Pebble Project

NORTHERN DYNASTY MINES INC.

DRAFT ENVIRONMENTAL BASELINE STUDIES PROPOSED 2007 STUDY PLANS

CHAPTER 6.
WATER QUALITY

DRAFT

SEPTEMBER 2007

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ACRONYMS AND ABBREVIATIONS

CAS	Columbia Analytical Services
HDR	HDR Alaska, Inc.
MDC	Mine Development Concept
NDM	Northern Dynasty Mines Inc.
QA	Quality Assurance
QC	Quality Control
SGS	SGS Environmental Services, Inc.
Shaw	Shaw Environmental, Inc.
SLR	SLR Alaska
WMC	Water Management Consultants

6. WATER QUALITY

6.1 Surface Water Quality—Mine Study Area

6.1.1 Introduction

HDR Alaska, Inc. (HDR), will lead the collection of surface water-quality data for streams, seeps, ponds, and lakes and for sediments in the mine study area. Sampling of ponds in the proposed tailings area will be conducted in coordination with SLR Alaska (SLR).

The objectives of the baseline study of surface water quality are as follows:

- To collect data for the characterization of surface water resources.
- To synthesize the information obtained into a baseline data set for use in project permitting.
- To provide input to the engineering design for Pebble Project.
- To establish a long-term monitoring plan.

To meet this objective, the following activities will be conducted in 2007:

- Sampling and chemical analyses of stream and seep surface water from each major drainage area to characterize the natural conditions in various seasons and under various flow regimes.
- Sampling and chemical analysis of naturally occurring constituents in pond and lake surface water to characterize range and variability.

The surface water-quality program for streams is being conducted in conjunction with the baseline study of surface water hydrology to assist with the water balance evaluation and to correlate water quality with flow conditions in the study area. Data from the surface water-quality program for seeps are also used to assess the water balance evaluation and to assess groundwater/surface water interaction.

In addition to the sampling of the surface water bodies, sediment sampling will be conducted to fill the requirements of the trace elements program (Chapter 7). Sediment sampling provides information on the long-term deposition or storage of metals in the stream substrates.

Table 6.1-1 contains summary of the study tasks for the surface water-quality study for each year, 2004 through 2007. Table 6.1-2 provides a record of sampling at each station from 2004 through 2006 by month, as well as planned sampling for 2007.

6.1.2 Study Area

The mine study area for the surface water-quality program includes the general vicinity of the proposed project, as well as downstream reaches of the streams in the vicinity of the proposed mine. Surface water resources in the mine study area consist of streams, seeps, ponds, and lakes.

6.1.3 Methods/Approach

6.1.3.1 Sample Stations and Sample Frequency

The selection of the sampling stations for water chemistry was coordinated with the selection of stations for studies of surface water hydrology (Chapter 4), groundwater hydrogeology (Chapter 5), trace elements (Chapter 7), and fish and aquatic resources (Chapter 11). The engineering team provided a preliminary mine development concept for consideration in selection of sample stations. This concept was used to locate stations that would be useful for baseline characterization.

Surface water stations were selected to accomplish the following:

- Characterize surface water quality.
- Establish baseline surface water-quality conditions.
- Provide data for fish habitat and resource studies.

Stream water-sampling stations will be located on the North Fork Koktuli River (NK), South Fork Koktuli River (SK), mainstem of the Koktuli River (KR), Upper Talarik Creek (UT), and Kaskanak Creek (KC). Samples for surface water monitoring will be collected at 36 stream stations as identified on Figure 6.1-1. Stream water-sampling events will occur monthly from January to December.

Seep inventory areas (Figure 6.1-2) were defined and selected by Water Management Consultants and HDR using a variety of criteria including quantity of flow, spatial distribution in the study area, and proximity to proposed mine facilities. The definitions of a seep as defined by HDR for the purposes of this task are as follows:

- Surface water expression that exhibits a distinct groundwater point source and distinct flow path extending downslope approximately 30 feet or until it enters a larger drainage feature.
- Large diffuse seep areas that coalesce into a distinct flow path with dry ground up-gradient.

Seeps will be sampled in March, May, July, September, and October.

Six lakes were selected for sampling in 2005 (Table 6.1-2) based on geographic representation. These sites will be sampled for water by HDR and for sediments and vegetation by SLR in August of 2007.

Twelve ponds were selected for sampling in 2006 for water, sediment, and vegetation based on geographic representation and potential source waters. HDR will collect water and sediments in these twelve ponds in August in conjunction with SLR's vegetation sampling. The ponds are identified in Table 7.1-2a in Chapter 7, and the locations are depicted on Figure 7.1-1. Stream sediments will be collected at selected stream water-sampling sites in June (Table 6.1-2).

Table 6.1-2 provides the 2007 data collection schedule by sampling station.

6.1.3.2 Field Studies

A detailed description of sampling procedures is presented in *Draft Environmental Baseline Studies; 2007*

of the water and sediments is expected to be much higher in these ponds due to the presence of decaying wood matter and beaver waste; in addition, diminished flow also may affect parameters such as dissolved oxygen. The results of the surface water-quality sampling will be used in the small pools study which is part of the wetlands program.

Lake Sampling. Water-quality grab samples and field parameter measurements will be collected in August at Black Lake, Big Wiggly Lake, Frying Pan Lake, Chiquita Lake, Mud Lake, and Lake No. 2.

Seep Sampling. The objective of conducting a seep sampling program is to document the water quality and flow of water discharging from select seeps in the study area. These data are useful for interpreting the groundwater regime, assessing interactions of groundwater and surface water, and investigating the geochemistry of these seeps. HDR will continue to sample the 44 seep stations set up in previous years, and will sample up to 56 additional seeps in 2007, depending on the results of reconnaissance surveys. At every seep location, team members will measure field parameters and will collect water-quality samples to be sent to the laboratory. Flow will also be measured using direct catch or portable weirs.

The seep inventory, a program to document the location and relative size of seeps within the mine study area, will continue in 2007. Inventories are conducted by flying over the area in a helicopter and documenting seeps with a global positioning system (GPS) unit. Figure 6.1-2 depicts seeps that have been inventoried in the past and areas that are proposed for inventory in 2007. More detailed information about the seeps program is available in the field sampling plan (NDM, In press2).

6.1.3.3 Quality Management

Northern Dynasty Mines Inc. (NDM) has appointed an Analytical QA/QC (quality assurance/quality control) Manager who is responsible for quality management of all laboratory programs. This oversight will ensure both consistency among the various programs within the baseline study and that data-quality objectives are met for the 2007 surface water-quality program.

The sample collection and handling protocols for the environmental baseline studies for Pebble Project are outlined in the *Draft Environmental Baseline Studies, 2007 Quality Assurance Project Plan* (NDM, In press1); the protocols for the surface water study are described in the 2007 field sampling plan for surface water quality, hydrology, and sediment (NDM, In press2).

6.1.3.4 Data Analysis and Reporting

Data presentation and evaluation include the following tasks:

- Tabulate and summarize water-chemistry data and statistics.
- Prepare plots of key analytical parameters, identify anomalies, and compare results to water-quality criteria.
- Present the temporal and spatial distribution of key analytical parameters.
- Evaluate season, flow, and water-quality relationships where appropriate.

The data also will be used as baseline input for the water-balance and water-chemistry (loading) models.

6.2 Groundwater Quality—Mine Study Area

Water Management Consultants (WMC) is the prime consultant for the groundwater-quality study in the mine study area, with support provided by SLR Alaska.

6.2.1 Objectives of Study

The objective of the groundwater quality study is to define the chemical characteristics of groundwater in the study area prior to development of the mine. This characterization will be used to document any potential changes to groundwater quality that result from mine development and to help define the groundwater flow system, as outlined in the hydrogeology objectives in Chapter 5.

6.2.2 Study Area/Scope

The mine study area encompasses the area around the headwaters of Koktuli River and Upper Talarik Creek. The study area includes all local and regional groundwater that has the potential to be affected by the proposed project or that has the potential to affect the surface water system. The study area is illustrated on Figure 5.1-1 in Chapter 5.

Major activities for the 2007 groundwater-quality study are as follows:

- Collect quarterly groundwater samples from each well (SLR).
- Plot and review the data after each sampling event (WMC).
- Report results (WMC).

6.2.3 Methods/Approach

Monitoring wells are being sampled both up-gradient and down-gradient of the proposed mine. The wells are being sampled under seasonal hydrologic conditions at key locations in the study area. Samples will be collected four times during the year: in March (late winter before break-up), May (spring after break-up), August (summer), and October (fall).

Samples will be collected at the monitoring wells and piezometers shown on Figure 6.2-1. The selection of the locations of these wells is discussed in Chapter 5. Groundwater samples will be obtained using dedicated sampling pumps as described in the *Draft Environmental Baseline Studies, 2007 Field Sampling Plans, Groundwater Studies, Mine Study Area* (NDM, In press3).

Groundwater samples will be collected concurrently with the groundwater monitoring described in the hydrogeology chapter (Chapter 5). Procedures for sample handling and data management will be the same as for surface water with the following exceptions:

- Groundwater samples to be analyzed for dissolved metals will be filtered in-line during sample collection in the field because of the potential for oxygen-depleted groundwater to become oxygenated.
- Field parameters will be measured in a flow-through cell.

Details of the groundwater sampling protocols are provided in the 2007 field sampling plan for groundwater (NDM, In press3).

Groundwater samples will be collected from 38 monitoring wells, as detailed in Table 5.1-2 of Chapter 5. The field parameters pH, specific electrical conductance (EC), temperature, and dissolved oxygen (DO) will be measured each time groundwater samples are collected.

The groundwater samples will be collected by SLR and submitted to the laboratory for analysis. All samples will be analyzed for a wide range of cations and anions. The parameters have been selected to fulfill two purposes:

- Provide baseline values for comparison with post-mining conditions.
- Provide general information on groundwater quality that can help with natural attenuation assessments and the site-wide water balance.

The parameters to be analyzed in the lab will are the same as those listed for surface water in Table 6.1-4, except groundwater will not be analyzed for organic carbon, and it will be analyzed for tritium.

NDM has appointed an Analytical QA/QC Manager who is responsible for quality management for all laboratory programs. This manager ensures both consistency among the various programs within the baseline study and that data-quality objectives are met for the water-quality program.

The groundwater quality data will be interpreted by WMC. The data will be plotted quarterly as the results become available. These plots will include the following:

- Box and whisker plots to compare all water-quality analyses.
- Time series to examine temporal trends.
- Piper plots to characterize the water type.
- Stiff diagrams to examine the spatial distribution of overall water quality.
- Bubble plots to examine the spatial distribution of individual parameters.

In addition, the concentrations of analytes in the groundwater will be evaluated to identify anomalies when compared with water-quality criteria. The discussion on groundwater quality will include comparisons and contrasts between catchments. All field and analytical parameters will be included in the evaluations. In addition, field observations such as color, odor, and turbidity will be considered.

The groundwater-quality characterization will be updated as more data become available over the year. The data will continue to be correlated to surface water- and seep water-quality, as well as to climatic and hydrologic variations. After the data from up to the end of 2007 have been interpreted, the monitoring locations and frequency will be reviewed.

6.3 Surface Water Quality—Transportation Corridor

No data for surface water quality in the transportation corridor are being collected in 2007.

6.4 Groundwater Quality—Transportation Corridor

No data for groundwater quality in the transportation corridor are being collected in 2007.

6.5 References

Northern Dynasty Mines Inc. (NDM). In press1. Draft Environmental Baseline Studies, 2007 Quality Assurance Project Plan.

———. In press2. Draft Environmental Baseline Studies; 2007 Field Sampling Plan; Surface Water Quality, Hydrology, and Sediment; Mine Study Area.

———. In press3. Draft Environmental Baseline Studies, 2007 Field Sampling Plans, Groundwater Studies, Mine Study Area

TABLES

TABLE 6.1-1
Pebble Project Environmental Studies
Study Summary for Surface Water Quality, 2004-2007
Consultant: HDR Alaska, Inc.

Field Studies Discipline	2004 Study Tasks	2005 Study Tasks	2006 Study Tasks	2007 Study Tasks
Surface Water Quality	**Mine Studies Area**			
	Baseline Surface-Water Quality Data Collection (7 Events)	Baseline Surface-Water Quality Data Collection (8 Events)	Baseline Surface-Water Quality Data Collection (10 Events)	Baseline Surface Water-Quality Data Collection (12 Events)
	Seep Sampling	Seep Sampling	Seep Sampling	Seeps - Sampling of Areas 1-19
	Sediment - Field Data Collection	Sediment - Field Data Collection	Seeps - Inventory	Seeps - Sampling of Areas J, L, and UT East Drainage
			Sediment - Field Data Collection	Seeps - Inventory
			Ponds and Lake Sampling	Sediment - Field Data Collection
				Ponds and Lake Sampling

Table 6.1-2
Pebble Project
Period-of-Record Index
Surface Water Quality, Mine Study Area

Period-of-Record By Discipline

Hydrology[2]

Sample Location	Year[1] / Month	J	F	M	A	M	J	J	A	S	O	N	D
KC100A	2004					I	I	I	C	C	C		
	2005	I		I	C	C	C	C	C	C	C		
	2006		I	I		C	C	C	C	C	C		I
	2007	I	I	I	C	C	C	C	C	C	C	I	I
KR100A	2004				I		I	I	I	I	I		
	2005			I			I	I	I	I	I		
	2006			I			I	I			I		I
	2007	I	I	I	I	I	I	I	I	I	I	I	I
NK100A (USGS)	2004						I	I	C	C	C		
	2005	I		I	C	C	C	C	C	C	C		
	2006			I	C	C	C	C	C	C	C		
	2007	I	I	I	C	C	C	C	C	C	C	I	I
NK100A1	2004												
	2005												
	2006												
	2007		I	I	C	C	C	C	C	C	C	I	I
NK100B	2004								I	I	I		
	2005	I		I		I	I	I	I	I	I		
	2006		I	I		I	I	I	I		I		I
	2007	I	I	I	C	C	C	C	C	C	C	I	I
NK100C	2004				I	I		I	C	C	C		
	2005	I		I		C	C	C	C	C	C		
	2006		I	I		C	C	C	C	C	C		I
	2007	I	I	I	C	C	C	C	C	C	C	I	I
NK119A	2004				I		I	I	C	C	C		
	2005	I		I		C	C	C	C	C	C		
	2006	I	I	I	C	C	C	C	C	C	C		I
	2007	I	I	I	C	C	C	C	C	C	C	I	I
NK119B	2004				I	I	I	I	I	I	I		
	2005	I		I		I	I	I	I	I	I		
	2006		I	I									
	2007	I	I	I	C	C	C	C	C	C	C	I	I
SK100A	2004				I		I	I	C	C	C		
	2005	I		I	C	C	C	C	C	C	C		
	2006		I	I	C	C	C	C	C	C	C		I
	2007	I	I	I	C	C	C	C	C	C	C	I	I
SK100B (USGS)	2004				I		I	I	C	C	C		
	2005	I		I	C	C	C	C	C	C	C		
	2006		I	I	C	C	C	C	C	C	C		I
	2007	I	I	I	C	C	C	C	C	C	C	I	I
SK100B1	2004												
	2005									I	I	C	C
	2006	C	C	C	C	C	C	C	C	C	C	C	I
	2007	I	I	I	C	C	C	C	C	C	C	I	I
SK100B2	2004												
	2005					I	I	I	I	I	I		
	2006		I	I		I	I	I	I	I	I		I
	2007	I	I	I	I	I	I	I	I	I	I	I	I

Water Quality

Sample Location	Year[1] / Month	J	F	M	A	M	J	J	A	S	O	N	D
KC100A	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006		Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
KR100A	2004				Q	Q	Q	Q	Q	Q	Q		
	2005			Q			Q	Q	Q	Q	Q		
	2006			Q			Q	Q			Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
NK100A (USGS)	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006		Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
NK100A1	2004												
	2005												
	2006												
	2007		Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
NK100B	2004				Q	Q			Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006		Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
NK100C	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006		Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
NK119A	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006	Q	Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
NK119B	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006												
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
SK100A	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006		Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
SK100B (USGS)	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006		Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
SK100B1	2004												
	2005									Q	Q		
	2006		Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
SK100B2	2004												
	2005					Q	Q	Q	Q	Q	Q		
	2006		Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q

Fish Tissue[3]

Sample Location	Year[1] / Month	J	F	M	A	M	J	J	A	S	O	N	D
KC100A	2004								W				
	2005								W				
	2006												
	2007												
KR100A	2004												
	2005												
	2006												
	2007												
NK100A (USGS)	2004								W				
	2005								W				
	2006												
	2007								W				
NK100A1	2004												
	2005												
	2006												
	2007												
NK100B	2004												
	2005												
	2006												
	2007												
NK100C	2004								W				
	2005								W				
	2006												
	2007												
NK119A	2004								W				
	2005								W				
	2006												
	2007												
NK119B	2004												
	2005												
	2006												
	2007												
SK100A	2004								W				
	2005								W				
	2006												
	2007												
SK100B (USGS)	2004								W				
	2005								W				
	2006												
	2007								W				
SK100B1	2004												
	2005												
	2006												
	2007												
SK100B2	2004												
	2005												
	2006												
	2007												

Macroinvertebrates

Sample Location	Year[1] / Month	J	F	M	A	M	J	J	A	S	O	N	D
KC100A	2004						D		D				
	2005												
	2006												
	2007												
KR100A	2004												
	2005												
	2006												
	2007												
NK100A (USGS)	2004						D		D				
	2005						S						
	2006												
	2007						S						
NK100A1	2004												
	2005												
	2006												
	2007												
NK100B	2004						D						
	2005												
	2006												
	2007												
NK100C	2004						D		D				
	2005						S						
	2006												
	2007						S						
NK119A	2004						D		D				
	2005												
	2006												
	2007						S						
NK119B	2004												
	2005												
	2006												
	2007												
SK100A	2004						D		D				
	2005												
	2006												
	2007						S						
SK100B (USGS)	2004						D		D				
	2005						S						
	2006												
	2007						S						
SK100B1	2004												
	2005												
	2006												
	2007												
SK100B2	2004												
	2005												
	2006												
	2007												

Sediment

Sample Location	Year[1] / Month	J	F	M	A	M	J	J	A	S	O	N	D
KC100A	2004						F	F		F			
	2005						F	F					
	2006												
	2007												
KR100A	2004							F		F			
	2005												
	2006												
	2007												
NK100A (USGS)	2004						F	F		F			
	2005						F	F					
	2006						F						
	2007						F						
NK100A1	2004												
	2005												
	2006												
	2007												
NK100B	2004						F						
	2005						F	F		F			
	2006						F						
	2007						F						
NK100C	2004						F	F		F			
	2005						F	F		F			
	2006						F						
	2007						F						
NK119A	2004						F	F		F			
	2005						F	F					
	2006												
	2007						F						
NK119B	2004												
	2005												
	2006												
	2007												
SK100A	2004						F						
	2005						F	F					
	2006						F						
	2007						F						
SK100B (USGS)	2004						F	F		F			
	2005						F	F					
	2006						F						
	2007						F						
SK100B1	2004												
	2005												
	2006												
	2007												
SK100B2	2004												
	2005												
	2006												
	2007												

Period-of-Record By Discipline

Hydrology[2]

Sample Location	Year[1] / Month	J	F	M	A	M	J	J	A	S	O	N	D
SK100C	2004						I	I	C	C	C		
	2005	I		I		C	C	C	C	C	C		
	2006		I	I		I	C	C	C	C	C		I
	2007	I	I	I	I	C	C	C	C	C	C	I	I
SK100D	2004						I	I	I	I	I		
	2005	I		I		I	I	I	I	I	I		
	2006		I	I			I	I	I	I	I		I
	2007	I	I	I	I	I	I	I	I	I	I	I	I
SK100F	2004					I	I	I	C	C	C		
	2005	I		I		C	C	C	C	C	C		
	2006	I	I	I		C	C	C	C	C	C		I
	2007	I	I	I	C	C	C	C	C	C	C	I	I
SK100G	2004				I	I	I	I	C	C	C		
	2005	I		I	C	C	C	C	C	C	C		
	2006	I	I	I		C	C	C	C	C	C		
	2007	I	I	I	C	C	C	C	C	C	C	I	I
SK119A	2004				I	I	I	I	C	C	C		
	2005	I		I	C	C	C	C	C	C	C		
	2006		I	I		C	C	C	C	C	C		I
	2007	I	I	I	C	C	C	C	C	C	C	I	I
SK124A	2004												
	2005	I		I		C	C	C	C	C	C		
	2006	I	I	I			C	C	C	C	C		I
	2007	I	I	I	I	C	C	C	C	C	C	I	I
SK131A	2004				I	I	I	I	I	I	I		
	2005	I		I		I	I	I	I	I	I		
	2006		I	I		I	I	I	I	I	I		I
	2007	I	I	I	I	I	I	I	I	I	I	I	I
SK133A	2004				I	I	I	I	I	I	I		
	2005			I		I	I	I	I	I	I		
	2006		I	I		I	I	I	I	I	I		I
	2007	I	I	I	I	I	I	I	I	I	I	I	I
SK134A	2004				I	I	I	I	I	I	I		
	2005	I		I		I	I	I	I	I	I		
	2006	I	I	I		I	I	I	I	I	I		I
	2007	I	I	I	I	I	I	I	I	I	I	I	I
SK136A	2004				I	I	I	I	I	I	I		
	2005	I		I		I	I	I	I	I	I		
	2006	I	I	I		I	I	I	I	I	I		
	2007	I	I	I	I	I	I	I	I	I	I	I	I
SK136B	2004				I	I	I	I	I	I	I		
	2005	I		I		I	I	I	I	I	I		
	2006	I	I	I		I	I	I	I	I	I		I
	2007	I	I	I	I	I	I	I	I	I	I	I	I
UT100A	2004					I			I	I	I		
	2005	I		I		I	I	I			I		
	2006			I			I	I		I			
	2007	I	I	I	I	I	I	I	I	I	I	I	I
UT100B (USGS)	2004					I	I	I	C	C	C		
	2005	I		I	C	C	C	C	C	C	C		
	2006		I	I	C	C	C	C	C	C	C		I
	2007	I	I	I	C	C	C	C	C	C	C	I	I

Water Quality

Sample Location	Year[1] / Month	J	F	M	A	M	J	J	A	S	O	N	D
SK100C	2004				Q	Q	Q	Q			Q		
	2005	Q				Q	Q	Q		Q	Q		
	2006					Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
SK100D	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006						Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
SK100F	2004					Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006	Q	Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
SK100G	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006	Q	Q	Q		Q	Q	Q	Q	Q	Q		
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
SK119A	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006		Q	Q		Q	Q	Q	Q		Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
SK124A	2004												
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006	Q	Q	Q			Q	Q	Q		Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
SK131A	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006		Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
SK133A	2004				Q	Q	Q	Q	Q	Q	Q		
	2005					Q	Q	Q	Q	Q	Q		
	2006		Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
SK134A	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006	Q	Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
SK136A	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006	Q	Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
SK136B	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006	Q	Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
UT100A	2004				Q	Q			Q	Q	Q		
	2005	Q		Q		Q	Q	Q			Q		
	2006			Q			Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
UT100B (USGS)	2004				Q	Q	Q	Q	Q	Q	Q		
	2005	Q		Q		Q	Q	Q	Q	Q	Q		
	2006		Q	Q		Q	Q	Q	Q	Q	Q		Q
	2007	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q

Fish Tissue[3]

Sample Location	Year[1] / Month	J	F	M	A	M	J	J	A	S	O	N	D
SK100C	2004								W				
	2005								W				
	2006												
	2007												
SK100D	2004												
	2005												
	2006												
	2007												
SK100F	2004								W				
	2005								W				
	2006												
	2007												
SK100G	2004								W				
	2005								W				
	2006												
	2007												
SK119A	2004								W				
	2005								W				
	2006												
	2007												
SK124A	2004												
	2005												
	2006												
	2007												
SK131A	2004												
	2005												
	2006												
	2007												
SK133A	2004												
	2005												
	2006												
	2007												
SK134A	2004												
	2005												
	2006												
	2007												
SK136A	2004												
	2005												
	2006												
	2007												
SK136B	2004												
	2005												
	2006												
	2007												
UT100A	2004												
	2005												
	2006												
	2007												
UT100B (USGS)	2004								W				
	2005								W				
	2006												
	2007								W				

Macroinvertebrates

Sample Location	Year[1] / Month	J	F	M	A	M	J	J	A	S	O	N	D
SK100C	2004						D						
	2005												
	2006												
	2007												
SK100D	2004												
	2005												
	2006												
	2007						S						
SK100F	2004						D		D				
	2005												
	2006												
	2007												
SK100G	2004						D		D				
	2005												
	2006												
	2007												
SK119A	2004						D		D				
	2005												
	2006												
	2007												
SK124A	2004												
	2005												
	2006												
	2007												
SK131A	2004												
	2005												
	2006												
	2007												
SK133A	2004												
	2005												
	2006												
	2007												
SK134A	2004												
	2005												
	2006												
	2007												
SK136A	2004												
	2005												
	2006												
	2007												
SK136B	2004												
	2005												
	2006												
	2007												
UT100A	2004												
	2005												
	2006												
	2007												
UT100B (USGS)	2004						D		D				
	2005						S						
	2006												
	2007						S						

Sediment

Sample Location	Year[1] / Month	J	F	M	A	M	J	J	A	S	O	N	D
SK100C	2004						F	F		F			
	2005						F	F					
	2006						F						
	2007						F						
SK100D	2004									F			
	2005												
	2006												
	2007												
SK100F	2004						F	F		F			
	2005						F						
	2006												
	2007						F						
SK100G	2004						F	F	F	F			
	2005						F	F					
	2006												
	2007						F						
SK119A	2004						F	F		F			
	2005						F						
	2006						F						
	2007												
SK124A	2004												
	2005												
	2006												
	2007												
SK131A	2004							F		F			
	2005												
	2006												
	2007												
SK133A	2004												
	2005												
	2006												
	2007												
SK134A	2004												
	2005												
	2006												
	2007												
SK136A	2004												
	2005												
	2006												
	2007												
SK136B	2004												
	2005												
	2006												
	2007												
UT100A	2004									F			
	2005												
	2006												
	2007												
UT100B (USGS)	2004						F	F	F	F			
	2005						F	F		F			
	2006						F						
	2007						F						

Sample Location	Year[1]	Period-of-Record By Discipline																																																											
		Hydrology[2]												Water Quality												Fish Tissue[3]												Macroinvertebrates												Sediment											
	Month	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
UT100C	2004				I	I											Q	Q			Q												W										D		D										F						
	2005			I																													W																												
	2006				I																																																									
	2007		I	I	C	C	C	C	C	C	C	I	I		Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q																		S																		
UT100C1	2004																																																												
	2005																																																														
	2006				I																																																									
	2007		I	I	C	C	C	C	C	C	C	I	I		Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q																																				
UT100C2	2004																																																												
	2005																																																														
	2006				I																																																								
	2007		I	I	C	C	C	C	C	C	C	I	I		Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q																																				
UT100D	2004				I	I	I	I	C	C	C						Q	Q	Q	Q	Q	Q	Q										W										D		D										F	F		F			
	2005	I		I		C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q										W										S												F	F		F			
	2006		I	I		C	C	C	C	C	C		I		Q	Q		Q	Q	Q	Q	Q	Q		Q																														F						
	2007	I	I	I	I	C	C	C	C	C	C	I	I	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q																		S												F						
UT100E	2004				I	I	I	I	C	C	C						Q	Q	Q	Q	Q	Q	Q										W										D		D										F	F		F			
	2005	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q										W																						F						
	2006	I	I	I	C	C	C	C	C	C	C		I	Q	Q	Q		Q	Q	Q	Q	Q	Q		Q																														F						
	2007	I	I	I	C	C	C	C	C	C	C	I	I	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q																														F						
UT119A	2004				I	I	I	I	C	C	C						Q	Q	Q	Q	Q	Q	Q										W										D		D										F	F		F			
	2005	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q										W																						F						
	2006	I	I	I	C	C	C	C	C	C	C		I		Q	Q		Q	Q	Q	Q	Q	Q		Q																														F						
	2007	I	I	I	C	C	C	C	C	C	C	I	I	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q																		S												F						
UT119B	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q																																						
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q																																F					
	2006	I	I	I		I	I	I	I	I	I		I	Q	Q	Q		Q	Q	Q	Q	Q	Q		Q																														F						
	2007	I	I	I	I	I	I	I	I	I	I	I	I	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q																																				
UT135A	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q																																						
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q																																						
	2006		I			I	I	I	I	I	I		I		Q	Q		Q	Q	Q	Q	Q	Q		Q																																				
	2007	I	I	I	I	C	C	C	C	C	C	I	I	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q																																				
UT138A	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q										W										D		D											F		F			
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q										W										S																		
	2006		I	I		I	I	I	I	I	I		I		Q	Q		Q	Q	Q	Q	Q	Q		Q																																				
	2007	I	I	I	I	I	I	I	I	I	I	I	I	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q																																				
UT141A	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q																																	F		F			
	2005			I		I	I	I	I	I	I					Q		Q	Q	Q	Q	Q	Q																																	F					
	2006		I	I		I	I	I	I	I	I		I		Q	Q		Q	Q	Q	Q	Q	Q		Q																														F						
	2007	I	I	I	I	I	I	I	I	I	I	I	I	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q																														F						
UT146A	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q																																	F		F			
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q																																						
	2006		I			I	I	I	I	I	I		I		Q			Q	Q	Q	Q	Q	Q		Q																																				
	2007	I	I	I	I	I	I	I	I	I	I	I	I	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q																																				
Black Lake	2004																																																												
	2005																																T																								F				
	2006																				Q												T												P																
	2007																				Q												T																												
Big Wiggly	2004																																T												M																
	2005																																T										M													F					
	2006																				Q																								P																
	2007																				Q												T																												

Sample Location	Year[1]	Hydrology[2]												Water Quality											
	Month	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Frying Pan Lake	2004																								
	2005																								
	2006																			Q					
	2007																				Q				
Chiquita Lake	2004																								
	2005																								
	2006																				Q				
	2007																				Q				
Lake No. 2	2004																								
	2005																								
	2006																				Q				
	2007																				Q				
Mud Lake (Near Lily Lake)	2004																								
	2005																								
	2006																				Q				
	2007																				Q				
Ponds	2004																								
	2005																								
	2006																				Q				
	2007																				Q				
Seeps	2004					X				X								X				X			
	2005			X				X	X		X					X				X	X		X		
	2006			X			X		X		X					X			X		X		X		
	2007			X		X		X		X	X					X		X		X		X	X		

Sample Location	Year[1]	Fish Tissue[3]												Macroinvertebrates												Sediment											
	Month	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Frying Pan Lake	2004								T												M																
	2005								T										M													F					
	2006																				P											F					
	2007								T																												
Chiquita Lake	2004																																				
	2005																																	F			
	2006																																				
	2007																																				
Lake No. 2	2004																																				
	2005								T																								F				
	2006								T												P																
	2007								T																												
Mud Lake (Near Lily Lake)	2004																																				
	2005																																	F			
	2006																																				
	2007																																				
Ponds	2004																																				
	2005																																				
	2006																																	F			
	2007																																	F			
Seeps	2004																																				
	2005																															7			5		
	2006																																				
	2007																																				

KEY:

- **C** Continuous stage/discharge hydrometric data collected in streams (gaged stations with dataloggers).
- **D** Macroinvertebrate sites sampled with drift nets AND ASCI methods; periphyton collected with RBP, and diatoms were assessed.
- **F** Sediment samples collected. Seep sediment samples show number of seeps sampled through 2007. Sediment symbol not shown on associated map.
- **I** Instantaneous stream discharge measurements taken each month coincident with water quality sampling (ungaged stations without dataloggers).
- **M** Macroinvertebrate samples from lakes collected with a modified ASCI approach and dredge. Periphyton collected with RBP, and diatoms were assessed.
- **P** Plankton tows.
- **Q** Surface water quality samples collected for field and laboratory analyses.
- **S** Macroinvertebrate sites sampled with Surber Sampler AND ASCI methods; periphyton collected with ADNR methods, and chlorophyll *a* was assessed.
- **T** Fish tissue samples from adult northern pike consisted of discrete muscle and liver samples. Arctic grayling and whitefish are sampled for muscle tissue only.
- **W** Before 2007, fish tissue samples consisted of discrete whole-body juvenile fish. In 2007, adult grayling and whitefish (muscle tissues) will be sampled. If species is not present in adequate numbers, an alternative location will be selected.
- **X** Seep flow measurements and water quality samples collected.

NOTES:

1. Work for 2007 is shown as planned, but has not yet been completed.
2. At stations where continuous hydrometric data are collected, continuous hydrographs will be estimated throughout winter months using standard hydrometric methods. Stream gages are reinstalled each spring as early as breakup conditions allow.
3. One stream sample site (to be determined in the field) in each of the three major drainages will be sampled for arctic grayling and whitefish; the sample matrix will be muscle tissue (filet). In lakes, grayling, whitefish and northern pike will be collected; muscle tissue samples will be collected from all three species, as well as liver (archive) samples from northern pike.

TABLE 6.1-3
Field Parameters for Surface Water

Parameter	Method (Meter)	Units	Detection Limit	Sensitivity	Precision	Accuracy
pH	YSI 556	pH units (0 to 14)	NA	0.01	0.01	±0.2
Electrical conductance	YSI 556	mS/cm (0 to 200)	0.001	0.001	0.001 to 0.1 (range dependent)	±0.5% + 0.001
Temperature	YSI 556	°C (-5 to 45)	NA	0.01	0.01	±0.15
Dissolved oxygen	YSI 556	mg/L (0 to 50)	0.2	0.01	0.01	±2 % to 20 mg/L
		% saturation (0-500)	2% air saturation	0.1%	0.1%	±2% of reading to 200%
Oxidation reduction potential	YSI 556	mV (-999 to +999)	0.1 mV	0.1 mV	0.1 mV	±20 mV
Turbidity	Hach 2100P	NTU (0-1000)	0.01	0.01	0.01 to 1 (range dependent)	±2% of reading or ±1 least significant digit; ±3% of reading at 500 to 1000 NTU

Notes:

°C = degrees Celsius

mg/L = milligrams per liter

mS/cm = millisiemens per centimeter

mV = millivolts

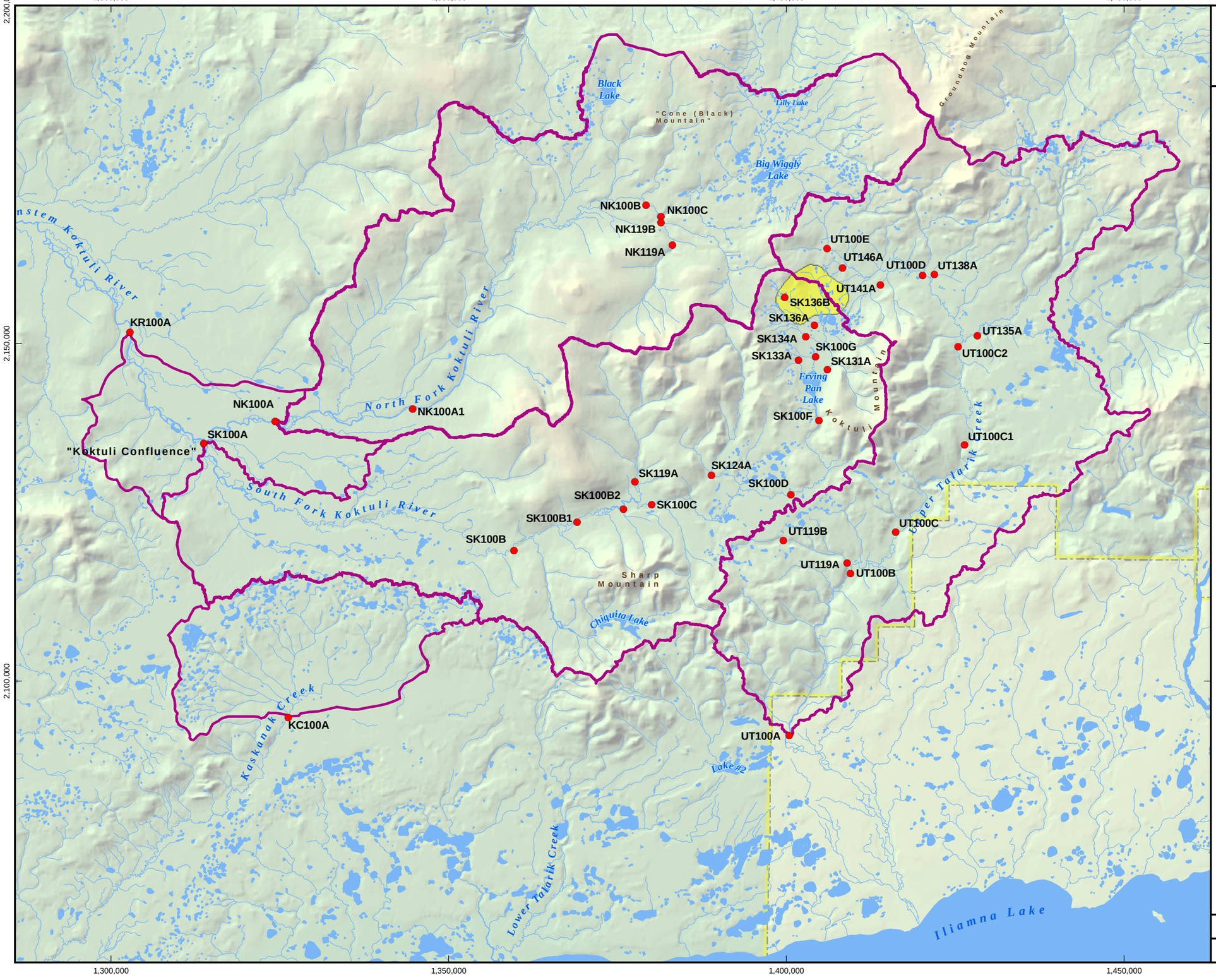
NA = not applicable

NTU = nephelometric turbidity units

TABLE 6.1-4
Surface-Water and Sediment Analytes for Laboratory Determination

Water Analytes		
Aluminum, total and dissolved	Manganese, total and dissolved	Alkalinity
Antimony, total and dissolved	Mercury, total and dissolved	Acidity
Arsenic, total and dissolved	Molybdenum, total and dissolved	Ammonia
Barium, total and dissolved	Nickel, total and dissolved	Chloride
Beryllium, total and dissolved	Potassium, total and dissolved	Cyanide, total
Bismuth, total and dissolved	Silver, total and dissolved	Cyanide, WAD (weak acid dissociable)
Boron, total and dissolved	Sodium, total and dissolved	Fluoride
Cadmium, total and dissolved	Thallium, total and dissolved	Hardness
Calcium, total and dissolved	Tin, total and dissolved	Nitrate + Nitrite
Chromium, total and dissolved	Selenium, total and dissolved	Phosphorus, total
Cobalt, total and dissolved	Silicon, dissolved only	Sulfate
Copper, total and dissolved	Vanadium, total and dissolved	Total dissolved solids
Iron, total and dissolved	Zinc, total and dissolved	Total suspended solids
Lead, total and dissolved	pH	Thiocyanate
Magnesium, total and dissolved	Specific conductance	Dissolved Organic Carbon
Sediment Analytes		
Aluminum	Iron	Tin
Arsenic	Lead	Vanadium
Barium	Magnesium	Zinc
Beryllium	Molybdenum	Mercury
Bismuth	Manganese	Total cyanide
Boron	Nickel	Chloride
Cadmium	Potassium	Fluoride
Calcium	Selenium	Sulfate
Chromium	Silver	Ammonia as N
Cobalt	Sodium	Total sulfur
Copper	Thallium	

FIGURES



Pebble Project

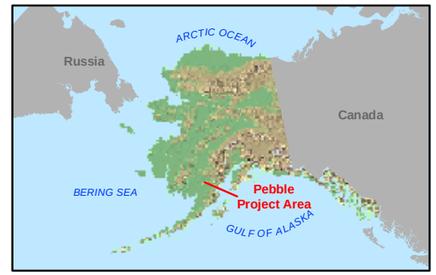
NORTHERN DYNASTY MINES INC.

Figure 6.1-1
2007 Study Plan
Surface Water Quality
Mine Study Area, Stream Sampling Stations

DRAFT

Legend

- Drainage Boundary
- Stream Sampling Station
- Stream
- Waterbody
- General Pit Outline
- Village Corporation Boundary (Private Land)



0 1.25 2.5 3.75 5 Miles

0 1.25 2.5 3.75 5 Kilometers

N

Scale 1:170,000

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

Figure 6.1-1	Date: July 27. 2007
Version: 1	Author: HDR - JC, MC

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344,679 359,919 375,159 390,399

6,648,209

6,632,969

ASP 5 NAD 83

Black Lake
"Cone (Black) Mountain"
Lilly Lake
Groundhog Mountain
Big Wiggly Lake
North Fork Koktuli River
South Fork Koktuli River
Frying Pan Lake
Koktuli Mountain
Upper Talarik Creek
Sharp Mountain
Chiquita Lake
Kaskanak Creek
Lake #2
Newhal

15 18 17 19 13 7 6 8 9 4 3 2 14 1 16

Pebble Project

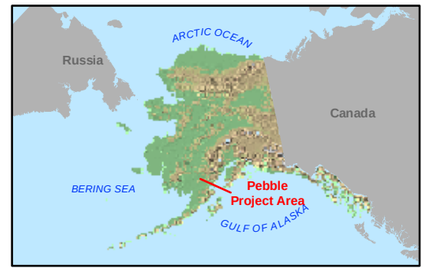
NORTHERN DYNASTY MINES INC.

Figure 6.1-2
2007 Study Plan
Surface Water Quality, Mine Study Area
Seep Sampling Stations
and Inventory Locations

DRAFT

Legend

- Current Sampling Sites
- Inventory Points to Date
- 18 Numbered Existing Inventory Areas
- New Inventory Area
- Stream
- Water Feature
- Drainage Boundary
- General Pit Outline
- Village Corporation Boundary



0 1 2 3 4 5 Miles

0 1 2 3 4 5 Kilometers

N

Scale 1:155,000

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

HDR_2007FieldStudyPlan6.1-2.mxd	Date: August 7, 2007
Version: 3	Author: HDR/RDI-MO/DWR

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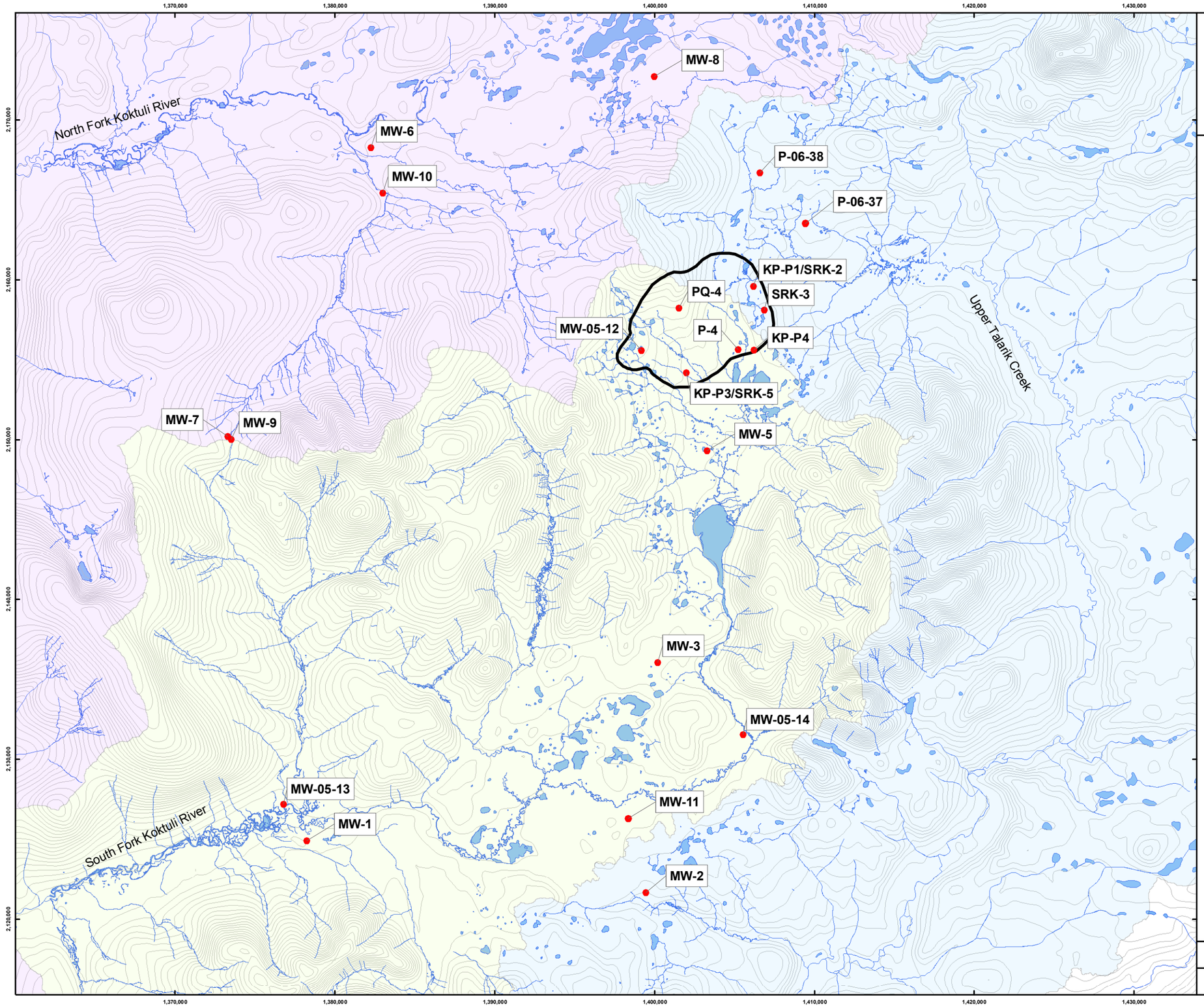
DRAFT

Pebble Project

NORTHERN DYNASTY MINES INC.

Figure 6.2-1
Existing Monitoring Well Locations

2007 Study Plan
Groundwater Studies
Mine Study Area

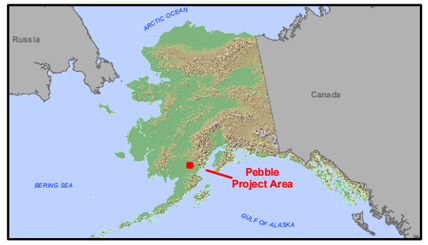


Legend

- Monitoring Well
- General Pit Outline
- Lakes
- Rivers
- 50-ft Contour Interval

Watershed

- North Fork Koktuli River
- South Fork Koktuli River
- Upper Talarik Creek



Feet
0 4,000 8,000 12,000 16,000

Meters
0 1,300 2,600 3,900 5,200

N

Scale 1:74,110

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

Project No: 7126	Date: July 31, 2007
Version: 6	Author: WMC-LC

File: \\Manu\projects\Pebble\scope schedule & budget\2007\study plan\Figure 6.2-1 Monitoring Well Locations.mxd