Alpine Facility and Vicinity

2002 Lake Monitoring and Recharge Study

Prepared for

ConocoPhillips

By

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1.0 Introduction

This report summarizes hydrologic observations and measurements made during a lake monitoring and recharge study conducted in and around the Alpine area in 2002 by Michael Baker Jr., Inc. (Baker). The study was performed at the request of ConocoPhillips Alaska (CPA), formerly Phillips Alaska, Inc. The study consisted of multi-season water surface elevation, depth, and ice thickness surveys; in situ physical and water quality parameter measurements; analytical water quality sampling and testing; and lake recharge observations at seven fresh water lakes.

MJM Research collected data on fish populations for these study lakes and a report that addresses potential impacts to fish populations from water use will be submitted under separate cover.

1.1 Acknowledgements

Many people were instrumental in making this program successful. We would like to thank Kuukpik/LCMF Incorporated for providing survey support and transportation support during the winter months. Their time and patience was greatly appreciated. Also, we thank Justin Harth (CPA) and Jessica Adema (CPA) for their assistance with logistical support, Larry Moulton (MJM Research) for providing historical lake data, Dennis and Ray (Doyon Security) for help with helicopter coordination, and the fine pilots of Maritime Helicopters for their skillful and safe flying. Caryn Rea (CPA) was instrumental in overseeing the logistical support for the entire field effort, as were her contributions during the writing of this report.

1.2 Purpose

The purpose of the study was to conduct monthly winter water quality and lake level measurements at two permanent source lakes and five lakes permitted for temporary water withdrawal. All seven lakes were located in the immediate vicinity of Alpine and were designated for this study by CPA. Figure 1-1 shows lake locations in relation to the Alpine facility. Aerial photographs of each lake are provided in Appendix A.

This program was designed to complement and build on information obtained during previous water monitoring programs in the Alpine area. Accordingly, with the exception of sampling frequency, the 2002 monitoring program was essentially identical to the 2001 investigation. The reduction of sampling frequency from biweekly to monthly was made based on data from the 2001 investigation that suggested that biweekly sampling was more frequent than was necessary.

1.3 2002 Study Overview and Approach

The study was comprised of monthly measurement and sampling events to assess lake level and chemical changes. Measurement events took place on a monthly basis beginning in January 2002.

Physical data on the permanent and temporary use lakes sampled under this study are presented in Table 1-1. At each lake, in-situ measurements of temperature, pH, conductivity, dissolved oxygen, turbidity, and salinity were made at approximately 3-foot intervals. Depth interval sampling was completed at the request of the Alaska Department of Fish & Game. Sampling for analytical analysis of biochemical oxygen demand (BOD) and chemical oxygen demand (COD) were made at a single depth that represented approximately half the distance between the bottom of ice and the bottom of the lake. Analytical sampling for turbidity was carried out during the initial sampling event in January, but was discontinued after that point.

Figure 1-1 Alpine Lakes Location Map

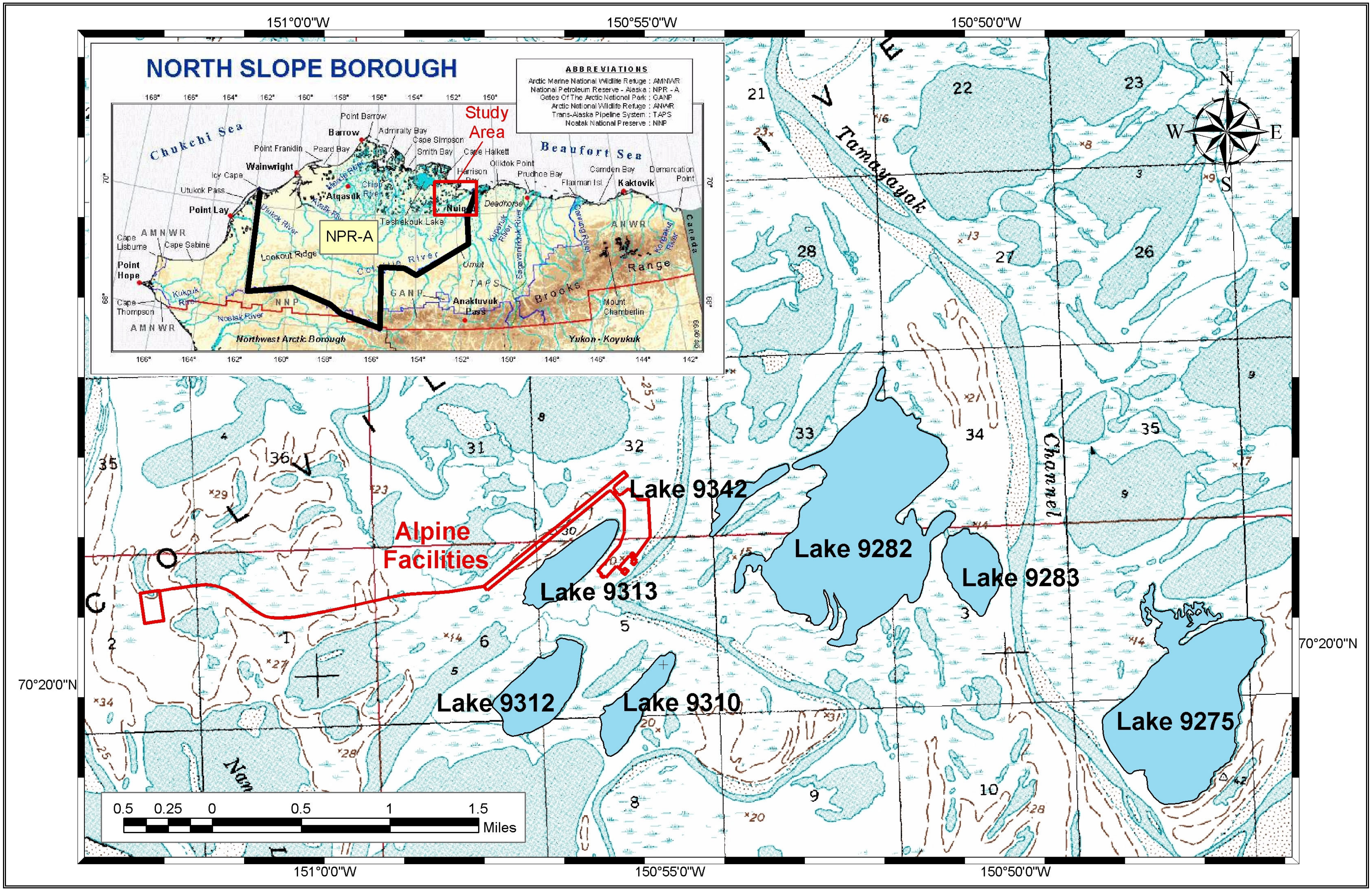


Table 1-1 2002 Alpine Study Lakes

Lake Number	Estimated Volume	Area	Max. Depth	Fish Presence
PERMANENT USE LAKES				
L9312	300* million gallons	100 acres	14 feet	Yes
L9313	160* million gallons	69 acres	12 feet	Yes
L9310 (Reference)	211 million gallons	60.5 acres	24 feet	Yes
TEMPORARY USE LAKES				
L9282	1,800* million gallons	480 acres	28 feet	Yes
L9342	65* million gallons	25 acres	11 feet	Yes
L9283	769 million gallons	74 acres	9 feet	Yes
L9275 (Reference	728 million gallons	376 acres	18 feet	Yes

1. *Volumes based on 2002 transect data provided by MJM Research.
2. Lake data provided by ConocoPhillips Alaska.

1.4 Winter Water Use

Lakes L9312 and L9313 provide a year-round water supply for CPA's existing Alpine facility. Water was also withdrawn from Lake L9282 to support winter construction of ice roads and pads. A total of just over 23 million gallons of water were removed from lakes L9312, L9313, and L9282 during the winter 2002 season. Water use totals from each of these lakes are summarized in Appendix B. Information in Appendix B was provided by CPA.

1.5 Winter 2001/2002 Weather

The winter of 2002 can be generally characterized as having had considerably below normal snowfall and above normal mid- to late-winter air temperatures. These conditions resulted in a spring breakup that occurred relatively rapidly, and was about two weeks earlier than had been observed in recent years. Because of the below normal snowpack, there was less meltwater available for tundra lake recharge than would typically be available (NRCS, 2002a,b).

2.0 2002 Study Methods

2.1 Physical Parameters

The physical parameters portion of the program consisted of installation of temporary benchmarks (TBMs) to facilitate measurement of ice and water surface elevations, and determination of ice thickness, total depth, and freeboard. Additionally, the recharge mechanism for each of the study lakes was identified. Each of these tasks is discussed below in detail.

Sampling location selection was based solely on depth. Locations selected represented points where water depths were such that it was assumed that sufficient under-ice free water would be available throughout the winter. Each sampling point was marked with a six-foot snow pole and the location recorded using a hand-held global positioning system (GPS) unit referenced to North American Datum of 1927 (NAD27). Sampling locations at each lake are shown on Figure 2-1 and Figure 2-2.

During the first sampling event, four TBMs from which water surface and ice elevations would be referenced were established at five of the seven lakes. Permanent staff gages at the remaining two lakes obviated TBM installation at those locations. Each TBM was composed of a 3-foot section of one-half-inch rebar. The TBM location was marked with crossed lathe and the rebar itself was marked with a surveyor whisker and bailing wire. Each TBM was tied to British Petroleum Mean Sea Level (BPMSL) datum. TBM locations at each lake are identified on Figure 2-1 and Figure 2-2. Kuukpik/LCMF provided survey assistance and transportation logistics.

During the winter sampling events, a two-cycle power auger was used to drill a six-inch sampling hole through the ice. Total depth was measured using a weighted tag line. Freeboard, the distance from the top of ice to the water surface in the sample hole, was measured using a pocket rod. Ice thickness was determined using a pole with a wire hook on the end. The pole was lowered into the hole until the hook found the underside of the ice. The pole was then withdrawn and the pocket rod used to measure the resultant ice thickness as marked along the pole. All measurements were made to the nearest hundredth-foot and were referenced to the top of ice.

Figure 2-1 Sampling Locations

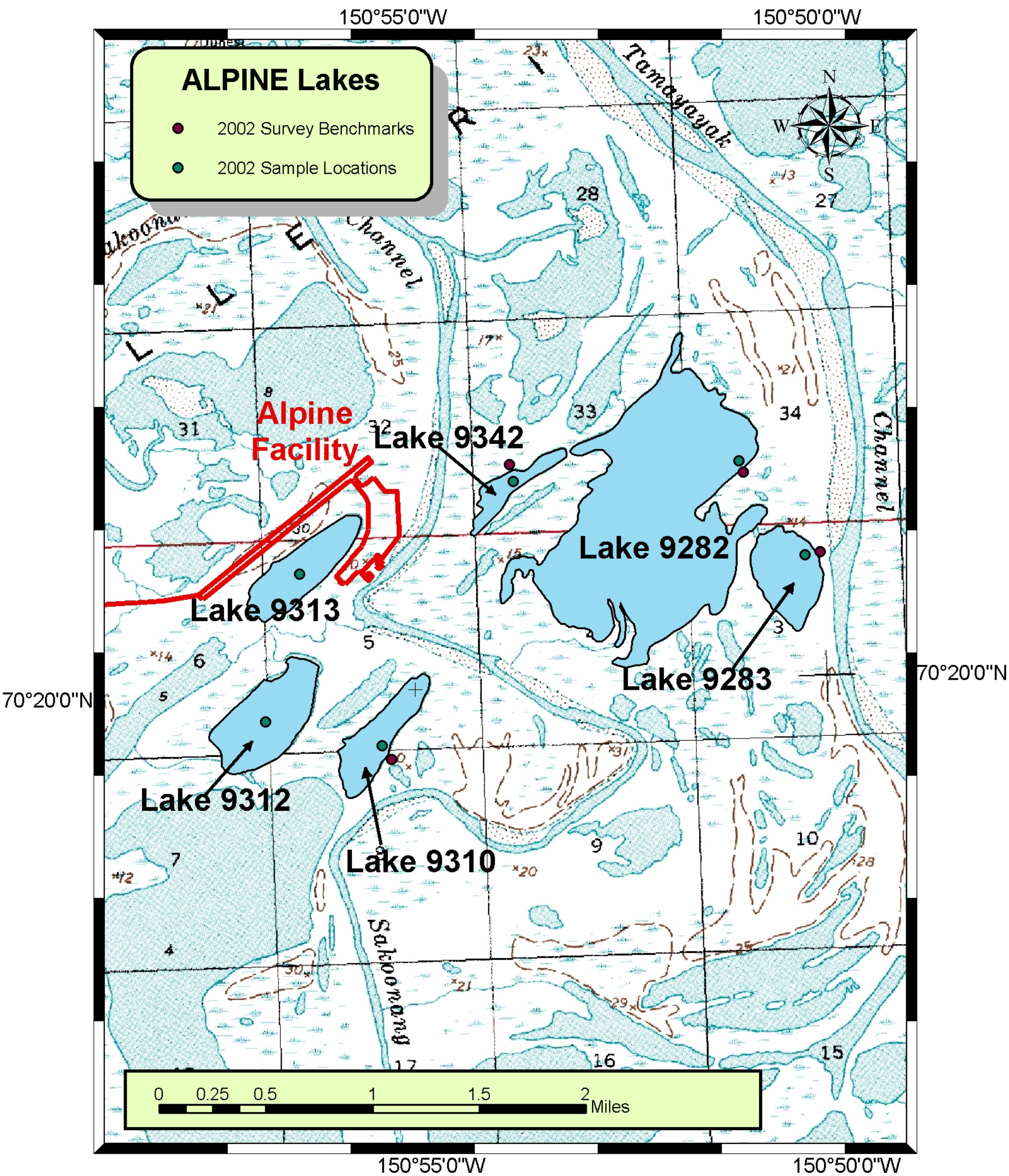
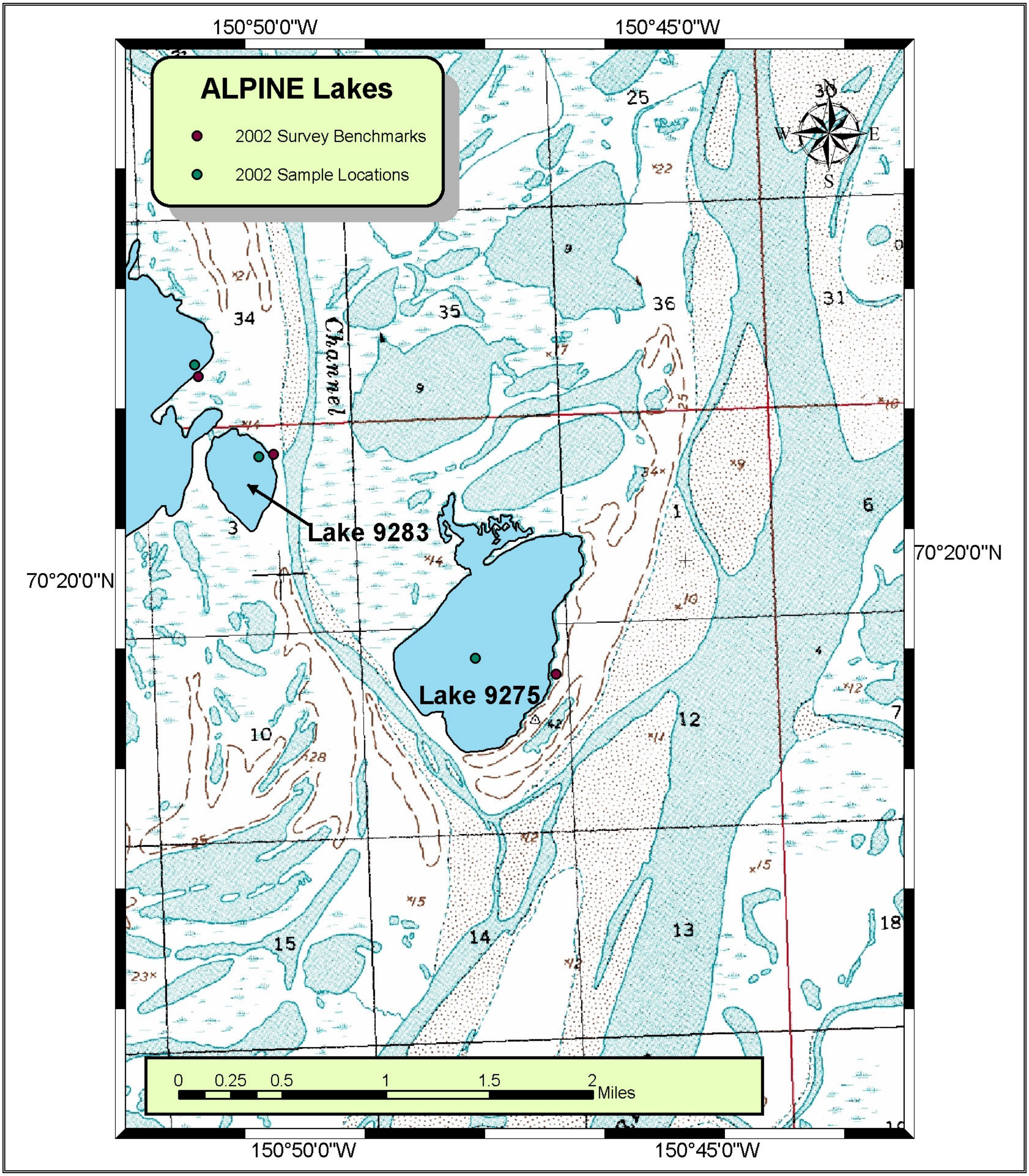


Figure 2-2 Sampling Locations, Lakes 9283 and 9275



During each sampling event, a standard level loop survey was tied to the TBMs in order to determine the elevation of the ice surface in the immediate vicinity of the sample hole. The elevation of the water surface was calculated by subtracting the measured freeboard from the elevation at the top of ice.

Lake recharge mechanisms were investigated during the May and June sampling events. Ground reconnaissance was used to document recharge at each lake. Recharge findings made on the ground were verified and documented with aerial photography.

2.2 In Situ Parameters

A Horiba U-10 in situ water quality meter was used to measure the following in situ water parameters:

- Temperature in degrees Celsius (^{o}C)
- pH in standard units
- Conductivity in microsiemens per centimeter (uS/cm)
- Dissolved oxygen in milligrams per liter (mg/L)
- Turbidity in nephlometric turbidity units (NTU)
- Salinity in milligrams per liter (mg/L)

In situ samples were collected at approximately three-foot intervals between the bottom of the ice (in summer the water surface) and the bottom of the lake. Because the accuracy of in situ turbidity measurements was questionable, a second turbidity measurement was made at each sampling location using a Hach 2100P turbidimeter. The meter was portable, and analysis was completed either onsite or in the field office at the end of the day. Turbidity samples were collected immediately following analytical sampling and prior to any other sampling activities at each sampling location.

Measures were taken to ensure that the instruments were protected from the cold. Two Horiba meters and two Hach turbidimeters were on hand at all times in case of meter damage or failure.

2.2.1 Instrument Calibration

All meters were calibrated according to the manufacturer's specifications. A summary of calibration procedures is outlined below:

Horiba U-10

Daily: Prior to sampling, a calibration check was performed using the meter's auto-calibrate function and calibration solution provided by the manufacturer. The calibration check was again performed at the end of the day if any results read during the course of the sampling day were suspect.

After Each Sampling Event: The meter was returned to Hannah Instrumentation, a local manufacture's representative for complete maintenance servicing performed according to the manufacturer's specifications. The servicing included multi-point calibration on all probes using span and zero check solutions, cleaning of all probes, and replacement of the semi-permeable membrane on the dissolved oxygen probe.

Hach 2100P Turbidimeter

Daily: Prior to sampling, a calibration check was performed using Gelex secondary particulate suspension standards provided by the manufacturer. The calibration was again performed at the end of the day if any results read during the course of the sampling day were suspect. If calibration check readings were not within 5 percent of the value of the standard, a complete recalibration using formazin standards was done before the meter was used in the field. Baker personnel performed all calibration of the HACH Turbidimeter.

Prior to the Field Season: Baker personnel used Hach StablCal stabilized formazin standards in 20-, 100-, and 800-NTU concentrations to recalibrate the instrument according to manufacturer-recommended procedures.

2.3 Analytical Parameters

Water samples for analytical evaluation were collected in lab-provided containers. Analytical samples were collected as grab samples at a depth of approximately one-half the depth of the water below the bottom of ice in the winter and approximately one-half the depth of the water in summer. A discreet-depth sampler was used to assure that water was collected from the desired depth.

Each sample container was labeled with pertinent sampling information and stored in an ice chest for transport to the analytical lab under standard chain-of-custody procedures. During mid-winter sampling events, chemical pack hand warmers were placed in the sample cooler to prevent the samples from freezing. During sampling events conducted in the spring, summer, and fall months, refreezable gel packs were placed in the sample cooler to keep the samples adequately chilled.

Study lake water samples were analyzed for the following parameters:

- Biochemical oxygen demand (BOD)
- Chemical oxygen demand (COD)

3.0 Results

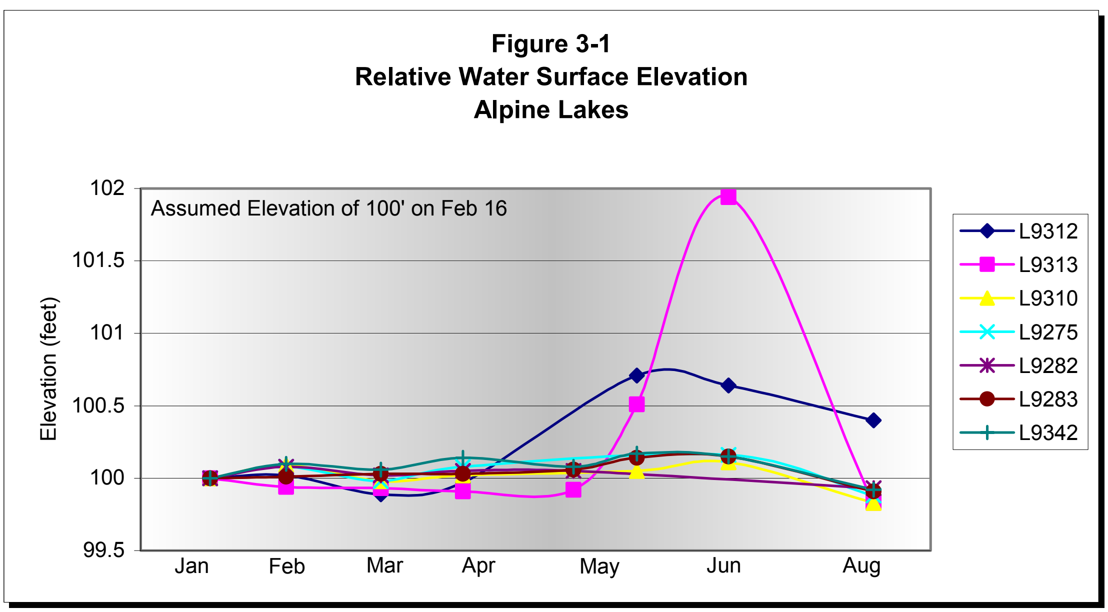
Results of all sampling events are tabulated in Appendix C. Table C-1 presents all physical and in situ parameters while all analytical results are provided in Table C-2.

3.1 Physical Parameters

Water Surface Elevation

All winter water surface elevation measurements were referenced to the top of ice and freeboard was subtracted to calculate water surface elevation. Alpine water surface elevation measurements are shown in Appendix C. Figure 3-1 compares relative water surface elevation changes between monthly sampling events for all the study lakes. Each lake's beginning water surface elevation has been assigned an arbitrary value of 100 feet so that the magnitudes of change at each lake can be compared.

Figure 3-1 Relative Water Surface Elevation



Water surface elevations varied very little over the winter months. Increases in water surface elevations were noted in spring and a discussion of recharge mechanisms is presented in Section 4. Water surface elevations decreased in all lakes between June and August. Evaporation is likely the main cause of water level decreases in these study lakes with the exceptions of Lakes L9312 and L9313 that were inundated by river water and subsequently has significant outflow. In these lakes evaporation was the main cause of water loss once water levels stabilized from outflow, although water use contributed to losses in Lakes L9312 and L9313.

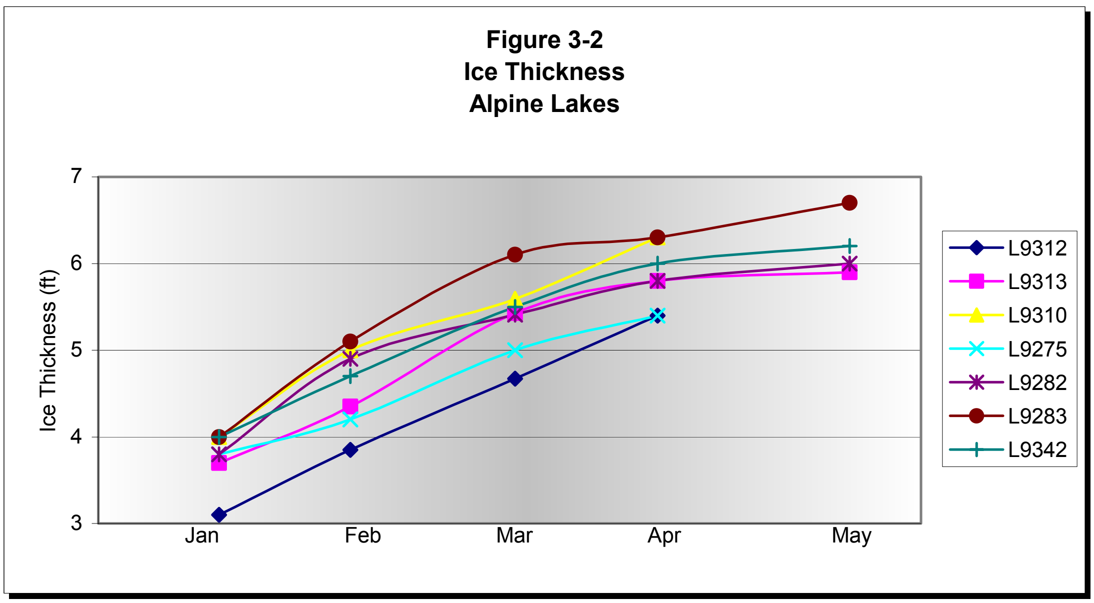
Measurement of evaporation rates was not part of this study, however, evaporation rates at Lakes L9312 and L9313, as well as daily evaporation rate estimation based on data collected at Kuparuk, were calculated in a previous study. Evaporation rates of 1.5 and 1.4 mm/day were calculated for Lakes L9312 and L9313, respectively. These rates compared favorably to the estimated Kuparuk open-water annual average evaporation rate of 1.9 mm/day, and the observed range of 0.9 to 2.7 mm/day based on data collected between 1986 and 1998 (Michael Baker Jr., Inc. 2000).

Ice Thickness

Figure 3-2 shows a graphical representation of ice thickness. Ice thickness measurements are provided in Appendix C.

The average early-February ice thickness was 4.59 feet while average late-April ice thickness was 5.86 feet. Average ice growth over the period was 2.09 feet. Ice growth rates at the lakes where water was withdrawn were comparable to rates at the lakes that were not pumped.

Figure 3-2 Ice Thickness



3.2 In Situ Parameters

As previously discussed, in situ parameters at all Alpine lakes were measured monthly and at multiple discreet depths within the water column at a given sample location. It should be noted that stratification within the water column was insignificant for all the study lakes with the exception of DO in Lakes L9312, L9282, and L9310. In these lakes dissolved oxygen decreased as depth increased.

Water Temperature

Early February temperatures in Alpine lakes averaged 1.6^{o}C. Average late summer temperatures averaged 9.0^{o}C.

pH

Over the course of the investigation, pH in Alpine lakes ranged from 7.3 to 8.5. Values of pH tended to decrease as winter progressed and then to rise during the open water season.

Conductivity

In situ conductivity generally tended to increase over the winter as the thickening of ice increased dissolved constituent concentrations in the free water.

Salinity

All lakes saw increases in salinity concentrations as the ice thickened.

Dissolved Oxygen

Dissolved oxygen (DO) concentrations decreased as ice thickness increased. The most heavily used lake, L9313, had the most significant mid-winter DO decrease. DO concentrations in the upper water column measured in Lake L9312 during January, February, and March were above 100% DO saturation.

Turbidity

Consistent turbidity trends were not noted in the study lakes. In three of the lakes, turbidity values increased over the course of the winter and then dropped again by mid-August. The four remaining lakes, however, including the two permanent water source lakes, experienced decreases in turbidity values over the course of the winter. Of those four, three showed increased turbidity between late-April and mid-August, and the fourth continued to decrease.

3.3 Alpine Analytical Parameters

Unlike in situ monitoring that was carried out at approximately three-foot intervals through the water column, analytical samples were collected at a single discreet depth that represented the point midway between the bottom of the ice, or in summer the water surface, and the lake bottom. Analytical laboratory reports are provided in Appendix D.

Biochemical Oxygen Demand

Without exception, BOD results were non-detect at all lakes over the course of the investigation (Appendices C and D).

Chemical Oxygen Demand

COD concentrations between the early-February and late-April sampling events decreased an average of about 15 mg/L. Average concentrations decreased again or stayed the same between the late-April and mid-August sampling events at all lakes.

Analytical Turbidity Measurements

Turbidity sampling was carried out during the initial sampling event in January, but was discontinued after that point. Turbidity concentrations measured during the January sampling event can be found in Appendices C and D.

4.0 Recharge Assessment

The study lakes were monitored during the May and June site visits to document recharge mechanisms. Recharge mechanisms and paths of inflows and outflows were observed and documented by ground reconnaissance. Aerial photographs for each of the lakes are presented in Appendix A. Recharge observations are summarized below. Water surface elevation measurements are summarized in Appendix C.

As previously discussed, water surface elevations at Lakes L9312 and L9313 were measured with permanent staff gages. Water surface elevations were surveyed at the remaining lakes based on temporary benchmarks installed by Kuukpik/LCMF. All elevations for the lakes are reported in BPMSL. Kuukpik/LCMF provided survey assistance throughout the program.

4.1 Lake L9312

It was apparent that Lake L9312 (refer to Photo A-1) was recharged by overflow from the Sakoonang Channel. Water was observed flowing from the Sakoonang Channel into Lake M9525 and eventually into Lake L9312 on May 25. Staff gage readings indicate that the lake was filled to the point of overflow and that, as the water surface elevation of the Sakoonang Channel began to decrease, so too did the water surface elevation in Lake L9312.

4.2 Lake L9313

It was apparent from the observations that Lake L9313 (refer to Photo A-2) was recharged by overflow from the Sakoonang Channel. Water was observed flowing from the Sakoonang Channel into Lake M9525 and then into Lake L9313 through the low divide separating these lakes on May 25. The water surface elevation in Lake L9313 reached a peak elevation on May 25. The water surface elevation then receded as water levels in the river dropped.

4.3 Lake L9310

Recharge to this lake (refer to Photo A-3) was by local snowmelt and runoff only. No evidence of recharge from the Sakoonang Channel was observed. Water surface elevation surveys indicate that water levels rose from breakup runoff and subsequently dropped due to drainage and/or evaporation between June and August.

4.4 Lake L9282

Recharge to this lake (refer to Photo A-4)was by local snowmelt and runoff only. No evidence of recharge from the Sakoonang Channel was observed. Observations indicate that recharge flows in the channel between Lake L9282 and the Sakoonang Channel came close but did not reach Lake L9282.

4.5 Lake L9342

Recharge to Lake L9342 (refer to Photo A-5) was caused by local snowmelt and runoff only. No evidence of recharge from the Sakoonang Channel was observed, however a hydraulic connection to Lake L9282 was observed on the east end of Lake L9342.

4.6 Lake L9283

Recharge to the lake (refer to Photo A-6) was caused by local snowmelt and runoff only. No evidence of recharge from the Sakoonang Channel was observed. A water surface elevation increase was noted in June followed by a subsequent decrease in August.

4.7 Lake L9275

Recharge to the lake (refer to Photo A-7) was caused by local snowmelt and runoff only. No evidence of recharge from the Tamayayak or East Channels was observed. Water surface elevation surveys indicate that water levels increased in June from breakup runoff and subsequently decreased due to drainage and/or evaporation between June and August.

5.0 References

Natural Resource Conservation Service (NRCS). 2002a. United States Department of Agriculture, *Alaska Basin Outlook Report, April 1, 2002*.

———. 2002b. Alaska Basin Outlook Report, May 1, 2002.

Michael Baker Jr., Inc. 2000. *Alpine Development Water Supply, 1999 Monitoring and Assessment*. Prepared for ARCO Alaska, Inc., Anchorage, Alaska.

Appendix A Alpine Lakes Photographs

Figure A-1 Lake L9313 on June 29, 2002.

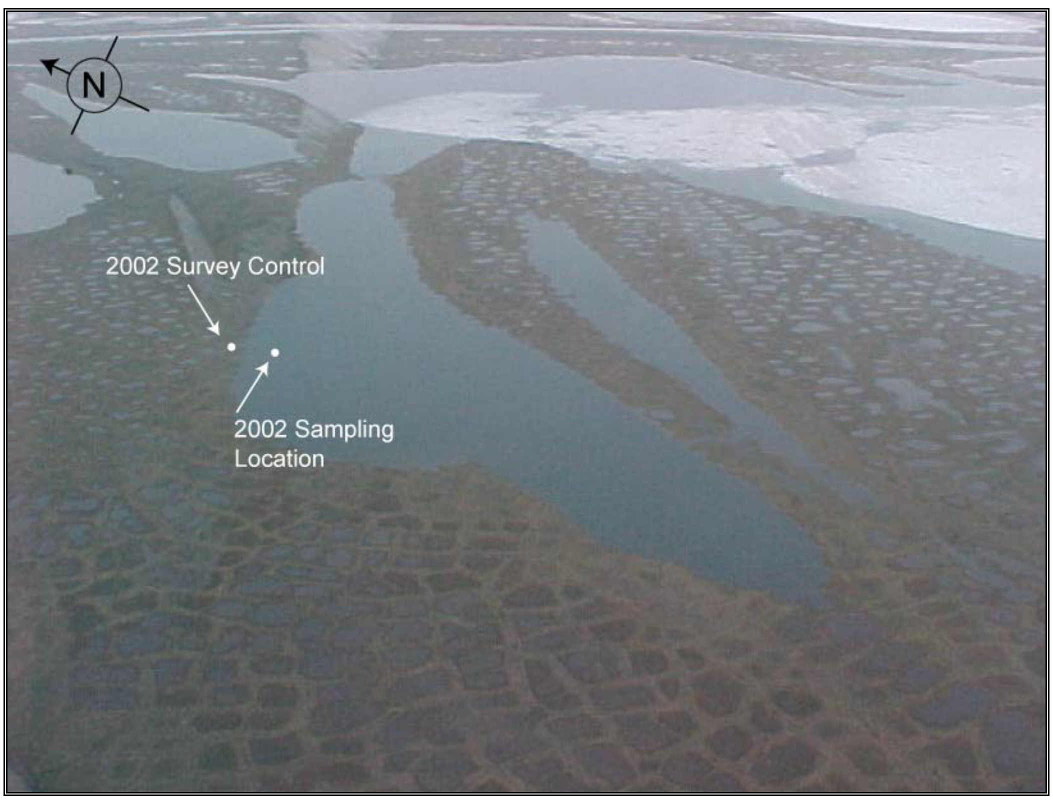


Figure A-2 Lake L9342 on June 29, 2002.

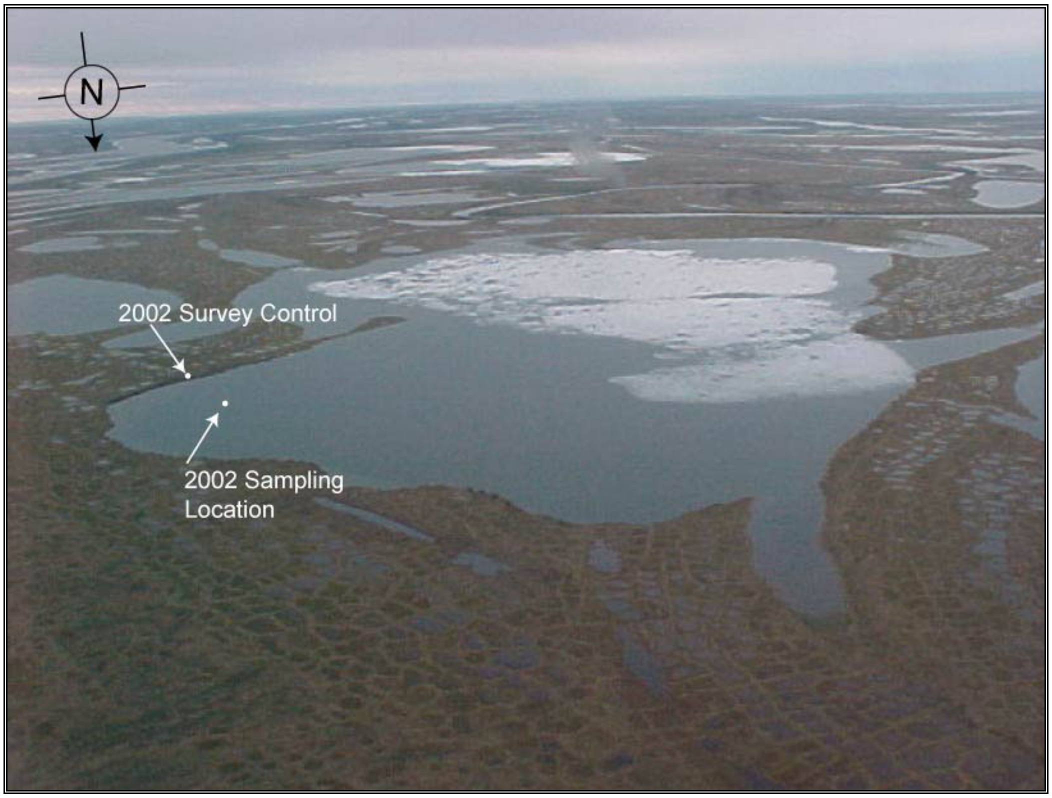


Figure A-3 Lake L9282 on June 29, 2002.

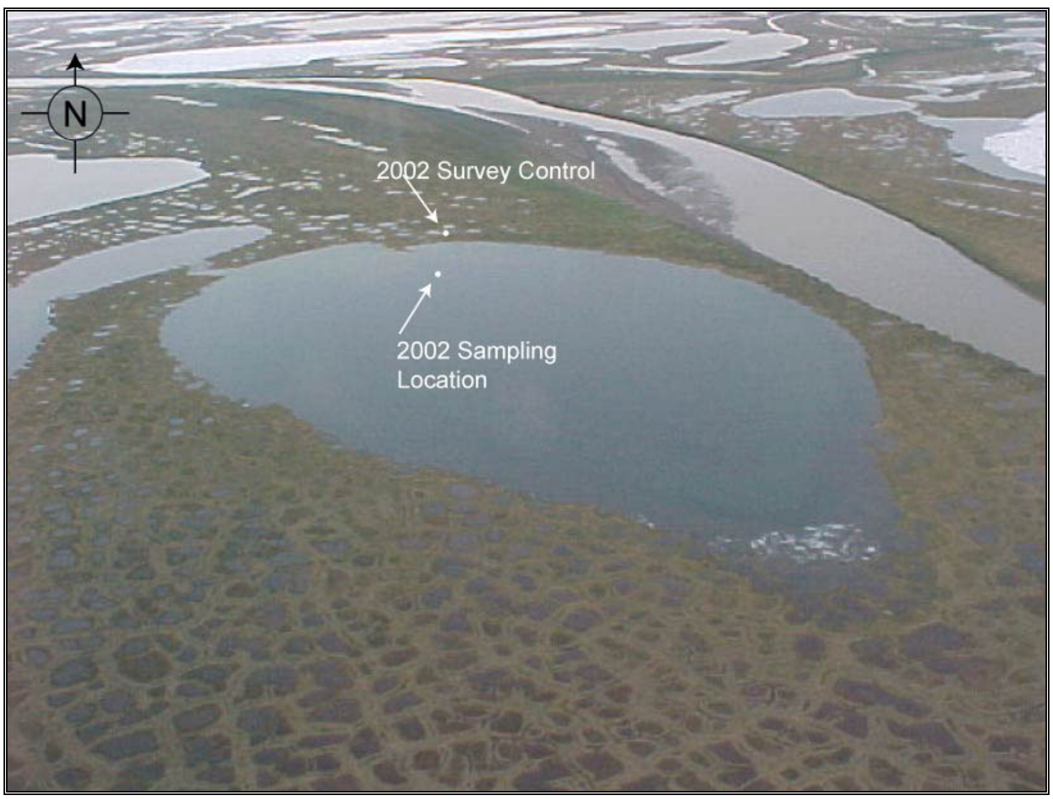


Figure A-4 Lake L9283 on June 29, 2002.

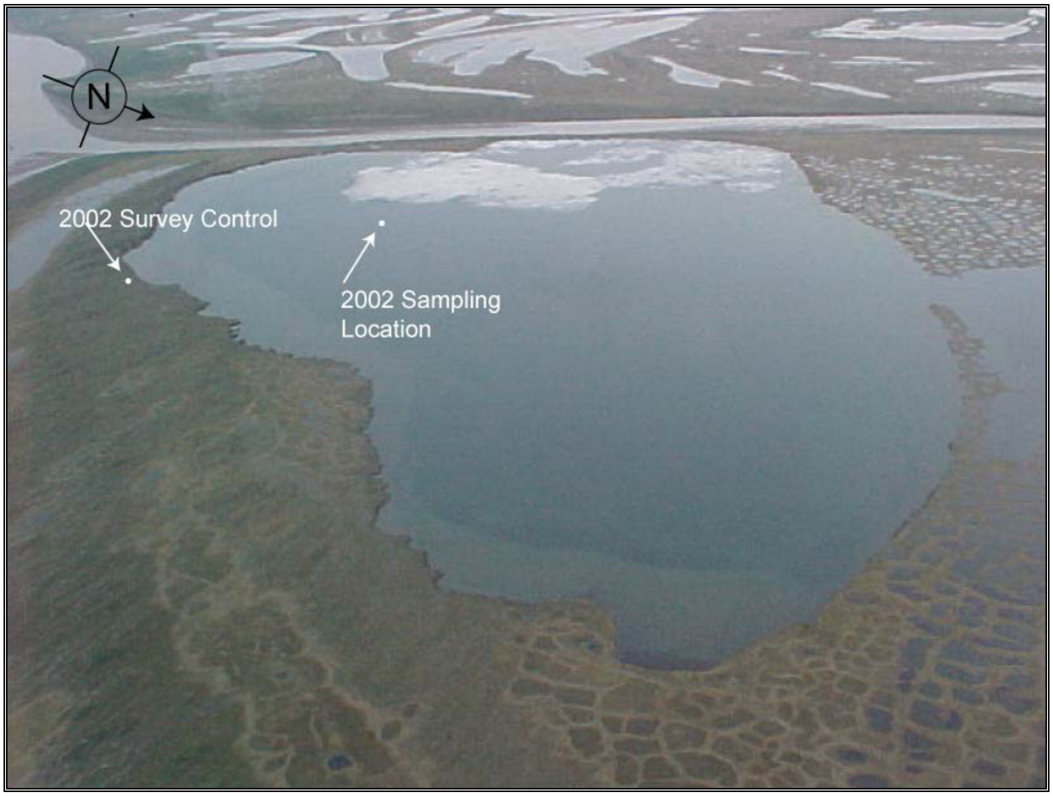


Figure A-5 Lake L9275 on June 29, 2002.

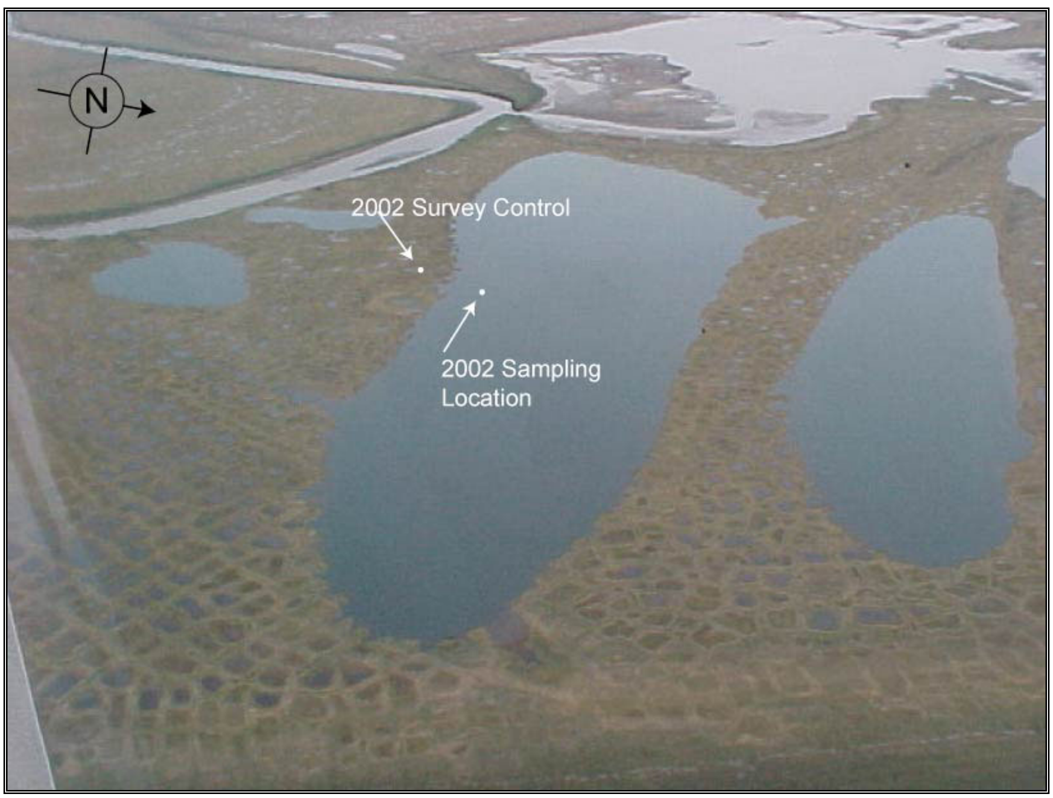


Figure A-6 Lake L9310 on June 29, 2002.

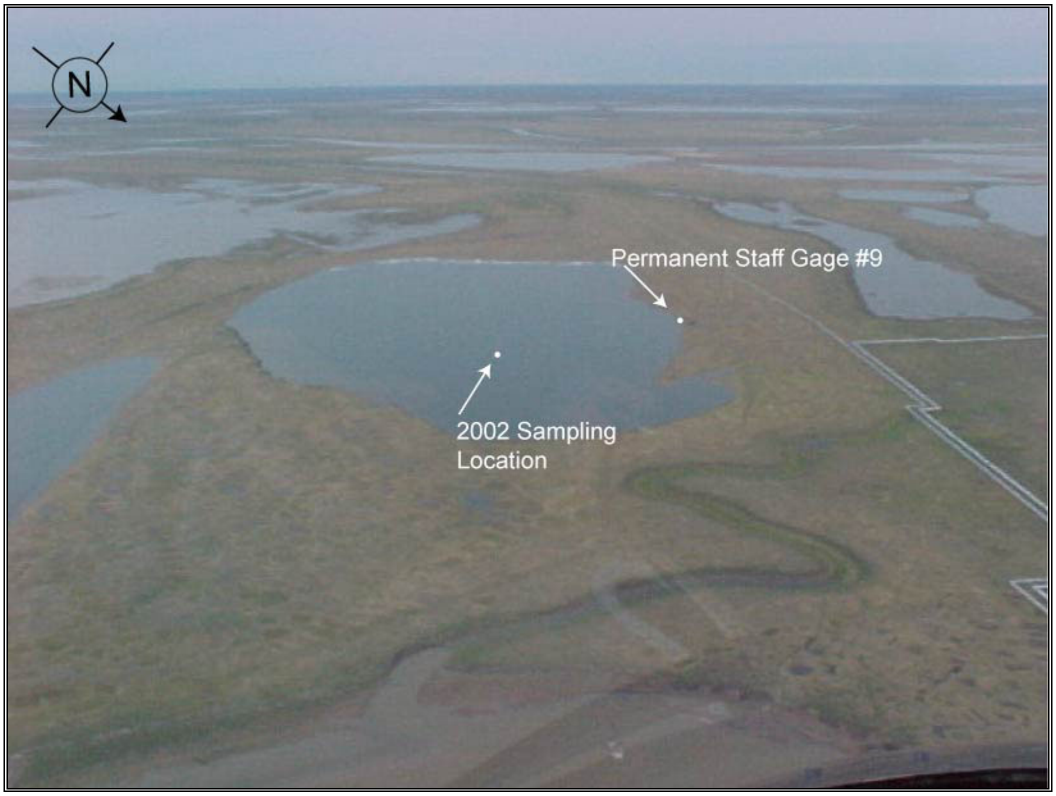


Figure A-7 Lake L9312 on June 29, 2002.

Table B-1
Alpine Pump Lakes Winter 2002 Water Use

Permit / Source	Type of Water Use	USE IN GALLONS										
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct-Dec	YTD
A2001-110 Expires 01/03/2007												
L9828	Ice Road/Pad	0	0	8,937,894	0	0	0	0	0	0	0	8,937,894
Source Monthly Totals		0	0	8,937,894	0	0	0	0	0	0	0	8,937,894
LAS 18597 Expires 12/30/2002												
L9282	Ice Road/Pad	0	0	3,767,677	345,870	0	0	0	0	0	0	4,113,547
Source Monthly Totals		0	0	3,767,677	345,870	0	0	0	0	0	0	4,113,547
L9282 Total		**0**	**0**	**12705571**	**345870**	**0**	**0**	**0**	**0**	**0**	**0**	**13,051,441**
L9312	Camp Supply	1,798,000	3,137,100	50,500	635,600	835,230	566,041	0	0	0	0	7,022,471
	Drilling/Well Support	0	0	0	163,567	969,003	1,445,659	0	0	0	0	2,578,229
Source Monthly Totals		1,798,000	3,137,100	50,500	799,167	1,804,233	2,011,700	0	0	0	0	9,600,700
L9312 Total		**1,798,000**	**3,137,100**	**50,500**	**799,167**	**1,804,233**	**2,011,700**	**0**	**0**	**0**	**0**	**9,600,700**
L9313	Camp Supply	362,800	228,000	1,355,300	138,300	0	206,090	1,392,750	1,902,400	1,602,200	0	7,187,840
	Drilling/Well Support	0	0	0	99,900	106,060	205,000	0	0	0	0	410,960
Source Monthly Totals		362,800	228,000	1,355,300	238,200	106,060	411,090	1,392,750	1,902,400	1,602,200	0	7,598,800
L9313 Total		**362,800**	**228,000**	**1,355,300**	**238,200**	**106,060**	**411,090**	**1,392,750**	**1,902,400**	**1,602,200**	**0**	**7,598,800**

All water use data provided by CPA

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Table C-1
2002 Alpine Lakes Monitoring and Recharge Study
Physical and In-Situ Water Quality Parameters

2002 Summary (January through August)

Lake Number	Sample Date	Sample Time	Sample Location Coordinates (NAD27)	Ice Surface Elevation (BPMSL)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	Free-board[2] (ft)	In-Situ Parameters: Sample Depth[3] (ft)	Temp. (°C)	pH	Conduc-tivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
PERMANENT USE LAKE															
L9312	1/16/02	14:50	N70°19'53.4" W150°56'48.6"	7.47	7.34	11.40	3.10	0.10	4.0	0.4	7.6	0.1	0.0	16.0*	0.3
									7.0	1.5	7.6	0.1	0.0	14.2*	0.5
									10.0	2.5	7.5	0.1	0.0	9.8	0.4
	2/9/02	11:05		7.46	7.36	11.4	3.85	0.1	5.0	0.6	7.5	0.1	0.0	15.9*	1.2
									8.0	1.6	7.3	0.1	0.0	15.5*	1.5
									10.0	2.3	7.2	0.1	0.0	13.7	2.1
	3/11/02	18:00		7.51	7.32	11.53	4.67	0.19	5.0	1.3	7.3	0.1	0.0	15.4*	2.0
									8.0	2.1	7.3	0.1	0.0	14.3*	1.6
									10.0	2.6	7.2	0.1	0.0	10.0	1.8
	4/6/02	17:20		7.63	7.31	11.68	5.4	0.29	6.5	2.0	6.9	0.1	0.0	9.7	0.6
									9.5	2.9	7.1	0.1	0.0	9.3	0.6
	5/11/02			-	-	Not Sampled[5]									
	5/31/02	18:35		-	8.05	No Sampling Planned									
	6/29/02	11:00		-	7.98	No Sampling Planned									
	8/14/02	16:25		-	7.74	11.9	-	-	4.0	9.4	8.2	0.0	0.0	11.3	0.5
									7.0	9.3	8.0	0.0	0.0	11.3	0.5
									10.0	9.3	7.8	0.1	0.0	11.2	0.6

Notes:
1 - Total depth is measured from the top of ice (in summer water surface) to the lake bottom.
2 - Freeboard is the distance from the top of ice to the water surface.
3 - Sample depth is measured from the top of ice in winter, from water surface in summer.
4 - In-situ turbidity error is likely a result of insufficient ambient light in under-ice conditions.
5 - Lake was not sampled as tundra travel restrictions did not permit access.
6 - DO concentrations with an asterisk exceed 100% saturation.

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Table C-1 (continued)
2002 Alpine Lakes Monitoring and Recharge Study
Physical and In-Situ Water Quality Parameters **2002 Summary (January through August)**

Lake Number	Sample Date	Sample Time	Sample Location Coordinates (NAD27)	Ice Surface Elevation (BPMSL)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	Free-board[2] (ft)	In-Situ Parameters: Sample Depth[3] (ft)	Temp. (°C)	pH	Conduc-tivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
PERMANENT USE LAKE															
L9313	1/16/02	17:10	N70°20'29.3" W150°56'20.2"	6.32	6.04	9.40	3.70	0.30	4.7	0.6	8.2	0.3	0.0	10.8	0.6
									7.7	1.9	7.5	0.3	0.0	9.5	0.6
	2/9/02	13:01		6.28	5.98	9.45	4.35	0.3	5.3	1.1	7.1	0.4	0.0	7.1	1.1
									8.3	2.1	7.1	0.4	0.0	6.0	1.1
	3/12/02	7:40		6.43	5.97	9.5	5.43	0.46	6.0	1.7	6.3	0.4	0.0	3.8	1.1
									9.0	2.2	6.3	0.5	0.0	2.8	1.2
	4/7/02	7:55		6.31	5.95	9.38	5.8	0.36	6.8	1.4	6.9	0.5	0.0	0.1	0.9
									8.0	2.1	6.9	0.6	0.0	0.0	0.9
	5/11/02	14:50		6.38	5.96	9.50	5.9	0.42	7.0	3.1	7.3	0.5	0.0	4.0[5]	13.9
	5/31/02	13:50		-	6.55	No Sampling Planned									
	6/29/02	11:00		-	7.98	No Sampling Planned									
	8/14/02	18:45		-	5.87	9.5	-	-	4.7	9.5	8.2	0.2	0.0	11.4	1.0
									7.7	9.4	8.4	0.2	0.0	11.4	1.6

Notes:

1 - Total depth is measured from the top of ice (in summer water surface) to the lake bottom.

2 - Freeboard is the distance from the top of ice to the water surface.

3 - Sample depth is measured from the top of ice in winter, from water surface in summer.

4 - In-situ turbidity error is likely a result of insufficient ambient light in under-ice conditions.

5 - Sample area was likely contaminated by the augering process resulting in an artifically high reading.

Baker

Table C-1 (continued)
2002 Alpine Lakes Monitoring and Recharge Study
Physical and In-Situ Water Quality Parameters — **2002 Summary (January through August)**

Lake Number	Sample		Sample Location Coordinates (NAD27)	Ice Surface Elevation (BPMSL)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	Free-board[2] (ft)	In-Situ Parameters						
	Date	Time							Sample Depth[3] (ft)	Temp. (°C)	pH	Conduc-tivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
R E F E R E N C E L A K E															
L9310	1/16/02	13:50	N70°19'46.6" W150°55'24.9"	9.05	8.78	20.90	4.00	0.30	5.0	0.4	7.7	0.2	0.0	11.3	0.5
									8.0	0.8	7.6	0.2	0.0	10.7	0.5
									11.0	1.6	7.6	0.2	0.0	9.5	0.5
									14.0	1.8	7.5	0.2	0.0	8.1	0.6
									17.0	2.0	7.5	0.2	0.0	6.1	0.9
									19.0	2.1	7.4	0.2	0.0	4.8	1.1
	2/9/02	9:55		9.17	8.87	21.35	5.0	0.3	6.0	0.5	7.6	0.2	0.0	10.2	0.7
									9.0	1.2	7.5	0.2	0.0	9.1	0.7
									12.0	1.6	7.4	0.2	0.0	8.5	0.8
									15.0	1.9	7.3	0.2	0.0	7.5	1.4
									18.0	2.0	7.2	0.2	0.0	5.4	1.8
									20.0	2.1	7.1	0.2	0.0	1.0	1.9
	03/11/02	15:45		9.09	8.76	18.46 [5]	5.59	0.33	6.5	2.5	7.2	0.2	0.0	9.1	0.8
									9.5	2.6	7.2	0.2	0.0	8.1	0.8
									12.5	2.4	7.1	0.2	0.0	7.1	0.8
									15.5	2.5	7.2	0.2	0.0	6.5	1.4
	4/6/02	16:07		9.23	8.8	21.09	6.3	0.46	7.5	1.3	7.8	0.4	0.0	7.9	0.7
									10.5	1.6	7.7	0.4	0.0	7.3	0.8
									13.5	1.9	7.6	0.4	0.0	6.4	0.9
									16.5	2.3	7.6	0.4	0.0	5.8	0.7
									19.5	2.3	7.6	0.4	0.0	5.3	0.8
	5/11/02			-	-	Not Sampled [6]									
	6/1/02	12:20		-	8.83	No Sampling Planned									
	6/29/02	10:30		-	8.89	No Sampling Planned									
	8/14/02	15:00		-	8.61	20.2	-	-	5.0	9.6	8.4	0.1	0.0	10.7	0.4
									8.0	9.4	8.6	0.1	0.0	11.1	0.5
									11.0	9.4	8.7	0.1	0.0	11.0	0.6
									14.0	9.4	8.7	0.1	0.0	10.9	0.5
									17.0	9.3	8.6	0.1	0.0	10.9	1.4
									19.0	9.3	8.7	0.1	0.0	10.8	0.5

Notes:

1 - Total depth is measured from the top of ice (in summer water surface) to the lake bottom.

2 - Freeboard is the distance from the top of ice to the water surface.

3 - Sample depth is measured from the top of ice in winter, from water surface in summer.

4 - In-situ turbidity error is likely a result of insufficient ambient light in under-ice conditions.

5 - March total depth is 2.89 feet shallower than February total depth.
Likely a function of sampling location, butcould be monitoring error.

6 - Lake was not sampled as tundra travel restrictions did not permit access.

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Table C-1 (continued)
2002 Alpine Lakes Monitoring and Recharge Study
Physical and In-Situ Water Quality Parameters **2002 Summary (January through August)**

Lake Number	Sample Date	Sample Time	Sample Location Coordinates (NAD27)	Ice Surface Elevation (BPMSL)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	Free-board[2] (ft)	In-Situ Parameters: Sample Depth[3] (ft)	Temp. (°C)	pH	Conduc-tivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
TEMPORARY USE LAKES															
L9275	1/15/02	16:00	N70°19'37.5" W150°47'38.9"	10.66	10.4	12.50	3.80	0.20	4.8	1.0	8.4	0.2	0.0	14.4	0.8
									7.8	1.4	8.7	0.2	0.0	14.4	0.6
									10.8	1.9	8.8	0.2	0.0	13.6	0.4
	2/8/02	12:29		10.68	10.48	12.5	4.2	0.2	5.2	1.0	7.6	0.3	0.0	12.6	0.6
									8.2	2.0	7.4	0.3	0.0	12.4	0.6
									11.2	2.0	7.5	0.3	0.0	12.0	0.6
	3/11/02	9:00		10.69	10.38	12.84	5.00	0.31	5.0	0.6	7.2	0.3	0.0	11.6	1.3
									8.0	1.3	7.6	0.3	0.0	11.6	0.9
									11.0	1.9	7.8	0.3	0.0	11.4	0.9
	4/6/02	8:15		10.64	10.48	12.65	5.4	0.23	6.5	1.3	6.9	0.3	0.0	9.5	0.7
									9.5	1.9	7.0	0.3	0.0	8.4	0.6
									11.0	2.2	7.2	0.3	0.0	8.5	0.6
	5/11/02			-	-	Not Sampled[5]									
	6/1/02			-	-	No Sampling Planned									
	6/29/02	10:50		-	10.56	No Sampling Planned									
	8/13/02	17:00		-	10.28	12.5	-	-	5.0	8.9	9.0	0.2	0.0	11.3	0.6
									8.5	8.9	9.0	0.2	0.0	11.4	0.5
									11.0	8.9	8.9	0.2	0.0	11.4	0.5

Notes:
1 - Total depth is measured from the top of ice (in summer water surface) to the lake bottom.
2 - Freeboard is the distance from the top of ice to the water surface.
3 - Sample depth is measured from the top of ice in winter, from water surface in summer.
4 - In-situ turbidity error is likely a result of insufficient ambient light in under-ice conditions.
5 - Lakes L9312, L9310 and L9275 were not sampled as tundra travel restrictions did not permit access to these sites.

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Table C-1 (continued)
2002 Alpine Lakes Monitoring and Recharge Study
Physical and In-Situ Water Quality Parameters

2002 Summary (January through August)

Lake Number	Sample Date	Sample Time	Sample Location Coordinates (NAD27)	Ice Surface Elevation (BPMSL)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	Free-board[2] (ft)	In-Situ Parameters: Sample Depth[3] (ft)	Temp. (°C)	pH	Conduc-tivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
TEMPORARY USE LAKES															
L9282	1/16/02	11:05	N70°20'53.3" W150°51'00.2"	9.01	8.69	21.00	3.80	0.30	4.8	0.5	7.9	0.2	0.0	9.1	1.4
									7.8	1.0	7.8	0.2	0.0	8.2	0.7
									10.8	1.2	7.8	0.3	0.0	10.0	0.5
									13.8	1.8	7.7	0.3	0.0	10.4	0.4
									16.8	2.0	7.6	0.3	0.0	9.0	0.6
									19.8	2.3	7.8	0.3	0.0	7.3	0.6
	2/8/02	15:42		9.07	8.77	21.0	4.9	0.3	5.0	1.0	7.7	0.4	0.0	11.8	0.5
									8.0	1.0	7.6	0.4	0.0	10.8	0.5
									11.0	2.0	7.6	0.4	0.0	10.6	0.5
									14.0	2.0	7.6	0.4	0.0	10.7	0.7
									17.0	2.0	7.6	0.4	0.0	10.8	0.9
									20.0	2.0	7.7	0.4	0.0	10.1	0.8
	3/11/02	13:25		9.15	8.71	21.1	5.41	0.44	6.0	1.0	7.4	0.4	0.0	9.4	1.4
									9.0	1.1	7.3	0.4	0.0	9.1	1.9
									12.0	1.5	7.3	0.4	0.0	8.8	0.9
									15.0	1.7	7.3	0.4	0.0	8.3	1.0
									18.0	1.9	7.2	0.4	0.0	8.2	1.0
	4/6/02	13:05		9.19	8.74	21.0	5.8	0.40	7.0	1.3	7.8	0.4	0.0	7.9	0.7
									10.0	1.6	7.7	0.4	0.0	7.3	0.8
									13.0	1.9	7.6	0.4	0.0	6.4	0.9
									16.0	2.3	7.6	0.4	0.0	5.8	0.7
									19.0	2.3	7.6	0.4	0.0	5.3	0.8
	5/11/02	9:40		9.22	8.74	20.8	6.0	0.48	7.0	2.0	6.9	0.3	0.0	10.4	3.5
									10.0	2.6	7.1	0.4	0.0	9.1	1.2
									13.0	2.8	7.1	0.4	0.0	7.4	0.7
									16.0	2.9	7.1	0.4	0.0	6.6	0.6
									19.0	2.7	7.2	0.4	0.0	5.7	1.1
	6/1/02	10:20		-	8.85	No Sampling Planned									
	6/29/02	10:50		-	8.83	No Sampling Planned									
	8/14/02	10:25		-	8.62	13.00	-	-	5	8.9	8.68	0.2	0.0	10.7	0.6
									8	8.9	8.84	0.2	0.0	10.6	0.8
									11.0	8.8	8.8	0.2	0.0	10.6	0.7
									14.0	8.8	8.8	0.2	0.0	10.6	0.6
									17.0	8.8	8.9	0.2	0.0	10.6	0.9
									20.0	8.8	8.9	0.2	0.0	10.5	0.6

Notes:

1 - Total depth is measured from the top of ice (in summer water surface) to the lake bottom.

2 - Freeboard is the distance from the top of ice to the water surface.

3 - Sample depth is measured from the top of ice in winter, from water surface in summer.

4 - In-situ turbidity error is likely a result of insufficient ambient light in under-ice conditions.

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Table C-1 (continued)
2002 Alpine Lakes Monitoring and Recharge Study
Physical and In-Situ Water Quality Parameters

2002 Summary (January through August)

Lake Number	Sample Date	Sample Time	Sample Location Coordinates (NAD27)	Ice Surface Elevation (BPMSL)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	Free-board[2] (ft)	In-Situ Parameters: Sample Depth[3] (ft)	Temp. (°C)	pH	Conduc-tivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
TEMPORARY USE LAKES															
L9283	1/16/02	9:00	N70°20'29.8" W150°50'15.0"	9.08	8.71	9.00	4.00	0.40	5.0	0.5	6.9	0.4	0.0	12.9	1.2
									8.0	0.9	7.2	0.5	0.0	12.1	0.8
	2/8/02	15:02		9.12	8.72	8.7	5.1	0.4	6.0	1.0	7.5	0.5	0.0	7.9	0.8
									7.0	1.0	7.5	0.4	0.0	8.7	1.0
	3/11/02	12:15		9.21	8.74	9.0	6.1	0.47	7.0	1.0	7.7	0.5	0.0	9.8	3.4
									8.0	2.0	7.5	0.5	0.0	10.2	6.0
	4/6/02	11:50		9.23	8.74	9.0	6.3	0.50	7.3	0.6	7.4	0.6	0.0	2.2	1.4
	5/11/02	12:20		9.37	8.77	9.1	6.7	0.60	7.7	2.3	7.2	0.7	0.0	1.7	2.1
	6/1/02	11:00		-	8.85	No Sampling Planned									
	6/29/02	10:04		-	8.86	No Sampling Planned									
	8/14/02	8:15		-	8.62	8.9	-	-	5	8.1	8.47	0.2	0.0	11.1	0.8
									8.0	8.0	8.5	0.2	0.0	11.0	0.9

Notes:

1 - Total depth is measured from the top of ice (in summer water surface) to the lake bottom.

2 - Freeboard is the distance from the top of ice to the water surface.

3 - Sample depth is measured from the top of ice in winter, from water surface in summer.

4 - In-situ turbidity error is likely a result of insufficient ambient light in under-ice conditions.

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Table C-1 (continued)
2002 Alpine Lakes Monitoring and Recharge Study
Physical and In-Situ Water Quality Parameters

2002 Summary (January through August)

Lake Number	Sample Date	Sample Time	Sample Location Coordinates (NAD27)	Ice Surface Elevation (BPMSL)	Water Surface Elevation (BPMSL)	Total Depth[1] (ft)	Ice Thickness (ft)	Free-board[2] (ft)	In-Situ Parameters: Sample Depth[3] (ft)	Temp. (°C)	pH	Conduc-tivity (mS/cm)	Salinity (%)	Dissolved Oxygen (mg/L)	Turbidity by Hach Meter (NTU)
TEMPORARY USE LAKES															
L9342	1/16/02	12:20	N70°20'50.1" W150°53'43.7"	9.01	8.71	11.30	4.00	0.30	5.0	0.6	7.7	0.1	0.0	10.0	0.4
									8.0	1.4	7.5	0.1	0.0	9.6	0.3
									10.0	1.9	7.2	0.2	0.0	8.1	0.4
	2/9/02	8:54		9.01	8.81	11.3	4.7	0.2	5.7	1.3	6.5	0.2	0.0	10.0	0.7
									8.7	1.9	6.7	0.2	0.0	9.3	0.6
									10.0	2.4	6.8	0.2	0.0	7.2	0.9
	3/11/02	14:45		9.04	8.77	10.78	5.5	0.27	6.5	1.1	6.2	0.2	0.0	8.5	1.4
									9.5	2.1	6.4	0.2	0.0	8.1	1.6
	4/6/02	14:05		9.13	8.85	11.17	6.0	0.29	7.0	1.8	7.6	0.2	0.0	5.7	0.5
									10.0	2.4	7.4	0.2	0.0	4.5	0.4
	5/11/02	8:20		9.23	8.79	11.23	6.2	0.44	7.2	2.4	6.3	0.2	0.0	6.8	5.0
									10.2	3.2	6.3	0.2	0.0	6.3	1.6
	6/1/02	9:40		-	8.88	No Sampling Planned									
	6/29/02	8:45		-	8.86	No Sampling Planned									
	8/14/02	13:00		-	8.63	11.80	-	-	5.0	8.9	8.34	0.1	0.0	11.0	0.8
									8.0	8.8	8.32	0.1	0.0	10.9	0.5
									10.0	8.8	8.4	0.1	0.0	10.8	0.4

Notes:
1 - Total depth is measured from the top of ice (in summer water surface) to the lake bottom.
2 - Freeboard is the distance from the top of ice to the water surface.
3 - Sample depth is measured from the top of ice in winter, from water surface in summer.
4 - In-situ turbidity error is likely a result of insufficient ambient light in under-ice conditions.

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Table C-2
2002 Alpine Lakes Monitoring and Recharge Study
Analytical Water Quality Parameters **2002 Summary (January through August)**

Lake Number	Sample Date	Sample Time	Analytical Sample Depth[1] (ft)	Biochemical Oxygen Demand by EPA Method 405.1 (mg/L)	Chemical Oxygen Demand by EPA Method 410.4 (mg/L)	Total Dissolved Solids by SM 2540C (mg/L)
PERMANENT USE LAKES						
L9312	1/16/02	14:50	7.3	U (2.0)	38.4	56
	2/9/02	11:05	7.3	U (2.0) [2]	28.0	Not Analyzed
	3/11/02	18:00	8.1	U (2.0) [2]	U (20.0)	Not Analyzed
	4/6/02	17:20	8.5	U (2.0) [2]	U (20.0)	Not Analyzed
	05/11/02	Not Sampled [3]				
	8/14/02	16:45	7.5	U (2.0)	U (20.0)	Not Analyzed
L9313	1/16/02	17:10	6.5	U (2.0)	46.7	218
	2/9/02	13:01	6.8	U (2.0) [2]	U (20.0)	Not Analyzed
	3/12/02	7:40	7.4	U (2.0)	U (20.0)	Not Analyzed
	4/7/02	7:55	7.6	U (2.0)	U (20.0)	Not Analyzed
	5/11/02	14:50	8.2	U (2.0)	23.0	Not Analyzed
	8/14/02	18:45	7.5	U (2.0)	U (20.0)	Not Analyzed
REFERENCE LAKE						
L9310	1/16/02	13:50	12.5	U (2.0)	34.3	106
	2/9/02	9:55	13.0	U (2.0) [2]	U (20.0)	Not Analyzed
	3/11/02	15:45	12.0	U (2.0) [2]	U (20.0)	Not Analyzed
	4/7/02	16:07	13.7	U (2.0) [2]	U (20.0)	Not Analyzed
	5/11/2002	Not Sampled [3]				
	8/14/02	15:00	13.0	U (2.0)	U (20.0)	Not Analyzed
TEMPORARY USE LAKES						
L9275	1/15/02	16:00	8.1	U (2.0)	U (20.0)	146
	2/8/02	12:29	8.3	U (2.0) [2]	44.7	Not Analyzed
	3/11/02	9:00	8.9	U (2.0) [2]	U (20.0)	Not Analyzed
	4/6/02	8:15	9.0	U (2.0) [2]	U (20.0)	Not Analyzed
	5/11/2002	Not Sampled [3]				
	8/13/02	18:15	8.5	U (2.0)	U (20.0)	
L9275 Dup	3/11/02	-	8.9	U (2.0) [2]	U (20.0)	Not Analyzed

Notes:

1 - Sample depth is equal to one-half the distance between the bottom of ice (in summer the water surface) and the bottom of the lake.

2 - Sample holding time had expired upon delivery to lab.

3 - Lakes L9312, L9310 and L9275 were not sampled in May 2002, as tundra travel restrictions did not permit access to these sites.

U = Analyte was not detected at detection limit indicated in parenthesis.

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Table C-2 (continued)
2002 Alpine Lakes Monitoring and Recharge Study
Analytical Water Quality Parameters — **2002 Summary (January through August)**

Lake Number	Sample Date	Sample Time	Analytical Sample Depth[1] (ft)	Biochemical Oxygen Demand by EPA Method 405.1 (mg/L)	Chemical Oxygen Demand by EPA Method 410.4 (mg/L)	Total Dissolved Solids by SM 2540C (mg/L)
TEMPORARY USE LAKES						
L9282	1/16/02	11:05	12.5	U (2.0)	38.4	210
	2/8/02	15:42	13.0	U (2.0) [2]	38.4	Not Analyzed
	3/11/02	13:25	13.3	U (2.0) [2]	23.0	Not Analyzed
	4/6/02	13:05	13.4	U (2.0) [2]	20.8	Not Analyzed
	5/11/02	9:40	13.4	U (2.0) [2]	U (20.0)	Not Analyzed
	8/14/02	11:00	13.0	U (2.0)	U (20.0)	Not Analyzed
L9283	1/16/02	9:00	6.5	U (2.0)	U (20.0)	279
	2/8/2002	15:02	6.0	U (2.0) [2]	48.8	Not Analyzed
	3/11/02	12:15	7.6	U (2.0) [2]	27.4	Not Analyzed
	4/6/02	11:50	7.5	U (2.0) [2]	25.2	Not Analyzed
	5/11/02	12:20	7.9	U (2.0) [2]	25.2	Not Analyzed
	8/14/02	9:15	7.0	U (2.0)	U (20.0)	Not Analyzed
L9283 Dup	1/16/02	-	6.5	U (2.0)	48.8	289
	4/6/02	-	7.5	U (2.0) [2]	34.0	Not Analyzed
	8/14/02	-	7.0	U (2.0)	U (20.0)	Not Analyzed
L9342	1/16/02	12:20	7.5	U (2.0)	44.7	104
	2/9/02	8:54	8.0	U (2.0) [2]	53.0	Not Analyzed
	3/11/02	14:45	8.1	U (2.0) [2]	U (20.0)	Not Analyzed
	4/6/02	14:05	8.6	U (2.0) [2]	U (20.00)	Not Analyzed
	5/11/02	8:20	8.7	U (2.0) [2]	U (20.00)	Not Analyzed
	8/14/02	13:20	8.0	U (2.0)	U (20.0)	Not Analyzed
L9342 Dup	2/9/02	-	8.0	U (2.0) [2]	U (20.0)	Not Analyzed
	5/11/02	-	8.7	U (2.0) [2]	U (20.0)	Not Collected

Notes:

1 - Sample depth is equal to one-half the distance between the bottom of ice (in summer the water surface) and the bottom of the lake.

2 - Sample holding time had expired upon delivery to lab.

U = Analyte was not detected at detection limit indicated in parenthesis.

Alpine Facilitiy and Vicinity 2002 Lake Monitoring and Recharge Study
November 2002

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