North Slope, Alaska, Snow-Course and Lake Survey Data: December 2010

Hole drilled in the ice at lake L9312.
Photo by Jeff Murray, December 2010

by

Kristie Hilton, Jeff Murray, and Michael Lilly

August 2012

Arctic Transportation Networks Project

Report GWS.TR.12.07

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Kristie Hilton[1], Jeff Murray[1], and Michael Lilly[1]

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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-foot (ac-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)	0.0929	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. Regulations related to tundra travel and water use on Alaska's North Slope apply combinations of both English and SI units. 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, snow depth was reported in inches (in) followed by the value in centimeters (cm) 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:

$$°F = 1.8(°C) + 32$$

Snow Water Equivalent (SWE):

Water content of a column of snow is determined by knowing the depth of the snowpack and density.

$$SWE = d_s * \rho_s / p_w$$

where:

d_s = snow depth

ρ_s = snow density

p_w = density of water.

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 (µΩ/cm). Conductivity can also be expressed as specific conductance at 25°C [SC25] in which the actual conductivity (µS/cm) 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 reported in mg/L is equivalent to the concentration in parts per million (ppm).

Millivolt (mV):
A unit of electromotive force equal to one thousandth of a volt.

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.

Abbreviations, Acronyms, and Symbols

AC	Actual conductivity
ADOT&PF	Alaska Department of Transportation and Public Facilities
ADNR	Alaska Department of Natural Resources
ASTM	American Society for Testing and Materials
atm	Atmospheres
ATN	Arctic Transportation Networks
C	Celsius (^{o}C)
cm	Centimeters
DO	Dissolved oxygen
DVM	Digital voltage multi-meter
F	Fahrenheit (^{o}F)
ft	Feet
GWS	Geo-Watersheds Scientific
in	Inches
kg	Kilograms
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
NRCS	Natural Resources Conservation Service
NWIS	National Water Information System
ORP	Oxygen-reduction potential
ppm	Parts per million
QA	Quality assurance
QC	Quality control
Sag	Sagavanirktok River
SC25	Specific conductance at 25°C
SWE	Snow water equivalent
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

PROJECT COOPERATORS

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

- U.S. Department of Energy, National Energy Technology Laboratory (NETL)
- ConocoPhillips Alaska, Inc. (CPA)
- Bureau of Land Management (BLM)
- Alaska Department of Natural Resources (ADNR)
- The Nature Conservancy
- Northern Alaska Environmental Center
- North Slope Borough
- National Weather Service (NWS)
- Geo-Watersheds Scientific (GWS)
- University of Alaska-Fairbanks (UAF)
- Idaho National Laboratory (INL)

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North Slope, Alaska, Snow-Course and Lake Survey Data: December 2010

INTRODUCTION

Geo-Watersheds Scientific (GWS), University of Alaska Fairbanks (UAF), and Idaho National Laboratory (INL), together with project cooperators, initiated a study in October 2009 to collect field data for the development of management tools for various aspects of Arctic Transportation Networks (ATN). Some of the variables collected include data from meteorological and lake stations, such as snow-depth, air and soil temperatures, unfrozen soil moisture, precipitation, wind, and radiation data. Data is also collected at selected lakes and reservoirs. Lake data may include snow depth and density data, water-quality and water-level measurements, and general observations of watershed conditions.

Snow depth is considered an important variable by regulatory agencies since tundra travel operations in the Coastal Tundra Area (Alaska state lands) can only commence once a spatially consistent snow depth is maintained. Agencies require 6 in (15 cm) of snow for tundra travel in the Coastal Plain management areas, and 9 in (23 cm) in the Foothills management areas. Soil temperatures are also used to manage tundra travel on Alaska state lands. The soil temperature must reach 23° F (-5°C) at a depth of 12 in (30 cm) (Bader, 2004) to ensure frozen soil has reached adequate soil strength to meet tundra travel management criteria. Many meteorological factors determine when these conditions will be met. An established network of meteorological stations paired with and increased manual snow measurements – both amount collected and number of sites visited – will improve the understanding of snow distribution and will assist in the development of predictive and management tools.

Ice thickness on lakes and reservoirs is another important parameter related to Arctic transportation networks. Adequate ice thickness must exist to warrant safe travel over ungrounded ice (ice not frozen to the bottom of lake or reservoir). In most cases, an end-of-season ice thickness of 7 ft (2.1 m) is assumed for lakes over 7 feet (2.1 m) deep on the North Slope. This is a conservative seasonal ice thickness that is rarely measured, but has provided a

safe management approach in lack of supporting data for seasonal ice thicknesses over the North Slope and over time. Ice thickness data collected by the ATN project and others will be used to help develop better management approaches associated with water use and North Slope lakes and reservoirs.

TRIP OBJECTIVES

The December field effort was primarily focused on conducting snow-courses, measuring lake ice thickness and water surface elevation, and verification of meteorological station operations. Snow sampling was performed at co-located ADNR sites as well as ATN project sampling sites (Figure 1). In addition to standard snow-course measurements addressed in Derry *et al.* 2009, alternative methods of measuring snow depth on the North Slope were compared. Concurrent with these activities, the 2L-Pad meteorological station was upgraded with a remote Campbell Scientific CC640 camera.

A workplan was published prior to the December field campaign containing a site-by-site list of objectives (Murray et al. 2010). Project accomplishments include the following:

1. L9312
   - Conducted snow courses at L9312 on tundra and lake ice surface and addition snow measurements to test snow measurement approaches
   - Updated datalogger operating system at L9312 meteorological station and performed general station maintenance
   - Measured lake ice parameters (ice thickness, freeboard, water surface elevation)

2. Kuparuk Area
   - Conducted snow courses at Kuparuk area sites and took additional snow measurements to test snow measurement approaches
   - Installed Campbell Scientific CC640 camera and camera lens heater at 2L meteorological station and performed general station maintenance

3. Toolik
   - Conducted snow courses on lake ice surface and took additional snow measurements to test snow measurement approaches
   - Measured lake ice parameters (ice thickness, freeboard, water surface elevation)

PROCEDURES

ATN's standard snow course procedure consisted of snow-depth measurements conducted in "L" shaped patterns on lake surfaces and/or tundra surfaces at predetermined locations according to GWS snow measurement methods (Derry et al. 2009). Snow-depth measurements were taken with a T-handle probe approximately every 3.3 ft (1 m) for 82 ft (25 m), then turning 90 degrees, and continuing for another 82 ft (25 m). Snow samples were also collected for density measurements with an Adirondack snow sampler. Five densities were collected at each location and averaged to establish a representative density. A number of sampling sites were co-located with ADNR snow and soil sampling sites to compare sampling methods. In 2010/11, ADNR measured snow depth by collecting 20 depth measurements along a transect spaced at 5 meter (16.4 ft) increments with a meter long ruler and 5 density measurements collected with a Federal Sampler (Derry et al. 2009).[1] To compare the precision of the ruler-based measurements to the standard T-handle probe technique, ATN project staff used both protocols at co-located sites on tundra and lake ice surfaces.

Additionally, ATN staff compared the effect of transect shape on the final snow-depth measurement. ATN recommends the "L-transect" method, which consists of a 50 meter transect with a right angle at the halfway point. ADNR, on the other hand, collects 20 snow depths along a 100 meter transect spaced at 5 meter increments. To further test the validity of these methods, snow depths were collected at established snow sampling sites along a straight 100-m transect using a T-probe. Depths were taken every 0.05 m for 100 m, resulting in 200 depth values (n=200). The resulting high resolution data was used to optimize snow-depth sample size and sample spacing and to verify the efficacy of the ATN and ADNR transect designs. To test method reliability, a third agency (LCMF, LLC.) completed snow course surveys using the ATN L-shaped transect and the 100 meter fine resolution transect at the L9312 tundra site.

[1] Note: this protocol is different than the method used during the 2009/10 season. Previously, ADNR measured snow depth along an 11 meter transect with depth samples measured every 0.5 meter (1.5 ft). In total, 20 depth values were measured per transect. In addition, two snow densities were collected near each transect with a Federal Snow Sampler.

Water 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 measured at Lake L9312 and Toolik Lake. Holes were drilled through the ice with a gas powered, 10-inch diameter ice auger. After the hole was drilled, water depth was measured with a flexible tape, and freeboard and ice thickness was measured with a folding tape. Snow depth was measured with the same T-handle probe that is used for snow courses.

SELECTED RESULTS

Snow course measurements were conducted at eleven sites during the December trip (Table 1), several of which are co-located with ADNR sites (Figure 1). For reference, ADNR snow and soil temperature monitoring locations are presented in Figure 2. Snow data collected at the sampling sites visited can be found in Appendix A.

Table 1. December snow sampling locations. Locations in bold indicate site is co-located with ADNR snow and soil temperature sampling sites.

Station	Elevation Ft	North Latitude NAD 83	West Longitude NAD 83
1J- Pad	82	70° 16.260'	149° 31.140'
2L-Pad	112	70° 11.481'	150° 19.397'
52-Mile	216	69° 32.820'	148° 36.360'
62-Mile	1,090	69° 25.320'	148° 40.140'
ANFO 2	27	70° 14.447'	148° 10.760'
Betty Pingo	34	70° 16.772'	148° 53.741'
L9312 - Lake Surface	7	70° 20.008’	150° 57.083’
L9312 - Tundra Surface	7	70° 19.995’	150° 56.918’
P-Pad	33	70° 16.967'	148° 54.807'
Sag River DOT	1,640	68° 45.686'	148° 52.746'
Toolik Lake (Toolik Camp)	2,362	68° 37.926'	149° 36.670'

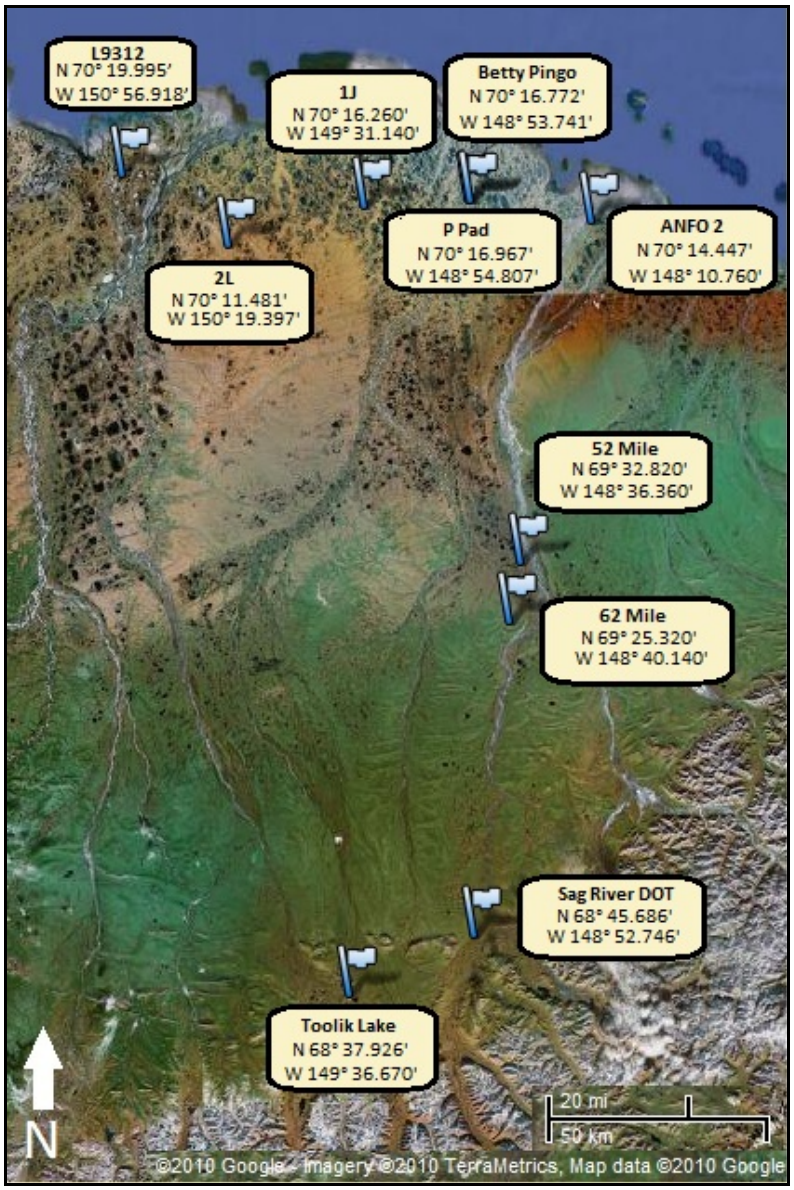

Figure 1. ATN snow-course locations visited in December 2010. Sampling locations co-located with ADNR include: 1J-Pad, 2L-Pad, 52-Mile, 62-Mile, ANFO 2, P-Pad, and Sag River DOT. (NAD 83)

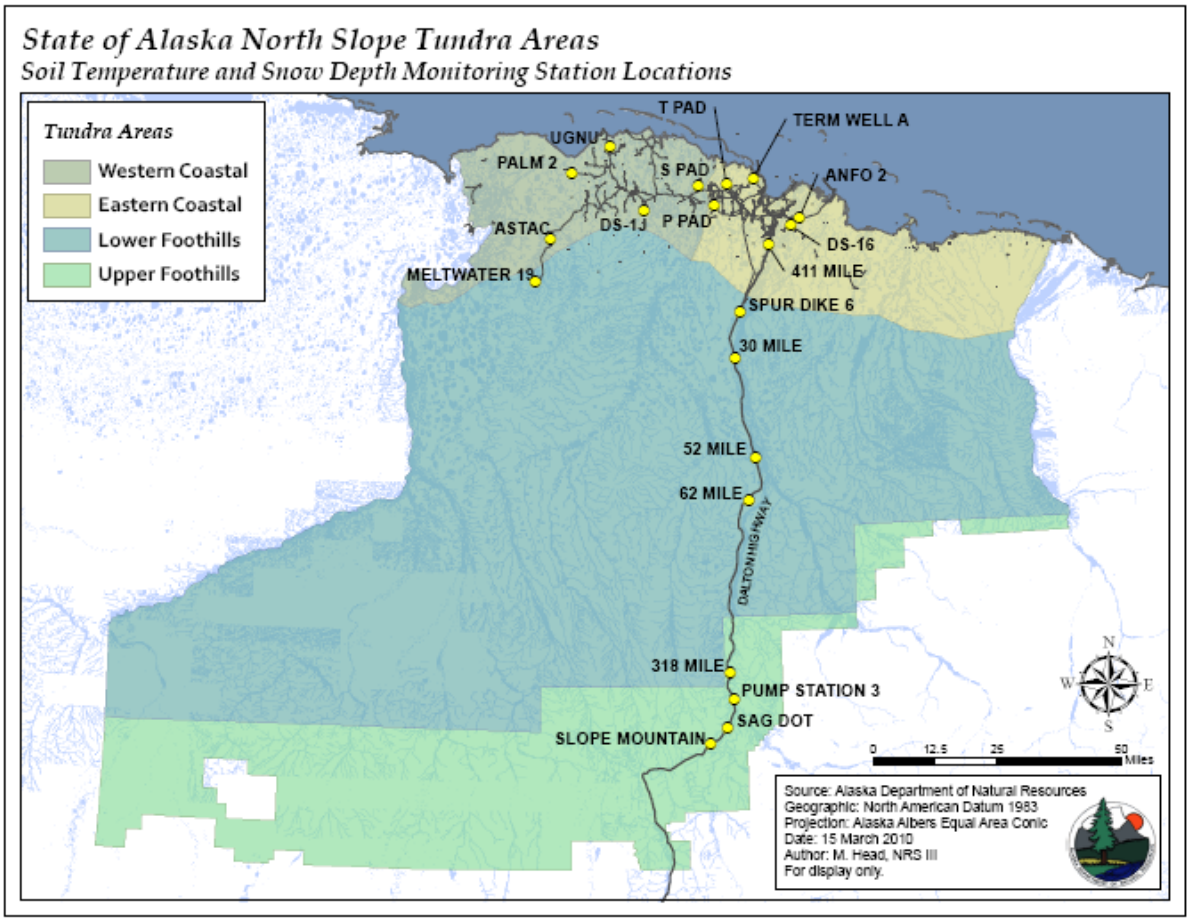

Figure 2. Map of ADNR snow and soil temperature sampling sites (ADNR, 2010).

Table 2 provides a summary of the snow data collected at the sampling sites visited in December. Individual snow forms and additional information about these sites can be found in the appendicies.

Table 2. Summary of snow depth, density, and SWE values from sites visited by ATN personnel in December, 2010.

	ATN Snow Data Collected in December, 2010				
	Avg. Snow Depth		Density	SWE	
	cm	in	g/cm^3	cm	in
Eastern Coastal Area					
P Pad	27.9	11.0	0.22	6.3	2.47
Betty Pingo	32.0	12.6	0.28	8.8	3.47
ANFO 2	23.7	9.3	0.26	6.1	2.39
Area Averages	***27.9***	***11.0***	***0.25***	***7.1***	***2.78***
Western Coastal Area					
1J-Pad	33.3	13.1	0.25	8.4	3.31
2L-Pad	31.9	12.6	0.25	7.8	3.09
L9312 - Tundra Surface	33.8	13.3	0.26	8.8	3.48
L9312 - Lake Surface	11.8	4.6	0.30	3.6	1.41
Area Averages	***27.7***	***10.9***	***0.27***	***7.2***	***2.82***
Lower Foothills Area					
52 Mile	31.6	12.4	0.19	6.0	2.36
62 Mile	32.5	12.8	0.17	5.5	2.17
Area Averages	***32.1***	***12.6***	***0.18***	***5.8***	***2.27***
Upper Foothills Area					
Sag R. DOT	28.4	11.2	0.16	4.6	1.83
Toolik Lake	17.2	6.8	0.19	3.3	1.29
Area Averages	***22.8***	***9.0***	***0.18***	***4.0***	***1.56***

Note: Above is ATN-collected data separated according to ADNR Regions

The December trip was the second effort to compare snow measurement techniques. Table 3 compares the results of the snow depth measurements that were obtained in December 2010 utilizing the previously described standard ATN method, the ADNR method, and the 100 m transect techniques. Data was collected by three agencies (ATN, LCMF, and ADNR) at overlapping sampling sites. LCMF personnel have experience performing the "L" transect measurements from the previous spring season field trips and were accompanied by ATN staff. It is important to note that ADNR did not collect data at the same time as ATN and LCMF, so the resulting differences in depths may be affected by wind and snow events occurring between relative sampling events. Future field efforts will continue collecting data using both ATN and ADNR measurement techniques to strengthen the robustness of results.

Table 3. Average snow depth measured by ATN, LCMF, and ADNR using various techniques. The following snow depth data was obtained December 2-10, 2010. Snow surveys used to compare sampling technique were conducted at each site within a two day period.

Average Snow Depth, December 2010 (cm)						
	Method					
Site	ATN "L"	LCMF "L"	ATN 100m	LCMF 100m	ATN Ruler	ADNR
P Pad	27.9	--	--	--	--	20.3
Betty Pingo	32.0	--	--	--	--	--
ANFO 2	23.7	--	21.8		20.5	21.6
1J	33.3	--	36.1	--	--	29.3
2L	31.9	--	--	--	--	25.9
L9312-Tundra	33.8	35.1	35.0	35.8	--	--
L9312-Lake Surface	11.8	--	--	--	--	--
52 Mile	31.6	--	--	--	--	--
62 mile	32.5	--	--	--	--	--
Sag River DOT	28.4	--	28.9	--	23.7	--
Toolik Lake	17.2	--	--	--	15.7	--

Field observations help explain the data displayed in Table 3. When comparing ATN's to LCMF's "L" transect at L9312, it was noted that the LCMF staff member used greater force when probing through the snow to reach the tundra surface than the ATN member. Also, while the two were measuring snow depth along transects approximately 10 feet apart, LCMF seemed to cross through greater snow drifting than ATN. Both variables, in addition to uneven tundra surface, can likely account for the difference in the resulting snow depth.

Generally, the ruler based approach resulted in lower snow depth averages compared to the standard ATN approach (Figure 3). Ruler-based snow depth readings collected by ATN staff were 12.9% less, on average, than snow depths reported by T-probe measurements. Similarly, ADNR snow depth readings, obtained using the ruler approach, were 16.7% less than the corresponding ATN measurements. Some of this difference may be attributed to the time gap between measurements or to changes in staff. Additional testing will help to confirm the cause for disparity in results.

Transect shape has less influence on the average snow depth (Figure 3). Snow depths reported by ATN staff measured using a T-probe along 100 m straight and 50 m L-shaped transects produced results within 2% of each other.

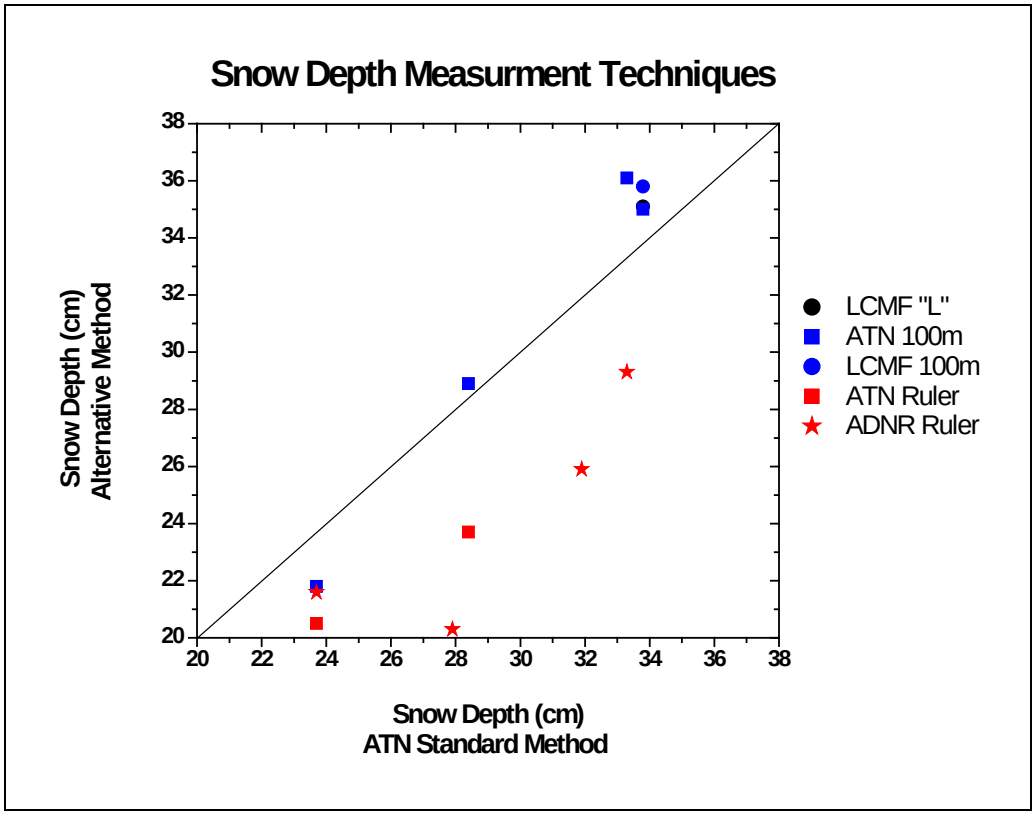

Figure 3. Snow depths obtained by LCMF, ATN, and ADNR staff comparing the standard ATN approach (T-probe along an L-shaped transect) to the ADNR ruler-based method (red) and the T-probe method along a straight 100 m transect (blue).

Ice thickness and water levels were measured at two lakes: L9312 and Toolik Lake. Between November and December, ice thickness decreased 0.05 ft at L9312, and increased 0.35 ft at Toolik Lake. Both lakes had approximately1.8 ft of ice in December. Water levels measured at L9312 were compared to previous sampling dates (Figure 4). The water level of L9312 gradually increased throughout November 2010 and then decreased 0.05 ft from 11/30/10 to 12/8/10. Furthermore, the water level was 0.17 ft higher on 12/8/10 than it was during the same time period the previous year (12/7/09).

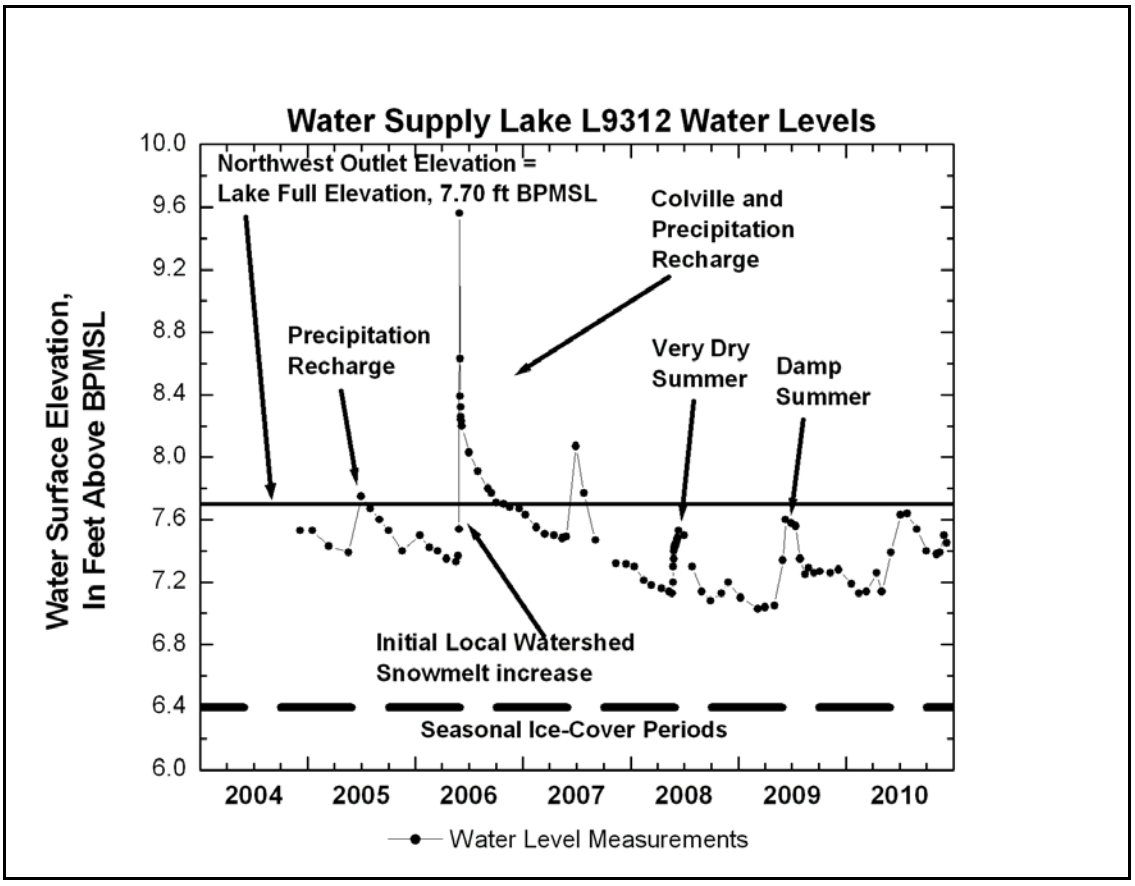

Figure 4. Plot of water levels at L9312 from 2004 through December 2010.

SUMMARY

During the December 2010 ATN trip, objectives focused on snow depth and density measurements as new questions have been raised regarding the accuracy of snow-sampling measurement collection. This is only the second field effort made to address these questions, and as of yet, data is insufficient from the November and December trips alone to draw conclusions about the accuracy of snow-sampling. In addition, lake and ice depth measurements were taken at L9312 and Toolik Lake, a lake level survey and station maintenance was completed at L9312, and at 2L-Pad Met station, a camera was installed to capture changes in snow and tundra conditions. The images are available online with other station data.

The collection of snow and lake information related to Arctic transportation networks will help the development of regulatory and user management tools and forecast modeling tools. These tools will help manage increasing resource development and variation of natural conditions in extreme Arctic climates.

REFERENCES

Alaska Department of Natural Resources. 2009. Winter Off-road Travel Conditions Monitoring Sampling Protocol. Alaska Department of Natural Resources, Division of Mining Land and Water. 4 pages.

Bader, H.R. 2004. Tundra Travel Research Project: Validation Study and Management Recommendations. Betula Consulting. 20 pages.

Derry, J., Lilly, M., Schultz, G., Cherry, J., 2009. Snow Data Collection Methods Related to Tundra Travel, North Slope, Alaska. December 2009, Geo-Watersheds Scientific, Report GWS.TR.09.05, Fairbanks, Alaska, 12 pp (plus appendices).

Murray, J., and Lilly, M. 2010. A Workplan for Snow Data Collection, Lake Observations and Meteorological Station Maintenance: December 2010. Geo-Watersheds Scientific, Fairbanks, Alaska. 13 pages.

APPENDIX A. SNOW SURVEY FORMS

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

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID: **ATN Project** Site Location/Lake ID: **ADNR J-Pad (100m-T)**

Survey Purpose: **Determine Snow Depth and SWE** Date: 12/6/2010 Time: 10:00

Location Description:	East of road before 1J-Pad, near soil thermistors. GWS measures to right (as looking at bore tube from road) and DNR measures to left.				
Survey objective:	Co-located snow survey site with DNR sampling site, tundra travel studies and management			Weather Observations	-10 F, Windy, Cloudy
Latitude:	N 70° 16.260'	Longitude:	W 149° 31.140'	Datum:	NAD83
Elevation:	82 ft	Elevation Datum:	NGVD29	Reference Markers:	Black PVC Pipe
Drainage Basin:	Unnamed stream east of Ugnuravik River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Surface slab, consistent below
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm) at 0.5m increments with T-handle Probe

	1	2	3	4	5	6	7	8
1	26.5	32.0	33.5	55.5	44.0	30.5	27.0	36.5
2	21.0	41.0	33.5	54.0	36.5	40.0	30.0	38.0
3	17.5	35.0	33.5	48.5	33.5	48.0	27.0	37.0
4	23.0	24.5	34.0	56.0	31.0	45.0	30.0	37.0
5	26.5	31.0	34.0	56.0	37.0	47.0	34.0	34.0
6	29.5	31.0	32.5	52.0	35.0	49.5	39.0	38.0
7	27.5	27.0	29.0	49.0	33.0	51.5	40.5	39.0
8	28.0	27.0	32.5	51.5	31.0	44.0	43.0	39.0
9	31.0	31.5	21.0	49.5	32.0	42.0	46.5	39.0
10	35.0	33.0	37.5	51.0	35.0	52.0	45.0	39.0
11	27.0	32.0	34.5	48.0	32.0	54.0	44.5	35.0
12	36.5	32.0	34.5	54.5	34.0	35.5	42.0	35.0
13	34.0	36.0	33.0	50.0	39.0	41.0	42.0	32.5
14	34.0	31.0	35.0	37.0	37.5	29.0	43.5	32.0
15	44.0	36.0	34.5	48.0	38.0	32.5	41.0	31.0
16	43.0	33.5	34.0	39.0	33.0	24.0	40.0	29.5
17	44.0	31.0	37.0	59.0	37.0	25.0	40.0	28.0
18	46.5	28.0	39.5	48.0	34.0	16.0	42.0	28.0
19	38.0	28.0	41.0	47.0	29.0	25.0	41.0	26.0
20	32.0	26.5	37.5	36.5	29.0	27.0	41.0	26.0
21	46.0	27.0	42.0	40.0	23.0	23.5	37.0	24.0
22	44.0	28.0	50.0	40.0	31.0	25.0	35.0	21.5
23	42.0	31.0	54.0	45.0	29.5	26.5	33.0	21.0
24	43.0	28.0	53.5	39.0	26.0	25.0	35.0	21.0
25	40.5	31.5	50.0	35.5	36.0	29.0	36.0	25.0

	(cm)		(inches)
Average snow depth =	**36.1**	Average snow depth =	**14.2**
Maximum snow depth =	59.0	Maximum snow depth =	**23.2**
Minimum snow depth =	16.0	Minimum snow depth =	**6.3**
Standard variation =	8.6	Standard variation =	**3.4**

Data entered by: Jeff Murray Date: 12/08/10

Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**ADNR J-Pad**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 12/6/2010	Time: 10:00

Location Description:	East of road before 1J-Pad, near soil thermistors. GWS measures to right (as looking at bore tube from road) and DNR measures to left.				
Survey objective:	Co-located snow survey site with DNR sampling site, tundra travel studies and management			Weather Observations	-10 F, Windy, Cloudy
Latitude:	N 70° 16.260'	Longitude:	W 149° 31.140'	Datum:	NAD83
Elevation:	82 ft	Elevation Datum:	NGVD29	Reference Markers:	Black PVC Pipe
Drainage Basin:	Unnamed stream east of Ugnuravik River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Surface slab, consistent below
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm)

	1	2	3	4	5
1	26.5	46.0	33.5	38.0	34.5
2	17.5	42.0	28.0	36.5	33.0
3	26.5	40.5	26.5	38.5	37.0
4	27.5	41.0	28.0	42.0	39.0
5	31.0	24.5	28.0	42.0	33.5
6	27.0	31.0	28.0	42.5	35.5
7	34.0	27.0	28.0	48.0	33.0
8	44.0	33.0	18.0	40.5	38.0
9	44.0	32.0	34.5	25.0	18.0
10	38.0	31.0	36.0	38.5	18.0

	(cm)
Average snow depth =	**33.3**
Maximum snow depth =	48.0
Minimum snow depth =	17.5
Standard deviation =	7.5

	(inches)
Average snow depth =	**13.1**
Maximum snow depth =	**18.9**
Minimum snow depth =	**6.9**
Standard deviation =	**3.0**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
A5	18	125.8	642.6	0.20	
A4	48	445.6	1713.6	0.26	
A1	24	221.9	856.8	0.26	
A3	34.5	422.4	1231.7	0.34	
A2	26	189.8	928.2	0.20	

Average Density =	**0.252**	
Average Snow Water Equivalent (SWE) =	**8.4**	cm H2O
Average Snow Water Equivalent =	**3.31**	inches H2O
Average Snow Water Equivalent =	**0.28**	feet H2O

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

Data entered by: Jeff Murray Date: 12/6/10
Data QA/QC by: K. Hilton Date: 12/19/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID: **ATN Project** Site Location/Lake ID: **ADNR J-Pad (Road)**
Survey Purpose: **Determine Snow Depth and SWE** Date: 12/6/2010 Time: 10:00

Location Description:	East of road before 1J-Pad, near soil thermistors. GWS measures to right (as looking at bore tube from road) and DNR measures to left.				
Survey objective:	Co-located snow survey site with DNR sampling site, tundra travel studies and management. Determine if road influences depth.			Weather Observations	-10 F, Windy, Cloudy
Latitude:	N 70° 16.260'	Longitude:	W 149° 31.140'	Datum:	NAD83
Elevation:	82 ft	Elevation Datum:	NGVD29	Reference Markers:	Black PVC Pipe
Drainage Basin:	Unnamed stream east of Ugnuravik River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Surface slab, consistent below
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm)

	1	2	3	4	5	6
1	21.0	37.0	19.0	52.0	19.5	20.0
2	20.0	36.0	18.0	36.0	20.5	22.0
3	20.0	27.5	31.0	41.0	18.5	30.0
4	18.0	28.5	17.0	53.0	19.5	23.0
5	24.0	27.0	36.0	58.0	18.0	18.0
6	20.0	35.5	52.0	66.0	19.0	
7	20.0	35.5	40.0	50.0	20.0	
8	31.0	38.0	47.0	27.0	27.0	
9	32.0	42.0	32.5	Road	23.5	
10	38.0	42.5	40.0	Road	35.0	
11	33.5	38.0	50.0	Road	34.0	
12	30.5	38.0	66.0	29.0	44.0	
13	47.0	34.0	28.0	52.0	43.0	
14	44.0	22.0	49.5	48.5	39.0	
15	21.0	24.5	40.5	53.5	36.0	
16	30.0	23.0	37.0	50.0	30.0	
17	32.0	24.0	33.0	43.5	23.5	
18	34.0	24.0	33.0	34.0	23.0	
19	26.0	20.0	45.0	24.0	23.0	
20	43.0	26.0	37.0	22.0	26.0	
21	46.0	29.0	39.0	33.0	20.0	
22	41.0	34.0	34.0	37.0	19.0	
23	29.5	39.0	34.0	25.0	20.0	
24	34.0	24.0	39.0	24.5	21.5	
25	34.0	19.0	33.0	21.0	20.0	

	(cm)		(inches)
Average snow depth =	**32.3**	Average snow depth =	**12.7**
Maximum snow depth =	66.0	Maximum snow depth =	**26.0**
Minimum snow depth =	17.0	Minimum snow depth =	**6.7**
Standard variation =	10.9	Standard variation =	**4.3**

Data entered by: Jeff Murray Date: 12/08/10
Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**ADNR 2L-Pad**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 12/7/2010	Time: 11:30

Location Description:	West of road between 2L-Pad and 2N-Pad, near soil thermistors. GWS measures to right (as looking at bore tube from road) and DNR measures to left.				
Survey objective:	Co-located snow survey site with DNR sampling site, tundra travel studies and management. Snow depth comparison between ATN personnel.			Weather Observations	-20 F, Cloudy, Wind
Latitude:	N 70° 11.481'	Longitude:	W 150° 19.397'	Datum:	NAD83
Elevation:	112 ft	Elevation Datum:	NGVD29	Reference Markers:	Just northeast of weather station
Drainage Basin:	Miluveach River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	2" surface slab, sintering below
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm)

	1	2	3	4	5
1	49.0	37.0	19.0	35.0	38.0
2	46.0	37.0	14.5	26.0	44.0
3	47.0	35.0	29.0	21.0	38.0
4	47.0	37.0	31.0	25.0	24.0
5	43.0	35.0	21.0	32.0	16.5
6	38.5	36.0	29.0	30.0	26.5
7	23.0	42.0	29.0	38.0	32.0
8	20.0	46.0	38.0	31.0	20.0
9	27.5	28.5	28.0	29.0	29.5
10	35.0	22.5	25.0	39.0	26.0

	(cm)
Average snow depth =	**31.9**
Maximum snow depth =	49.0
Minimum snow depth =	14.5
Standard deviation =	8.6

	(inches)
Average snow depth =	**12.6**
Maximum snow depth =	**19.3**
Minimum snow depth =	**5.7**
Standard deviation =	**3.4**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
2L1	18	130.2	642.6	0.20	
2L2	22	193.7	785.4	0.25	
2L3	18	151.7	642.6	0.24	
2L4	26	192.3	928.2	0.21	
2L5	45	540.8	1606.5	0.34	

Average Density =	**0.246**	
Average Snow Water Equivalent (SWE) =	**7.8**	cm H2O
Average Snow Water Equivalent =	**3.09**	inches H2O
Average Snow Water Equivalent =	**0.26**	feet H2O

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

Data entered by: Jeff Murray Date: 12/15/10
Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**ADNR 52 Mile**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 12/5/2010	Time: 16:15

Location Description:	Off of Dalton Highway, top of ridge, west side of highway.				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations:	10 F, Light wind, Cloudy
Latitude:	N 69° 25.547'	Longitude:	W 148.606'	Datum:	NAD 83
Elevation:	1,090 ft	Elevation Datum:	NGVD29	Reference Markers:	Stakes in ground
Drainage Basin:	Toolik River	Slope Direction:	Ridge Top	Vegetation Type:	Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Sintering to surface, melting
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm)

	1	2	3	4	5
1	38.0	28.0	36.0	29.0	38.0
2	38.0	23.0	36.0	33.5	35.0
3	30.0	35.5	35.0	33.0	52.0
4	34.5	19.5	35.0	29.0	36.0
5	33.0	33.5	36.0	27.0	38.0
6	38.0	31.0	35.0	24.0	33.0
7	35.0	35.0	25.5	25.0	28.0
8	29.0	30.0	26.0	23.0	27.0
9	23.0	33.0	32.0	20.0	23.0
10	25.0	36.0	38.0	34.0	31.0

(cm)

Average snow depth =	**31.6**
Maximum snow depth =	52.0
Minimum snow depth =	19.5
Standard variation =	6.0

(inches)

Average snow depth =	**12.4**
Maximum snow depth =	**20.5**
Minimum snow depth =	**7.7**
Standard variation =	**2.4**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
H1	24	223.1	856.8	0.26	
H2	26	116.3	928.2	0.13	
H5	35	182.4	1249.5	0.15	
H3	30	138.7	1071.0	0.13	
H4	45	463.0	1606.5	0.29	

Average Density =	**0.190**	
Average Snow Water Equivalent (SWE) =	**6.0**	cm H2O
Average Snow Water Equivalent =	**2.36**	inches H2O
Average Snow Water Equivalent =	**0.20**	feet H2O

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

Data entered by: Jeff Murray Date: 12/14/2010

Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID: **ATN Project** Site Location/Lake ID: **ADNR 62 Mile**

Survey Purpose: **Determine Snow Depth and SWE** Date: 12/5/2010 Time: 15:15

Location Description:	Off of Dalton Highway, top of ridge, west side of highway.				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations:	-10 F, Light wind, Cloudy
Latitude:	N 69° 25.320'	Longitude:	W 148° 40.140'	Datum:	NAD 83
Elevation:	1,090 ft	Elevation Datum:	NGVD29	Reference Markers:	Stakes in ground
Drainage Basin:	Toolik River	Slope Direction:	Ridge Top	Vegetation Type:	Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Sintering to surface, melting
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm)

	1	2	3	4	5
1	24.5	40.0	32.0	34.0	31.0
2	26.5	33.0	26.5	35.5	51.0
3	28.0	28.0	38.0	30.0	58.0
4	27.0	39.0	26.0	30.0	25.5
5	23.0	38.5	25.0	31.0	31.0
6	19.0	38.0	21.0	29.5	41.0
7	19.0	33.0	26.0	34.0	53.0
8	14.0	32.0	24.0	36.0	51.0
9	27.0	31.0	33.0	38.5	46.0
10	41.5	28.0	32.5	17.0	47.5

(cm)

Average snow depth = **32.5**

Maximum snow depth = 58.0

Minimum snow depth = 14.0

Standard variation = 9.4

(inches)

Average snow depth = **12.8**

Maximum snow depth = **22.8**

Minimum snow depth = **5.5**

Standard variation = **3.7**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
142	26	152.0	928.2	0.16	
:)	12	74.5	428.4	0.17	
Z3	26	160.2	928.2	0.17	
E1	18	91.7	642.6	0.14	
N4	19	133.4	678.3	0.20	

Average Density = **0.170**

Average Snow Water Equivalent (SWE) = **5.5** cm H2O

Average Snow Water Equivalent = **2.17** inches H2O

Average Snow Water Equivalent = **0.18** feet H2O

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

Data entered by: Jeff Murray Date: 12/5/10

Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**ANFO2 (100m-R)**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 12/6/2010	Time: 16:40

Location Description:	Off road to the North. Near Duck Island gravel pit. Close to PVC pipe.. GWS stays to right (as looking at pipe) and DNR stays left.				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations	Cold, Dark, Breeze
Latitude:	N 70° 14.460'	Longitude:	W 148° 10.800'	Datum:	NAD 83
Elevation:	27 ft.	Elevation Datum:	NGVD29	Reference Markers:	Black PVC pipe
Drainage Basin:	Sagavanirktok River	Slope Direction:	Flat	Vegetation Type:	Upland Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Hard surface layer, consistent below
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (inches) at 1m increments with Ruler

	1	2	3	4
1	8.00	9.75	5.00	8.50
2	12.25	8.00	9.50	7.50
3	12.00	6.50	8.00	7.00
4	9.25	7.00	8.50	5.00
5	7.50	5.25	7.50	6.00
6	10.00	6.75	7.25	8.00
7	7.00	7.50	6.75	7.00
8	5.25	6.75	8.50	5.00
9	5.50	7.50	10.00	5.00
10	6.50	9.00	9.50	7.50
11	10.50	8.50	8.00	7.25
12	15.25	7.00	8.75	7.50
13	11.00	9.50	7.50	7.75
14	12.25	7.50	7.00	6.50
15	10.25	11.75	7.50	5.75
16	7.50	13.25	8.00	5.50
17	7.25	11.00	6.00	9.50
18	8.50	12.00	8.00	6.50
19	7.50	12.50	8.50	6.00
20	7.50	11.00	9.00	6.00
21	7.25	7.50	6.00	7.50
22	8.00	8.75	6.50	7.75
23	8.50	7.00	6.50	6.50
24	10.00	5.00	10.25	8.50
25	8.50	5.75	11.00	8.50

(inches)

Average snow depth =	**8.1**
Maximum snow depth =	15.3
Minimum snow depth =	5.0
Standard variation =	2.0

(cm)

Average snow depth =	**20.5**
Maximum snow depth =	**38.7**
Minimum snow depth =	**12.7**
Standard variation =	**5.1**

Data entered by: Jeff Murray Date: 12/08/10
Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID: **ATN Project** Site Location/Lake ID: **ANFO2 (100m-T)**
Survey Purpose: **Determine Snow Depth and SWE** Date: 12/6/2010 Time: 16:10

Location Description:	Off road to the North. Near Duck Island gravel pit. Close to PVC pipe.. GWS stays to right (as looking at pipe) and DNR stays left.				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations	Cold, Dark, Breeze
Latitude:	N 70° 14.460'	Longitude:	W 148° 10.800'	Datum:	NAD 83
Elevation:	27 ft.	Elevation Datum:	NGVD29	Reference Markers:	Black PVC pipe
Drainage Basin:	Sagavanirktok River	Slope Direction:	Flat	Vegetation Type:	Upland Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Hard surface layer, consistent below
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm) at 1m increments

	1	2	3	4
1	17.0	18.0	17.5	27.0
2	17.0	24.0	23.5	23.0
3	12.5	25.5	21.0	21.0
4	27.0	23.0	29.0	19.5
5	16.0	23.0	33.0	20.0
6	17.0	19.0	30.0	19.5
7	19.0	22.0	28.5	20.0
8	22.0	15.5	36.0	22.0
9	21.0	20.0	31.0	19.0
10	21.0	19.0	21.5	22.0
11	21.0	25.0	26.0	28.0
12	15.5	22.5	19.0	32.0
13	16.0	25.0	15.0	29.0
14	21.5	26.5	24.0	38.0
15	22.0	22.0	22.0	28.0
16	23.0	20.0	20.0	18.0
17	18.0	20.0	20.0	16.0
18	15.0	20.0	15.0	15.0
19	20.5	19.5	13.5	19.0
20	21.0	24.0	15.5	26.0
21	24.0	21.0	21.0	22.0
22	28.0	25.0	16.0	25.0
23	27.0	14.0	21.0	31.0
24	20.0	14.5	28.5	33.0
25	18.0	14.5	21.0	20.0

(cm)
Average snow depth = **21.8**
Maximum snow depth = 38.0
Minimum snow depth = 12.5
Standard variation = 5.1

(inches)
Average snow depth = **8.6**
Maximum snow depth = **15.0**
Minimum snow depth = **4.9**
Standard variation = **2.0**

Data entered by: Jeff Murray Date: 12/08/10
Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**ANFO2**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 12/6/2010	Time: 16:30

Location Description:	Off road to the North. Near Duck Island gravel pit. Close to PVC pipe.. GWS stays to right (as looking at pipe) and DNR stays left.				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations	Cold, Dark, Breeze
Latitude:	N 70° 14.460'	Longitude:	W 148° 10.800'	Datum:	NAD 83
Elevation:	27 ft.	Elevation Datum:	NGVD29	Reference Markers:	Black PVC pipe
Drainage Basin:	Sagavanirktok River	Slope Direction:	Flat	Vegetation Type:	Upland Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Hard surface layer, consistent below
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm)

	1	2	3	4	5
1	17.0	21.0	24.0	20.0	34.5
2	17.0	15.5	28.0	23.0	36.0
3	12.5	16.0	27.0	17.0	37.0
4	27.0	21.5	20.0	16.5	41.0
5	16.0	22.0	18.0	18.0	40.0
6	17.0	23.0	20.0	17.0	41.0
7	19.0	18.0	20.0	17.0	44.0
8	22.0	15.0	20.0	19.5	42.5
9	21.0	20.5	18.0	25.0	37.5
10	21.0	21.0	20.0	30.0	30.5

(cm)

Average snow depth =	**23.7**
Maximum snow depth =	44.0
Minimum snow depth =	12.5
Standard deviation =	8.3

(inches)

Average snow depth =	**9.3**
Maximum snow depth =	**17.3**
Minimum snow depth =	**4.9**
Standard deviation =	**3.3**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
P5	18	149.7	642.6	0.23	
P4	30	308.9	1071.0	0.29	
P3	30	345.1	1071.0	0.32	
P1	14	110.1	499.8	0.22	
P2	31	242.3	1106.7	0.22	

Average Density = **0.257**

Average Snow Water Equivalent (SWE) = **6.1** cm H2O

Average Snow Water Equivalent = **2.39** inches H2O

Average Snow Water Equivalent = **0.20** feet H2O

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

Data entered by: Jeff Murray Date: 12/8/2010

Data QA/QC by: K. Hilton Date: 12/19/2010

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**Betty Pingo**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 12/9/2010	Time: 22:15

Location Description:	Near Wyoming gage. At staked snow site. Started east and then went north. Point of beginning is flagged rebar. Vertical snow gauge = 0.2'. Snow Depth under Judd sensor = 26 cm - center, 24, 24, 28, 27, average= 25.8cm . Wyoming Gauge = 31-1/2".				
Survey objective:	SWE and tundra travel studies and management			Weather Observations .	Cold, Dark, Breeze
Latitude:	N 70° 16.772'	Longitude:	W 148° 53.741'	Datum:	NAD83
Elevation:	34 ft.	Elevation Datum:	NVGD27	Reference Markers:	Re-bar and lathe
Drainage Basin:	Kuparuk River	Slope Direction:	Flat	Vegetation Type:	Lowland Moist Sedge-Shrub Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Soft, consistent
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm)

	1	2	3	4	5
1	38.0	48.0	25.5	35.0	15.0
2	45.0	50.5	22.0	34.0	14.0
3	44.0	47.5	20.5	30.0	15.0
4	43.0	41.0	33.0	28.0	12.0
5	38.0	40.5	44.5	25.0	15.0
6	43.0	41.0	48.5	21.0	14.0
7	45.0	40.5	51.0	21.0	16.0
8	48.0	35.0	46.0	18.0	15.5
9	40.5	30.0	47.0	18.0	14.0
10	41.5	28.5	39.0	16.0	19.0

	(cm)
Average snow depth =	**32.0**
Maximum snow depth =	51.0
Minimum snow depth =	12.0
Standard variation =	12.6
	(inches)
Average snow depth =	**12.6**
Maximum snow depth =	**20.1**
Minimum snow depth =	**4.7**
Standard variation =	**5.0**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
P5	38	413.1	1356.6	0.30	
P3	40	426.3	1428.0	0.30	
P4	21	139.3	749.7	0.19	
P2	18	182.7	642.6	0.28	
P1	16	173.9	571.2	0.30	

Average Density = **0.276**

Average Snow Water Equivalent (SWE) = **8.8** cm H2O

Average Snow Water Equivalent = **3.47** inches H2O

Average Snow Water Equivalent = **0.29** feet H2O

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

Data entered by: Jeff Murray Date: 12/15/10

Data QA/QC by: K. Hilton Date: 12/19/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID: **ATN** Site Location/Lake ID: **L9312 - Lake Surface**

Survey Purpose: **Determine snow depth, SWE** Date: 12/8/2010 Time: 10:45

Location Description:	On lake surface ~150 yards east from L9312 pumphouse.				
Survey objective:	Determine snow depth and density for application to lake recharge studies, and tundra travel management.			Weather Observations:	Cold, Clear, Windy
Latitude:	N 70° 19.995'	Longitude:	W 150° 56.918'	Datum:	NAD 83
Elevation:	7 ft	Elevation Datum:	BPMSL	Reference Markers:	Lathe
Drainage Basin:	Colville Basin	Slope Direction:	Flat	Vegetation Type:	None, Ice surface
Slope Angle:	Flat	Access Notes:	Snow Machine	Other:	Packed snow, Areas of bare ice
Snow Depth Probe Type:		T- probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray., Jeff Derry	

Snow Course Depths (cm)

	1	2	3	4	5
1	26.0	12.5	7.0	11.0	18.5
2	21.0	10.0	10.0	7.5	18.0
3	22.0	13.0	10.0	7.5	16.5
4	20.0	13.0	2.0	7.5	11.0
5	14.0	14.5	2.0	6.0	9.0
6	19.5	12.5	3.0	12.0	12.5
7	18.0	9.5	6.0	11.0	12.0
8	21.0	9.0	6.5	10.0	13.5
9	19.0	2.0	3.0	15.0	15.0
10	13.0	8.0	6.0	15.0	7.0

(cm)

Average snow depth = **11.8**

Maximum snow depth = 26.0

Minimum snow depth = 2.0

Standard variation = 5.7

(inches)

Average snow depth = **4.6**

Maximum snow depth = **10.2**

Minimum snow depth = **0.8**

Standard variation = **2.2**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
A	26	263.1	928.2	0.28	
B	7	66.7	249.9	0.27	
C	12	132.3	428.4	0.31	
D	26.5	381.0	946.1	0.40	
E	9	82.8	321.3	0.26	

Average Density = **0.304**

Average Snow Water Equivalent (SWE) = **3.6** cm H2O

Average Snow Water Equivalent = **1.41** inches H2O

Average Snow Water Equivalent = **0.12** feet H2O

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

Data entered by: Jeff Derry Date: 12/8/10

Data QA/QC by: Date:

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN**	Site Location/Lake ID:	**L9312-Tundra (100m)-JD**
Survey Purpose:	**Determine snow depth, SWE**	Date: 12/8/2010	Time: 9:00

Location Description:	On tundra on staked course, adjacent and north of L9312 weather station.				
Survey objective:	Determine snow depth and density for application to lake recharge studies, and tundra travel management.			Weather Observations:	Cold, Dark, Calm
Latitude:	N 70° 19.995'	Longitude:	W 150° 56.918'	Datum:	NAD 83
Elevation:	7 ft	Elevation Datum:	BPMSL	Reference Markers:	Orange stakes
Drainage Basin:	Colville River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Snow Machine	Other:	Hard surface slab, consistent below
Snow Depth Probe Type:		T-probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry, Jack (LCMF)	

Snow Course Depths (cm) at 0.5m increments with T-handle Probe

	1	2	3	4	5	6	7	8
1	22.0	37.0	65.5	20.0	35.0	32.0	26.5	43.0
2	24.0	38.0	64.5	22.0	32.5	35.0	24.0	38.0
3	21.0	38.0	59.5	26.5	33.0	34.0	25.0	37.5
4	17.0	41.5	56.0	28.0	20.0	37.0	19.0	41.5
5	9.5	39.0	50..5	25.0	15.0	38.0	18.0	15.5
6	16.5	37.0	47.5	24.0	16.0	39.5	16.0	18.0
7	37.5	37.0	48.0	28.0	20.5	42.0	21.0	24.5
8	44.0	31.0	49.0	23.5	22.0	41.5	28.0	31.0
9	49.0	25.0	46.5	22.0	21.0	41.0	34.0	27.0
10	53.0	20.0	46.0	25.0	21.0	35.0	37.0	28.0
11	52.0	15.0	51.5	19.0	19.5	32.0	42.0	27.5
12	55.0	26.0	54.0	27.0	25.0	30.0	40.0	26.0
13	50.5	32.0	58.0	30.5	22.0	32.0	39.0	30.0
14	51.5	40.0	54.0	32.0	19.0	29.0	39.5	25.5
15	47.5	43.5	48.5	26.5	31.5	27.0	42.5	24.5
16	45.5	47.5	44.5	27.0	47.0	31.5	41.0	24.0
17	43.5	52.0	42.0	34.5	34.0	35.0	43.0	25.5
18	41.0	51.0	31.0	38.0	20.0	29.5	45.0	25.5
19	32.0	69.5	24.0	37.5	17.0	40.0	41.0	28.0
20	25.0	74.0	24.5	36.5	41.0	40.0	48.0	29.0
21	18.0	72.0	23.0	34.0	22.5	44.0	54.0	31.0
22	15.0	75.0	26.0	39.0	27.0	42.5	53.5	31.5
23	17.5	73.5	17.5	36.0	33.5	40.0	52.0	32.0
24	21.0	71.5	14.5	44.5	35.0	37.0	50.5	33.0
25	30.0	67.0	20.0	36.0	32.0	29.5	47.0	33.0

	(cm)		(inches)
Average snow depth =	**35.0**	Average snow depth =	**13.8**
Maximum snow depth =	75.0	Maximum snow depth =	**29.5**
Minimum snow depth =	9.5	Minimum snow depth =	**3.7**
Standard variation =	13.2	Standard variation =	**5.2**

Data entered by: Jeff Murray Date: 12/08/10

Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN**	Site Location/Lake ID:	**L9312-Tundra (100m)-JM**
Survey Purpose:	**Determine snow depth, SWE**	Date: 12/8/2010	Time: 9:00

Location Description:	On tundra on staked course, adjacent and north of L9312 weather station.				
Survey objective:	Determine snow depth and density for application to lake recharge studies, and tundra travel management.			Weather Observations:	Cold, Dark, Calm
Latitude:	N 70° 19.995'	Longitude:	W 150° 56.918'	Datum:	NAD 83
Elevation:	7 ft	Elevation Datum:	BPMSL	Reference Markers:	Orange stakes
Drainage Basin:	Colville River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Snow Machine	Other:	Hard surface slab, consistent below
Snow Depth Probe Type:		T-probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry, Jack (LCMF)	

Snow Course Depths (cm) at 0.5m increments with T-handle Probe

	1	2	3	4	5	6	7	8
1	24.5	42.0	56.0	27.0	30.0	33.0	25.0	32.0
2	45.0	40.0	51.5	26.0	19.0	34.0	17.0	28.0
3	14.0	36.5	48.0	24.0	16.0	37.5	22.0	21.0
4	22.0	40.0	49.0	26.5	15.0	36.0	19.0	17.0
5	40.0	35.0	47.5	26.0	19.5	40.0	18.0	16.0
6	47.5	30.5	47.0	25.0	22.5	39.5	24.0	14.0
7	52.0	22.0	47.0	23.0	21.5	39.5	21.0	24.5
8	51.5	13.0	49.0	24.0	21.5	37.0	24.0	23.0
9	52.0	25.0	53.0	28.0	21.0	28.0	26.0	24.5
10	52.0	34.0	55.5	30.0	22.0	31.0	42.0	24.0
11	52.0	38.0	57.0	32.0	23.0	29.0	38.0	27.0
12	49.0	43.0	52.0	35.0	14.0	29.0	38.0	30.0
13	47.0	48.0	47.5	33.0	34.0	28.0	41.5	29.0
14	44.0	51.0	41.5	31.0	49.0	30.0	46.0	29.0
15	43.0	62.0	51.0	36.0	32.5	29.0	44.0	29.0
16	27.0	69.0	26.0	42.0	19.0	32.0	45.0	28.5
17	25.5	72.5	26.0	41.0	19.5	37.0	39.0	28.0
18	18.0	71.0	29.0	38.0	20.0	41.0	43.0	25.0
19	15.0	74.0	27.0	39.0	25.0	43.0	48.0	28.0
20	21.0	73.0	24.0	43.0	26.0	44.0	47.0	29.0
21	23.0	68.5	15.0	48.0	32.0	41.0	45.0	23.0
22	32.0	65.0	23.0	43.0	37.0	38.0	41.0	22.0
23	37.5	65.5	23.0	40.0	33.5	33.0	40.0	32.0
24	39.0	67.0	22.0	36.0	31.0	30.5	35.0	33.0
25	39.0	57.0	28.0	34.0	24.0	24.0	41.0	35.0

	(cm)		(inches)
Average snow depth =	**35.0**	Average snow depth =	**13.8**
Maximum snow depth =	74.0	Maximum snow depth =	**29.1**
Minimum snow depth =	13.0	Minimum snow depth =	**5.1**
Standard variation =	13.0	Standard variation =	**5.1**

Data entered by: Jeff Murray Date: 12/08/10

Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN**	Site Location/Lake ID:	**L9312-Tundra (100m)-LCMF**
Survey Purpose:	**Determine snow depth, SWE**	Date: 12/8/2010	Time: 9:00

Location Description:	On tundra on staked course, adjacent and north of L9312 weather station.				
Survey objective:	Determine snow depth and density for application to lake recharge studies, and tundra travel management.			Weather Observations:	Cold, Dark, Calm
Latitude:	N 70° 19.995'	Longitude:	W 150° 56.918'	Datum:	NAD 83
Elevation:	7 ft	Elevation Datum:	BPMSL	Reference Markers:	Orange stakes
Drainage Basin:	Colville River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Snow Machine	Other:	Hard surface slab, consistent below
Snow Depth Probe Type:		T-probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry, Jack (LCMF)	

Snow Course Depths (cm) at 0.5m increments with T-handle Probe

	1	2	3	4	5	6	7	8
1	25.0	39.0	65.0	22.0	36.0	32.0	27.0	45.0
2	26.0	40.0	66.0	23.0	34.0	35.0	25.0	42.0
3	21.0	41.0	60.0	28.0	26.0	34.0	25.0	42.0
4	17.0	43.0	56.0	29.0	19.0	35.0	18.0	32.0
5	9.0	39.0	51.0	26.0	15.0	38.0	18.0	20.0
6	16.0	39.0	49.0	24.0	18.0	39.5	17.0	19.0
7	37.0	37.0	49.0	27.0	21.0	42.0	22.0	26.0
8	45.0	34.0	49.0	28.0	25.0	42.0	26.0	32.0
9	49.0	26.0	46.0	24.0	23.0	39.0	37.0	31.0
10	52.0	21.0	46.5	20.0	24.0	36.0	37.0	30.0
11	53.0	13.0	51.0	24.0	21.0	35.0	42.0	30.0
12	51.0	30.0	55.0	27.0	25.0	29.0	41.0	31.0
13	51.0	37.0	58.0	32.0	26.0	33.0	40.0	31.0
14	51.0	42.0	55.0	32.0	20.0	30.0	39.0	26.0
15	49.0	44.5	50.0	34.0	24.0	27.0	41.0	26.0
16	46.0	48.0	44.0	28.0	29.0	29.0	41.0	27.0
17	44.5	52.0	41.0	39.0	36.0	32.0	44.0	26.0
18	41.0	61.0	31.0	42.0	21.0	32.0	44.0	27.0
19	31.0	71.0	26.0	41.0	18.0	40.0	45.0	28.0
20	30.0	74.0	26.0	37.0	22.0	41.0	48.0	30.0
21	19.0	71.0	24.0	37.0	24.0	44.0	53.0	32.0
22	15.0	74.0	30.0	41.0	28.0	44.0	53.0	33.0
23	19.0	74.0	20.0	50.0	34.0	40.0	52.0	33.0
24	23.0	71.0	16.0	45.0	36.0	38.0	50.0	33.0
25	32.0	67.0	22.0	40.0	32.0	32.0	46.0	33.0

	(cm)		(inches)
Average snow depth =	**35.8**	Average snow depth =	**14.1**
Maximum snow depth =	74.0	Maximum snow depth =	**29.1**
Minimum snow depth =	9.0	Minimum snow depth =	**3.5**
Standard variation =	13.0	Standard variation =	**5.1**

Data entered by: Jeff Murray Date: 12/08/10

Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN**	Site Location/Lake ID:	**L9312 - Tundra-JD**
Survey Purpose:	**Determine snow depth, SWE**	Date: 12/8/2010	Time: 10:00

Location Description:	On tundra on staked course, adjacent and north of L9312 weather station.				
Survey objective:	Determine snow depth and density for application to lake recharge studies, and tundra travel management.			Weather Observations	Cold, Dark, Calm
Latitude:	N 70° 19.995'	Longitude:	W 150° 56.918'	Datum:	NAD 83
Elevation:	7 ft	Elevation Datum:	BPMSL	Reference Markers:	Orange stakes
Drainage Basin:	Colville River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Snow Machine	Other:	Hard surface layer, consistent throughout
Snow Depth Probe Type:		T-probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm)

	1	2	3	4	5
1	22.0	18.0	47.5	33.0	23.5
2	21.0	17.5	51.0	33.5	25.0
3	9.5	30.0	74.0	36.0	26.0
4	37.5	38.0	75.0	29.0	27.0
5	49.0	41.5	71.5	27.0	31.0
6	52.0	37.0	26.5	18.0	31.0
7	50.5	31.0	27.5	19.0	27.0
8	47.5	20.0	23.5	18.0	33.0
9	43.5	26.0	33.5	20.5	31.5
10	32.0	40.0	36.0	22.5	51.0

(cm)	
Average snow depth =	**33.8**
Maximum snow depth =	75.0
Minimum snow depth =	9.5
Standard variation =	14.4

(inches)	
Average snow depth =	**13.3**
Maximum snow depth =	**29.5**
Minimum snow depth =	**3.7**
Standard variation =	**5.7**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
.	13	123.1	464.1	0.27	
\\	22	207.9	785.4	0.26	
!	38	391.5	1356.6	0.29	
?	54	515.1	1927.8	0.27	
:	26	205.5	928.2	0.22	

Average Density =	**0.261**	
Average Snow Water Equivalent (SWE) =	**8.8**	cm H2O
Average Snow Water Equivalent =	**3.48**	inches H2O
Average Snow Water Equivalent =	**0.29**	feet H2O

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

Data entered by: Jeff Murray Date: 12/8/10

Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID:	**ATN**	Site Location/Lake ID:	**L9312 - Tundra-JM**
Survey Purpose:	**Determine snow depth, SWE**	Date: 12/8/2010	Time: 10:00

Location Description:	On tundra on staked course, adjacent and north of L9312 weather station.				
Survey objective:	Determine snow depth and density for application to lake recharge studies, and tundra travel management.			Weather Observations	Cold, Dark, Calm
Latitude:	N 70° 19.995'	Longitude:	W 150° 56.918'	Datum:	NAD 83
Elevation:	7 ft	Elevation Datum:	BPMSL	Reference Markers:	Orange stakes
Drainage Basin:	Colville River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Snow Machine	Other:	Hard surface layer, consistent throughout
Snow Depth Probe Type:		T-probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm)

	1	2	3	4	5
1	24.5	23.0	69.0	23.0	25.0
2	14.0	37.5	71.0	23.5	38.5
3	40.0	39.0	73.0	26.0	22.0
4	52.0	40.0	65.0	28.0	28.0
5	52.0	40.0	67.0	24.0	24.0
6	52.0	30.5	24.0	23.0	14.0
7	47.0	13.0	22.0	20.0	16.5
8	43.0	34.0	58.0	17.0	23.5
9	25.5	43.0	24.5	14.0	24.0
10	15.0	51.0	26.0	16.5	36.5

	(cm)
Average snow depth =	**33.7**
Maximum snow depth =	73.0
Minimum snow depth =	13.0
Standard variation =	16.5

	(inches)
Average snow depth =	**13.2**
Maximum snow depth =	**28.7**
Minimum snow depth =	**5.1**
Standard variation =	**6.5**

Data entered by: Jeff Murray Date: 12/8/10

Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID: **ATN** Site Location/Lake ID: **L9312 - Tundra (LCMF)**

Survey Purpose: **Determine snow depth, SWE** Date: 12/8/2010 Time: 9:30

Location Description:	On tundra on staked course, adjacent and north of L9312 weather station.				
Survey objective:	Determine snow depth and density for application to lake recharge studies, and tundra travel management.			Weather Observations:	Cold, Dark, Calm
Latitude:	N 70° 19.995'	Longitude:	W 150° 56.918'	Datum:	NAD 83
Elevation:	7 ft	Elevation Datum:	BPMSL	Reference Markers:	Orange stakes
Drainage Basin:	Colville River	Slope Direction:	Flat	Vegetation Type:	Lowland Wet Sedge Tundra
Slope Angle:	Flat	Access Notes:	Snow Machine	Other:	Hard surface slab. Consistent below
Snow Depth Probe Type:		T-probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry, Jack (LCMF)	

Snow Course Depths (cm)

	1	2	3	4	5
1	25.0	19.0	48.0	34.0	25.0
2	21.0	19.0	61.0	36.0	26.0
3	9.0	32.0	74.0	35.0	27.0
4	37.0	40.0	74.0	30.0	31.0
5	49.0	43.0	71.0	27.0	32.0
6	53.0	39.0	26.0	20.0	30.0
7	51.0	34.0	30.0	20.0	28.0
8	49.0	21.0	24.0	19.0	33.0
9	44.5	30.0	32.0	22.0	34.0
10	31.0	42.0	36.0	24.0	57.0

(cm)

Average snow depth = **35.1**

Maximum snow depth = 74.0

Minimum snow depth = 9.0

Standard variation = 14.5

(inches)

Average snow depth = **13.8**

Maximum snow depth = **29.1**

Minimum snow depth = **3.5**

Standard variation = **5.7**

Data entered by: Jeff Murray Date: 12/08/10

Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**ADNR P-Pad**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 12/9/2010	Time: 21:36

Location Description:	On access road to P-Pad, north side, near Betty Pingo, near soil thermistors. GWS measurements on right (as looking at sensor pipe from road) and DNR measurements on left.				
Survey objective:	Co-located snow survey site with DNR sampling site, tundra travel studies and management			Weather Observations	Cold, Dark, Breeze
Latitude:	N 70° 16.967'	Longitude:	W 148° 54.807'	Datum:	NAD83
Elevation:	33 ft.	Elevation Datum:	NGVD29	Reference Markers:	none
Drainage Basin:	Kuparuk River	Slope Direction:	Flat	Vegetation Type:	Lowland Moist Sedge-Shrub Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Surface slab, consistent below
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm)

	1	2	3	4	5
1	33.0	28.5	34.0	26.5	24.0
2	36.0	22.0	36.0	37.0	25.0
3	33.0	20.0	39.0	38.0	25.0
4	32.0	17.0	40.0	30.0	30.0
5	22.0	12.0	38.5	23.5	28.0
6	22.0	11.0	42.0	13.5	30.5
7	33.0	17.5	32.0	16.0	32.0
8	26.0	16.0	39.0	17.0	31.0
9	25.0	39.0	23.5	25.0	25.0
10	42.0	29.0	23.0	26.0	31.0

	(cm)
Average snow depth =	**27.9**
Maximum snow depth =	42.0
Minimum snow depth =	11.0
Standard variation =	8.1

	(inches)
Average snow depth =	**11.0**
Maximum snow depth =	**16.5**
Minimum snow depth =	**4.3**
Standard variation =	**3.2**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
31	31	332.9	1106.7	0.30	
32	32	283.6	1142.4	0.25	
36	36	281.6	1285.2	0.22	
24	24	180.5	856.8	0.21	
13	13	66.0	464.1	0.14	

Average Density =	**0.224**	
Average Snow Water Equivalent (SWE) =	**6.3**	cm H2O
Average Snow Water Equivalent =	**2.47**	inches H2O
Average Snow Water Equivalent =	**0.21**	feet H2O

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

Data entered by: Jeff Murray Date: 12/15/10
Data QA/QC by: K. Hilton Date: 12/19/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID: **ATN Project** Site Location/Lake ID: **Sag River DOT (100m - R)**

Survey Purpose: **Determine Snow Depth and SWE** Date: 12/5/2010 Time: 13:15

Location Description:	On Road to DOT garage. Near PVC pipe. GWS stays to right (as looking at pipe) and DNR stays left.				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations	-10 F, Calm, Dusk
Latitude:	N 68° 45.686'	Longitude:	W 148° 52.746'	Datum:	NAD 83
Elevation:	1640 ft.	Elevation Datum:	NGVD29	Reference Markers:	Black PVC pipe
Drainage Basin:	Kuparuk River	Slope Direction:	Flat	Vegetation Type:	Upland Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Fluffy surface, 2 slabs below
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (inches) at 0.5m increments with Ruler

	1	2	3	4	5	6	7	8
1	9.50	10.50	10.50	10.00	9.25	17.25	8.50	9.00
2	8.75	9.25	10.75	10.50	7.00	15.50	7.75	7.50
3	8.00	7.75	10.25	9.50	11.00	14.50	9.00	8.00
4	7.50	8.75	10.25	8.00	8.50	16.50	7.00	5.75
5	9.50	8.00	10.75	11.00	7.50	14.50	7.25	7.50
6	9.50	8.00	11.00	11.00	7.00	12.50	6.50	7.50
7	9.00	8.50	11.50	8.75	6.50	11.50	7.25	6.50
8	7.00	7.75	10.25	7.75	9.00	12.50	8.50	8.00
9	8.75	10.00	10.50	11.25	8.00	11.00	7.50	5.00
10	12.00	6.00	10.25	11.00	9.75	11.00	6.25	7.00
11	10.50	6.50	10.50	8.50	9.75	11.00	7.00	9.00
12	10.25	9.25	12.00	9.50	10.50	9.75	7.50	7.00
13	10.50	7.75	12.00	8.00	8.00	10.00	7.50	9.75
14	11.50	10.00	9.00	12.00	8.00	10.50	9.50	8.25
15	9.75	7.50	8.75	9.50	9.25	9.50	7.00	9.50
16	11.00	10.25	9.50	10.25	7.00	11.00	7.25	9.00
17	9.50	9.25	11.00	10.50	7.50	9.70	6.50	8.25
18	10.50	8.00	11.25	9.50	7.75	10.00	8.75	6.25
19	10.00	8.00	11.75	7.50	9.00	12.00	7.25	8.50
20	8.25	8.75	9.50	9.50	9.50	10.00	7.50	6.50
21	7.50	8.75	6.00	10.50	11.00	12.00	8.50	6.75
22	10.75	8.25	11.00	10.75	14.00	9.50	8.75	7.00
23	8.75	6.75	10.25	9.50	17.00	9.75	9.00	6.50
24	9.00	8.00	10.50	7.50	17.25	12.50	8.50	6.00
25	7.75	7.50	12.50	7.50	16.00	9.75	9.00	7.25

	(inches)		(cm)
Average snow depth =	**9.3**	Average snow depth =	**23.7**
Maximum snow depth =	17.3	Maximum snow depth =	**43.8**
Minimum snow depth =	5.0	Minimum snow depth =	**12.7**
Standard variation =	2.1	Standard variation =	**5.4**

Data entered by: Jeff Murray Date: 12/08/10

Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID: **ATN Project** Site Location/Lake ID: **Sag River DOT (100m - T)**
Survey Purpose: **Determine Snow Depth and SWE** Date: 12/5/2010 Time: 12:45

Location Description:	On Road to DOT garage. Near PVC pipe. GWS stays to right (as looking at pipe) and DNR stays left.				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations	-10 F, Calm, Dusk
Latitude:	N 68° 45.686'	Longitude:	W 148° 52.746'	Datum:	NAD 83
Elevation:	1640 ft.	Elevation Datum:	NGVD29	Reference Markers:	Black PVC pipe
Drainage Basin:	Kuparuk River	Slope Direction:	Flat	Vegetation Type:	Upland Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Fluffy surface, 2 slabs below
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm) at 0.5m increments with T-handle Probe

	1	2	3	4	5	6	7	8
1	26.0	27.0	28.5	44.5	21.5	35.0	30.5	23.0
2	22.0	31.0	29.0	43.0	20.0	31.0	30.5	23.5
3	19.5	23.5	33.5	47.0	19.0	30.0	31.5	27.0
4	20.0	35.5	27.5	52.5	34.5	27.0	34.5	34.0
5	24.0	31.5	26.5	47.0	28.5	38.0	32.0	23.5
6	19.0	29.5	38.0	44.5	27.0	29.5	24.0	25.5
7	23.0	24.0	28.5	42.0	25.0	29.0	26.5	37.0
8	23.0	19.0	33.5	40.0	19.0	31.5	23.0	30.0
9	21.0	23.0	25.5	39.0	27.5	32.0	24.0	31.5
10	26.0	20.0	25.0	23.5	28.0	30.5	25.0	33.0
11	26.5	19.0	34.0	19.0	25.0	27.5	37.0	28.0
12	26.0	26.0	26.0	33.0	32.5	26.5	26.5	32.0
13	23.0	26.0	37.0	28.0	26.0	25.5	29.5	28.5
14	30.0	19.0	29.5	34.0	30.0	36.5	22.0	36.0
15	21.0	21.0	30.0	29.5	31.0	32.5	32.5	30.5
16	29.0	21.0	31.5	37.0	29.5	36.0	21.0	29.0
17	22.0	16.5	35.0	27.0	36.0	33.0	30.0	23.0
18	22.0	21.5	33.5	31.5	23.0	41.0	29.0	28.5
19	22.5	25.0	41.0	31.0	27.5	36.0	32.0	32.0
20	23.5	22.0	34.0	27.0	38.0	40.5	25.0	27.0
21	23.5	21.5	25.0	24.0	34.0	33.0	24.5	24.0
22	26.0	20.0	37.0	20.0	25.0	30.0	28.5	25.5
23	20.5	20.0	45.5	24.0	25.5	29.0	32.5	37.0
24	25.0	23.0	38.5	32.5	31.5	33.0	32.0	28.5
25	24.0	24.5	44.0	19.5	28.5	37.0	27.0	27.5

	(cm)		(inches)
Average snow depth =	**28.9**	Average snow depth =	**11.4**
Maximum snow depth =	52.5	Maximum snow depth =	**20.7**
Minimum snow depth =	16.5	Minimum snow depth =	**6.5**
Standard variation =	6.5	Standard variation =	**2.5**

Data entered by: Jeff Murray Date: 12/08/10
Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID: **ATN Project** Site Location/Lake ID: **Sag River DOT (L)**
Survey Purpose: **Determine Snow Depth and SWE** Date: 12/5/2010 Time: 13:45

Location Description:	On Road to DOT garage. Near PVC pipe. GWS stays to right (as looking at pipe) and DNR stays left.				
Survey objective:	SWE and Tundra Travel (Co-located snow survey site with DNR sampling site)			Weather Observations	-10 F, Calm, Dusk
Latitude:	N 68° 45.686'	Longitude:	W 148° 52.746'	Datum:	NAD 83
Elevation:	1640 ft.	Elevation Datum:	NGVD29	Reference Markers:	Black PVC pipe
Drainage Basin:	Kuparuk River	Slope Direction:	Flat	Vegetation Type:	Upland Tussock Tundra
Slope Angle:	Flat	Access Notes:	Truck	Other:	Fluffy surface, 2 slabs below
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm)

	1	2	3	4	5
1	26.0	23.5	21.0	32.0	22.0
2	19.5	20.5	21.5	39.5	43.0
3	24.0	24.0	22.0	40.0	22.0
4	23.0	31.0	20.0	46.5	38.0
5	21.0	35.5	23.0	38.0	33.5
6	26.5	29.5	32.0	37.0	34.0
7	23.0	19.0	36.0	44.0	28.5
8	21.0	20.0	29.0	36.5	23.0
9	22.0	26.0	32.0	32.0	20.0
10	22.5	19.0	39.5	33.0	27.0

(cm)
Average snow depth = **28.4**
Maximum snow depth = 46.5
Minimum snow depth = 19.0
Standard deviation = 7.7

(inches)
Average snow depth = **11.2**
Maximum snow depth = **18.3**
Minimum snow depth = **7.5**
Standard deviation = **3.0**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
K1	20	117.1	714.0	0.16	
K5	18	122.8	642.6	0.19	
K4	20	112.3	714.0	0.16	
K2	20	118.0	714.0	0.17	
K3	21	103.0	749.7	0.14	

Average Density = **0.163**
Average Snow Water Equivalent (SWE) = **4.6** cm H2O
Average Snow Water Equivalent = **1.83** inches H2O
Average Snow Water Equivalent = **0.15** feet H2O

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

Data entered by: Jeff Murray Date: 12/14/2010
Data QA/QC by: Kristie Hilton Date: 12/19/2010

Arctic Transportation Networks Project
Form F-012: Snow Survey Form

Project ID:	**ATN Project**	Site Location/Lake ID:	**Toolik Lake Site 4**
Survey Purpose:	**Determine Snow Depth and SWE**	Date: 12/5/2010	Time: 10:10

Location Description:	Toolik Lake. Site #4. Near center of lake.				
Survey objective:	SWE and tundra travel studies and management. Standard L-Transect			Weather Observations:	-8 F, Calm, Clear, Dark
Latitude:	N 68° 37.926'	Longitude:	W 149° 36.670'	Datum:	NAD 83
Elevation:	2500 ft.	Elevation Datum:	NGVD27	Reference Markers:	none
Drainage Basin:	Toolik Lake	Slope Direction:	none	Vegetation Type:	None. Lake Ice
Slope Angle:	none	Access Notes:	Snow Machine	Other:	Soft, consistent throughout
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (cm)

	1	2	3	4	5
1	15.0	12.5	16.0	15.0	22.0
2	14.5	12.5	16.5	13.5	27.5
3	15.0	16.5	17.0	14.5	20.0
4	13.5	16.0	16.5	15.0	26.0
5	13.0	15.0	16.5	15.5	25.0
6	13.0	16.0	14.5	16.0	21.0
7	16.0	16.5	14.5	18.5	28.0
8	15.0	13.5	15.0	18.0	27.0
9	14.0	13.0	16.0	17.5	24.5
10	13.0	14.0	14.0	22.0	29.5

(cm)

Average snow depth =	**17.2**
Maximum snow depth =	29.5
Minimum snow depth =	12.5
Standard deviation =	4.5

(inches)

Average snow depth =	**6.8**
Maximum snow depth =	**11.6**
Minimum snow depth =	**4.9**
Standard deviation =	**1.8**

Snow Sample Depths and Weights

Bag #	Snow Depth (cm)	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Organic Plug (cm)
F3	14	100.7	499.8	0.20	
P4	12	79.1	428.4	0.18	
8Q	15	85.6	535.5	0.16	
F1	17	121.8	606.9	0.20	
F2	21	152.2	749.7	0.20	

Average Density = **0.190**

Average Snow Water Equivalent (SWE) = **3.3** cm H2O

Average Snow Water Equivalent = **1.29** inches H2O

Average Snow Water Equivalent = **0.11** feet H2O

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

Data entered by: Jeff Murray Date: 12/14/10

Data QA/QC by: Kristie Hilton Date: 12/19/10

Arctic Transportation Networks Project

Form F-012: Snow Survey Form

Project ID: **ATN Project** Site Location/Lake ID: **Toolik Lake Site 4 (Ruler)**

Survey Purpose: **Determine Snow Depth and SWE** Date: 12/5/2010 Time: 10:20

Location Description:	Toolik Lake. Site #4. Near center of lake.				
Survey objective:	SWE and tundra travel studies and management. L-Transect with Ruler to compare with ADNR's sampling method.			Weather Observations:	-8 F, Calm, Clear, Dark
Latitude:	N 68° 37.926'	Longitude:	W 149° 36.670'	Datum:	NAD 83
Elevation:	2500 ft.	Elevation Datum:	NGVD27	Reference Markers:	none
Drainage Basin:	Toolik Lake	Slope Direction:	none	Vegetation Type:	None. Lake Ice
Slope Angle:	none	Access Notes:	Snow Machine	Other:	Soft, consistent throughout
Snow Depth Probe Type:		T-Handle Probe		Snow-Survey Team Names:	
Snow Tube Type:	Adirondack Snow Tube			Jeff Murray, Jeff Derry	

Snow Course Depths (in)

	1	2	3	4	5
1	5.75	4.50	6.00	4.50	7.50
2	5.50	6.00	6.00	5.25	7.25
3	5.00	6.00	6.00	5.25	9.75
4	4.75	5.75	5.50	5.50	7.00
5	4.75	5.50	5.25	5.50	7.25
6	6.00	5.75	5.25	6.75	10.75
7	5.50	4.75	5.50	6.50	10.50
8	5.00	4.50	5.25	6.25	6.50
9	4.50	5.00	5.25	8.00	10.75
10	4.25	5.75	5.75	8.00	10.50

(inches)

Average snow depth = **6.2**

Maximum snow depth = 10.8

Minimum snow depth = 4.3

Standard deviation = 1.7

(cm)

Average snow depth = **15.7**

Maximum snow depth = **27.3**

Minimum snow depth = **10.8**

Standard deviation = **4.3**

Depths measured to nearest 1/4 inch

Data entered by: Jeff Murray Date: 12/14/10

Data QA/QC by: Kristie Hilton Date: 12/18/10

APPENDIX B. ADNR SNOW DATA

The following tables report snow information measured by ADNR staff. ADNR snow measurement methods prior to 11/15/10 recorded snow depths to the nearest 1-inch increment. Snow depths were recorded to the nearest 0.25-inch. Depth measurements were taken with a construction-scale metal ruler at 20 locations spread out over an approximate 300 foot transect. Density measurements were taken with a Federal Sampler at 5 locations.

Upper Foothills

Slope Mountain (N 68° 43.480' W 149° 0.540')

Date																						average		
																						g/cm^3	in	cm
11/2/2010	depth (in)	6	9	10	5	10	6	7	7	7	11	7	7	9	10	6	7	7	8	8	6		7.65	19.43
	density (g/cm^3)	0.135	0.164	0.182	0.169	0.15																0.16		
	SWE (in)	0.74	1.23	1.003	1.182	0.976																	1.03	2.61
11/18/2010	depth (in)	15	8.75	16.75	13	13	12	14.5	10	8.5	17.75	10	11.5	19	9.5	14	6.5	10.5	9	8.5	12.5		12.01	30.51
	density (g/cm^3)	0.205	0.182	0.257	0.248	0.13																0.20		
	SWE (in)	2.662	1.687	2.882	2.109	0.618																	1.99	5.06
12/2/2010	depth (in)	13	12.25	12.75	14	13	11.25	14	13.75	16.75	18	14	13.75	15.75	15.75	16.5	19	14.5	12	13	13.5		14.33	36.39
	density (g/cm^3)																					--		
	SWE (in)																						--	--

Upper Foothills

Sag River DOT (N 68° 45.183' W 148° 52.759')

Date																						average		
																						g/cm^3	in	cm
11/2/2010	depth (in)	9	8	9	8	6	8	11	11	9	8	10	10	9	8	7	8	7	9	8	8		8.55	21.72
	density (g/cm^3)	0.11	0.11	0.128	0.116	0.092																0.11		
	SWE (in)	0.95	0.96	0.958	0.814	0.739																	0.88	2.24
11/18/2010	depth (in)	7.5	11.5	8.5	7.5	7	8	5.5	5	5.5	7.5	6.75	6	10.5	8.75	7	7	8	6.75	3.75	3.5		7.08	17.97
	density (g/cm^3)	0.243	0.172	0.164	0.19	0.1																0.17		
	SWE (in)	1.264	1.12	1.426	0.498																		1.08	2.74
12/2/2010	depth (in)	11	11.75	9.25	8.75	9	12	11	11.5	10.75	7	7	10.5	12.5	6	11	10.5	15.5	9	7	9.75		10.04	25.50
	density (g/cm^3)	0.188	0.183	0.184	0.174	0.142																0.17		
	SWE (in)	0.845	1.463	0.828	0.783	1.134																	1.01	2.57

Upper Foothills

Pump Station 3 (N 68° 50.348' W 148° 49.120')

Date																						average		
																						g/cm^3	in	cm
11/2/2010	depth (in)	8	8	8	8	9	9	8	9	8	9	9	9	9	8	9	9	9	8	9	9		8.60	21.84
	density (g/cm^3)	0.14	0.13	0.135	0.122	0.127																0.13		
	SWE (in)	1.17	1.00	1.079	0.914	1.079																	1.05	2.66
11/18/2010	depth (in)	10.5	6.75	10.25	7	6.5	10	8.5	6.5	8	7.5	10.5	8.5	8	8	7	7.75	6.5	6.5	9.5	10.25		8.20	20.83
	density (g/cm^3)	0.15	0.137	0.193	0.127	0.145																0.15		
	SWE (in)	0.972	1.027	1.494	0.701	0.945																	1.03	2.61
12/2/2010	depth (in)	15.25	10.5	9.5	12.25	11	12.75	13	10.5	12.25	11.75	12.5	12	12.25	10.75	9.25	12	11	12.5	14	9.5		11.73	29.78
	density (g/cm^3)	0.14	0.156	0.207	0.122	0.153																0.16		
	SWE (in)	1.539	1.326	3.109	1.347	1.68																	1.80	4.57

Upper Foothills

318 Mile (N 68° 55.197' W 148° 51.025')

Date																						average		
																						g/cm^3	in	cm
11/2/2010	depth (in)	9	9	8	9	8	8	8	9	8	10	8	8	7	7	10	8	10	8	8	8		8.40	21.34
	density (g/cm^3)	0.10	0.09	0.101	0.113	0.108																0.10		
	SWE (in)	0.82	0.84	0.958	1.02	0.976																	0.92	2.34
11/18/2010	depth (in)	9	9.75	13	11.25	12.25	10.75	7	6	6.5	9.25	12.75	4.25	11	12	8.5	6	10	7.5	5	10.25		9.10	23.11
	density (g/cm^3)	0.15	0.25	0.18	0.33	0.13																0.21		
	SWE (in)	1.78	2.67	1.24	3.43	1.37																	2.10	5.33
12/2/2010	depth (in)	14.5	13.75	17	11.5	13.25	15	11.5	11.5	16	15.75	11.5	12.5	14	8.75	15	12.25	16	17.5	9.5	8.5		13.26	33.69
	density (g/cm^3)	0.14	0.20	0.254	0.146	0.191																0.19		
	SWE (in)	1.10	2.93	4.315	0.952	3.105																	2.48	6.30

Lower Foothills

62 Mile (N 69° 25.192' W 148° 40.840')

Date																							average		
																							g/cm^3	in	cm
10/21/2010	depth (in)	7	10	10	9	9	10	9	10	12	12	11	12	10	9	12	8	8	12	6	10			9.80	24.89
	density (g/cm^3)	0.17	0.13	0.162	0.135	0.122																	0.14		
	SWE (in)	1.72	0.99	1.295	1.144	1.285																		1.29	3.27
11/2/2010	depth (in)	12	13	13	16	16	11	13	15	9	9	10	7	12	14	11	10	13	15	17	9			12.25	31.12
	density (g/cm^3)	0.12	0.11	0.136	0.088	0.098																	0.11		
	SWE (in)	2.01	1.67	1.288	1.055	1.027																		1.41	3.58
12/2/2010	depth (in)	11	11	9.25	10.5	7.5	13	12	10.25	9	12.75	14	12	14.5	9	12	13.5	12.5	13	10.5	12.75			11.50	29.21
	density (g/cm^3)	0.22	0.16	0.26	0.3	0.2																	0.23		
	SWE (in)	3.26	1.70	3.772	4.497	2.044																		3.05	7.76

Lower Foothills

52 Mile (N 69° 32.492' W 148° 36.216')

Date																							average		
																							g/cm^3	in	cm
10/21/2010	depth (in)	9	8	10	11	11	10	6	8	8	7	7	9	8	10	10	8	12	10	10	7			8.95	22.73
	density (g/cm^3)	0.10	0.12	0.125	0.109	0.099																	0.11		
	SWE (in)	0.85	0.93	1.127	0.873	0.89																		0.94	2.38
11/18/2010	depth (in)	8.5	8	5	12	9	11.5	10.75	3.25	4.5	9	11	12.5	10	6	9.5	15.25	8.25	11	6.75	10.7			9.12	23.17
	density (g/cm^3)																						--		
	SWE (in)																							--	--
12/2/2010	depth (in)	17.25	11.75	18	18	12	13.5	13	16.25	8.5	15.75	10	13.5	18	13	14	7	12.5	15	10.5	10.5			13.40	34.04
	density (g/cm^3)	0.18	0.39	0.217	0.298	0.222																	0.26		
	SWE (in)	1.93	3.52	3.205	3.281	1.666																		2.72	6.91

Lower Foothills

30 Mile (N 69° 50.204' W 148° 45.288')

Date																							average		
																							g/cm^3	in	cm
10/21/2010	depth (in)	2	3	4	1	1	1	2	2	2	2	3	3	1	4	2	1	1	4	3	1			2.15	5.46
	density (g/cm^3)																						--		
	SWE (in)																							--	--
11/18/2010	depth (in)	5	4	4	4.5	9	4.5	7.25	5.25	3.75	4.25	5.75	8	3.25	6.75	3.25	4.75	2.5	2	4.5	9.75			5.10	12.95
	density (g/cm^3)																						--		
	SWE (in)																							--	--
12/2/2010	depth (in)	10.5	8	9	7	6.75	10	7	4.25	4.25	7.5	5	9	4.25	4.25	3.5	7.25	11	8.5	5.25	7.75			7.00	17.78
	density (g/cm^3)	0.26	0.29	0.236	0.262	0.194																	0.25		
	SWE (in)	2.83	2.92	2.473	2.556	1.941																		2.55	6.47
12/14/2010	depth (in)	9.25	12	8	7.5	7	12.5	7	7.5	8	8.5	12.5	6.25	7	5	7.5	4	3.5	7	5.5	4.75			7.51	19.08
	density (g/cm^3)																						--		
	SWE (in)																							--	--

Lower Foothills

Spur Dike 6 - 20 Mile (N 69° 58.300' W 148° 42.324')

Date																							average		
																							g/cm^3	in	cm
10/21/2010	depth (in)	6	3	4	5	6	2	4	3	2	2	3	3	5	4	4	3	5	6	3	3			3.80	9.65
	density (g/cm^3)																						--		
	SWE (in)																							--	--
12/2/2010	depth (in)	5.25	9	10.5	8.25	10.5	9	10	7.25	13	9.25	8.75	9	12	10	9.75	11.5	8.5	9.5	8.25	9			9.41	23.91
	density (g/cm^3)	0.26	0.25	0.239	0.278	0.293																	0.26		
	SWE (in)	2.76	2.09	1.793	3.267	4.978																		2.98	7.57
12/15/2010	depth (in)	8.75	11.75	7.75	8.75	12.5	13.5	8.25	11	11	10.75	8.75	9.5	10.5	16.75	22.75	11	9.5	6.75	10	4.75			10.71	27.21
	density (g/cm^3)	0.33	0.24	0.245	0.256	0.321																	0.28		
	SWE (in)	6.01	3.04	3.126	1.92	2.971																		3.41	8.67

Lower Foothills

Meltwater 19 (N 70° 54.000' W 150° 26.528')

Date																							average		
																							g/cm^3	in	cm
10/21/2010	depth (in)	7	8	11	11	7	9	9	10	8	9	7	7	11	10	9	9	11	11	8	9			9.05	22.99
	density (g/cm^3)	0.17	0.22	0.191	0.24	0.211																	0.21		
	SWE (in)	1.12	2.06	1.525	2.044	1.9																		1.73	4.39
11/1/2010	depth (in)	8	8	12	9	6	8	4	4	6	9	8	6	5	8	12	6	3	6	14	5			7.35	18.67
	density (g/cm^3)	0.18	0.21	0.246	0.172	0.218																	0.21		
	SWE (in)	1.10	1.38	2.336	1.034	2.075																		1.58	4.02
11/17/2010	depth (in)	10.25	13.75	16	6	6.5	16	8.25	5	10.5	6	14.5	10.5	12	5.25	12	8	10.75	5.25	13.5	9			9.95	25.27
	density (g/cm^3)	0.388	0.208	0.24	0.342	0.308																	0.30		
	SWE (in)	4.363	0.782	1.082	2.391	2.618																		2.25	5.71
11/30/2010	depth (in)	14.25	17.5	6	11	15	9	19.75	4	7.75	14	7.75	15.5	13.5	11.5	13	15	12	11.5	14.5	13			12.28	31.18
	density (g/cm^3)	0.187	0.264	0.227	0.205	0.213																	0.22		
	SWE (in)	1.865	3.768	2.669	1.944	2.027																		2.45	6.23

Eastern Coastal Area

UAF 411 Mile (N 70° 09.949' W 148° 27.307')

Date																						average		
																						g/cm^3	in	cm
12/8/2010	depth (in)	11.5	9.25	10.5	11.5	9.75	10.5	11.5	11.25	12.75	7.75	9.25	10	9	12.25	12	13.75	8.5	16.25	8.5	11.75		10.88	27.62
	density (g/cm^3)	0.26	0.30	0.374	0.263	0.295																0.30		
	SWE (in)	3.44	5.05	7.011	1.711	3.693																	4.18	10.62
12/15/2010	depth (in)	14	11.5	10	17.5	16.7	13.5	9	12	9.5	12.5	7	11.75	11	15.5	12.5	16	12.75	14	13.75	9		12.47	31.68
	density (g/cm^3)	0.26	0.30	0.336	0.286	0.242																0.29		
	SWE (in)	3.28	3.71	8.145	4.431	3.514																	4.62	11.73

Eastern Coastal Area

P Pad (N 70° 16.552' W 147° 54.432')

Date																						average		
																						g/cm^3	in	cm
11/1/2010	depth (in)	7	7	7	15	6	6	6	5	5	11	6	7	6	10	9	9	9	7	10	7		7.75	19.69
	density (g/cm^3)	0.11	0.14	0.168	0.134	0.2																0.15		
	SWE (in)	0.96	0.78	1.092	0.938	1.597																	1.07	2.73
12/8/2010	depth (in)	7.5	9.5	5.5	5.5	5.25	5.5	5	10.25	5.75	6.5	7	9	10.5	9.75	7.25	7.5	10	14.5	9.25	8.75		7.99	20.29
	density (g/cm^3)	0.24	0.23	0.251	0.285	0.319																0.27		
	SWE (in)	1.37	1.82	1.57	1.992	2.875																	1.92	4.89
12/15/2010	depth (in)	10	9	17.5	6.5	10.5	5.5	4	14	7	11.25	5.75	18	6	15.5	6.75	7.5	7	14	18	12.5		10.31	26.19
	density (g/cm^3)	0.26	0.27	0.223	0.261	0.318																0.27		
	SWE (in)	2.48	2.05	1.731	4.177	3.02																	2.69	6.84

Eastern Coastal Area

T Pad (N 70° 20.420' W 148° 48.360')

Date																						average		
																						g/cm^3	in	cm
11/1/2010	depth (in)	8	8	6	10	7	6	8	7	5	10	8	5	9	9	10	8	7	12	5	8		7.80	19.81
	density (g/cm^3)	0.12	0.13	0.104	0.106	0.124																0.12		
	SWE (in)	0.91	0.79	0.677	0.739	0.745																	0.77	1.96
11/29/2010	depth (in)	6.5	15.5	9.5	11.5	11.25	9	12.5	14.5	12.75	9	12.75	11	9	11	13.25	12	13	6.2	9	10		10.96	27.84
	density (g/cm^3)	0.29	0.19	0.145	0.167	0.146																0.19		
	SWE (in)	3.57	1.31	0.972	1.086	0.91																	1.57	3.99
12/8/2010	depth (in)	7.5	11	9.75	7.5	9.25	9	5.5	7.25	7.75	9	6.5	13	7.75	13.75	8.25	10.75	11.75	11	10.75	6.5		9.18	23.30
	density (g/cm^3)	0.26	0.39	0.345	0.315	0.352																0.33		
	SWE (in)	2.33	6.86	3.964	2.913	3.521																	3.92	9.95
12/15/2010	depth (in)	19	8.75	11.5	5.5	6.5	13	11	6.25	7.5	9.75	8	6	7.75	11.25	12.5	6.75	10.75	12.75	9.5	9.25		9.66	24.54
	density (g/cm^3)	0.34	0.19	0.262	0.183	0.299																0.25		
	SWE (in)	2.53	1.02	2.092	0.824	3.064																	1.91	4.84

Eastern Coastal Area

Term Well A (N 70° 21.468' W 148° 34.840')

Date																						average		
																						g/cm^3	in	cm
11/1/2010	depth (in)	4	4	5	5	3	6	7	6	5	4	6	4	6	6	6	5	6	4	4	5		5.05	12.83
	density (g/cm^3)	0.21	0.19	0.124	0.224	0.101																0.17		
	SWE (in)	1.98	1.33	0.931	2.016	0.605																	1.37	3.48
11/15/2010	depth (in)	7	13	8.25	5.5	4.25	6.25	11	5.5	5	6	5.5	5.25	11	6.5	6.5	6.75	5.5	5.5	5.5	11		7.04	17.88
	density (g/cm^3)	0.40	0.21	0.298	0.184	0.272																0.27		
	SWE (in)	2.38	1.24	1.937	0.873	2.583																	1.80	4.58
11/29/2010	depth (in)	13	8	11	13.5	13	5.75	9.75	10.5	13.25	6.75	5.5	9.5	14.75	10	6	10	9	11	11.5	7.25		9.95	25.27
	density (g/cm^3)	0.22	0.16	0.29	0.296	0.217																0.24		
	SWE (in)	2.09	0.95	3.916	4.349	2.061																	2.67	6.79

Eastern Coastal Area

DS 16 (N 70° 13.192' W 148° 15.216')

Date																						average		
																						g/cm^3	in	cm
11/1/2010	depth (in)	9	9	9	9	10	9	9	9	8	9	8	9	10	10	9	12	11	12	11	11		9.65	24.51
	density (g/cm^3)	0.17	0.15	0.176	0.148	0.142																0.16		
	SWE (in)	1.77	1.75	1.663	1.628	1.343																	1.63	4.14
11/15/2010	depth (in)	8	8	7	6	7.25	12	9	8	10.75	9.5	10.75	10	7.75	10	6.5	8.5	10.5	11.5	11.25	13.5		9.29	23.59
	density (g/cm^3)	0.25	0.25	0.255	0.233	0.224																0.24		
	SWE (in)	1.48	2.28	1.913	1.398	1.288																	1.67	4.25
11/29/2010	depth (in)	15	13	14.75	15.5	16	13.75	12.75	11	15.75	13	13.5	13.25	14	17	11	13	16.5	21	9.75	10.5		14.00	35.56
	density (g/cm^3)	0.26	0.28	0.278	0.253	0.232																0.26		
	SWE (in)	3.10	3.93	3.054	3.222	2.549																	3.17	8.05
12/8/2010	depth (in)	8.25	12.75	7.5	9.75	9.25	16	9.75	8.5	8.5	9.5	14	14.5	14.25	12.25	18	12.5	13.25	10	12	16.25		11.84	30.07
	density (g/cm^3)																					--		
	SWE (in)																						--	--
12/15/2010	depth (in)	8.75	16.5	15	13.5	10	18	15	11	8.75	9.75	16.5	13.75	13.75	13.75	20.25	12.75	11.75	10.5	13	16		13.41	34.07
	density (g/cm^3)																					--		
	SWE (in)																						--	--

Eastern Coastal Area																									
ANFO Pad (N 70° 14.276' W 148° 10.480')																							average		
Date																							g/cm^3	in	cm
11/1/2010	depth (in)	10	8	9	10	9	7	8	9	8	9	9	8	7	8	9	7	9	7	8	8			8.35	21.21
	density (g/cm^3)	0.18	0.12	0.195	0.158	0.194																			
	SWE (in)	1.17	1.08	1.855	1.498	1.742																			
11/15/2010	depth (in)	7	5.5	5.5	8	8	5	7	9	9	11.25	10	6.75	9.75	9.5	5.25	9	7	5	4.25	10.25			7.60	19.30
	density (g/cm^3)	0.27	0.73	0.12	0.204	0.206																	0.50		
	SWE (in)	1.61	4.35	0.542	1.174	1.649																		1.87	4.74
11/29/2010	depth (in)	8.5	12.5	11.75	12.75	12.5	12.25	16.5	14	10	13	11.75	9.5	11.5	11.5	10	9	9	15.25	9	9.75			11.50	29.21
	density (g/cm^3)	0.26	0.23	0.247	0.231	0.269																	0.25		
	SWE (in)	2.69	2.36	3.03	1.79	2.889																		2.55	6.48
12/8/2010	depth (in)	6	6.25	8	8.5	8	9	7.75	13.75	9.25	12	11	8	10	6	7	7	8.75	6.5	6.75	10.5			8.50	21.59
	density (g/cm^3)	0.27	0.35	0.275	0.313	0.293																	0.30		
	SWE (in)	2.15	2.99	1.783	3.524	4.105																		2.91	7.39
12/15/2010	depth (in)	8	7	9.5	7.5	10.25	8.5	10	12.25	14.5	12.75	12.25	9.5	9.5	10.75	8	7.5	10.5	8	7	7			9.51	24.16
	density (g/cm^3)	0.31	0.29	0.337	0.295	0.341																	0.31		
	SWE (in)	3.28	2.49	3.538	2.511	3.579																		3.08	7.82

Western Coastal Area

DS-2L (ASTAC) (N 70° 14.625' W 150° 27.904')

Date																						average		
																						g/cm^3	in	cm
11/3/2010	depth (in)	6	5	7	6	10	5	5	7	7	6	9	8	6	7	7	5	9	6	5	9		6.75	17.15
	density (g/cm^3)	0.08	0.22	0.144	0.173																	0.15		
	SWE (in)	0.37	1.52	0.721	1.213																		0.96	2.43
11/17/2010	depth (in)	9.5	10.75	15.5	13.2	8	10	7	8	5.75	5.25	7.75	9.25	12.25	8.25	13	6.5	6.75	5.75	7	6.25		8.79	22.31
	density (g/cm^3)																					--		
	SWE (in)																						--	--
11/30/2010	depth (in)	10	17.75	11	10.5	13	13	12	9	12.5	12.75	7	10	18	12	10.5	13.5	18	12.5	15.5	9.7		12.41	31.52
	density (g/cm^3)	0.19	0.33	0.328	0.3	0.329																0.29		
	SWE (in)	1.98	6.19	5.74	4.947	4.61																	4.69	11.92
12/8/2010	depth (in)	6.5	5	5	11	9	8.75	9	11	11.75	11.75	19	11.75	12.5	14	11	14	9.5	5.5	9.75	8		10.19	25.88
	density (g/cm^3)	0.27	0.30	0.344	0.338	0.318																0.31		
	SWE (in)	2.67	2.65	4.469	4.225	3.662																	3.54	8.98

Western Coastal Area

Palm 2 (N 70° 23.240' W 150° 8.168')

Date																						average		
																						g/cm^3	in	cm
11/3/2010	depth (in)	5	7	7	7	7	8	5	8	10	7	5	6	8	8	7	9	4	7	5	7		6.85	17.40
	density (g/cm^3)																					--		
	SWE (in)																						--	--
11/30/2010	depth (in)	10	14.75	11	14	13.5	12.5	10.5	18	12.5	13	12.25	19	16	17.5	11.25	15.5	17.5	12	10	11.5		13.61	34.58
	density (g/cm^3)	0.30	0.19	0.137	0.213	0.192																0.21		
	SWE (in)	3.47	1.63	1.168	2.174	1.865																	2.06	5.23
12/8/2010	depth (in)	8.5	10	12	22	12	12	11.75	12.75	8.75	5.5	9.5	10	6.25	9	12	16	12	12.5	7.75	10		11.01	27.97
	density (g/cm^3)	0.26	0.29	0.319	0.294	0.337																0.30		
	SWE (in)	3.29	3.13	2.872	3.002	4.215																	3.30	8.39
12/12/2010	depth (in)	11.5	12.25	16.25	19.25	16	11.5	11.5	13.5	12	9.5	11	7.75	11.5	8	12	13.5	15.5	11.25	10	9		12.14	30.83
	density (g/cm^3)	0.24	0.24	0.345	0.307	0.237																0.27		
	SWE (in)	2.43	2.18	4.311	2.453	1.776																	2.63	6.68

Western Coastal Area

Ugnu (N 70° 27.288' W 150° 48.324')

Date																						average		
																						g/cm^3	in	cm
11/3/2010	depth (in)	6	7	7	11	5	5	6	8	6	6	5	6	7	5	5	5	6	6	6	5		6.15	15.62
	density (g/cm^3)																					--		
	SWE (in)																						--	--
11/17/2010	depth (in)	6	10	7.75	5	4	6.5	13	9.75	7.25	9.25	11	13	13.5	8	13.75	12.75	7	9	7.75	6.5		9.04	22.96
	density (g/cm^3)	0.32	0.32	0.331	0.309	0.266																0.31		
	SWE (in)	2.32	3.03	2.401	1.776	2.065																	2.32	5.89
11/30/2010	depth (in)	10	12	9.5	9	8	13	8.25	9	10	16.2	10	9	10.25	13.5	7.5	11	9.75	11.5	7	10.75		10.26	26.06
	density (g/cm^3)	0.19	0.29	0.179	0.247	0.237																0.23		
	SWE (in)	1.38	4.14	1.295	1.79	1.484																	2.02	5.13
12/8/2010	depth (in)	13	6.5	6.5	11.75	7.75	7.25	6	6.5	7.75	6	6.5	9.25	10	3.75	12.25	9.5	12	15.5	12.5	6.7		8.85	22.47
	density (g/cm^3)																					--		
	SWE (in)																						--	--
12/12/2010	depth (in)	7.5	9	8.25	9	10	6	5.5	5.5	9	6	6.75	11.5	16	13	19	8.25	6.25	9.25	9	5.5		9.01	22.89
	density (g/cm^3)																					--		
	SWE (in)																						--	--

Western Coastal Area

DS-1J (N 70° 16.260' W 147° 31.140')

Date																						average		
																						g/cm^3	in	cm
11/30/2010	depth (in)	6.75	11	7.5	12	12	9	13	9.7	10.5	4.5	6	16	16.5	7	7.5	4	13.5	12.5	17	6		10.10	25.65
	density (g/cm^3)	0.29	0.27	0.21	0.216	0.313																0.26		
	SWE (in)	3.42	2.31	2.621	1.511	4.064																	2.79	7.07
12/8/2010	depth (in)	8.25	9	9.5	7	11.25	10	12	8.75	12.25	9	6	12	15	13.5	18	8.75	12.5	22	18.5	7.5		11.54	29.31
	density (g/cm^3)																					--		
	SWE (in)																						--	--
12/12/2010	depth (in)	8.5	10.75	7	13.5	11.25	8.5	4.75	6	9.25	6.75	9	23.5	22	11	7.75	20	13.75	14.25	20.5	18.5		12.33	31.31
	density (g/cm^3)	0.24	0.22	0.254	0.286	0.262																0.25		
	SWE (in)	1.07	1.08	1.903	1.288	2.673																	1.60	4.07

Western Coastal Area																								
S Pad (N 70° 20.312' W 149° 2.528')																							average	
Date																						g/cm^3	in	cm
11/3/2010	depth (in)	10	8	6	8	5	4	5	3	5	4	3	5	4	5	12	6	5	7	5	6		5.80	14.73
	density (g/cm^3)																					--		
	SWE (in)																						--	--
11/16/2010	depth (in)	5.75	7	5.5	5.5	4.5	6	5	6	5	5	5	6	5	5.75	4.75	11.25	6.75	7	12	11		6.49	16.48
	density (g/cm^3)	0.18	0.19	0.287	0.253	0.3																0.24		
	SWE (in)	1.08	1.07	2.295	1.773	1.876																	1.62	4.11
11/30/2010	depth (in)	6.5	7.5	10.25	16	8	11.5	8.5	18.5	9.5	7.75	6	15	10	5.5	7.75	14.5	6.5	4.5	8.25	6		9.40	23.88
	density (g/cm^3)	0.25	0.23	0.261	0.296	0.294																0.27		
	SWE (in)	3.81	3.34	3.779	3.992	3.971																	3.78	9.60
12/8/2010	depth (in)	7.75	6.5	8	7.75	7.25	7	6.25	10.5	8.5	7.75	5.25	8.25	7.5	5	15	17	6	6	8.75	6.75		8.14	20.67
	density (g/cm^3)	0.20	0.38	0.32	0.323	0.318																0.31		
	SWE (in)	4.06	4.80	4.799	4.284	3.257																	4.24	10.77
12/12/2010	depth (in)	5.75	6.75	8	9	9.25	4.75	4.5	9.25	6.5	8.25	5.5	8	8	5.75	18	16	7.5	5	9.5	9.5		8.24	20.92
	density (g/cm^3)	0.25	0.25	0.308	0.245	0.279																0.27		
	SWE (in)	2.35	2.90	5.318	1.779	2.58																	2.99	7.58

APPENDIX C. ADNR SNOW DATA SUMMARY

The following table reports a summary of snow information obtained by ADNR staff.

	Oct 21-22			Nov 1-5			Nov 15-19			Nov 29-Dec3			Dec 6-10			Dec 12-15		
	Depth (in)	Density (g/cm^3)	SWE (in)	Depth (in)	Density (g/cm^3)	SWE (in)	Depth (in)	Density (g/cm^3)	SWE (in)	Depth (in)	Density (g/cm^3)	SWE (in)	Depth (in)	Density (g/cm^3)	SWE (in)	Depth (in)	Density (g/cm^3)	SWE (in)
Eastern Coastal Area																		
ANFO Pad	--	--	--	8.4	--	--	7.6	0.50	1.9	11.5	0.25	2.6	8.5	0.30	2.9	9.5	0.31	3.1
DS 16	--	--	--	9.7	0.16	1.6	9.3	0.25	1.7	14.0	0.26	3.2	11.8	--	--	13.4	--	--
UAF 411 mi	--	--	--	--	--	--	--	--	--	--	--	--	10.88	0.30	4.18	12.47	0.29	4.62
Term Well A	--	--	--	5.1	0.20	1.4	7.0	0.30	1.8	10.0	0.24	2.7	--	--	--	--	--	--
P Pad	--	--	--	7.8	0.12	1.1	--	--	--	--	--	--	8.0	0.27	1.9	10.3	0.27	2.7
T Pad	--	--	--	7.8	0.13	0.8	--	--	--	10.96	0.19	1.57	9.18	0.33	3.92	9.66	0.25	1.91
Area Averages	N/A	N/A	N/A	7.7	0.15	1.2	8.0	0.35	1.8	11.6	0.24	2.5	9.7	0.30	3.2	11.1	0.28	3.1
Western Coastal Area																		
S Pad	--	--	--	5.8	--	--	6.5	0.18	1.6	9.4	0.27	3.8	8.1	0.31	4.2	8.2	0.27	3.0
DS-1J	--	--	--	--	--	--	--	--	--	10.10	0.26	2.79	11.54	--	--	12.33	0.25	1.6
UGNU Pad	--	--	--	6.2	--	--	9.0	0.32	2.3	10.3	0.23	2.0	8.9	--	--	9.0	--	--
Palm 2	--	--	--	6.9	--	--	--	--	--	13.61	0.21	2.06	11.01	0.30	3.30	12.14	0.27	2.63
DS-2L (ASTAC)	--	--	--	6.8	0.15	1.0	8.8	--	--	12.4	0.29	4.69	10.2	0.31	3.54	--	--	--
Area Averages	N/A	N/A	N/A	6.4	0.15	1.0	8.1	0.25	2.0	11.2	0.25	3.1	9.9	0.31	3.7	10.4	0.26	2.4
Lower Foothills Area																		
SpurDike 6-20 Mi	3.8	--	--	--	--	--	--	--	--	9.41	0.26	2.98	--	--	--	10.71	0.28	3.41
30 Mile	2.2	--	--	--	--	--	5.1	--	--	7.0	0.25	2.55	--	--	--	7.51	--	--
52 Mile	9.0	0.11	0.9	--	--	--	9.1	--	--	13.4	0.26	2.72	--	--	--	--	--	--
62 Mile	9.8	0.15	1.3	12.3	0.12	1.4	--	--	--	11.50	0.23	3.05	--	--	--	--	--	--
Meltwater 19	9.1	0.20	1.7	7.4	0.20	1.6	10.0	0.30	2.3	12.3	0.22	2.5	--	--	--	--	--	--
Area Averages	6.8	0.15	1.3	9.8	0.16	1.5	8.1	0.30	2.3	10.7	0.24	2.8	--	--	--	--	--	--
Upper Foothills Area																		
318 Mile	--	--	--	8.4	0.09	0.9	9.1	0.20	2.1	13.3	0.19	2.5	--	--	--	--	--	--
Pump 3	--	--	--	8.6	0.13	1.1	8.2	0.14	1.0	11.7	0.16	4.6	--	--	--	--	--	--
Sag R. DOT	--	--	--	8.6	0.11	0.9	7.1	0.21	1.1	10.0	0.17	1.0	--	--	--	--	--	--
Slope Mountain	--	--	--	7.7	0.99	1.0	12.0	0.19	2.0	14.3	--	--	--	--	--	--	--	--
Area Averages	N/A	N/A	N/A	8.3	0.33	1.0	9.1	0.19	1.6	12.3	0.17	2.7	--	--	--	--	--	--

APPENDIX D. ELEVATION SURVEY FORMS

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

Arctic Transportation Networks

Form F-011: Elevation Survey Form

Project ID: **ATN Project** Site Location/Lake ID: L9312

Survey Purpose: **Water-Level Elevations** Date: 12/8/2010 Time: 10:30

Location:	Lake L9312, located southeast of Alpine pad, survey by pump house benchmarks							
Survey objective:	Determine FWS Elevation.					Weather Observations:		
Instrument Type:	Leica NA720		Instrument ID:	5482372 (GWS owned)				
Rod Type:	Fiberglass		Rod ID:	Crane Fiber Glass		Cold, Overcast, Slight breeze		
Bench Mark Information:						Survey Team Names		
Name	Agency Responsible	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (ddd-mm.mmm)		Jeff Murray, Jack (LCMF)		
L9312"P"	CP	11.73	na	na				

Station	**BS (ft)**	**HI (ft)**	**FS (ft)**	**Elevation (fasl)**	**Distance (ft)**	**Horizontal Angle**	**Vertical Angle**	**Remarks**
TBM "P"	1.190	12.92		11.73				Top of inlet pipe support
TBM "O"		12.920	1.450	11.47				Top of inlet pipe support. BM Elev=11.44'
99-32-59		12.920	-1.650	14.57				Top of Pumphouse SE VSM. BM Elev = 14.53
L9312 WL		12.920	5.470	**7.45**				
L9312 Ice		12.920	5.360	7.56				
Turn on L9312 Ice								
L9312 Ice	5.16	12.720		7.56				
L9312 WL		12.720	5.27	7.45				**WL = 7.45**
99-32-59		12.720	-1.850	14.57				
TBM"O"		12.720	1.260	11.46				
TBM"P"		12.720	0.990	11.73				close survey to 0.01'

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

APPENDIX E. LAKE HYDROLOGICAL MEASUREMENTS

The following form reports physical measurements pertaining to lake ice obtained during field sampling.

Arctic Transportation Networks Project

FORM F-005: WATER-LEVEL MEASUREMENT FORM

Lake or Site ID: **L9312**

Local Number: Survey ID

All measurements in feet, unless noted	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (dd-mm.mmm)
	7.00	N 70° 19.995'	W 150° 56.918'

Vertical-Datum Corrections, reference survey notes in site folders

Date	MP ID	MP Elevation (feet above BP Sea Level)	
3/26/2004	"P"	11.61	
1/16/2006	"P"	11.73	(BM elevation adjusted)

ABBREVIATIONS

BOI, bottom of ice

Calib, used to calibrate PT

IS, ice surface
LB, lake bottom
LS, land surface
MP, measuring point
N/A, not available
WS, water surface

Date	Time	Method	Snow Depth	Total Depth IS to LB	Estimated Error	Ice Thickness (IS to BOI)	Freeboard (IS to WS)	WS Elevation	IS Elevation
11/16/10	12:45	Tape/Levels	0.41'	10.83'	+/- 0.01'	1.9'	0.16'	7.39'	7.55'
12/8/10	10:15	Tape/Levels	0.48'	11.01	+/- 0.01'	1.85'	0.11'	7.45'	7.56'

Collected Data Values

Lake-Full Elevation = measured at staff gage or near vertical benchmark after lake outflow ceased following spring snowmelt
Freeboard (FB) = Height of ice level over water level in open hole
Ice Thickness (IT) = Measured distance between top and bottom of ice
Total Depth (TD) = Measured distance from water surface to lake bottom
Estimated Error = Field estimate of water level measurement error

Calculated Values

Ice Surface (IS) Elevation = Water Elevation + Freeboard
Ice Bottom (IB) Elevation = Ice Surface Elevation - Ice Thickness

Arctic Transportation Networks Project

FORM F-005: WATER-LEVEL MEASUREMENT FORM

Lake or Site ID: **Toolik Lake**

Local Number: Survey ID NAD83

All measurements in feet, unless noted	Elevation (ft)	Latitude (dd-mm.mmm)	Longitude (dd-mm.mmm)
	2382 ft.	N 68° 37.926'	W 149° 36.670'

Vertical-Datum Corrections, reference survey notes in site folders

ABBREVIATIONS

BOI, bottom of ice

Calib, used to calibrate PT

IS, ice surface

LB, lake bottom

LS, land surface

MP, measuring point

N/A, not available

WS, water surface

WD, water depth

Date	Time	Method	Snow Depth	Total Depth IS to LB	Estimated Error	Ice Thickness (IS to BOI)	Freeboard (IS to WS)	WD	Latitude (dd-mm.mmm)	Longitude (dd-mm.mmm)
11/19/10	13:30	Tape	0.41'	38.40'	+/- 0.01	1.45'	0.00'	38.40'	N 68° 37.926'	W 149° 36.670'
12/5/10	10:00	Tape	0.52'	42.90'	+/- 0.01	1.80'	0.10'	42.80'	N 68° 37.926'	W 149° 36.670'

Collected Data Values

Lake-Full Elevation = measured at staff gage or near vertical benchmark after lake outflow ceased following spring snowmelt

Freeboard (FB) = Height of ice level over water level in open hole

Ice Thickness (IT) = Measured distance between top and bottom of ice

Total Depth (TD) = Measured distance from water surface to lake bottom

Estimated Error = Field estimate of water level measurement error

Calculated Values

Ice Surface (IS) Elevation = Water Elevation + Freeboard

Ice Bottom (IB) Elevation = Ice Surface Elevation - Ice Thickness