Survey Data for Selected North Slope Lakes and Reservoirs from the Kuparuk River to Bullen Point: 2009

by
Kristie Hilton, Greta Myerchin, Celine van Breukelen, William Schnabel, and Michael Lilly

January 2010
Kuparuk Foothills and Sagavanirktok River/Bullen Point Hydrology Projects
Report No. INE/WERC 09.05

Greta Myerchin and Celine van Breukelen conducting a snow survey, photo by Robert Christensen.
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Kristie Hilton\textsuperscript{1}, Greta Myerchin\textsuperscript{2}, Celine van Breukelen\textsuperscript{2}, William Schnabel\textsuperscript{2}, Michael Lilly\textsuperscript{1}

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**Alaska Department of Transportation and Public Facilities**

**Alaska Department of Natural Resources**

January 2010

Sagavanirktok River/Bullen Point, Kuparuk Foothills, and Umiat Corridor Hydrology Projects

Report Number INE/WERC 09.05

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\textsuperscript{2}University of Alaska Fairbanks, Water and Environmental Research Center
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Fairbanks, Alaska 99775
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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 Alaska Department of Transportation and Public Facilities (AKDOT&PF) and the Alaska Department of Natural Resources (ADNR). The contents of the report do not necessarily reflect the views of policies of the AKDOT&PF, ADNR 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, Alaska Department of Transportation and Public Facilities, Alaska Department of Natural Resources, or other project sponsors.
## Conversion Factors

### Multiplication Factors

<table>
<thead>
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<th>Multiply</th>
<th>By</th>
<th>To obtain</th>
</tr>
</thead>
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<td>meter (mm)</td>
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<tr>
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<tr>
<td>Square foot per day (ft&lt;sup&gt;2&lt;/sup&gt;/d)</td>
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<td>square meter per day (m&lt;sup&gt;2&lt;/sup&gt;/d)</td>
</tr>
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<td>cubic meter per second (m&lt;sup&gt;3&lt;/sup&gt;/sec)</td>
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<td>meter per day (m/d)</td>
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<td>centimeter per second (cm/sec)</td>
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<td>foot per mile (ft/mi)</td>
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<td>foot per mile (ft/mi)</td>
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<td>meter per kilometer (m/km)</td>
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<td><strong>Pressure</strong></td>
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<td></td>
</tr>
<tr>
<td>pound per square inch (lb/in&lt;sup&gt;2&lt;/sup&gt;)</td>
<td>6.895</td>
<td>kilopascal (kPa)</td>
</tr>
</tbody>
</table>
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 value in cubic meters per second (m³/s) in parentheses.

Physical and Chemical Water-Quality Units:
Temperature:
Water and air temperature is 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

Electrical Conductance (Actual Conductivity and Specific Conductance):
In this report conductivity of water is expressed as Actual Conductivity [AC] in microSiemens per centimeter (µS/cm). This unit is equivalent to micromhos per centimeter. Elsewhere, conductivity is commonly expressed as Specific Conductance at 25°C [SC25] in µS/cm which is temperature corrected. To convert AC to SC25 the following equation can be used:

Error! Bookmark not defined.

\[ SC25 = \frac{AC}{1 + r(T - 25)} \]

where:

\( SC25 \) = Specific Conductance at 25°C, in µS/cm
\( AC \) = Actual Conductivity, in µS/cm
\( r \) = temperature correction coefficient for the sample, in °C
\( T \) = temperature of the sample, in °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 (ppm).

Vertical Datum:
“Sea level” in the following report 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 World Geodetic System of 1984.
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
F        Fahrenheit (°F).
ft       Feet
GWS      Geo-Watersheds Scientific
GWSI     USGS Ground-Water Site Inventory
km²      Square kilometers
kPa      Kilopascal
lb/in²   Pounds per square inch
m        Meters
mg/L     Milligrams per liter
μg/L     Micrograms per liter
mi²      Square miles
mm       Millimeters
μS/cm    Microsiemens per centimeter
mV       Millivolt
NGVD     National Geodetic Vertical Datum
NWIS     National Water Information System
ppm      Parts per million
QA       Quality assurance
QC       Quality control
SAR      Synthetic aperture radar
SC25     Specific conductance at 25°C
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
ABSTRACT

Water resources are limited in many areas of the North Slope, Alaska, particularly during mid-winter operations. Water is used for ice road construction and maintenance, drilling and facility operations, and potable water supplies. Identifying potential water sources for this region will help both industry and resource-management agencies.

Sampling conducted in the spring and summer of 2009 served as part of ongoing studies of watershed hydrology and lakes in the combined study areas for the Sagavanirktok River/Bullen Point, Kuparuk Foothills, and Umiat Corridor Hydrology projects. Field chemistry measurements, lake depth, ice thickness, and snow measurements were collected at each of the sites visited during spring ice cover conditions. Ten lakes anticipated to remain unfrozen at the bottom throughout the winter were pre-selected for field sampling. Four of these sites were former gravel pits, and six were natural lakes. Chemical profiles of the gravel pits demonstrated the potential of gravel pits and deeper lakes to provide significant water resources as well as over-wintering fish habitat. The natural lakes sampled were very shallow or frozen throughout the depth profile at the time of sampling, indicating that they would not likely serve as adequate late-winter water resources or fish habitat. Additional ice thickness and snow depth measurements on lakes were also collected to help with regional hydrologic analysis. Additional field work in July 2009 mapped bathymetry of three of the selected lake sites along the Dalton Highway for the purpose of ground truthing the synthetic aperture radar (SAR) data. Data from this project will also be used for analysis in the Arctic Transportation Networks project, sponsored by the US Department of Energy.

ACKNOWLEDGEMENTS

The data presented in this report was funded by grant ADN #2562122, Alaska Department of Transportation and Public Facilities, and by grant ADN #1099000, Department of Natural Resources, providing background data for lakes in the combined study areas. We also thank Northern Region ADOT&PF staff who provided information for water sources along the Dalton Highway.
Survey Data for Selected North Slope Lakes and Reservoirs from the Kuparuk River to Bullen Point: 2009

INTRODUCTION

Water resources are essential for construction and maintenance of gravel roads, and ice road / pad construction on the North Slope of Alaska. Yet many natural lakes are too shallow to provide significant freshwater resources throughout the winter operations period. Reservoirs, usually resulting from the construction of gravel mine sites, have historically been used as long-term water sources when adequate recharge exists. The Coastal Plain and Foothills regions between the Kuparuk River and Bullen Point, west of the Canning River, have hosted numerous oil and gas exploration activities over the past 25 years. Future development in many of these areas will require a network of natural lakes, or reservoirs, to provide adequate water supplies. In planning transportation networks, an opportunity for concurrent gravel resources and long-term water resource development exists. Physical and chemical measurements illustrate many natural lakes are insufficient for use as winter water resources or overwintering fish habitat. The larger rivers in the area (Kuparuk, Sagavanirktok, Kadleroshilik, Shaviovik, and Kavik Rivers) have low winter baseflows and are not generally considered potential sources for obtaining water during winter months.

Three coordinated projects are studying the watershed hydrology and water resources in the central North Slope region: Sagavanirktok River/Bullen Point, Kuparuk Foothills, and Umiat Corridor Hydrology projects. The 2009 activities described in this report were funded by the Sagavanirktok/Bullen Point and Kuparuk Foothills projects, however the information provided may be useful for all of the projects. Lakes and reservoirs selected for sampling in 2009 fell between the Kuparuk River and Bullen Point, east of the Canning River (Figure 1). Some of these sites were located in the Foothills region near the Kuparuk and Sagavanirktok Rivers (Figure 2), while others were located within a few miles of the Arctic coast (Figure 3).
OBJECTIVES
The objective of this report is to provide lake and reservoir data collected in the early spring and summer of 2009. At the time of water chemistry sampling, spring snowmelt had not yet started and lake ice conditions were near a winter maximum. Bathymetric mapping took place in July, shortly after all the ice had melted. These data are intended to help resource developers and management agencies evaluate potential water resources in the region, and to help identify areas where water resources may be scarce.
Figure 1. Map of the combined project study areas.
Figure 2. Study area and lake location map for the Sagavanirktok River/Kuparuk Foothills Region, North Slope.

Figure 3. Study area and lake location map for Bullen Region, North Slope, Alaska.
PROCEDURES

Water Chemistry

Spring water chemistry measurements were conducted under lake and reservoir ice. A hole was drilled through the ice with a 2-inch diameter ice auger powered by a cordless drill. Physical measurements of depth (lake bottom to water surface), freeboard (water surface to top of ice), ice thickness (bottom of ice to top of ice), and snow depth (top of ice to top of snow, measured at the hole where snow was cleared to drill) were taken with a weighted flexible measuring tape and folding rule. The precision with which physical measurements are reported takes into account field conditions.

Figure 4. Greta Myerchin and Celine van Breukelen drill a hole in the ice at Lake S0901 for physical and water-quality measurements, photo by Robert Christensen.

Temperature, pH, dissolved oxygen (DO), and electrical conductivity were measured with either a Yellow Springs Instruments (YSI) 556 multi-parameter meter, a YSI ProODO (Optical Dissolved Oxygen) meter, or a Hach LDO (Luminescent Dissolved Oxygen) meter. The calibration of each parameter was checked before and after each day of sampling, or as field
conditions allowed. To pass the calibration check, parameters had to be within 10% of the calibration standard value. All parameters passed each pre- and post-calibration check, with the exception of a few conductivity measurements. Data tables for the calibration checks are available in Appendix A.

**Bathymetry**

Bathymetric surveys were conducted at three road-accessible lakes during Summer 2009 for the purpose of ground truthing depth predictions derived from satellite data. The survey results are considered to be approximate, and are not intended for regulatory use. Individual data points were collected from a canoe using a leadline. At each of the data points, the depth and position were saved into a Trimble GeoExplorer III DGPS. The path of the canoe was tracked in a separate GPS and was guided by a member of the team on shore to help ensure spatial distribution of measurements. To mark the perimeter, the GPS was set to automatically save its position every five seconds. The perimeter of the lake was marked by walking the shoreline and logging the position every five seconds.

The data were downloaded from the GPS using Trimble’s PathFinder Office Version 3.10. The rover files were exported from PathFinder Office to shape files. The shape files were used to interpolate the bathymetric surface using the Geostatistical Analyst package in the ArcMap from ESRI. All surface interpolation and statistical analysis of the data was performed using UTM Z6 WGS 84 coordinates. Maps of the bathymetric surface were generated using ordinary kriging. Surface statistics and contours were computed from the kriged surfaces.

**RESULTS**

**Water Chemistry**

Six lakes and four reservoirs were pre-selected for potential sampling. Three lakes, S0901, S0903 and MP29 contained little or no under-ice water at sample locations, therefore water-quality parameters were not obtained from these lakes. Physical and chemical measurements were collected for the remaining sites and are included in this report. Some conductivity measurements did not pass post-calibration standards and the results are not included in this report, see Appendix A for calibration information.
As illustrated in Table 1, the six natural lakes sampled were found to be relatively shallow or frozen to the bottom, while three of the man-made gravel pits, which now serve as reservoirs, were deep relative to other lakes in the area. One reservoir was sampled near the shoreline in shallow water, where the ice was frozen to the reservoir bottom, and no data was collected. Ice thicknesses were generally around 4 ft deep at the natural lakes and over 6 ft deep at the reservoirs. Three of the reservoirs were between 17 and 32 ft deep.

Table 1. Select sample locations and physical measurements.

<table>
<thead>
<tr>
<th>Location</th>
<th>North Latitude (WGS84)</th>
<th>West Longitude (WGS84)</th>
<th>Date</th>
<th>Ice Thickness (ft)</th>
<th>Water Depth (ft)</th>
<th>Freeboard (ft)</th>
<th>Snow Depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W0702</td>
<td>69 42.165'</td>
<td>149 48.538'</td>
<td>4/21/2009</td>
<td>4.17</td>
<td>8.66</td>
<td>0.15</td>
<td>0.95</td>
</tr>
<tr>
<td>W0801</td>
<td>69 32.995'</td>
<td>150 23.318'</td>
<td>4/21/2009</td>
<td>4.53</td>
<td>6.95</td>
<td>0.8</td>
<td>1.08</td>
</tr>
<tr>
<td>W0802</td>
<td>69 33.138'</td>
<td>150 20.733'</td>
<td>4/21/2009</td>
<td>3.90</td>
<td>5.25</td>
<td>0.00</td>
<td>0.72</td>
</tr>
<tr>
<td>S0901-1</td>
<td>69 50.693'</td>
<td>148 46.690'</td>
<td>4/23/2009</td>
<td>4.43</td>
<td>frozen</td>
<td>na</td>
<td>0.75</td>
</tr>
<tr>
<td>S0902-1</td>
<td>69 34.823'</td>
<td>148 38.498'</td>
<td>4/22/2009</td>
<td>4.33</td>
<td>5.05</td>
<td>0.03</td>
<td>0.72</td>
</tr>
<tr>
<td>S0903-1</td>
<td>69 28.593'</td>
<td>148 34.505'</td>
<td>4/22/2009</td>
<td>4.00</td>
<td>3.71</td>
<td>0.30</td>
<td>0.92</td>
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<tr>
<td>MP27 Pit</td>
<td>69 53.361'</td>
<td>148 46.928'</td>
<td>4/23/2009</td>
<td>2.26</td>
<td>frozen</td>
<td>na</td>
<td>1.61</td>
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<td>Annie Pit</td>
<td>69 59.193'</td>
<td>148 41.056'</td>
<td>4/23/2009</td>
<td>6.49</td>
<td>23.45</td>
<td>0.36</td>
<td>0.56</td>
</tr>
<tr>
<td>Badami Pit</td>
<td>70 07.775'</td>
<td>146 59.980'</td>
<td>4/25/2009</td>
<td>6.9</td>
<td>17.11</td>
<td>0.6</td>
<td>0.2</td>
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<td>Shaviovik Pit</td>
<td>70 09.458'</td>
<td>147 15.370'</td>
<td>4/29/2009</td>
<td>6.8</td>
<td>32.95</td>
<td>0.8</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Table 2 presents the actual ice thickness measured for the Kuparuk region lakes compared to predicted ice thickness. This information is germane to the method currently under development whereby SAR data and ice thickness estimates are utilized to provide bathymetric information. This method will be described more fully in the project final report. The predicted ice thickness was calculated using modified Stefan’s equation for ice growth, as described in White (2004):

\[
t = C \times \sqrt{AFDD},
\]

\(t = \text{ice thickness in inches}\)

\(C = \text{coefficient ranging from 0.5 to 0.7 for an average lake with snow, and}\)

\(AFDD = \text{accumulated freezing degree days in °F days}\).
FDD were counted beginning September 25, 2008, the day the daily average air temperature dropped below freezing.

Table 2. Select predicted and measured ice thicknesses.

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>∑FDD¹ (°F)</th>
<th>Measured Ice Thickness (ft)</th>
<th>Predicted Ice Thickness² (ft) (C=.57)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W0702</td>
<td>4/21/2009</td>
<td>7795.1</td>
<td>4.17</td>
<td>4.19</td>
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<tr>
<td>W0801</td>
<td>4/21/2009</td>
<td>7795.1</td>
<td>4.53</td>
<td>4.19</td>
</tr>
<tr>
<td>W0802</td>
<td>4/21/2009</td>
<td>7795.1</td>
<td>3.90</td>
<td>4.19</td>
</tr>
<tr>
<td>S0901-1</td>
<td>4/23/2009</td>
<td>7846.0</td>
<td>4.43</td>
<td>4.21</td>
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<td>4/22/2009</td>
<td>7818.5</td>
<td>4.33</td>
<td>4.20</td>
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<td>S0903-1</td>
<td>4/22/2009</td>
<td>7818.5</td>
<td>4.00</td>
<td>4.20</td>
</tr>
</tbody>
</table>

¹ Temperature data were obtained from the National Climatic Data Center (NCDC) station at Prudhoe Bay.
² Ice thickness was calculated using modified Stefan’s Equation.
At sample locations with sufficient under ice water, water chemistry characteristics were measured. These results are compiled in Tables 3, 4, 5, 6, 7, 8, and 9. Temperature and dissolved oxygen are plotted as a function of depth for lakes/reservoirs providing sufficient information in Figures 5 – 10.

Table 3. W0902-1 chemistry data.

<table>
<thead>
<tr>
<th>Location</th>
<th>W0902-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>4/22/2009</td>
</tr>
<tr>
<td>Lat/lon</td>
<td>N 69 34.823' W 148 38.498'</td>
</tr>
<tr>
<td>Datum</td>
<td>NAD 83</td>
</tr>
<tr>
<td>Depth BWS (ft)</td>
<td>5.05</td>
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<tr>
<td>Freeboard (ft)</td>
<td>0.72</td>
</tr>
<tr>
<td>Ice thickness (ft)</td>
<td>4.33</td>
</tr>
<tr>
<td>Snow depth (ft)</td>
<td>0.72</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>YSI Pro ODO</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Depth (ft BWS)</td>
<td>Temp. °C</td>
<td>pH</td>
<td>Cond. (μS/cm)</td>
<td>DO (mg/L)</td>
</tr>
<tr>
<td>1616</td>
<td>4</td>
<td>0.4</td>
<td>---</td>
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<td>0.64</td>
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<table>
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<tr>
<th>YSI 556</th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Depth (ft BWS)</td>
<td>Temp. °C</td>
<td>pH</td>
<td>Cond. (μS/cm)</td>
<td>DO (mg/L)</td>
</tr>
<tr>
<td>1625</td>
<td>4</td>
<td>0.11</td>
<td>7.21</td>
<td>1420</td>
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</table>

Sampled by: Myerchin, V. Breukelen
Instruments: YSI 556 SN#04DE5945AC and YSI Pro ODO
Pre-sampling calibration check: pass 4/22/09
Post-sampling calibration check: pass 4/22/09
Table 4. W0702 chemistry data.

<table>
<thead>
<tr>
<th>Location</th>
<th>W0702</th>
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<tbody>
<tr>
<td>Date</td>
<td>4/21/2009</td>
</tr>
<tr>
<td>Depth BWS (ft)</td>
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</tr>
<tr>
<td>Freeboard (ft)</td>
<td>0.15</td>
</tr>
<tr>
<td>Ice thickness (ft)</td>
<td>4.17</td>
</tr>
<tr>
<td>Snow depth (ft)</td>
<td>0.95</td>
</tr>
</tbody>
</table>

YSI Pro
ODO

<table>
<thead>
<tr>
<th>Time</th>
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<th>Temp. °C</th>
<th>pH</th>
<th>Cond. (μS/cm)</th>
<th>DO (mg/L)</th>
<th>DO (%)</th>
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<td>---</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
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<td>---</td>
<td>0.2</td>
<td>0.02</td>
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<tr>
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<tr>
<td>1113</td>
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<td>0.00</td>
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<td>1115</td>
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<td>0.90</td>
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</tbody>
</table>

YSI 556

<table>
<thead>
<tr>
<th>Time</th>
<th>Depth (ft BWS)</th>
<th>Temp. °C</th>
<th>pH</th>
<th>Cond. (μS/cm)</th>
<th>DO (mg/L)</th>
<th>DO (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0.98</td>
<td>7.72</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>8</td>
<td>0.95</td>
<td>7.90</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

***invalid recorded measurement

Sampled by: Myerchin, V. Breukelen
Instruments: YSI 556 SN#04DE5945AC and YSI Pro ODO
Pre-sampling calibration check: pass 4/20/09
Post-sampling calibration check: pass 4/22/09, conductivity failed

Figure 5. Temperature and dissolved oxygen in relation to depth below the water surface at W0702.
Table 5. W0801 chemistry data.

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Depth BWS (ft)</th>
<th>Freeboard (ft)</th>
<th>Ice thickness (ft)</th>
<th>Snow depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W0801</td>
<td>4/21/2009</td>
<td>6.95</td>
<td>0.8</td>
<td>4.53</td>
<td>1.08</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Datum</th>
<th>YSI Pro ODO</th>
<th>Temperature (°C)</th>
<th>pH</th>
<th>Conductivity (µS/cm)</th>
<th>DO (mg/L)</th>
<th>DO (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAD 83</td>
<td>Depth</td>
<td>Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ft BWS</td>
<td>1237</td>
<td>4</td>
<td>0.6</td>
<td>---</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1239</td>
<td>5</td>
<td>.0.1</td>
<td>---</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1240</td>
<td>6</td>
<td>0.4</td>
<td>---</td>
<td>0.03</td>
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<tr>
<td></td>
<td></td>
<td>1241</td>
<td>6.8</td>
<td>1.0</td>
<td>---</td>
<td>0.19</td>
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</table>

<table>
<thead>
<tr>
<th>Datum</th>
<th>YSI 556</th>
<th>Temperature (°C)</th>
<th>pH</th>
<th>Conductivity (µS/cm)</th>
<th>DO (mg/L)</th>
<th>DO (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Depth</td>
<td>Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ft BWS</td>
<td>1243</td>
<td>5</td>
<td>8.10</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1245</td>
<td>6.8</td>
<td>1.28</td>
<td>7.83</td>
<td>---</td>
</tr>
</tbody>
</table>

Sampled by: Myerchin, C. van Breukelen
Instruments: YSI 556 SN#04DE5945AC and YSI Pro ODO
Pre-sampling calibration check: pass 4/20/09
Post-sampling calibration check: pass 4/22/09, conductivity failed

Figure 6. Temperature and dissolved oxygen in relation to depth below the water surface at W0801.
### Table 6. W0802 chemistry data.

<table>
<thead>
<tr>
<th>Location</th>
<th>W0802</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>4/21/2009</td>
</tr>
<tr>
<td>Depth BWS (ft)</td>
<td>5.25</td>
</tr>
<tr>
<td>Latitude</td>
<td>N 69 33.138'</td>
</tr>
<tr>
<td>Freeboard (ft)</td>
<td>0.0</td>
</tr>
<tr>
<td>Longitude</td>
<td>W 150 23.318'</td>
</tr>
<tr>
<td>Ice thickness (ft)</td>
<td>3.9</td>
</tr>
<tr>
<td>Datum</td>
<td>NAD 83</td>
</tr>
<tr>
<td>Snow depth (ft)</td>
<td>0.72</td>
</tr>
</tbody>
</table>

#### YSI Pro ODO

<table>
<thead>
<tr>
<th>Time</th>
<th>Depth (ft BWS)</th>
<th>Temp. °C</th>
<th>pH</th>
<th>Cond. (μS/cm)</th>
<th>DO (mg/L)</th>
<th>DO (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1405</td>
<td>3</td>
<td>0.0</td>
<td>---</td>
<td>---</td>
<td>0.17</td>
<td>1.2</td>
</tr>
<tr>
<td>1406</td>
<td>4</td>
<td>-1.0</td>
<td>---</td>
<td>---</td>
<td>0.04</td>
<td>0.3</td>
</tr>
<tr>
<td>1408</td>
<td>4.3</td>
<td>-1.0</td>
<td>---</td>
<td>---</td>
<td>0.00</td>
<td>0.0</td>
</tr>
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</table>

#### YSI 556

<table>
<thead>
<tr>
<th>Time</th>
<th>Depth (ft BWS)</th>
<th>Temp. °C</th>
<th>pH</th>
<th>Cond. (μS/cm)</th>
<th>DO (mg/L)</th>
<th>DO (%)</th>
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</thead>
<tbody>
<tr>
<td>1410</td>
<td>4</td>
<td>0.02</td>
<td>7.20</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

Sampled by: Myerchin, C. van Breukelen
Instruments: YSI 556 SN#04DE5945AC and YSI Pro ODO
Pre-sampling calibration check: pass 4/20/09
Post-sampling calibration check: pass 4/22/09, conductivity failed

---

**Figure 7.** Temperature and dissolved oxygen in relation to depth below the water surface at W0802.
Table 7. Annie pit chemistry data.

<table>
<thead>
<tr>
<th>Location</th>
<th>Annie Pit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>4/25/2009</td>
</tr>
<tr>
<td>Depth BWS (ft)</td>
<td>23.45</td>
</tr>
<tr>
<td>Latitude</td>
<td>N 70 07.775</td>
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<tr>
<td>Freeboard (ft)</td>
<td>0.36</td>
</tr>
<tr>
<td>Longitude</td>
<td>W 146 59.980</td>
</tr>
<tr>
<td>Ice thickness (ft)</td>
<td>6.49</td>
</tr>
<tr>
<td>Datum</td>
<td>NAD 83</td>
</tr>
<tr>
<td>Snow depth (ft)</td>
<td>0.56</td>
</tr>
</tbody>
</table>

**YSI Pro ODO**

<table>
<thead>
<tr>
<th>Time</th>
<th>Depth (ft BWS)</th>
<th>Temp. °C</th>
<th>pH</th>
<th>Cond. (µS/cm)</th>
<th>DO (mg/L)</th>
<th>DO (%)</th>
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</thead>
<tbody>
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<td>1151</td>
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<td>1152</td>
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<td>10.22</td>
<td>70.5</td>
</tr>
<tr>
<td>1153</td>
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<td>0.2</td>
<td>---</td>
<td>---</td>
<td>10.20</td>
<td>70.2</td>
</tr>
<tr>
<td>1155</td>
<td>11</td>
<td>0.3</td>
<td>---</td>
<td>---</td>
<td>10.23</td>
<td>70.6</td>
</tr>
<tr>
<td>1156</td>
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<td>0.5</td>
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<td>---</td>
<td>10.21</td>
<td>70.9</td>
</tr>
<tr>
<td>1157</td>
<td>15</td>
<td>0.6</td>
<td>---</td>
<td>---</td>
<td>10.19</td>
<td>70.9</td>
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<tr>
<td>1158</td>
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<td>0.8</td>
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<td>---</td>
<td>10.11</td>
<td>70.7</td>
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<tr>
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<td>10.06</td>
<td>70.3</td>
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<tr>
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<td>20</td>
<td>0.9</td>
<td>---</td>
<td>---</td>
<td>9.98</td>
<td>70.2</td>
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<td>21.5</td>
<td>1.0</td>
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<td>7.69</td>
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**YSI 556**

<table>
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<th>Temp. °C</th>
<th>pH</th>
<th>Cond. (µS/cm)</th>
<th>DO (mg/L)</th>
<th>DO (%)</th>
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</thead>
<tbody>
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<td>7.54</td>
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<td>---</td>
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<td>14</td>
<td>---</td>
<td>7.56</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
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</table>

Sampled by: Myerchin, van Breukelen  
Instruments: YSI 556 SN#04DE5945AC and YSI Pro ODO  
Pre-sampling calibration check: pass 4/22/09  
Post-sampling calibration check: pass 4/23/09, conductivity failed
Figure 8. Temperature and dissolved oxygen in relation to depth below the water surface at Annie Pit.

Figure 9. Temperature and dissolved oxygen in relation to depth below the water surface at Badami Pit.
Table 8. Badami gravel pit chemistry data.

<table>
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<th>Location</th>
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<tbody>
<tr>
<td>Date</td>
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</tr>
<tr>
<td>Latitude</td>
<td>N 70 07.775</td>
</tr>
<tr>
<td>Longitude</td>
<td>W 146 59.980</td>
</tr>
<tr>
<td>Depth BWS (ft)</td>
<td>17.11</td>
</tr>
<tr>
<td>Freeboard (ft)</td>
<td>0.6</td>
</tr>
<tr>
<td>Ice thickness (ft)</td>
<td>6.9</td>
</tr>
<tr>
<td>Datum</td>
<td>NAD 83</td>
</tr>
<tr>
<td>Snow depth (ft)</td>
<td>0.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Depth (ft BWS)</th>
<th>Temp. °C</th>
<th>pH</th>
<th>Cond. (µS/cm)</th>
<th>DO (mg/L)</th>
<th>DO (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16:53</td>
<td>7</td>
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<td>---</td>
<td>12.7</td>
<td>87.7</td>
</tr>
<tr>
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<td>8</td>
<td>0.91</td>
<td>---</td>
<td>---</td>
<td>12.7</td>
<td>87.1</td>
</tr>
<tr>
<td>17:02</td>
<td>9</td>
<td>1.65</td>
<td>---</td>
<td>---</td>
<td>12.6</td>
<td>86.9</td>
</tr>
<tr>
<td>17:04</td>
<td>11</td>
<td>2.00</td>
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<td>---</td>
<td>12.6</td>
<td>86.8</td>
</tr>
<tr>
<td>17:08</td>
<td>13</td>
<td>2.26</td>
<td>---</td>
<td>---</td>
<td>12.5</td>
<td>86.8</td>
</tr>
<tr>
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<td>2.40</td>
<td>---</td>
<td>---</td>
<td>12.4</td>
<td>86.4</td>
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<tr>
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<td>16</td>
<td>2.47</td>
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<td>---</td>
<td>12.3</td>
<td>85.6</td>
</tr>
<tr>
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<td>17</td>
<td>2.43</td>
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<td>---</td>
<td>12.1</td>
<td>83.9</td>
</tr>
<tr>
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<td>17.92</td>
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<td>---</td>
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<td>10.0</td>
<td>69.9</td>
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</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Depth (ft BWS)</th>
<th>Temp. °C</th>
<th>pH</th>
<th>Cond. (µS/cm)</th>
<th>DO (mg/L)</th>
<th>DO (%)</th>
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</thead>
<tbody>
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<td>18.1</td>
<td>128.0</td>
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</table>

Sampled by: Derry, Gieck
Instruments: YSI 556 SN#04D5945AC and Hach LDO
Hach Pre-sampling calibration check: pass 4/27/09
YSI Pre-sampling calibration check: pass 4/23/09
YSI Post-sampling calibration check: pass 4/26/09
Table 9. Shaviovik gravel pit chemistry data.

<table>
<thead>
<tr>
<th>Location</th>
<th>Shaviovik Pit</th>
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<tbody>
<tr>
<td>Date</td>
<td>4/29/2009</td>
</tr>
<tr>
<td>Depth BWS (ft)</td>
<td>32.95</td>
</tr>
<tr>
<td>Latitude</td>
<td>N 70°09.458</td>
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<tr>
<td>Freeboard (ft)</td>
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</tr>
<tr>
<td>Longitude</td>
<td>W 147°15.370</td>
</tr>
<tr>
<td>Ice thickness (ft)</td>
<td>6.8</td>
</tr>
<tr>
<td>Datum</td>
<td>NAD 83</td>
</tr>
<tr>
<td>Snow depth (ft)</td>
<td>0.2</td>
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</table>

<table>
<thead>
<tr>
<th>Hach LDO</th>
</tr>
</thead>
<tbody>
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</tr>
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<td>0335</td>
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<td>0338</td>
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<tr>
<td>0342</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>YSI 556</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
</tr>
<tr>
<td>19:20 (4/25/09)</td>
</tr>
</tbody>
</table>

Sampled by: Derry, Gieck
Instrument: YSI 556 SN#04D5945AC and Hach LDO
Hach Pre-sampling calibration check: pass 4/27/09
YSI Post-sampling calibration check: pass 4/23/09
YSI Post-sampling calibration check: pass 4/26/09
Bathymetry

The three lakes where bathymetric surveys were conducted were all shallow thaw lakes.

Summary bathymetric information is provided in Table 10, and the bathymetric sounding and contour maps are shown in Figure 11 and Figure 12. The bathymetry results indicated that these lakes are typical of shallow thaw lakes and would not be good candidates for over winter water use.

Table 10. Summary of bathymetry results

<table>
<thead>
<tr>
<th>Lake</th>
<th>Date Visited</th>
<th>Area (m²)</th>
<th>Average depth (m)</th>
<th>Max Depth (m)</th>
<th>Number of Depths Collected³</th>
</tr>
</thead>
<tbody>
<tr>
<td>S0901</td>
<td>10-Jul-09</td>
<td>387,212</td>
<td>1.08</td>
<td>1.95</td>
<td>111</td>
</tr>
<tr>
<td>S0902</td>
<td>9-Jul-09</td>
<td>357,965</td>
<td>1.04</td>
<td>1.90</td>
<td>145</td>
</tr>
<tr>
<td>S0903</td>
<td>8-Jul-09</td>
<td>486,289</td>
<td>0.90</td>
<td>2.10</td>
<td>111</td>
</tr>
</tbody>
</table>

³ “Number of Depths Collected” is the number of data points collected using the lead line method, and does not include those points used to mark the perimeter of the lake.
Figure 11: Sounding locations for lakes S0901, S0902, S0903
Figure 12: Contour lines (meters) for lakes S0901, S0902, S0903
SUMMARY

Lake chemistry and physical data were collected during spring (before snowmelt) and summer conditions in the region between the Canning River and Kuparuk River, North Slope, Alaska. These data were collected to help support winter water use planning and management.

The collected data indicate three of the gravel mine site reservoirs had high DO levels. Two of these sites, Shaviovik and Badami Pits, served as active water sources during the winter of 2008-09. This information is consistent with data retrieved from other reservoirs that receive adequate recharge and are also used as winter water sources. Locating gravel mine sites in areas with adequate recharge characteristics will help improve the future distribution and volume of winter water availability. The data collected at Kuparuk Foothills lakes W0802, S0901, S0902 and S0903 this season indicated these natural lakes froze nearly or fully to the bottom and would not serve as an adequate late winter water sources. Lakes W0702 and W0801 had more unfrozen water at the lake bottom at winter’s end (4.5 ft and 2.4 ft, respectively). DO levels in these lakes were found to be close to zero, thus indicating that the lakes do not likely support overwintering fish species highly sensitive to low DO conditions. Estimates of ice thickness via the modified Stefan’s Equation were generally consistent with physical measurements collected at six lake sites, thus indicating that the modified Stefan’s Equation will be applicable in the derivation of bathymetric information from SAR data.
REFERENCES

APPENDIX A. WATER QUALITY ASSURANCE DATA

The following tables report the pre- and post-calibration checks for water quality meters used during field sampling.
QAQC Information for Sites W0702, W0801, W0802.

**Calibration and Quality Assurance Information**

**Meter:** YSI 556 MPS, S/N 04D5945 AC – pH, Conductivity  
YSI Pro ODO, TTT Environmental – Dissolved Oxygen

**Site Location:** W0702, 0801, W0802

**PRE-SAMPLING QA**

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**DO 100 (%)**

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**Calibration and Quality Assurance Information**

**Meter:** YSI 556 MPS, S/N 04D5945 AC – pH, Conductivity  
YSI Pro ODO, TTT Environmental – Dissolved Oxygen

**Site Location:** S0903-1, -2, -3, -4 and S0902-1, -2, -3.

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**POST-SAMPLING QA**

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### Calibration and Quality Assurance Information

**Meter:** YSI 556 MPS, S/N 04D5945 AC – pH, Conductivity
    YSI Pro ODO, TTT Environmental – Dissolved Oxygen

**Site Location:** Annie Pit, MP27, S0901-1 and S0901-2

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QAQC Information for Sites Badami and Shaviovik.

### Calibration and Quality Assurance Information

**Meter:** YSI 556 MPS, S/N 04D5945 AC – pH, Conductivity  
Hach LDO, BLM – Dissolved Oxygen

**Site Location:** Badami and Shaviovik

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