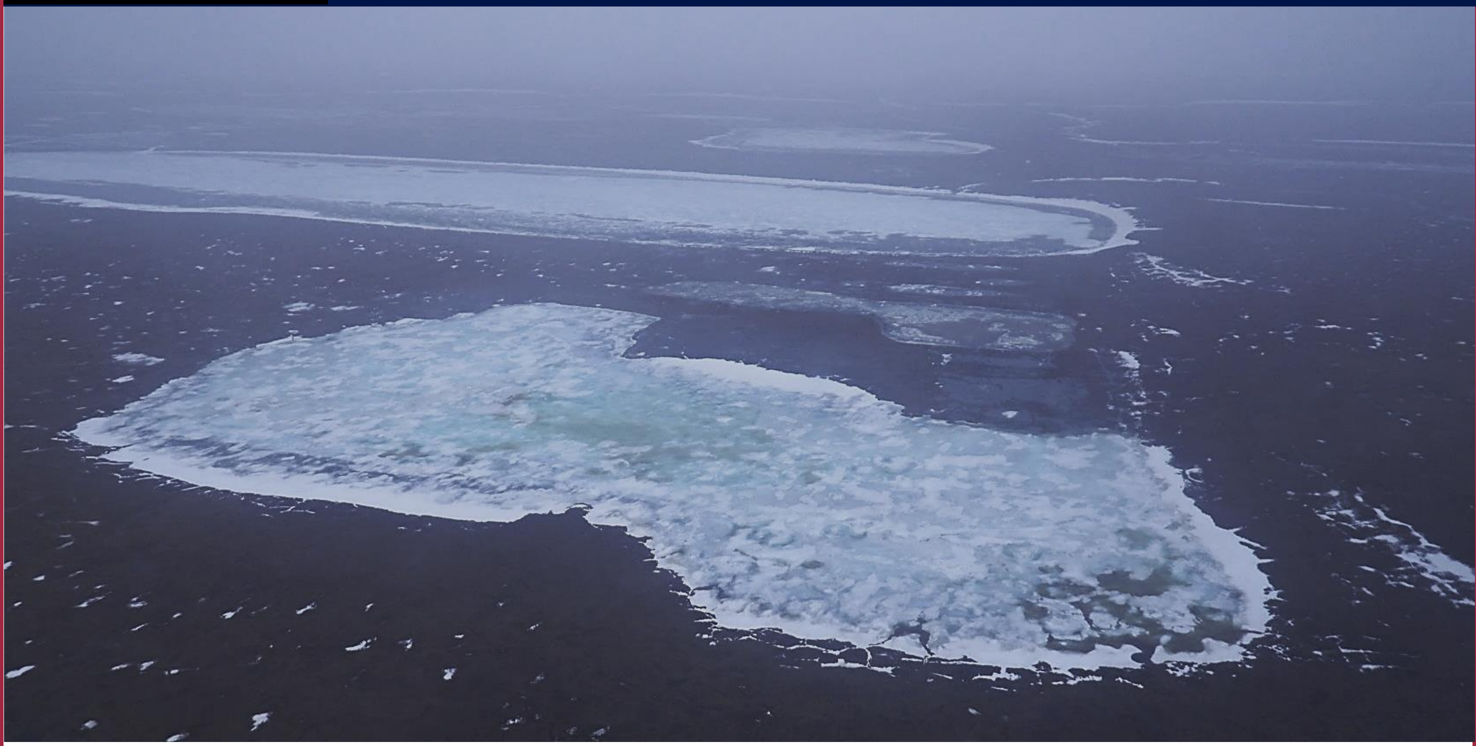
2014

ALPINE AREA LAKES RECHARGE STUDIES



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ACRONYMS AND ABBREVIATIONS

ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
Baker	Michael Baker Jr., Inc.
BPMSL	British Petroleum Mean Sea Level
CPAI	ConocoPhillips Alaska, Inc.
CRD	Colville River Delta
GIS	Geographic information system
GPS	Global positioning system
HWM	High water mark
NAD83	North American Datum of 1983
NRCS	Natural Resources Conservation Service
Mgal	Million gallons
SWE	Snow water equivalent
TBM	Temporary benchmark
WSE	Water surface elevation

1.0 INTRODUCTION

Conoco Phillips Alaska, Inc. (CPAI) withdraws water and ice from lakes within the Colville River Delta (CRD) and near Kuparuk. The use of ice roads and pads during the winter months is necessary for maintenance and operations at the Alpine oil field. This temporary infrastructure supports overland transportation of resources. Winter seasonal construction of ice roads and pads requires withdrawal of millions of gallons of fresh water and ice chips from area lakes, typically between December and May.

To comply with stipulations of Alaska Department of Fish and Game (ADF&G) Fish Habitat Permits and Alaska Department of Natural Resources (ADNR) Temporary Water Use Permits, CPAI conducts studies at water withdrawal lakes to document seasonal recharge. Michael Baker Jr., Inc. (Baker) conducted late season snow surveys and spring lake recharge studies to monitor water levels and provide photo documentation for permit compliance. This report summarizes the hydrologic observations, measurements, and analyses undertaken for this project.

Baker was supported during field monitoring by CPAI Alpine Environmental Coordinators, Umiaq/LCMF, LLC, and Pathfinder Aviation. All Baker and support team crew members are recognized for their contribution to an incident-free field effort.

1.1 STUDY OVERVIEW

The objectives of the 2014 Alpine Area Lakes Recharge Studies include collection and analysis of spring breakup recharge data at thirteen water withdrawal lakes. Lake studies included observations and photos, gage water surface elevation (WSE) measurements, and late season snow surveys.

For the purposes of this report, the lakes are grouped as Detailed Study Lakes and General Study Lakes. The 2014 Detailed and General Study Lakes are listed in Table 1.1 and the locations are shown on Figure 1.1.

Table 1.1: 2014 Alpine Area Detailed and General Study Lakes

Detailed Study Lakes	M9602 and M9605
General Study Lakes	B8530, B8531/L9326, B8533, L9132, L9323, L9324, K209, K214, M9603, M9607, and Nanuq Lake

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2014 ALPINE AREA LAKES RECHARGE STUDY

FIGURE: 1.1

(SHEET 1 of 1)

Lake recharge was determined using visual observations and photos focusing on key hydrologic features, including peak water levels, hydraulic connectivity with other bodies of water, and inflow/outflow locations. Existing staff gages were restored during spring breakup setup and data was collected when Baker field personnel were in the vicinity of these lakes.

Late-season snow surveys and calculation of available recharge volumes were conducted for lakes M9602 and M9605 prior to breakup. Catchment basins were delineated prior to field investigations using available topography and aerial imagery. Basin-specific snow water equivalent (SWE) was calculated using data collected during the snow surveys. Potential snowmelt contribution was calculated using SWE values and delineated catchment basin areas. Estimated recharge volumes were calculated using WSE data and delineated lake specific area.

1.2 Lake Recharge Background

Annual recharge of lakes in the CRD and Kuparuk River Unit occurs as a result of three primary mechanisms: spring breakup flooding, snow melt, and precipitation. Of these, spring breakup flooding and snow melt (considered overland flow) were investigated. Lake elevation, proximity to streams, and local topography typically dictate the recharge mechanism. Lakes located within annually inundated stream floodplains or hydraulically connected areas recharge primarily from spring breakup flood flows. Lakes not inundated because of distance or topographical limitations depend solely on snowmelt runoff and precipitation for recharge.

The magnitude of spring breakup flooding fluctuates from year to year in terms of stage and discharge. If flood stage is relatively low, bankfull recharge may not occur depending on topography and elevation. In addition, flow extents are affected by the unpredictable establishment and release of ice jams during breakup. Presence and location of ice jams can determine whether a lake becomes hydraulically connected to a stream recharge source regardless of flood magnitude.

The amount of snowmelt runoff a lake receives depends on terrain, topography, and the properties of the snow in the catchment basin. SWE of a basin can be determined by the depth and density of snow within a catchment in the spring when melting occurs; it is directly proportional to the quantity of potential snowmelt recharge. SWE will vary with the type of terrain and may be presented as a weighted, basin-specific value. For lakes sharing similar topographical and climatological features with those previously studied, average SWE values may be multiplied by catchment basin area to calculate a conservative estimate of potential snowmelt recharge. This method was previously used for lakes M9602 and M9605 (Baker 2010); a comparison of the 2010 thru 2014 results is included in Section 4.1.5.

In this study, the lake catchment basin terrain is designated as lake or tundra. Lake areas were assumed to contribute all snowmelt based on analysis of snow survey data and estimated recharge volumes. However, all tundra snowmelt will not directly contribute to lake recharge because of variations in vegetation and topography relative to the lake. The quantity of snowmelt retained in tundra areas differs for each lake catchment basin.

Kane et al. (1999) performed a study in the Kuparuk River Basin to determine an average quantity of snowmelt retained in tundra areas of lake catchment basins as a percentage of total potential snowmelt contribution, based on estimated recharge quantities. Study findings suggest applying an average runoff coefficient of 0.67 to tundra SWE as a reduction factor to account for snowmelt retention.

In 2007, Baker performed a recharge monitoring study for lakes within the CRD. Results suggested an average tundra SWE runoff coefficient of 0.67, further validating the value obtained by Kane et al. (Baker 2007). Similar topography and proximity to the CRD and Kuparuk River basins justifies using a runoff coefficient of 0.67 for calculating the total estimated snowmelt contribution for lakes M9602 and M9605.

2.0 Permits and Water Use

CPAI requires water sources for building ice roads and ice pads, drilling, drinking water, and general operations. ADNR, ADF&G, or both agencies grant permits on the condition of CPAI compliance with temporary water use requirements to regulate water withdrawal and maintain conditions supportive of fish habitat. To maintain fish habitat, lakes must seasonally recharge water volumes borrowed during the winter season and lost naturally through evaporation. Fish Habitat and Temporary Water Use permits stipulate the water withdrawal quantities for each water year. Additionally, these permits specify the form of water that may be borrowed from each lake – liquid only, specific quantities of liquid and ice, or a total of both without designation of individual quantities. Ice aggregate removal is permitted over naturally grounded portions of the lake 4 feet deep or less. A water year is defined as one year beginning and ending with spring breakup (June through May). Actual withdrawal quantities are reported by CPAI per water year; these numbers are compared to the maximum water withdrawal allowed. If two permits are issued for one lake, the maximum water withdrawal by CPAI is less than or equal to the lesser allowable quantity.

Lakes M9602, M9603, M9605, and Nanuq Lake were permitted for specific borrow quantities of liquid and ice. The remaining nine lakes were permitted for a total of both borrow quantities without designation of individual quantities. Water and ice was withdrawn from all study lakes except Lake L9132 during the 2013/2014 ice road construction season; lakes M9602 and M9605 were used as both water and ice sources.

Table 2.1 summarizes the permits regulating water use, purpose, and permitted versus actual withdrawal volumes by form at the thirteen water withdrawal lakes. The permitted and actual withdrawal volumes are based on third and fourth quarter 2013 and first and second quarter 2014 water use reports (CPAI 2013a, 2013b, 2014a, and 2014b).

Table 2.1: Summary of Permitted and Actual Withdrawal Volumes

2014 Alpine Area Lakes Recharge Study										
Lake	Permit		Permit Expiration	Water Use Purpose	Permitted Volume[1]			Withdrawal Volume[3]		
	ADF&G	ADNR			Liquid	Ice	Total Water[2]	Liquid	Ice	Total Water
					(Mgal)					
B8530	FG03-III-0383	TWUP A2013-145	12/15/2018	Ice Road/Pad	:::	:::	32.00	17.26	0.00	17.26
B8531/L9326	FG03-III-0382	TWUP A2008-180/TWUP A2013-145	12/16/2013 12/15/2018	Ice Road/Pad	:::	:::	6.59	5.32	0.00	5.32
B8533	FH03-III-0377	TWUP A2011-153	12/5/2016	Ice Road/Pad/DS/ Wells SPT/Drilling Make-Up	:::	:::	32.22	:::	:::	27.72
L9132	Non Fish Bearing	TWUP A2011-153	12/5/2016	:::	:::	:::	12.04	0.00	0.00	0.00
L9323	FH03-III-0380	TWUP A2008-181/TWUP A2013-146	12/15/2018	Ice Road/Pad	:::	:::	8.51	:::	:::	8.15
L9324	FG03-III-0381	TWUP A2013-146	12/15/2018	Ice Road/Pad	:::	:::	1.65	1.08	0.00	1.08
K209	FH11-III-0302	LAS 23900	Permanent	Ice Road Pad	:::	:::	11.00	:::	:::	7.64
K214	FH11-III-0299	LAS 2762	Permanent	Ice Road/Pad/Drilling Make-Up/Other/DS/ Wells SPT	:::	:::	37.80	:::	:::	4.87
M9602	FH05-III-0327	TWUP A2010-119	12/2/2015	Ice Road/Pad	0.76	30.63	31.39	0.16	4.81	4.97
M9603	FH05-III-0338	TWUP A2011-154	12/8/2016	Ice Road/Pad	8.72	14.53	23.25	:::	:::	5.04
M9605	FH05-III-0328	TWUP A2010-119	12/2/2015	Ice Road/Pad	8.52	13.62	22.14	5.55	2.62	8.17
M9607	FH03-III-0384	TWUP A2008-180/TWUP A2013-145	12/15/2018	Ice Road/Pad	:::	:::	5.47	4.54	0.00	4.54
Nanuq Lake	FH06-III-0150	TWUP A2011-51	12/11/2016	Ice Road/Pad	0.13	13.43	13.56	0.00	10.28	10.28
Notes	1 Per water year. Some permits do not stipulate specific liquid/ice volumes. 2 Total permitted withdrawal may be either ice, water, or a combination 3 Total withdrawal volume between June 1, 2013 and May 31, 2014. Specific liquid/ice withdrawal volumes not available when not stipulated in permit. ::: n/a									

3.0 STUDY METHODS

3.1 CATCHMENT BASIN AREA DELINEATION (DETAILED STUDY LAKES)

The catchment basins for lakes M9602 and M9605, including lake and tundra areas, were delineated using satellite imagery, topographic maps, and visual assessment of the local topography prior to the field study. Topographic data for this area is limited and as a result, the catchment basin delineation for both lakes is subjective. In addition to limited topography, seasonal data about nearby water bodies such as wetlands and ponds, with potential to contribute to recharge, is lacking. These areas have additional capacity and were not included within the catchment basin delineation.

3.2 WATER SURFACE ELEVATIONS SURVEYS

To estimate lake water recharge, changes in WSE were measured at each study lake except B8533, L9132, and Nanuq Lake. Gages were rehabilitated for 2014. WSE monitoring was conducted at ten study lakes during the pre-breakup, breakup, and post-breakup periods.

Photo 1: Staff gage at Lake M9607, pre breakup; May 5, 2014

A staff gage assembly consists of a metal gage faceplate mounted on a two-by-four timber. The timber is attached with U-bolts to a 1.5-inch wide angle iron driven approximately 2 feet into the ground. All gages installed are indirect-read staff gages; meaning, the values read on the gage faceplate do not directly correspond to a known elevation. Photo 1 shows the gage setup at Lake M9607. A tabulated list of gage and temporary benchmark (TBM) locations is included in Appendix A.

Standard differential leveling techniques were used to establish staff gage elevations with local TBMs. A single new TBM was installed when a preexisting TBM was farther than ¼ mile from the study lake. New TBMs were all given an arbitrary elevation of 100.00 feet. An arbitrary elevation of 100.00 feet is typically used to avoid confusion with actual British Petroleum Mean Sea Level (BPMSL) elevations which are much lower in the surrounding terrain.

Elevations of the staff gages at lakes L9323 and L9324 were based on preexisting TBMs tied to BPMSL elevations. Elevations of gages at the remaining eleven lakes were based on TBMs established in 2011, 2012, and 2014 with arbitrary elevations of 100.00 feet. WSE recorded at staff gages tied to arbitrary elevations are relative to each other and used to illustrate a change in WSE for the specific lake; they are not tied to BPMSL elevations.

Pre-breakup WSE was located at all lakes, except lakes M9602 and M9605, by using an electric drill to auger a 2-inch sampling hole in the ice covering the lake. Because ice was grounded in the sample area at lakes M9602 and M9605, top of ice elevations were substituted for pre-breakup WSE for analysis. Top of ice elevations vary from actual WSE depending on ice thickness and density, snow cover, and location and are used as a conservative approximation (Baker 2002). Ice surface elevation was determined through differential leveling. WSE was calculated by subtracting measured freeboard from the ice surface elevation at the sample location. Freeboard was measured using a pocket rod.

During site visits, the observed water level on the gage faceplates was recorded. Chalk was applied to the angle iron during each site visit to capture high water marks (HWM). Subsequent HWMs were recorded during site visits when floodwaters removed the chalk. In some cases, HWMs were not evident.

When water levels were not sufficiently high to be recorded on the staff gage face plates, standard differential leveling techniques were used to measure WSE. The horizontal position of each staff gage and TBM was recorded using a handheld global positioning system (GPS) in North American Datum of 1983 (NAD83). Gage readings associated with local ponding were recorded, but were not used to generate the lake recharge hydrograph.

3.3 Snow Water Equivalent Surveys (Detailed Study Lakes)

3.3.1 Double Sampling Method

A double sampling method snow survey was conducted on lakes M9602 and M9605, as recommended in various industry papers and the 2007 CRD lakes recharge report (Baker 2007). Prior to fieldwork, snow sampling points were identified along predetermined transects.

Each snow survey transect was positioned to align across or perpendicular to snow features such as drifts and local topography (Woo 1997). For the double sampling method, measurements were recorded by measuring snow depth and mass at a smaller number of sample points, and by measuring snow depth at a larger number of sample points. While vegetation is not a major factor affecting snow distribution in the arctic, terrain has a major effect. Terrain-based snow surveys allow for more accurate determinations of mean catchment snow values and produces sufficient spatial snow information for most hydrological studies (Woo 1997). For the purposes of this study, terrain was identified in the field as either lake (based on the presence of ice) or tundra (based on the presence of vegetation) for each sample collected. Terrain was verified using existing maps in geographic information system (GIS) format.

3.3.2 Sampling Transects and Points

Aerial imagery and topographic contours were used to delineate the lake catchment basins. Transects were aligned radiating outwards from the estimated center of the lake to the edge of the drainage basin to account for variability of drifted snow across the ice and at and over banks. Additional transects were selected to capture irregularities, including basin arms or other departures from a classic bowl shape.

Sampling points were then established along transects at a uniform spacing of approximately 200 feet. The total number of sampling points was dependent on the length of each transect and the anticipated variability in snow within the terrain unit. By placing a sampling point at the intersection of transects and spacing sampling points at a uniform distance along transects, random sampling was accomplished. Each terrain type covered by a single transect included at least one snow mass sampling point. Sampling points were stored in two GPS units.

At lakes M9602 and M9605, isolated mechanically disturbed areas of snow of various size and shapes were encountered. Berms were formed by snow clearing to access lake surface ice for aggregate removal, and by the accumulation of snow drifts. Prior to the survey, additional snow had re-covered previously cleared lake surfaces though not necessarily to the median natural depth. Snowmelt contribution from the berms was considered an additional lake recharge source. To estimate berm quantities, snow mass and depths were sampled along representative transects and berm areas were found by recording circumnavigation tracks in a GPS unit. Berm snowmelt contribution calculations were performed assuming natural median snow depth on the cleared areas was reached at the time of investigation.

3.3.3 Snow Density Sampling

Density measurements were conducted according to procedures outlined in *National Resource Conservation Service (NRCS) Snow Survey Sampling Guide* (NRCS 2006) and *British of Columbia Snow Survey Manual* (BC Ministry of Environment 1981), using a $1^{5}/_{8}$-inch ID Model 3600 Mt. Rose (Standard Federal) snow sampling tube and scale (Photo 3.2). This sampler was chosen based on its common acceptance and use by the NRCS. Snow depth alone was sampled using a graduated snow pole.

Photo 2: Collecting core using Mt. Rose Snow Sampler (Model 3600); April 30, 2014

If shallow snow was encountered having a SWE of less than 2 inches, estimated by having a depth of less than twelve inches, bulk sampling was conducted (NRCS 2006). Bulk sampling is a grouping of multiple samples collected in the immediate area of the sample point, recording sample depth of each sample and averaging, then weighing pooled core samples (Photo 3.3). Bulk samples are then divided by the number of samples collected to determine an average weight for the sample location (Baker 2007).

Photo 3: Weighing bucket of pooled snow samples; April 30, 2014

3.3.4 Snow Water Equivalent Lake Recharge Methods

The methods and equations used in this report for calculating SWE and the potential recharge contribution are the same used in the Baker 2007 report. Terrain-specific average snow depths were collected by field crews using the graduated snow pole (Photo 3.4) and snow sampler. To calculate the terrain specific snow depth for each lake catchment, Equation 1 was used.

Photo 4: Field crew taking snow core with Mt Rose Sampler and depth measurements with a graduated snow pole; April 30, 2014

Equation 1 - Terrain Specific Snow Depth of Catchment

$$d_i = \left[\sum_{l=1}^{p} d_l \right] \Big/ p$$

$$d_i = Terrain\ Specific\ Snow\ Depth\ of\ Catchment\ (in)$$
$$l = Individual\ Sample$$
$$p = Total\ Number\ of\ Terrain\ Specific\ Depth\ Samples$$
$$d_l = Measured\ Snow\ Depth\ (in)$$

Terrain specific average snow densities were then calculated using the snow sampler's cross sectional area, core depth, and the weights of the snow samples using Equation 2.

Equation 2 – Terrain Specific Snow Density of Catchment

$$\rho_i = \left[\sum_{k=1}^{m} \left(\frac{M_{snow}}{A_{core} d_{snow}} \right)_k \right] \Big/ m$$

$$\rho_i = Terrain\ Specific\ Snow\ Density\ of\ Catchment\ (lb/in^3)$$
$$k = Individual\ Sample$$
$$m = Total\ Number\ of\ Terrain\ Specific\ Core\ Samples$$
$$M_{snow} = Measured\ Mass\ of\ Snow\ Sample\ (lb)$$
$$A_{core} = Area\ of\ Sampling\ Tube\ (in^2)$$
$$d_{snow} = Depth\ of\ Snow\ Sample\ (in)$$

Using the terrain specific snow densities, terrain specific SWE were then calculated using Equation 3.

Equation 3 – Terrain Specific SWE of Catchment

$$SWE_i = \frac{(\rho_i d_i)}{\rho_w}$$

$$SWE_i = Terrain\ Specific\ Snow\ Water\ Equivalent\ of\ Catchment\ (in)$$
$$\rho_i = Terrain\ Specific\ Snow\ Density\ (lb/in^3)$$
$$d_i = Terrain\ Specific\ Snow\ Depth\ (in)$$
$$\rho_w = Density\ of\ Fresh\ Water\ (lb/in^3)$$

An area weighted SWE was calculated for the catchment basins using Equation 4. This calculation is based on Woo (1997) and Rovansek, Kane, and Hinzman (1993).

Equation 4 – Catchment Specific, Area Weighted SWE

$$SWE_C = \frac{\left(\sum_{i=1}^{n} \rho_i d_i A_i \Big/ \sum_{i=1}^{n} A_i \right)}{\rho_w}$$

$$SWE_C = Catchment\ Specific\ Snow\ Water\ Equivalent\ (in)$$
$$i = Terrain$$
$$n = Total\ Terrains\ Sampled\ in\ Catchment$$
$$\rho_i = Terrain\ Specific\ Snow\ Density\ (lb/in^3)$$
$$d_i = Terrain\ Specific\ Snow\ Depth\ (in)$$
$$A_i = Terrain\ Specific\ Area\ (ft^2)$$
$$\rho_w = Density\ of\ Fresh\ Water\ (lb/in^3)$$

Total calculated potential snowmelt contribution (V_P) and estimated recharge (V_O) were calculated for each lake using Equation 5 and Equation 6. The 2007 delta-wide runoff coefficient of 0.67 was applied to snowmelt contributed from tundra areas to account for reduced tundra contribution.

Equation 5 –Total Calculated Potential Snowmelt Contribution, per Lake

$$V_P = C_1 \left(SWE_l\ A_l + 0.67\ SWE_t\ A_t \right)$$

$$V_P = Total\ Calculated\ Potential\ Snowmelt\ Contribution\ (gal)$$
$$C_1 = Gallons\ of\ Water\ /\ ft^3\ /\ in$$
$$SWE_l = Lake\ Specific\ Average\ Snow\ Water\ Equivalent\ (in)$$
$$SWE_t = Tundra\ Specific\ Average\ Snow\ Water\ Equivalent\ (in)$$
$$A_l = Lake\ Specific\ Area\ (ft^2)$$
$$A_t = Tundra\ Specific\ Area\ (ft^2)$$
$$0.67 = 2007\ Delta - wide\ Runoff\ Coefficient$$

Equation 6 – Estimated Recharge, per Lake

$$V_O = C_2 A_l WSE_\Delta$$

$$V_O = Estimated\ Recharge\ (gal)$$
$$C_2 = Gallons\ of\ Water / ft^3$$
$$A_l = Lake\ Specific\ Area\ (ft^2)$$
$$WSE_\Delta = Difference\ Between\ Pre-Breakup\ and\ Peak\ WSE\ (ft)$$

3.4 Lake Recharge Observations

Throughout breakup, each lake was monitored for changes in WSE. Aerial photographs were taken from a helicopter using a GPS camera. Photos were taken from various perspectives to capture the extent of snow melt, flow pattern, potential lake water recharge sources, and hydraulic connectivity with other water bodies. Written documentation of visual observations combined with time-stamped GPS photos support identification of each lake's recharge mechanism(s), extent, and timeline.

Hydrographs showing change in WSE over time were used to determine estimated lake recharge. Recession of floodwaters is evident in a negative slope after peak stage, indicating a lake has recharged over bankfull conditions and is discharging excess water by means of overbank flow.

3.5 2013/2014 Ice Road Contributions

As-built drawings for the 2013/2014 ice road construction season were used to estimate the volume of ice road melt water recharge that contributed to lakes M9602 and M9605 catchment basins. Ice road contributions to local hydrology were determined using an estimated value of one million gallons of water per mile of ice road (ASCG 2005).

4.0 STUDY RESULTS

4.1 DETAILED STUDY LAKES

The catchment basin delineations, snow surveys, SWE calculation results, WSE observations, lake recharge observations, and historical comparison for the detailed study lakes, M9602 and M9605, are presented in this section.

4.1.1 CATCHMENT BASIN DELINEATION

Catchment basin delineations for lakes M9602 and M9605 are presented in Figure 4.1 and Figure 4.2. Lake areas were taken from bathymetry reports (Appendix B) and GIS layers provided by CPAI.

Above average temperatures in late April and early May initialized melting of snow and ice within the catchment basin of lakes M9602 and M9605. By mid-May, most of the tundra in the catchment basin was exposed with areas of patchy snow cover. Temperatures dropped below average between mid-May and early June, delaying further melting in the catchment basins.

Photo 5: Lake M9602 during breakup, looking south; June 6, 2014

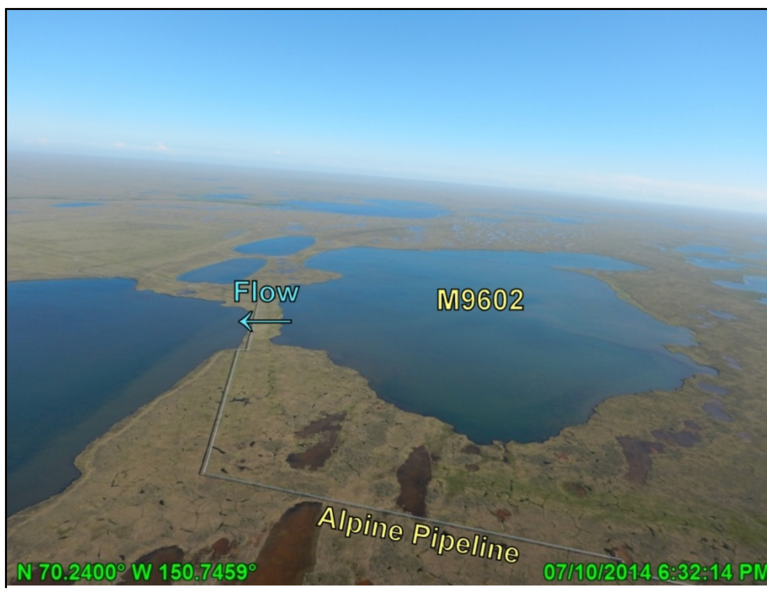


Photo 6: Lake M9602 post-breakup, looking south; July 10, 2014

On June 6, only local melt was present around the Lake M9602 boundary with no flow passing into Lake M9601 (Photo 5). During breakup monitoring, no overland flow sources were identified as contributing to the recharge of Lake M9602 aside from local snowmelt. During the final visit on July 10, outflow was observed into Lake M9601 (Photo 6).

Recharge processes during the 2014 season for Lake M9605 were comparable to the 2013 breakup (Baker 2013). On June 6, inflow was identified from a wetland to the southeast, and outflow was identified through a channel into an unnamed lake to the north (Photo 7). The catchment basin includes only a portion of this southern wetland and therefore the area of the basin is likely conservative.

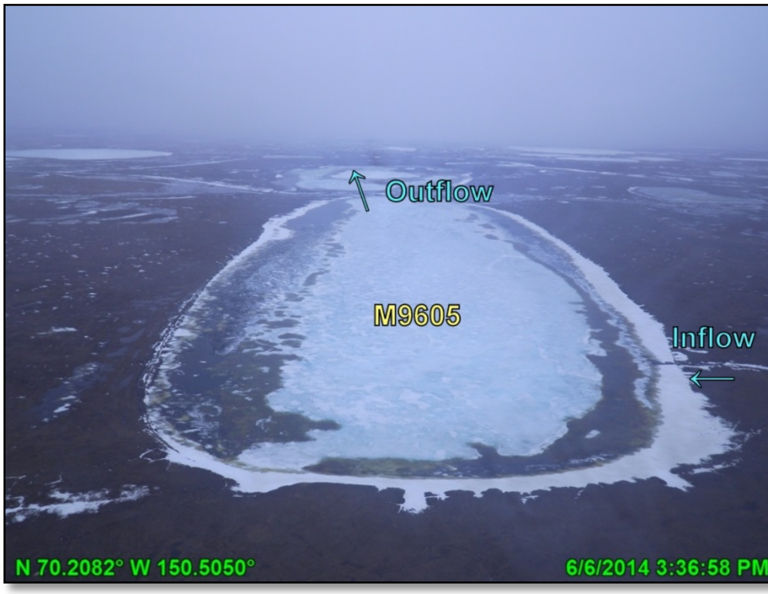
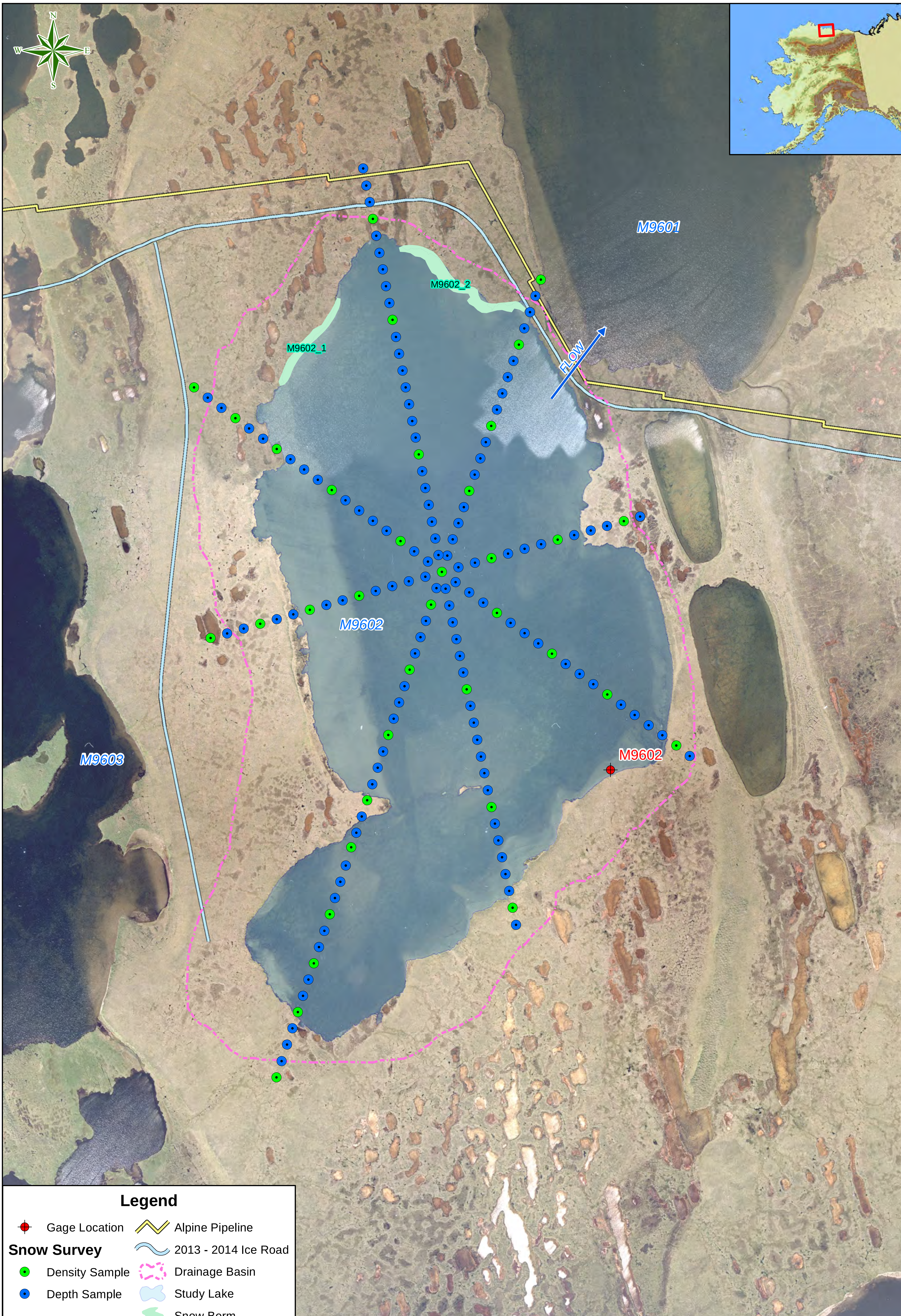


Photo 7: Lake M9605 during breakup receiving inflow, looking north; June 6, 2014



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M9602
DRAINAGE BASIN DELINEATION
& SNOW SURVEY LOCATIONS
FIGURE: 4.1
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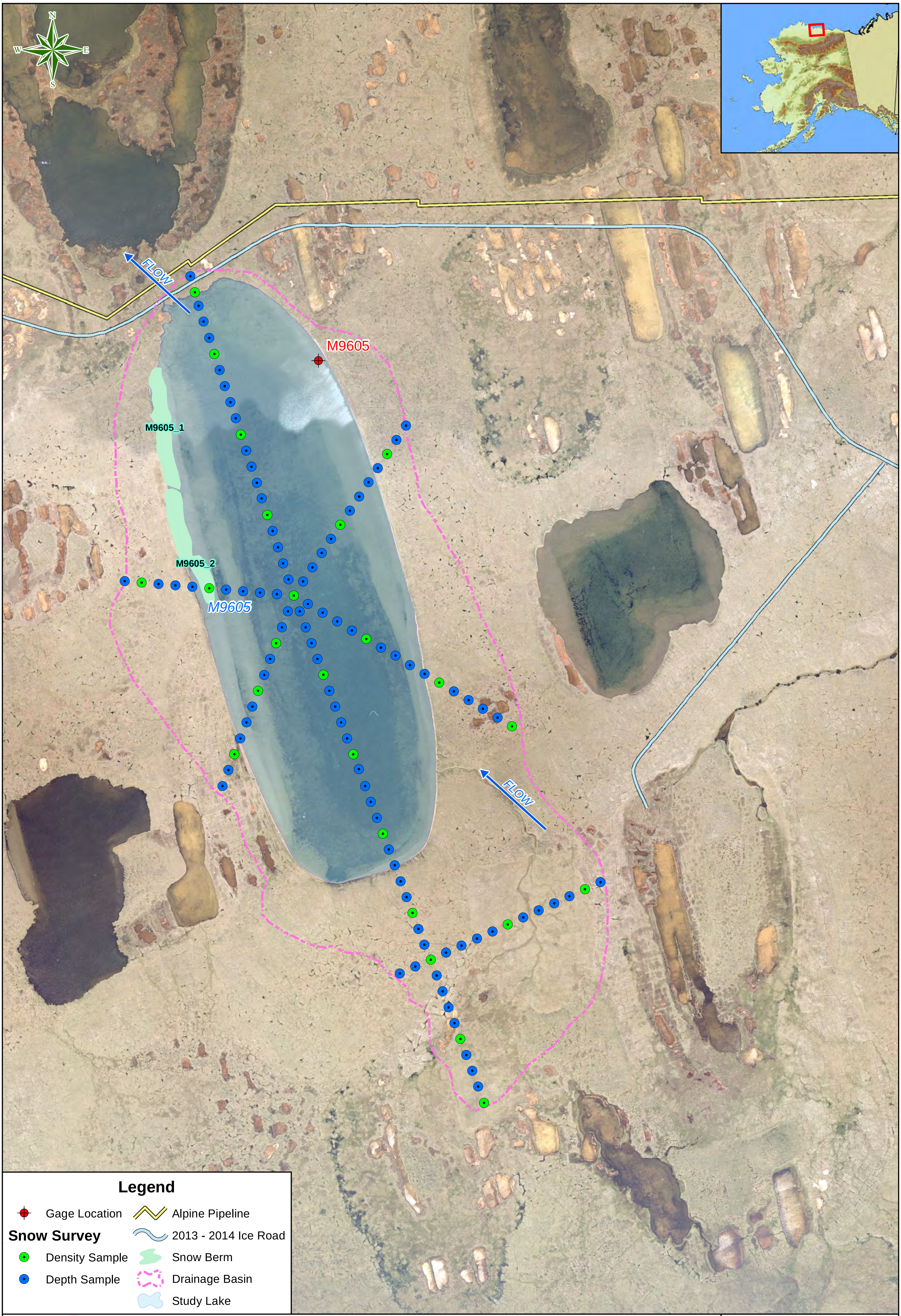

ConocoPhillips Alaska

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M9605

DRAINAGE BASIN DELINEATION & SNOW SURVEY LOCATIONS

FIGURE: 4.2

(SHEET 1 of 1)

4.1.2 Snow Survey and Snow Water Equivalent

Photo 8: Snow berm located on the northern bank of Lake M9602, looking east; April 20, 2014

Snow surveys were conducted prior to CRD spring breakup setup at Lake M9602 on April 29 and at Lake M9605 on April 30.

Seasonal snow cover conditions at the lakes varied from the Baker 2013 results (Baker 2013). Snow cover on the lakes was thinner, denser, and comprised less SWE than on nearby tundra. Overall snow depths were less than in 2013, except the lake snow depth average for Lake M9605, which was the same as that measured in 2013.

Snow density was generally greater over both lake and tundra, except the tundra surrounding Lake M9605 where the 2014 average density was the same as the 2013 average density. The catchment basin of Lake M9602 contained the same overall SWE, and the basin of Lake M9605 contained less overall SWE than in 2013.

Snow berms and drifts were present at lakes M9602 and M9605, and are shown in Photo 8 and Photo 9, respectively. Both lakes had two berms; those on Lake M9602 were located along the north bank while berms on Lake M9605 were located along the west bank.

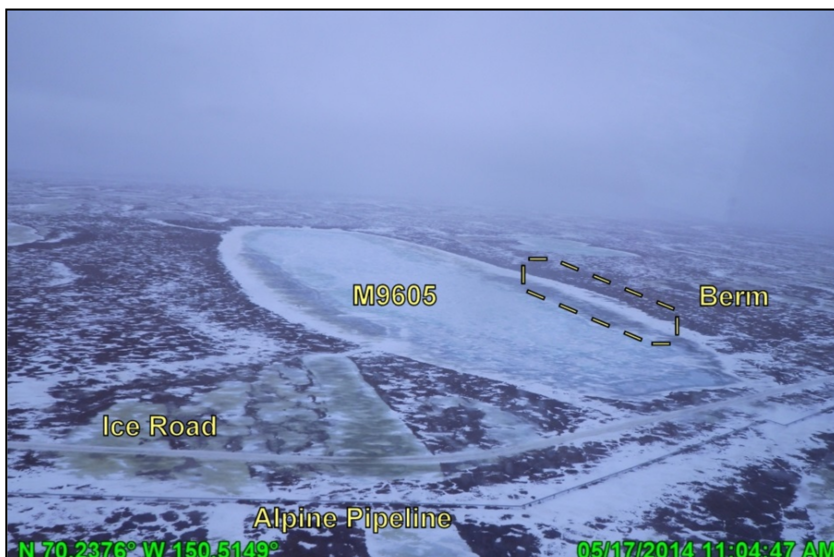


Photo 9: Berms along west bank of M9605 pre-breakup, looking south; May 17 2014

Berm snowmelt contribution calculations were performed assuming natural median snow depth on the cleared areas was reached at the time of investigation. Overall depth and density of the berms was greater than adjacent naturally accumulated snow resulting in an increased SWE for these features. The SWE summaries for lakes

M9602 and M9605 and their respective berms are presented in Table 4.1. Comprehensive snow survey data sheets are included in Appendix C.

Table 4.1: Detailed Study Lakes Snow Survey Summary

Lake	Area[1] (ft²)		Average Snow Depth (in)		Average Density (lb/in)		Average SWE (in)		Catchment Basin Weighted SWE[2] (in)
	Lake	Tundra	Lake	Tundra	Lake	Tundra	Lake	Tundra	
M9602	28,426,616	14,677,378	8.3	15.8	0.011	0.010	2.55	4.45	3.19
M9605	14,841,964	17,865,930	8.0	15.4	0.011	0.008	2.48	3.49	3.03
Notes:	1. Calculated from delineated drainage basins determined from aerial imagery minus the area encompassed by berms 2. Specific to feature per lake and tundra contribution based on respective areas.								

4.1.3 Water Surface Elevation

WSE was measured during and after spring breakup at lakes M9602 and M9605. Multiple attempts to measure pre-breakup WSE through holes drilled into the lake ice were unsuccessful. Only grounded ice was encountered at the drilled locations and therefore WSEs were not acquired. Top of ice elevations were measured at lakes M9602 and M9605 and were used as a conservative approximation for analysis purposes.

Melting of ice and snow at lakes M9602 and M9605 occurred slower than other study lakes because they are located outside of the CRD and lack significant channelized and overland flow. During breakup monitoring, substantial ice and snow covered the lake surfaces and no flow was observed into or out of Lake M9602, while two small channels transmitted flow into and out of Lake M9605.

Final WSEs for Lakes M9602 and M9605 were measured on July 10, at which point all snow and ice in the catchment basins had melted. WSE data and graphic representations for the Detailed Study Lakes are presented in Table 4.2 and Table 4.3.

Table 4.2: WSE Data for Lake M9602

Date and time	WSE (feet)	Observations
5/5/14 1:00 PM	*96.24*	*Grounded ice observed, elevation represents top of ice elevation*
6/6/14 3:27 PM	97.50	No outflow observed
7/10/14 6:20 PM	96.13	Outflow into Lake M9601 to the northeast

Notes:

1. Elevations are assumed based on TBM M9602-X at 100.00 feet, installed by Baker in May 2011
2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct

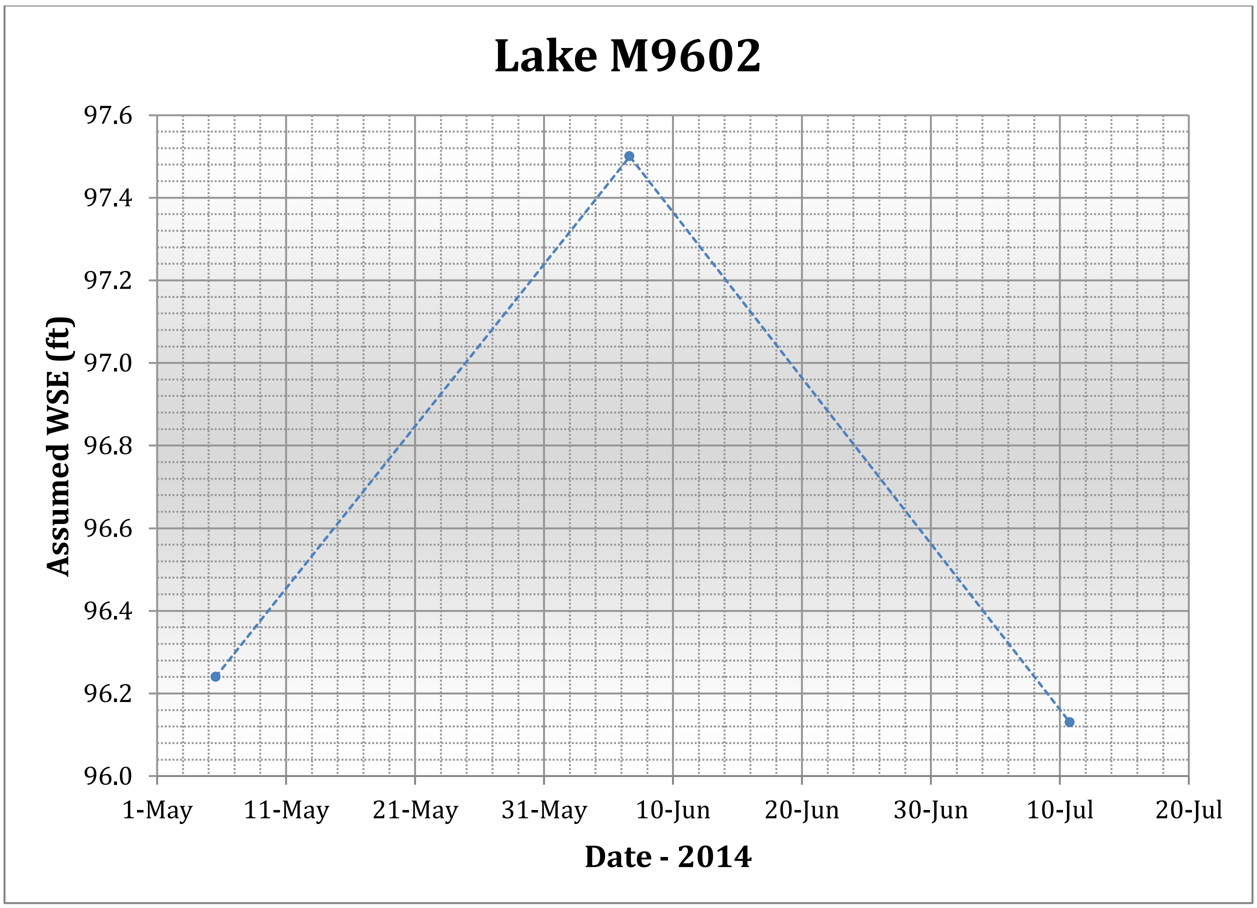
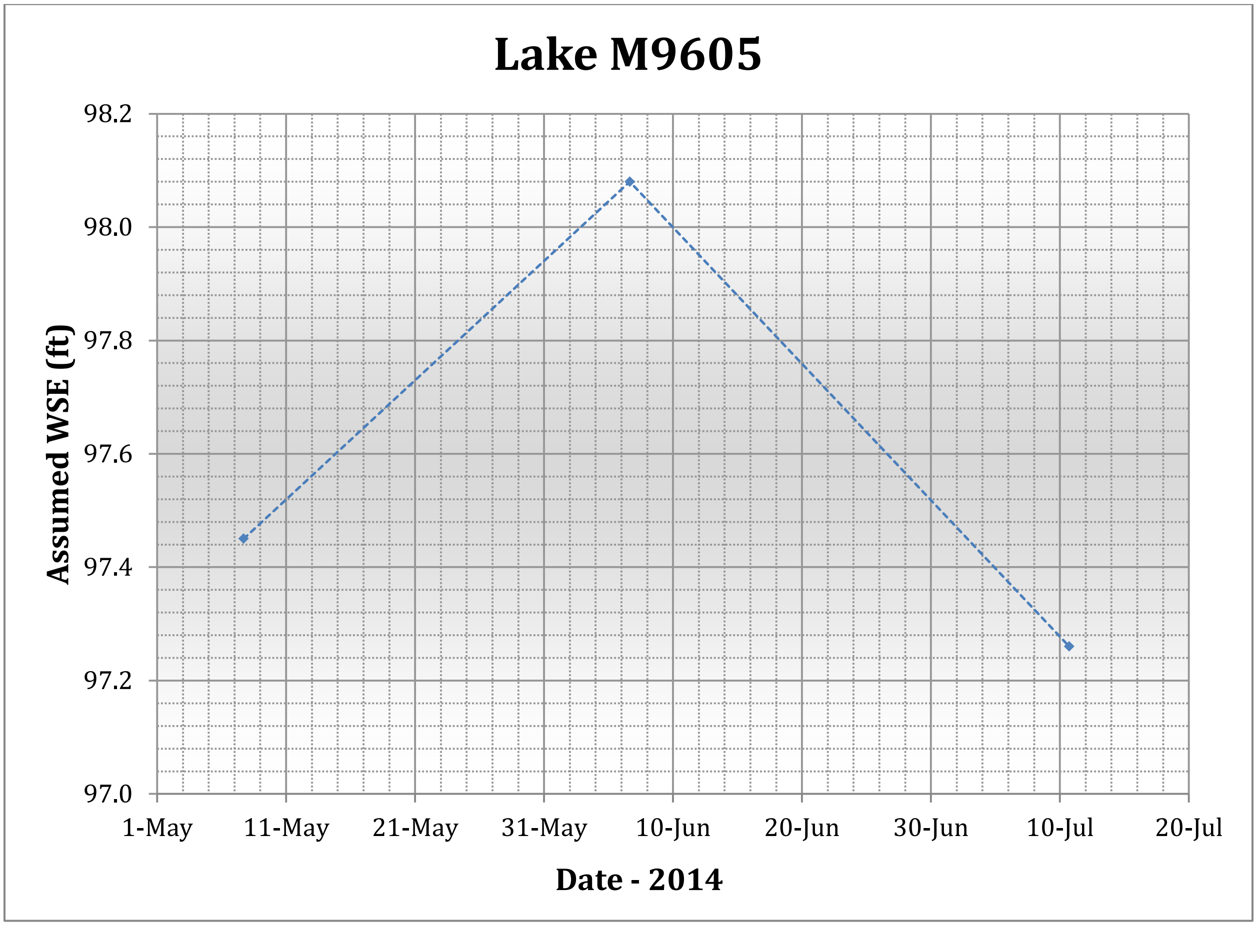


Table 4.3: WSE Data for Lake M9605

Date and time	WSE (feet)	Observations
5/7/14 5:00 PM	*97.45*	*Grounded ice observed, elevation represents top of ice elevation*
6/6/14 3:41 PM	98.08	Inflow from a wetland to the southeast
7/10/14 5:35 PM	97.26	Outflow north into unnamed lake

Notes:

1. Elevations are assumed based on TBM M9605-X at 100.00 feet, installed by Baker in May 2011
2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct



4.1.4 Lake Recharge

During the 2014 monitoring season, Lake M9602 recharged over bankfull conditions as observed by channelized outflow to Lake M9601 (Photo 10), and is verified by a rise and recession of WSE presented in the hydrograph (Table 4.2). Lake M9605 recharged over bankfull conditions as observed by channelized outflow to an unnamed lake to the north (Photo 11), and is verified by a rise and recession of WSE presented in the hydrograph (Table 4.3).

Photo 10: Outflow from Lake M9602 into Lake M9601, looking southwest; July 10, 2014

Potential snowmelt contributions were calculated for lakes M9602 and M9605 based on SWE and lake areas, including areas of mechanically formed berms and their associated drifted snow accumulation.

Estimated recharge volume was determined by multiplying the lake surface area by the difference between the observed HWM elevation and pre-breakup top of ice elevation for lakes M9602 and M9605. The actual pre-breakup WSE is likely below the top of ice elevation; therefore, using the top of ice elevation provides a conservative estimate of recharge volume. The values are presented with calculated potential snowmelt contributions along with permitted and actual water use quantities for lakes M9602 and M9605 in Table 4.4.

Photo 11: Outflow from Lake M9605 to unnamed lake to the north, looking south; July 10, 2014

Table 4.4: Detailed Study Lakes Spring Breakup Recharge Summary

Lake	Calculated Potential Snowmelt Contribution[1]				Estimated Recharge[2]	Permitted Annual Water Use[3]	Actual Water Use[4]
	Lake	Tundra	Ice Road	Total			
	(Mgal)						
M9602	45.1	27.3	0.3	75.7	270.2	31.39	4.97
M9602 Berm 1	0.6	0.3	-				
M9602 Berm 2	1.9	0.3	-				
M9605	23.0	26.0	0.1	53.9	71.6	22.14	8.17
M9605 Berm 1	2.2	0.3	-				
M9605 Berm 2	1.8	0.4	-				
Notes:	1. Using the 2007 delta-wide runoff coefficient (0.67) and 2014 SWE. 2. Area of lake surface multiplied by the difference between peak WSE and the pre-breakup top of ice elevation. As a result, the estimated recharge quantities are likely lower than actual recharge. 3. Per AK DNR Fish Habitat Permit FH05-III-0327 Amendment #2 for Lake M9602, and FH05-III-0328 Amendment #2 for Lake M9605. 4. Total combined liquid and ice as water equivalent per CPAI water use report.						

4.1.5 Historical Results

Historical potential snowmelt contributions to lakes M9602 and M9605 are shown in Table 4.5. The catchment basin of Lake M9602 contained the same overall SWE, and the basin of Lake M9605 contained less overall SWE than in 2013. Drainage basin delineations were refined in 2011 (Baker 2011); these delineations were used in the succeeding years, including 2014.

Table 4.5: Comparison of Historical Results

Comparison of Historical Calculated Potential Snowmelt					
Lake	2010[1]	2011	2012	2013	2014
	(Mgal)				
M9602	48.3	101.1	77.5	75.1	75.7
M9605	40.6	61.8	67.6	61.1	53.9
Note:	1. Determined based on empirical data				

4.2 General Study Lakes

The lake recharge results and WSE data for the General Study Lakes are presented in this section.

4.2.1 Water Surface Elevation

WSE was measured before, during, and after spring breakup at lakes B8530, B8531/L9326, L9323, L9324, K209, K214, M9603, and M9607. Only aerial observations were performed at lakes B8533 and L9132 and Nanuq Lake. Throughout the study period, photos were taken to document changes at the lakes (Appendix D).

In general, WSE at the General Study Lakes increased during the breakup flood event and then decreased because of outflow as water levels subsided. The WSE data and hydrographs are presented in Table 4.6 through Table 4.13.

Table 4.6: WSE Data for Lake B8530

Date and Time	WSE (feet)	Observations
5/6/14 11:00 AM	95.12	
6/6/14 3:05 PM	95.47	No hydraulic connections
7/11/14 4:55 PM	95.18	No hydraulic connections

Notes:

1. Elevations are assumed based on TBM B8530-X at 100.00 feet, installed by Baker in May 2012
2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct

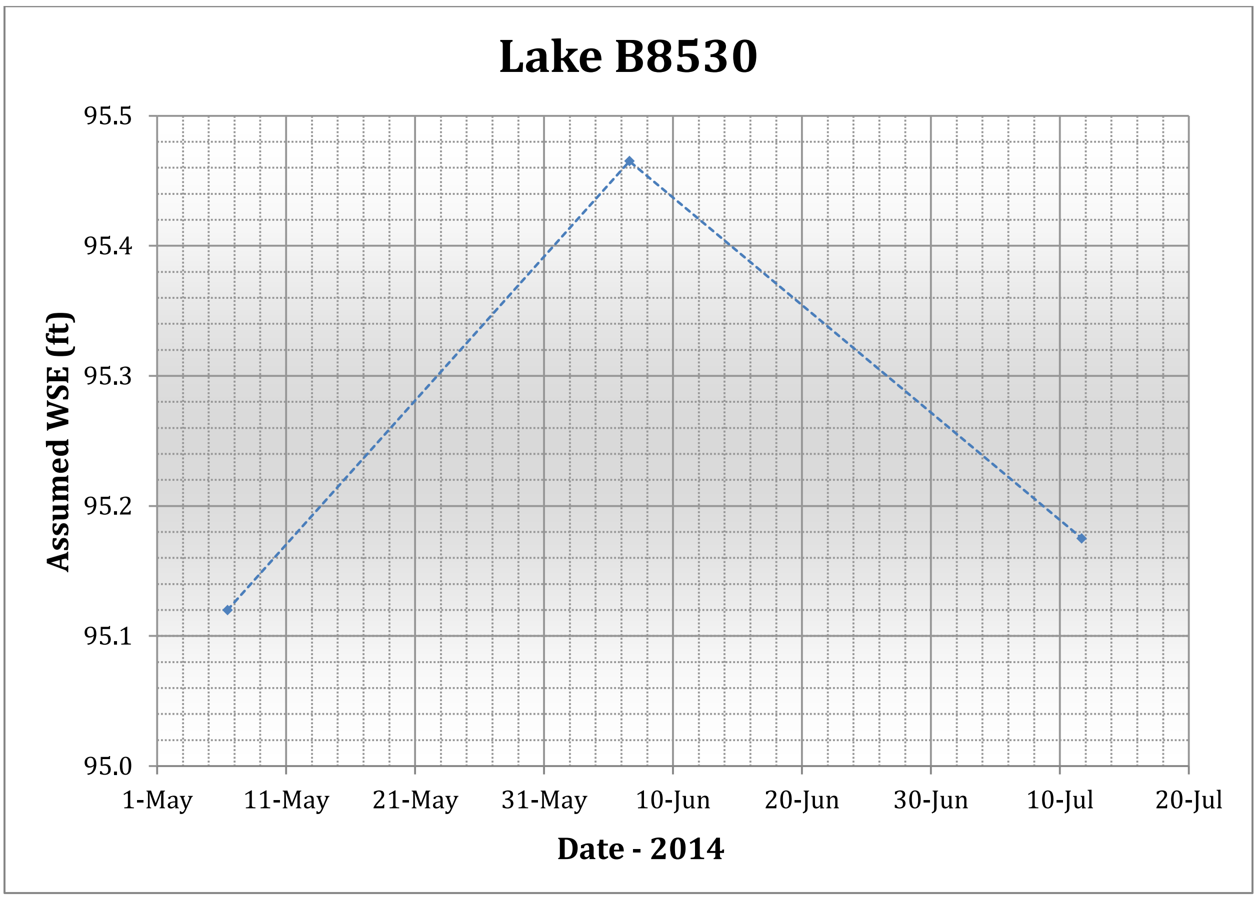


Table 4.7: WSE Data for Lake B8531/L9326

Date and Time	WSE (feet)	Observations
5/7/14 1:00 PM	90.61	
6/6/14 2:54 PM	92.65	No hydraulic connections
7/10/14 5:25 PM	90.91	Hydraulically connected to Lake M9606 via swale

Notes:

1. Elevations are assumed based on TBM B8531/L9326-X at 100.00 feet, installed by Baker in May 2011
2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct

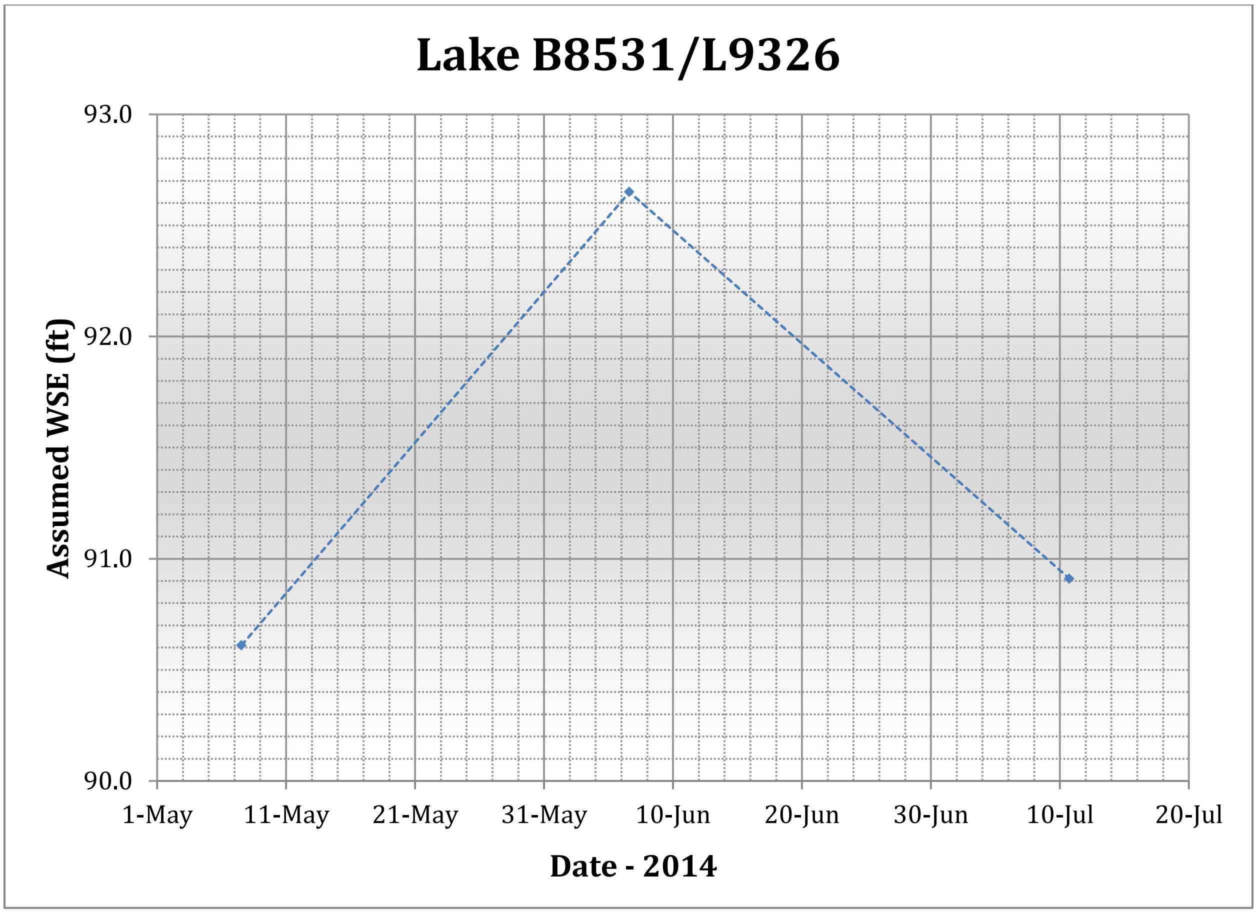


Table 4.8: WSE Data for Lake L9323

Date and Time	WSE (feet BPMSL)	Observations
5/6/14 4:00 PM	8.20	No hydraulic connections
5/23/14 2:35 PM	8.58	
6/1/14 4:02 PM	8.50	
6/2/14 11:39 AM	8.62	
6/3/14 11:38 AM	8.80	No hydraulic connections
6/8/14 12:04 PM	8.65	
7/10/14 1:27 PM	8.40	No hydraulic connections

Notes:

1. Elevations are based on Monument NANUQ 4 at 12.758 feet BPMSL, surveyed by LCMF in May 2011
2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct

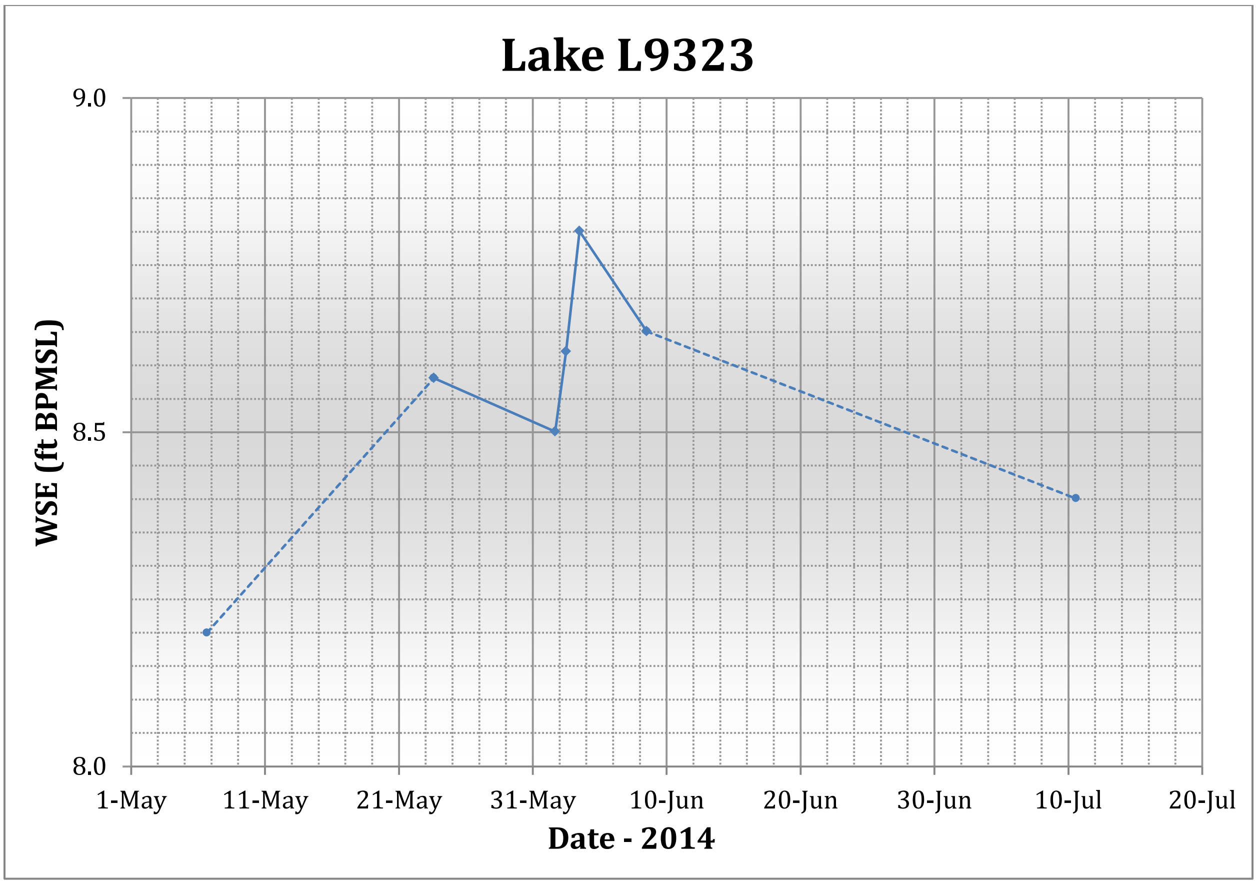


Table 4.9: WSE Data for Lake L9324

Date and Time	WSE (feet BPMSL)	Observations
5/6/14 2:30 PM	6.24	
5/18/14 10:22 AM	6.85	Inflow from Sakoonang Channel through southern paleolake
5/20/14 9:30 AM	10.90	
5/21/14 11:43 AM	9.55	
5/22/14 10:37 AM	8.69	
6/1/14 12:00 AM	10.45	High water mark – time approximated
6/1/14 4:37 PM	10.34	
6/2/14 12:12 PM	10.06	
6/3/14 12:09 PM	9.46	
6/4/14 3:25 PM	-	Connect to Nigliq Channel via Silas Slough
6/8/14 12:42 PM	7.03	
7/12/14 2:06 PM	4.82	Hydraulically connected to paleolake, no active drainage

Notes:

1. Elevations are based Monument NANUQ 5 at 17.461 feet BPMSL, surveyed by LCMF in May 2011
2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct

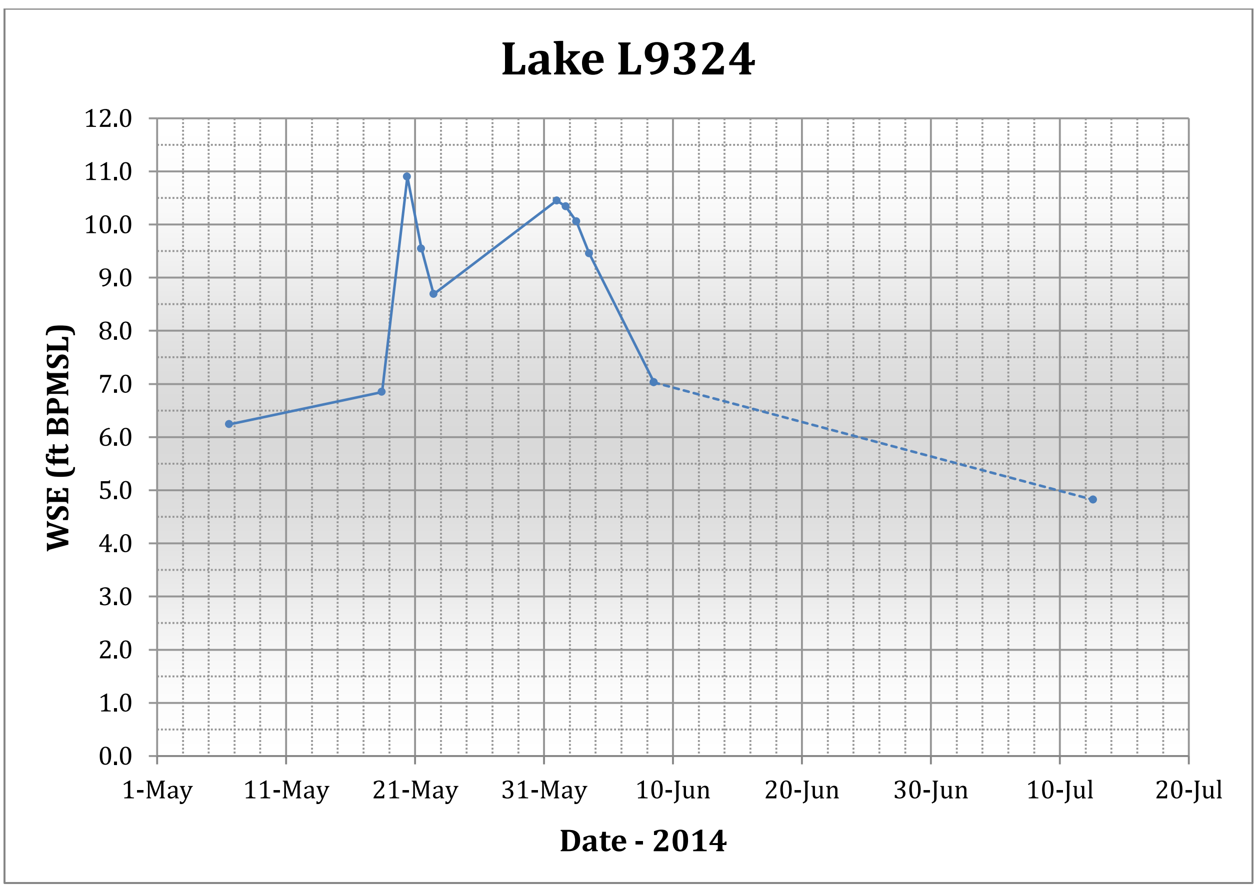


Table 4.10: WSE Data for Lake K209

Date and Time	WSE (feet BPMSL)	Observations
5/7/14 2:19 PM	90.73	
6/6/14 3:50 PM	91.26	No hydraulic connections
7/10/14 5:05 PM	90.80	Outflow north into unnamed lake

Notes:

1. Elevations are assumed on TBM K209-X at 100.00 feet BPMSL, installed by Baker in 2014
2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct

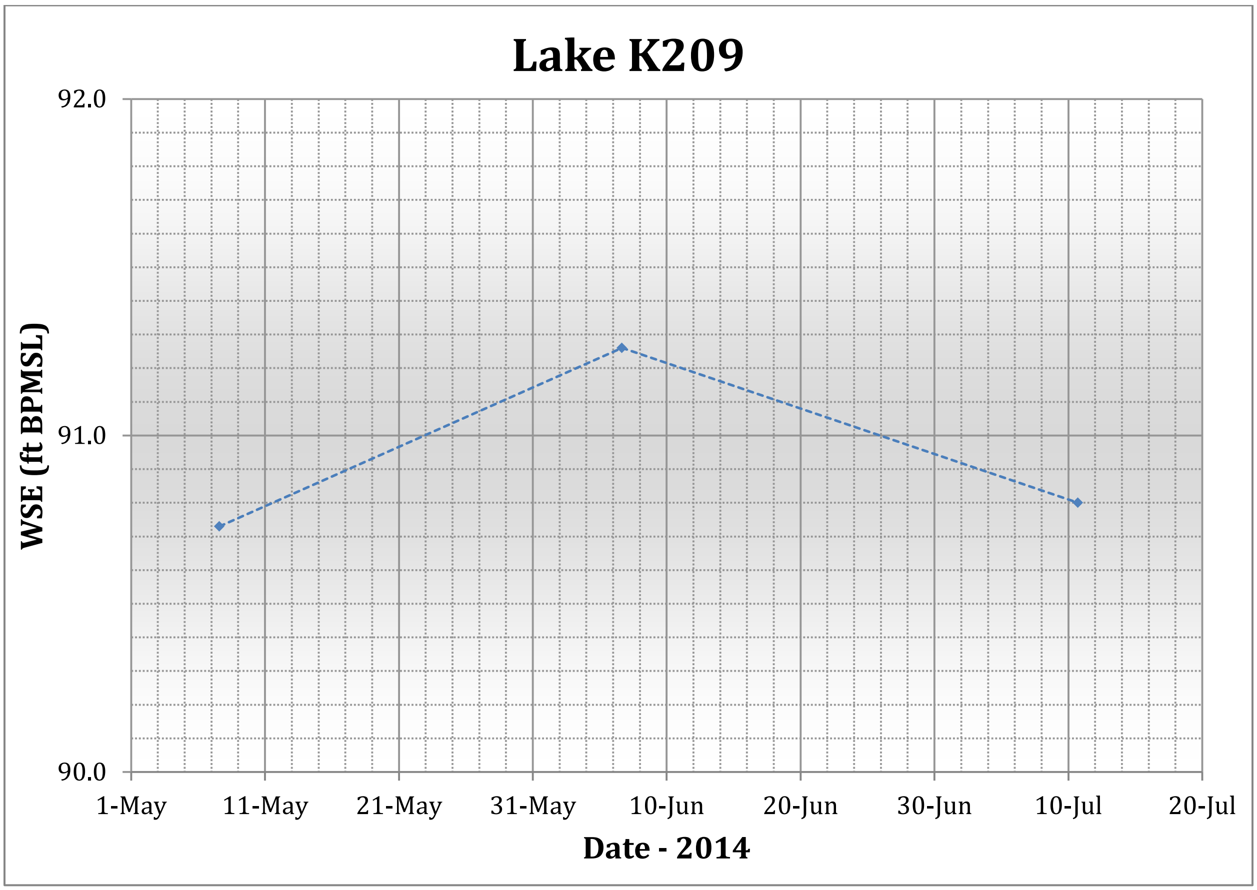


Table 4.11: WSE Data for Lake K214

Date and Time	WSE (feet BPMSL)	Observations
5/7/14 12:37 PM	*94.40*	*Grounded ice observed, elevation represents top of ice elevation*
6/6/14 4:06 PM	94.32	Inflow from culverts on the south bank
7/10/14 4:50 PM	93.89	Hydraulically isolated

Notes:

1. Elevations are assumed on TBM K214-X at 100.00 feet BPMSL, installed by Baker in 2014
2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct

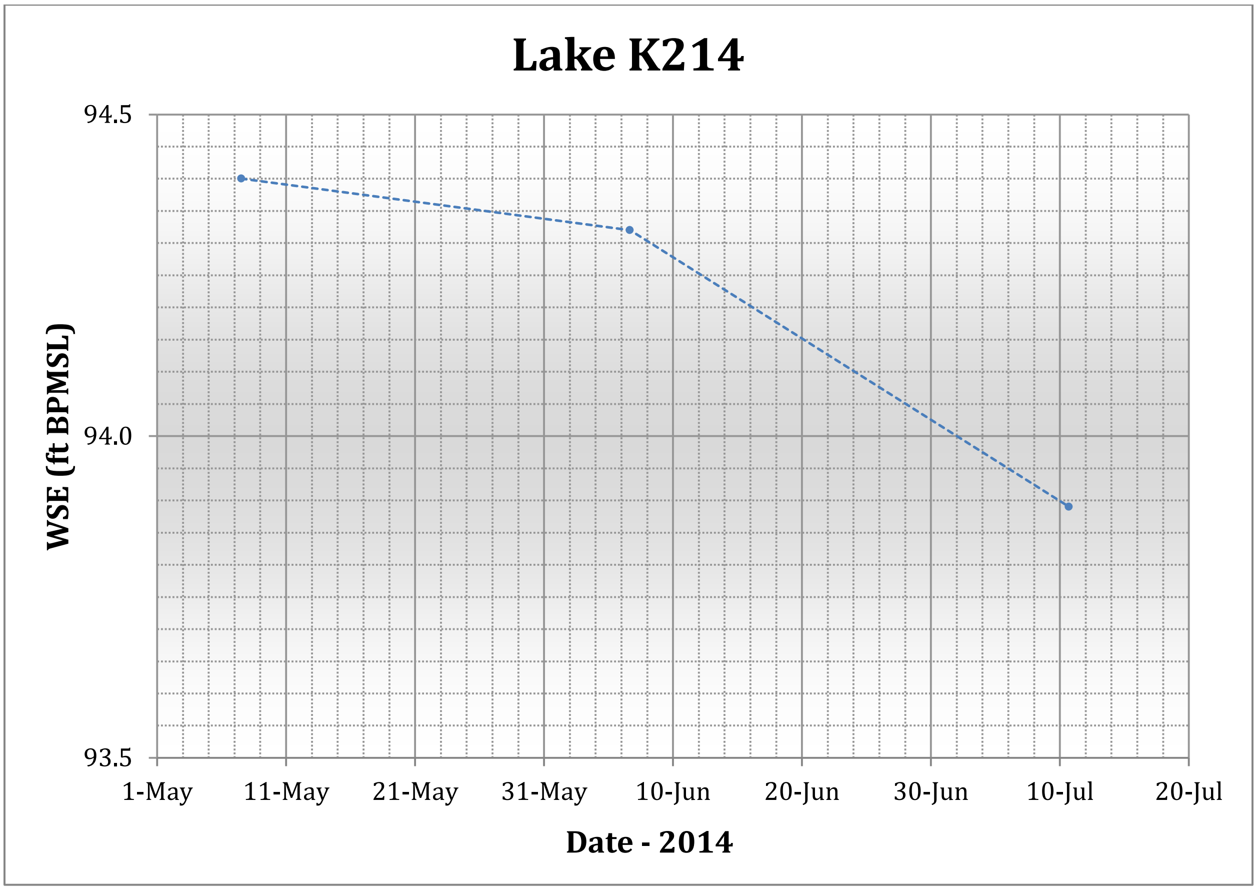


Table 4.12: WSE Data for Lake M9603

Date and Time	WSE (feet)	Observations
5/5/14 2:00 PM	96.34	
6/6/14 3:20 PM	98.00	No hydraulic connections
7/12/14 12:00 AM	96.68	Outflow north into Lake L9334/M9506

Notes:

1. Elevations are assumed based on TBM M9603-X at 100.00 feet, installed by Baker in May 2011
2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct

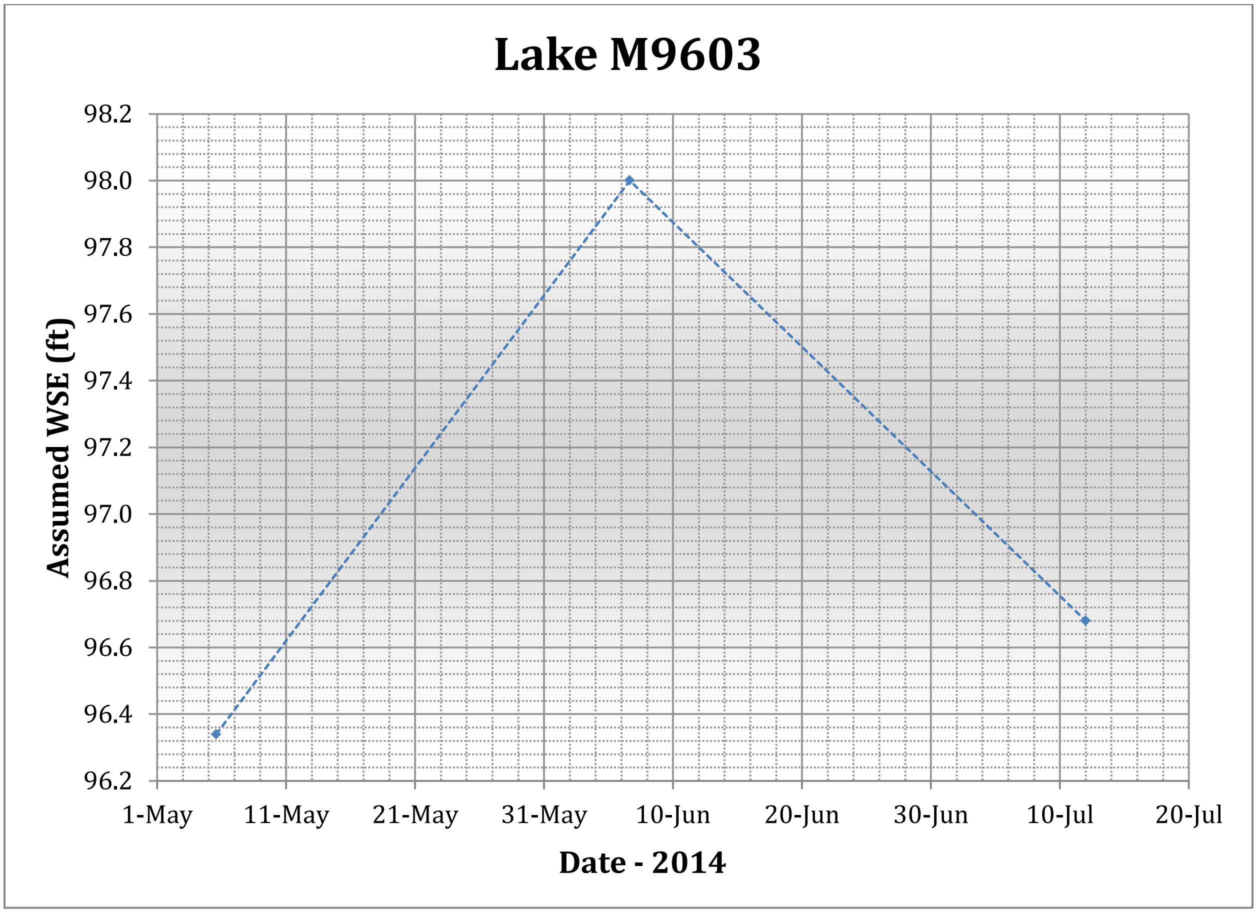
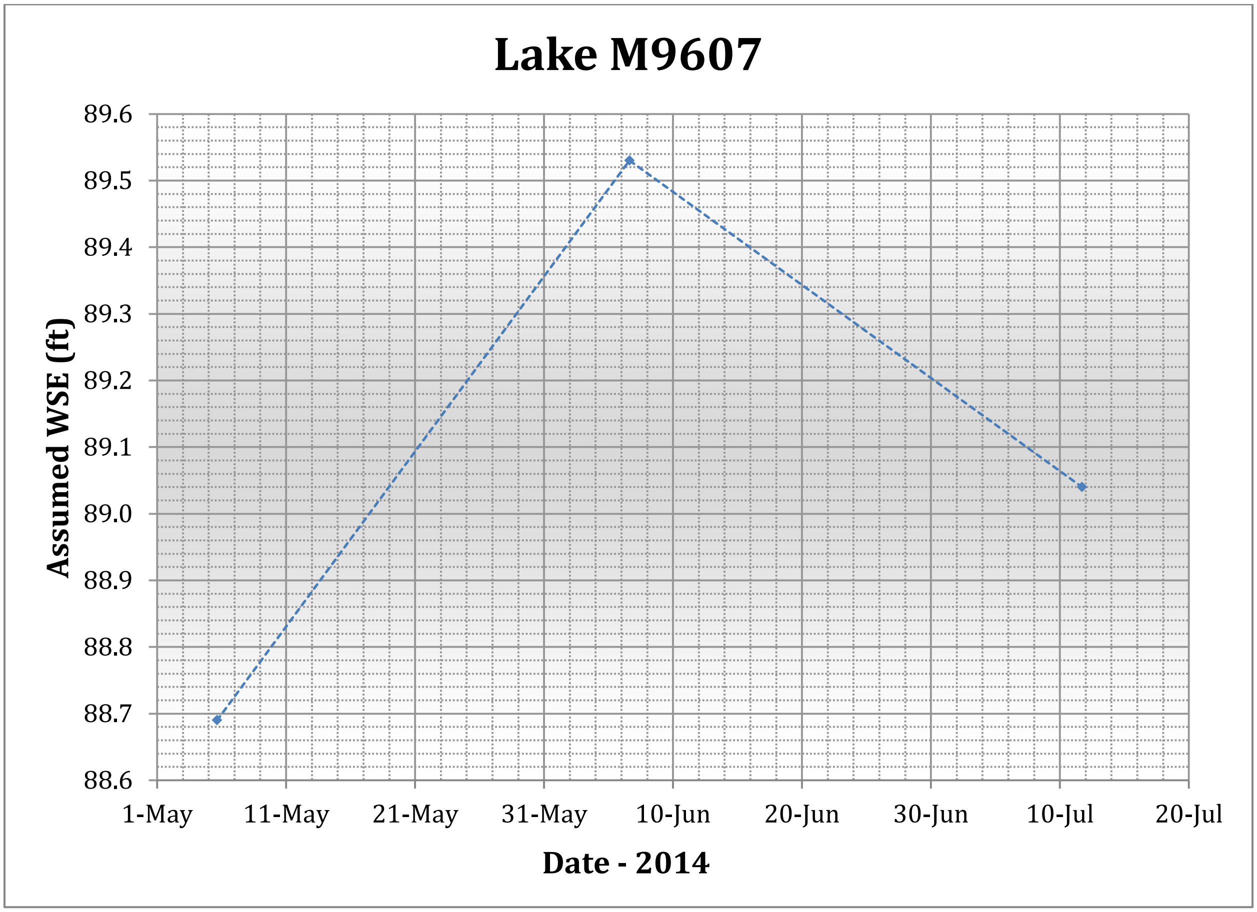


Table 4.13: WSE Data for Lake M9607

Date and Time	WSE (feet)	Observations
5/5/14 3:25 PM	88.69	
6/6/14 3:11 PM	89.53	No hydraulic connections
7/11/14 5:05 PM	89.04	No hydraulic connections

Notes:

1. Elevations are assumed based on TBM M9607-X at 100.00 feet, installed by Baker in May 2011
2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct



4.2.2 Lake Recharge

Most General Study Lakes were observed to fully recharge over bankfull during the 2014 monitoring season. This was evident by visual observations and the rise and recession of WSE in the hydrographs. Lake L9132 is the only lake where it is not clear if hydraulic connections draining into the low lying wetlands to the southeast existed.

All General Study Lakes, except Lake B8530, should be considered hydraulically isolated during the remainder of the year. Lake B8530 is hydraulically connected to Lake M9608 during the open water season.

4.3 SUMMARY

A compilation of 2014 hydrologic observations, including whether the lake recharged to bankfull, the primary recharge mechanism, additional hydraulic connections, and estimated bankfull WSE is provided in Table 4.14.

Table 4.14: Summary of 2014 Hydrologic Recharge Observations

Study Lake	Recharge to Bankfull	Primary Recharge Mechanism	Additional Hydraulic Connection[1]		Estimated Bankfull WSE[3] (feet BPMSL)
			Flow In	Flow Out	
M9602	√	Local melt	No channelized drainage into lake	Lake M9601 (northeast) via small drainage.	95.7 [4]
M9605	√	Local melt	Small drainages from wetlands (southeast and southwest)	Unnamed lake (north) via small drainage across ice road	91.2 [4, 5]
General Study Lakes					
B8530[2]	√	Local melt	No channelized drainage into lake	No channelized drainage out of lake	95.1 [4]
B8531/L9326	√	Local melt	No channelized drainage into lake	Lake M9606 (south) via swale	90.9 [4,5]
B8533	√	Local melt	Channelized flow from L9278 (east)	Flow into marshy area (north)	--
L9132	Inconclusive	Local melt	No channelized drainage into lake	No channelized drainage out of lake	--
L9323	√	Local melt	No channelized drainage into lake	No channelized drainage out of lake	8.3
L9324	√	Sakoonang via paleolake (southeast)	Sakoonang via paleolake (southeast), Nigliq Channel (northwest)	Channelized drainage into southeastern paleolake.	4.8
K209	√	Local melt	No channelized drainage into lake	Unnamed lake (north) via small drainage	*
K214	√	Road culverts (south)	Road culverts (south)	No channelized drainage out of lake	*
M9603	√	Local melt	No channelized drainage into lake	Channelized flow into Lake L9334/M9506 (north)	96.6 [4,5]
M9607	√	Local melt	No channelized drainage into lake	No channelized drainage out of lake	89.0 [4]
Nanuq Lake	√	Nigliq Channel (west)	Nigliq Channel (west)	M9524 (northwest)	--

Notes:
-- Recharge based on visual observation
1. Observations between May 1 and July 12, 2014. Unless specified, hydraulic connections are likely seasonal only.
2. Additional annual connection with Lake M9608 (west)
3. WSE estimated based on gage readings for all years available
4. WSE based on assumed elevation of 100.00 feet BPMSL
5. WSE estimated during active outflowing of water from the lake; actual WSE is likely lower
* Additional data required to estimate WSE

5.0 REFERENCES

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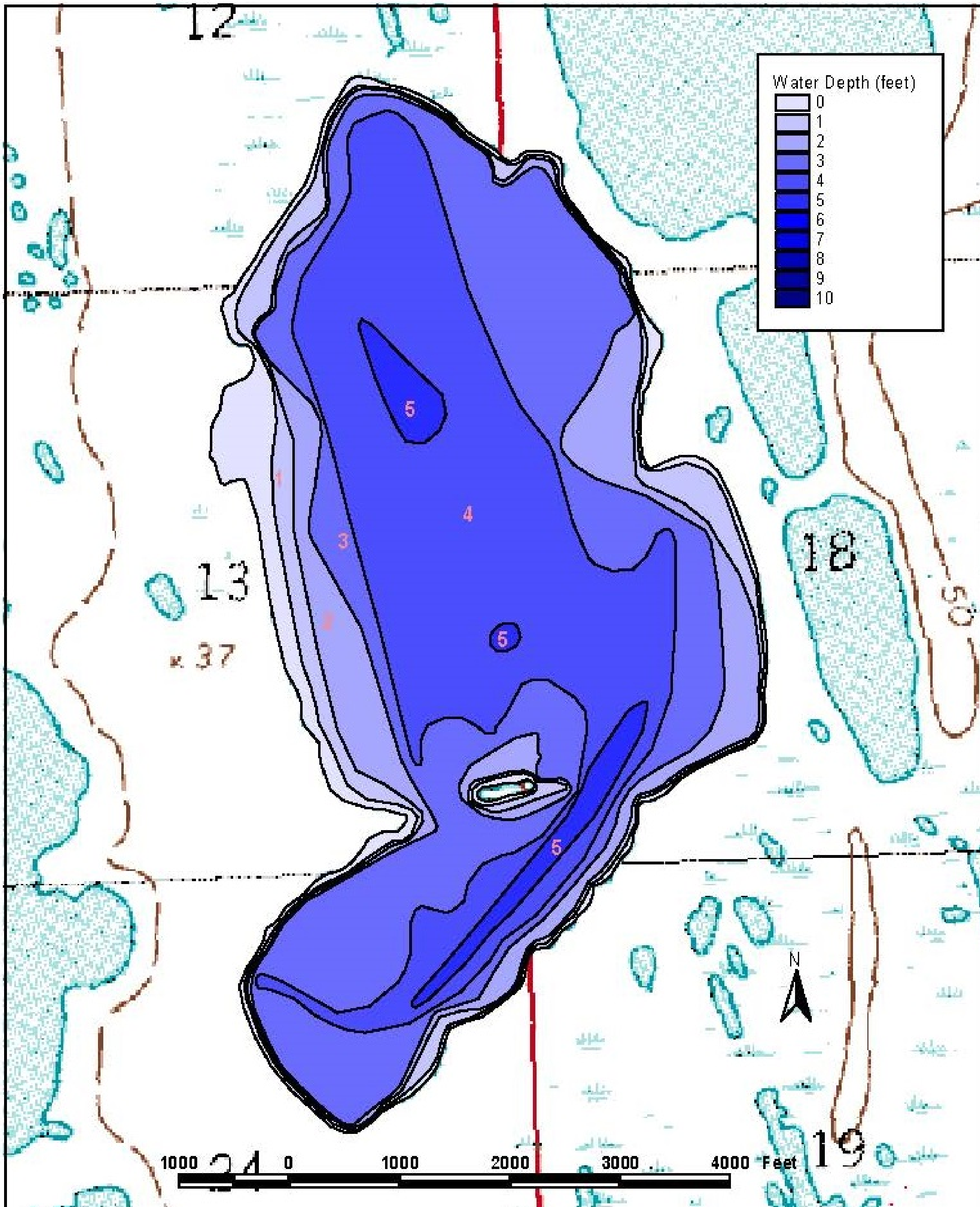
Appendix A Gage and TBM Locations

Monitoring Location	Site Name	Type	Latitude[1]	Longitude[1]
B8530	B8530-A	Gage	70.2437°	-150.8819°
	B8530-X	TBM	70.2436°	-150.8816°
B8531/L9326	B8531/L9326-A	Gage	70.2727°	-150.9947°
	B8531/L9326-X	TBM	70.2726°	-150.9948°
B8533	Lake B8533/L9315	Aerial Photos	70.3512°	-151.0314°
L9132	Lake L9132	Aerial Photos	70.2119°	-150.5365°
L9323	L9323-A	Gage	70.2956°	-150.9840°
	NANUQ 4	TBM	70.2954°	-150.9814°
L9324	L9324-A1	Gage	70.2914°	-150.9813°
	L9324-B	Gage	70.2914°	-150.9814°
	NANUQ 5	TBM	70.2917°	-150.9807°
K209	K209-A	Gage	70.2324°	-150.3611°
	K209-X	TBM	70.2324°	-150.3626°
K214	K214-A	Gage	70.2825°	-149.9169°
	K214-X	TBM	70.2826°	-149.9177°
M9602	M9602-A1	Gage	70.2160°	-150.7229°
	M9602-X	TBM	70.2160°	-150.7204°
M9603	M9603-A	Gage	70.2212°	-150.7897°
	M9603-X	TBM	70.2213°	-150.7896°
M9605	M9605-A1	Gage	70.2305°	-150.5174°
	M9605-X	TBM	70.2291°	-150.5128°
M9607	M9607-A1	Gage	70.2440°	-150.8684°
	M9607-X	TBM	70.2443°	-150.8665°
Nanuq Lake	Nanuq Lake	Aerial Photos	70.3225°	-151.0129°
Note 1: Locations are referenced to NAD 83 datum in decimal degrees.				

Appendix B Lake Bathymetry: Lakes M9602 and M9605

B.1 Lake M9602



Depth contours of lake M9602 based on transects surveyed on July 12, 2005
(depths in 1 foot intervals)

(not to be used for navigation or to direct use of heavy equipment)

Lake M9602

Other Names: AA10.1
Location: 70.22147°N 150.73865°W
USGS Quad Sheet: Harrison Bay A-2: T10N R5/6E, Sec 112/13/24/7/18/19
Habitat: Tundra Lake
Area: 658 acres
Maximum Depth: 6.4 feet
Active Outlet: No
Total Lake Volume: 734.9 million gallons (2005 data)
Volume Under 4 ft of ice: 42.9 million gallons
Volume Under 5 ft of ice: 2.6 million gallons
Volume Under 7 ft of ice: 0.0 million gallons
Potential Aggregate: 391.5 acres (water depth 4 ft or less)

Maximum Recommended Winter Removal: **0.78 million gallons**
(30% of volume under 5 feet of ice)
(does not include volume associated with ice aggregate)

Water Use History:

Year	Water Removed (all sources) (mill. Gals)
1998/1999	3.03
2000/2001	7.96
2001/2002	2.84
2002/2003	13.69
2003/2004	3.65
2004/2005	7.83

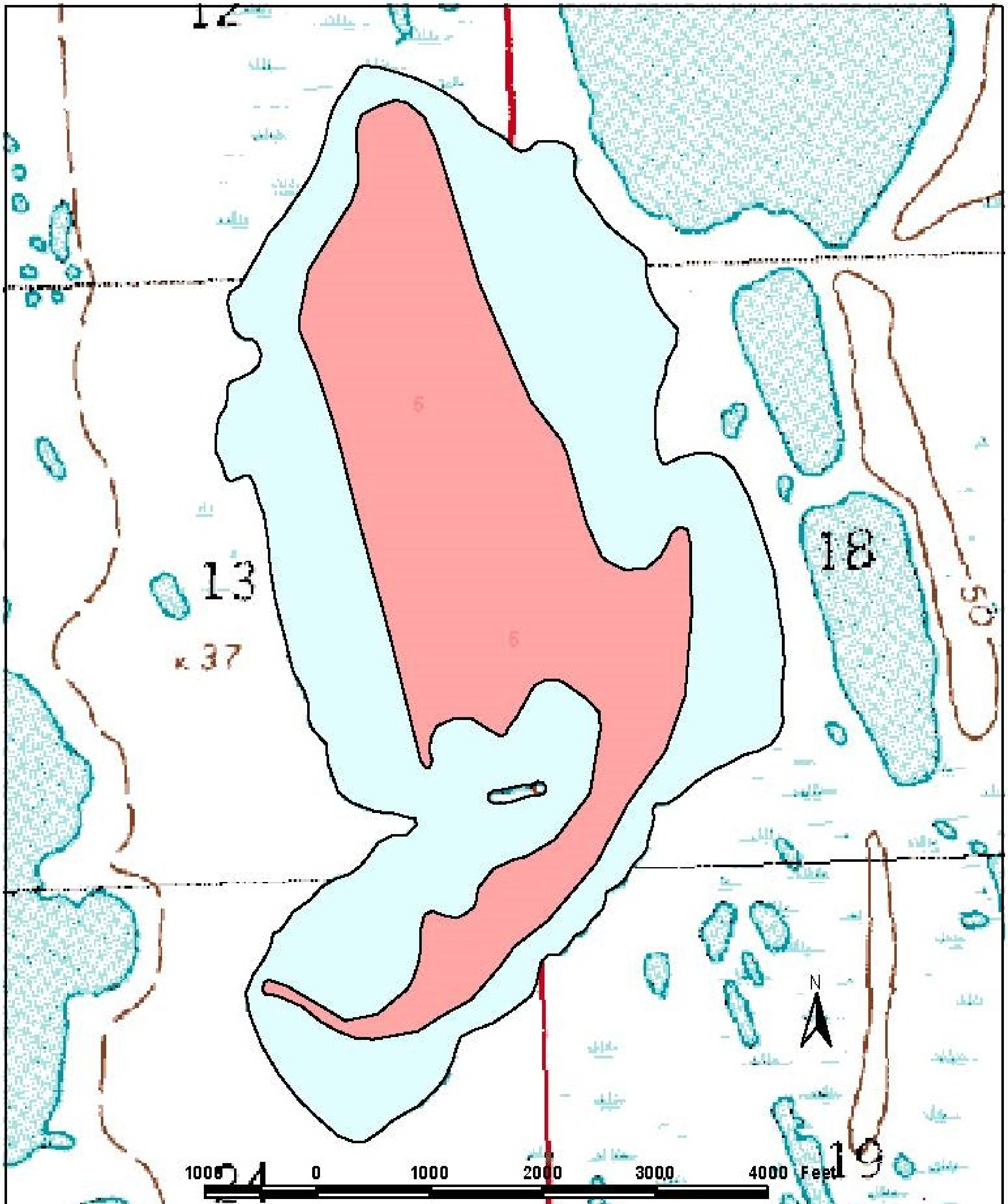
Water Chemistry:

Year of Test	Calcium (mg/l)	Magnesium (mg/l	Chloride (mg/l)	Sodium (mg/l)	Total Hardness [CaCO3] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
1996	15.9	13.5	2.9	31.5	90				J. Lobdell
1997								8.04	
2002						209	0.8	8.02	
2005	25.0	2.3	14.8	4.9	72	142	1.5	8.00	

Catch Record:

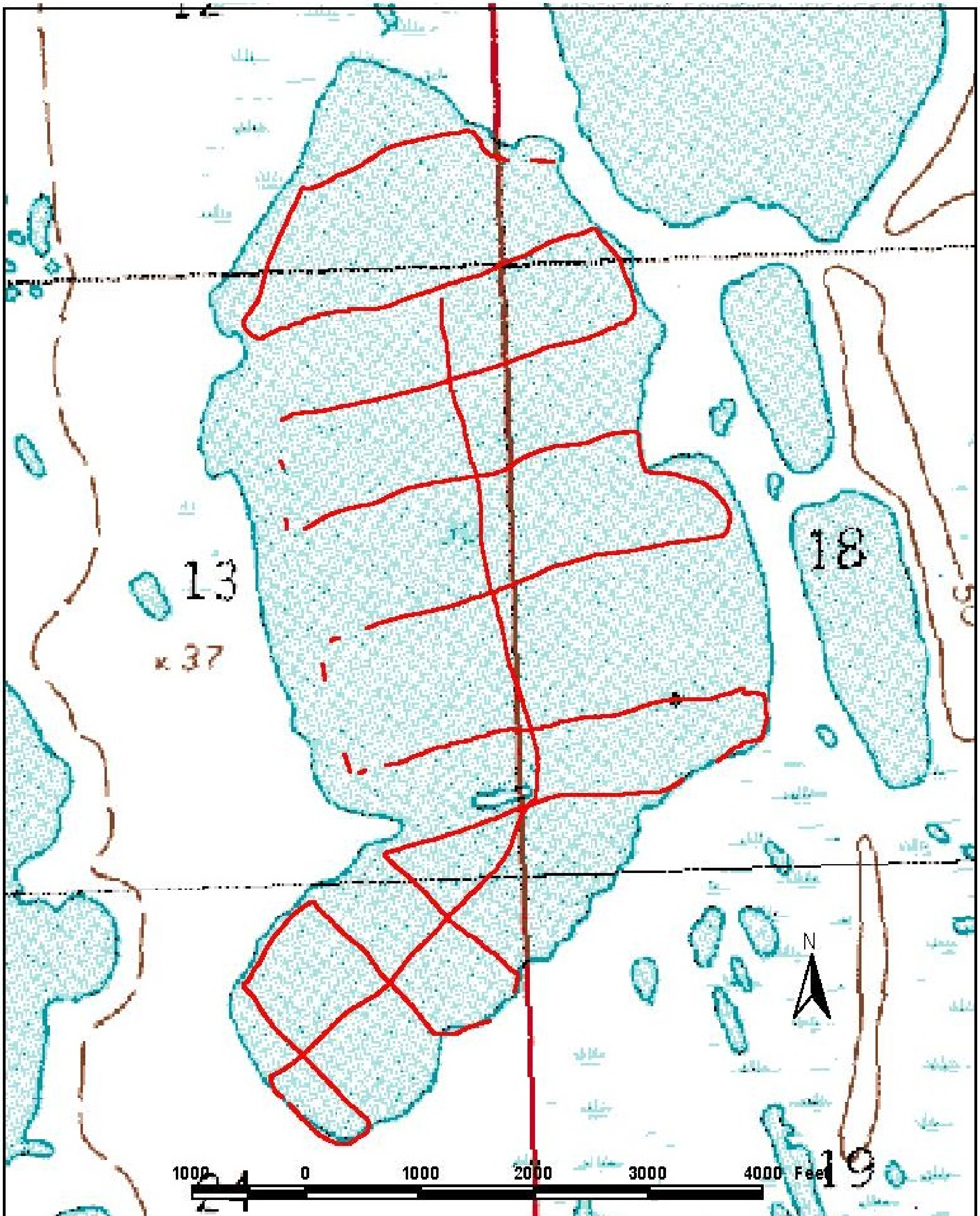
Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 26 96	10.7	None	0
Observed	Jul 15 02		Ninespine stickleback	many

Last Revised: September 30, 2005



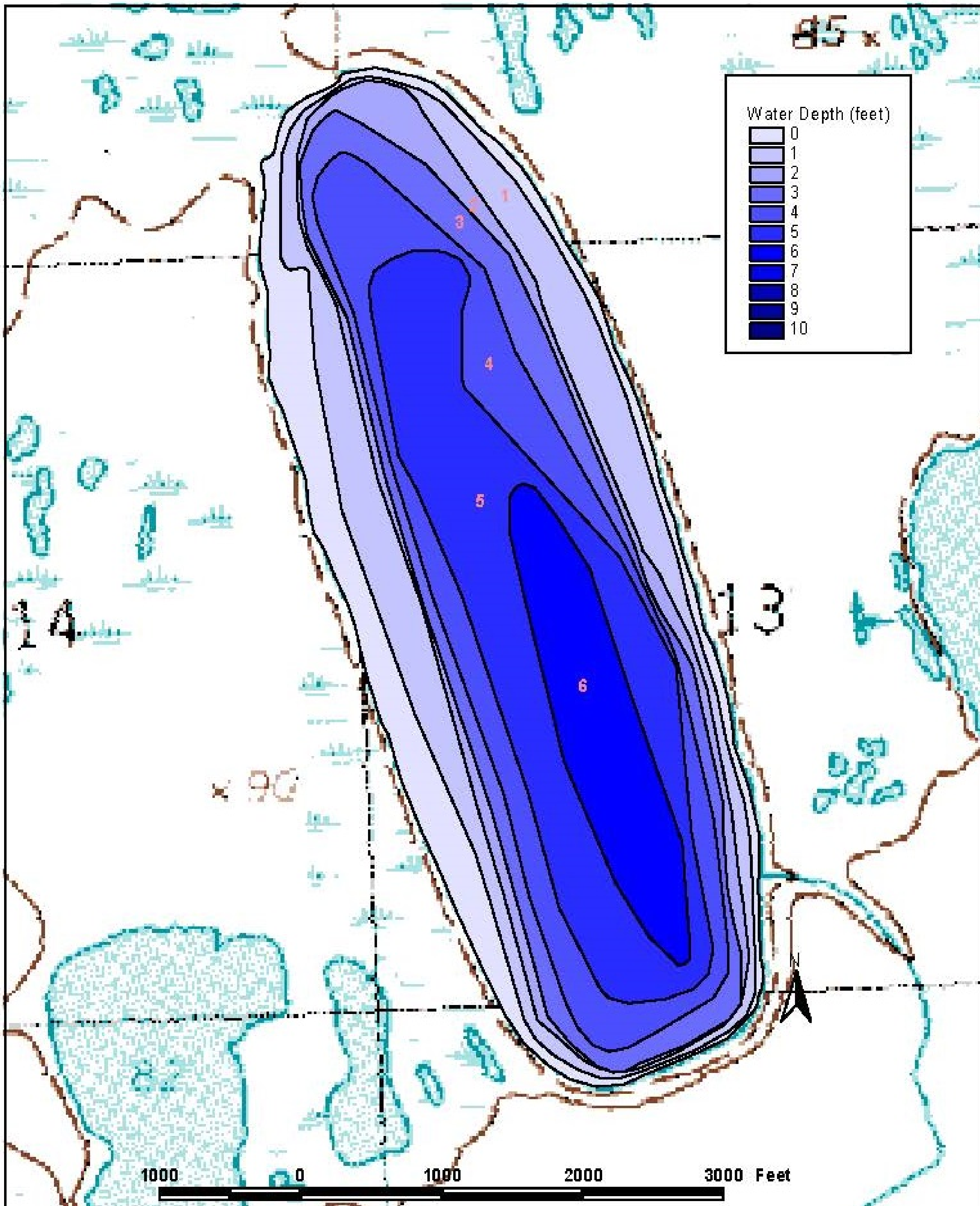
Regions of lake M9602 less than 4 fet deep (light shaded) and likely to be available for ice chips, based on transects surveyed on July 12, 2005 .

(not to be used for navigation or to direct use of heavy equipment)



Depth transects measured at lake M9602 on July 12, 2005.

B.2 Lake M9605



Depth contours of lake M9605 based on transects surveyed on July 20, 2005
(depths in 1 foot intervals)

(not to be used for navigation or to direct use of heavy equipment)

Lake M9605

Other Names: AA14.1
Location: 70.22099°N 150.51572°W
USGS Quad Sheet: Harrison Bay A-1: T10N R6E, Sec 11/12/13/14/24
Habitat: Tundra Lake
Area: 350 acres
Maximum Depth: 7.2 feet
Active Outlet: No
Total Lake Volume: 408.9 million gallons (2005 data)
Volume Under 4 ft of ice: 75.9 million gallons
Volume Under 5 ft of ice: 28.4 million gallons
Volume Under 7 ft of ice: 0.0 million gallons
Potential Aggregate: 174.1 acres (water depth 4 ft or less)

Maximum Recommended Winter Removal: **8.52 million gallons**
(30% of volume under 5 feet of ice)
(does not include volume associated with ice aggregate)

Water Use History:

Year	Water Removed (all sources) (mill. Gals)
1998/1999	6.13
2000/2001	18.26
2001/2002	9.22
2002/2003	17.34
2003/2004	5.89
2004/2005	12.82

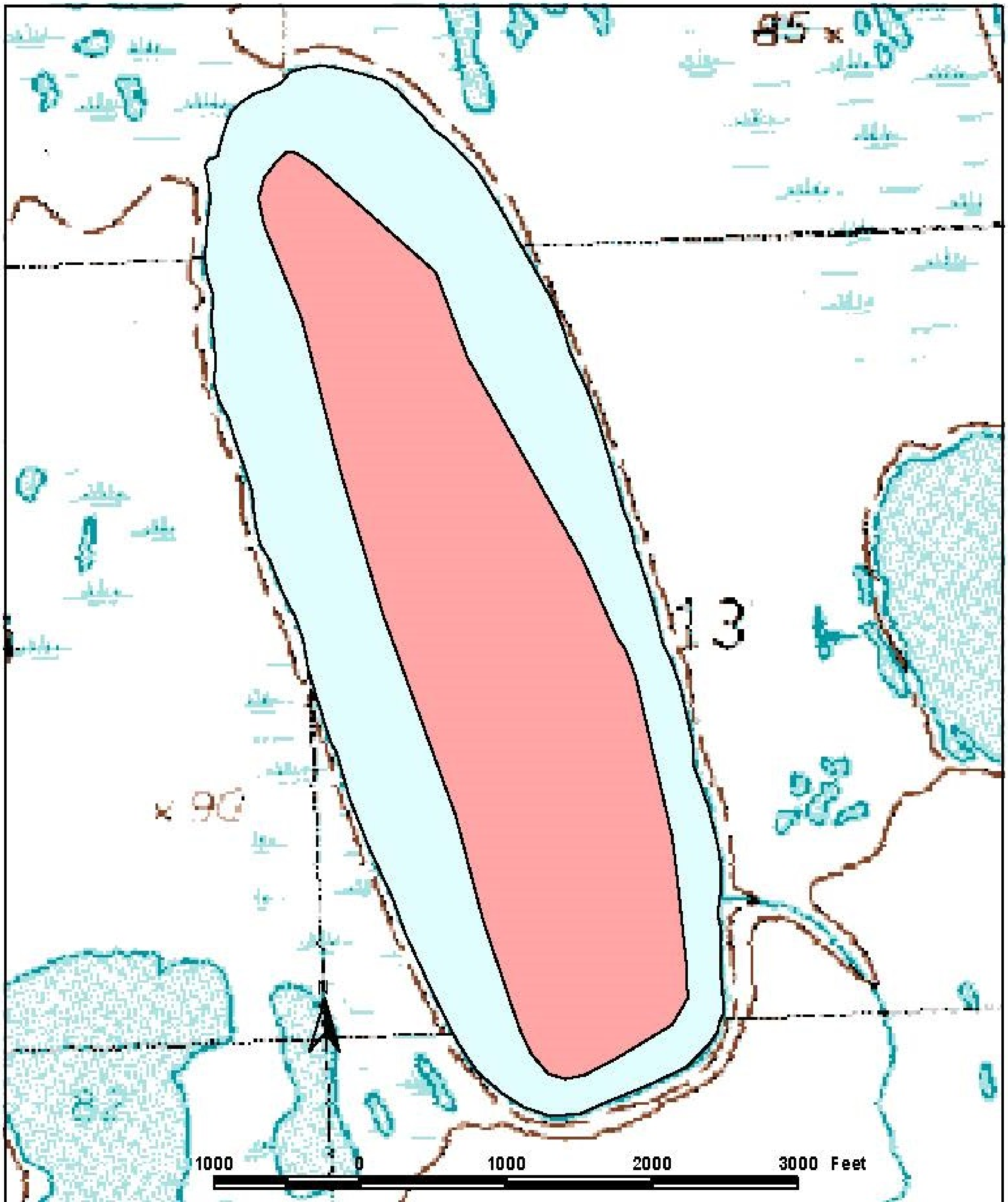
Water Chemistry:

Year of Test	Calcium (mg/l	Magnesium (mg/l)	Chloride (mg/l)	Sodium (mg/l)	Total Hardness [CaCO3] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
1996	9.8	9.8	2.9	31.2	90				J. Lobdell
2005	21.0	1.7	8.9	3.3	59	137	0.7	8.10	

Catch Record:

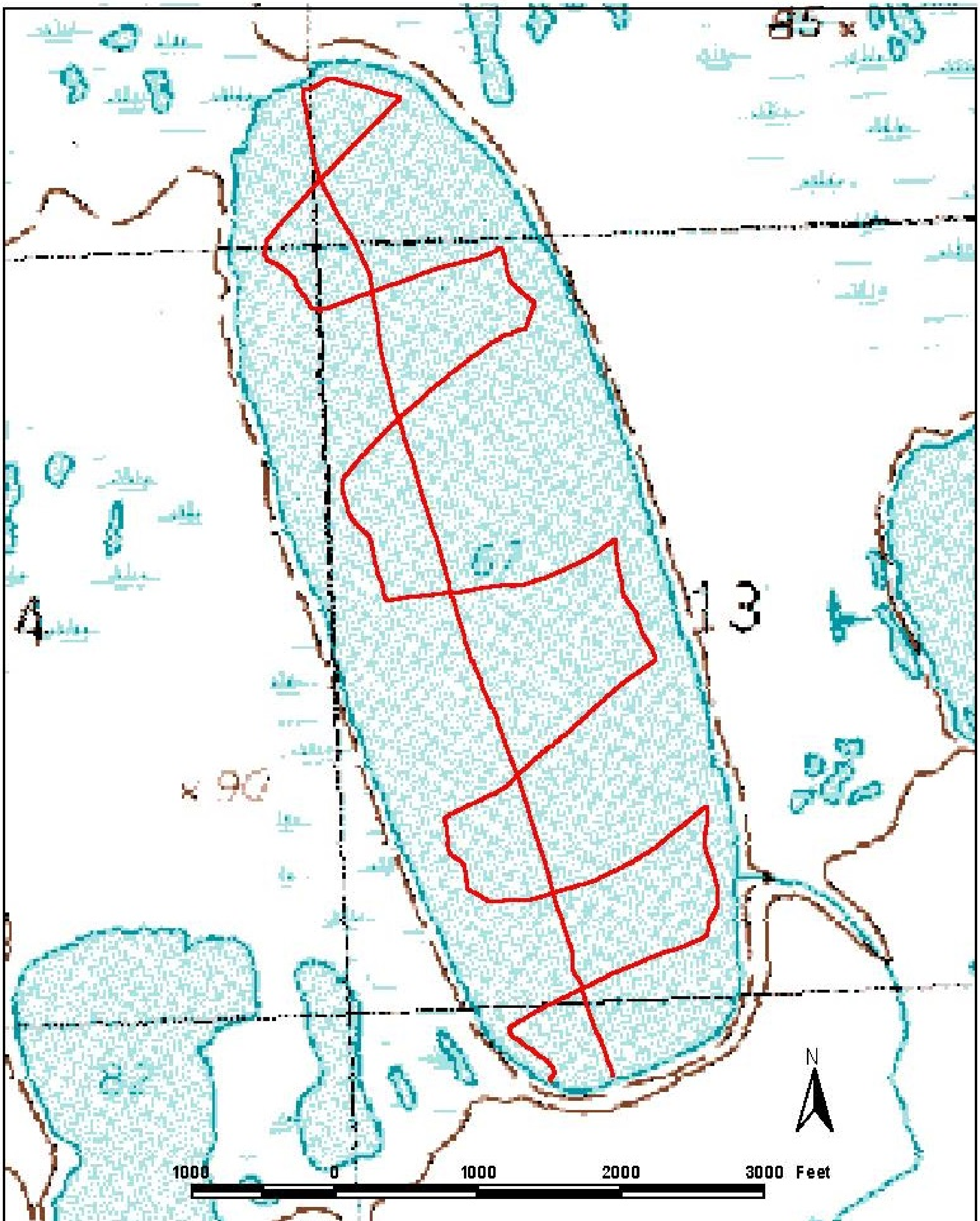
Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 18 96	4.3	None	0
Gill Net	Jul 20 05	6.7	None	0
Minnow Traps	Jul 20 05	12.2	Ninespine stickleback	1

Last Revised: September 30, 2005



Regions of lake M9605 less than 4 fet deep (light shaded) and likely to be available for ice chips, based on transects surveyed on July 20, 2005 .

(not to be used for navigation or to direct use of heavy equipment)



Depth transects measured at lake M9605 on July 20, 2005.

Appendix C Snow Survey Sheets: Lakes M9602 and M9605

C.1 Lake M9602

C.1.1 Pooled Snow Survey Data

Pooled Snow Survey Data Sheet						
Date: 4/29/2014	Start Time: 11:00		End Time: 17:45		Observers: GCY, SNW, MNU	
Catchment Basin: M9602		Driving Wrench Used: Mt. Rose			Tube Section Used: 0-62"	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Calculations	
PS023	1	Lake	7.5	7.4	Bucket & Core Weight (lb) =	1.18
	2		8.0	7.8	Empty Bucket Weight (lb) =	0.68
	3		8.0	7.6	Average Mass (lb) =	0.17
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2223		Sum (in) =	**22.8**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150.7389		Average (in) =	**7.6**	Average SWE (in) =	**2.23**
PS024	1	Lake	11.5	11.5	Bucket & Core Weight (lb) =	1.78
	2		13.0	12.6	Empty Bucket Weight (lb) =	0.68
	3		12.0	12.0	Average Mass (lb) =	0.37
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2249		Sum (in) =	**36.1**	Average Density (lb/in^3) =	**0.015**
Longitude	W 150.7364		Average (in) =	**12.0**	Average SWE (in) =	**4.90**
PS025	1	Lake	13.0	12.4	Bucket & Core Weight (lb) =	1.36
	2		13.5	13.5	Empty Bucket Weight (lb) =	0.68
	3				Average Mass (lb) =	0.34
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2269		Sum (in) =	**25.9**	Average Density (lb/in^3) =	**0.013**
Longitude	W 150.7344		Average (in) =	**13.0**	Average SWE (in) =	**4.54**
PS026	1	Lake	3.3	3.2	Bucket & Core Weight (lb) =	0.98
	2		3.3	3.3	Empty Bucket Weight (lb) =	0.68
	3		3.5	3.3	Average Mass (lb) =	0.06
	4		3.5	3.5	Core Area (in^2) =	2.0739
	5		3.5	3.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2296		Sum (in) =	**16.7**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150.7319		Average (in) =	**3.3**	Average SWE (in) =	**0.80**
PS027	1	Tundra	44.3	44.3	Bucket & Core Weight (lb) =	3.12
	2		43.0	43.0	Empty Bucket Weight (lb) =	0.68
	3				Average Mass (lb) =	1.22
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2316		Sum (in) =	**87.3**	Average Density (lb/in^3) =	**0.013**
Longitude	W 150.7299		Average (in) =	**43.6**	Average SWE (in) =	**16.29**
PS028	1	Lake	6.3	6.2	Bucket & Core Weight (lb) =	1.30
	2		5.5	5.4	Empty Bucket Weight (lb) =	0.68
	3		5.0	5.0	Average Mass (lb) =	0.12
	4		5.0	5.0	Core Area (in^2) =	2.0739
	5		5.0	4.8	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2227		Sum (in) =	**26.4**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150.7342		Average (in) =	**5.3**	Average SWE (in) =	**1.66**
Note 1: Locations are referenced to NAD 83 datum.						

Pooled Snow Survey Data Sheet						
Date: 4/29/2014	Start Time: 11:00		End Time: 17:45		Observers: GCY, SNW, MNU	
Catchment Basin: M9602		Driving Wrench Used: Mt. Rose			Tube Section Used: 0-62"	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Calculations	
PS029	1	Lake	5.0	5.0	Bucket & Core Weight (lb) =	1.08
	2		5.0	4.8	Empty Bucket Weight (lb) =	0.68
	3		3.5	3.2	Average Mass (lb) =	0.08
	4		4.5	4.2	Core Area (in^2) =	2.0739
	5		4.5	4.3	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2233		Sum (in) =	**21.5**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150.7280		Average (in) =	**4.3**	Average SWE (in) =	**1.07**
PS030	1	Tundra	14.5	9.0	Bucket & Core Weight (lb) =	1.42
	2		15.0	11.5	Empty Bucket Weight (lb) =	0.68
	3		14.0	13.5	Average Mass (lb) =	0.15
	4		12.5	10.0	Core Area (in^2) =	2.0739
	5		7.0	6.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2240		Sum (in) =	**50.5**	Average Density (lb/in^3) =	**0.007**
Longitude	W 150.7218		Average (in) =	**10.1**	Average SWE (in) =	**1.98**
PS031	1	Lake	15.0	15.0	Bucket & Core Weight (lb) =	1.26
	2		15.5	15.5	Empty Bucket Weight (lb) =	0.64
	3				Average Mass (lb) =	0.31
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2210		Sum (in) =	**30.5**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150.7336		Average (in) =	**15.3**	Average SWE (in) =	**4.14**
PS032	1	Lake	3.0	3.0	Bucket & Core Weight (lb) =	0.94
	2		2.5	2.5	Empty Bucket Weight (lb) =	0.64
	3		2.5	2.5	Average Mass (lb) =	0.06
	4		2.5	2.5	Core Area (in^2) =	2.0739
	5		2.5	2.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2197		Sum (in) =	**13.0**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150.7284		Average (in) =	**2.6**	Average SWE (in) =	**0.80**
PS033	1	Lake	6.3	6.3	Bucket & Core Weight (lb) =	1.04
	2		6.0	6.0	Empty Bucket Weight (lb) =	0.64
	3		6.0	6.0	Average Mass (lb) =	0.13
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2184		Sum (in) =	**18.3**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150.7231		Average (in) =	**6.1**	Average SWE (in) =	**1.78**
PS034	1	Tundra	12.0	12.0	Bucket & Core Weight (lb) =	1.38
	2		14.0	13.8	Empty Bucket Weight (lb) =	0.64
	3		12.5	12.5	Average Mass (lb) =	0.25
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2168		Sum (in) =	**38.3**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150.7166		Average (in) =	**12.8**	Average SWE (in) =	**3.29**
Note 1: Locations are referenced to NAD 83 datum.						

Pooled Snow Survey Data Sheet						
Date: 4/29/2014		Start Time: 11:00		End Time: 17:45	Observers: GCY, SNW, MNU	
Catchment Basin: M9602		Driving Wrench Used: Mt. Rose			Tube Section Used: 0-62"	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Calculations	
PS035	1	Lake	5.5	5.5	Bucket & Core Weight (lb) =	1.46
	2		5.5	5.5	Empty Bucket Weight (lb) =	0.64
	3		6.0	6.0	Average Mass (lb) =	0.16
	4		6.5	6.5	Core Area (in^2) =	2.0739
	5		6.0	6.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2212		Sum (in) =	**29.5**	Average Density (lb/in^3) =	**0.013**
Longitude	W 150.7398		Average (in) =	**5.9**	Average SWE (in) =	**2.19**
PS036	1	Lake	2.5	2.5	Bucket & Core Weight (lb) =	0.86
	2		2.5	2.5	Empty Bucket Weight (lb) =	0.64
	3		2.5	2.5	Average Mass (lb) =	0.04
	4		2.5	2.5	Core Area (in^2) =	2.0739
	5		3.0	3.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2191		Sum (in) =	**13.0**	Average Density (lb/in^3) =	**0.008**
Longitude	W 150.7418		Average (in) =	**2.6**	Average SWE (in) =	**0.59**
PS037	1	Lake	23.0	23.0	Bucket & Core Weight (lb) =	1.74
	2		22.5	22.5	Empty Bucket Weight (lb) =	0.64
	3				Average Mass (lb) =	0.55
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2170		Sum (in) =	**45.5**	Average Density (lb/in^3) =	**0.012**
Longitude	W 150.7437		Average (in) =	**22.8**	Average SWE (in) =	**7.34**
PS038	1	Tundra	15.0	15.0	Bucket & Core Weight (lb) =	1.68
	2		10.0	10.0	Empty Bucket Weight (lb) =	0.64
	3		18.0	18.0	Average Mass (lb) =	0.35
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2149		Sum (in) =	**43.0**	Average Density (lb/in^3) =	**0.012**
Longitude	W 150.7457		Average (in) =	**14.3**	Average SWE (in) =	**4.63**
PS039	1	Lake	3.5	3.5	Bucket & Core Weight (lb) =	1.10
	2		4.3	4.2	Empty Bucket Weight (lb) =	0.64
	3		5.0	5.0	Average Mass (lb) =	0.09
	4		5.0	5.0	Core Area (in^2) =	2.0739
	5		4.5	4.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2134		Sum (in) =	**22.2**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150.7471		Average (in) =	**4.4**	Average SWE (in) =	**1.23**
PS040	1	Lake	4.5	4.5	Bucket & Core Weight (lb) =	1.06
	2		4.0	4.0	Empty Bucket Weight (lb) =	0.64
	3		4.0	4.0	Average Mass (lb) =	0.08
	4		3.5	3.5	Core Area (in^2) =	2.0739
	5		3.5	3.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2113		Sum (in) =	**19.5**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150.7490		Average (in) =	**3.9**	Average SWE (in) =	**1.12**
Note 1: Locations are referenced to NAD 83 datum.						

Pooled Snow Survey Data Sheet						
Date: 4/29/2014	Start Time: 11:00		End Time: 17:45		Observers: GCY, SNW, MNU	
Catchment Basin: M9602			Driving Wrench Used: Mt. Rose		Tube Section Used: 0-62"	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in)		Calculations	
			w/ Dirt Plug	w/o Dirt Plug		
PS041	1	Lake	2.5	2.5	Bucket & Core Weight (lb) =	0.94
	2		2.0	2.0	Empty Bucket Weight (lb) =	0.64
	3		3.0	3.0	Average Mass (lb) =	0.06
	4		2.5	2.5	Core Area (in^2) =	2.0739
	5		2.5	2.3	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2097		**Sum (in) =**	**12.3**	**Average Density (lb/in^3) =**	**0.012**
Longitude	W 150.7505		**Average (in) =**	**2.5**	**Average SWE (in) =**	**0.80**
PS042	1	Lake	14.0	13.5	Bucket & Core Weight (lb) =	1.96
	2		12.0	12.0	Empty Bucket Weight (lb) =	0.64
	3		11.5	11.5	Average Mass (lb) =	0.33
	4		13.5	13.5	Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2082		**Sum (in) =**	**50.5**	**Average Density (lb/in^3) =**	**0.013**
Longitude	W 150.7519		**Average (in) =**	**12.6**	**Average SWE (in) =**	**4.41**
PS043	1	Lake	20.0	18.0	Bucket & Core Weight (lb) =	1.62
	2		17.0	16.7	Empty Bucket Weight (lb) =	0.64
	3		20.0	19.0	Average Mass (lb) =	0.33
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2061		**Sum (in) =**	**53.7**	**Average Density (lb/in^3) =**	**0.009**
Longitude	W 150.7539		**Average (in) =**	**17.9**	**Average SWE (in) =**	**4.36**
PS044	1	Lake	5.3	5.3	Bucket & Core Weight (lb) =	1.26
	2		4.5	4.5	Empty Bucket Weight (lb) =	0.68
	3		6.0	6.0	Average Mass (lb) =	0.12
	4		6.5	6.4	Core Area (in^2) =	2.0739
	5		7.3	7.3	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2215		**Sum (in) =**	**29.4**	**Average Density (lb/in^3) =**	**0.010**
Longitude	W 150.7466		**Average (in) =**	**5.9**	**Average SWE (in) =**	**1.55**
PS045	1	Lake	9.0	9.0	Bucket & Core Weight (lb) =	1.22
	2		9.0	9.0	Empty Bucket Weight (lb) =	0.68
	3		9.0	9.0	Average Mass (lb) =	0.18
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2210		**Sum (in) =**	**27.0**	**Average Density (lb/in^3) =**	**0.010**
Longitude	W 150.7513		**Average (in) =**	**9.0**	**Average SWE (in) =**	**2.40**
PS046	1	Tundra	14.0	14.0	Bucket & Core Weight (lb) =	1.20
	2		14.5	14.5	Empty Bucket Weight (lb) =	0.64
	3				Average Mass (lb) =	0.28
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2205		**Sum (in) =**	**28.5**	**Average Density (lb/in^3) =**	**0.009**
Longitude	W 150.7559		**Average (in) =**	**14.3**	**Average SWE (in) =**	**3.74**
Note 1: Locations are referenced to NAD 83 datum.						

Pooled Snow Survey Data Sheet						
Date: 4/29/2014	Start Time: 11:00		End Time: 17:45		Observers: GCY, SNW, MNU	
Catchment Basin: M9602		Driving Wrench Used: Mt. Rose			Tube Section Used: 0-62"	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Calculations	
PS047	1	Tundra	13.5	13.5	Bucket & Core Weight (lb) =	1.40
	2		13.5	13.3	Empty Bucket Weight (lb) =	0.64
	3				Average Mass (lb) =	0.38
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2201		Sum (in) =	**26.8**	Average Density (lb/in^3) =	**0.014**
Longitude	W 150.7606		Average (in) =	**13.4**	Average SWE (in) =	**5.07**
PS048	1	Lake	4.5	4.4	Bucket & Core Weight (lb) =	1.26
	2		5.0	4.8	Empty Bucket Weight (lb) =	0.64
	3		5.0	5.0	Average Mass (lb) =	0.12
	4		4.5	4.5	Core Area (in^2) =	2.0739
	5		4.5	4.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2232		Sum (in) =	**23.2**	Average Density (lb/in^3) =	**0.013**
Longitude	W 150.7428		Average (in) =	**4.6**	Average SWE (in) =	**1.66**
PS049	1	Lake	10.0	10.0	Bucket & Core Weight (lb) =	1.18
	2		10.0	10.0	Empty Bucket Weight (lb) =	0.64
	3		9.5	9.5	Average Mass (lb) =	0.18
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2248		Sum (in) =	**29.5**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150.7494		Average (in) =	**9.8**	Average SWE (in) =	**2.40**
PS050	1	Tundra	17.0	17.0	Bucket & Core Weight (lb) =	1.26
	2		17.0	17.0	Empty Bucket Weight (lb) =	0.64
	3				Average Mass (lb) =	0.31
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2261		Sum (in) =	**34.0**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150.7546		Average (in) =	**17.0**	Average SWE (in) =	**4.14**
PS051	1	Tundra	14.0	13.8	Bucket & Core Weight (lb) =	1.18
	2		12.5	12.5	Empty Bucket Weight (lb) =	0.64
	3				Average Mass (lb) =	0.27
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2271		Sum (in) =	**26.3**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150.7585		Average (in) =	**13.1**	Average SWE (in) =	**3.61**
PS052	1	Tundra	15.5	14.5	Bucket & Core Weight (lb) =	1.06
	2		14.5	14.5	Empty Bucket Weight (lb) =	0.64
	3				Average Mass (lb) =	0.21
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude			Sum (in) =	**29.0**	Average Density (lb/in^3) =	**0.007**
Longitude	W 150.7625		Average (in) =	**14.5**	Average SWE (in) =	**2.80**

Note 1: Locations are referenced to NAD 83 datum.

Pooled Snow Survey Data Sheet						
Date: 4/29/2014	Start Time: 11:00		End Time: 17:45		Observers: GCY, SNW, MNU	
Catchment Basin: M9602		Driving Wrench Used: Mt. Rose			Tube Section Used: 0-62"	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Calculations	
PS053	1	Lake	7.5	7.5	Bucket & Core Weight (lb) =	1.48
	2		8.0	7.7	Empty Bucket Weight (lb) =	0.64
	3		7.0	7.0	Average Mass (lb) =	0.21
	4		7.5	7.2	Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2260		**Sum (in) =**	**29.4**	**Average Density (lb/in^3) =**	**0.014**
Longitude	W 150.7412		**Average (in) =**	**7.4**	**Average SWE (in) =**	**2.80**
PS054	1	Lake	4.0	4.0	Bucket & Core Weight (lb) =	1.26
	2		4.0	3.7	Empty Bucket Weight (lb) =	0.64
	3		4.5	4.5	Average Mass (lb) =	0.12
	4		4.5	4.5	Core Area (in^2) =	2.0739
	5		4.0	4.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2303		**Sum (in) =**	**20.7**	**Average Density (lb/in^3) =**	**0.014**
Longitude	W 150.7438		**Average (in) =**	**4.1**	**Average SWE (in) =**	**1.66**
PS055	1	Tundra	11.0	11.0	Bucket & Core Weight (lb) =	1.26
	2		12.0	12.0	Empty Bucket Weight (lb) =	0.64
	3		11.0	10.0	Average Mass (lb) =	0.21
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2335		**Sum (in) =**	**33.0**	**Average Density (lb/in^3) =**	**0.009**
Longitude	W 150.7458		**Average (in) =**	**11.0**	**Average SWE (in) =**	**2.76**
PS056	1	Lake	5.5	5.5	Bucket & Core Weight (lb) =	1.34
	2		5.5	5.5	Empty Bucket Weight (lb) =	0.64
	3		5.5	5.5	Average Mass (lb) =	0.14
	4		6.0	6.0	Core Area (in^2) =	2.0739
	5		5.5	5.5	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2185		**Sum (in) =**	**28.0**	**Average Density (lb/in^3) =**	**0.012**
Longitude	W 150.7364		**Average (in) =**	**5.6**	**Average SWE (in) =**	**1.87**
PS057	1	Tundra	7.5	7.5	Bucket & Core Weight (lb) =	1.40
	2		11.0	11.0	Empty Bucket Weight (lb) =	0.64
	3		11.0	11.0	Average Mass (lb) =	0.25
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2148		**Sum (in) =**	**29.5**	**Average Density (lb/in^3) =**	**0.012**
Longitude	W 150.7339		**Average (in) =**	**9.8**	**Average SWE (in) =**	**3.38**
PS058	1	Tundra	16.5	15.0	Bucket & Core Weight (lb) =	1.26
	2		15.0	13.5	Empty Bucket Weight (lb) =	0.64
	3				Average Mass (lb) =	0.31
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2116		**Sum (in) =**	**28.5**	**Average Density (lb/in^3) =**	**0.010**
Longitude	W 150.7318		**Average (in) =**	**14.3**	**Average SWE (in) =**	**4.14**

Note 1: Locations are referenced to NAD 83 datum.

Pooled Snow Survey Data Sheet						
Date: 4/30/2014	**Start Time:** 11:00		**End Time:** 17:45		**Observers:** GCY, SNW, MNU	
Catchment Basin: M9602		**Driving Wrench Used:** Mt. Rose			**Tube Section Used:** 0-62"	
Snow Sample No.	**Pooled Sample #**	**Terrain Type**	**Snow Depth (in) w/ Dirt Plug**	**Snow Depth (in) w/o Dirt Plug**	**Calculations**	
B-PS16	1	Tundra	54.0	54.0	**Bucket & Core Weight (lb) =**	1.84
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	1.18
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2313	**Sum (in) =**	**54.0**		**Average Density (lb/in^3) =**	**0.011**
Longitude	W 150.7365	**Average (in) =**	**54.0**		**Average SWE (in) =**	**15.76**
B-PS17	1	Lake	53.0	53.0	**Bucket & Core Weight (lb) =**	2.02
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	1.36
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2312	**Sum (in) =**	**53.0**		**Average Density (lb/in^3) =**	**0.012**
Longitude	W 150.7367	**Average (in) =**	**53.0**		**Average SWE (in) =**	**18.16**
B-PS18	1	Tundra	27.5	27.5	**Bucket & Core Weight (lb) =**	1.22
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	0.56
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2325	**Sum (in) =**	**27.5**		**Average Density (lb/in^3) =**	**0.010**
Longitude	W 150.7406	**Average (in) =**	**27.5**		**Average SWE (in) =**	**7.48**
B-PS19	1	Lake	37.5	37.5	**Bucket & Core Weight (lb) =**	1.70
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	1.04
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2324	**Sum (in) =**	**37.5**		**Average Density (lb/in^3) =**	**0.013**
Longitude	W 150.7407	**Average (in) =**	**37.5**		**Average SWE (in) =**	**13.89**
B-PS20	1	Tundra	30.0	29.5	**Bucket & Core Weight (lb) =**	1.20
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	0.54
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2300	**Sum (in) =**	**29.5**		**Average Density (lb/in^3) =**	**0.009**
Longitude	W 150.7505	**Average (in) =**	**29.5**		**Average SWE (in) =**	**7.21**
B-PS21	1	Lake	35.0	35.0	**Bucket & Core Weight (lb) =**	1.60
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	0.94
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2300	**Sum (in) =**	**35.0**		**Average Density (lb/in^3) =**	**0.013**
Longitude	W 150.7504	**Average (in) =**	**35.0**		**Average SWE (in) =**	**12.55**
Note 1: Locations are referenced to NAD 83 datum.						

Pooled Snow Survey Data Sheet						
Date: 4/30/2014	**Start Time:** 11:00		**End Time:** 17:45		**Observers:** GCY, SNW, MNU	
Catchment Basin: M9602		**Driving Wrench Used:** Mt. Rose			**Tube Section Used:** Mt. Rose	
Snow Sample No.	**Pooled Sample #**	**Terrain Type**	**Snow Depth (in)**		**Calculations**	
			w/ Dirt Plug	**w/o Dirt Plug**		
B-PS22	1	Lake	30.0	30.0	**Bucket & Core Weight (lb) =**	1.18
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	0.52
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2300		**Sum (in) =**	**30.0**	**Average Density (lb/in^3) =**	**0.008**
Longitude	W 150.7503		**Average (in) =**	**30.0**	**Average SWE (in) =**	**6.94**
Note 1: Locations are referenced to NAD 83 datum.						

C.1.2 *Snow Depth Survey Data*

Snow Depth Survey Data Sheet				
Date: 4/29/2014		**Start Time:** 11:00		**Observers:** GCY, SNW, MNU
Catchment Basin: M9602		**End Time:** 17:45		
Snow Sample No.	**Terrain Type**	**Snow Depth (in)**	**Location**	
			Latitude	**Longitude**
SS085	Lake	12.6	N 70.2228	W 150.7384
SS086	Lake	13.4	N 70.2233	W 150.7379
SS087	Lake	16.1	N 70.2238	W 150.7374
SS088	Lake	6.7	N 70.2243	W 150.7369
SS089	Lake	11.0	N 70.2254	W 150.7359
SS090	Lake	18.5	N 70.2259	W 150.7354
SS091	Lake	8.3	N 70.2264	W 150.7349
SS092	Lake	3.5	N 70.2275	W 150.7339
SS093	Lake	11.0	N 70.2280	W 150.7334
SS094	Lake	3.5	N 70.2285	W 150.7329
SS095	Lake	4.3	N 70.2290	W 150.7324
SS096	Lake	0.8	N 70.2301	W 150.7314
SS097	Tundra	0.0	N 70.2306	W 150.7309
SS098	Tundra	13.0	N 70.2311	W 150.7304
SS099	Lake	7.9	N 70.2224	W 150.7373
SS100	Lake	4.3	N 70.2226	W 150.7358
SS101	Lake	13.8	N 70.2229	W 150.7327
SS102	Lake	12.2	N 70.2230	W 150.7311
SS103	Lake	11.8	N 70.2232	W 150.7295
SS104	Lake	15.4	N 70.2235	W 150.7264
SS105	Tundra	16.9	N 70.2237	W 150.7249
SS106	Tundra	18.5	N 70.2238	W 150.7233
SS107	Tundra	6.7	N 70.2241	W 150.7202
SS108	Lake	5.1	N 70.2219	W 150.7376
SS109	Lake	9.4	N 70.2216	W 150.7363
SS110	Lake	9.1	N 70.2213	W 150.7349
SS111	Lake	11.0	N 70.2207	W 150.7323
SS112	Lake	9.8	N 70.2203	W 150.7310
SS113	Lake	8.3	N 70.2200	W 150.7297
SS114	Lake	7.5	N 70.2194	W 150.7271
SS115	Lake	5.9	N 70.2191	W 150.7258
SS116	Lake	8.7	N 70.2187	W 150.7245
SS117	Lake	4.3	N 70.2181	W 150.7218
SS118	Lake	7.1	N 70.2178	W 150.7205
SS119	Lake	7.1	N 70.2175	W 150.7192
SS120	Lake	23.2	N 70.2171	W 150.7179
SS121	Tundra	19.3	N 70.2165	W 150.7153
SS122	Lake	14.2	N 70.2217	W 150.7394
SS123	Lake	7.9	N 70.2207	W 150.7403
SS124	Lake	6.3	N 70.2202	W 150.7408
SS125	Lake	5.9	N 70.2197	W 150.7413

Snow Depth Survey Data Sheet				
Date: 4/29/2014		Start Time: 11:00 AM		Observers: GCY, SNW, MNU
Catchment Basin: M9602		End Time: 5:45 PM		
Snow Sample No.	Terrain Type	Snow Depth (in)	Location	
			Latitude	Longitude
SS126	Lake	5.9	N 70.2186	W 150.7423
SS127	Lake	5.1	N 70.2181	W 150.7428
SS128	Lake	8.7	N 70.2176	W 150.7432
SS129	Lake	7.9	N 70.2165	W 150.7442
SS130	Lake	6.3	N 70.2160	W 150.7447
SS131	Lake	8.7	N 70.2155	W 150.7452
SS132	Tundra	10.6	N 70.2144	W 150.7461
SS133	Lake	12.2	N 70.2139	W 150.7466
SS134	Lake	8.3	N 70.2129	W 150.7476
SS135	Lake	8.7	N 70.2123	W 150.7481
SS136	Lake	5.9	N 70.2118	W 150.7486
SS137	Lake	2.0	N 70.2108	W 150.7495
SS138	Lake	3.1	N 70.2102	W 150.7500
SS139	Lake	7.9	N 70.2092	W 150.7510
SS140	Lake	23.6	N 70.2087	W 150.7515
SS141	Tundra	20.9	N 70.2076	W 150.7524
SS142	Tundra	13.4	N 70.2071	W 150.7529
SS143	Tundra	10.2	N 70.2066	W 150.7534
SS144	Lake	7.5	N 70.2221	W 150.7404
SS145	Lake	13.0	N 70.2220	W 150.7420
SS146	Lake	6.3	N 70.2218	W 150.7435
SS147	Lake	9.8	N 70.2216	W 150.7451
SS148	Lake	22.4	N 70.2213	W 150.7482
SS149	Lake	9.4	N 70.2212	W 150.7497
SS150	Lake	21.3	N 70.2209	W 150.7528
SS151	Tundra	8.7	N 70.2207	W 150.7544
SS152	Tundra	9.8	N 70.2204	W 150.7575
SS153	Tundra	15.4	N 70.2202	W 150.7590
SS154	Lake	6.7	N 70.2226	W 150.7402
SS155	Lake	5.9	N 70.2229	W 150.7415
SS156	Lake	9.1	N 70.2236	W 150.7441
SS157	Lake	5.9	N 70.2239	W 150.7454
SS158	Lake	5.9	N 70.2242	W 150.7467
SS159	Lake	11.4	N 70.2245	W 150.7480
SS160	Lake	12.2	N 70.2252	W 150.7507
SS161	Lake	0.0	N 70.2255	W 150.7520
SS162	Lake	0.0	N 70.2258	W 150.7533
SS163	Tundra	12.6	N 70.2265	W 150.7559
SS164	Tundra	15.0	N 70.2268	W 150.7572
SS165	Tundra	15.0	N 70.2274	W 150.7598
SS166	Tundra	15.7	N 70.2277	W 150.7611

Snow Depth Survey Data Sheet				
Date: 4/29/2014		Start Time: 11:00 AM		Observers: GCY, SNW, MNU
Catchment Basin: M9602		End Time: 5:45 PM		
Snow Sample No.	Terrain Type	Snow Depth (in)	Location	
			Latitude	Longitude
SS167	Lake	13.8	N 70.2228	W 150.7392
SS168	Lake	2.8	N 70.2233	W 150.7395
SS169	Lake	7.9	N 70.2239	W 150.7399
SS170	Lake	8.3	N 70.2244	W 150.7402
SS171	Lake	4.7	N 70.2249	W 150.7405
SS172	Lake	7.1	N 70.2255	W 150.7408
SS173	Lake	5.9	N 70.2265	W 150.7415
SS174	Lake	8.3	N 70.2271	W 150.7418
SS175	Lake	5.5	N 70.2276	W 150.7422
SS176	Lake	5.9	N 70.2281	W 150.7425
SS177	Lake	2.4	N 70.2287	W 150.7428
SS178	Lake	10.2	N 70.2292	W 150.7431
SS179	Lake	14.6	N 70.2298	W 150.7435
SS180	Lake	4.7	N 70.2308	W 150.7441
SS181	Lake	4.7	N 70.2314	W 150.7445
SS182	Lake	0.0	N 70.2319	W 150.7448
SS183	Lake	9.1	N 70.2324	W 150.7451
SS184	Tundra	29.9	N 70.2330	W 150.7455
SS185	Tundra	14.2	N 70.2340	W 150.7461
SS186	Tundra	10.2	N 70.2346	W 150.7464
SS187	Tundra	13.0	N 70.2351	W 150.7468
SS188	Lake	6.3	N 70.2217	W 150.7385
SS189	Lake	2.4	N 70.2212	W 150.7381
SS190	Lake	13.8	N 70.2207	W 150.7378
SS191	Lake	5.1	N 70.2201	W 150.7374
SS192	Lake	10.2	N 70.2196	W 150.7371
SS193	Lake	8.7	N 70.2191	W 150.7367
SS194	Lake	7.1	N 70.2180	W 150.7360
SS195	Lake	5.9	N 70.2175	W 150.7357
SS196	Lake	8.3	N 70.2169	W 150.7353
SS197	Lake	15.7	N 70.2164	W 150.7350
SS198	Lake	7.9	N 70.2159	W 150.7346
SS199	Lake	4.7	N 70.2153	W 150.7343
SS200	Lake	4.3	N 70.2142	W 150.7336
SS201	Lake	4.7	N 70.2137	W 150.7332
SS202	Lake	5.5	N 70.2132	W 150.7329
SS203	Lake	8.7	N 70.2126	W 150.7325
SS204	Tundra	58.7	N 70.2121	W 150.7322
SS205	Tundra	15.7	N 70.2110	W 150.7315

C.2 *Lake M9605*

C.2.1 *Pooled Snow Survey Data*

Pooled Snow Survey Data Sheet						
Date: 4/30/2014	Start Time: 9:30		End Time: 16:00		Observers: SNW, MNU, GCY	
Catchment Basin: M9605		Driving Wrench Used: Mt. Rose			Tube Section Used: 0-62"	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Calculations	
PS200	1	Tundra	10.0	10.0	Bucket & Core Weight (lb) =	1.30
	2		9.0	8.5	Empty Bucket Weight (lb) =	0.64
	3		7.5	7.5	Average Mass (lb) =	0.17
	4		11.0	11.0	Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2308		Sum (in) =	**37.0**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150.5254		Average (in) =	**9.3**	Average SWE (in) =	**2.20**
PS201	1	Lake	9.5	9.5	Bucket & Core Weight (lb) =	1.52
	2		9.5	9.5	Empty Bucket Weight (lb) =	0.64
	3		10.0	10.0	Average Mass (lb) =	0.22
	4		9.5	9.5	Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2289		Sum (in) =	**38.5**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150.5235		Average (in) =	**9.6**	Average SWE (in) =	**2.94**
PS202	1	Lake	11.5	11.5	Bucket & Core Weight (lb) =	1.40
	2		11.5	11.5	Empty Bucket Weight (lb) =	0.64
	3		11.0	11.0	Average Mass (lb) =	0.25
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2263		Sum (in) =	**34.0**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150.5209		Average (in) =	**11.3**	Average SWE (in) =	**3.38**
PS203	1	Lake	8.5	8.5	Bucket & Core Weight (lb) =	1.46
	2		8.0	8.0	Empty Bucket Weight (lb) =	0.64
	3		8.5	8.5	Average Mass (lb) =	0.21
	4		9.0	9.0	Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2237		Sum (in) =	**34.0**	Average Density (lb/in^3) =	**0.012**
Longitude	W 150.5183		Average (in) =	**8.5**	Average SWE (in) =	**2.74**
PS204	1	Lake	8.0	8.0	Bucket & Core Weight (lb) =	1.46
	2		7.5	7.4	Empty Bucket Weight (lb) =	0.64
	3		7.5	7.5	Average Mass (lb) =	0.21
	4		7.5	7.5	Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2211		Sum (in) =	**30.4**	Average Density (lb/in^3) =	**0.013**
Longitude	W 150.5157		Average (in) =	**7.6**	Average SWE (in) =	**2.74**
PS205	1	Lake	2.5	2.5	Bucket & Core Weight (lb) =	0.94
	2		3.0	3.0	Empty Bucket Weight (lb) =	0.64
	3		3.0	2.9	Average Mass (lb) =	0.06
	4		3.0	3.0	Core Area (in^2) =	2.0739
	5		3.0	3.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2185		Sum (in) =	**14.4**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150.5128		Average (in) =	**2.9**	Average SWE (in) =	**0.80**
Note 1: Locations are referenced to NAD 83 datum.						

Pooled Snow Survey Data Sheet						
Date: 4/30/2014	Start Time: 9:30		End Time: 16:00		Observers: SNW, MNU, GCY	
Catchment Basin: M9605		Driving Wrench Used: Mt. Rose			Tube Section Used: 0-62"	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Calculations	
PS206	1	Lake	6.0	6.0	Bucket & Core Weight (lb) =	1.26
	2		6.0	5.8	Empty Bucket Weight (lb) =	0.64
	3		6.5	6.5	Average Mass (lb) =	0.12
	4		6.0	6.0	Core Area (in^2) =	2.0739
	5		6.0	6.0	Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2160		Sum (in) =	**30.3**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150.5099		Average (in) =	**6.1**	Average SWE (in) =	**1.66**
PS207	1	Lake	6.5	6.5	Bucket & Core Weight (lb) =	1.20
	2		7.0	7.0	Empty Bucket Weight (lb) =	0.64
	3		6.5	6.5	Average Mass (lb) =	0.14
	4		6.5	6.5	Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2134		Sum (in) =	**26.5**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150.5070		Average (in) =	**6.6**	Average SWE (in) =	**1.87**
PS208	1	Tundra	18.0	16.5	Bucket & Core Weight (lb) =	1.46
	2		16.0	15.8	Empty Bucket Weight (lb) =	0.64
	3		17.0	17.0	Average Mass (lb) =	0.27
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2108		Sum (in) =	**49.3**	Average Density (lb/in^3) =	**0.008**
Longitude	W 150.5041		Average (in) =	**16.4**	Average SWE (in) =	**3.65**
PS209	1	Tundra	13.5	12.0	Bucket & Core Weight (lb) =	1.18
	2		12.5	12.5	Empty Bucket Weight (lb) =	0.64
	3		7.5	7.0	Average Mass (lb) =	0.18
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2093		Sum (in) =	**31.5**	Average Density (lb/in^3) =	**0.008**
Longitude	W 150.5023		Average (in) =	**10.5**	Average SWE (in) =	**2.40**
PS210	1	Tundra	17.0	16.8	Bucket & Core Weight (lb) =	1.48
	2		17.0	16.0	Empty Bucket Weight (lb) =	0.64
	3		18.0	18.0	Average Mass (lb) =	0.28
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2068		Sum (in) =	**50.8**	Average Density (lb/in^3) =	**0.008**
Longitude	W 150.4995		Average (in) =	**16.9**	Average SWE (in) =	**3.74**
PS211	1	Tundra	12.5	12.5	Bucket & Core Weight (lb) =	1.24
	2		12.5	11.0	Empty Bucket Weight (lb) =	0.64
	3		11.5	9.5	Average Mass (lb) =	0.20
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2047		Sum (in) =	**33.0**	Average Density (lb/in^3) =	**0.009**
Longitude	W 150.4971		Average (in) =	**11.0**	Average SWE (in) =	**2.67**
Note 1: Locations are referenced to NAD 83 datum.						

Pooled Snow Survey Data Sheet						
Date: 4/30/2014	Start Time: 9:30		End Time: 16:00		Observers: SNW, MNU, GCY	
Catchment Basin: M9605		Driving Wrench Used: Mt. Rose			Tube Section Used: 0-62"	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Calculations	
PS212	1	Tundra	21.0	20.9	**Bucket & Core Weight (lb) =**	1.76
	2		21.5	21.5	**Empty Bucket Weight (lb) =**	0.64
	3		20.5	20.5	**Average Mass (lb) =**	0.37
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2105		**Sum (in) =**	**62.9**	**Average Density (lb/in^3) =**	**0.009**
Longitude	W 150.4950		**Average (in) =**	**21.0**	**Average SWE (in) =**	**4.98**
PS213	1	Tundra	22.5	22.5	**Bucket & Core Weight (lb) =**	1.50
	2		22.5	21.5	**Empty Bucket Weight (lb) =**	0.64
	3				**Average Mass (lb) =**	0.43
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2117		**Sum (in) =**	**44.0**	**Average Density (lb/in^3) =**	**0.009**
Longitude	W 150.4877		**Average (in) =**	**22.0**	**Average SWE (in) =**	**5.74**
PS214	1	Tundra	17.0	17.0	**Bucket & Core Weight (lb) =**	1.10
	2		16.3	16.3	**Empty Bucket Weight (lb) =**	0.64
	3				**Average Mass (lb) =**	0.23
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2169		**Sum (in) =**	**33.3**	**Average Density (lb/in^3) =**	**0.007**
Longitude	W 150.4948		**Average (in) =**	**16.6**	**Average SWE (in) =**	**3.07**
PS215	1	Tundra	9.0	9.0	**Bucket & Core Weight (lb) =**	1.10
	2		9.0	8.0	**Empty Bucket Weight (lb) =**	0.64
	3		8.0	8.0	**Average Mass (lb) =**	0.12
	4		10.5	8.5	**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2183		**Sum (in) =**	**33.5**	**Average Density (lb/in^3) =**	**0.007**
Longitude	W 150.5018		**Average (in) =**	**8.4**	**Average SWE (in) =**	**1.54**
PS216	1	Lake	4.8	4.8	**Bucket & Core Weight (lb) =**	1.10
	2		4.5	4.4	**Empty Bucket Weight (lb) =**	0.64
	3		4.5	4.5	**Average Mass (lb) =**	0.09
	4		4.5	4.4	**Core Area (in^2) =**	2.0739
	5		4.5	4.4	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2197		**Sum (in) =**	**22.5**	**Average Density (lb/in^3) =**	**0.010**
Longitude	W 150.5087		**Average (in) =**	**4.5**	**Average SWE (in) =**	**1.23**
PS217*	1	Lake	3.0	2.8	**Bucket & Core Weight (lb) =**	1.00
	2		3.3	3.1	**Empty Bucket Weight (lb) =**	0.64
	3		3.0	2.8	**Average Mass (lb) =**	0.07
	4		2.8	2.8	**Core Area (in^2) =**	2.0739
	5		3.0	2.8	**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2213		**Sum (in) =**	**14.2**	**Average Density (lb/in^3) =**	**0.012**
Longitude	W 150.5238		**Average (in) =**	**2.8**	**Average SWE (in) =**	**0.96**

Note 1: Locations are referenced to NAD 83 datum.

* Point located on snow berm, sample taken to the east on natural snow pack.

Pooled Snow Survey Data Sheet

Date:	4/30/2014	Start Time:	9:30	End Time:	16:00	Observers:	SNW, MNU, GCY
Catchment Basin:	M9605	**Driving Wrench Used:**	Mt. Rose	**Tube Section Used:**	0-62"		

Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Calculations	
PS218	1	Tundra	16.0	16.0	**Bucket & Core Weight (lb) =**	1.22
	2		15.5	15.5	**Empty Bucket Weight (lb) =**	0.64
	3				**Average Mass (lb) =**	0.29
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2214		**Sum (in) =**	**31.5**	**Average Density (lb/in^3) =**	**0.009**
Longitude	W 150.5302		**Average (in) =**	**15.8**	**Average SWE (in) =**	**3.87**
PS219	1	Tundra	16.8	16.8	**Bucket & Core Weight (lb) =**	1.18
	2		17.0	17.0	**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	0.26
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2257		**Sum (in) =**	**33.8**	**Average Density (lb/in^3) =**	**0.007**
Longitude	W 150.5069		**Average (in) =**	**16.9**	**Average SWE (in) =**	**3.47**
PS220	1	Lake	9.5	9.5	**Bucket & Core Weight (lb) =**	1.28
	2		10.0	9.8	**Empty Bucket Weight (lb) =**	0.66
	3		9.5	9.5	**Average Mass (lb) =**	0.21
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2234		**Sum (in) =**	**28.8**	**Average Density (lb/in^3) =**	**0.010**
Longitude	W 150.5113		**Average (in) =**	**9.6**	**Average SWE (in) =**	**2.76**
PS221	1	Lake	7.8	7.8	**Bucket & Core Weight (lb) =**	1.42
	2		8.3	8.3	**Empty Bucket Weight (lb) =**	0.66
	3		9.0	8.9	**Average Mass (lb) =**	0.25
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2195		**Sum (in) =**	**24.9**	**Average Density (lb/in^3) =**	**0.015**
Longitude	W 150.5174		**Average (in) =**	**8.3**	**Average SWE (in) =**	**3.38**
PS222	1	Lake	10.5	10.5	**Bucket & Core Weight (lb) =**	1.40
	2		10.5	10.5	**Empty Bucket Weight (lb) =**	0.66
	3		10.3	10.2	**Average Mass (lb) =**	0.25
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2180		**Sum (in) =**	**31.2**	**Average Density (lb/in^3) =**	**0.011**
Longitude	W 150.5190		**Average (in) =**	**10.4**	**Average SWE (in) =**	**3.29**
PS223	1	Tundra	10.0	10.0	**Bucket & Core Weight (lb) =**	1.24
	2		9.5	9.5	**Empty Bucket Weight (lb) =**	0.66
	3		11.0	11.0	**Average Mass (lb) =**	0.19
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2159		**Sum (in) =**	**30.5**	**Average Density (lb/in^3) =**	**0.009**
Longitude	W 150.5212		**Average (in) =**	**10.2**	**Average SWE (in) =**	**2.58**

Note 1: Locations are referenced to NAD 83 datum.

Pooled Snow Survey Data Sheet						
Date: 4/30/2014	**Start Time:** 9:30		**End Time:** 16:00		**Observers:** SNW, MNU, GCY	
Catchment Basin: M9605 Berm		**Driving Wrench Used:** Mt. Rose			**Tube Section Used:** 0-62"	
Snow Sample No.	**Pooled Sample #**	**Terrain Type**	**Snow Depth (in)**		**Calculations**	
			w/ Dirt Plug	**w/o Dirt Plug**		
B-PS01	1	Lake	15.0	15.0	**Bucket & Core Weight (lb) =**	1.64
	2		18.0	18.0	**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	0.49
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2209		**Sum (in) =**	**33.0**	**Average Density (lb/in^3) =**	**0.014**
Longitude	W 150.5234		**Average (in) =**	**16.5**	**Average SWE (in) =**	**6.54**
B-PS02	1	Lake	49.0	49.0	**Bucket & Core Weight (lb) =**	1.88
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	1.22
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2209		**Sum (in) =**	**49.0**	**Average Density (lb/in^3) =**	**0.012**
Longitude	W 150.5237		**Average (in) =**	**49.0**	**Average SWE (in) =**	**16.29**
B-PS03	1	Lake	37.5	37.5	**Bucket & Core Weight (lb) =**	1.56
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	0.90
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2209		**Sum (in) =**	**37.5**	**Average Density (lb/in^3) =**	**0.012**
Longitude	W 150.5241		**Average (in) =**	**37.5**	**Average SWE (in) =**	**12.02**
B-PS04	1	Lake	45.0	45.0	**Bucket & Core Weight (lb) =**	1.44
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	0.78
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2225		**Sum (in) =**	**45.0**	**Average Density (lb/in^3) =**	**0.008**
Longitude	W 150.5267		**Average (in) =**	**45.0**	**Average SWE (in) =**	**10.41**
B-PS05	1	Lake	49.0	49.0	**Bucket & Core Weight (lb) =**	1.54
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	0.88
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2225		**Sum (in) =**	**49.0**	**Average Density (lb/in^3) =**	**0.009**
Longitude	W 150.5263		**Average (in) =**	**49.0**	**Average SWE (in) =**	**11.75**
B-PS06	1	Lake	37.0	37.0	**Bucket & Core Weight (lb) =**	1.62
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	0.96
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2226		**Sum (in) =**	**37.0**	**Average Density (lb/in^3) =**	**0.013**
Longitude	W 150.5261		**Average (in) =**	**37.0**	**Average SWE (in) =**	**12.82**

Note 1: Locations are referenced to NAD 83 datum.

Pooled Snow Survey Data Sheet						
Date: 4/30/2014	Start Time: 9:30		End Time: 16:00		Observers: SNW, MNU, GCY	
Catchment Basin: M9605 Berm	Driving Wrench Used: Mt. Rose				Tube Section Used: 0-62"	
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Calculations	
B-PS07	1	Lake	20.0	20.0	Bucket & Core Weight (lb) =	1.06
	2				Empty Bucket Weight (lb) =	0.66
	3				Average Mass (lb) =	0.40
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2244		Sum (in) =	**20.0**	Average Density (lb/in^3) =	**0.010**
Longitude	W 150.5279		Average (in) =	**20.0**	Average SWE (in) =	**5.34**
B-PS08	1	Tundra	47.0	47.0	Bucket & Core Weight (lb) =	1.86
	2				Empty Bucket Weight (lb) =	0.66
	3				Average Mass (lb) =	1.20
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2243		Sum (in) =	**47.0**	Average Density (lb/in^3) =	**0.012**
Longitude	W 150.5273		Average (in) =	**47.0**	Average SWE (in) =	**16.02**
B-PS09	1	Lake	22.0	22.0	Bucket & Core Weight (lb) =	1.18
	2				Empty Bucket Weight (lb) =	0.66
	3				Average Mass (lb) =	0.52
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2244		Sum (in) =	**22.0**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150.5269		Average (in) =	**22.0**	Average SWE (in) =	**6.94**
B-PS10	1	Lake	30.0	30.0	Bucket & Core Weight (lb) =	1.44
	2				Empty Bucket Weight (lb) =	0.66
	3				Average Mass (lb) =	0.78
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2252		Sum (in) =	**30.0**	Average Density (lb/in^3) =	**0.013**
Longitude	W 150.5283		Average (in) =	**30.0**	Average SWE (in) =	**10.41**
B-PS11	1	Tundra	47.0	47.0	Bucket & Core Weight (lb) =	1.78
	2				Empty Bucket Weight (lb) =	0.66
	3				Average Mass (lb) =	1.12
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2252		Sum (in) =	**47.0**	Average Density (lb/in^3) =	**0.011**
Longitude	W 150.5278		Average (in) =	**47.0**	Average SWE (in) =	**14.95**
B-PS12	1	Lake	22.0	22.0	Bucket & Core Weight (lb) =	1.22
	2				Empty Bucket Weight (lb) =	0.66
	3				Average Mass (lb) =	0.56
	4				Core Area (in^2) =	2.0739
	5				Freshwater Density (lb/in^3) =	0.0361
Latitude	N 70.2252		Sum (in) =	**22.0**	Average Density (lb/in^3) =	**0.012**
Longitude	W 150.5273		Average (in) =	**22.0**	Average SWE (in) =	**7.48**
Note 1: Locations are referenced to NAD 83 datum.						

Pooled Snow Survey Data Sheet						
Date: 4/30/2014		**Start Time:** 9:30		**End Time:** 16:00	**Observers:** SNW, MNU, GCY	
Catchment Basin: M9605 Berm		**Driving Wrench Used:** Mt. Rose			**Tube Section Used:** 0-62"	
Snow Sample No.	**Pooled Sample #**	**Terrain Type**	**Snow Depth (in)**		**Calculations**	
			w/ Dirt Plug	**w/o Dirt Plug**		
B-PS13	1	Tundra	38.0	38.0	**Bucket & Core Weight (lb) =**	1.52
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	0.86
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2271		**Sum (in) =**	**38.0**	**Average Density (lb/in^3) =**	**0.011**
Longitude	W 150.5291		**Average (in) =**	**38.0**	**Average SWE (in) =**	**11.48**
B-PS14	1	Lake	55.0	55.0	**Bucket & Core Weight (lb) =**	2.18
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	1.52
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2271		**Sum (in) =**	**55.0**	**Average Density (lb/in^3) =**	**0.013**
Longitude	W 150.5286		**Average (in) =**	**55.0**	**Average SWE (in) =**	**20.30**
B-PS15	1	Lake	19.0	19.0	**Bucket & Core Weight (lb) =**	1.10
	2				**Empty Bucket Weight (lb) =**	0.66
	3				**Average Mass (lb) =**	0.44
	4				**Core Area (in^2) =**	2.0739
	5				**Freshwater Density (lb/in^3) =**	0.0361
Latitude	N 70.2271		**Sum (in) =**	**19.0**	**Average Density (lb/in^3) =**	**0.011**
Longitude	W 150.5281		**Average (in) =**	**19.0**	**Average SWE (in) =**	**5.88**
Note 1: Locations are referenced to NAD 83 datum.						

C.2.2 SNOW DEPTH SURVEY DATA

Snow Depth Survey Data Sheet				
Date: 4/30/2014		**Start Time:** 9:30		**Observers:** GCY, SNW, MNU
Catchment Basin: M9605		**End Time:** 16:00		
Snow Sample No.	**Terrain Type**	**Snow Depth (in)**	**Location**	
			Latitude	**Longitude**
SS400	Tundra	2.0	N 70.2314	W 150.5258
SS401	Lake	0.0	N 70.2304	W 150.5250
SS402	Lake	5.1	N 70.2299	W 150.5245
SS403	Lake	3.9	N 70.2294	W 150.5240
SS404	Lake	13.0	N 70.2283	W 150.5229
SS405	Lake	9.1	N 70.2278	W 150.5225
SS406	Lake	7.5	N 70.2273	W 150.5219
SS407	Lake	9.4	N 70.2268	W 150.5214
SS408	Lake	13.8	N 70.2257	W 150.5204
SS409	Lake	5.9	N 70.2252	W 150.5198
SS410	Lake	8.3	N 70.2247	W 150.5193
SS411	Lake	9.4	N 70.2242	W 150.5188
SS412	Lake	9.8	N 70.2231	W 150.5178
SS413	Lake	5.1	N 70.2226	W 150.5173
SS414	Lake	9.8	N 70.2221	W 150.5167
SS415	Lake	6.3	N 70.2216	W 150.5162
SS416	Lake	2.4	N 70.2206	W 150.5151
SS417	Lake	4.3	N 70.2200	W 150.5145
SS418	Lake	5.5	N 70.2195	W 150.5140
SS419	Lake	8.3	N 70.2190	W 150.5134
SS420	Lake	13.4	N 70.2180	W 150.5122
SS421	Lake	3.5	N 70.2175	W 150.5116
SS422	Lake	1.6	N 70.2170	W 150.5111
SS423	Lake	8.3	N 70.2165	W 150.5105
SS424	Lake	9.4	N 70.2155	W 150.5093
SS425	Lake	9.8	N 70.2149	W 150.5087
SS426	Lake	8.7	N 70.2144	W 150.5082
SS427	Lake	5.9	N 70.2139	W 150.5076
SS428	Lake	3.9	N 70.2129	W 150.5064
SS429	Lake	48.8	N 70.2124	W 150.5059
SS430	Tundra	13.4	N 70.2119	W 150.5053
SS431	Tundra	14.2	N 70.2114	W 150.5047
SS432	Tundra	21.7	N 70.2103	W 150.5035
SS433	Tundra	20.1	N 70.2098	W 150.5030
SS434	Tundra	11.4	N 70.2088	W 150.5018
SS435	Tundra	17.7	N 70.2083	W 150.5012
SS436	Tundra	11.0	N 70.2078	W 150.5006
SS437	Tundra	17.7	N 70.2073	W 150.5000
SS438	Tundra	20.5	N 70.2063	W 150.4989
SS439	Tundra	15.4	N 70.2058	W 150.4983
SS440	Tundra	13.8	N 70.2053	W 150.4977
SS441	Tundra	13.8	N 70.2089	W 150.5053

Snow Depth Survey Data Sheet				
Date: 4/30/2014		Start Time: 9:30 AM		Observers: GCY, SNW, MNU
Catchment Basin: M9605		End Time: 4:00 PM		
Snow Sample No.	Terrain Type	Snow Depth (in)	Location	
			Latitude	Longitude
SS442	Tundra	17.7	N 70.2091	W 150.5038
SS443	Tundra	11.8	N 70.2096	W 150.5009
SS444	Tundra	27.6	N 70.2098	W 150.4994
SS445	Tundra	19.3	N 70.2100	W 150.4979
SS446	Tundra	14.2	N 70.2103	W 150.4965
SS447	Tundra	13.8	N 70.2107	W 150.4935
SS448	Tundra	15.0	N 70.2110	W 150.4921
SS449	Tundra	13.0	N 70.2112	W 150.4906
SS450	Tundra	12.2	N 70.2114	W 150.4892
SS451	Tundra	11.0	N 70.2119	W 150.4862
SS452	Tundra	13.0	N 70.2172	W 150.4962
SS453	Tundra	13.4	N 70.2175	W 150.4976
SS454	Tundra	15.7	N 70.2177	W 150.4990
SS455	Tundra	14.6	N 70.2180	W 150.5004
SS456	Tundra	11.8	N 70.2186	W 150.5032
SS457	Tundra	9.4	N 70.2188	W 150.5045
SS458	Lake	3.9	N 70.2192	W 150.5059
SS459	Lake	2.0	N 70.2194	W 150.5073
SS460	Lake	7.9	N 70.2200	W 150.5101
SS461	Lake	11.0	N 70.2202	W 150.5115
SS462	Lake	3.5	N 70.2205	W 150.5129
SS463	Lake	10.2	N 70.2208	W 150.5143
SS464	Lake	3.1	N 70.2211	W 150.5173
SS465	Lake	2.4	N 70.2212	W 150.5189
SS466	Lake	11.8	N 70.2212	W 150.5205
SS467	Lake	3.9	N 70.2212	W 150.5222
SS468	Tundra	35.4	N 70.2213	W 150.5254
SS469	Tundra	11.0	N 70.2214	W 150.5270
SS470	Tundra	11.0	N 70.2214	W 150.5286
SS471	Tundra	13.8	N 70.2215	W 150.5318
SS472	Tundra	12.6	N 70.2266	W 150.5051
SS473	Tundra	18.9	N 70.2261	W 150.5060
SS474	Tundra	26.8	N 70.2252	W 150.5078
SS475	Lake	15.4	N 70.2247	W 150.5087
SS476	Lake	5.9	N 70.2243	W 150.5095
SS477	Lake	13.4	N 70.2238	W 150.5104
SS478	Lake	9.1	N 70.2229	W 150.5122
SS479	Lake	5.9	N 70.2224	W 150.5131
SS480	Lake	7.5	N 70.2220	W 150.5139
SS481	Lake	5.9	N 70.2215	W 150.5148
SS482	Lake	6.7	N 70.2206	W 150.5163
SS483	Lake	2.8	N 70.2200	W 150.5168

Snow Depth Survey Data Sheet				
Date: 4/30/2014		**Start Time:** 9:30 AM		**Observers: GCY, SNW, MNU**
Catchment Basin: M9605		**End Time:** 4:00 PM		
Snow Sample No.	**Terrain Type**	**Snow Depth (in)**	**Location**	
			Latitude	**Longitude**
SS484	Lake	8.7	N 70.2190	W 150.5179
SS485	Lake	15.7	N 70.2185	W 150.5185
SS486	Lake	8.3	N 70.2175	W 150.5196
SS487	Lake	5.5	N 70.2170	W 150.5201
SS488	Tundra	23.2	N 70.2164	W 150.5207
SS489	Tundra	15.7	N 70.2154	W 150.5218
SS490	Tundra	14.6	N 70.2149	W 150.5223

Appendix D Alpine Area Lakes Recharge Study Photos

D.1 Lake B8530

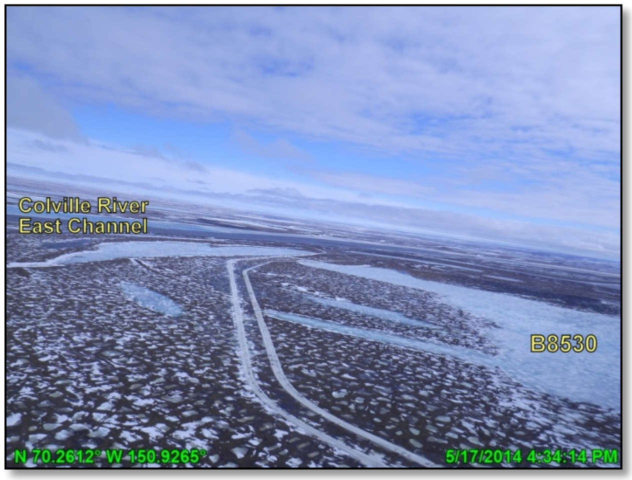


Photo D.1: Lake B8530 pre-breakup, looking west; May 17, 2014

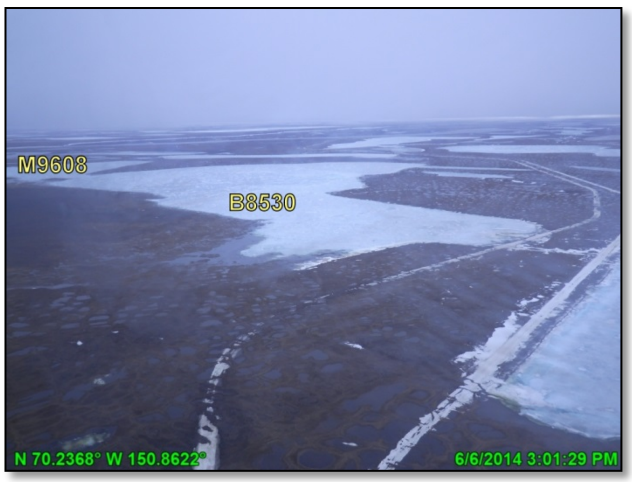


Photo D.2: Lake B8530 during breakup, looking northwest; June 6, 2014

Photo D.3: Lake B8530 post-breakup, looking northwest; July 11, 2014

D.2 Lake B8531/L9326

Photo D.4: Lake B8531/L9326 pre-breakup, looking southwest; May 16, 2014

Photo D.5: Lake B8531/L9326 during breakup, looking southeast; June 6, 2014

Photo D.6: Lake B8531/L9326 post-breakup, looking southeast; July 11, 2014

D.3 Lake B8533

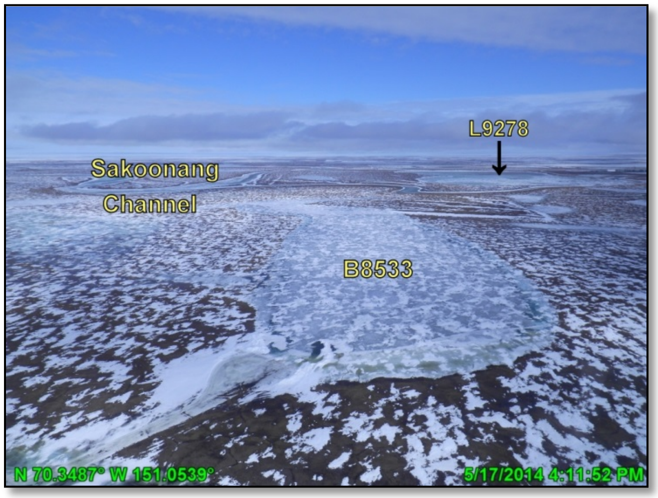


Photo D.7: Lake B8533 pre-breakup, looking east; May 17, 2014

Photo D.8: Lake B8533 during breakup, looking northeast; June 7, 2014

Photo D.9: Lake B8533 post-breakup, looking northeast; July 11, 2014

D.4 Lake L9132

Photo D.10: Lake L9132 pre-breakup, looking east; May 17, 2014

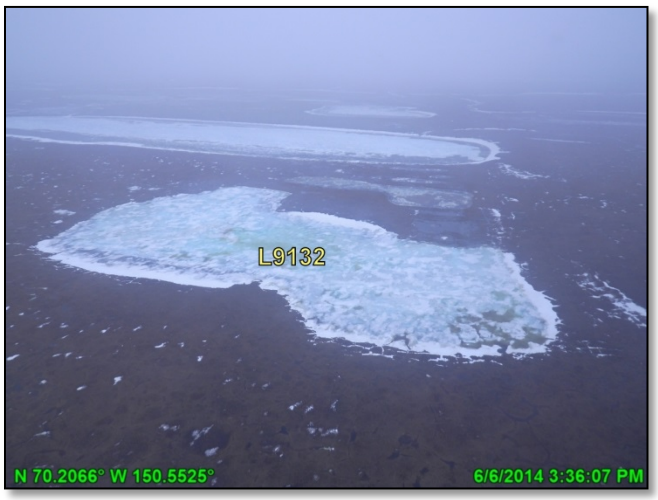


Photo D.11: Lake L9132 during breakup, looking east; June 6, 2014

Photo D.12: Lake L9132 post-breakup, looking southeast; July 10, 2014

D.5 Lake L9323

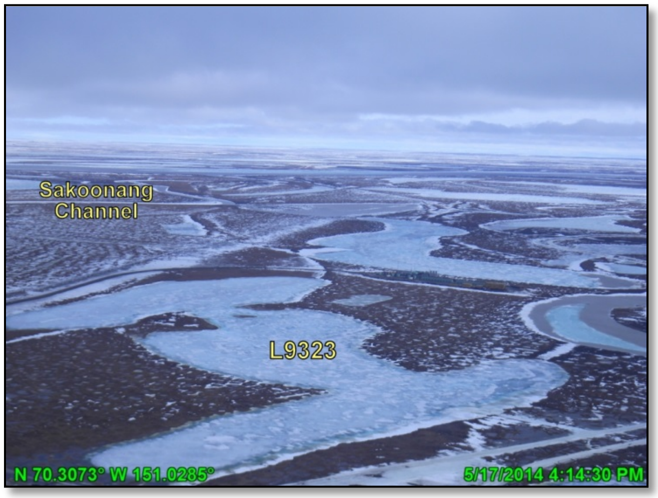


Photo D.13: Lake L9323 pre-breakup, looking southeast; May 17, 2014

Photo D.14: Lake L9323 during breakup, looking northeast; June 8, 2014

Photo D.15: Lake L9323 post-breakup, looking southeast; July 11, 2014

D.6 Lake L9324

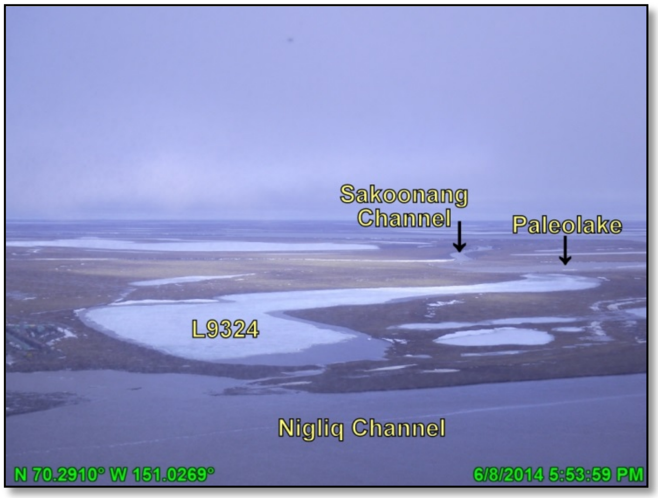


Photo D.16: Lake L9324 during breakup, looking east; June 8, 2014

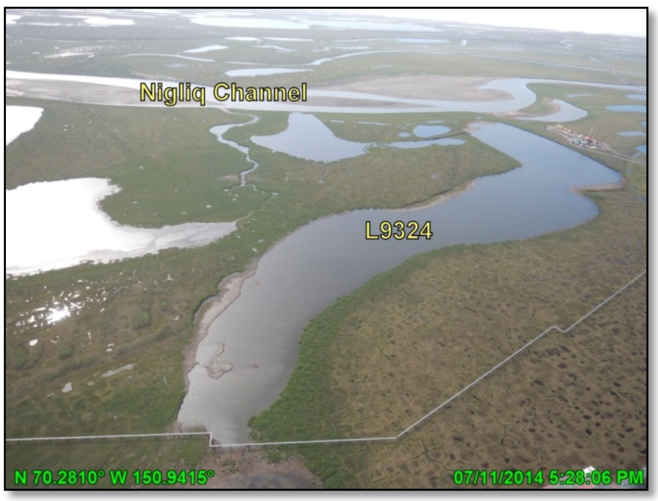


Photo D.17: Lake L9324 post-breakup, looking west; July 11, 2014

D.7 Lake K209

Photo D.18: Lake K209 pre-breakup, looking southwest; May 17, 2014

Photo D.19: Lake K209 during breakup, looking south; June 6, 2014

Photo D.20: Lake K209 post-breakup, looking south; July 10, 2014

D.8 Lake K214

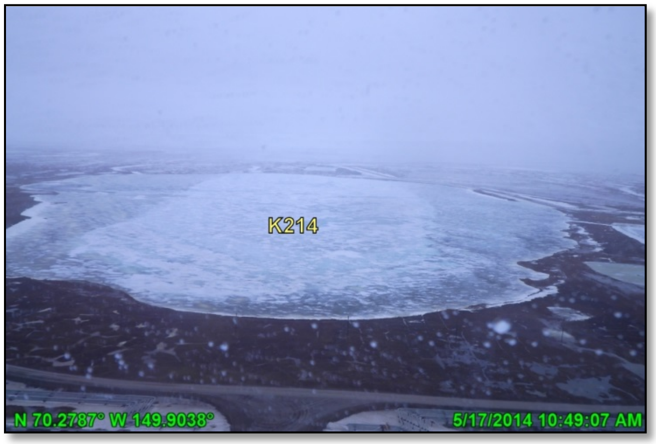


Photo D.21: Lake K214 pre-breakup, looking north; May 17, 2014

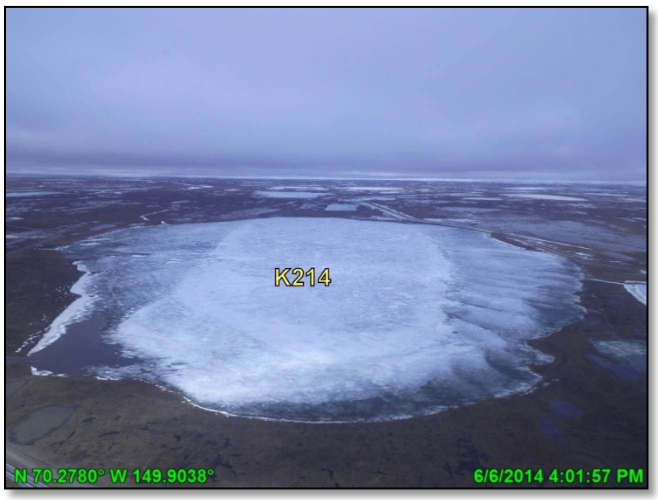


Photo D.22: Lake K214 during breakup, looking north; June 6, 2014

Photo D.23: Lake K214 post-breakup, looking northeast; July 10, 2014

D.9 Lake M9602

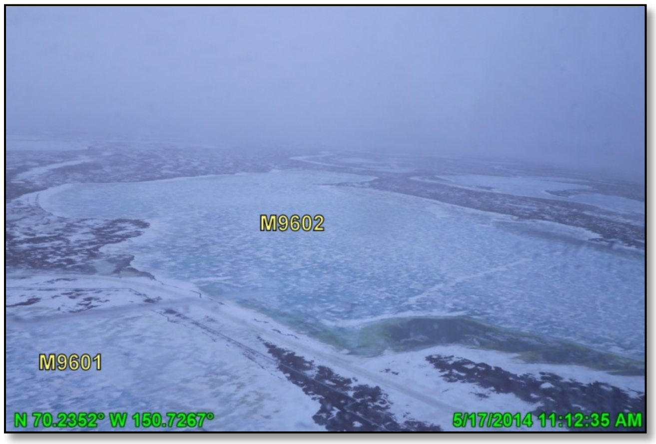


Photo D.24: Lake M9602 pre-breakup, looking south; May 17, 2014

Photo D.25: Lake M9602 during breakup, looking south; June 6, 2014

Photo D.26: Lake M9602 post-breakup, looking southwest; July 10, 2014

D.10 Lake M9603

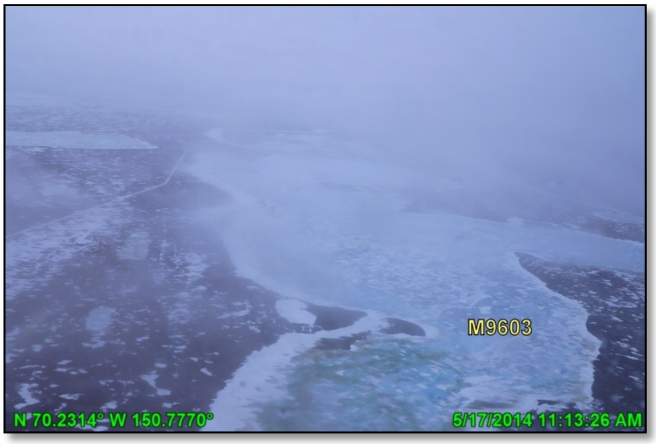


Photo D.27: Lake M9603 pre-breakup, looking south; May 17, 2014

Photo D.28: Lake M9603 during breakup, looking southeast; June 6, 2014

Photo D.29: Lake M9603 post-breakup, looking southeast; July 10, 2014

D.11 Lake M9605

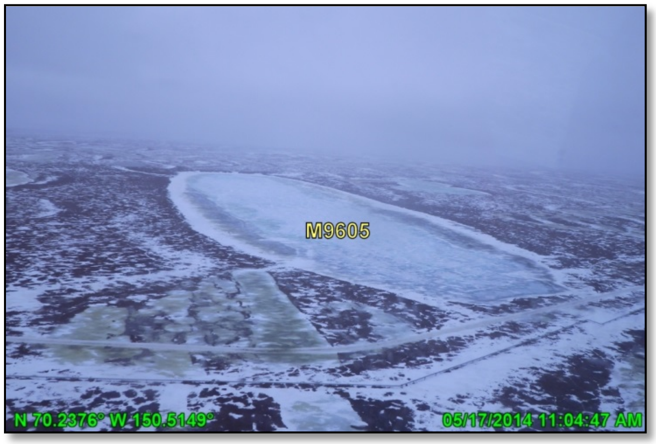


Photo D.30: Lake M9605 pre-breakup, looking south; May 17, 2014

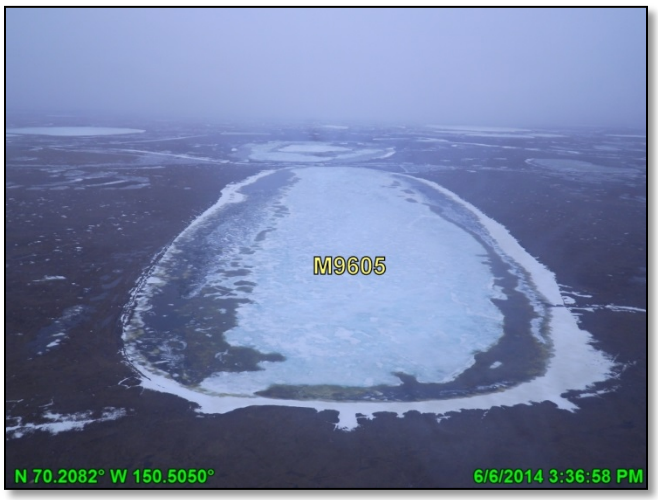


Photo D.31: Lake M9605 during breakup, looking north; June 6, 2014

Photo D.32: Lake M9605 post-breakup, looking south; July 10, 2014

D.12 Lake M9607

Photo D.33: Lake M9607 pre-breakup, looking northwest; May 22, 2014

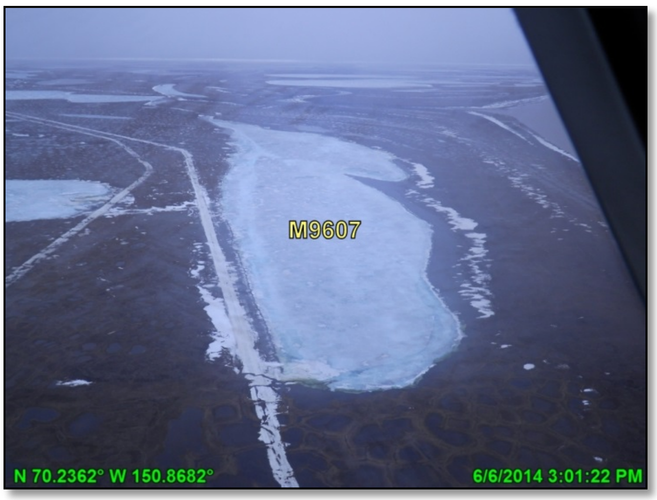


Photo D.34: Lake M9607 during breakup, looking north; June 6, 2014

Photo D.35: Lake M9607 post-breakup, looking northwest; July 11, 2014

D.13 Nanuq Lake

Photo D.36: Nanuq Lake during breakup, looking north; June 8, 2014

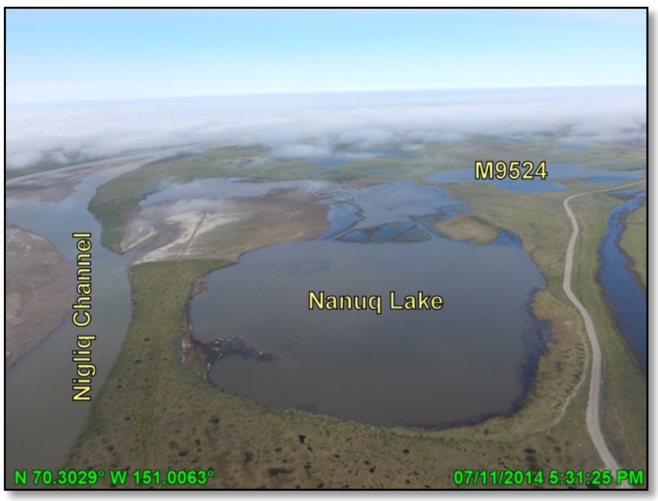


Photo D.37: Nanuq Lake, post-breakup, looking north; July 11, 2014

2014 Alpine Area Lakes Recharge Studies