Lake Chemistry and Physical Data For Selected North Slope, Alaska, Lakes: November 2007

Sampling Tent on South Cell of Mine Site B. Photograph by D. Reichardt

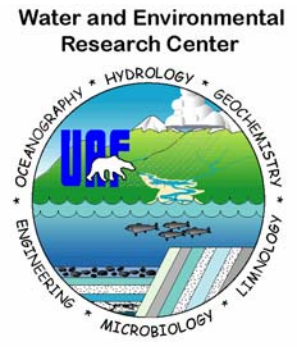
by

Jeff Derry, Kristie Holland, Dan Reichardt, Matthew Whitman, and Michael Lilly

November 2007

North Slope Lakes Hydrologic Project

Report No. INE/WERC 07.22



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By:

Jeff Derry[1], Kristie Holland[1], Dan Reichardt[1], Matthew Whitman[2], and Michael Lilly[1]

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- U.S. Department of Energy
- National Energy Technology Laboratory
- BP Exploration (Alaska), Inc.
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[1]Geo-Watersheds Scientific, Fairbanks, Alaska
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For additional information write to:

Publications,
Water and Environmental Research Center
University of Alaska Fairbanks
Fairbanks, Alaska 99775
www.uaf.edu/water/

For Project Information write to:

Daniel White – Project Manager
Box 5860, WERC. UAF
Fairbanks, AK 99775-5860
907-474-6222
ffdmw@uaf.edu

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DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the accuracy of the data presented herein. This research was funded by the U.S. Department of Energy (DOE) and the National Energy Technology Laboratory (NETL). Funding and support was also provided by the Bureau of Land Management (BLM), BP Exploration (Alaska) Inc. (BPX), ConocoPhillips Alaska, Inc. (CPA), and Geo-Watersheds Scientific (GWS). The contents of the report do not necessarily reflect the views or policies of the DOE, NETL, BLM, BPX, CPA, GWS, or any local sponsor. This work does not constitute a standard, specification, or regulation.

The use of trade and firm names in this document is for the purpose of identification only and does not imply endorsement by the University of Alaska Fairbanks (UAF), DOE, NETL, BLM, BPX, CPA, GWS, or other project sponsors.

CONVERSION FACTORS, UNITS, WATER QUALITY UNITS, VERTICAL AND HORIZONTAL DATUM, ABBREVIATIONS AND SYMBOLS

Conversion Factors

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter (mm)
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
Acre	43559.999	square feet (ft^2)
Acre	0.405	hectare (ha)
Square foot (ft^2)	3.587e-8	square mile (mi^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
gallon (gal)	3785.412	milliliter (mL)
Cubic foot (ft^3)	28.317	liter (L)
Acre-ft	1233	Cubic meter (m^3)
	Velocity and Discharge	
foot per day (ft/d)	0.3048	meter per day (m/d)
Square foot per day (ft^2/d)	.0929	square meter per day (m^2/d)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/sec)
	Hydraulic Conductivity	
foot per day (ft/d)	0.3048	meter per day (m/d)
foot per day (ft/d)	0.00035	centimeter per second (cm/sec)
meter per day (m/d)	0.00115	centimeter per second (cm/sec)
	Hydraulic Gradient	
foot per foot (ft/ft)	5280	foot per mile (ft/mi)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
	Pressure	
pound per square inch (lb/in^2)	6.895	kilopascal (kPa)

Units

For the purposes of this report, both English and Metric (SI) units were employed. The choice of "primary" units employed depended on common reporting standards for a particular property or parameter measured. Whenever possible, the approximate value in the "secondary" units was also provided in parentheses. Thus, for instance, stream flow was reported in cubic feet per second (cfs) followed by the equivalent value in cubic meters per second (m^3/s) in parentheses.

Physical and Chemical Water-Quality Units:

Temperature:

Water and air temperature are given in degrees Celsius (°C) and in degrees Fahrenheit (°F). Degrees Celsius can be converted to degrees Fahrenheit by use of the following equation:

$$°F = 1.8(°C) + 32$$

Specific electrical conductance (conductivity):

Conductivity of water is expressed in microsiemens per centimeter at 25°C (µS/cm). This unit is equivalent to microhms per centimeter at 25°C.

Milligrams per liter (mg/L) or micrograms per liter (µg/L):

Milligrams per liter is a unit of measurement indicating the concentration of chemical constituents in solution as weight (milligrams) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is the same as for concentrations in parts per million.

Millivolt (mV):

A unit of electromotive force equal to one thousandth of a volt.

Vertical Datum:

In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929), a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called *Sea Level Datum of 1929*.

Horizontal Datum:

The horizontal datum for all locations in this report is the North American Datum of 1983 or North American Datum of 1927.

Abbreviations, Acronyms, and Symbols

AC	Actual conductivity
ADOT&PF	Alaska Department of Transportation and Public Facilities
ASTM	American Society for Testing and Materials
atm	atmospheres
C	Celsius
DO	Dissolved oxygen
DVM	digital voltage multi-meter
e-tape	electric tape
F	Fahrenheit (^{o}F).
ft	feet
GWS	Geo-Watersheds Scientific
GWSI	USGS Ground-Water Site Inventory
km^2	square kilometers
kPa	kilopascal
lb/in^2	pounds per square inch
m	meters
mg/L	milligrams per liter, equivalent to ppm
µg/L	micrograms per liter
mi^2	square miles
mm	millimeters
µS/cm	microsiemens per centimeter
mV	Millivolt
NGVD	National Geodetic Vertical Datum
NTU	Nephelometric Turbidity Units
NWIS	National Water Information System
ORP	oxygen-reduction potential
ppm	parts per million, equivalent to mg/L
SC25	specific conductance at 25^{o}C
SWE	Snow Water Equivalent
QA	quality assurance
QC	quality control
UAF	University of Alaska Fairbanks
USACE	U.S. Army Corps of Engineers, Alaska District
USGS	U.S. Geological Survey
WERC	Water and Environmental Research Center
WWW	World Wide Web
YSI	Yellow Springs Instruments

Lake Nomenclature

KDA	Kuparuk Dead Arm (Prudhoe Bay field, serves Prudhoe Bay field operations)
MSB	Mine Site B (Prudhoe Bay field, serves Milne Point and Kuparuk field operations)
L9312	Lake L9312 (Alpine field, serves Alpine field operations)
L9817	Lake L9817 (Alpine field, serves Alpine field operations)
K113	Lake K113 (Prudhoe Bay field, not currently used for field operations)

PROJECT COOPERATORS

The North Slope Lakes project covers a large area of the North Slope and benefits from a number of positive partnerships, all contributing to the overall project objectives.

- BP Exploration (Alaska) Inc.
- ConocoPhillips Alaska, Inc. (CPA)
- Bureau of Land Management
- Alaska Department of Natural Resources
- The Nature Conservancy
- Northern Alaska Environmental Center

ACKNOWLEDGEMENTS

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Lake Chemistry and Physical Data For Selected North Slope, Alaska, Lakes: November 2007

INTRODUCTION

The University of Alaska Fairbanks (UAF) Water and Environmental Research Center (WERC) and Geo-Watersheds Scientific (GWS), together with project cooperators, initiated a study in the Fall of 2002 (Phase One) to obtain baseline information about the physical and chemical characteristics of North Slope tundra lakes. The project was extended in 2005 (Phase Two). The location of the study lakes changed and was expanded to include other reservoirs so as to further develop the understanding and simulation tools necessary for water-source management. K113 is an un-pumped lake in the Kuparuk oilfield and is sampled on selected field trips during the year. L9312 is a natural lake studied in the Alpine operations area. L9817 is a natural lake in eastern NPRA, west of Nuiqsut. L9817 had been used in past years for ice-road construction, but was not pumped during the 2005-06 or 2006-07 winters, however, it was heavily pumped throughout the 2007-08 winter. Two reservoir systems (mine sites) were added to the study in 2005. Mine Site B, also known as Six-mile Lake, is located near the Milne Point facility at the intersection of the Spine Road with the Milne Point access road and has two cells connected to Milne Creek. The Kuparuk Reservoir System (Kuparuk Deadarm Lakes) has nine reservoirs. The three southernmost reservoir cells (1-3) are included in the study to observe ground-water and surface-water interactions between each cells and the adjacent Kuparuk River. Study location can be seen in Figure 1.

Water-quality and hydrologic data is collected in the field during monthly visits to the lakes and water samples are collected from priority locations for further analysis at the UAF-WERC chemistry laboratories. The purposes of this publication are to 1) report data collected for the month of November 2007, 2) summarize accomplished field trip objectives.

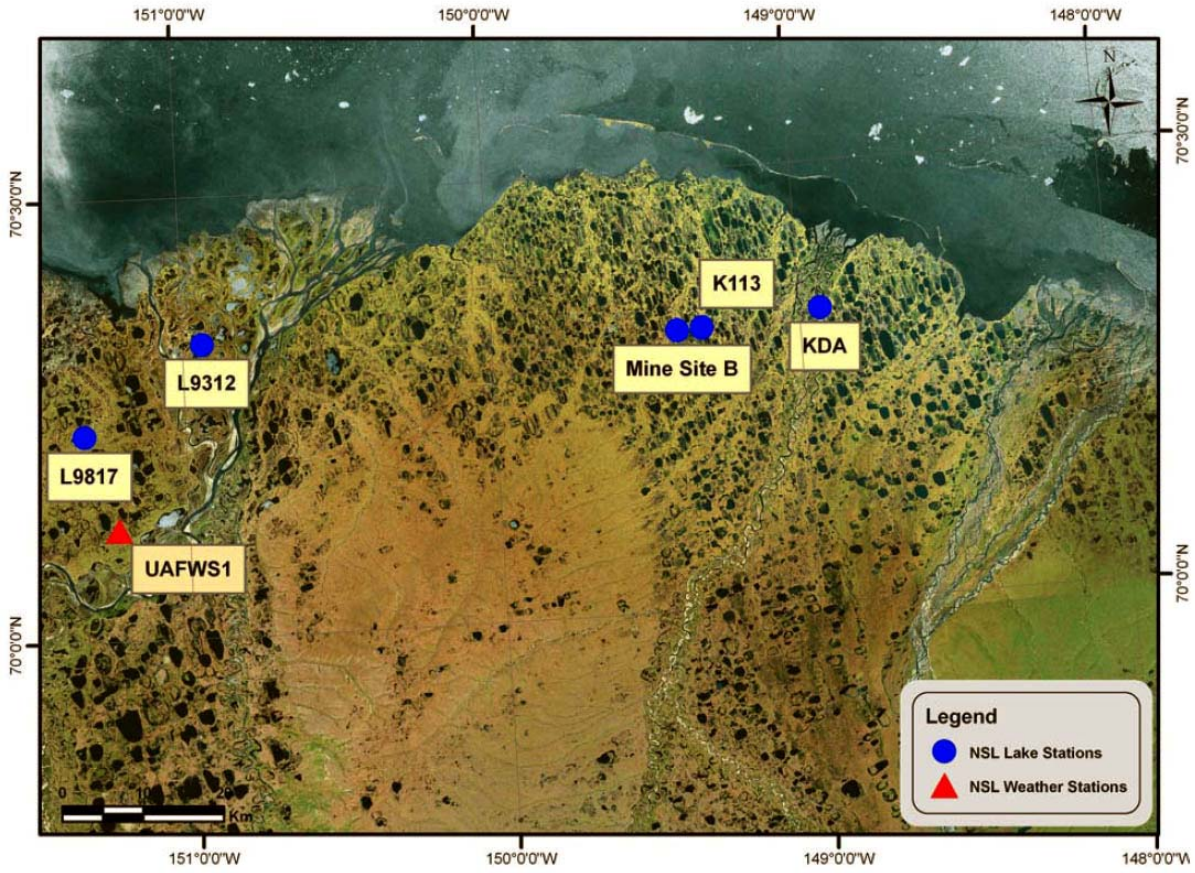

Figure 1. Location of study lakes in the NPR-A, Alpine, Kuparuk, and Prudhoe Bay field operating areas, North Slope, Alaska.

TRIP OBJECTIVES

The goal of each sampling trip is to collect physical and chemical data from each study lake. For each lake, a series of holes are drilled at designated sampling locations or a raft is taken onto the water when conditions are ice free. Logistical, personnel, and weather constraints, can limit the amount of time available in the field for sampling. A project workplan was distributed before the trip outlining the sampling schedule (Lilly and others, 2007). In November 2007, we focused on the following locations/tasks:

1. L9312, Alpine Facility
    - Measure field water-quality parameters at standard locations. This includes vertical profile measurements for temperature, dissolved oxygen (DO), conductivity, pH, turbidity, oxygen reduction potential (ORP) and barometric pressure.
    - Survey water levels to local elevation control.
    - Conduct snow surveys at standard locations.
    - Automated data collection and station maintenance (Figure 2).
2. Mine Site B, Milne-Point Facility
    - Measure field water-quality parameters on North and South cells. This includes vertical profile measurements at each location for temperature, dissolved oxygen (DO), conductivity, pH, turbidity, and barometric pressure.
    - Measure water-quality parameters at one location in Milne Creek upstream of South cell.
    - Survey water levels to local elevation control.
    - Conduct snow surveys at standard locations
    - Measure water depth transects at eastern and western channels between North and South cells.
3. Kuparuk Deadarm Lakes, (Cells 1-3)
    - Measure field water-quality parameters on cells 1 and 2. This includes vertical profile measurements at each location for temperature, dissolved oxygen (DO), conductivity, pH, turbidity, and barometric pressure.
    - Survey water levels of KDA 1-3 to local elevation control.
    - Collect water elevation data from KDA cells 4 & 5 via known elevation control points.
    - Conduct snow surveys at standard locations.
    - Automated data collection station maintenance.
4. Prudhoe Bay Operating Area, Primary Objective
    - Betty Pingo: Automated data collection station maintenance and snow survey.
    - F-pad: Automated data collection station maintenance.

Figure 2. L9312 Meteorlogical station covered with rime and ice, Photo by J. Derry.

PROCEDURES

Water Chemistry Sampling

All field work follows the specified health, safety, and environmental guidelines outlined by BPX and CPA (White and Lilly, 2007 *a*, *b*, *c*). Physical measurements of water depth were taken at each sampling location. Water quality parameters such as temperature, pH, turbidity, oxygen reduction potential (ORP), conductivity, and dissolved oxygen (DO) were obtained by using an In-Situ Troll 9000 (submersible meter), at multiple depths throughout the water column. The precision with which physical measurements were reported takes into account field conditions. The calibration of each parameter was checked before and after each day of sampling using the criteria in Table 1.

Snow Surveys

Small-scale snow depth measurements were conducted in "L" shaped patterns on lake surface and/or tundra surface at predetermined locations . Snow depth measurements were taken every meter for twenty-five meters, then turning 90 degrees, and continuing for another twenty-five

meters. Snow samples were also collected for density measurements with an Adirondack snow sampler. Five densities were collected from points on tundra and lake and averaged to establish a representative density.

Table 1. In-Situ Troll 9000 calibration quality control criteria.

Parameter	Standards used	Acceptable deviation from calibration standard value
Turbidity	Factory calibrated	± 2 (NTU)
pH	4.01, 7.0, 10.0	± 0.2
Conductivity	447 (µs/cm)	within 10%
100% DO	100 % saturated	within 10%
0% DO	0 % saturated solution	within 0.3 mg/L
ORP	In-Situ Quick Cal 224 mV	within 10%

SELECTED RESULTS

Water-quality parameter sampling, water elevation levels, and snow surveys were conducted during the November field activities. A water depth profile of the two channels connecting the North and South Cell of Mine Site B was also undertaken. Water elevations going into freeze-up are lower for L9312, MSB, and Kuparuk Deadarm Lakes compared to this time last year.

Figure 3 shows water elevation measurements for L9312 from December 2004 to November 2007. L9312 has an outlet control elevation of 7.73'. On 12/5/04 water elevations were 7.53'; 11/17/05 elevations were 7.4'; 11/18/06 elevations were 7.68'; and 11/13/07 elevations were 7.32'. For the period going into freeze-up, November 2007 water elevations are the lowest for the four years of record.

Figure 4 shows water elevation measurements for Mine Site B North and South cells from October 2005 to November 2007. Mine Site B has an approximate outlet elevation control of 96.00' (relative to temporary datum of 100.00'). There are two channels that provide a direct

hydrological connection between the North and South cells for certain periods of the year. These channels have allowed a connection during the month of October for the last three years. On 12/15/05 water elevations were 95.33'; on 11/15/06 elevations were 95.9'; and on 11/17/07 elevations were 95.17'. For the three years of record going into winter, water elevations are lowest for November 2007.

Figure 5 shows water elevation measurements for Kuparuk Deadarm Reservoir cells 1-3 from December 2005 to November 2007. Cell 1 does not have a direct hydrologic connection with cells 2 and 3 except during spring flooding. Two connection channels provide a hydrologic link between cells 2 and 3. Prior to April 2007, cells 2 and 3 had a winter period disconnect. After channel modifications were conducted in April 2007, the cells were hydrologically connected during the latter winter months of 2007. On 12/15/05 cell 1, 2, and 3 had an elevation of 8.76', 7.42', and 7.41', respectively. On 11/14/06 elevations were 8.32', 7.99', and 7.98'. On 11/16/07 elevations were 7.85', 7.33', and 7.4'. Similarly to L9312 and Mine Site B, water levels are at there lowest for the month of November compared to previous years of study.

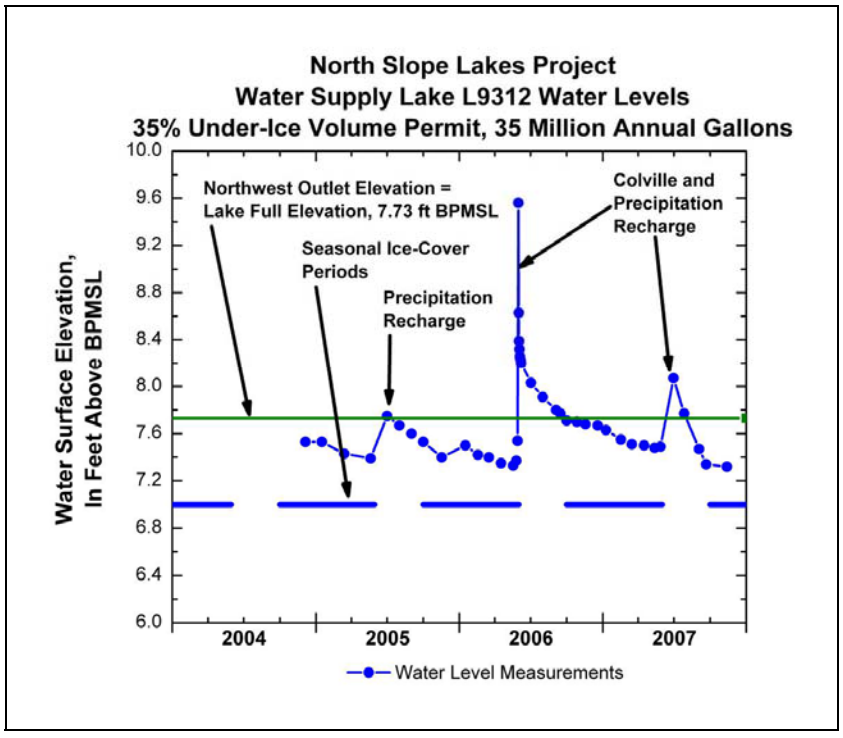

Figure 3. Water elevations for L9312, 2005-2007.

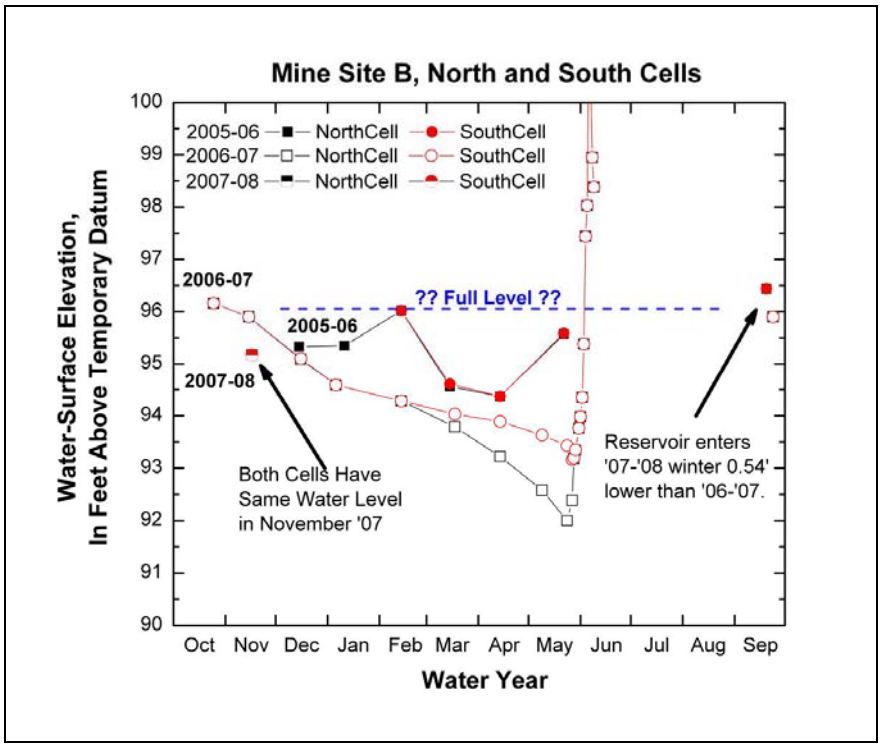

Figure 4. Water elevations for Mine Site B North and South cells, 2005-2007.

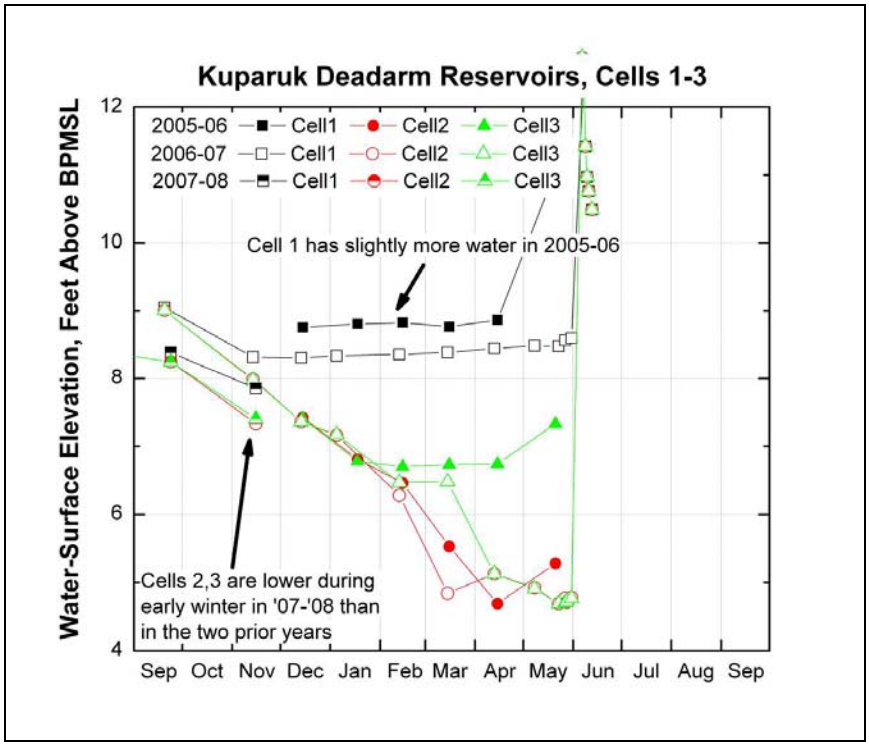

Figure 5. Water elevation for Kuparuk Deadarm Reservoirs cells 1-3, 2005-2007.

SUMMARY

Sampling occurred at Kuparuk Deadarm Lakes, Mine Site B and L9312 during the November field campaign. Table 2 summarizes selected data acquired and compares with findings from November 2006 field activities. Ice thickness is approximately 0.50' greater from that of last year. Water levels compared to this time last year at MSB, KDA, and L9312 are down 0.74', 0.65', and 0.36', respectively. Each lake visited had one or more locations where water-quality parameters were taken along a depth profile of the water column. These locations have more historical data than other locations on the lakes, and have been chosen as representative of the deeper portion of the respective lakes.

Table 2. Ice thickness, Median DO Concentration, Median Actual Conductance and Water Level for select North Slope lakes in mid-November 2007. In parenthesis are results for November 2006.

Sampling Site	Ice Thickness [ft]; (Nov. 2006)	Median DO Concentration[mg/L]; (Nov. 2006)	Median Actual Conductivity[μS/cm]; (Nov. 2006)	Water level [ft]; (Nov. 2006)
KDA1-CT	1.85;(1.15)	14.5;(14.64)	93.7;(111.7)	7.33;(7.98)
KDA2-CT	1.60; (1.0)	14.51; (14.78)	93.7; (108.6)	7.33; (7.98)
MSBS-CT	1.7;(1.30)	13.0;(10.97)	139;(214.0)	95.17;(95.91) arbitrary elevation of 100'
MSBN-CT	1.6; (1.23)	13.00;(11.71)	137;(205.4)	95.17; (95.91) arbitrary elevation of 100'
L9312 Raft B	1.26; (1.4)	13.63; (15.79)	50.7;(46.6)	7.32; (7.68)

Continuous monitoring of water quality parameters and spatial distribution of snow cover at North Slope lakes throughout the winter will help in the understanding and development of simulation tools necessary for water resource management. As water levels drop during the winter, it is important to identify the changing water chemistry as well as the potential spring recharge. This information is necessary for permitting agencies as well as the industry professionals who depend on this resource for facility use and ice road/pad construction. Through monthly hydrologic assessments, water chemistry testing, and water sample analysis, we will continue to answer some of the questions brought forth on the effects of mid-winter pumping of North Slope tundra lakes.

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APPENDIX A. WATER QUALITY FIELD SAMPLING FORMS

The following forms report the data collected with the water quality meters during field sampling.

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: L9312 Raft B

Sample Purpose: **Lake Water Quality** Date: 11/13/07 Time: 12:49

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.995' Easting: W150°56.918' Datum: NAD83

Measurements By: Whitman Time: n/a

Water Depth (ft): 10.96 Ice Thickness (ft): 1.26

Freeboard (ft): 0.05 Snow Depth (ft): 0.10

Elev. (BPMSL +/- .02): 7.32 Survey By: JED Date: 11/13/07 Time: 14:00

Water Sampling By: Sample Depths BWS (ft): 1 Date: Time:

2

WATER QUALITY METER INFORMATION 3

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	Not Done	Pass

Parameters	**Field Measurements**									
Time:	12:52	12:55	12:56	12:59	13:01	13:04	13:07	13:11		
Depth BWS (ft):	2	3	4	5	7	9	10	BOT		
Temp (°C):	1.25	0.79	0.92	1.29	1.60	2.25	2.54	2.75		
pH:	7.58	7.84	7.90	7.92	7.92	7.75	7.56	7.37		
Barometeric (mmHg):	751.1	751.1	751.2	751.1	751.2	751.2	751.2	751.3		
Pressure (kPa):	7.557	8.660	11.708	14.645	20.637	26.642	29.573	32.117		
Conductivity (µS/cm):	50.59	49.64	49.36	48.81	48.49	48.46	51.84	58.44		
RDO (ppm): (mg/L)	14.03	14.60	14.77	14.98	15.16	14.29	12.15	9.06		
Turbidity (NTU):	0.3	0.2	0.2	0.2	0.2	0.3	0.8	16.3		
ORP	-429	-443	-450	-453	-456	-452	-448	-449		

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):**			**Depth BWS (ft):**			**Depth BWS (ft):**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks:

Field-Form Filled Out By: DAR Date: 11/13/07

QAQC Check By: JED Date: 11/13/07

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: L9312 Screen

Sample Purpose: **Lake Water Quality** Date: 11/13/07 Time: 13:45

FIELD MEASUREMENTS

GPS Coord. Northing: N70°20.003' Easting: W150°57.005' Datum: NAD83

Measurements By: Whitman Time: n/a

Water Depth (ft): 11.34 Ice Thickness (ft): 1.28

Freeboard (ft): 0.03 Snow Depth (ft): 0.10

Elev. (BPMSL +/- .02): 7.32 Survey By: JED Date: 11/13/07 Time: 14:00

Water Sampling By: Sample Depths BWS (ft): 1 Date: 11/13/07 Time: 0:00

2

WATER QUALITY METER INFORMATION 3

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	Not Done	Pass

Parameters	**Field Measurements**									
Time:	13:58	14:01	14:04	14:05	14:09	14:12	14:16	14:18		
Depth BWS (ft):	2	3	5	7	9	10	11	BOT		
Temp (°C):	0.47	0.57	1.14	1.64	2.19	2.69	2.90	2.93		
pH:	7.03	7.34	7.46	7.49	7.28	7.06	6.99	7.09		
Barometeric (mmHg):	751.4	751.5	751.6	751.6	751.7	751.8	751.9	751.9		
Pressure (kPa):	5.730	8.508	14.679	21.023	26.622	29.600	32.413	33.392		
Conductivity (µS/cm):	49.90	49.54	48.92	48.77	49.37	53.46	71.87	78.21		
RDO (ppm): (mg/L)	15.17	15.52	15.63	14.68	13.27	10.21	5.42	4.29		
Turbidity (NTU):	2.0	0.1	0.1	0.2	0.6	1.0	12.7	45.2		
ORP	263	249	240	229	235	237	227	212		

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):_____**			**Depth BWS (ft):_____**			**Depth BWS (ft):_____**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks:

Field-Form Filled Out By: DAR Date: 11/13/07

QAQC Check By: JED Date: 11/13/07

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: L9312 SH_SHORE_MID

Sample Purpose: **Lake Water Quality** Date: 11/13/07 Time: 15:36

FIELD MEASUREMENTS

GPS Coord. Northing: N70°20.017' Easting: W150°57.101' Datum: NAD83

Measurements By: Whitman Time: n/a

Water Depth (ft): 7.94 Ice Thickness (ft): 1.30

Freeboard (ft): 0.1 Snow Depth (ft): 0.10

Elev. (BPMSL +/- .02): 7.32 Survey By: JED Date: 11/13/07 Time: 14:00

Water Sampling By: Sample Depths BWS (ft): 1 Date: 11/13/07 Time: 15:36

2

3

WATER QUALITY METER INFORMATION

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	Not Done	Pass

Parameters	**Field Measurements**									
Time:	15:36	15:39	15:41	15:45	15:48	15:52				
Depth BWS (ft):	2	3	5	6	7	BOT				
Temp (°C):	0.32	0.54	1.10	1.50	1.71	1.77				
pH:	7.74	7.71	7.69	7.63	7.57	7.50				
Barometeric (mmHg):	751.7	751.8	751.8	751.9	752.0	752.0				
Pressure (kPa):	5.716	8.695	14.638	17.610	20.602	22.822				
Conductivity (µS/cm):	43.69	50.38	49.88	49.81	50.06	50.67				
RDO (ppm): (mg/L)	14.17	14.36	14.46	14.37	13.86	13.21				
Turbidity (NTU):	0.3	0.3	0.3	0.4	1.2	37.8				
ORP	-421	-420	-419	-419	-417	-416				

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):**			**Depth BWS (ft):**			**Depth BWS (ft):**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks:

Field-Form Filled Out By: DAR Date: 11/13/07

QAQC Check By: JED Date: 11/13/07

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: L9312 SH

Sample Purpose: **Lake Water Quality** Date: 11/13/07 Time: 14:49

FIELD MEASUREMENTS

GPS Coord. Northing: N70°20.017' Easting: W150°57.076' Datum: NAD83

Measurements By: Whitman Time: n/a

Water Depth (ft): 9.07 Ice Thickness (ft): 1.29

Freeboard (ft): 0.09 Snow Depth (ft): 0.10

Elev. (BPMSL +/- .02): 7.32 Survey By: JED Date: 11/13/07 Time: 14:00

Water Sampling By: Sample Depths BWS (ft): 1 Date: Time:

2

WATER QUALITY METER INFORMATION 3

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	Not Done	Pass

Parameters	**Field Measurements**									
Time:	14:49	14:57	15:02	15:06	15:14	15:19				
Depth BWS (ft):	2	3	5	7	8	BOT				
Temp (°C):	0.21	0.84	1.33	1.78	2.01	2.22				
pH:	7.71	7.80	7.77	7.54	7.32	7.23				
Barometeric (mmHg):	751.9	751.8	751.9	752.0	752.1	752.1				
Pressure (kPa):	5.640	8.598	14.659	20.547	23.677	26.091				
Conductivity (µS/cm):	45.95	49.50	49.68	49.64	50.15	51.29				
RDO (ppm): (mg/L)	14.50	14.63	14.36	12.80	10.18	8.24				
Turbidity (NTU):	0.3	0.1	0.1	0.6	0.6	10.7				
ORP	-447	-449	-449	-442	-434	-431				

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):**			**Depth BWS (ft):**			**Depth BWS (ft):**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks:

Field-Form Filled Out By: DAR Date: 11/13/07

QAQC Check By: JED Date: 11/13/07

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: KDA1-CT

Sample Purpose: **Lake Water Quality** Date: 11/16/07 Time: 13:20

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.894' Easting: W148°56.743' Datum: NAD83

Measurements By: JED Time: n/a

Water Depth (ft): 20 Ice Thickness (ft): 1.80

Freeboard (ft): 0.1 Snow Depth (ft): 0.50

Elev. (BPMSL +/- .02): 7.85 Survey By: DAR Date: 11/16/07 Time: 15:45

Water Sampling By: Sample Depths BWS (ft): 1 Date: Time:

2

WATER QUALITY METER INFORMATION 3

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	PASS	PASS

Parameters	**Field Measurements**									
Time:	13:26	13:30	13:33	13:37	13:42	13:45	13:49	13:52	13:56	
Depth BWS (ft):	2	3	5	7	9	11	13	15	16	
Temp (°C):	0.25	0.67	1.24	1.47	1.57	1.60	1.64	1.79	1.88	
pH:	8.17	8.22	8.30	8.35	8.40	8.42	8.44	8.43	8.40	
Barometeric (mmHg):	759.4	759.4	759.5	759.6	759.7	759.7	759.8	759.9	759.9	
Pressure (kPa):	4.762	7.740	13.392	19.391	25.309	31.312	32.292	43.234	46.223	
Conductivity (µS/cm):	93.07	93.03	93.48	93.75	93.65	93.52	93.46	93.41	93.84	
RDO (ppm): (mg/L)	14.81	14.87	14.90	14.84	14.70	14.72	14.61	14.40	13.90	
Turbidity (NTU):	0.1	0.0	0.0	-0.1	0.0	-0.1	-0.1	0.0	0.0	
ORP	173	172	169	167	166	166	167	168	170	

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):_____**			**Depth BWS (ft):_____**			**Depth BWS (ft):_____**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks: gps coordinate from March'07 field form was N70°19.903' W148°56.675' NAD83. This located the hole 20 feet south of the north shore. We relocated KDA1-CT to a location near the center of KDA1 that corresponding with Reichardt's memory of the location from previous years.

Field-Form Filled Out By: DAR Date: 11/16/07

QAQC Check By: JED Date: 11/18/07

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: KDA1-CT

Sample Purpose: **Lake Water Quality** Date: 11/16/07 Time: 13:20

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.894' Easting: W148°56.743' Datum: NAD83

Measurements By: JED Time: n/a

Water Depth (ft): 20 Ice Thickness (ft): 1.80

Freeboard (ft): 0.1 Snow Depth (ft): 0.50

Elev. (BPMSL +/- .02): 7.85 Survey By: DAR Date: 11/16/07 Time: 15:45

Water Sampling By: Sample Depths BWS (ft): 1 Date: Time:

2

3

WATER QUALITY METER INFORMATION

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	PASS	PASS

Parameters	**Field Measurements**									
Time:	14:02	14:11	14:21	14:31	14:35					
Depth BWS (ft):	17	18	19	20	BOT					
Temp (°C):	1.98	2.16	2.31	2.45	2.46					
pH:	8.33	8.13	8.01	7.96	7.96					
Barometeric (mmHg):	760	760.0	760.0	760.2	760.2					
Pressure (kPa):	49.163	52.236	55.182	58.153	59.016					
Conductivity (µS/cm):	94.94	97.35	102.00	106.00	106.20					
RDO (ppm): (mg/L)	13.21	10.67	8.24	6.00	5.32					
Turbidity (NTU):	0.1	0.2	0.7	1.3	390.3					
ORP	174	182	186	183	61					

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):_____**			**Depth BWS (ft):_____**			**Depth BWS (ft):_____**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks:

Field-Form Filled Out By: DAR Date: 11/16/07

QAQC Check By: JED Date: 11/18/07

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: KDA2-CT

Sample Purpose: **Lake Water Quality** Date: 11/16/07 Time: 11:30

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.966' Easting: W148°56.429' Datum: NAD83

Measurements By: JED Time: 11:30

Water Depth (ft): 19.3 Ice Thickness (ft): 1.60

Freeboard (ft): 0.1 Snow Depth (ft): 0.40

Elev. (BPMSL +/- .02): 7.33 Survey By: DAR Date: 11/16/07 Time: 15:45

Water Sampling By: Sample Depths BWS (ft): 1 Date: 11/16/07 Time: 11:30

2

3

WATER QUALITY METER INFORMATION

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	PASS	PASS

Parameters	**Field Measurements**									
Time:	11:33									
Depth BWS (ft):	2	3	5	7	9	11	13	15	17	
Temp (°C):	0.37	0.64	0.96	1.22	1.28	1.34	1.44	1.60	2.00	
pH:	8.12	8.14	8.15	8.15	8.16	8.20	8.24	8.28	7.98	
Barometeric (mmHg):	758.9	759.0	459.1	759.2	759.3	759.4	759.4	759.5	759.6	
Pressure (kPa):	4.758	7.715	13.396	19.363	25.421	31.268	37.194	43.216	49.189	
Conductivity (µS/cm):	96.26	95.99	96.11	96.25	96.17	96.00	95.94	96.01	101.70	
RDO (ppm): (mg/L)	13.85	14.19	14.24	14.17	14.13	14.08	14.01	13.97	10.34	
Turbidity (NTU):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ORP	189	189	189	189	190	189	187	185	196.00	

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):_____**			**Depth BWS (ft):_____**			**Depth BWS (ft):_____**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks:

Field-Form Filled Out By: DAR Date: 11/16/07

QAQC Check By: JED Date: 11/18/07

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: KDA2-CT

Sample Purpose: **Lake Water Quality** Date: 11/16/07 Time: 11:30

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.966' Easting: W148°56.429' Datum: NAD83

Measurements By: JED Time: 11:30

Water Depth (ft): 19.3 Ice Thickness (ft): 1.60

Freeboard (ft): 0.1 Snow Depth (ft): 0.40

Elev. (BPMSL +/- .02): 7.33 Survey By: DAR Date: 11/16/07 Time: 15:45

Water Sampling By: Sample Depths BWS (ft): 1 Date: 11/16/07 Time: 11:30

2

WATER QUALITY METER INFORMATION 3

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	PASS	PASS

Parameters	**Field Measurements**									
Time:	12:26		12:37							
Depth BWS (ft):	18	19	BOT							
Temp (°C):	2.21	2.39	2.42							
pH:	7.84	7.77	7.76							
Barometeric (mmHg):	759.6	759.7	759.8							
Pressure (kPa):	52.149	55.138	56.815							
Conductivity (µS/cm):	113.7	127.80	133.50							
RDO (ppm): (mg/L)	7.99	5.81	5.12							
Turbidity (NTU):	0.3	1.1	71.2							
ORP	201	203	80							

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):_____**			**Depth BWS (ft):_____**			**Depth BWS (ft):_____**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks:

Field-Form Filled Out By: DAR Date: 11/16/07

QAQC Check By: JED Date: 11/18/07

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: Mine Site B North Cell

Sample Purpose: **Lake Water Quality** Date: 11/17/07 Time: 11:49

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.280' Easting: W149°24.009' Datum: NAD83

Measurements By: JED Time: n/a

Water Depth (ft): 34.6 Ice Thickness (ft): 1.60

Freeboard (ft): 0.05 Snow Depth (ft): 0.50

Elev. (BPMSL +/- .02): 95.17 Survey By: DAR Date: 11/17/07 Time: 15:45

Water Sampling By: Sample Depths BWS (ft): 1 Date: Time:

2

WATER QUALITY METER INFORMATION 3

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	Pass	Pass

Parameters	**Field Measurements**									
Time:	11:49	11:55	12:01	12:03	12:07	12:11	12:14	12:16	12:19	12:21
Depth BWS (ft):	2	3	5	7	9	11	13	15	17	19
Temp (°C):	0.31	0.43	1.03	1.48	1.73	1.79	1.82	1.83	1.85	1.93
pH:	8.37	8.40	8.48	8.53	8.65	8.75	8.93	8.91	8.98	9.04
Barometeric (mmHg):	757.4	757.5	757.4	757.6	757.7	757.8	757.8	757.9	758.0	758.0
Pressure (kPa):	4.980	7.717	13.398	19.369	25.295	31.291	37.272	43.105	49.104	55.084
Conductivity (µS/cm):	138.4	137.3	137.0	137.2	137.3	137.1	136.9	136.9	136.8	136.5
RDO (ppm): (mg/L)	12.97	13.20	13.12	13.01	12.80	12.67	12.64	12.64	12.60	12.55
Turbidity (NTU):	0.2	0.1	0.3	0.1	0.1	0.2	0.1	0.1	0.1	0.1
ORP	188	184	178	174	167	161	156	151	148	145

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):**			**Depth BWS (ft):**			**Depth BWS (ft):**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks:

Field-Form Filled Out By: JED Date: 11/18/07

QAQC Check By: DAR Date: 11/18/07

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: Mine Site B North Cell

Sample Purpose: **Lake Water Quality** Date: 11/17/07 Time: 11:49

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.280' Easting: W149°24.009' Datum: NAD83

Measurements By: JED Time: n/a

Water Depth (ft): 34.6 Ice Thickness (ft): 1.60

Freeboard (ft): 0.05 Snow Depth (ft): 0.50

Elev. (BPMSL +/- .02): 95.17 Survey By: DAR Date: 11/17/07 Time: 15:45

Water Sampling By: Sample Depths BWS (ft): 1 Date: Time:

2

WATER QUALITY METER INFORMATION 3

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	Pass	Pass

Parameters	**Field Measurements**									
Time:	12:23	12:26	12:28	12:30	12:37	12:42	12:48	12:52	12:59	13:02
Depth BWS (ft):	21	23	25	27	29	31	32	33	34	Bot
Temp (°C):	1.99	2.03	2.11	2.20	2.47	2.62	2.69	2.78	2.84	2.86
pH:	9.08	9.11	9.11	9.07	8.56	8.32	8.19	8.11	8.14	8.29
Barometeric (mmHg):	758.0	758.1	758.1	758.1	758.1	758.2	758.3	758.3	758.3	758.3
Pressure (kPa):	61.079	66.993	72.927	78.868	84.838	90.870	93.881	96.736	99.809	102.786
Conductivity (µS/cm):	136.5	136.5	136.5	136.8	142.7	154.8	163.7	175.4	198.5	228.8
RDO (ppm): (mg/L)	12.47	12.42	12.38	11.97	8.55	5.91	3.83	1.76	0.43	0.42
Turbidity (NTU):	0.3	0.2	0.2	0.2	0.3	1.8	2.4	2.9	4.9	56.5
ORP	142	141	140	141	159	167	172	174	-63	-125

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):**			**Depth BWS (ft):**			**Depth BWS (ft):**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks:

Field-Form Filled Out By: JED Date: 11/18/07

QAQC Check By: DAR Date: 11/18/07

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: Mine Site B South -CT

Sample Purpose: **Lake Water Quality** Date: 11/17/07 Time: 14:36

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.214' Easting: W149°24.020' Datum: NAD83

Measurements By: JED Time: n/a

Water Depth (ft): 27.5 Ice Thickness (ft): 1.70

Freeboard (ft): 0.1 Snow Depth (ft): none/trace

Elev. (BPMSL +/- .02): 95.17 Survey By: DAR Date: 11/17/07 Time: 15:45

Water Sampling By: Sample Depths BWS (ft): 1 Date: Time:

2

WATER QUALITY METER INFORMATION 3

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	Pass	Pass

Parameters	**Field Measurements**									
Time:	13:30	13:34	13:40	13:44	13:47	13:50	13:55	1:58	14:04	14:08
Depth BWS (ft):	2	3	5	7	9	11	13	15	17	19
Temp (°C):	0.33	0.34	1.13	1.52	1.71	1.75	1.78	1.88	1.98	2.10
pH:	8.16	8.18	8.21	8.26	8.30	8.37	8.43	8.48	8.52	8.55
Barometeric (mmHg):	757.0	757.0	757.1	757.1	757.2	757.2	757.3	757.4	757.4	757.5
Pressure (kPa):	4.727	7.619	13.378	19.393	25.276	31.249	37.246	43.231	49.028	55.094
Conductivity (µS/cm):	142.5	141.2	139.1	139.1	139.0	138.9	138.7	138.4	138.2	138.2
RDO (ppm): (mg/L)	13.47	13.58	13.31	13.14	12.89	12.76	12.71	12.67	12.54	12.35
Turbidity (NTU):	0.3	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2
ORP	119	123	127	128	127	127	127	126	127	127

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):**			**Depth BWS (ft):**			**Depth BWS (ft):**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks:

Field-Form Filled Out By: JED Date: 11/18/07

QAQC Check By: DAR Date: 11/18/07

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: Mine Site B South -CT

Sample Purpose: **Lake Water Quality** Date: 11/17/07 Time: 13:49

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.214' Easting: W149°24.020' Datum: NAD83

Measurements By: JED Time: n/a

Water Depth (ft): 27.5 Ice Thickness (ft): 1.70

Freeboard (ft): 0.1 Snow Depth (ft): none/trace

Elev. (BPMSL +/- .02): 95.17 Survey By: DAR Date: 11/17/07 Time: 15:45

Water Sampling By: Sample Depths BWS (ft): 1 Date: Time:

2

WATER QUALITY METER INFORMATION 3

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	Pass	Pass

Parameters	**Field Measurements**									
Time:	14:36	14:41	14:45	14:52	15:00	15:05				
Depth BWS (ft):	21	23	25	26	27	Bot				
Temp (°C):	2.36	2.43	2.63	2.74	2.84	2.92				
pH:	8.43	8.32	8.14	8.07	8.03	8.02				
Barometeric (mmHg):	757.6	757.6	757.7	757.7	757.6	757.6				
Pressure (kPa):	61.041	67.066	72.953	75.970	78.877	81.622				
Conductivity (µS/cm):	139.0	141.1	149.3	155.7	162.3	167.7				
RDO (ppm): (mg/L)	10.25	8.99	6.60	4.46	1.94	1.35				
Turbidity (NTU):	0.3	0.5	2.0	2.8	4.0	23.9				
ORP	178	179	183	183	103	-27				

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):**			**Depth BWS (ft):**			**Depth BWS (ft):**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks:

Field-Form Filled Out By: JED Date: 11/18/07

QAQC Check By: DAR Date:

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: Mine Site B South - SW

Sample Purpose: **Lake Water Quality** Date: 11/17/07 Time: 15:49

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.186' Easting: W149°24.234' Datum: NAD83

Measurements By: JED Time: n/a

Water Depth (ft): 19.7 Ice Thickness (ft): 1.60

Freeboard (ft): 0.1 Snow Depth (ft): 0.40

Elev. (BPMSL +/- .02): 95.17 Survey By: DAR Date: 11/17/07 Time: 15:45

Water Sampling By: Sample Depths BWS (ft): 1 Date: Time:

2

WATER QUALITY METER INFORMATION 3

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	Pass	Pass

Parameters	**Field Measurements**									
Time:	15:31	15:35	15:38	15:42	15:45	15:48	15:51	15:53	15:56	16:00
Depth BWS (ft):	2	3	5	7	9	11	13	15	17	18
Temp (°C):	0.31	0.40	1.10	1.49	1.70	1.73	1.74	1.81	1.90	1.99
pH:	8.11	8.14	8.22	8.30	8.38	8.44	8.50	8.54	8.56	8.55
Barometeric (mmHg):	756.6	756.6	756.7	756.7	756.8	756.9	756.9	757.0	757.1	757.1
Pressure (kPa):	4.777	7.731	13.296	19.361	25.344	31.263	37.234	43.149	49.123	52.004
Conductivity (µS/cm):	140.7	139.6	139.4	139.0	139.2	139.4	139.5	139.3	139.2	139.2
RDO (ppm): (mg/L)	13.11	13.14	13.08	12.94	12.79	12.66	12.57	12.49	12.37	12.22
Turbidity (NTU):	0.3	0.3	0.3	0.2	0.3	0.3	0.2	0.3	0.3	0.2
ORP	117	121	120	120	119	117	117	117	118	120

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):**			**Depth BWS (ft):**			**Depth BWS (ft):**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks:

Field-Form Filled Out By: JED Date: 11/18/07

QAQC Check By: DAR 11/18/07

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: Mine Site B South - SW

Sample Purpose: **Lake Water Quality** Date: 11/17/07 Time: 15:49

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.186' Easting: W149°24.234' Datum: NAD83

Measurements By: JED Time: n/a

Water Depth (ft): 19.7 Ice Thickness (ft): 1.60

Freeboard (ft): 0.1 Snow Depth (ft): 0.40

Elev. (BPMSL +/- .02): 95.17 Survey By: DAR Date: 11/17/07 Time: 15:45

Water Sampling By: Sample Depths BWS (ft): 1 Date: Time:

2

WATER QUALITY METER INFORMATION 3

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	Pass	Pass

Parameters	**Field Measurements**									
Time:	16:05	16:14								
Depth BWS (ft):	19	BOT								
Temp (°C):	1.98	2.11								
pH:	8.47	8.35								
Barometeric (mmHg):	757.2	757.3								
Pressure (kPa):	55.045	57.927								
Conductivity (µS/cm):	139.3	141.1								
RDO (ppm): (mg/L)	11.74	10.83								
Turbidity (NTU):	0.5	2.9								
ORP	125	134								

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):_____**			**Depth BWS (ft):_____**			**Depth BWS (ft):_____**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks:

Field-Form Filled Out By: JED Date: 11/18/07

QAQC Check By: DAR Date: 11/18/07

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004a: Water Quality Field-Sampling General

Project ID: **North Slope Lakes** Site Location/Lake ID: MSB South - Stream Junction

Sample Purpose: **Lake Water Quality** Date: 11/17/07 Time: 15:49

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.181' Easting: W149°24.315' Datum: NAD83

Measurements By: JED Time: n/a

Water Depth (ft): 4.3 Ice Thickness (ft): 1.70

Freeboard (ft): 0.1 Snow Depth (ft): 0.90

Elev. (BPMSL +/- .02): 95.17 Survey By: DAR Date: 11/17/07 Time: 15:45

Water Sampling By: Sample Depths BWS (ft): 1 Date: Time:

2

WATER QUALITY METER INFORMATION 3

Calibration Information

Parameter (s)	Owner	Meter Make/Model	Serial No.	Pre-Sampling QAQC Check	Post-Sampling QAQC Check
MULTI	GWS	IN-SITU Troll 9000	33033	Pass	Pass

Parameters	**Field Measurements**								
Time:		5:00	5:06	5:11					
Depth BWS (ft):		3	4	Bot					
Temp (°C):		0.13	0.24	0.29					
pH:		7.57	7.52	7.51					
Barometeric (mmHg):		756.8	756.8	756.7					
Pressure (kPa):		7.534	10.243	12.141					
Conductivity (µS/cm):		202.0	208.9	217.6					
RDO (ppm): (mg/L)		8.43	7.29	5.44					
Turbidity (NTU):		1.5	2.7	4.8					
ORP		222	221	209					

FIELD TESTING OF WATER SAMPLES (if small probe is used)

Probe:

Depth (ft)					
Temp (°C)					
pH					
Eh					

NORTH SLOPE LAB CHEMISTRY ANALYSIS

Parameter	**Depth BWS (ft):**			**Depth BWS (ft):**			**Depth BWS (ft):**			**Method**
	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	rep 1	rep 2	rep 3	
Oxygen (mg/L)										Hach spec 0.3-15 mg/L
Alkalinity (mg/L as $CaCO_3$)										Digital titrator 10-4000 mg/L as CaCO3
Total iron--UF (mg/L)										Hach spec 0.02-3.00 mg/L
Filtered Iron--F tot Fe (mg/L)										Hach spec 0.02-3.00 mg/L
Ammonia (mg/L NH_3-N)****										0.01-0.50 mg/L NH3-N
Ammonia/ Iron dilution										

Remarks:

Field-Form Filled Out By: JED Date: 11/18/07

QAQC Check By: DAR Date: 11/18/07

APPENDIX B. WATER QUALITY METER CALIBRATION FORMS

The following forms report the pre- and post-calibration checks for the water quality meters used during field sampling.

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004e: Water Quality Meter Calibration Form

Project ID: **North Slope Lakes** Site Location/Lake ID: L9312

Sample Purpose: **Lake Water Quality**

WATER QUALITY METER INFORMATION

Meter Make: InSitu Make: Troll 9000

Owner: GW Scientific S/N: 33033

CALIBRATION AND QUALITY ASSURANCE INFORMATION

Pre-Sampling QA

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail

Post-Sampling QA

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	11/15/07	9:18	Oakton 4.01	2612530	Dec-08	4.01	pass
ph 7.00	11/15/07	9:21	Oakton 7.00	2612531	Dec-08	6.99	pass
ph 10.00	11/15/07	9:26	Oakton 10.00	2612532	Jun-08	9.93	pass
Conductivity 447 µS/cm	11/15/07	9:31	Oakton 447	2412150	Dec-05	478.4	pass
ORP	11/15/07	9:46	InSitu Quick Cal Soln	2207B	Aug-07	207	pass
Saturated O_2	11/15/07	9:41	Bubbled Nanopure			92.2% saturatio	pass
Zero O_2	11/15/07	9:53	Hanna HI7040	G1012	Feb-11	0.02	pass

Remarks: We were unable to do a pre-cal check for L9312 due to the standards being delayed in shipping.

ph/ORP probe SN:PP10242 (GWS)

Field-Form Filled Out By: DAR Date: 11/15/2007

QAQC Check By: JED Date: 11/15/2007

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004e: Water Quality Meter Calibration Form

Project ID: **North Slope Lakes** Site Location/Lake ID: Kuparuk Deadarm Lakes

Sample Purpose: **Lake Water Quality**

WATER QUALITY METER INFORMATION

Meter Make: InSitu Make: Troll 9000

Owner: GW Scientific S/N: 33033

CALIBRATION AND QUALITY ASSURANCE INFORMATION

Pre-Sampling QA

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	11/15/07	9:18	Oakton 4.01	2612530	Dec-08	4.01	pass
ph 7.00	11/15/07	9:21	Oakton 7.00	2612531	Dec-08	6.99	pass
ph 10.00	11/15/07	9:26	Oakton 10.00	2612532	Jun-08	9.93	pass
Conductivity 447 µS/cm	11/15/07	9:31	Oakton 447	2412150	Dec-05	478.4	pass
ORP	11/15/07	9:46	InSitu Quick Cal Soln	2207B	Aug-07	207	pass
Saturated O_2	11/15/07	9:41	Bubbled Nanopure			92.2% saturatio	pass
Zero O_2	11/15/07	9:53	Hanna HI7040	G1012	Feb-11	0.02	pass

Post-Sampling QA

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	11/16/07	19:18	Oakton 4.01	2612530	Dec-07	4.05	pass
ph 7.00	11/16/07	19:24	Oakton 7.00	2612531	Dec-07	7.02	pass
ph 10.00	11/16/07	19:27	Oakton 10.00	2612532	Jun-08	10.03	pass
Conductivity 447 µS/cm	11/16/07	19:30	Oakton 447	2412150	Dec-05	430.3	pass
ORP	11/16/07	19:52	InSitu Quick Cal Soln	2207B	Aug-07	214	pass
Saturated O_2	11/16/07	19:39	Bubbled Nanopure			97.8% saturation	pass
Zero O_2	11/16/07	20:41	Hanna HI7040	G1012	Feb-11	0.2	pass

Remarks: ph/ORP probe SN:PP10242 (GWS)

Field-Form Filled Out By: JED Date: 11/18/2007

QAQC Check By: DAR Date: 11/18/2007

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-004e: Water Quality Meter Calibration Form

Project ID: **North Slope Lakes** Site Location/Lake ID: Mine Site B

Sample Purpose: **Lake Water Quality**

WATER QUALITY METER INFORMATION

Meter Make: InSitu Make: Troll 9000

Owner: GW Scientific S/N: 33033

CALIBRATION AND QUALITY ASSURANCE INFORMATION

Pre-Sampling QA

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	11/16/07	19:18	Oakton 4.01	2612530	Dec-07	4.05	pass
ph 7.00	11/16/07	19:24	Oakton 7.00	2612531	Dec-07	7.02	pass
ph 10.00	11/16/07	19:27	Oakton 10.00	2612532	Jun-08	10.03	pass
Conductivity 447 µS/cm	11/16/07	19:30	Oakton 447	2412150	Dec-05	430.3	pass
ORP	11/16/07	19:52	InSitu Quick Cal Soln	2207B	Aug-07	214	pass
Saturated O_2	11/16/07	19:39	Bubbled Nanopure			97.8 saturation	pass
Zero O_2	11/16/07	20:41	Hanna HI7040	G1012	Feb-11	0.2	pass

Post-Sampling QA

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	11/17/07	21:19	Oakton 4.01	2612530	Dec-07	4.06	Pass
ph 7.00	11/17/07	21:22	Oakton 7.00	2612531	Dec-07	7.06	Pass
ph 10.00	11/17/07	21:23	Oakton 10.00	2612532	Jun-08	10.02	Pass
Conductivity 447 µS/cm	11/17/07	21:25	Oakton 447	2412150	Dec-05	395.7	Pass
ORP	11/17/07	21:31	InSitu Quick Cal Soln	2207B	Aug-07	213.000	Pass
Saturated O_2	11/17/07	21:28	Bubbled Nanopure			101.4	Pass
Zero O_2	11/17/07	21:39	Hanna HI7040	G1012	Feb-11	0.02	Pass

Remarks: ph/ORP probe SN:PP10242 (GWS)

Field-Form Filled Out By: JED Date: 11/18/2007

QAQC Check By: DAR Date: 11/18/2007

APPENDIX C. ELEVATION SURVEY FORMS

The following form reports the elevation survey information obtained during field sampling.

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-011: Elevation Survey Form

Project ID: **North Slope Lakes** Site Location/Lake ID: L9312

Survey Purpose: **Water-Level Elevations** Date: 11/13/2007 Time: 2:15pm

Location:	Lake L9312, located southeast of Alpine pad, survey by pump house benchmarks							
Survey objective:	Determine FWS Elevation.					Weather Observations:		
Instrument Type:	Leica NA720		Instrument ID:	5482367 (GWS owned)		Foggy and cool. Calm winds. 8°F		
Rod Type:	Fiberglass		Rod ID:	Sokkia Fiber Glass				
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		Jeff Derry, Matt Whitman		
L9312"P"	CP	11.72	na	na				
Station	**BS (ft)**	**HI (ft)**	**FS (ft)**	**Elevation (fasl)**	**Distance (ft)**	**Horizontal Angle**	**Vertical Angle**	**Remarks**
TBM "P"	0.91	12.63		11.72				Top of inlet pipe support
TBM "O"		12.63	1.16	11.47				Top of inlet pipe support
99-32-59		12.63	-1.95	14.58				Top of VSM plate, SE corner of pump house
L9312 WL		12.63	5.31	**7.32**				**Water Surface Level**
Turn on L9312 WL								
L9312 WL	5.45	12.77		7.32				
99-32-59		12.77	-1.81	14.58				
TBM"O"		12.77	1.30	11.47				
TBM"P"		12.77	1.05	11.72				close survey to 0.00

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-011: Elevation Survey Form

Project ID: **North Slope Lakes** Site Location/Lake ID: Mine Site B

Survey Purpose: **Water-Level Elevations** Date: 11/17/2007 Time: 15:41

Location:	Mine Site B aka 6 mile Lake							
Survey objective:	Determine lake water elevation in North and South Cells					Weather Observations:		
Instrument Type:	Leica NA720		Instrument ID:	5482367 (GWS owned)		15°F, 10 mph E wind, mostly overcast		
Rod Type:	Craine fiberglass 20'		Rod ID:	GWS owned				
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		Reichardt, Whitman		
TBM_1	nr	100.00 Arbitrary	N70°19.308'	W149°23.882'				

Station	**BS (ft)**	**HI (ft)**	**FS (ft)**	**Elevation (fasl)**	**Distance (ft)**	**Horizontal Angle**	**Vertical Angle**	**Remarks**
TBM_1	4.760	104.760		100.000				
MSBN-SH		104.760	9.594	**95.166**				**WL MSBN=95.166'**
VSMS		104.760	0.878	103.882				
VSMN		104.760	1.253	103.507				
VSM_Cut		104.760	3.341	101.419				
Move instrument to ^2, turn on VSM-CUT								
VSM_Cut	3.016	104.435		101.419				
VSMN		104.435	0.927	103.508				
VSMS		104.435	0.551	103.884				
MSBN-SH		104.435	9.269	95.166				
TBM_1		104.435	4.432	100.003				Survey leg closes within ±0.01
Move instrument to ^3 on island, turn on MSBN Water Level								
MSBN-SH'	5.960	101.126		95.166				Shot level to ice. Added FB to calculate BS
MSBS-SH		101.126	5.957	**95.169**				**WL MSBS=95.169'**
Move instrument to ^4, turn on MSBS-SH. Water Surface has frozen in hole.								
MSBS-SH	5.429	100.598		95.169				
MSBN-SH'		100.598	5.436	95.162				Survey leg closes within ±0.01

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-011: Elevation Survey Form

Project ID: **North Slope Lakes** Site Location/Lake ID: KDA 1,2,3

Survey Purpose: **Water-Level Elevations** Date: 11/16/2007 Time: 15:50

Location:	Kuparuk Deadarm Lakes, east of the Spine Road Kuparuk bridge.							
Survey objective:	Determine FWS Elevation of cell 1, cell 2 and cell 3.					Weather Observations:		
Instrument Type:	Leica NA720		Instrument ID:	5482367 (GWS owned)		13°F, 20 mph E. wind. Overcast. ½ mile vis.		
Rod Type:	Fiberglass		Rod ID:	Sokkia Fiber Glass				
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		Dan Reichardt, Matt Whitman		
BM1	BP	19.32	na	na				

Station	**BS (ft)**	**HI (ft)**	**FS (ft)**	**Elevation (fasl)**	**Distance (ft)**	**Horizontal Angle**	**Vertical Angle**	**Remarks**
BM1	1.148	20.468		19.320				
KDA3-SH		20.468	13.042	7.426				
KDA2-SH		20.468	13.120	7.348				Water surface at hole is not frozen and some error is inherent in holding the 17 foot tall rod steady on open water
KDA2-ICE		20.468	12.970	7.498				
Turn on KDA2-Ice. Move to Inst.2								
KDA2-ICE	12.792	20.290		7.498				
KDA2-SH		20.290	12.978	7.312				**Average KDA2 WL=7.330'**
KDA3-SH		20.290	12.926	7.364				**Average KDA23 WL=7.395'**
BM1		20.290	0.961	19.329				close survey to 0.01
Move to Inst.3								
KDA2-SH'	7.025	14.355		7.330				
KDA1-SH		14.355	6.505	**7.850**				**KDA1 WL=7.85**
KDA1-ICE		14.355	6.498	7.857				
Turn on KDA3-ICE. Move to Inst.4								
KDA1-ICE	6.778	14.635		7.857				
KDA1-SH		14.635	6.795	7.840				
KDA2-SH'		14.635	7.298	7.337				close survey to 0.01

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-011: Elevation Survey Form

Project ID: **North Slope Lakes** Site Location/Lake ID: KDA 4,5

Survey Purpose: **Water-Level Elevations** Date: 11/16/2007 Time: 13:45

Location:	Kuparuk Deadarm Lakes, east of the Spine Road Kuparuk bridge.							
Survey objective:	Determine FWS Elevation of cells 4 and 5.					Weather Observations:		
Instrument Type:	Leica NA720		Instrument ID:	5482367 (GWS owned)		13°F, 20 mph E. wind. Overcast. ½ mile vis.		
Rod Type:	Fiberglass		Rod ID:	Sokkia Fiber Glass				
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		Dan Reichardt, Matt Whitman		
BM1	BP	19.62	na	na				

Station	**BS (ft)**	**HI (ft)**	**FS (ft)**	**Elevation (fasl)**	**Distance (ft)**	**Horizontal Angle**	**Vertical Angle**	**Remarks**
BM3	1.945	21.565		19.620				
TP1		21.565	10.521	11.044				
TURN ON TP1, MOVE TO INST 2								
TP1	1.263	12.307		11.044				
KDA5-SH		12.307	6.890	5.417				Water surface at hole is not frozen and some error is inherent in holding the 17 foot tall rod steady on open water
KDA4-SH		12.307	6.810	5.497				
TOC5-H		12.307	5.815	6.492				
TOC4		12.307	5.750	6.557				
TURN ON TOP OF KDA4 CULVERT, MOVE TO INST 3								
TOC4	5.892	12.449		6.557				
TOC5-H		12.449	5.953	6.496				
KDA4-SH		12.449	6.989	5.460				**Average KDA4 WL=5.479'**
KDA5-SH		12.449	7.050	5.399				**Average KDA5 WL=5.408'**
TP1		12.449	3.125	9.324				
TURN ON TP2, MOVE TO INST4								
TP2	11.343	20.667		9.324				
BM3		20.667	1.031	19.636				close survey to 0.02

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasml; foresight, FS; height of instrument, HI; minutes, mm; seconds, ss; BP Mean Sea Level, BPMSL

APPENDIX D. SNOW DEPTH AND WATER CONTENT SURVEY FORMS

The following forms report the snow survey information obtained during field sampling.

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-012: Snow Depth and Water Content Survey Form

Project ID: **North Slope Lakes** Site Location/Lake ID: **L9312-WxStation**

Survey Purpose: **Determine snow water equivalent** Date: 11/13/2007 Time: 1:00pm

Location Description:	North of weather station at L9312. Start at east snow pole, transect goes 25 m west x 25 m North. See L9312 WxSta Snow 070922.JPG for layout.				
Survey objective:	Determine Snow Water Equivalent			Weather Observations:	Foggy, cool. Calm winds. 8°F
Latitude:		Longitude:		Datum:	
Elevation:	Approximately 10 ft	Elevation Datum:	BPMSL	Reference Markers:	Orange snow poles
Drainage Basin:	Lake L9312	Slope Direction:	East	Vegetation Type:	Tussuck tundra
Slope Angle:	2°	Access Notes:		Other:	
Snow Depth Probe Type:		T-handle probe		Snow-Survey Team Names	
Snow Tube Type:	Arinodack snow tube			Jeff Derry and Matt Whitman	

Snow Course Depths, in cm.

	1	2	3	4	5
1	13.0	16.0	12.0	21.0	26.0
2	12.0	16.0	13.0	29.0	34.0
3	13.0	14.0	12.0	23.0	15.0
4	12.0	12.0	14.0	18.0	20.0
5	21.0	11.0	13.0	24.0	10.0
6	16.0	11.0	11.0	19.0	16.0
7	12.0	22.0	13.0	17.0	16.0
8	15.0	25.0	14.0	11.0	18.0
9	18.0	25.0	20.0	15.0	36.0
10	17.0	17.0	21.0	21.0	33.0

	(cm)
Average snow depth =	**17.7**
Maximum snow depth =	36.0
Minimum snow depth =	10.0
Standard variation =	6.2

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm^3)	Density (gr/cm^3)
DW4-1	10.16	67.4	362.7	0.19
DW4-2	22.86	132.7	816.1	0.16
DW4-3	22.86	158.0	816.1	0.19
DW4-4	12.7	68.8	453.4	0.15
DW4-5	17.78	111.3	634.7	0.18

Average Density =	**0.17**	
Average Snow Water Equivalent (SWE) =	**3.1**	cm H2O
Average Snow Water Equivalent =	**1.21**	inches H2O
Average Snow Water Equivalent =	**0.10**	feet H2O

SWE = avg. snow depth*(density snow/density water)

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-012: Snow Depth and Water Content Survey Form

Project ID: **North Slope Lakes** Site Location/Lake ID: **L9312_SNO_1**

Survey Purpose: **Determine snow water equivalent** Date: 11/13/2007 Time: 3:00pm

Location Description:	South side of L9312 on tundra. Marked by snow poles. Start at south pole. Travel 25 meters north to pole. Turn left 90° and travel 25 meters west to ending pole.				
Survey objective:	Determine Snow Water Equivalent			Weather Observations:	Foggy, cool. Calm winds. 8°F
Latitude:		Longitude:		Datum:	
Elevation:	Approximatley 15 ft.	Elevation Datum:	BPMSL	Reference Markers:	Orange poles
Drainage Basin:	Lake L9312	Slope Direction:	South	Vegetation Type:	Tussuck tundra
Slope Angle:	2°	Access Notes:		Other:	
Snow Depth Probe Type:		T-handle probe		Snow-Survey Team Names	
Snow Tube Type:	Arinodack snow tube			Dan Reichardt and Matt Whitman	

Snow Course Depths, in cm.

	1	2	3	4	5
1	13.0	19.0	20.0	26.0	20.0
2	27.0	21.0	21.0	28.0	21.0
3	17.0	16.0	18.0	27.0	15.0
4	19.0	26.0	20.0	24.0	20.0
5	19.0	26.0	23.0	18.0	25.0
6	19.0	17.0	16.0	23.0	20.0
7	26.0	24.0	38.0	21.0	17.0
8	23.0	20.0	43.0	11.0	20.0
9	25.0	26.0	24.0	28.0	17.0
10	19.0	19.0	25.0	25.0	20.0

	(cm)
Average snow depth =	**21.9**
Maximum snow depth =	43.0
Minimum snow depth =	11.0
Standard variation =	5.5

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm^3)	Density (gr/cm^3)
DW4-1	13.97	71.1	498.7	0.14
DW4-2	20.32	54.7	725.4	0.08
DW4-3	17.78	111.5	634.7	0.18
DW4-4	15.24	100.0	544.1	0.18
DW4-5	20.32	118.9	725.4	0.16

Average Density =	**0.15**	
Average Snow Water Equivalent (SWE) =	**3.2**	cm H2O
Average Snow Water Equivalent =	**1.28**	inches H2O
Average Snow Water Equivalent =	**0.11**	feet H2O

SWE = avg. snow depth*(density snow/density water)

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-012: Snow Depth and Water Content Survey Form

Project ID: **North Slope Lakes** Site Location/Lake ID: **L9312_Raft_B**

Survey Purpose: **Determine snow water equivalent** Date: 11/13/2007 Time: 1:20pm

Location Description:	Started 5 meters north of "Raft B" on L9312. Travelled 25 meters northerly towards Raft A. Turned left 90° and travelled 25 meters west to end point.				
Survey objective:	Determine Snow Water Equivalent			Weather Observations:	Foggy, cool. Calm winds. 8°F
Latitude:	N 70° 19.995'	Longitude:	W 150° 56.918'	Datum:	NAD 83
Elevation:	7 ft	Elevation Datum:	BPMSL	Reference Markers:	Raft B is marked with lathe
Drainage Basin:	Lake L9312	Slope Direction:	Flat	Vegetation Type:	Ice
Slope Angle:	Flat	Access Notes:	Snowmobile	Other:	
Snow Depth Probe Type:		T-handle probe		Snow-Survey Team Names	
Snow Tube Type:	Arinodack snow tube			Jeff Derry and Matt Whitman	

Snow Course Depths, in cm.

	1	2	3	4	5
1	7.0	7.0	7.0	5.0	6.0
2	7.0	7.0	5.0	3.0	7.0
3	7.0	6.0	6.5	6.0	5.5
4	7.5	5.0	7.0	5.0	9.0
5	6.5	4.0	6.5	5.0	9.0
6	6.5	5.0	6.5	5.5	10.0
7	5.0	6.0	5.0	5.5	9.0
8	5.0	5.0	3.0	6.0	5.5
9	7.0	6.5	6.0	8.0	6.5
10	6.5	7.5	6.5	7.0	5.0

	(cm)
Average snow depth =	**6.2**
Maximum snow depth =	10.0
Minimum snow depth =	3.0
Standard variation =	1.4

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm^3)	Density (gr/cm^3)
DW4-1	6.35	56.5	226.7	0.25
DW4-2	6.35	48.1	226.7	0.21
DW4-3	5.08	45.2	181.4	0.25
DW4-4	7.62	61.7	272.0	0.23
DW4-5	6.35	52.6	226.7	0.23

Average Density =	**0.23**	
Average Snow Water Equivalent (SWE) =	**1.5**	cm H2O
Average Snow Water Equivalent =	**0.57**	inches H2O
Average Snow Water Equivalent =	**0.05**	feet H2O

SWE = avg. snow depth*(density snow/density water)

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-012: Snow Depth and Water Content Survey Form

Project ID: **North Slope Lakes** Site Location/Lake ID: **KDA2-CT**

Survey Purpose: **Determine snow water equivalent** Date: 11/16/2007 Time: 16:00

Location Description:	At KDA2-CT snow course bears North 25 meters, then West 25 meters.				
Survey objective:	Determine Snow Water Equivalent			Weather Observations:	13°F, 20 mph East wind.
Latitude:	N70°19.966'	Longitude:	W14°856.429'	Datum:	NAD83
Elevation:	Approximately 10 ft	Elevation Datum:	BPMSL	Reference Markers:	KDA-CT Lathe
Drainage Basin:	Kuparuk River	Slope Direction:	flat	Vegetation Type:	Ice
Slope Angle:	flat	Access Notes:	Highway vehicle	Other:	
Snow Depth Probe Type:		T-handle probe		Snow-Survey Team Names	
Snow Tube Type:	Arinodack snow tube			Jeff Derry	

Snow Course Depths, in cm.

	1	2	3	4	5
1	13.0	13.0	13.0	13.0	13.0
2	13.0	17.0	11.0	9.0	8.0
3	13.0	15.0	3.0	13.0	10.0
4	9.0	13.0	5.0	4.0	8.0
5	7.0	9.0	15.0	8.0	8.0
6	8.0	8.0	11.0	10.0	13.0
7	8.0	7.0	6.0	10.0	11.0
8	5.0	3.0	6.0	3.0	4.0
9	8.0	1.0	7.0	0.0	5.0
10	10.0	8.0	1.0	0.0	8.0

	(cm)
Average snow depth =	**8.5**
Maximum snow depth =	17.0
Minimum snow depth =	0.0
Standard variation =	4.1

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm^3)	Density (gr/cm^3)
S4	10	66.3	357.0	0.19
S5	13	67.3	464.1	0.15
T3	12	87.9	428.4	0.21
T5	6	33.0	214.2	0.15
T4	8	39.9	285.6	0.14

Average Density =	**0.17**	
Average Snow Water Equivalent (SWE) =	**1.4**	cm H2O
Average Snow Water Equivalent =	**0.55**	inches H2O
Average Snow Water Equivalent =	**0.05**	feet H2O

SWE = avg. snow depth*(density snow/density water)

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-012: Snow Depth and Water Content Survey Form

Project ID: **North Slope Lakes** Site Location/Lake ID: **MSB-CT**

Survey Purpose: **Determine snow water equivalent** Date: 12/17/2007 Time: 16:42

Location Description:	At MSBN-CT snow course bears West 25 meters, then South 25 meters.				
Survey objective:	Determine Snow Water Equivalent			Weather Observations:	15°F, 10 mph E wind, mostly overcast. Dark.
Latitude:	N70°19.280'	Longitude:	W149°24.009'	Datum:	NAD83
Elevation:	Approximately 50 ft BPMSL.	Elevation Datum:	BPMSL	Reference Markers:	Lathe is at MSBN-CT
Drainage Basin:	Milne Creek	Slope Direction:	Flat	Vegetation Type:	Ice
Slope Angle:	flat	Access Notes:	Highway Vehicle	Other:	24-72 hour old snow being rapidly transported by 20+
Snow Depth Probe Type:		T-handle probe		Snow-Survey Team Names	
Snow Tube Type:	Arinodack snow tube			Reichardt, Whitman	

Snow Course Depths, in cm.

	1	2	3	4	5
1	8.0	3.0	6.0	4.0	3.0
2	7.0	3.0	5.0	1.0	1.0
3	7.0	1.0	2.0	1.0	1.0
4	8.0	1.0	1.0	4.0	0.0
5	9.0	4.0	2.0	4.0	0.0
6	5.0	1.0	3.0	6.0	3.0
7	15.0	1.0	3.0	4.0	1.0
8	4.0	3.0	4.0	3.0	3.0
9	5.0	4.0	4.0	4.0	3.0
10	3.0	6.0	4.0	1.0	3.0

	(cm)
Average snow depth =	**3.6**
Maximum snow depth =	15.0
Minimum snow depth =	0.0
Standard variation =	2.7

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm^3)	Density (gr/cm^3)
S2	9.5	54.1	339.2	0.16
L2	2	18.1	71.4	0.25
L1	3	20.5	107.1	0.19
L5	6	21.2	214.2	0.10
T1	3	11.9	107.1	0.11

Average Density =	**0.16**	
Average Snow Water Equivalent (SWE) =	**0.6**	cm H2O
Average Snow Water Equivalent =	**0.23**	inches H2O
Average Snow Water Equivalent =	**0.02**	feet H2O

SWE = avg. snow depth*(density snow/density water)

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-012: Snow Depth and Water Content Survey Form

Project ID: **North Slope Lakes** Site Location/Lake ID: **MSB-SNOTUN**

Survey Purpose: **Determine snow water equivalent** Date: 12/17/2007 Time: 17:00

Location Description:	At MSBN-SNOTUN snow course bears West 25 meters, then South 25 meters.				
Survey objective:	Determine Snow Water Equivalent			Weather Observations:	15°F, 10 mph E wind, mostly overcast. Dark.
Latitude:	N70°19.256'	Longitude:	W149°24.242'	Datum:	NAD83
Elevation:	Approximately 50 ft BPMSL.	Elevation Datum:	BPMSL	Reference Markers:	Lathe is at MSBN-SNOTUN in tundra west of Lake
Drainage Basin:	Milne Creek	Slope Direction:	Flat	Vegetation Type:	Tussock Tundra
Slope Angle:	flat	Access Notes:	Highway Vehicle	Other:	2 day old snow being transported by 20+ mph winds
Snow Depth Probe Type:		T-handle probe		Snow-Survey Team Names	
Snow Tube Type:	Arinodack snow tube			Reichardt, Whitman	

Snow Course Depths, in cm.

	1	2	3	4	5
1	11.0	15.0	27.0	16.0	10.0
2	17.0	14.0	24.0	17.0	11.0
3	13.0	15.0	24.0	13.0	13.0
4	13.0	16.0	11.0	13.0	15.0
5	12.0	15.0	16.0	15.0	21.0
6	10.0	16.0	13.0	13.0	20.0
7	19.0	17.0	19.0	17.0	16.0
8	17.0	18.0	34.0	16.0	7.0
9	13.0	23.0	20.0	17.0	9.0
10	16.0	27.0	14.0	16.0	9.0

	(cm)
Average snow depth =	**16.1**
Maximum snow depth =	34.0
Minimum snow depth =	7.0
Standard variation =	5.1

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm^3)	Density (gr/cm^3)
X	10	36.7	357.0	0.10
L3	15	66.5	535.5	0.12
T2	35.5	243.2	1267.4	0.19
45	14	65.7	499.8	0.13
Y	15.5	81.1	553.4	0.15

Average Density = **0.14**

Average Snow Water Equivalent (SWE) = **2.2** cm H2O

Average Snow Water Equivalent = **0.88** inches H2O

Average Snow Water Equivalent = **0.07** feet H2O

SWE = avg. snow depth*(density snow/density water)

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-012: Snow Depth and Water Content Survey Form

Project ID:	**North Slope Lakes**	Site Location/Lake ID:	**Betty Pingo**
Survey Purpose:	**Determine snow water equivalent**	Date: 11/18/2007	Time: 16:00

Location Description:	Near Wyoming gage. At staked snow site. Started east and then went north. Point of beginning is flagged rebar.				
Survey objective:	Determine Snow Water Equivalent			Weather Observations:	Overcast, 5F, slight breeze
Latitude:	N70°16.772'	Longitude:	W148°53.741'	Datum:	NAD83
Elevation:	Approximately 10 ft	Elevation Datum:	BPMSL	Reference Markers:	Re-bar and lathe
Drainage Basin:	Kuparuk River	Slope Direction:	flat	Vegetation Type:	Tussock Tundra
Slope Angle:	flat	Access Notes:	Highway vehicle	Other:	
Snow Depth Probe Type:		T-handle probe		Snow-Survey Team Names	
Snow Tube Type:	Arinodack snow tube			Jeff Derry	

Snow Course Depths, in cm.

	1	2	3	4	5
1	45.0	26.0	21.0	11.0	10.0
2	37.0	22.0	23.0	11.0	20.0
3	17.0	24.0	22.0	12.0	23.0
4	16.0	32.0	12.0	13.0	29.0
5	17.0	23.0	20.0	13.0	21.0
6	17.0	28.0	17.0	10.0	26.0
7	22.0	33.0	13.0	15.0	20.0
8	20.0	29.0	11.0	34.0	17.0
9	22.0	32.0	11.0	23.0	18.0
10	20.0	33.0	10.0	26.0	10.0

	(cm)
Average snow depth =	**20.7**
Maximum snow depth =	45.0
Minimum snow depth =	10.0
Standard variation =	8.1

Snow Sample Depths and Weights

Bag #	Depth (cm)	Weight (gr)	Volume (cm^3)	Density (gr/cm^3)
jed1	20	97.5	714.0	0.14
jed2	15	120.8	535.5	0.23
jed3	34	106.8	1213.8	0.09
jed5	16	218.0	571.2	0.38
jed4	14	203.0	499.8	0.41

Average Density =	**0.25**	
Average Snow Water Equivalent (SWE) =	**5.1**	cm H2O
Average Snow Water Equivalent =	**2.02**	inches H2O
Average Snow Water Equivalent =	**0.17**	feet H2O

SWE = avg. snow depth*(density snow/density water)