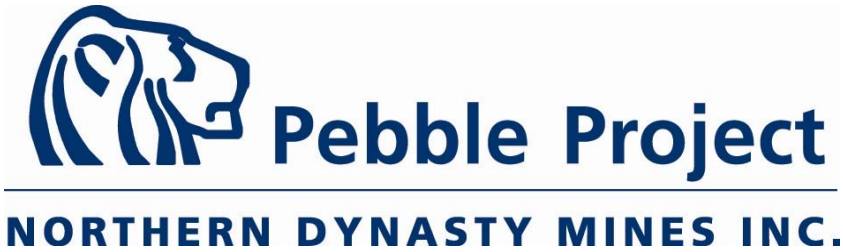

DRAFT ENVIRONMENTAL BASELINE STUDIES

FIELD SAMPLING PLAN

CHAPTER 11. FISH AND AQUATIC HABITAT

LAKE ILIAMNA STUDY

NOVEMBER 2005

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Appendix

Acronyms

QAPP	quality assurance project plan
QA	quality assurance
NDM	Northern Dynasty Mines Inc.
ORP	oxidation reduction potential
GPS	global positioning system
DI	deionized
SGS	SGS Environmental Services Inc.
NCA	North Creek Analytical Services Inc.
CAS	Columbia Analytical Service
MS	matrix spike
MSD	matrix spike duplicate
HDPE	high density polyethylene
TDS	total dissolved solids
TSS	total suspended solids
ml	milliliter(s)
VOA	volatile organic analysis
VOC	volatile organic compound
SVOC	semivolatile organic compound
BTEX	benzene, toluene, ethylbenzene, and xylenes
PCBs	polychlorinated biphenyls
L	liter(s)
oz	ounce
PAH	polyaromatic hydrocarbon
mS/cm	milliSiemens/centimeter

1. Introduction

This field sampling plan provides the protocol that is followed during the Iliamna Lake study. This plan describes in detail the methods for collection of water-quality, sediment, mussel-tissue, and zooplankton samples and the procedures for storage, handling, and shipping of samples. While every effort will be made to follow the protocols and timing outlined in this sampling plan, it should be noted that weather, field conditions and boating conditions are likely to be variable during the course of this program, and sampling protocols and timing may be modified in response to these conditions.

2. Project Background

2.1 Project Purpose and Scope

Northern Dynasty Minerals, Ltd., a Canadian company based out of Vancouver, British Columbia, and its U.S. affiliate Northern Dynasty Mines, Inc., are proposing an open-pit mining operation in southwestern Alaska. The prospect contains gold, copper, molybdenum, and silver deposits. The site is located approximately 15 miles north of Lake Iliamna within the eastern drainage of the Mulchatna River. It is on the divide separating the watersheds of Upper Talarik Creek and the south fork of the Koktuli River. NDM has launched extensive programs to collect data on engineering, environmental, and socioeconomic aspects in preparation for the permitting process.

In 2005 a series of biological sampling locations will be established in the northeastern portion of Lake Iliamna. Data collected at these sampling sites will be used to determine baseline conditions and to provide a basis for detecting potential changes in the waterbody.

Ambient water-quality conditions, water-chemistry samples, and zooplankton will be collected at five sites in the lake once per month for six consecutive months (May through October). In addition, organics, sediment, and mussel tissue will be collected during the June and September sampling efforts.

2.2 Project Site Description

The study area is located in the northeast portion of Lake Iliamna, is bounded on the west by the confluence of Upper Talarik Creek with Lake Iliamna, and extends eastward as far as the port site at Pile Bay Village (Figure 1). These boundaries allow the study to incorporate runoff from the mine area (via Upper Talarik Creek), three potential barge-landing sites, and representative rivers that are hydrologically up-gradient of the north shore of the lake.

The five nearshore sampling sites will be located in Pile Bay, Knutson Bay, Northeast Bay (just east of Iliamna boat dock), Roadhouse Bay, and at the mouth of Upper Talarik Creek. Activities

at the sites will involve both surface and benthic sampling. Sites were chosen based on their proximity to the proposed road alignment, barge-landing sites, and currently populated villages.

3. Project Scope and Objectives

3.1 Objectives

The objective of the Iliamna Lake study is to establish baseline conditions in the lake relative to chemical and physical water quality, trace metals in sediments, zooplankton diversity, and contaminant levels in mussel tissue. Collection of these data will supplement the ongoing investigations of fresh-water systems in the project area.

3.2 Sample Analysis Summary

Samples of water, sediment, and mussel tissue collected for analysis will be analyzed by the laboratory for the parameters defined in the *Draft Environmental Baseline Studies, 2005 Final Quality Assurance Project Plan* (QAPP; NDM, 2005). Reports will be sent to the quality assurance (QA)/quality control (QC) manager and Northern Dynasty Mines Inc. (NDM) by the laboratory.

Samples collected for zooplankton will be processed and identified by laboratory technicians at HDR Alaska Inc. A final report with results will be prepared and delivered to NDM in early 2006.

4. Project Organization and Responsibility

4.1 Project Team

The project will be managed by Andra Love, Senior Environmental Scientist at HDR Alaska Inc. She will be responsible for assigning tasks and ensuring that protocols are followed. Rebecca Moore will act as the Assistant Project Lead for this study. Field collection will be performed by a three-person team. Additional team members may be added during May for mussel-bed reconnaissance and in June and September for mussel and sediment collections. Shaw Environmental Inc. will be responsible for filling out electronic chain-of-custody forms (e-Chain) for samples that will be sent to the laboratory for analysis.

4.2 Subcontractors

Tony Yeo, with the University of Alaska Anchorage, will be providing advice on sampling methods and statistical analyses. The Environment and Natural Resources Institute (ENRI) will provide QA/QC on the zooplankton identifications performed by HDR Alaska Inc. John Baechler will provide transportation services by boat between sites on Iliamna Lake.

5. Field Activities Summary

Sample collection for the Iliamna Lake study will include surface and subsurface water samples, sediment samples, mussel-tissue samples, and zooplankton tows. Ambient water conditions (field parameters) also will be measured and recorded. The following is a summary of field activities to occur at each site.

- Dissolved oxygen, pH levels, specific conductance, oxidation reduction potential (ORP), and temperature will be measured at each sampling location.
- A secchi disk reading will be recorded at each location.
- Water-chemistry samples will be collected at three depths from each location. Water samples will be unfiltered except for the dissolved metals sample. During the June and September sampling efforts, additional water samples will be collected to analyze for organics. Two additional sets of samples will be collected for purposes of duplicate and triplicate samples. All samples will be shipped to the appropriate laboratories by Shaw Environmental Inc. Primary and duplicate samples will be analyzed at SGS and triplicate samples will be analyzed by CAS.
- During June and September, sediment samples will be gathered at five locations. Duplicate and triplicate samples will be collected at one of the five sampling location. All samples will be shipped to the appropriate laboratories by Shaw Environmental Inc. Samples will be sieved at the laboratory and analyzed for a designated suite of trace metals. Primary and duplicate samples will be analyzed at SGS and triplicate samples will be analyzed at CAS.
- One vertical zooplankton tow will be conducted at each site. Three zooplankton tows will be collected at one of the five sites to provide duplicate and triplicate samples. Zooplankton from each tow will be stored separately in plastic bottles and preserved in alcohol within 24 hours. Samples will be transported to the HDR laboratory for later taxonomic identification.
- Ten mussel-tissue samples (or enough to achieve 75 grams of wet weight) will be collected at each site. Whole samples will be stored double-bagged in Ziploc bags and frozen. Samples will be shipped on gel-ice by Shaw Environmental Inc. Tissue will be analyzed for a designated suite of trace metals at the appropriate laboratories. Primary samples will be analyzed by CAS. CAS will divide tissue for duplicate and triplicate samples and ship to North Creek Analytical for analysis.

6. Analytical Sample Collection and Handling

6.1 Sampling Procedures

Upon arrival at the sampling location, the boat will be anchored and turned off. Sampling equipment will be prepared by one scientist while another team member records site-specific information and ambient water-quality measurements. Notes will be recorded on a field form

created for the lake study or in field notebooks in accordance with the procedures outlined in the QAPP (NDM, 2005). The information recorded will include date and time, site conditions, station identification (global positioning system [GPS] and landmark features), sampler identification, weather observations, sample location depths, number of samples/sample containers at the site, and presence of notable biological species.

To avoid stirring the water column, every attempt will be made to collect samples in the following order (note that this order may change in the instance of challenging weather or boating conditions):

1. Field parameters measured and recorded, thermocline established (Section 7).
2. Water-chemistry samples collected: 1 meter, thermocline (or half-depth), and 1 meter from substrate (turbidity sample also collected at this time).
3. Plankton tow sample(s) collected.
4. Secchi disk measurement recorded (Section 7).
5. Sediment sample(s) collected.
6. Mussel sample collected.

6.1.1 Surface and Sub-Surface Water Collection

Water samples will be collected monthly from the five sampling stations (Figure 1) from May through October to characterize and establish baseline water-quality conditions in Iliamna Lake. Sample sites will be accessed by boat operated by a local hire. Exact sample locations will be marked with a handheld GPS. Water samples will be analyzed for a suite of trace metals and analytes as specified in the QAPP (NDM, 2005). Samples for organics analyses will be collected only in June and September. The processing of water samples (filtration, when necessary), handling, and transport to the analytical laboratories will follow procedures outlined in the QAPP.

Water-chemistry samples will be collected at three depths using an 8-liter Model 1010 Niskin water sampler for a total of three samples per site. The Niskin sampler will be used to collect a sample approximately 1 meter below the surface of the water, then at the mid-point of the thermocline (or at the mid-point of the total depth at the site), and finally at 1 meter above the substrate on the lake bottom. Every attempt will be made to collect the water samples in that order to avoid water-column mixing.

The Niskin sampler will be lowered until the top of the unit is at the desired sample depth. A messenger will be dropped down the line to trigger the sample bottle to collect the water at the specified depth. The sampler will be raised to the boat for sample volume extraction. All Niskin handling will be conducted by a gloved scientist designated as the “dirty hands” technician. A gloved “clean hands” technician will be responsible for handling the prepared laboratory bottles, lids, and/or other containers and will physically place the container into the cooler. Sampling will continue until all three depths have been sampled with all scientists changing gloves between samples. Sample equipment will be made of non-metallic materials and will be properly cleaned between samples and between sites (Section 6.2).

6.1.2 Zooplankton Collection

Zooplankton tows will occur during all six sampling events, May through October. One vertical tow will occur per site. Three tows will be collected at one site during each sampling event for duplicate and triplicate QC purposes.

Sample tows will be taken at a depth of 20 meters (or at the substrate depth) using an 80-micrometer-mesh tow net. The net will be lowered until the mouth reaches the bottom or a depth of 20 meters and then will be raised at a constant speed to collect the sample. The net will be lifted out of the water and rinsed from the outside to wash organisms from the side of the net into the attached sample bucket. The sample bucket will be removed, and the net will be turned inside out and rinsed into a white tray. The sample and rinse water will be transferred to a plastic container and will be preserved with alcohol within 24 hours. Samples will be transported to the HDR laboratory with HDR scientists at the completion of each field event. At the laboratory, samples will be processed in accordance with the zooplankton section of *Standard Methods for the Examination of Water and Wastewater* (APHA, 1998).

6.1.3 Sediment Collection

Sediment samples will be collected during the June and September sampling events. Sediment will be extracted from the substrate at Pile Bay, Knutson Bay, Northeast Bay, Roadhouse Bay, and at the Upper Talarik outlet (Figure 1) after water-quality and zooplankton collections have occurred. In addition, sediment samples may be collected from the mussel bed locations in September. Samples will be collected with an Ekman dredge sampler and a flat-bottom container that will be cleaned as described in Section 6.2. Samples will be transferred from the flat-bottom container to clean sample bottles provided by the laboratory. Sample bottles will be transferred to Shaw Environmental Inc. personnel in Iliamna for transportation to the appropriate laboratories.

6.1.4 Mussel Collection

Mussels will be collected during the June and September sampling events. For reconnaissance purposes, in May mussel beds will be located and an estimated ratio of mussel size to wet weight will be determined with a small hand-held spring-loaded scale. During the June sampling event, mussels will be collected at each site (assuming mussels are present at each site). If no mussels are present at the site, the field team will locate mussel beds near the site, when possible. Enough mussels will be collected to achieve 75 grams of wet weight (approximately 10 mussels as estimated before field reconnaissance).

At each sample site the collected mussels will be kept whole, double-bagged in Ziploc bags, and labeled in accordance with procedures in the QAPP (NDM, 2005). A laboratory split will provide duplicate and triplicate QC samples. The mussels will be frozen and then placed on gel-ice for shipping to the appropriate laboratories by Shaw Environmental Inc.

6.2 Sampling Equipment Decontamination

For water-chemistry, sediment, and mussel-tissue collections, a “clean hands” and a “dirty hands” technician will be established. The “clean hands” technician will be responsible for handling the sample bottles, removing and replacing sample-bottle lids, storing the bottles in the sample cooler, and handling of all the gel-ice packs. The designated “dirty hands” technician will be responsible for handling the sampling equipment, taking notes, and opening and closing of the sample cooler. This technician will lower the Niskin sampler, send down the messenger, raise the sampler, and prepare the sampler for transfer of the collected water to the sample bottles. All technicians will wear powder-free latex gloves.

To determine the most effective cleaning method for the field equipment, two methods of sample-equipment washing will occur during the May sampling event. Between sites, sampling equipment will be washed in an Alconox solution and rinsed three times in deionized (DI) water. An equipment rinse blank will be collected after this decontamination. Following the Alconox procedure, the sampling equipment will be washed in a 1 percent hydrochloric acid bath and rinsed three times in DI water. A second equipment blank will be collected after this decontamination procedure. All remaining wastewater from the rinsing procedures will be stored in 5-gallon buckets for later disposal.

The results of the analysis of the two initial equipment blanks will determine the preferred method of equipment cleaning for all subsequent sampling events, for which equipment blanks will be collected at a 5 percent frequency.

6.3 Sample Handling

Mussel samples will be stored in coolers on gel-ice in the field until they can be frozen and transferred to Shaw Environmental Inc. in Iliamna. Water and sediment samples will be stored in coolers and kept cool on gel-ice in the field until they can be transferred to Shaw Environmental Inc. in Iliamna. Zooplankton samples will be stored in plastic bottles and will be preserved with alcohol within 24 hours. The zooplankton samples will be transported to the HDR laboratory with HDR scientists.

6.3.1 Sample containers, volumes, and preservation requirements for water, sediment, mussel tissue, and zooplankton

The Niskin samplers are capable of collecting 8 liters of water per sample, which should be close to the volume needed for analysis. Samples will be collected in pre-preserved bottles (when necessary) provided in advance by the final-destination laboratory. Table 1 reflects the water-sample container requirements for the Iliamna Lake study.

Zooplankton will be collected and stored in plastic bottles. Samples will be preserved in a solution of 70 percent denatured alcohol. Approximately seven clean bottles and about two gallons of denatured alcohol will be needed per month.

TABLE 1. Sample containers and preservation requirements for water samples

Analytical Set	Bottle Type (SGS/NCA)	Bottle Type (CAS)	Analysis	Lab Method	Preservative	Hold Time	Req. Temp.	Comments
1	1 extra volume for MS/MSD	no extra volume for MS/MSD	Total Metals[1]	E200.8/200.7	HNO_3	6 months	None	Unfiltered
2	(1) 1L HDPE 1 extra volume for MS/MSD	(1) 1 L 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) 1 L 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) 1 L HDPE no extra volume for MS/MSD	Ammonia as N	SM4500-NH3-G	H_2SO_4	28 days	4 °C	Unfiltered
			Phosphorus total	E365.3				
			Nitrate-nitrite total	E300.0, E353.2				
5	(2) 1 L 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) 1 L 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	1 L HDPE Same bottle as analytical set 4	Nitrate-nitrite total	E353.2	H_2SO_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 no extra VOA vials for MS/MSD	VOCs (or BTEX)	SW8260B	HCl	14 days	4 °C	Unfiltered
10	(2) 1 L amber glass jar with Teflon cap 4 extra volumes for MS/MSD	(2) 1 L amber glass jar with Teflon cap no extra volumes for MS/MSD	SVOCs	SW8270C	None	7 days to extraction; 40 days to analysis of extract	4 °C	Unfiltered
11	(2) 1 L amber glass jar with Teflon cap 4 extra volumes for MS/MSD	(2) 1 L amber glass jar with Teflon cap no extra volumes for MS/MSD	Pesticides/PCBs	E508	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

Please refer to acronyms list for definitions of acronyms and abbreviations used in table.

The required sample volume for sediment is approximately 7 ounces per sample. Samples are to be stored in clean 8-ounce glass vials that will be provided by the laboratory. Samples will be kept on gel-ice at 4°C. Table 2 reflects the necessary container requirements and analyses for the sediment samples.

The required sample volume for mussel tissue is 75 grams of wet weight, homogenized tissue per sample. Samples are to be stored in clean Ziploc bags and kept frozen for preservation. Approximately 200 clean Ziploc bags will be needed for this effort.

6.3.2 Sample Identification

Sampling locations will be identified on the field forms and in the logbooks. Each sample will be labeled individually with a waterproof label listing the following information:

- Project name: Pebble Project
- Date: month/day/year
- Time
- Preservation method
- Sample identification (example: 060504UT100ETF001, see below)
- Analysis
- Sampler's initials

Each sampling location will be identified by the sampler on the field form. The sample identification format is as described in the following example:

060505PB1ATF001

Where:

060505 is the date as month/day/year
PB1A is the location ID
TF is the matrix code for fish (or mussel) tissue
001 is a sequential sample number

201—sequential number for field duplicates
301—sequential number for field triplicates
401—sequential number for field equipment rinse blanks
501—sequential number for field DI water blanks
601—sequential number for field trip blanks

WS is the matrix code for surface water
SE is the matrix code for sediment

TABLE 2. Sample containers and parameters for sediment samples

Analytical Set	Bottle Type (SGS)	Bottle Type (CAS)	Analysis	Lab Method	Preservative	Hold time	Required Temp
1	(1) 8 oz.	(1) 8 oz.	Total Metals[1]	SW6010B/6020/7471 (Hg)	None	6 months	None
2	(1) 4 oz prewt'd[4] amber	(1) 4 oz prewt'd[4] amber	Gasoline Range Organics	AK101	MeOH w/BFB	28 days	4°C
3	(1) 4 oz prewt'd[4] amber	(1) 4 oz prewt'd[4] amber	Benzene, toluene, ethylbenzene, and xylenes	SW8260B	MeOH w/surrogate	14 days	4°C
4	(1) 8 oz	(1) 8 oz	Diesel and residual range organics	AK102/103	None	14 days to extraction, 40 days to analysis of extract	4°C
5	(1) 8 oz	(1) 8 oz	PCBs/ Pesticides, PAH	SW8081/8082	None	14 days to extraction, 40 days to analysis of extract	4°C
6	(1) 4 oz	(1) 4 oz	Cyanide	SM4500CN-E	None	28 days[2]	4°C
7	(1) 4 oz	(1) 4 oz	Ammonia as N	SM4500NH3	None	28 days	4°C
8	(1) 4 oz	(1) 4 oz	Chloride	E300.0	None	28 days[3]	4°C
			Fluoride	E300.0	None		
			Sulfate	E300.0	None		
9	(1) 4 oz	(1) 4 oz	Fraction Organic Carbon	ASTMD4129	None	180 days	4°C

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

2. Per EPA methods fact sheet titled: "Total Petroleum Hydrocarbons, Reactive Cyanide, Reactive Sulfide, Ignitability, and Corrosivity"

3. Holding time is from date of preparation

4. Preweighed and tared

Please refer to acronyms list for definitions of acronyms and abbreviations used in table.

6.4 Sample Custody

6.4.1 Chain of Custody

The chain-of-custody forms for the analytical samples will include the following:

- Sample identification code
- Signature of sampler
- Date and time of collection: month/day/year
- Project name: Pebble-Project
- Number and type of containers: number of Ziploc bags or bottles containing samples
- Sample preservation
- Sample analysis requested
- Inclusive dates of possession
- Signature of receiver

Also include the following on the chain-of-custody form:

HDR Alaska, Inc.
2525 C. Street Suite 305
Anchorage, Alaska 99503
(907) 644-2000.

Samples will remain with field staff throughout the day. Chain-of-custody forms will accompany each cooler shipped to analytical laboratories. Completed forms will be sealed in a Ziploc bag and taped to the inside of the cooler lid. Other chain-of-custody components will include sample labels, custody seals, field notebooks, cooler tracking log, and sample shipment receipts.

6.4.2 Sample cooler procedures

- Place bubble wrap in the bottom and along the sides of coolers.
- Place glass containers in individual bubble-wrap sleeves.
- Fill spaces between sample bottles with gel-ice and additional bubble wrap.
- Place a minimum of two layers of frozen gel-ice over the containers. Pack coolers with 50 percent gel-ice and 50 percent samples.
- Place bubble wrap over gel-ice to fill remaining void.
- Secure cooler lid with strapping tape.
- Attach two signed, dated, and timed custody seals onto cooler lid.
- Attach shipping label that includes the chain-of-custody identification to the top of the cooler.

Sample coolers will be shipped from Iliamna to Anchorage by Shaw Environmental personnel via Iliamna Air Taxi. A Shaw Environmental cooler custodian will receive the samples in Anchorage and arranges delivery to one of the 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.

6.4.3 Laboratory Contacts

Columbia Analytical Services, Inc.
1317 S. 13th Ave
Kelso, WA 98626-2845
Phone: (360) 577-7222
Fax (360) 636-1068

Contact: Lynda Huckestein
LHuckestein@kelso.caslab.com
Direct: (360) 501-13358

North Creek Analytical
9405 SW Nimbus Avenue
Beaverton, OR 97008-7132
Phone: (503) 906-9200
Fax: (503) 906-9210

Contact: Crystal Jones
CJones@ncalabs.conm
Direct: (503) 906-9234

SGS Environmental Services, Inc.
200 W. Potter Dr.
Anchorage, AK 99518
Phone: (907) 562-2343
Fax: (907) 561-5301

Contact: Steve Crupi
Steve_Crupi@sgs.com
Direct: (907) 550-3213

6.5 Field Quality Control Samples

6.5.1 Deionized Water Blank

One DI blank will be collected for each sampling event for total metals. The DI water used for decontamination will be collected in an empty total metals analysis bottle and submitted to the primary laboratory.

6.5.2 Equipment Blank

Equipment blanks will occur at a frequency of 5 percent and will be analyzed for dissolved metals.

6.5.3 Field Duplicates

Field duplicates are the quality control sample and will occur at a frequency of 10 percent.

6.5.4 Field Triplicates

Field triplicates are the quality assurance sample and will occur at a frequency of 10 percent.

7. Measurement of Field Parameters

Ambient water-quality parameters that will be measured are temperature, dissolved oxygen, conductivity, pH, and ORP. These field parameters will be measured at 1-meter depth increments from the surface to the substrate (or 20 meters maximum) using a YSI 556 Multi-probe System. Measurements will be taken by placing the probe into the water, activating the YSI meter, and reading the output screen with all the parameters on it. The instrument will be checked in confidence solution or calibrated daily. The YSI temperature measurements will be used to determine depth at thermocline for later water-chemistry sampling. Maintenance of the YSI meter will be performed by TTT Environmental in Anchorage, Alaska.

Secchi disk transparency will be recorded during each of the five sampling events. The Secchi disk will be lowered into the lake until the disk disappears completely from view. Due to the potentially large variability due to wind and wave action on Iliamna Lake, observation of the disk will be made through an aquascope. The disk will be lowered until it is out of view and the depth will be recorded. The disk then will be lowered approximately 0.3 meters and then raised until it reappears. The second depth will also be recorded, and the average of the two depth readings will be calculated to the nearest 0.25 meter. This value will be recorded as the Secchi disk transparency reading.

8. Equipment Calibration for YSI 556

Prior to initial use, electrolyte solution must be added to the membrane cap. Install the membrane cap as follows:

- Unscrew and remove probe sensor guard.
- Discard old membrane cap.
- Thoroughly rinse the sensor tip with distilled water.
- Prepare electrolyte solution.
- Fill membrane cap half full with electrolyte solution.
- Reattach membrane cap onto sensor, moderately tight. A small amount of solution should overflow.
- DO NOT touch the membrane surface.
- Screw probe sensor guard on moderately tight.

All of the sensors, except temperature, require calibration if air pressure changes occur.

Calibration tips are as follows:

- Ensure that all sensors are completely immersed in calibration solutions.
- The top vent hole of the conductivity sensor must also be immersed during some of the calibrations.
- Loosen the transport/calibration cup during dissolved oxygen calibration to allow pressure equilibration.
- For maximum accuracy, use a small amount of previously used calibration solution to pre-rinse the probe module. You may wish to save old calibration standards for this purpose.
- Rinse probe module between calibration solutions with ambient-temperature water.
- Use paper towels or clean cotton cloths to dry probe between rinses. Making sure the probe is dry reduces carry-over contamination of calibrator solutions and increases the accuracy of the calibration.
- Install all port plugs in the ports where the sensors are not installed. It is extremely important to keep these electrical connectors dry.

TABLE 3. Calibration solution volumes

Sensor to calibrate	Upright	Upside Down
Conductivity	55 ml	55 ml
pH/ORP	30 ml	60 ml

8.1.1 Conductivity Calibration

- Make sure an O-ring is installed in the groove of the bottom cap of the transport/calibration cup, and that the bottom cap is securely tightened.
- Remove probe sensor guard.
- Remove O-ring from the probe module.

1. Press **On/Off** key to display the run screen.
2. Press the **Escape** key to display main menu.
3. Use arrow keys to highlight the Calibrate selection.
4. Press **Enter**. The Calibrate screen is displayed.
5. Use the arrow keys to highlight the Conductivity selection.
6. Press **Enter**. The Conductivity Calibration Selection Screen is displayed.
7. Use the arrow keys to highlight the Specific Conductance selection.
8. Press **Enter**. The Conductivity Calibration Entry Screen is displayed.

9. Pour the correct amount of conductivity standard into a clean, dry or pre-rinsed transport/calibration cup.
10. Use caution when working with calibration solution, which may be hazardous to your health.
11. Rinse conductivity sensor with a small amount of standard that can be discarded. Make certain you avoid cross-contamination of solutions. Be certain that there are no salt deposits around the oxygen and pH/ORP sensors, especially if you are employing standards of low conductivity.
12. Immerse sensor into the solution completely past its vent hole.
13. Move probe up and down in the solution to remove any bubbles from the conductivity cell.
14. Screw the transport/calibration cup on the probe securely.
15. Use the keypad to enter the calibration value of the standard you are using. Enter the value in milliSiemens per centimeter (mS/cm) at 25°C.

Conductivity Standards:

- Fresh water: 1 mS/cm
- Brackish water: 10 mS/cm
- Sea water: 50 mS/cm

16. Press **Enter**. The Conductivity Calibration Screen is displayed.
17. Allow one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on screen and will change with time as they stabilize.
18. Observe the reading under Specific Conductance. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted. Press **Enter**.
19. Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen.
20. Press Escape to return to the calibrate menu.
21. Rinse the probe module and sensors in tap or purified water and dry.

8.1.2 Dissolved Oxygen Calibration in Percent Saturation

1. Press **On/Off** key to display the run screen.
2. Press the **Escape** key to display the main menu.
3. Use arrow keys to highlight the Calibrate selection.
4. Press **Enter**. The Calibrate screen is displayed.

NOTE: the instrument must be on for at lease 20 minutes to polarize the dissolved oxygen (DO) sensor before calibrating.

5. Use the arrow keys to highlight the Dissolved Oxygen selection.
6. Press **Enter**. The dissolved oxygen calibration screen is displayed.
7. Use the arrow keys to highlight the DO% selection.
8. Press **Enter**. The DO Barometric Pressure Entry Screen is displayed.
9. Place approximately 3 millimeters (1/8 inch) of water in the bottom of the transport/calibration cup.
10. Place the probe module into the transport/calibration cup.
11. Make sure that the DO and temperature sensors are NOT immersed in the water.
12. Secure the transport/calibration cup to the module using only one or two threads to ensure the DO sensor is vented to the atmosphere.
13. Use the keypad to enter the current local barometric pressure.
14. Press **Enter**. The DO% saturation calibration screen is displayed.
15. Allow approximately 10 minutes for the air in the transport/calibration cup to become water saturated and for the temperature to equilibrate before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
16. Observe the reading under the DO%. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to continue.
17. Press **Enter**. This returns you to the DO calibration screen.
18. Press **Escape** to return to the calibration menu.
19. Rinse the probe module and sensors in tap or purified water and dry.

8.1.3 Dissolved Oxygen Calibration in Milligrams per Liter

1. Press **On/Off** key to display the run screen.
2. Press the **Escape** key to display the main menu.
3. Use arrow keys to highlight the Calibrate selection.
4. Press **Enter**. The Calibrate screen is displayed.

NOTE: the instrument must be on for at lease 20 minutes to polarize the DO sensor before calibrating.

5. Use the arrow keys to highlight the Dissolved Oxygen selection.
6. Press **Enter**. The dissolved oxygen calibration screen is displayed.

7. Use the arrow keys to highlight the DO mg/L selection.
8. Press **Enter**. The DO mg/L Entry Screen is displayed.
9. Place the probe module in the water with a known DO concentration. Be sure to completely immerse all of the sensors.
10. Use the keypad to enter the known DO concentration of the water.
11. Press **Enter**. The Dissolved Oxygen mg/L Calibration Screen is displayed.
12. Stir the probe through the water to provide fresh sample to the DO sensor.
13. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
14. Observe the DO mg/L reading, and when the reading stabilizes for at least 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted. Press **Enter**.
15. Press **Enter**. This returns you to the DO calibration screen.
16. Press **Escape** to return to the calibrate menu.
17. Rinse the probe module and sensors in tap or purified water and dry.

8.1.4 ph Calibration

1. Press **On/Off** key to display the run screen.
2. Press the **Escape** key to display the main menu.
3. Use arrow keys to highlight the Calibrate selection.
4. Press **Enter**. The Calibrate screen is displayed.
5. Use the arrow keys to highlight the pH selection.
6. Press **Enter**. The pH calibration screen is displayed.
7. Select the 3-point option. In this procedure, the pH sensor is calibrated with a pH 7 buffer and two additional buffers. This method assures maximum accuracy.
8. Use the arrow keys to highlight the 3-point selection.
9. Press **Enter**. The pH Entry Screen is displayed.
10. Place the correct amount of pH buffer into a clean, dry or pre-rinsed transport/calibration cup.
11. Ensure that the sensor is as dry as possible. Ideally, rinse the pH sensor with a small amount of buffer that can be discarded. Be certain that you avoid cross-contamination of buffers with other solutions.
12. Immerse the sensor end of the probe module into the solution.
13. Move the probe up and down in the solution to remove any bubbles.

14. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.
15. Use the keypad to enter the calibration value of the buffer you are using at the current temperature—pH vs. temperature values are printed on the labels of all YSI pH buffers.
16. Press **Enter**. The pH calibration screen is displayed.
17. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
18. Observe the reading under pH. When the reading shows no significant change after 30 seconds, press **Enter.** The screen will indicate that the calibration has been accepted and prompt you to press **Enter**.
19. Press **Enter**. This returns you to the Specified pH Calibration Screen.
20. Rinse the probe module, transport/calibration cup, and sensors in tap or purified water and dry.
21. Repeat steps 10 through 18 above using the second pH buffer.
22. Press **Enter**.
23. Press **Escape**.
24. Rinse the probe module and sensors in tap or purified water and dry.

8.1.5 Oxidation Reduction Potential Calibration

1. Press **On/Off** key to display the run screen.
2. Press the **Escape** key to display the main menu.
3. Use arrow keys to highlight the Calibrate selection.
4. Press **Enter**. The Calibrate screen is displayed.
5. Use the arrow keys to highlight the ORP selection.
6. Press **Enter**. The ORP calibration screen is displayed.
7. Place the correct amount of a known ORP solution (Zobell solution) into a clean, dry or pre-rinsed transport/calibration cup. Rinse the ORP sensor with a small amount of solution that can be discarded. Be certain that you avoid cross-contamination with other solutions.
8. Immerse sensor end of probe into the solution.
9. Move the probe up and down in the solution to remove any bubbles from the ORP sensor.
10. Screw the transport/calibration cup on the threaded end of the probe module and tighten securely.
11. Use the keypad to enter the correct value of the calibration solution you are using at the current temperature.

TABLE 4. Zobell solution values

Temperature °C	Zobell Solution Value (mV)
-5	270.0
0	263.5
5	257.0
10	250.5
15	244.0
20	237.5
25	231.0
30	224.5
35	218.0
40	211.5
45	205.0
50	198.5

12. Press **Enter**. The ORP calibration screen is displayed.
13. Allow at lease one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize. Verify that the temperature reading matches the value you used from Table 4.
14. Observe the reading under ORP. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted. Press **Enter**.
15. Rinse the probe module and sensors in tap or purified water and dry.

8.1.6 Return to Factory Settings

1. Press **On/Off** key to display the run screen.
2. Press the **Escape** key to display the main menu.
3. Use arrow keys to highlight the Calibrate selection.
4. Press **Enter**. The Calibrate screen is displayed.
5. Use the arrow keys to highlight the Conductivity selection. Note: the conductivity sensor is being used as an example; however, this process will work for any sensor.
6. Press **Enter**.
7. Use the arrow keys to highlight the Specific Conductance.
8. Press **Enter**.
9. Press and hold the **Enter** key down and press the **Escape** key.
10. Use the arrow keys to highlight the YES selection. This returns a sensor to the factory settings.

11. Press **Enter**.
12. Press **Escape**.

9. Record Keeping

9.1.1 Field Calibration Logbook

Each case for a YSI meter contains a yellow write-in-the-rain calibration logbook. YSI meters must be calibrated daily, and the calibration results should be recorded in the logbook each time along with any information pertaining to the meter.

9.1.2 Field Data Forms

Field forms (see appendix) will be used to record all field data, including the location of the sampling station, recorded measurements, and primary and quality control samples collected at the site.

10. References

APHA 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition. American Public Health Association, Washington DC

Northern Dynasty Mines Inc. (NDM). 2005. Draft Environmental Baseline Studies, 2005 Final Quality Assurance Project Plan.

FIGURE

155°12'0"W 155°0'0"W 154°48'0"W 154°36'0"W 154°24'0"W 154°12'0"W 154°0'0"W 153°48'0"W 153°36'0"W

60°12'0"N

60°0'0"N

59°48'0"N

59°36'0"N

Port Alsworth

Nondalton

Iliamna

Northeast Bay

Bucket Lake

Whistlewing Bay

Roadhouse Bay

Newhalen

Upper Talarik

Knutson Bay

Pedro Bay

Flat Island

Finn Bay

Pile Bay

Pile Bay

Northern Dynasty Mines Inc.

Pebble Project

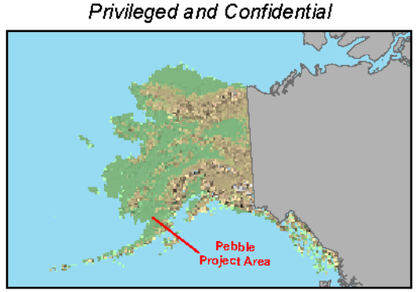
Iliamna Lake Field Sampling Plan
Figure 1

Legend

- Villages
- Lake Sampling Sites (water quality, zooplankton, sediments)
- Mussel Sampling Sites (mussels, sediments)

Sites from HDR, file date 01/25/2005

Privileged and Confidential



0 1.25 2.5 5 7.5 10 Miles

0 2 4 8 12 16 Kilometers

N

Scale 1:331,028

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

File: Fig3Iliamna LakeFieldSamplingPlan.mxd	Date: March 3, 2005
Version: 1	Author: HDR-DS

Z:\200847 Northern Dynasty Mine\als\13988 Macroinvertebrate Road\GIS\MXD\Fig1IliamnastdypIn.mxd

APPENDIX
Field Forms

Site ID: _____ **Date:** _____ **Iliamna Lake Study Field Data Collection Form – Pebble Project - 2005**

GPS: N_____ **Start time:**_____ **Weather:** Air Temp:~_____°F/C,_____ _____

W_____ **End time:** _____ **Team:** _____

Collection Plan Checklist: Depth Profile: Y N **Water:** Y N **WQ Field Param's:** Y N **Secchi Trans**: Y N **Zooplankton:** Y N **Sediment:** Y N **Mussels:** Y N

Depth	Temperature	Conductivity	DO (% sat)	pH (pH units)	DO	ORP	Notes
1 m	°C	mS/cm	%	pH	mg/L	mV	
2 m	°C	mS/cm	%	pH	mg/L	mV	
3 m	°C	mS/cm	%	pH	mg/L	mV	
4 m	°C	mS/cm	%	pH	mg/L	mV	
5 m	°C	mS/cm	%	pH	mg/L	mV	
6 m	°C	mS/cm	%	pH	mg/L	mV	
7 m	°C	mS/cm	%	pH	mg/L	mV	
8 m	°C	mS/cm	%	pH	mg/L	mV	
9 m	°C	mS/cm	%	pH	mg/L	mV	
10 m	°C	mS/cm	%	pH	mg/L	mV	
11 m	°C	mS/cm	%	pH	mg/L	mV	
12 m	°C	mS/cm	%	pH	mg/L	mV	
13 m	°C	mS/cm	%	pH	mg/L	mV	
14 m	°C	mS/cm	%	pH	mg/L	mV	
15 m	°C	mS/cm	%	pH	mg/L	mV	
16 m	°C	mS/cm	%	pH	mg/L	mV	
17 m	°C	mS/cm	%	pH	mg/L	mV	
18 m	°C	mS/cm	%	pH	mg/L	mV	
19 m	°C	mS/cm	%	pH	mg/L	mV	
20 m	°C	mS/cm	%	pH	mg/L	mV	

Depth Profile Notes/Site Sketch:

Site ID: **Date:**

Water Quality Sample and Field Parameter Collection ***Remember to bring trip blanks into the field with you!***

Sample ID:_____	**Sample ID:**_____	**Sample ID:**_____
Sample Depth:_____ **Time:**_____	**Sample Depth:**_____ **Time:**_____	**Sample Depth:**_____ **Time:**_____
Low Hg____**(1)** 500mL TSS/TDS___ ___**(2)** 1-L	Low Hg____**(1)** 500mL TSS/TDS___ ___**(2)** 1-L	Low Hg____**(1)** 500mL TSS/TDS___ ___**(2)** 1-L
Metals____ ____**(2)** 1-L Nutrients___**(1)** 500mL	Metals____ ____**(2)** 1-L Nutrients___**(1)** 500mL	Metals____ ____**(2)** 1-L Nutrients___**(1)** 500mL
Cn/Thio___ ___**(2)** 250mL Anions____**(1)** 120mL	Cn/Thio___ ___**(2)** 250mL Anions____**(1)** 120mL	Cn/Thio___ ___**(2)** 250mL Anions____**(1)** 120mL
June/Sept: SVOCs/Pests__ __ __ __(4) 1-L ambers	**June**/Sept: SVOCs/Pests__ __ __ __(4) 1-L ambers	**June**/Sept: SVOCs/Pests__ __ __ __(4) 1-L ambers
June/Sept: VOCs___ ___ ___(3) 40ml VOAs	**June**/Sept: VOCs___ ___ ___(3) 40ml VOAs	**June**/Sept: VOCs___ ___ ___(3) 40ml VOAs
Duplicate: Y N **Triplicate:** Y N **MS/MSD:** Y N	**Duplicate:** Y N **Triplicate:** Y N **MS/MSD:** Y N	**Duplicate:** Y N **Triplicate:** Y N **MS/MSD:** Y N
pH:_____units Temp:_____^{o}C	pH:_____units Temp:_____^{o}C	pH:_____units Temp:_____^{o}C
DO_____mg/L DO _____% sat	DO_____mg/L DO _____% sat	DO_____mg/L DO _____% sat
Cond_____mS/cm ORP_____mV	Cond_____mS/cm ORP_____mV	Cond_____mS/cm ORP_____mV
Turb_____NTU Time _____	Turb_____NTU Time _____	Turb_____NTU Time _____
Notes:	Notes:	Notes:

Secchi Disk Transparency: Y N

Disappear Depth_____

Reappear Depth_____ Average Depth_____ Time_____

Tow Net Zooplankton Collection: Y N

# of sample bottles: _____

Notes:

Sediment Collection: Y N **Mussel Collection:** Y N **Station Coordinates: N** **W**

Sediment Sample ID: _____ Time_____

Collection Depth_____Collection Method/Team_____

____ (1) 8oz jar

Duplicate: Y N **Triplicate:** Y N **MS/MSD:** Y N

Notes:

Mussel Sample ID: _____ Time_____

Collection Depth_____Collection Method/Team_____

Duplicate: Y N **Triplicate:** Y N **MS/MSD:** Y N

# of organisms/sample:_____Notes:

General Site Notes:

Collection Summary: Depth Profile: Y N **Water:** Y N **WQ Field Param's:** Y N **Secchi Trans**: Y N **Zooplankton:** Y N **Sediment:** Y N **Mussels:** Y N

*Notes: (1) 250-ml (HNO3 preserved) for thiocynate, and (1) 250-ml (NaOH preserved) for Cn; **for triplicate samples: use (1) 1-L bottle for cyanide instead of (1) 250ml (as in primary/duplicates)

MUSSEL AND SEDIMENT SAMPLE LOGIN AND SHIPMENT TRACKING SHEET

Station ID	Dup Y/N	GPS Coordinates	Collection Depth	Collect Date	Collect Time	Samplers Initials	Ship Date	Shippers Initials

Notes: