mine | Sediment, Aquatic | | | | | | | X | X | | | | |
| BEESC | Transport. Corridor | Surface Water/ Sediment/Soil/ Vegetation | | | | | | | | X | | | | |
| SRK | Mine | Leachate Water (Rock Drainage) | | | | | | | X | X | X | X | | |
| 3PP | Mine | Small Pools | | | | | | | | X | | | | |
| ABR | All | Mammalian Tissue | | | | X | | X | X | X | | | | |

**TABLE 1-7**
**2007 Summary of Field QA/QC Samples**

| Type of Field QA/QC Sample | Analysis | Frequency | Sampling Events |
|---|---|---|---|
| Field duplicate (QC sample) | All parameters | 10 percent | All |
| Field triplicate (QA sample) | All parameters | 10 percent | All |
| Deionized water blank | Total metals | 1 per sampling event | Surface water and groundwater |
| Equipment blank | Dissolved metals | 5 percent | Surface water, groundwater, and sediment/soil |
| Trip blank | Low-level Hg | 1 per cooler | Surface water and groundwater |

**TABLE 1-8**
**Benchmark Criteria for Water for the Environmental Baseline Studies**

| Analyte | Lowest Surface or Drinking Water Criteria |
|---|---|
| ***Inorganics in Water (milligrams per liter [mg/L])*** | |
| Alkalinity | 20 |
| Ammonia as N | 0.18 |
| Chloride | 230 |
| Cyanide-total | 0.0052 |
| Fluoride | 1 |
| Nitrate + Nitrite | 10 |
| Sulfate | 250 |
| Total Dissolved Solids | 500 |
| Total Suspended Solids | 30 |
| ***Volatile Organic Compounds (micrograms per liter [µg/L])*** | |
| 1,1-Dichloroethylene | 7 |
| 1,1,1-Trichloroethane | 200 |
| 1,1,2-Trichloroethane | 5 |
| 1,2-Dichloroethane | 5 |
| 1,2-Dichloropropane | 5 |
| 1,2,4-Trichlorobenzene | 7 |
| Benzene | 5 |
| Carbon tetrachloride | 5 |
| Cis-1,2-Dichloroethylene | 70 |
| Dichloromethane | 5 |
| Ethylbenzene | 700 |
| o-Dichlorobenzene | 600 |
| Para-Dichlorobenzene | 75 |

**TABLE 1-8**
**Benchmark Criteria for Water for the Environmental Baseline Studies**

| Analyte | Lowest Surface or Drinking Water Criteria |
|---|---|
| Pentachlorophenol | 1 |
| Styrene | 100 |
| Tetrachlorobenzene | 5 |
| Toluene | 1,000 |
| Vinyl Chlorides | 2 |
| Total Xylenes | 10,000 |
| ***Metals in Water (µg/L)*** | |
| Al | 87 |
| Sb | 5.6 |
| As | 10 |
| Ba | 1,000 |
| Be | 4 |
| Cd | 0.1 |
| Cr | 24 |
| Cr +6 (6) | 11 |
| Cu | 2.7 |
| Fe | 300 |
| Pb | 0.54 |
| Mn | 50 |
| Hg | 0.05 |
| Mo | 10 |
| Ni | 16 |
| Se | 4.6 |
| Na[1] | 250,000 |
| Ag | 0.32 |
| Tl | 0.24 |
| V | 100 |
| Zn | 36 |
| ***Pesticides (µg/L)*** | |
| 4,4'-DDT | 0.001 |
| Aldrin | 3.0 |
| Chlordane | 0.0043 |
| Dieldrin | 0.056 |
| Endosulfan I | 0.056 |
| Endosulfan II | 0.056 |

**TABLE 1-8**
**Benchmark Criteria for Water for the Environmental Baseline Studies**

| Analyte | Lowest Surface or Drinking Water Criteria |
|---|---|
| Endrin | 0.036 |
| Endrin aldehyde | 0.76 |
| gamma-BHC (Lindane) | 0.2 |
| Heptachlor | 0.0038 |
| Heptachlor epoxide | 0.0038 |
| Lindane | 0.0002 |
| Methoxychlor | 0.03 |
| Toxaphene | 0.0002 |
| ***Semivolatile Organic Compounds (µg/L)*** | |
| Benzo[a]pyrene | 0.2 |
| Di(2-ethylhexyl)adipate | 400 |
| Di(2-ethylhexyl)phthalate | 6 |
| Hexachlorobenzene | 1 |
| Hexachlorocyclopentadiene | 50 |

*Notes:*
*1. ADEC secondary maximum contaminant level for sodium*

**TABLE 1-9**
**Benchmark Criteria for Soil and Sediment for the Environmental Baseline Studies**

| Analyte | Lowest Soil Criteria | Lowest Sediment Criteria |
|---|---|---|
| ***Petroleum Hydrocarbons (milligrams per kilogram [mg/kg]) soil only*** | | |
| Gasoline-range Organics | 300 | None |
| Diesel-range Organics | 250 | None |
| Residual-range Organics | 11,000 | None |
| Benzene | 0.008 | None |
| Toluene | 5.4 | None |
| Ethylbenzene | 5.5 | 0.004 |
| Xylenes | 0.1 | 0.004 |
| ***Inorganics (mg/kg)*** | | |
| Cyanide, Total | 27 | None |
| ***Metals (mg/kg)*** | | |
| Al | None | 18,000 |
| Sb | 3.6 | 3 |
| As | 2 | 5.9 |
| Ba | 1,100 | 48 |
| Be | 42 | None |
| Cd | 5 | 0.583 |
| Cr | $>10^6$ | 36.2 |
| Co | None | 10 |
| Cu | None | 18.7 |
| Fe | None | 40,000 |
| Pb | 400 | 30.2 |
| Mn | None | 260 |
| Hg | 1.4 | 0.13 |
| Ni | 87 | 15.9 |
| Se | 3.5 | 1.0 |
| Ag | 21 | 0.73 |
| Sn | None | 3.4 |
| V | 3,400 | 57 |
| Zn | 9,100 | 89 |

Benchmark criteria for soil and sediment are based on the following references:

- Alaska Administrative Code 18 AAC 75, Alaska Department of Environmental Conservation Soil Cleanup Levels, Under 40-Inch Zone.

- National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables, updated September 1999. Values in the tables are the lowest among the threshold effects level (TEL), probable effects level (PEL), and upper effects level for freshwater sediment and among TEL (effects range—low) and PEL (effects range—medium).

Additional confirmation analysis for weak acid dissociable (WAD) cyanide has been included in the analysis scheme for 2007 data collection for surface water and groundwater. Frontier Geoscience laboratory in Seattle, Washington, will perform cyanide (available) confirmation analysis by EPA Method 1677 when WAD cyanide in a primary sample is reported at a value greater than or equal to the method reporting limit (MRL) and total cyanide is reported at a value greater than or equal to the method detection limit (MDL).

### 1.6.1 Data Quality Measurements

The quality of laboratory data is measured by the precision, accuracy, representativeness, comparability, and completeness of the data. Data quality objectives (DQOs) for the Pebble Project analytical parameters and sample media are provided in Tables 1-10 through 1-15.

**TABLE 1-10**
**Data Quality Objectives, Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***Inorganics—Surface Water*** | | | | | |
| pH | N/A | pH units | SM4500H$^+$B | N/A | N/A |
| Specific Conductance | 1 | µmhos/cm | SM2510B | N/A | 20 |
| Acidity | 10 | mg/L | SM2310B | 90-110 | 25 |
| Alkalinity | 10 | mg/L | SM2320B | 90-110 | 20 |
| Ammonia as N | 0.1 | mg/L | SM4500NH3-G | 75-125 | 25 |
| Chloride | 0.2 | mg/L | E300.0 | 90-110 | 20 |
| Cyanide, total | 0.005 | mg/L | SM4500CN-E | 75-125 | 25 |
| Cyanide, WAD | 0.005 | mg/L | SM4500CN-I | 75-125 | 25 |
| Dissolved Organic Carbon | 0.5 | mg/L | SM5310 | 75-125 | 25 |
| Low-level Cyanide, available | 0.005 | mg/L | E1677 | 80-120 | 25 |
| Fluoride | 0.2 | mg/L | E300.0 | 90-110 | 20 |
| Hardness, total | N/A | mg/L | SM2340B | N/A | N/A |
| Nitrate + Nitrite | 0.1 | mg/L | SM4500-NO3 F | 90-110 | 20 |
| Phosphorus, total | 0.01 | mg/L | E365.3 | 75-125 | 25 |
| Sulfate | 0.2 | mg/L | E300.0 | 90-110 | 20 |
| Thiocyanate | 1 | mg/L | SM4500CN-M | 75-125 | 20 |
| Total Dissolved Solids | 10 | mg/L | SM2540C | N/A | 25 |
| Total Suspended Solids | 5 | mg/L | SM2540D | N/A | 20 |

**TABLE 1-10**
**Data Quality Objectives, Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***Inorganics—Seep Water*** | | | | | |
| pH | N/A | pH units | SM4500H$^{+}$B | N/A | N/A |
| Specific Conductance | 1 | µmhos/ cm | SM2510B | N/A | 20 |
| Acidity | 2 | mg/L | SM2310B | N/A | 25 |
| Alkalinity | 2 | mg/L | SM2320B | N/A | 20 |
| Ammonia as N | 0.05 | mg/L | SM4500NH3-G | 75-125 | 25 |
| Chloride | 0.5 | mg/L | E300.0 | 90-110 | 20 |
| Cyanide, total | 0.005 | mg/L | SM4500CN-E | 75-125 | 25 |
| Cyanide, WAD | 0.005 | mg/L | SM4500CN-I | 75-125 | 25 |
| Low-level Cyanide, available | 0.005 | mg/L | E1677 | 80-120 | 25 |
| Fluoride | 0.1 | mg/L | E300.0 | 90-110 | 20 |
| Hardness, total | N/A | mg/L | SM2340B | N/A | N/A |
| Nitrate + Nitrite | 0.02 | mg/L | SM4500-NO3 F | 90-110 | 20 |
| Phosphorus, total | 0.01 | mg/L | E365.3 | 75-125 | 25 |
| Sulfate | 0.5 | mg/L | E300.0 | 90-110 | 20 |
| Thiocyanate | 0.1 | mg/L | SM4500CN-M | 75-125 | 20 |
| Total Dissolved Solids | 10 | mg/L | SM2540C | N/A | 25 |
| Total Suspended Solids | 5 | mg/L | SM2540D | N/A | 20 |
| ***Metals (Total and Dissolved)—Surface Water*** | | | | | |
| Hg, low-level (total only for surface water) | 0.005 | µg/L | E1631 | 71-125 | 20 |
| Al | 2.0 | µg/L | E200.8 | 85-115 | 20 |
| Sb | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| As | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Ba | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| Be | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| Bi | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| B | 5 | µg/L | E200.8 | 85-115 | 20 |
| Cd | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| Ca[1] | 50 | µg/L | E200.8 | 85-115 | 20 |
| Cr | 0.2 | µg/L | E200.8 | 85-115 | 20 |
| Co | 0.02 | µg/L | E200.8 | 85-115 | 20 |
| Cu | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| Fe[1] | 20 | µg/L | E200.7 | 85-115 | 20 |

**TABLE 1-10**
**Data Quality Objectives, Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Pb | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| Mg[1] | 20 | µg/L | E200.8 | 85-115 | 20 |
| Mn | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| Mo | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| Ni | 0.2 | µg/L | E200.8 | 85-115 | 20 |
| K[1] | 50 | µg/L | E200.8 | 85-115 | 20 |
| Se | 1.0 | µg/L | E200.8 | 85-115 | 20 |
| Si (dissolved only) | 100 | µg/L | E200.7 | 85-115 | 20 |
| Ag | 0.02 | µg/L | E200.8 | 85-115 | 20 |
| Na[1] | 100 | µg/L | E200.8 | 85-115 | 20 |
| Tl | 0.02 | µg/L | E200.8 | 85-115 | 20 |
| Sn | 0.2 | µg/L | E200.8 | 85-115 | 20 |
| V | 1 | µg/L | E200.8 | 85-115 | 20 |
| Zn | 1 | µg/L | E200.8 | 85-115 | 20 |
| ***Metals (Total and Dissolved)—Seep Water*** | | | | | |
| Hg, low level (total only for surface water) | 0.005 | µg/L | E1631 | 71-125 | 20 |
| Al | 1.0 | µg/L | E200.8 | 85-115 | 20 |
| Sb | 0.4 | µg/L | E200.8 | 85-115 | 20 |
| As | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Ba | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| Be | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| Bi | 100 | µg/L | E200.7 | 85-115 | 20 |
| B | 10 | µg/L | E200.7 | 85-115 | 20 |
| Cd | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| Ca[1] | 200 | µg/L | E200.7 | 85-115 | 20 |
| Cr | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| Co | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| Cu | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Fe[1] | 20 | µg/L | E200.7 | 85-115 | 20 |
| Pb | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| Mg[1] | 200 | µg/L | E200.7 | 85-115 | 20 |
| Mn | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Mo | 0.5 | µg/L | E200.8 | 85-115 | 20 |

**TABLE 1-10**
**Data Quality Objectives, Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Ni | 0.6 | µg/L | E200.8 | 85-115 | 20 |
| K[1] | 300 | µg/L | E200.7 | 85-115 | 20 |
| Se | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| Si (dissolved only) | 428 | µg/L | E200.7 | 85-115 | 20 |
| Ag | 0.05 | µg/L | E200.8 | 85-115 | 20 |
| Na[1] | 300 | µg/L | E200.7 | 85-115 | 20 |
| Tl | 0.1 | µg/L | E200.8 | 85-115 | 20 |
| Sn | 100 | µg/L | E200.7 | 85-115 | 20 |
| V | 0.2 | µg/L | E200.8 | 85-115 | 20 |
| Zn | 2 | µg/L | E200.8 | 85-115 | 20 |

*Notes:*
*1. May be analyzed by inductively coupled plasma (200.7).*

*Key:*
*E = EPA (1983, 1991, and 2001b).*
*µmhos/cm = micromhos per centimeter.*
*N/A = not applicable*
*SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1998.*

**TABLE 1-11**
**Data Quality Objectives, Iliamna Lake Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***PCBs*** | | | | | |
| Aroclor 1016 | 0.1 | µg/L | E508 | 69-115 | 25 |
| Aroclor 1221 | 0.1 | µg/L | E508 | N/A | 25 |
| Aroclor 1232 | 0.1 | µg/L | E508 | N/A | 25 |
| Aroclor 1242 | 0.1 | µg/L | E508 | N/A | 25 |
| Aroclor 1248 | 0.1 | µg/L | E508 | N/A | 25 |
| Aroclor 1254 | 0.1 | µg/L | E508 | N/A | 25 |
| Aroclor 1260 | 0.1 | µg/L | E508 | 61-110 | 25 |
| ***Volatile Organic Compounds*** | | | | | |
| 1,1,1,2-Tetrachloroethane | 0.5 | µg/L | SW5030/8260B | 81-120 | 20 |
| 1,1,1-Trichloroethane | 1 | µg/L | SW5030/8260B | 82-120 | 20 |
| 1,1,2,2-Tetrachloroethane | 0.5 | µg/L | SW5030/8260B | 80-123 | 20 |
| 1,1,2-Trichloroethane | 1 | µg/L | SW5030/8260B | 86-116 | 20 |
| 1,1-Dichloroethane | 1 | µg/L | SW5030/8260B | 81-120 | 20 |
| 1,1-Dichloroethene | 1 | µg/L | SW5030/8260B | 70-130 | 20 |
| 1,1-Dichloropropene | 1 | µg/L | SW5030/8260B | 80-121 | 20 |
| 1,2,3-Trichlorobenzene | 1 | µg/L | SW5030/8260B | 86-124 | 20 |
| 1,2,3-Trichloropropane | 1 | µg/L | SW5030/8260B | 86-118 | 20 |
| 1,2,4-Trichlorobenzene | 1 | µg/L | SW5030/8260B | 85-120 | 20 |
| 1,2,4-Trimethylbenzene | 1 | µg/L | SW5030/8260B | 87-117 | 20 |
| 1,2-Dibromo-3-chloropropane | 1 | µg/L | SW5030/8260B | 80-122 | 20 |
| 1,2-Dichlorobenzene | 1 | µg/L | SW5030/8260B | 86-114 | 20 |
| 1,2-Dichloroethane | 0.5 | µg/L | SW5030/8260B | 82-119 | 20 |
| 1,2-Dichloropropane | 1 | µg/L | SW5030/8260B | 88-115 | 20 |
| 1,3,5-Trimethylbenzene | 1 | µg/L | SW5030/8260B | 87-118 | 20 |
| 1,3-Dichlorobenzene | 1 | µg/L | SW5030/8260B | 83-118 | 20 |
| 1,3-Dichloropropane | 0.4 | µg/L | SW5030/8260B | 86-118 | 20 |
| 1,4-Dichlorobenzene | 0.5 | µg/L | SW5030/8260B | 82-121 | 20 |
| 2,2-Dichloropropane | 1 | µg/L | SW5030/8260B | 77-135 | 20 |
| 2-Butanone (MEK) | 10 | µg/L | SW5030/8260B | 67-136 | 20 |
| 2-Chloroethyl vinyl ether | 10 | µg/L | SW5030/8260B | 63-148 | 20 |
| 2-Chlorotoluene | 1 | µg/L | SW5030/8260B | 85-121 | 20 |
| 2-Hexanone | 10 | µg/L | SW5030/8260B | 76-130 | 20 |

**TABLE 1-11**
**Data Quality Objectives, Iliamna Lake Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| 4-Chlorotoluene | 1 | µg/L | SW5030/8260B | 81-126 | 20 |
| 4-Isopropyltoluene | 1 | µg/L | SW5030/8260B | 83-119 | 20 |
| 4-Methyl-2-pentanone (MIBK) | 10 | µg/L | SW5030/8260B | 73-134 | 20 |
| Acetone | 10 | µg/L | SW5030/8260B | 51-135 | 20 |
| Benzene | 0.4 | µg/L | SW5030/8260B | 84-115 | 20 |
| Bromobenzene | 1 | µg/L | SW5030/8260B | 87-115 | 20 |
| Bromochloromethane | 1 | µg/L | SW5030/8260B | 76-126 | 20 |
| Bromodichloromethane | 0.5 | µg/L | SW5030/8260B | 81-120 | 20 |
| Bromoform | 1 | µg/L | SW5030/8260B | 85-126 | 20 |
| Bromomethane | 3 | µg/L | SW5030/8260B | 57-141 | 20 |
| Carbon disulfide | 2 | µg/L | SW5030/8260B | 37-146 | 20 |
| Carbon tetrachloride | 1 | µg/L | SW5030/8260B | 79-132 | 20 |
| Chlorobenzene | 0.5 | µg/L | SW5030/8260B | 88-115 | 20 |
| Chloroethane | 1 | µg/L | SW5030/8260B | 60-133 | 20 |
| Chloroform | 0.4 | µg/L | SW5030/8260B | 86-115 | 20 |
| Chloromethane | 1 | µg/L | SW5030/8260B | 56-125 | 20 |
| Cis-1,2-Dichloroethene | 1 | µg/L | SW5030/8260B | 79-120 | 20 |
| Cis-1,3-Dichloropropene | 0.5 | µg/L | SW5030/8260B | 90-126 | 20 |
| Dibromochloromethane | 0.5 | µg/L | SW5030/8260B | 88-116 | 20 |
| Dibromomethane | 1 | µg/L | SW5030/8260B | 86-119 | 20 |
| Ethylbenzene | 1 | µg/L | SW5030/8260B | 85-120 | 20 |
| Hexachlorobutadiene | 0.6 | µg/L | SW5030/8260B | 81-126 | 20 |
| Isopropylbenzene (Cumene) | 1 | µg/L | SW5030/8260B | 80-120 | 20 |
| Methyl iodide | 1 | µg/L | SW5030/8260B | 65-144 | 20 |
| Methylene chloride | 5 | µg/L | SW5030/8260B | 72-120 | 20 |
| Methyl-t-butyl ether | 5 | µg/L | SW5030/8260B | 83-119 | 20 |
| Naphthalene | 2 | µg/L | SW5030/8260B | 82-126 | 20 |
| n-Butylbenzene | 1 | µg/L | SW5030/8260B | 83-130 | 20 |
| n-Propylbenzene | 1 | µg/L | SW5030/8260B | 87-123 | 20 |
| o-Xylene | 1 | µg/L | SW5030/8260B | 80-120 | 20 |
| p&m-Xylene | 2 | µg/L | SW5030/8260B | 80-120 | 20 |
| Sec-Butylbenzene | 1 | µg/L | SW5030/8260B | 88-125 | 20 |
| Styrene | 1 | µg/L | SW5030/8260B | 84-129 | 20 |
| Tert-Butylbenzene | 1 | µg/L | SW5030/8260B | 86-121 | 20 |

**TABLE 1-11**
**Data Quality Objectives, Iliamna Lake Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Tetrachloroethene | 1 | µg/L | SW5030/8260B | 79-117 | 20 |
| Toluene | 1 | µg/L | SW5030/8260B | 81-115 | 20 |
| trans-1,2-Dichloroethene | 1 | µg/L | SW5030/8260B | 71-127 | 20 |
| trans-1,3-Dichloropropene | 1 | µg/L | SW5030/8260B | 89-125 | 20 |
| Trichloroethene | 1 | µg/L | SW5030/8260B | 82-118 | 20 |
| Trichlorofluoromethane | 1 | µg/L | SW5030/8260B | 72-129 | 20 |
| Vinyl chloride | 1 | µg/L | SW5030/8260B | 50-134 | 20 |
| ***Semivolatile Organics*** | | | | | |
| 1,2,4-Trichlorobenzene | 10 | µg/L | SW3510/8270C | 46-105 | 20 |
| 1,2-Dichlorobenzene | 10 | µg/L | SW3510/8270C | 36-95 | 20 |
| 1,3-Dichlorobenzene | 10 | µg/L | SW3510/8270C | 33-91 | 20 |
| 1,4-Dichlorobenzene | 10 | µg/L | SW3510/8270C | 34-93 | 20 |
| 2,4,5-Trichlorophenol | 10 | µg/L | SW3510/8270C | 57-110 | 20 |
| 2,4,6-Trichlorophenol | 10 | µg/L | SW3510/8270C | 58-115 | 20 |
| 2,4-Dichlorophenol | 10 | µg/L | SW3510/8270C | 52-105 | 20 |
| 2,4-Dimethylphenol | 10 | µg/L | SW3510/8270C | 32-93 | 20 |
| 2,4-Dinitrophenol | 70 | µg/L | SW3510/8270C | 54-130 | 20 |
| 2,4-Dinitrotoluene | 10 | µg/L | SW3510/8270C | 68-120 | 20 |
| 2,6-Dinitrotoluene | 10 | µg/L | SW3510/8270C | 59-115 | 20 |
| 2-Chloronaphthalene | 10 | µg/L | SW3510/8270C | 50-105 | 20 |
| 2-Chlorophenol | 10 | µg/L | SW3510/8270C | 37-96 | 20 |
| 2-Methyl-4,6-dinitrophenol | 50 | µg/L | SW3510/8270C | 69-130 | 20 |
| 2-Methylnaphthalene | 10 | µg/L | SW3510/8270C | 54-105 | 20 |
| 2-Methylphenol (o-Cresol) | 10 | µg/L | SW3510/8270C | 42-102 | 20 |
| 2-Nitroaniline | 10 | µg/L | SW3510/8270C | 50-115 | 20 |
| 2-Nitrophenol | 10 | µg/L | SW3510/8270C | 46-110 | 20 |
| 3&4-Methylphenol (p&m-Cresol) | 20 | µg/L | SW3510/8270C | 47-107 | 20 |
| 3,3-Dichlorobenzidine | 10 | µg/L | SW3510/8270C | 34-110 | 20 |
| 3-Nitroaniline | 10 | µg/L | SW3510/8270C | 42-110 | 20 |
| 4-Bromophenyl-phenylether | 10 | µg/L | SW3510/8270C | 54-115 | 20 |
| 4-Chloro-3-methylphenol | 10 | µg/L | SW3510/8270C | 61-110 | 20 |
| 4-Chloroaniline | 10 | µg/L | SW3510/8270C | 20-110 | 20 |
| 4-Chlorophenyl-phenylether | 10 | µg/L | SW3510/8270C | 59-120 | 20 |

**TABLE 1-11**
**Data Quality Objectives, Iliamna Lake Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| 4-Nitroaniline | 10 | µg/L | SW3510/8270C | 40-120 | 20 |
| 4-Nitrophenol | 50 | µg/L | SW3510/8270C | 48-120 | 20 |
| Acenaphthene | 10 | µg/L | SW3510/8270C | 47-110 | 20 |
| Acenaphthylene | 10 | µg/L | SW3510/8270C | 50-105 | 20 |
| Acetophenone | 10 | µg/L | SW3510/8270C | 10-150 | 30 |
| Aniline | 10 | µg/L | SW3510/8270C | 10-130 | 20 |
| Anthracene | 10 | µg/L | SW3510/8270C | 55-120 | 20 |
| Azobenzene | 10 | µg/L | SW3510/8270C | 55-123 | 20 |
| Benzo(a)Anthracene | 10 | µg/L | SW3510/8270C | 58-120 | 20 |
| Benzo[a]pyrene | 10 | µg/L | SW3510/8270C | 65-120 | 20 |
| Benzo[b]Fluoranthene | 10 | µg/L | SW3510/8270C | 61-120 | 20 |
| Benzo[g,h,i]perylene | 10 | µg/L | SW3510/8270C | 40-123 | 20 |
| Benzo[k]fluoranthene | 10 | µg/L | SW3510/8270C | 56-124 | 20 |
| Benzoic acid | 50 | µg/L | SW3510/8270C | 41-97 | 20 |
| Benzyl alcohol | 10 | µg/L | SW3510/8270C | 44-110 | 20 |
| Bis(2-Chloroethoxy)methane | 10 | µg/L | SW3510/8270C | 59-105 | 20 |
| Bis(2-Chloroethyl)ether | 10 | µg/L | SW3510/8270C | 41-108 | 20 |
| Bis(2-Chloroisopropyl)ether | 10 | µg/L | SW3510/8270C | 47-105 | 20 |
| Bis(2-Ethylhexyl)phthalate | 10 | µg/L | SW3510/8270C | 83-125 | 20 |
| Butylbenzylphthalate | 10 | µg/L | SW3510/8270C | 61-120 | 20 |
| Chrysene | 10 | µg/L | SW3510/8270C | 59-120 | 20 |
| Dibenzo[a,h]anthracene | 10 | µg/L | SW3510/8270C | 42-125 | 20 |
| Dibenzofuran | 10 | µg/L | SW3510/8270C | 55-115 | 20 |
| Diethylphthalate | 10 | µg/L | SW3510/8270C | 58-120 | 20 |
| Dimethylphthalate | 10 | µg/L | SW3510/8270C | 54-125 | 20 |
| Di-n-butylphthalate | 10 | µg/L | SW3510/8270C | 55-115 | 20 |
| Di-n-octylphthalate | 10 | µg/L | SW3510/8270C | 63-135 | 20 |
| Fluoranthene | 10 | µg/L | SW3510/8270C | 61-120 | 20 |
| Fluorene | 10 | µg/L | SW3510/8270C | 58-110 | 20 |
| Hexachlorobenzene | 10 | µg/L | SW3510/8270C | 58-120 | 20 |
| Hexachlorobutadiene | 10 | µg/L | SW3510/8270C | 47-105 | 20 |
| Hexachlorocyclopentadiene | 30 | µg/L | SW3510/8270C | 10-86 | 20 |
| Hexachloroethane | 10 | µg/L | SW3510/8270C | 33-91 | 20 |
| Indeno[1,2,3-c,d]pyrene | 10 | µg/L | SW3510/8270C | 45-125 | 20 |

**TABLE 1-11**
**Data Quality Objectives, Iliamna Lake Water (Fresh)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Isophorone | 10 | µg/L | SW3510/8270C | 52-110 | 20 |
| Naphthalene | 10 | µg/L | SW3510/8270C | 46-100 | 20 |
| Nitrobenzene | 10 | µg/L | SW3510/8270C | 51-106 | 20 |
| N-Nitrosodimethylamine | 10 | µg/L | SW3510/8270C | 31-95 | 20 |
| N-Nitroso-di-n-propylamine | 10 | µg/L | SW3510/8270C | 51-120 | 20 |
| N-Nitrosodiphenylamine | 10 | µg/L | SW3510/8270C | 50-120 | 20 |
| Pentachlorophenol | 50 | µg/L | SW3510/8270C | 61-115 | 20 |
| Phenanthrene | 10 | µg/L | SW3510/8270C | 51-120 | 20 |
| Phenol | 10 | µg/L | SW3510/8270C | 37-94 | 20 |
| Pyrene | 10 | µg/L | SW3510/8270C | 63-128 | 20 |

*Key:*
*E = EPA (1983, 1991, and 2001b).*
*SW = RCRA Solid Waste Manual (EPA, 1993)*

**TABLE 1-12**
**Data Quality Objectives, Soil and Sediment (Terrestrial)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***Inorganics*** | | | | | |
| Ammonia as N | 2.5 | mg/kg | SM4500NH3 | 75-125 | 25 |
| Cyanide, total | 0.025 | mg/kg | SM4500CN-E | 75-125 | 20 |
| Chloride | 10 | mg/kg | E300.0 | 75-125 | 20 |
| Fluoride | 2.5 | mg/kg | E300.0 | 75-125 | 20 |
| Sulfate | 2.5 | mg/kg | E300.0 | 75-125 | 20 |
| ***Metals*** | | | | | |
| Al | 0.5 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Sb | 0.3 | mg/kg | SW3050/6020 | 80-120 | 20 |
| As | 0.3 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Ba | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Be | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Bi | 50 | mg/kg | SW3050/6010B | 80-120 | 20 |
| B | 0.25 | mg/kg | SW3050/6010B | 80-120 | 20 |
| Cd | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Ca | 100 | mg/kg | SW3050/6010B | 80-120 | 20 |

**TABLE 1-12**
**Data Quality Objectives, Soil and Sediment (Terrestrial)**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| Cr | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Co | 0.025 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Cu | 0.25 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Fe | 10 | mg/kg | SW3050/6010B | 80-120 | 20 |
| Pb | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Mg | 100 | mg/kg | SW3050/6010B | 80-120 | 20 |
| Mn | 0.3 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Hg | 0.1 | mg/kg | SW3050/7471A | 83-118 | 20 |
| Mo | 0.3 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Ni | 0.3 | mg/kg | SW3050/6020 | 80-120 | 20 |
| K | 100 | mg/kg | SW3050/6010B | 80-120 | 20 |
| Se | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Ag | 0.025 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Na | 100 | mg/kg | SW3050/6010B | 80-120 | 20 |
| Tl | 0.05 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Sn | 0.05 | mg/kg | SW3050/6010B | 80-120 | 20 |
| V | 0.1 | mg/kg | SW3050/6020 | 80-120 | 20 |
| Zn | 1 | mg/kg | SW3050/6020 | 80-120 | 20 |

*Key:*
*E = EPA (1983) adapted to soil matrices.*
*SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition. Adapted to soil matrices.*
*SW = EPA (1993).*

**TABLE 1-13**
**Data Quality Objectives, Vegetation**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***Inorganics*** | | | | | |
| Cyanide, total | 0.5 | mg/kg | SW 9012A | N/A | N/A |
| ***Metals*** | | | | | |
| Al | 2.0 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Sb | 0.05 | mg/kg | SW3050/6020 | 70-130 | 30 |
| As | 0.5 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Ba | 0.05 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Be | 0.02 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Bi | 0.02 | mg/kg | SW3050/6020 | 70-130 | 30 |
| B | 20 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Cd | 0.05 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Ca | 10 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Cr | 2 | mg/kg | SW3050/6010B | 75-125 | 30 |
| Co | 0.02 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Cu | 0.1 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Fe | 4.0 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Pb | 0.05 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Mg | 4 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Mn | 1.0 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Hg | 0.02 | mg/kg | SW3050/7471A | 60-130 | 30 |
| Mo | 0.05 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Ni | 0.2 | mg/kg | SW3050/6020 | 70-130 | 30 |
| K | 400 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Se | 1.0 | mg/kg | SW3050/6020 | 60-130 | 30 |
| Ag | 0.02 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Na | 20 | mg/kg | SW3050/6010B | 70-130 | 30 |
| Tl | 0.02 | mg/kg | SW3050/6020 | 70-130 | 30 |
| Sn | 10 | mg/kg | SW3050/6010B | 70-130 | 30 |
| V | 0.2 | mg/kg | SW3050/6020 | 75-125 | 30 |
| Zn | 0.5 | mg/kg | SW3050/6020 | 70-130 | 30 |

*Key:*
*SW = RCRA Solid Waste Manual (EPA, 1993).*

**TABLE 1-14**
**Data Quality Objectives, Fish and Fresh-water Bivalve Tissue**

| Parameter | Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***Metals*** | | | | | |
| Sb | 0.05 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| As | 0.5 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Be | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Cd | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Cr | 0.5 | mg/kg | PSEP/6010B | 70-130 | 30 |
| Cu | 0.1 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Pb | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Hg | 0.001 | mg/kg | E1631 | 70-130 | 30 |
| Mo | 0.05 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Ni | 0.2 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Se | 1 | mg/kg | PSEP/7740A | 60-130 | 30 |
| Ag | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Tl | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Zn | 0.5 | mg/kg | PSEP/E200.8 | 70-130 | 30 |

*Key:*
*E = EPA (1983 and 2001b).*
*PSEP = Puget Sound Estuary Program referencing "Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound" (1996).*

**TABLE 1-15**
**Data Quality Objectives, Mammalian Tissue**

| Parameter | Method Reporting Limit | Method Detection Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|---|
| ***Metals*** | | | | | | |
| Sb | 0.012 | 0.001 | mg/kg | E200.8 | 70-130 | 30 |
| As | 0.12 | 0.01 | mg/kg | E200.8 | 70-130 | 30 |
| Be | 0.0048 | 0.0005 | mg/kg | E200.8 | 70-130 | 30 |
| Cd | 0.005 | 0.001 | mg/kg | E200.8 | 70-130 | 30 |
| Cr | 0.1 | 0.1 | mg/kg | SW6010B | 70-130 | 30 |
| Cu | 0.024 | 0.005 | mg/kg | E200.8 | 70-130 | 30 |
| Pb | 0.005 | 0.001 | mg/kg | E200.8 | 70-130 | 30 |
| Hg | 0.02 | 0.004 | mg/kg | SW7471A | 70-130 | 30 |
| Mo | 0.012 | 0.001 | mg/kg | E200.8 | 70-130 | 30 |
| Ni | 0.05 | 0.01 | mg/kg | E200.8 | 70-130 | 30 |
| Se | 0.24 | 0.12 | mg/kg | SW7740A | 60-130 | 30 |
| Ag | 0.005 | 0.001 | mg/kg | E200.8 | 70-130 | 30 |
| Tl | 0.005 | 0.001 | mg/kg | E200.8 | 70-130 | 30 |
| Zn | 0.12 | 0.01 | mg/kg | E200.8 | 70-130 | 30 |

*Key:*
*E = EPA (1983).*
*SW = RCRA Solid Waste Manual (1993).*

### 1.6.2 Precision

Precision is a qualitative measure of the reproducibility of a measurement under a given set of conditions. For duplicate measurements, analytical precision can be expressed as the relative percent difference (RPD). The level of effort for laboratory precision will be at a minimum frequency of 1 in 20 (5 percent) or one per laboratory batch, whichever is more frequent. Laboratory precision is calculated from laboratory duplicates. Field precision will be at a minimum frequency of 1 in 20 field samples (10 percent).

QC and QA samples for fish, bivalve, mammal, and vegetation tissues are homogenized at the laboratory (CAS) rather than being individually collected in the field. For these types of samples, the primary laboratory (CAS) will analyze 10 percent as QC samples and will ship 10 percent to STL, Inc., as QA homogenate samples.

If calculated from duplicate measurements:

$$RPD = [(C_1 - C_2) \times 100] / [(C_1 + C_2) / 2]$$

Where:

RPD = relative percent difference

$C_1$ = larger of the two observed values

$C_2$ = smaller of the two observed values

If calculated from three or more replicates, relative standard deviation (RSD) rather than RPD is used:

$$RSD = (s / y) \times 100$$

Where:

RSD = relative standard deviation

s = standard deviation

y = mean of replicate analysis

Standard deviation is defined as follows:

$$S = [\Sigma n( y^i - y)^2 / (n-1)]^{0.5}$$

Where:

S = standard deviation

yi = measured value of the ith replicate

y = mean of replicate measurements

n = number of replicates

### 1.6.3 Accuracy

For samples processed by the analytical laboratory, accuracy will be evaluated with matrix spikes (MS), laboratory control samples (LCS), and performance evaluation (PE) samples. MS will be analyzed at an overall frequency of 10 percent throughout the project duration.

For measurements where matrix spikes are used:

$$\%R = 100 \times (S - U / C_{SA})$$

Where:

%R = percent recovery

S = measured concentration in spiked aliquot

U = measured concentration in unspiked aliquot

$C_{SA}$ = actual concentration of spike added

For situations where a PE or LCS sample is used instead of or in addition to matrix spikes:

$$\%R = 100 \times (C_m / C_{srm})$$

Where:

%R = percent recovery

$C_m$ = measured concentration of PE or LCS sample

$C_{srm}$ = actual concentration of PE or LCS sample

The levels of effort for precision and accuracy measurements are listed in Table 1-16.

**TABLE 1-16**
**Precision and Accuracy Evaluation for the Pebble Project EBS**

| Parameter Group | Type of Test (Precision/Accuracy) | Level of Effort |
|---|---|---|
| Inorganic Analytes | PE sample[1] | 1 for 2007 program (ACZ) |
| | Field duplicate (QC) | 10 percent |
| | Field triplicate (QA) | 10 percent |
| | Laboratory duplicate | 5 percent or 1 per analytical batch |
| | Laboratory control sample | 1 to 2 per analytical batch of 20 samples or fewer |
| | Matrix spike (not required for all analytes) | 5 percent of total samples submitted over project duration |
| Metals | PE sample[1] | 1 for 2007 program (ACZ) |
| | Field duplicate (QC) | 10 percent |
| | Field triplicate (QA) | 10 percent |
| | Laboratory control sample | 1 per analytical batch of 20 samples or fewer |
| | Matrix spike/matrix spike duplicate | 5 percent of total samples submitted over project duration |
| Organic Analytes | Field duplicate (QC) | 10 percent |
| | Field triplicate (QA) | 10 percent |
| | Laboratory control sample | 2 per analytical batch of 20 samples or fewer (1 per batch if batch includes an MS/MSD set) |
| | Matrix spike/matrix spike duplicate (not required for all analytes) | 5 percent of total samples submitted over project duration |

*Notes:*

1. *PE samples are certified for specific chemical or physical properties and are issued with certificates that report the results of the characterization and indicate the use of the material.*

### 1.6.4 Representativeness

Representativeness is a measure of how closely measured results reflect the actual concentration or distribution of the chemical compounds in the environment. Sample collection and handling methods can affect representativeness, for example through contaminated sampling equipment or inadequate sample preservation. To avoid such problems, sampling-plan designs, sampling techniques, and sample-handling protocols (for example, storage, preservation, and transportation) have been developed, as described in Section 2. Documentation will establish that protocols have been followed and that sample identification and integrity are assured. Field blanks and field duplicates are used to assess field and transport

contamination and sampling variation. Laboratory sample retrieval, storage, and handling procedures also have been developed and are discussed in Section 2. Laboratory method blanks will be run at the minimum frequency of 5 percent or one per analytical batch to assess laboratory contamination.

### 1.6.5 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement system. The target completeness objectives are 90 percent for each analytical parameter; the actual completeness can vary with the intrinsic nature of the samples. The completeness of the data will be assessed during the data review.

Completeness is defined as follows for all measurements:

$$\%C = 100 \times (V / n)$$

Where:

%C = percent completeness

V = number of measurements judged valid

n = total number of measurements

### 1.6.6 Comparability

Comparability is the level of confidence with which one data set can be compared with another. This objective is met by selecting field sampling methods and laboratory analytical methods that are comparable throughout the baseline environmental studies. Changing sampling techniques or laboratory methods during the study may compromise comparability. The field sampling methods have been evaluated to ensure comparability among consultants collecting samples of the same media from the mine study area and from the transportation corridor. The laboratory methods employed by the primary and QA laboratories have been evaluated to ensure that methods used for primary, QC, and QA samples are comparable. Comparability will also be maintained by the use of consistent units.

## 1.7 Special Training and Certification

The laboratories selected for the Pebble Project EBS have obtained certifications and participate in periodic auditing programs that establish their level of performance. Table 1-17 summarizes state and federal certifications and accreditation programs that the Pebble Project laboratories participate in.

**TABLE 1-17**
**Laboratory Certifications and Accreditation Programs**

| Laboratory | Program |
|---|---|
| SGS Environmental Services, Inc. | ADEC Drinking Water and Contaminated Sites Lab Approval |
| | U.S. Air Force Center for Environmental Excellence |
| | National Environmental Laboratory Accreditation Program |
| | U.S. Navy |
| | U.S. Department of Agriculture |
| Columbia Analytical Services, Inc. | ADEC Contaminated Sites Lab Approval |
| | U.S. Air Force Center for Environmental Excellence |
| | National Environmental Laboratory Accreditation Program |
| | U.S. Navy |
| Test America, Inc. | ADEC Drinking Water and Contaminated Sites Lab Approval |
| | National Environmental Laboratory Accreditation Program for Oregon |
| | U.S. Navy |
| ACZ Laboratories, Inc. | National Environmental Laboratory Accreditation Program for Utah |
| Severn Trent Laboratories | ADEC Contaminated Sites Lab Approval |
| | State of California Environmental Laboratory Accreditation Program |
| | State of Washington Department of Energy |
| | Naval Facilities Engineering Service Center Quality Assurance Program |
| | State of Oregon Environmental Laboratory Accreditation Program |

## 1.8 Documents and Records

### 1.8.1 Quality Assurance Project Plan

The QAPP is controlled by the Analytical QA/QC Manager. Approved QAPPs and updated versions will be provided to the parties presented in the distribution list (Section 1.2). Document control information (revision number and date) is shown in the bottom right corner of each page.

### 1.8.2 Laboratory Reports

The minimum information that must be included in the hardcopy data-report package is as follows:

- Transmittal letter.
- Case narrative to discuss at a minimum all issues that may negatively affect data quality including sample handling, preservation, holding times, sample matrix, and QC results.
- Chain-of-custody documents.
- Cooler receipt form documenting cooler temperatures, sample preservation, and condition upon receipt by the laboratory.

- Custody seals.
- Sample analytical results. Do not report results from multiple dilutions for a given parameter.
- Method blank results.
- Surrogate recovery results and acceptance criteria for applicable organic methods.
- Dates of sample collection, receipt, preparation, and analysis for all tests.
- Matrix spike result(s) with calculated recovery, including associated acceptance criteria.
- Duplicate or duplicate matrix spike result(s) (as appropriate to method) with calculated RPD and acceptance criteria.
- LCS and/or QC check sample result(s) with calculated recovery and associated acceptance criteria.
- Initial calibration results summary and continuing calibration verification-standard results with calculated recoveries and acceptance criteria.
- Summary forms of associated QC and calibration parameters.
- Run or sequence logs for each method.

For each report or sample delivery group, laboratories will submit the U.S. Army Corp of Engineers (USACE) COELT EDF v 1.2a electronic deliverables.

### 1.8.3 Data Quality Assurance Reports

DQARs will assess the data and address corrective action related to field and laboratory activities. These reports will be prepared and controlled by the Analytical QA/QC Manager.

### 1.8.4 STORET Electronic Deliverables

All water-quality data collected at the edge or outside of mixing zones that will be used to establish baseline conditions will be submitted to the ADEC permitter in a format compatible with the EPA water-quality monitoring STORET database.

# 2.0 Data Generation and Acquisition

The generation, compilation, reporting, and archiving of data are critical components of field and laboratory operations. In order to generate data of known and acceptable quality, the QA/QC practices for data management must be complete, comprehensive, and in keeping with the overall QA objectives of the project.

## 2.1 Sampling Process Design

Producing data of known quality that are considered representative of the sampling environment at an appropriate level of detail is achieved by establishing a QA program with specified data-gathering protocols overseen by the Analytical QA/QC Manager. The main components of the QA program include the following:

- Verification of use of proper sample containers and preservative.
- Collection and analysis of blank/duplicate samples.
- Specific procedures for handling, labeling, and shipping samples.
- Field equipment calibration.
- Equipment decontamination.
- Field documentation.
- Field corrective action.

All field blanks/duplicates and triplicates will be noted on the chain-of-custody forms and in field logbooks.

See Section 1.5 for the following information:

- Types and estimated numbers of samples required.
- Sampling frequency.
- Sample matrices.
- Parameters of interest.

The Pebble Project study plans (NDM, 2005, 2006, In press) present the sampling locations and rationale for the design.

Sample collection, handling, and shipping procedures include the following:

- Field collection.
- Labeling.
- Packaging.
- Chain-of-custody forms.
- Shipping.

The Project Managers are responsible for implementing the sample handling and shipping procedures described below. The Analytical QA/QC Manager will check for quality assurance measures on these activities.

## 2.2 Sampling Methods

General field-sampling methods are contained in the study plans (NDM, 2005, 2006, In press8) and field sampling plans (e.g., NDM, In press1-7). Corrective action is the responsibility of the Analytical QA/QC Manager and Project Managers for HDR, ABR, BEESC, and SLR. When a failure in the sampling system occurs, this management team will cooperate to investigate the failure and implement necessary corrective action.

For all field samples, containers will be provided by the laboratory conducting the analyses. Tables 2-1, 2-2, and 2-3 summarize the required containers, sample volumes, preservation, and maximum holding times for all parameters.

**TABLE 2-1**
**Sample Bottle Schedule and Sampling Parameters for Surface Water/Groundwater Collection**

| Sample Set | Bottle Type SGS | Bottle Type CAS/ Test America | Analysis | Lab Method | Preser-vative | Hold Time | Req. Temp. | Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | (1) 1L HDPE<br>1 extra volume for MS/MSD | (1) 1L HDPE (CAS) | Total metals[1] (except Hg) | E200.8/200.7 | $HNO_3$ | 6 months | None | Unfiltered |
| 2 | (1) 1L HDPE<br>(1) extra unpreserved container for dissolved metals collection<br>(1) 1L extra volume for MS/MSD | (1) 1L HDPE (CAS)<br>(1) extra unpreserved container for dissolved metals collection | Dissolved metals[2] (except Hg) | E200.8/200.7 | $HNO_3$ | 6 months | None | Field Filtered |
| 3 | | (1) 500-ml fluoropoly (CAS)<br>(1) 250-ml fluoropoly (Test America)<br>No extra volume for MS/MSD | Low-level Hg (total only) | E1631 | HCl | 90 days | None | Unfiltered |
| 4 (WG only) | | (2) 500-ml fluoropoly (CAS)<br>(2) 250-ml fluoropoly (Test America)<br>No extra volume for MS/MSD | Low level Hg (total and dissolved) | E1631 | HCl | 90 days | None | Unfiltered (total)<br>Filtered (dissolved) |
| 5 | (1) 250-ml Nalgene<br>No extra volume for MS/MSD | (1) 1L HDPE | Cyanide, total | SM4500CN-E | NaOH | 14 days | 4°C | Unfiltered |
| | | | Cyanide, WAD | SM4500CN-I | NaOH | 14 days | 4°C | Unfiltered |
| | | | Cyanide, available (low-level confirmation) | E1677 | NaOH | 14 days | 4°C | Unfiltered |

**TABLE 2-1**
**Sample Bottle Schedule and Sampling Parameters for Surface Water/Groundwater Collection**

| Sample Set | Bottle Type SGS | Bottle Type CAS/ Test America | Analysis | Lab Method | Preser-vative | Hold Time | Req. Temp. | Comments |
|---|---|---|---|---|---|---|---|---|
| 6 | (1) 500-ml HDPE<br>(1) 500-ml extra for MS/MSD | (1) 1L HDPE | Ammonia as N ($NH_3$) | SM4500-NH3-G | $H_2SO_4$ | 28 days | 4°C | Unfiltered |
| | | | Phosphorus, total (P) | E365.3 | $H_2SO_4$ | 28 days | 4°C | Unfiltered |
| | | | Nitrate-nitrite, total ($NO_3$ + $NO_2$) | SM4500-NO3 F | $H_2SO_4$ | 28 days | 4°C | Unfiltered |
| 7 | (2) 1L HDPE<br>(2) 1L extra volumes needed for MS/MSD | (1) 1L HDPE | TDS | SM2540C | None | 7 days | 4°C | Unfiltered |
| | | | TSS | SM2540D | None | 7 days | 4°C | Unfiltered |
| | | | Alkalinity | 2320B | None | 14 days | 4°C | Unfiltered |
| | | | Acidity | SM2310B | None | 14 days | 4°C | Unfiltered |
| | | | Specific Conductance | SM2510B | None | 28 days | 4°C | Unfiltered |
| | | | pH | SM4500$H^+$B | None | 24 hours | 4°C | Unfiltered |
| 8 | (1) 120-ml Nalgene<br>(2) 120-ml Nalgene extra volume for MS and lab duplicate | No separate sample needed; analyzed from CAS sample set 7 | Chloride, fluoride, sulfate | E300.0 | None | 28 days | 4°C | Unfiltered |
| 9 | (1) 250-ml HDPE<br>No extra volume for MS/MSD | No separate sample needed; analyzed from CAS sample set 1 | Thiocyanate | SM4500CN-M | HNO3 | 28 days | 4°C | Unfiltered |
| 10 | (1) 250-ml glass with Teflon-lined cap | (1) 250-mL glass with Teflon-lined cap | DOC | SM5310 | $H_2SO_4$ | 28 days | 4°C | Filtered |
| 11 (WS only) | (3) 40-ml VOA vial with Teflon-lined septum<br>(6) extra volumes for MS/MSD | (3) 40-ml VOA vial with Teflon-lined septum | VOCs | SW8260B | HCl | 14 days | 4°C | Unfiltered |

**TABLE 2-1**
**Sample Bottle Schedule and Sampling Parameters for Surface Water/Groundwater Collection**

| Sample Set | Bottle Type SGS | Bottle Type CAS/ Test America | Analysis | Lab Method | Preser-vative | Hold Time | Req. Temp. | Comments |
|---|---|---|---|---|---|---|---|---|
| 12 (WS only) | (2) 1L amber glass with Teflon-lined cap | (2) 1L amber glass with Teflon-lined cap | SVOCs | SW8270C | None | 7 days to extraction; 40 days to analysis of extract | 4°C | Unfiltered |
| 13 (WS only) | (2) 1L amber glass with Teflon-lined cap | (2) 1L amber glass with Teflon-lined cap | PCBs | SW8082 | None | | 4°C | Unfiltered |

*Notes:*
*1. Total metals: Al, Sb, As, Ba, B, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Ag, Na, Se, Sn, Tl, V, Zn, and Hardness*
*2. Dissolved Metals: Al, Sb, As, Ba, B, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Ag, Na, Se, Si, Sn, Tl, V, and Zn*
*Key:*
*°C = degrees Celsius*
*DOC = dissolved organic carbon*
*HCL = hydrogen chloride (hydrochloric acid)*
*HDPE = high density polyethylene*
*$HNO_3$ = nitric acid*
*$H_2SO_4$ = sulfuric acid*
*L = liters*
*ml = milliliters*
*N/A = Not applicable*
*VOA = volatile organics analysis*
*WG = groundwater*
*WS = surface water*

**TABLE 2-2**
**Sample Bottle Schedule and Sampling Parameters for Soil and Sediment Collection**

| Set | Bottle Type SGS | Bottle Type CAS | Bottle Type STL | Analysis | Lab Method | Preser-vative | Hold Time | Req. Temp. |
|---|---|---|---|---|---|---|---|---|
| 1 | (1) 8-oz glass | (1) 8-oz glass | (1) 8-oz glass | Total Metals[1] | SW6010B/ 6020/ 7471 (Hg) | None | 6 months | 4°C[4] |
| | | | | Cyanide, Total | SM4500CN-E | None | 28 days[2] | 4°C |
| | | | | Ammonia as N | SM4500NH3 | None | 28 days | 4°C |
| | | | | Chloride, fluoride, sulfate | E300.0 | None | 28 days[3] | 4°C |
| 2 (soil only) | (1) 4-oz glass | (1) 4-oz glass | (1) 4-oz glass | Total organic carbon | ASTM D4129-82M | None | 180 days | 4°C |
| 3 (soil only) | (1) 8-oz glass | (1) 8-oz glass | (1) 8-oz glass | Diesel/residual-range organics | AK102/103 | None | 14 days to extraction, 40 days to analysis of extract | 4°C |

*Notes:*
*1. Total metals: Al, Sb, As, Ba, B, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Ag, Na, Se, Sn, Tl, V, Zn, and Hg.*
*2. Holding Time: from EPA methods fact sheet titled "Total Petroleum Hydrocarbons, Reactive Cyanide, Reactive Sulfide, Ignitability, and Corrosivity."*
*3. Holding Time is from the date of preparation.*
*4. For total metals there is no temperature requirement with the exception of Hg, which requires storage at 4°C.*
*Key:*
*oz = ounce*
*prewt'd = reweighed and tared*

**TABLE 2-3**
**Sample Bottle Schedule and Sampling Parameters for Biological Tissue Collection**

| Tissue Type | Min. Sample Amount (grams) | Bottle Type (CAS/STL) | Analysis | Lab Method | Shipping Preservation and Time | Hold Time | Required Laboratory Storage Temp. |
|---|---|---|---|---|---|---|---|
| Vegetation | 25 | Ziploc bag or glass jar | Hg | SW7471 | Cool on blue ice | 28 days | 4 $^{o}$C |
| | | | Total Metals[1] | SW6010B/6020/E200.8 | | 6 months | None |
| | | | Cyanide | SM4500CN-E | | 14 days | 4 $^{o}$C |
| Mammalian | 5 | Ziploc bag or glass jar (hair samples) | Total Metals[2] | E200.8/SW6010B/7471A/ 7740 | Freeze < -20 $^{o}$C (Iliamna) | 12 months | Freeze at ≤ -20 $^{o}$C |
| | 50 | Ziploc bag or glass jar (tissue samples) | | | Freeze < -20 $^{o}$C (Iliamna) | | |
| | 10 ml | (1) 4-oz glass (blood) | | | Cool on blue ice | | |
| Fish and Bivalve | 45 | Ziploc or similar plastic bag | Low-level Hg | E1631 | Cool on blue ice or freeze on dry ice if shipping time will exceed 24 hours. Samples must arrive at the lab within 48 hours of shipment. | 12 months | Freeze at ≤ -20 $^{o}$C |
| | | | Total Metals[2] | SW6010B(Cr) E200.8 SW7740 (Se) SW6010B/6020 | | | |

*Notes:*
*1. Al, Sb, As, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Tl, Sn, V, Zn*
*2. Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Mo, Ni, Se, Ag, Tl, and Zn*

### 2.2.1 Field Collection Procedures

In all cases, field collection procedures will be followed to minimize contamination of samples, prevent cross-contamination between samples, and ensure sample validity by conducting proper preservation and storage in the field according to the requirements specified in this QAPP.

Surface water samples will be collected for analysis in the following order:

1. Mercury.
2. Total metals.
3. Dissolved metals.
4. Total suspended solids, total dissolved solids, etc.
5. Settleable solids (Imhoff cones in the field).
6. Miscellaneous parameters (ammonia, phosphorus, WAD cyanide, etc.).

For mercury, many states are establishing new National Pollutant Discharge Elimination System (NPDES) limits at very low levels with the intent of maintaining water-quality standards in the receiving streams. The new limits may approach or even be less than the detection limit of routine analytical methods. To ensure that reliable data are produced at these extremely low detection levels, additional emphasis **must** be placed on clean sampling and clean laboratory practices to minimize contamination. The following general field procedures are recommended by CAS, the laboratory that will perform mercury analysis for the Pebble Project EBS.

- Sampling cleanliness will be documented through the use of trip blanks and field sampling blanks.
- Only non-metallic sampling equipment will be used and no metal object will be allowed to come into direct or indirect contact with the sample or sample containers (storing samples at all times in properly cleaned and sealed containers [ice chests] can help prevent inadvertent contact with such objects, as well as prevent inadvertent contamination).
- Only non-talc gloves will be used, and gloves will be changed between sample collections.
- Samples will be collected directly into sample containers that are documented clean at the levels of concern.
- All sample containers will be double-bagged.
- It may be necessary to designate one “clean hands” sampler to perform all operations involving direct contact with the sample and one “dirty hands” sampler for all other operations (e.g., record keeping).
- Smoking will not be allowed in the vicinity of any sampling activities or sampling equipment. Smokers must wash their hands thoroughly with soap and water before handling samples or sampling equipment.

For fish being collected for contaminant analyses, collection procedures will follow many of the methods of Zhang et al. (2001) and Jewett et al. (2003), including the following:

- Specimens will be photographed before dissection to provide confirmation of species identification. A label showing the sample number will be placed beside the fish and will be included in the photograph.

- Total fish length and sex will be recorded in the field for each specimen; any necessary dissection to determine sex will be done using surgical sheets, powder-free latex gloves, and an acid-washed titanium knife or scalpel. The disposable gloves will be changed between dissections.
- For smaller fish (e.g., less than 6 inches total length), the entire animal will be placed in a Ziploc-type plastic bag and frozen immediately.
- For larger fish (e.g., greater than 6 inches total length), immediate freezing of all tissues in an entire animal would be difficult under field conditions; therefore, tissue dissections for muscle and liver samples will be done in Iliamna as follows:
  - Immediately upon capture, the fish will be placed in clean plastic bags and placed in a cooler with ice. To avoid contamination, the fish must be placed in a clean plastic bag immediately upon being removed from the water and not be placed on any surface, such as the bottom of the boat.
  - Dissection will occur indoors at a clean site in Iliamna.
  - The cutting surface will be washed with soap and water and covered with heavy-duty aluminum foil.
  - Either stainless steel disposable scalpels or stainless steel knives will be used for dissection. Knives will be washed with soap and water and rinsed with deionized water between uses. Scalpels will be replaced between fish.
  - For the fish tissue samples from large fish, the muscle tissue will be collected immediately below the dorsal fin.
  - Approximately 25 grams (g) each of liver and muscle tissue (about a 3x3x1-inch piece of tissue) will be extracted from each fish using powder-free gloves and will be placed in an individually labeled zipper-seal bag. Tissue samples will be immediately placed in a freezer.
  - Frozen tissue samples will be packaged in a cooler and sent to the laboratory using packaging recommendations provided by the lab. Chain-of-custody procedures will be followed.
  - Each sample from an individual fish will be labeled with the sample identification number including a suffix of "M" for muscle tissue or "L" for liver tissue (see Section 2.3.1).

For vegetation samples, 50 grams will be collected from a representative plant in each plant class within the sample location, if available.

For 10 percent of fish samples, at least 75 grams will be collected, and for 10 percent of vegetation samples, at least 150 grams will be collected. This will allow the preparation of QA/QC samples at the primary laboratory (CAS). CAS will ship QA samples to STL for analysis.

### 2.2.2 Field Documentation

The entire sampling team will be responsible for recording field observations, field equipment calibration information, field measurements, and sample documentation, including sample identification, sample duplicates, and date and time the sample was collected. Field forms will be maintained for each task. Field forms will consist of waterproof, bound pages with every appropriate area completed in waterproof ink. Blank pages will be marked as such with a diagonal line across the page, when appropriate.

Proper documentation for sample custody includes keeping records of all materials and procedures involved in sampling. Project field forms will be used to record field data. All information on the sampling station and respective samples and blanks collected at each site, including the positions of the

station, will be recorded by the field crew. The crew leader will review all data before leaving the sampling station. Completed field forms will be kept on file for future reference.

### 2.2.3 Corrections to Field Documentation

Unless weather conditions prevent it, all original data will be recorded with waterproof ink. No accountable documents will be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. If an error is made on an accountable document, the person who made the entry must make corrections by drawing a line through the error, initialing and dating the lined-out item, and entering the correct information. Erroneous information is not to be obliterated, but must remain legible. Any error subsequently discovered on an accountable document will be corrected by the person who made the entry. All such corrections will be initialed and dated.

## 2.3 Sample Handling and Custody

Sample handling and custody procedures are required in the field, in the laboratory, and during transport. The procedures take into account the nature of the samples, the maximum holding times, and shipping options from Iliamna to the laboratories.

### 2.3.1 Sample Labeling

Each sample container will have a waterproof label large enough to contain the information needed to easily identify each sample. The information to be included on each label will include the project name, date, time, preservative (if added), sample identification code, analysis, and sampler's initials. Sample codes are formatted to indicate sample date (month and year), location, matrix, and number. Each sampling location will be identified by the sampler on the field form. An example of sample identification code follows:

0107CR199AWS001

Where:

0107 is the date as month/year

CR199A is the location ID

WS is the matrix code (in this case for surface water)

001 is a sequential sample number

For field duplicates, the sequential sample number is 201, and for triplicates, 301. The suffix 401 is used for field equipment rinse blanks (all equipment coming in contact with samples). The suffix 402 is used for filter rinses (in-line filters only). The suffix 405 is used for filter rinses related to dissolved organic carbon (DOC) sampling. The suffix 501 is used for deionized water blanks. The suffix 601 is used for trip blanks.

For trip blanks, laboratory codes, followed by "TB," are used for the location ID. Laboratory codes are SGS for SGS Environmental Services, Inc., CASK for Columbia Analytical Services, Inc., and TAPO for Test America, Inc. An example of a sample ID code for a surface water trip blank for SGS is 0107SGSTBWS601 for the first trip blank in January 2007. If more than one trip blank is used in the same event for the same matrix, the sequential ID increases to 602 and so on, as needed.

Matrix codes are as follows:

- WO – marine water
- MS – marine sediment
- SE – sediment
- SL – surface soil
- SS – subsurface soil
- WS – surface water
- WG – groundwater
- TF – fish tissue
- TP – plant tissue
- HA – hair
- MU – mammalian muscle tissue
- VI – vibrissae
- KI – mammalian kidney tissue
- LI – mammalian liver tissue
- SE – serum (blood)

Samples collected from seep locations should be given the matrix code of WS or SE as applicable. The location IDs for seep samples should start with "SP" to indicate the sample is from a seep location without regard to matrix type. Following the "SP" will be a two- or three-digit sequential number to differentiate the locations and then a two-digit number to indicate the year that the seep was first identified. For example, the first seep site to be identified in 2007 would be assigned location ID SP00107. If a seep site is sampled again in a subsequent year, the location ID should not be changed from that assigned when the seep was first identified.

For large fish for which analyses will be conducted on both muscle and liver tissue, the sample code will include a suffix of "M" for muscle or "L" for liver tissue. For example, the first sample of fish liver tissue collected from location CR199A collected on August 20, 2007, would have the following sample ID code: 0807CR199ATF001L.

For vegetation samples, a species suffix will be added to the sample ID code. For example, 0807TE12TP002-Pm is the second sample of *picea mariana* (black spruce) collected at location TE12 in August 2007. Berry only samples are designated with a "B" at the end of the species suffix. Table 2-4 lists vegetation species names and suffixes.

For samples of fish, bivalves, and mammalian tissue also, a species suffix will be added to the sample code. Table 2-5 lists these species suffixes.

These samples ID codes are designed to facilitate data management for the life of this project.

**TABLE 2-4**
**Summary of Vegetation Species Names and Suffixes**

| Species Suffix | Latin Name | Common Name |
|---|---|---|
| | ***Aquatic*** | |
| Apa | *Alisma plantago-aquatica* | Broad-leaved water plantain |
| Cde | *Ceratophyllum demersum* | Coontail, hornwort |
| Cdo | *Cucuta douglasii* | Water hemlock |
| Cve | *Callitriche verna* | Vernal water-starwort |
| Hvu | *Hippuris vulgaris* | Mare's tail |
| La | *Lycopodium annotinum* | Stiff clubmoss |
| Lmi | *Lemna minor* | Common duckweed |
| Msp | *Myriophyllum spicatum* | Eurasian water-milfoil, spiked water-milfoil |
| Npo | *Nuphar lutea* ssp. *polysepala* | Yellow pond-lily |
| Pam | *Polygonum amphibium* | Water smartweed |
| Pf | *Potamogeton friesii* | Flat-stalked pondweed |
| Pfi | *Stuckenia filiformis* ssp. *alpinus* | Northern slender pondweed, thread-leaved pondweed |
| Ppe | *Potamogeton perfoliatus* | Clasping-leaf pondweed |
| Pta | *Potamogeton* sp. | Pondweeds, not keyed to sp. |
| Raq | *Ranunculus aquatilis* | Large-leaved white water-crowfoot |
| Rgm | *Ranunculus gmelinii* | Yellow water-crowfoot |
| San | *Sparganium angustifolium* | Narrow-leafed bur-reed |
| Scu | *Sagittaria cuneata* | Arum-leaved arrowhead |
| Seu | *Sparganium eurycarpum* | Giant bur-reed |
| Tla | *Typha latifolia* | Common cattail |
| Utr | *Utricularia vulgaris (or minor, or intermedia)* | Bladderwort |
| | ***Ferns & Allies*** | |
| Af | *Athyrium filix-femina* | Lady fern |
| Dd | *Dryopteris expansa* | Spreading wood fern |
| Ea | *Equisetum arvense* | Common horsetail, field horsetail |
| Ep | *Equisetum pratense* | Meadow horsetail |
| | ***Forbes*** | |
| Ab | *Achillea borealis* | Boreal yarrow |
| Ad | *Aconitum delphinifolium* | Monkshood |
| Ag | *Angelica genuflexa* | Kneeling angelica |
| At | *Artemisia tilesii* | Wormwood |
| Cha | *Chamerion angustifolium* | Fireweed |
| Cp | *Comarum palustre* | Marsh cinquefoil, marsh five finger |
| Ead | *Epilobium ciliatum* ssp. *ciliatum* | Fringed willowherb |

**TABLE 2-4**
**Summary of Vegetation Species Names and Suffixes**

| Species Suffix | Latin Name | Common Name |
|---|---|---|
| Ec | *Epilobium ciliatum* | Slender willowherb |
| Ha | *Hedysarum alpinum* | Wild potato, Eskimo potato, alpine sweetvetch |
| Hbm | *Hedysarum boreale* ssp. *mackenziei* | Sweetvetch, wild sweet pea |
| Hmx | *Heracleum maximum* | Cow parsnip, wild celery, putchkie |
| Is | *Iris setosa* | Iris |
| Ln | *Lupinus nootkatensis* | Nootka lupine |
| Pa | *Polygonum alpinum* | Alaska wild rhubarb |
| Pfr | *Petasites frigidus* | Coltsfoot |
| Ppu | *Polemonium pulcherrimum* | Beautiful Jacob's ladder |
| Rar | *Rumex arcticus* | Arctic dock |
| Rr | *Rhodiola integrifolia* ssp. *integrifolia* | Ledge stonecrop, sedum rosea |
| Sc | *Sanguisorba canadensis* | Canadian burnet |
| Sd | *Solidago decumbens* | Goldenrod |
| Vvi | *Veratrum viride* | False hellebore |
| ***Grasses*** | | |
| Csp | *Calamagrostis* sp. | Blue joint grass, reed grass, not keyed to sp. |
| Ear | *Leymus arenarius* | Lyme-grass |
| Es | *Eriophorum scheuchzeri* | Alaska cotton, cottongrass |
| ***Woody Herbs*** | | |
| CCu | *Flavocetraria cucullata* | Curled snow lichen |
| Cr | *Cladina rangiferina* | Reindeer lichen, caribou moss |
| Hs | *Hylocomium splendens* | Stair-step moss |
| Pcc | *Ptilium crista-castrensis* | Knight's plume moss |
| ***Sedges*** | | |
| Ca | *Carex aquatilis* | Water sedge |
| Cm | *Carex microchaeta* | Small-awned sedge |
| Cut | *Carex utriculata* | Common yellow lake sedge |
| Ss | Sedge sp. | Sedge, *carex*, not keyed to sp. |
| ***Shrubs*** | | |
| Ac | *Alnus crispa* | Mountain alder |
| Ap | *Andromeda polifolia* | Bog rosemary |
| Ar | *Arctostaphylos rubra* | Red bearberry |
| Avs | *Alnus viridis* ssp. *sinuata* | Sitka alder |
| Bg | *Betula glandulosa* | Dwarf birch, resin birch |
| Bn | *Betula nana* | Arctic dwarf birch |

| | | |
|---|---|---|
| Df | *Dasiphora floribunda* | Shrubby cinquefoil, potentilla, tundra rose |
| En | *Empetrum nigrum* | Crowberry |
| EnB | *Empetrum nigrum* | Crowberry (berries only) |
| Jc | *Juniperus communis* | Common juniper |
| Lp | *Ledum palustre* | Narrow-leaf Labrador tea |
| Lpe | *Luetkea pectinata* | Partridgefoot |
| Mf | *Menziesia ferruginea* | Fool's huckleberry, false azalea |
| Mg | *Myrica gale* | Sweetgale |
| Oh | *Oplopanax horridus* | Devil's club |
| Ra | *Rosa acicularis* | Prickly rose |
| Rc | *Rubus chamaemorus* | Cloudberry |
| RcB | *Rubus chamaemorus* | Cloudberry (berries only) |
| Rg | *Ribes glandulosum* | Skunk currant |
| Rh | *Ribes hudsonianum* | Northern black currant |
| Rl | *Ribes laxiflorum* | Trailing black currant |
| Ro | *Rosa* sp. | Wild rose, not keyed to species (not tundra rose) |
| Rp | *Rubus pedatus* | Trailing raspberry |
| Rs | *Rubus spectabilis* | Salmonberry |
| Rt | *Ribes triste* | Northern red currant |
| Sa | *Salix alaxensis* | Felt-leaf willow |
| Sar | *Salix arctica* | Arctic willow, rock willow |
| Sb | *Salix brachycarpa* | Barrenground willow |
| Sba | *Salix barclayi* | Barclay's willow |
| Sg | *Salix glauca* | Glaucous willow, greyleaf willow |
| Sp | *Salix planifolia* | Planeleaf willow, diamondleaf willow |
| Sps | *Spirea stevenii* | Beauverd spirea |
| Sr | *Sambucus racemosa* | Elderberry |
| Srt | *Salix reticulata* | Netleaf willow, snow willow |
| Ssp | *Salix* sp. | Willow, not keyed to species |
| Sxs | *Salix sitchensis* | Sitka willow |
| Vo | *Vaccinium ovalifolium* | Ovalleaf blueberry or huckleberry, early blueberry |
| Vu | *Vaccinium uliginosum* | Bog blueberry |
| VuB | *Vaccinium uliginosum* | Bog blueberry (berries only) |
| Vv | *Vaccinium vitis-idaea* | Lingonberry, low-bush cranberry |
| VvB | *Vaccinium vitis-idaea* | Lingonberry, low-bush cranberry (berries only) |
| ***Trees*** | | |
| Bp | *Betula papyrifera* | Paper birch |
| Pb | *Populus balsamifera* | Cottonwood |
| Pg | *Picea glauca* | White spruce |

| | | |
|---|---|---|
| Pm | *Picea mariana* | Black spruce |
| Pt | *Populus tremuloides* | Quaking aspen |
| Tm | *Tsuga mertensiana* | Mountain hemlock |
| ***Woody Herbs*** | | |
| Cc | *Cornus canadensis* | Bunchberry |
| CcB | *Cornus canadensis* | Bunchberry (berries only) |

**TABLE 2-5**
**Summary of Mammal, Fish, and Bivalve Tissue Species Names and Suffixes**

| Species Suffix | Latin Name | Common Name |
|---|---|---|
| ***Mammal*** | | |
| Bb | *Ursus arctos* | Brown bear |
| Ca | *Rangifer tarandus* | Caribou |
| Hs | *Phoca vitulina* | Harbor seal |
| ***Fish*** | | |
| AC | *Salvelinus alpinus Linnaeus* | Char, Arctic char |
| AG | *Thymallus arcticus Pallus* | Arctic grayling |
| BT | *Lota lota* | Burbot |
| CH | *Oncorhynchus keta* | Chum salmon, dog salmon |
| CS | *Oncorhynchus kisutch* | Coho salmon, silver salmon |
| DV | *Salvelinus malma Walbaum* | Dolly Varden |
| FS | *Platichthys stellatus* | Starry flounder |
| FX | (various genera) | Flounder, not keyed to species |
| GW | *Hexagrammos stelleri* | Whitespot greenling |
| GX | *Hexagrammos* sp. | Greenling, not keyed to species |
| HC | *Telmessus cheiragonus* | Helmet crab |
| HT | *Fusitriton oregonensis* | Oregon Hairy Triton |
| KS | *Oncorhynchus tshawytscha* | King salmon, chinook salmon |
| NP | *Esox lucius linnaeus* | Northern pike |
| PC | *Hyas lyratus* | Pacific lyre crab |
| PS | *Oncorhynchus gorbuscha* | Pink salmon, humpback salmon |
| RN | *Neptunea lyrata* | Ribbed neptune |
| RT | *Oncorhynchus mykiss* | Rainbow trout, Steelhead trout |
| SC | *Cottidae* sp. | Sculpin, not keyed to species |
| SP | *Leptocottus armatus* | Pacific staghorn sculpin |
| SS | *Oncorhynchus nerka* | Red salmon, sockeye salmon |

**TABLE 2-5**
**Summary of Mammal, Fish, and Bivalve Tissue Species Names and Suffixes**

| Species Suffix | Latin Name | Common Name |
|---|---|---|
| SX | *Oncorhynchus* sp. | Salmon, not keyed to species |
| WX | (various genera) | Whitefish, not keyed to species |
| YS | *Limanda aspera* | Yellowfin sole |
| ***Bivalve*** | | |
| AS | *Mactromeris polynyma* | Arctic surf clam |
| FMab | *Anodonta beringiana* | Freshwater mussel |
| MA | *Macoma obliqua* | Oblique macoma |
| MMmm | *Modiolus modiolus* | Northern horsemussel (marine) |
| MMmt | *Mytilus trossulus* | Foolish mussel (marine) |
| NC | *Clinocardium nuttalli* | Cockle, Nuttall's cockle |
| SO | *Mya arenaria* | Soft-shell clam |

### 2.3.2 Sample Packaging

Each analytical-sample bottle will be packed to prevent breakage and then placed in an iced cooler to keep the samples cooled to 4° (±2°) Celsius (C). Gel-ice packs for samples will be kept in dedicated freezers that are only used for the storage of ice or sample jars. One copy of the chain-of-custody form will be placed in a sealed plastic bag and then placed inside of the cooler. In addition, the cooler lid will be sealed with tape and chain-of-custody seals will be attached to the outside of the cooler so that the seals must be broken if the cooler is opened.

To preserve the integrity of water, soil, tissue, and sediment samples from collection to receipt by laboratories, all shipments will adhere to the following requirements at a minimum:

- Coolers will be packaged with 25 percent frozen blue ice and 75 percent samples. For water samples, avoid packing too much blue ice around any one sample to avoid freezing samples.
- For fish-tissue samples, ensure that the tissues are completely frozen before they are placed into the iced cooler for shipment. Be sure that samples are segregated from other freezer contents by being placed in an appropriate larger sealed container (including custody tape).
- ALL samples in ALL coolers are to be shipped using Alaska Airlines GoldStreak (or other airport-to-airport equivalent). For samples sent to Columbia Analytical Services, Inc., in Kelso, Washington, write on the airbill "by way of Portland." CAS has daily courier service from Portland to their lab in Kelso. Samples may be shipped to Seattle without this instruction.
- Each cooler will include a completed chain-of-custody (COC) form for the samples contained in the cooler, with all required analyses clearly specified.
- Each cooler will include a bottle of water labeled Temperature Blank. The laboratory will measure and record the temperature from this bottle and the air temperature in the cooler.

### 2.3.3 Chain-of-custody Form

COC forms will be used for all samples. Once collected, the samples will remain within sight of the sampler or will be secured until the samples are prepared for shipment. Each time a cooler changes hands,

both the sender and the receiver will sign and date the COC form. The laboratory will forward the original form to the Analytical QA/QC Manager. The field sampling teams will verify all COC forms before sample shipment and will make a copy of each to maintain a duplicate set of records. The following information is to be included on the COC form:

- Sample identification code.
- Signature of sampler.
- Date and time of collection.
- Project name.
- Type of sample.
- Number and type of containers.
- Sample preservation.
- Sample analysis requested.
- Inclusive dates of possession.
- Signature of receiver.

The consulting company's name, address, and phone number are required on the COC form. Instruct laboratories to invoice Northern Dynasty Mines Inc. and to mail reports to:

Steve Crupi
Shaw Environmental, Inc.
2000 West International Airport Road, Suite C-1
Anchorage, AK 99502

Other COC components will include sample labels, field notebooks, sample shipment receipts, and the laboratory logbook. The lab-specific analytical parameters are presented in Tables 1-10 through 1- 15.

## 2.4 Laboratory Procedures and Analytical Methods

Laboratories will employ the following general procedures, especially when conducting low-level detection analyses.

The laboratory should use ultra-clean reagent, specially-cleaned glassware, and other precautions such as the use of laminar flow hoods for sample digestion and preparation. Results for soil, sediment, vegetation, and fish tissues will be reported on a dry-weight basis.

Analytical methods selected for the Pebble Project EBS are presented in Table 2-6. The instrument method is given for each parameter. The procedures are routine for the laboratories selected for this project and adhere to EPA methods for the analysis of water and solid samples. CAS and STL will be conducting metals analysis on fish tissues following the Puget Sound Estuary Program (PSEP) "Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound" (1996). CAS will prepare vegetation samples following Standard Operating Procedure GEN-TISP dated 7/13/04. See Tables 1-11 through 1-16 for preparation methods.

**TABLE 2-6**
**Analytical Parameters, Methods, and Techniques/Instrumentation**

| Parameter | Method (Water) | Method (Solids) | Technique/Instrumentation |
|---|---|---|---|
| ***Organics*** | | | |
| Total organic carbon | SM5310 | ASTM D4129-82M | Combustion or oxidation |
| VOCs | SW8260B | N/A | Gas chromatography/mass spectrometry |
| SVOCs | SW8270C | N/A | Gas chromatography/mass spectrometry |
| PCBs | SW8082 | SW8082 | Gas chromatography with electron capture detector |
| DRO/RRO | N/A | AK102/103 | Gas chromatography with flame ionization detector |
| ***Inorganics*** | | | |
| pH | SM4500$H^+$ B | N/A | Electrode |
| Specific Conductance | SM2510B | N/A | Resistor network |
| Acidity | SM2310B | N/A | Titration |
| Alkalinity | SM2320B | MA | Titration |
| Ammonia as N | SM4500NH3 | SM4500NH3 | AquaKem wet chemistry analyzer |
| Chloride | E300.0 | N/A | Ion chromatography/ion selective electrode |
| Cyanide, total | SM4500CN-E | SM4500CN –E | AquaKem wet chemistry analyzer |
| Cyanide, WAD | SM4500CN-I | N/A | AquaKem wet chemistry analyzer |
| Cyanide, low-level available | E1677 | N/A | Ligand exchange/amperometry |
| Fluoride | E300.0 | N/A | Ion chromatography/ion selective electrode |
| Hardness | SM2340B | N/A | Calculation |
| Nitrate + Nitrite | E353.2 or SM4500-NO3 F | N/A | Spectrophotometer |
| Phosphorus, total | E365.3 | N/A | AquaKem wet chemistry analyzer |
| Sulfate | E300.0 | N/A | Ion chromatography |
| Thiocyanate | SM4500CN-M | N/A | Spectroscopy (colorimetric) |
| TDS | SM2540C | N/A | Gravimetric |
| TSS | SM2540D | N/A | Gravimetric |
| ***Metals*** | | | |
| Low-level mercury | E1631 | E1631 | Cold vapor atomic fluorescence |
| Mercury | | SW7470 | Cold vapor atomic absorption |
| Metals[1] | E200.7/200.8 | E200.8<br>SW6010B/6020<br>SW7740 (Se) | Inductively coupled plasma atomic emission spectroscopy<br>Inductively coupled plasma mass spectrometry<br>Graphite furnace atomic absorption |

*Notes:*

*1. Al, Sb, As, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Si (dissolved only), Ag, Na, Tl, Sn, V, Zn. Water samples are analyzed for total and dissolved metals.*

*Key:*
*DRO = diesel-range organics*
*RRO = residual-range organics*

## 2.5 Quality Control

The QAPP program consists of three components:

- Field QA identifies the procedures to be used in the field to verify that samples and field monitoring data are collected according to the requirements of the project. The objective of field QA is to produce data—both from field measurements and for samples collected for laboratory analyses—that can be demonstrated to be representative of the environment sampled and are of known and acceptable quality. The Analytical QA/QC Manager is responsible for reviewing at least 10 percent of the field data; the data review records will be kept in a log by the QA/QC Manager.
- Laboratory QA identifies the protocols to be used by the laboratories to demonstrate that project data are analyzed according to EPA-accepted methods and that reported values are accurate. The objective of the laboratory QA/QC program is to produce data that will meet state and federal analytical requirements.
- Data QA identifies the protocols to be used to verify that laboratory and field data have been reported accurately. The objective of the data QA/QC program is to demonstrate that the data reported meet the project-specified requirements.

### 2.5.1 Data Uses and Data Quality Objectives

Quality assurance requirements are established in this QAPP to achieve the project objectives for the data uses. Applicable quality control procedures, quantitative target limits, and the level of effort for assessing the data quality are dictated by the intended use of the data and the nature of the required field and analytical methods. The objective is to collect data of known and sufficient quality for NDM to meet the standards set by state and federal environmental regulations.

Federal and state levels of concern (e.g., ambient water-quality criteria or maximum contaminant levels) exist for many of the parameters being analyzed in the EBS program. The analytical methods that have been selected will allow detection of chemical constituents at or below levels of concern.

### 2.5.2 Data Quality Assurance/Quality Control Program

The data QA/QC program serves four major functions:

- Maintenance of a duplicate record of all field data.
- Sample tracking through laboratory analysis.
- Data validation.
- Oversight of data management.

The QA/QC Manager will maintain close communications with all analytical laboratories to verify sample receipt, proper sample management, and strict adherence to sample holding times. The laboratories will immediately inform the QA/QC Manager of sample breakage, inadequate sample media

to meet QA objectives, or other sample problems. The QA/QC Manager will then notify the respective field team so that corrective action can be implemented as deemed necessary.

Following receipt of the analytical data package, the QA/QC Manager will verify that all applicable data have been received, will compare the data to detection limits, and will compare preliminary results with previous results. Should major discrepancies be found, the QA/QC Manager will communicate these, where appropriate, to the respective field team. Possible corrective measures will then be evaluated as deemed necessary.

### 2.5.3 Laboratory Quality Assurance/Quality Control Program

Specific protocols to ensure laboratory data of known and consistent quality can be found in the quality assurance manuals for the individual laboratories, which are on file at the Shaw office in Anchorage. The QA/QC Manager and laboratory project chemists will oversee implementation of these protocols. Project-specific criteria are provided in Tables 1-10 through 1-15.

Data validation will be conducted by Shaw. Any discrepancies will be noted and discussed with one or more of the following, as necessary:

- Ms. Waak, laboratory project chemist for this project with SGS.
- Ms. Jones, laboratory project chemist for this project with Test America, Inc.
- Ms. Huckestein, laboratory project chemist for this project with CAS.
- Ms. Sue Webber, laboratory project chemist for this project with ACZ.
- Ms. Terri Torres, laboratory project chemist for this project with STL.

## 2.6 Equipment Testing, Inspection, and Maintenance

The laboratory project chemists are responsible for all laboratory-equipment maintenance decisions. In the event of equipment failure that will affect the analytical schedule, the laboratory operations manager will notify the QA/QC Manager. Field team managers are responsible for field-equipment maintenance decisions.

## 2.7 Inspection/Acceptance of Supplies and Consumables

All supplies and consumables (sample reference materials and reagents) will be inspected and checked in by the laboratory project chemist or the quality assurance officer.

## 2.8 Data Management

### 2.8.1 Field Forms

All pertinent field survey and sampling information will be recorded on field forms during each day of the field effort and at each sample site. The field team leader will be responsible for seeing that sufficient detail is recorded on the forms. No general rules can specify the extent of information that must be entered on the forms; however, the objective is that the field forms contain sufficient information so that field activities can be reconstructed without relying on the memory of the field crew. All entries will be made in indelible ink. All corrections will consist of initialed, single-line-out deletions.

Strict custody procedures will be maintained with the field forms used. While being used in the field, forms will remain with the field team and will be secured on a clip board or, at a minimum, with rubber bands AT ALL TIMES. Upon completion of the field effort, forms will be filed in an appropriately secure manner in a bound notebook labeled "original data." These forms will remain with the task manager. Photocopies of the original data will be used as working documents.

### 2.8.2 Laboratory Data

Laboratory data results are received by electronic mail by the Analytical QA/QC Manager. The laboratories also send paper copies of analysis results to the Analytical QA/QC Manager. Laboratory data are validated by Shaw, then uploaded to the NDM chemistry database.

# 3.0 Assessment and Oversight

## 3.1 Assessments and Response Actions

Field assessments will be discussed between the Analytical QA/QC Manager and the field team manager. Any response actions will then be undertaken by the Analytical QA/QC Manager during regular field sampling/monitoring events. Internal assessment for laboratories will be performed according to each laboratory's quality management plans (QMPs), which are kept on file at the Shaw office in Anchorage.

## 3.2 Reports to Management

Following receipt of an analytical data package by Shaw, the Analytical QA/QC Manager at Shaw will review the data following the methods described in Section 4.2.

These QA/QC checks of data will be kept on file at Shaw by the Analytical QA/QC Manager and will be included in data quality assessment reports of the data. Where data do not meet the requirements specified in this QA/QC program, the data will be flagged with qualifiers. Should major discrepancies be found, the Analytical QA/QC Manager will communicate these to NDM's Environmental Study Director, Loretta Ford. Possible corrective measures will then be evaluated, as deemed necessary. These data reviews will be summarized and included in the DQAR reports by Shaw to NDM.

Laboratory reports will include the elements presented in Section 1.8.2 of this QAPP.

# 4.0 Data Review, Validation, and Usability

Data review and validation will be conducted on all data collected for the Pebble Project environmental baseline studies.

## 4.1 Data Review

Data generated for this project will be reviewed by both the laboratory and by Shaw. The laboratory has primary responsibility for correctly identifying and quantifying analytes and compounds of interest, for identifying matrix interferences, and for identifying and, if possible, correcting instrument anomalies. The laboratory is also responsible for the technical quality of the data and for meeting all quality control objectives by correctly following the analytical methods using instrumentation that is in proper working order for the given method.

The review process will be coordinated initially by the bench-level scientists who will review all data for accuracy and completeness. The bench-level scientist will also compare all QC sample results with control criteria outlined in Tables 1-10 through 1-15 and will initiate appropriate corrective action if criteria are not met.

Prior to summary reports, the data will be reviewed by the laboratory QA/QC manager to ensure that the data are representative, complete, and accurate.

## 4.2 Validation and Verification Methods

Data validation is the review process to screen data for anomalies and possible errors. Data accepted from the laboratory will be verified and validated by Shaw. The data validation process will include review of the following:

- Analytical methodology.
- Detection limits.
- Cross-contamination as indicated by blank data.
- Laboratory accuracy and precision.
- Adherence to holding times.
- Sample preservation.
- Initial and continuing calibration.
- Field precision (QA/QC samples).
- Total metals versus dissolved metals.

Data will be validated in accordance with the following procedures:

- *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA, 1999)
- *Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review* (EPA, 2001a)

- *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, Final* (EPA, 2002a)

Field precision will be evaluated using criteria presented in Table 4-1. The primary and duplicate sample results are compared by calculating a precision value (i.e., RPD). The precision values from these comparisons are used to generate control limits, and the precision values for the primary versus triplicate sample results are compared to the control limits. For samples for which precision results fall in the Disagreement or Major Disagreement category, the duplicate or triplicate sample data and the associated primary laboratory data will be evaluated for any biases that may explain the disagreements. In some cases, associated sample results may be qualified as estimates (J) or rejected (R) based on professional judgment.

**TABLE 4-1**
**Criteria for Comparing Field QC and QA Sample Data**

| Matrix | Parameter | Disagreement | Major Disagreement |
|---|---|---|---|
| All | All | >5x difference when one result is <MDL | >10x difference when one result is <MDL |
| All | All | >3x difference when one result is <MRL | >5x difference when one result is <MRL |
| Water | All except TPH | >2x difference | >3x difference |
| Soil, Sediment, and Tissues | All except metals, VOCs, BTEX, and TPH | >4x difference | >5x difference |
| Soil, Sediment, and Tissues | Metals | >2x difference | >3x difference |
| Water, Soil, and Sediment | TPH | Arbitrary (suggest >3x difference) | Arbitrary (suggest >5x difference) |
| Soil, Sediment, and Tissues | VOCs and BTEX | Arbitrary (suggest >5x difference) | Arbitrary (suggest >10x difference) |

*Key:*
*BTEX = benzene, toluene, ethylbenzene, and xylenes*
*TPH = total petroleum hydrocarbons*

Evaluation of total and dissolved metals will involve comparison of results for instances where dissolved is greater than total. Sample results are acceptable if the following criteria are met:

- Where both results are greater than 5 times the MRL, and the RPD between results is less than or equal to 20 percent.
- Where the total metals result is less than or equal to 5 times the MRL, and the absolute value of the difference between the results is less than or equal to the MRL. If the total metals result is not detected at the MDL, then the value of the MDL will be used for the comparison.
- Where both total and dissolved results are below the MRL.

For an individual sample where criteria are not met for up to 30 percent of the parameters, then the associated QC data (including method blanks and field blanks) will be evaluated for bias. Consequently,

results may be qualified with a "J," indicating an estimate. If more than 30 percent of the parameters fail to meet the criteria, then both the total and dissolved metals samples will be reanalyzed. If reanalysis does not eliminate the problem, then results will be qualified with a "J," indicating an estimate (Zeiner, 1994).

Water samples to be analyzed for dissolved metals are prepared in the field by pumping the sample with a peristaltic pump through Tygon tubing with a disposable, in-line, 0.45-micron filter. A summary of the certified limits of detection (LOD) provided by the manufacturer (Voss Manufacturers) for their high-capacity groundwater capsule for filtering water samples is presented in Table 4-2. This table is intended to document the possible contribution of metals from the filter to water samples. Note that selenium is the only metal where the filter LOD is greater than the regulatory limit. Selenium has not been found in filtered samples for dissolved metals analysis at greater concentrations than in samples for total metals analysis.

**TABLE 4-2**
**Summary of Metals Limit of Detection in Filters**

| Parameter | MRL (µg/L) | Filter LOD (µg/L) | Lowest EPA or ADEC Regulatory Limit | Filter LOD > MRL | Filter LOD > Regulatory Limit |
|---|---|---|---|---|---|
| Hg, low level (total only) | 0.005 | 0.05 | 0.05 | Yes | No |
| Al | 1.0 | 0.2 | 87 | No | No |
| Sb | 0.05 | 0.1 | 5.6 | Yes | No |
| As | 0.5 | 0.2 | 10 | No | No |
| Ba | 0.05 | 0.1 | 1000 | Yes | No |
| Be | 0.02 | 0.04 | 4 | Yes | No |
| Bi | 0.1 | 0.04 | None | No | No |
| B | 0.5 | 5 | None | Yes | No |
| Cd | 0.02 | 0.03 | 0.1 | Yes | No |
| Co | 0.02 | 0.02 | None | No | No |
| Cu | 0.1 | 0.5 | 2.7 | Yes | No |
| Pb | 0.02 | 0.5 | 0.54 | Yes | No |
| Mn | 0.05 | 0.3 | 50 | Yes | No |
| Mo | 0.05 | 0.05 | 10 | No | No |
| Ni | 0.2 | 0.5 | 16 | Yes | No |
| Se | 1.0 | 7 | 4.6 | Yes | Yes |
| Si (dissolved only) | 100 | Not reported | None | Not reported | No |
| Ag | 0.02 | 0.03 | 0.32 | No | No |
| Tl | 0.01 | 0.05 | 0.24 | Yes | No |
| Sn | 0.1 | 0.2 | None | Yes | No |
| V | 0.2 | 0.03 | 100 | No | No |
| Zn | 0.5 | 1 | 36 | yes | No |

Aqueous samples are evaluated for ion balance by the laboratories. This is a QC check on results to identify any data that may be suspect. If ion-balance criteria are not met, the relevant data are evaluated to identify the cause for the poor balance.

Where data do not meet the requirements specified in this QAPP, the data will be flagged with qualifiers. Reviews of data will be summarized and included in the QA report.

The following are validation flags that may be attached to data for this project:

- U Analyte was not detected at the sample quantitation limit. Detections below this limit were attributed to associated blank contamination.
- UJ The analyte was analyzed, but was not detected above the level of the reported sample quantitation limit. The reported quantitation limit is approximate and may be inaccurate or imprecise.
- J The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
- J+ The result is an estimated quantity, but the result may be biased high.
- J- The result is an estimated quantity, but the result may be biased low.
- R The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.
- B Vegetation samples: the result was detected at a value less than 10 times the amount in the associated field blank. The result is flagged to inform the user of potential contamination.

## 4.3 Reconciliation with User Requirements

A periodic review of the objectives of this project will be done on a yearly basis to determine if user requirements have changed.

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# DRAFT ENVIRONMENTAL BASELINE STUDIES
# 2008
# QUALITY ASSURANCE PROJECT PLAN

# PEBBLE PROJECT

## ENVIRONMENTAL BASELINE STUDIES

## 2008 QUALITY ASSURANCE PROJECT PLAN

Prepared For:

**State of Alaska Large Mine Permitting Team**
**Department of Natural Resources**

Prepared By:

3201 C Street, Suite 604
Anchorage, AK 99503
(907) 339-2600

June 2008

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# Acronyms and Abbreviations

| | |
|---|---|
| 3PPI | Three Parameters Plus, Inc. |
| ABR | ABR, Inc.—Environmental Research & Services |
| ACZ | ACZ Laboratories, Inc. |
| ADEC | Alaska Department of Environmental Conservation |
| ADNR | Alaska Department of Natural Resources |
| AVS-SEM | Acid Volatile Sulfides-Simultaneously Extracted Metals |
| BEESC | Bristol Environmental & Engineering Services Corporation |
| BTEX | benzene, toluene, ethylbenzene, and xylenes |
| C | Celsius |
| CAS or CASK | Columbia Analytical Services, Inc. |
| COC | chain-of-custody |
| DOC | dissolved organic carbon |
| DQAR | data quality assurance report |
| DRO | diesel-range organics |
| DQO | data quality objective |
| EPA | United States Environmental Protection Agency |
| EBS | environmental baseline studies |
| FSP | field sampling plan |
| g | gram(s) |
| GERG | Geochemical and Environmental Research Group |
| HDPE | high-density polyethylene |
| HDR | HDR Alaska, Inc. |
| LCS | laboratory control sample |
| L | liter(s) |
| LOD | limit of detection |
| MDL | method detection limit |
| µg/L | micrograms per liter |
| µmhos/cm | micromhos per centimeter |
| mg/kg | milligrams per kilogram |
| mg/L | milligrams per liter |
| mL | milliliter(s) |
| MRL | method reporting limit |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| NEPA | National Environmental Policy Act |
| oz | ounce(s) |
| PAH | polynuclear aromatic hydrocarbon |
| PARCC | precision, accuracy, representativeness, comparability, and completeness |
| PCBs | polychlorinated biphenyls |
| PE | performance evaluation |
| PSEP | Puget Sound Estuary Program |
| QA | quality assurance |
| QAPP | quality assurance project plan |
| QC | quality control |
| R2 | R2 Resource Consultants, Inc. |
| RPD | relative percent difference |
| RRO | residual-range organics |

| | |
|---|---|
| RSD | relative standard deviation |
| SGS or SGSA | SGS Environmental Services, Inc. |
| Shaw | Shaw Alaska, Inc. |
| SHC | saturated hydrocarbons |
| SLR | SLR Alaska, Inc. |
| SRK | Steffen, Robertson and Kirsten (Canada) Inc. |
| SRMs | standard reference materials |
| SOP | standard operating procedure |
| SVOC | semivolatile organic compound |
| TA or TAWA | TestAmerica Laboratories, Inc. |
| TEL | threshold effects level |
| TLC | Teflon-lined cap |
| TOC | total organic carbon |
| TPH | total petroleum hydrocarbon |
| TSS | total suspended solids |
| TDS | total dissolved solids |
| VOC | volatile organic compound |
| WAD | weak acid dissociable |

# 1.0 Program Summary

## 1.1 *Title and Approval Sheets*

**Program Title:**

Pebble Project, Environmental Baseline Studies

**Organization:**

Pebble Partnership

| Pebble Partnership Personnel | Signature | Date |
|---|---|---|
| Bruce Jenkins<br>Chief Operating Officer/Environmental Study Director<br>Pebble Partnership<br>E-mail: brucejenkins@pebblepartnership.com<br>Phone: 604-684-6365 | | |
| Jane Whitsett<br>Environmental Studies Manager<br>Pebble Partnership<br>E-mail: janewhitsett@pebblepartnership.com<br>Phone: 907-339-2600 | | |
| Michael Smith<br>NEPA and Permitting Manager<br>Pebble Partnership<br>E-mail: michaelsmith@pebblepartnership.com<br>Phone: 907-339-2606 | | |
| **Shaw Alaska, Inc. Personnel** | | |
| Steven R. Crupi<br>Analytical QA/QC Manager<br>Shaw Alaska, Inc.<br>E-mail: steve.crupi@shawgrp.com<br>Phone: 907-249-6312 | | |
| **Agency Personnel** | | |
| Dave Johnson<br>Tech Eng II / Architect II<br>Alaska Department of Environmental Conservation<br>E-mail: david.johnson1@alaska.gov<br>Phone: 907-262-5210, x238 | | |

## 1.2 Distribution List

- Pebble Partnership
- Three Parameters Plus, Inc.
- ABR Inc.
- ACZ Laboratories Inc.
- Columbia Analytical Services, Inc.
- Dana E. Stewart Information Technology
- HDR Alaska, Inc.
- Pentec Environmental
- R2 Resource Consultants, Inc.
- SGS Environmental Services, Inc.
- Shaw Alaska, Inc.
- SLR International Corp.
- TestAmerica, Inc.
- Texas A&M Geochemical and Environmental Research Group

## 1.3 Project Organization

The environmental baseline studies (EBS) for the Pebble Project are managed by Pebble Partnership, who is using the expertise of highly experienced technical advisors. Those advisors include SLR International Corp. (SLR), Bristol Environmental & Engineering Services Corporation (BEESC), HDR Alaska, Inc. (HDR), Three Parameters Plus, Inc. (3PPI), ABR, Inc.—Environmental Research & Services (ABR), Pentec Environmental, R2 Resource Consultants, Inc. (R2), SRK Consulting (Canada) Inc. (SRK), and Shaw Alaska, Inc. (Shaw). The project team will collect surface water and groundwater, marine water, marine sediment, marine tissue (fish, bivalve, and algae), and mammal tissue.

This quality assurance project plan (QAPP) provides the analytical quality assurance (QA)/quality control (QC) requirements for 2008. The QAPP is applicable to the QA/QC aspects of field sampling and laboratory chemical analysis. Pebble Partnership is preparing study plans for 2008 that will provide a comprehensive description of the 2008 environmental baseline studies for agency and stakeholder review. Field sampling plans (FSPs) also are being prepared to address the specifics of field sampling for each media undergoing chemical analysis. The program is divided into two study disciplines, as follows.

| DISCIPLINE | MEDIA | STUDY DIRECTOR |
|---|---|---|
| **Water Quality Studies** | Surface water and groundwater | Jane Whitsett, Pebble Partnership |
| **Trace Elements Studies** | Sediment, vegetation, fish, bivalves, mammal tissues, and marine water | Jane Whitsett, Pebble Partnership |

The Pebble Project EBS includes collection of QA/QC samples at a frequency of 10 percent for all media. Primary and QC (field duplicate) samples are analyzed by the primary laboratories. QA (field triplicate) samples are analyzed by the QA laboratories. The QA laboratory analyses provide a check on the primary laboratory's accuracy and precision throughout the project. The primary and QA laboratories and the media for which they are responsible are identified in Table 1-1. Table 1-2 summarizes contact information for the Pebble Project laboratories. Field teams are responsible for collection of QA/QC samples in the field. Shaw is responsible for shipment of samples to the appropriate laboratories.

**Table 1-1**
**Summary of Primary and QA Analytical Laboratories for Environmental Baseline Studies**

| Media | Primary Laboratories | QA Laboratories |
|---|---|---|
| Surface Water and Groundwater | SGS — Anchorage, AK | CAS — Kelso, WA |
| Fish, Algal, and Mammalian Tissue | CAS — Kelso, WA | TA– Tacoma, WA |
| Marine Water | CAS — Kelso, WA | TA — Tacoma, WA |
| Marine Sediment | CAS — Kelso, WA<br>Texas A&M GERG — College Station, TX [a] | TA — Tacoma, WA |
| Marine Bivalve Tissue | CAS — Kelso, WA<br>Texas A&M GERG — College Station, TX [a] | TA — Tacoma, WA |

*a. Lipid Content, polynuclear aromatic hydrocarbons, saturated hydrocarbons*

*SGS = SGS Environmental Services, Inc.*

*CAS = Columbia Analytical Services, Inc.*

*TA = TestAmerica, Inc.*

*GERG = Geochemical and Environmental Research Group*

**Table 1-2**
**Laboratory Contact Information**

| | |
|---|---|
| Karen Waak<br>SGS Environmental Services, Inc.<br>200 W. Potter Dr.<br>Anchorage, AK 99518<br>907-562-2343 phone, 907-550-3203 direct<br>907-561-5301 fax<br>Karen.Waak@sgs.com | Lynda Huckestein<br>Columbia Analytical Services, Inc.<br>1317 S. 13th Avenue<br>Kelso, WA 98626<br>360-501-3358 direct phone<br>360-636-1068 fax<br>lhuckestein@kelso.caslab.com |
| Richard Reid<br>TestAmerica, Inc.<br>9405 SW Nimbus Ave.<br>Beaverton, OR 97008<br>503-906-9237 direct phone<br>503-906-9210 fax<br>Richard.Reid@testamericainc.com | Mike Priebe (local contact)<br>TestAmerica, Inc.<br>2000 W. International Airport Road, Suite A10<br>Anchorage, AK 99502<br>907-563-9200 phone, 907-317-3412 cell<br>907-563-9210 fax<br>Mike.Priebe@testamericainc.com |
| Terri Torres<br>TestAmerica, Inc - Tacoma<br>5755 8th Street East<br>Tacoma, WA 98424<br>253-922-2310<br>Terri.Torres@testamericainc.com | Sue Webber<br>ACZ Laboratories, Inc.<br>2773 Downhill Drive<br>Steamboat Springs, CO 80487<br>800-334-5493, x110<br>suew@acz.com |
| Terry Wade, PhD<br>Geochemical and Environmental Research Group<br>Texas A&M<br>833 Graham Road<br>College Station, TX 77845<br>979-862-2323, x134<br>terry@gerg.tamu.edu | |

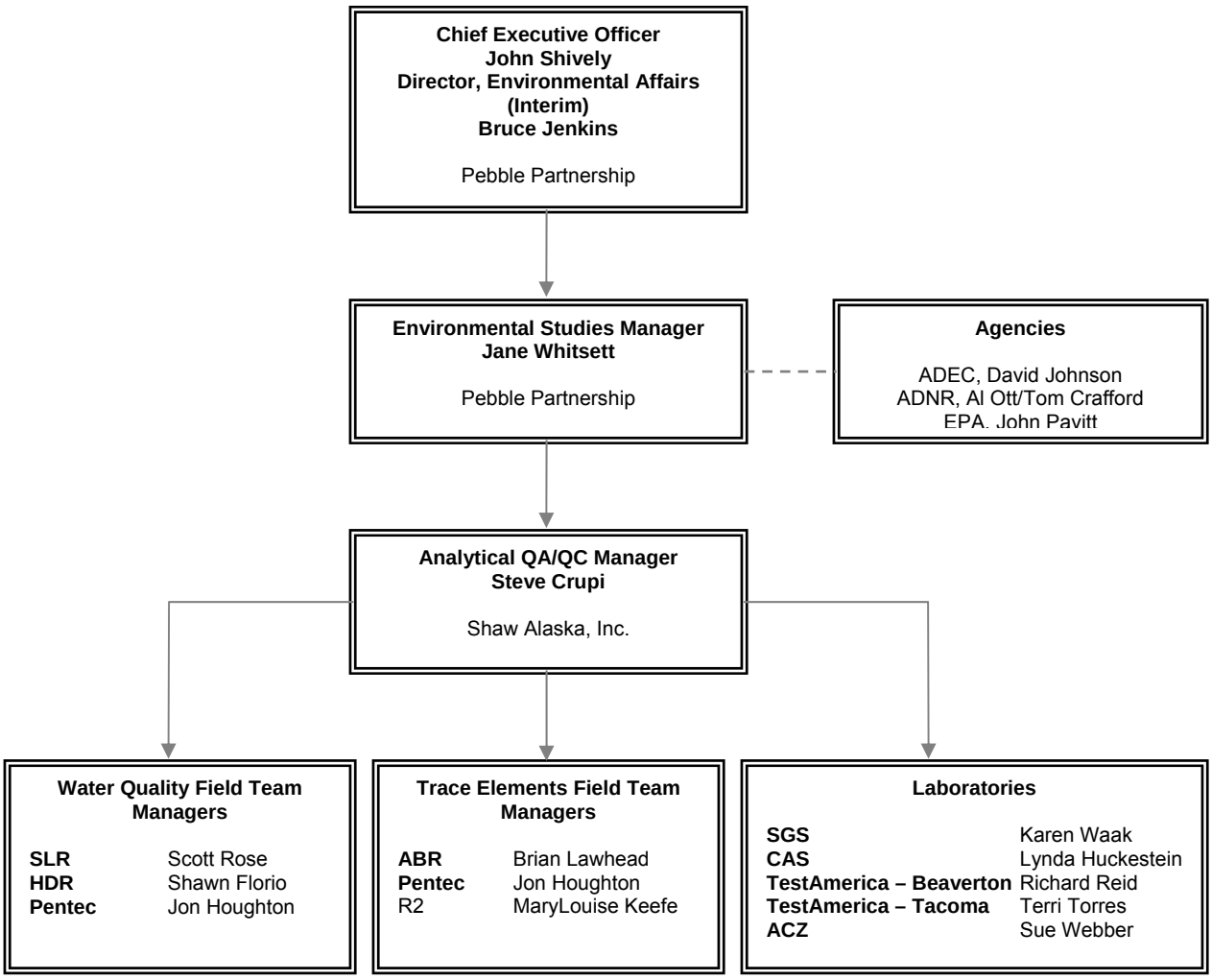
Pebble Partnership's environmental consultants will collect all field samples for laboratory analysis. HDR will collect surface water samples, and SLR will collect groundwater samples. Pentec will collect marine water, sediment, vegetation, and tissues for the marine study. ABR will collect mammalian tissue, and R2 will collect fish from lakes and streams. Shaw will provide analytical QA/QC management for the project. Key personnel and their roles are described below in Table 1-3 and are identified in the organizational chart (Figure 1-1).

**Table 1-3**
**Summary of Pebble Project EBS Key Personnel and Roles**

| Personnel | Responsibilities |
|---|---|
| **Pebble Partnership** | |
| Bruce Jenkins, Director, Environmental Affairs (Interim) | Responsible for development and execution of overall project scope and schedule. |
| Jane Whitsett, Environmental Studies Manager | Provides oversight of project team, deliverables, and schedule. Responsible for oversight of sample collection and analysis of trace elements in surface water, groundwater, marine water, marine sediment, marine vegetation, and bivalve and fish tissue. |
| **SHAW ALASKA, INC.** | |
| Steven R. Crupi, Analytical QA/QC Manager | Responsible for preparation of QAPP and review of laboratory data and deliverables to ensure that technical and quality requirements stipulated by regulatory agencies and Pebble Partnership are met. |
| **FIELD TEAMS** | |
| **SLR**, Mark Stelljes | General oversight of trace element program. |
| **SLR,** Scott Rose | Responsible for managing collection of groundwater samples. |
| **HDR**, Shawn Florio | Responsible for managing collection of surface water. |
| **ABR**, Brian Lawhead | Responsible for oversight of the mammalian tissue-collection activities. |
| **R2**, MaryLouise Keefe | Responsible for managing collection of fish tissues from lakes and streams. |
| **Pentec**, Jon Houghton | Responsible for managing collection of water, sediment, and plant and animal tissue for the marine study. |
| **LABORATORIES** | |
| **SGS Environmental Services, Inc.,** Karen Waak, Project Chemist | Responsible for executing and reporting laboratory work (inorganics and organics) for primary and QC surface and groundwater samples collected by field teams. |
| **Columbia Analytical Services, Inc.,** Lynda Huckestein, Project Chemist | Responsible for executing and reporting laboratory work for primary samples of fish, bivalve, algal, and mammalian tissues; marine water; and marine sediment and for QA surface and groundwater samples collected by field teams. |
| **Texas A&M - Geochemical and Environmental Research Group** | Responsible for executing and reporting laboratory work for analyses of organic analytes in primary samples of marine sediment and bivalve tissue. |
| **TestAmerica, Inc.** Terri Torres, Project Chemist | Responsible for executing and reporting laboratory work for QA samples of mammalian, fish, bivalve, and algal tissue; marine sediment; and marine water collected by field teams. |
| **ACZ Laboratories, Inc.** | Responsible for testing primary water samples (inorganics only), as needed. |

| Personnel | Responsibilities |
|---|---|
| **AGENCIES** | |
| **Alaska Department of Environmental Conservation (ADEC)**<br>David Johnson | <br>Pebble Project Manager<br>Tech Eng II / Architect II |
| **Alaska Dept. of Natural Resources (ADNR)**<br>Al Ott<br>Tom Crafford | <br>Manager, Office of Habitat Management and Permitting<br>Manager, Large Mine Permitting Team |
| **U.S Environmental Protection Agency (EPA)**<br>John Pavitt | <br>Project Manager |

**Figure 1-1**
**Pebble Project Analytical Chemistry Organization Chart**




## 1.4 Project Background and Objectives

Environmental studies are being conducted for the Pebble Project to develop baseline data for comparison to future conditions (e.g., during construction, operations, and closure), as outlined in the study plans and field sampling plans being prepared for 2008.

### 1.4.1 Background

The Pebble Project is a proposed mining operation for a copper, gold, molybdenum, and silver deposit located in southwestern Alaska. Pebble Partnership is conducting extensive study programs to collect the engineering, environmental, and socioeconomic data necessary for a feasibility study and the preparation of applications for state and federal permits.

Pebble Partnership considers environmental stewardship one of the cornerstones to pursuing the development of the Pebble Project. This involves diligent characterization of existing conditions in the environment in the vicinity of the project and their incorporation into the project design and operation.

### 1.4.2 Objectives of the Program

Pebble Partnership is in the process of evaluating the Pebble Project and is performing environmental baseline studies as part of this evaluation. The overall objective of the environmental baseline studies is to characterize the environment that will be potentially affected by development of the Pebble Project. Data will be collected for the characterization of water quality and of concentrations of naturally occurring constituents (also referred to as trace elements) in plant and animals tissues and in marine sediment. These data will be used to establish existing baseline conditions and to provide data that can be used in the future with longer term monitoring programs to evaluate long-term trends for National Environmental Policy Act (NEPA) activities and permitting.

Specific objectives for the water quality and trace elements programs are described below.

#### 1.4.2.1 Water Quality Objectives

The water chemistry baseline studies include collection and analysis of samples of surface water and groundwater. The main objectives of these studies are to:

- Collect baseline data to provide defensible documentation of the naturally occurring levels and spatial and temporal variability of trace elements in surface and groundwater.
- Define the chemical characteristics of groundwater in the project vicinity that is currently used for drinking water.
- Evaluate sources that could be used for make-up water for the mine development.
- Provide a database for the site water-chemistry and site-loading models for project design and environmental impact assessment.
- Develop the baseline for evaluating possible environmental effects during construction, operation, and closure of the mine.
- Provide data to compliment the evaluation of site geochemistry.

This information is key to understanding current conditions and trends. The baseline water chemistry data also are important for determining if site-specific water chemistry standards are required for waterbodies in the vicinity of the project.

#### 1.4.2.2 Marine Water Quality and Trace Element Objectives

Samples of marine water, marine sediment, and marine tissues will be collected and analyzed for trace elements. The objectives of the trace elements study are as follows:

- Collect baseline data to provide defensible documentation of the naturally occurring levels and spatial and temporal variability of trace elements in marine water.

- Collect baseline data to provide defensible documentation of the naturally occurring levels of trace elements and spatial and temporal variability of trace elements and organics in marine sediments and marine tissues.
- Collect and summarize data on background levels of targeted naturally occurring constituents in the marine environment that could potentially be affected by mine development and port (Iniskin/Iliamna Estuary) activities.

This information is key to understanding current conditions and will provide a baseline for evaluating possible future environmental effects to these media during mine construction, operation, and closure, and also to support long-term site-monitoring objectives.

## 1.5 Project/Task Description and Schedule

This section provides a project description, summary of work to be performed, description of products to be produced, and the schedule for implementation.

The Pebble Project is located in southwestern Alaska, about 230 miles from Anchorage, 18 miles northwest of Iliamna, and 60 miles from tidewater at Cook Inlet. The study areas will be accessed by air from Iliamna for field tasks.

### 1.5.1 Task Descriptions

The tasks covered by this QAPP include field sampling, laboratory analysis and reporting, and data validation. Each task is discussed briefly below.

#### 1.5.1.1 Task 1 — Field Sampling

The sampling approach is discussed in the field sampling plans and in this QAPP. Table 1-4 summarizes sample quantities planned for 2008.

#### 1.5.1.2 Task 2 — Laboratory Analysis and Reporting

Samples will be analyzed for the parameters detailed in Table 1-5. Laboratories will provide hardcopy and electronic reports to the Analytical QA/QC Manager. Reports will include data summaries, QC results, and calibration data. Shaw will validate the laboratory data. The validated analytical data will then be uploaded into the Pebble Partnership database for access by data users.

**Table 1-4**
**Pebble Project 2008 EBS Estimated Sample Quantities**

| Consultant | Area | Media | Primary Samples | MS/MSD Samples | QC Duplicate Samples | Total Primary-lab Samples | QA Triplicate Samples |
|---|---|---|---|---|---|---|---|
| ABR | Transportation Corridor | Mammal Tissue | 120 | 12 | 10 | 142 | 10 |
| HDR | Mine Study Area | Surface Water — Streams | 284 | 28 | 28 | 340 | 28 |
| HDR | Mine Study Area | Surface Water — Seeps | 140 | 14 | 14 | 168 | 14 |
| SLR | Mine Study Area | Groundwater | 306 | 31 | 31 | 368 | 31 |
| Pentec | Iniskin/Iliamna Estuary | Marine Water | 24 | 3 | 3 | 30 | 3 |
| Pentec | Iniskin/Iliamna Estuary | Marine Sediment | 25 | 3 | 3 | 31 | 3 |
| Pentec | Iniskin/Iliamna Estuary | Marine Tissues (veg., bivalves, and fish) [a] | 100 | 10 | 10 | 120 | 10 |
| R2 | Mine Study Area | Freshwater Fish Tissue [b] | 220 | 22 | 22 | 264 | 22 |
| | | Total | 1219 | 123 | 121 | 1463 | 121 |

*a. Vegetation, fish, and bivalve tissue QA/QC samples are prepared by the primary laboratory (CAS). CAS will ship QA samples to the QA laboratory (TestAmerica.) for these media.*

*b. Freshwater fish for will be collected, dissected for muscle and liver tissue, tested and the remaining tissue freeze dried for possible additional or conformational analyses.*

*MS = matrix spike; MSD = matrix spike duplicate.*

**Table 1-5**
**Pebble Project 2008 EBS Summary of Laboratory Analyses**

| Parameter | Method (Water) | Method (Solids) | Surface Water | Groundwater | Freshwater Fish | Mammalian Tissue | Marine Algae | Marine Water | Marine Sediment | Marine Fish | Marine Bivalve |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Inorganics*** | | | | | | | | | | | |
| pH | SM4500$H^+$ B | | X | X | | | | | | | |
| Specific Conductance | SM2510B | | X | X | | | | | | | |
| Acidity | SM2310B | | X | X | | | | | | | |
| Alkalinity | SM2320B | | X | X | | | | | | | |
| Ammonia as N | SM4500NH3-F | | X | X | | | | X | | | |
| Chloride | E300.0 | | X | X | | | | | | | |
| Cyanide, total | SM4500CN-E | | X | X | | | | X | X | | |
| Cyanide, WAD | SM4500-CN-I | | X | X | | | | X | | | |
| Cyanide, speciation | ASTM D6994-04M | | X | X | | | | | | | |
| Fluoride | E300.0 | | X | X | | | | | | | |
| Hardness | SM2340B | | X | X | | | | | | | |
| Nitrate + Nitrite | SM4500-NO3F | | X | X | | | | | | | |
| Phosphorus, total | E365.3 | | X | X | | | | | | | |
| Sulfate | E300.0 | | X | X | | | | | | | |
| Thiocyanate | SM4500CN-M | | X | X | | | | | | | |
| TDS | SM2540C | | X | X | | | | | | | |
| TSS | SM2540D | | X | X | | | | X | | | |
| Low-level Mercury | E1631 | | X | X | X | | X | X | | X | X |
| Mercury | | SW7471A | | | | X | | | X | | |
| Metals[f] | E200.7/200.8 | SW6010B/6020 | X[a] | X[a] | X | X[b] | X[c] | X[d] | X[e] | X[c] | X[c] |
| AVS-SEM | | Draft E1991/ SW6010B/ SW7470A | | | | | | | X | | |

| Parameter | Method (Water) | Method (Solids) | Surface Water | Groundwater | Freshwater Fish | Mammalian Tissue | Marine Algae | Marine Water | Marine Sediment | Marine Fish | Marine Bivalve |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Organics*** | | | | | | | | | | | |
| TOC | SM5310B | ASTM D4129-82M | X | | | | | | X | | |
| DOC/TOC | SM5310B | | X | X | | | | | | | |
| DRO/RRO | AK102/103 | | X | | | | | | | | |
| PCBs | SW8082 | | X | | | | | | | | |
| VOCs | SW8260B | | X | | | | | | | | |
| SVOCs | SW8270C | | X | | | | | | | | |
| PAHs | | GERG9733 | | | | | | | X | X | X |
| SHCs | | GERG0008 | | | | | | | X | X | X |
| ***Other*** | | | | | | | | | | | |
| Lipid Content | | GERG9727 | | | | | | | | | X |
| Grain Size | | PSEP | | | | | | | X | | |

*a. Total and dissolved metals for surface and groundwater: Al, Sb, As, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Si (dissolved only), Ag, Na, Tl, Sn, V, Zn.*

*b. Total metals for mammalian tissue: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Mo, Ni, Se, Ag, Tl, and Zn.*

*c. Total metals for marine tissue: Al, Sb, As, B, Be, Cd, Cr, Cu, Pb, Hg, Mo, Ni, Se, Ag, Sn, Tl, and Zn.*

*c. Total and dissolved metals for marine water: Al, Sb, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Pb, Mn, Ni, Ag, Se, Sn, Tl, V, Zn.*

*e. Total metals for marine sediment: Al, Sb, As, Ba, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Sn, and Zn.*

*f. Freshwater fish samples will be collected in 2008 for testing of muscle and liver tissue.*

*AVS-SEM = acid volatile sulfides-simultaneously extracted metals*
*DOC = dissolved organic carbon*
*DRO = diesel-range organics*
*E = EPA (1983, 1991 and 2001b)*
*M = modified*
*PCBs = polychlorinated biphenyls*
*RRO = residual-range organics*
*SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition. 1998*
*SOP = standard operating procedure*
*SVOCs = semivolatile organic compounds*
*SW = EPA (1993)*
*TDS = total dissolved solids*
*TOC = total organic carbon*
*TSS = total suspended solids*
*VOCs = volatile organic compounds*
*WAD = weak acid dissociable*

#### 1.5.1.3 Task 3 — Data Validation and Data Quality Assurance Reports

Laboratory data will be reviewed using the EPA *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA, 1999), EPA *Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review* (EPA, 2001a), and EPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2002a). These guidelines will be modified as needed for the specific analytical methods being used. Data quality assurance reports (DQARs) will be prepared by the Analytical QA/QC Manager and submitted to Pebble Partnership. These reports will discuss analytical QA/QC results and potential effects to the project based on the results of data validation.

### 1.5.2 Schedule

Field sampling for 2008 will be conducted according to the schedule in Table 1-6. Laboratories have been contracted to deliver their reports to Shaw within 30 days from sample receipt. Note that delays in this schedule may occur during peak field season. DQARs will be prepared by Shaw for samples collected in 2008 for each media from the mine study area, the transportation corridor, and the port (Iniskin/Iliamna Estuary) area.

**Table 1-6**
**Pebble Project 2008 EBS Field Sampling Schedule**

| Consul-tant | Area | Media | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HDR | Mine Study Area | Surface Water, Streams | X | X | X | X | X | X | X | X | X | X | X | X |
| HDR | Mine Study Area | Surface Water, Seeps | | | X | | X | | X | X | | X | | |
| SLR | Mine Study Area | Groundwater | | | X | | X | | | X | | | X | |
| ABR | Transportation Corridor | Mammalian Tissue | | | | | | | | | X | | | |
| R2 | Mine Study Area | Fish Tissue | | | | | | | | X | X | | | |
| Pentec | Iniskin/Iliamna Estuary | Water/ Sediment/ Tissue | | | | | X | X | X | | X | | | |

## 1.6 Quality Objectives and Criteria

The principal objectives of the QA program are to maintain an acceptable level of quality for field activities, sample collection, sample handling, laboratory analysis, and data analysis and to document the quality of data at each processing level. This program clearly identifies major aspects of the project requiring specific quality control and demonstrates that quality control is a major focus for this project.

QA/QC requirements are established in this QAPP to achieve the project objectives for the data users. Applicable QC procedures, quantitative target limits, and level of effort for assessing the data quality are dictated by the intended use of the data and the nature of the required field and analytical methods. The project objectives are to collect data of known and sufficient quality for the Pebble Partnership to rely on as accurate and precise environmental baseline data. A summary of field QA/QC samples is given in Table 1-7.

**Table 1-7**
**Pebble Project 2008 EBS Summary of Field QA/QC Samples**

| Type of Field QA/QC Sample | Analysis | Sampling Events | Frequency |
|---|---|---|---|
| Field duplicate (QC sample) | All parameters (201) | All | 10 percent |
| Field triplicate (QA sample) | All parameters (301) | All | 10 percent |
| Equipment blank | Total metals (401) | Surface and Groundwater, Marine Water, Marine Sediment, Fish and Mammal Tissue | 5 percent (401, 403)/ minimally one per event |
| | Dissolved metals (402, 403) | Surface Water, Groundwater, Marine Water | Minimum one per filter lot for filter rinse blanks (402, 404) |
| | DOC (404) | Surface and Groundwater | |
| Deionized water blank | Total metals (501) | Surface, Ground, and Marine Water; Marine Sediment, Fish and Mammal Tissue | 1 per sampling event |
| | TOC (502) | Surface and Groundwater, Marine Sediment | |
| Trip blank | Low-level Hg (601) | Surface Water, Groundwater, Marine Water | 1 per cooler groundwater |

Federal and state levels of concern (for example, ambient water quality criteria or maximum contaminant levels) are used as benchmark criteria in the QAPP. Analytical methods that will allow detection of chemical constituents at or below benchmark criteria have been specified wherever possible. Note that the benchmark criteria are not necessarily based on enforceable standards. The analytical parameters and benchmark criteria for water and marine sediment are listed in Tables 1-8 and 1-9, respectively. Both EPA and ADEC standards were reviewed. Benchmark criteria for water are based on the following references: *Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances* (ADEC, 2003); *Fact sheet: Revised National Recommended Water Quality Criteria* (EPA, 2003); and *National Recommended Water Quality Criteria*, EPA-822-R-02-047 (EPA, 2002b). The tables present the lowest of the three standards. Parameters included in the environmental baseline study but not shown in these tables do not have benchmark criteria.

**Table 1-8**
**Benchmark Criteria for Water**

| Analyte | Lowest Surface or Drinking Water Criteria |
|---|---|
| ***Inorganics in Water (mg/L)*** | |
| Alkalinity | 20[c] |
| Ammonia as N | 0.18[c] |
| Chloride | 230[c] |
| Cyanide-total | 0.0052[c] |
| Fluoride | 1[c] |
| Nitrate + Nitrite | 10[c] |
| Sulfate | 250[h] |
| TDS | 500[h] |
| TSS | 30[h] |
| ***Volatile Organic Compounds ([µg/L)*** | |
| 1,1-Dichloroethylene | 7[b] |
| 1,1,1-Trichloroethane | 200[b] |
| 1,1,2-Trichloroethane | 5[b] |
| 1,2-Dichloroethane | 5[b] |
| 1,2-Dichloropropane | 5[b] |
| 1,2,4-Trichlorobenzene | 70[b] |
| Benzene | 5[b] |
| Carbon tetrachloride | 5[b] |
| Cis-1,2-Dichloroethylene | 70[b] |
| Dichloromethane | 5[b] |
| Ethyl benzene | 700[b] |
| o-Dichlorobenzene | 600[b] |
| Para-Dichlorobenzene | 75[b] |
| Pentachlorophenol | 1[b] |
| Styrene | 100[b] |
| Tetrachloroethene | 5[c] |
| Toluene | 1,000[b] |
| Vinyl Chlorides | 2[b] |
| Total Xylenes | 10,000[b] |
| ***Metals in Water (µg/L)*** | |
| Al | 87[c] |
| Sb | 5.6[g] |
| As | 10[e] |
| Ba | 1,000[g] |
| Be | 4[b] |
| Cd | 0.1[c] |

| Analyte | Lowest Surface or Drinking Water Criteria |
|---|---|
| Cr | 24[c] |
| Cr +6 (6) | 11[f] |
| Cu | 2.7[c] |
| Fe | 1000[g] |
| Pb | 0.54[c] |
| Mn | 50[c] |
| Hg | 0.012[c] |
| Mo | 10[c] |
| Ni | 16[c] |
| Se | 4.6[c] |
| Na | 250,000[a] |
| Ag | 0.32[c] |
| Tl | 0.24[d] |
| V | 100[c] |
| Zn | 36[c] |
| ***Pesticides (µg/L)*** | |
| 4,4'-DDT | 0.001[c] |
| Aldrin | 3.0[c] |
| Chlordane | 0.0043[c] |
| Dieldrin | 0.056[c] |
| Endosulfan I | 0.056[c] |
| Endosulfan II | 0.056[c] |
| Endrin | 0.036[c] |
| Endrin aldehyde | 0.76[c] |
| gamma-BHC (Lindane) | 0.2[c] |
| Heptachlor | 0.0038[c] |
| Heptachlor epoxide | 0.0038[c] |
| Lindane | 0.2[c] |
| Methoxychlor | 0.03[c] |
| Toxaphene | 0.0002[c] |
| ***Semivolatile Organic Compounds (µg/L)*** | |
| Benzo[a]pyrene | 0.2[b] |
| Di(2-ethylhexyl)adipate | 400[b] |
| Di(2-ethylhexyl)phthalate | 6[b] |
| Hexachlorobenzene | 1[b] |
| Hexachlorocyclopentadiene | 50[b] |

*Notes:*

*a. ADEC secondary maximum contaminant level for sodium.*

*b. ADEC 18AAC75.*

*c. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances, (ADEC, 2003).*

*d. EPA Revised National Recommended Water Quality Criteria (EPA, 2003).*

*e. EPA Safe Drinking Water Act (SDWA) National Primary Drinking Water Regulations, January 23, 2006.*

*f. National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables, Updated September 1999 (Buchman, 1999). Values in this table are the lowest among the threshold effects level (TEL), probable effects level, and upper effects level for freshwater sediment and among TEL, effects range—low and effects range—medium.*

*g. EPA National Recommended Water Quality Criteria, EPA-822-R-02-047 (EPA, 2002b).*

*h. Pogo Mine Project, Final Environmental Impact Statement, Table 4.3-14 (USEPA, 2003).*

*mg/L = milligrams per liter.*

*µg/L = micrograms per liter.*

**Table 1-9**
**Benchmark Criteria for Marine Sediment**

| Analyte | Lowest Marine Sediment Criteria [a] |
|---|---|
| ***Inorganics (mg/kg)*** | |
| Cyanide (Total) | None |
| ***Metals (mg/kg)*** | |
| Al | 18,000 |
| Sb | 3 |
| As | 5.9 |
| Ba | 48 |
| Be | None |
| Cd | 0.583 |
| Cr | 36.2 |
| Co | 10 |
| Cu | 18.7 |
| Fe | 40,000 |
| Pb | 30.2 |
| Mn | 260 |
| Hg | 0.13 |
| Ni | 15.9 |
| Se | 1.0 |
| Ag | 0.73 |
| Sn | 3.4 |
| V | 57 |
| Zn | 89 |

*Note:*

*a. National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables, Updated September 1999 (Buchman, 1999). Values in this table are the lowest among the threshold effects level (TEL), probable effects level, and upper effects level for freshwater sediment and among TEL, effects range—low and effects range—medium.*

### 1.6.1 Data Quality Parameters

The quality of laboratory data is measured by the precision, accuracy, representativeness, comparability, and completeness (PARCC) of the data. The analytical parameters and the associated data-quality objectives (DQOs) for accuracy and precision are shown in Tables 1-10 through 1-15. The elements of PARCC are described following the tables. The method reporting limits (MRLs) and method detection limits (MDLs) reported in these tables are provided by the laboratory. "Method detection limit" is defined as the minimum concentration of an analyte that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero in a given matrix. "Method reporting limit" is defined as the lowest concentration at which an analyte can be detected in a sample and its concentration be reported with reasonable certainty. The MRL is often about 3 to 5 times the MDL; the only technical requirement is that it be equal to or greater than the MDL. Other limits that may be provided on laboratory reports are practical quantitation limit (PQL), limit of quantitation (LOQ), and estimated quantitation limit (EQL). These limits are set to increase the confidence level in quantification and can be defined as 2 to 5 times above the MDL.

If the result for weak acid dissociable (WAD) cyanide in a primary sample is reported at a value greater than or equal to the MRL, the sodium-hydroxide-preserved container with the remaining sample volume will be shipped back to Shaw to be stored. Pebble Partnership will be notified, and the possible direction for confirmation of the result will be discussed.

**Table 1-10**
**Data Quality Objectives—Fresh Water**

| Parameter | SGS Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***Inorganics—Water*** | | | | | |
| pH | 0.1 | pH units | SM4500$H^+$B | N/A | N/A |
| Specific Conductance | 1 | μmhos/ cm | SM2510B | N/A | 20 |
| Acidity | 10 | mg/L | SM2310B | 90-110 | 25 |
| Alkalinity | 10 | mg/L | SM2320B | 90-110 | 20 |
| Ammonia as N | 0.1 | mg/L | SM4500NH3-F | 75-125 | 25 |
| Chloride | 0.1 | mg/L | E300.0 | 90-110 | 20 |
| Cyanide - total | 0.005 | mg/L | SM4500CN-E | 75-125 | 25 |
| Cyanide - WAD | 0.005 | mg/L | SM4500CN-I | 75-125 | 25 |
| Dissolved Organic Carbon | 0.5 | mg/L | SM5310B | 75-125 | 25 |
| Total Organic Carbon | 0.5 | mg/L | SM5310B | 85-115 | 20 |
| Fluoride | 0.1 | mg/L | E300.0 | 90-110 | 20 |
| Hardness - total | N/A | mg/L | SM2340B | N/A | N/A |
| Nitrate + Nitrite | 0.1 | mg/L | SM4500-NO3 F | 90-110 | 20 |
| Phosphorus - total | 0.01 | mg/L | E365.3 | 75-125 | 25 |
| Sulfate | 0.1 | mg/L | E300.0 | 90-110 | 20 |
| Thiocyanate | 1 | mg/L | SM4500CN-M | 75-125 | 20 |
| TDS | 10 | mg/L | SM2540C | N/A | 25 |
| TSS | 0.5 | mg/L | SM2540D | N/A | 20 |

| Parameter | ACZ Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***Inorganics—Water*** | | | | | |
| pH | N/A | pH units | SM4500H$^{+}$B | N/A | N/A |
| Specific Conductance | 10 | μmhos/cm | SM2510B | N/A | 20 |
| Acidity | 10 | mg/L | SM2310B | N/A | 25 |
| Alkalinity | 20 | mg/L | SM2320B | N/A | 20 |
| Ammonia as N | 0.5 | mg/L | SM4500NH3-G | 75-125 | 25 |
| Chloride | 3 | mg/L | E300.0 | 90-110 | 20 |
| Cyanide - total | 0.03 | mg/L | SM4500CN-E | 75-125 | 25 |
| Cyanide - WAD | 0.03 | mg/L | SM4500CN-I | 75-125 | 25 |
| Fluoride | 0.5 | mg/L | E300.0 | 90-110 | 20 |
| Hardness - total | N/A | mg/L | SM2340B | N/A | N/A |
| Nitrate + Nitrite | 0.1 | mg/L | SM4500-NO3 F | 90-110 | 20 |
| Phosphorus - total | 0.05 | mg/L | E365.3 | 75-125 | 25 |
| Sulfate | 3 | mg/L | E300.0 | 90-110 | 20 |
| Thiocyanate | 0.5 | mg/L | SM4500CN-M | 75-125 | 20 |
| TDS | 20 | mg/L | SM2540C | N/A | 25 |
| TSS | 20 | mg/L | SM2540D | N/A | 20 |
| **Parameter** | **SGS Method Reporting Limit** | **Units** | **Method** | **Accuracy Limits (%)** | **Precision Limits (%)** |
| ***Metals (Total and Dissolved)—Water*** | | | | | |
| Hg (low level) (total only for surface water) | 0.005 | μg/L | E1631 | 71-125 | 20 |
| Al | 2.0 | μg/L | E200.8 | 85-115 | 20 |
| Sb | 0.05 | μg/L | E200.8 | 85-115 | 20 |
| As | 0.5 | μg/L | E200.8 | 85-115 | 20 |
| Ba | 0.05 | μg/L | E200.8 | 85-115 | 20 |
| Be | 0.05 | μg/L | E200.8 | 85-115 | 20 |
| Bi | 0.05 | μg/L | E200.8 | 85-115 | 20 |
| B | 5 | μg/L | E200.8 | 85-115 | 20 |
| Cd | 0.05 | μg/L | E200.8 | 85-115 | 20 |
| Ca [a] | 50 | μg/L | E200.8 | 85-115 | 20 |
| Cr | 0.2 | μg/L | E200.8 | 85-115 | 20 |
| Co | 0.02 | μg/L | E200.8 | 85-115 | 20 |
| Cu | 0.1 | μg/L | E200.8 | 85-115 | 20 |
| Fe [a] | 20 | μg/L | E200.8 | 85-115 | 20 |
| Pb | 0.1 | μg/L | E200.8 | 85-115 | 20 |
| Mg [a] | 20 | μg/L | E200.8 | 85-115 | 20 |
| Mn | 0.05 | μg/L | E200.8 | 85-115 | 20 |
| Mo | 0.05 | μg/L | E200.8 | 85-115 | 20 |
| Ni | 0.2 | μg/L | E200.8 | 85-115 | 20 |
| K [a] | 50 | μg/L | E200.8 | 85-115 | 20 |
| Se | 1.0 | μg/L | E200.8 | 85-115 | 20 |
| Si (dissolved only) | 100 | μg/L | E200.8 | 85-115 | 20 |
| Ag | 0.02 | μg/L | E200.8 | 85-115 | 20 |
| Na [a] | 100 | μg/L | E200.8 | 85-115 | 20 |
| Tl | 0.02 | μg/L | E200.8 | 85-115 | 20 |
| Sn | 0.2 | μg/L | E200.8 | 85-115 | 20 |
| V | 1 | μg/L | E200.8 | 85-115 | 20 |
| Zn | 1 | μg/L | E200.8 | 85-115 | 20 |

| Parameter | ACZ Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***Metals (Total and Dissolved)—Water*** | | | | | |
| Hg (low level) (total only for surface water) | 0.5 | µg/L | E1631 | 71-125 | 20 |
| Al | 5 | µg/L | E200.8 | 85-115 | 20 |
| Sb | 2 | µg/L | E200.8 | 85-115 | 20 |
| As | 1 | µg/L | E200.8 | 85-115 | 20 |
| Ba | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Be | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Bi | 200 | µg/L | E200.7 | 85-115 | 20 |
| B | 1 | µg/L | E200.7 | 85-115 | 20 |
| Cd | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Ca [a] | 1,000 | µg/L | E200.7 | 85-115 | 20 |
| Cr | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Co | 0.3 | µg/L | E200.8 | 85-115 | 20 |
| Cu | 3 | µg/L | E200.8 | 85-115 | 20 |
| Fe [a] | 50 | µg/L | E200.7 | 85-115 | 20 |
| Pb | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Mg [a] | 1,000 | µg/L | E200.7 | 85-115 | 20 |
| Mn | 3 | µg/L | E200.8 | 85-115 | 20 |
| Mo | 3 | µg/L | E200.8 | 85-115 | 20 |
| Ni | 3 | µg/L | E200.8 | 85-115 | 20 |
| K [a] | 2,000 | µg/L | E200.7 | 85-115 | 20 |
| Se | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Si (Dissolved only) | 900 | µg/L | E200.7 | 85-115 | 20 |
| Ag | 0.3 | µg/L | E200.8 | 85-115 | 20 |
| Na [a] | 2,000 | µg/L | E200.7 | 85-115 | 20 |
| Tl | 0.5 | µg/L | E200.8 | 85-115 | 20 |
| Sn | 0.5 | µg/L | E200.7 | 85-115 | 20 |
| V | 1 | µg/L | E200.8 | 85-115 | 20 |
| Zn | 10 | µg/L | E200.8 | 85-115 | 20 |
| **Parameter** | **SGS Method Reporting Limit** | **Units** | **Method** | **Accuracy Limits (%)** | **Precision Limits (%)** |
| ***PAHs—Water*** | | | | | |
| Acenaphthylene | 0.05 | µg/L | SW8270C SIM | 50-105 | 30 |
| Acenaphthene | 0.05 | µg/L | SW8270C SIM | 45-110 | 30 |
| Fluorene | 0.05 | µg/L | SW8270C SIM | 50-110 | 30 |
| Phenanthrene | 0.05 | µg/L | SW8270C SIM | 50-115 | 30 |
| Anthracene | 0.05 | µg/L | SW8270C SIM | 50-110 | 30 |
| Fluoranthene | 0.05 | µg/L | SW8270C SIM | 55-115 | 30 |
| Pyrene | 0.05 | µg/L | SW8270C SIM | 50-126 | 30 |
| Benzo(a)Anthracene | 0.05 | µg/L | SW8270C SIM | 55-110 | 30 |
| Chrysene | 0.05 | µg/L | SW8270C SIM | 55-110 | 30 |
| Benzo[b]Fluoranthene | 0.05 | µg/L | SW8270C SIM | 45-120 | 30 |
| Benzo[k]fluoranthene | 0.05 | µg/L | SW8270C SIM | 49-125 | 30 |
| Benzo[a]pyrene | 0.05 | µg/L | SW8270C SIM | 55-110 | 30 |
| Indeno[1,2,3-c,d]pyrene | 0.05 | µg/L | SW8270C SIM | 45-125 | 30 |

| Parameter | SGS Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***PAHs—Water (cont.)*** | | | | | |
| Dibenzo[a,h]anthracene | 0.05 | µg/L | SW8270C SIM | 40-125 | 30 |
| Benzo[g,h,i]perylene | 0.05 | µg/L | SW8270C SIM | 40-125 | 30 |
| Naphthalene | 0.1 | µg/L | SW8270C SIM | 40-115 | 30 |
| 1-Methylnaphthalene | 0.05 | µg/L | SW8270C SIM | 35-121 | 30 |
| 2-Methylnaphthalene | 0.05 | µg/L | SW8270C SIM | 45-105 | 30 |

Notes:
a. May be analyzed by inductively coupled plasma (EPA Method 200.7).
µmhos/cm = micromhos per centimeter.
Sources:
E = EPA, 1983, 1991, and 2001b.
SM = Standard Methods for the Examination of Water and Wastewater *(Clesceri et al, 1998)*.
SW = EPA, 1993.

**Table 1-11**
**Data Quality Objectives—Mammalian Tissue**

| Parameter | CAS Method Reporting Limit [a] | CAS Method Detection Limit [a] | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|---|
| Sb | 0.015 | 0.0006 | mg/kg | E200.8 | 70-130 | 30 |
| As | 0.15 | 0.015 | mg/kg | E200.8 | 70-130 | 30 |
| Be | 0.006 | 0.0015 | mg/kg | E200.8 | 70-130 | 30 |
| Cd | 0.006 | 0.003 | mg/kg | E200.8 | 70-130 | 30 |
| Cr | 0.3 | 0.18 | mg/kg | SW6010B | 70-130 | 30 |
| Cu | 0.03 | 0.009 | mg/kg | E200.8 | 70-130 | 30 |
| Pb | 0.006 | 0.0018 | mg/kg | E200.8 | 70-130 | 30 |
| Hg | 0.006 | 0.009 | mg/kg | SW7471B | 70-130 | 30 |
| Mo | 0.015 | 0.006 | mg/kg | E200.8 | 70-130 | 30 |
| Ni | 0.06 | 0.009 | mg/kg | E200.8 | 70-130 | 30 |
| Se | 0.3 | 0.15 | mg/kg | SW7740A | 60-130 | 30 |
| Ag | 0.006 | 0.0018 | mg/kg | E200.8 | 70-130 | 30 |
| Tl | 0.006 | 0.0015 | mg/kg | E200.8 | 70-130 | 30 |
| Zn | 0.15 | 0.12 | mg/kg | E200.8 | 70-130 | 30 |

*Notes:*
*a. Values expressed on wet weight basis assuming 30% solid content.*
*Sources:*
*E = EPA, 1983.*
*SW = EPA, 1993.*

**Table 1-12**
**Data Quality Objectives—Marine Water**

| Parameter | CAS Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| *Inorganics* | | | | | |
| Ammonia as N | 0.1 | mg/L | SM4500$NH_3$G | 75-125 | 20 |
| Cyanide-total | 0.01 | mg/L | SM4500CN-E | 75-125 | 20 |
| Cyanide-Wad | 0.01 | mg/L | SM4500CN-I | 75-125 | 20 |
| TSS | 5 | mg/L | E160.2 | 75-125 | 20 |
| *Metals* | | | | | |
| Al | 50.0 | µg/L | SW6010B | 93-111 | 20 |
| Sb | 0.05 | µg/L | E200.8 | 93-106 | 20 |
| As | 0.5 | µg/L | E200.8 | 75-125 | 20 |
| Ba | 5 | µg/L | SW6010B | 93-114 | 20 |
| Be | 0.02 | µg/L | E200.8 | 38-114 | 20 |
| B | 10 | µg/L | SW6010B | 76-132 | 20 |
| Cd | 0.02 | µg/L | E200.8 | 79-114 | 20 |
| Cr | 0.2 | µg/L | E200.8 | 76-119 | 20 |
| Co | 0.02 | µg/L | E200.8 | 80-112 | 20 |
| Cu | 0.1 | µg/L | E200.8 | 81-113 | 20 |
| Fe | 20 | µg/L | SW6010B | 58-142 | 20 |
| Pb | 0.02 | µg/L | E200.8 | 81-112 | 20 |
| Mn | 5 | µg/L | SW6010B | 95-112 | 20 |
| Hg | 0.005 | µg/L | E1631 | 77-123 | 20 |
| Ni | 0.2 | µg/L | E200.8 | 87-113 | 20 |
| Se | 1.0 | µg/L | SW7742A | 71-122 | 20 |
| Ag | 0.02 | µg/L | E200.8 | 78-110 | 20 |
| Tl | 0.02 | µg/L | E200.8 | 79-110 | 20 |
| Sn | 50 | µg/L | SW6010B | 75-125 | 20 |
| V | 10 | µg/L | SW6010B | 94-110 | 20 |
| Zn | 0.5 | µg/L | E200.8 | 75-136 | 20 |

*Sources:*

*E = EPA, 1983 and 2001b.*
*SM* = Standard Methods for the Examination of Water and Wastewater *(Clesceri et al, 1998).*
*SW = EPA, 1993.*

**Table 1-13**
**Data Quality Objectives—Marine Sediment**

| Parameter | CAS Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| *Inorganics* | | | | | |
| TOC | 0.05 | % | ASTMD4129 | 75-125 | 30 |
| PAH | 5.0 | µg/kg | GERG9733 | | |
| SHC | 300 | µg/kg | GERG0008 | | |
| *Metals* | | | | | |
| Al | 2.0 | mg/kg | SW3050/200.8 | 53-147 | 30 |
| Sb | 0.05 | mg/kg | SW3050/200.8 | 32-162 | 30 |
| As | 0.5 | mg/kg | SW3050/200.8 | 80-115 | 30 |
| Ba | 0.05 | mg/kg | SW3050/200.8 | 91-127 | 30 |
| Cd | 0.05 | mg/kg | SW3050/200.8 | 79-127 | 30 |
| Cr | 2 | mg/kg | SW3050/200.8 | 77-127 | 30 |
| Co | 0.02 | mg/kg | SW3050/200.8 | 91-129 | 30 |
| Cu | 0.1 | mg/kg | SW3050/200.8 | 80-128 | 30 |
| Fe | 4.0 | mg/kg | SW3050/SW6010 | 64-154 | 30 |
| Pb | 0.05 | mg/kg | SW3050/200.8 | 81-129 | 30 |
| Mn | 0.1 | mg/kg | SW3050/200.8 | 80-120 | 30 |
| Hg | 0.02 | mg/kg | SW7471B | 75-118 | 30 |
| Ni | 0.2 | mg/kg | SW3050/200.8 | 83-131 | 30 |
| Se | 1.0 | mg/kg | SW3050/200.8 | 84-133 | 30 |
| Ag | 0.02 | mg/kg | SW3050/200.8 | 76-128 | 30 |
| Sn | 1 | mg/kg | SW3050/200.8 | 70-130 | 30 |
| Zn | 0.5 | mg/kg | SW3050/200.8 | 77-139 | 30 |
| *AVS-SEM metals* | | | | | |
| Cd | 0.2 | mg/kg | SW6010 | 75-125 | 30 |
| Cu | 0.4 | mg/kg | SW6010 | 75-125 | 30 |
| Pb | 3 | mg/kg | SW6010 | 75-125 | 30 |
| Hg | 0.01 | mg/kg | SW7470A | 75-125 | 30 |
| Ni | 0.5 | mg/kg | SW6010 | 75-125 | 30 |
| Zn | 0.4 | mg/kg | SW6010 | 75-125 | 30 |

*Sources:*

*ASTM = American Society for Testing and Materials International.*

*GERG = Texas A&M Geochemical and Environmental Research Group.*

*SW = EPA, 1993.*

**Table 1-14**
**Data Quality Objectives—Marine Tissue**

| Parameter | CAS Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| *Organics* | | | | | |
| Lipid Content | 0.1 | % | GERG9727 | N/A | 30 |
| PAH | 5.0 | µg/kg | GERG9733 | | |
| SHC | 300 | µg/kg | GERG0008 | | |
| *Metals- Fish and Bivalve Tissue* | | | | | |
| Sb | 0.05 | mg/kg | PSEP/E200.8 | 85-115 | 30 |
| As | 0.5 | mg/kg | PSEP/E200.8 | 85-115 | 30 |
| B | 5 | mg/kg | PSEP/SW6010B | 85-115 | 30 |
| Be | 0.02 | mg/kg | PSEP/E200.8 | 85-115 | 30 |
| Cd | 0.02 | mg/kg | PSEP/E200.8 | 85-115 | 30 |
| Cr | 0.5 | mg/kg | PSEP/SW6010B | 85-115 | 30 |
| Cu | 0.1 | mg/kg | PSEP/E200.8 | 85-115 | 30 |
| Pb | 0.02 | mg/kg | PSEP/E200.8 | 85-115 | 30 |
| Hg | 0.001 | mg/kg | E1631 | 85-115 | 30 |
| Mo | 0.05 | mg/kg | PSEP/E200.8 | 85-115 | 30 |
| Ni | 0.2 | mg/kg | PSEP/E200.8 | 85-115 | 30 |
| Se | 1 | mg/kg | PSEP/SW7740A | 85-115 | 30 |
| Ag | 0.02 | mg/kg | PSEP/E200.8 | 85-115 | 30 |
| Tl | 0.02 | mg/kg | PSEP/E200.8 | 85-115 | 30 |
| Sn | 5 | mg/kg | PSEP/E200.8 | 85-115 | 30 |
| Zn | 0.5 | mg/kg | PSEP/E200.8 | 85-115 | 30 |

*Sources:*

*E = EPA, 1983 and 2001b.*

*PSEP = Puget Sound Estuary Program referencing "Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment and Tissue Samples" (PSWQAT, 1997).*

*SW = EPA, 1993.*

**Table 1-15**
**Data Quality Objectives—Freshwater Fish Tissue[a]**

| Parameter | CAS Method Reporting Limit | Units | Method | Accuracy Limits (%) | Precision Limits (%) |
|---|---|---|---|---|---|
| ***Metals*** | | | | | |
| Sb | 0.05 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| As | 0.5 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Be | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Cd | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Cr | 0.5 | mg/kg | PSEP/SW6010B | 70-130 | 30 |
| Cu | 0.1 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Pb | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Hg | 0.001 | mg/kg | E1631 | 70-130 | 30 |
| Mo | 0.05 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Ni | 0.2 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Se | 1 | mg/kg | PSEP/SW7740A | 60-130 | 30 |
| Ag | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Tl | 0.02 | mg/kg | PSEP/E200.8 | 70-130 | 30 |
| Zn | 0.5 | mg/kg | PSEP/E200.8 | 70-130 | 30 |

*Notes:*

*a. Freshwater fish tissue will be collected in 2008, and muscle and liver tissue will be tested, plus the remaining portion will be freeze-dried and archived.*

*E = EPA, 1983 and 2001b.*

*PSEP = Puget Sound Estuary Program referencing "Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment and Tissue Samples" (PSWQAT, 1997).*

*SW = EPA, 1993.*

### 1.6.2 Precision

Precision is a qualitative measure of the reproducibility of a measurement under a given set of conditions. For duplicate measurements, analytical precision can be expressed as the relative percent difference (RPD). The level of effort for laboratory precision will be at a minimum frequency of one in 20 (5 percent) or one per laboratory batch, whichever is more frequent. Laboratory precision is calculated from laboratory duplicates. Field precision will be at a minimum frequency of one in 10 field samples (10 percent).

QC and QA samples for mammal, marine fish, marine bivalve, and marine vegetation tissues are homogenized at the laboratory (CAS) rather than being individually collected in the field. The primary laboratory (CAS) will analyze 10 percent for each sample matrix as QC samples and will ship 10 percent to TestAmerica, Inc., as QA homogenate samples. The same percentages will apply to the freshwater fish tissue matrices if they are released for testing (not expected until 2009).

The formula for calculating RPD from duplicate measurements is as follows:

$$RPD = [(C_1 - C_2) \times 100] \div [(C_1 + C_2) / 2]$$

RPD = relative percent difference

$C_1$ = larger of the two observed values

$C_2$ = smaller of the two observed values

If calculated from three or more replicate analyses, relative standard deviation (RSD) rather than RPD is used:

$$RSD = (s / y) \times 100$$

RSD = relative standard deviation

s = standard deviation

y = mean of replicate measurements

Standard deviation is defined as follows:

$$s = [\Sigma n ( y^i - y)^2 / (n - 1)]^{0.5}$$

s = standard deviation

$y^i$ = measured value of the $i^{th}$ replicate

y = mean of replicate measurements

n = number of replicates

### 1.6.3 Accuracy

For samples processed by the analytical laboratory, accuracy will be evaluated with matrix spikes (MS), matrix spike duplicates (MSD), laboratory duplicates (DUP), laboratory control samples (LCS), and performance evaluation (PE) samples. MS/MSD (metals) and MS/DUP (inorganic nonmetals) will be analyzed at an overall frequency of 5 percent throughout the project duration.

For measurements where matrix spikes are used, percent recovery is calculated as follows:

$\%R = 100 \times (S - U / C_{SA})$

%R = percent recovery

S = measured concentration in spiked aliquot

U = measured concentration in unspiked aliquot

$C_{SA}$ = actual concentration of spike added

For situations where a PE or LCS sample is used instead of or in addition to matrix spikes, percent recovery is calculated as follows:

$\%R = 100 \times (C_m / C_{srm})$

%R = percent recovery

$C_m$ = measured concentration of PE or LCS sample

$C_{srm}$ = actual concentration of PE or LCS sample

The level of effort for precision and accuracy measurements is listed in Table 1-16.

**Table 1-16**
**Precision and Accuracy Evaluation for the Pebble Project EBS**

| Parameter Group | Type of Test (precision/accuracy) | Level of Effort |
|---|---|---|
| Inorganic Analytes | PE sample [a] | 1 for 2008 program |
| | Field duplicates (QC) | 10 percent |
| | Field triplicates (QA) | 10 percent |
| | Laboratory duplicates | 5 percent or 1 per analytical batch |
| | Laboratory control samples | 1 to 2 per analytical batch of 20 samples or fewer |
| | Matrix spikes/matrix spike duplicates (not required for all analytes) and lab duplicates | 5 percent of total samples submitted over project duration |
| Metals | PE sample [a] | 1 for 2008 program |
| | Field duplicates (QC) | 10 percent |
| | Field triplicates (QA) | 10 percent |
| | Laboratory control samples | 1 per analytical batch of 20 samples or fewer |
| | Matrix spikes/matrix spike duplicates | 5 percent of total samples submitted over project duration |
| Organic Analytes | Field duplicates (QC) | 10 percent |
| | Field triplicates (QA) | 10 percent |
| | Laboratory control samples | 2 per analytical batch of 20 samples or fewer (1 per batch if batch includes an MS/MSD set) |
| | Matrix spikes/matrix spike duplicates | 5 percent of total samples submitted over project duration |

*Notes:*

*a. PE samples are certified for specific chemical or physical properties and are issued with certificates that report the results of the characterization and indicate the use of the material.*

### 1.6.4 Representativeness

Representativeness is a measure of how closely the measured results reflect the actual concentration or distribution of the chemical compounds in the environment. Sampling-plan design, sampling techniques, and sample-handling protocols (for example, storage, preservation, and transportation) have been developed and are discussed in other sections of this document. Documentation will establish that protocols have been followed, and sample identification and integrity assured. Field blanks and field duplicates will be used to assess field and transport contamination and sampling variation. Laboratory sample-retrieval, -storage, and -handling procedures also have been developed and are discussed in other sections of this document. Laboratory method blanks will be run at the minimum frequency of 5 percent or one per analytical batch to assess laboratory contamination.

### 1.6.5 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement system. The target completeness objectives are 90 percent for each analytical parameter; the actual completeness can vary with the intrinsic nature of the samples. The completeness of the data will be assessed during the data review.

Completeness is defined as follows for all measurements:

$$\%C = 100 \times (V / n)$$

%C = percent completeness

V = number of measurements judged valid

n = total number of measurements

### 1.6.6 Comparability

Comparability is the level of confidence with which one data set can be compared with another. This objective is met by selecting field sampling methods and laboratory analytical methods that are comparable throughout the baseline environmental studies. Changing sampling techniques or laboratory methods during the study may compromise comparability. The field sampling methods have been evaluated to ensure comparability among consultants collecting samples of the same media. The laboratory methods employed by the primary and QA laboratories have been evaluated to ensure that methods used for primary, QC, and QA samples are comparable. Comparability will also be maintained by the use of consistent units.

## 1.7 Special Training and Certification

The laboratories selected for the Pebble Project EBS have obtained certifications and participate in periodic auditing programs that establish their level of performance. Table 1-17 summarizes state and federal certifications and accreditation programs that the Pebble Project laboratories participate in.

**Table 1-17**
**Laboratory Certifications and Accreditation Programs**

| Laboratory | Program |
|---|---|
| SGS Environmental Services, Inc. | Alaska Department of Environmental Conservation, Drinking Water and Contaminated Sites Lab Approval |
| | Air Force Center for Environmental Excellence |
| | National Environmental Laboratory Accreditation Program |
| | U.S. Navy (NAVSEA) |
| | U.S. Department of Agriculture |
| Columbia Analytical Services, Inc. | Alaska Department of Environmental Conservation, Contaminated Sites Lab Approval |
| | Air Force Center for Environmental Excellence |
| | National Environmental Laboratory Accreditation Program |
| | U.S. NAVY (NAVSEA) |
| TestAmerica, Inc. (Portland, OR) | Alaska Department of Environmental Conservation, Drinking Water and Contaminated Sites Lab Approval |
| | National Environmental Laboratory Accreditation Program for Oregon |
| | U.S. NAVY (NAVSEA) |
| TestAmerica, Inc. (Tacoma, WA) | Alaska Department of Environmental Conservation, Contaminated Sites Lab Approval |
| | State of California Environmental Laboratory Accreditation Program |
| | State of Washington Department of Energy |
| | Naval Facilities Engineering Service Center Quality Assurance Program |
| | State of Oregon Environmental Laboratory Accreditation Program |
| ACZ Laboratories, Inc. | National Environmental Laboratory Accreditation Program for Utah |

## 1.8 Documents and Records

### 1.8.1 Quality Assurance Project Plan

The QAPP document will be controlled by the Analytical QA/QC Manager. Approved QAPPs and updated versions will be provided to the parties presented in the Distribution List (Section 1.2). Document control information (revision number and date) is shown at the bottom right corner of each page.

### 1.8.2 Laboratory Reports

The minimum information that must be included in the hardcopy data-report package is as follows:

- Transmittal letter.
- Case narrative to discuss, at a minimum, all issues that may negatively affect data quality including sample handling, preservation, holding times, sample matrix, and QC results.
- Chain-of-custody documents.

- Cooler receipt form documenting cooler temperatures, sample preservation, and condition upon receipt by the laboratory.
- Custody seals.
- Sample analytical results. Do not report results from multiple dilutions for a given parameter.
- Method blank results.
- Surrogate recovery results and acceptance criteria for applicable organic methods.
- Dates of sample collection, receipt, preparation, and analysis for all tests.
- Matrix spike results with calculated recovery, including associated acceptance criteria.
- Duplicate or duplicate matrix spike results (as appropriate to method) with calculated RPD and acceptance criteria.
- LCS and/or QC check sample results with calculated recovery and associated acceptance criteria.
- Initial calibration results summary and continuing calibration verification-standard results with calculated recoveries and acceptance criteria.
- Summary forms of associated QC and calibration parameters.
- Run or sequence logs for each method.

For each report or sample delivery group, laboratories will submit United States Army Corp of Engineers (USACE) COELT EDF v 1.2a electronic deliverables.

### 1.8.3 Data Quality Assurance Reports

DQAR reports will assess the data and address corrective action related to field and laboratory activities. These reports will be prepared and controlled by the Analytical QA/QC Manager.

### 1.8.4 STORET Electronic Deliverables

All water-quality data collected at the edge or outside of mixing zones that will be used to establish baseline conditions will be submitted to the ADEC permitter in the EPA water-quality-monitoring STORET database-compatible format.

# 2.0 Data Generation and Acquisition

The generation, compilation, reporting, and archiving of data are critical components of field and laboratory operations. In order to generate data of known and acceptable quality, the QA/QC practices for data management must be complete and comprehensive and in keeping with the overall QA objectives of the project.

To ensure consistency with rounding, industry accepted rounding rules will be used. Rules for rounding numbers where the digit to be dropped is a 5 are as follows. If there is a nonzero digit beyond the five, round up. When there are zeroes or no digits after the five, round down if the digit to be retained is even, or if the digit to be retained is odd, round up; thus, the result will always be an even number.

## 2.1 Sampling Process Design

Producing data of known quality that are considered representative of the sampling environment at an appropriate level of detail is achieved by establishing a QA program with specified data-gathering protocols overseen by the Analytical QA/QC Manager. The main components of the proposed QA program include the following:

- Verification of use of proper sample containers and preservatives.
- Collection and analysis of blank/duplicate samples.
- Specific procedures for handling, labeling, and shipping samples.
- Field equipment calibration.
- Equipment decontamination.
- Field documentation.
- Field corrective action.

All field blanks, and duplicate and triplicate samples will be noted on the chain-of-custody form and in field log books.

Section 1.5 provides the following information:

- Types and numbers of samples expected.
- Sampling frequency.
- Sample matrices.
- Parameters of interest.

The 2008 field sampling plans for Pebble Project will present the sampling locations and the rationale for the sampling-program designs.

## 2.2 Sampling Methods

General field sampling methods are contained in the respective field sampling plans for the various sampling programs. Corrective action is the responsibility of the Analytical QA/QC Manager and Project Managers for ABR, HDR, Pentec, R2, 3PPI, and SLR. When a failure in the sampling system occurs, this management team will cooperate to investigate the failure and implement necessary corrective actions.

For all field samples except mammal tissue, containers will be provided by the laboratory conducting the analyses. Sample containers for mammal tissue will be provided by ABR. Tables 2-1 through 2-5 summarize the required containers, sample volumes, preservation, and maximum holding times for all parameters and sample matrices.

Reduced-volume sample sets should be used only for water in winter months or when flow level does not allow for full-volume collection and provided enough sample volume is collected in order to complete initial testing and retesting for all parameters. Laboratories responsible for completing analysis will determine the volume needed to meet the testing/retesting requirements.

**Table 2-1**
**Sample Bottle Schedule and Sampling Parameters for Surface Water/Groundwater**

| Sample Set | Bottle Type SGS | Bottle Type CAS | Analysis | Lab Method | Preser-vative | Hold Time | Req. Temp. | Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | (1) 500-mL HDPE<br>1 extra volume for MS/MSD | (1) 1-L HDPE | Total metals [a] (except Hg) | E200.8/200.7 | $HNO_3$ | 6 months | None | Unfiltered |
| 2 | (1) 500-mL HDPE<br>(1) extra unpreserved container for collection<br>(1) 1-L extra volume for MS/MSD | (1) 1-L HDPE<br>(1) extra unpreserved container for collection | Dissolved [b] metals (except Hg) | E200.8/200.7 | $HNO_3$ | 6 months | None | Field Filtered |
| 3 | (1) 500-mL fluoropoly | (1) 500-mL fluoropoly<br>No extra volume for MS/MSD | Low-level Hg (total only) | E1631 | HCl | 90 days | None | Unfiltered |
| 4 (ground-water only) | (1) 500-mL fluoropoly | (2) 500-mL fluoropoly<br>No extra volume for MS/MSD | Low-level Hg (total and dissolved) | E1631 | HCl | 90 days | None | Unfiltered (total)<br>Filtered (dissolved) |
| 5 | (1) 250-mL Nalgene<br>No extra volume for MS/MSD | (1) 1-L HDPE | Cyanide, total | SM4500CN-E | NaOH | 14 days | 4°C | Unfiltered |
| | | | Cyanide, WAD | SM4500CN-I | NaOH | 14 days | 4°C | Unfiltered |
| | | | Cyanide Speciation (confirmation) | ASTM D 6994-04 Mod. | NaOH | 30 days | 4°C | Unfiltered |
| 6 | (1) 500-mL HDPE<br>(1) 500-mL extra volume for MS/MSD | (1) 1-L HDPE | Ammonia as N ($NH_3$) | SM4500-NH3-F | $H_2SO_4$ | 28 days | 4°C | Unfiltered |
| | | | Phosphorus, total (P) | E365.3 | $H_2SO_4$ | 28 days | 4°C | Unfiltered |
| | | | Nitrate-nitrite, total ($NO_3$ + $NO_2$) | SM4500-NO3-F | $H_2SO_4$ | 28 days | 4°C | Unfiltered |

| Sample Set | Bottle Type SGS | Bottle Type CAS | Analysis | Lab Method | Preser-vative | Hold Time | Req. Temp. | Comments |
|---|---|---|---|---|---|---|---|---|
| 7 | (2) 1-L HDPE<br>(2) 1-L extra volumes for MS/MSD | (1) 1-L HDPE | TDS | SM2540C | None | 7 days | 4°C | Unfiltered |
| | | | TSS | SM2540D | None | 7 days | 4°C | Unfiltered |
| | | | Alkalinity | SM2320B | None | 14 days | 4°C | Unfiltered |
| | | | Acidity | SM2310B | None | 14 days | 4°C | Unfiltered |
| | | | Specific Conductance | SM2510B | None | 28 days | 4°C | Unfiltered |
| | | | pH | SM4500$H^+$B | None | 24 hours | 4°C | Unfiltered |
| 8 | (1) 120-mL Nalgene<br>(2) 120-mL Nalgene extra volumes for MS and lab duplicate | No separate sample needed — analyzed from CAS sample set 7 | Chloride, fluoride, sulfate | E300.0 | None | 28 days | 4°C | Unfiltered |
| 9 | (1) 250-mL HDPE<br>No extra volume for MS/MSD | No separate sample needed — analyzed from CAS sample set 1 | Thiocyanate | SM4500CN-M | HNO3 | 28 days | 4°C | Unfiltered |
| 10 | (1) 250-mL glass with TLC | (1) 250-mL HDPE | DOC / TOC | SM5310B | HCL (SGS)<br>$H_2SO_4$ (CAS) | 28 days | 4°C | Filtered |

*Notes:*

*a. Total metals: Al, Sb, As, Ba, B, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Ag, Na, Se, Sn, Tl, V, Zn, and Hardness.*

*b. Dissolved metals: Al, Sb, As, Ba, B, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Ag, Na, Se, Si, Sn, Tl, V, and Zn.*

*HDPE = high-density polyethylene.*

*Hg = mercury.*

*L = liters.*

*mL = milliliters.*

*N/A = not applicable.*

*TLC = Teflon-lined cap.*

Sources:

E = EPA, 1983, 1991, and 2001b.

SM = Standard Methods for the Examination of Water and Wastewater *(Clesceri et al, 1998)*.

SW = EPA, 1993.

**Table 2-2**
**Sample Bottle Schedule and Sampling Parameters for Biological Tissue (Non-marine)**

| Tissue Type | Minimum Sample Amount (grams) | Bottle Type (CAS/ TestAmerica) | Analysis | Lab Method | Shipping Preservation | Hold Time | Required Laboratory Storage Temp. |
|---|---|---|---|---|---|---|---|
| Freshwater Fish Tissue | 75 | Whirl Pak bag, double bagged | Total Metals [a] | E200.8/ SW6010B/7740A/ 1631 | Freeze <-20˚C (Iliamna) | Hg: 12 months Metals: 24 months [b] | Freeze Dry |
| Mammalian Tissue | 5 | Whirl Pak bag or glass jar (hair) | Total Metals [a] | E200.8/ SW6010B/ 7740A/7471B [c] | Freeze <-20˚C (Iliamna) | | Freeze at ≤ -20 °C |
| | 50 | Whirl Pak bag or glass jar (tissue) | | | Freeze <-20˚C (Iliamna) | | |
| | 10 mL | (1) 4-oz glass (blood and serum) | | | Freeze <-20˚C (Iliamna) | | |

*Notes:*

*a. Total metals = Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Mo, Ni, Se, Ag, Tl, and Zn.*

*b. Holding times for freeze-dried animal tissue samples: mercury is 12 months, all other metals 24 months. For non-freeze-dried, frozen tissue samples: mercury is 28 days, all other metals 24 months.*

*c. Human hair is the standard reference material (SRM) for bear hair, used according to Reference Sheet IAEA-086 (Bleise et al., 2000). Bovine blood is the SRM for mammal blood, from SRM 966 (Wise and Watters, 2007)*

*Sources:*

*E = EPA, 1983 and 2001b.*

*SW = EPA, 1993.*

**Table 2-3**
**Sample Bottle Schedule and Sampling Parameters for Marine Water**

| Sample Set | Bottle Type TA | Bottle Type CAS | Analysis | Lab Method | Preservative | Hold Time | Req. Temp. | Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | (1) 500-mL HDPE<br>1 extra volume for MS/MSD | (1) 1-L + (1) 500-mL HDPE<br>2 extra volumes for MS/MSD | Total Metals a (except Hg) | E200.8/<br>SW6010B b | HNO3 | 6 months | None | Unfiltered |
| 2 | (1) 500-mL HDPE<br>(1) extra unpreserved container for collection<br>(1) 1-L extra volume for MS/MSD | (1) 1-L + (1) 500-mL HDPE<br>(1) extra unpreserved container for collection<br>2 extra volumes for MS/MSD | Dissolved Metals a (except Hg) | E200.8/<br>SW6010B b | HNO3 | 6 months | None | Field filtered |
| 3 | (1) 500-mL fluoropoly | (1) 500-mL fluoropoly<br>No extra volume for MS/MSD | Low-level Hg, total | E1631 | HCl | 90 days | None | Unfiltered |
| 4 | (1) 500-mL fluoropoly | (1) 500-mL fluoropoly<br>No extra volume for MS/MSD | Low-level Hg, dissolved | E1631 | HCl | 90 days | None | Field filtered |
| 5 | (1) 1-L HDPE | (1) 1-L HDPE | TSS | E160.2 | None | 7 days | 4°C | Unfiltered |
| 6 | (1) 125-mL HDPE | (1) 250-mL HDPE | Ammonia as N (NH3) | SM4500NH3G | H2SO4 | 28 days | 4°C | Unfiltered |

*Notes:*

*a. Total and dissolved metals: Al, Sb, As, Ba, B, Be, Cd, Co, Cr, Cu, Fe, Pb, Mn, Ni, Ag, Se, Sn, Tl, V, Zn.*

*b. Selenium by SW7740A.*

*Sources:*

*E = EPA, 1983 and 2001b.*
*SM* = Standard Methods for the Examination of Water and Wastewater *(Clesceri et al, 1998).*
*SW = EPA, 1993.*

**Table 2-4**
**Sample Bottle Schedule and Sampling Parameters for Marine Sediment**

| Set | Bottle Type CAS/ GERG | Bottle Type TA | Analysis | Lab Method | Preservative | Hold Time | Req. Temp. |
|---|---|---|---|---|---|---|---|
| 1[d] | (1) 4-oz glass | (1) 4-oz glass | Total Metals [a] | SW3050/200.8/ 7471B (Hg) | None | 6 months | 4°C |
| | | | Cyanide, Total | SM4500CN-E | None | 28 days [b] | 4°C |
| | | | AVS-SEM | SW6010 [c] | None | 14 days | 4°C |
| | | | TOC | ASTMD4129 | None | 6 months | 4°C |
| 2[d] | (1) 1-L in 1-gal zipper-seal bag | (1) 1-L in 1-gal zipper-seal bag | Grain Size | PSEP | None | None | 4°C |
| 3[d] | (1) 8-oz glass | N/A | PAH | GERG9733 | None | 14 days | 4°C |
| | | | SHC | GERG0008 | None | 14 days | 4°C |

*Notes:*

*a. Total metals: Al, Sb, As, Ba, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Sn, and Zn.*

*b. Holding time from EPA fact sheet titled "Total Petroleum Hydrocarbons, Reactive Cyanide, Reactive Sulfide, Ignitability, and Corrosivity" (EPA, 2007).*

*c. Hg by SW7470A.*

*d. Additional volume collection for MS/MSD testing is not required. The specified containers, if filled will provide sufficient volume.*

*N/A = not applicable.*

*Sources:*

*ASTM = American Society for Testing and Materials International.*

*GERG = Texas A&M Geochemical and Environmental Research Group.*

*SW = EPA, 1993.*

**Table 2-5**
**Minimum Sample Amounts and Sampling Parameters for Marine Tissue**

| Tissue Type | Set | Minimum Sample Amount (grams) | Analysis | Lab Method | Shipping Preservation and Time | Hold Time | Required Laboratory Storage Temp. |
|---|---|---|---|---|---|---|---|
| Algal Tissue | 1 | 20 grams | Hg | E1631 | Freeze at ≤ -20 °C; ship on blue ice; samples must arrive at the lab within 48 hours of shipment | 28 days | Freeze at ≤ -20 °C |
| | 2 | | Total Metals[a] | PSEP/E200.8 | | 6 months | |
| Bivalve Tissue | 1 | 20 grams | Low-level Hg | E1631 | | 28 days | |
| | 2 | | Total Metals[a] | PSEP/E200.8 | | 12 months | |
| | 3 | 60 grams | PAH/SHC | GERG9733/0008 | | 14 days | |
| | 4 | 20 grams | Lipid content | GERG9727 | | none | |
| Fish Tissue | 1 | 20 grams | Low-level Hg | E1631 | | 28 days | |
| | 2 | | Total Metals[a] | PSEP/E200.8 | | 12 months | |

*Note:*
a. Total metals: Al, Sb, As, B, Be, Cd, Cr, Cu, Pb, Hg, Mo, Ni, Se, Ag, Sn, Tl, and Zn.

*Sources:*

*E = EPA, 1983 and 2001b.*

*PSEP = Puget Sound Estuary Program referencing "Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment and Tissue Samples" (PSWQAT, 1997).*

*SW = EPA, 1993.*

### 2.2.1 Sample Collection and Analysis

Procedures for sample collection, handling, and shipping include the following:

- Field collection.
- Labeling.
- Packaging.
- Chain-of-custody forms.
- Shipping.

The Sample Managers are responsible for implementing the following sample-handling and shipping procedures. The QA/QC Manager will check for quality assurance measures on these activities.

### 2.2.2 Field Collection Procedures

In all cases, field collection procedures will be performed so as to minimize contamination of samples, prevent cross-contamination between samples, and ensure sample validity by conducting proper preservation and storage in the field according to the requirements specified in this QAPP.

Surface water samples will be collected by analysis in the following order:

1. Mercury.
2. Total metals.
3. Dissolved metals.
4. Total suspended solids, total dissolved solids, etc.
5. Miscellaneous parameters (ammonia, phosphorus, WAD cyanide, etc.).

For mercury, many states are establishing new National Pollutant Discharge Elimination System (NPDES) limits at very low levels based on maintaining water-quality standards in the receiving streams. The new limits may approach or even be less than the detection limit of analytical methods. To ensure that reliable data are produced at these low detection levels, emphasis must be placed on clean sampling and clean laboratory practices to minimize contamination. The following general field procedures for water samples for mercury analysis are recommended by CAS, a laboratory that will perform mercury analysis for the Pebble Project EBS.

1. Sampling cleanliness will be documented through the use of trip blanks and equipment rinse blanks. Trip blanks for low-level mercury analysis will be treated as a regular sample by being at the specific site of sampling (removed from the ice chest during sampling) and will accompany all other mercury samples in the field and will be returned from the field only at the end of the day. This may require that a separate cooler be taken into the field specifically for mercury samples.
2. Only non-metallic sampling equipment will be used and no metal object will be allowed to come into direct or indirect contact with the sample or sample containers (storing samples at all times in properly cleaned and sealed containers [ice chests] can help prevent inadvertent contact with such objects, as well as preventing inadvertent contamination).
3. Only non-talc gloves will be used, and gloves will be changed between sample collections.
4. Samples will be collected directly into sample containers that are documented clean at the levels of concern.
5. All sample containers will be double-bagged.
6. It may be necessary to designate a “clean hands” sampler to perform all operations involving direct contact with the samples and a “dirty hands” sampler for all other operations.

**Smoking is not allowed in the vicinity of any sampling activities or equipment. Smokers must wash their hands thoroughly with soap and water before handling samples or sampling equipment.**

For freshwater fish being collected for contaminant analyses and for marine fish, fish collection procedures will follow many of the methods of Zhang et al. (2001) and Jewett et al. (2003). These include the following:

- Photo documentation of the specimen will occur before dissection to provide confirmation of species identification. A label to identify the sample number will be placed beside the fish in the photograph.
- Total fish length and sex will be recorded for each specimen in the field; any necessary dissection to determine sex will be done using surgical sheets, powder-free latex gloves, and an acid-washed titanium knife or scalpel. Disposable gloves will be changed between each dissection.
- For smaller fish (i.e., 6 inches or less in total length), the entire animal will be placed in a zipper-seal plastic bag and frozen immediately.
- For larger fish (i.e., more than 6 inches in total length), the entire animal will be placed in clean plastic bags in a cooler with ice. For freshwater fish, the entire fish will be frozen immediately upon returning from the field, and the entire frozen animal will be shipped to CAS for dissection under CAS SOP MET-TISP Revision 5. For larger marine fish, the fish will be dissected on board the survey vessel, and the tissue samples will be frozen for shipment to the laboratory.
- Frozen tissue samples will be packaged in a cooler and sent to the laboratory under chain-of-custody procedures and using packaging recommendations provided by the lab.
- Each sample from an individual fish will be labeled with the sample identification number, including suffixes specifying species and tissue type (Section 2.3.1). (The suffix indicating tissue type for freshwater fish will be added by the laboratory after dissection.)

For vegetation samples, 50 grams, if available, will be collected from a representative plant (or plants) in each plant class within the sample location.

At least 75 grams of tissue will be collected for 10 percent of marine fish samples and 150 grams for 10 percent of marine vegetation samples. This will allow the preparation of QA/QC samples at the primary laboratory (CAS). CAS will ship QA samples to TestAmerica for analysis.

### 2.2.3 Field Documentation

Field observations, field equipment-calibration information, field measurements, and sample documentation—including sample identification, sample duplicates, and the collection date/time—will be the responsibility of the entire sampling team. Field forms will be maintained for each task. Field forms will consist of waterproof bound pages with every appropriate area marked in waterproof ink. Blank pages will be marked as such with a diagonal line across the page, when appropriate.

Proper documentation for sample custody includes keeping records of all materials and procedures involved in sampling. Project field forms will be used to record field data. All information on the sampling station and respective samples and blanks collected at each site, including the positions of the

station, will be recorded by the field crew. The field crew leader will review all data before leaving the sampling station. Completed field forms will be kept on file for future reference.

### 2.2.4 Corrections to Field Documentation

Unless weather conditions prevent it, all original data will be recorded with waterproof ink. No accountable documents will be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. If an error is made on an accountable document assigned to a person, that person must make corrections by drawing a line through the error, initialing and dating the lined-out item, and entering the correct information. The erroneous information is not to be obliterated. Any subsequent error discovered on an accountable document will be corrected by the person who made the entry. All such subsequent corrections will be initialed and dated.

## 2.3 Sample Handling and Custody

Sample handling and custody procedures are required in the field and the laboratory, and during transport. The procedures take into account the nature of the samples, the maximum holding times, and shipping options from Iliamna to the laboratories.

### 2.3.1 Labeling

Each sample container will have a waterproof label large enough to contain the information needed to easily identify each sample. The information to be included on each label will include the project name, date, time, preservative (if added), sample identification code (sample ID), analysis, and sampler's initials. Sample IDs will be formatted to indicate sample date (month and year), location, matrix, and number. Each sampling location will be identified by the sampler on the field form.

An example of standard sample identification code is as follows:

0107CR199AWS001

Where:

0107 is the date as month/year
CR199A is the location ID
WS is the matrix code for surface water (see list of additional codes below)
001 is a sequential sample number

Consultants should try to make their location IDs no longer than 6 characters, and the sample IDs should never be longer than 25 characters. These sample IDs are defined to facilitate data management for the life of this project.

The sequential sample number for field duplicates is 201, and for triplicates, 301. The sequential number 401 is used for equipment rinse blanks (for all equipment coming in contact with sample, except the filter) for total metals analysis, which are collected at a 5 percent frequency (minimum of one per sampling event). The sequential number 402 is used for filter rinses for dissolved metals analysis, which are collected at a frequency of one per filter lot. The sequential number 403 is used for equipment rinse blanks for dissolved metals analysis (for all equipment coming in contact with the sample, including the

filter), which are collected at a 5 percent frequency (minimum of one per sampling event). The sequential number 404 is used for filter rinses for DOC analysis, which are collected at a frequency of one per filter lot. The sequential numbers 501 and 502 are used for deionized water blanks for total metals and TOC analyses, respectively, which are collected at a frequency of one per event. The sequential number 601 is used for trip blanks.

For trip blanks, laboratory codes are used for the location ID. The laboratory codes are SGSA for SGS Environmental Services, Inc., Anchorage, AK, and CASK for Columbia Analytical Services, Inc., Kelso, WA, respectively. An example of a surface-water trip blank ID for SGS may be 0108SGSAWS601 for the first trip blank in January 2008. If more than one trip blank is used in the same event for the same matrix, the sequential ID is increased to 602 and so on, as needed.

Additional matrix codes are as follows:

- WO — marine water
- MS — marine sediment
- SE — sediment
- SO — surface soil
- SS — subsurface soil
- WS — surface water
- WG — groundwater
- TF — fish tissue
- TP — plant tissue
- TA — animal tissue

Samples collected from seep locations should be given the matrix code WS or SE, as applicable. Most location IDs for seep samples start with "SP" to indicate the sample is from a seep location without regard to matrix type; select locations will begin with "SRK." Seep location IDs will contain a two- to three-digit sequential number to differentiate the locations. If a seep site is sampled in more than one year, the location ID should not be changed from that assigned the year the seep was first identified.

For vegetation samples, a letter code for each species will be added to the sample ID with a hyphen between the sample ID and the specie code. Table 2-6 is a list of vegetation species and their associated codes. An example of a vegetation sample ID is 0808TE12TP001-Pima for the first sample of *picea mariana* (black spruce) collected at location TE12 in August 2008. Berry-only samples are designated with a "B" at the end of the species code.

For large fish and all animal tissue a species code (Table 2-7) and a code for tissue type (listed below) are added to the sample ID with hyphens separating the sample ID and species code, and the species code and

tissue-type code. In general the format will be the standard-format sample ID-species code-tissue type. For example, the first liver-tissue sample from a northern pike from location CR199A collected on August 20, 2008, would have the following sample ID: 0808CR199ATF001-NP-LI. Additionally, as an option, the consultant may choose to specify if the fish is a juvenile or an adult by using a "-j" or "-a," respectively, after the species code; the example given above would then become 0808CR199ATF001-NP-a-LI, denoting that this is a liver-tissue sample from an adult northern pike. In an example for mammal tissue, the first sample of kidney tissue from a caribou collected from location PRTGCR on March 25, 2008, would have the sample ID 0308PRTGCRTA001-Ca-KI.

Codes for tissue types are as follows:

- HA — hair
- MU — muscle tissue
- VI — vibrissae (whiskers)
- KI — kidney tissue
- LI — liver tissue
- LB — blood serum
- WB — whole blood
- BL — blubber
- WL — whole body

**Table 2-6**
**Species Names and Codes for Vegetation**

| Plant Code | Latin Name | Common Name |
|---|---|---|
| | ***Algae*** | |
| RW | *Fucus distichus ssp. Evanescens* | Rockweed |
| | ***Aquatic Vegetation*** | |
| Alpl | *Alisma plantago-aquatica* | Broad-leaved water plantain |
| Cave | *Callitriche verna* | Vernal water starwort |
| Cede | *Ceratophyllum demersum* | Coon's tail, hornwort |
| Cido | *Cucuta douglasii* | Water hemlock |
| Hivu | *Hippuris vulgaris* | Mare's tail |
| Lemi | *Lemna minor* | Common duckweed |
| Mysp | *Myriophyllum spicatum* | Eurasian watermilfoil, Spiked watermilfoil |
| Nupo | *Nuphar lutea ssp polysepala* | Yellow pond lily |
| Poam | *Polygonum amphibium* | Water smartweed |
| Pofi | *Potamogeton filiformis* | Thread-leaved pondweed |
| Pofr | *Potamogeton friesii* | Flat-stalked pondweed, Freis' pondweed |
| Pope | *Potamogeton perfoliatus* | Clasping-leaf pondweed |
| Potasp | *Potamogeton sp.* | Pondweeds (not keyed to species) |
| Raaq | *Ranunculus aquatilis* | Large-leaved white water-crowfoot |
| Ragm | *Ranunculus gmelinii* | Yellow water-crowfoot |
| Sacu | *Sagittaria cuneata* | Arum-leaved arrowhead |
| Span | *Sparganium angustifolium* | Narrow-leafed bur-reed |
| Speu | *Sparganium eurycarpum* | Giant bur-reed |
| Tyla | *Typha latifolia* | Common cattail |
| Utrisp | *Utricularia sp.* | Bladderwort (not keyed to species) |

| Plant Code | Latin Name | Common Name |
|---|---|---|
| | ***Ferns & Allies*** | |
| Atfi | *Athyrium filix-femina* | Lady fern |
| Drex | *Dryopteris expansa* | Spreading wood fern |
| | ***Forbes*** | |
| Acbo | *Achillea borealis* | Boreal yarrow, Northern yarrow |
| Acde | *Aconitum delphinifolium* | Monkshood |
| Ange | *Angelica genuflexa* | Kneeling angelica, Wild celery (Bentleaf) |
| Anlu | *Angelica lucida* | Wild celery |
| Arti | *Artemisia tilesii* | Wormwood |
| Chan | *Chamerion angustifolium* | Fireweed |
| Copa | *Comarum palustre* | Marsh five finger |
| Coca | *Cornus Canadensis* | Dwarf dogwood |
| CocaB | *Cornus Canadensis* | Dwarf dogwood (Berry) |
| Epci | *Epilobium ciliatum* | Fringed willowherb, Slender willowherb |
| Eppa | *Epilobium palustre* | Marsh willow herb |
| Eqar | *Equisetum arvense* | Common horsetail, Field horsetail |
| Eqfl | *Equisetum fluviatile* | Water horsetail, Swamp horsetail |
| Eqpr | *Equisetum pretense* | Meadow horsetail |
| Heal | *Hedysarum alpinum* | Alpine sweetvetch, Wild potato, Eskimo potato |
| Hema | *Hedysarum mackenzii* | Wild sweet pea, Sweetvetch |
| Hela | *Heracleum lanatum* | Cow parsnip, Putchkie |
| Irse | *Iris setosa* | Iris |
| Lisc | *Ligusticum scoticum* | Beach lovage |
| Lupe | *Luetkea pectinata* | Partridgefoot |
| Luno | *Lupinus nootkatensis* | Nootka lupine |
| Petasp | *Petasites sp.* | Coltsfoot (not keyed to species) |
| Poac | *Polemonium acutiflorum* | Beautiful Jacob's ladder |
| Popu | *Polemonium pulcherrimum* | Tall Jacob's ladder |
| Poal | *Polygonum alpinum* | Alaska wild rhubarb |
| Rhin | *Rhodiola integrifolia* | Rose root, Ledge stonecrop, Sedum rosea |
| Ruch | *Rubus chamaemorus* | Cloudberry |
| RuchB | *Rubus chamaemorus* | Cloudberry (Berry) |
| Rupe | *Rubus pedatus* | Trailing raspberry |
| Ruar | *Rumex arcticus* | Arctic dock, Sour dock |
| Saca | *Sanguisorba Canadensis* | Canadian burnet |
| Solisp | *Solidago sp.* | Goldenrod (not keyed to species) |
| Treu | *Trientalis europea* | Star flower |
| Vevi | *Veratrum viride* | False hellebore |
| | ***Grasses*** | |
| Caaq | *Carex aquatilis* | Northern water sedge |
| Calasp | *Calamagrostis sp.* | Blue joint grass, Reed grass (not keyed to species) |
| Cami | *Carex microchaeta* | Small-awned sedge, Short stalk sedge |
| Caresp | *Carex sp.* | Sedge (not keyed to species) |
| Caut | *Carex utriculata* | Common yellow lake sedge |
| Eriosp | *Eriophorum sp.* | Alaska cottongrass (not keyed to species) |
| Lear | *Leymus arenarius* | American dune grass, Lyme grass |
| Lemo | *Leymus mollis* | Reeve beach wildrye |
| | ***Lichen*** | |
| Cladsp | *Cladina sp.* | Reindeer lichen (not keyed to species) |
| Flcu | *Flavocetraria cucullata* | Curled snow lichen |
| Peltsp | *Peltigera sp.* | Peltigera lichen (not keyed to species) |
| Thamsp | *Thamnolia sp.* | Whiteworm lichen (not keyed to species) |
| | ***Mosses*** | |
| Hysp | *Hylocomium splendens* | Stair-step moss |
| Lycosp | *Lycopodium sp.* | Stiff clubmoss (not keyed to species) |
| Plsc | *Pleurozium schreberi* | Schreber's big red stem moss |
| Polysp | *Polytrichum sp.* | Hair cap moss (not keyed to species) |
| Ptcr | *Ptilium crista-casttensis* | Knights plume moss, Green terrestrial moss |
| Spsp | *Sphagnum sp.* | Sphagnum moss (not keyed to species) |

| Plant Code | Latin Name | Common Name |
|---|---|---|
| | ***Shrubs*** | |
| Alcr | *Alnus crispa* | Mountain alder |
| Alsi | *Alnus viridus ssp sinuata* | Sitka alder |
| Anpo | *Andromeda polifolia* | Bog rosemary |
| Arru | *Arctostaphylos rubra* | Red bearberry |
| Begl | *Betula glandulosa* | Scrub birch, Dwarf Birch, Resin Birch |
| Bena | *Betula nana* | Arctic dwarf birch |
| Dafl | *Dasiphora floribunda* | Shrubby cinquefoil, Potentilla (tundra rose) |
| Dila | *Diapensia lapponicum* | Lapland diapensia |
| Emni | *Empetrum nigrum* | Crowberry |
| EmniB | *Empetrum nigrum* | Crowberry (Berry) |
| Juco | *Juniperus communis* | Common juniper |
| Lede | *Ledum decumbens* | Labrador tea (Eskimo tea) |
| Lepa | *Ledum palustre* | Narrow-leaf Labrador tea |
| Lopr | *Loiseleuria procumbens* | Alpine azalea |
| Mefe | *Menziesia ferruginea* | Fool's huckleberry, False azalea |
| Myga | *Myrica gale* | Sweetgale |
| Opho | *Oplopanax horridus* | Devil's club |
| OphoB | *Oplopanax horridus* | Devil's club (Berry) |
| Rigl | *Ribes glandulosum* | Skunk currant |
| Rihu | *Ribes hudsonianum* | Northern black currant |
| Rila | *Ribes laxiflorum* | Trailing black currant |
| Ritr | *Ribes triste* | Northern red currant |
| Roac | *Rosa acicularis* | Prickly rose |
| Rosasp | *Rosa sp.* | Wild rose (not keyed to species, not tundra rose) |
| Rusp | *Rubus spectabilis* | Salmonberry |
| RuspB | *Rubus spectabilis* | Salmonberry (Berry) |
| Saal | *Salix alaxensis* | Feltleaf willow |
| Saar | *Salix arctica* | Arctic willow, Rock willow |
| Saba | *Salix barclayi* | Barclay willow |
| Sabr | *Salix brachycarpa* | Barrenground willow |
| Safu | *Salix fuscescens* | Alaska bog willow |
| Sagl | *Salix glauca* | Grey-leaf willow, Glaucous Willow |
| Samo | *Salix monticola* | Mountain willow |
| Sapl | *Salix planifolia* | Diamond leaf willow, Plane leaf willow |
| Sare | *Salix reticuleta* | Net leaf willow, Snow willow |
| Saro | *Salix rotundifolia* | Least willow |
| Sasi | *Salix sitchensis* | Sitka willow |
| Salisp | *Salix sp.* | Willow species (not keyed to species) |
| Sara | *Sambucus racemosa* | Elderberry |
| Spst | *Spirea stevenii* | Alaska spirea, Beauverd spirea |
| Vaov | *Vaccinium ovalifolium* | Early blueberry, Ovaleaf blueberry or Huckleberry |
| VaovB | *Vaccinium ovalifolium* | Early blueberry, Ovaleaf blueberry or Huckleberry (Berry) |
| Vaox | *Vaccinium oxycoccos* | Bog cranberry |
| VaoxB | *Vaccinium oxycoccos* | Bog cranberry (Berry) |
| Vaul | *Vaccinium uliginosum* | Bog blueberry |
| VaulB | *Vaccinium uliginosum* | Bog blueberry (Berry) |
| Vavi | *Vaccinium vitis-idaea* | Lingonberry (low-bush cranberry) |
| VaviB | *Vaccinium vitis-idaea* | Lingonberry (low-bush cranberry) (Berry) |
| Vied | *Viburnum edule* | Cranberry (high bush) |
| ViedB | *Viburnum edule* | Cranberry (high bush) (Berry) |
| | ***Trees*** | |
| Bepa | *Betula papyrifera* | Paper birch |
| Pigl | *Picea glauca* | White spruce |
| Pima | *Picea mariana* | Black spruce |
| Poba | *Populus balsamifera* | Balsam poplar, Cottonwood |
| Potr | *Populus tremuloides* | Quaking aspen |
| Tsme | *Tsuga mertensiana* | Mountain hemlock |

**Table 2-7**
**Species Names and Codes for Bivalves, Fish, and Mammals**

| Species Code | Latin Name | Common Name |
|---|---|---|
| | ***Bivalves*** | |
| AS | *Mactromeris polynyma* | Arctic surf clam |
| FMab | *Anodonta beringiana* | Freshwater mussel |
| HC | *Telmessus cheiragonus* | Helmet crab |
| HT | *Fusitriton oregonensis* | Oregon hairy triton |
| MA | *Macoma obliqua* | Oblique macoma |
| MMmm | *Modiolus modiolus* | Northern horsemussel |
| MMmt | *Mytilus trossulus* | Blue Mussel |
| NC | *Clinocardium nuttalli* | Cockle, Nuttall's heart cockle |
| PC | *Hyas lyratus* | Pacific lyre crab |
| RN | *Neptunea lyrata* | Whelk - Neptune's lyre |
| SO | *Mya arenaria* | Soft-shell clam |
| | ***Fish*** | |
| AC | *Salvelinus alpinus Linnaeus* | Char, Arctic char |
| AG | *Thymallus arcticus Pallus* | Arctic grayling |
| BT | *Lota lota* | Burbot |
| CH | *Oncorhynchus keta* | Chum salmon, Dog salmon |
| CS | *Oncorhynchus kisutch* | Coho salmon, Silver salmon |
| DV | *Salvelinus malma Walbaum* | Dolly Varden |
| FS | *Platichthys stellatus* | Starry flounder |
| FX | *(various genera)* | Flatfish, not keyed to species |
| GW | *Hexagrammos stelleri* | Whitespot greenling |
| GX | *Hexagrammos sp.* | Greenling, not keyed to species |
| HE | *Clupea pallasi* | Herring |
| HT | *Fusitriton oregonensis* | Oregon hairy triton |
| KS | *Oncorhynchus tshawytscha* | King salmon, Chinook salmon |
| LS | *Spirinchus thaleichthys* | Longfin smelt |
| NP | *Esox lucius linnaeus* | Northern pike |
| PH | *Hippoglossus stenolepis* | Pacific halibut |
| PS | *Oncorhynchus gorbuscha* | Pink salmon, Humpback salmon |
| PR | *Lumpenus sagitta* | Snake prickleback |
| RN | *Neptunea lyrata* | Ribbed neptune |
| RT | *Oncorhynchus mykiss* | Rainbow trout, Steelhead trout |
| SC | *Cottidae sp.* | Sculpin, not keyed to species |
| SP | *Leptocottus armatus* | Pacific staghorn sculpin |
| SS | *Oncorhynchus nerka* | Sockeye salmon, Red salmon |
| SX | *Oncorhynchus sp.* | Salmon, not keyed to species |
| WX | *(various genera)* | Whitefish, not keyed to species |
| YS | *Limanda aspera* | Yellowfin sole |
| | ***Mammals*** | |
| BRBE | *Ursus arctos* | Brown bear |

### 2.3.2 Packaging

Each analytical sample bottle will be packed to prevent breakage and will be placed in an iced cooler to keep the samples cooled to 4°±2° Celsius (C). Gel-ice packs for samples will be kept in dedicated freezers that are used only for the storage of ice or sample jars. One copy of the chain-of-custody form will be placed in a sealed plastic bag and then placed inside of the cooler. In addition, the cooler lid will be sealed with tape and chain-of-custody seals will be attached to the outside of the cooler such that the seals must be broken if the cooler is opened.

To preserve the integrity of samples of water, sediment, and plant and animal tissues until receipt by laboratories, all shipments will adhere to the following requirements at a minimum:

1. Coolers will be packaged with 25 percent frozen gel-ice and 75 percent samples. For water samples, avoid packing too much gel-ice around any one sample to avoid freezing samples.

2. For animal-tissue samples (fish, bivalve, mammal), ensure that the tissues are completely frozen before they are placed into the iced cooler for shipment. Be sure that all samples are segregated from other freezer contents by being placed in an appropriate larger sealed container (including custody tape).

3. Each cooler will include a completed chain-of-custody (COC) form for the samples contained in the cooler with all required analyses clearly specified.

4. Each cooler will include a bottle of water labeled "Temperature Blank." The laboratory will measure and record the temperature from this bottle and the air temperature in the cooler.

5. ALL samples shipped outside Alaska will be shipped using Alaska Airlines GoldStreak (or other airport-to-airport equivalent). For samples sent to Columbia Analytical Services, Inc., in Kelso, Washington, write on the airbill "by way of Portland." (Samples may be shipped to Seattle without this instruction). CAS has daily courier service from Portland to their lab in Kelso.

### 2.3.3 Chain-of-custody Form

COC forms will be used for all samples. Once collected, the samples will remain within sight of the sampler or will be secured until the samples are prepared for shipment. Each time the sample cooler changes hands, both the sender and the receiver will sign and date the COC form. The laboratory will forward the original COC form to the Analytical QA/QC Manager. The field sampling teams will verify all COC forms before sample shipment and will make a copy of each to maintain a duplicate set of records. The following information is to be included on the COC form:

- Sample identification code.
- Date and time of collection.
- Project name.
- Type of sample.
- Number and type of containers.
- Sample analysis requested.
- Inclusive dates of possession.
- Signature of receiver.

The consulting company's name, address, and phone number are required on the COC form. Laboratories will be instructed to invoice Pebble Partnership c/o Pebble Mines Corp., the general partner, and to mail reports to the Analytical QA/QC Manager:

Steve Crupi
Shaw Alaska, Inc.
2000 West International Airport Road, Suite C-1
Anchorage, AK 99502

Other COC components will include sample labels, field notebooks, sample shipment receipts, and the laboratory logbook.

## 2.4 Laboratory Procedures and Analytical Methods

Laboratories will employ the following general procedures, especially when conducting low-level detection analyses.

The laboratory should use ultraclean reagent, specially cleaned glassware, and other precautions such as the use of laminar flow hoods for sample digestion and preparation. Marine sediment, marine vegetation, and fish tissues will be reported on a dry-weight basis.

Sample bottles provided for sample collection are to be precleaned. Laboratories are required to maintain, on file, documentation or certification that bottles are precleaned.

Analytical methods selected for the Pebble Project EBS are presented in Table 2-8. The instrument method is given for each parameter. The procedures are routine for the laboratories selected for this project and adhere to EPA methods for the analysis of water and solid samples. CAS and TA will be conducting metals analysis on fish and bivalve tissues following the Puget Sound Estuary Program (PSEP) "Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment and Tissue Samples" (PSWQAT, 1997). CAS will prepare vegetation samples following Standard Operating Procedure GEN-TISP dated July 13, 2004. The laboratory-specific analytical parameters are presented in Tables 1-10 through 1- 15.

**Table 2-8**
**Pebble Project Analytical Parameters, Methods, and Techniques / Instrumentation**

| Parameter | Method, Water | Method, Solids | Technique/Instrumentation |
|---|---|---|---|
| | | ***Organics*** | |
| Total and Dissolved Organic Carbon | SM5310B | ASTM D4129-82M | Combustion or oxidation |
| VOCs | SW8260B | N/A | Gas chromatography/mass spectrometry |
| SVOCs | SW8270C | N/A | Gas chromatography/mass spectrometry |
| PCBs | SW8082 | SW8082 | Gas chromatography with electron capture detector |
| DRO/RRO | N/A | AK102/103 | Gas chromatography with flame ionization detector |
| Lipid Content | NA | GERG9727 | Analytical Balance |
| PAH | N/A | GERG9733 | |
| SHC | N/A | GERG0008 | |
| | | ***Inorganics*** | |
| pH | SM4500$H^+$ B | N/A | Electrode |
| Specific Conductance | SM2510B | N/A | Resistor network |
| Acidity | SM2310B | N/A | Titration |
| Alkalinity | SM2320B | MA | Titration |
| Ammonia as N | SM4500NH3 | SM4500NH3 | AquaKem wet chemistry analyzer |
| Chloride | E300.0 | E300.0 | Ion chromatography/ion selective electrode |
| Cyanide, total | SM4500CN-E | SM4500CN –E | AquaKem wet chemistry analyzer |
| Cyanide, WAD | SM4500CN-I | N/A | AquaKem wet chemistry analyzer |
| Cyanide, Speciation available | ASTM D 6994-04 M | N/A | Ligand exchange/amperometry |
| Fluoride | E300.0 | E300.0 | Ion chromatography/ion selective electrode |
| Hardness | SM2340B | N/A | Calculation |
| Nitrate + Nitrite | E353.2 or SM4500-NO3 F | SM4500-NO3-F | Spectrophotometer |
| Phosphorus, total | E365.3 | N/A | AquaKem wet chemistry analyzer |
| Sulfate | E300.0 | E300.0 | Ion chromatography |
| Thiocyanate | SM4500CN-M | N/A | Spectroscopy (colorimetric) |
| Total dissolved solids | SM2540C | N/A | Gravimetric |
| Total suspended solids | SM2540D | N/A | Gravimetric |
| AVS-SEM | N/A | SW6010/7470 | |
| Low-level mercury | E1631 | E1631 | Cold vapor atomic fluorescence spectrophotometer |
| Mercury | E245.1 | SW7470A | Cold vapor atomic absorption |
| Methyl Mercury | N/A | E1630 | |
| Metals [a] | E200.7/200.8 | E200.8<br>SW6010B/6020<br>SW7740 (Se) | Inductively coupled plasma atomic emission spectroscopy<br>Inductively coupled plasma mass spectrometry<br>Graphite furnace atomic absorption |

*Notes:*

*a. Metals: Al, Sb, As, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Si (dissolved only), Ag, Na, Tl, Sn, V, Zn. Water samples are analyzed for total and dissolved metals.*

## 2.5 Quality Assurance

The QAPP program consists of three components:

1. Field QA identifies the procedures to be used in the field to verify that samples and field monitoring data are collected according to the requirements of the project. The objective of field QA is to produce data—both field measurements and samples collected for laboratory analyses—that can be demonstrated to be representative of the environment sampled and are of known and acceptable quality. The Analytical QA/QC Manager is responsible for reviewing at least 10 percent of the field data, and data review records will be kept in a log by the Analytical QA/QC Manager.

2. Laboratory QA identifies the protocols to be used by the laboratories, demonstrating to Pebble Partnership that project data are analyzed according to EPA-accepted methods and that reported values are accurate. The objective of the laboratory QA/QC program is to produce data that will meet state and federal analytical requirements.

3. Data QA identifies the protocols to be used to verify that laboratory and field data have been reported accurately. The objective of the data QA/QC program is to demonstrate that the data reported meet the project-specified requirements.

### 2.5.1 Data Uses and Data-quality Objectives

Quality assurance requirements are established in this QAPP to achieve the project objectives for the data uses. Applicable quality control procedures, quantitative target limits, and level of effort for assessing the data quality are dictated by the intended use of the data and the nature of the required field and analytical methods. The project objectives are to collect data of known and sufficient quality for the Pebble Partnership to meet the standards set by state and federal environmental regulations.

Federal and state levels of concern (e.g., ambient water-quality criteria or maximum contaminant levels) exist for many of the parameters being analyzed in the EBS program. Analytical methods have been specified that will allow detection of chemical constituents at or below levels of concern.

### 2.5.2 Data Quality Assurance/Quality Control Program

The proposed data QA/QC program serves four major functions:

1. Maintenance of a duplicate record of all field data.

2. Sample tracking through laboratory analysis.

3. Data validation.

4. Oversight of data management.

The second major component of the proposed data QA program is sample tracking throughout the laboratory analytical process. The Analytical QA/QC Manager will maintain close communications with all analytical laboratories to verify sample receipt, proper sample management, and strict adherence to sample holding times. The laboratories will immediately inform the Analytical QA/QC Manager of sample breakage, inadequate sample media to meet QA objectives, and other sample problems. The

Analytical QA/QC Manager will then notify the respective field team so that corrective action can be implemented as deemed necessary.

Following receipt of the analytical data package, the Analytical QA/QC Manager will verify that all data have been received, will compare them to detection limits, and will compare preliminary results with previous results. Should major discrepancies be found, the Analytical QA/QC Manager will communicate these, where appropriate, to the respective field team. Possible corrective measures will then be evaluated as deemed necessary.

### 2.5.3 Laboratory Quality Assurance/Quality Control Program

Specific protocols to ensure laboratory data of known and consistent quality can be found in the SGS, CAS, and TA quality assurance manuals, which are on file in the Shaw Anchorage office. The Analytical QA/QC Manager and Laboratory Project Chemists will oversee implementation of these protocols. Project-specific criteria are shown in Tables 1-10 through 1-15.

Data validation will be conducted by Shaw. Any discrepancies will be noted and discussed with:

- Ms. Karen Waak, Laboratory Project Chemist for this project with SGS, or
- Ms. Lynda Huckestein, Laboratory Project Chemist for this project with CAS, or
- Ms. Terri Torres, Laboratory Project Chemist for this project with TA, or
- Ms. Sue Webber, Laboratory Project Chemist for this project with ACZ.

## 2.6 Instrument/Equipment Testing, Inspection, and Maintenance

The Laboratory Project Chemists are responsible for all laboratory equipment maintenance decisions. In the event of equipment failure that will affect the analytical schedule, the laboratory Operations Manager will notify the Analytical QA/QC Manager. Field team managers are responsible for field equipment maintenance decisions.

## 2.7 Inspection/Acceptance of Supplies and Consumables

All supplies and consumables (sample reference materials and reagents) will be inspected and checked in by the Laboratory Project Chemist or the Quality Assurance Officer.

## 2.8 Data Management

All pertinent field survey and sampling information will be recorded on field forms during each day of the field effort and at each sample site. The field crew leader will be responsible for seeing that sufficient detail is recorded on the forms. No general rules can specify the extent of information that must be entered on the forms; however, the objective is that the field forms contain sufficient information so that field activities can be reconstructed without relying on the memory of the field crew. All entries will be made in indelible ink. All corrections will consist of initialed, single-line-out deletions.

Strict custody procedures will be maintained with the field forms used. While being used in the field, forms will remain with the field team and will be secured on a clip board or, at a minimum, with rubber bands AT ALL TIMES. Upon completion of the field effort, forms will be filed in an appropriately secure manner in a bound notebook labeled "original data." These forms will remain with the task manager. Photocopies of the original data will be used as working documents.

Laboratory data results are received by electronic mail by the Analytical QA/QC Manager. The laboratories also will send paper copies of analysis results to the Analytical QA/QC Manager. Laboratory data will be validated by Shaw, then uploaded to the Pebble Partnership chemistry database.

# 3.0 Assessment and Oversight

## 3.1 Assessments and Response Actions

Field assessments will be discussed between the Analytical QA/QC Manager and the field team manager. Any response actions will then be undertaken by the Analytical QA/QC Manager during regular field sampling/monitoring events. Internal assessment for the laboratory will be performed according to laboratory's quality management plans (QMPs), which are kept on file in the Shaw Anchorage office.

## 3.2 Reports to Management

Following receipt of the analytical data package by Shaw, the Analytical QA/QC Manager at Shaw will review the data with regard to the following:

- Analytical methodology.
- Detection limits.
- Accuracy, precision, and adherence to holding times.

These QA/QC checks of data will be kept on file at Shaw by the Analytical QA/QC Manager and included in data-quality assessment reports on the data. Where data do not meet the requirements specified in this QA/QC program, the data will be flagged with qualifiers. Should major discrepancies be found, the Analytical QA/QC Manager will communicate these to Pebble Partnership's Environmental Studies Manager, Jane Whitsett. Possible corrective measures then will be evaluated as deemed necessary. These data reviews will be summarized and included in the DQAR reports by Shaw to Pebble Partnership.

Laboratory reports will include the elements described in Section 1.8.2 of this QAPP.

# 4.0 Data Review, Validation, and Usability

Data review and validation will be conducted on all data collected for the Pebble Project environmental baseline studies.

## 4.1 Data Review

Data generated for this project will be reviewed by both the laboratory and by Shaw. The laboratory has primary responsibility for correctly identifying and quantifying analytes and compounds of interest, for identifying matrix interferences, and for identifying and, if possible, correcting instrument anomalies. The laboratory also is responsible for the technical quality of the data and for meeting all quality-control parameters by correctly following the analytical methods using instrumentation that is in proper working order for the given method.

The review process will be coordinated initially by the bench-level scientists who will review all data for accuracy and completeness. The bench-level scientist also will compare all QC sample results with the control criteria outlined in Tables 1-10 through 1-15 and will initiate appropriate corrective action if criteria are not met.

Prior to preparation of summary reports, the data will be reviewed by the laboratory QA/QC manager to ensure that the data are representative, complete, and accurate.

## 4.2 Validation and Verification Methods

Data validation is the review process to screen data for anomalies and possible errors. Data accepted from the laboratory will be verified and validated by Shaw. The data validation process will include review of the following:

- Analytical methodology.
- Detection limits.
- Cross-contamination as indicated by blank data.
- Laboratory accuracy and precision.
- Adherence to holding times.
- Sample preservation.
- Initial and continuing calibration.
- Field precision (QA/QC samples).
- Total metals vs. dissolved metals.

Data will be validated in accordance with the following procedures:

- *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA, 1999)
- *Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review* (EPA, 2001a)
- *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2002a)

### 4.2.1 Field Precision

Field precision will be evaluated using the criteria presented in Table 4-1. Two sets of data are compared to each other for precision: the primary vs. duplicate sample sets and the primary vs. triplicate sample sets. For results that fall in the Disagreement or Major Disagreement columns, the duplicate or triplicate sample data and the associated laboratory data will be evaluated for any biases that may explain the disagreements. In some cases, associated samples may be qualified as estimates (J) or rejected (R) based on professional judgment.

**Table 4-1**
**Criteria for Comparing Field QC and QA Sample Data**

| Matrix | Parameter | Disagreement | Major Disagreement |
|---|---|---|---|
| All | All | > 5x difference when one result is < MDL | > 10x difference when one result is < MDL |
| All | All | > 3x difference when one result is < MRL | > 5x difference when one result is < MRL |
| Water | All except TPH | > 2x difference | > 3x difference |
| Marine Sediment and Tissues | All except metals, VOCs, BTEX and TPH | > 4x difference | > 5x difference |
| Marine Sediment and Tissues | Metals | > 2x difference | > 3x difference |
| Water and Marine Sediment | TPH | Arbitrary (suggest > 3x difference) | Arbitrary (suggest > 5x difference) |
| Marine Sediment and Tissues | VOCs and BTEX | Arbitrary (suggest > 5x difference) | Arbitrary (suggest > 10x difference) |

*Notes:*

*BTEX = benzene, toluene, ethylbenzene, and xylenes.*

*TPH = total petroleum hydrocarbons.*

### 4.2.2 Total vs. Dissolved Metals

Evaluation of total and dissolved metals will involve comparison of results in instances where dissolved is greater than total. Sample results are acceptable if the following criteria are met:

1. Where both results are greater than five times the MRL, and the RPD between results is less than or equal to 20 percent.

2. Where the total metals result is less than or equal to 5 times the MRL, and the absolute value of the difference between the results is less than or equal to the MRL. If the total metals result is not detected at the MDL, then the value of the MDL will be used for the comparison.

3. Where both total and dissolved results are below the MRL.

For an individual sample where criteria are not met for up to 30 percent of the parameters, then the associated QC data (including method blanks and field blanks) will be evaluated for bias. Consequently, results may be qualified, with a "J," as an estimate. If the results for more than 30 percent of the parameters fail to meet the criteria, then both total and dissolved samples will be reanalyzed. If reanalysis does not eliminate the problem, then results will be qualified, with a "J," as an estimate (Zeiner, 1994).

Water samples for dissolved metals analysis are prepared in the field by filtering the sample with a peristaltic pump through Tygon tubing with a disposable 0.45 micron filter in line. A comparison of the certified limits of detection (LOD) provided by the manufacturer (Voss Manufacturers) for their High Capacity Groundwater Capsule for filtering water samples is presented in Table 4-2. This table is intended to document the possible contribution of metals to dissolved water samples due to the filter. Note that selenium is the only metal where the filter LOD is greater than the regulatory limit.

**Table 4-2**
**Summary of Metals Limit of Detection in Filters**

| Parameter | MRL (µg/L) | Filter LOD, (µg/L) | Lowest EPA or ADEC Regulatory Limit | Filter LOD > MRL | Filter LOD > Regulatory Limit |
|---|---|---|---|---|---|
| Hg (low level) (total only) | 0.005 | 0.05 | 0.05 | Yes | No |
| Al | 1.0 | 0.2 | 87 | No | No |
| Sb | 0.05 | 0.1 | 5.6 | Yes | No |
| As | 0.5 | 0.2 | 10 | No | No |
| Ba | 0.05 | 0.1 | 1000 | Yes | No |
| Be | 0.02 | 0.04 | 4 | Yes | No |
| Bi | 0.1 | 0.04 | None | No | No |
| B | 0.5 | 5 | None | Yes | No |
| Cd | 0.02 | 0.03 | 0.1 | Yes | No |
| Co | 0.02 | 0.02 | None | No | No |
| Cu | 0.1 | 0.5 | 2.7 | Yes | No |
| Pb | 0.02 | 0.5 | 0.54 | Yes | No |
| Mn | 0.05 | 0.3 | 50 | Yes | No |
| Mo | 0.05 | 0.05 | 10 | No | No |
| Ni | 0.2 | 0.5 | 16 | Yes | No |
| Se | 1.0 | 7 | 4.6 | Yes | Yes |
| Si (Dissolved only) | 100 | Not reported | None | Not reported | No |
| Ag | 0.02 | 0.03 | 0.32 | No | No |
| Tl | 0.01 | 0.05 | 0.24 | Yes | No |
| Sn | 0.1 | 0.2 | None | Yes | No |
| V | 0.2 | 0.03 | 100 | No | No |
| Zn | 0.5 | 1 | 36 | yes | No |

### 4.2.3 Cation-Anion Balance

Aqueous samples are evaluated for ion balance by the laboratories. This is a QC check on results to identify any data that may be suspect. If ion-balance criteria are not met, the relevant data are evaluated to identify the cause for the poor balance.

### 4.2.4 Data Qualification

Where data do not meet the requirements specified in this QAPP program, the data will be flagged with qualifiers. These reviews of data will be summarized and included in the QA report. The following are validation flags that will be inserted into electronic format for upload into the Pebble Partnership database:

U Analyte was not detected at the sample quantitation limit. Detections below this limit were attributed to associated blank contamination.

UJ The analyte was analyzed, but was not detected above the level of the reported sample quantitation limit. The reported quantitation limit is approximate and may be inaccurate or imprecise.

J The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

J+ The result is an estimated quantity, but the result may be biased high.

J- The result is an estimated quantity, but the result may be biased low.

R The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.

B Vegetation samples: the result was detected at a value less than 10 times the amount in the associated field blank. The result is flagged to inform the user of potential contamination.

## 4.3 Reconciliation with User Requirements

A periodic review of the objectives of this project will be accomplished on a yearly basis to determine if user requirements have changed.

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