2007 Colville River Delta Lakes Recharge Monitoring and Analysis

Submitted to

ConocoPhillips

Submitted by

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1.0 Introduction

Ongoing operations in the Colville River Delta use ice roads and pads for access and transportation during the winter months. Each season, millions of gallons of fresh water are withdrawn to meet winter construction and operation requirements. Additional fresh water is used for potable water supplies at temporary rig camps and make-up water for drilling operations. Removal of grounded ice aggregate can supplement water withdrawal without impacting overwintering fish habitat. Water withdrawal for construction and operations may begin as early as December and continue into May.

This report summarizes hydrologic observations, measurements, and analyses made during the 2007 Colville River Delta Lakes Recharge Monitoring and Analysis Project. The study was performed at the request of ConocoPhillips Alaska, Inc. (CPAI) by Michael Baker Jr., Inc. (Baker). Tasks consisted of pre-breakup and breakup monitoring, including delineation of lake drainage basins, water surface elevation and snow water equivalent surveys, and lake recharge observations. Thirty permitted lakes, identified by CPAI, were included in the recharge study (CPAI 2006).

1.1 Acknowledgements

Baker was pleased to work with and would like to sincerely thank CPAI, Kuukpik/LCMF Inc., and Maritime Helicopters for their time, patience, and continuous support. They were instrumental in making this a safe and successful program.

1.2 Study Overview and Purpose

The State of Alaska Department of Natural Resources (ADNR) Office of Habitat Management and Permitting (OHMP) oversees fish habitat permitting in the Colville River Delta. The purpose of the 2007 Colville River Delta Lakes Lake Recharge Monitoring and Analysis project was to document the mechanisms and extent of recharge for 30 lakes identified by CPAI (CPAI 2006), to support removal of six inches of grounded ice in addition to permitted water withdrawal volumes If lakes are shown to have adequate recharge, ice chips can be removed from grounded ice without impacting fish habitat. The OHMP approved removal of additional ice chips for the 30 lakes for the 2006/2007 winter season only. The location of each lake within the CRD is presented in Figure 1-1.

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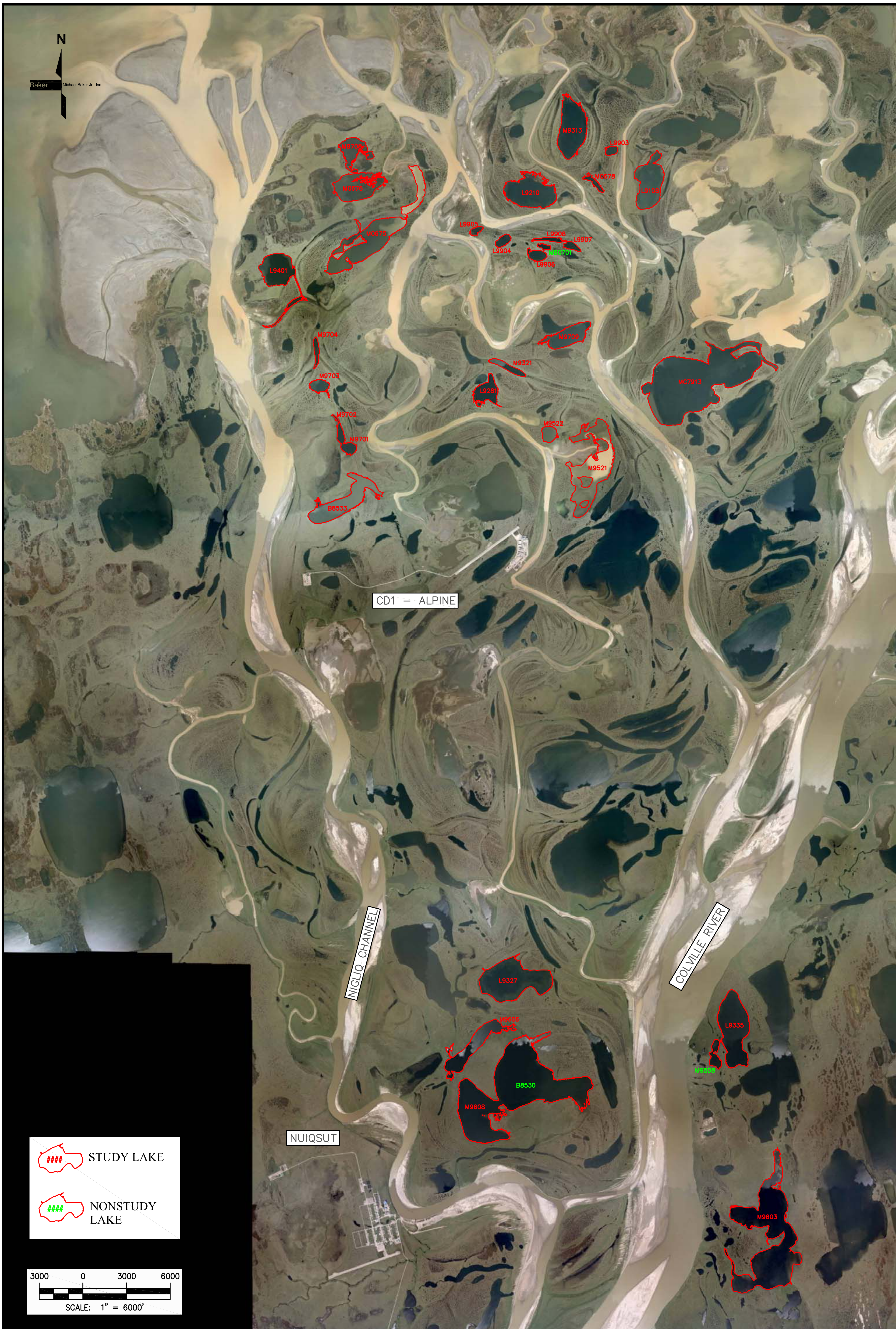

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Alaska, Inc.

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COLVILLE RIVER DELTA
LAKE RECHARGE
STUDY LAKES

FIGURE 1-1
(SHEET 1 OF 1)

Drainage basins of the 30 permitted lakes were determined using one foot pixel resolution orthophotography. Direct recharge measurements, including water surface elevation and snow water equivalent (SWE) surveys, were conducted at a subset of six lakes (Table 1-1). Ground truthing of delineated drainage basins was also performed at the six lakes after the 2007 spring breakup.

Table 1-1 2007 Colville River Delta Subset of Six Field Study Lakes

Study Lakes	
L9210	L9906
M9313	L9908
L9327	M9703

This report presents the results of the Colville River Delta (CRD) Lake Recharge Monitoring and Analysis study and compares those results with previously conducted North Slope studies. Historic hydrologic and meteorologic data were also used to relate 2007 observations to regional averages. Observed and estimated recharge volumes were compared to water withdrawal volumes reported during the 2006/2007 winter season.

1.3 Background

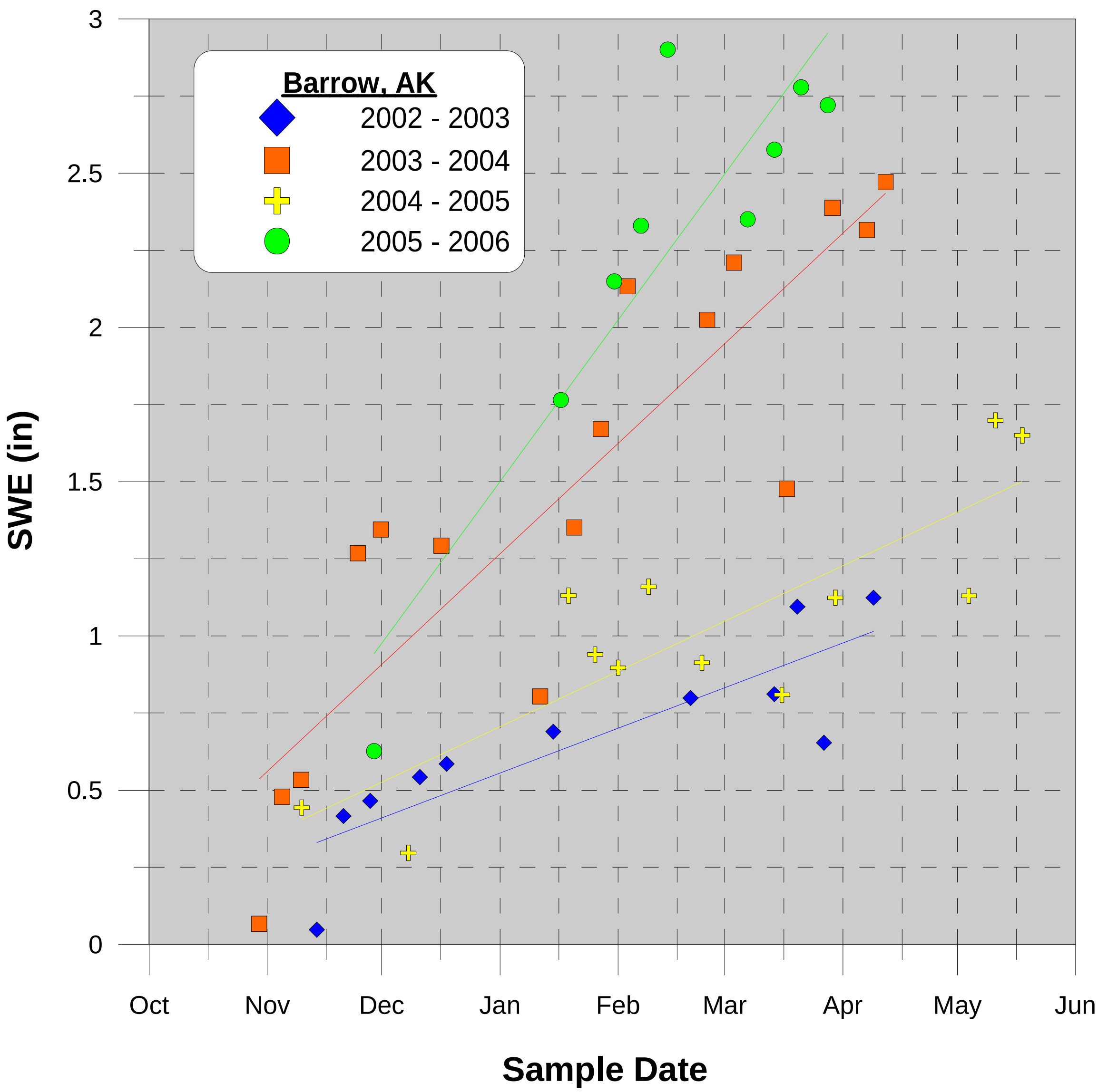
The three primary mechanisms which contribute to annual recharge of lakes in the CRD include spring breakup flooding from the Colville River and its distributaries, meteorological precipitation, and spring snow melt. Lake recharge by floodwater is dependent on the magnitude and distribution of floodwaters during spring breakup and the topography of the tundra surrounding each lake. From past observations, it is clear that not all lakes are recharged by floodwaters in an average year; however, during large flood events the majority of CRD lakes are recharged by floodwaters. Local ice jamming during spring breakup can also increase the number of lakes that are recharged, even during a relatively low magnitude flood.

The hydrologic cycle on the North Slope is typical of extreme northern latitudes, driven by precipitation, condensation, infiltration, runoff and evaporation. According to the U.S, Geological Survey (USGS), the mean annual precipitation of the western north slope of Alaska is 7.5 inches (Jones and Fahl 1994). The official record, maintained by the Alaska Climate Research Center (ACRC), for the mean annual total water equivalent precipitation between 1971 and 2000 at Barrow and Prudhoe Bay is 4.16 and 4.02 inches, respectively. Approximately 75% of the mean annual total water equivalent precipitation is in the form of rain between June and September with the remaining 25% occurring in the form of snow during the winter. The ACRC represents the official measured annual precipitation and does not consider trace and immeasurable precipitation, which are included in the USGS precipitation record.

Average evaporation rates near Alpine during the summer of 1999 were estimated at approximately 1.5 millimeters per day, equating to a total seasonal (approximately 80 days) volume of approximately 4.7 inches (Baker 2002). The open water season, and extent of evaporative loss, is dependent on seasonal weather patterns, lake morphology, and spring ice thickness. Given the extent of evaporative loss relative to precipitation, a greater understanding of snow water equivalence prior to spring breakup is necessary with regard to lake recharge.

In general, snow cover on lake ice is thinner, denser, and comprises less SWE due to lower snow depths than on the adjacent tundra (Sturm and Liston 2003). Snow depth also tends to increase on lake ice towards the west due to prevailing wind patterns.

In addition to the spatial fluctuations in SWE, annual and seasonal variations also occur. An example of the annual variations in SWE is evident from data collected at Imikpuk Lake in Barrow. Dr. Martin Keffries has overseen the collection of SWE data as part of the Alaska Lake Ice and Snow Observatory Network (ALISON) since 2002. Graph 1-1 presents the results. The data demonstrate seasonal and annual variability of local SWE values. The maximum SWE was generally measured in May prior to breakup (Keffries 2007).



Source: Keffries 2007

Graph 1-1 Historical Snow Water Equivalent Data (2002-2006) Barrow, AK

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2.0 Winter 2006/2007 Water Use and Weather

2.1 Winter Permitted Lake Water Use

Water was withdrawn from six of the thirty permitted lakes; B8533/L9315, M9603, M9703, M0676, M9313, and M9606. Water was also withdrawn from B8530 under a separate permit. Though not included in the study, it was hydraulically connected to lake M9608 after spring thaw. Aerial imagery and ground observations suggest persistent connectivity of the two lakes and consequently of their respective drainage areas. Permitted and actual withdrawal volumes are tabulated for each of the thirty lakes (Table 2-1), as well as B8530, based on fourth quarter 2006 and second quarter 2007 water use reports (CPAI 2007a and 2007b, respectively)

2.2 Winter North Slope Weather

Physical processes on the North Slope are dominated by arctic weather conditions. Snow accumulation, ablation, and sublimation during winter months are driven by local and regional weather. As a result, prevailing 2006/2007 winter weather conditions played a significant role in the measurements and observations recorded during this study. Weather components of significant importance are precipitation, temperature, and wind.

The April and May 2007 National Resource Conservation Service (NRCS) Basin Outlook Reports were used as sources of summarized regional precipitation data (NRCS 2007a). A number of NRCS weather and SNOTEL stations were used to evaluate regional arctic precipitation and snowpack conditions. Stations are located at Deadhorse/Prudhoe Bay (62 miles east of Alpine), Atigun Camp and Atigun Pass (156 miles southeast), Imnaviat Creek (126 miles southeast), as well as Umiat Airport and Umiat Meteorological Station (73 miles southwest). Supplementary data provided by NRSC included the Snowpack Map for May 1, 2007 (NRCS 2007b).

Additionally, tabulated weather data from Barrow (147 miles northwest), Nuiqsut (9 miles south), Kuparuk (31 miles east), and Deadhorse/Prudhoe Bay airstrips were evaluated for the 2006/2007 winter season. Historic data was compiled by Weather Underground using data from Federal Aviation Administration maintained Automated Surface Observation System (ASOS) stations. Baker performed a comparison of observed trends in temperature, wind, relative humidity, and occurrence of precipitation events for these identified locations. The comparisons can be used to qualify regional data as it pertains to the CRD.

Table 2-1 2006 Summary of Permitted and Actual Withdrawal Volumes for the 30 Lakes

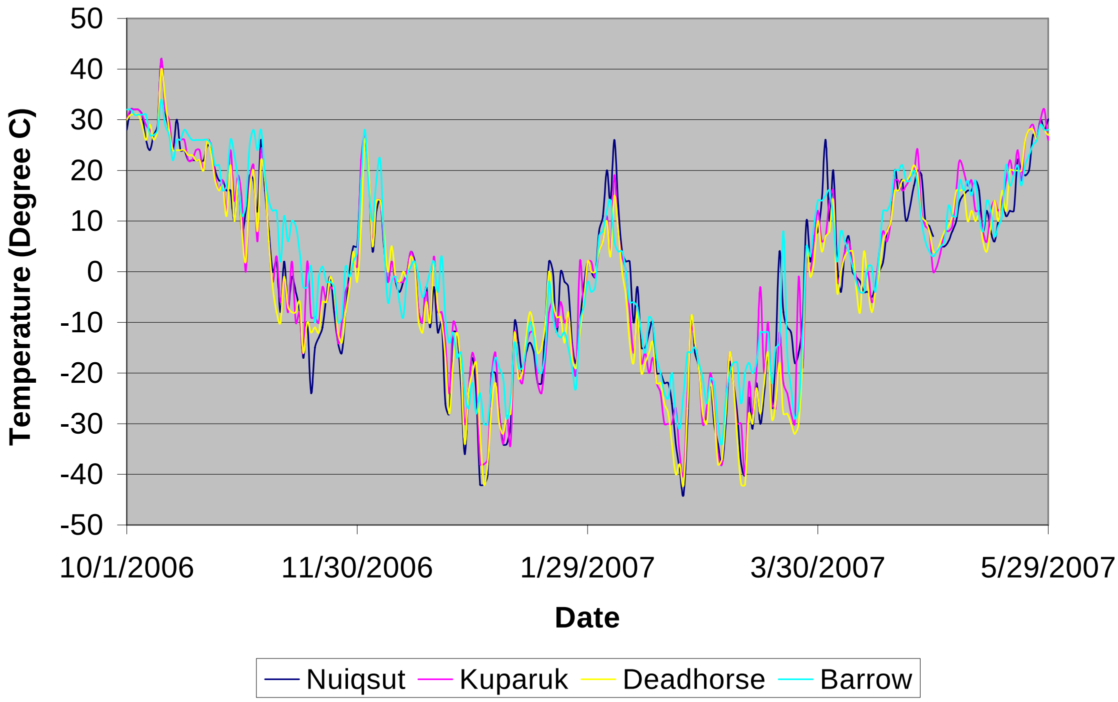
Lake Name	Permit Number	6/1/2006 - 5/31/2007 Withdrawl Volume (million gal.)			Current Permit Volume (million gal.)		
		Water Withdrawal	Ice Aggregate Removal	Total Withdrawal	Water Withdrawal	Ice Aggregate Removal(1)	Total Permitted Withdrawal
B8533/L9315	A2006-125	28.14	0.00	28.14	32.22	1.83	34.05
M9603	A2006-128	3.13	1.09	4.22	8.72	14.53	23.25
L9281	A2006-125	0.00	0.00	0.00	10.60	0.55	11.15
L9335	A2006-125	0.00	0.00	0.00	3.43	1.14	4.57
L9401	A2006-126	0.00	0.00	0.00	3.04	2.85	5.89
L9904	A2006-126	0.00	0.00	0.00	3.29	0.06	3.35
L9905	A2006-126	0.00	0.00	0.00	1.95	0.22	2.17
L9906	A2006-126	0.00	0.00	0.00	1.92	0.12	2.04
L9907	A2006-126	0.00	0.00	0.00	1.51	0.33	1.84
L9908	A2006-127	0.00	0.00	0.00	2.27	0.21	2.48
L9907 & L9908(2)	-	0.00	0.00	0.00	3.78	0.54	4.32
M9321	A2006-127	0.00	0.00	0.00	2.18	0.16	2.34
M9521	A2006-127	n/a	0.00	0.00	0.00	16.57	16.57
M9522	A2006-127	0.00	0.00	0.00	8.03	0.29	8.32
M9701	A2006-128	0.00	0.00	0.00	1.15	0.26	1.41
M9702	A2006-128	0.00	0.00	0.00	2.25	0.26	2.51
M9701 & M9702(3)	-	0.00	0.00	0.00	3.40	0.52	3.92
M9703	A2006-128	5.17	0.00	5.17	7.86	0.19	8.05
M9704	A2006-129	0.00	0.00	0.00	0.72	0.15	0.87
M9709	A2006-129	0.00	0.00	0.00	13.27	0.60	13.87
M0675	A2006-130	0.00	0.00	0.00	4.51	4.06	8.57
M0676	A2006-130	0.00	0.52	0.52	0.01	5.63	5.64
M0678	A2006-130	0.00	0.00	0.00	6.48	0.20	6.68
MC7913/M911	A2006-130	0.00	0.00	0.00	73.91	2.85	76.76
L9108	A2006-125	0.00	0.00	0.00	14.18	1.00	15.18
M9708	A2006-129	0.00	0.00	0.00	1.85	0.86	2.71
L9210/M9213	A2005-72	0.00	0.00	0.00	28.20	1.69	29.89
L9327	A2005-72	0.00	0.00	0.00	1.42	1.40	2.82
L9903	A2005-72	0.00	0.00	0.00	1.63	0.15	1.78
M9313	A2005-72	2.45	0.00	2.45	19.00	1.15	20.15
M9606	A2005-72	6.14	0.00	6.14	7.20	1.38	8.58
M9608	A2005-72	0.00	0.00	0.00	16.65	1.52	18.17
B8530(4)	A2003-63	18.29	0.00	18.29	22.34	0.00	22.34
M9608 & B8530(5)	-	18.29	0.00	18.29	38.99	1.52	40.51

Notes:
-- Blue highlights lakes where water withdrawn and/or ice aggregrate was removed.
1. Ice aggregrate removal volumes were approved for the 2006/2007 winter season only.
2. L9907 and L9908 are hydraulically connected.
3. M9701 and M9702 are hydraulically connected.
4. B8530 is not included as one of the thirty study lakes.
5. B8530 and M9608 are hydraulically connected.

The NRCS Basin Outlook Reports detailed considerably variable snowpack across the State of Alaska. While record highs occurred in the southeast, interior Alaska saw snow water equivalents that were less than 50 percent of normal for May 1. As of April 1, Prudhoe Bay was at 68% of normal precipitation having received 2.6 inches since October 1. During the month of April, the Arctic Slope received little precipitation. The May 1, 2007, NRCS Alaska Snowpack Map presented regional North Slope estimates at 70 – 89 % of normal.

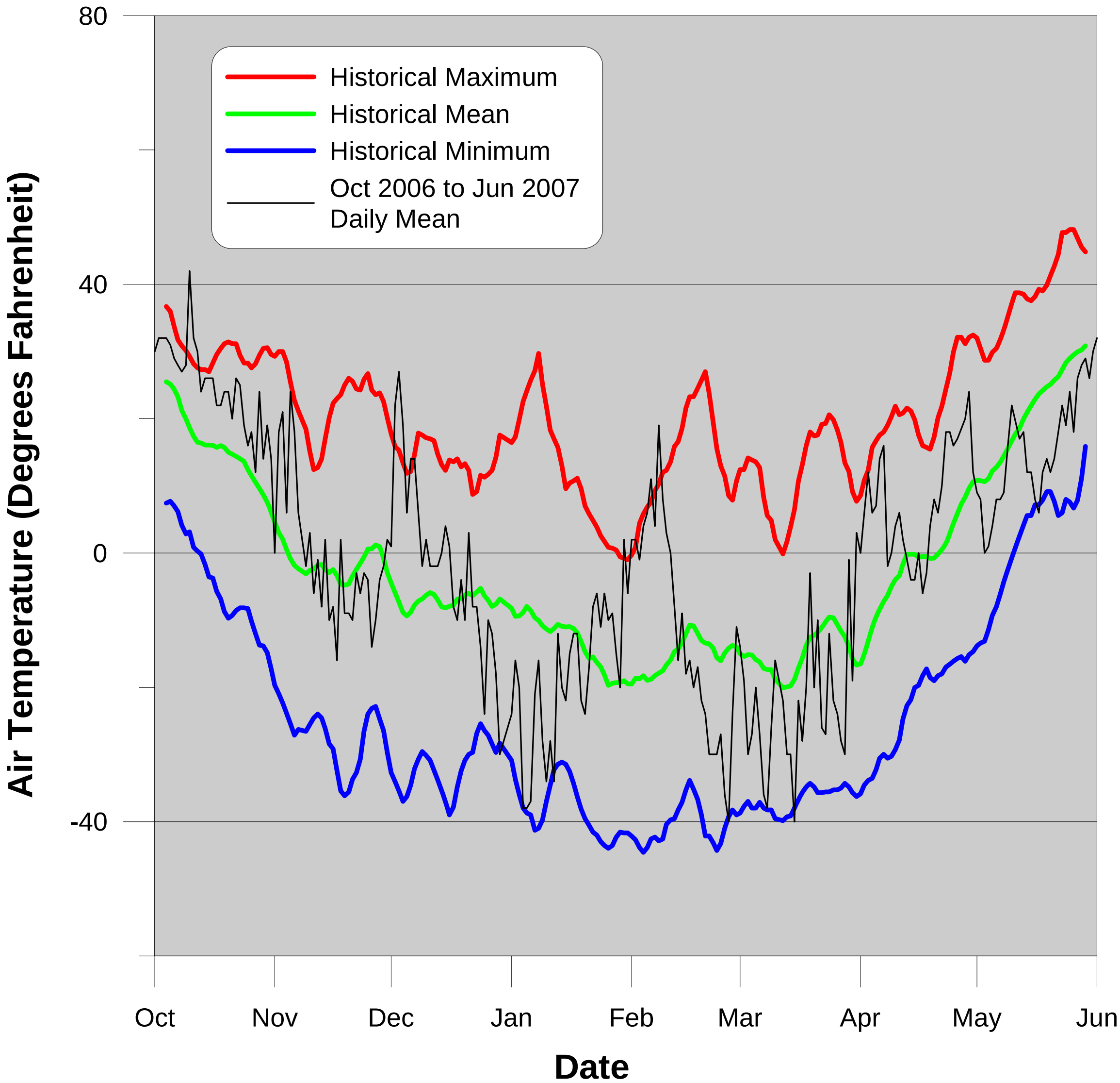
Tabulated weather data revealed a strong correlation between the four coastal stations. Similar daily mean temperatures were observed across the region with analogous warming and cooling trends (Graph 2-1).

Graph 2-1 Daily Mean Air Temperatures at Nuiqsut, Kuparuk, Deadhorse, and Barrow

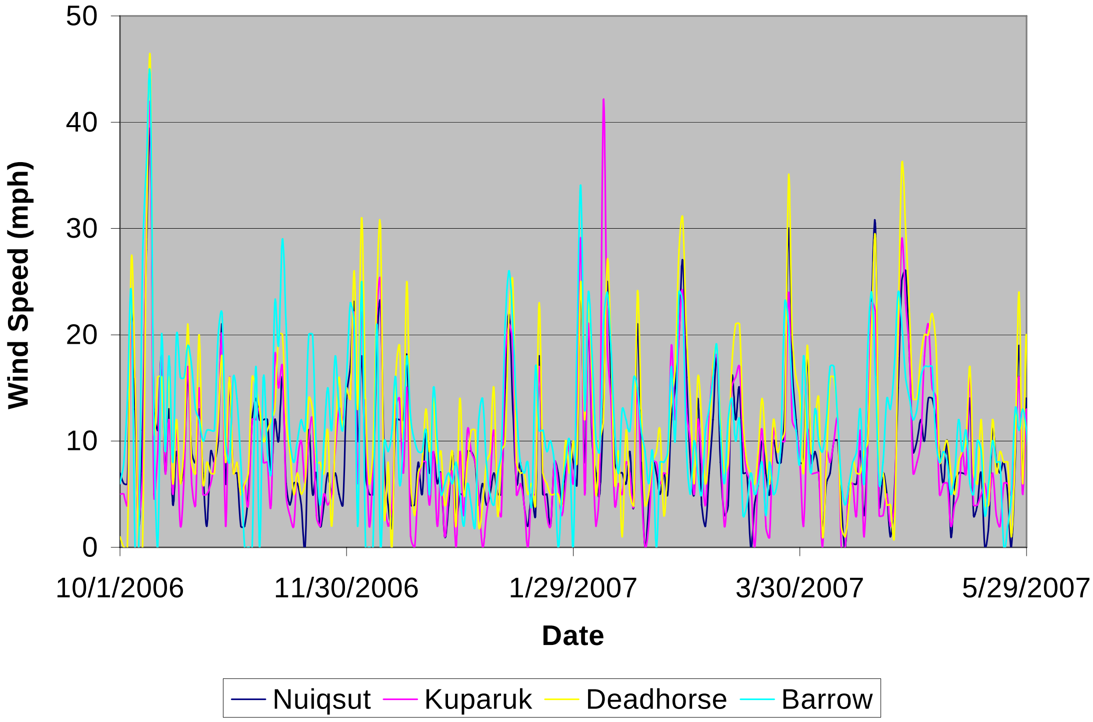


Past meteorological data from Nuiqsut was not available. To evaluate the severity of the 2006/2007 winter conditions in the CRD, Kuparuk data was compared to a six-year historic record. Overall, temperatures observed at Kuparuk were within the range of normal highs and lows as presented in Graph 2-2. Abnormally warm weeks were observed in December and February with temperatures dropping below normal during the months of January and March. Record highs were observed in October, late November, and early February. Observed trends in temperature relative to historic values are assumed to translate well to the CRD given the strong correlation of observed mean daily values between Nuiqsut and Kuparuk in 2006/2007.

Graph 2-2 Kuparuk Historic Air Temperature, 2000 - 2006 (October to June)



Graph 2-3 Daily Mean Wind Speed at Nuiqsut, Kuparuk, Deadhorse, and Barrow

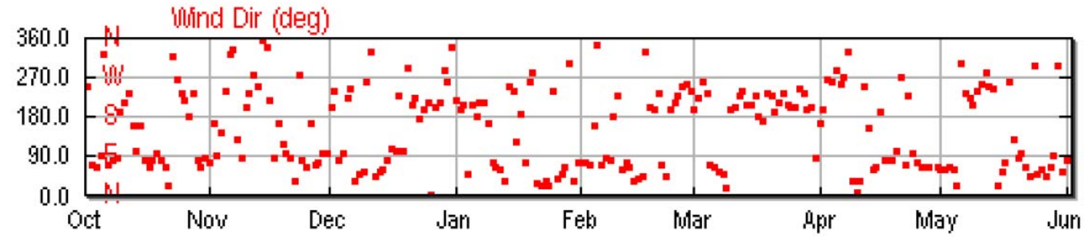


Observed winter 2006/2007 wind velocities suggest that conditions in the CRD were typical of the region (Graph 2-3). A point of significant interest is the daily variability of high winds, with numerous daily mean velocities well above 20 miles per hour (mph). Though wind bearing shifted throughout the winter season, it predominantly followed an east-west line dominated by easterly winds (Graph 2-4).

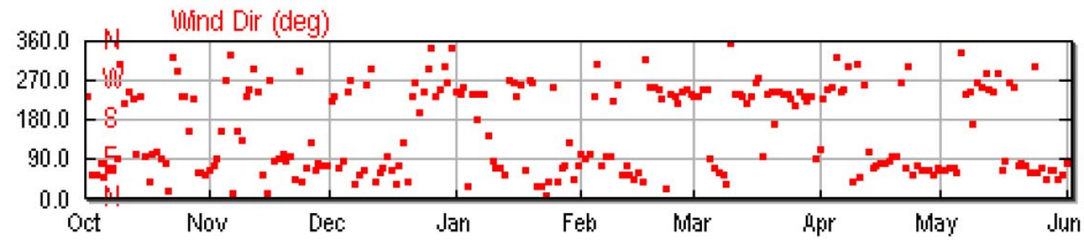
An analysis of historic wind data suggests prevalent winter (October – April) and spring (May and June) winds originate from the east-northeast (70 to 80 degrees) with average wind speeds of 12.6 and 11.7 mph, respectively (Baker 2007b).

Graph 2-4 Winter 2006/2007 Mean Daily Wind Direction at Nuiqsut, Kuparuk, Deadhorse and Barrow Airfields

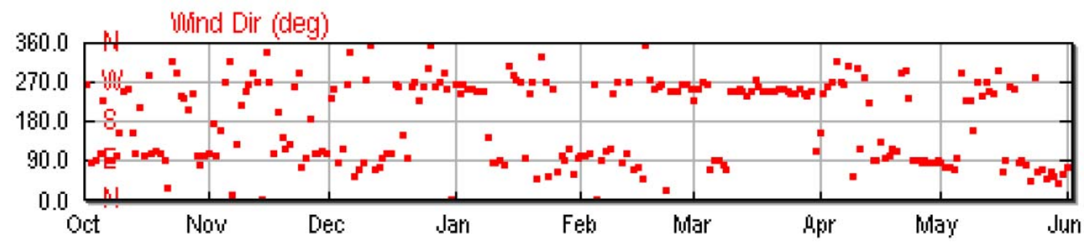
Nuiqsut



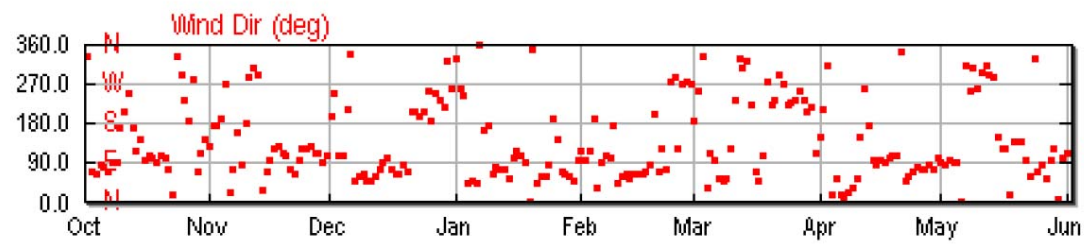
Kuparuk



Deadhorse

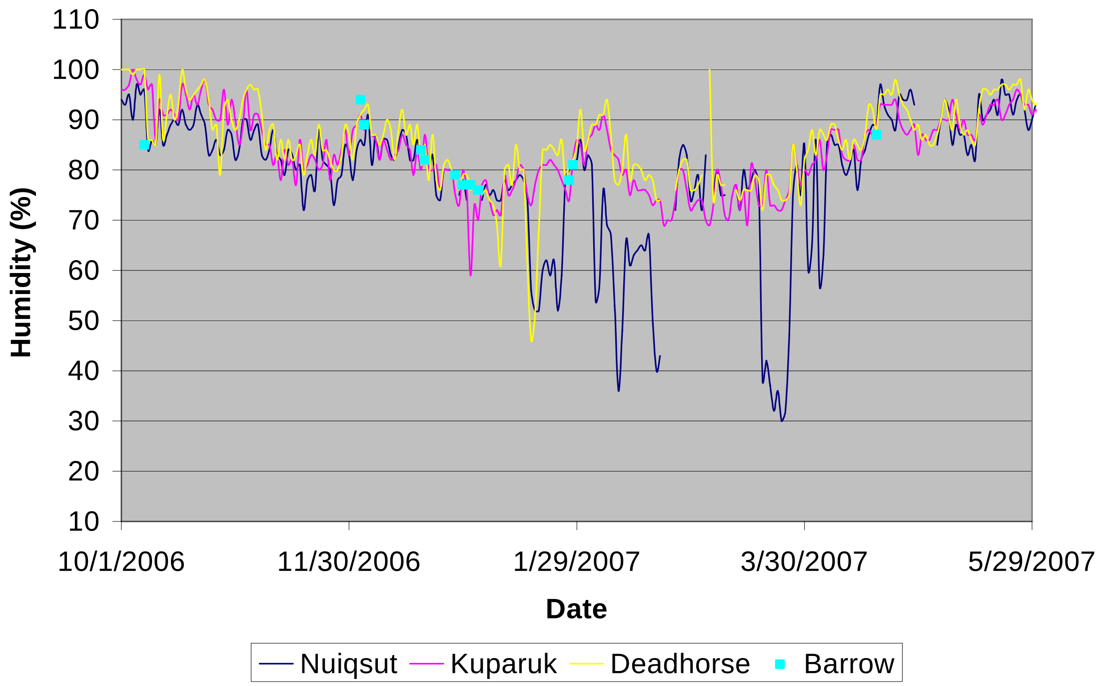


Barrow



Source: Weather Underground

Graph 2-5 Daily Mean Humidity at Nuiqsut, Kuparuk, Deadhorse, and Barrow



Humidity trends were relatively uniform between the four coastal stations (Graph 2-5). Data values collected at Nuiqsut were consistently lower than the other stations. Periods of significantly low relative humidity were reported at Nuiqsut during January, early February, and March. Between October 1, 2006 and June 1, 2007, 163 daily precipitation events associated with snow were documented at Nuiqsut. This value was the lowest of the four identified locations: Kuparuk (180 days), Deadhorse (178 days), and Barrow (191 days).

Sublimation of snow is equivalent to the evaporation of water and is a significant means of water loss during the winter months. The rate of sublimation rapidly increases with increased wind speeds and lower relative humidity. Snow water equivalent in effect decreases without additional precipitation or deposition. Decreased humidity, in conjunction with high winds, observed in the CRD during the winter of 2007 suggests a low snow water equivalent relative to the rest of the region.

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3.0 Study Methods

3.1 Catchment Basin Area Delineation

The primary focus of the catchment basin delineation was to ensure that the estimates were conservative yet accurate. The catchment basin area for each study lake was delineated using 1999 and 2004 AeroMap 2-foot contours and spot elevations. The vertical accuracy of the elevation data was equal to half the contour interval. The extent of lake margins between years was compared using 2004 and 2005 aerial photography and no significant changes were noted. Field observations were used to verify the catchement basin delineations,.

In addition to the use of contours and spot elevations, an analysis of large polygon fields, lake floodplains, and lake connectivity to other water bodies was conducted. Dense polygon fields of considerable size located within a study lake's catchment area were not considered to be a part of the lakes catchment basin area unless there was evidence of a distinct channel from the polygon field to the lake capable of transporting water during breakup conditions. Instead, the polygon fields were considered a confined waterbody that would not contribute significant snowmelt runoff to the adjacent lake.

3.2 Water Surface Elevation (WSE) Surveys

Water surface elevation surveys were conducted to estimate recharge at each of the six field study lakes. All water surface elevations are tied to an assumed datum which is independent at each of the field study lakes. The reported values do not represent "true elevations" with respect to a known datum such as BPMSL.

Standard level loop survey techniques were used to correlate water surface elevations to local temporary benchmarks (TBMs). Three TBMs were established near each of the monitored lakes. One TBM was provided an assumed elevation of 100 feet from which remaining TBM elevations were established. During winter sampling events, water surface elevation was calculated by subtracting measured freeboard (the distance from the top of ice to the water surface) from the surveyed ice surface elevation at the sample hole. During open water conditions, water surface elevation was calculated by adding water depth, measured on the survey rod, to the surveyed lake bed elevation near shore. Kuukpik/LCMF provided survey assistance in establishing TBMs and surveying winter water surface elevations. Water surface elevation surveys were conducted once in the winter, once prior to breakup, and once after breakup.

During the winter sampling events, an electric drill was used to auger a 2-inch (minimum) sampling hole through the ice. Freeboard was measured using a weighted rag tape when obtaining water depth. Ice thickness was measured using a graduated pole with a hook on the end. The pole was lowered into the water until the hook found the underside of the ice. The resultant ice thickness was measured from graduated marks along the pole.

3.3 Snow Water Equivalent (SWE) Surveys

3.3.1 Double Sampling Method

At each of the six field study lakes, a double sampling method snow survey was conducted measuring snow pack in two separate ways: (1) by measuring snow depth and mass at a smaller number of points, and (2) by measuring only snow depth at a large number of points. Sampling points were located along predetermined transects. Each transect was positioned such that it was aligned across, or perpendicular to, snow features (such as drifts and local topography) as suggested by Woo (1997). In the arctic, where vegetation is not a major factor affecting snow distribution, terrain has a major effect. Thus, terrain-based snow surveys allow the determination of mean catchment snow values and produce sufficient spatial snow information for most hydrological studies (Woo 1997).

The double sampling method was selected based on the limited depth of snow cover characteristic of the arctic. Goodison, Ferguson, and McKay (1981) suggest that in shallow snowpacks (less than 1 meter), depth and density have been found to be essentially independent and there is typically less temporal and spatial variability in density than in depth. Additionally, Rovansek, Kane, and Hinzman (1993) found that snow water equivalent estimates resulting from double sampling methods have less variance than when measuring snow mass and depth at every location. The double sampling method can also accelerate the speed at which a sampling program is executed, with depth measurements taking a fraction of the time required for measuring both depth and sample weight.

3.3.2 Sampling Transects and Points

Starting with aerial imagery, topographic contours, and spot elevations, the lake-water perimeter and lake's associated catchment basin were delineated (Section 3.1). Data specific to each terrain type was then identified as respective area, shape, relief, and potential locations for drift formation. Most lake catchment basins in the CRD have a boundary ridge encircling the lake body, thus transects were positioned perpendicular to local relief radiating from a central location on the lake. Additional transects were positioned to cover irregularities of a typical "bowl" shape. Irregularities can include drainage gullys, pingos and mounds, or basin arms.

Once transects were established, sampling points along each transect were identified. Uniform spacing of points was necessary to provide systematic sampling. The number of depth measurements was dependent on the length of the transect and variability of snow within the terrain unit. The number of depth measurements included those taken to determine snow density, of which there was no less than two points per transect (Woo 1997). Initial point locations were selected independent of local topography and terrain type to maintain random sampling along transects. In the case of adjoining transects, like those radiating from a single location, a point was positioned at their intersection, with successive points positioned a fixed distance from the initial point. Each terrain type that was covered by a single transect contained at least one snow mass sampling point.

3.3.3 Sampling

Density measurements were conducted according to procedures outlined in *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. This particular sampler was chosen based on its common acceptance and use by the NRCS.

Snow depth alone was sampled using a graduated snow pole. In addition, if shallow snow was encountered having a SWE of less than 2 inches, a bulk sampling was conducted (NRCS 2006). A bulk sampling is a grouping of multiple samples collected in the immediate area of the sample point, recording sample depth of each sample, and weighing of pooled core samples.

3.4 Calculating Snow Depth, Snow Density, and SWE

3.4.1 SWE Lake Recharge Methods

Two primary terrain types compose the lake catchment basins within the CRD: lake and tundra. To calculate the terrain specific snow depth for each lake catchment Equation 1 was used.

Equation 1 –Terrain Specific Snow Depth of Catchment

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

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

The terrain specific snow density was calculated using data collected with the snow sampler: core cross sectional area, core depth, and snow sample weight. All densities specific to a terrain type were then averaged using Equation 2.

Equation 2 –Terrain Specific Snow Density of Catchment

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

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

The terrain specific snow water equivalent for each lake catchment sampled was determined using Equation 3.

Equation 3 – Terrain Specific Snow Water Equivalent of Catchment

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

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

An area weighted snow water equivalent was calculated for each lake's catchment basin. In addition, a delta wide area weighted snow water equivalent was calculated from the catchment basins sampled. Equations 4 and 5 were used in these calculations, respectively, and were based on those presented by Woo (1997), with considerations of Rovansek, Kane, and Hinzman (1993).

Equation 4 –Catchment Specific, Area Weighted Snow Water Equivalent

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

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

Equation 5 – Delta Wide, Area Weighted Snow Water Equivalent

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

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

3.5 Lake Recharge Observations

Physical characteristics of each lake were noted including the lake's apparent outlet, presence of lake ice, evident and potential lake water recharge sources, location of remaining snow, and presence or absence of bank full conditions. Images linked to geographic coordinates were taken of each lake from a number of angles to capture the extent of local melt and hydraulic connectivity with other waterbodies. Ground observations were performed when they were deemed necessary.

3.6 2006/2007 Ice Road and Pad Contributions

As-built drawings for the 2006/2007 construction season were used to estimate the volume of melt water recharge contributed to catchement basins where ice roads and pads were located. Ice road contributions were determined using an average value of one million gallons of water per mile of ice road. Ice pad contributions were calculated multiplying the pad's surface area by an average pad thickness of 0.72 feet, which was computed using the average value of one million gallons of water per mile of 35 foot wide ice road.

4.0 Program Implementation Overview

This section presents summaries of monitoring events conducted during the study. These summaries are synopses of information documented in the field with the intent of providing pertinent, qualitative information not identified in the results section.

Prior to field deployment, drainage basins were delineated for each of the thirty lakes as described in Section 3.1. Snow survey transects and sampling points were subsequently identified, given the delineated basin and lake geometries of the six field study lakes. Sample location coordinates were stored in two Garmin GPSmap60 units to ensure valid field sampling.

Overall, the 2007 CRD spring breakup event was mild having both a flood and stage frequency interval of approximately 3 years. Initial flood waters in the delta were observed on May 30. Passage of major ice flows and subsequent, short-term ice jamming in the Colville River were observed on June 3. Ice jamming was also observed in the Nigliq Channel near Nuiqsut and CD4 on June 4 and 5, respectively. Moderate ice jamming was also observed on the Sakoonang Channel on June 3. Peak water surface elevations in the CRD occurred over late June 5 and early June 6. Waters quickly receded, dropping as much as four feet by June 8.

4.1 Pre-breakup Sampling

Winter water surface elevations of seven lakes (L9906, L9908, L9210, L9281, L9327, M9321, and M9313) were initially surveyed on February 17 and 18, 2007. Lakes L9281 and M9321 were replaced by Lake M9703, surveyed on March 7, finalizing the six lake field study set. Ice thickness and water surface elevation were again surveyed prior to breakup: Lakes L9906, L9908, L9210, L9327 and M9313 on May 10; and Lake M9703 on May 24. Average ice thickness of the lakes was 5.55 feet.

Snow water equivalent (SWE) surveys were conducted for the final sample subset on May 11 and May 14, 2007, prior to spring breakup. In addition, Lakes L9310, L9312, and L9313 were surveyed on May 10, 2007. Initial spring flow in the CRD was observed on May 30.

4.2 Post-breakup Sampling

It was assumed that aerial observations of the 30 study lakes would be performed during breakup to capture any potential floodwater recharge. Due to mechanical complications with the helicopter and alternative tasks associated with breakup monitoring, observations were not performed until shortly after peak stage. Aerial observations, including notes and geo-coded images, were made on the morning of June 9. Images of lakes M9709, M9321, and L9281 were lost to file corruption and replacements were taken on July 16. Staff gage measurements were used to determine recharge by floodwater when physical observations were not possible.

Water surface elevations were surveyed on June 10 after peak stage had receded. Wind speeds gusted to 38 miles per hour (mph), with a mean wind speed of 24 mph, resulting in persistent waves on the lakes. Natural stilling areas along the periphery of lakes were used to minimize impact of waves. Multiple water shots were taken to confirm resulting water surface elevations. All surveyed lakes were at or within 0.05-feet of bankfull based on observed water level relative to local vegetation.

5.0 Results

5.1 Catchment Basin Delineation

Lake water and catchment perimeters were determined for each of the 30 lakes using aerial photography and topographic contours and spot elevations (Figures 5-1 through 5-13). Lake and tundra catchment areas were determined for each lake and are presented in Table 5-1.

Ground truthing of catchment delineation for each of the six field study lakes in the sampled subset was performed after recession of spring flood waters. No changes were made to the predetermined catchment basin perimeters given local topographic data, suggesting that the methods used in catchment delineation are appropriate.

Two of the thirty withdrawal lakes are hydraulically connected to distinct water bodies throughout the summer season and were identified as such prior to basin delineation (Figures 5-11 and 5-12). Likewise, Lake L9335 is connected to M9508, and Lake M9608 is connected to B8530 (a permitted withdrawal lake). These lakes and their catchment basins ultimately share recharge water with one another. In the case of M9608-B8530, withdrawal volumes from both lakes should be considered when estimating spring recharge of each lake. In all cases, catchment basin delineation included that of the connected waterbodies.

Hydraulic connectivity was noted during spring sampling of three additional lakes included in the study. Lake L9906 was hydraulically connected to a previously unnamed lake immediately north, now identified as MB0701. The pre-breakup catchment basin delineation was corrected to account for the inclusion of MB0701. Lakes L9907 and L9908, both of which are study lakes, were also hydraulically connected. Historic aerial imagery and water surface elevation data suggest annual connectivity of the two lakes, though local topography limits this connectivity to relatively high, bankfull water surface elevations. For this reason, the lakes were treated both as hydraulically isolated and connected water bodies in catchment basin delineation. Figure 5-2 presents the combined catchment basin of both lakes. Table 5-1 lists each lake's area and associated catchment basin area, as well as their combined areas.

Table 5-1 Study Lakes Catchement Basin and Lake Surface Areas

Lake Name	Total Basin Area (ft^2)	Lake Surface Area (ft^2)
B8533/L9315	16,333,000	5,895,000
M9603	45,213,000	20,327,000
L9281	5,276,000	2,224,000
L9335	17,086,000	9,053,000
L9401	10,711,000	4,858,000
L9904	1,951,000	611,000
L9905	1,121,000	364,000
L9906	4,836,000	1,082,000
L9907	1,566,000	475,000
L9908	1,017,000	455,000
L9907 & L9908	2,582,000	930,000
M9321	3,328,000	960,000
M9521	22,458,000	9,474,000
M9522	2,200,000	939,000
M9701	-	-
M9702	-	-
M9701 & M9702	4,591,000	1,318,000
M9703	2,288,000	971,000
M9704	1,301,000	569,000
M9709	10,329,000	4,697,000
M0675	19,594,000	10,561,000
M0676	7,321,000	5,054,000
M0678	1,491,000	535,000
MC7913/M911	41,929,000	27,088,000
L9108	9,159,000	5,279,000
M9708	7,034,000	3,133,000
L9210/M9213	10,008,000	6,388,000
L9327	18,610,000	9,710,000
L9903	1,313,000	447,000
M9313	9,924,000	6,187,000
M9606	12,639,000	4,718,000
M9608	-	-
B8530	-	-
M9608 & B8530	64,714,000	28,516,000
Notes: Combined lakes were observed to be hydraulically connected		

5.2 Water Surface Elevation (WSE) Survey

Water surface elevations collected by Baker at the six field study lakes are presented in Table 5-2.

Table 5-2 Water Surface Elevations of Field Study Lake Subset

Lake	Winter 2007		Pre-Breakup 2007		Post-Breakup 2007	
	Elevation (ft)	Date	Elevation (ft)	Date	Elevation (ft)	Date
L9906	93.58	February 18	93.64	May 10	93.81	June 10
L9908	97.59	February 18	97.70	May 10	97.81	June 10
M9703	98.29	March 7	97.70	May 24	98.65	June 10
L9210	96.59	February 18	96.68	May 10	96.95	June 10
L9327	94.71	February 18	94.74	May 10	94.89	June 10
M9313	97.18	February 18	97.23	May 10	97.43	June 10

Between February and May measurements, water surface elevations increased at all lakes, excluding M9703. Increases in water surface elevation are attributed to snow deposition on ungrounded ice. Snow deposition on buoyant ice contributes to the mass of the ice thus displacing a certain amount of water. The observed rise in WSE would be approximately equal to that of the associated displacement minus any water withdrawn from the lake during this period. Lake M9703 had approximately 5.2 million gallons of water withdrawn from March through May, resulting in a significant elevation drop beyond the rise associated with snow deposition.

Field observations and a comparison of pre- and post-breakup WSE at the sample lakes revealed sufficient recharge of all six lakes to bankfull elevation. Of the six lakes, four were recharged strictly from local snow melt. Lake M9703 recharged from overbank floodwater of the Nigliq Channel, seeing a rise of nearly one foot in elevation. Increases in observed WSE at the remaining lakes were less, ranging from 1.3 inches to 3.1 inches.

5.3 Snow Survey and Snow Water Equivalent (SWE)

Snow surveys were conducted on six of the thirty study lakes. Lakes L9313, L9312, and L9310 were also surveyed as part of the 2007 Spring Breakup monitoring program. Snow survey data sheets, including a list of sampling point locations, for each of the nine surveyed lakes are presented in Appendix A. Sampling point locations are also presented in Figures 5-14 through 5-19 for each lake and respective catchment basin. The hydraulic connectivity of Lakes L9906 and MB0701 was not known until after breakup. As a result, the snow survey of L9906 was based on a catchment basin that did not include MB0701. Lake L9908 was also surveyed without the inclusion of L9907 and its catchment basin.

Area weighted delta-wide values of density, snow depth, and snow water equivalent were determined using the small subset of six sample lakes, as well as a combination of the sample subset and three lakes sampled during the 2007 Spring Breakup monitoring program. The resulting data is presented in Table 5-3; respectively identified as Delta-S and Delta W. With the inclusion of the three alternate lakes, snow water equivalent decreased slightly from 2.07 inches (Delta-S) to 1.93 inches (Delta-W). Area weighted delta-wide, and terrain specific average values are also presented relative to sample variability in Graphs 5-1 through 5-3. Overall general snow cover characteristics were similar to those identified by Sturm and Liston (2003). Snow cover on lakes was thinner, denser, and comprised less SWE than on nearby tundra.

Variability of snow depth values did range significantly (Graph 5-1); a result of periodic drifting and deposition within macrocatchments (e.g., polygons and lake edges).

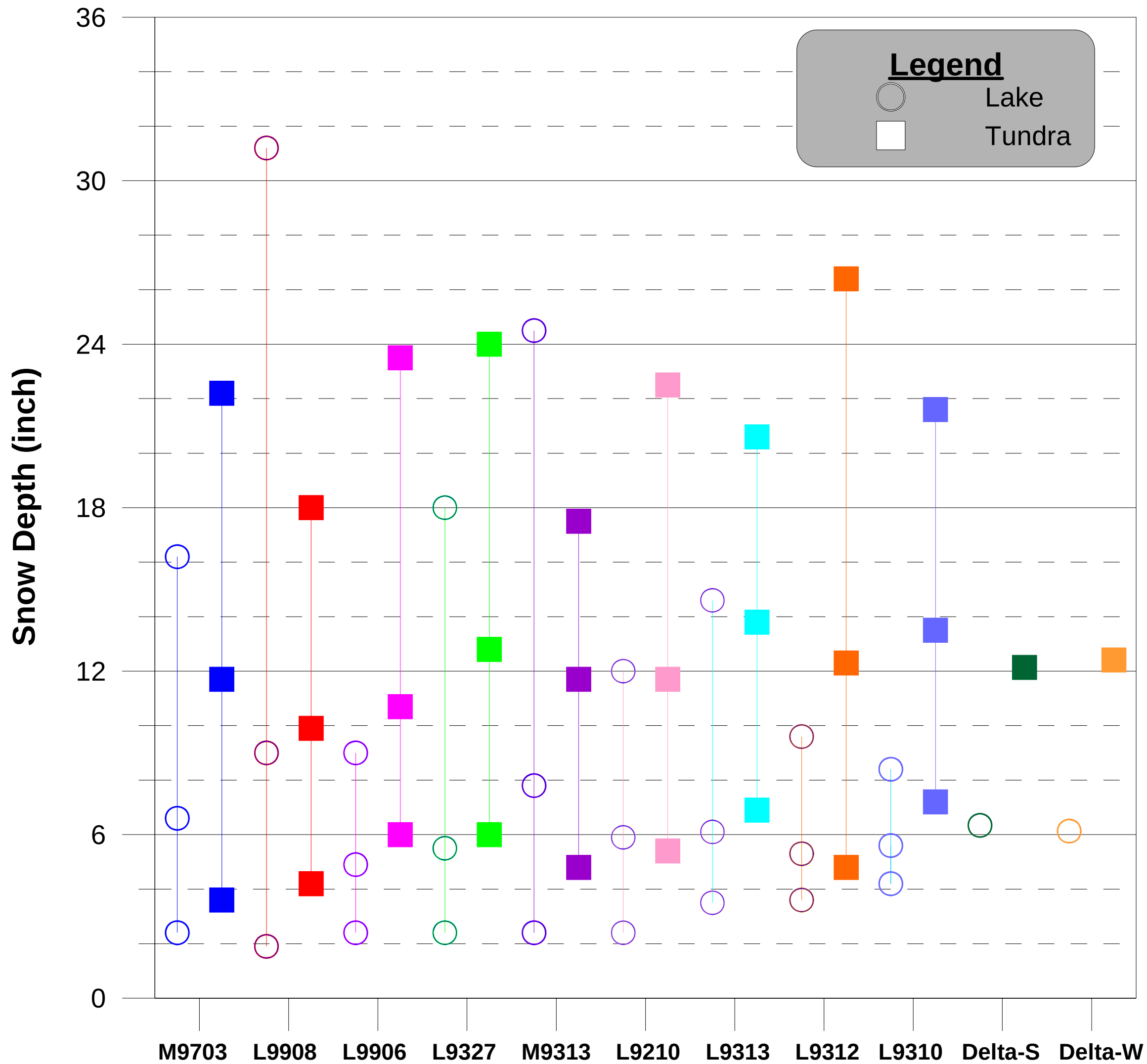
The distribution of snow depth measurements was more uniform across tundra than lake ice. Periodic snow drifts across lake ice consistently placed maximum values well above average snow depths. Some anomalies to this trend were observed. The greatest observed snow depth in the L9908 catchment was on lake ice; a result of lake edge deposition. Lake L9312 had the greatest observed snow depth on the tundra of all the sampled catchments.

Table 5-3 2007 Observed and Calculated SWE

Lake Name	Drainage Area (ft^2)		Density (lb/in^3)		Snow Depth (in)		Snow Water Equivalent (in)		
	Lake	Tundra	Lake	Tundra	Lake	Tundra	Lake	Tundra	Area Weighted
L9210	6,388,000	3,619,000	0.009	0.007	5.9	11.7	1.43	2.43	**1.79**
M9313	6,187,000	3,737,000	0.011	0.009	7.8	11.7	2.50	3.02	**2.69**
L9327	9,710,000	8,900,000	0.008	0.007	5.5	12.8	1.23	2.49	**1.83**
L9906	1,082,000	3,754,000	0.009	0.009	4.9	10.7	1.26	2.71	**2.36**
L9908	455,000	562,000	0.010	0.008	9.0	9.9	2.41	2.15	**2.27**
M9703	971,000	1,173,000	0.008	0.008	6.6	11.7	1.46	2.70	**2.14**
Delta-S	-	-	0.009	0.008	6.3	11.9	1.63	2.61	**2.07**
L9310	2,874,000	2,517,000	0.004	0.006	5.59	13.46	0.69	2.38	**1.48**
L9312	4,861,000	4,944,000	0.007	0.007	5.3	12.3	1.05	2.22	**1.64**
L9313	3,382,000	3,131,000	0.007	0.006	6.1	13.8	1.23	2.18	**1.69**
Delta-W	-	-	0.008	0.007	6.1	12.3	1.44	2.49	**1.93**

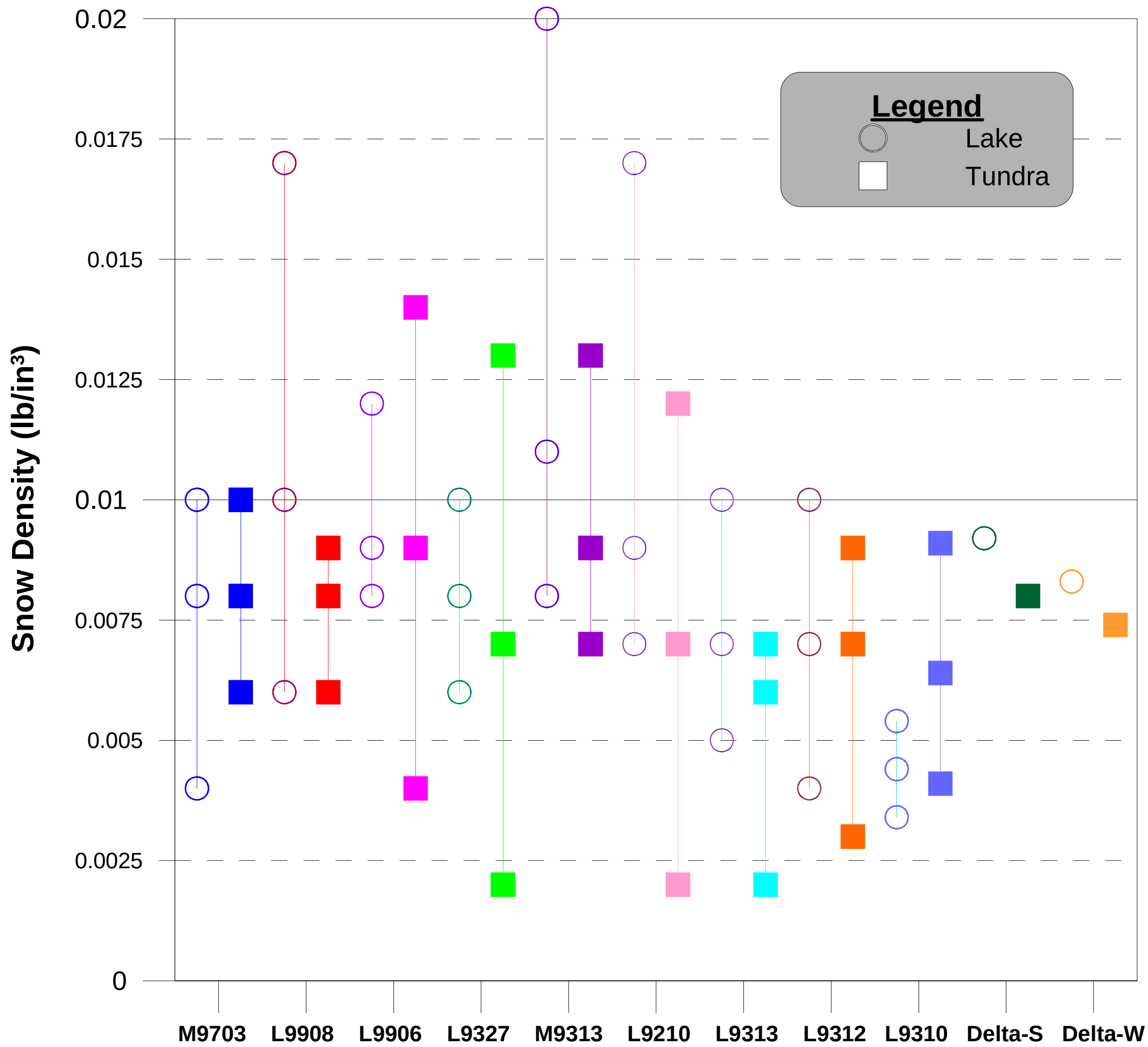
Notes:
Delta-S was calculated using only data collected from six sampled study lakes in May 2007
Delta-W was calculated using all snow survey data collected in May 2007

Graph 5-1 Minimum, Average, and Maximum Snow Depths of Snow Sampled Lakes

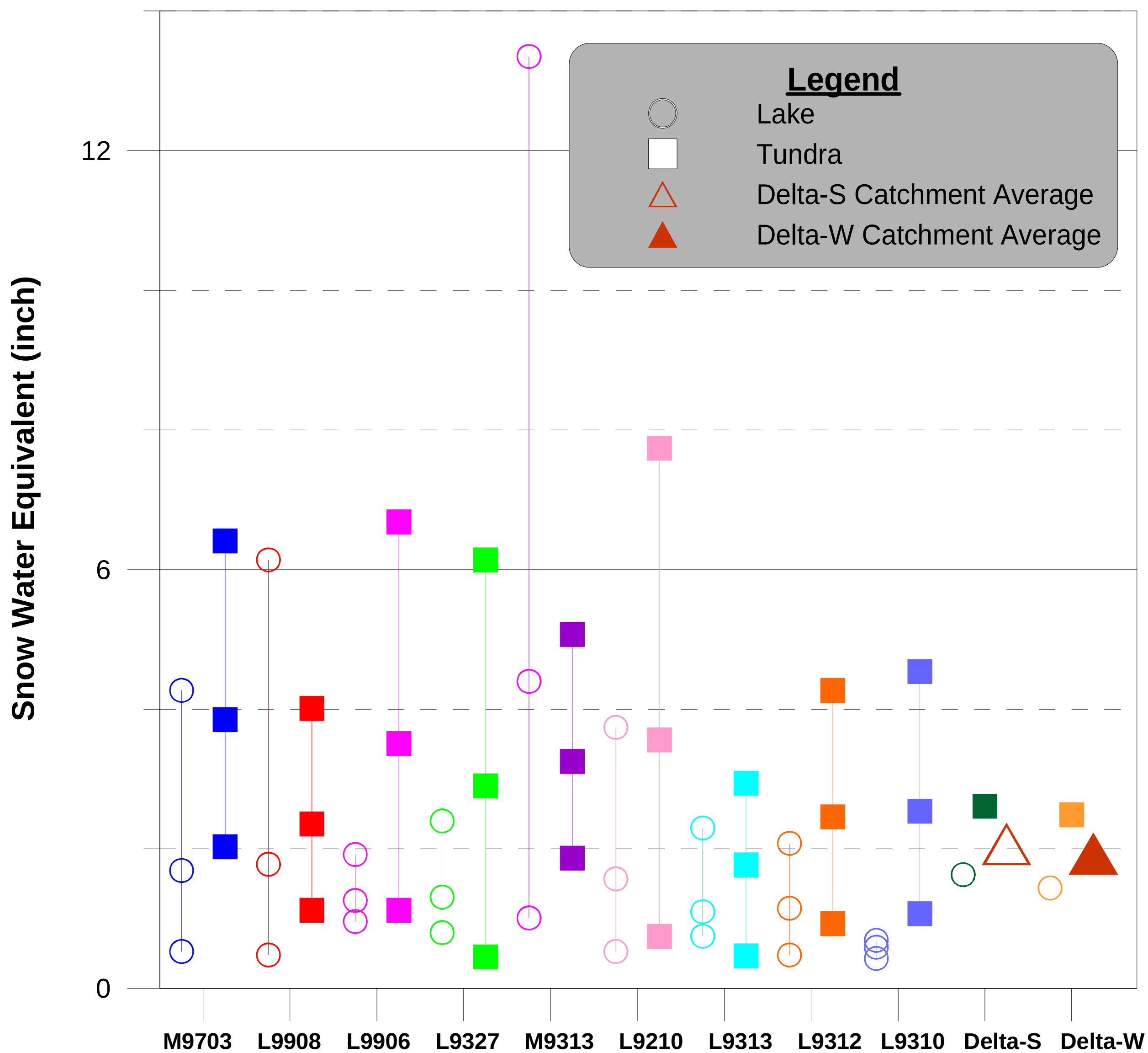


Trends in snow depth variability were also observed in snow density (Graph 5-2) and snow water equivalent (Graph 5-3).

Graph 5-2 Minimum, Average, and Maximum Snow Density of Snow Sampled Lakes



Graph 5-3 Minimum, Average, and Maximum SWE of Snow Sampled Lakes



Snow densities varied by as much as 0.011 pounds per cubic inch (lb/in^3) within individual catchments. Maximum and minimum values of measured snow density were 0.02 and 0.002 lb/in^3. Average snow densities within six of the nine catchments were higher on lakes than on tundra. In the few remaining cases, lake specific density was equivalent or below tundra specific snow density. Though snow density was greater on lakes, observed snow depths were considerably lower overall on lakes than on tundra. As a result, snow water equivalent was consistently lower on lakes than on tundra. Of the nine lakes studied, M9313 was anomalous with respect to density and snow water equivalent. This is likely a direct result of snow deposition within the catchment being augmented by the presence of, and snow removal from, the CD3 pad and airstrip facilities according to CPAI's snow removal plan. These actions can contribute to the augmentation of local snow topography and wind deposition within the catchment..

5.4 Relating Snow Water Equivalent (SWE) and Lake Recharge

Water surface elevation surveys and snow surveys were used to evaluate snow water equivalent as it relates to lake water recharge. Only four of the six study lakes were recharged strictly from snowmelt and are discussed here. No water withdrawal occurred after the May 10 sample date. Observed increases in water surface elevation, in conjunction with lake area, were used to estimate a lake recharge volume. To better understand the contribution of terrain-specific SWE, volumes as a percentage of total terrain specific snowmelt were estimated.

Snow deposition on buoyant ice can contribute to the mass of ice and displace a certain volume of water, thus increasing the lake's water surface elevation. This is evident in the observed rise in WSE at each of the six lakes between winter and pre-breakup surveys (Table 5-2). Consequently, the rise in WSE observed between May 10 and June 10 is the result of a certain percentage of snowmelt volume on the lake and across the tundra. The extent of ice displacement however is difficult to estimate given the quality and quantity of ice, and total area of buoyancy. To account for ice displacement, the contributing lake SWE volume was calculated as the percentage of grounded ice area only. This is the most conservative approach and assumes that all snow on buoyant ice displaces an equivalent amount of water. The grounded ice area, as a percentage of the total lake area, was determined using available lake bathymetry (Appendix B) and an average ice thickness of 5.5 feet observed at the time of WSE surveys.

Subsequently, the percentage of snowmelt runoff from the tundra contributing to lake recharge at each lake was calculated. The difference in the total volume associated with an observed rise in WSE and the estimated contributing lake specific SWE volume is the contributing tundra SWE volume. Resulting percentages of tundra runoff contributing to lake recharge are presented in Table 5-4.

Table 5-4 Estimated snow water recharge volumes

Lake	Observed WSE Rise[1] (inch)	Associated Volume[2] (mgal)	Grounded Ice Area[3] (%)	Lake SWE Volume Contribution[4] (mgal)	Tundra SWE Volume Contribution[5] (%)
M9313	2.40	9.26	32	3.09	71 [6]
L9327	1.80	10.90	20	1.49	68
L9906	2.04	1.38	16	0.14	20
L9908	1.32	0.37	37	0.25	16

Notes:
1. Observed rise in water surface elevation between May 10, 2007 and June 10, 2007
2. Volume calculated from lake area (Table 5-3) and observed rise in water surface elevation
3. Values estimated from average ice thickness (5.5 feet) applied to available lake bathymetry (Appedix B)
4. Value is the percentage of grounded ice applied to lake snow water equivalent volume (Table 5-3)
   Assumed lake-snowmelt volume not accounted for in WSE surveys
5. Percentage of tundra-snowmelt contributing to lake recharge
6. Percentage does not include an approximate 0.52 million gallons of water contributed to the basin from the 2007 CD3 ice pad

The percentage of snowmelt contributing to the recharge of M9313 was 71%. This percentage does not include an approximate 0.52 million gallons of water associated with the 2007 CD3 ice pad falling within the lake's catchment basin (Figure5-1). Water volume resulting from snowmelt runoff on the catchement basin of L9327 was 68%. The 3% difference of snowmelt contributing to the recharge between M9313 and L9327 is likely the direct result of CD3 facilities and operations as discussed in Section 5.4. In comparison, these values are consistent with the 15 year average snowpack runoff to snowpack water equivalent determined by Kane et al. (1999) for the Kuparuk River Basin, at 67%. The remaining lakes, L9908 and L9906 are considerably less at 16% and 20% respectively.

No feature specific to lakes L9908 and L9906 conclusively accounts for the lower values; however a number of characteristics are unique to these lakes. Both lakes were hydraulically connected to other waterbodies (L9908 to L9907 and L9906 to MB0701). Lake and tundra specific contributions to each lake are augmented by adjacent drainage basins and direction of flow. Both lakes had competent ice extending near the lake edge, particularly L9908 (Photo 21, Appendix C). The presence of grounded ice during the June 10 survey could underestimate the contribution of snowmelt runoff from the tundra. Lake-rim drifts and intact snow along the margins of grounded ice are assumed to have melted, though their presence suggests a greater contribution from the tundra than is estimated above. These lakes were excluded from the computed delta-wide tundra specific snowpack runoff to snow water equivalent ratio.

5.5 Delta-Wide Lake Recharge Observations

The 30 lakes included in this study program were monitored during the 2007 spring breakup season. Monitoring included visual observations and aerial photography to document the recharge mechanisms, extent of flooding, and provide a basis for the evaluation of each lake's watershed. Visual observations provided a qualitative determination of recharge relative to bank full conditions. A tabulated compilation of hydrologic observation at each lake is provided in Table 5-5. Referenced photographs are presented in Appendix C.

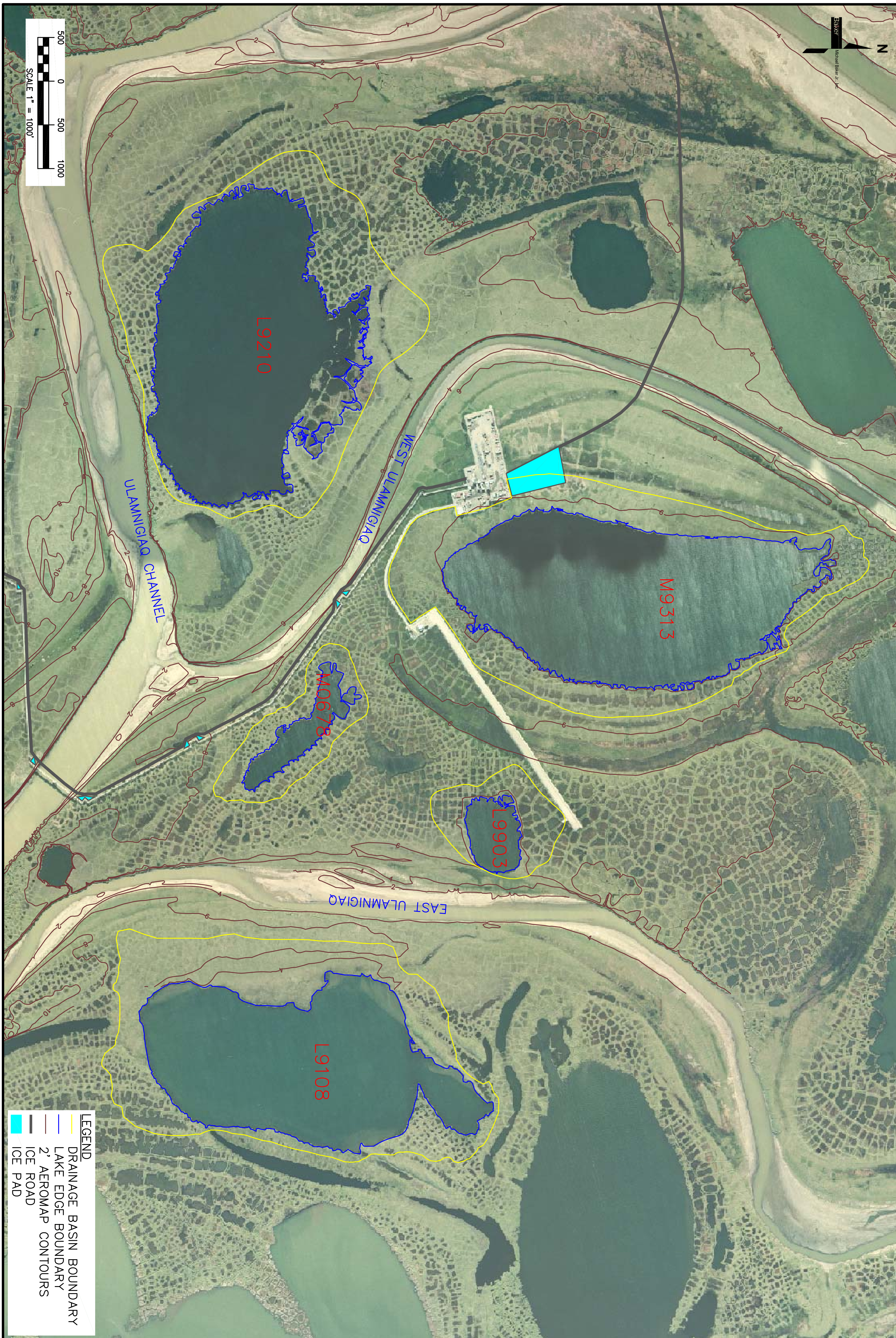
Table 5-5 Summary of Hydrologic Recharge Observations

Study Lake	Bankfull	Primary Recharge Mech		Hydrological Connection			Lake Ice	Photo	Notes
	Recharge	River	Snow	River	Lake	Other	Intact / Free	(Appendix A)	
B8533	✓	✓		Sakoonang	M9701	Wetland	Intact	1,2,3	Direct recharge via Sakoonang tributary
L9108	✓	✓					Intact	4	Possible recharge from East Ulamnigiaq Channel @ SW end
L9210	✓	✓					Intact	5	Possible recharge from northern overbank floodwaters
L9281	✓		✓				Intact	6,29	
L9327	?		✓				Intact	7,8	Prevelant snow drifts present along lake edge
L9335	?		✓		M9508		Intact	9,10	Prevelant snow drifts present along lake edge
L9401	✓	✓			M0675	Wetland	Intact	11,12	Recharge from Sakoonang Channel via M0675 & Nigliq Channel
L9903	✓		✓				Intact	13	
L9904	✓		✓				Intact	14,15	
L9905	✓	✓					Intact	16	Recharge from Tamayagiaq Channel
L9906	✓		✓		MB0701		Intact	17,18,19	Flow observed from MB0701 to L9906
L9907	✓		✓		L9908		Intact	20	
L9908	✓		✓		L9907		Intact	17,19,21	
M0675	✓	✓					Intact	22,23	
M0676	✓	✓			M9708		Intact	24,25	Recharge from Sakoonang Channel, small amount of ice
M0678	✓		✓				Intact	26,27	
M9313	✓		✓				Intact	28	
M9321	✓		✓				Intact	29	
M9521	✓	✓					Free	30,31,32	Recharge from Sakoonang Channel
M9522	✓	✓					Intact	33,34	Recharge from Sakoonang Channel via M9521
M9603	?		✓		Lake to N		Intact	35,36,37	Prevelant snow drifts present along lake edge
M9606	✓	✓			B8530		Intact	38,39,40	Direct connection with B8530, Recharge via Nigliq Channel
M9608	✓	✓			B8530		Intact	38,40,41	Recharge via Nigliq Channel
M9701	✓	✓			B8533, M9702	Wetland	Intact	42,43	Recharge from Sakoonang via Channel B8533
M9702	✓	✓			B8533, M9701	Wetland	Intact	42,43	Recharge from Sakoonang Channel via M9701
M9703	✓	✓					Intact	44,45,46	Recharge from Nigliq Channel
M9704	✓	✓					Intact	63,64,65	Recharge from Nigliq Channel
M9708	✓	✓			M0676		Intact	24,25	Recharge from Sakoonang Channel
M9709	✓		✓				Intact	66	Recharge from Sakoonang Channel via M0676
MC7913	✓		✓		Lakes to N		Intact	67,68	Connected to lakes via NW channel, flow likely N

Notes:
? : Question mark indicates unknown recharge conditions resulting from late-season snow drifts along lake margins

Of the 30 lakes monitored, all but three recharged to, or very near, bankfull conditions. Lakes were considered bankfull based on an observed water surface elevation that was in contact with bank vegetation. Water surface elevations were not surveyed to identify this elevation or confirm previously identified elevations. The remaining three lakes (L9327, L9335 and M9603) were not recharged from floodwater, nor had all lake-rim drifts melted. Drifts along leeward banks inhibited confirmation of complete, bankfull recharge.

Sixteen of the study lakes recharged via overbank floodwaters. These lakes were scattered across the CRD being recharged via the Nigliq, Sakoonang, or Tamayagiaq channels. The majority of these lakes were located along the east bank of the Nigliq Channel. Lakes L9108 and L9210 could have been recharged via floodwater; however, visual observations and peak stage relative to local topography could not confirm this. Observed rise in water surface elevation and potential contribution from snow melt do however suggest floodwater recharge of lakes L9108 and L9210, as noted in Table 5-5.



ConocoPhillips
Alaska, Inc.

DATE: 10/08/2007	PROJECT: 110919
DRAWN: OOO	FILE: CD3_LAKES_V4.DWG
CHECKED: MDM	SCALE: AS SHOWN

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Anchorage, Alaska 99503
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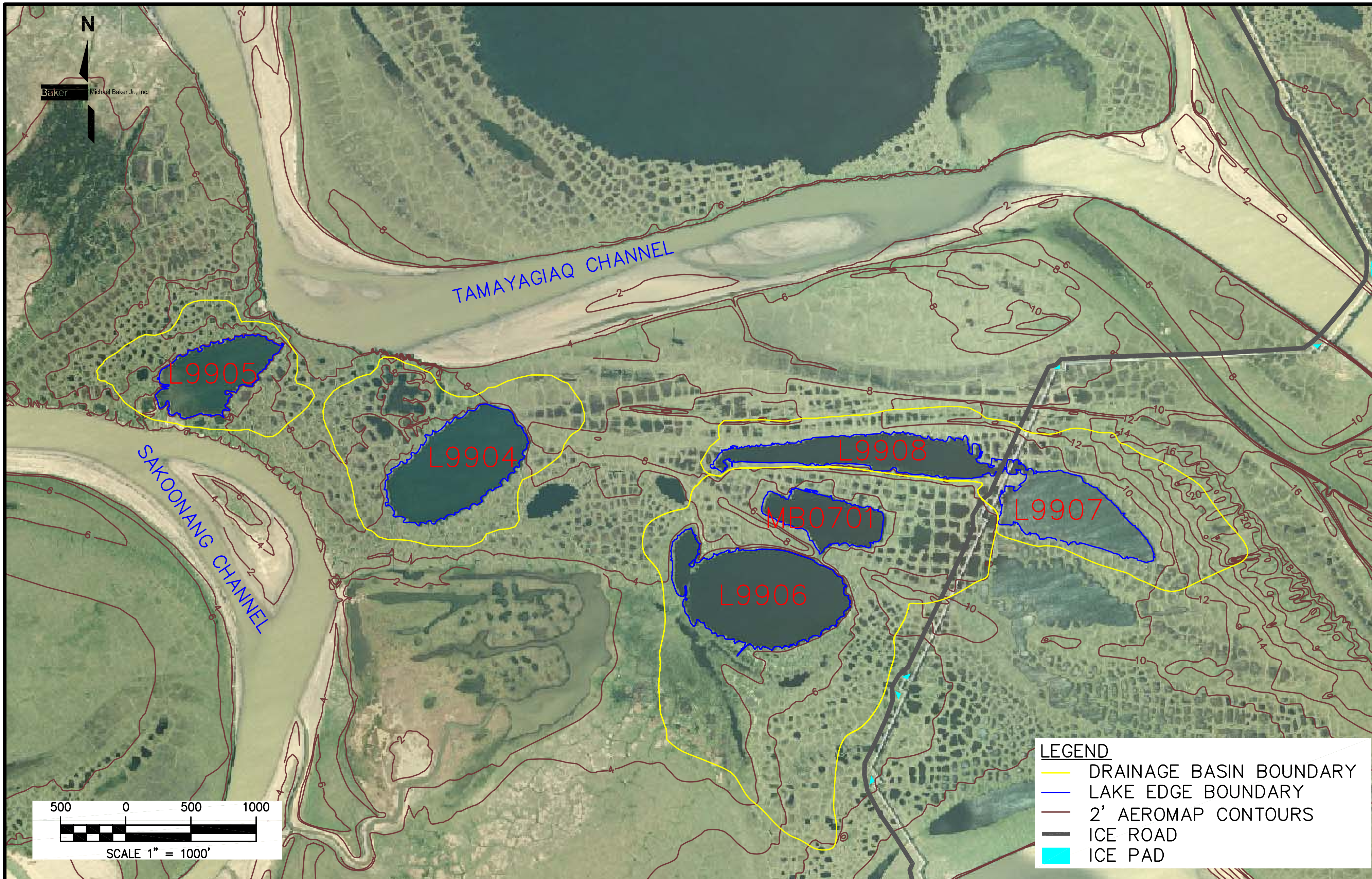
2007 COLVILLE DELTA LAKES
L9210, L9108, L9903, M9313, M0678
DRAINAGE BASINS

FIGURE 5-1
(SHEET 1 OF 1)



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2007 COLVILLE DELTA LAKES

L9904, L9905, L9906, L9907, L9908

DRAINAGE BASINS

FIGURE 5-2

(SHEET 1 OF 1)

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DATE:	10/08/2007	PROJECT:	110919
DRAWN:	OOO	FILE:	NORTH_SAK_LAKES_V2.DWG
CHECKED:	MDM	SCALE:	AS SHOWN

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2007 COLVILLE DELTA LAKES
L9281, M9321, M9709
DRAINAGE BASINS

FIGURE 5-3
(SHEET 1 OF 1)

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DATE:	10/08/2007	PROJECT:	110919
DRAWN:	OOO	FILE:	NORTH_SAK_LAKES_V2.DWG
CHECKED:	MDM	SCALE:	AS SHOWN

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2007 COLVILLE DELTA LAKES
MC7913
DRAINAGE BASIN
FIGURE 5-4
(SHEET 1 OF 1)

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DATE:	10/08/2007	PROJECT:	110919
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CHECKED:	MDM	SCALE:	AS SHOWN

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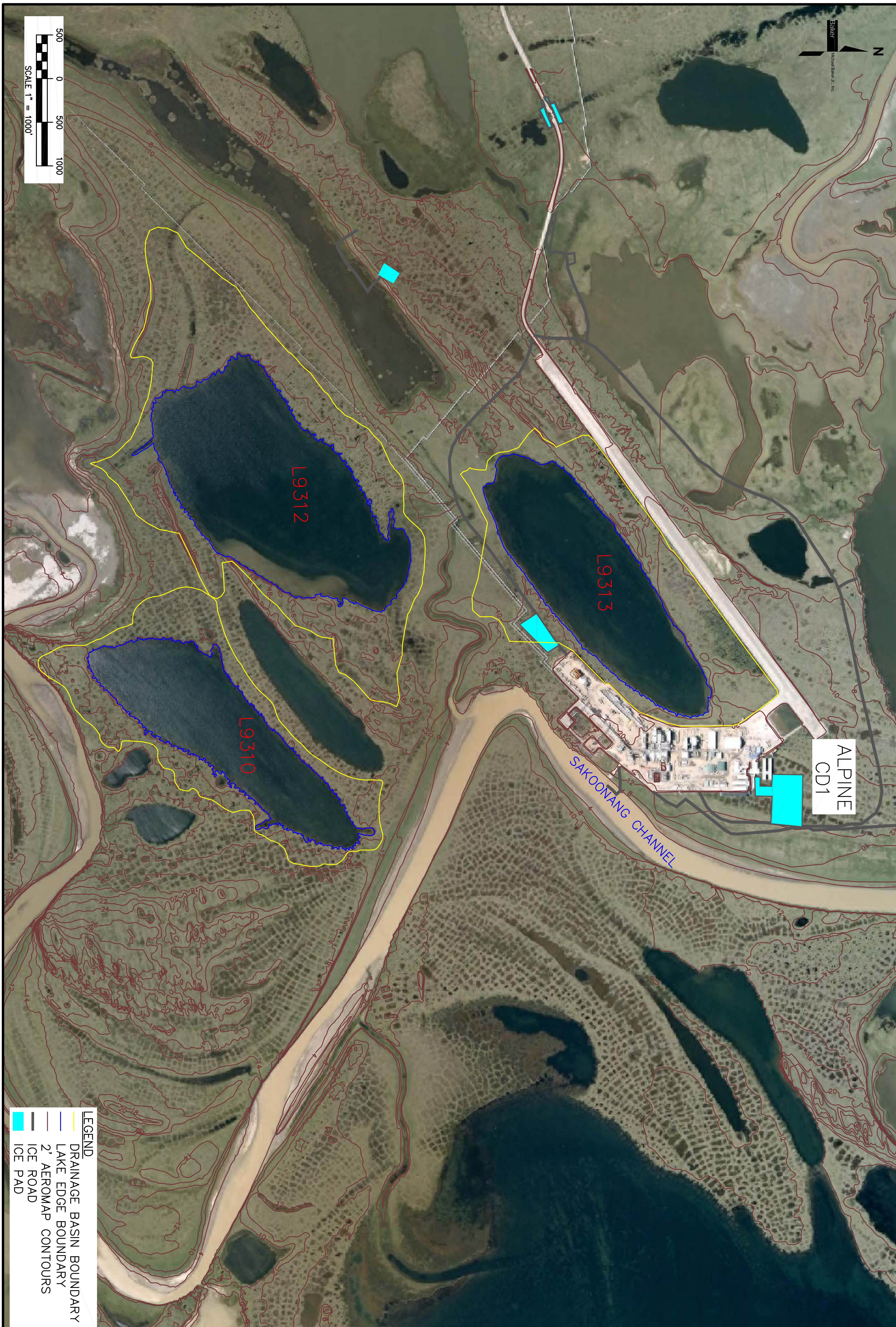
2007 COLVILLE DELTA LAKES
M9521 AND M9522
DRAINAGE BASINS

FIGURE 5-5
(SHEET 1 OF 1)



ConocoPhillips
Alaska, Inc.

DATE:	10/08/2007	PROJECT:	110919
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CHECKED:	MDM	SCALE:	AS SHOWN

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2007 COLVILLE DELTA LAKES
L9310, L9312, L9313
DRAINAGE BASINS

FIGURE 5-6
(SHEET 1 OF 1)

ConocoPhillips
Alaska, Inc.

DATE:	10/08/2007	PROJECT:	110919
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CHECKED:	MDM	SCALE:	AS SHOWN

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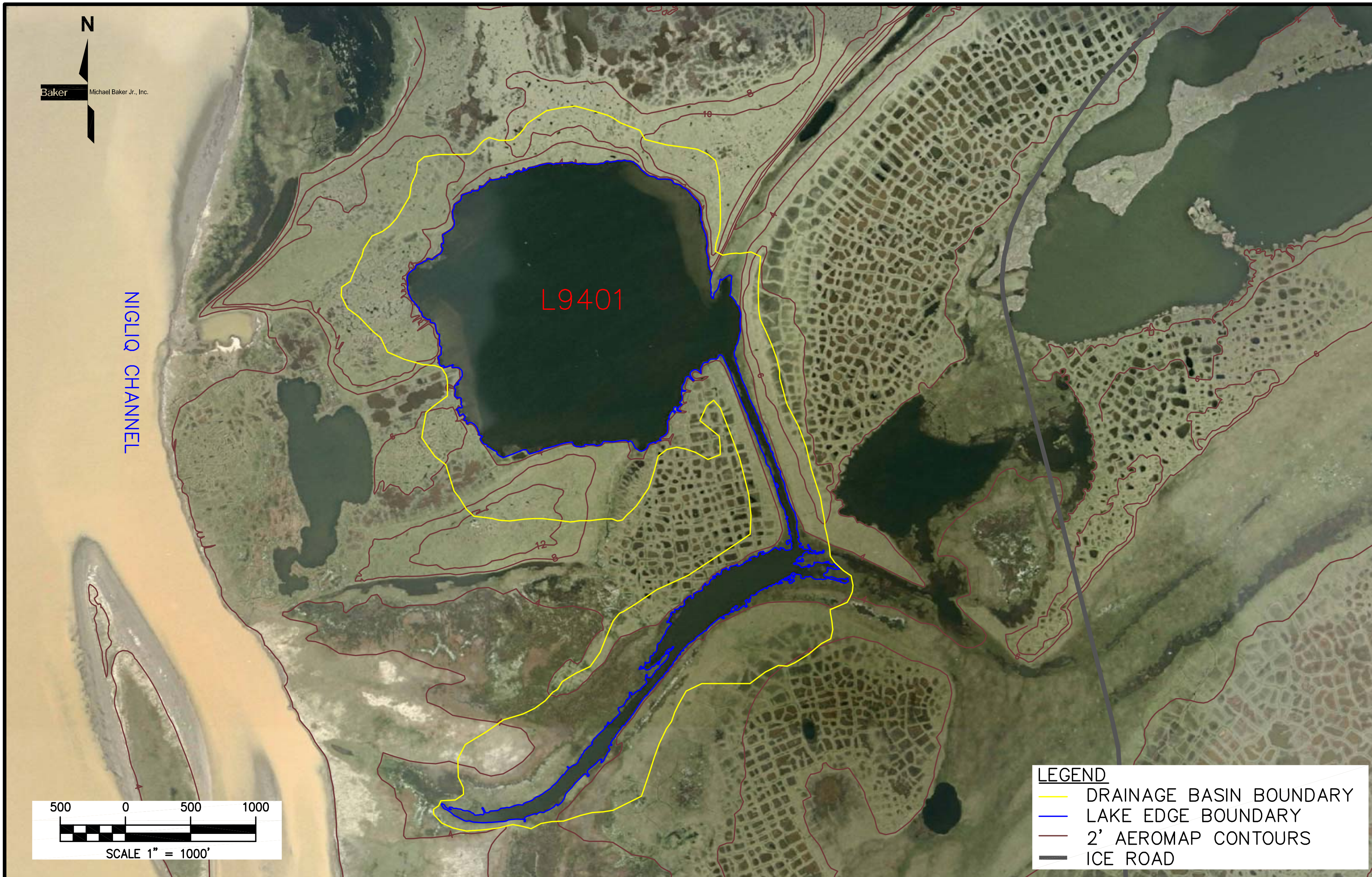
2007 COLVILLE DELTA LAKES
M9708, M0675, M0676
DRAINAGE BASINS

FIGURE 5-7
(SHEET 1 OF 1)



ConocoPhillips Alaska, Inc.

DATE:	10/08/2007	PROJECT:	110919
DRAWN:	OOO	FILE:	M9706_M0676_L9401_V2.DWG
CHECKED:	MDM	SCALE:	AS SHOWN

Baker

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2007 COLVILLE DELTA LAKES

L9401

DRAINAGE BASIN

FIGURE 5-8

(SHEET 1 OF 1)

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Alaska, Inc.

DATE:	10/08/2007	PROJECT:	110919
DRAWN:	OOO	FILE:	M9701_M9704_B8533_V2.DWG
CHECKED:	MDM	SCALE:	AS SHOWN

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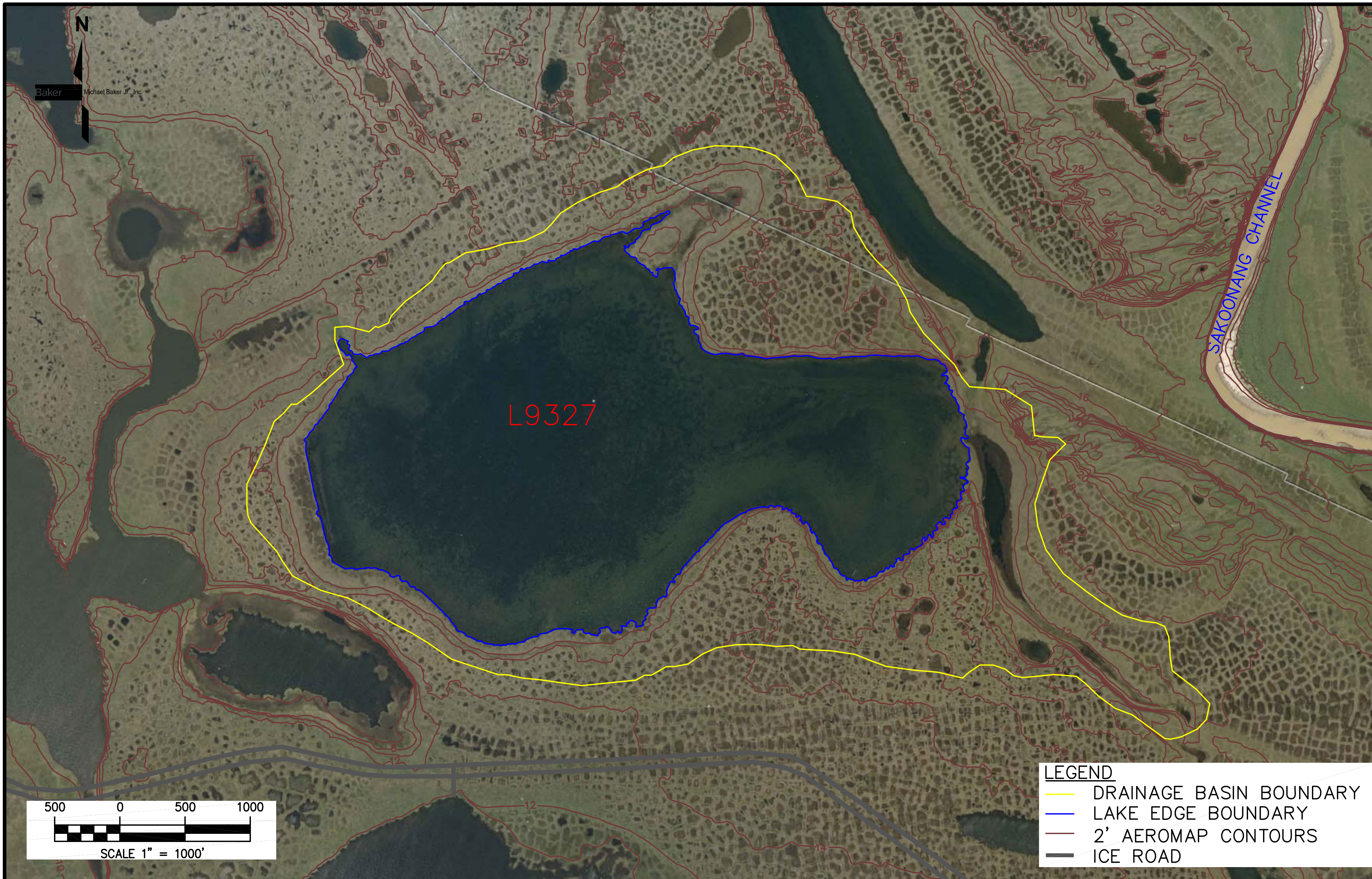
2007 COLVILLE DELTA LAKES

B8533, M9701, M9702, M9703, M9704

DRAINAGE BASINS

FIGURE 5-9

(SHEET 1 OF 1)



ConocoPhillips Alaska, Inc.

DATE:	10/08/2007	PROJECT:	110919
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CHECKED:	MDM	SCALE:	AS SHOWN

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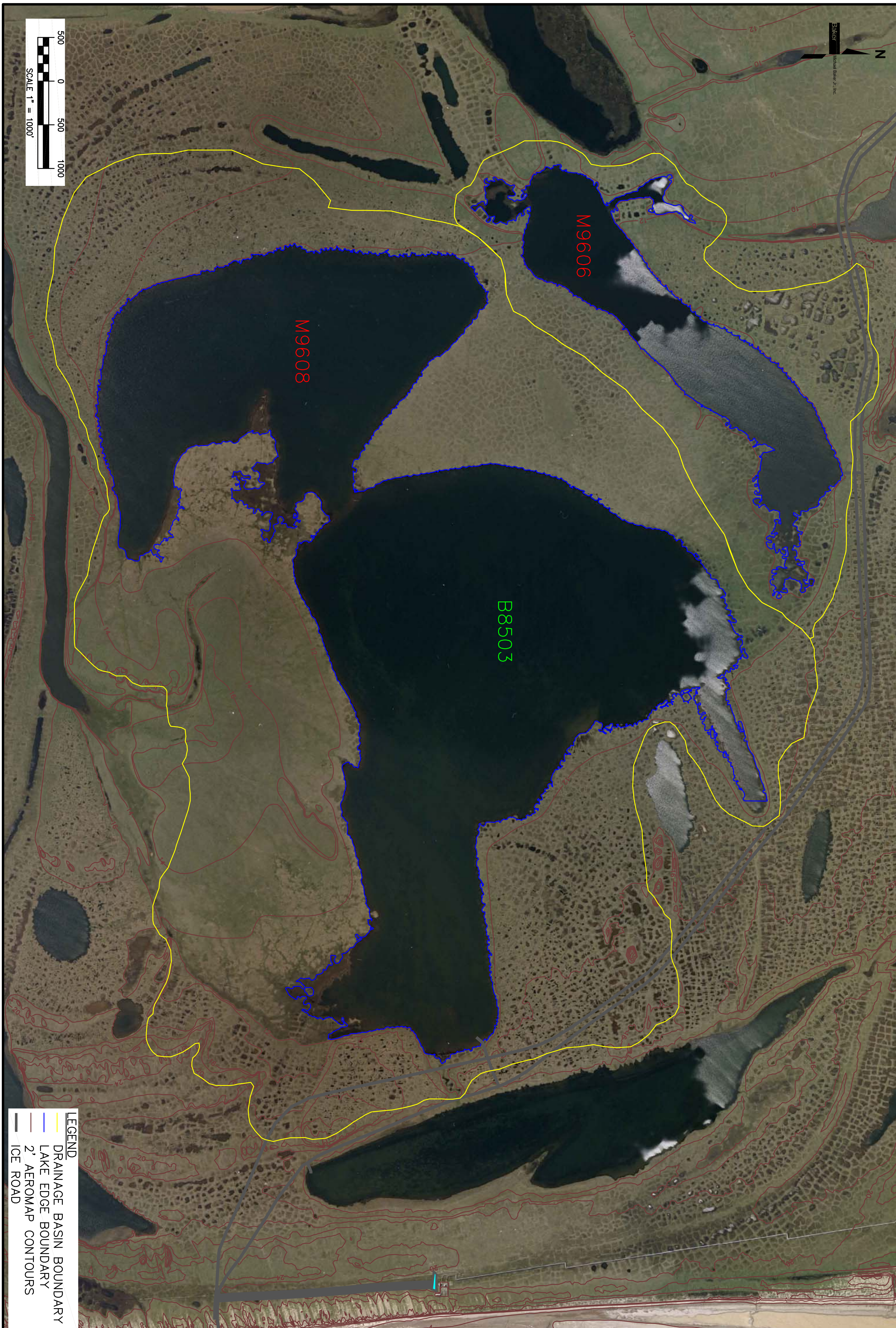
2007 COLVILLE DELTA LAKES

L9327

DRAINAGE BASIN

FIGURE 5-10

(SHEET 1 OF 1)



ConocoPhillips
Alaska, Inc.

DATE:	10/08/2007	PROJECT:	110919
DRAWN:	OOO	FILE:	L9327_M9606_M9608_V2.DWG
CHECKED:	MDM	SCALE:	AS SHOWN

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2007 COLVILLE DELTA LAKES
M9606 AND M9608
DRAINAGE BASINS

FIGURE 5-11
(SHEET 1 OF 1)

ConocoPhillips Alaska, Inc.

DATE:	10/08/2007	PROJECT:	110919
DRAWN:	OOO	FILE:	L9335_M9603.DWG
CHECKED:	MDM	SCALE:	AS SHOWN

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2007 COLVILLE DELTA LAKES

L9335

DRAINAGE BASIN

FIGURE 5-12

(SHEET 1 OF 1)

ConocoPhillips
Alaska, Inc.

DATE:	10/08/2007	PROJECT:	110919
DRAWN:	OOO	FILE:	L9335_M9602.DWG
CHECKED:	MDM	SCALE:	AS SHOWN

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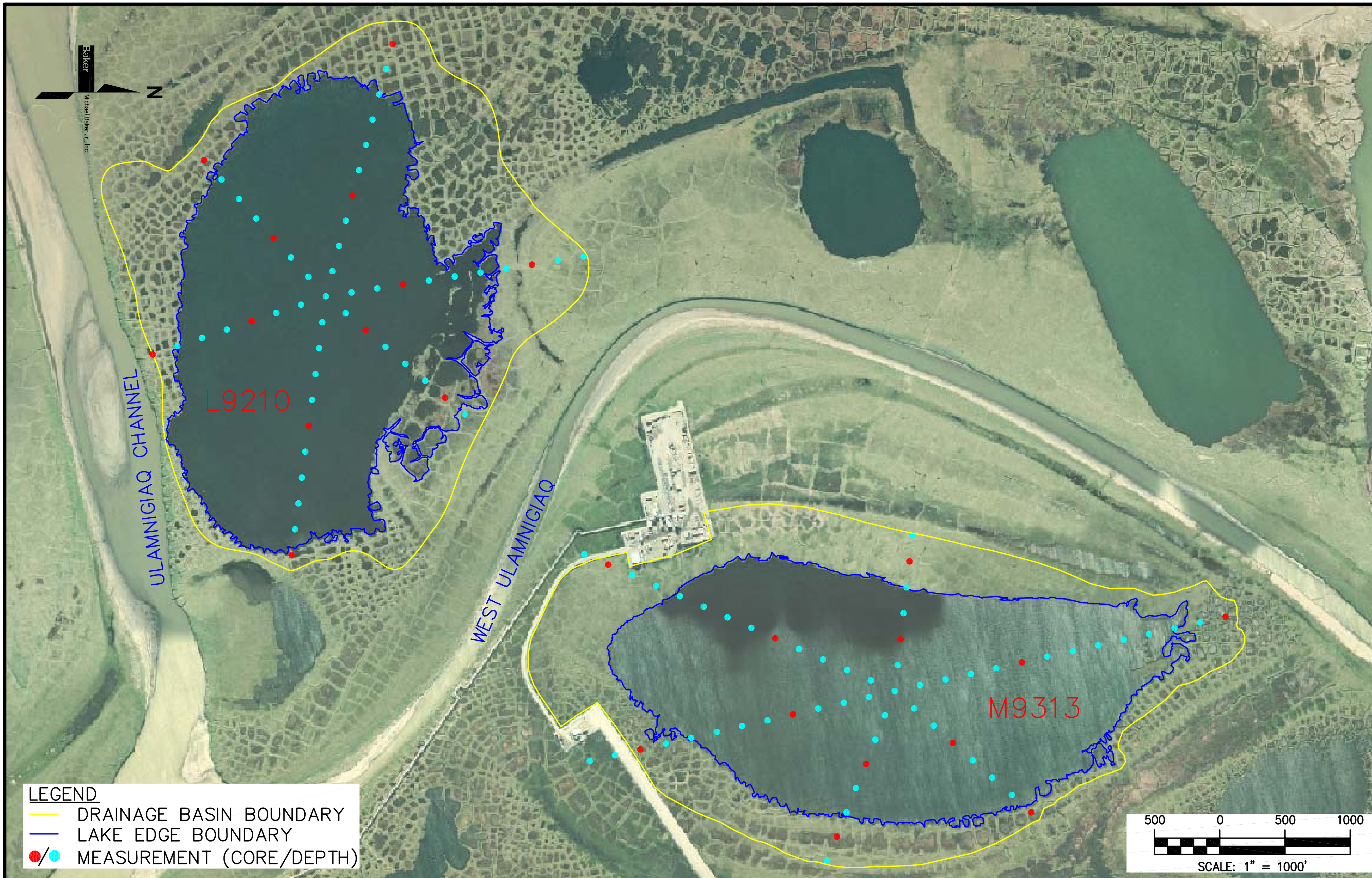
2007 COLVILLE DELTA LAKES

M9603

DRAINAGE BASIN

FIGURE 5-13

(SHEET 1 OF 1)



ConocoPhillips
Alaska, Inc.

DATE:	10/08/2007	PROJECT:	110919
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CHECKED:	MDM	SCALE:	AS SHOWN

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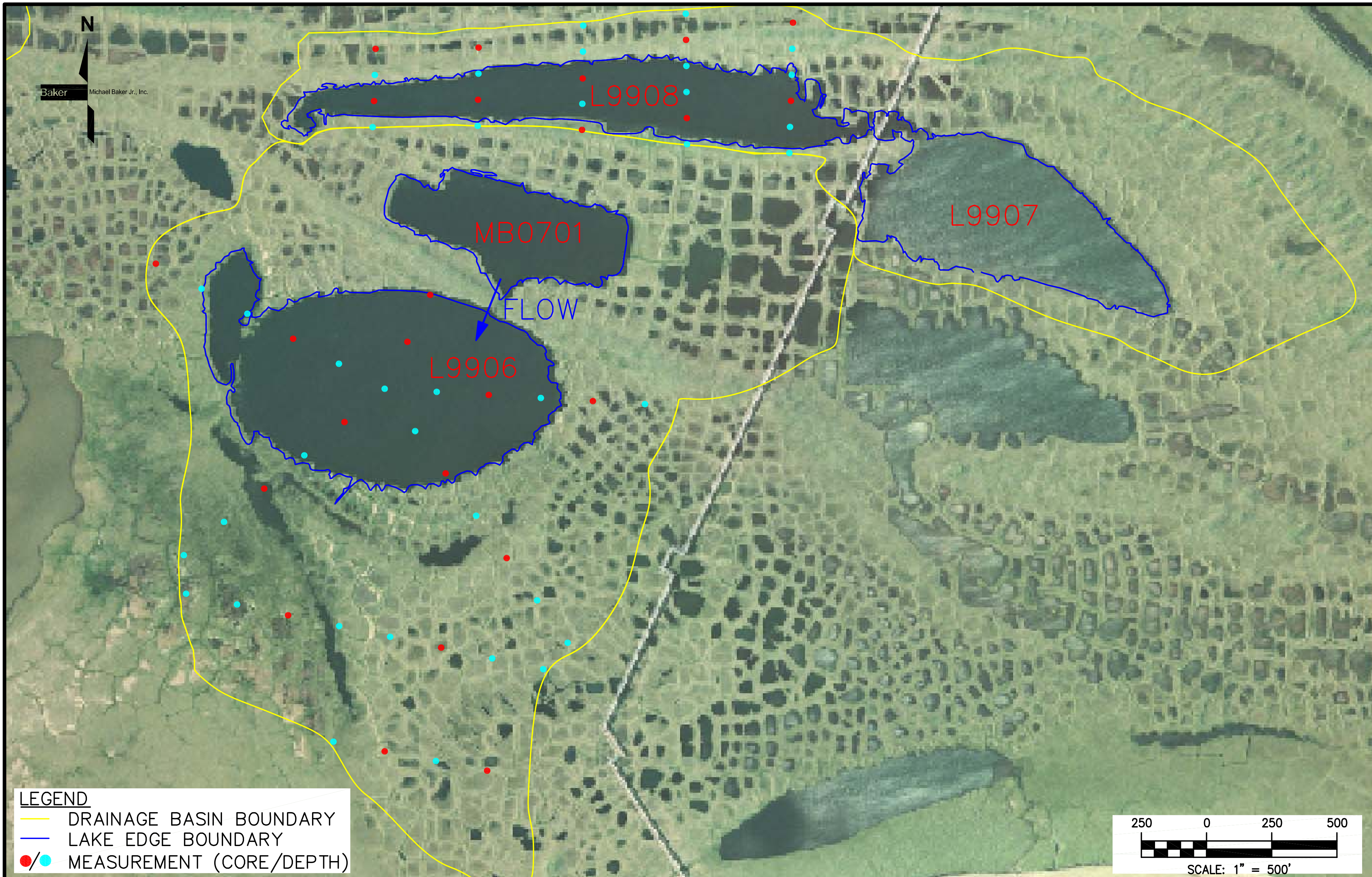
2007 COLVILLE DELTA LAKES
L9210 AND M9313
SNOW SURVEY POINTS

FIGURE 5-14
(SHEET 1 OF 1)



ConocoPhillips
Alaska, Inc.

DATE:	08/03/2007	PROJECT:	110919
DRAWN:	OOO	FILE:	L9906_L9908.DWG
CHECKED:	MDM	SCALE:	AS SHOWN

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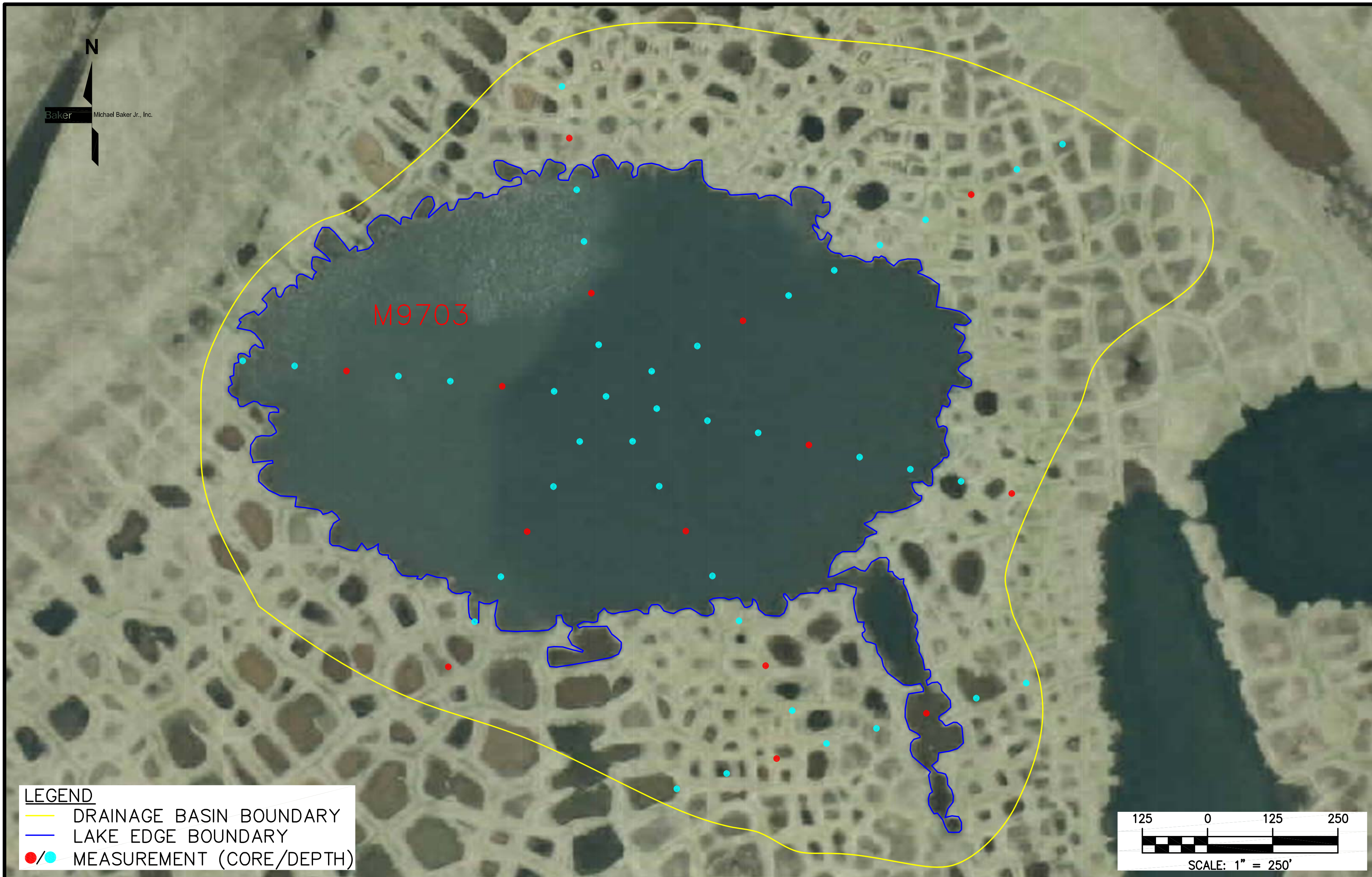
2007 COLVILLE DELTA LAKES

L9906 AND L9908

SNOW SURVEY POINTS

FIGURE 5-15

(SHEET 1 OF 1)



ConocoPhillips Alaska, Inc.

DATE:	08/03/2007	PROJECT:	110919
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CHECKED:	MDM	SCALE:	AS SHOWN

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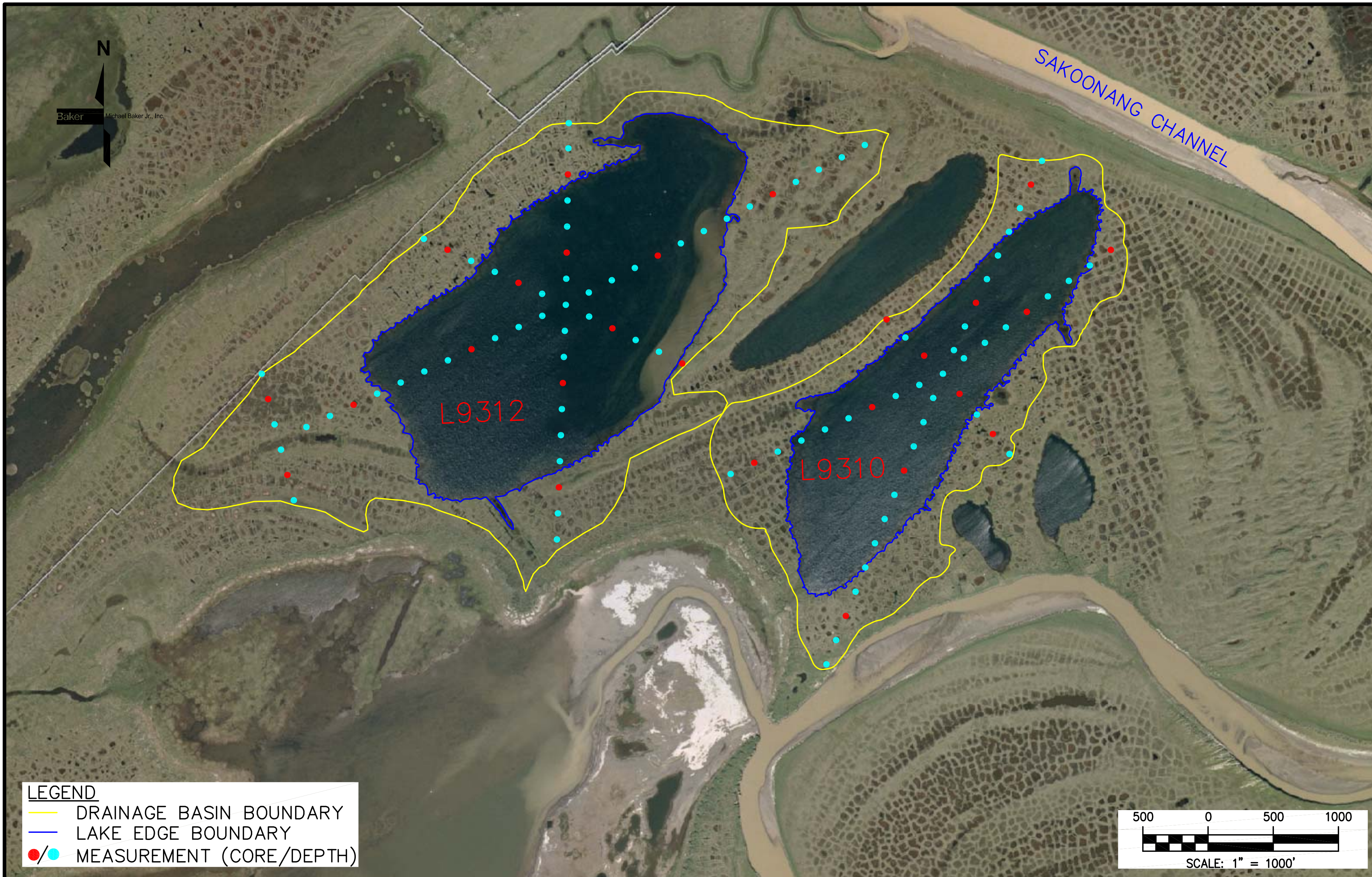
2007 COLVILLE DELTA LAKES

M9703

SNOW SURVEY POINTS

FIGURE 5-16

(SHEET 1 OF1)



ConocoPhillips Alaska, Inc.

DATE:	08/03/2007	PROJECT:	110919
DRAWN:	OOO	FILE:	L9313_L9312_L9310.DWG
CHECKED:	MDM	SCALE:	AS SHOWN

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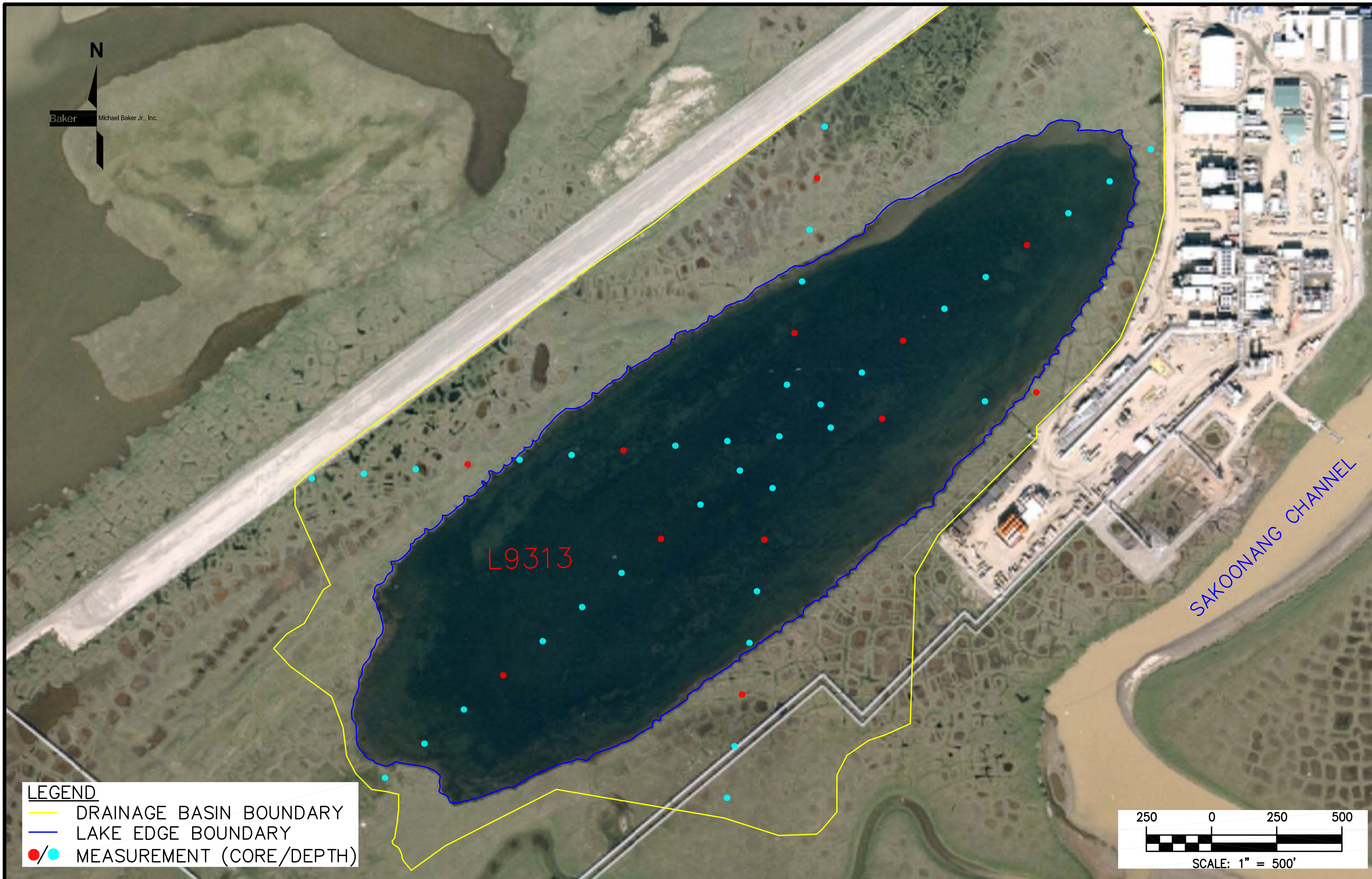
2007 COLVILLE DELTA LAKES

L9312 AND L9310

SNOW SURVEY POINTS

FIGURE 5-17

(SHEET 1 OF 1)



ConocoPhillips
Alaska, Inc.

DATE:	08/3/2007	PROJECT:	110919
DRAWN:	OOO	FILE:	L9313_L9312_L9310.DWG
CHECKED:	MDM	SCALE:	AS SHOWN

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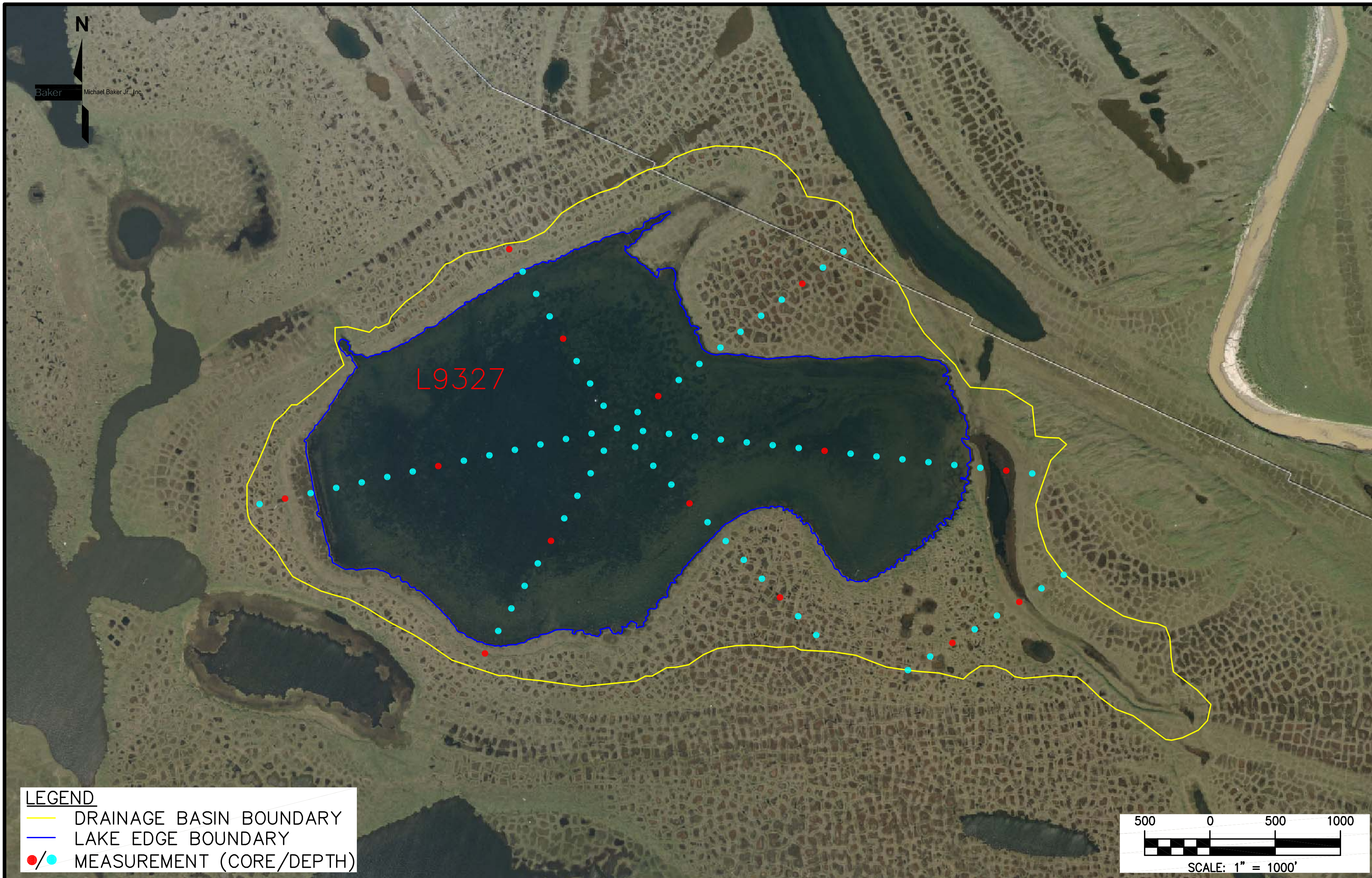
2007 COLVILLE DELTA LAKES

L9313

SNOW SURVEY POINTS

FIGURE 5-18

(SHEET 1 OF 1)



ConocoPhillips Alaska, Inc.

DATE:	08/03/2007	PROJECT:	110919
DRAWN:	OOO	FILE:	L9327.DWG
CHECKED:	MDM	SCALE:	AS SHOWN

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2007 COLVILLE DELTA LAKES

L9327

SNOW SURVEY POINTS

FIGURE 5-19

(SHEET 1 OF 1)

6.0 Discussion

6.1 Snow Water Equivalent (SWE)

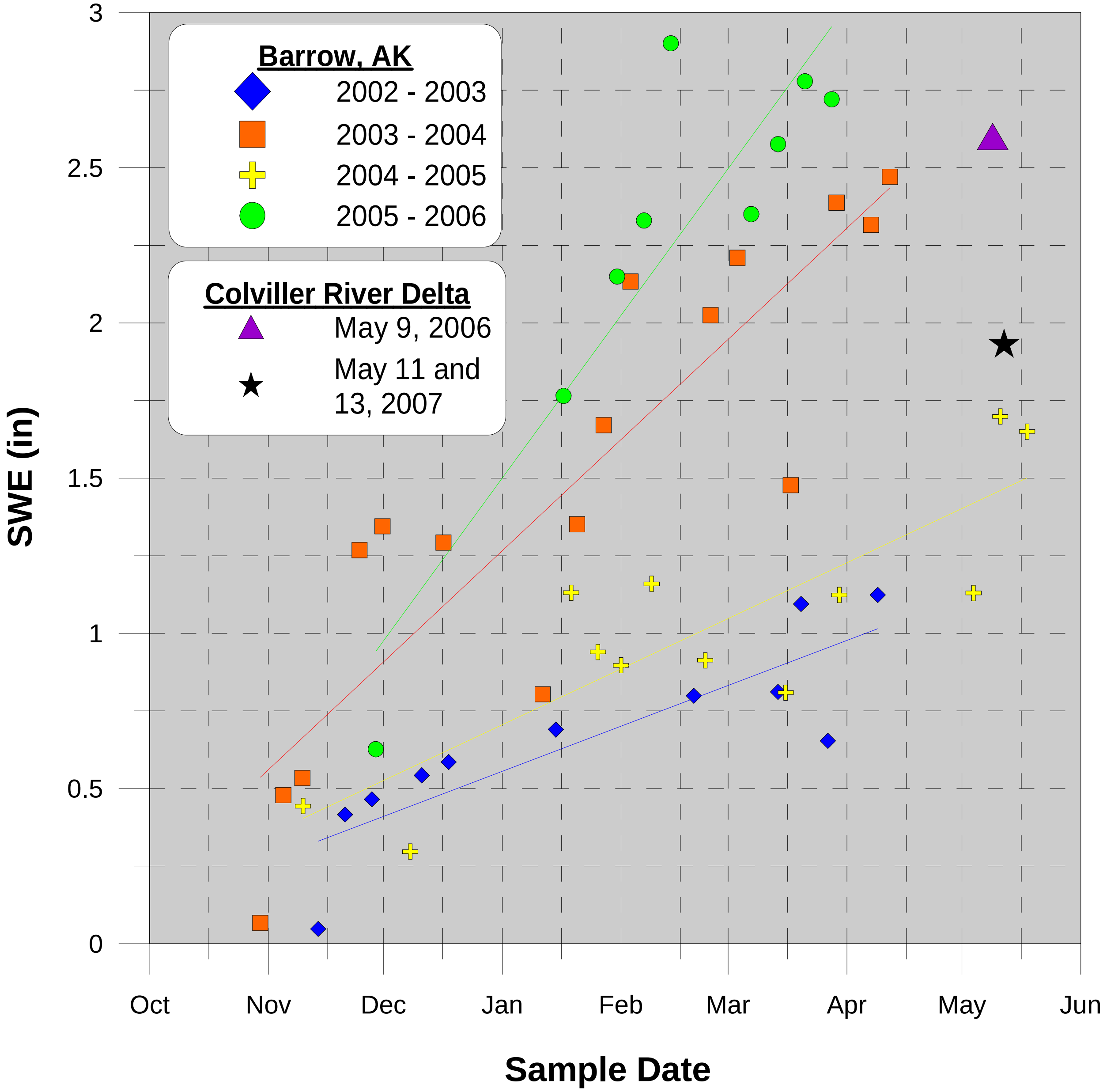
The 2006/2007 winter season in the Colville River Delta was typical of the region, short of notably lower relative humidity. Based on historic data in the Kuparuk River Basin alternating record highs and near record lows occurred throughout the winter season. The average wind velocity between October 1 and June 1 in the Colville River Delta was also typical of the region, with a value of 9.2 mph falling below the historic average of approximately 12 mph. Fewer days of precipitation were also recorded in Nuiqsut than surrounding weather stations. NRCS Basin Outlook Reports and snowpack maps predicted regional precipitation as of May 1 at 70 – 89% of normal.

Hydraulic connectivity of multiple lakes was observed, including B8530 which is regulated under a separate water withdrawal permit. It is likely that the lakes are hydraulically isolated from one another during the winter season, thus limiting the affects of water removal to the open water season. Drainage basins of perennially connected lakes were combined to better represent the potential for lake water recharge.

Snow water equivalent was variable between lakes and terrain type. Predictability of SWE variability could not be determined based on lake or basin morphology (e.g. relative sizes, orientation, location). Additional lakes, not included in the thirty permitted lakes, were included to obtain a more representative Delta-wide average, and terrain specific averages, of SWE. A final Delta-wide SWE of 1.93 inches was determined from nine lakes within the Delta. Representative terrain specific values were determined for tundra and lake SWEs; 2.49 and 1.44 inches respectively. A comparison of SWE values within the Delta, and across the region suggest that NRCS predictions have been relatively accurate. This data includes average snow water equivalence of lakes L9313 and L9312 in 2006. The results support our understanding of annual and spatial variability of normal snow water equivalence.

SWE data collected in Barrow at Imikpuk Lake (see Section 1.2) varied significantly over the four year study period. Graph 6-1 presents this data in conjunction with 2006 and 2007 CRD data.

Graph 6-1 Historical Snow Water Equivalent Data (2002-2006) Barrow, AK & Colville River Delta (2006-2007)



Review of NRCS Snowpack Maps from three of the four years of observation (2003, 2004, and 2005) suggests a normal snow water equivalent of 2.5 inches for the Barrow area. The ranges of pre-breakup snow pack estimates were relatively accurate with the exception of 2006. April 2006 NRCS Snowpack Maps underestimated the observed conditions at Imikpuk Lake assuming a normal value of 2.5 inches.

A delta-wide SWE provides some understanding of overall snowpack conditions, however, terrain specific SWE provide an even better representation of local conditions when applied to lake recharge estimates. Use of terrain specific SWE weight the variability of lake and tundra snowpack to their respective areas. The area ratio of lake to tundra within sampled basins varied from 0.3 to 2.2, demonstrating the impact terrain specific SWE can have on the overall recharge of a given lake.

Snow water equivalence can be highly variable across a region, even varying significantly between neighboring lakes. The most obvious consequence of this is that a local or regional SWE does not truly represent conditions at a specific lake or its potential for recharge. The inclusion of numerous lakes in obtaining a delta-wide average can provide a good overall estimate as it relates to regional conditions, assuming the distribution of sampled lakes is a representative population of the region. Given available data, NRCS Snowpack Maps can provide a general understanding of snowpack conditions. However an understanding of normal snow distribution and how it relates locally to regional snow distribution is necessary. Appreciating the limitations of available data and estimated snow water equivalence, a reasonable estimate of potential lake water recharge can be achieved when using delta-wide terrain specific snow water equivalents than NRCS Snowpack Maps alone. However the most accurate means of estimating potential lake recharge requires direct measurements of individual lake catchments.

6.2 Lake Water Recharge

Twelve years of recharge data collected at Lakes L9313 and L9312 from 1995 to 2007 suggest complete recharge of both lakes during each spring breakup event. Table 6-1 identifies the years in which floodwaters were the primary mode of recharge of the two lakes. In each year of floodwater recharge, observed peak discharge and water surface elevations approached or exceeded a 3-year recurrence interval (Baker 2007a). The estimated recurrence interval for 2007 is 3-years based on the breakup studies completed (report to be published later in 2007).

All but three of the thirty lakes recharged to bankfull conditions during spring breakup in 2007 based on aerial observations. Recharge of the remaining three lakes could not be determined due to the presence of competent ice along the lake edge and distribution of substantial snow drifts.

Table 6-1 Historic Floodwater Recharge Summary of Alpine Drinking Water Lakes

Year	Floodwater Recharge	
	Lake L9312	Lake L9313
1995	✓	✓
1996	-	-
1998	-	-
1999	-	-
2000	✓	✓
2001	-	✓
2002	✓	✓
2003	-	✓
2004	✓	✓
2005	-	-
2006	✓	✓
2007	✓	✓

Water surface elevations and ground truthing of the nine surveyed lakes (six field study lakes, two drinking water lakes, and one control lake) revealed sufficient recharge of all lakes to bankfull conditions. Five of the nine lakes recharged from overbank floodwaters. Of the thirty lakes 14 recharged conclusively from floodwater. Two additional lakes, though not visually observed to have been recharged from overbank flow, appear to have recharged from floodwater given peak water surface elevations, local topography, and surrounding tundra saturation. Historic data and the recurrence intervals of observed peak stage and discharge within the Delta suggest that 2007 was a typical year with respect to overbank floodwaters.

A summary of permitted withdrawal volumes from each of the thirty lakes and potential recharge volumes are presented in (Table 6-2). Potential recharge volumes were calculated from delta-wide terrain-specific snow water equivalents and an assumed contribution of 67% (Section 5.4) of snowmelt runoff from contributing drainage basins.

Table 6-2 Permitted Withdrawal Volumes for Study Lakes and SWE Recharge Volumes

Lake Name	Permit Number	Current Permit Volume(1) (million gal.)			Total Basin Area (ft²)	Lake Surface Area (ft²)	Lake Recharge Volume Based on SWE (million gal.)(3,4)	Recharge: Permit Volume Ratio	Recharged via Floodwaters 2007
		Water Withdrawl	Ice Aggregate Removal(2)	Total Permitted Withdrawl					
B8533/L9315	A2006-125	32.22	1.83	34.05	16,333,000	5,895,000	16.15	0.5	✓
M9603	A2006-128	8.72	14.53	23.25	45,213,000	20,327,000	44.13	1.9	-
L9281	A2006-125	10.60	0.55	11.15	5,276,000	2,224,000	5.17	0.5	-
L9335	A2006-125	3.43	1.14	4.57	17,086,000	9,053,000	16.48	3.6	-
L9401	A2006-126	3.04	2.85	5.89	10,711,000	4,858,000	10.45	1.8	✓
L9904	A2006-126	3.29	0.06	3.35	1,951,000	611,000	1.94	0.6	-
L9905	A2006-126	1.95	0.22	2.17	1,121,000	364,000	1.11	0.5	✓
L9906	A2006-126	1.92	0.12	2.04	4,836,000	1,082,000	4.88	2.4	-
L9907	A2006-126	1.51	0.33	1.84	1,566,000	475,000	1.56	0.8	-
L9908	A2006-127	2.27	0.21	2.48	1,017,000	455,000	0.99	0.4	-
L9907 & L9908(6)	-	3.78	0.54	4.32	2,582,000	930,000	2.55	0.6	-
M9321	A2006-127	2.18	0.16	2.34	3,328,000	960,000	3.32	1.4	-
M9521	A2006-127	0.00	16.57	16.57	22,458,000	9,474,000	22.01	1.3	✓
M9522	A2006-127	8.03	0.29	8.32	2,200,000	939,000	2.15	0.3	✓
M9701	A2006-128	1.15	0.26	1.41	-	-	-	-	-
M9702	A2006-128	2.25	0.26	2.51	-	-	-	-	-
M9701 & M9702(7)	-	3.40	0.52	3.92	4,591,000	1,318,000	4.59	1.2	✓
M9703	A2006-128	7.86	0.19	8.05	2,288,000	971,000	2.24	0.3	✓
M9704	A2006-129	0.72	0.15	0.87	1,301,000	569,000	1.27	1.5	✓
M9709	A2006-129	13.27	0.60	13.87	10,329,000	4,697,000	10.07	0.7	-
M0675	A2006-130	4.51	4.06	8.57	19,594,000	10,561,000	18.87	2.2	✓
M0676	A2006-130	0.01	5.63	5.64	7,321,000	5,054,000	6.89	1.2	✓
M0678	A2006-130	6.48	0.20	6.68	1,491,000	535,000	1.47	0.2	-
MC7913/M911	A2006-130	73.91	2.85	76.76	41,929,000	27,088,000	39.75	0.5	-
L9108	A2006-125	14.18	1.00	15.18	9,159,000	5,279,000	8.77	0.6	✓
M9708	A2006-129	1.85	0.86	2.71	7,034,000	3,133,000	6.87	2.5	✓
L9210/M9213	A2005-72	28.20	1.69	29.89	10,008,000	6,388,000	9.50	0.3	✓
L9327	A2005-72	1.42	1.40	2.82	18,610,000	9,710,000	17.97	6.4	-
L9903	A2005-72	1.63	0.15	1.78	1,313,000	447,000	1.30	0.7	-
M9313	A2005-72	19.00	1.15	20.15	9,924,000	6,187,000	9.44	0.5	-
M9606	A2005-72	7.20	1.38	8.58	12,639,000	4,718,000	12.47	1.5	✓
M9608	A2005-72	16.65	1.52	18.17	-	-	-	-	-
B8530(8)	A2003-63	22.34	0.00	22.34	-	-	-	-	-
M9608 & B8530(9)	-	38.99	1.52	40.51	64,714,000	28,516,000	63.24	1.6	✓

Notes:
1. Volumes based on fish habitat requirements
2. Ice aggregate removal volumes were approved for the 2006/2007 winter season only.
3. Values based on an estimated terrain specific delta wide, area weighted snow water equivalents: 1.44-inches (lake) and 2.49-inches (tundra).
4. A coefficient of 0.67 was used to calculate lake water recharge volume resulting from snowmelt runoff
5. Based on 2006/2007 as-built ice road drawings provided by LCMF and one million gallons of water per mile of ice road.
6. L9907 and L9908 were hydraulically connected during spring breakup. A combined catchment is used in a supplemental combined recharge calculation.
7. M9701 and M9702 are hydraulically connected year-round. A combined catchment is used in recharge calculations.
8. B8530 is not included in the thirty permitted study lakes.
9. B8530 and M9608 are hydraulically connected year-round. A combined catchment is used in recharge calculations.

Current water withdrawal volumes are based on fish habitat requirements and do not take into account the potential for snow water recharge. The second to last column in Table 6-2 presents a ratio of potential recharge volume to total permitted withdrawal volumes (water and ice) based on 2007 delta-wide SWE values. Fourteen of the 30 lakes have a recharge volume greater than the total permitted volume, independent of floodwater recharge. The amount of water contributed to catchment basins by 2006/2007 ice roads and ice pads located within a lake's catchment basin was not included in the recharge to permit volume ratio. Contributions from ice roads and pads were minimal relative to total recharge and had little effect on the presented ratios.

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7.0 References

Alaska Climate Research Center (ACRC), Geophysical Institute, University of Alaska Fairbanks. Website accessed Summer 2007. (http://climate.gi.alaska.edu)

BC Ministry of Environment. 1981. British Columbia Snow Survey Manual.

Bowling, L. C., D. L. Kane, R. E. Gieck, L. D. Hinzman, and D. P. Lettenmaier. 2003. The role of surface storage in a low-gradient Arctic Watershed, Water Resources Research, 39(4), 1087.

ConocoPhillips AK, Inc. (CPAI). 2006. Summary Information Lakes for Alpine Development & Other Oil-Related Uses Fall 2006 Temporary Water Use Applications.

—— 2007a.Alaska Department of Natural Resources Alpine 4th Quarter 2006 Water Use Report.

—— 2007b.Alaska Department of Natural Resources Alpine 2nd Quarter 2007 Water Use Report.

Goodison, B.E., Ferguson H.L. and McKay, G.A. (1981). Measurement and Data Analysis. Chapter 6 in Handbook of Snow, Gray, D.M. and Male, D.H. (Eds.), Pergamon Press Canada Ltd., pp. 191-274.

Jones, S.H., and C.B. Fahl. 1994. Magnitude and frequency of floods in Alaska and conterminous basins of Canada: U.S. Geological Survey Water-Resources Investigations Report 93-4179. 1994.

Kane, D.L., L.D. Hinzman, J.P. Namara, Z. Zhang, and C.S. Benson. 1999. Kuparuk River Basin, Arctic Alaska. Northern Research Basins Twelfth International Symposium and Workshop. Iceland University Press., J. Eliasson (Ed), pp. 182-196

Keffries, 2007. Oral communication b/t Dr. Keffries (University of Alaska, Fairbanks) and Mike Alexander (Baker)

Michael Baker Jr., Inc. (Baker). 2002. Alpine Water Supply Risk Assessment 2002 Update. Prepared for Phillips Alaska, Inc.

—— 2006. Colville River Delta Two-Dimensional Surface Water Model CD5 Update. Prepared for ConocoPhillips Alaska.

—— 2007a. 2006 Colville River Delta and Fish Creek Basin Spring Break Up and Hydrologic Assessment. Prepared for ConocoPhillips Alaska.

—— 2007b. North Slope Crude Oil Sales Transmission Pipeline Spill-Surface Water Transport Analysis. Prepared for ConocoPhillips Alaska.

National Resources Conservation Services (NRCS), United States Department of Agriculture. 2006. Snow Survey Sampling Guide. Website accessed spring 2007. (http://www.wcc.nrcs.usda.gov/factpub/ah169/ah169.htm)

National Resources Conservation Services (NRCS), United States Department of Agriculture.2007a. Alaska Basin Outlook Reports. Accessed summer 2007. (http://www.wcc.nrcs.usda.gov/cgibin/bor.pl)

National Resources Conservation Services (NRCS), United States Department of Agriculture. 2007b. Alaska Snowpack Maps. Accessed summer 2007. (http://www.wcc.nrcs.usda.gov/cgibin/ak_snow.pl?state=alaska)

Rovansek, R.J., D.L Kane, and L.D. Hinzman. 1993. Improving Estimates of Snowpack Water Equivalent Using Double Sampling, Proceedings of the Eastern and Western Snow Conference, Quebec City.

Sturm M. and Liston G.E. The Snow Cover on Lakes of the Arctic Coastal Plain of Alaska. *J. of Glaciology*, 49 (166), 370-380

Weather Underground. Website access summer 2007. (http://www.wunderground.com)

Woo, Ming-ko. 1997. Arctic Snow Cover Information for Hydrological Investigations as Various Scales, Proceedings of the Northern Res. Basin Symposium/Workshop. Nordic Hydrology, 29 (4/5), 245 – 266.

Appendix A Snow Survey Sheets

Snow Survey Data Sheet

Date: 5/10/2007	**Start Time:** 8:13	**End Time:** 11:15	**Observers:** MDM, OOO
Catchement Basin: L9310	**Driving Wrench Used:** Yes		**Tube Section Used:** 1

Snow Sample No.	Sample Type	Terrain Type	Snow Depth (in)		Core Length (in)	Tube & Core Weight (lb)	Empty Tube Weight (lb)	Water Equivalent (in)	Density (lb/in^3)
			w/ Dirt Plug	w/o Dirt Plug					
SS1*	Core	Lake	—	5.2	—	2.18	1.96	0.59	0.004
SS2*	Core	Tundra	—	9.4	—	2.28	1.96	1.07	0.004
SS3*	Core	Lake	—	5.0	—	2.24	1.98	0.69	0.005
SS4	Core	Tundra	18.5	17.3	—	2.28	1.98	4.01	0.008
SS5*	Core	Lake	—	4.3	—	2.22	1.98	0.64	0.005
SS6	Core	Tundra	20.5	18.0	—	3.08	2.74	4.54	0.009
SS7*	Core	Lake	—	5.0	—	2.20	2.00	0.53	0.004
SS8*	Core	Tundra	—	10.2	—	2.30	1.94	1.20	0.004
SS9*	Core	Lake	—	4.5	—	2.14	1.98	0.43	0.003
SS10*	Core	Tundra	—	16.2	—	2.58	1.98	2.00	0.004
SS11*	Core	Lake	—	5.0	—	2.16	1.96	0.67	0.005
SS12*	Core	Tundra	—	10.8	—	2.56	1.84	2.40	0.008
SS13	Depth	Lake	—	6.0					
SS14	Depth	Lake	—	7.1					
SS15	Depth	Lake	—	4.8					
SS16	Depth	Lake	—	5.0					
SS17	Depth	Tundra	—	10.8					
SS18	Depth	Lake	—	6.2					
SS19	Depth	Tundra	—	14.8					
SS20	Depth	Lake	—	5.5					
SS21	Depth	Lake	—	7.8					
SS22	Depth	Lake	—	7.2					
SS23	Depth	Lake	—	5.8					
SS24	Depth	Tundra	—	7.2					
SS25	Depth	Tundra	—	12.0					
SS26	Depth	Tundra	—	16.3					
SS27	Depth	Tundra	—	7.8					
SS28	Depth	Tundra	—	15.8					
SS29	Depth	Lake	—	4.2					
SS30	Depth	Lake	—	5.8					
SS31	Depth	Lake	—	4.8					
SS32	Depth	Lake	—	5.4					
SS33	Depth	Lake	—	4.2					
SS34	Depth	Lake	—	7.2					
SS35	Depth	Tundra	—	12.0					
SS36	Depth	Tundra	—	11.4					
SS37	Depth	Tundra	—	19.4					
SS38	Depth	Tundra	—	21.6					
SS39	Depth	Lake	—	4.2					
SS40	Depth	Lake	—	5.5					
SS41	Depth	Lake	—	4.8					
SS42	Depth	Lake	—	8.4					
SS43	Depth	Lake	—	4.8					
SS44	Depth	Tundra	—	10.8					
SS45	Depth	Tundra	—	13.8					
SS46	Depth	Lake	—	7.2					

Snow Survey Calculations

Average Area: Tundra = 2516717 ft^2
Lake = 2874091 ft^2

Average SWE: Tundra = 2.38 in
Lake = 0.69 in

Average Snow Depth: Tundra = 13.46 in
Lake = 5.59 in

Average Density: Tundra = 0.006 lb/in^3
Lake = 0.004 lb/in^3

Catchement Basin Weighted SWE = 1.48 in

NOTES:

* Pooled sample measurement conducted, snow depth without dirt plug, SWE, and density represents the average of pooled samples.

Pooled Snow Survey Data Sheet

Date: 5/10/2007 | **Start Time:** 8:13 | **End Time:** 11:15 | **Observers:** MDM, OOO

Catchement Basin: L9310 | **Driving Wrench Used:** Yes | **Tube Section Used:** 1

Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in)		Core Length (in)	Bucket & Core Weight (lb)	Empty Bucket Weight (lb)	Water Equivalent (in)	Density (lb/in^3)
			w/ Dirt Plug	w/o Dirt Plug					
SS1	1	Lake	—	5.0	—	—	1.96	—	—
	2	Lake	—	5.0	—	—	—	—	—
	3	Lake	—	5.5	—	—	—	—	—
	4	Lake	—	5.5	—	—	—	—	—
	5	Lake	—	5.0	—	—	—	—	—
			Sum =	**26.0**		2.18	**0.22**	—	—
			Average =	**5.2**			**0.04**	0.59	0.004
SS2	1	Tundra	11.0	9.0	—	—	1.96	—	—
	2	Tundra	12.0	10.5	—	—	—	—	—
	3	Tundra	11.0	9.5	—	—	—	—	—
	4	Tundra	11.0	8.5	—	—	—	—	—
			Sum =	**37.5**		2.28	**0.32**	—	—
			Average =	**9.4**			**0.08**	1.07	0.004
SS3	1	Lake	—	5.0	—	—	1.98	—	—
	2	Lake	—	5.0	—	—	—	—	—
	3	Lake	—	5.0	—	—	—	—	—
	4	Lake	—	5.0	—	—	—	—	—
	5	Lake	—	5.0	—	—	—	—	—
			Sum =	**25.0**		2.24	**0.26**	0.69	0.005
			Average =	**5.0**			**0.05**		
SS5	1	Lake	—	4.0	—	—	1.98	—	—
	2	Lake	—	4.0	—	—	—	—	—
	3	Lake	—	4.4	—	—	—	—	—
	4	Lake	—	4.4	—	—	—	—	—
	5	Lake	—	4.5	—	—	—	—	—
			Sum =	**21.3**		2.22	**0.24**	—	—
			Average =	**4.3**			**0.05**	0.64	0.005
SS7	1	Lake	—	5.2	—	—	2.00	—	—
	2	Lake	—	4.8	—	—	—	—	—
	3	Lake	—	5.0	—	—	—	—	—
	4	Lake	—	4.9	—	—	—	—	—
	5	Lake	—	4.9	—	—	—	—	—
			Sum =	**24.8**		2.20	**0.20**	—	—
			Average =	**5.0**			**0.04**	0.53	0.004
SS8	1	Tundra	12.0	11.1	—	—	1.94	—	—
	2	Tundra	12.5	7.0	—	—	—	—	—
	3	Tundra	12.5	10.5	—	—	—	—	—
	4	Tundra	12.5	12.0	—	—	—	—	—
			Sum =	**40.6**		2.30	**0.36**	—	—
			Average =	**10.2**			**0.09**	1.20	0.004
SS9	1	Lake	—	4.5	—	—	1.98	—	—
	2	Lake	—	4.5	—	—	—	—	—
	3	Lake	—	4.5	—	—	—	—	—
	4	Lake	—	4.5	—	—	—	—	—
	5	Lake	—	4.5	—	—	—	—	—
			Sum =	**22.5**		2.14	**0.16**	—	—
			Average =	**4.5**			**0.03**	0.43	0.003
SS10	1	Tundra	17.0	15.8	—	—	1.98	—	—
	2	Tundra	17.0	16.5	—	—	—	—	—
	3	Tundra	18.0	16.5	—	—	—	—	—
	4	Tundra	17.5	16.0	—	—	—	—	—
			Sum =	**64.8**		2.58	**0.60**	—	—
			Average =	**16.2**			**0.15**	2.00	0.004
SS11	1	Lake	—	5.0	—	—	1.96	—	—
	2	Lake	—	5.0	—	—	—	—	—
	3	Lake	—	5.0	—	—	—	—	—
	4	Lake	—	5.0	—	—	—	—	—
			Sum =	**20.0**		2.16	**0.20**	—	—
			Average =	**5.0**			**0.05**	0.67	0.005
SS12	1	Tundra	—	9.8	—	—	1.84	—	—
	2	Tundra	—	9.9	—	—	—	—	—
	3	Tundra	12.0	10.0	—	—	—	—	—
	4	Tundra	15.0	13.5	—	—	—	—	—
			Sum =	**43.2**		2.56	**0.72**	—	—
			Average =	**10.8**			**0.18**	2.40	0.008

Snow Sample #	Catchement Basin	Sample Type	Lat. (NAD 83)	Long. (NAD 83)
SS1	L9310	Core	N 70° 19' 48.16"	W 150° 55' 29.17"
SS2	L9310	Core	N 70° 19' 45.20"	W 150° 55' 21.51"
SS3	L9310	Core	N 70° 19' 54.42"	W 150° 55' 14.34"
SS4	L9310	Core	N 70° 19' 59.21"	W 150° 54' 55.73"
SS5	L9310	Core	N 70° 19' 55.07"	W 150° 55' 25.78"
SS6	L9310	Core	N 70° 20' 04.04"	W 150° 55' 13.85"
SS7	L9310	Core	N 70° 19' 51.0"	W 150° 55' 37.22"
SS8	L9310	Core	N 70° 19' 53.71"	W 150° 55' 45.77"
SS9	L9310	Core	N 70° 19' 42.33"	W 150° 55' 41.26"
SS10	L9310	Core	N 70° 19' 31.30"	W 150° 55' 53.88"
SS11	L9310	Core	N 70° 19' 47.06"	W 150° 55' 48.65"
SS12	L9310	Core	N 70° 19' 42.74"	W 150° 56' 14.87"
SS13	L9310	Depth	N 70° 19' 49.66"	W 150° 55' 32.95"
SS14	L9310	Depth	N 70° 19' 50.87"	W 150° 55' 28.32"
SS15	L9310	Depth	N 70° 19' 52.04"	W 150° 55' 23.60"
SS16	L9310	Depth	N 70° 19' 53.24"	W 150° 55' 18.97"
SS17	L9310	Depth	N 70° 19' 55.63"	W 150° 55' 09.71"
SS18	L9310	Depth	N 70° 19' 56.83"	W 150° 55' 05.08"
SS19	L9310	Depth	N 70° 19' 58.0"	W 150° 55' 00.36"
SS20	L9310	Depth	N 70° 19' 51.47"	W 150° 55' 30.56"
SS21	L9310	Depth	N 70° 19' 53.25"	W 150° 55' 28.17"
SS22	L9310	Depth	N 70° 19' 56.85"	W 150° 55' 23.40"
SS23	L9310	Depth	N 70° 19' 58.66"	W 150° 55' 21.01"
SS24	L9310	Depth	N 70° 20' 00.44"	W 150° 55' 18.62"
SS25	L9310	Depth	N 70° 20' 02.26"	W 150° 55' 16.23"
SS26	L9310	Depth	N 70° 20' 05.82"	W 150° 55' 11.46"
SS27	L9310	Depth	N 70° 19' 46.63"	W 150° 55' 25.20"
SS28	L9310	Depth	N 70° 19' 43.70"	W 150° 55' 17.73"
SS29	L9310	Depth	N 70° 19' 47.84"	W 150° 55' 35.05"
SS30	L9310	Depth	N 70° 19' 45.99"	W 150° 55' 37.15"
SS31	L9310	Depth	N 70° 19' 44.18"	W 150° 55' 39.16"
SS32	L9310	Depth	N 70° 19' 40.48"	W 150° 55' 43.37"
SS33	L9310	Depth	N 70° 19' 38.66"	W 150° 55' 45.47"
SS34	L9310	Depth	N 70° 19' 36.81"	W 150° 55' 47.57"
SS35	L9310	Depth	N 70° 19' 34.96"	W 150° 55' 49.68"
SS36	L9310	Depth	N 70° 19' 33.15"	W 150° 55' 51.78"
SS37	L9310	Depth	N 70° 19' 29.48"	W 150° 55' 55.89"
SS38	L9310	Depth	N 70° 19' 27.63"	W 150° 55' 57.99"
SS39	L9310	Depth	N 70° 19' 48.82"	W 150° 55' 38.21"
SS40	L9310	Depth	N 70° 19' 47.94"	W 150° 55' 43.38"
SS41	L9310	Depth	N 70° 19' 46.22"	W 150° 55' 53.91"
SS42	L9310	Depth	N 70° 19' 45.34"	W 150° 55' 59.17"
SS43	L9310	Depth	N 70° 19' 44.46"	W 150° 56' 04.44"
SS44	L9310	Depth	N 70° 19' 43.62"	W 150° 56' 09.61"
SS45	L9310	Depth	N 70° 19' 41.87"	W 150° 56' 20.14"
SS46	L9310	Depth	N 70° 19' 52.37"	W 150° 55' 41.49"

Snow Survey Data Sheet

Date: 5/10/2007	Start Time: 13:00	End Time: 15:30	Observers: MDM, OOO
Catchement Basin: L9312	Driving Wrench Used: Yes		Tube Section Used: 1

Snow Sample No.	Sample Type	Terrain Type	Snow Depth (in)		Core Length (in)	Tube & Core Weight (lb)	Empty Tube Weight (lb)	Water Equivalent (in)	Density (lb/in³)
			w/ Dirt Plug	w/o Dirt Plug					
SS47*	Core	Tundra	—	12.5	—	2.9	1.98	3.07	0.009
SS48*	Core	Lake	—	5.0	—	2.24	1.98	0.69	0.005
SS49*	Core	Tundra	—	11.1	—	2.24	1.96	0.93	0.003
SS50*	Core	Lake	—	4.7	—	2.26	1.96	0.80	0.006
SS51*	Core	Lake	—	8.0	—	2.68	1.96	1.92	0.009
SS52	Core	Tundra	15.5	13.5	—	2.12	1.96	2.14	0.006
SS53	Core	Tundra	17.2	14.2	—	2.22	1.98	3.20	0.008
SS54*	Core	Lake	—	7.2	—	2.74	1.96	2.08	0.010
SS55*	Core	Lake	—	4.0	—	2.14	1.96	0.48	0.004
SS56*	Core	Lake	—	4.1	—	2.3	1.96	0.91	0.008
SS57	Core	Tundra	17.2	16.7	—	2.3	1.98	4.27	0.009
SS58*	Core	Tundra	—	8.9	—	2.26	1.98	0.93	0.004
SS59	Core	Tundra	16.0	15.0	—	2.22	1.98	3.20	0.008
SS60*	Core	Tundra	—	12.4	—	2.56	1.98	1.94	0.006
SS61	Depth	Lake	—	8.4					
SS62	Depth	Lake	—	5.4					
SS63	Depth	Tundra	—	15.0					
SS64	Depth	Tundra	—	10.8					
SS65	Depth	Lake	—	9.6					
SS66	Depth	Lake	—	4.8					
SS67	Depth	Lake	—	3.8					
SS68	Depth	Lake	—	5.8					
SS69	Depth	Lake	—	4.8					
SS70	Depth	Lake	—	4.8					
SS71	Depth	Lake	—	5.0					
SS72	Depth	Lake	—	5.3					
SS73	Depth	Lake	—	7.0					
SS74	Depth	Lake	—	4.0					
SS75	Depth	Lake	—	4.8					
SS76	Depth	Lake	—	3.6					
SS77	Depth	Tundra	—	11.0					
SS78	Depth	Tundra	—	19.0					
SS79	Depth	Tundra	—	8.6					
SS80	Depth	Tundra	—	15.6					
SS81	Depth	Tundra	—	19.0					
SS82	Depth	Tundra	—	26.4					
SS83	Depth	Lake	—	4.6					
SS84	Depth	Lake	—	3.6					
SS85	Depth	Lake	—	4.8					
SS86	Depth	Tundra	—	7.4					
SS87	Depth	Tundra	—	4.8					
SS88	Depth	Lake	—	6.0					
SS89	Depth	Lake	—	4.1					
SS90	Depth	Tundra	—	6.0					
SS91	Depth	Tundra	—	9.6					
SS92	Depth	Lake	—	4.1					
SS93	Depth	Lake	—	3.8					
SS94	Depth	Lake	—	3.6					
SS95	Depth	Lake	—	5.4					
SS96	Depth	Lake	—	7.4					
SS97	Depth	Lake	—	8.3					
SS98	Depth	Tundra	—	13.2					
SS99	Depth	Tundra	—	13.2					
SS100	Depth	Tundra	—	10.8					
SS101	Depth	Tundra	—	9.6					
SS102	Depth	Tundra	—	8.4					
SS103	Depth	Tundra	—	13.6					
SS104	Depth	Tundra	—	5.4					

Snow Survey Calculations

Average Area: Tundra = 4943536 ft²
Lake = 4860982 ft²

Average SWE: Tundra = 2.22 in
Lake = 1.05 in

Average Snow Depth: Tundra = 12.3 in
Lake = 5.3 in

Average Density: Tundra = 0.007 lb/in³
Lake = 0.007 lb/in³

Catchement Basin Weighted SWE = 1.64 in

NOTES:

* Pooled sample measurement conducted, snow depth without dirt plug, SWE, and density represents the average of pooled samples.

Pooled Snow Survey Data Sheet

Date: 5/10/2007 | **Start Time:** 13:00 | **End Time:** 15:30 | **Observers:** MDM, OOO

Catchement Basin: L9312 | **Driving Wrench Used:** Yes | **Tube Section Used:** 1

Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Core Length (in)	Bucket & Core Weight (lb)	Empty Bucket Weight (lb)	Water Equivalent (in)	Density (lb/in^3)
SS47	1	Tundra	14	12.5	—	—	1.98	—	—
	2	Tundra	14	13.0	—	—	—	—	—
	3	Tundra	13.5	13.5	—	—	—	—	—
	4	Tundra	13	11.0	—	—	—	—	—
			Sum =	**50.0**		2.9	**0.92**	—	—
			Average =	**12.5**			**0.23**	3.07	0.009
SS48	1	Lake	—	4.8	—	—	1.98	—	—
	2	Lake	—	5.0	—	—	—	—	—
	3	Lake	—	5.0	—	—	—	—	—
	4	Lake	—	5.0	—	—	—	—	—
	5	Lake	—	5.0	—	—	—	—	—
			Sum =	**24.8**		2.24	**0.26**	—	—
			Average =	**5.0**			**0.05**	0.69	0.005
SS49	1	Tundra	14	11.7	—	—	1.96	—	—
	2	Tundra	13.5	11.0	—	—	—	—	—
	3	Tundra	13	10.5	—	—	—	—	—
	4	Tundra	13	11.0	—	—	—	—	—
			Sum =	**44.2**		2.24	**0.28**	—	—
			Average =	**11.1**			**0.07**	0.93	0.003
SS50	1	Lake	—	4.8	—	—	1.96	—	—
	2	Lake	—	5.0	—	—	—	—	—
	3	Lake	—	4.6	—	—	—	—	—
	4	Lake	—	4.6	—	—	—	—	—
	5	Lake	—	4.5	—	—	—	—	—
			Sum =	**23.5**		2.26	**0.3**	—	—
			Average =	**4.7**			**0.06**	0.80	0.006
SS51	1	Lake	—	8.0	—	—	1.96	—	—
	2	Lake	—	8.0	—	—	—	—	—
	3	Lake	—	8.0	—	—	—	—	—
	4	Lake	—	8.0	—	—	—	—	—
	5	Lake	—	8.0	—	—	—	—	—
			Sum =	**40.0**		2.68	**0.72**	—	—
			Average =	**8.0**			**0.14**	1.92	0.009
SS54	1	Lake	—	7.0	—	—	1.96	—	—
	2	Lake	—	7.5	—	—	—	—	—
	3	Lake	—	7.5	—	—	—	—	—
	4	Lake	—	7.0	—	—	—	—	—
	5	Lake	—	7.0	—	—	—	—	—
			Sum =	**36.0**		2.74	**0.78**	—	—
			Average =	**7.2**			**0.16**	2.08	0.010
SS55	1	Lake	—	4.0	—	—	1.96	—	—
	2	Lake	—	4.0	—	—	—	—	—
	3	Lake	—	4.0	—	—	—	—	—
	4	Lake	—	4.0	—	—	—	—	—
	5	Lake	—	4.0	—	—	—	—	—
			Sum =	**20.0**		2.14	**0.18**	—	—
			Average =	**4.0**			**0.04**	0.48	0.004
SS56	1	Lake	—	4.0	—	—	1.96	—	—
	2	Lake	—	4.0	—	—	—	—	—
	3	Lake	—	4.2	—	—	—	—	—
	4	Lake	—	4.2	—	—	—	—	—
	5	Lake	—	4.2	—	—	—	—	—
			Sum =	**20.6**		2.3	**0.34**	—	—
			Average =	**4.1**			**0.07**	0.91	0.008
SS58	1	Tundra	11.5	9.0	—	—	1.98	—	—
	2	Tundra	11	9.0	—	—	—	—	—
	3	Tundra	11	9.0	—	—	—	—	—
	4	Tundra	11	8.5	—	—	—	—	—
			Sum =	**35.5**		2.26	**0.28**	—	—
			Average =	**8.9**			**0.07**	0.93	0.004
SS60	1	Tundra	12	11.0	—	—	1.98	—	—
	2	Tundra	13.5	13.0	—	—	—	—	—
	3	Tundra	13.5	12.5	—	—	—	—	—
	4	Tundra	13.6	13.0	—	—	—	—	—
			Sum =	**49.5**		2.56	**0.58**	—	—
			Average =	**12.4**			**0.15**	1.94	0.006

Snow Sample #	Catchement Basin	Sample Type	Lat. (NAD 83)	Long. (NAD 83)
SS47	L9312	Core	N 70° 20' 03.02"	W 150° 56' 11.68"
SS48	L9312	Core	N 70° 19' 58.24"	W 150° 56' 37.19"
SS49	L9312	Core	N 70° 19' 50.13"	W 150° 56' 31.39"
SS50	L9312	Core	N 70° 19' 52.70"	W 150° 56' 47.14"
SS51	L9312	Core	N 70° 19' 58.38"	W 150° 56' 57.60"
SS52	L9312	Core	N 70° 20' 04.26"	W 150° 56' 57.58"
SS53	L9312	Core	N 70° 19' 40.66"	W 150° 56' 58.51"
SS54	L9312	Core	N 70° 19' 48.53"	W 150° 56' 58.01"
SS55	L9312	Core	N 70° 19' 56.04"	W 150° 57' 08.28"
SS56	L9312	Core	N 70° 19' 50.96"	W 150° 57' 18.57"
SS57	L9312	Core	N 70° 19' 46.64"	W 150° 57' 44.79"
SS58	L9312	Core	N 70° 19' 58.45"	W 150° 57' 24.34"
SS59	L9312	Core	N 70° 19' 41.28"	W 150° 57' 59.42"
SS60	L9312	Core	N 70° 19' 46.98"	W 150° 58' 03.93"
SS61	L9312	Depth	N 70° 19' 51.0"	W 150° 56' 36.57"
SS62	L9312	Depth	N 70° 19' 51.87"	W 150° 56' 41.85"
SS63	L9312	Depth	N 70° 19' 36.72"	W 150° 56' 58.81"
SS64	L9312	Depth	N 70° 19' 38.69"	W 150° 56' 58.71"
SS65	L9312	Depth	N 70° 19' 42.63"	W 150° 56' 58.41"
SS66	L9312	Depth	N 70° 19' 44.59"	W 150° 56' 58.31"
SS67	L9312	Depth	N 70° 19' 46.56"	W 150° 56' 58.11"
SS68	L9312	Depth	N 70° 19' 50.50"	W 150° 56' 57.91"
SS69	L9312	Depth	N 70° 19' 52.47"	W 150° 56' 57.71"
SS70	L9312	Depth	N 70° 19' 54.44"	W 150° 56' 57.61"
SS71	L9312	Depth	N 70° 19' 53.57"	W 150° 56' 52.33"
SS72	L9312	Depth	N 70° 19' 55.38"	W 150° 56' 52.53"
SS73	L9312	Depth	N 70° 19' 56.32"	W 150° 56' 47.45"
SS74	L9312	Depth	N 70° 19' 57.30"	W 150° 56' 42.27"
SS75	L9312	Depth	N 70° 19' 59.19"	W 150° 56' 32.11"
SS76	L9312	Depth	N 70° 20' 00.16"	W 150° 56' 26.93"
SS77	L9312	Depth	N 70° 20' 01.10"	W 150° 56' 21.84"
SS78	L9312	Depth	N 70° 20' 02.05"	W 150° 56' 16.76"
SS79	L9312	Depth	N 70° 20' 03.96"	W 150° 56' 06.50"
SS80	L9312	Depth	N 70° 20' 04.91"	W 150° 56' 01.42"
SS81	L9312	Depth	N 70° 20' 05.88"	W 150° 55' 56.33"
SS82	L9312	Depth	N 70° 20' 06.82"	W 150° 55' 51.25"
SS83	L9312	Depth	N 70° 19' 56.41"	W 150° 56' 57.60"
SS84	L9312	Depth	N 70° 20' 00.35"	W 150° 56' 57.59"
SS85	L9312	Depth	N 70° 20' 02.29"	W 150° 56' 57.59"
SS86	L9312	Depth	N 70° 20' 06.23"	W 150° 56' 57.58"
SS87	L9312	Depth	N 70° 20' 08.13"	W 150° 56' 57.58"
SS88	L9312	Depth	N 70° 19' 55.24"	W 150° 57' 02.99"
SS89	L9312	Depth	N 70° 19' 56.85"	W 150° 57' 13.67"
SS90	L9312	Depth	N 70° 19' 57.62"	W 150° 57' 18.96"
SS91	L9312	Depth	N 70° 19' 59.22"	W 150° 57' 29.64"
SS92	L9312	Depth	N 70° 19' 53.56"	W 150° 57' 02.87"
SS93	L9312	Depth	N 70° 19' 52.72"	W 150° 57' 08.14"
SS94	L9312	Depth	N 70° 19' 51.84"	W 150° 57' 13.31"
SS95	L9312	Depth	N 70° 19' 50.12"	W 150° 57' 23.83"
SS96	L9312	Depth	N 70° 19' 49.24"	W 150° 57' 29.10"
SS97	L9312	Depth	N 70° 19' 48.36"	W 150° 57' 34.36"
SS98	L9312	Depth	N 70° 19' 47.52"	W 150° 57' 39.53"
SS99	L9312	Depth	N 70° 19' 45.76"	W 150° 57' 50.06"
SS100	L9312	Depth	N 70° 19' 44.92"	W 150° 57' 55.32"
SS101	L9312	Depth	N 70° 19' 43.17"	W 150° 58' 00.86"
SS102	L9312	Depth	N 70° 19' 39.36"	W 150° 57' 57.88"
SS103	L9312	Depth	N 70° 19' 45.06"	W 150° 58' 02.40"
SS104	L9312	Depth	N 70° 19' 48.87"	W 150° 58' 05.47"

Snow Survey Data Sheet

Date:	5/10/2007	Start Time:	16:00	End Time:	18:00	Observers:	MDM, OOO
Catchement Basin:	L9313	Driving Wrench Used:	Yes			Tube Section Used:	1

Snow Sample No.	Sample Type	Terrain Type	Snow Depth (in)		Core Length (in)	Tube & Core Weight (lb)	Empty Tube Weight (lb)	Water Equivalent (in)	Density (lb/in^3)
			w/ Dirt Plug	w/o Dirt Plug					
SS105*	Core	Lake	—	3.5	—	2.28	1.98	0.80	0.008
SS106	Core	Tundra	17.0	16.0	—	2.2	1.98	2.94	0.007
SS107*	Core	Lake	—	5.0	—	2.24	1.96	0.75	0.005
SS108*	Core	Tundra	—	6.9	—	2.16	2.02	0.47	0.002
SS109*	Core	Lake	—	7.2	—	2.4	1.96	1.17	0.006
SS110*	Core	Lake	—	8.5	—	2.98	2.12	2.30	0.010
SS111*	Core	Lake	—	5.1	—	2.34	1.98	0.96	0.007
SS112*	Core	Tundra	—	9.4	—	2.5	1.96	1.80	0.007
SS113*	Core	Lake	—	4.5	—	2.32	1.96	0.96	0.008
SS114*	Core	Lake	—	4.4	—	2.28	1.96	0.85	0.007
SS115*	Core	Lake	—	5.0	—	2.34	1.96	1.01	0.007
SS116*	Core	Tundra	—	10.0	—	2.54	1.98	1.87	0.007
SS117	Depth	Lake	—	6.4					
SS118	Depth	Lake	—	8.4					
SS119	Depth	Lake	—	10.2					
SS120	Depth	Lake	—	7.8					
SS121	Depth	Lake	—	6.6					
SS122	Depth	Lake	—	7.3					
SS123	Depth	Lake	—	7.3					
SS124	Depth	Lake	—	8.4					
SS125	Depth	Lake	—	14.6					
SS126	Depth	Tundra	—	9.8					
SS127	Depth	Lake	—	6.6					
SS128	Depth	Lake	—	4.2					
SS129	Depth	Tundra	—	12.6					
SS130	Depth	Tundra	—	12.6					
SS131	Depth	Lake	—	4.2					
SS132	Depth	Lake	—	3.6					
SS133	Depth	Lake	—	4.2					
SS134	Depth	Tundra	—	12.0					
SS135	Depth	Tundra	—	14.2					
SS136	Depth	Lake	—	4.8					
SS137	Depth	Lake	—	7.8					
SS138	Depth	Lake	—	6.0					
SS139	Depth	Lake	—	4.8					
SS140	Depth	Lake	—	4.2					
SS141	Depth	Lake	—	5.4					
SS142	Depth	Lake	—	4.8					
SS143	Depth	Tundra	—	20.6					
SS144	Depth	Lake	—	4.2					
SS145	Depth	Lake	—	3.6					
SS146	Depth	Lake	—	7.2					
SS147	Depth	Tundra	—	14.6					
SS148	Depth	Tundra	—	18.6					
SS149	Depth	Tundra	—	19.8					
SS150	Depth	Tundra	—	16.6					
SS151	Depth	Lake	—	6.2					

Snow Survey Calculations

Average Area:	Tundra =	3131338 ft^2
	Lake =	3382142 ft^2
Average SWE:	Tundra =	2.18 in
	Lake =	1.23 in
Average Snow Depth:	Tundra =	13.8 in
	Lake =	6.1 in
Average Density:	Tundra =	0.006 lb/in^3
	Lake =	0.007 lb/in^3
Catchement Basin Weighted SWE =		1.69 in

NOTES:

* Pooled sample measurement conducted, snow depth without dirt plug, SWE, and density represents the average of pooled samples.

Pooled Snow Survey Data Sheet

Date: 5/10/2007 | **Start Time:** 16:00 | **End Time:** 18:00 | **Observers:** MDM, OOO

Catchement Basin: L9313 | **Driving Wrench Used:** Yes | **Tube Section Used:** 1

Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Core Length (in)	Bucket & Core Weight (lb)	Empty Bucket Weight (lb)	Water Equivalent (in)	Density (lb/in^3)
SS105	1	Lake	—	3.5	—	—	1.98	—	—
	2	Lake	—	3.5	—	—	—	—	—
	3	Lake	—	3.5	—	—	—	—	—
	4	Lake	—	3.5	—	—	—	—	—
	5	Lake	—	3.5	—	—	—	—	—
			Sum =	**17.5**		2.28	**0.3**	—	—
			Average =	**3.5**			**0.06**	0.80	0.008
SS107	1	Lake	—	4.5	—	—	1.96	—	—
	2	Lake	—	4.5	—	—	—	—	—
	3	Lake	—	5.5	—	—	—	—	—
	4	Lake	—	5.0	—	—	—	—	—
	5	Lake	—	5.5	—	—	—	—	—
			Sum =	**25.0**		2.24	**0.28**	—	—
			Average =	**5.0**			**0.06**	0.75	0.005
SS108	1	Tundra	9	8.5	—	—	2.02	—	—
	2	Tundra	8.5	8.0	—	—	—	—	—
	3	Tundra	8.5	5.5	—	—	—	—	—
	4	Tundra	8.5	5.5	—	—	—	—	—
			Sum =	**27.5**		2.16	**0.14**	—	—
			Average =	**6.9**			**0.04**	0.47	0.002
SS109	1	Lake	—	7.5	—	—	1.96	—	—
	2	Lake	—	7.0	—	—	—	—	—
	3	Lake	—	7.0	—	—	—	—	—
	4	Lake	—	7.5	—	—	—	—	—
	5	Lake	—	7.0	—	—	—	—	—
			Sum =	**36.0**		2.4	**0.44**	—	—
			Average =	**7.2**			**0.09**	1.17	0.006
SS110	1	Lake	—	8.5	—	—	2.12	—	—
	2	Lake	—	8.5	—	—	—	—	—
	3	Lake	—	8.5	—	—	—	—	—
	4	Lake	—	8.5	—	—	—	—	—
	5	Lake	—	8.5	—	—	—	—	—
			Sum =	**42.5**		2.98	**0.86**	—	—
			Average =	**8.5**			**0.17**	2.30	0.010
SS111	1	Lake	—	5.0	—	—	1.98	—	—
	2	Lake	—	5.0	—	—	—	—	—
	3	Lake	—	5.5	—	—	—	—	—
	4	Lake	—	5.0	—	—	—	—	—
	5	Lake	—	5.0	—	—	—	—	—
			Sum =	**25.5**		2.34	**0.36**	—	—
			Average =	**5.1**			**0.07**	0.96	0.007
SS112	1	Tundra	12.5	10.5	—	—	1.96	—	—
	2	Tundra	11.5	9.5	—	—	—	—	—
	3	Tundra	11	9.5	—	—	—	—	—
	4	Tundra	11	8.0	—	—	—	—	—
			Sum =	**37.5**		2.5	**0.54**	—	—
			Average =	**9.4**			**0.14**	1.80	0.007
SS113	1	Lake	—	4.5	—	—	1.96	—	—
	2	Lake	—	4.5	—	—	—	—	—
	3	Lake	—	4.5	—	—	—	—	—
	4	Lake	—	4.5	—	—	—	—	—
	5	Lake	—	4.5	—	—	—	—	—
			Sum =	**22.5**		2.32	**0.36**	—	—
			Average =	**4.5**			**0.07**	0.96	0.008
SS114	1	Lake	—	4.5	—	—	1.96	—	—
	2	Lake	—	4.5	—	—	—	—	—
	3	Lake	—	4.5	—	—	—	—	—
	4	Lake	—	4.5	—	—	—	—	—
	5	Lake	—	4.0	—	—	—	—	—
			Sum =	**22.0**		2.28	**0.32**	—	—
			Average =	**4.4**			**0.06**	0.85	0.007
SS115	1	Lake	—	5.0	—	—	1.96	—	—
	2	Lake	—	5.0	—	—	—	—	—
	3	Lake	—	5.0	—	—	—	—	—
	4	Lake	—	5.0	—	—	—	—	—
	5	Lake	—	5.0	—	—	—	—	—
			Sum =	**25.0**		2.34	**0.38**	—	—
			Average =	**5.0**			**0.08**	1.01	0.007
SS116	1	Tundra	14	13.0	—	—	1.98	—	—
	2	Tundra	10	9.0	—	—	—	—	—
	3	Tundra	10	8.0	—	—	—	—	—
	4	Tundra	12	10.0	—	—	—	—	—
			Sum =	**40.0**		2.54	**0.56**	—	—
			Average =	**10.0**			**0.14**	1.87	0.007

Snow Sample #	Catchement Basin	Sample Type	Lat. (NAD 83)	Long. (NAD 83)
SS105	L9313	Core	N 70° 20' 30.42"	W 150° 56' 40.96"
SS106	L9313	Core	N 70° 20' 29.81"	W 150° 56' 58.38"
SS107	L9313	Core	N 70° 20' 34.95"	W 150° 56' 21.99"
SS108	L9313	Core	N 70° 20' 40.80"	W 150° 56' 19.77"
SS109	L9313	Core	N 70° 20' 34.72"	W 150° 56' 09.83"
SS110	L9313	Core	N 70° 20' 38.40"	W 150° 55' 56.12"
SS111	L9313	Core	N 70° 20' 31.77"	W 150° 56' 12.04"
SS112	L9313	Core	N 70° 20' 32.86"	W 150° 55' 54.76"
SS113	L9313	Core	N 70° 20' 27.11"	W 150° 56' 36.59"
SS114	L9313	Core	N 70° 20' 21.88"	W 150° 56' 54.0"
SS115	L9313	Core	N 70° 20' 27.14"	W 150° 56' 24.98"
SS116	L9313	Core	N 70° 20' 21.29"	W 150° 56' 27.30"
SS117	L9313	Depth	N 70° 20' 31.42"	W 150° 56' 17.74"
SS118	L9313	Depth	N 70° 20' 32.12"	W 150° 56' 06.25"
SS119	L9313	Depth	N 70° 20' 32.48"	W 150° 56' 00.56"
SS120	L9313	Depth	N 70° 20' 32.27"	W 150° 56' 18.90"
SS121	L9313	Depth	N 70° 20' 33.51"	W 150° 56' 14.36"
SS122	L9313	Depth	N 70° 20' 35.95"	W 150° 56' 05.19"
SS123	L9313	Depth	N 70° 20' 37.16"	W 150° 56' 00.66"
SS124	L9313	Depth	N 70° 20' 39.64"	W 150° 55' 51.48"
SS125	L9313	Depth	N 70° 20' 40.85"	W 150° 55' 46.95"
SS126	L9313	Depth	N 70° 20' 42.09"	W 150° 55' 42.41"
SS127	L9313	Depth	N 70° 20' 32.99"	W 150° 56' 22.76"
SS128	L9313	Depth	N 70° 20' 36.91"	W 150° 56' 21.21"
SS129	L9313	Depth	N 70° 20' 38.84"	W 150° 56' 20.44"
SS130	L9313	Depth	N 70° 20' 42.77"	W 150° 56' 18.99"
SS131	L9313	Depth	N 70° 20' 29.10"	W 150° 56' 24.21"
SS132	L9313	Depth	N 70° 20' 25.21"	W 150° 56' 25.75"
SS133	L9313	Depth	N 70° 20' 23.25"	W 150° 56' 26.52"
SS134	L9313	Depth	N 70° 20' 19.36"	W 150° 56' 27.97"
SS135	L9313	Depth	N 70° 20' 17.39"	W 150° 56' 28.74"
SS136	L9313	Depth	N 70° 20' 29.72"	W 150° 56' 27.89"
SS137	L9313	Depth	N 70° 20' 28.42"	W 150° 56' 32.24"
SS138	L9313	Depth	N 70° 20' 25.80"	W 150° 56' 40.94"
SS139	L9313	Depth	N 70° 20' 24.49"	W 150° 56' 45.29"
SS140	L9313	Depth	N 70° 20' 23.19"	W 150° 56' 49.65"
SS141	L9313	Depth	N 70° 20' 20.57"	W 150° 56' 58.35"
SS142	L9313	Depth	N 70° 20' 19.27"	W 150° 57' 02.70"
SS143	L9313	Depth	N 70° 20' 17.93"	W 150° 57' 07.05"
SS144	L9313	Depth	N 70° 20' 30.84"	W 150° 56' 29.31"
SS145	L9313	Depth	N 70° 20' 30.65"	W 150° 56' 35.18"
SS146	L9313	Depth	N 70° 20' 30.23"	W 150° 56' 46.73"
SS147	L9313	Depth	N 70° 20' 30.0"	W 150° 56' 52.61"
SS148	L9313	Depth	N 70° 20' 29.59"	W 150° 57' 04.16"
SS149	L9313	Depth	N 70° 20' 29.39"	W 150° 57' 10.03"
SS150	L9313	Depth	N 70° 20' 29.17"	W 150° 57' 15.81"
SS151	L9313	Depth	N 70° 20' 31.06"	W 150° 56' 23.53"

Snow Survey Data Sheet

Date: 5/14/2007	**Start Time:** 13:40	**End Time:** 15:30	**Observers:** MTA, EJK
Catchement Basin: L9210	**Driving Wrench Used:** Yes		**Tube Section Used:** 1

Snow Sample No.	Sample Type	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Core Length (in)	Tube & Core Weight (lb)	Empty Tube Weight (lb)	Water Equivalent (in)	Density (lb/in^3)
SS152	Core	Lake	8.0	8.0	—	2.24	1.96	3.74	0.017
SS153*	Core	Tundra	—	5.8	—	2.24	1.96	0.75	0.005
SS154*	Core	Lake	—	3.5	—	2.2	1.96	0.64	0.007
SS155*	Core	Tundra	—	9.8	—	2.66	1.98	1.82	0.007
SS156*	Core	Lake	—	4.0	—	2.24	1.96	0.75	0.007
SS157*	Core	Lake	—	7.6	—	2.58	1.98	1.60	0.008
SS158	Core	Lake	9.0	9.0	—	2.1	1.96	1.87	0.008
SS159	Core	Tundra	21.0	21.0	—	2.46	1.96	6.68	0.011
SS160	Core	Lake	—	8.0	—	2.1	1.96	1.87	0.008
SS161	Core	Tundra	14.5	13.5	—	2.26	1.96	0.80	0.002
SS162*	Core	Lake	—	2.6	—	2.16	1.96	0.53	0.007
SS163	Core	Tundra	22.5	22.5	—	2.56	1.98	7.74	0.012
SS164	Depth	Lake	—	3.0					
SS165	Depth	Lake	—	4.8					
SS166	Depth	Lake	—	5.4					
SS167	Depth	Lake	—	6.0					
SS168	Depth	Lake	—	2.4					
SS169	Depth	Lake	—	7.2					
SS170	Depth	Tundra	—	14.4					
SS171	Depth	Tundra	—	10.8					
SS172	Depth	Tundra	—	6.0					
SS173	Depth	Lake	—	8.4					
SS174	Depth	Lake	—	7.2					
SS175	Depth	Lake	—	7.2					
SS176	Depth	Lake	—	12.0					
SS177	Depth	Tundra	—	5.4					
SS178	Depth	Lake	—	4.8					
SS179	Depth	Lake	—	4.2					
SS180	Depth	Lake	—	9.0					
SS181	Depth	Lake	—	3.6					
SS182	Depth	Lake	—	6.0					
SS183	Depth	Lake	—	4.8					
SS184	Depth	Lake	—	3.6					
SS185	Depth	Lake	—	12.0					
SS186	Depth	Lake	—	4.8					
SS187	Depth	Lake	—	12.0					
SS188	Depth	Lake	—	4.2					
SS189	Depth	Lake	—	4.8					
SS190	Depth	Tundra	—	14.4					
SS191	Depth	Lake	—	4.2					
SS192	Depth	Lake	—	4.8					
SS193	Depth	Lake	—	4.8					
SS194	Depth	Lake	—	8.4					
SS195	Depth	Tundra	—	6.0					
SS196	Depth	Lake	—	3.0					
SS197	Depth	Lake	—	7.2					
SS198	Depth	Lake	—	4.2					
SS199	Depth	Lake	—	2.4					
SS200	Depth	Lake	—	4.8					
SS201	Depth	Lake	—	6.6					
SS202	Depth	Tundra	—	9.0					
SS203	Depth	Tundra	—	13.8					

Snow Survey Calculations

Average Area: Tundra = 3619174 ft^2; Lake = 6388463 ft^2

Average SWE: Tundra = 2.43 in; Lake = 1.43 in

Average Snow Depth: Tundra = 11.7 in; Lake = 5.9 in

Average Density: Tundra = 0.007 lb/in^3; Lake = 0.009 lb/in^3

Catchement Basin Weighted SWE = 1.79 in

NOTES:

* Pooled sample measurement conducted, snow depth without dirt plug, SWE, and density represents the average of pooled samples.

Pooled Snow Survey Data Sheet									
Date:	5/14/2007		**Start Time:**	13:40	**End Time:**	15:30	**Observers:**	MTA, EJK	
Catchement Basin:		L9210	**Driving Wrench Used:**		Yes		**Tube Section Used:**		1
Snow Sample No.	**Pooled Sample #**	**Terrain Type**	**Snow Depth (in)**		**Core Length (in)**	**Bucket & Core Weight (lb)**	**Empty Bucket Weight (lb)**	**Water Equivalent (in)**	**Density (lb/in^3)**
			w/ Dirt Plug	**w/o Dirt Plug**					
SS153	1	Tundra	—	6.5	—	—	1.96	—	—
	2	Tundra	—	7.0	—	—	—	—	—
	3	Tundra	—	4.5	—	—	—	—	—
	4	Tundra	—	5.0	—	—	—	—	—
	5	Tundra	—	6.0	—	—	—	—	—
			Sum =	**29.0**		2.24	**0.28**	—	—
			Average =	**5.8**			**0.06**	0.75	0.005
SS154	1	Lake	—	3.0	—	—	1.96	—	—
	2	Lake	—	3.0	—	—	—	—	—
	3	Lake	—	4.0	—	—	—	—	—
	4	Lake	—	4.0	—	—	—	—	—
	5	Lake	—	3.5	—	—	—	—	—
			Sum =	**17.5**		2.2	**0.24**	—	—
			Average =	**3.5**			**0.05**	0.64	0.007
SS155	1	Tundra	—	7.5	—	—	1.98	—	—
	2	Tundra	—	9.0	—	—	—	—	—
	3	Tundra	—	10.0	—	—	—	—	—
	4	Tundra	—	11.0	—	—	—	—	—
	5	Tundra	—	11.5	—	—	—	—	—
			Sum =	**49.0**		2.66	**0.68**	—	—
			Average =	**9.8**			**0.14**	1.82	0.007
SS156	1	Lake	—	4.0	—	—	1.96	—	—
	2	Lake	—	4.0	—	—	—	—	—
	3	Lake	—	4.0	—	—	—	—	—
	4	Lake	—	4.0	—	—	—	—	—
	5	Lake	—	4.0	—	—	—	—	—
			Sum =	**20.0**		2.24	**0.28**	—	—
			Average =	**4.0**			**0.06**	0.75	0.007
SS157	1	Lake	—	8.0	—	—	1.98	—	—
	2	Lake	—	8.5	—	—	—	—	—
	3	Lake	—	6.5	—	—	—	—	—
	4	Lake	—	8.0	—	—	—	—	—
	5	Lake	—	7.0	—	—	—	—	—
			Sum =	**38.0**		2.58	**0.6**	—	—
			Average =	**7.6**			**0.12**	1.60	0.008
SS162	1	Lake	—	2.5	—	—	1.96	—	—
	2	Lake	—	2.5	—	—	—	—	—
	3	Lake	—	2.5	—	—	—	—	—
	4	Lake	—	3.0	—	—	—	—	—
	5	Lake	—	2.5	—	—	—	—	—
			Sum =	**13.0**		2.16	**0.2**	—	—
			Average =	**2.6**			**0.04**	0.53	0.007

Snow Sample #	Catchement Basin	Sample Type	Lat. (NAD 83)	Long. (NAD 83)
SS152	L9210	Core	N 70° 24' 44.56"	W 150° 55' 52.25"
SS153	L9210	Core	N 70° 24' 47.40"	W 150° 56' 26.33"
SS154	L9210	Core	N 70° 24' 48.46"	W 150° 55' 32.41"
SS155	L9210	Core	N 70° 24' 58.18"	W 150° 55' 37.29"
SS156	L9210	Core	N 70° 24' 45.70"	W 150° 55' 22.0"
SS157	L9210	Core	N 70° 24' 51.79"	W 150° 55' 07.13"
SS158	L9210	Core	N 70° 24' 41.51"	W 150° 55' 00.29"
SS159	L9210	Core	N 70° 24' 40.37"	W 150° 54' 31.24"
SS160	L9210	Core	N 70° 24' 37.09"	W 150° 55' 23.65"
SS161	L9210	Core	N 70° 24' 29.67"	W 150° 55' 15.84"
SS162	L9210	Core	N 70° 24' 38.66"	W 150° 55' 42.36"
SS163	L9210	Core	N 70° 24' 33.34"	W 150° 55' 59.64"
SS164	L9210	Depth	N 70° 24' 42.65"	W 150° 55' 29.44"
SS165	L9210	Depth	N 70° 24' 44.60"	W 150° 55' 30.39"
SS166	L9210	Depth	N 70° 24' 46.55"	W 150° 55' 31.45"
SS167	L9210	Depth	N 70° 24' 50.41"	W 150° 55' 33.36"
SS168	L9210	Depth	N 70° 24' 52.36"	W 150° 55' 34.32"
SS169	L9210	Depth	N 70° 24' 54.31"	W 150° 55' 35.28"
SS170	L9210	Depth	N 70° 24' 56.23"	W 150° 55' 36.34"
SS171	L9210	Depth	N 70° 25' 00.13"	W 150° 55' 38.25"
SS172	L9210	Depth	N 70° 25' 02.04"	W 150° 55' 39.21"
SS173	L9210	Depth	N 70° 24' 44.19"	W 150° 55' 25.72"
SS174	L9210	Depth	N 70° 24' 47.20"	W 150° 55' 18.29"
SS175	L9210	Depth	N 70° 24' 48.74"	W 150° 55' 14.57"
SS176	L9210	Depth	N 70° 24' 50.25"	W 150° 55' 10.85"
SS177	L9210	Depth	N 70° 24' 53.30"	W 150° 55' 03.42"
SS178	L9210	Depth	N 70° 24' 42.42"	W 150° 55' 23.59"
SS179	L9210	Depth	N 70° 24' 42.19"	W 150° 55' 17.84"
SS180	L9210	Depth	N 70° 24' 41.96"	W 150° 55' 11.99"
SS181	L9210	Depth	N 70° 24' 41.74"	W 150° 55' 06.14"
SS182	L9210	Depth	N 70° 24' 41.28"	W 150° 54' 54.54"
SS183	L9210	Depth	N 70° 24' 41.05"	W 150° 54' 48.69"
SS184	L9210	Depth	N 70° 24' 40.82"	W 150° 54' 42.84"
SS185	L9210	Depth	N 70° 24' 40.59"	W 150° 54' 37.09"
SS186	L9210	Depth	N 70° 24' 40.79"	W 150° 55' 27.51"
SS187	L9210	Depth	N 70° 24' 38.96"	W 150° 55' 25.58"
SS188	L9210	Depth	N 70° 24' 35.23"	W 150° 55' 21.63"
SS189	L9210	Depth	N 70° 24' 33.37"	W 150° 55' 19.70"
SS190	L9210	Depth	N 70° 24' 31.50"	W 150° 55' 17.87"
SS191	L9210	Depth	N 70° 24' 41.31"	W 150° 55' 33.81"
SS192	L9210	Depth	N 70° 24' 40.0"	W 150° 55' 38.08"
SS193	L9210	Depth	N 70° 24' 37.32"	W 150° 55' 46.73"
SS194	L9210	Depth	N 70° 24' 35.98"	W 150° 55' 51.0"
SS195	L9210	Depth	N 70° 24' 34.64"	W 150° 55' 55.28"
SS196	L9210	Depth	N 70° 24' 43.13"	W 150° 55' 35.16"
SS197	L9210	Depth	N 70° 24' 43.62"	W 150° 55' 40.79"
SS198	L9210	Depth	N 70° 24' 44.07"	W 150° 55' 46.52"
SS199	L9210	Depth	N 70° 24' 45.04"	W 150° 55' 57.88"
SS200	L9210	Depth	N 70° 24' 45.49"	W 150° 56' 03.61"
SS201	L9210	Depth	N 70° 24' 45.98"	W 150° 56' 09.24"
SS202	L9210	Depth	N 70° 24' 46.46"	W 150° 56' 14.97"
SS203	L9210	Depth	N 70° 24' 46.92"	W 150° 56' 20.70"

Snow Survey Data Sheet

Date: 5/14/2007 | **Start Time:** 9:10 | **End Time:** 11:00 | **Observers:** MTA, EJK

Catchement Basin: M9313 | **Driving Wrench Used:** Yes | **Tube Section Used:** 1

Snow Sample No.	Sample Type	Terrain Type	Snow Depth (in)		Core Length (in)	Tube & Core Weight (lb)	Empty Tube Weight (lb)	Water Equivalent (in)	Density (lb/in^3)
			w/ Dirt Plug	w/o Dirt Plug					
SS344	Core	Lake	8.5	8.5	—	2.12	1.96	2.14	0.009
SS345*	Core	Tundra	—	8.2	—	2.66	1.96	1.87	0.008
SS346*	Core	Lake	—	6.6	—	2.66	1.96	1.87	0.010
SS347	Core	Tundra	11.0	10.5	—	2.12	1.96	2.14	0.007
SS348*	Core	Lake	—	6.2	—	2.46	1.96	1.34	0.008
SS349	Core	Tundra	16.0	15.5	—	2.2	1.96	3.20	0.007
SS350	Core	Tundra	13.5	13.5	—	2.24	1.96	3.74	0.010
SS351*	Core	Lake	—	4.0	—	2.34	1.96	1.01	0.009
SS352	Core	Lake	24.5	24.5	—	2.96	1.96	13.35	0.020
SS353	Core	Tundra	18.0	17.5	—	2.36	1.98	5.07	0.010
SS354	Core	Lake	18.5	18.5	—	2.46	1.96	6.68	0.013
SS355	Core	Tundra	10.0	10.0	—	2.22	1.96	3.47	0.013
SS356	Depth	Lake	—	6.0					
SS357	Depth	Lake	—	8.4					
SS358	Depth	Lake	—	4.8					
SS359	Depth	Lake	—	8.4					
SS360	Depth	Lake	—	6.0					
SS361	Depth	Lake	—	7.8					
SS362	Depth	Lake	—	6.6					
SS363	Depth	Lake	—	9.6					
SS364	Depth	Lake	—	2.4					
SS365	Depth	Lake	—	4.2					
SS366	Depth	Tundra	—	9.6					
SS367	Depth	Tundra	—	11.4					
SS368	Depth	Lake	—	4.8					
SS369	Depth	Lake	—	7.2					
SS370	Depth	Lake	—	4.2					
SS371	Depth	Lake	—	14.4					
SS372	Depth	Lake	—	6.0					
SS373	Depth	Lake	—	6.0					
SS374	Depth	Lake	—	7.2					
SS375	Depth	Lake	—	7.2					
SS376	Depth	Lake	—	7.8					
SS377	Depth	Tundra	—	13.8					
SS378	Depth	Lake	—	3.0					
SS379	Depth	Lake	—	8.4					
SS380	Depth	Lake	—	9.6					
SS381	Depth	Lake	—	2.4					
SS382	Depth	Lake	—	3.6					
SS383	Depth	Lake	—	7.2					
SS384	Depth	Lake	—	16.8					
SS385	Depth	Tundra	—	4.8					
SS386	Depth	Runway	—	—					
SS387	Depth	Runway	—	—					
SS388	Depth	Lake	—	10.8					
SS389	Depth	Lake	—	3.6					
SS390	Depth	Lake	—	4.8					
SS391	Depth	Lake	—	3.0					
SS392	Depth	Lake	—	13.2					
SS393	Depth	Lake	—	15.0					
SS394	Depth	Lake	—	7.2					
SS395	Depth	Lake	—	7.2					
SS396	Depth	Tundra	—	14.4					
SS397	Depth	Tundra	—	13.6					
SS398	Depth	Out of Basin	—	—					
SS399	Depth	Lake	—	5.4					
SS400	Depth	Lake	—	10.8					
SS401	Depth	Tundra	—	4.8					
SS402	Depth	Tundra	—	15.6					

Snow Survey Calculations

Average Area:	Tundra =	3736493	ft^2
	Lake =	6187065	ft^2
Average SWE:	Tundra =	3.02	in
	Lake =	2.50	in
Average Snow Depth:	Tundra =	11.7	in
	Lake =	7.8	in
Average Density:	Tundra =	0.009	lb/in^3
	Lake =	0.011	lb/in^3
Catchement Basin Weighted SWE =		2.69	in

NOTES:

* Pooled sample measurement conducted, snow depth without dirt plug, SWE, and density represents the average of pooled samples.

Pooled Snow Survey Data Sheet									
Date:	5/14/2007		Start Time:	9:10	End Time: 11:00		Observers:	MTA, EJK	
Catchement Basin:		M9313	Driving Wrench Used:		Yes		Tube Section Used:		1
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in)		Core Length (in)	Bucket & Core Weight (lb)	Empty Bucket Weight (lb)	Water Equivalent (in)	Density (lb/in^3)
			w/ Dirt Plug	w/o Dirt Plug					
SS345	1	Tundra	—	8.0	—	—	1.96	—	—
	2	Tundra	—	8.0	—	—	—	—	—
	3	Tundra	—	7.5	—	—	—	—	—
	4	Tundra	—	8.5	—	—	—	—	—
	5	Tundra	—	9.0	—	—	—	—	—
			Sum =	**41.0**		2.66	**0.7**	—	—
			Average =	**8.2**			**0.14**	1.87	0.008
SS346	1	Lake	—	6.5	—	—	1.96	—	—
	2	Lake	—	7.0	—	—	—	—	—
	3	Lake	—	7.0	—	—	—	—	—
	4	Lake	—	6.5	—	—	—	—	—
	5	Lake	—	6.0	—	—	—	—	—
			Sum =	**33.0**		2.66	**0.7**	—	—
			Average =	**6.6**			**0.14**	1.87	0.010
SS348	1	Lake	—	5.5	—	—	1.96	—	—
	2	Lake	—	6.5	—	—	—	—	—
	3	Lake	—	7.0	—	—	—	—	—
	4	Lake	—	6.5	—	—	—	—	—
	5	Lake	—	5.5	—	—	—	—	—
			Sum =	**31.0**		2.46	**0.5**	—	—
			Average =	**6.2**			**0.10**	1.34	0.008
SS351	1	Lake	—	4.0	—	—	1.96	—	—
	2	Lake	—	4.0	—	—	—	—	—
	3	Lake	—	4.0	—	—	—	—	—
	4	Lake	—	4.0	—	—	—	—	—
	5	Lake	—	4.0	—	—	—	—	—
			Sum =	**20.0**		2.34	**0.38**	—	—
			Average =	**4.0**			**0.08**	1.01	0.009

Snow Sample #	Catchement Basin	Sample Type	Lat. (NAD 83)	Long. (NAD 83)
SS344	M9313	Core	N 70° 25' 23.90"	W 150° 53' 46.32"
SS345	M9313	Core	N 70° 25' 21.80"	W 150° 53' 29.78"
SS346	M9313	Core	N 70° 25' 18.37"	W 150° 53' 57.10"
SS347	M9313	Core	N 70° 25' 06.91"	W 150° 53' 48.75"
SS348	M9313	Core	N 70° 25' 16.96"	W 150° 54' 14.20"
SS349	M9313	Core	N 70° 25' 04.25"	W 150° 54' 30.14"
SS350	M9313	Core	N 70° 25' 26.98"	W 150° 54' 31.95"
SS351	M9313	Core	N 70° 25' 26.39"	W 150° 54' 14.38"
SS352	M9313	Core	N 70° 25' 35.57"	W 150° 54' 09.58"
SS353	M9313	Core	N 70° 25' 50.88"	W 150° 54' 20.53"
SS354	M9313	Core	N 70° 25' 30.48"	W 150° 53' 51.23"
SS355	M9313	Core	N 70° 25' 36.44"	W 150° 53' 35.97"
SS356	M9313	Depth	N 70° 25' 26.0"	W 150° 54' 02.77"
SS357	M9313	Depth	N 70° 25' 27.92"	W 150° 54' 04.11"
SS358	M9313	Depth	N 70° 25' 29.84"	W 150° 54' 05.45"
SS359	M9313	Depth	N 70° 25' 31.76"	W 150° 54' 06.80"
SS360	M9313	Depth	N 70° 25' 33.65"	W 150° 54' 08.24"
SS361	M9313	Depth	N 70° 25' 37.49"	W 150° 54' 10.93"
SS362	M9313	Depth	N 70° 25' 39.38"	W 150° 54' 12.27"
SS363	M9313	Depth	N 70° 25' 41.30"	W 150° 54' 13.71"
SS364	M9313	Depth	N 70° 25' 43.22"	W 150° 54' 15.06"
SS365	M9313	Depth	N 70° 25' 45.14"	W 150° 54' 16.40"
SS366	M9313	Depth	N 70° 25' 47.03"	W 150° 54' 17.75"
SS367	M9313	Depth	N 70° 25' 48.95"	W 150° 54' 19.19"
SS368	M9313	Depth	N 70° 25' 27.50"	W 150° 53' 58.86"
SS369	M9313	Depth	N 70° 25' 28.97"	W 150° 53' 55.04"
SS370	M9313	Depth	N 70° 25' 31.95"	W 150° 53' 47.42"
SS371	M9313	Depth	N 70° 25' 33.46"	W 150° 53' 43.60"
SS372	M9313	Depth	N 70° 25' 34.97"	W 150° 53' 39.78"
SS373	M9313	Depth	N 70° 25' 25.32"	W 150° 53' 57.25"
SS374	M9313	Depth	N 70° 25' 24.61"	W 150° 53' 51.74"
SS375	M9313	Depth	N 70° 25' 23.22"	W 150° 53' 40.80"
SS376	M9313	Depth	N 70° 25' 22.51"	W 150° 53' 35.29"
SS377	M9313	Depth	N 70° 25' 21.12"	W 150° 53' 24.36"
SS378	M9313	Depth	N 70° 25' 24.11"	W 150° 54' 01.32"
SS379	M9313	Depth	N 70° 25' 22.18"	W 150° 53' 59.89"
SS380	M9313	Depth	N 70° 25' 20.26"	W 150° 53' 58.54"
SS381	M9313	Depth	N 70° 25' 16.45"	W 150° 53' 55.76"
SS382	M9313	Depth	N 70° 25' 14.53"	W 150° 53' 54.32"
SS383	M9313	Depth	N 70° 25' 12.64"	W 150° 53' 52.97"
SS384	M9313	Depth	N 70° 25' 10.72"	W 150° 53' 51.53"
SS385	M9313	Depth	N 70° 25' 08.80"	W 150° 53' 50.19"
SS386	M9313	Depth	N 70° 25' 04.99"	W 150° 53' 47.41"
SS387	M9313	Depth	N 70° 25' 03.06"	W 150° 53' 45.97"
SS388	M9313	Depth	N 70° 25' 24.18"	W 150° 54' 04.98"
SS389	M9313	Depth	N 70° 25' 22.37"	W 150° 54' 07.28"
SS390	M9313	Depth	N 70° 25' 20.58"	W 150° 54' 09.58"
SS391	M9313	Depth	N 70° 25' 18.77"	W 150° 54' 11.89"
SS392	M9313	Depth	N 70° 25' 15.14"	W 150° 54' 16.40"
SS393	M9313	Depth	N 70° 25' 13.33"	W 150° 54' 18.71"
SS394	M9313	Depth	N 70° 25' 11.51"	W 150° 54' 21.02"
SS395	M9313	Depth	N 70° 25' 09.70"	W 150° 54' 23.32"
SS396	M9313	Depth	N 70° 25' 07.88"	W 150° 54' 25.62"
SS397	M9313	Depth	N 70° 25' 06.07"	W 150° 54' 27.83"
SS398	M9313	Depth	N 70° 25' 02.44"	W 150° 54' 32.44"
SS399	M9313	Depth	N 70° 25' 26.19"	W 150° 54' 08.53"
SS400	M9313	Depth	N 70° 25' 26.58"	W 150° 54' 20.24"
SS401	M9313	Depth	N 70° 25' 26.78"	W 150° 54' 26.09"
SS402	M9313	Depth	N 70° 25' 27.17"	W 150° 54' 37.71"

Snow Survey Data Sheet

Date: 5/11/2007	**Start Time:** 9:30	**End Time:** 12:48	**Observers:** MTA, EJK		
Catchement Basin: L9327	**Driving Wrench Used:** Yes		**Tube Section Used:** 1		

Snow Sample No.	Sample Type	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Core Length (in)	Tube & Core Weight (lb)	Empty Tube Weight (lb)	Water Equivalent (in)	Density (lb/in^3)
SS204	Core	Tundra	18.0	17.4	—	2.34	1.96	5.07	0.011
SS205*	Core	Lake	—	5.5	—	2.44	1.94	1.34	0.009
SS206*	Core	Tundra	—	11.5	—	2.9	2.0	2.40	0.008
SS207	Core	Lake	8.4	8.4	—	2.16	1.98	2.40	0.010
SS208*	Core	Lake	—	7.1	—	2.4	1.96	1.17	0.006
SS209*	Core	Tundra	—	8.9	—	2.13	1.96	0.45	0.002
SS210*	Core	Tundra	—	8.8	—	2.3	1.96	0.91	0.004
SS211*	Core	Lake	—	3.4	—	2.24	1.94	0.80	0.009
SS212*	Core	Lake	—	5.3	—	2.28	1.96	0.85	0.006
SS213*	Core	Tundra	—	10.4	—	2.24	1.96	0.75	0.003
SS214	Core	Tundra	12.6	12.6	—	2.3	1.96	4.54	0.013
SS215	Core	Tundra	22.0	21.5	—	2.42	1.96	6.14	0.010
SS216*	Core	Lake	—	9.1	—	2.8	1.98	2.19	0.009
SS217	Core	Tundra	25.2	24.0	—	2.26	1.94	4.27	0.006
SS218	Depth	Lake	—	12.6					
SS219	Depth	Lake	—	5.4					
SS220	Depth	Lake	—	4.8					
SS221	Depth	Lake	—	3.6					
SS222	Depth	Lake	—	6.6					
SS223	Depth	Lake	—	3.0					
SS224	Depth	Lake	—	18.0					
SS225	Depth	Lake	—	6.0					
SS226	Depth	Lake	—	4.8					
SS227	Depth	Lake	—	5.4					
SS228	Depth	Tundra	—	12.0					
SS229	Depth	Tundra	—	15.6					
SS230	Depth	Tundra	—	9.0					
SS231	Depth	Tundra	—	14.4					
SS232	Depth	Tundra	—	14.4					
SS233	Depth	Tundra	—	6.6					
SS234	Depth	Lake	—	4.8					
SS235	Depth	Lake	—	5.4					
SS236	Depth	Lake	—	3.6					
SS237	Depth	Lake	—	6.0					
SS238	Depth	Lake	—	6.6					
SS239	Depth	Lake	—	13.2					
SS240	Depth	Lake	—	4.2					
SS241	Depth	Lake	—	6.6					
SS242	Depth	Lake	—	6.0					
SS243	Depth	Lake	—	3.6					
SS244	Depth	Lake	—	3.6					
SS245	Depth	Lake	—	4.8					
SS246	Depth	Tundra	—	14.4					
SS247	Depth	Tundra	—	14.4					
SS248	Depth	Tundra	—	8.4					
SS249	Depth	Tundra	—	10.8					
SS250	Depth	Tundra	—	10.8					
SS251	Depth	Tundra	—	7.2					
SS252	Depth	Tundra	—	6.0					
SS253	Depth	Tundra	—	12.0					
SS254	Depth	Tundra	—	15.6					
SS255	Depth	Tundra	—	6.0					
SS256	Depth	Tundra	—	9.6					
SS257	Depth	Tundra	—	15.0					
SS258	Depth	Tundra	—	19.2					
SS259	Depth	Lake	—	4.8					
SS260	Depth	Lake	—	7.2					
SS261	Depth	Lake	—	6.0					
SS262	Depth	Lake	—	4.8					
SS263	Depth	Lake	—	3.6					
SS264	Depth	Lake	—	2.4					
SS265	Depth	Lake	—	3.6					
SS266	Depth	Lake	—	4.8					
SS267	Depth	Lake	—	2.4					
SS268	Depth	Lake	—	3.6					
SS269	Depth	Lake	—	2.4					
SS270	Depth	Lake	—	3.6					
SS271	Depth	Tundra	—	17.4					
SS272	Depth	Tundra	—	18.6					
SS273	Depth	Lake	—	6.6					
SS274	Depth	Lake	—	3.0					
SS275	Depth	Lake	—	5.4					
SS276	Depth	Lake	—	4.8					
SS277	Depth	Lake	—	6.0					
SS278	Depth	Lake	—	2.4					
SS279	Depth	Lake	—	7.2					
SS280	Depth	Lake	—	5.4					
SS281	Depth	Lake	—	3.0					
SS282	Depth	Lake	—	6.6					

Snow Survey Calculations

Average Area:	Tundra =	8900252.87	ft^2
	Lake =	9710027.06	ft^2
Average SWE:	Tundra =	2.49	in
	Lake =	1.23	in
Average Snow Depth:	Tundra =	12.8	in
	Lake =	5.5	in
Average Density:	Tundra =	0.007	lb/in^3
	Lake =	0.008	lb/in^3
Catchement Basin Weighted SWE =		1.83	in

NOTES:

* Pooled sample measurement conducted, snow depth without dirt plug, SWE, and density represents the average of pooled samples.

Pooled Snow Survey Data Sheet										
Date:	5/11/2007		**Start Time:**	9:30	**End Time:**	12:48	**Observers:**	MTA, EJK		
Catchement Basin:		L9327	**Driving Wrench Used:**		Yes		**Tube Section Used:**			1
Snow Sample No.	**Pooled Sample #**	**Terrain Type**	**Snow Depth (in)**		**Core Length (in)**	**Bucket & Core Weight (lb)**	**Empty Bucket Weight (lb)**	**Water Equivalent (in)**	**Density (lb/in^3)**	
			w/ Dirt Plug	**w/o Dirt Plug**						
SS205	1	Lake	—	5.4	—	—	1.94	—	—	
	2	Lake	—	4.8	—	—	—	—	—	
	3	Lake	—	5.4	—	—	—	—	—	
	4	Lake	—	6.0	—	—	—	—	—	
	5	Lake	—	6.0	—	—	—	—	—	
			Sum =	**27.6**		2.44	**0.5**	—	—	
			Average =	**5.5**			**0.10**	1.34	0.009	
SS206	1	Tundra	13.5	11.5	—	—	2	—	—	
	2	Tundra	12	11.5	—	—	—	—	—	
	3	Tundra	13	11.5	—	—	—	—	—	
	4	Tundra	13	11.5	—	—	—	—	—	
	5	Tundra	12.5	11.5	—	—	—	—	—	
			Sum =	**57.5**		2.9	**0.9**	—	—	
			Average =	**11.5**			**0.18**	2.40	0.008	
SS208	1	Lake	—	7.2	—	—	1.96	—	—	
	2	Lake	—	8.4	—	—	—	—	—	
	3	Lake	—	6.0	—	—	—	—	—	
	4	Lake	—	6.6	—	—	—	—	—	
	5	Lake	—	7.2	—	—	—	—	—	
			Sum =	**35.4**		2.4	**0.44**	—	—	
			Average =	**7.1**			**0.09**	1.17	0.006	
SS209	1	Tundra	—	8.4	—	—	1.96	—	—	
	2	Tundra	—	8.4	—	—	—	—	—	
	3	Tundra	—	8.4	—	—	—	—	—	
	4	Tundra	—	9.6	—	—	—	—	—	
	5	Tundra	—	9.6	—	—	—	—	—	
			Sum =	**44.4**		2.3	**0.34**	—	—	
			Average =	**8.9**			**0.07**	0.91	0.004	
SS210	1	Tundra	—	7.8	—	—	1.96	—	—	
	2	Tundra	—	8.4	—	—	—	—	—	
	3	Tundra	—	8.4	—	—	—	—	—	
	4	Tundra	—	9.6	—	—	—	—	—	
	5	Tundra	—	9.6	—	—	—	—	—	
			Sum =	**43.8**		2.3	**0.34**	—	—	
			Average =	**8.8**			**0.07**	0.91	0.004	
SS211	1	Lake	—	3.0	—	—	1.94	—	—	
	2	Lake	—	3.0	—	—	—	—	—	
	3	Lake	—	3.6	—	—	—	—	—	
	4	Lake	—	3.6	—	—	—	—	—	
	5	Lake	—	3.6	—	—	—	—	—	
			Sum =	**16.8**		2.24	**0.3**	—	—	
			Average =	**3.4**			**0.06**	0.80	0.009	
SS112	1	Lake	—	4.8	—	—	1.96	—	—	
	2	Lake	—	4.8	—	—	—	—	—	
	3	Lake	—	4.8	—	—	—	—	—	
	4	Lake	—	7.8	—	—	—	—	—	
	5	Lake	—	4.2	—	—	—	—	—	
			Sum =	**26.4**		2.28	**0.32**	—	—	
			Average =	**5.3**			**0.06**	0.85	0.006	
SS213	1	Tundra	—	9.0	—	—	1.96	—	—	
	2	Tundra	—	7.8	—	—	—	—	—	
	3	Tundra	—	9.6	—	—	—	—	—	
	4	Tundra	—	12.6	—	—	—	—	—	
	5	Tundra	—	13.2	—	—	—	—	—	
			Sum =	**52.2**		2.44	**0.48**	—	—	
			Average =	**10.4**			**0.10**	1.28	0.004	
SS216	1	Lake	—	10.8	—	—	1.98	—	—	
	2	Lake	—	10.8	—	—	—	—	—	
	3	Lake	—	9.6	—	—	—	—	—	
	4	Lake	—	7.2	—	—	—	—	—	
	5	Lake	—	7.2	—	—	—	—	—	
			Sum =	**45.6**		2.8	**0.82**	—	—	
			Average =	**9.1**			**0.16**	2.19	0.009	

Snow Sample #	Catchement Basin	Sample Type	Lat. (NAD 83)	Long. (NAD 83)
SS204	L9327	Core	N 70° 15' 45.07"	W 150° 56' 48.65"
SS205	L9327	Core	N 70° 15' 47.68"	W 150° 56' 14.56"
SS206	L9327	Core	N 70° 16' 04.11"	W 150° 55' 59.53"
SS207	L9327	Core	N 70° 15' 57.44"	W 150° 55' 47.20"
SS208	L9327	Core	N 70° 15' 53.22"	W 150° 55' 25.74"
SS209	L9327	Core	N 70° 16' 01.87"	W 150° 54' 53.99"
SS210	L9327	Core	N 70° 15' 47.99"	W 150° 54' 07.90"
SS211	L9327	Core	N 70° 15' 49.31"	W 150° 54' 48.48"
SS212	L9327	Core	N 70° 15' 45.16"	W 150° 55' 18.43"
SS213	L9327	Core	N 70° 15' 38.21"	W 150° 54' 57.92"
SS214	L9327	Core	N 70° 15' 34.98"	W 150° 54' 19.36"
SS215	L9327	Core	N 70° 15' 38.14"	W 150° 54' 04.61"
SS216	L9327	Core	N 70° 15' 42.19"	W 150° 55' 49.22"
SS217	L9327	Core	N 70° 15' 33.64"	W 150° 56' 03.55"
SS218	L9327	Depth	N 70° 15' 50.75"	W 150° 55' 34.88"
SS219	L9327	Depth	N 70° 15' 52.43"	W 150° 55' 37.96"
SS220	L9327	Depth	N 70° 15' 54.11"	W 150° 55' 41.04"
SS221	L9327	Depth	N 70° 15' 55.76"	W 150° 55' 44.12"
SS222	L9327	Depth	N 70° 15' 59.09"	W 150° 55' 50.29"
SS223	L9327	Depth	N 70° 16' 00.78"	W 150° 55' 53.37"
SS224	L9327	Depth	N 70° 16' 02.43"	W 150° 55' 56.45"
SS225	L9327	Depth	N 70° 15' 51.99"	W 150° 55' 30.36"
SS226	L9327	Depth	N 70° 15' 54.46"	W 150° 55' 21.22"
SS227	L9327	Depth	N 70° 15' 55.70"	W 150° 55' 16.70"
SS228	L9327	Depth	N 70° 15' 56.94"	W 150° 55' 12.08"
SS229	L9327	Depth	N 70° 15' 58.15"	W 150° 55' 07.66"
SS230	L9327	Depth	N 70° 15' 59.39"	W 150° 55' 03.13"
SS231	L9327	Depth	N 70° 16' 00.63"	W 150° 54' 58.52"
SS232	L9327	Depth	N 70° 16' 03.08"	W 150° 54' 49.48"
SS233	L9327	Depth	N 70° 16' 04.32"	W 150° 54' 44.95"
SS234	L9327	Depth	N 70° 15' 50.58"	W 150° 55' 29.07"
SS235	L9327	Depth	N 70° 15' 50.39"	W 150° 55' 23.26"
SS236	L9327	Depth	N 70° 15' 50.22"	W 150° 55' 17.44"
SS237	L9327	Depth	N 70° 15' 50.03"	W 150° 55' 11.63"
SS238	L9327	Depth	N 70° 15' 49.83"	W 150° 55' 05.92"
SS239	L9327	Depth	N 70° 15' 49.67"	W 150° 55' 00.11"
SS240	L9327	Depth	N 70° 15' 49.47"	W 150° 54' 54.30"
SS241	L9327	Depth	N 70° 15' 49.11"	W 150° 54' 42.67"
SS242	L9327	Depth	N 70° 15' 48.91"	W 150° 54' 36.86"
SS243	L9327	Depth	N 70° 15' 48.75"	W 150° 54' 31.15"
SS244	L9327	Depth	N 70° 15' 48.55"	W 150° 54' 25.34"
SS245	L9327	Depth	N 70° 15' 48.36"	W 150° 54' 19.53"
SS246	L9327	Depth	N 70° 15' 48.19"	W 150° 54' 13.71"
SS247	L9327	Depth	N 70° 15' 47.83"	W 150° 54' 02.09"
SS248	L9327	Depth	N 70° 15' 40.22"	W 150° 53' 54.75"
SS249	L9327	Depth	N 70° 15' 39.18"	W 150° 53' 59.73"
SS250	L9327	Depth	N 70° 15' 37.06"	W 150° 54' 09.50"
SS251	L9327	Depth	N 70° 15' 36.02"	W 150° 54' 14.48"
SS252	L9327	Depth	N 70° 15' 33.91"	W 150° 54' 24.25"
SS253	L9327	Depth	N 70° 15' 32.87"	W 150° 54' 29.23"
SS254	L9327	Depth	N 70° 15' 35.40"	W 150° 54' 49.80"
SS255	L9327	Depth	N 70° 15' 36.80"	W 150° 54' 53.86"
SS256	L9327	Depth	N 70° 15' 39.58"	W 150° 55' 02.08"
SS257	L9327	Depth	N 70° 15' 40.98"	W 150° 55' 06.15"
SS258	L9327	Depth	N 70° 15' 42.39"	W 150° 55' 10.21"
SS259	L9327	Depth	N 70° 15' 43.79"	W 150° 55' 14.37"
SS260	L9327	Depth	N 70° 15' 46.57"	W 150° 55' 22.59"
SS261	L9327	Depth	N 70° 15' 47.97"	W 150° 55' 26.65"
SS262	L9327	Depth	N 70° 15' 49.37"	W 150° 55' 30.72"
SS263	L9327	Depth	N 70° 15' 49.04"	W 150° 55' 37.73"
SS264	L9327	Depth	N 70° 15' 47.32"	W 150° 55' 40.58"
SS265	L9327	Depth	N 70° 15' 45.61"	W 150° 55' 43.42"
SS266	L9327	Depth	N 70° 15' 43.90"	W 150° 55' 46.37"
SS267	L9327	Depth	N 70° 15' 40.48"	W 150° 55' 52.06"
SS268	L9327	Depth	N 70° 15' 38.77"	W 150° 55' 54.91"
SS269	L9327	Depth	N 70° 15' 37.06"	W 150° 55' 57.76"
SS270	L9327	Depth	N 70° 15' 35.35"	W 150° 56' 00.70"
SS271	L9327	Depth	N 70° 15' 44.65"	W 150° 56' 54.33"
SS272	L9327	Depth	N 70° 15' 45.52"	W 150° 56' 42.97"
SS273	L9327	Depth	N 70° 15' 45.94"	W 150° 56' 37.29"
SS274	L9327	Depth	N 70° 15' 46.39"	W 150° 56' 31.61"
SS275	L9327	Depth	N 70° 15' 46.81"	W 150° 56' 25.93"
SS276	L9327	Depth	N 70° 15' 47.26"	W 150° 56' 20.24"
SS277	L9327	Depth	N 70° 15' 48.13"	W 150° 56' 08.88"
SS278	L9327	Depth	N 70° 15' 48.58"	W 150° 56' 03.19"
SS279	L9327	Depth	N 70° 15' 49.01"	W 150° 55' 57.61"
SS280	L9327	Depth	N 70° 15' 49.46"	W 150° 55' 51.93"
SS281	L9327	Depth	N 70° 15' 49.88"	W 150° 55' 46.24"
SS282	L9327	Depth	N 70° 15' 50.33"	W 150° 55' 40.56"

Snow Survey Data Sheet

Date: 5/14/2007 | **Start Time:** 16:40 | **End Time:** 17:55 | **Observers:** MTA, EJK

Catchement Basin: L9906 | **Driving Wrench Used:** Yes | **Tube Section Used:** 1

Snow Sample No.	Sample Type	Terrain Type	Snow Depth (in)		Core Length (in)	Tube & Core Weight (lb)	Empty Tube Weight (lb)	Water Equivalent (in)	Density (lb/in^3)
			w/ Dirt Plug	w/o Dirt Plug					
SS283*	Core	Lake	—	4.6	—	2.32	1.96	0.96	0.008
SS284	Core	Tundra	24.5	23.5	—	2.46	1.96	6.68	0.010
SS285*	Core	Lake	—	4.6	—	2.36	1.96	1.07	0.008
SS286	Core	Tundra	15.0	14.5	—	2.26	1.96	4.01	0.010
SS287*	Core	Lake	—	5.0	—	2.36	1.96	1.07	0.008
SS288	Core	Tundra	11.0	10.0	—	2.1	1.96	1.87	0.007
SS289*	Core	Lake	—	5.9	—	2.68	1.96	1.92	0.012
SS290	Core	Tundra	10.0	10.0	—	2.22	1.96	3.47	0.013
SS291	Core	Tundra	17.5	16.5	—	2.44	1.96	6.41	0.014
SS292	Core	Tundra	9.0	9.0	—	2.14	1.96	2.40	0.010
SS293*	Core	Tundra	—	10.7	—	2.38	1.96	1.12	0.004
SS294	Core	Tundra	10.0	9.0	—	2.12	1.96	2.14	0.009
SS295*	Core	Tundra	—	8.2	—	2.52	1.96	1.50	0.007
SS296	Core	Lake	7.0	7.0	—	2.12	1.96	2.14	0.011
SS297	Depth	Lake	—	2.4					
SS298	Depth	Lake	—	3.6					
SS299	Depth	Lake	—	3.6					
SS300	Depth	Tundra	—	13.2					
SS301	Depth	Lake	—	2.4					
SS302	Depth	Tundra	—	10.2					
SS303	Depth	Tundra	—	10.2					
SS304	Depth	Tundra	—	6.0					
SS305	Depth	Lake	—	5.4					
SS306	Depth	Tundra	—	9.0					
SS307	Depth	Tundra	—	10.2					
SS308	Depth	Lake	—	5.4					
SS309	Depth	Lake	—	9.0					
SS310	Depth	Tundra	—	8.4					
SS311	Depth	Tundra	—	6.0					
SS312	Depth	Tundra	—	8.4					
SS313	Depth	Tundra	—	7.2					
SS314	Depth	Tundra	—	7.2					
SS315	Depth	Tundra	—	12.0					
SS316	Depth	Tundra	—	20.4					
SS317	Depth	Tundra	—	6.6					
SS318	Depth	Tundra	—	10.8					

Snow Survey Calculations

Average Area:	Tundra =	2565196	ft^2
	Lake =	812963	ft^2
Average SWE:	Tundra =	2.71	in
	Lake =	1.26	in
Average Snow Depth:	Tundra =	10.7	in
	Lake =	4.9	in
Average Density:	Tundra =	0.009	lb/in^3
	Lake =	0.009	lb/in^3
Catchement Basin Weighted SWE =		2.36	in

NOTES:

* Pooled sample measurement conducted, snow depth without dirt plug, SWE, and density represents the average of pooled samples.

Pooled Snow Survey Data Sheet									
Date: 5/14/2007			Start Time: 16:40		End Time: 17:55		Observers: MTA, EJK		
Catchement Basin: L9906			Driving Wrench Used: Yes				Tube Section Used: 1		
Snow Sample No.	Pooled Sample #	Terrain Type	Snow Depth (in)		Core Length (in)	Bucket & Core Weight (lb)	Empty Bucket Weight (lb)	Water Equivalent (in)	Density (lb/in^3)
			w/ Dirt Plug	w/o Dirt Plug					
SS283	1	Lake	—	3.5	—	—	1.96	—	—
	2	Lake	—	4.0	—	—	—	—	—
	3	Lake	—	4.0	—	—	—	—	—
	4	Lake	—	5.5	—	—	—	—	—
	5	Lake	—	6.0	—	—	—	—	—
			Sum =	**23.0**		2.32	**0.36**	—	—
			Average =	**4.6**			**0.07**	0.96	0.008
SS285	1	Lake	—	4.0	—	—	1.96	—	—
	2	Lake	—	4.5	—	—	—	—	—
	3	Lake	—	4.5	—	—	—	—	—
	4	Lake	—	5.0	—	—	—	—	—
	5	Lake	—	5.0	—	—	—	—	—
			Sum =	**23.0**		2.36	**0.4**	—	—
			Average =	**4.6**			**0.08**	1.07	0.008
SS287	1	Lake	—	5.0	—	—	1.96	—	—
	2	Lake	—	5.0	—	—	—	—	—
	3	Lake	—	5.0	—	—	—	—	—
	4	Lake	—	5.0	—	—	—	—	—
	5	Lake	—	5.0	—	—	—	—	—
			Sum =	**25.0**		2.36	**0.4**	—	—
			Average =	**5.0**			**0.08**	1.07	0.008
SS289	1	Lake	—	4.5	—	—	1.96	—	—
	2	Lake	—	4.5	—	—	—	—	—
	3	Lake	—	6.0	—	—	—	—	—
	4	Lake	—	6.0	—	—	—	—	—
	5	Lake	—	8.5	—	—	—	—	—
			Sum =	**29.5**		2.68	**0.72**	—	—
			Average =	**5.9**			**0.14**	1.92	0.012
SS293	1	Tundra	10	9.5	—	—	1.96	—	—
	2	Tundra	11	10.0	—	—	—	—	—
	3	Tundra	12	11.0	—	—	—	—	—
	4	Tundra	12	11.0	—	—	—	—	—
	5	Tundra	13	12.0	—	—	—	—	—
			Sum =	**53.5**		2.38	**0.42**	—	—
			Average =	**10.7**			**0.08**	1.12	0.004
SS295	1	Tundra	7.5	7.0	—	—	1.96	—	—
	2	Tundra	8	8.0	—	—	—	—	—
	3	Tundra	8	8.0	—	—	—	—	—
	4	Tundra	9	8.5	—	—	—	—	—
	5	Tundra	10	9.5	—	—	—	—	—
			Sum =	**41.0**		2.52	**0.56**	—	—
			Average =	**8.2**			**0.11**	1.50	0.007

Snow Sample #	Catchement Basin	Sample Type	Lat. (NAD 83)	Long. (NAD 83)
SS283	L9906	Core	N 70° 24' 00.70"	W 150° 55' 06.96"
SS284	L9906	Core	N 70° 24' 02.48"	W 150° 55' 04.47"
SS285	L9906	Core	N 70° 23' 58.75"	W 150° 54' 57.73"
SS286	L9906	Core	N 70° 23' 58.58"	W 150° 54' 46.01"
SS287	L9906	Core	N 70° 23' 55.77"	W 150° 55' 02.46"
SS288	L9906	Core	N 70° 23' 52.59"	W 150° 54' 55.47"
SS289	L9906	Core	N 70° 23' 57.64"	W 150° 55' 13.91"
SS290	L9906	Core	N 70° 23' 55.10"	W 150° 55' 22.82"
SS291	L9906	Core	N 70° 23' 50.32"	W 150° 55' 19.85"
SS292	L9906	Core	N 70° 23' 49.18"	W 150° 55' 02.65"
SS293	L9906	Core	N 70° 23' 45.25"	W 150° 55' 08.82"
SS294	L9906	Core	N 70° 23' 44.57"	W 150° 54' 57.25"
SS295	L9906	Core	N 70° 24' 03.51"	W 150° 55' 35.34"
SS296	L9906	Core	N 70° 24' 00.75"	W 150° 55' 19.75"
SS297	L9906	Depth	N 70° 23' 58.92"	W 150° 55' 09.45"
SS298	L9906	Depth	N 70° 23' 58.82"	W 150° 55' 03.59"
SS299	L9906	Depth	N 70° 23' 58.65"	W 150° 54' 51.87"
SS300	L9906	Depth	N 70° 23' 58.48"	W 150° 54' 40.15"
SS301	L9906	Depth	N 70° 23' 57.33"	W 150° 55' 05.95"
SS302	L9906	Depth	N 70° 23' 54.18"	W 150° 54' 58.96"
SS303	L9906	Depth	N 70° 23' 51.03"	W 150° 54' 51.88"
SS304	L9906	Depth	N 70° 23' 49.44"	W 150° 54' 48.39"
SS305	L9906	Depth	N 70° 23' 56.37"	W 150° 55' 18.37"
SS306	L9906	Depth	N 70° 23' 53.79"	W 150° 55' 27.29"
SS307	L9906	Depth	N 70° 23' 52.52"	W 150° 55' 31.74"
SS308	L9906	Depth	N 70° 23' 59.82"	W 150° 55' 14.65"
SS309	L9906	Depth	N 70° 24' 01.68"	W 150° 55' 24.94"
SS310	L9906	Depth	N 70° 24' 02.58"	W 150° 55' 30.14"
SS311	L9906	Depth	N 70° 23' 50.71"	W 150° 55' 25.68"
SS312	L9906	Depth	N 70° 23' 51.06"	W 150° 55' 31.41"
SS313	L9906	Depth	N 70° 23' 49.96"	W 150° 55' 14.11"
SS314	L9906	Depth	N 70° 23' 49.57"	W 150° 55' 08.38"
SS315	L9906	Depth	N 70° 23' 48.82"	W 150° 54' 56.91"
SS316	L9906	Depth	N 70° 23' 48.43"	W 150° 54' 51.09"
SS317	L9906	Depth	N 70° 23' 44.92"	W 150° 55' 02.99"
SS318	L9906	Depth	N 70° 23' 45.57"	W 150° 55' 14.56"

Snow Survey Data Sheet

Date: 5/14/2007	**Start Time:** 15:50	**End Time:** 16:30	**Observers:** MTA, EJK
Catchement Basin: L9908	**Driving Wrench Used:** Yes		**Tube Section Used:** 1

Snow Sample No.	Sample Type	Terrain Type	Snow Depth (in)		Core Length (in)	Tube & Core Weight (lb)	Empty Tube Weight (lb)	Water Equivalent (in)	Density (lb/in^3)
			w/ Dirt Plug	w/o Dirt Plug					
SS319*	Core	Lake	—	3.0	—	2.16	1.98	0.48	0.006
SS320	Core	Tundra	17.0	17.0	—	2.26	1.96	4.01	0.009
SS321*	Core	Lake	—	4.6	—	2.32	1.98	0.91	0.007
SS322	Core	Tundra	10.5	10.5	—	2.14	1.96	2.40	0.008
SS323*	Core	Tundra	—	5.0	—	2.38	1.96	1.12	0.008
SS324*	Core	Lake	—	1.9	—	2.32	1.98	0.91	0.017
SS325*	Core	Lake	—	2.7	—	2.14	1.96	0.48	0.006
SS326	Core	Tundra	9.5	9.0	—	2.12	1.96	2.14	0.009
SS327	Core	Lake	19.0	19.0	—	2.42	1.96	6.14	0.012
SS328	Core	Tundra	15.0	13.5	—	2.12	1.96	2.14	0.006
SS329	Depth	Tundra	—	8.4					
SS330	Depth	Tundra	—	6.6					
SS331	Depth	Tundra	—	10.2					
SS332	Depth	Lake	—	8.4					
SS333	Depth	Lake	—	2.4					
SS334	Depth	Tundra	—	10.8					
SS335	Depth	Tundra	—	9.0					
SS336	Depth	Tundra	—	4.2					
SS337	Depth	Lake	—	2.4					
SS338	Depth	Lake	—	8.4					
SS339	Depth	Tundra	—	7.2					
SS340	Depth	Tundra	—	9.6					
SS341	Depth	Lake	—	31.2					
SS342	Depth	Lake	—	15.0					
SS343	Depth	Tundra	—	18.0					

Snow Survey Calculations

Average Area:	Tundra =	561711	ft^2
	Lake =	454964	ft^2
Average SWE:	Tundra =	2.15	in
	Lake =	2.41	in
Average Snow Depth:	Tundra =	9.9	in
	Lake =	9.0	in
Average Density:	Tundra =	0.008	lb/in^3
	Lake =	0.010	lb/in^3
Catchement Basin Weighted SWE =		2.27	in

NOTES: SS341& SS327 bank drifts - representative of narrow lake
* Pooled sample measurement conducted, snow depth without dirt plug, SWE, and density represents the average of pooled samples.

Pooled Snow Survey Data Sheet									
Date:	5/14/2007		**Start Time:**	15:50	**End Time:**	16:30	**Observers:**	MTA, EJK	
Catchement Basin:		L9908	**Driving Wrench Used:**		Yes		**Tube Section Used:**		1
Snow Sample No.	**Pooled Sample #**	**Terrain Type**	**Snow Depth (in)**		**Core Length (in)**	**Bucket & Core Weight (lb)**	**Empty Bucket Weight (lb)**	**Water Equivalent (in)**	**Density (lb/in^3)**
			w/ Dirt Plug	**w/o Dirt Plug**					
SS319	1	Lake	—	3.0	—	—	1.98	—	—
	2	Lake	—	3.0	—	—	—	—	—
	3	Lake	—	3.0	—	—	—	—	—
	4	Lake	—	3.0	—	—	—	—	—
	5	Lake	—	3.0	—	—	—	—	—
			Sum =	**15.0**		2.16	**0.18**	—	—
			Average =	**3.0**			**0.04**	0.48	0.006
SS321	1	Lake	—	6.0	—	—	1.98	—	—
	2	Lake	—	5.5	—	—	—	—	—
	3	Lake	—	4.0	—	—	—	—	—
	4	Lake	—	3.5	—	—	—	—	—
	5	Lake	—	4.0	—	—	—	—	—
			Sum =	**23.0**		2.32	**0.34**	—	—
			Average =	**4.6**			**0.07**	0.91	0.007
SS323	1	Tundra	5	4.0	—	—	1.96	—	—
	2	Tundra	8	7.0	—	—	—	—	—
	3	Tundra	6	7.0	—	—	—	—	—
	4	Tundra	3	2.5	—	—	—	—	—
	5	Tundra	5.5	4.5	—	—	—	—	—
			Sum =	**25.0**		2.38	**0.42**	—	—
			Average =	**5.0**			**0.08**	1.12	0.008
SS324	1	Lake	—	2.0	—	—	1.98	—	—
	2	Lake	—	2.5	—	—	—	—	—
	3	Lake	—	2.0	—	—	—	—	—
	4	Lake	—	2.0	—	—	—	—	—
	5	Lake	—	1.0	—	—	—	—	—
			Sum =	**9.5**		2.32	**0.34**	—	—
			Average =	**1.9**			**0.07**	0.91	0.017
SS325	1	Lake	—	2.0	—	—	1.96	—	—
	2	Lake	—	2.5	—	—	—	—	—
	3	Lake	—	3.0	—	—	—	—	—
	4	Lake	—	3.0	—	—	—	—	—
	5	Lake	—	3.0	—	—	—	—	—
			Sum =	**13.5**		2.14	**0.18**	—	—
			Average =	**2.7**			**0.04**	0.48	0.006

Snow Sample #	Catchement Basin	Sample Type	Lat. (NAD 83)	Long. (NAD 83)
SS319	L9908	Core	N 70° 24' 09.76"	W 150° 55' 11.13"
SS320	L9908	Core	N 70° 24' 11.72"	W 150° 55' 11.03"
SS321	L9908	Core	N 70° 24' 09.88"	W 150° 54' 59.38"
SS322	L9908	Core	N 70° 24' 11.82"	W 150° 54' 59.47"
SS323	L9908	Core	N 70° 24' 08.77"	W 150° 54' 47.66"
SS324	L9908	Core	N 70° 24' 10.71"	W 150° 54' 47.65"
SS325	L9908	Core	N 70° 24' 09.29"	W 150° 54' 35.96"
SS326	L9908	Core	N 70° 24' 12.23"	W 150° 54' 36.14"
SS327	L9908	Core	N 70° 24' 09.99"	W 150° 54' 24.25"
SS328	L9908	Core	N 70° 24' 12.96"	W 150° 54' 24.14"
SS329	L9908	Depth	N 70° 24' 08.79"	W 150° 55' 11.23"
SS330	L9908	Depth	N 70° 24' 10.72"	W 150° 55' 11.03"
SS331	L9908	Depth	N 70° 24' 08.88"	W 150° 54' 59.39"
SS332	L9908	Depth	N 70° 24' 10.85"	W 150° 54' 59.38"
SS333	L9908	Depth	N 70° 24' 09.78"	W 150° 54' 47.65"
SS334	L9908	Depth	N 70° 24' 11.75"	W 150° 54' 47.74"
SS335	L9908	Depth	N 70° 24' 12.72"	W 150° 54' 47.74"
SS336	L9908	Depth	N 70° 24' 08.32"	W 150° 54' 35.87"
SS337	L9908	Depth	N 70° 24' 10.29"	W 150° 54' 35.96"
SS338	L9908	Depth	N 70° 24' 11.26"	W 150° 54' 36.05"
SS339	L9908	Depth	N 70° 24' 13.23"	W 150° 54' 36.23"
SS340	L9908	Depth	N 70° 24' 08.02"	W 150° 54' 24.36"
SS341	L9908	Depth	N 70° 24' 09.02"	W 150° 54' 24.35"
SS342	L9908	Depth	N 70° 24' 10.99"	W 150° 54' 24.24"
SS343	L9908	Depth	N 70° 24' 11.96"	W 150° 54' 24.24"

Snow Survey Data Sheet

Date:	5/11/2007	Start Time:	15:30	End Time:	17:30	Observers:	MTA, EJK
Catchement Basin:	M9703	Driving Wrench Used:	Yes			Tube Section Used:	1

Snow Sample No.	Sample Type	Terrain Type	Snow Depth (in) w/ Dirt Plug	Snow Depth (in) w/o Dirt Plug	Core Length (in)	Tube & Core Weight (lb)	Empty Tube Weight (lb)	Water Equivalent (in)	Density (lb/in^3)
SS403*	Core	Lake	—	4.5	—	2.30	1.94	0.96	0.008
SS404*	Core	Lake	—	6.0	—	2.50	1.96	1.44	0.009
SS405*	Core	Lake	—	5.0	—	2.16	1.96	0.53	0.004
SS406	Core	Tundra	22.2	22.2	—	2.42	1.94	6.41	0.010
SS407*	Core	Lake	—	4.4	—	2.4	1.96	1.17	0.010
SS408	Core	Tundra	15.6	14.4	—	2.20	1.98	2.94	0.007
SS409*	Core	Tundra	—	12.8	—	2.72	1.96	2.03	0.006
SS410	Core	Lake	16.2	16.2	—	2.28	1.96	4.27	0.010
SS411	Core	Lake	8.4	8.4	—	2.10	1.96	1.87	0.008
SS412	Core	Tundra	15.0	13.8	—	2.22	1.96	3.47	0.009
SS413*	Core	Lake	—	8.1	—	2.92	1.98	2.51	0.011
SS414	Core	Tundra	18.5	17.0	—	2.26	2.00	3.47	0.007
SS415*	Core	Lake	—	5.7	—	2.26	1.98	0.75	0.005
SS416	Depth	Tundra	18.5	17.5	—	2.32	1.96	4.81	0.010
SS417	Depth	Lake	—	4.8					
SS418	Depth	Lake	—	5.4					
SS419	Depth	Lake	—	5.4					
SS420	Depth	Lake	—	2.4					
SS421	Depth	Lake	—	8.4					
SS422	Depth	Lake	—	7.2					
SS423	Depth	Lake	—	10.8					
SS424	Depth	Lake	—	6.0					
SS425	Depth	Lake	—	3.6					
SS426	Depth	Tundra	—	5.4					
SS427	Depth	Lake	—	3.6					
SS428	Depth	Lake	—	4.8					
SS429	Depth	Lake	—	4.8					
SS430	Depth	Tundra	—	19.2					
SS431	Depth	Tundra	—	13.2					
SS432	Depth	Tundra	—	8.4					
SS433	Depth	Tundra	—	12.6					
SS434	Depth	Tundra	—	4.8					
SS435	Depth	Tundra	—	7.8					
SS436	Depth	Tundra	—	13.2					
SS437	Depth	Tundra	—	4.2					
SS438	Depth	Lake	—	5.4					
SS439	Depth	Lake	—	6.0					
SS440	Depth	Lake	—	4.8					
SS441	Depth	Lake	—	7.2					
SS442	Depth	Lake	—	15.0					
SS443	Depth	Tundra	—	3.6					
SS444	Depth	Lake	—	6.0					
SS445	Depth	Lake	—	6.6					
SS446	Depth	Lake	—	10.8					
SS447	Depth	Lake	—	12.0					
SS448	Depth	Tundra	—	18.0					
SS449	Depth	Tundra	—	13.2					
SS450	Depth	Tundra	—	4.8					
SS451	Depth	Tundra	—	9.0					
SS452	Depth	Lake	—	6.0					
SS453	Depth	Lake	—	3.0					
SS454	Depth	Lake	—	4.2					
SS455	Depth	Tundra	—	10.8					

Snow Survey Calculations

Average Area:	Tundra =	1173129	ft^2
	Lake =	970994	ft^2
Average SWE:	Tundra =	2.70	in
	Lake =	1.46	in
Average Snow Depth:	Tundra =	11.7	in
	Lake =	6.6	in
Average Density:	Tundra =	0.008	lb/in^3
	Lake =	0.008	lb/in^3
Catchement Basin Weighted SWE =		2.14	in

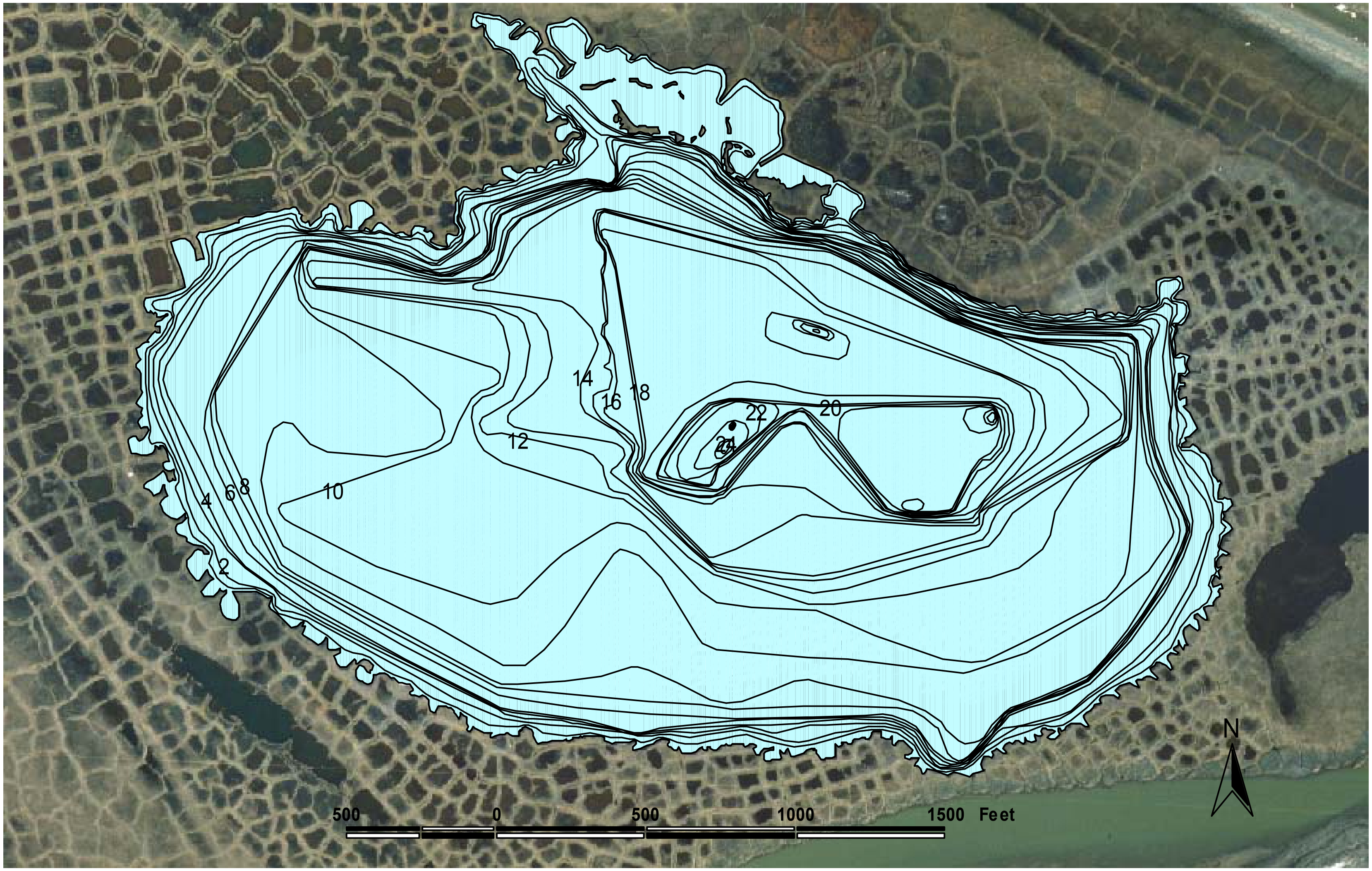
NOTES:

* Pooled sample measurement conducted, snow depth without dirt plug, SWE, and density represents the average of pooled samples.

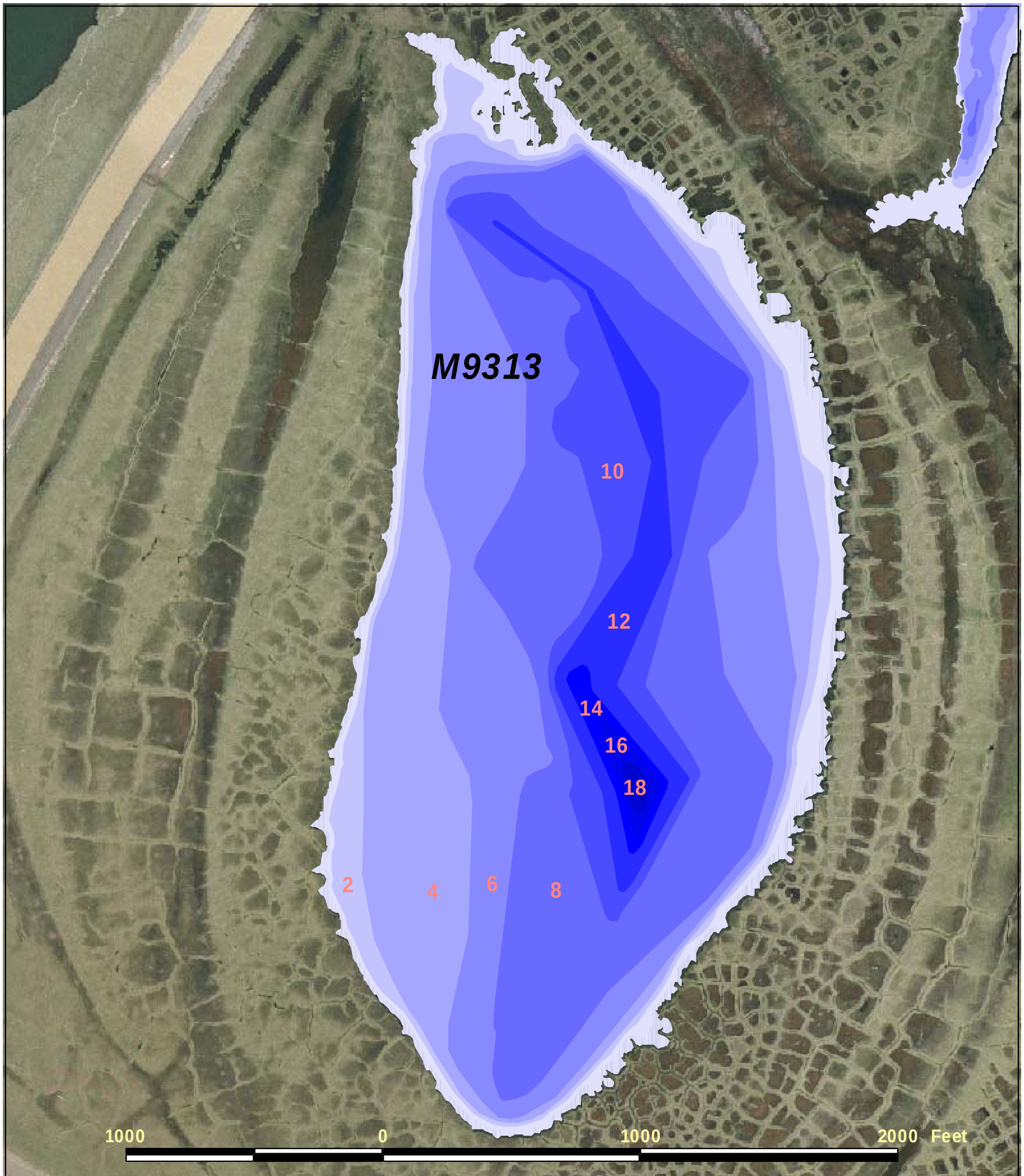
Pooled Snow Survey Data Sheet									
Date: 5/11/2007			**Start Time:** 15:30		**End Time:** 17:30		**Observers:** MTA, EJK		
Catchement Basin: M9703			**Driving Wrench Used:** Yes				**Tube Section Used:** 1		
Snow Sample No.	**Pooled Sample #**	**Terrain Type**	**Snow Depth (in)**		**Core Length (in)**	**Bucket & Core Weight (lb)**	**Empty Bucket Weight (lb)**	**Water Equivalent (in)**	**Density (lb/in^3)**
			w/ Dirt Plug	**w/o Dirt Plug**					
SS403	1	Lake	—	4.8	—	—	1.94	—	—
	2	Lake	—	4.8	—	—	—	—	—
	3	Lake	—	4.8	—	—	—	—	—
	4	Lake	—	4.8	—	—	—	—	—
	5	Lake	—	3.6	—	—	—	—	—
			Sum =	**22.8**		2.30	**0.36**	—	—
			Average =	**4.5**			**0.07**	0.96	0.008
SS404	1	Lake	—	6.0	—	—	1.96	—	—
	2	Lake	—	6.0	—	—	—	—	—
	3	Lake	—	6.0	—	—	—	—	—
	4	Lake	—	6.0	—	—	—	—	—
	5	Lake	—	6.0	—	—	—	—	—
			Sum =	**30.0**		2.50	**0.54**	—	—
			Average =	**6.0**			**0.11**	1.44	0.009
SS405	1	Lake	—	4.8	—	—	1.96	—	—
	2	Lake	—	5.4	—	—	—	—	—
	3	Lake	—	4.8	—	—	—	—	—
	4	Lake	—	4.8	—	—	—	—	—
	5	Lake	—	4.8	—	—	—	—	—
			Sum =	**24.6**		2.16	**0.2**	—	—
			Average =	**5.0**			**0.04**	0.53	0.004
SS407	1	Lake	—	6.0	—	—	1.96	—	—
	2	Lake	—	6.0	—	—	—	—	—
	3	Lake	—	5.4	—	—	—	—	—
	4	Lake	—	0.6	—	—	—	—	—
	5	Lake	—	5.4	—	—	—	—	—
			Sum =	**23.4**		2.40	**0.44**	—	—
			Average =	**4.4**			**0.09**	1.17	0.009
SS409	1	Tundra	—	12.6	—	—	1.96	—	—
	2	Tundra	—	13.2	—	—	—	—	—
	3	Tundra	—	13.2	—	—	—	—	—
	4	Tundra	—	11.4	—	—	—	—	—
	5	Tundra	—	13.8	—	—	—	—	—
			Sum =	**64.2**		2.72	**0.76**	—	—
			Average =	**12.8**			**0.15**	2.03	0.006
SS413	1	Lake	—	9.0	—	—	1.98	—	—
	2	Lake	—	7.5	—	—	—	—	—
	3	Lake	—	8.5	—	—	—	—	—
	4	Lake	—	9.0	—	—	—	—	—
	5	Lake	—	7.5	—	—	—	—	—
			Sum =	**41.5**		2.92	**0.94**	—	—
			Average =	**8.1**			**0.19**	2.51	0.011
SS415	1	Lake	—	6.0	—	—	1.98	—	—
	2	Lake	—	6.0	—	—	—	—	—
	3	Lake	—	4.8	—	—	—	—	—
	4	Lake	—	6.0	—	—	—	—	—
	5	Lake	—	6.0	—	—	—	—	—
			Sum =	**28.8**		2.26	**0.28**	—	—
			Average =	**5.7**			**0.06**	0.75	0.005

Snow Sample #	Catchement Basin	Sample Type	Lat. (NAD 83)	Long. (NAD 83)
SS403	M9703	Core	N 70° 22' 28.74"	W 151° 02' 29.09"
SS404	M9703	Core	N 70° 22' 29.0"	W 151° 02' 37.80"
SS405	M9703	Core	N 70° 22' 26.01"	W 151° 02' 27.52"
SS406	M9703	Core	N 70° 22' 23.44"	W 151° 02' 31.80"
SS407	M9703	Core	N 70° 22' 26.08"	W 151° 02' 18.68"
SS408	M9703	Core	N 70° 22' 23.57"	W 151° 02' 14.02"
SS409	M9703	Core	N 70° 22' 21.82"	W 151° 02' 13.32"
SS410	M9703	Core	N 70° 22' 22.73"	W 15° 10' 24.97"
SS411	M9703	Core	N 70° 22' 27.75"	W 151° 02' 11.79"
SS412	M9703	Core	N 70° 22' 26.88"	W 15° 10' 20.44"
SS413	M9703	Core	N 70° 22' 30.05"	W 151° 02' 15.60"
SS414	M9703	Core	N 70° 22' 32.50"	W 15° 10' 22.97"
SS415	M9703	Core	N 70° 22' 30.53"	W 151° 02' 24.21"
SS416	M9703	Core	N 70° 22' 33.45"	W 151° 02' 25.56"
SS417	M9703	Depth	N 70° 22' 28.58"	W 151° 02' 23.24"
SS418	M9703	Depth	N 70° 22' 28.68"	W 151° 02' 26.21"
SS419	M9703	Depth	N 70° 22' 28.84"	W 151° 02' 31.96"
SS420	M9703	Depth	N 70° 22' 28.90"	W 151° 02' 34.93"
SS421	M9703	Depth	N 70° 22' 29.06"	W 151° 02' 40.78"
SS422	M9703	Depth	N 70° 22' 29.16"	W 151° 02' 43.65"
SS423	M9703	Depth	N 70° 22' 27.73"	W 151° 02' 24.67"
SS424	M9703	Depth	N 70° 22' 26.87"	W 151° 02' 26.09"
SS425	M9703	Depth	N 70° 22' 25.16"	W 151° 02' 28.95"
SS426	M9703	Depth	N 70° 22' 24.30"	W 151° 02' 30.38"
SS427	M9703	Depth	N 70° 22' 27.76"	W 151° 02' 21.69"
SS428	M9703	Depth	N 70° 22' 26.90"	W 151° 02' 20.13"
SS429	M9703	Depth	N 70° 22' 25.25"	W 151° 02' 17.12"
SS430	M9703	Depth	N 70° 22' 24.40"	W 151° 02' 15.57"
SS431	M9703	Depth	N 70° 22' 22.72"	W 151° 02' 12.47"
SS432	M9703	Depth	N 70° 22' 21.20"	W 151° 02' 18.95"
SS433	M9703	Depth	N 70° 22' 21.53"	W 151° 02' 16.13"
SS434	M9703	Depth	N 70° 22' 22.11"	W 151° 02' 10.51"
SS435	M9703	Depth	N 70° 22' 22.41"	W 151° 00' 27.79"
SS436	M9703	Depth	N 70° 22' 23.02"	W 151° 00' 22.16"
SS437	M9703	Depth	N 70° 22' 23.32"	W 151° 01' 59.44"
SS438	M9703	Depth	N 70° 22' 28.39"	W 151° 02' 20.38"
SS439	M9703	Depth	N 70° 22' 28.16"	W 151° 02' 17.52"
SS440	M9703	Depth	N 70° 22' 27.94"	W 151° 02' 14.65"
SS441	M9703	Depth	N 70° 22' 27.52"	W 151° 00' 28.93"
SS442	M9703	Depth	N 70° 22' 27.33"	W 151° 00' 26.07"
SS443	M9703	Depth	N 70° 22' 27.11"	W 151° 00' 23.21"
SS444	M9703	Depth	N 70° 22' 29.07"	W 151° 02' 20.70"
SS445	M9703	Depth	N 70° 22' 29.56"	W 151° 02' 18.15"
SS446	M9703	Depth	N 70° 22' 30.54"	W 151° 02' 13.06"
SS447	M9703	Depth	N 70° 22' 31.03"	W 151° 02' 10.61"
SS448	M9703	Depth	N 70° 22' 31.52"	W 151° 00' 28.07"
SS449	M9703	Depth	N 70° 22' 32.01"	W 151° 00' 25.52"
SS450	M9703	Depth	N 70° 22' 32.98"	W 151° 00' 20.43"
SS451	M9703	Depth	N 70° 22' 33.51"	W 151° 01' 57.88"
SS452	M9703	Depth	N 70° 22' 29.56"	W 151° 02' 23.72"
SS453	M9703	Depth	N 70° 22' 31.50"	W 151° 02' 24.59"
SS454	M9703	Depth	N 70° 22' 32.48"	W 151° 02' 25.08"
SS455	M9703	Depth	N 70° 22' 34.43"	W 151° 02' 26.04"

Appendix B Lake Bathymetry



Depth contours of lake L9210, based on transects surveyed on September 1, 2002 (depth intervals in 1 foot increments).

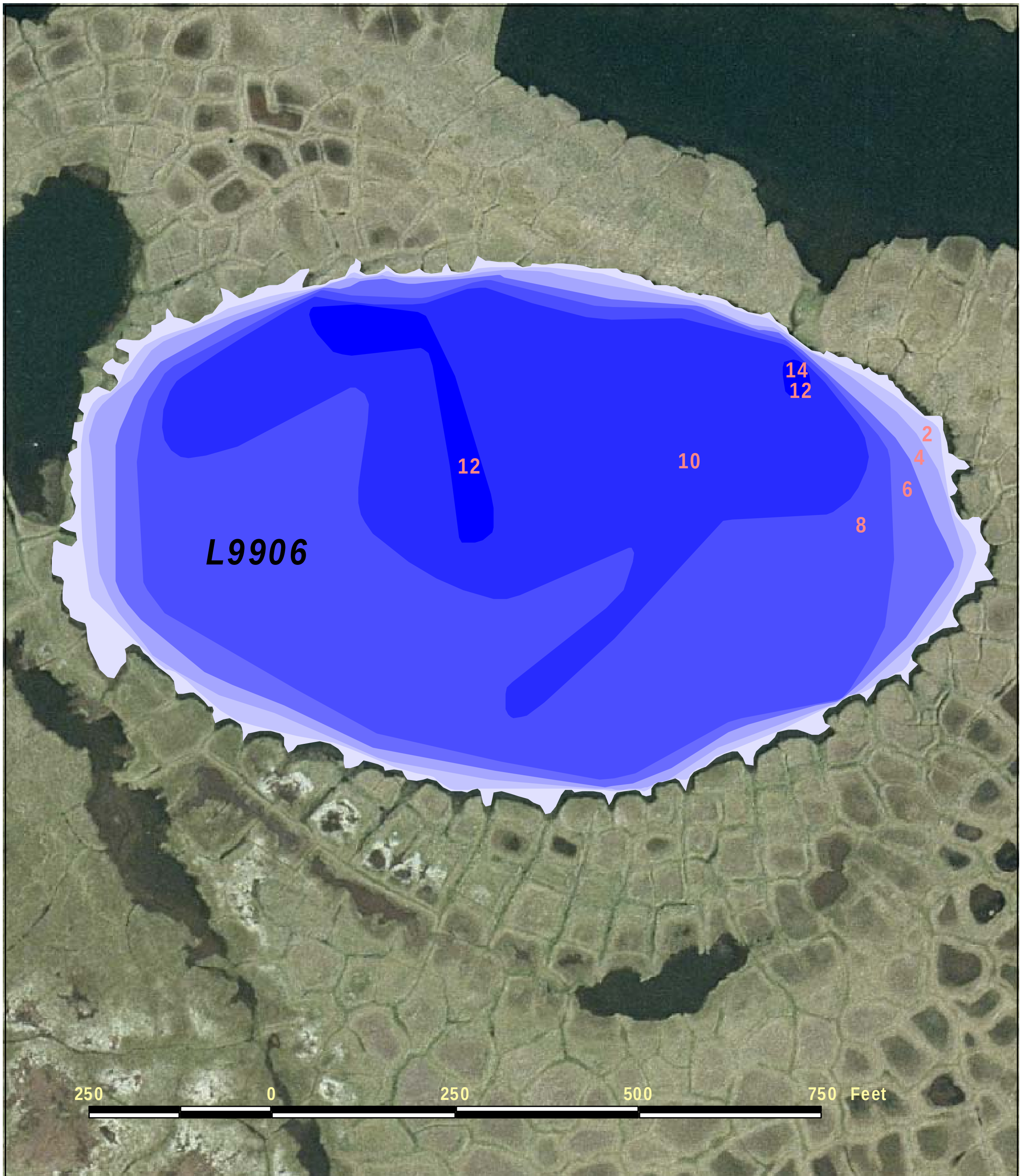


Depth contours of lake M9313 based on transects surveyed on September 1, 2002.
(depths in 2 foot intervals)

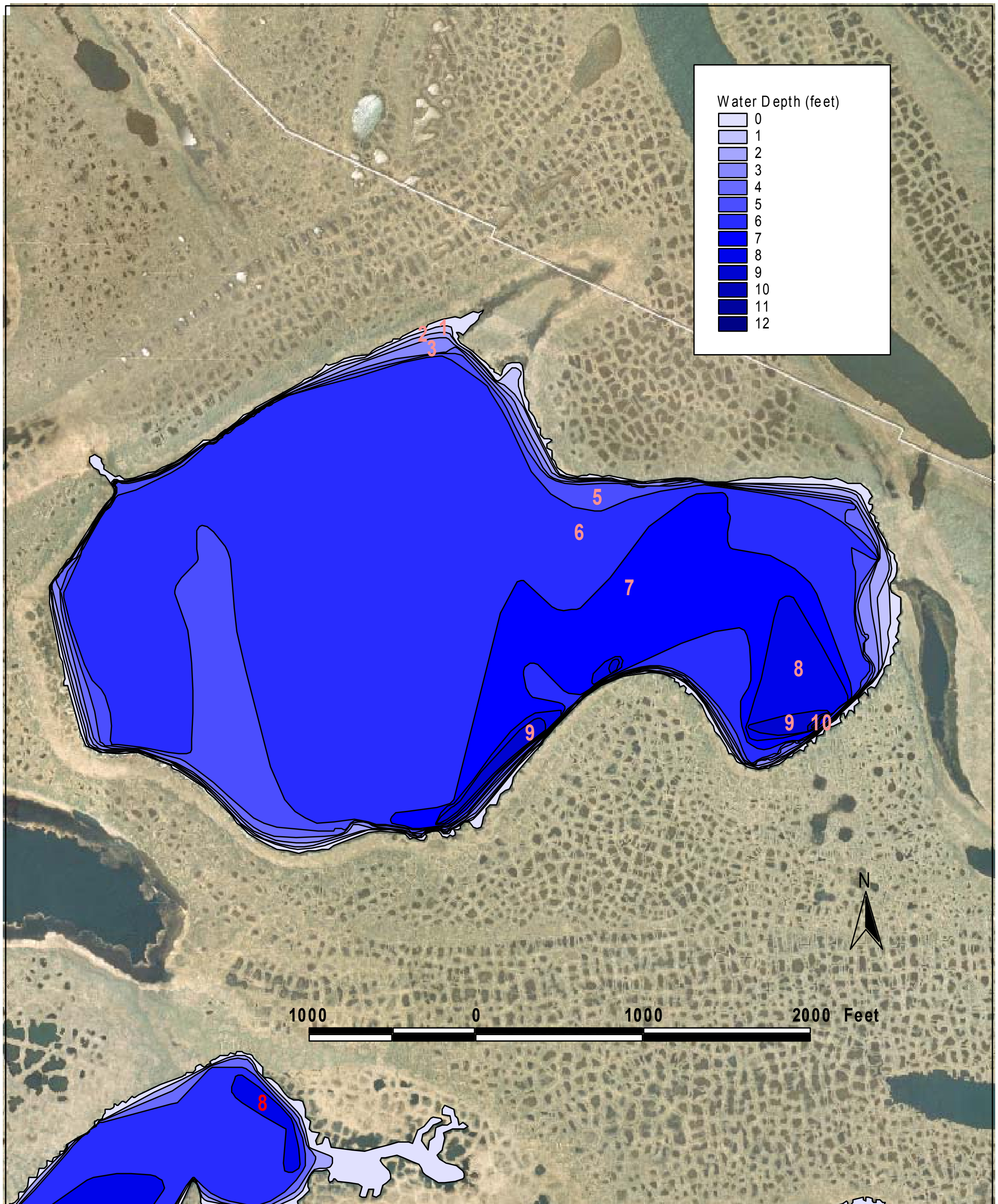
(not to be used for navigation or to direct operation of heavy equipment)

Depth contours of lake L9908 based on transects surveyed on July 29, 2006.
(depths in 1 foot intervals)

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

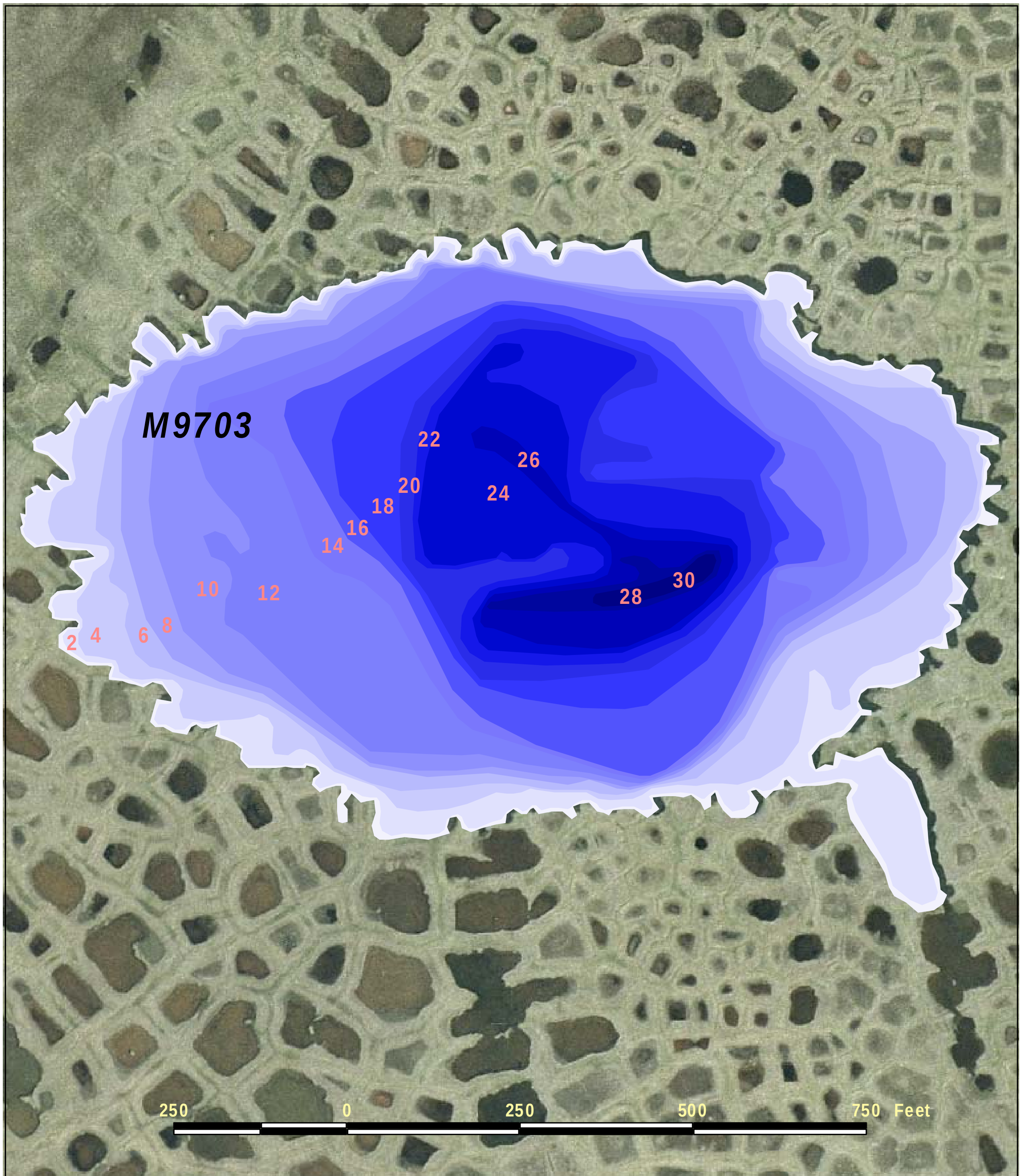


Depth contours of lake L9906 based on transects surveyed on July 16, 2006
(depths in 2 foot intervals)
(not to be used for navigation or to direct operation of heavy equipment)



Depth contours of lake L9327 based on transects surveyed on July 13, 2005.
(depths in 1 foot intervals)

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



Depth contours of lake M9703 based on transects surveyed on July 16, 2006
(depths in 2 foot intervals)

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

Appendix C. Aerial Photographs

Photo 1 B8533 north of CD2 (left)

Photo 2 B8533 hydraulically connected to northern wetland

Photo 3 B8533 and Sak slough (top)

Photo 4 L9108 and possible recharge channel (bottom right)

Photo 5 L9210 north of Ulam Channel (bottom)

Photo 6 L9281 south of M9321 and Tam Channel (bottom)

Photo 7 L9327 (bottom) and B8531 (top)

Photo 8 L9327 (center) south of Sak Channel

Photo 9 L9335 (center) east of Colville River

Photo 10 L9335 and M9508 (right)

Photo 11 L9401 (top right) hydraulically connected to M0675 (bottom right)

Photo 12 L9401 east of Nigliq Channel (top)

Photo 13 L9903 and CD3 airstrip (top right)

Photo 14 L9904 (center) bound by Ulam (left) and Tam (bottom) channels

Photo 15 L9904 south of Tam Channel (bottom)

Photo 16 L9905 (center) bound by Ulam (left) and Tam (bottom) channels

Photo 17 L9906 (bottom), MB0701 (center) and L9908 (top)

Photo 18 L9906 (bottom) south of Ulam Channel (top)

Photo 19 L9906 (top), MB0701 (center) and L9908 (botoom)

Photo 20 L9907 (top) south of Ulam Channel pipline crossing

Photo 21 L9908 (center) hydraulically connected to L9907 (bottom left)

Photo 22 M0675 (center)

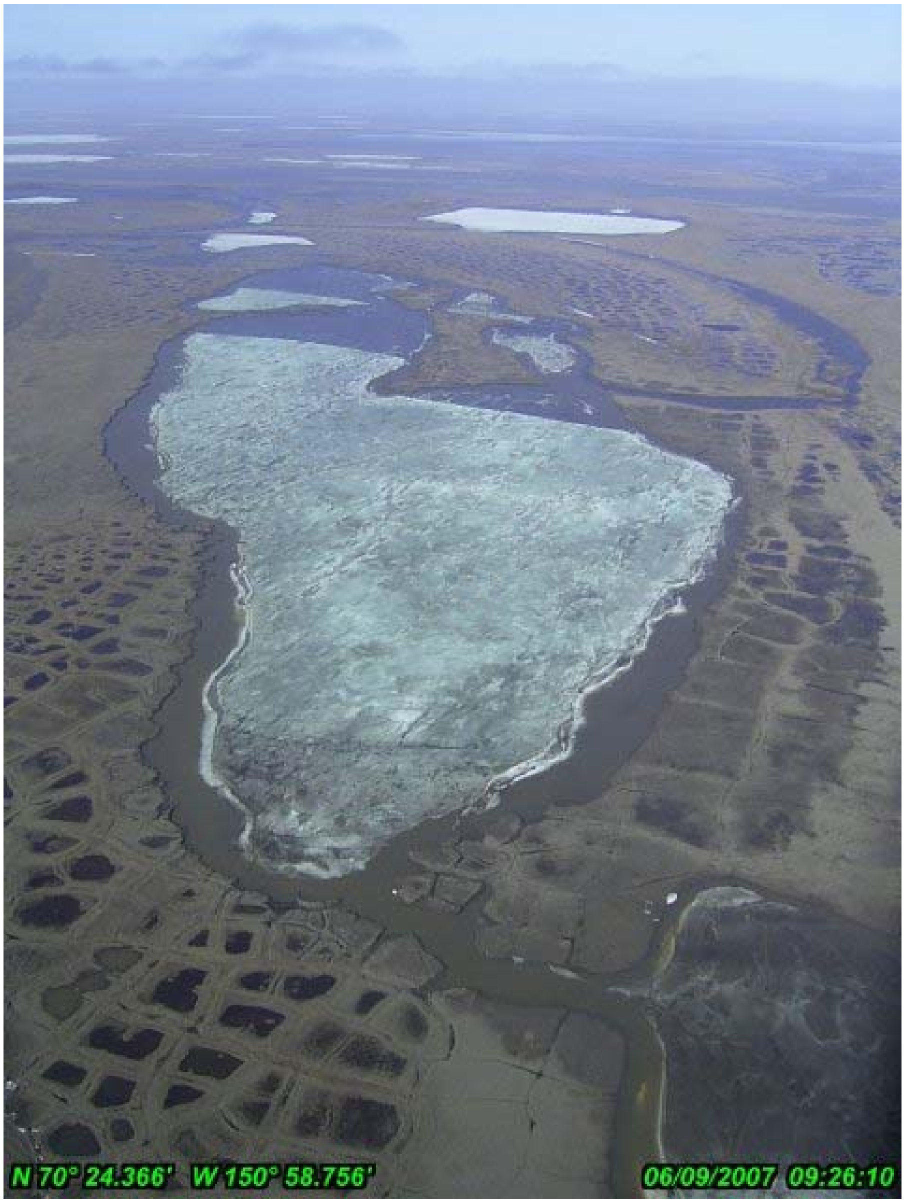


Photo 23 M0675 west of Sak Channel

Photo 24 M0676 (left) and M9708 (right)

Photo 25 M0676 (bottom) and M9708 (top)

Photo 26 M0678 (center) south east of CS3 airstrip (upper left)

Photo 27 M0678

Photo 28 M9313 (center) north of CD3 facilities

Photo 29 M9321 (center) and L9281 (upper right)

Photo 30 South end of M9521 recharging from Sak Channel

Photo 31 North end of M9521 recharging from Sak Channel

Photo 32 M9521 (top)

Photo 33 M9522 (center) west of M9521

Photo 34 M9522 (center) north of M9521 recharge channel

Photo 35 M9603 (center) looking north

Photo 36 North end of M9603 east of Colville River (bottom)

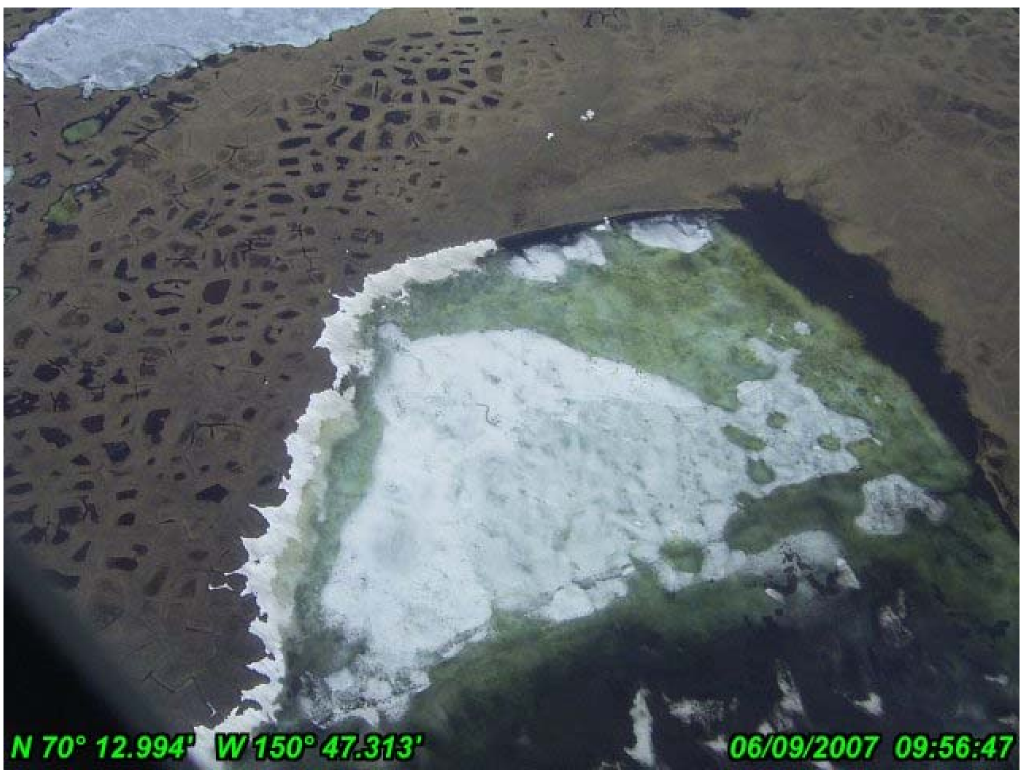


Photo 37 M9603 west bank

Photo 38 M9606 (bottom) hydraulically connected to B8503 (center) and M9608 (right)

Photo 39 M9606 (center) east of Nigliq Channel (top)

Photo 40 M9606 (center), B8503 (left) and M9608 (top)

Photo 41 B8530 (botom) and M9608 (top)

Photo 42 M9701 (center bottom) and M9702 (center top) connected to wetland

Photo 43 M9701 (bottom) and M9702 (top)

Photo 44 M9703 (center) and recharge swale (top right)

Photo 45 M9703 (center)

Photo 46 M9703 (center) and recharge swale (bottom)

Photo 47 M9704 (center)

Photo 48 M9704 (center) and recharge channel east of Nigliq Channel

Photo 49 M9704 (center)

Photo 50 M9709 (center) east of CD3 pipeline

Photo 51 MC7913 (center)

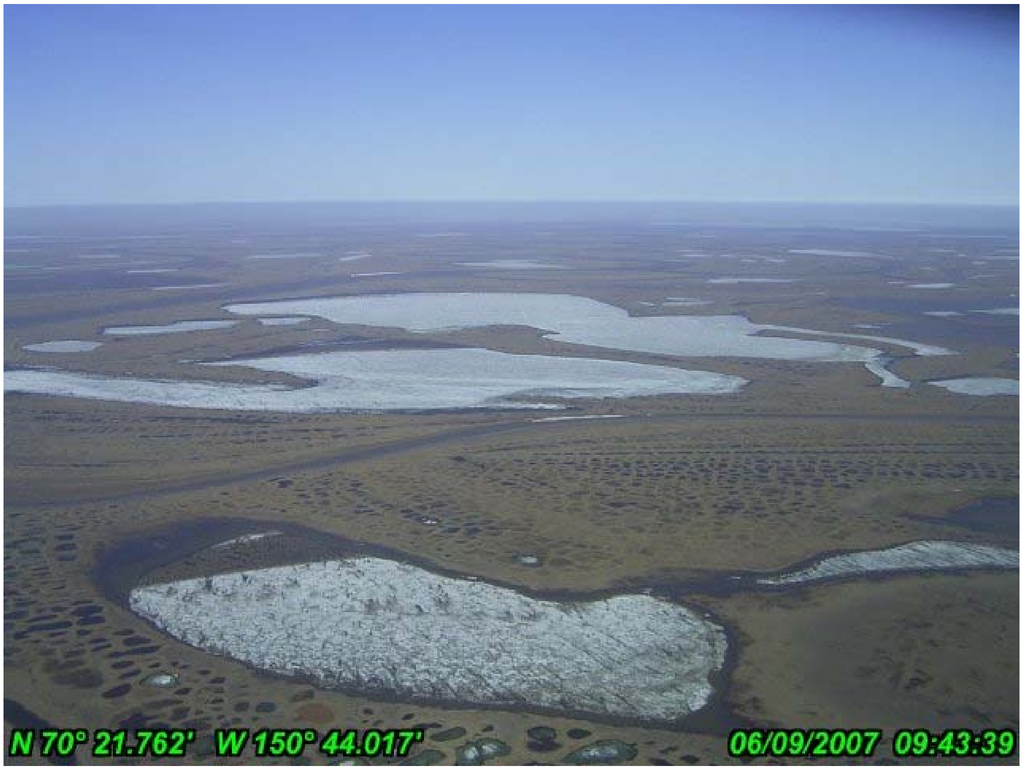


Photo 52 MC7913 (bottom)