



Pebble Project

NORTHERN DYNASTY MINES INC.

**DRAFT ENVIRONMENTAL BASELINE STUDIES
FIELD SAMPLING PLAN**

**CHAPTER 4. SURFACE WATER
ROAD / PORT**

NOVEMBER 2005

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- Sample Transfer Log
- Field Notes (Example)
- Surface-Water Field Form (Blank and Example)
- Field Discharge Measurements (Blank and Example)
- Field Observer Form
- Field Sampling Plan Acknowledgement Form

ACRONYMS AND ABBREVIATIONS

ADOT&PF	Alaska Department of Transportation and Public Facilities
BEESC	Bristol Environmental and Engineering Services Corporation
BP	barometric pressure
°C	degrees Celsius
CAS	Columbia Analytical Services
cm	centimeter(s)
COC	chain of custody
DI	deionized
DM	discharge measurement
DO	dissolved oxygen
FSP	field sampling plan
GS	gauge station
HDPE	high density polyethylene
kg	kilogram(s)
L	liter(s)
µg	microgram(s)
µS	microsiemen(s)
mg	milligram(s)
ml	milliliter(s)
mS	millisiemen(s)
mV	millivolts
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
NCA	North Creek Analytical
NDM	Northern Dynasty Mines, Inc.
NTU	nephelometric turbidity unit(s)
ORP	oxidation reduction potential
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
SD	sediment sample
SGS	SGS Laboratories

SOP	standard operating procedure
TDS	total dissolved solids
TSS	total suspended solids
USGS	U.S. Geological Survey
WAD	weak acid dissociable
WS	surface water-chemistry sample

1.0 INTRODUCTION

An environmental monitoring program is being conducted to develop baseline environmental data for the Pebble Project. Information on the proposed development and an overview of the environmental program are described in the Pebble Project *Draft Baseline Environmental Studies, Proposed 2005 Study Plan* (NDM, in press).

The purpose of this field sampling plan (FSP) is to detail tasks and establish field procedures for conducting a study of surface-water hydrology and chemistry, and sediment chemistry. The field work for this study will involve collecting and analyzing surface-water samples from waterways along the proposed road corridor and collecting sediment samples from ponds and waterways along the proposed road corridor. This FSP also provides the basis for appropriate quality assurance (QA) and quality control (QC) measures to be instituted and monitored during data-collection activities.

The surface-water studies for the road/port will be conducted by Bristol Environmental and Engineering Services Corporation (BEESC) under direct contract to Northern Dynasty Mines Inc. (NDM). The study area includes the preferred road corridor, as identified by the Alaska Department of Transportation and Public Facilities (ADOT&PF), between the mine site and Cook Inlet and will also include the area surrounding the proposed port site as shown in Figure 1. The corridor will be one mile in width along the defined alignment.

Sampling is intended to characterize baseline concentrations of naturally occurring compounds in surface water along the road corridor and at the port site for evaluation of potential environmental impacts associated with development of the project and for evaluation of potential future ecological risks associated with dust migration.

2.0 PROJECT SCOPE AND OBJECTIVES

2.1 OBJECTIVES

The objectives of the baseline surface-water hydrology portion of this program include the following:

- Characterize stream drainage basins based on size, slope, vegetative cover, and other factors.
- Collect streamflow data to be used in predicting potential peak- and low-flow conditions.
- Collect data for evaluation of proposed facilities including water-management and water-supply structures.

The main objectives of the water-quality portion of this study are as follows:

- Collect baseline data to provide defensible documentation of the naturally occurring levels and variability of trace elements in surface water.
- Provide a 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 of the road and port facilities.

Sediments will be collected within the road corridor and at the port facility. The objectives of the trace elements study are as follows:

- Collect baseline data to provide defensible documentation of the naturally occurring levels and variability of trace elements in sediments including their spatial and temporal variability, prior to mining operations.
- Provide a database for the site sediment 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 of the road and port facilities.

The information to be gathered in the water-quality and sediment studies is key to understanding current conditions along the road corridor and at the port site and will provide a baseline for the evaluation of future potential environmental impacts to surface water and sediments along the road corridor and at the port site.

2.2 SAMPLE ANALYSIS SUMMARY

Surface-water and sediment samples will be collected from fresh water streams along the preferred road corridor—identified by ADOT&PF—between the Newhalen River and Cook

Inlet, including the area surrounding the port site (ADOT&PF, 2005). Sediment samples will also be collected from the deposition areas of five ponds along the road corridor.

The surface-water (Table 1) and sediment (Table 2) analyses methods and method reporting limits are detailed in the *Environmental Baseline Studies, 2005 Final Quality Assurance Project Plan* (QAPP; NDM, 2005).

Table 1. Surface-water Analytes for Laboratory and Field Determination

Analyte	Method	Method Reporting Limit, µg/L
Aluminum, total and dissolved	E200.8	1.0
Antimony, total and dissolved	E200.8	0.05
Arsenic, total and dissolved	E200.8	0.5
Barium, total and dissolved	E200.8	0.05
Beryllium, total and dissolved	E200.8	0.02
Bismuth, total and dissolved	E200.8	0.1
Boron, total and dissolved	E200.7/200.8	0.5
Cadmium, total and dissolved	E200.8	0.02
Calcium, total and dissolved	200.7	50
Chromium, total and dissolved	E200.8	0.2
Cobalt, total and dissolved	E200.8	0.02
Copper, total and dissolved	E200.8	0.1
Iron, total and dissolved	E200.7/200.8	20
Lead, total and dissolved	E200.8	0.02
Magnesium, total and dissolved	E200.7/200.8	20
Manganese, total and dissolved	E200.8	0.05
Mercury, total	E1631	0.005
Molybdenum, total and dissolved	E200.8	0.05
Nickel, total and dissolved	E200.8	0.2
Potassium, total and dissolved	E200.7/200.8	50
Selenium, total and dissolved	E200.8	1
Silicon, dissolved	E200.8	100
Silver, total and dissolved	E200.8	0.02
Sodium, total and dissolved	E200.7/200.8	100
Thallium, total and dissolved	E200.8	0.01
Tin, total and dissolved	E200.8	0.1
Vanadium, total and dissolved	E200.8	0.2
Zinc, total and dissolved	E200.8	0.5
pH	E150.1	N/A
Specific conductance	SM20 2510B	2 (µS/cm)

Analyte	Method	Method Reporting Limit, µg/L
Alkalinity	SM20 2320B	10 (mg/L)
Acidity	E305.2	10 (mg/L)
Ammonia	SM20 4500NH3-G	0.1 (mg/L)
Chloride	E300.0	0.2 (mg/L)
Cyanide-total	SM20 4500CN-E	0.01 (mg/L)
Cyanide-WAD	SM20 4500CN-I	0.01 (mg/L)
Fluoride	E300.0	0.1 (mg/L)
Hardness (total)	SM20 2340B	N/A
Nitrate + Nitrite	E300.0	0.1 (mg/L)
Phosphorus-total	E365.3	0.01 (mg/L)
Sulfate	E300.0	0.2 (mg/L)
Total dissolved solids	E160.1	10 (mg/L)
Total suspended solids	E160.2	5 (mg/L)
Thiocyanate	Lab SOP	1 (mg/L)
Field Parameters	Units	Sensitivity
Temperature	Degrees Celsius	0.01
Dissolved Oxygen	mg/L	0.01
Dissolved Oxygen	%	0.1
Specific Conductance	mS/cm	0.001
pH	Standard Units	0.01
Turbidity	NTU	0.01
Oxidation reduction potential	mV	0.1

Notes:

E – Methods for Chemical Analysis of Inorganic Substances in Environmental Samples, EPA/600/R-93-100, August 1993, and Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91-010, June 1991.

SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition.

SOP = standard operating procedure

WAD = weak acid dissociable

µg/L = micrograms per liter

µS/cm = microsiemens per centimeter

mg/L = milligrams per liter

mS/cm = millisiemens per centimeter

NTU = nephelometric turbidity unit

mV = millivolts

N/A = not applicable

Table 2. Sediment Analytes for Laboratory Determination

Analyte	Method	Method Reporting Limit, mg/kg
Aluminum	SW3050/6020	2.0
Antimony	SW3050/6020	0.05
Arsenic	SW3050/6020	0.5
Barium	SW3050/6020	0.05
Beryllium	SW3050/6020	0.02
Bismuth	SW3050/6020	0.05
Boron	SW3050/6010B	20
Cadmium	SW3050/6020	0.05
Calcium	SW3050/6020	10
Chromium	SW3050/6020	0.2
Cobalt	SW3050/6020	0.02
Copper	SW3050/6020	0.1
Iron	SW3050/6020	4.0
Lead	SW3050/6020	0.05
Magnesium	SW3050/6020	4
Manganese	SW3050/6020	0.05
Mercury	SW3050/7471	0.02
Molybdenum	SW3050/6020	0.05
Nickel	SW3050/6020	0.2
Potassium	SW3050/6020	400
Selenium	SW3050/6020	1.0
Silver	SW3050/6020	0.02
Sodium	SW3050/6020	20
Thallium	SW3050/6020	0.02
Tin	SW3050/6020	1
Vanadium	SW3050/6020	0.2
Zinc	SW3050/6020	0.5
Ammonia	SM20 4500NH3	0.2
Chloride	E300.0	1
Cyanide-total	SM20 4500CN-E	0.2
Fluoride	E300.0	2
Sulfate	E300.0	2

Notes:

E – Methods for Chemical Analysis of Inorganic Substances in Environmental Samples, EPA/600/R-93-100, August 1993, and Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91-010, June 1991.

SW – Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition.

mg/kg = milligrams per kilogram

2.3 FIELD ACTIVITIES

Detailed procedures for the surface-water hydrology studies, water-quality field activities, and sediment collection are included in Section 4. Appropriate QA/QC procedures will be used, and QA/QC samples will be collected based on the schedule set up by the analytical laboratories.

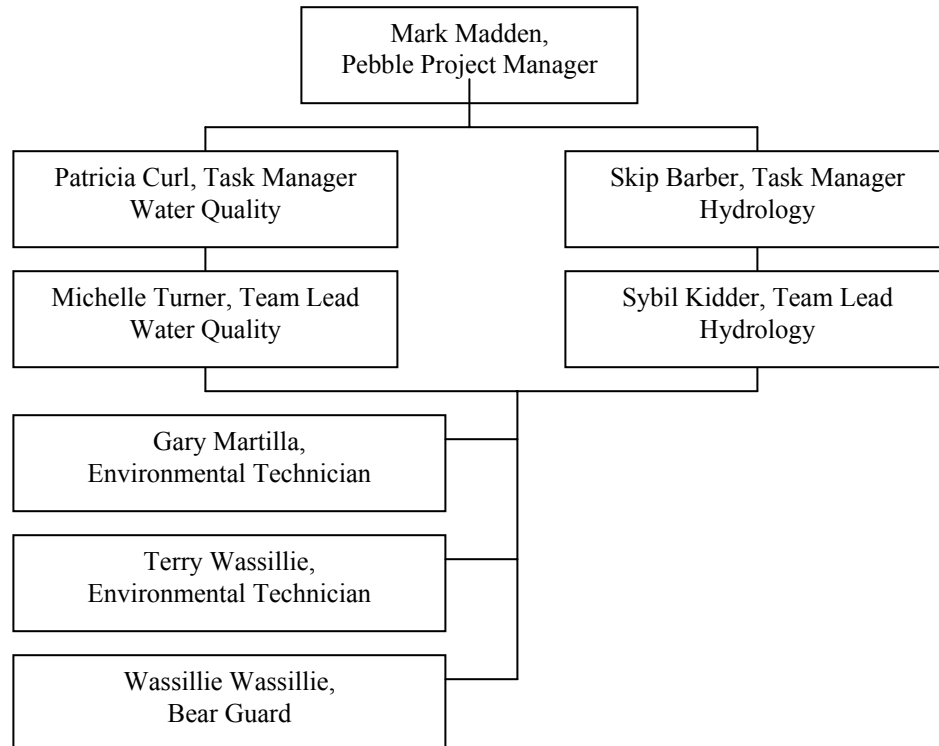
The surface-water sampling program will quantify the water chemistry throughout the year and under a range of different hydrologic conditions at key surface-water locations. The sampling program is designed to occur during breakup and to catch high flow in summer (which may take more than one sampling event), low flow in summer, a fall storm event, and a low flow in winter. As hydrologic conditions change (for example, variation of flows because of breakup and storm events), there is greater potential for varying water chemistry. Therefore, the sampling program consists of eight planned surface-water baseline events for a 12-month period.

The sediment-sampling program will quantify the metals and anions in sediments collected in surface-water streams and five ponds along the road corridor. Sediments from streams and tundra ponds will be collected in May, July, and September. Stream sediments will be collected at the same times and locations as surface-water samples.

In all cases, field collection procedures will be performed so as to minimize contamination of samples, to prevent cross-contamination between samples, and to ensure sample validity by conducting proper preservation and storage in the field according to the requirements in the *Draft Environmental Baseline Studies, 2005 Final Quality Assurance Project Plan* (NDM, 2005).

3.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The project manager maintains overall responsibility for all aspects of the project. The water-quality task manager is responsible for and coordinates the field work and report writing for the surface water-quality and sediment sampling programs. The field team consists of a team lead working with three locally hired environmental technicians to collect the water-quality samples and flow data at each sampling station. An organizational chart depicting the BEESC staff managing and assisting on the water-quality and hydrology programs is provided below.



4.0 FIELD ACTIVITIES

Field activities will include several tasks for the hydrology program and collection of analytical samples and field-parameter measurements for the water-quality program. A list of the surface-water and hydrology baseline stations and the data to be collected are listed in Table 3. Monitoring sites are depicted on Figure 1. Activities related to measurements of field parameters are included in Section 6.

Table 3. Surface-water Monitoring Sites and Data Collection

Location ID	Location Name	2005 Sampling to be Performed							
		Feb	Mar	May	Jun	Jul	Aug	Sep	Oct
GS11A	Canyon Creek	DM, WS	DM, WS	DM, WS, SD	DM, WS	DM, WS, SD	DM, WS	DM, WS, SD	DM, WS
GS14B	unnamed creek	DM, WS	DM, WS	DM, WS, SD	DM, WS	DM, WS, SD	DM, WS	DM, WS, SD	DM, WS
GS17A	Tributary of Eagle Bay Creek	DM, WS	DM, WS	DM, WS, SD	DM, WS	DM, WS, SD	DM, WS	DM, WS, SD	DM, WS
GS21	unnamed creek	DM, WS	DM, WS	DM, WS, SD	DM, WS	DM, WS, SD	DM, WS	DM, WS, SD	DM, WS
GS3A	Iliamna River	WS	WS	WS, SD	WS	WS, SD	WS	WS, SD	WS
GS4A	Pile River	DM, WS	DM, WS	DM, WS, SD	DM, WS	DM, WS, SD	DM, WS	DM, WS, SD	DM, WS
GS8A	Knutson Creek	DM, WS	DM, WS	DM, WS, SD	DM, WS	DM, WS, SD	DM, WS	DM, WS, SD	DM, WS
NHRIV	Newhalen River	WS	WS	WS, SD	WS	WS, SD	WS	WS, SD	WS
Pond1	tundra pond			SD		SD		SD	
Pond2	tundra pond			SD		SD		SD	
Pond3	tundra pond			SD		SD		SD	
Pond4	tundra pond			SD		SD		SD	
Pond5	tundra pond			SD		SD		SD	

Notes: GS – Gauge station
DM – Discharge measurement
WS – Surface water-quality sample
SD – Sediment sample

A list of field equipment used for sampling operations is presented in Table 4. The list provides information on where equipment and supplies are normally kept and sources for replacement materials.

Table 4. Field Equipment Schedule

Equipment	Source
YSI 556 Multiparameter Meter	BEESC
Hach 2100 P Turbidity Meter	BEESC
Boat and Motor	BEESC* / locally hired
DH-81 Depth-Integrated Sampler/Rod	BEESC*
Digital Camera	BEESC
Satellite Phone	SatComm Alaska
Calibration Solutions for YSI and Hach Meters	TTT Environmental*
Peristaltic Pump	BEESC
Marsh McBirney Flow Meter	BEESC*
Computer	BEESC
Printer	BEESC*
Consumables: nitrile gloves, paper towels, deionized (DI) water (provided by the laboratory), dipper/measuring cup, buckets, garbage bags, insect repellent	BEESC Inventory*—various suppliers
Filtering Supplies: 0.45-micron disposable filters, surgical silicon tubing, polyethylene tubing	TTT Environmental*
Rite-in-the-Rain Books and Forms	BEESC inventory
Sample Shipping Supplies: Ziploc bags, markers, printer cartridges, paper for COC forms, custody seals, clear tape, labels	Various suppliers*

* Items maintained in inventory in Iliamna.

5.0 SAMPLING PROCEDURES

5.1 DISCHARGE MEASUREMENTS

Instantaneous-discharge measurements will be collected at each established gauge station during each field event. Measurements are typically taken using top-setting wading rods. If the water is too deep or swift to wade, a boat will be employed to obtain discharge measurements. A moving boat may require a sounding weight attached to the electromagnetic sensor to stabilize the sensor in the current.

Field procedures defined by the U. S. Geological Survey (USGS; Rantz et al., 1982) and the *Draft Environmental Baseline Studies, 2005 Final Quality Assurance Project Plan* (NDM, 2005) will be used to obtain instantaneous-discharge measurements. A Marsh-McBirney Model 2000 FlowMate current meter will be used to measure stream depths and velocities. Procedures for discharge measurements defined by the USGS are outlined below:

1. Visually check wading rod and current meter for damage. Repair damage to equipment and replace batteries as necessary.
2. Attach the electronic sensor to the wading rod. Check the electric connection between the sensing unit on the wading rod and the recorder. Adjust the velocity output to read feet/second.
3. Anchor surveyor's tape tautly across the stream perpendicular to the direction of stream flow and attach on either side of the stream. Provide at least one foot of clearance between the water surface and the surveyor's tape. For large streams when boat measurements are used, a heavy-duty, premeasured tag-line or rope will be anchored across the stream channel.
4. Divide the cross-section of the stream into one-foot or two-foot intervals based on the width of the stream. Narrower stream widths will be sectioned into one-foot intervals and wider stream widths will be sectioned into two-foot intervals.
5. Person wading in stream calls out to onshore data recorder the location of the first measuring point with respect to the surveyor's tape. Person in stream measures water depth at that vertical, using wading rod, to the nearest 0.05 foot, if possible.
6. Data recorder calls out height(s) above the streambed at which velocity measurements are to be made. If the water is more than 2.5 feet deep, measurements should be made at 20 and 80 percent of the water-column height. For water columns less than 2.5 feet deep, a single measurement of velocity at 60 percent of the water-column height will suffice. Person wading adjusts height of current meter on the wading rod accordingly.
7. Person wading stands downstream of the surveyor's tape, facing upstream, holding the wading rod vertical in the water with the current meter facing directly into the current. Person should not stand directly behind the meter but either to the left or right so as not to influence velocity readings.
8. Person wading observes visual output at each vertical for a minimum of 40 seconds or until the electronic reading stabilizes.
9. Repeat procedure at each vertical.
10. Data recorder records all appropriate information on the field form.

5.2 SURFACE-WATER SAMPLING

Water-chemistry samples are collected using the depth-integrated sampling method unless otherwise noted. Samples for low-level mercury analyses will be collected as a grab sample.

5.2.1 DH-81 Depth-Integrated Sampling

Analytical samples are collected using an equal-discharge, depth-integrated technique. Depth-integrated collection is conducted using a DH-81 depth-integrated sampler where adequate depths permit its use. Depth integration in shallow streams is completed with a grab sample that is depth-integrated by hand (Section 5.2.2). Equal-discharge collection is conducted by dividing the stream into segments based on percent discharge. A minimum of eight depth-integrated sample collections is required at each site to fill all the sample bottles required for analyses. All depth-integrated samples collected at a site are poured into a five-gallon plastic bucket. By taking the eight or more depth-integrated samples at estimated spacing and combining these before filling sample bottles, a complete discharge and depth-integrated sample is collected. Methods for depth-integrated sampling are described below:

1. Label sample bottles (Table 5) with sample site, analysis, date, time, and “BEESC” and “Pebble Project.”
2. Visually check DH-81 sampler for damage.
3. Using the decontamination procedure detailed in Section 5.4, decontaminate all parts of sampler to be used (including nozzle, body, gasket, and sample bottle) and all other sampling equipment that will come into direct contact with the sample, such as the five-gallon bucket and the measuring cup/dipper.
4. Locate sampling sites by dividing the stream into areas with equal discharge. A minimum of 4 subsections should be sampled. If more sample volume is required, more subsamples can be taken by dividing the stream into more areas of equal discharge.
5. Put on new nitrile gloves before collecting samples using the DH-81.
6. At the selected stream location, lower the sampler into the stream with one continuous motion, making sure the sampler handle is vertical. Lower the sampler to the streambed at a rate based on the rating curve for the nozzle size used and the velocity of the stream. The sample bottle should be just under half full upon encountering the streambed. Raise the sampler at a rate similar to the descent rate. The collection bottle should not be completely full upon removal from the stream. Pour contents of collection bottle into the clean five-gallon bucket.
7. Repeat procedure until at least eight bottles have been collected. If collecting QA/QC and matrix spike/matrix spike duplicate (MS/MSD) samples, collect at least 25 bottles to make sure that enough sample volume has been collected.
8. Collect analytical samples from the composite sample in the five-gallon bucket using a decontaminated measuring cup to pour water into the bottles. Do not allow bottles to fill completely such that preservative is not lost. Be sure to hold bottles over the ground and not over the bucket as they are filled to reduce chances of preservative from a bottle contaminating the main sample.
9. Fill out appropriate field forms (see appendix) documenting sampling location, time, and other pertinent information before leaving sampling site.

Table 5. Sample Bottles for Surface-water Collection

Parameter	Bottle Type	Number of Bottles	Preservative	Comments
Primary and QC samples				
Low-level mercury	250 ml fluoropoly	1	HCl	Collect as a grab sample
Total metals, hardness	500 ml HDPE	1	HNO ₃	
Dissolved metals	500 ml HDPE	1	HNO ₃	Collect in 500 ml unpreserved container and field filter into HNO ₃ -preserved container.
Cyanide (total and WAD)	250 ml HDPE	1	NaOH	
Thiocyanate	250 ml HDPE	1	HNO ₃	
TSS, TDS, alkalinity, acidity, specific conductance, pH	1- L HDPE	2	none	
Ammonia, phosphorus, nitrate and nitrite	250 ml HDPE	1	H ₂ SO ₄	
Anions	120 ml nalgene	1	none	
QA Samples				
Low-level mercury	500 ml fluoropoly	1	HCl	Collect as a grab sample
Total metals, hardness	1-L HDPE	1	HNO ₃	
Dissolved metals	1-L HDPE	1	HNO ₃	Collect in 1-L unpreserved container and field filter into HNO ₃ -preserved container.
Cyanide (total and WAD)	1-L HDPE	1	NaOH	
Thiocyanate	500 ml HDPE	1	HNO ₃	
TSS, TDS, alkalinity, acidity, specific conductance, pH, anions	1- L HDPE	2	none	
Ammonia, phosphorus, nitrate and nitrite	1-L HDPE	1	H ₂ SO ₄	
MS/MSD samples				
TSS, TDS, alkalinity, acidity, specific conductance, pH	1- L HDPE	2	none	
Anions	120 ml nalgene	1	none	

Notes: HCl = hydrochloric acid
H₂SO₄ = sulfuric acid
TDS = total dissolved solids

HDPE = high density polyethylene
ml = milliliters
TSS = total suspended solids

HNO₃ = nitric acid
NaOH = sodium hydroxide

5.2.2 Grab Sampling

This procedure is to be used only when sample collection conditions do not allow integrated sampling. This may include winter conditions when only a single boring through ice is feasible.

Decontaminate sample-collection container(s) if employed. After decontamination, double rinse collection container(s) in stream water at a location downstream of the sampling point. In some cases, grab samples will be taken directly into the sample bottles and no decontamination or rinse will be necessary. Procedures for collecting grab samples are outlined below:

1. Label sample bottles with sample site, analysis, date, time, sampler, and “BEESC Pebble Project.”
2. Locate sampling site at an accessible point in the stream exhibiting greatest flow and/or highest velocity.
3. Put on new nitrile gloves
4. If using a sample-collection container, submerge the container so that the mouth of the container is two to three inches below the surface of the stream. Pour the contents of the collection container into a clean five-gallon bucket. Repeat the procedure until the bucket is at least half full. If collecting QA/QC and MS/MSD samples, collect at least two full buckets. Pour sample into sampling bottles.
5. If collecting using the sample bottles, submerge the sample bottle at the sampling point such that mouth of container is two to three inches below the surface of the stream. Uncap bottle while below the surface of the water, and fill slowly. Do not allow bottle to fill completely such that preservative is lost.
6. Fill out appropriate field forms (see appendix) documenting sampling location, time, and other pertinent information before leaving sampling site.

5.2.3 Low-level Mercury Grab Sampling

This procedure is to be used when collecting water samples for ultra-low mercury analysis. Minimum exposure of sampling equipment and bottles is required to eliminate contaminants from air, particulates, equipment, or sampling operations. The sample is allowed no contact with metallic equipment. Low-level mercury samples are collected as grab samples directly into the sample bottles and no decontamination or rinse will be necessary. Procedures for collecting grab samples are outlined below:

1. Remove the bottle from the doubled Ziploc bags.
2. Label sample bottles with sample site, analysis, date, time, sampler, and “BEESC Pebble Project.”
3. Put on a new set of nitrile gloves. If the sampler already is wearing gloves for sampling of other parameters, these must be replaced with a new set of nitrile gloves.
4. Locate sampling site at a point in the stream exhibiting greatest flow and/or highest velocity.
5. Submerge the sample bottle at sampling point such that mouth of container is two to three inches below the surface of the stream. Uncap bottle while below the surface of

the water, and fill slowly. If filling sample bottle directly, do not allow bottle to fill completely such that preservative is lost.

6. Completely fill the bottle using the cap to dip water from the stream.
7. Cap the bottle and double bag with Ziploc bags.
8. Fill out appropriate field forms (see appendix) documenting sampling location, time, and other pertinent information before leaving sampling site.

5.2.4 Sample Filtration

All dissolved-metals samples will be filtered within 12 hours of the time that they are collected. Samples will be filtered at the base camp after each field day. Sample filtration procedures are outlined below:

1. Label the dissolved metals sample bottle into which the filtered sample will be collected. Include sample site, analysis, date, time, sampler, and “BEESC Pebble Project.”
2. Put on nitrile gloves.
3. Cut two small pieces of silicon tubing (approximately 4 inches long) and two longer pieces of Teflon tubing (approximately 12 inches long). Run one piece of silicone tubing through the peristaltic pump and attach a piece of Teflon tubing to each end. On the effluent side of the pump attach the second piece of silicon tubing and a 0.45-micron filter cartridge to the end of the tubing, making sure it is oriented correctly. Place the influent end of the tubing in the sample bottle.
4. Turn on the peristaltic pump, and fill the dissolved metals sample container.
5. If extremely turbid sample water is obtained, use the same procedure using a pre-filter (usually 3.0 microns) followed by 0.45-micron filtration.
6. Put dissolved-metals sample bottle with other bottles from same site to be packaged for shipping.

5.3 SEDIMENT SAMPLING

Sediment samples will be collected from streams and ponds along the road corridor.

Sediment samples collected from streams will be co-located with the surface-water sample-collection sites. If possible, a composite will be collected from three points within the streambed: near each bank and from the bottom of the streambed near mid-channel. In cases of fast-flowing or rocky streams it may be difficult to obtain sediment from the bottom of the stream, in which case the sample will be composited from the bank samples.

Pond-sediment samples will be collected from the deposition side (west side) of ponds along the road corridor. A composite sample will be collected from three locations spread along the deposition side of the pond identified for sediment sampling.

Methods for sediment sampling are described below:

1. Label sample bottles (Table 6) with sample site, analysis, date, time, and “BEESC” and “Pebble Project.”

2. Decontaminate all equipment to be used in sampling (spoons, trowels, bowl, etc.) using the decontamination procedure detailed in Section 5.4.
3. Locate sampling sites. A minimum of three sites is required.
4. Put on long sediment-sampling gloves.
5. Put on nitrile gloves over the sediment-sampling gloves.
6. Stand downstream when collecting the sample to avoid disturbing the sample collection area.
7. Collect roughly equal amounts of sediment from each of the selected locations. Collect enough sample to fill a minimum of two to three bottles. Collect additional sample volume if QA/QC will be performed on the sample.
8. Composite the sample in a large stainless steel bowl by mixing with a spoon or trowel.
9. Remove any vegetation or pebbles or rocks larger than one-half inch in size.
10. Allow the sample to sit to let water come to the top, then decant off water.
11. Fill the sample container with sediment. Once the container is full, gently tap it on a rock or hard surface to compact it and encourage water to rise to the top of the bottle. Decant off water and repeat until the bottle is completely full with sediment with a minimum amount of water.
12. Using clean stream or pond water and a gloved hand, carefully rinse sediment off the threads of the container. When the container threads are clean, screw on the cap. Rinse the container with stream or pond water.
10. If collecting QA/QC and MS/MSD samples, collect at least four bottles to make sure that enough sample has been collected.
11. Fill out appropriate field form (see appendix) documenting sampling location, time, and other pertinent information before leaving sampling site.

Table 6. Sample Bottles for Sediment Collection

Parameter	Bottle Type	Number of Bottles	Preservative	Comments
Primary and QC samples				
Total metals, total cyanide, ammonia, anions	8 oz HDPE	1	none	
QA Samples				
Total metals, total cyanide, ammonia, anions	8 oz HDPE	1	none	
MS/MSD samples				
Total metals, total cyanide, ammonia, anions	8 oz HDPE	1	none	

Notes: Anions = chloride, fluoride, and sulfate
 oz = ounce

5.4 SAMPLING EQUIPMENT DECONTAMINATION

Sampling equipment that should be decontaminated prior to collecting samples include the DH-81 collection bottle, cap and nozzle; the five-gallon bucket used for compositing samples;

sample-collection containers, if any, for grab samples; and implements used in sediment sampling. Methods for decontaminating sampling equipment are outlined below:

1. Spray all parts of the equipment using a pre-mixed Alconox and DI water solution. If there is obvious sediment or biological material on the equipment, use a brush to remove material. DI water will be provided by the laboratory which is performing metals analyses.
2. Rinse the equipment using DI water several times and ensure that all traces of the Alconox solution and other materials are removed.
3. Immerse the equipment downstream of the sampling location and rinse completely prior to collecting a sample.

During winter sampling events, below-freezing conditions prevent using spray bottles. In these conditions, the following methodology should be used:

1. Pour warm DI water into the bucket or DH-81 sample bottle and scrub thoroughly with a clean brush. The DI water should be kept in a small ice chest with a heat source (heating pads) to keep it warm.
2. Rinse the equipment using warm DI water several times and ensure that all traces of material are removed.
3. Immerse the equipment downstream of the sampling location and rinse completely prior to collecting a sample.

5.5 FIELD QUALITY-CONTROL SAMPLES

To aid in evaluating the accuracy of the analytical data, trip blanks, QC (duplicate) samples, QA (triplicate) samples, matrix spike samples, and matrix spike duplicate samples are collected and subjected to the same analyses as identified for task samples. Equipment (also known as field) blanks and DI water blanks also are collected. The field QA/QC samples are summarized below and in the QAPP (NDM, 2005).

5.5.1 Trip Blank

A trip blank will be provided for the low-level mercury analysis and should accompany the field staff into the field for each field day. The trip blank that accompanies the field team at each sampling site should be labeled as a trip blank with the effective date noted. Trip blanks should be included as a separate line item in the Sample Transfer Log (see appendix). At the end of each field day, the trip blank should be provided to Shaw Environmental, Inc. (Shaw), staff. The sample will be packaged and sent with the samples that it accompanied during the field day. If QA low-level mercury samples are collected, a QA trip blank must accompany the field staff into the field in addition to the primary laboratory trip blank.

5.5.2 Field Duplicates

QC samples are collected at a frequency of 10 percent during all sampling events for all parameters.

5.5.3 Field Triplicates

QA samples are collected at a frequency of 10 percent during all sampling events for all parameters.

5.5.4 MS/MSDs

MS/MSDs are collected at a frequency of 10 percent during all sampling events from the same locations as QA/QC samples. MS/MSDs are collected only for primary laboratories. The additional bottle requirements for MS/MSDs are provided in the QAPP.

5.5.5 Equipment Blank

An equipment blank is collected at a frequency of five percent—or a minimum of once per sampling event—and submitted for dissolved-metals analysis. If possible, the equipment blank is collected during the first day's sampling. The procedure for collecting the equipment blank is outlined below:

1. After sampling at a site, decontaminate the DH-81, five-gallon bucket, and any other sampling equipment used, as described in Section 5.4.
2. Pour DI into the DH-81 sample bottle and dispense through the nozzle into the five-gallon bucket, and thoroughly rinse all other sampling equipment
3. Filter the sample as described in Section 5.2.4.
4. Collect the filtered sample in a dissolved-metals bottle labeled "equipment blank."

5.5.6 DI Water Blank

A DI water blank is collected once per sampling event and is submitted for total metals analysis. The laboratory-provided DI water used for decontamination will be collected in an empty total-metals analysis bottle and submitted to the primary laboratory for total-metals analysis. If possible, the DI-water blank is collected during the first day's sampling.

5.6 SAMPLE CUSTODY

Once collected, samples will remain within sight of the sampler or in a secured location until the samples are transferred to Shaw personnel. Shaw personnel at Iliamna will be responsible for labeling and creating chain-of-custody (COC) forms, shipping samples, and laboratory notification. COC forms, based on the Sample Transfer Log (see appendix), will be used for all samples.

5.6.1 Sample Handling

Samples will be packed to prevent breakage and will be kept chilled during field operations by transporting the samples with frozen gel ice. A daily trip blank will accompany all samples to be analyzed for mercury.

5.6.2 Sample Containers

Sample container requirements are described in Tables 5 and 6 and in the QAPP (NDM, 2005). The field team leader should review the bottle order received from the laboratory against the QAPP prior to departing for Iliamna to verify that the necessary sample containers and container types have been obtained and that preservation requirements have been met.

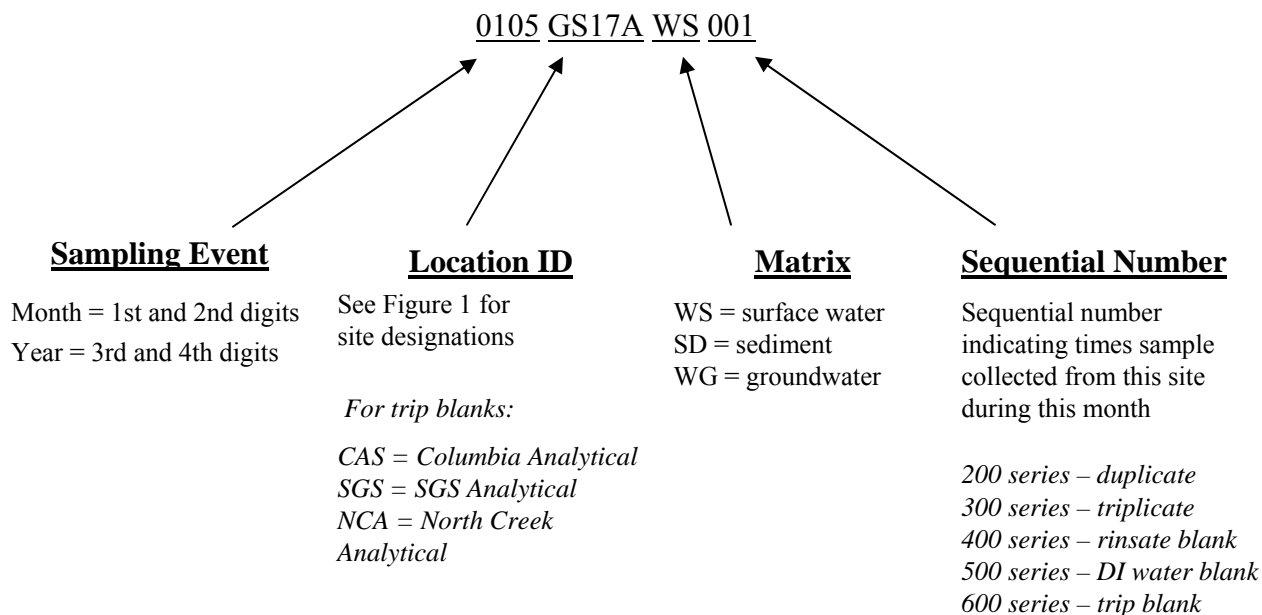
5.6.3 Sample Relinquishing

All samples will be relinquished to Shaw personnel for packing and shipment to laboratories following the procedures outlined below:

1. Verify that all sample containers have been removed from coolers and organized with all bottles from a single location together so that Shaw personnel can label them.
2. Verify that all sample containers have been clearly identified. All sample containers will be labeled at a minimum with “BEESC,” “Pebble,” the location ID, date, and time of sample collection.
3. Complete the Sample Transfer Log for all samples including trip blanks (see appendix). Note any items of interest, such as collection of QA/QC samples and/or MS/MSD samples, on the bottom of the form.
4. Notify Shaw personnel that samples are ready for transfer and where they are located. Verify whether or not samples should be placed in a refrigerator.

5.6.4 Sample Identification

Shaw is responsible for labeling and shipping analytical samples. Each sample container will be identified with 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, analysis, and sampler’s initials. Sample identification (ID) will be formatted to indicate sample event (month and year), location, matrix, and number. Sample IDs for a sampling event that begins in one month and is completed in the following month will contain the month and year during which the event began. Each sampling location will be identified on the field form. These samples IDs are defined to facilitate data management for the life of this project. An example of a sample ID is shown below:



Laboratory codes are used for the Location ID for trip blanks. Laboratory codes are SGS for SGS Environmental Services, Inc., CAS for Columbia Analytical Services, Inc., and NCA for North Creek Analytical Services, Inc. A sample ID for a surface-water trip blank for NCA might be 0105NCATBSW601 for the first trip blank in January 2005. If more than one trip blank were submitted on the same COC form for the same matrix, the Sequential Number would be increased to 602.

The Sequential Number for field duplicates will be in the 200 series, and triplicates will be the 300 series. The 400 series is used for field equipment rinse blanks, the 500 series is used for DI-water blanks, and 600 series is used for trip blanks.

6.0 FIELD MEASUREMENTS

6.1 PARAMETERS

Portable water-quality testing instruments will be used for the in situ measurement of pH, temperature, dissolved oxygen, conductivity, oxidation reduction potential (ORP), and turbidity.

6.2 EQUIPMENT CALIBRATION AND QUALITY CONTROL

Field equipment used for collection, measurement, and testing is subject to a strict program of control, calibration, adjustment, and maintenance. Recorded measurements will not be taken until field readings stabilize. These values will then be recorded. A calibration check will be performed before each day's sampling. All calibration activities will be documented on appropriate field calibration forms.

The field crew leader will review data measured in the field, and senior personnel will perform final validation by checking procedures used in the field and comparing the data with previous results.

Data that cannot be validated will be documented, and corrective action may be required. Corrective actions for field sampling include procedures to be followed when field data results are not within the acceptable error-tolerance range. These procedures include the following:

- Comparing data readings being measured with readings previously recorded.
- Recalibrating equipment (e.g., pH meters).
- Replacing or repairing faulty equipment.
- Resampling when feasible.

The field team leader is responsible for ordering appropriate field corrective actions when deemed necessary. All field corrective actions will be recorded in the field book.

Equipment will be maintained in good operating condition.

6.2.1 YSI 556 Calibration Check

The calibration of the YSI 556 meter is checked or verified for three parameters: specific conductivity, ORP, and pH based on temperature readings. Calibration check procedures are detailed below:

1. Prior to checking the calibration, verify that the instrument is clean.
2. Make sure the YSI 5580 confidence solution is not too cold (close to freezing) as this will affect the calibration check. Confidence solution is best stored indoors.

3. Rinse the instrument with confidence solution by placing a small amount in the calibration cup, screwing the cup into the meter base, and gently tipping the base so that all meters have been coated with confidence solution.
4. Discard the used confidence solution.
5. Fill the calibration cup with confidence solution so that all meters are covered. Place the meter probe into the solution and allow readings to stabilize.
6. Record readings in the calibration notebook.
7. Compare the readings to those on the YSI 5580 confidence solution bottle. If all readings are within acceptable parameters, the YSI 556 calibration is good and the instrument does not need to be calibrated. If one or more of the readings is not within acceptable parameters, the YSI 556 calibration is not good and the instrument must be recalibrated for those parameters following the procedure in Section 6.2.2.

6.2.2 YSI 556 Calibration

The YSI 556 meters can be calibrated for four parameters: dissolved oxygen, pH, conductivity, and ORP. Procedures for calibrating for each parameter are provided below. Prior to calibrating the instrument, clean the sensors with an Alconox solution and rinse several times with DI water. Shake off excess water prior to immersing the probe in the calibration cup with solution. Make sure that the sensors are covered when running the calibration. Used calibration solution can be used to rinse the sensors prior to calibration to provide an extra level of accuracy.

To enter calibration mode:

1. Press the on/off key to display the run screen.
2. Press the escape key to display the main menu screen.
3. Use the arrow keys to highlight the calibrate selection.
4. Press the enter key. The calibrate screen is displayed.

6.2.2.1 Conductivity

1. On the calibrate screen, select conductivity and press enter.
2. Select specific conductance and press enter. Note that calibrating for specific conductance will also calibrate for conductivity and salinity.
3. Place 55 ml of the 1.413 mS/cm conductivity solution in the clean, dry calibration cup, and immerse the sensors in the solution.
4. Rotate or move the probe module up and down to remove any bubbles from the conductivity cell. Make sure that the conductivity sensor is completely immersed past the vent hole.
5. Tighten the calibration cup onto the probe module.
6. Enter the calibration value: 1.413 mS/cm. Note that the value for specific conductivity is always in mS/cm at 25°C.
7. Press enter and allow at least one minute for the temperature to stabilize. Note the temperature of the calibration solution for the pH and ORP calibrations.
8. When the specific conductivity reading is stable for 30 seconds, press enter. Press enter again to accept the calibration.

9. Press escape to return to the calibrate screen.
10. Rinse the sensors and calibration cup and save the solution for a pre-rinse prior to the next calibration.

6.2.2.2 Dissolved Oxygen

1. On the calibrate screen, select dissolved oxygen (DO) and press enter.
2. Select DO% and press enter. Note that calibrating for DO% will also calibrate for DO mg/L.
3. Place 1/8 inch of water into the calibration cup, and place the probe module into the cup making sure that the DO and temperature sensors are NOT immersed in the water.
4. Secure the cup to the module by securing only 1 or 2 threads to ensure that the DO sensor is vented to the atmosphere.
5. Use the keypad to enter the local barometric pressure (BP). Barometric-pressure readings from the Iliamna airport can be obtained at <http://weather.noaa.gov/weather/current/PAIL.html>. Note that these readings have been adjusted for sea level and must be corrected to obtain the pressure at the correct altitude. The following calculation must be performed to convert the units from inches mercury (Hg) to millimeters (mm) Hg and to adjust for the local elevation:
 - a. Corrected BP (inches Hg) x 25.4 = Corrected BP (mm Hg)
 - b. True BP = Corrected BP (mm Hg) – (2.5 x (altitude/100))
6. Allow 10 minutes for the air in the calibration cup to become water saturated and for the temperature to equilibrate. When the DO% reading shows no significant change for 30 seconds, press enter. Press enter again to accept the calibration.
7. Press escape to return to the calibration menu.

6.2.2.3 pH

1. On the calibrate screen, select pH and press enter.
2. Select 3 point and press enter. A 3 point calibration is used to correctly read surface waters that are both basic and acidic.
3. Place 30 ml of the first pH buffer in the clean, dry calibration cup and immerse the sensors in the solution.
4. Rotate or move the probe module up and down to remove any bubbles from the pH sensor. Make sure that the sensor is completely immersed.
5. Tighten the calibration cup onto the probe module.
6. Enter the value of the pH buffer at the current temperature. The temperature of the stored calibration solution for the pH and ORP should have been recorded during the conductivity calibration.
7. Press enter and allow at least one minute for the temperature to stabilize.
8. When the pH reading is stable for 30 seconds, press enter. Press enter again to accept the calibration.
9. Press enter to return to the specified pH calibration screen.
10. Rinse the probe module, calibration cup, and sensors in DI water and dry.
11. Repeat steps 3 through 10 for the second and third buffer solutions.
12. Press escape to return to the calibrate screen.

13. Rinse the sensors and calibration cup and save the solution for a pre-rinse prior to the next calibration.

6.2.2.4 Oxidation Reduction Potential

1. On the calibrate screen, select ORP and press enter.
2. Place 30 ml of the ORP solution in the clean, dry calibration cup, and immerse the sensors in the solution.
3. Rotate or move the probe module up and down to remove any bubbles from the ORP sensor. Make sure that the sensor is completely immersed.
4. Tighten the calibration cup onto the probe module.
5. Enter the value of the ORP solution at the current temperature. The temperature of the stored calibration solution for the pH and ORP should have been recorded during the conductivity calibration.
6. Press enter and allow at least one minute for the temperature to stabilize.
7. When the ORP reading is stable for 30 seconds, press enter. Press enter again to accept the calibration.
8. Press escape to return to the calibrate screen.
9. Rinse the sensors and calibration cup and save the solution for a pre-rinse prior to the next calibration.

6.2.3 Hach 2100P Turbidimeter Calibration Check

Routine calibration checks should be performed on the 2100P Turbidimeter using the Gelex secondary turbidity standards. In order to be used for checking the calibration in the future, the Gelex standards must have values assigned to them immediately after calibration has been performed with Formazin. These standards should be used as a calibration check prior to every field day. If the readings are outside 5 percent accuracy, the instrument should be recalibrated using StablCal stabilized Formazin standards.

6.2.4 Hach 2100P Turbidimeter Calibration

A recalibration should be performed at a minimum of once every three months. Methods for calibrating the Turbidimeter using the Formazin standards, for assigning values to the Gelex secondary standards, and for checking the calibration are outlined below.

6.2.4.1 Calibration

1. If the StablCal standards have been sitting for longer than one month, they must be shaken to break the condensed suspension into its original particle size. If the standards are used on a weekly interval, start at step 2 below. Standards with <0.1 NTU (nephelometric turbidity unit) should not be shaken.
 - a. Shake the standard vigorously for two to three minutes to resuspend any particles.
 - b. Allow the standard to stand undisturbed for five minutes.
2. Gently invert the bottle five to seven times.
3. Prepare the sample cell.

- a. Clean the cell using an Alconox solution and a DI water rinse.
 - b. Allow the cell to air dry. Handle the cell by the top to avoid scratching or contaminating the glass surface.
 - c. Apply a small bead of silicone oil to the surface of the cell and rub with a lint-free cloth. Note that the cloth will absorb oil and after a few applications, it will suffice to simply rub the cloth over the cell. Avoid using too much oil; the cell should appear dry with little or no visible oil.
4. Turn on the instrument by pressing I/O.
 5. Press CAL. The CAL and SO icons will display, indicating that the instrument is calibrating the first standard at 0 NTU.
 6. Rinse the sample cell one time with the standard and discard the rinsate.
 7. Fill the cell with the first standard. Cap the cell and let stand for one minute.
 8. Insert the cell in the compartment by aligning the orientation mark on the cell with the mark on the front of the compartment.
 9. Close the lid.
 10. Press → to get a numerical display.
 11. Press READ. The instrument will count from 60 to 0 and then switch to the next standard.
 12. Repeat steps 6 through 11 for the three remaining standards.
 13. When the last standard is done, the display will increment back to S0. Press CAL to accept the calibration, and the instrument will return to measurement mode.
 14. If E1, E2 or CAL? are flashing after the CAL button is pressed, check the standards and repeat the calibration. Refer to the instrument manual for troubleshooting guidelines.

6.2.4.2 Assigning values to the Gelex secondary standards

1. Only assign values to Gelex standards after completing a calibration using Formazin standards. Select automatic range mode using the RANGE key.
2. Thoroughly clean the outside of the Gelex vials, and apply a thin coating of silicone oil. See Step 3 under Calibration (above) for instructions on preparing a sample cell.
3. Place the 0-10 NTU Gelex standard in the cell compartment, and align the diamond on the vial with the orientation mark on the instrument. Close the lid and press READ.
4. Mark the value on the band near the top of the vial.
5. Repeat steps 2 through 4 for each Gelex standard.

6.2.4.3 Checking calibration

1. Check the instrument calibration using the Gelex standards.
2. If the readings are not within five percent of the previously established values, recalibrate using the StablCal stabilized Formazin standard.

6.3 EQUIPMENT MAINTENANCE AND DECONTAMINATION

Field meters should be decontaminated prior to calibration, prior to calibration check, between samples, or if there is visible sediment or biological material on the probe or sensors. Decontamination procedures for the YSI 556 are outlined below:

1. Spray all parts of the equipment using a pre-mixed Alconox and DI water solution. If there is obvious sediment or biological material on the equipment, lightly brush to remove material.
2. Rinse the equipment using DI water several times, and ensure that all traces of the Alconox solution and other materials are removed.

To decontaminate the Hach 2100P, rinse the equipment using DI water several times and ensure that all traces of the Alconox solution and other materials are removed.

Maintenance for the YSI 556 may include cleaning of sensors and replacement of the dissolved oxygen membrane. Maintenance procedures for the Hach 2100P that may be performed in the field include cleaning, and battery and lamp replacement. Complete descriptions of these procedures can be found in the instrument manuals, which will be kept with the instruments at all times. If maintenance and troubleshooting procedures in the instrument manuals do not fix the instruments, they will be sent to their respective manufacturer for repair.

The FlowMate velocity meter should be equipped with fresh batteries. Alkaline or nickel-cadmium (NiCad) batteries are recommended. Remove batteries from equipment between monitoring events. Sensors should be cleaned periodically to remove any oil or grease. Spray the sensors with an Alconox solution and rinse with fresh water.

6.4 FIELD MEASUREMENT PROCEDURES

The water levels, pH, temperature, dissolved oxygen, conductivity, ORP, and turbidity field measurements will be recorded in the field logbook, or on field sampling sheets, as appropriate.

6.4.1 YSI 556

1. Replace the calibration cup with the protective sampling cup.
2. Turn the instrument on, and place the probe in the stream and allow it to equilibrate until readings are steady prior to recording the readings.
3. Record the readings.
4. pH readings for sites where the water temperature is cooler than 1.0°C are often biased low, possibly due to ice formation around the pH bulb. Note the pH reading, and if it is unusually low (pH of 4.0 or less), note this in the field notebook. Measurements for questionable results may be re-collected from samples' dissolved-metals containers by decanting an aliquot into the calibration cup prior to performing field filtration.
5. In cases where the ambient temperature is very low and ice forms on the meters, readings may be collected by filling the calibration cup with sample water, screwing the cup onto the probe, then placing the cup into a secondary container filled with warm water (such as an insulated coffee cup). All parameters, with the exception of temperature, can be collected.
6. All field parameter results, including those that are questionable and any other relevant information, are recorded and maintained in field notebooks or field forms.

6.4.2 Hach 2100p

1. Decontaminate the sample cell using several rinses of DI water. Be careful to handle the cell by the top to avoid smudging or scratching the glass.
2. Rinse the sample cell several times with sample water.
3. Fill the cell with sample water, cap the sample cell, and dry it with ChemWipes or a clean, lint-free cloth.
4. Apply a thin film of silicone oil. Wipe with a clean, lint-free cloth to create an even film on the surface of the cell.
5. Turn on the instrument and place on a flat, sturdy surface.
6. Place the sample cell in the instrument compartment making sure that the mark on the cell aligns with the mark on the compartment. Close the lid.
7. Hit the RANGE key until AUTO RNG is displayed.
8. Press READ. The final measurement will display after approximately 13 seconds. If the reading is very unstable, press the SIGNAL AVERAGE key to average 10 measurements; this takes approximately 20 seconds.
9. Record the reading on the data sheet.

6.4.3 FlowMate Flow Meter

1. Press the ON/C button to turn the on the power.
2. After displaying the software version and segment test display, select the units of measure. Press the ON/C and OFF buttons simultaneously to cycle through measurement and beeper options. Select a mode which will display in FT/S.
3. Once the sensor is immersed in current facing upstream, allow 45 to 60 seconds for the flow velocity reading to stabilize.
4. Record velocity data.

7.0 RECORD KEEPING

Field observations, field equipment-calibration information, field measurements, and sample documentation (including sample identification, sample duplicates and triplicates, and date and time of sample collection) will be the responsibility of the entire sampling team. Record keeping will be accomplished with field logbooks and field forms, as described below.

No general rules can specify the extent of information that must be entered on the field records; however, they will contain sufficient information so that all field activity can be reconstructed without relying on the memory of the field crew. When in doubt, record more information rather than less.

7.1 FIELD LOGBOOKS AND FIELD FORMS

Field logbooks will be used to record any deviations from the sampling methods and additional notes which are not recorded on the field forms. Calibration logbooks are maintained for each field-parameter meter and are used for the entire sampling season. The data in the calibration logbooks include the name of the person doing the calibration, date and time, calibration solution and expiration date, and the reading versus calibration value.

A field logbook and field forms will be maintained on a daily basis to document field activities, including the collection of every sample. The field logbook will be bound, with consecutively numbered pages. An example of a completed field logbook entry is included in the appendix. Field forms (see appendix), including Surface-Water Field Forms and Field Discharge Measurement Forms, will be used for recording specific information about water flows and sample collection. All field notes will be entered into the field notebook or field forms in indelible ink unless conditions prohibit. If any changes are made to the field record, the original notation will be crossed out with a single line and initialed and dated by the person making the correction. At a minimum, field logbooks or field forms will contain the following information:

- Date and time that work commenced.
- Name and location of site.
- Description of work area.
- Date and times of sample collection or event.
- Name of the leader of the field team; names of all field personnel; and the names, addresses, and telephone numbers of all pertinent project contacts.
- Summary of equipment-preparation procedures.
- Field observations (weather conditions, field instrument readings).
- Number and type of samples collected and sample identification numbers.
- Sample location.

- Explanations of any deviations from this field sampling plan, with rationale for deviation.
- Problems encountered and their resolution.

Field activities, site conditions, and sampling locations will be documented with photographs.

7.2 FIELD OBSERVER FORMS

Field observer forms will be used to record when observers were used on native lands. At a minimum the forms must record the dates and times observers were used, the name and affiliation of the observer, the types of sampling they observed (sediment or surface water), and at which sample locations they were present. An example of a field observer form is included in the appendix.

7.3 CORRECTIONS TO DOCUMENTATION

Unless weather conditions prevent it, all original data will be recorded using waterproof ink. No 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, the author 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 is to remain legible. Any corrections made after the initial information is recorded will be initialed and dated.

8.0 FIELD PERFORMANCE AND SYSTEM AUDITS

Shaw will perform periodic field performance and system audits based on this Sampling Plan. Each field team will be accompanied into the field for compliance with both the hydrology and water-quality monitoring protocols. Audit results will be provided to BEESC by Shaw personnel and will be reviewed to ensure that field-sampling protocols are being followed or modified appropriately when necessary to meet the data-quality objectives.

9.0 REFERENCES

Alaska Department of Transportation and Public Facilities (ADOT&PF). 2005. Iliamna Regional Transportation Corridor Analysis. Prepared by PN&D. July.

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———. 2005. Draft Environmental Baseline Studies, 2005 Final Quality Assurance Project Plan.

Rantz, S.E., et al. 1982. Measurement and Computation of Stage and Discharge. U.S. Geological Survey Water Supply Paper 2175.

FIGURES

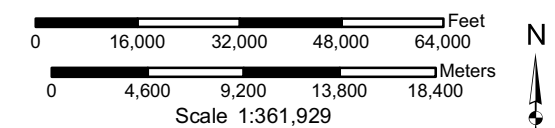
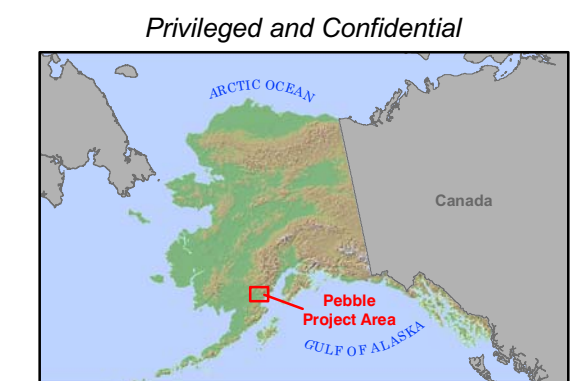


Pebble Project

Surface Water and Sediment Sampling Figure 1.

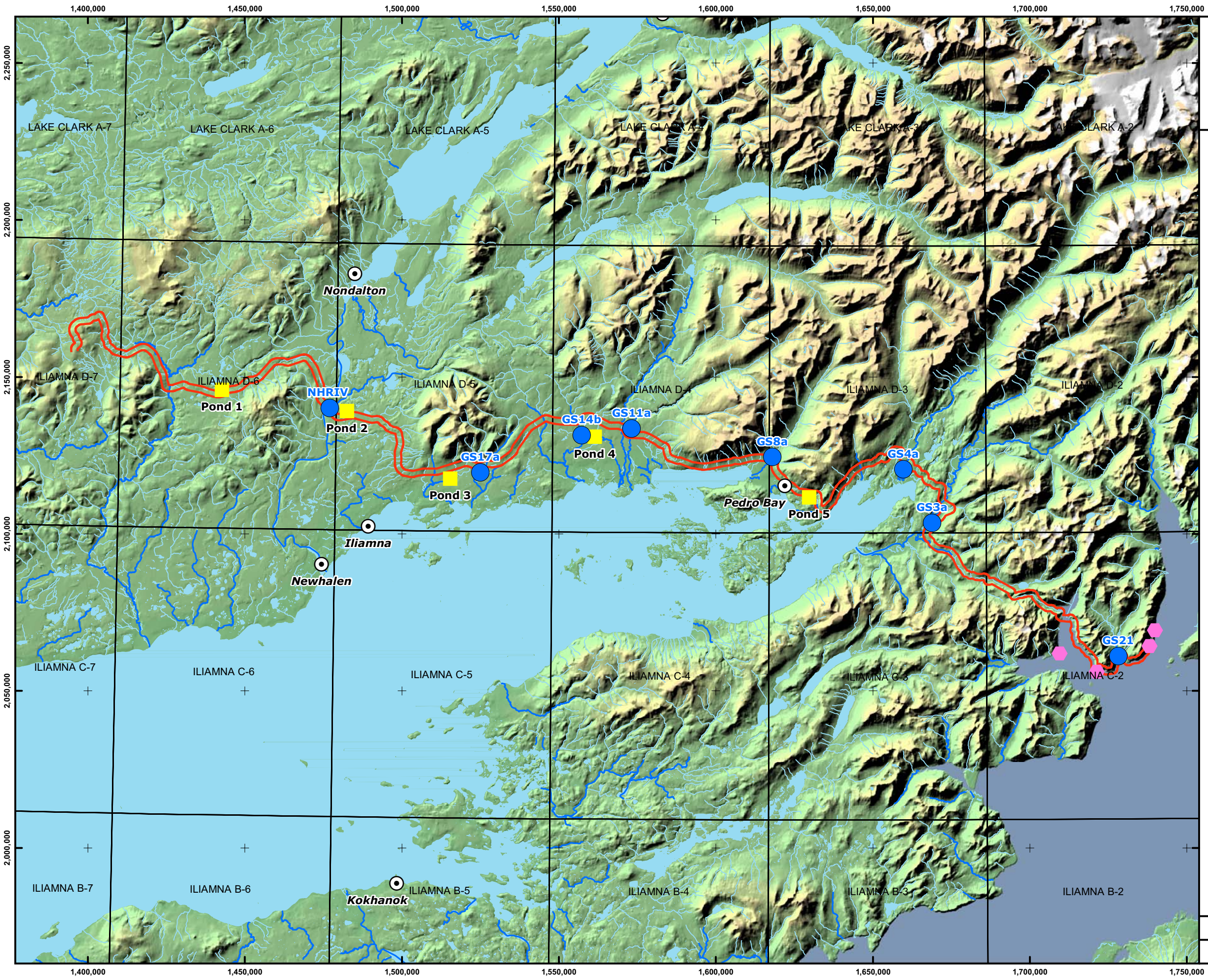
Legend

- Towns
- 2005 Surface Water Quality and Sediment Sampling Locations
- Tundra Ponds
- Potential Port Sites
- Road Corridor
- Quadrangle 63360
- Anadromous Fish Stream
- Stream



Alaska State Plane Zone 5 (units US feet)
1983 North American Datum

File: Sample_Map_20050601.mxd	Date: June 1, 2005
Version: 1	Author: BEESC-ME



APPENDIX

2 May 2005

Get ready for travel to Uiamwa. Checked calibration for the YSI. Dropped off car. & my place. Arrived @ Uiamwa @ 2pm. Met Joannie and Terry, Wassilie, and Gary. Will have to share vehicle w/ other people staying @ Uiamwa 1st.

Terry mentioned that weather at the post site would be deteriorating.

Spoke w/ Kelli and asked if we could change to PB lands. Could not get an answer so decided to do 6521, then come back to Uiamwa lands.

Set up equipment and gathered stuff for the next day. End of day @ 7pm.

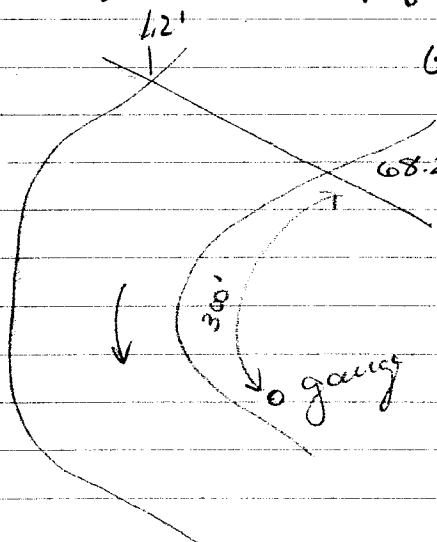
3 May 2005

Start work @ 7:00. Gather material. Had to calibrate YSI and borrow van.

8:00 ready to go. Dave + Ty are pilots. Head out to 6521 arrive @ 6521 9:30.

Water is high. Slight breeze + overcast. Temp ~ 140°F.

Gage was empty.



6521 retest =

temp = 9.61 °C

SPed cond = 0.056 mS/cm

cond = 39

DO = 106.0% / 12.00 mg/l

pH = 6.00

ORP = 294



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SURFACE WATER FIELD FORM Pebble Gold Copper Project

Station No.: _____
GPS coordinates _____

Date: _____
Start Time: _____
End Time: _____

Team:
Team Leader: _____
Team Members: _____

Site Observer: N/A

Flow:
Type of Flow Meter: _____
Total Flow = _____
Measurement Rating: Excellent, Good, Fair, Poor
Additional Information:
(e.g., ice thickness) _____
Stream Width: _____
Stream Depth: _____

In-situ Field Parameters:
Meter Make and Model YSI 556 MPS
Meter Number: 05A 2014 AB

Calibration Check:
Calibration Solution: _____
Expiration Date: _____
pH = _____
Cond = _____
Turb = _____
Recalibrate: Y/N _____

Stream Meter Readings:
pH = _____
Spec Cond = _____
Cond = _____
Turb = _____
DO = _____
Temp = _____
ORP = _____

Sample No.: _____
Time: _____
Number of Bottles _____
Filtration: Y/N _____

Additional Comments:

Analyses Requested:
Total Metals _____
Diss. Metals _____
Etc. _____
QA/QC _____

Weather:
Air Temperature _____
Precipitation _____
Wind _____

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SURFACE WATER FIELD FORM Pebble Gold Copper Project

Station No.: GS21
GPS coordinates Lat. N 59° 38.5294
Long. W 153° 31,4267

Date: 5-3-05
Start Time: 0930
End Time: 1045

Team:
Team Leader: Michelle Turner
Team Members: Sybil Kidder
Terry Wassillie
Wassillie Wassillie
Gary Martilla

Site Observer: N/A
(Shaw) Bryan Cherry

Flow:
Type of Flow Meter: Marsh McBirney
Total Flow = _____
Measurement Rating: Excellent, Good, Fair, Poor
Additional Information:
(e.g., ice thickness) upstream from gauge
Stream Width: 68.10 feet
Stream Depth: 1.90 feet (average)

In-situ Field Parameters:
Meter Make and Model YSI 556 MPS
Meter Number: 05A 2014 AB

Calibration Check:
Calibration Solution: _____
Expiration Date: _____
pH = _____
Cond = _____
Turb = _____
Recalibrate: Y/N _____

Sample No.: 0505GS21WS001
Time: 1000

Number of Bottles 10
Filtration: Y/N Yes

Analyses Requested:
Total Metals Yes
Diss. Metals Yes
Etc. _____
QA/QC _____

Weather: Clear, sunny
Air Temperature 40 °F.
Precipitation None
Wind Slight wind

Water Surface
Elevation: 98.92

Stream Meter Readings:
pH = 4.79 (6.00)
Spec.Cond = 0.053 mS/cm (0.56)
Cond = 30 uS/cm (39)
Turb = 0.26 NTU
DO = 14.62 mg/L (12.00)
Temp = 2.99 Degrees C
ORP = 286.0 (294)
DO% = 107% (106.0%)

Additional Comments:
Flow and samples collected upstream
from gauge pole at shallower area.
Sediment sample was collected at
1030 at three spots along the east
bank and middle.

Field reading were confirmed at
hanger. Hanger readings included in
parentheses.

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FIELD DISCHARGE MEASUREMENTS

Name of stream: CANYON CREEK - WEST CHANNEL

Location: N 59°50.418' W 154°21.952'

Gage #: 11a Date: 5/03/05 Time: 11:45

Gage Reading: 0 Water Surface Elev: 93.86

Water temp: _____ °F Air temp: 55 °F Slope: SEE FILES ft/ft

Skew	Distance	Depth	2/10 V	6/10 V	8/10 V
	32	0		0	
	37.5'	0.3		0.86	
	37	0.4		1.86	
	35	0.7		2.77	
	33	1.0		4.68	
	31	1.0		4.71	
	29	1.3		5.22	
	27	1.5		5.16	
	25	1.3		5.21	
	23	1.6		4.70	
	21	1.7		4.82	
	19	1.5		4.36	
	17	1.5		4.08	
	15	1.7		4.48	
	13	1.5		5.03	
	11	1.3		4.26	
	9	1.3		3.47	
	7	1.2		3.40	
	5	0.5		2.03	
	4.7	0		0	

FUB
EOW

EOW
TUB

Note: If the depth of water is 3' or greater then take velocity measurements @ 2/10 & 8/10 of the depth of water. Otherwise velocity measurements will be taken at 6/10 of the depth.

Notes taken by: S. KIDDER

Survey notes: GS-11a - CANYON CRK - WEST CHANNEL

HI = 5.18 + bolt on gage 100 105.18 = instrument HI

Instrument HI = 105.18 - Rod 11.32 WS = 93.86

Cross section notes:

TOB	Elev.				
	Rod	10.02			
EOW	Distance	15.78			
	Elev.				
TOB	Rod	10.18			
	Distance				
EOW	Elev.				
	Rod	9.48			
GS BOLT	Distance				
	Elev.				
EOW	Rod	11.32			
	Distance				
GS BOLT	Elev.				
	Rod	5.18			
EOW	Distance				
	Elev.				
EOW	Rod	8.24			
	Distance				
EOW	Elev.				
	Rod				
EOW	Distance				
	Elev.				
EOW	Rod				
	Distance				

Slope Computations

Elev.		Elev.	
Rod		Rod	
Upstream Distance		Downstream Distance	

Pebble Project Gold Copper Field Observer Form

NDM Consultant Company Name	Bristol Environmental & Engineering Services Corporation	
Team Leader		
Land Access Location		
Native Corporation		
Date and Duration Observer Required (hours)		
Reason for Access (type of monitoring)		
Observer Confirmed	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Observer Name		
Date Confirmed		
Dates and Hours Observer Used		
Comments:		
Verified by:	Richard Moses	Date

