Lake Survey Data for the Kuparuk Foothills Region: Spring 2006

Sampling lake water chemistry, D. White

by

Molly Chambers, Michael Lilly, Daniel White,

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Kuparuk Foothills Hydrology Project

Report No. INE/WERC 06.05

Water and Environmental Research Center

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

Conversion Factors

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter (mm)
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (mm)
mile (mi)	1.609	kilometer (km)
	Area	
Acre	43559.826	square feet (ft^2)
Acre	0.407	hectare (ha)
square foot (ft^2)	2.590	square mile (mi^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
gallon (gal)	3785	milliliter (mL)
cubic foot (ft^3)	23.317	liter (L)
Acre-ft	1233	cubic meter (m^3)
	Velocity and Discharge	
foot per day (ft/d)	0.3048	meter per day (m/d)
Square foot per day (ft^2/d)	.0929	square meter per day (m^2/d)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/sec)
	Hydraulic Conductivity	
foot per day (ft/d)	0.3048	meter per day (m/d)
foot per day (ft/d)	0.00035	centimeter per second (cm/sec)
meter per day (m/d)	0.00115	centimeter per second (cm/sec)
	Hydraulic Gradient	
foot per foot (ft/ft)	5280	foot per mile (ft/mi)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
	Pressure	
pound per square inch (lb/in^2)	6.895	kilopascal (kPa)

Units

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

Physical and Chemical Water-Quality Units:

Temperature:

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

$$°F = 1.8(°C) + 32$$

Specific electrical conductance (conductivity):

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

Abbreviations, Acronyms, and Symbols

AC	Actual Conductivity
ADOT&PF	Alaska Department of Transportation and Public Facilities
ASTM	American Society for Testing and Materials
atm	atmospheres
C	Celsius
DO	Dissolved Oxygen
DVM	digital voltage multi-meter
e-tape	electric tape
F	Fahrenheit (^{o}F).
ft	feet
GWS	Geo-Watersheds Scientific
GWSI	USGS Ground-Water Site Inventory
INE	Institute of Northern Engineering
km^2	square kilometers
kPa	kilopascal
lb/in^2	pounds per square inch
m	meters
mg/L	milligrams per liter
μg/L	micrograms per liter
mi^2	square miles
mm	millimeters
μS/cm	microsiemens per centimeter
mV	Millivolt
NGVD	National Geodetic Vertical Datum
NWIS	National Water Information System
ORP	oxygen-reduction potential
ppm	parts per million
QA	quality assurance
QC	quality control
SC25	specific conductance at 25^{o}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

The abundance of natural lakes is limited in the foothills region of the North Slope, Alaska, which affects the available water resources needed during mid-winter operations periods. Water is needed for ice road construction and maintenance, drilling and facility operations, and potable water supplies. The foothills region area between the Sagavanirktok River and the Kuparuk River has numerous shallow lakes on the north side of the White Hills. Identifying potential water sources for this region will help both industry and resource-management agencies. Sampling conducted in spring 2006 was a preliminary study of lakes. Field chemistry measurements, lake depth, ice thickness, and snow measurements were collected at each site. Lakes with a potential for unfrozen water in mid-winter were pre-selected for field sampling. The natural lakes sampled were generally found to have little under-ice water available. Data from this project will also be used for analysis in the North Slope Lakes project, sponsored by the US Department of Energy.

ACKNOWLEDGEMENTS

This project was funded by grant ADN #2562123, Alaska Department of Transportation and Public Facilities. Alaska Department of Natural Resources provided background data for lakes in the study area. Information was also provided by Kuparuk Watershed projects funded by the National Science Foundation.

Lake Survey Data for the Kuparuk Foothills Region: Spring 2006

INTRODUCTION

Water resources are essential to construction and maintenance of gravel road, and ice road / pad construction on the North Slope of Alaska. Yet many natural lakes are too shallow to provide significant freshwater throughout the winter operations period. The area between the Sagavanirktok River and the Kuparuk River has numerous, but shallow, lakes in the White Hills region. Future development in this area will need a network of natural lakes, or gravel-mine sites to provide water. In planning transportation networks, an opportunity for concurrent gravel procurement and water resource development exists. Physical and chemical measurements show that many natural lakes are insufficient for use as winter water resources or overwintering fish habitat. Although not monitored, the larger rivers in the area (Kuparuk and Toolik) have low winter baseflows and are not generally considered potential sites for obtaining water in the winter months.

OBJECTIVES

The objectives of this report are to make available lake data collected in the early spring of 2006. Spring snowmelt had not started and lake ice conditions were at a winter maximum. Snow depth measurements on and adjacent to lakes were also collected to help with regional hydrologic analysis. This data will help resource developers and management agencies evaluate potential water sources in the region, and areas where future water sources are needed.

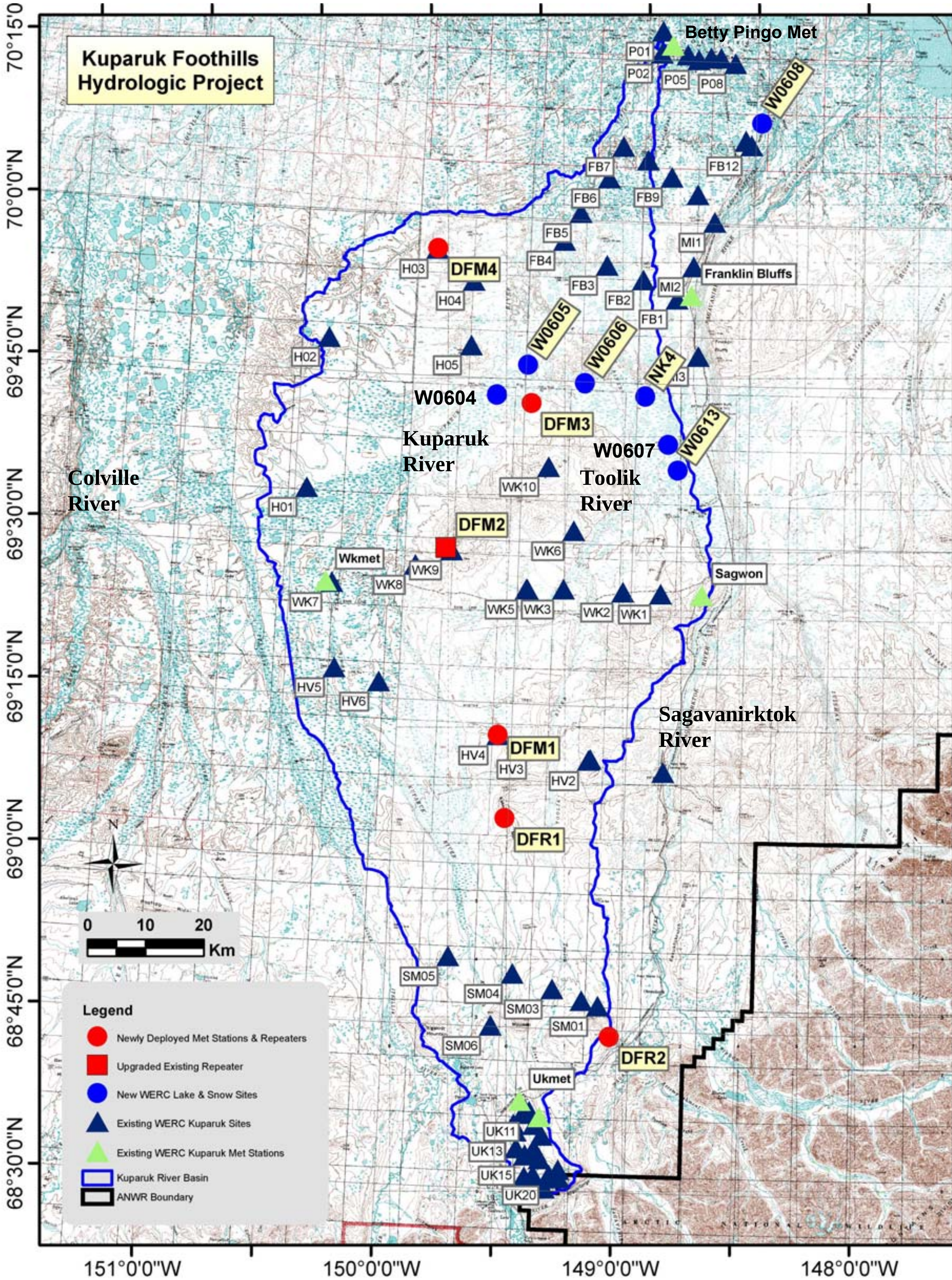

Figure 1. Study area and lake location map for Kuparuk foothills region, North Slope, Alaska.

PROCEDURE

Lakes selected for the study fell between 50 and 60 miles south of the arctic coast, and within 25 miles to the west of the Dalton Highway (Figure 1). As seen in figure 1, few lakes are present in the foothills relative to the coastal plain. There is no current road access to the lakes and all lakes were accessed by helicopter. At each lake, the ice was drilled with a 2-inch 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 hole where snow was cleared to drill) were taken with a folding measure with a hook for feeling the bottom of ice or a weighted flexible measuring tape. The precision with which physical measurements are reported takes into account field conditions. Temperature, pH, oxidation-reduction potential (ORP), dissolved oxygen (DO), and electrical conductivity were measured with a Yellow Springs Instruments (YSI) 556 multi-parameter meter. The calibration of each parameter was checked before and after each day of sampling. To pass the calibration check, pH had to be within 0.2 pH units and ORP, DO, and conductivity had to be within 10% of the calibration standard value. All parameters passed each check and DO and conductivity checks had error less than 5% (Appendix A). Actual conductivity (AC) was temperature compensated to specific conductivity at 25°C (SC_{25}) by 2% per degree Celsius (Hem 1985).

RESULTS

Four lakes were visited along the potential in the Kuparuk foothills region (Table 1). Of these, W0613 had enough sub-ice water for chemistry measurements. Lake W0613 had limited unfrozen water at the sample sites. Dissolved oxygen and oxidation-reduction potential were low, indicating a reducing environment with insufficient end of winter oxygen for fish (Table 2).

Hole locations (Table 1) are plotted on a Landsat image of lake W0613 in figure 2. Synthetic aperture radar (SAR) images adjacent to the Landsat images give some indication of the likelihood of finding liquid water (Duguay and Lefleur, 2003; Jeffries and others, 1995).

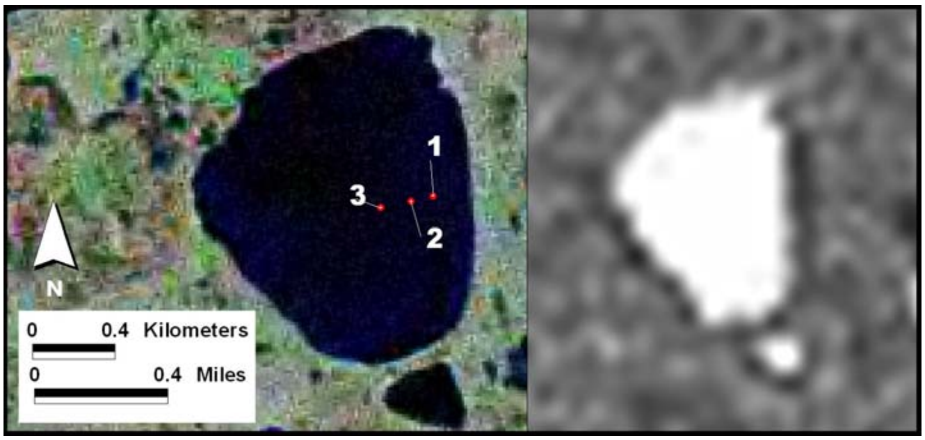

Figure 2. Satellite imagery of lake W0613 (MDA Federal 2004, ESA 1994-1999).

The Landsat image (left, color) show the locations of sampling sites (Figure 2). The SAR image (right, grayscale) is from January 26, 1994, a low snow year. Dark areas on the SAR image during this stage of winter indicate grounded ice. Bright or white areas indicate liquid water under the ice at the time the image was captured. This lake appears to only have grounded ice around the edges by the end of January.

Table 1. Sampling locations and physical measurements.

Location	North Latitude (NAD83)	West Longitude (NAD83)	Date	Ice thickness (ft)	Water depth (ft)[a]	Freeboard (ft)	Snow depth (ft)
W0613 hole 1	69.61740	148.81830	5/4/2006	1.35	dry	- -	- -
W0613 hole 2	69.61716	148.82103	5/4/2006	3.85	4.3[b]	0.05	1.2
W0613 hole 3	69.61684	148.82472	5/4/2006	3.78	4.43	0.00	1.3
W0613 hole 4	69.61669	148.82716	5/4/2006	3.57	4.63	-0.11	1.3
W0605 center hole	69.76936	149.48720	5/1/2006	1.8	dry	- -	1.1
W0605 hole 2	69.76873	149.48871	5/1/2006	1.8	dry	- -	1.0
W0605 hole 3	69.76729	149.48981	5/1/2006	2.1	dry	- -	1.3
W0606 center hole	69.74670	149.22887	5/1/2006	1.1	dry	- -	1.0
W0606 hole 2	69.74551	149.22983	5/1/2006	0.9	dry	- -	0.6
W0606 hole 3	69.74477	149.23016	5/1/2006	0.92	dry	- -	0.9
W0606 hole 4	69.74475	149.22919	5/1/2006	0.85	dry	- -	0.7
W0606 hole 5	69.74644	149.22810	5/1/2006	1.2	dry	- -	0.8
W0607 hole 1	69.65757	148.86206	5/1/2006	2.0	dry	- -	1.0
W0607 hole 2	69.65730	148.86688	5/1/2006	2.45	dry	- -	1.4
W0607 hole 3	69.65720	148.87143	5/1/2006	2.6	dry	- -	1.4
W0607 hole 4	69.65728	148.87415	5/1/2006	2.7	dry	- -	1.5
W0607 hole 5	69.65701	148.87863	5/1/2006	2.55	dry	- -	1.3
W0607 hole 6	69.65632	148.88144	5/1/2006	1.7	dry	- -	1.0

[a]Bottom of lake to water surface.

[b]Too muddy for water chemistry.

Table 2. Lake W0613 chemistry data.

Location	W0613		
Date	5/4/2006	**Depth BWS (ft)**	4.43
Latitude	N 69.61684	**Freeboard (ft)**	0.00
Longitude	W 148.82472	**Ice thickness (ft)**	3.78
Datum	NAD 83	**Snow depth (cm)**	39.6* (1.30 ft)

Time	Depth (ft BWS)	Temp. °C	pH	ORP (mV)	DO (mg/L)	Conductivity AC (μS/cm)	Conductivity SC_{25} (μS/cm)**
17.14	4	0.22	6.87	-122.2	1.44	406	805

*mean of 50 depths, WC1 snow survey

**Temperature corrected by 2% per degree Celsius.

Sampled by: Chambers, Lilly
Instrument: YSI 556 SN#04G127880AA
Pre-sampling calibration check: pass 5/3/06
Post-sampling calibration check: pass 5/4/06

Poor weather for helicopter access limited sampling at other Kuparuk foothills lakes. Many of the other lakes in the region are expected to have little or no water available during late winter conditions.

SUMMARY

The data collected indicate that little mid- to late-winter water is available in the foothills region area between the Sagavanirktok and Kuparuk Rivers. The use of SAR satellite data helped indicate lakes with potential water under ice. Additional investigation of water availability in late winter through SAR imagery would help better characterize regional water availability. The location of gravel mine sites in areas with adequate recharge characteristics will help improve the distribution and volume of winter water availability. Areas along streams or older drained lakes with adequate recharge would both serve as potential areas for long-term water sources.

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MDA Federal 2004. Landcover 2000/ETM+ Edition Mosaics. Tile N-06-65, N-06-70. Sioux Falls, Dakota: USGS

APPENDIX A. WATER QUALITY ASSURANCE DATA

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

Instrument: YSI 556 SN# 04G127880AA **Rented from TTT, Anchorage**

Date		**Conductivity**			**pH**			**DO**			**ORP**		
pass/fail	**By**	standard*	reading	error (%)	standard*	reading	difference	standard*	reading	error (%)	standard*	reading	error (%)
4/19/2006	TT	1.413 mS	1.413 mS	0	7.000	7.02	0.02	100	99.4	-0.6	220	228	3.6
pass					4.01	4.00	-0.01						
					10.000	10.04	0.04						
4/21/2006	MC	338	346	2.4	4.01	3.95	-0.06	100	99.2	-0.8	251	236.3	-5.9
pass					7.00	7.02	0.02						
					10.00	10.03	0.03						
4/29/2006	MC	252	264	4.8	4.01	4.11	0.10	100	104.6	4.6	246	232.9	-5.3
pass					7.00	7.09	0.09						
					10.00	10.08	0.08						
4/30/2006	MC	285	296	3.9	4.01	4.07	0.06	100	103.9	3.9	238	217.6	-8.6
pass					7.00	7.11	0.11						
					10.00	10.16	0.16						
5/1/2006	MC							100	102.5	2.5			
pass													
5/2/2006	MC	315	326	3.5	4.01	4.06	0.05	100	102.1	2.1	233	212.2	-8.9
pass					7.00	7.07	0.07	0	1.8	n/a			
					10.00	10.05	0.05						
5/3/2006	MC	319	328	2.8	4.01	4.09	0.08	100	104.1	4.1	232	211.0	-9.1
pass					7.00	7.08	0.08	0	0.15	n/a			
					10.00	10.07	0.07						
5/4/2006	MC	316	330	4.4	4.01	4.07	0.06	100	101.7	1.7	231	213.5	-7.6
pass					7.00	7.09	0.09	0	0.20	n/a			
					10.00	10.05	0.05						
				max error: 4.8%		**max. difference:**	**0.16**		**max error:**	**4.6%**		**max error:**	**-9.1%**

*Standard values were temperature compensated. Saturated DO standard was chilled, bubbled nanopure water. The conductivity standard was also chilled. Conductivity was measured as actual conductance, and results must be temperature compensated to specific conductance. A 2% per degree to 25°C compensation is recommended.

Units--conductivity: µS/cm unless otherwise noted; pH: pH units; DO: % of saturation for temperature, barometric pressure; ORP: mV

Error/recalibration cut-offs: recalibration was deemed necessary when error exceeded 10% or 0.2 pH units.