



Pebble Project
NORTHERN DYNASTY MINES INC.

**DRAFT ENVIRONMENTAL BASELINE STUDIES
FIELD SAMPLING PLAN**

**CHAPTER 4. SURFACE WATER
MINE AREA**

NOVEMBER 2005

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Figure 1. 2005 Surface-water-quality and hydrology baseline site map

APPENDICES

Appendix A. Surface-water-quality and Hydrology Field Form

ABBREVIATIONS

ADEC	Alaska Department of Environmental Conservation
BP	barometric pressure
BTEX	benzene, toluene, ethylbenzene, xylene
°C	degrees Celsius
CAS	Columbia Analytical Services
COC	chain of custody
DO	dissolved oxygen
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
ft/sec	feet per second
GPS	global positioning system
µg/L	micrograms per liter
µmhos/cm	micromhos per centimeter
µS/cm	microsiemens per centimeter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
ml	milliliter(s)
mm	millimeter(s)
MRL	method reporting limit
ng/L	nanograms per liter
MS	matrix spike
MSD	matrix spike duplicate
NCA	North Creek Analytical
NDM	Northern Dynasty Mines Inc.
NK	North Fork of Kuktuli River
NTU	nephelometric turbidity units
ORP	oxidation-reduction potential
PCB	polychlorinated biphenyl
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
SK	South Fork of Kuktuli River
SOP	standard operating procedure
SVOC	semivolatile organic compound

TDS	total dissolved solid
TSS	total suspended solid
USGS	U.S. Geological Survey
UT	Upper Talarik Creek
VOC	volatile organic compound
WAD	weak acid dissociable
WMC	Water Management Consultants

1. INTRODUCTION

This field sampling plan includes the protocols for the hydrology, sediment, and water-quality baseline studies to be performed in 2005 for the Pebble Project, a proposed gold-copper-molybdenum mine located in southwestern Alaska. The program results will be used in a feasibility study and applications for construction, operation, and closure of the open-pit mine and related infrastructure. U.S. Environmental Protection Agency (EPA) guidance (EPA, 2003) was considered when developing this field sampling plan at the start of the program in April 2004.

2. PROJECT BACKGROUND

2.1 Project Purpose and Scope

Northern Dynasty Mines Inc. is proposing to develop the Pebble Project; therefore a series of environmental studies is being conducted to provide background information necessary for mine planning, permitting, and development. This field sampling plan includes the methodology for the collection of hydrology, sediment, and water-quality data for the baseline studies.

2.2 Project Site Description

The project area is shown on Figure 1 and includes the mineralized area and potential mine, mill, and tailings-disposal facilities. The project area is drained by the north and south forks of the Koktuli River, Upper Talarik Creek, and tributaries of these waterbodies. The Kaskanak Creek watershed is located to the southwest of the project area and will be studied to identify potential interbasin transfer from the South Fork Koktuli River. Thirty-one surface-water stations are being sampled for hydrology and water quality in the north and south forks of Koktuli River, Upper Talarik Creek, and Kaskanak Creek in 2005. Sediments will be collected in sixteen streams, six lakes, and approximately ten seeps near the mine site for the trace elements baseline program.

3. PROJECT SCOPE AND OBJECTIVES

3.1 Objectives

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

- Characterization of current site conditions and site resources.
- Collection of surface-water baseline data for comparison to future conditions (construction, operations, and closure).

- Collection of data for design of facilities including water-management and water-supply structures.

The main objectives of the surface-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.
- Evaluate alternative water-supply sources.
- Provide a database for the site surface-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.
- Support project permitting.

Baseline studies will provide physical flow information and water-quality data for surface-water systems in the vicinity of the proposed mine, mill, and tailings-disposal facilities. Surface-water baseline conditions will be documented to provide information on hydrologic interaction and on how they change throughout the year. Surface-water flow and quality data will be linked to provide estimates of baseline surface-water load from the mineralized area to downgradient surface-water systems. This information will be used to understand current conditions and to provide a baseline for the evaluation of potential future impacts during operation and closure.

3.2 Sample Analysis Summary

The list of laboratory analyses that will be performed in the baseline water-quality program in 2005 is in Table 1. Quality assurance (QA) samples will be shipped to Columbia Analytical Services in Kelso, Washington. Primary and duplicate, or quality control (QC), samples tested for metals and low-level mercury samples are shipped to North Creek Analytical in Beaverton, Oregon, and the inorganic, organic, and cyanide samples are being analyzed at SGS Laboratory in Anchorage, Alaska.

TABLE 1. Surface-water and sediment parameters for laboratory determination.

Analyte	Method	Method Reporting Limit
Aluminum, total and dissolved	EPA 200.8	1.0 µg/L
Antimony, total and dissolved	EPA 200.8	0.05 µg/L
Arsenic, total and dissolved	EPA 200.8	0.5 µg/L
Barium, total and dissolved	EPA 200.8	0.05 µg/L
Beryllium, total and dissolved	EPA 200.8	0.02 µg/L
Bismuth, total and dissolved	EPA 200.8	0.1 µg/L
Boron, total and dissolved	EPA 200.8	0.5 µg/L
Cadmium, total and dissolved	EPA 200.8	0.02 µg/L
Calcium, total and dissolved	EPA 200.7/200.8	50 µg/L
Chromium, total and dissolved	EPA 200.8	0.2 µg/L
Cobalt, total and dissolved	EPA 200.8	0.02 µg/L
Copper, total and dissolved	EPA 200.8	0.1 µg/L
Iron, total and dissolved	EPA 200.7	20 µg/L
Lead, total and dissolved	EPA 200.8	0.02 µg/L
Magnesium, total and dissolved	EPA 200.7/200.8	20 µg/L
Manganese, total and dissolved	EPA 200.8	0.05 µg/L
Mercury, total	EPA 1631	0.005 µg/L
Molybdenum, total and dissolved	EPA 200.8	0.05 µg/L
Nickel, total and dissolved	EPA 200.8	0.2 µg/L
Potassium, total and dissolved	EPA 200.7/200.8	50 µg/L
Selenium, total and dissolved	EPA 200.8	1 µg/L
Silicon, dissolved	EPA 200.8	100 µg/L
Silver, total and dissolved	EPA 200.8	0.02 µg/L
Sodium, total and dissolved	EPA 200.7/200.8	100 µg/L
Thallium, total and dissolved	EPA 200.8	0.01 µg/L
Tin, total and dissolved	EPA 200.8	1 µg/L
Vanadium, total and dissolved	EPA 200.8	0.2 µg/L
Zinc, total and dissolved	EPA 200.8	0.5 µg/L
pH	EPA 150.1	NA
Specific Conductance	SM 2510B	2 µS/cm
Alkalinity	SM 2320B	10 mg/L
Acidity	EPA 305.2	NA
Ammonia	SM 4500NH3G	0.1 mg/L
Chloride	EPA 300.0	0.2 mg/L
Cyanide—total	SM 4500-CN E	0.01 mg/L
Cyanide—WAD	SM 4500-CN I	0.01 mg/L
Fluoride	EPA 300.0	0.1 mg/L
Nitrate + nitrite	EPA 300.0	0.1 mg/L
Phosphorus, total	EPA 365.3	0.1 mg/L

Analyte	Method	Method Reporting Limit
Sulfate	EPA 300.0	0.01 mg/L
Total dissolved solids	EPA 160.1	10 mg/L
Total suspended solids	EPA 160.2	5 mg/L
Thiocyanate	Laboratory SOP	1 mg/L
Pesticides, SVOCs, VOCS	various	See 2005 NDM QAPP (NDM, 2005) for MRL

Sediments		
Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mo, Mn, Ni, K, Se, Ag, Na, Tl, Sn, V, Zn	SW3050/6020	See Table 1-12 in 2005 NDM QAPP (NDM, 2005) for MRL
Hg	SW 3050/7471	0.02 mg/kg
Total Cyanide	SM 4500CN-E	0.2 mg/kg
Chloride	EPA 300.0	1 mg/kg
Fluoride	EPA 300.0	2 mg/kg
Sulfate	EPA 300.0	2 mg/kg
Ammonia as N	SM 4500NH3	0.2 mg/kg

EPA = 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

SW = U.S. EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Third edition, September 1986

µg/L = micrograms per liter

µS/cm = microsiemens per centimeter

mg/L = milligrams per liter

mg/kg = milligrams per kilogram

MRL = method reporting limit

NA = not applicable

SOP = standard operating procedure

SVOC = semivolatile organic compound

VOC = volatile organic compound

WAD = weak acid dissociable

% = percent

3.3 Field Activities

Detailed procedures for the surface-water hydrology, sediment, and water-quality field activities are included in Sections 5 and 6. Appropriate QA/QC procedures will be used, and QA/QC samples will be collected at a 10 percent frequency, which is based on the schedule set up by the analytical laboratories and the laboratory QA manager at Shaw Environmental.

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 couple of low-flow events 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. The sampling program consists of nine planned surface-water events for a 12-month period.

Organic samples will be collected to identify baseline conditions and develop site-specific cleanup standards. Site specific standards will be considered only in the event of a future petroleum release. Seasonal variation in organic concentrations will not be a factor in determining cleanup standards, and samples will be collected once in July 2005.

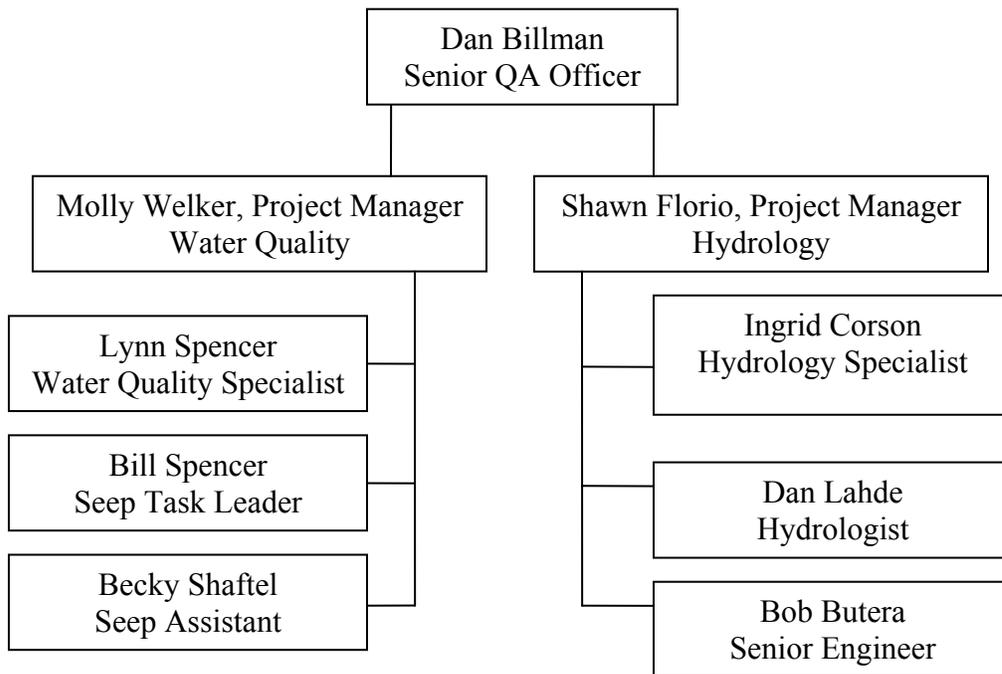
In all cases, field-collection procedures are performed so as to minimize contamination of samples, prevent cross-contamination between samples, and ensure sample validity by conducting proper preservation and storage in the field according to the requirements in the *Draft Environmental Baseline Studies,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

Part of the surface-water baseline program includes sampling seeps for flow and water quality in March, July, August, and October in of 2005. The objective of the seep sampling program is to document the amount and chemistry of water discharging from seeps or springs in the vicinity of the ore deposit. Discharge at each seep will be measured by directing flow over a 60° V-notch weir, where possible. If flows are too large to use the weir, measurements will be made along a cross-section using a top-setting wading rod and current meter. Flows may be estimated based on visual observations if the above methods cannot be used. Water-chemistry parameters to be analyzed for the seep samples are exactly the same as those analyzed for the surface-water samples (Table 1). Field parameters that will be measured at the seep locations are the same as those measured at the surface-water sites: pH, dissolved oxygen, specific conductance, temperature, turbidity, and oxidation-reduction potential. YSI Multiprobe 556 and Hach turbidity meters will be deported directly at the seep discharge for measurement of field parameters.

Sediment data will also be collected from streams, lakes, and seeps in the proposed mine site to be incorporated into the trace elements program of the baseline environmental studies. Sediments will be collected from 16 stream locations in June, July, and September and will be co-located at a subset of the water-quality, hydrology, fish-tissue, and macroinvertebrate sampling stations. Sediments will be collected in approximately ten seeps in June and October and in six lakes in July.

4. PROJECT ORGANIZATION AND RESPONSIBILITY

Molly Welker and Shawn Florio will coordinate the field work and report-writing for the hydrology, sediment, and surface-water-quality programs. The field teams will consist of two water-quality specialists working with two hydrologists to collect the flow data, and sediment and water-quality samples. A variety of HDR Alaska Inc. (HDR) employees and local hires will help with the field work when needed. An organization chart depicting the main HDR staff managing and assisting on the hydrology, sediment, and water-quality programs is provided below.



4.1 Subcontractors

Two subcontractors (Denise Herzog of Apex North Consulting and Tony Yeo of the University of Alaska-Anchorage) are involved in the project. Their involvement includes technical review of the reports and advice on statistical procedures to be used for data analysis.

5. HYDROLOGY MONITORING AND SEDIMENT SAMPLING

Field activities will include several tasks described below for the hydrology program and sediment program. Water-chemistry field activities are included in Section 6. Activities for measuring field parameters are described in Section 7. The hydrology and surface-water baseline stations and the hydrology data to be collected are listed in Table 2.

TABLE 2. Hydrology and surface-water baseline sites and hydrology data type.

Location ID	Operator	Data Type	Rationale	Period of Continuous Record
North Fork Kaktuli River				
NK100C	HDR	Continuous stage and discharge	NK "basin" integrator for NK headwaters	Jul-Oct 2004
NK119A	HDR	Continuous stage and discharge	Downstream of G tailings site	Jul-Oct 2004
NK119B	HDR	Instantaneous discharge only	Drains northwest side of mineralized area	
NK100A	USGS	Continuous stage and discharge	Lower main stem NK near SK confluence	Aug 2004-Current
NK100B	HDR	Instantaneous discharge only	Integrates NK 100C and NK 100A.	
South Fork Kaktuli River				
SK136B	HDR	Instantaneous discharge only	Drains mineralized area	
SK136A	HDR	Instantaneous discharge only	Drains mineralized area	
SK134A	HDR	Instantaneous discharge only	South of mineralized area	
SK133A	HDR	Instantaneous discharge only	South of mineralized area	
SK100G	HDR	Continuous stage and discharge	Upper main stem; upstream of Frying Pan Lake; same reach as Cominco Stations 6 and 14	Jul-Oct 2004
SK131A	HDR	Instantaneous discharge only	Drains Kaktuli Mountain	
SK100F	HDR	Continuous stage and discharge	Main stem downstream of Frying Pan Lake (poss. sink); same reach as Cominco CQ Station 17	Aug, Sep 1991; Jun – Oct 1992; Jul-Oct 2004
SK100D	HDR	Instantaneous discharge only	Main stem downstream of flow loss; Cominco Station 5	

Location ID	Operator	Data Type	Rationale	Period of Continuous Record
SK100C	HDR	Continuous stage and discharge	Main stem and upstream of flow gain; Cominco CQ Station 16	Jul-Oct 1993; Jul-Oct 2004
SK119A	HDR	Continuous stage and discharge	Tributary and flows to "aquifer recharge-discharge" area; Cominco Stations 18 and 20	Jul-Oct 2004
SK124A	HDR	Continuous stage and discharge	Provides flow data for Bear Valley	
SK100B	USGS	Continuous stage and discharge	Main stem downstream of flow gain	Aug 2004-Current
SK100A	HDR	Continuous stage and discharge	Lower main stem SK near confluence with NK	Jul-Oct 2004
Upper Talarik Creek				
UT100E	HDR	Continuous stage and discharge	Upper reach of UT; downstream of potential flow gain from NK; upstream of drainage from ore body; same reach as Cominco Station 8	Jul-Oct 2004
UT146A	HDR	Instantaneous discharge only	Drains mineralized area; headwaters in mineralized zone	
UT141A	HDR	Instantaneous discharge only	"Low point" for new drainage north of mine area; added Q to UT	
UT100D	HDR	Continuous stage and discharge	Integrates all UT from MDC; Cominco CQ Station 13	Aug-Sep 1991; Jun-Oct 1992; Sep-Oct 1993; Jul-Oct 2004
UT138A	HDR	Instantaneous discharge only	Drains locally named Pig Mountain	
UT135A	HDR	Instantaneous discharge only	Major UT tributary near confluence with main stem of UT; winter flow contribution; Cominco CQ Station 19	Aug-Oct 1993; May-Sep 1994
UT119B	HDR	Instantaneous discharge only	Downstream of flow gain from SK	
UT119A	HDR	Continuous stage and discharge	Integrates mine/mill groundwater effects on UT from reduced flow from SK and WQ and biological sampling.	Jul-Oct 2004
UT100B	USGS	Continuous stage and discharge	Lower reach of UT; downstream of UT-1.190 effects; downstream of mineralized zone	Aug 2004-Current
UT100A	HDR	Instantaneous discharge only	Downstream of mineralized zone; integrates all of UT	
Kaskanak Creek				
KC100A	HDR	Continuous stage and discharge	Evaluate potential interbasin transfer of water from SK	Jul-Oct 2004

Location ID	Operator	Data Type	Rationale	Period of Continuous Record
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Main Stem Kaktuli River

KR100A	HDR	Instantaneous discharge only	Integrates NK and SK; lowest watershed site	
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Notes:

Continuous-stage data collected when ice is present are suspect because of a continuously changing cross-section and other variables.

CQ = continuous discharge

MDC = mine development concept

NK = North Fork of the Kaktuli River

Q = flow or discharge

SK = South Fork of the Kaktuli River

USGS = U.S. Geological Survey

UT = Upper Talarik Creek

WQ = water quality

Sediment will be collected from a total of six lake locations in July. Samples will be collected from the following lake locations:

- Frying Pan Lake and Big Wiggly Lake.
- Two new lake sites in the southern portion of the mine site area and co-located with newly proposed fish-monitoring sites. Final locations to be determined.
- Two lake sites considered prime moose pond habitat and co-located with aquatic-vegetation sampling sites. Final locations to be determined.

Lake samples will be collected from a boat in a location which is most likely to accumulate sediment. Sediment will be collected using a dredge or core sampling techniques.

Sediment samples will be collected from up to ten seep locations in July and October. Sediment samples will be located at a subset of the seeps where water-quality samples are collected in 2005.

5.1 Datalogger Installation and Monitoring

Dataloggers used for this project are MiniTROLL units manufactured by In-Situ, Inc. Each datalogger is designed to record water depth and water temperature. A 5-pound-per-square-inch (psi) pressure transducer within the MiniTROLL unit records changes in water-surface elevation and has an accuracy rating to 0.01 feet. The units are set to observe water depth and temperature on a one-minute interval. One-minute observations are recorded only for changes in water depth of 0.01 foot or greater; however, observations are recorded every 10 minutes, regardless of changes in water depth. Temperature is recorded for every depth recording.

Dataloggers will be re-installed in April and May 2005 at twelve locations. The timing of installations may be specific to each site depending on conditions. The units will be installed by driving a steel angle iron into the streambed until the angle is solidly anchored. Where possible, the angle iron that was

installed in 2004 will be used again in 2005. A prefabricated polyvinyl chloride (PVC) housing shell is connected to the angle iron at the channel bottom with steel clamps. PVC conduit is then installed above the housing, and the MiniTROLL unit is placed in the housing with the cable secured in the conduit. A junction box to protect the cable connection is installed at the top of conduit. The top of the PVC housing remains open, and holes are drilled in the sides of the PVC to allow free water pressure over the sensors.

A channel cross-section is surveyed at each datalogger upon re-installation. Two or three temporary benchmarks, which were established in 2004 at each site, will provide local data for vertical control. A minimum of one temporary benchmark on each bank will define the cross-section to be established. Cross-section distances are measured with a survey tape, and a survey level is used for vertical measurements. The datalogger is tied to the surveyed cross-section by surveying the elevation of the top of the angle iron post and the water-surface elevation at the angle iron post.

Data from the dataloggers are scheduled to be downloaded monthly from installation in the spring through October 2005.

5.2 Instantaneous Discharge Measurements

Field procedures defined by the USGS (Rantz et al., 1982) and in the *Draft Environmental Baseline Studies, 2005 Final Quality Assurance Project Plan* (NDM, 2005) are used to obtain instantaneous discharge measurements. Price AA, Pygmy, and Marsh McBirney current meters will be used, depending on stream depths and velocities. According to the USGS (Rickman, pers. comm., 2005) Pygmy meters will be used when the depth of the water is <1.5 feet (ft) and the flow is <3.5 feet per second (ft/sec); Price AA meters will be used when the depth is >1.5 ft and the flow is >3.5 ft/sec. The Marsh McBirney meter can be used when the depth of water is greater than 4 to 6 inches and the velocities are >0.5 ft/sec.

Instantaneous discharge measurements will be collected at each sampling location during each field event. Measurements will be taken using top-setting wading rods. If the water is too deep or swift to wade in 2005, a boat will be employed to obtain discharge measurements. A sounding weight may also be used with the boat to help stabilize the current meter. Backup current meters will be kept on hand in 2005 for use in the event of equipment malfunctions. Procedures for discharge measurements defined by the USGS are outlined below:

1. Visually check wading rod, current meter (Marsh McBirney, Pygmy, or AA type), and headsets for damage. Repair damage to equipment and replace batteries as necessary.
2. Evaluate reach of stream to determine type of meter necessary to make flow measurement. For shallow, low-velocity streams, use a Pygmy or Marsh McBirney current meter; for relatively deep, higher velocity streams, use a Marsh McBirney or a standard AA-type meter.
3. Perform spin test on selected meter if appropriate; the cups on the Pygmy meter should spin continuously for at least 30 seconds; on the AA meter, the cups should spin for at least 2 minutes. If the current meter fails the spin test, lubricate and adjust as necessary to achieve desired results.
4. Attach current meter and head set, or electric recorder, to wading rod. Check the electric connection between the current meter and headset or recorder by spinning cups on the current meter. Adjust equipment as necessary such that a clear signal is received upon every revolution of the cups.

5. Anchor surveyor's tape tautly across the stream perpendicular to the direction of streamflow and attach on either side of the stream. Attempt to provide at least 1 foot of clearance between the water surface and surveyor's tape.
6. Determine the spacing of the vertical partial sections, generally using 25 to 35 partial sections. The number of sections shall be based on an estimated distribution of the discharge across the entire cross-section. With a smooth cross-section and even velocity distribution, fewer cross-sections may be used. Space the partial sections to meet the USGS objective, which is that no partial section should have more than 10 percent of the total discharge in it. A more ideal measurement is one in which no partial section has more than 5 percent of the total discharge in it. However, the USGS recognizes this is not always practical and is seldom accomplished when 25 partial sections (or fewer) are used. Equal widths of partial sections across the entire cross-section are not recommended unless the discharge is well distributed. Make the width of the partial sections less as depths and velocities become greater (USDOI, 1969).
7. Person wading in stream calls out to data recorder on shore 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.
8. 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 will 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.
9. 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.
10. Person wading counts clicks or observes visual output at each vertical for a minimum of 40 seconds and calls final tally of both number of clicks and time to data recorder. Click count should correlate with velocity chart provided with each meter.
11. Repeat procedure at each vertical.
12. Data recorder records other appropriate information on the field form.

5.3 Upper Hyporheic Zone Measurements

Changes potentially resulting from the proposed mine include altered hydraulic exchange between the groundwater and streams. Temperatures within the hyporheic zone—the saturated zone under a river or stream comprising substrate with the interstices filled with water—are important to the spawning success of salmonids (Rubin, 1995). Since a change to the hydraulic exchange rates could affect the temperature regime within the hyporheic zone, baseline data of temperatures in the hyporheic zone are being collected. Comparison of temperatures in the hyporheic zone to those in the adjacent groundwater and the above in-stream water column may also be used to better understand the hydraulic connections between these systems.

Temperature will be measured at four locations within the mine area. These locations, determined in concert among HDR's fisheries group, Water Management Consultants (WMC), and the Alaska Department of Natural Resources (DNR), include:

- The spring and salmon-spawning area on the main stem of South Fork Koktuli just downstream of the confluence with Tributary 1.190,
- Upper Talarik close to surface-water station UT100B,
- Upper Talarik in the general vicinity of surface-water station UT146A, and,
- North Fork Koktuli, a little downstream of NK100B.

Installation of the hyporheic monitoring stations is planned for June 2005. Continuously logged thermistors will be installed at each station to measure hyporheic temperatures at multiple depths down to a total depth of 10 feet below the stream bottom. Thermistor strings will be constructed and installed to measure temperatures every 6 inches to a depth of 3 feet; then every 12 inches to the total depth of 10 feet. One thermistor will be placed at the sediment/water interface and another will be placed about 6 inches (less in shallow streams) above the stream bottom. The thermistor strings will likely be installed through a 3/4-inch steel pipe. HDR plans to install the steel pipe using an electric jackhammer. Once the thermistor string is placed inside the steel pipe, the pipe will be removed, leaving the thermistors in place.

The thermistors will be connected to a datalogger mounted to an angle iron installed immediately adjacent to the thermistor string. After the stations have been installed, HDR will download the thermistor data according to the same schedule as for the surface-water hydrology-monitoring program. The stations will be capable of data collection throughout the year.

5.4 Low-Flow Stream Profiling

An evaluation of baseline hydrology, as well as potential changes to watersheds from the proposed mine, requires characterization of the hydraulic connections between surface-water and groundwater resources. To aid the hydrogeology study, a series of low-flow stream-flow profiles will be completed. These profiles will consist of 10 to 15 instantaneous discharge measurements along the North Fork of Koktuli River, South Fork of Koktuli River, Upper Talarik Creek, and tributaries for a total of up to 45 measurements. The measurements will be collected during the low-flow periods in March and following spring runoff (planned for late June or early July). Measurements will be collected using the same field methods described above for the monthly discharge measurements. HDR will provide the resulting data to WMC following each of the two field efforts. The specific stream reaches to be measured during the summer low-flow period are being determined in consultation with WMC.

5.5 Groundwater/Surface-water Exchange Measurements

In conjunction with the studies described in Sections 5.3 and 5.4, which target the exchange of groundwater and surface water, mini-piezometers and seepage meters also are planned for 12 locations within the mine-site drainages. HDR, with input from WMC, will install a pair of mini-piezometers at each station following breakup in 2005 to evaluate the direction of groundwater flow (gaining or losing) during low-flow conditions. Two drive-point mini-piezometers will be driven into the hyporheic zone at

each station. One each will be installed at three and 10 feet below the stream bottom using a vibrating hammer.

Differential water elevations will be collected using an electronic water-level indicator from each pair of mini-piezometers on the same schedule as the surface-water hydrology field program.

Seepage-meter measurements will also be recorded at these locations to document the quantity of groundwater flux into or out of the streambed. Seepage meters will be constructed in Anchorage from 55-gallon drums, as described by Lee and Cherry (1978).

The data collected during these studies will be provided to WMC for use with other groundwater and surface-water data to interpret groundwater recharge and discharge patterns.

5.6 Lake and Seep Sediment Sampling

Lake sediment samples will be collected from the top 0.5 feet of sediment by using Lexan tubes, Ponar dredge, Eckman dredge, or hand troweling. The seep- and lake-sediment sampling will be coordinated between the trace elements program and aquatic biological program. Sampling for lake sediments will occur once in six lakes in July 2005, and sediment sampling will occur in approximately 10 seeps in July and October 2005.

The exact device used at each location will be recorded in the field logbook and on the field data sheets. For all sampling methods, the individual collecting the sample will stand downstream (i.e., facing the current) when collecting the samples, to avoid disturbance of the sampling area.

The following steps will be used during the sediment sampling and compositing:

1. All samples and sampling equipment will be handled with gloved hands.
2. All non-disposable sampling equipment will be decontaminated prior to and between sampling areas.
3. Grab samples will be collected along a transect perpendicular to surface-water flow at each location. The outermost samples will be collected just below watermark with one sample collected within the stream channel. If feasible, samples will be collected at approximately equal intervals. Sampling plan will be sufficiently flexible to allow alternate locations (e.g., behind boulders, etc.)
4. Grab samples will be composited (i.e., three samples along a transect) and thoroughly mixed in a large stainless-steel bowl using gloved hands prior to filling the sample containers. The bowl can be placed within plastic garbage bags to eliminate the need for decontamination between samples.
5. Large debris (e.g., rocks, gravel, and sticks) will be hand picked and removed in the field during homogenization of the transect samples.
6. Place the composited sediment into sampling bottles; 25 grams of sediment is required by the laboratory for their sediment analyses.
7. At stations where field duplicate samples are obtained, each sample will be collected, homogenized, and sampled as if it were an entirely new sample, with complete cross-

contamination prevention efforts used. Triplicate samples will come from the same composited sample.

8. Fill out appropriate field form(s) documenting sampling-location description and coordinates, time, sampling device(s) used, and other pertinent information before leaving sampling site. Additionally, photo documentation and a GPS (global positioning system) location of the sample site will be taken.

Samples may be screened at the analytical laboratory to remove material greater than 2 millimeters. Analyses will be run on the sample that passes the 2-millimeter sieve. Sufficient fine-grained material (25 grams) must be present in sample jar for laboratory analysis. Coarse material should not be sent to the lab. Additional volume of sample will be sent to the laboratory if there is a question about providing adequate material.

5.7 Stream Sediment Sampling

The frequency for stream sediment sampling is different than for lake sediment sampling due to the dynamic changes expected from variation in streamflow. Stream sediment sampling will be carried out in close coordination with groundwater baseline hydrology and surface-water-quality work. Specifically, stream sediment samples will be collected concurrent with surface-water samples at 16 surface-water stations in June, July, and September 2005 (Table 4).

TABLE 4. Sediment sampling sites in sixteen streams at the Mine Site.

Stream	Sampling Location
Upper Talarik Creek	UT100B, UT100C, UT100D, UT100E, UT119A
North Fork Kaktuli River	NK100A, NK100B, NK100C, NK119A
South Fork Kaktuli River	SK100A, SK100B, SK100C, SK100F, SK100G, SK119A
Kaskanak Creek	KC100A

Sediment sampling sites are co-located with fish and macroinvertebrate sites.

Sediment samples will be analyzed for the parameters listed in Table 5.

TABLE 5. Summary of sediment analyses.

Analysis	Analytical Method
Total Metals	SW 3050/6020
Hg	SW 3050/7471
Total Cyanide	SM 4500CN-E
Chloride	EPA 300.0
Fluoride	EPA 300.0
Sulfate	EPA 300.0
Ammonia as N	SM 4500NH3

EPA — 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.

SW — U.S. EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Third edition, September 1986.

6. WATER-CHEMISTRY SAMPLING

6.1 Surface-water Sampling

6.1.1 DH-81 Depth-Integrated Sampling

Analytical samples will be collected using an equal-discharge, depth-integrated technique. Depth-integration collection will be conducted using a DH-81 depth-integrated sampler where adequate depths permit its use. Depth-integration in shallow streams will be completed with a grab sample that is depth-integrated by hand. Equal-discharge collection will be 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. Individual depth-integrated samples will be composited in a 5-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 will be collected. The only exception will be the collection of low-level mercury with a grab sample. Methods for depth-integrated sampling are described below:

1. Label sample bottles with sample site, analysis, date, time, sampler, and “HDR Pebble Project.”
2. Visually check DH-81 suspended sediment sampler for damage.
3. Decontaminate all parts of sediment sampler used including nozzle, body, gasket, and sample bottle. Spray with an Alconox solution and rinse several times with lots of deionized water.
4. Locate sampling sites by dividing the stream into areas with equal discharge. A minimum of four subsections should be sampled. If more sample volume is required, more subsamples will be taken by dividing the stream into more areas of equal discharge.

5. At the selected stream location, lower the sediment sampler into the stream with one continuous motion, making sure the sampler handle is vertical. Lower the sediment 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 5-gallon bucket.
6. Repeat procedure until at least eight bottles have been collected.
7. Put on nitrile gloves and collect analytical samples from composite sample in 5-gallon bucket using a decontaminated dipper to pour water into the bottles. Do not allow bottle to fill completely such that preservative is not lost.
8. Fill out appropriate field form documenting sampling location, time, and other pertinent information before leaving sampling site.

6.1.2 Grab Sampling

Decontaminate sampling collection container if employed. After decontamination, put the double rinse collection container in stream water at a location downstream of the sampling point. In many cases, grab samples will be taken directly into the sample bottles and no decontamination will be necessary.

Procedures for collecting grab samples are outlined below:

1. Label sample bottles with sample site, analysis, date, time, sampler, and "HDR Pebble Project."
2. Locate sampling site at a point in the stream exhibiting greatest flow and/or highest velocity.
3. Put on nitrile gloves and submerge sample collection container or sample bottle at sampling point such that mouth of container is 2 to 3 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 not lost.
4. Pour sample into sampling bottles if sampling collection container is used.
5. Fill out appropriate field form(s) documenting sampling location, time, and other pertinent information before leaving sampling site.

6.1.3 Sample Filtration

All dissolved metals samples will be filtered within 12 hours of the time 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 "HDR Pebble Project."
2. Put on nitrile gloves. Run silicone tubing through the peristaltic pump and attach a 0.45 micron filter cartridge to the end of the tubing. Place the other end of the tubing in the total metals sample bottle.
3. Fill the dissolved metals sample container.

4. If extremely turbid sample water is obtained, use same procedure using pre-filter (usually 3.0 micron) followed by 0.45 micron filtration.
5. Put dissolved metals sample bottle with other bottles from same site to be packaged for shipping.

6.2 Sampling Equipment Decontamination

Sampling equipment that will be decontaminated prior to collecting samples includes the DH-81 collection bottle, cap, and nozzle and the 5-gallon bucket used for compositing samples. Methods for decontaminating sampling equipment are outlined below:

1. Spray all parts of the equipment using a pre-mixed Alconox and Global deionized water solution. If there is obvious sediment or biological material on the equipment, use a brush to remove material.
2. Rinse the equipment using deionized 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 will be used:

1. Pour warm deionized water into the bucket or DH-81 sample bottle and scrub thoroughly with a clean brush.
2. Rinse the equipment using warm deionized 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.

6.3 Sample Handling

Samples will be stored in the field in coolers with frozen gel-ice at the method-required range of 4°C (+/- 2°C). If the sample coolers approach the warm end of the temperature range, coolers will be shipped via helicopter to Shaw staff at base camp to ensure that sample temperatures are maintained. The appropriate chain-of-custody procedures will be maintained in the event that samples are shipped via helicopter without the sampler present. During winter sampling events, samples are kept in plastic bags until transfer to Shaw staff at base camp at the end of each day.

Table 6 lists the sample containers, sample volumes, container types, and preservation requirements.

TABLE 6. Sample containers, sample volumes, container types, and preservation requirements.

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	E1631	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 Metals (2)	E200.8/200.7	HNO ₃	6 months	None	Filtered
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				
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	H ₂ SO ₄	28 days	4°C	Unfiltered
			Phosphorus total	E365.3				
			Nitrate-nitrite total	E300.0, E353.2				
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		7 days		
			Alkalinity	2320B		14 days		
			Acidity	305.2		14 days		
			Specific conductance	SM2510B		28 days		
			pH	E150.1		24 hours		
			Chloride	E300.0		28 days		
			Fluoride	E300.0		28 days		
			Sulfate	E300.0		28 days		

Analytical Set	Bottle Type (SGS/NCA)	Bottle Type (CAS)	Analysis	Lab Method	Preservative	Hold Time	Req. Temp.	Comments
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	H ₂ SO ₄	28 days	4°C	Unfiltered
9	(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
10	(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
11	(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

BTEX = benzene, toluene, ethylbenzene, xylene

MS/MSD = matrix spike/matrix spike duplicate

PCB = polychlorinated biphenyl

TDS = total dissolved solid

TSS = total suspended solid

6.3.1 Sample Identification

Sampling locations will be identified on the field forms and in the log books. Sample identification will follow the methodology described below:

0105CR199ASW001

Where 0105 is the month and year (January 2005),
CR199A is the location ID (see Figure 1),
SW is the matrix code for surface water, and
001 is a sequential sample number.

Additional matrix codes to be used under this field sampling plan include:

SP for seeps

Additional sequential sample numbers are as follows:

201 – field duplicates,
301 – field triplicates,
401 – field equipment rinse blanks,
501 – deionized water blanks, and
601 – trip blanks.

For trip blanks, laboratory codes are used for the station ID. The only trip blanks included under this field sampling plan are for low-level mercury analyses that will be submitted to Columbia Analytical Services and North Creek Analytical. Sample identification for a mercury trip blank collected in January 2005 is 0105CASKTBSW601 for CAS and 0105NCAPTBSW601 for NCA. If additional trip blanks are used on the same date, increase the sequential sample number to 602, etc.

6.4 Sample Custody

Samples will be kept with field staff during the day unless warm conditions or excess weight on the helicopter become an issue, at which point they will be sent back to Shaw staff at base camp. The appropriate sample custody procedures—which include signatures, dates, and times by both the person in possession of the samples and the receiver of the samples—will always be followed during sample transfer. This may include transfers between samplers and Shaw staff. HDR will enter samples in the Shaw Transfer Log at the end of each day.

Chain-of-custody (COC) forms will accompany each cooler shipped to analytical laboratories. The e-Chain program will be used to generate electronic COC forms by a Shaw Environmental Sample Custodian. Once the COC form is completed, insert the COC form in a ziplock bag and seal the bag. Tape the ziplock bag with the COC form to the inside of the cooler lid. Other chain-of-custody components will include sample labels, custody seals, field notebook, cooler tracking log, sample shipment receipts, and the laboratory logbook.

Sample coolers will be packed by a Shaw Environmental Sample Custodian according to the following procedures:

1. Place a layer of bubble wrap in the bottom of the cooler and around the sides.
2. Place glass containers in individual bubble-wrap sleeves. Place sample containers and temperature blank on the bubble wrap.
3. Secure containers from tipping over by placing packing material in/around containers; frozen gel-ice will also be used where possible.
4. Place a minimum of two layers of frozen gel-ice over the containers. Pack coolers with 50 percent gel-ice and 50 percent samples.
5. Place bubble wrap over the gel-ice and fill remaining void space to secure containers from vertical movement.
6. Close cooler and secure the lid with strapping tape by wrapping tape around the entire cooler and back onto itself. Press tape to secure it to cooler, especially on the bottom to prevent tape from ripping when coolers are slid across a surface.
7. Attach two signed, dated, and timed custody seals onto cooler lid, one on the front and one on the back of the cooler.
8. Attach shipping label that includes the chain-of-custody ID to the top of cooler.
9. Complete the Anchorage to Iliamna columns in the Cooler Tracking Form.

Sample coolers will be shipped from Iliamna, to Anchorage via Iliamna Air Taxi (or other airport-to-airport service) where a Shaw Environmental Cooler Custodian will receive them, packs the coolers, and arranges delivery to one of three analytical laboratories. Coolers designated to go to SGS will be hand delivered, and coolers designated to go to Columbia Analytical Services (CAS) and North Creek Analytical (NCA) will be shipped by Alaska Airlines Gold Streak (or other airport-to-airport equivalent). The following procedures provide shipping protocol for shipping laboratory samples from Iliamna to analytical laboratories.

1. Complete and place the following shipping information on the coolers for shipment from Iliamna to Anchorage:
Shaw Environmental, Inc.
Anchorage Alaska
NOTIFY ON ARRIVAL: Shaw Environmental 243-6300
COOLER Identification Number:
2. Place "Keep Chilled" labels on the coolers.
3. Deliver the samples to Iliamna Air Taxi (or other airport-to-airport service) and complete the airbill information for shipment. Write on the airbill:
Shaw Environmental, Inc.
Anchorage Alaska
NOTIFY ON ARRIVAL: Shaw Environmental 243-6300
"KEEP COOL"

4. Complete the Cooler Tracking Log for Iliamna to Anchorage shipping and convey the information to the Shaw Environmental Cooler Custodian in Anchorage as soon as possible.

After the coolers arrive in Anchorage, the Shaw Environmental Cooler Custodian will immediately take possession of the coolers and will use the following protocol to deliver the coolers to the appropriate laboratory.

1. Complete the time and date received and custody seal time and date columns in the Cooler Tracking Log.
2. Verify all coolers that were shipped have been received.
3. Evaluate necessity for gel-ice change-out. For coolers shipped to CAS and NCA, evaluate if the time and date recorded on the custody seal is recent enough (within 12 hours) to ship the coolers to the destination laboratory and keep the samples at 4°C or less. Take into account the following information for the time required for coolers to arrive at the destination laboratory:
 - a. CAS has courier service available to pick up samples at the Portland Airport Monday through Friday. Delivery to the lab is a minimum of one hour depending on other pickups in the Portland area. CAS sample receiving hours are from 8AM to 5PM Monday through Friday and from 8AM to 2PM on Saturday. CAS does have swing-shift staff working to receive samples and put them into cold storage if they arrive after normal business hours. On the day before a Saturday delivery, the Shaw Environmental Sample Custodian will contact CAS and notify them of all sample shipments and airbill numbers and arrange for Saturday delivery.
 - b. NCA has courier service to pick up samples from the Portland airport for delivery to their lab. NCA will be notified of the shipment, its airbill number, and its arrival. NCA sample receiving will be notified on weekdays. NCA sample receiving is from 7AM to 6PM, Monday through Friday. NCA is typically closed on weekends, and arrangements need to be made the previous Friday for weekend receiving.
 - c. SGS sample receiving is Monday through Friday 8AM to 6PM and sometimes on Saturday from 9AM to noon by prior arrangement. Saturday delivery will be coordinated the previous day.
4. Ship the coolers going to CAS and NCA via Alaska Airlines Gold Streak (or other airport-to-airport equivalent) as soon as possible. Samples shipped to CAS and NCA need to be shipped to the Portland airport. Shipping samples from Anchorage to Portland can take from 5 to 9 hours to arrive. During normal business hours, samples shipped from Anchorage at noon will be available for pickup in Portland the following morning. Thus, any shipments on Friday will not be picked up until Monday unless special arrangements are made. In this situation, the Cooler Custodian will emphasize to the shipper that the coolers must be kept chilled and that they have sufficient gel-ice. If coolers cannot be chilled, the Cooler Custodian will store the samples over the weekend in a refrigerator. For samples that are held in the Shaw Environmental office, COC procedures will be adhered to. The samples that are held over will be repacked with frozen gel-ice and shipped as soon as possible. Write the following information on the airbill:

"By Way of Portland" for samples shipped to CAS.

"KEEP CHILLED"

"Notify On Arrival:" (enter respective name and number of lab contact from information provided below)

5. Hand deliver the coolers going to SGS in Anchorage.
6. Complete the date and time shipped, shipping method, airbill number, and shipped to columns on the Cooler Tracking Log.
7. Contact the respective lab and inform them of cooler shipment, airbill number, and anticipated arrival time. Complete the contact date and time column in the Cooler Tracking Log.
8. Continue tracking the shipped coolers until the laboratory receives them and takes custody. Complete laboratory time and date columns in the Cooler Tracking Log.

Laboratory Contacts: The following are the addresses and contacts for the respective laboratories.

COLUMBIA ANALYTICAL SERVICES, INC.

1317 S. 13th Ave
Kelso, WA 98626-284
Phone: (360) 577-7222
Fax: (360) 636-1068
Project Chemist: Lynda Huckestein
LHuckestein@kelso.caslab.com
Direct: (360) 501-3358

NORTH CREEK ANALYTICAL

9405 SW Nimbus Avenue
Beaverton, OR 97008-7132
Phone: (503) 906-9200
Fax: (503) 906-9210
Project Chemist: Crystal Jones
CJones@ncalabs.com
Direct: (503) 906-9234

SGS/CT&E ENVIRONMENTAL SERVICES

200 W Potter Dr
Anchorage, AK 99518-1605
Phone (907) 562-2343
Fax (907) 561-5301
Project Chemist: Steven R. Crupi
steve_crupi@sgs.com

6.5 Field Quality Control Samples

6.5.1 Deionized Water Blank

One deionized water blank will be collected for each sampling event for total metals. The deionized water used for decontamination will be collected in an empty total metals analysis bottle and submitted to the primary laboratory. The water for the deionized blank is provided by the laboratory conducting the analysis. Deionized water blanks are required for primary and QA laboratories.

6.5.2 Equipment Blank

Equipment blanks will be collected at a frequency of 5 percent and submitted for dissolved metals analysis. The procedure for collected the equipment blank is outlined below:

1. Decontaminate the DH-81 and 5-gallon bucket as described in Section 6.2 after sampling at a site.
2. Pour deionized water into the DH-81 sample bottle and dispense through the nozzle into the 5-gallon bucket.
3. Label the dissolved metals bottle with “equipment blank,” the sample site previous to collection, analysis, date, time, sampler, and “HDR Pebble Project.”
4. Collect the dissolved metals sample from the 5-gallon bucket.

6.5.3 Trip Blank

Trip blanks will be provided for the low-level mercury and VOCs analyses and will accompany the field staff into the field for each field day. The trip blank that accompanies the field team at each sampling site will be noted on the sampling form. At the end of each field day, the trip blank will be provided to Shaw staff and will be packaged and sent with the samples that it accompanied during the field day.

6.5.4 Field Duplicates

Field duplicates are the quality control sample and will be collected at a frequency of 10 percent during all sampling events for all parameters and will be analyzed by the primary laboratory.

6.5.5 Field Triplicates

Field triplicates are the quality assurance sample and will be collected at a frequency of 10 percent during all sampling events for all parameters and will be analyzed by the QA laboratory.

6.5.6 Matrix Spikes

Matrix spikes will be collected at a frequency of 10 percent during all sampling events for analysis by the primary laboratory. Matrix spikes are not required for QA samples.

7. MEASUREMENT OF FIELD PARAMETERS

7.1 Parameters

Two field meters (YSI 556 and Hach 2100P) will be used to measure the following parameters: specific conductance, temperature, pH, dissolved oxygen, oxidation-reduction potential, and turbidity. The procedure for collecting field measurements is outlined in Section 7.4.

7.2 Equipment Calibration and Quality Control

7.2.1 YSI 556

The YSI 556 meters will be calibrated for four parameters: dissolved oxygen, pH, specific conductance, and oxidation-reduction potential (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 deionized 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.

Conductivity:

1. On the calibrate screen, select conductivity and press enter.
2. Select specific conductance and press enter. Note that calibrating to specific conductance will also calibrate conductivity and salinity.
3. Place 55 ml of the 1.413 $\mu\text{S}/\text{cm}$ 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 $\mu\text{S}/\text{cm}$. Note that the value for specific conductivity is always in $\mu\text{S}/\text{cm}$ 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.

Dissolved Oxygen:

1. On the calibrate screen, select dissolved oxygen and press enter.
2. Select DO% and press enter. Note that calibrating to DO% will also calibrate dissolved oxygen (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. Barometric pressure (BP) 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 Hg to millimeters (mm) Hg and to adjust for the local elevation in the mine area:
 - a. Corrected BP (inches Hg) x 25.4 = Corrected BP (mm Hg)
 - b. True BP = Corrected BP (mm Hg) – (2.5 * (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.

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 solutions should have been recorded during the conductivity calibration for the pH and ORP.

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 deionized 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.

ORP:

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 solutions should have been recorded during the conductivity calibration for the pH and ORP.
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.

7.2.2 Hach 2100P Turbidimeter

Routine calibration checks will be performed on the 2100P Turbidimeter using the Gelex secondary turbidity standards. The Gelex standards must have values assigned to them immediately after calibration has been performed with formazin in order to be used for checking the calibration in the future. These standards will be used as a calibration check prior to every field day. If the readings are outside 5 percent accuracy, the instrument will be recalibrated using the StablCal stabilized formazin standards. A recalibration will be performed at a minimum of once every three months. Methods for calibrating the turbidimeter using the formazin standards, assigning values to the Gelex secondary standards, and checking the calibration are outlined below.

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 <0.1 nephelometric turbidity units (NTU) should not be shaken.
 - a. Shake the standard vigorously for 2 to 3 minutes to resuspend any particles.
 - b. Allow the standard to stand undisturbed for 5 minutes.
2. Gently invert the bottle 5 to 7 times.
3. Prepare the sample cell.
 - a. Clean the cell using an Alconox solution and a deionized 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 it is calibrating the first standard at 0 NTU.
6. Rinse the sample cell one time with the standard and discard the rinse.
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.

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 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.

Checking calibration:

1. Check the instrument calibration using the Gelex standards.
2. If the readings are not within 5 percent of the previously established values, recalibrate using the StablCal stabilized formazin standard.

7.3 Equipment Maintenance and Decontamination

Field meters will be decontaminated prior to calibration or if there is visible sediment or biological material on the probe or sensors. Decontamination procedures are outlined below:

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

Maintenance procedures for the Hach 2100P that will be performed in the field include cleaning and battery and lamp replacement. Maintenance for the YSI 556 includes cleaning of sensors and replacement of the dissolved oxygen membrane. 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 are insufficient, the instruments will be sent to their respective manufacturers for repair.

7.4 Collection of Field Measurements

YSI 556

1. Turn the YSI 556 on and place the probe module in the YSI confidence solution and check the readings. If the pH does not agree within 0.1 units or the other parameters are not within 5 percent, recalibrate the instrument.
2. Place the probe in the stream and allow it to equilibrate at least 5 minutes or until the dissolved oxygen is steady prior to recording the readings for pH, specific conductance, dissolved oxygen, and ORP.

Hach 2100p

1. Decontaminate the sample cell using an Alconox solution and several rinses with deionized water. Be careful to handle the cell by the top to avoid smudging or scratching the glass.
2. Collect the sample from the stream or seep in a clean container, transfer to the sample cell, and cap the sample cell.
3. Wipe the cell with a clean, lint-free cloth to remove fingerprints and water.
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 for turbidity.

8. RECORD KEEPING

All records will be made in waterproof ink unless weather conditions prevent its use. Corrections will be made by drawing a line through the corrected entry and initialing and dating the line. All corrections will remain legible.

8.1 Field Log Books

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

8.2 Field Forms

Field forms will be used to record all field data, including the location of the sampling station (Table 7 and Figure 1), recorded measurements, and primary and quality control samples collected at the site (see Appendix A). Improvements to field forms may be made throughout the year as needed.

TABLE 7. 2005 hydrology and surface-water-quality site locations.

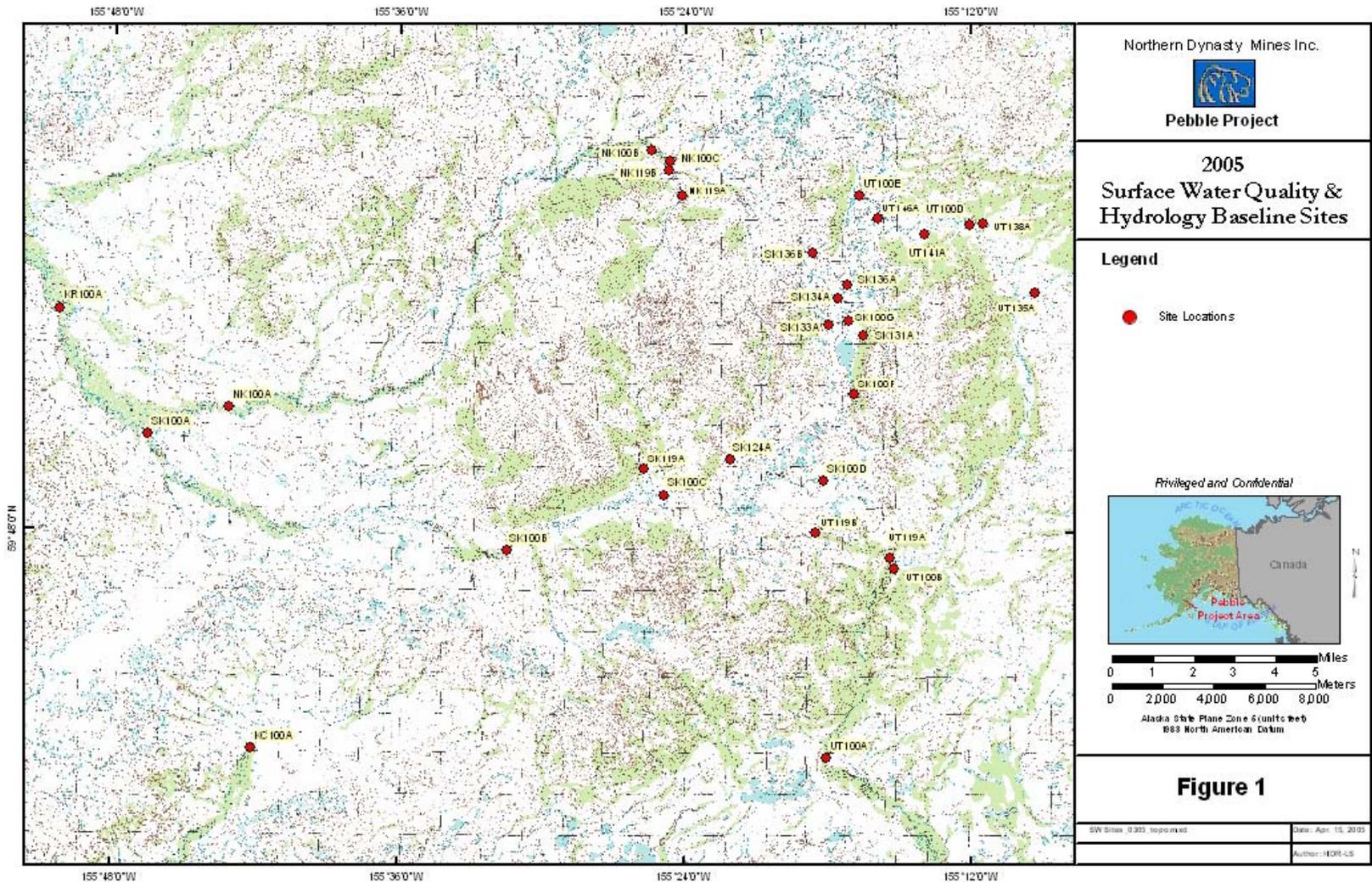
Site ID	Degrees, Decimal Minutes		Decimal Degrees	
	WGS 84		WGS 84	
	Longitude	Latitude	Longitude	Latitude
KC100A	W155.°42.129'	N59.°43.402'	-155.702150	59.723367
KR100A	W155.°50.262'	N59.°52.660'	-155.837700	59.877667
NK100A	W155.°43.136'	N59.°50.584'	-155.718933	59.843067
NK100B	W155.°25.541'	N59.°26.073'	-155.425700	59.934550
NK100C	W155.°24.595'	N59.°55.822'	-155.409917	59.930367
NK119A	W155.°24.104'	N59.°55.088'	-155.401700	59.918130
NK119B	W155.°24.703'	N59.°55.633'	-155.411717	59.927217
SK100A	W155.°46.545'	N59.°50.010'	-155.775750	59.833500
SK100B	W155.°31.452'	N59.°47.591'	-155.524200	59.793183
SK100B2	W155.°48.652'	N59.°26.329'	-155.43881	59.81086
SK100C	W155.°24.857'	N59.°48.777'	-155.414283	59.812950
SK100D	W155.°18.159'	N59.°49.084'	-155.302650	59.818067
SK100F	W155.°16.877'	N59.°50.909'	-155.281283	59.848483
SK100G	W155.°17.083'	N59.°52.457'	-155.284717	59.874283
SK119A	W155.°25.693'	N59.°49.326'	-155.428217	59.822100
SK124A	W155.°22.009'	N59.°41.523'	-155.366816	59.692200
SK131A	W155.°16.503'	N59.°52.146'	-155.275050	59.869100
SK133A	W155.°17.917'	N59.°52.369'	-155.298617	59.872817
SK134A	W155.°17.577'	N59.°52.937'	-155.292950	59.882283
SK136A	W155.°17.182'	N59.°53.222'	-155.286367	59.887033
SK136B	W155.°18.639'	N59.°53.887'	-155.310650	59.898117
UT100A	W155.°18.013'	N59.°43.241'	-155.300217	59.720683
UT100B	W155.°15.215'	N59.°47.215'	-155.253583	59.786917
UT100D	W155.°11.995'	N59.°54.481'	-155.199917	59.908017
UT100E	W155.°16.637'	N59.°55.090'	-155.277283	59.918167
UT119A	W155.°15.372'	N59.°47.461'	-155.250600	59.791020
UT119B	W155.°18.466'	N59.°47.977'	-155.307767	59.799617
UT135A	W155.°09.289'	N59.°53.042'	-155.154817	59.884033
UT138A	W155.°11.430'	N59.°54.510'	-155.190500	59.908500
UT141A	W155.°13.913'	N59.°54.295'	-155.231883	59.904917
UT146A	W155.°15.884'	N59.°54.625'	-155.264733	59.910417

9. FIELD PERFORMANCE AND SYSTEM AUDITS

During the March 2005 sampling event, Shaw Environmental, Inc., performed a field performance and system audit based on the 2004 sampling plan. A Shaw employee accompanied each field team to the field to audit compliance with the protocols for both hydrology and water-quality monitoring. Sample handling and equipment calibration and maintenance procedures also were reviewed at base camp. The audit results were provided by Shaw staff to HDR field members and reviewed to ensure that field sampling protocols are being followed or modified appropriately when necessary in order to meet the data quality objectives. Based on the methods provided in this 2005 field sampling plan, a second audit will be performed during one field event in the summer.

10. REFERENCES

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Appendix A:

Surface-water Quality and Hydrology Field Form

June 2005
 Discharge/ Water Quality Measurements
 Pebble Project - Mine Site

Station ID:	Date:	Start Time :	End Time:	GPS - Lat:
Team:			Site Observer/ Bear Guard:	
Photos:		Camera:	Weather: Air ° (F) (C)	Wind: Precip:
Sample Matrix: (SW) (Seeps) (Sediments): Streams Lakes Seeps				
Seep Measurement Method: (Weir) (Direct catch estimate) (Flow channel estimate)				Estimated % Capture:
HYDROLOGY				
Method: (Wade) (Ice) (Boat)		Type of meter: (M. McBirney) (AA) (Pygmy)		Meter #: Spin test: (Y) (N)
Gage Height:	Time:	Measurement estimated error: (Excellent) (Good) (Fair) (Poor)		
Based on following conditions:				
WATER QUALITY				
<u>In-situ Field Parameters</u>		<u>Meter Readings</u>		Additional Comments:
Meter Make and Model: _____		Temperature: _____ °C		_____
Meter Make and Model: _____		Conductivity: _____ mS/cm		_____
Meter Number: _____		DO: _____ % saturation		_____
Sample Type		DO: _____ mg/L		_____
Duplicate:	Y N	pH _____ STD units		_____
Triplicate:	Y N	ORP: _____ mV		_____
MS/MSD:	Y N	Turbidity: _____ NTU		_____
<u>Sketch, Notes and Remarks</u>				

June 2005
Instantaneous Flow Measurements
Pebble Project - Mine Site

Site: _____
 Date: _____
 Time: _____
 Team: _____

Type of meter: (M. McBirney) (AA) (Pygmy)
 Meter #: _____

Measurement No.: 2005 - 5

Angle Coef.	Notes	Section #	Dist.	Depth	VELOCITY			Time	Revo- lutions	Adjust for Angle Coef.	Adjusted Velocity	Area	Discharge	Description
					At Depth .6	At Depth .2	At Depth .8							
(deg)			(ft)	(ft)	(fps)	(fps)	(fps)	(sec)			(fps)	(s.f.)	(cfs)	
	Bank	0												
		1												
		2												
		3												
		4												
		5												
		6												
		7												
		8												
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		32												
		33												
		34												
		35												
TOTAL														