

**U.S. Department of the Interior
U.S. Geological Survey**

Water-Quality Data from Lakes and Streams in the Grand Portage Reservation, Minnesota, 1997–98

by Thomas A. Winterstein

Open-File Report 00–364

Prepared in cooperation with the Grand Portage Reservation

U.S. Department of the Interior

Bruce Babbitt, Secretary

U.S. Geological Survey

Charles G. Groat, Director

Use of trade, product, industry, or firm names in this report is for descriptive or location purposes only and does not constitute endorsement of products by the U.S. Government.

Mounds View, Minnesota, 1999

For additional information write to:

District Chief

U.S. Geological Survey, WRD

2280 Woodale Drive

Mounds View MN 55112

Copies of this report can be purchased from:

U.S. Geological Survey

Branch of Information Services

Box 25286

Federal Center

Denver CO 80225

For more information on the USGS in Minnesota, you may connect to the Minnesota District home page at <http://mn.water.usgs.gov>

For more information on all USGS reports and products (including maps, images, and computerized data), call 1-888-ASK-USGS

Open-File Report 00-364

Contents

Introduction 1

Methods of investigations and results 1

References cited..... 4

Supplemental information 5

Illustrations

Figure 1. Map showing location of study area and data collection sites in the Grand Portage Reservation, northeastern Minnesota..... 2

Figure 2. Piper diagram showing percentage distribution of major ion concentrations determined for water sampled from lakes and streams in the Grand Portage Reservation, Minnesota, 1997-98 3

Tables

1. Water-quality data collected from lakes and streams in the Grand Portage Reservation, 1997-98 6

2. Physical characteristics of Cuffs, Little, Loon, and Speckled Trout Lakes, Grand Portage Reservation, 1997-98..... 11

3. Relative percent difference between concentrations of constituents in the sample and replicate sample from Speckled Trout and Little Lake 15

4. Trace metal and organic compounds in the sediments of Cuffs and Loon Lakes, May and September 1998 16

Conversion Factors, Water-Quality Abbreviations, and Sea Level Datum.

<u>Multiply</u>	<u>By</u>	<u>To obtain</u>
inch (in.)	2.54	centimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
degrees Fahrenheit	°C = (°F – 32) / 1.8	degrees Celsius

Chemical concentrations are given in metric units. Chemical concentrations of substances in water are given in milligrams per liter (mg/L), nanograms per liter (ng/L), or micrograms per liter (µg/L). Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as mass (milligrams) of solute per unit volume (liter) of water.

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Water year: The water year is October 1 through September 30 and is named for the calendar year in which it ends.

Water-Quality Data from Lakes and Streams in the Grand Portage Reservation, Minnesota, 1997-98

Thomas A. Winterstein

INTRODUCTION

The Grand Portage Reservation is located in northeastern Cook County, Minnesota (fig. 1). In 1997 and 1998 the U.S. Geological Survey (USGS) conducted a study, in cooperation with the Grand Portage Band of Chippewa, to determine the quality of water in selected inland lakes and streams in the Reservation. The USGS collected and analyzed water from two streams, two wetlands, and four lakes (fig 1). Water samples were collected in the spring and fall of 1997 and 1998. In addition, samples of bottom sediments were collected from two of the four lakes in 1998.

The purpose of this report is to present the data collected by the USGS from the study during 1997-98. Water-quality data include temperature, pH, specific conductance, dissolved oxygen, alkalinity, and concentrations of major ions, nutrients, and trace metals. Lake sediment data include concentrations of trace metals and selected organic compounds.

METHODS OF INVESTIGATION AND RESULTS

Water samples for water-quality analysis were collected from the two streams, two wetlands, and four lakes during June and October 1997, and May and September 1998 (fig. 1, and table 1, at the back of the report). The samples were collected, treated, and stored in accordance with procedures described in Horowitz and others (1994).

The water-quality samples from the four lakes and Swamp Lake Wetland were collected with a Kemmerer sampler. Each of the four lakes were divided into three equal areas and a composite sample was made from equal volumes of water collected at the center of each area. The samples were collected at mid-depth because these lakes are shallow. The sample from Swamp Lake Wetland was collected at mid-depth from the center of a stream that flowed from the wetland into Swamp Lake. The collection point was inside the wetland about one-quarter of a mile upstream from the mouth of the stream. The water-quality samples from Red Rock Creek, Red Rock Creek tributary, and the outlet stream from Center Lake Creek Wetland were collected with a peristaltic pump.

The samples were analyzed at the USGS National Water Quality Laboratory (NWQL) in Arvada, Colorado for major ions, nutrients, and trace metals.

Field measurements (temperature, pH, specific conductance, and dissolved oxygen) were made in accordance with procedures described in Wilde and Radtke (1998). The measurements were made with a portable, multiparameter meter calibrated at the start of each sampling day. In lakes, measurements were made at intervals between the lake surface and lake bottom. Alkalinity was determined by incremental titration.

The field measurements and the analytical results from NWQL are in tables 1 and 2, at the back of the report and in figure 2.

Six quality assurance samples were collected. Two replicates were collected: one from Speckled Trout Lake during May 1998 and one from Little Lake during September 1998. Four field blanks were collected: one before sampling Red Rock Creek above Sawmill during June 1997, one before sampling Little Lake during October 1997, one before sampling Cuffs Lake during May 1998, and one before sampling Loon Lake during September 1998 (table 1).

Replicate samples are collected to assess the quality, reliability, and precision (reproducibility) of the data generated by the analysis of the samples for chemical constituents. The relative percent difference between the values for the sample and the replicate sample are shown in table 3, at the back of the report. The relative percent difference was calculated as

$$\frac{X_1 - X_2}{X_1 + X_2} \times 100,$$

where X_1 is the value for the sample and X_2 is the value for the replicate sample.

Field blanks were collected by passing inorganic-free, de-ionized water through all sample equipment contacted by the actual sample. Field blanks are collected to ensure that equipment cleaning between sampling sites remove all contamination from the previous site, that sampling and sample-processing procedures do not contaminate the equipment, and that transporting and handling the sampling equipment between sites does not contaminate the equipment.

The concentrations of analyzed constituents in the field blank were below the detection limit or very low

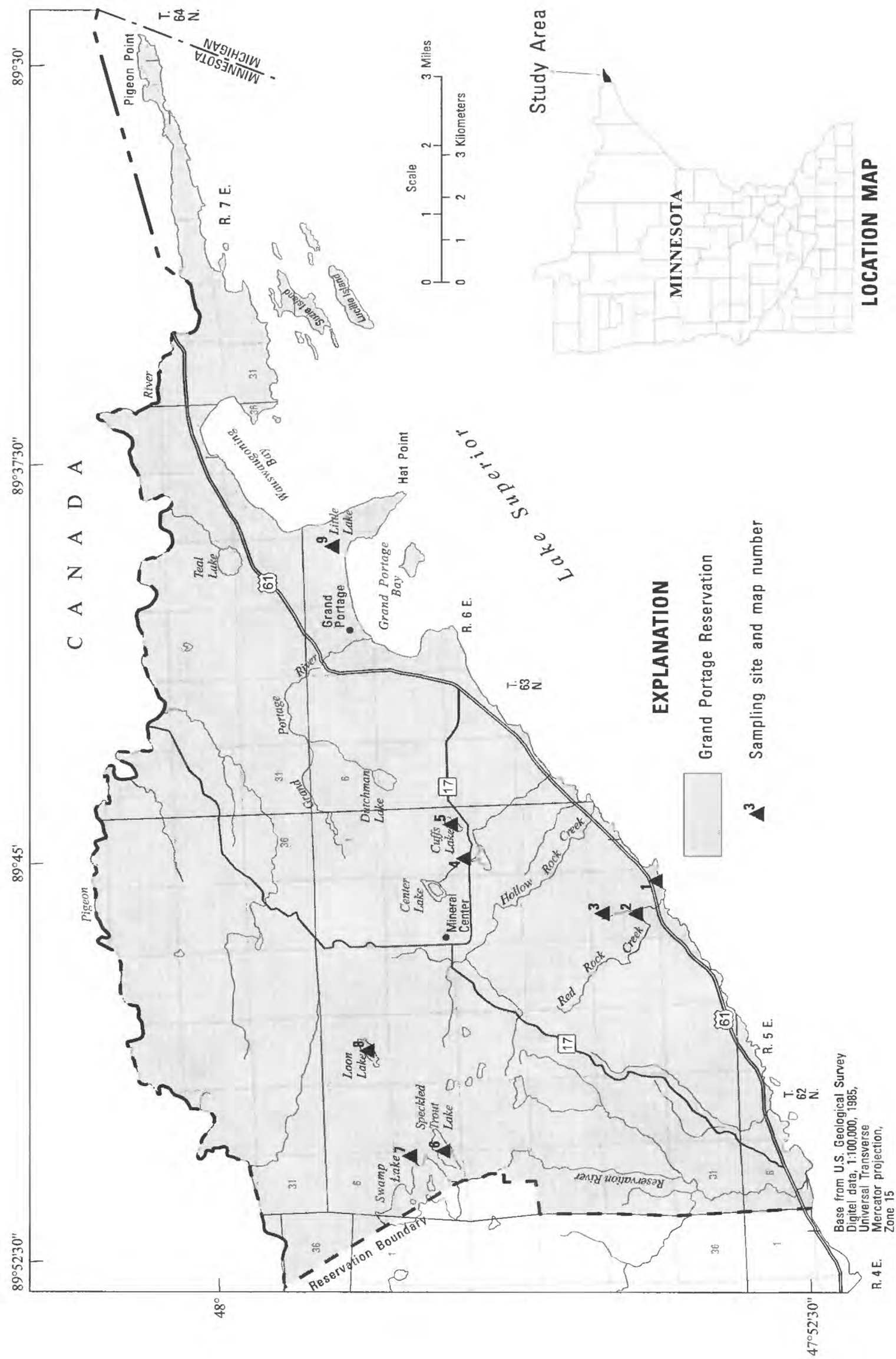


Figure 1. Location of the study area and data collection sites in the Grand Portage Reservation, northeastern Minnesota.

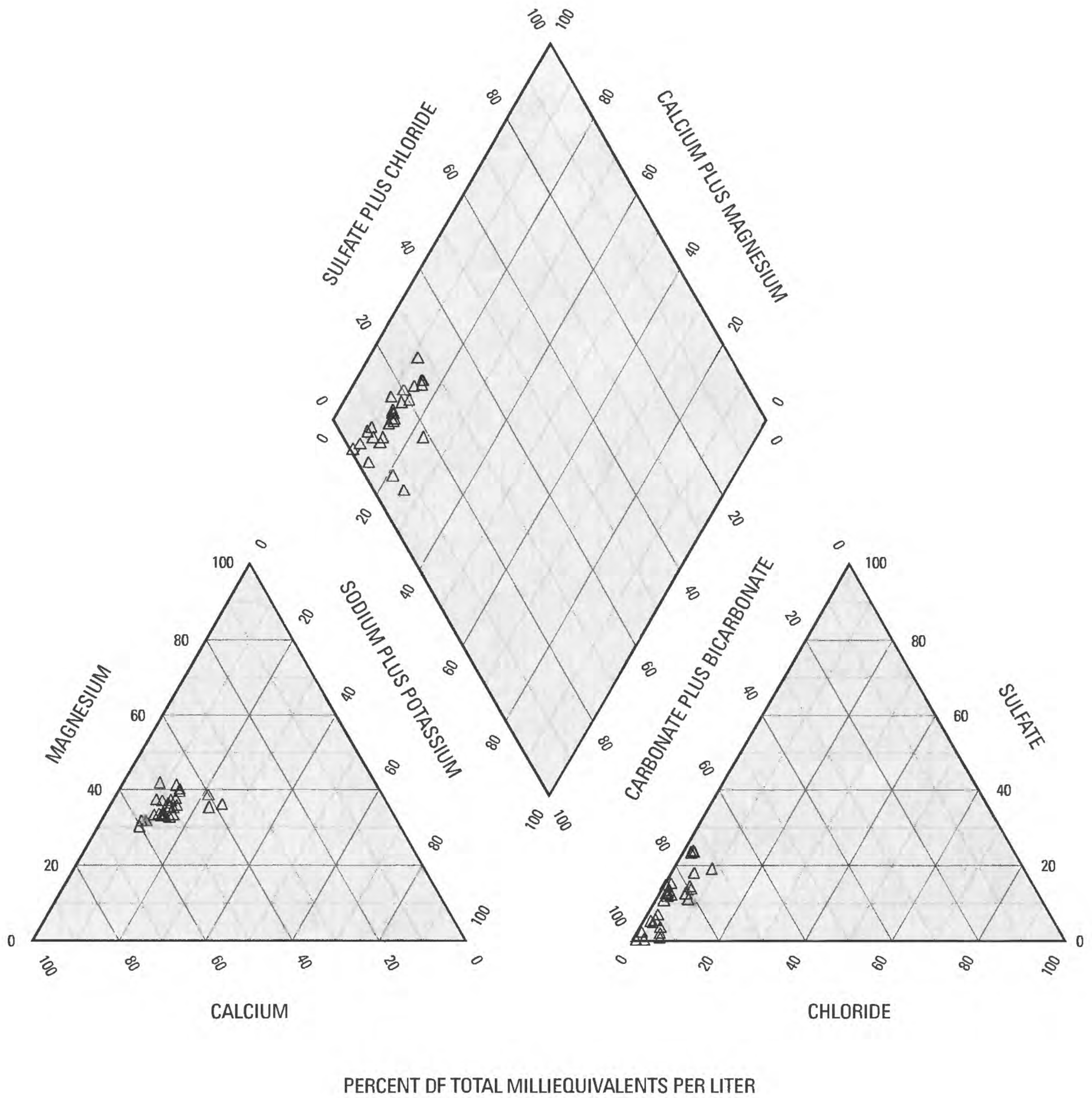


Figure 2. Percentage distribution of major ion concentrations determined for water sampled from lakes and streams in the Grand Portage Reservation, Minnesota, 1997-98

compared to the concentrations of the constituents in the samples from the wells, except as noted below. The concentrations of ammonia in the field blanks for Cuffs Lake, May 7, 1998, and Loon Lake, September 9, 1998, were close to or above the concentrations reported for the samples from the lakes for these days. The concentration of orthophosphate in the field blank for Loon Lake, September 9, 1998, was very close to the concentration reported for the lake for this date. The concentrations of chloride and sulfate were much greater in the field blank for Red Rock Creek above Sawmill, May 5, 1998, than in the sample taken from the Creek that date. The concentration of dissolved silica in the field blank for Little Lake, October 8, 1997, was close to the concentration in the sample taken from Little Lake that day. The concentration of dissolved copper in the field blank for Cuffs Lake, May 7, 1998, was close to the concentration in the sample from the lake that day. The concentrations of dissolved cop-

per in the field blanks for Loon Lake, September 9, 1998, and Little Lake, October 8, 1997, were as great as concentrations measured in samples from the other lakes and streams.

Lake sediment samples were collected at the center of Cuffs and Loon Lakes. During May 1998, a sample was collected from Loon Lake with a 6-in. by 6-in. by 6-in. Eckman dredge. A polyethylene paddle was used to remove the sample from the sediment collected with the dredge. The sample was removed from the center of the dredge and about 2 in. below the top. During September 1998, samples were collected from Cuffs and Loon Lake with a core barrel made from 2-in. acrylic tubing. The samples were taken from the core barrel just below the water-sediment interface. In both lakes the lake sediment is clay- and silt-sized, black, organic material. The bottom material was analyzed for trace metals and selected organic compounds at the Quanterra Incorporated, Arvada, Colorado. The results

of the analysis are in table 4, at the back of the report.

REFERENCES CITED

- Horowitz, A.J., Demas, C.R., Fitzgerald, K.K., Miller, T.L., and Rickert, D.A., 1994, U.S. Geological Survey protocol for the collection and processing of surface-water samples for the subsequent determination of inorganic constituents in filtered water: U.S. Geological Survey Open-File Report 94-539, 57 p.
- Wilde, F.D., and Radtke, D.B., eds., 1998, Field measurements: U.S. Geological Survey Handbooks for Water-Resources Investigations, Book 9, Chapter A6, unpagged.

SUPPLEMENTAL INFORMATION

Table 1. Water-quality data collected from lakes and streams in the Grand Portage Reservation, 1997-98
[mm, millimeter; $\mu\text{S}/\text{cm}$, microSiemens per centimeter; mg, milligrams; μg , micrograms; L, liter; $^{\circ}\text{C}$, degrees Celsius, <, less than; E, estimated; --, no data; shaded rows are quality-assurance samples]

Sampling site (shown in figure 1)	Station name	Station number	Date	Water temperature (degrees celsius)	Air temper- ature (degrees celsius)	Barometric pressure (mm of Hg)	Specific conductance, field measurement ($\mu\text{S}/\text{cm}$ at 25°C)	Specific conductance, laboratory measurement ($\mu\text{S}/\text{cm}$ at 25°C)	Oxygen, dissolved (mg/L)	pH, field measure- ment (standard units)
1	Red Rock Creek below Sawmill	475417089461701	June 26, 1997	17.5	--	--	61	65	7.4	7.2
			Oct. 8, 1997	12.0	--	732	164	173	6.6	7.4
			May 4, 1998	15.0	--	734	47	90	8	8.3
2	Red Rock Creek above Sawmill	475422089463801	June 26, 1997	16.8	--	748	51	56	7.9	7.4
		Field blank	June 26, 1997	--	--	--	--	2	--	--
			May 5, 1998	12.7	--	734	76	83	7.4	7.8
3	Red Rock Creek tributary	475456089462801	June 24, 1997	12.0	13	740	119	126	7.3	7.6
			May 5, 1998	10.5	--	729	83	90	8.5	8.1
4	Center Lake Creek wet- land	475637089451401	June 24, 1997	14.1	16	727	60	64	1.9	7.2
			Oct. 7, 1997	10.0	--	725	42	49	2.3	6.6
			May 5, 1998	11.2	--	720	42	48	6.3	6.7
5	Cuffs Lake, center of lake	475647089443701	June 24, 1997	18.6	12	728	31	36	5.6	6.9
			Oct. 7, 1997	12.7	--	725	46	52	8.1	7.2
			May 7, 1998	15.7	--	727	43	51	8.1	7.6
		Field blank	May 7, 1998	--	--	--	--	1	--	--
			Sept. 9, 1998	16.0	--	738	50	56	7.8	7.5
6	Speckled Trout Lake	475704089504401	June 25, 1997	20.1	18	--	38	42	8.4	7.5
			Oct. 7, 1997	12.9	--	721	42	48	9.3	7.7
			May 6, 1998	14.6	--	--	37	46	9.1	7.7
		Replicate	May 6, 1998	14.6	--	--	37	47	9.1	7.7
			Sept. 8, 1998	18.2	15	728	47	51	8.6	7.8
7	Swamp Lake Wetland	475729089505401	June 25, 1997	16.2	17	723	27	30	5.4	6.8
			Oct. 7, 1997	9.9	--	721	100	109	4.9	7.1
			May 6, 1998	11.6	--	716	38	48	6.3	7.3
			Sept. 10, 1998	13.9	15	728	102	105	6.2	7.5
8	Loon Lake, center of lake	475759089484701	June 26, 1997	19.8	20	--	19	23	8.1	7.3
			Oct. 8, 1997	12.8	--	712	22	27	9.6	7.5
			May 7, 1998	14.2	--	717	19	25	9.3	8.0
			Sept. 9, 1998	17.8	17	725	24	28	9.0	7.5
		Field blank	Sept. 9, 1998	--	--	--	--	1	--	--
9	Little Lake, center of lake	475813089393001	June 24, 1997	17.1	13	746	108	112	7.6	7.5
			Oct. 8, 1997	14.2	--	731	112	119	8.6	7.8
		Field blank	Oct. 8, 1997	--	--	--	--	3	--	--
			May 5, 1998	17.8	--	733	114	119	9.2	7.8
			Sept. 10, 1998	17.0	17	746	130	133	6.2	7.5
		Replicate	Sept. 10, 1998	17.0	--	746	130	133	6.2	7.5

Table 1. Water-quality data collected from lakes and streams in the Grand Portage Reservation, 1997-98--Continued

Station name	Date	Acid							Nitrogen, nitrite, dissolved (mg/L as N)
		pH, laboratory measurement (standard units)	Total alkalinity, dissolved, incremental titration, field (mg/L as CaCO ₃)	neutralizing capacity, unfiltered, titration to pH 4.5, laboratory (mg/L as CaCO ₃)	Carbonate, dissolved, incremental titration, field measurement (mg/L as CO ₃)	Bicarbonate dissolved, incremental titration, field measurement (mg/L as HCO ₃)	Solids, sum of constituents dissolved (mg/L)	Nitrogen, ammonia dissolved (mg/l as N)	
Red Rock Creek below Sawmill	June 26, 1997	7.4	28	27	0	34	42	<.015	<.010
	Oct. 8, 1997	7.4	78	81	0	95	98	<.015	<.010
	May 4, 1998	7.5	34	35	0	41	53	.038	<.010
Red Rock Creek above Sawmill	June 26, 1997	7.1	24	23	0	29	38	<.015	<.010
	June 26, 1997	7.5	--	1.6	--	--	--	<.015	<.010
	May 5, 1998	7.2	28	30	0	35	51	.037	<.010
Red Rock Creek Tributary	June 24, 1997	7.5	57	60	0	70	72	<.015	<.010
	May 5, 1998	7.4	36	38	0	44	54	.023	<.010
Center Lake Creek Wetland	June 24, 1997	6.7	28	29	0	34	34	<.015	<.010
	Oct. 7, 1997	6.4	17	18	0	21	--	<.015	<.010
	May 5, 1998	6.9	17	18	0	20	25	.041	<.010
Cuffs Lake, center of lake	June 24, 1997	7.5	16	15	0	20	17	<.015	<.010
	Oct. 7, 1997	6.8	20	22	0	24	23	<.015	<.010
	May 7, 1998	7.8	17	18	0	21	24	.035	<.010
	May 7, 1998	7.8	--	1.6	--	--	--	.041	<.010
	Sept. 9, 1998	6.8	22	24	0	27	27	.46	<.010
Speckled Trout Lake	June 25, 1997	7.2	17	18	0	21	24	<.015	<.010
	Oct. 7, 1997	7.4	18	20	0	22	25	<.015	<.010
	May 6, 1998	7.3	18	19	0	22	25	.074	<.010
	May 6, 1998	7.8	18	20	0	22	--	.090	<.010
	Sept. 8, 1998	7.4	20	22	0	24	27	.036	<.010
Swamp Lake Wetland	June 25, 1997	6.7	7	11	0	9	17	<.015	<.010
	Oct. 7, 1997	7.2	48	51	0	59	64	<.015	<.010
	May 6, 1998	7.2	17	18	0	21	28	.033	<.010
	Sept. 10, 1998	7.2	48	51	0	59	59	.034	<.010
Loon Lake, center of lake	June 26, 1997	7.2	7	8	0	9	11	<.015	<.010
	Oct. 8, 1997	7.1	6	9.9	0	7	10	<.015	<.010
	May 7, 1998	6.9	8	8.1	0	10	12	<.020	<.010
	Sept. 9, 1998	7.1	7	9.7	0	9	--	.048	<.010
	Sept. 9, 1998	7.2	--	1.6	--	--	--	.040	<.010
Little Lake, center of lake	June 24, 1997	7.3	41	44	0	50	55	<.015	<.010
	Oct. 8, 1997	7.7	47	48	0	57	60	.015	.042
	Oct. 8, 1997	7.4	1	1.5	--	--	--	<.15	<.010
	May 5, 1998	7.8	39	41	0	48	59	.034	<.010
	Sept. 10, 1998	7.5	36	40	0	44	258	.046	<.010
	Sept. 10, 1998	7.3	36	41	0	44	--	.048	<.010

Table 1. Water-quality data collected from lakes and streams in the Grand Portage Reservation, 1997-98--Continued

Station name	Date	Nitrogen, ammonia plus organic, total (mg/L as N)	Nitrogen,nitrite plus nitrate, dissolved (mg/L as N)	Phosphorus, total (mg/L as P)	Phosphorus, dissolved (mg/L as P)	Phosphorus, orthophos- phate, dissolved (mg/L as P)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)
Red Rock Creek below Sawmill	June 26, 1997	.84	.097	.057	<.010	<.010	7.2	3.1	1.9	.55
	Oct. 8, 1997	.60	<.050	<.010	<.010	<.010	20	8.7	3.4	1.5
Red Rock Creek above Sawmill	May 4, 1998	.57	<.050	<.010	<.010	<.010	9.0	3.8	2.7	.65
	June 26, 1997	.69	.120	.033	<.010	<.010	6.3	2.7	1.6	.58
Red Rock Creek tributary	June 26, 1997	<.20	<.050	<.010	<.010	<.010	<.020	<.010	<.20	<.10
	May 5, 1998	.56	.053	.036	<.010	<.010	7.8	3.7	2.2	.73
Center Lake Creek wetland	June 24, 1997	.38	.114	.061	<.010	<.010	13	5.7	2.9	.79
	May 5, 1998	.32	<.050	<.010	<.010	<.010	8.9	3.9	2.4	.46
Cuffs Lake, center of lake	June 24, 1997	.76	<.050	.020	<.010	<.010	7.1	3.6	1.2	.25
	Oct. 7, 1997	.99	<.050	.020	<.010	<.010	5.1	2.8	1.6	<.10
Speckled Trout Lake	May 5, 1998	.65	<.050	.023	<.010	<.010	4.7	2.4	1.4	.37
	June 24, 1997	.81	<.050	.040	<.010	<.010	3.4	1.8	.99	.29
Swamp Lake Wetland	Oct. 7, 1997	1.1	<.050	.026	<.010	<.010	4.0	2.3	2.5	1.1
	May 7, 1998	--	<.050	--	<.010	<.010	4.1	2.1	2	1.1
Loon Lake, center of lake	May 7, 1998	<.10	<.050	<.010	<.010	<.010	<.020	<.004	<.10	<.10
	Sept. 9, 1998	1.3	<.050	.022	<.010	<.010	4.8	2.8	2.6	.54
Little Lake, center of lake	June 25, 1997	.27	<.050	<.010	<.010	<.010	4.4	1.7	1.2	.23
	Oct. 7, 1997	.42	<.050	<.010	<.010	<.010	4.9	1.9	1.3	.26
Swamp Lake Wetland	May 6, 1998	.40	<.050	.067	<.010	<.010	4.6	1.7	1.2	.18
	May 6, 1998	.51	<.050	.026	<.010	<.010	4.6	1.7	1.3	.18
Loon Lake, center of lake	Sept. 8, 1998	.54	<.050	<.010	<.010	.017	5.3	2.0	1.4	.22
	June 25, 1997	.83	.052	.015	<.010	<.010	4.3	1.4	.68	.18
Little Lake, center of lake	Oct. 7, 1997	.33	<.050	<.010	<.010	<.010	13	4.0	2.1	.44
	May 6, 1998	.63	<.050	<.010	<.010	<.010	5.8	1.9	1.1	.17
Swamp Lake Wetland	Sept. 10, 1998	.43	<.050	<.010	.018	.020	13	4.3	2.4	.17
	June 26, 1997	.53	<.050	<.010	<.010	<.010	2.1	.81	.55	.27
Loon Lake, center of lake	Oct. 8, 1997	.70	<.050	.018	<.010	<.010	2.6	1.1	.74	.32
	May 7, 1998	.47	<.050	.035	<.010	<.010	2.3	.92	.66	.28
Little Lake, center of lake	Sept. 9, 1998	1.1	<.050	.021	<.010	.017	2.6	1.3	.9	.39
	Sept. 9, 1998	<.10	<.050	<.050	<.050	.016	<.020	<.004	<.10	<.10
Swamp Lake Wetland	June 24, 1997	.40	<.050	<.010	<.010	<.010	12	4.5	3.0	.27
	Oct. 8, 1997	.77	<.050	.012	<.010	<.010	12	5.6	3.7	.31
Loon Lake, center of lake	Oct. 8, 1997	<.20	<.050	<.010	<.010	<.010	<.020	<.010	<.20	<.10
	May 5, 1998	.50	<.050	<.010	<.010	<.010	13	4.6	2.8	.35
Swamp Lake Wetland	Sept. 10, 1998	1.5	<.050	<.010	<.010	.018	12	6.3	5.3	.28
	Sept. 10, 1998	1.5	<.050	<.010	<.010	.018	12	6.3	5.3	.27

Table 1. Water-quality data collected from lakes and streams in the Grand Portage Reservation, 1997-98--Continued

Station name	Date	Chloride, dissolved (mg/L as Cl)	Sulfate, dissolved (mg/L as SO ₄)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO ₂)	Aluminum, dissolved (µg/L as Al)	Arsenic, dissolved (µg/L as As)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)
Red Rock Creek below Sawmill	June 26, 1997	.54	1.6	<10	9.4	--	--	--	--	--
	Oct. 8, 1997	2.8	2.9	<10	12	--	--	--	--	--
	May 4, 1998	2.0	5.6	<10	8.7	--	--	--	--	--
Red Rock Creek above Sawmill	June 26, 1997	.44	1.8	<10	8.7	398	<1	17	<1.0	1.5
	May 5, 1998	<10	<10	<10	10	72	<1	<16	<1.0	<1.0
	May 5, 1998	1.4	6.5	<10	.23	<5.0	<1	14	<1.0	<1.0
Red Rock Creek tributary	June 24, 1997	1.0	2.9	<10	11	--	--	--	--	--
	May 5, 1998	.84	5.0	<10	10	--	--	--	--	--
	June 24, 1997	.15	<10	<10	3.9	--	--	--	--	--
Center Lake Creek wetland	Oct. 7, 1997	<10	2.9	<10	6.9	--	--	--	--	--
	May 5, 1998	.20	2.3	<10	3.0	--	--	--	--	--
	June 24, 1997	.30	<10	<10	.36	--	--	--	--	--
Cuffs Lake, center of lake	Oct. 7, 1997	.80	.39	<10	.39	--	--	--	--	--
	May 7, 1998	.92	2.6	.10	<10	65	<1	<16	<1.0	<1.0
	May 7, 1998	<10	<10	<10	<10	<10	<1	<16	<1.0	<1.0
Speckled Trout Lake	Sept. 9, 1998	1.0	.17	<10	.83	31	<1	19	<1.0	<1.0
	June 25, 1997	.24	2.5	<10	3.8	24	<1	17	<1.0	<1.0
	Oct. 7, 1997	.26	2.1	<10	3.8	13	<1	18	<1.0	<1.0
Swamp Lake wetland	May 6, 1998	.26	2.8	<10	3.6	--	--	19	<1.0	<1.0
	May 6, 1998	.24	2.8	<10	3.8	22	<1	<16	<1.0	<1.0
	Sept. 8, 1998	.35	2.6	<10	3.3	18	<1	18	<1.0	<1.0
Loon Lake, center of lake	June 25, 1997	<10	.17	<10	4.8	169	1	18	<1.0	<1.0
	Oct. 7, 1997	.55	2.6	<10	12	12	<1	35	<1.0	<1.0
	May 6, 1998	.20	3.0	<10	5.3	116	<1	22	<1.0	<1.0
Little Lake, center of lake	Sept. 10, 1998	.19	1.8	<10	8.1	12	<1	39	<1.0	<1.0
	June 26, 1997	.14	2.3	<10	.44	--	--	--	--	--
	Oct. 8, 1997	.13	1.8	<10	.27	--	--	--	--	--
Swamp Lake wetland	May 7, 1998	.14	2.5	<10	.15	--	--	--	--	--
	Sept. 9, 1998	<10	2.1	<10	.95	--	--	--	--	--
	Sept. 9, 1998	<10	<10	<10	<10	<10	<1	<16	<1.0	<1.0
Loon Lake, center of lake	June 24, 1997	2.2	7.2	<10	1.6	--	--	--	--	--
	Oct. 8, 1997	3	6.1	<10	.45	--	--	--	--	--
	Oct. 8, 1997	.27	<10	<10	.36	<5.0	<1	9.6	<1.0	<1.0
Swamp Lake wetland	May 5, 1998	3.4	10	.13	1.2	--	--	--	--	--
	Sept. 10, 1998	7.8	10	.12	.44	--	--	--	--	--
	Sept. 10, 1998	7.4	9.1	.12	.42	--	--	--	--	--

Table 1. Water-quality data collected from lakes and streams in the Grand Portage Reservation, 1997-98--Continued

Station name	Date	Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)	Manganese, dissolved (µg/L as Mn)	Molybdenum, dissolved (µg/L as Mo)	Nickel, dissolved (µg/L as Ni)	Selenium, dissolved (µg/L as Se)
Red Rock Creek below Sawmill	June 26, 1997	--	500	--	14	--	--	--
	Oct. 8, 1997	--	100	--	35	--	--	--
	May 4, 1998	--	320	--	4.5	--	--	--
Red Rock Creek above Sawmill	June 26, 1997	6.8	510	<1.0	12	<1.0	1.9	<1
	May 5, 1998	6.4	430	<1.0	64	<1.0	1.7	<1
	May 5, 1998	1.0	<3.0	<1.0	<1.0	<1.0	<1.0	<1
Red Rock Creek Tributary	June 24, 1997	--	15	--	4.8	--	--	--
	May 5, 1998	--	28	--	<4.0	--	--	--
Center Lake Creek Wetland	June 24, 1997	--	1200	--	75	--	--	--
	Oct. 7, 1997	--	740	--	27	--	--	--
	May 5, 1998	--	350	--	8.0	--	--	--
Cuffs Lake, center of lake	June 24, 1997	--	290	--	5.1	--	--	--
	Oct. 7, 1997	--	150	--	3.1	--	--	--
	May 7, 1998	3.0	200	<1.0	<4.0	<1.0	<1.0	<1
Speckled Trout Lake	May 7, 1998	2.4	<10	<1.0	<4.0	<1.0	<1.0	<1
	Sept. 9, 1998	3.4	410	<1.0	6.2	<1.0	<1.0	<1
	June 25, 1997	1.1	15	<1.0	<1.0	<1.0	<1.0	<1
	Oct. 7, 1997	1.8	5.6	<1.0	<1.0	<1.0	<1.0	<1
	May 6, 1998	2.7	45	<1.0	<4.0	<1.0	<1.0	<1
Swamp Lake Wetland	May 6, 1998	2.2	45	<1.0	<4.0	<1.0	<1.0	<1
	Sept. 8, 1998	1.4	<10	<1.0	<4.0	<1.0	<1.0	<1
	June 25, 1997	1.8	480	<1.0	40	<1.0	<1.0	<1
	Oct. 7, 1997	2.1	130	<1.0	48	<1.0	<1.0	<1
	May 6, 1998	4.1	270	<1.0	34	<1.0	<1.0	<1
Loon Lake, center of lake	Sept. 10, 1998	1.4	140	<1.0	25	<1.0	<1.0	<1
	June 26, 1997	--	29	--	<1.0	--	--	--
	Oct. 8, 1997	--	9.8	--	<1.0	--	--	--
	May 7, 1998	--	51	--	<4.0	--	--	--
	Sept. 9, 1998	--	48	--	<4.0	--	--	--
Little Lake, center of lake	Sept. 9, 1998	2.1	<10	<1.0	<4.0	<1.0	<1.0	<1
	June 24, 1997	--	33	--	1.4	--	--	--
	Oct. 8, 1997	--	23	--	<1.0	--	--	--
	Oct. 8, 1997	4.4	<3.0	<1.0	<1.0	<1.0	<1.0	<1
	May 5, 1998	--	26	--	<4.0	--	--	--
	Sept. 10, 1998	--	23	--	<4.0	--	--	--
	Sept. 10, 1998	--	24	--	<4.0	--	--	--

Table 2.. Physical Characteristics of Cuffs, Little, Loon, and Speckled Trout Lakes, Grand Portage Reservation, 1997--98

[The lakes were divided into 3 equal areas. The measurements were made at the center of each area. The Station column is the area that the measurements were made in: C, center; E, eastern; W, western; N, northern; S., southern; NE, northeastern; SW, southwestern. °C, degrees celsius; μS/cm, microSiemens per centimeter at 25 °C; mg/L, milligrams per liter; --, no data]

Lake name	Date	Station	Depth of lake (feet)	Secchi disk depth (feet)	Depth of measurement (feet)	pH	Temperature (°C)	Specific conductivity (μS/cm)	Dissolved oxygen (mg/L)	Dissolved oxygen (percent saturation)
Cuffs Lake	6/24/97	NE	2.6	>2.6	1.3	7.1	18.9	32	5.5	57
		C	2.8	>2.8	1.4	7.0	18.4	31	5.5	62
		SW	2.1	>2.1	1.0	6.8	18.4	30	5.8	62
	7/10/97	NE	1.0	--	0.5	7.3	12.8	45	8.0	79
		C	.5	--	.02	7.1	12.6	45	8.2	80
		SW	1.0	--	.05	7.1	12.7	45	8.3	82
	5/7/98	NE	3.8	>3.8	1	7.6	15.7	43	8.0	84
					3.3	7.5	15.6	43	7.8	81
		C	4.0	>4.0	1	7.5	15.8	43	8.1	84
	9/9/98				3.3	7.2	15.6	39	6.8	70
		SW	3.5	>3.5	1	7.6	16.0	43	8.4	87
		NE	2.5	2.4	1.25	7.9	16.4	51	7.1	74
		C	2.6	>2.6	1.3	7.4	15.8	50	7.7	79
		SW	2.2	>2.2	1.1	7.3	15.8	50	8.7	92
Little Lake	6/24/97	E	2.3	--	1.2	7.7	17.2	109	7.3	78
		C	2.3	--	1.2	7.4	17.2	108	7.8	82
		W	2.0	--	1.0	7.3	16.8	108	8.0	84
	8/10/97	E	--	--	--	8.2	13.7	110	7.7	84
		C	--	--	--	7.6	14.4	111	9.0	90
		W	--	--	--	7.6	14.5	116	9.2	96
	5/5/98	E	2.2	>2.2	1.1	8.0	17.8	114	9.2	100
		C	2.2	>2.2	1.1	7.8	17.8	114	9.2	100
		W	2.5	>2.5	1.2	7.6	17.8	114	9.2	100
	9/10/98	E	<1.0	--	0.5	7.6	16.7	126	6.7	68
		C	<1.0	--	0.5	7.4	17.2	131	5.8	68
		W	<1.0	--	0.5	7.4	17.4	134	6.0	64
Loon Lake	6/26/98	SW	4.7	3.9	1	7.7	19.8	19	8.1	94
					2	7.6	19.8	19	8.1	94
					3	7.5	19.8	19	8.1	94
					4	7.5	19.7	19	8.2	94
		C	4.8	3.8	1	7.3	19.8	19	8.1	94
					2	7.2	19.8	19	8.1	94
					3	7.2	19.9	19	8.1	94
					4	7.3	19.8	19	8.1	94
		NE	5.1	4.1	1	7.1	19.7	19	8.1	94
					2	7.1	19.7	19	8.1	94
					3	7.1	19.7	19	8.1	94
					4	7.1	19.6	19	8.1	94
	8/10/97	SW	4.3	3.3	4.6	7.1	19.5	19	7.4	--
					0.5	7.6	12.7	22	9.6	96
					1.5	7.6	12.7	22	9.5	96
					2.5	7.5	12.6	22	9.5	96
					3.5	7.5	12.6	22	9.5	96
		C	4.0	3.3	0.5	7.4	12.8	22	9.7	98

Table 2.. Physical Characteristics of Cuffs, Little, Loon, and Speckled Trout Lakes, Grand Portage Reservation, 1997--98

[The lakes were divided into 3 equal areas. The measurements were made at the center of each area. The Station column is the area that the measurements were made in: C, center; E, eastern; W, western; N, northern; S., southern; NE, northeastern; SW, southwestern. °C, degrees celsius; µS/cm, microSiemens per centimeter at 25 °C; mg/L, milligrams per liter; --, no data]

Lake name	Date	Station	Depth of lake (feet)	Secchi disk depth (feet)	Depth of measurement (feet)	pH	Temperature (°C)	Specific conductivity (µS/cm)	Dissolved oxygen (mg/L)	Dissolved oxygen (percent saturation)
Loon Lake-- Continuted	8/10/97	NE	4.5	3.7	1.5	7.5	12.8	22	9.7	98
					2.5	7.4	12.8	22	9.7	98
					3.5	7.4	12.8	22	9.7	98
					0.5	7.4	13.0	22	9.7	98
					1.5	7.4	12.9	22	9.7	98
					2.5	7.4	13.0	22	9.7	98
	5/7/98	SW	4.2	4.0	3.5	7.4	12.9	22	9.7	98
					1.0	8.1	14.2	18	9.0	90
					1.6	8.0	14.2	18	9.0	90
		C	4.2	4.0	3.3	8.0	14.2	18	9.1	91
					1.0	8.0	14.3	19	9.4	94
					1.6	7.9	14.3	19	9.3	93
		NE	4.9	4.2	3.3	7.8	14.3	19	9.3	93
					1.0	8.0	14.8	19	9.3	95
					1.6	7.9	14.8	19	9.3	94
	9/9/98	SW	3.4	3.2	3.3	7.8	--	19	9.3	95
					1.0	7.7	17.5	24	9.0	98
					2.0	7.8	17.5	24	9.0	97
		C	3.5	3.2	3.0	7.8	17.5	24	9.0	97
					1.0	7.3	17.9	24	9.0	98
					2.0	7.4	17.8	24	9.0	98
		NE	3.8	3.2	3.0	7.4	17.8	24	9.1	99
					1.5	7.2	17.9	24	9.0	98
					2.5	7.2	17.9	24	9.0	98
Speckled Trout Lake	6/25/97	NE	8.3	6.9	3.5	7.3	17.9	24	9.1	99
					1.0	8.0	20.2	38	8.4	95
					2.0	7.9	20.2	38	8.4	95
					3.0	7.9	20.2	38	8.4	95
					4.0	7.8	20.1	38	8.4	95
					5.0	7.8	20.2	38	8.5	96
					6.0	7.8	20.1	38	8.5	96
					7.0	7.7	20.1	38	8.5	96
					7.8	7.6	20.1	38	7.7	90
		C	--	6.2	1.0	7.5	20.2	39	8.4	95
					2.0	7.5	20.2	39	8.4	95
					3.0	7.5	20.2	38	8.4	95
					4.0	7.5	20.2	38	8.4	95
					5.0	7.5	20.1	38	8.4	95
					6.0	7.5	20.1	38	8.5	95
					7.0	7.5	20.0	38	8.5	96
					8.0	7.5	19.8	38	8.6	96
					9.0	7.5	19.8	38	8.6	96
					9.7	7.5	19.8	38	8.3	--

Table 2.. Physical Characteristics of Cuffs, Little, Loon, and Speckled Trout Lakes, Grand Portage Reservation, 1997--98

[The lakes were divided into 3 equal areas. The measurements were made at the center of each area. The Station column is the area that the measurements were made in: C, center; E, eastern; W, western; N, northern; S., southern; NE, northeastern; SW, southwestern. °C, degrees celsius; μS/cm, microSiemens per centimeter at 25 °C; mg/L, milligrams per liter; --, no data]

Lake name	Date	Station	Depth of lake (feet)	Secchi disk depth (feet)	Depth of measurement (feet)	pH	Temperature (°C)	Specific conductivity (μS/cm)	Dissolved oxygen (mg/L)	Dissolved oxygen (percent saturation)
Speckled Trout Lake--Continued	6/25/97	SW	4.9	>4.9	1.0	7.4	20.2	38	8.4	94
					2.0	7.4	20.1	38	8.4	94
					3.0	7.4	20.1	39	8.3	94
					4.0	7.4	20.0	39	8.2	92
					4.6	7.4	20.0	39	7.8	84
	7/10/97	NE	7.5	5.4	.5	7.9	13.1	42	9.2	92
					1.5	7.9	13.1	42	9.2	92
					2.5	7.8	13.1	42	9.2	92
					3.5	7.8	13.1	42	9.2	92
					4.5	7.8	13.0	42	9.3	93
					5.5	7.8	12.9	42	9.3	93
					6.5	7.8	12.8	41	9.3	93
					7.0	7.8	12.8	42	7.1	76
		C	8.7	5.3	.5	7.7	12.9	42	9.2	93
					1.5	7.7	12.9	42	9.2	93
					2.5	7.7	12.9	42	9.2	93
					3.5	7.7	12.9	41	9.2	93
					4.5	7.7	12.8	42	9.2	93
					5.5	7.7	12.8	42	9.3	93
					6.5	7.7	12.7	41	9.3	93
					7.5	7.7	12.7	41	9.3	93
					8.5	7.7	12.7	42	9.3	78
		SW	5.4	5.4	.5	7.6	12.9	41	9.2	93
					1.5	7.6	12.9	42	9.3	93
					2.5	7.6	12.9	41	9.3	93
					3.5	7.7	12.9	41	9.3	94
					4.5	7.7	12.9	41	9.4	94
	5/6/98	NE	7.9	6.4	5.0	7.4	12.9	43	9.3	62
					1.0	8.0	14.6	36	9.1	94
					1.6	7.9	14.6	37	9.2	94
					3.3	7.9	14.5	37	9.2	94
					4.9	7.8	14.4	37	9.1	94
		C	12.5	--	6.6	7.8	14.1	36	9.2	93
					1.6	7.8	14.7	37	9.1	94
					3.3	7.7	14.3	37	9.1	94
					4.9	7.7	14.2	37	9.1	94
					6.6	7.7	14.1	37	9.2	94
		SW	3.6	--	8.2	7.7	14.1	37	9.2	94
					9.8	7.6	14.0	37	9.3	95
					11.5	7.2	13.8	37	8.7	87
					1.6	7.7	14.9	37	9.3	97
					3.3	7.8	14.6	39	9.2	94
	9/9/98	NE	9.9	5.5	1.5	7.8	18.5	47	8.5	92

Table 2.. Physical Characteristics of Cuffs, Little, Loon, and Speckled Trout Lakes, Grand Portage Reservation, 1997--98
 [The lakes were divided into 3 equal areas. The measurements were made at the center of each area. The Station column is the area that the measurements were made in: C, center; E, eastern; W, western; N, northern; S., southern; NE, northeastern; SW, southwestern. °C, degrees celsius; μS/cm, microSiemens per centimeter at 25 °C; mg/L, milligrams per liter; --, no data]

Lake name	Date	Station	Depth of lake (feet)	Secchi disk depth (feet)	Depth of measurement (feet)	pH	Temperature (°C)	Specific conductivity (μS/cm)	Dissolved oxygen (mg/L)	Dissolved oxygen (percent saturation)
Speckled Trout Lake--Continued	9/9/98	C	9.9	5.5	2.5	7.8	18.5	47	8.5	92
					3.5	7.8	18.4	47	8.5	92
					4.5	7.8	18.3	47	8.5	92
					5.5	7.8	18.2	47	8.6	92
					6.5	7.8	18.1	46	8.6	93
					7.5	7.6	18.1	47	8.7	92
					8.4	7.1	18.4	60	0.2	--
					1.5	7.8	18.4	47	8.5	92
					2.5	7.8	18.4	47	8.5	92
					3.5	7.8	18.4	47	8.5	92
					4.5	7.8	18.2	47	8.5	92
					5.5	7.8	18.1	47	8.5	92
					6.5	7.9	18.5	47	8.5	92
					7.5	7.9	17.9	47	8.6	92
					8.5	7.8	17.8	47	8.6	92
					9.5	7.8	17.7	47	8.9	93
		SW	5.0	5.5	1.5	7.9	18.2	47	8.6	93
					2.5	7.8	18.2	47	8.6	93
					3.5	7.9	18.2	47	8.6	93
					4.5	7.8	18.2	47	8.7	93

Table 3. Relative percent difference between concentrations of constituents in the sample and replicate sample from Speckled Trout Lake and Little Lake

[$\mu\text{S}/\text{cm}$ at 25 °C, microSiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; $\mu\text{g}/\text{L}$, micrograms per liter; <, less than; --, relative percent difference not calculated]

	Speckled Trout Lake, Station 475704089504401, May 6, 1998			Little Lake, center of lake, Station 475813089393001, September 10, 1998		
	Sample	Replicate	Relative percent difference	Sample	Replicate	Relative percent difference
Specific conductance, laboratory measurement, ($\mu\text{S}/\text{cm}$ at 25 °C)	46	47	-1.1	133	133	0
pH, laboratory measurement (standard units)	7.3	7.8	-3.3	7.5	7.3	1.4
Acid neutralizing capacity, unfiltered, titration To pH 4.5, laboratory, (mg/L as CaCO_3)	19	20	-2.6	40	41	-1.2
Nitrogen, ammonia dissolved (mg/L as N)	0.074	0.090	-9.8	0.046	0.048	-2.1
Nitrogen, Nitrite, Dissolved (mg/L as N)	<.010	<.010	--	<.010	<.010	--
Nitrogen, ammonia plus organic, total (mg/L as N)	0.40	0.51	-12.1	1.5	1.5	0
Nitrogen, nitrite plus nitrate, dissolved (mg/L as N)	<.050	<.050	--	<.050	<.050	--
Phosphorus, total (mg/L as P)	0.067	0.026	44.1	<.010	<.010	--
Phosphorus, dissolved (mg/L as P)	<.010	<.010	--	<.010	<.010	--
Phosphorus, orthophosphate, dissolved (mg/L as P)	<.010	<.010	--	0.018	0.018	0
Calcium, dissolved (mg/L as Ca)	4.6	4.6	0	12	12	0
Magnesium, dissolved (mg/L as Mg)	1.7	1.7	0	6.3	6.3	0
Sodium, dissolved (mg/L as Na)	1.2	1.3	-4	5.3	5.3	0
Potassium, dissolved (mg/L as K)	0.18	0.18	0	0.28	0.27	1.8
Chloride, dissolved (mg/L as Cl)	0.26	0.24	4	7.8	7.4	2.6
Sulfate, dissolved (mg/L as SO_4)	2.8	2.8	0	10	9.1	4.7
Fluoride, dissolved (mg/L as F)	<.10	<.10	--	0.12	0.12	0
Silica, dissolved (mg/L as SiO_2)	3.6	3.8	-2.7	0.44	0.42	2.3
Aluminum dissolved ($\mu\text{g}/\text{L}$ as Al)	--	22	--	--	--	--
Arsenic dissolved ($\mu\text{g}/\text{L}$ as As)	--	<1	--	--	--	--
Boron dissolved ($\mu\text{g}/\text{L}$ as B)	19	<16	--	--	--	--
Cadmium dissolved ($\mu\text{g}/\text{L}$ as Cd)	<1.0	<1.0	--	--	--	--
Chromium dissolved ($\mu\text{g}/\text{L}$ as Cr)	<1.0	<1.0	--	--	--	--
Copper dissolved ($\mu\text{g}/\text{L}$ as Cu)	2.7	2.2	10.2	--	--	--
Iron, dissolved ($\mu\text{g}/\text{L}$ as Fe)	45	45	0	23	24	-2.1
Lead dissolved ($\mu\text{g}/\text{L}$ as Pb)	<1.0	<1.0	--	--	--	--
Manganese dissolved ($\mu\text{g}/\text{L}$ as Mn)	<4.0	<4.0	--	<4.0	<4.0	--
Molybdenum dissolved ($\mu\text{g}/\text{L}$ as Mo)	<1.0	<1.0	--	--	--	--
Nickel dissolved ($\mu\text{g}/\text{L}$ as Ni)	<1.0	<1.0	--	--	--	--
Selenium dissolved ($\mu\text{g}/\text{L}$ as Se)	<1	<1	--	--	--	--

Table 4. Trace metal and organic compounds in the sediments of Cuffs and Loon Lakes, May and September, 1998
[µg/g, micrograms per gram; µg/Kg, micrograms per kilogram; g, grams; µg, micrograms; <, less than]

Sampling site (shown in figure 1)	Station name	Station number	Date	Arsenic, total in bottom material (µg/g as As)	Cadmium, recovered from bottom material (µg/g as Cd)	Chromium, recovered from bottom material (µg/g as Cr)	Cobalt, recovered from bottom material (µg/g as Co)	Copper, recovered from bottom material (µg/g as Cu)	Iron, recovered from bottom material (µg/g as Fe)
5	Cuffs Lake, center of lake	475647089443701	September 9, 1998	3	2	44	10	49	17,000
8	Loon Lake, center of lake	475759089484701	May 7, 1998	2	1	14	<10	40	6,000
			September 9, 1998	3	2	19	10	39	7,600

Station name	Date	Lead, recovered from bottom material (µg/g as Pb)	Manganese, recovered from bottom material (µg/g as Mn)	Nickel, recovered from bottom material (µg/g as Ni)	Zinc, recovered from bottom material (µg/g as Zn)	Aldrin, total in bottom material (µg/Kg)	Lindane, total in bottom material (µg/Kg)	Chlordane, total in bottom material (µg/Kg)
Cuffs Lake, center of lake	September 9, 1998	20	71	40	100	<1.00	<1.00	<15.0
Loon Lake, center of lake	May 7, 1998	<10	120	<10	130	<2.00	<2.00	<30.0
	September 9, 1998	20	91	30	100	<2.50	<2.50	<37.5

Station name	Date	p,p -DDD, recovered from bottom material (µg/Kg)	p,p -DDE, recovered from bottom material (µg/Kg)	p,p -DDT, recovered from bottom material (µg/Kg)	Dieldrin, total in bottom material (µg/Kg)	Endosulfan, total in bottom material (µg/Kg)	Endrin, total in bottom material (µg/Kg)	Toxaphene, total in bottom material (µg/Kg)
Cuffs Lake, center of lake	September 9, 1998	<2.50	<1.00	<2.50	<1.00	<1.00	<1.00	<250
Loon Lake, center of lake	May 7, 1998	<5.00	<2.00	<5.00	<2.00	<2.00	<2.00	<500
	September 9, 1998	<6.25	<2.50	<6.25	<2.50	<2.50	<2.50	<625

Station name	Date	Heptachlor, total in bottom material (µg/Kg)	Heptachlor epoxide, total in bottom material (µg/Kg)	Methoxy-chlor, total in bottom material (µg/Kg)	PCB, total in bottom material (µg/Kg)	Mirex, total in bottom material (µg/Kg)
Cuffs Lake, center of lake	September 9, 1998	<1.00	<1.00	<12.0	<25.0	<1.00
Loon Lake, center of lake	May 7, 1998	<2.00	<2.00	<25.0	<50.0	<2.00
	September 9, 1998	<2.50	<2.50	<31.3	<62.5	<2.50