

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



Channels connecting North and South cells at Mine Site B (6-Mile Lake), Photo by D. Reichardt (GW-Scientific).

by
Jeff Derry, Kristie Holland, Dan Reichardt and Michael Lilly

November 2007

North Slope Lakes Hydrologic Project
Report No. INE/WERC 07.12

Water and Environmental
Research Center



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By:

Jeff Derry¹, Kristie Holland¹, Dan Reichardt¹ and Michael Lilly¹

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- U.S. Department of Energy
- National Energy Technology Laboratory
- BP Exploration (Alaska), Inc.
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- Geo-Watersheds Scientific

November 2007

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Report Number INE/WERC 07.12

¹Geo-Watersheds Scientific, Fairbanks, Alaska

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November 2007

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DISCLAIMER

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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
<u>Length</u>		
inch (in.)	25.4	millimeter (mm)
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
<u>Area</u>		
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)
<u>Volume</u>		
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)
<u>Velocity and Discharge</u>		
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)
<u>Hydraulic Conductivity</u>		
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)
<u>Hydraulic Gradient</u>		
foot per foot (ft/ft)	5280	foot per mile (ft/mi)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
<u>Pressure</u>		
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 (m³/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:

$$^{\circ}\text{F} = 1.8(^{\circ}\text{C}) + 32$$

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 (°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°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

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Lake Chemistry and Physical Data For Selected North Slope, Alaska, Lakes: September 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 reservoirs to help 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 has been used in previous years for ice-road construction, but was not used during winters of 2005-06 or 2006-07. 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 eight 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. Water levels are occasionally measured in Cells 4 and 5. Figure 1 shows the location of study lakes and reservoirs.

Water-quality and hydrologic data are 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 September 2007, 2) summarize accomplished field trip objectives.

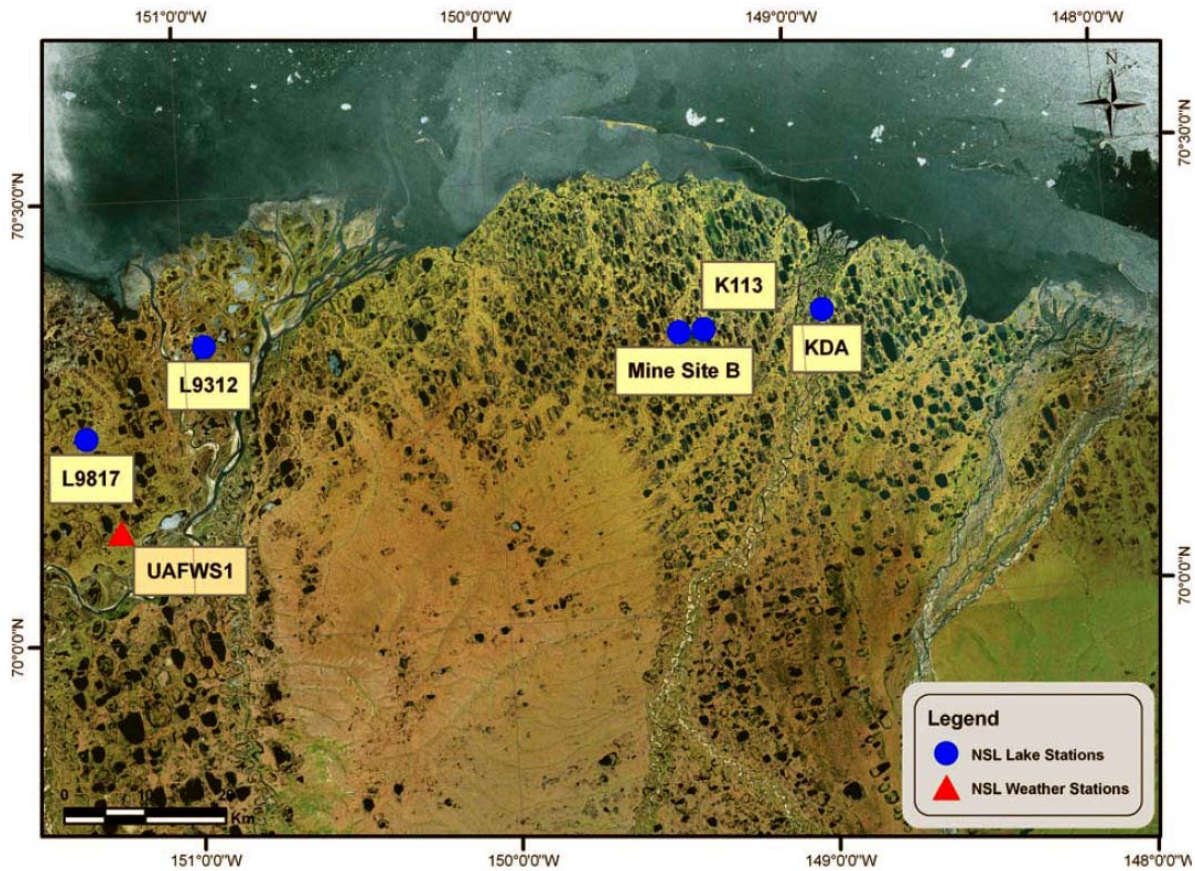


Figure 1. Location of study lakes in the NPR-A, Alpine, Kuparuk, and Prudhoe Bay field operating areas, North Slope, Alaska.

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 September 2007, we focused on the following locations/tasks:

1. L9312, Alpine Facility

- Measure field water-quality parameters near Raft B location. 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.
- Survey inlet and outlet channel water levels.
- Re-locate meteorological station approximately 500' northeast of present location.

2. Mine Site B, Milne-Point Facility

- Measure field water-quality parameters at chemistry measuring points along the shore of North and South Cells. This includes vertical profile measurements at each location for temperature, dissolved oxygen (DO), conductivity, pH, turbidity, and barometric pressure.
- Survey water levels to local elevation control.
- Collect a water depth profile of the two channels connecting the North and South Cells.
- Install three temperature profile thermistors in North Cell.

3. Kugaruk Deadarm Lakes, (Cells 1-3)

- Measure field water-quality parameters. 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- 7 via known elevation control points.
- Install three temperature profile thermistors in KDA cell 2.



Figure 2. Newly relocated meteorological station at L9312. Photo by D. Reichardt.

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.

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

A transect of the depth profile of the two channels connecting the North and South cells of MSB was conducted during the September field activities. The L9312 meteorological station was relocated to a location that would not impede construction activities on the L9312 pump house scheduled for this winter. In addition, water-quality parameter sampling was conducted, water elevation levels surveyed, and thermistor strings installed at MSB North Cell and KDA Cell 2.

Channel and outlet elevations were collected on this trip to help show various examples of connecting channels between cells in a reservoir (Mine Site B) and an outlet control channel for a natural lake (L9312). The configuration of channels connecting reservoir cells can help maintain surface-water connections between cells during open-water and ice-cover conditions. The natural lowering of water levels to an “outlet control elevation” and water withdrawals, may drop water levels below channel bottom elevations. During winter ice cover, ice growth in the channels can additionally block off channels and isolated cells. Channels that have bottom elevations lower than the outlet control elevation for the connected reservoirs, and are lower than maximum water withdrawal elevation and winter ice growth can maintain connections between cells throughout the winter period. When culverts or pipes connect cells, the highest bottom elevation of the pipe determines the outlet control elevation. When there are multiple culverts in

place, the lowest culvert usually determines the outlet control elevation. Damaged or blocked culverts may impact the effective outlet control elevation.

Figure 3 shows the cross section of the two channels connecting MSB North and South Cells. Going into winter conditions the water elevation was 95.90 ft. based off of established survey points using an arbitrary survey elevation of 100 ft. The distance from the eastern edge of the east channel to the western edge of west channel was approximately 256 ft. The east channel is 72 ft. across and the deepest section is 5.6 ft. deep. The profile of the channel shows approximately 16 ft. of the channel is at least 5.3 ft. deep. The west channel is between 62 and 70 feet in width and 6.7 ft. at its deepest point. The profile of the channel shows approximately 12 ft. of the channel is at least 6.4 feet deep.

The deepest point of the two channels is 89.2 ft., making this the point at which, under freezing conditions progressing down to this depth, the two water bodies may be disconnected.

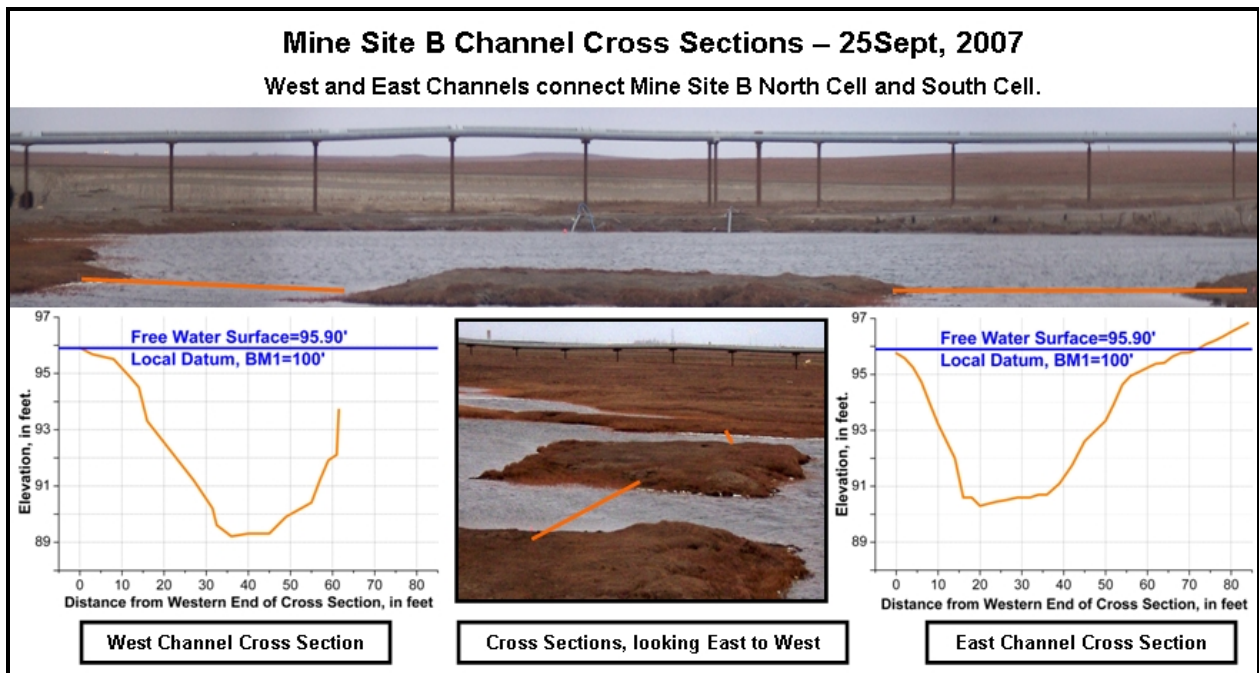


Figure 3. Mine Site B North and South Cell connecting channels cross-section profiles.

The lowest outlet control elevation for Lake L9312 was investigated in October 2007 by the North Slope Lakes project for the purposes of determining the water level at which L9312 is

considered full. In September 2007 we further investigated the outlet channel to determine the outlet control elevation in an unfrozen condition.

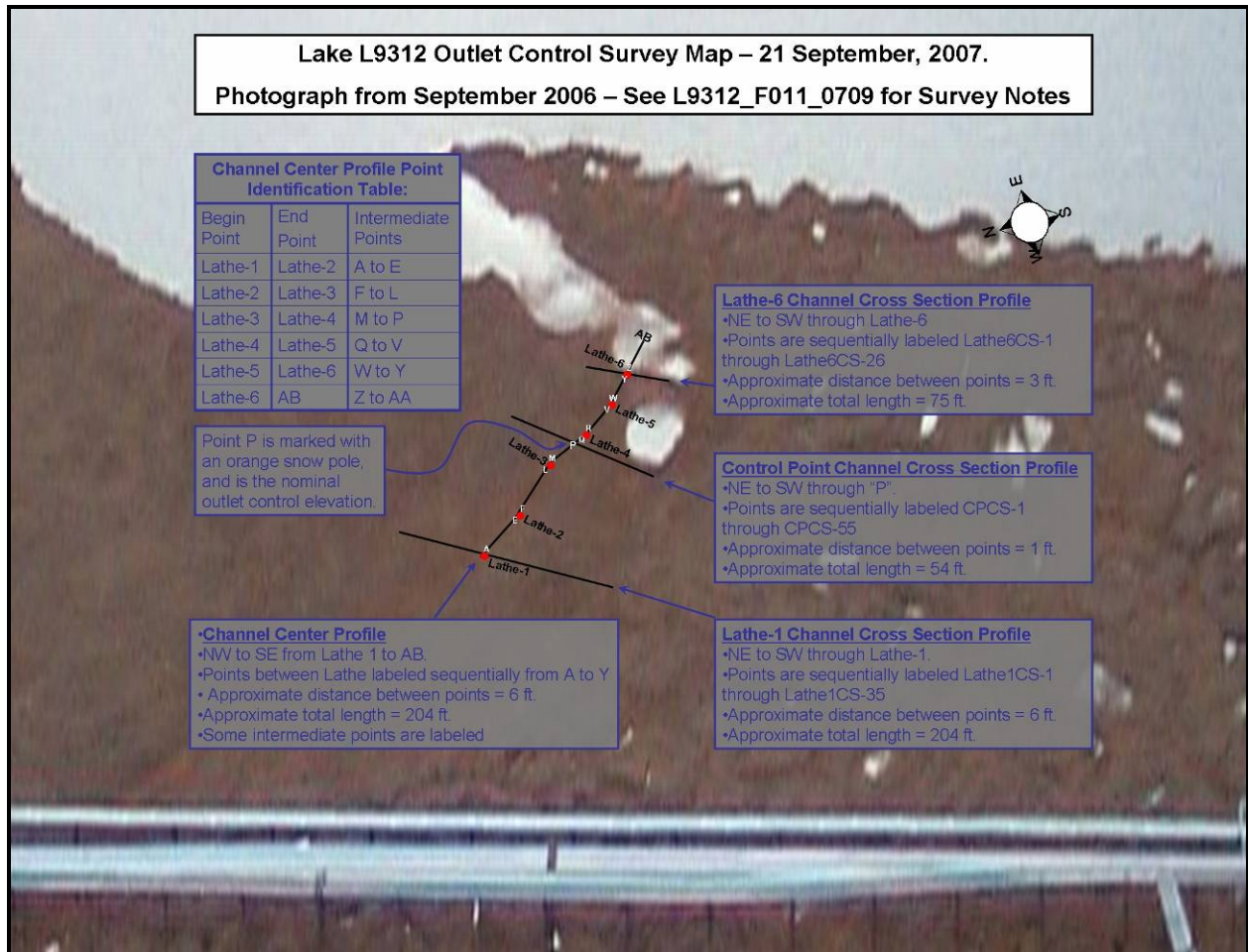


Figure 4. Lake L9312 Outlet Channel Profiles Site Map

The outlet channel under normal conditions for Lake L9312 drains from the northwest shoreline, overland for several hundred feet where it enters a channel passing under a pipeline running along the western side of the lake. At low flows the channel is not well defined between the lake edge and the pipeline, yet by looking for grassy vegetation, localized low points and wet spots we identified the channel and staked out the upper 204 feet with 6 pieces of lathe and surveyed the channel centerline ground elevation using a 6-foot spacing between points. Three channel cross-sections were also surveyed. A cross-section was located at the beginning and end of the centerline profile, and one cross section profile was located through the point "P". See Figure 4 for a site map of the surveyed profiles.

The centerline profile, shown in Figure 5, helps us identify 2 potential outlet control points, labeled Point “F” and Point “P”. Point “F” was rejected as being observed to be downstream of the outlet control point during overland flow conditions in May 2007. Point “P” coincided with the previously identified outlet control point location and was accepted as the likely outlet elevation control point. Point “F” and Point “P” differ by only 0.06’.

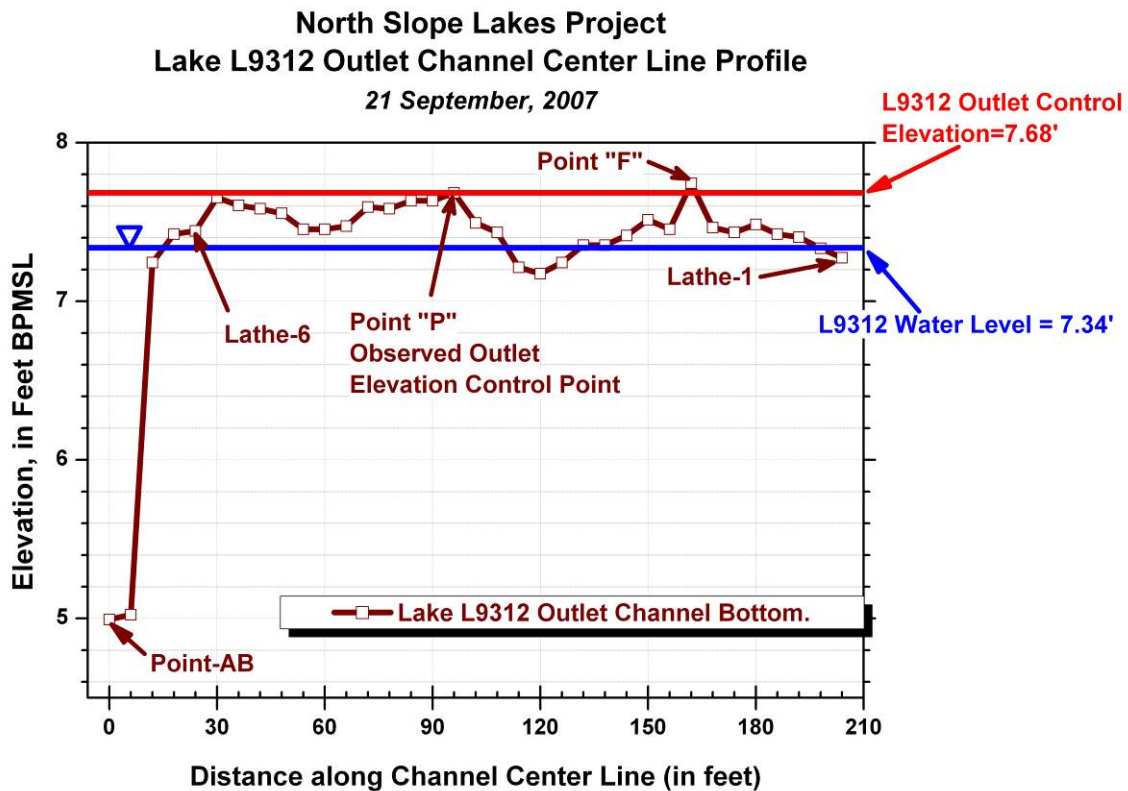


Figure 5 Lake L9312 outlet channel center-line profile. Point A-B is on the lake edge.

We also completed 3 channel cross-sections profiles. Lathe-6 and Lathe-1 cross-section profiles are located near the beginning and end of the channel centerline profile to help define the channel shape. The associated survey data is included in Appendix C. The outlet-control cross-section profile, shown in Figure 6 passes through the identified outlet control point, Point “P”, and extends into the tundra 15 feet to the NE and 29 feet to the SW with horizontal points

measured at 1 foot intervals. This cross section passes through point “P” with an elevation measured on either side, but not on point “P” itself. The variability of tundra surface elevation is evident in this graph with points within 1 foot of point “P” being nearly 0.2 ft lower than point P itself. The tundra surface is very rough and low points are not necessarily hydraulically connected to each other so we consider it wise to conservatively accept the observed outlet control point “P” as the lake full elevation, rather than accepting the lowest point in the Outlet Control Cross Section to be representative of an outlet control.

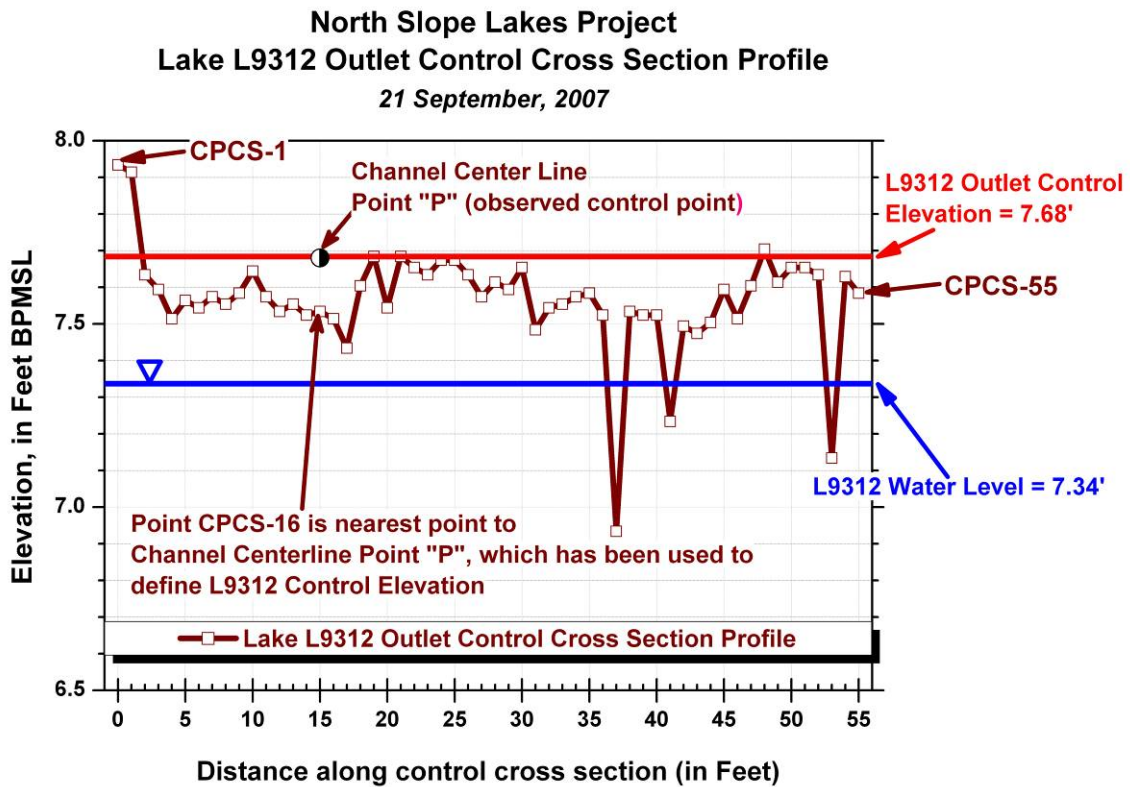


Figure 6. Lake L9312 Outlet Control Cross Section Profile

Table 2 compares Lake L9312 lake outlet control elevations as determined by different methodology. There is close agreement between all three methods, with a difference between the minimum and maximum measured control elevations of only 0.05 ft. Determining outlet control elevations on a tundra surface may only be practical to a 0.1 ft.

Table 2. Lake L9312 Outlet Control Elevations, Method Comparison

Date	Methodology	Elevation (ft BPMSL)
10/27/2006	Level of frozen water surface backed up behind observed Outlet Control Point "P"	7.73
10/27/2006	Level of Lake L9312 after going into freeze up with no observed flow in outlet channel	7.70
9/21/2007	Elevation of thawed channel bottom at Outlet Control Point "P"	7.68

SUMMARY

Understanding the physical hydrologic conditions and constraints going into freeze up, along with 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 due to freezing and pumping activities in the winter, it is important to identify the timing and depth of freezing of the water column. Outlet control elevations can be used to better define full lake or reservoir elevations. 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.

REFERENCES

Lilly, M.R., Reichardt, D., Derry, J. 2007. A Workplan for Meteorological Station Maintenance, Lake Chemistry Sampling, and Surveying at Study Lakes in Alpine, Kuparuk River, and Prudhoe Bay Areas: September 2007. Water and Environmental Research Center, University of Alaska Fairbanks. 16 pages.

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White, D.M., and Lilly, M.R. 2007 *c*. ConocoPhillips Alaska, Inc.: Health, Safety, and Environmental Plan. Water and Environmental Research Center, University of Alaska Fairbanks. 5 p.

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
 Sample Purpose: Lake Water Quality

Site Location/Lake ID: L9312 Raft B
 Date: 9/22/07 Time: nr

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.995' Easting: W150°56.918' Datum: NAD83
 Measurements By: DAR Time: nr
 Water Depth (ft): nr Ice Thickness (ft): 0.00
 Freeboard (ft): na Snow Depth (ft): 0.00
 Elev. (BPMSL): 7.34 Survey By: DAR Date: 9/21/07 Time: 7:30
 Water Sampling By: na Sample Depths BWS (ft): 1 na Date: na Time: na
 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	UAF	IN-SITU TROLL 9000	33205	PASS	Pass
Parameters					
	Field Measurements				
Time:	10:29	10:30	10:31	10:31	10:32
Depth BWS (ft):	1	3	5	7	9
Temp (°C):	3.03	3.05	3.04	3.04	3.02
pH:	7.30	7.32	7.34	7.35	7.36
Barometric (mmHg):	762.8	762.7	762.8	762.8	762.8
Pressure (kPa):	0.760	1.168	1.853	2.696	2.073
Conductivity (µS/cm):	45.76	45.74	45.73	45.73	75.73
RDO (ppm): (mg/L)	12.60	12.60	12.63	12.62	12.62
Turbidity (NTU):	0.9	1.5	0.9	0.9	0.7
ORP	245	245	244	244	243

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
Alkalinity (mg/L as CaCO ₃)										
Total iron--UF (mg/L)										
Filtered Iron--F tot Fe (mg/L)										

Remarks: Sampling done from boat. Lake is ice free. 32 degree F. Wind is 20 mph from the East.

Field-Form Filled Out By: A. Blackburn Date: 10/8/07
 QAQC Check By: J. Derry Date: 10/25/07

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: MSBS-SW
 Sample Purpose: Lake Water Quality Date: 9/26/07 Time: 18:05

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.186' Easting: W149°24.234' Datum: NAD83
 Measurements By: DAR Time: 19:00
 Water Depth (ft): nr Ice Thickness (ft): 0.00
 Freeboard (ft): 0.00 Snow Depth (ft): 0.00
 Elev. (BPMSL +/- .02): 95.90 Survey By: DAR, GM Date: 9/24/07 Time: 14:30
 Water Sampling By: na Sample Depths BWS (ft): 1 na Date: na Time: na
 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	UAF	IN-SITU TROLL 9000	33205	PASS	Pass
Parameters					
Field Measurements					
Time:	18:07				
Depth BWS (in):	6"				
Temp (°C):	2.01				
pH:	8.13				
Barometric (mmHg):	-				
Pressure (kPa):	-				
Conductivity (µS/cm):	131.5				
RDO (ppm): (mg/L)	12.49				
Turbidity (NTU):	195.0				
ORP					

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 CaCO ₃
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 NH ₃ -N
Ammonia/ Iron dilution										

Remarks: Sampling done on SW side of MSBS from the shore.

Field-Form Filled Out By: A. Blackburn Date: 10/8/07
 QAQC Check By: J. Derry Date: 10/25/07

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: MSBS-E
 Sample Purpose: Lake Water Quality Date: 9/26/07 Time: 18:05

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.186' Easting: W149°24.234' Datum: NAD83
 Measurements By: DAR Time: 19:00
 Water Depth (ft): nr Ice Thickness (ft): 0.00
 Freeboard (ft): 0.00 Snow Depth (ft): 0.00
 Elev. (BPMSL +/- .02): 95.90 Survey By: DAR, GM Date: 9/24/07 Time: 14:30
 Water Sampling By: na Sample Depths BWS (ft): 1 na Date: na Time: na
 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	UAF	IN-SITU TROLL 9000	33205	PASS	Pass
Parameters					
Field Measurements					
Time:	18:05				
Depth BWS (in):	6"				
Temp (°C):	2.19				
pH:	8.11				
Barometric (mmHg):	-				
Pressure (kPa):	-				
Conductivity (µS/cm):	130.2				
RDO (ppm): (mg/L)	11.58				
Turbidity (NTU):	175.0				
ORP					

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 CaCO ₃
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 NH ₃ -N
Ammonia/ Iron dilution										

Remarks: Sampling done on E side of MSBS from the shore

Field-Form Filled Out By: A. Blackburn Date: 10/8/07
 QAQC Check By: J. Derry Date: 10/25/07

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: MSBN-NE
 Sample Purpose: Lake Water Quality Date: 9/26/07 Time: 18:00

FIELD MEASUREMENTS

GPS Coord. Northing: N70°19.186' Easting: W149°24.234' Datum: NAD83
 Measurements By: DAR Time: 19:00
 Water Depth (ft): nr Ice Thickness (ft): 0.00
 Freeboard (ft): 0.00 Snow Depth (ft): 0.00
 Elev. (BPMSL +/- .02): 95.90 Survey By: DAR, GM Date: 9/24/07 Time: 14:30
 Water Sampling By: na Sample Depths BWS (ft): 1 na Date: na Time: na
 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	UAF	IN-SITU TROLL 9000	33205	PASS	Pass
Parameters					
Field Measurements					
Time:	18:00				
Depth BWS (in):	6"				
Temp (°C):	2.55				
pH:	8.22				
Barometric (mmHg):	-				
Pressure (kPa):	-				
Conductivity (µS/cm):	133.1				
RDO (ppm): (mg/L)	11.03				
Turbidity (NTU):	159.0				
ORP					

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 CaCO ₃
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 NH ₃ -N
Ammonia/ Iron dilution										

Remarks: Sampling done on NE side of MSBN from the shore

Field-Form Filled Out By: A. Blackburn Date: 10/8/07
 QAQC Check By: J. Derry Date: 10/25/07

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
 Sample Purpose: Lake Water Quality

Site Location/Lake ID: L9312

WATER QUALITY METER INFORMATION

Meter Make: In-Situ
 Owner: UAF

Make: Troll 9000
 S/N: 33025

CALIBRATION AND QUALITY ASSURANCE INFORMATION

Pre-Sampling QA

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	9/21/07	19:30	Oakton pH 4.01	2612530	Dec-08	4.08 @ 18.02	Pass
pH 7.00	9/21/07	19:30	Oakton pH 10.01	2612531	Dec-08	7.04 @ 17.58	Pass
pH 10.00	9/21/07	19:30	Oakton 447mS	2612532	Jun-08	10.02 @ 16.9	Pass
Conductivity	9/21/07	19:19	Oakton 447us/cm	2412150	Dec-05	385.5 @ 17.33	Pass
0% RDO	9/21/07	19:10	Hana HI7040	G1012	Feb-11	0 @ 19.43	Pass
100% RDO	9/21/07	19:08	Distilled H2O	---	---	8.88 @ 19.43	Pass
ORP	9/21/07	19:16	Quick Cal Solution	2207B	Aug-07	217 @ 18.7	Pass

Post-Sampling QA

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	9/22/07	21:10	Oakton pH 4.01	2612530	Dec-08	4.06 @ 16.88	Pass
pH 7.00	9/22/07	21:12	Oakton pH 10.01	2612531	Dec-08	7.02 @ 18.5	Pass
pH 10.00	9/22/07	21:20	Oakton 447mS	2612532	Jun-08	9.97 @ 18.38	Pass
Conductivity	9/22/07	21:25	Oakton 447us/cm	2412150	Dec-05	402.3 @ 19	Pass
0% RDO	9/22/07	21:38	Hana HI7040	G1012	Feb-11	-0.010	Pass
100% RDO	9/22/07	21:51	Distilled H2O	---	---	9.53 @ 18.98	Pass
ORP	9/22/07	21:54	Quick Cal Solution	2207B	Aug-07	217 @ 19.1	Pass

Remarks: Rugged Reader-UAF Long cord (25') SN:88443 Short cord (6') comm cable-UAF

Field-Form Filled Out By: A. Blackburn
 QAQC Check By: J. Derry

Date: 10/6/2007
 Date: 10/25/2007

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: MSB
 Sample Purpose: Lake Water Quality

WATER QUALITY METER INFORMATION

Meter Make: In-Situ Make: Troll 9000
 Owner: UAF S/N: 33025

CALIBRATION AND QUALITY ASSURANCE INFORMATION

Pre-Sampling QA

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	9/23/07	10:58	Oakton pH 4.01	2612530	Dec-08	4.03 @ 15.33	Pass
pH 7.00	9/23/07	10:55	Oakton pH 10.01	2612531	Dec-08	7.00 @ 15.16	Pass
pH 10.00	9/23/07	11:01	Oakton 447mS	2612532	Jun-08	10.06 @ 15.38	Pass
Conductivity	9/23/07	10:49	Oakton 447us/cm	2412150	Dec-05	351.8 @ 14.3	Pass
0% RDO	9/23/07	11:11	Hana HI7040	G1012	Feb-11	0.01 @ 14.81	Pass
100% RDO	9/23/07	10:48	Distilled H2O	---	---	10.09 @ 14.24	Pass
ORP	9/23/07	10:53	Quick Cal Solution	2207B	Aug-07	219 @ 15.2	Pass

Post-Sampling QA

Parameter	Date	Time	Standard	Lot No.	Exp.	Meter Reading	Pass/Fail
pH 4.01	9/26/07	20:21	Oakton pH 4.01	2612530	Dec-08	4.04 @ 14.8	Pass
pH 7.00	9/26/07	20:25	Oakton pH 10.01	2612531	Dec-08	7.01 @ 14.9	Pass
pH 10.00	9/26/07	20:31	Oakton 447mS	2612532	Jun-08	10.05 @ 14.8	Pass
Conductivity	9/26/07	20:09	Oakton 447us/cm	2412150	Dec-05	350.2 @ 14.8	Pass
0% RDO	9/26/07	20:37	Hana HI7040	G1012	Feb-11	0 @ 14.8	Pass
100% RDO	9/26/07	20:05	Distilled H2O	---	---	10.03 @ 14.79	Pass
ORP	9/26/07	20:15	Quick Cal Solution	2207B	Aug-07	223 @ 14.9	Pass

Remarks: _____

Field-Form Filled Out By: A. Blackburn Date: 10/6/2007
 QAQC Check By: J. Derry Date: 10/25/2007

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: 9/21/2007 Time: 15:32

Location: Lake L9312, located southeast of Alpine pad, survey by pump house benchmarks								
Survey objective: Determine FWS Elevation. Determine Lake Outlet Control elevation.					Weather Observations:			
Instrument Type: Leica NA720		Instrument ID: 5482367 (GWS owned)		31 deg F. 12 mi/hr wind. Light snow. 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)	Mike Rourke (LCMF) - Gunner Roy (LCMF) - Rodman Dan Reichardt (GWS) - Notes, party chief			
L9312 "P"	CP	11.72 BPMSL	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
P	1.977	13.697		11.720				Top of inlet pipe support
O		13.697	2.235	11.462				Top of inlet pipe support
L9312 WL		13.697	6.360	7.337				Water Surface Level
STAFF		13.697	13.697	0.000				Staff Gage reading
PH-VSM		13.697	-0.869	14.566				Top of VSM plate, SE corner of pump house
Turn on PH-VSM								
PH-VSM	-0.789	13.777		14.566				
O		13.777	2.314	11.463				0.001
P		13.777	2.056	11.721				close survey to +0.001
TP1		13.777	3.892	9.885				
Turn on TP1								
TP1	4.440	14.325		9.885				
TP2		14.325	3.884	10.441				
Turn on TP2								
TP2	3.759	14.200		10.441				
TP1		14.200	4.311	9.889				close to 0.004'
Turn on TP2								
TP2	2.193	12.634		10.441				

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm!; 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: L9312
 Survey Purpose: Water-Level Elevations Date: 9/21/2007 Time: 15:32

Location: Lake L9312, located southeast of Alpine pad, survey by pump house benchmarks								
Survey objective: Determine FWS Elevation. Determine Lake Outlet Control elevation.					Weather Observations:			
Instrument Type: Leica NA720		Instrument ID: 5482367 (GWS owned)			31 deg F. 12 mi/hr wind. Light snow. 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)		Mike Rourke (LCMF) - Gunner Roy (LCMF) - Rodman Dan Reichardt (GWS) - Notes, party chief		
L9312 "P"	CP	11.72 BPMSL	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasi)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
Lathe1		12.634	5.360	7.274				Downstream of SW Outlet control point
A		12.634	5.300	7.334				from Lathe-1 to AB is the Outlet Channel Bottom Profile, from downstream to upstream of the control point. An elevation is shot every 6 feet, estimated.
B		12.634	5.230	7.404				
C		12.634	5.210	7.424				
D		12.634	5.150	7.484				
E		12.634	5.200	7.434				
Lathe2		12.634	5.170	7.464				
F		12.634	4.890	7.744				
G		12.634	5.180	7.454				
H		12.634	5.120	7.514				
I		12.634	5.220	7.414				
J		12.634	5.280	7.354				
K		12.634	5.280	7.354				
L		12.634	5.390	7.244				
Lathe3		12.634	5.460	7.174				
M		12.634	5.420	7.214				
N		12.634	5.200	7.434				
O		12.634	5.140	7.494				

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; 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: L9312
 Survey Purpose: Water-Level Elevations Date: 9/21/2007 Time: 15:32

Location: Lake L9312, located southeast of Alpine pad, survey by pump house benchmarks								
Survey objective: Determine FWS Elevation. Determine Lake Outlet Control elevation.					Weather Observations:			
Instrument Type: Leica NA720		Instrument ID: 5482367 (GWS owned)		31 deg F. 12 mi/hr wind. Light snow. 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)	Mike Rourke (LCMF) - Gunner Roy (LCMF) - Rodman Dan Reichardt (GWS) - Notes, party chief			
L9312 "P"	CP	11.72 BPMSL	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
P		12.634	4.950	7.684				Outlet Control Point
Q		12.634	5.000	7.634				
Lathe4		12.634	5.000	7.634				
TP2		12.634	2.195	10.439				-0.004
R		12.634	5.050	7.584				
S		12.634	5.040	7.594				
T		12.634	5.160	7.474				
U		12.634	5.180	7.454				
V		12.634	5.180	7.454				
Lathe5		12.634	5.080	7.554				
W		12.634	5.050	7.584				
X		12.634	5.030	7.604				
Y		12.634	4.980	7.654				
Lathe6		12.634	5.190	7.444				
Z		12.634	5.210	7.424				
AZ		12.634	5.390	7.244				Channel at edge of lake not water surface.
AA		12.634	7.610	5.024				2.2' Below Water Level
AB		12.634	7.640	4.994				2.3' Below Water Level

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; 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: L9312
 Survey Purpose: Water-Level Elevations Date: 9/21/2007 Time: 15:32

Location: Lake L9312, located southeast of Alpine pad, survey by pump house benchmarks								
Survey objective: Determine FWS Elevation. Determine Lake Outlet Control elevation.					Weather Observations:			
Instrument Type: Leica NA720		Instrument ID: 5482367 (GWS owned)		31 deg F. 12 mi/hr wind. Light snow. 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)		Mike Rourke (LCMF) - Gunner Roy (LCMF) - Rodman Dan Reichardt (GWS) - Notes, party chief		
L9312 "P"	CP	11.72 BPMSL	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasi)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
TP2		12.634	2.189	10.445				0.004'
Fine tune level of Instrument								
TP2		12.634	2.194	10.440				-0.001
CPCS-1		12.634	4.700	7.934				CPCS-1 through CPCS-15 is the cross section of the channel from NE to SW through the outlet control point. Total cross section length is 54'. Interval between shots is 1', measured with nylon tape. The cross section is approximately perpendicular to the channel
CPCS-2		12.634	4.720	7.914				
CPCS-3		12.634	5.000	7.634				
CPCS-4		12.634	5.040	7.594				
CPCS-5		12.634	5.120	7.514				
CPCS-6		12.634	5.070	7.564				
CPCS-7		12.634	5.090	7.544				
CPCS-8		12.634	5.060	7.574				
CPCS-9		12.634	5.080	7.554				
CPCS-10		12.634	5.050	7.584				
CPCS-11		12.634	4.990	7.644				
CPCS-12		12.634	5.060	7.574				
CPCS-13		12.634	5.100	7.534				
CPCS-14		12.634	5.080	7.554				
CPCS-15		12.634	5.110	7.524				

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasi; 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: L9312
 Survey Purpose: Water-Level Elevations Date: 9/21/2007 Time: 15:32

Location: Lake L9312, located southeast of Alpine pad, survey by pump house benchmarks								
Survey objective: Determine FWS Elevation. Determine Lake Outlet Control elevation.					Weather Observations:			
Instrument Type: Leica NA720		Instrument ID: 5482367 (GWS owned)			31 deg F. 12 mi/hr wind. Light snow. 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)		Mike Rourke (LCMF) - Gunner Roy (LCMF) - Rodman Dan Reichardt (GWS) - Notes, party chief		
L9312 "P"	CP	11.72 BPMSL	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
CPCS-16		12.634	5.100	7.534				Nearest point to outlet control point "P"
CPCS-17		12.634	5.120	7.514				
CPCS-18		12.634	5.200	7.434				
CPCS-19		12.634	5.030	7.604				
CPCS-20		12.634	4.950	7.684				
CPCS-21		12.634	5.090	7.544				
CPCS-22		12.634	4.950	7.684				
CPCS-23		12.634	4.980	7.654				
CPCS-24		12.634	5.000	7.634				
CPCS-25		12.634	4.960	7.674				
CPCS-26		12.634	4.960	7.674				
CPCS-27		12.634	5.000	7.634				
CPCS-28		12.634	5.060	7.574				
CPCS-29		12.634	5.020	7.614				
CPCS-30		12.634	5.040	7.594				
CPCS-31		12.634	4.980	7.654				
CPCS-32		12.634	5.150	7.484				
CPCS-33		12.634	5.090	7.544				

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; 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: L9312
 Survey Purpose: Water-Level Elevations Date: 9/21/2007 Time: 15:32

Location: Lake L9312, located southeast of Alpine pad, survey by pump house benchmarks								
Survey objective: Determine FWS Elevation. Determine Lake Outlet Control elevation.				Weather Observations:				
Instrument Type:	Leica NA720	Instrument ID:	5482367 (GWS owned)		31 deg F. 12 mi/hr wind. Light snow. 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)	Mike Rourke (LCMF) - Gunner Roy (LCMF) - Rodman Dan Reichardt (GWS) - Notes, party chief			
L9312 "P"	CP	11.72 BPMSL	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasi)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
CPCS-34		12.634	5.080	7.554				
CPCS-35		12.634	5.060	7.574				
CPCS-36		12.634	5.050	7.584				
CPCS-37		12.634	5.110	7.524				
CPCS-38		12.634	5.700	6.934				
CPCS-39		12.634	5.100	7.534				
CPCS-40		12.634	5.110	7.524				
CPCS-41		12.634	5.110	7.524				
CPCS-42		12.634	5.400	7.234				
CPCS-43		12.634	5.140	7.494				
CPCS-44		12.634	5.160	7.474				
CPCS-45		12.634	5.130	7.504				
CPCS-46		12.634	5.040	7.594				
CPCS-47		12.634	5.120	7.514				
CPCS-48		12.634	5.030	7.604				
CPCS-49		12.634	4.930	7.704				
CPCS-50		12.634	5.020	7.614				
CPCS-51		12.634	4.980	7.654				

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; 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: L9312
 Survey Purpose: Water-Level Elevations Date: 9/21/2007 Time: 15:32

Location: Lake L9312, located southeast of Alpine pad, survey by pump house benchmarks								
Survey objective: Determine FWS Elevation. Determine Lake Outlet Control elevation.					Weather Observations:			
Instrument Type: Leica NA720		Instrument ID: 5482367 (GWS owned)			31 deg F. 12 mi/hr wind. Light snow. 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)		Mike Rourke (LCMF) - Gunner Roy (LCMF) - Rodman Dan Reichardt (GWS) - Notes, party chief		
L9312 "P"	CP	11.72 BPMSL	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasi)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
CPCS-51		12.634	4.980	7.654				
CPCS-52		12.634	5.000	7.634				
CPCS-53		12.634	5.500	7.134				
CPCS-54		12.634	5.005	7.629				
CPCS-55		12.634	5.050	7.584				
Lathe6CS-1		12.634	4.790	7.844				Lathe6CS-1 to Lathe6CS-26 is channel cross section from NE to SW through Lathe-6. Shot interval is 6 feet, approximately.
Lathe6CS-2		12.634	4.880	7.754				
Lathe6CS-3		12.634	4.950	7.684				
Lathe6CS-4		12.634	4.990	7.644				
Lathe6CS-5		12.634	4.950	7.684				
Lathe6CS-6		12.634	5.040	7.594				
Lathe6CS-7		12.634	5.030	7.604				
Lathe6CS-8		12.634	5.050	7.584				
Lathe6CS-9		12.634	5.240	7.394				
Lathe6		12.634	5.230	7.404				
Lathe6CS-11		12.634	5.090	7.544				
Lathe6CS-12		12.634	4.980	7.654				
Lathe6CS-13		12.634	5.040	7.594				

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasi; 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: L9312
 Survey Purpose: Water-Level Elevations Date: 9/21/2007 Time: 15:32

Location: Lake L9312, located southeast of Alpine pad, survey by pump house benchmarks								
Survey objective: Determine FWS Elevation. Determine Lake Outlet Control elevation.					Weather Observations:			
Instrument Type: Leica NA720		Instrument ID: 5482367 (GWS owned)			31 deg F. 12 mi/hr wind. Light snow. 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)	Mike Rourke (LCMF) - Gunner Roy (LCMF) - Rodman Dan Reichardt (GWS) - Notes, party chief			
L9312 "P"	CP	11.72 BPMSL	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasi)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
Lathe6CS-14		12.634	4.870	7.764				
Lathe6CS-15		12.634	5.150	7.484				
Lathe6CS-16		12.634	5.140	7.494				
Lathe6CS-17		12.634	5.020	7.614				
Lathe6CS-18		12.634	5.100	7.534				
Lathe6CS-19		12.634	5.140	7.494				
Lathe6CS-20		12.634	5.160	7.474				
Lathe6CS-21		12.634	5.100	7.534				
Lathe6CS-22		12.634	5.050	7.584				
Lathe6CS-23		12.634	4.840	7.794				
Lathe6CS-24		12.634	5.030	7.604				
Lathe6CS-25		12.634	4.980	7.654				
Lathe6CS-26		12.634	4.880	7.754				
Lathe1CS-1		12.634	5.230	7.404				Lathe1CS-1 to Lathe1CS-35 is channel cross section from NE to SW through Lathe-1. Shot interval is 3 feet, approximately.
Lathe1CS-2		12.634	5.270	7.364				
Lathe1CS-3		12.634	5.250	7.384				
Lathe1CS-4		12.634	5.200	7.434				
Lathe1CS-5		12.634	5.120	7.514				

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasi; 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: L9312
 Survey Purpose: Water-Level Elevations Date: 9/21/2007 Time: 15:32

Location: Lake L9312, located southeast of Alpine pad, survey by pump house benchmarks								
Survey objective: Determine FWS Elevation. Determine Lake Outlet Control elevation.					Weather Observations:			
Instrument Type: Leica NA720		Instrument ID: 5482367 (GWS owned)		31 deg F. 12 mi/hr wind. Light snow. 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)		Mike Rourke (LCMF) - Gunner Roy (LCMF) - Rodman Dan Reichardt (GWS) - Notes, party chief		
L9312 "P"	CP	11.72 BPMSL	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasi)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
Lathe1CS-6		12.634	5.260	7.374				
Lathe1CS-7		12.634	5.130	7.504				
Lathe1CS-8		12.634	5.130	7.504				
Lathe1CS-9		12.634	5.340	7.294				
Lathe1		12.634	5.560	7.074				0.200' lower than from channel center profile
Lathe1CS-11		12.634	5.030	7.604				
Lathe1CS-12		12.634	5.090	7.544				
Lathe1CS-13		12.634	4.950	7.684				
Lathe1CS-14		12.634	5.160	7.474				
Lathe1CS-15		12.634	5.100	7.534				
Lathe1CS-16		12.634	5.110	7.524				
Lathe1CS-17		12.634	5.120	7.514				
Lathe1CS-18		12.634	5.210	7.424				
Lathe1CS-19		12.634	5.110	7.524				
Lathe1CS-20		12.634	5.130	7.504				
Lathe1CS-21		12.634	5.270	7.364				
Lathe1CS-22		12.634	5.140	7.494				
Lathe1CS-23		12.634	5.050	7.584				

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasi; 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: L9312
 Survey Purpose: Water-Level Elevations Date: 9/21/2007 Time: 15:32

Location: Lake L9312, located southeast of Alpine pad, survey by pump house benchmarks								
Survey objective: Determine FWS Elevation. Determine Lake Outlet Control elevation.					Weather Observations:			
Instrument Type: Leica NA720		Instrument ID: 5482367 (GWS owned)			31 deg F. 12 mi/hr wind. Light snow. 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)		Mike Rourke (LCMF) - Gunner Roy (LCMF) - Rodman Dan Reichardt (GWS) - Notes, party chief		
L9312 "P"	CP	11.72 BPMSL	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasi)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
Lathe1CS-24		12.634	4.77	7.864				
Lathe1CS-25		12.634	5.17	7.464				
Lathe1CS-26		12.634	5.21	7.424				
Lathe1CS-27		12.634	5.05	7.584				
Lathe1CS-28		12.634	4.66	7.974				
Lathe1CS-29		12.634	4.77	7.864				
Lathe1CS-30		12.634	4.79	7.844				
Lathe1CS-31		12.634	5.37	7.264				
Lathe1CS-32		12.634	5.51	7.124				
Lathe1CS-33		12.634	5.28	7.354				
Lathe1CS-34		12.634	4.85	7.784				
Lathe1CS-35		12.634	4.36	8.274				
TP2		12.634	2.192	10.442				closes to +.001

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; 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: 9/24/2007 Time: 14:30

Location:	Mine Site B, NE corner of North Cell, temporary datum							
Survey objective:	Lake water elevation survey				Weather Observations:			
Instrument Type:	Leica NA720	Instrument ID:	5482372 (GWS owned)		35° F 20 mph east wind; Light Cloud cover			
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:					Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-)	Longitude (ddd-mm.mmm)		DAR,JED		
TBM_1	nr	100.00 Arbitrary	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasi)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
TBM_1	5.36	105.36		100.00				
RB4		105.36	8.08	97.28				
MSB_N		105.36	9.46	95.90				
VSMS		105.36	1.33	104.03				
VSMN		105.36	1.71	103.66				
VSM_Cut		105.36	3.80	101.57				
Move instrument to ^2, turn on TBM2								
VSM_Cut	3.70	105.27		101.57				
VSMN		105.27	1.61	103.66				
VSMS		105.27	1.24	104.03				
MSB_N		105.27	9.37	95.90				MSBN WL
RB4		105.27	7.99	97.28				
TBM_1		105.27	5.26	100.01				Survey closes within+/- 0.01

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; 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: MSB-East Channel Transect
 Survey Purpose: Water-Level Elevations Date: 9/24/2007 Time: 14:30

Location:	Survey of the channel bottom of the eastern channel connecting MSB_S and MSB_N							
Survey objective:	Lake water elevation survey				Weather Observations:			
Instrument Type:	Leica NA720	Instrument ID:	5482372 (GWS owned)		13 Degrees F 25 mph wind clear, unrestricted			
Rod Type:	Craine fiberglass 20'	Rod ID:	GWS owned					
Bench Mark Information:					Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-	Longitude (ddd-mm.mmm)		DAR,JED		
TBM_1	nr	100.00 Arbitrary	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasi)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
MSB_East Channel, start on east side of channel. Point of beginning is rebar 12 feet East of waters edge. Station # is feet from point of beginning. Starting at 24 feet, elevation is determined by measuring water depth with survey rod. Water surface elevation is known, and entered as HI. Depth is entered as F\$								
Top of Re-bar	4.97	102.36		97.39				
Bottom of Re-bar		102.36	5.53	96.83				
4		102.36	5.84	96.52				
6		102.36	6.01	96.35				
8		102.36	6.16	96.20				
10		102.36	6.28	96.08				
12		102.36	6.46	95.90		Water Surface		
14		102.36	6.58	95.78				
16		102.36	6.59	95.77				
18		102.36	6.72	95.64				
20		102.36	6.95	95.41				
22		102.36	6.98	95.38				
24		95.90	0.66	95.24				
26		95.90	0.81	95.09				
28		95.90	0.95	94.95				
30		95.90	1.27	94.63				
32		95.90	1.95	93.95				
34		95.90	2.56	93.34				

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

University of Alaska Fairbanks, Water and Environmental Research Center

Form F-011: Elevation Survey Form

Project ID: North Slope Lakes Site Location/Lake ID: MSB-East Channel Transect
 Survey Purpose: Water-Level Elevations Date: 9/25/2007 Time: 14:30

Location:		Survey of the channel bottom of the eastern channel connecting MSB_S and MSB_N						
Survey objective:		Lake water elevation survey			Weather Observations:			
Instrument Type:		Leica NA720	Instrument ID:	5482372 (GWS owned)		13 Degrees F 25 mph wind clear, unrestricted		
Rod Type:		Craine fiberglass 20'	Rod ID:	GWS owned				
Bench Mark Information:					Survey Team Names			
Name	Agency Responsible	Elevation (ft)	Latitude (dd-	Longitude (ddd-mm.mmm)		DAR,JED		
TBM_1	nr	100.00 Arbitrary	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasi)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
36		95.90	3.29	92.61				
44		95.90	4.80	91.10				
47		95.90	5.20	90.70				
50		95.90	5.20	90.70				
52		95.90	5.30	90.60				
54		95.90	5.30	90.60				
57		95.90	5.40	90.50				
60		95.90	5.45	90.45				
62		95.90	5.60	90.30				
66		95.90	5.30	90.60				
68		95.90	5.30	90.60				
70		95.90	3.90	92.00				
72		95.90	3.29	92.61				
74		95.90	2.68	93.22				
76		95.90	1.94	93.96				
78		95.90	1.17	94.73				
80		95.90	0.65	95.25				
82		95.90	0.32	95.58				
84		95.90	0.14	95.76				

Abbreviations: backsight, BS; degrees, dd; feet, ft; feet above mean sea level, fasm; foresight, FS; height of instrument, H; 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: MSB-West Channel Transect
 Survey Purpose: Water-Level Elevations Date: 9/25/2007 Time: 19:30

Location:	Survey of the channel bottom of the two channels connecting MSB_S and MSB_N. Note: Distance from Soil Clump to r-bar on west side of west channel is 114'.							
Survey objective:	Mine Site B Western Channel Cross Section Depth				Weather Observations:			
Instrument Type:	n/a		Instrument ID:	13 Degrees F 25 mph wind clear, unrestricted				
Rod Type:	Craine fiberglass 20'		Rod ID:					GWS owned
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-	Longitude (ddd-mm.mmm)		DAR,JED		
TBM_1	nr	100.00 Arbitrary	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
MSB_West Channel, start on east side of channel. Point of beginning is an elevated soil clump, 8.5 feet East of waters edge. Station # is feet from point of beginning. Elevation determined by measuring water depth with survey rod. Water surface elevation is known, and entered as HI. Depth is entered as FS.								
8.5		95.91	2.20	93.71				
9		95.91	3.80	92.11				
11		95.91	4.00	91.91				
13		95.91	4.70	91.21				
15		95.91	5.50	90.41				
21		95.91	6.00	89.91				
25		95.91	6.60	89.31				
30		95.91	6.60	89.31				
34		95.91	6.70	89.21				
37.5		95.91	6.30	89.61				
38.5		95.91	5.70	90.21				
43		95.91	4.70	91.21				
54		95.91	2.60	93.31				
56		95.91	1.40	94.51				
58		95.91	1.05	94.86				
62		95.91	0.40	95.51				
67		95.91	0.23	95.68				
70		95.91	0.00	95.91				Water edge

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
 Survey Purpose: Water-Level Elevations Date: 9/24/2007 Time: 16:15

Location:	Kuparuk Deadarm Reservoirs Cells 1, 2, 3							
Survey objective:	Lake water elevation survey					Weather Observations:		
Instrument Type:	Leica NA720	Instrument ID:	5482372 (GWS owned)		20 Degrees F 30MPH wind, bright sunshine			
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)		DAR,JED		
TBM__	nr	100' Temp.	na	na				
Station	BS (ft)	HI (ft)	FS (ft)	Elevation (fasl)	Distance (ft)	Horizontal Angle	Vertical Angle	Remarks
TBM_1	0.67	19.99		19.32				
KDA2		19.99	11.74	8.25				KDA2-WL
TP1		19.99	10.44	9.55				
Turn on TP1, move instrument to ^2								
TP1	10.38	19.93		9.55				
KDA2		19.93	11.68	8.25				
TBM_1		19.93	0.61	19.32				
Survey KDA1 using KDA_2 WL								
KDA_2	4.69	12.93		8.25				
KDA_1		12.93	4.55	8.38				
TP2		12.93	3.64	9.30				
TP2	3.97	13.26		9.30				
KDA_1		13.26	4.87	8.39				KDA1-WL
KDA_2		13.26	5.01	8.25				
Survey re-bar in KDA 3 located on east side of lake Rebar was set August 17, bottom of rebar was WL on 8/17/07								
KDA_2	7.80	16.04		8.25				
WL_Aug16		16.04	7.10	8.94				
top of rebar KDA 3		16.04	5.86	10.18				
Turn on top of rebar								
top of rebar KDA 3	5.49	15.67		10.18				
WL_Aug16		15.67	6.72	8.94				KDA3-WL_Aug17
KDA_2		15.67	7.41	8.25				

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