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.

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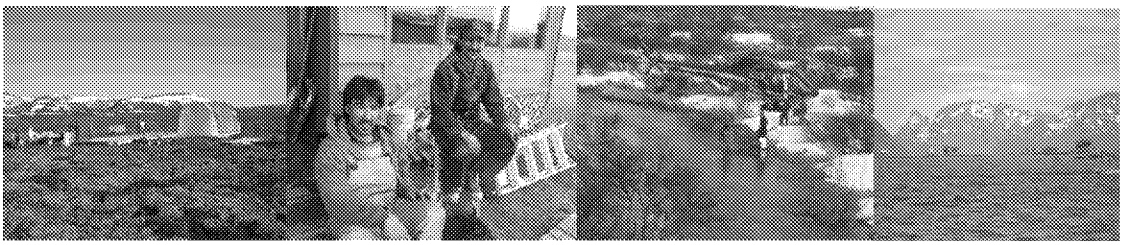
APPENDIX

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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Figure

1-1 Pebble Project Organization Chart

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 Chief Operating Officer E-mail: brucej@hdgold.com Phone: 604-684-6365 **NDM**		
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Michael Smith Manager, Project Permitting E-mail: michaels@hdgold.com Phone: 907-339-2600 **NDM**		
Jane Whitsett Analytical QA/QC Manager E-mail: jane.whitsett@shawgrp.com Phone: 907-243-6300 **Shaw Environmental, Inc.**		

Agency Personnel	Signature	Date
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Al Ott Project Manager E-mail: al_ott@dnr.state.ak.us Phone: 907-459-7279 **ADNR**		
Cindi Godsey Project Manager E-mail: godsey.cindi@epa.gov Phone: 907-271-5083 **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

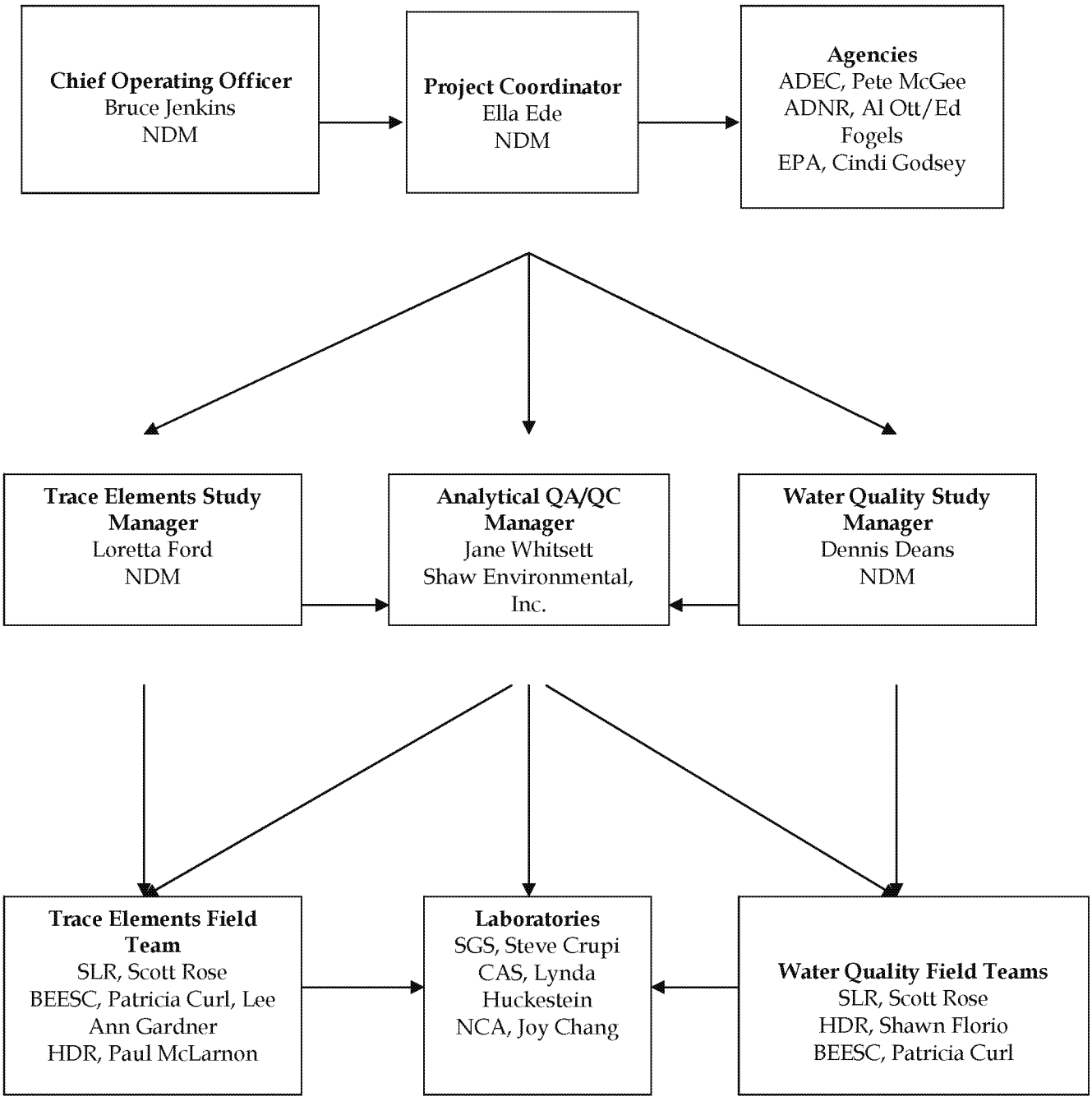
Steve Crupi SGS Environmental Services, Inc. 200 W. Potter Dr. Anchorage, AK 99518 562-2343 phone 550-3213 direct 561-5301 fax Steve_Crupi@sgs.com	**Lynda Huckestein** 1317 S. 13th Avenue Kelso, WA 98626 360-501-3358 direct phone 360-636-1068 fax lhuckestein@kelso.caslab.com
Joy Chang (primary contact) North Creek Analytical, Inc. 9405 SW Nimbus Ave. Beaverton, OR 97008 503-906-9234 direct phone 503-906-9210 fax jchang@ncalabs.com	**Mike Priebe (local contact)** North Creek Analytical, Inc. 2000 W. International Airport Road, Suite A10 Anchorage, Alaska 99502 563-9200 phone/317-3412 cell 563-9210 fax 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. Bruce Jenkins, Chief Operating Officer Ella Ede, Project Coordinator Loretta Ford, Trace Elements Study Manager Dennis Deans, Water and Aquatics Study Manager	• Responsible for development and execution of overall project scope and schedule. • Provides oversight of project team, deliverables, and schedule. • Responsible for sample collection and analysis of trace elements in surface soil, sediment, vegetation, and fish tissue. • Responsible for sample collection and analysis of surface water, groundwater, and fish tissue samples.
Shaw Environmental, Inc. 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 SLR, Scott Rose HDR, Shawn Florio BEESC, Patricia Curl, Lee Ann Gardner HDR, Paul McLarnon	• Responsible for collection of groundwater, surface soil, sediment, and vegetation samples for the mine area. • Responsible for collection of surface water for the mine area. • 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. • Responsible for collection of fish tissues for the mine area.
Laboratories **SGS Environmental Services, Inc.** Steve Crupi, Project Chemist Columbia Analytical Services, Inc. Lynda Huckestein, Project Chemist North Creek Analytical Services, Inc. Joy Chang, Project Chemist	• Responsible for executing and reporting laboratory scope of work for primary and QC samples collected by field teams. • 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. • 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 **ADEC** William "Pete" McGee **ADNR** Al Ott Ed Fogels **EPA** Cindi Godsey	• Project Manager • Project Manager • Acting Quality Assurance Manager • 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 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 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 1 extra volume for MS/MSD	(1) 1L HDPE No extra volume for MS/MSD	Total Hg Total Metals	Hg 1	E245.1 E200.8/ 200.7	HNO_3 HNO_3	28 days 6 Months	4 °C None	Unfiltered
2	(1) 1L HDPE 1 extra volume for MS/MSD	(1) 1L HDPE No extra volume for MS/MSD	Dissolved Hg (GW only) Dissolved Metals	Hg 1	E245.1 E200.8/ 200.7	HNO_3 HNO_3	28 days 6 Months	4 °C None	Filtered
3	(2) 250 mL HDPE No extra volume for MS/MSD	(1) 1L HDPE 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 No extra volume for MS/MSD	(1) 1L HDPE 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 2 extra volumes for TDS/TSS lab duplicates 60 mL Nalgene* (*Cl, F, SO4 only) 1 extra volume for MS and 1 extra volume for lab	(2) 1L HDPE 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 No extra volume for MS/MSD	250 mL HDPE No extra volume for MS/MSD	Thiocyanate	Thiocyanate	Lab SOP	HNO_3	28 days	4 °C	Unfiltered
7	500 mL Fluoropoly No extra volume for MS/MSD	500 mL Fluoropoly 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 6 extra VOA vials for MS/MSD	(3) 40 ml VOA vial with Teflon septum lid 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 4 extra volumes for MS/MSD	(2) 1- Liter Amber glass jar with Teflon cap 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 6 extra VOA vials for MS/MSD	(3) 40 ml VOA vial with Teflon septum lid 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 4 extra volumes for MS/MSD	with Teflon cap 4 extra volumes for MS/MSD					analysis of extract		
13(SW only)	(2) 1- Liter Amber glass jar with Teflon cap 4 extra volumes for MS/MSD	(2) 1- Liter Amber glass jar with Teflon cap 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™ 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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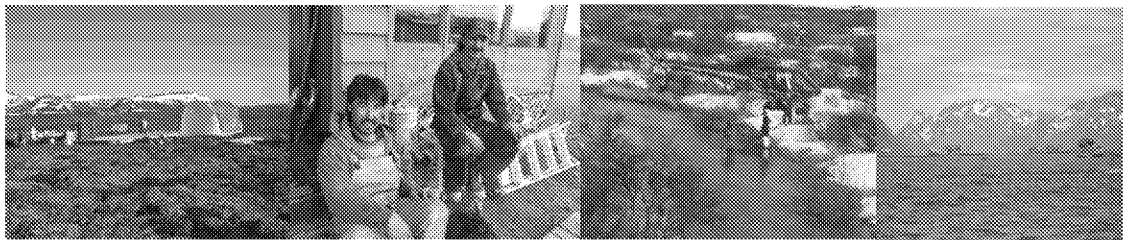
DRAFT ENVIRONMENTAL BASELINE STUDIES
PROPOSED 2005
QUALITY ASSURANCE PROJECT PLAN



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
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March 4, 2005

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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

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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

EPA-7609-0014440_00079

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

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Agency Personnel	Signature	Date
William D. "Pete" McGee Pebble Project Manager E-mail: pete_mcgee@dec.state.ak.us Phone: 907-451-2101 **Alaska Department of Environmental Conservation (ADEC)**		
James Gendron Quality Assurance Officer E-mail: james_gendron@dec.stltg.ak.usPhone: 907-465-5305**Alaska Department of Environmental Conservation (ADEC)**		
Cindi GodseyProject ManagerE-mail: 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.

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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 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.

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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

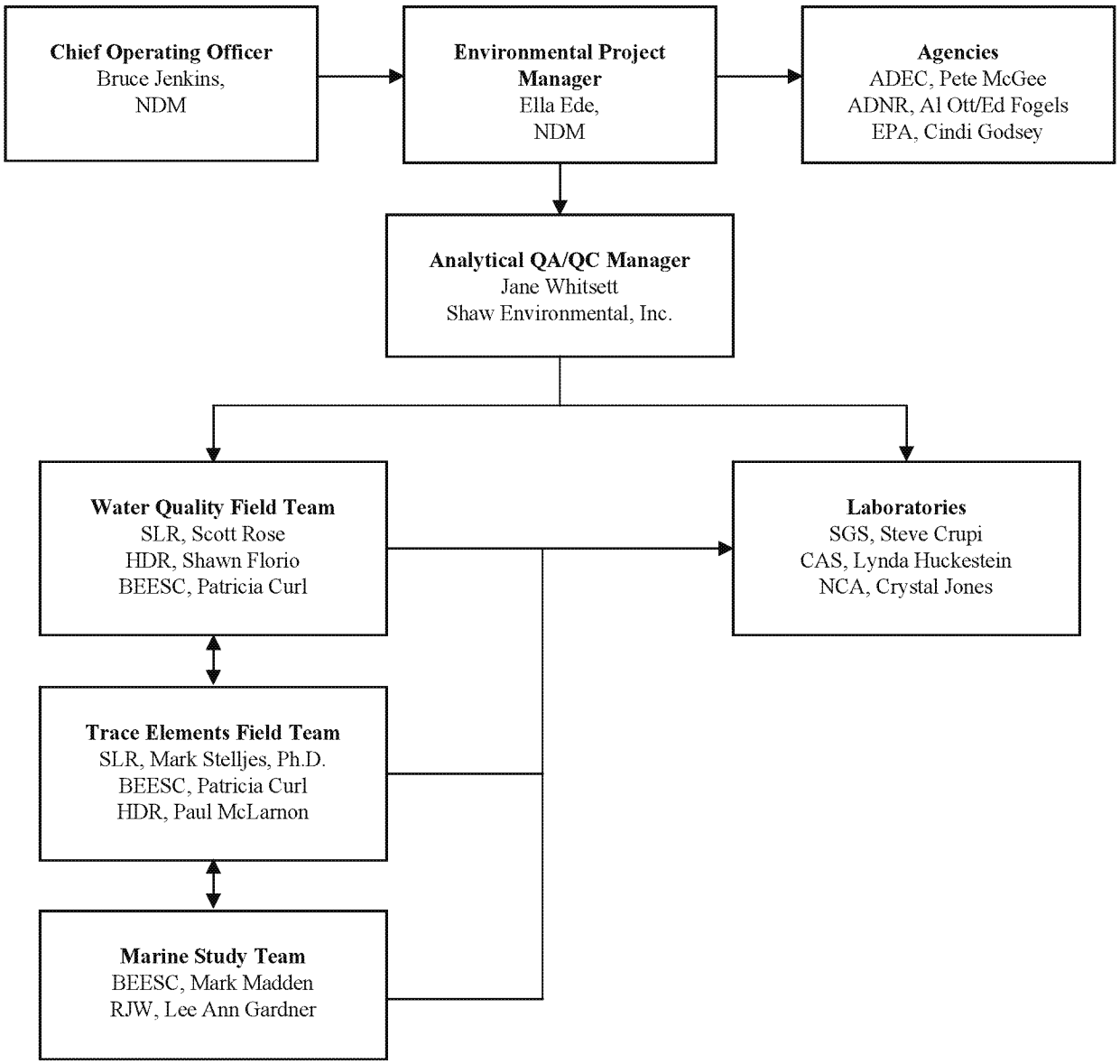
Steve Crupi SGS Environmental Services, Inc. 200 W. Potter Dr. Anchorage, AK 99518 907-562-2343 phone, 907-550-3213 direct 907-561-5301 fax Steve_Crupi@sgs.com	**Lynda Huckestein** Columbia Analytical Services, Inc. 1317 S. 13th Avenue Kelso, WA 98626 360-501-3358 direct phone 360-636-1068 fax lhuckestein@kelso.caslab.com
Crystal Jones North Creek Analytical, Inc. 9405 SW Nimbus Ave. Beaverton, OR 97008 503-906-9234 direct phone 503-906-9210 fax cjones@ncalabs.com	**Mike Priebe (local contact)** North Creek Analytical, Inc. 2000 W. International Airport Road, Suite A10 Anchorage, Alaska 99502 907-563-9200 phone, 907-317-3412 cell 907-563-9210 fax 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. 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. 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. 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	
William "Pete" McGee	Pebble Project Manager
James Gendron	Quality Assurance Officer
ADNR	
Al Ott	Manager, Office of Habitat Management and Permitting
Ed Fogels	Manager, Large Mine Planning Team
EPA	
Cindi Godsey	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.

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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.

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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..

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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

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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
GRO = gasoline-range organics
RRO = residual-range organics
SOP = standard operating procedure
VOCs = volatile organic compounds
DRO = diesel-range organics
PCBs = polychlorinated biphenyls
TDS = total dissolved solids
SVOCs = semivolatile 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

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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 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 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

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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:

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

%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 1-18 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.

EPA-7609-0014440_00116

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 1 extra volume for MS/MSD	(1) 1L HDPE 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 1 extra volume for MS/MSD	(1) 1L HDPE 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 No extra volume for MS/MSD	(1) 1L HDPE 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 No extra volume for MS/MSD	(1) 1L HDPE 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 2 extra volumes for TDS/TSS lab duplicates 60 ml Nalgene* (*Cl, F, SO_4 only) 1 extra volume for MS and 1 extra volume for lab duplicate	(2) 1L HDPE 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 No extra volume for MS/MSD	250 ml HDPE No extra volume for MS/MSD	Thiocyanate	Lab SOP	HNO_3	28 days	4 °C	Unfiltered
7	500 ml Fluoropoly No extra volume for MS/MSD	500 ml Fluoropoly 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 6 extra VOA vials for MS/MSD	Teflon septum lid 6 extra VOA vials for MS/MSD						
10 (Marine SW only)	(2) 1L amber glass jar with Teflon cap 4 extra volumes for MS/MSD	(2) 1L amber glass jar with Teflon cap 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 6 extra VOA vials for MS/MSD	(3) 40 ml VOA vial with Teflon septum lid 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 4 extra volumes for MS/MSD	(2) 1L amber glass jar with Teflon cap 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 4 extra volumes for MS/MSD	(2) 1L amber glass jar with Teflon cap 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 SW6010B/6020 SW7740 (Se) SW7471 (Hg)	Inductively coupled plasma atomic emission spectroscopy Inductively coupled plasma mass spectrometry 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.

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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)

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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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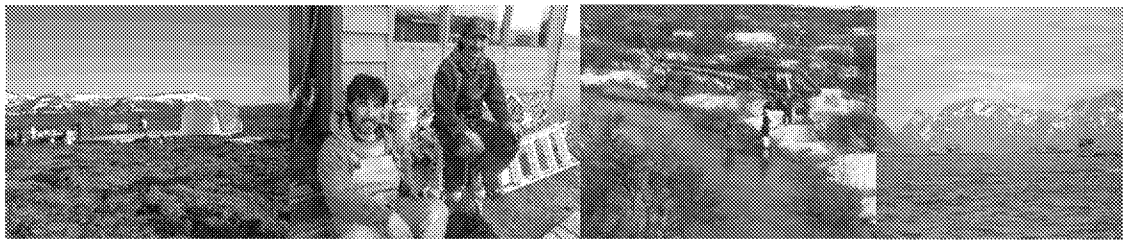
2006
QUALITY ASSURANCE PROJECT PLAN



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
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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

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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

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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 Chief Operating Officer/Environmental Study Director **NDM** E-mail: brucej@hdgold.com Phone: 604-684-6365		July 18/06
Dennis Deans Asst. Environmental Study Director **NDM** E-mail: dennisd@hdgold.com Phone: 604-684-6365		18/07/06
Ella Ede Environmental Project Manager **NDM** E-mail: ellae@northerndynasty.com Phone: 907-339-2600		7/18/06
Michael Smith NEPA and Permitting Manager **NDM** E-mail: michaels@northerndynasty.com Phone: 907-339-2606	SE for MSmith	7/18/06

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

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

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- 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.

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

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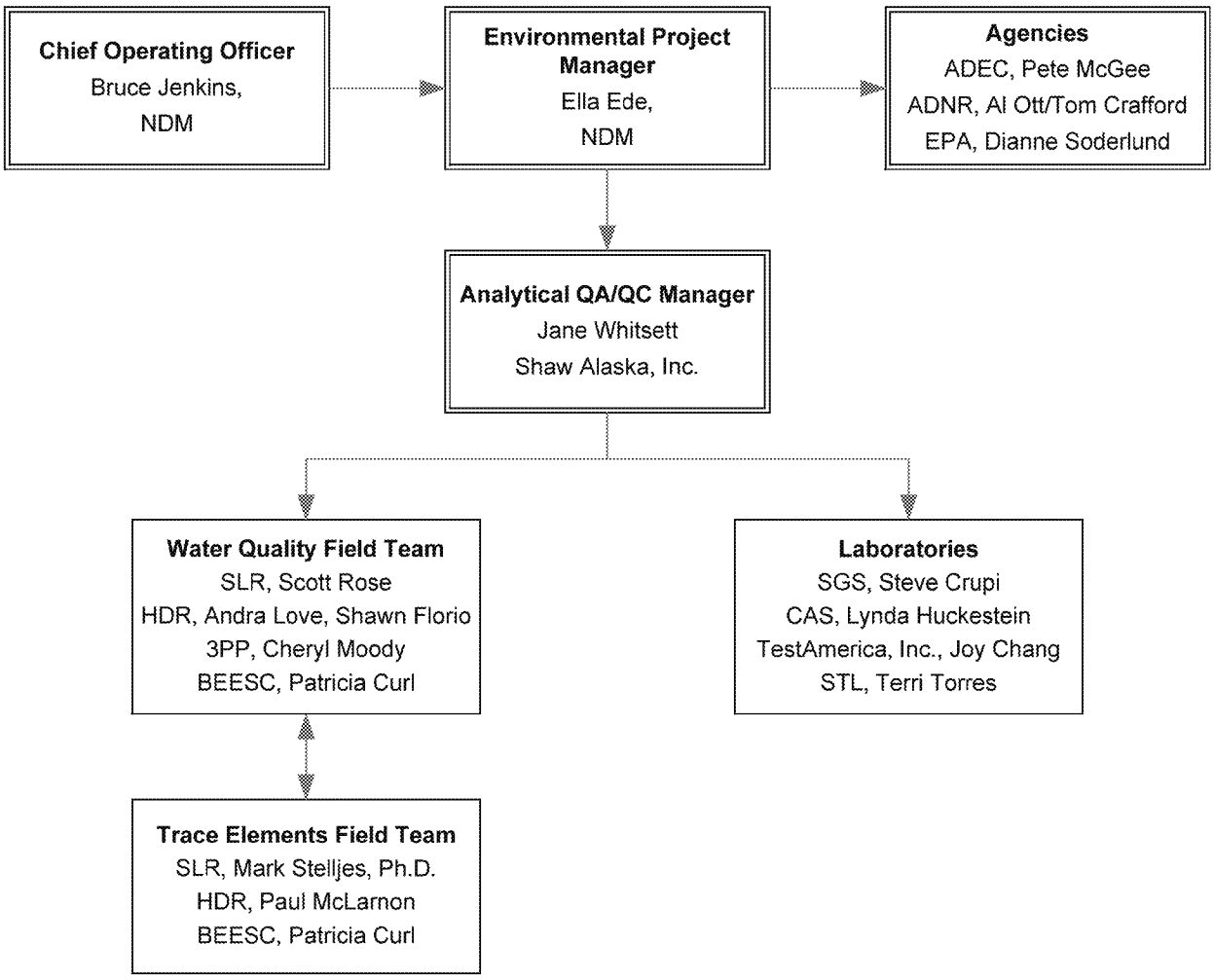
Table 1-3 (continued)
Summary of Pebble Project EBS Key Personnel and Roles

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.

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- 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.

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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.

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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.

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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

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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).

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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:

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

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 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 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

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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.

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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.

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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

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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 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 (1) extra unpreserved container for dissolved metals collection (1) 1L extra volume for MS/MSD	(1) 1L HDPE (CAS) (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) (1) 250-ml fluoropoly (NCA) 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) (2) 250-ml fluoropoly (NCA) No extra volume for MS/MSD	Low level Hg (total and dissolved)	E1631	HCl	90 days	None	Unfiltered (total) Filtered (dissolved)
5	(1) 250-ml Nalgene 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 (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 (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 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 (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 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 SW7471A(Hg)	None None	6 months (SW6010B) 28 days (SW7471A)	Ambient 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.

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- 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.

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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.

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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

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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.

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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 SW6010B/6020 SW7740 (Se)	Inductively coupled plasma atomic emission spectroscopy Inductively coupled plasma mass spectrometry Graphite furnace atomic absorption
Sulfur, total	N/A	E300M	Ion chromatography/ion selective electrode
AVS	N/A	Draft E1991	Colorimetric
SEM	N/A	SW6010B 7470A	Inductively coupled plasma atomic emission spectroscopy 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.

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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.

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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.

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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

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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

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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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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.

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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

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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

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

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Agency Personnel	Signature	Date
Environmental Program Manager Sharmon Stambaugh **Alaska Department of Environmental Conservation (ADEC)** E-mail: sharmon.stambaugh@alaska.gov 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:

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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 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 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.

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TABLE 1-2
Laboratory Contact Information

Karen Waak SGS Environmental Services, Inc. 200 W. Potter Dr. Anchorage, AK 99518 907-562-2343 phone, 907-550-3203 direct 907-561-5301 fax Karen.Waak@sgs.com	Lynda Huckestein Columbia Analytical Services, Inc. 1317 S. 13th Avenue Kelso, WA 98626 360-501-3358 direct phone 360-636-1068 fax lhuckestein@kelso.caslab.com
Crystal Jones Test America, Inc. 9405 SW Nimbus Ave. Beaverton, OR 97008 503-906-9233 direct phone 503-906-9210 fax cjones@testamericainc.com	Mike Priebe (local contact) Test America, Inc. 2000 W. International Airport Road, Suite A10 Anchorage, Alaska 99502 907-563-9200 phone, 907-317-3412 cell 907-563-9210 fax mpriebe@testamericainc.com
Terri Torres Severn Trent Laboratories—Seattle 5755 8th Street East Tacoma, WA 98424 253-922-2310 terri.torres@testamericainc.com	Sue Webber ACZ Laboratories, Inc. 2773 Downhill Drive Steamboat Springs, CO 80487 800-334-5493, x110 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).

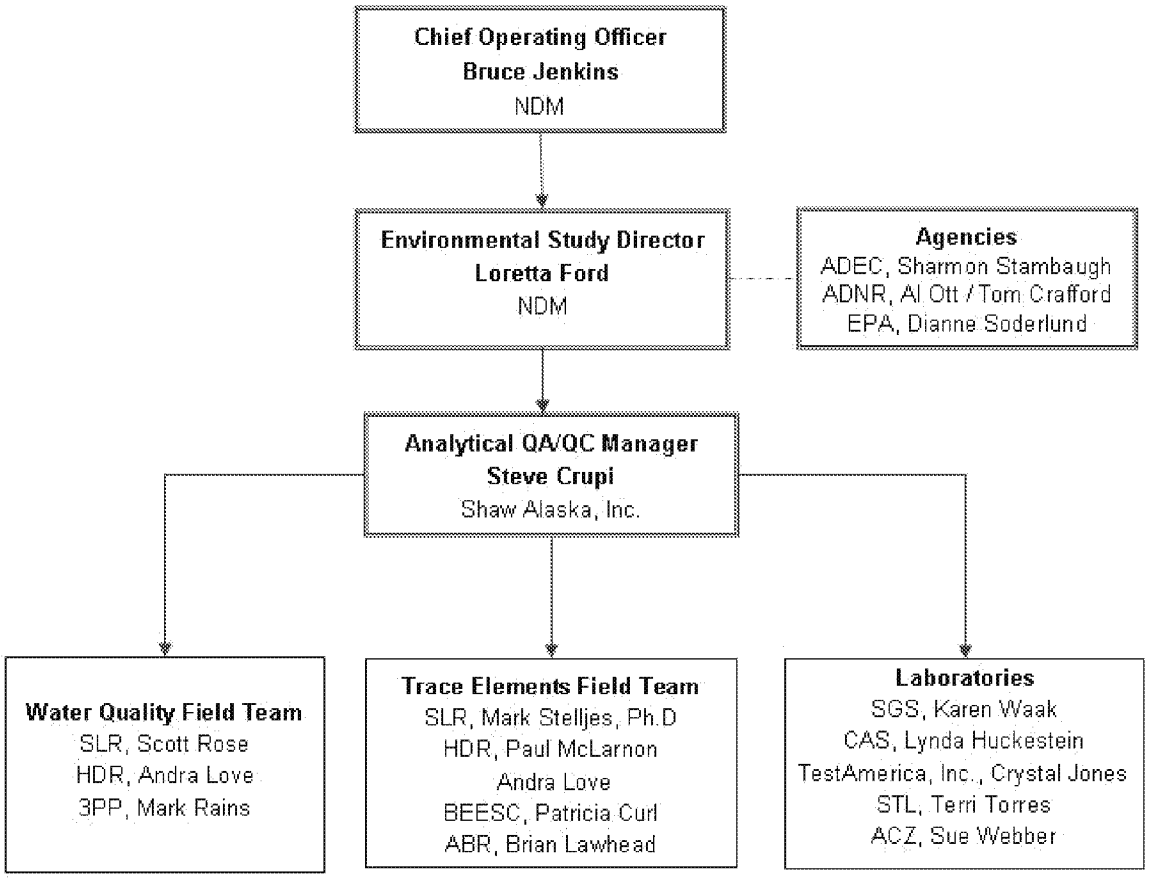
TABLE 1-3
Summary of Pebble Project EBS Key Personnel and Roles

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	
Sharmon Stambaugh	Environmental Program Manager III
Alaska Dept. of Natural Resources	
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 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.

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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.

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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
E = EPA (1983, 1991 and 2001b)
PCBs = polychlorinated biphenyls
DRO = diesel-range organics
M = modified
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.

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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.

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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.

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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.

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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 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 (1) extra unpreserved container for dissolved metals collection (1) 1L extra volume for MS/MSD	(1) 1L HDPE (CAS) (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) (1) 250-ml fluoropoly (Test America) 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) (2) 250-ml fluoropoly (Test America) No extra volume for MS/MSD	Low level Hg (total and dissolved)	E1631	HCl	90 days	None	Unfiltered (total) Filtered (dissolved)
5	(1) 250-ml Nalgene 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 (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 (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	SM4500H^+B	None	24 hours	4°C	Unfiltered
8	(1) 120-ml Nalgene (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 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 (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 °C
			Total Metals[1]	SW6010B/6020/E200.8		6 months	None
			Cyanide	SM4500CN-E		14 days	4 °C
Mammalian	5	Ziploc bag or glass jar (hair samples)	Total Metals[2]	E200.8/SW6010B/7471A/ 7740	Freeze < -20 °C (Iliamna)	12 months	Freeze at ≤ -20 °C
	50	Ziploc bag or glass jar (tissue samples)			Freeze < -20 °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 °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.

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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	SM4500H$^+$ 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 SW6010B/6020 SW7740 (Se)	Inductively coupled plasma atomic emission spectroscopy Inductively coupled plasma mass spectrometry 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

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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.

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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)

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- *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,

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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:

THE pebble PARTNERSHIP

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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

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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

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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
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Michael Smith NEPA and Permitting Manager Pebble Partnership E-mail: michaelsmith@pebblepartnership.com Phone: 907-339-2606	_____	_____
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Agency Personnel		
Dave Johnson Tech Eng II / Architect II Alaska Department of Environmental Conservation E-mail: david.johnson1@alaska.gov Phone: 907-262-5210, x238	_____	_____

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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.

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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 Texas A&M GERG — College Station, TX [a]	TA — Tacoma, WA
Marine Bivalve Tissue	CAS — Kelso, WA 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

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Table 1-2
Laboratory Contact Information

Karen Waak SGS Environmental Services, Inc. 200 W. Potter Dr. Anchorage, AK 99518 907-562-2343 phone, 907-550-3203 direct 907-561-5301 fax Karen.Waak@sgs.com	Lynda Huckestein Columbia Analytical Services, Inc. 1317 S. 13th Avenue Kelso, WA 98626 360-501-3358 direct phone 360-636-1068 fax lhuckestein@kelso.caslab.com
Richard Reid TestAmerica, Inc. 9405 SW Nimbus Ave. Beaverton, OR 97008 503-906-9237 direct phone 503-906-9210 fax Richard.Reid@testamericainc.com	Mike Priebe (local contact) TestAmerica, Inc. 2000 W. International Airport Road, Suite A10 Anchorage, AK 99502 907-563-9200 phone, 907-317-3412 cell 907-563-9210 fax Mike.Priebe@testamericainc.com
Terri Torres TestAmerica, Inc - Tacoma 5755 8th Street East Tacoma, WA 98424 253-922-2310 Terri.Torres@testamericainc.com	Sue Webber ACZ Laboratories, Inc. 2773 Downhill Drive Steamboat Springs, CO 80487 800-334-5493, x110 suew@acz.com
Terry Wade, PhD Geochemical and Environmental Research Group Texas A&M 833 Graham Road College Station, TX 77845 979-862-2323, x134 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).

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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.

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Personnel	Responsibilities
AGENCIES	
Alaska Department of Environmental Conservation (ADEC) David Johnson	 Pebble Project Manager Tech Eng II / Architect II
Alaska Dept. of Natural Resources (ADNR) Al Ott Tom Crafford	 Manager, Office of Habitat Management and Permitting Manager, Large Mine Permitting Team
U.S Environmental Protection Agency (EPA) John Pavitt	 Project Manager

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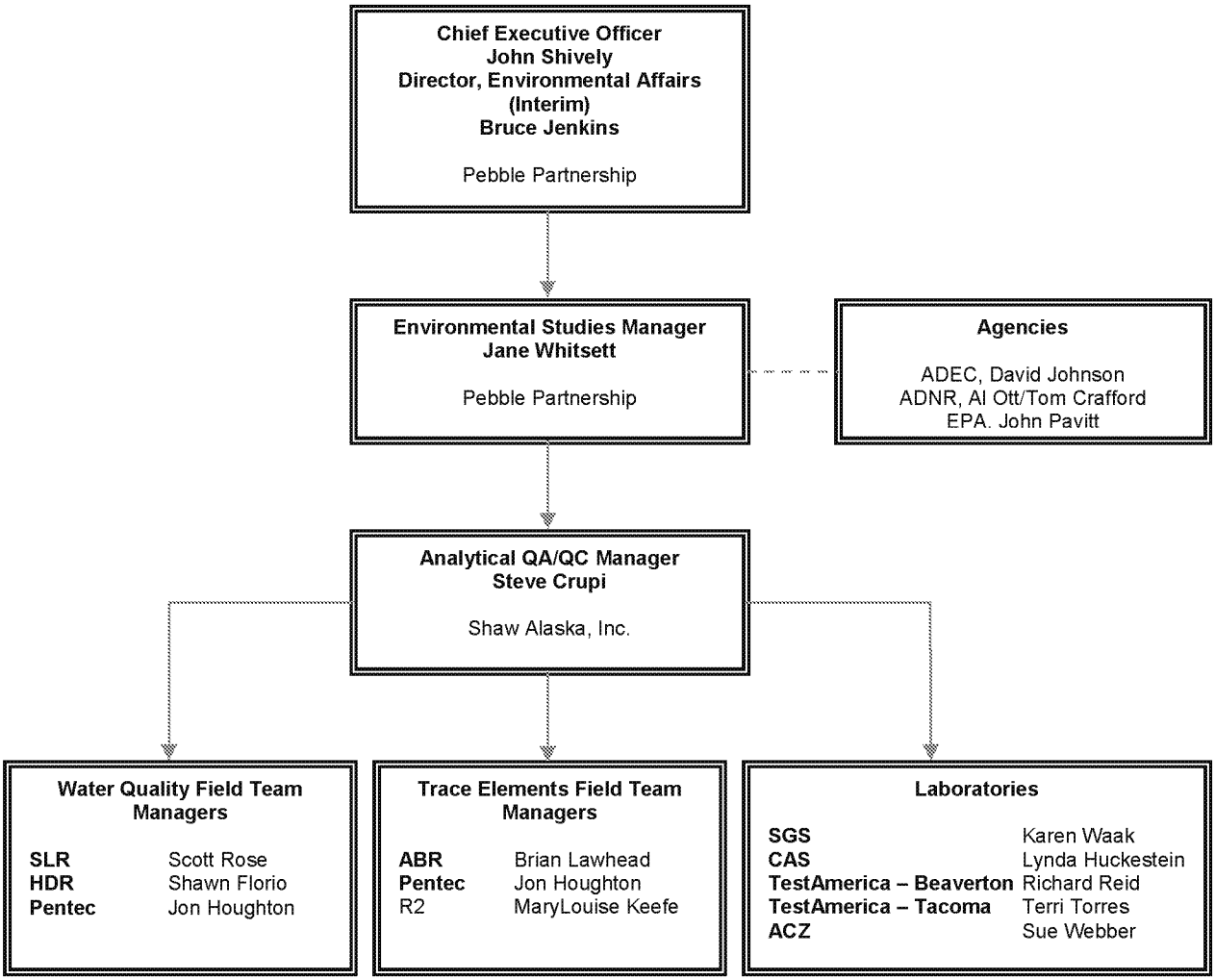
Figure 1-1
Pebble Project Analytical Chemistry Organization Chart



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.

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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.

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- 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.

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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.

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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	SM4500H^{+} 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

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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.

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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) Dissolved metals (402, 403) DOC (404)	Surface and Groundwater, Marine Water, Marine Sediment, Fish and Mammal Tissue Surface Water, Groundwater, Marine Water Surface and Groundwater	5 percent (401, 403)/ minimally one per event Minimum one per filter lot for filter rinse blanks (402, 404)
Deionized water blank	Total metals (501) TOC (502)	Surface, Ground, and Marine Water; Marine Sediment, Fish and Mammal Tissue Surface and Groundwater, Marine Sediment	1 per sampling event
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.

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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]

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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.

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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	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-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

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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

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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

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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.

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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	SM4500NH$_3$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.

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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.

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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.

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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 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), 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.

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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.

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- 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.

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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.

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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 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 (1) extra unpreserved container for collection (1) 1-L extra volume for MS/MSD	(1) 1-L HDPE (1) extra unpreserved container for collection	Dissolved metals [b] (except Hg)	E200.8/200.7	HNO_3	6 months	None	Field Filtered
3	(1) 500-mL fluoropoly	(1) 500-mL fluoropoly 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 No extra volume for MS/MSD	Low-level Hg (total and dissolved)	E1631	HCl	90 days	None	Unfiltered (total) Filtered (dissolved)
5	(1) 250-mL Nalgene 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 (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

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Sample Set	Bottle Type SGS	Bottle Type CAS	Analysis	Lab Method	Preser-vative	Hold Time	Req. Temp.	Comments
7	(2) 1-L HDPE (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	SM4500H$^+$B	None	24 hours	4°C	Unfiltered
8	(1) 120-mL Nalgene (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 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) 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.

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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.

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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 1 extra volume for MS/MSD	(1) 1-L + (1) 500-mL HDPE 2 extra volumes for MS/MSD	Total Metals a (except Hg)	E200.8/ SW6010B b	HNO3	6 months	None	Unfiltered
2	(1) 500-mL HDPE (1) extra unpreserved container for collection (1) 1-L extra volume for MS/MSD	(1) 1-L + (1) 500-mL HDPE (1) extra unpreserved container for collection 2 extra volumes for MS/MSD	Dissolved Metals a (except Hg)	E200.8/ SW6010B b	HNO3	6 months	None	Field filtered
3	(1) 500-mL fluoropoly	(1) 500-mL fluoropoly 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 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.

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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.

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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.

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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

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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

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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

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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)

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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)

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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

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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.

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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.

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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	SM4500H$^+$ 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 SW6010B/6020 SW7740 (Se)	Inductively coupled plasma atomic emission spectroscopy Inductively coupled plasma mass spectrometry 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.

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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

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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.

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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.

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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.

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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.

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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.

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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

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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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5.0 References

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