Appendix V5-3C

Boston Property N.W.T. Environmental Data Report (1994)

MAC RESOURCES

BHP Minerals Canada Ltd.
Boston Property N.W.T.

ENVIRONMENTAL DATA REPORT

Prepared for:
BHP Minerals Canada Ltd.
Vancouver, Canada

Prepared by:
Rescan Environmental Services Ltd.
Vancouver, Canada

November 1994

Rescan

TABLE OF CONTENTS

List of Figures

List of Tables

List of Plates

1.0 Introduction

1.0 INTRODUCTION

At the request of BHP Minerals Canada Ltd. (BHP), Rescan Environmental Services Ltd. prepared and submitted a workplan to continue the environmental management program for the Boston property, NWT (Figure 1-1). The objectives of the program were to provide sufficient data to support applications for a Land Use Permit and Water Licence should a bulk sampling program be contemplated for the Boston Project in 1995. Following review by BHP, the workplan was accepted and the field program carried out late in the summer of 1994.

The 1994 program represents a continuation of work which was initiated in 1993. The 1993 data may be found in the 1993 Boston project *Environmental Data Report*. The scope of work for the 1994 program consisted of site visits in August to collect data on the following parameters: hydrology, meteorology, water quality, limnology (Spyder and Stickleback Lakes), and aquatic and terrestrial resources. In addition, the existing weather station was upgraded to allow uninterrupted data collection on a year round basis.

This report summarizes the work completed in the Boston environmental program to date. Some biological samples collected from the streams in the project area in 1993 were preserved at the time of collection and submitted for analyses in 1994. Stream sampling was not possible this year due to low water levels and little or no flow. Two zooplankton samples, from tows conducted in 1993 in each lake, were also sent for taxonomy, and 1993 fish aging and tissue data are included in Appendix A. Ekman grab samples and phytoplankton samples collected from Spyder and Stickleback Lakes in 1994 were sent for analyses. The remaining biological samples collected from Spyder and Stickleback Lakes in 1993 are being archived.

The following data are included herein:

- bathymetric profile of a portion of Spyder Lake;
- a summary of meteorological data;

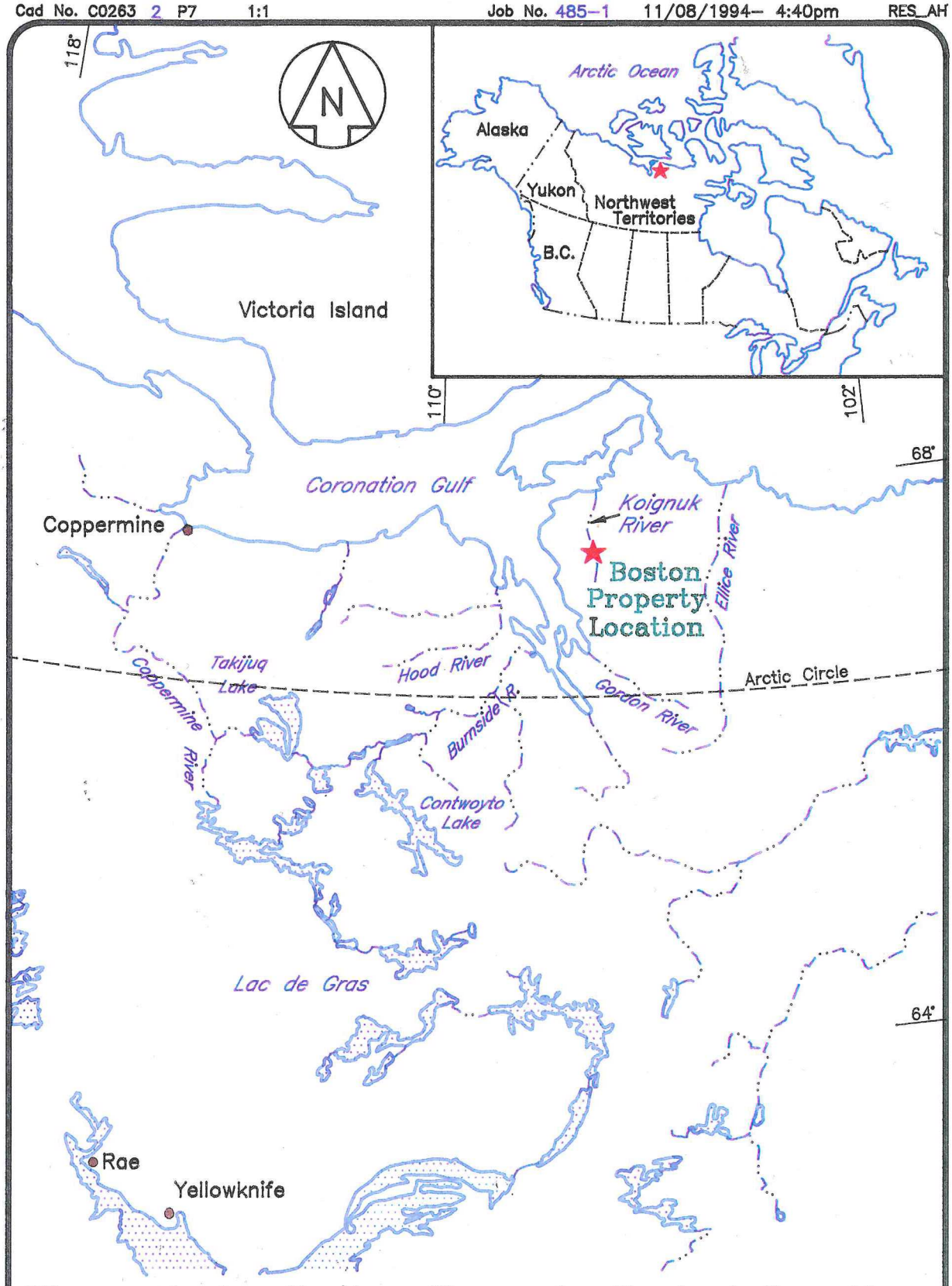


Figure 1-1 : Boston Property Project Location, Northwest Territories

BHP

Rescan

- hydrology (measurement of surface water discharges from Stickleback and Trout Creeks);
- 1994 water quality results, including field parameters (*e.g.* dissolved oxygen, pH, and temperature);
- aquatic survey results for presence/absence of fish through gillnetting, and minnow trapping and benthic invertebrate, phytoplankton and zooplankton surveys; and
- a reconnaissance level wildlife survey and literature review.

Acid-base accounting (static) testwork performed in 1993 to determine the potential for acid rock drainage indicated a strong net neutralizing potential throughout the rock sequence. Discussions with the Boston project geological staff confirmed that similar results were expected for this year's program; therefore, no further acid base accounting was performed as a part of the 1994 program.

2.0 Review of the 1993 Field Program

2.0 REVIEW OF THE 1993 FIELD PROGRAM

A baseline survey was initiated for the BHP Boston Project in 1993. Surveys included meteorology and hydrology data collection, water quality sampling, bathymetric surveys of two lakes, as well as reconnaissance-level fisheries and aquatic ecology surveys. Figure 2-1 shows the sampling sites appropriate to each activity. The results of this program were submitted to BHP in an environmental data report and are summarized below.

2.1 Bathymetry

Cursory bathymetric surveys were completed in the southern arm of Spyder Lake and adjoining Stickleback Lake during 1993 using a depth sounder attached to a Raytheon chart recorder and a topographical map for positioning. The 1994 bathymetric survey of Spyder Lake used differential GPS and a Lowrance depth sounder to obtain greater precision and accuracy and allow for defining formations first identified in 1993.

2.2 Meteorology

A datalogger-supported weather station was installed on-site in August 1993. The ten-metre, dedicated tower collects hourly readings on temperature, humidity, rainfall, and wind speed and direction. The weather station was updated in 1994 with the addition of a state-of-the-art Campbell Scientific CR10 datalogger. The wind monitor and tipping bucket rain gauge were both re-calibrated and re-installed. A ultrasonic depth sensor was added to monitor snow depth. The station is powered by a deep-cycle, marine battery which is recharged by a 30 W solar panel. The current configuration allows for uninterrupted data collection on a year round basis.

2.3 Water Quality, Fisheries and Aquatic Surveys

In August 1992, BHP established three water quality sampling stations on the property. In June 1993, three more stations were added to supplement the database. The August 1993 program, completed by Rescan, added one more station (Stickleback) to the program. Each of the seven water quality sites was

Cad No. C0590 1 P2 | Job No. 485-1 | 11/08/1994- 2:02pm | RES_BF

7,503,000m N
7,504,000m N
7,505,000m N
7,506,000m N
7,507,000m N
7,508,000m N

N

0 250 500 750 1000 m

Scale 1 : 16,000

440,000m E
441,000m E
442,000m E
443,000m E

WQ4
WQ5
WQ6
WQ3
WQ7
WQ1
WQ2
WQ8

Area of Drilling

STICKLEBACK LAKE
Stickleback Creek
Trout Creek
TROUT LAKE
SPYDER LAKE

Camp
Weather Station

LEGEND :

- Rock
- Weather Station
- Gang Net Set Location
- WQ ⊗ Station Location

For All : Water Quality, Benthics, Sediments
For Lakes Include : Zooplankton, Phytoplankton
For Streams Include : Electrofishing, Periphyton, Flow Discharge

BHP

Figure 2-1 : Sampling Locations (1993-1994)

Rescan

Fig 2-1

sampled in August 1993, and included field measurements of dissolved oxygen (D.O.), temperature and pH. The lake stations were sampled from several depths, where possible, and included D.O. and temperature profiles.

In conjunction with water sampling, reconnaissance-level fisheries and aquatic studies were conducted on Spyder and Stickleback Lakes and connecting streams. These surveys included fish presence/absence surveys using gillnetting or electroshocking methods; and benthos, phytoplankton, zooplankton and periphyton sampling, where available. Sediment samples were also collected and the results of chemical and particle size analyses are included herein. Flow measurements were taken at two stream sites.

3.0 Results of the 1994 Field Program

3.0 RESULTS OF THE 1994 FIELD PROGRAM

The 1994 field program was carried out at the Boston property as a continuation of the environmental baseline studies initiated in 1993. The study was expanded to include a wildlife component, and biological samples (algae, plankton, and benthic invertebrates) were analyzed to provide information on the flora and fauna present in selected streams and lakes on the property. The following sections describe each component of the study and the results of the 1994 program.

3.1 Spyder Lake Bathymetry

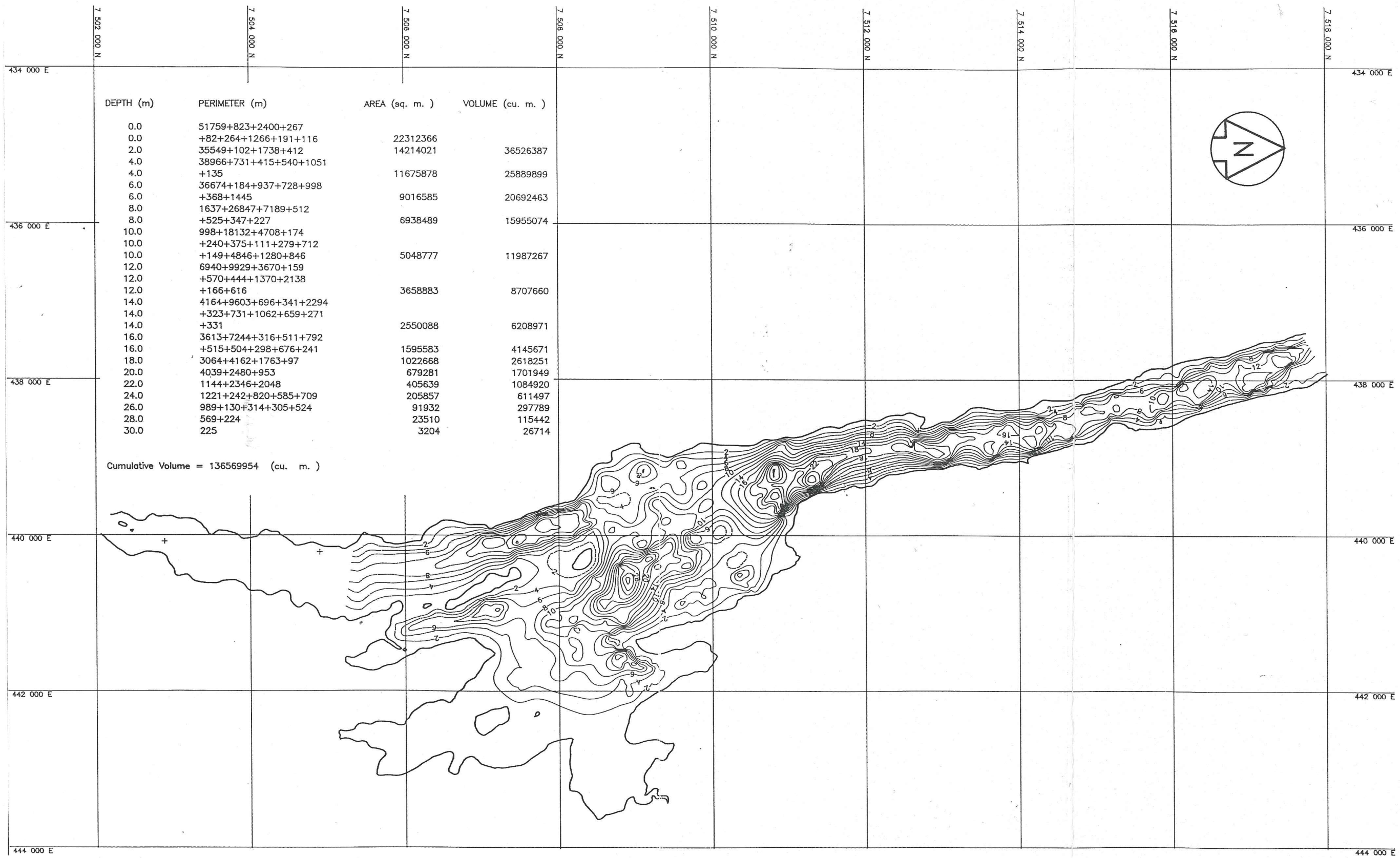
Spyder Lake lies within a north-south, elongated (12 km), narrow (0.5 - 3.0 km), irregularly shaped basin. The lake is part of a glacially scoured river valley system which is confined by a narrow outlet to form the present lake. Physical measurements indicated that the lake is poorly stratified thermally in the summer, with no depletion of dissolved oxygen in near-bottom waters. Stickleback and Trout Lakes, in contrast, are small, oval-shaped, two-metre-deep basins with fairly flat bottoms.

The 1993 survey used the Raytheon echosounding chart recorder to record depths, and a topographic map for positioning. The objective of this cursory survey was to locate deep holes or trenches, if any, and to roughly estimate their volumes, in Spyder Lake as well as the total volume of Stickleback Lake. Topographic formations in Spyder Lake were identified from this survey that required further elucidation.

A bathymetrical survey of the mid portion of Spyder Lake (Figure 3-1) was carried out in August 1994, using differential GPS and a Lowrance depth sounder, to provide a more detailed profile of the lake. This survey indicated a maximum depth of 30+ m in a confined depression roughly in the centre of the widened portion of the lake and depths up to 24 m in the centre channel of the lake. The bathymetric profile confirms that the lake is a flooded portion of the river valley system, which eventually becomes the Koignuk River as it flows to the top of Bathurst Inlet.

DEPTH (m)	PERIMETER (m)	AREA (sq. m.)	VOLUME (cu. m.)
0.0	51759+823+2400+267		
0.0	+82+264+1266+191+116	22312366	
2.0	35549+102+1738+412	14214021	36526387
4.0	38966+731+415+540+1051		
4.0	+135	11675878	25889899
6.0	36674+184+937+728+998		
6.0	+368+1445	9016585	20692463
8.0	1637+26847+7189+512		
8.0	+525+347+227	6938489	15955074
10.0	998+18132+4708+174		
10.0	+240+375+111+279+712		
10.0	+149+4846+1280+846	5048777	11987267
12.0	6940+9929+3670+159		
12.0	+570+444+1370+2138		
12.0	+166+616	3658883	8707660
14.0	4164+9603+696+341+2294		
14.0	+323+731+1062+659+271		
14.0	+331	2550088	6208971
16.0	3613+7244+316+511+792		
16.0	+515+504+298+676+241	1595583	4145671
18.0	3064+4162+1763+97	1022668	2618251
20.0	4039+2480+953	679281	1701949
22.0	1144+2346+2048	405639	1084920
24.0	1221+242+820+585+709	205857	611497
26.0	989+130+314+305+524	91932	297789
28.0	569+224	23510	115442
30.0	225	3204	26714

Cumulative Volume = 136569954 (cu. m.)



BHP

Figure 3-1 : Bathymetry of Mid Portion of Spyder Lake

0 1 2 km
Scale 1 : 50,000

Rescan

Fig 3-1

3.2 Meteorology

The Boston property lies within the Arctic Circle in the zone of continuous permafrost. The area experiences short, relatively cool summers and extremely cold winters (January temperatures often below -30°C). Mean annual precipitation is less than 150 mm (Atmospheric Environment Service data for 1992).

To monitor site-specific meteorological variables, a weather station (Plate 3-1) was installed at the Boston site in July 1993. The meteorological station was upgraded in August 1994. Wherever possible sensors from the existing weather station were salvaged, re-calibrated and re-installed. The upgrade included calibration of the wind monitor and tipping bucket rain gauge and installation of a new temperature/relative humidity sensor and datalogger. Variables measured include temperature, snow depth, humidity, rainfall, and wind speed and direction. Variables are sampled at five second intervals, and the hourly average values stored in a Campbell Scientific CR10 datalogger (Plate 3-2). This site-specific data will be augmented by regional climatic data from Atmospheric Environment Service (AES) stations at Byron Bay, Coppermine and Contwoyto Lake.

The station was downloaded in late August 1994. Temperature and relative humidity are plotted in Figure 3-2, and wind speed and direction are charted in Figure 3-3. From August 29, 1993 to November 19, 1993, the average daily temperature recorded was -8.5°C. The maximum recorded temperature was 5.5°C on September 7, and a minimum temperature of -32.3°C was recorded on November 1. Daily relative humidity averaged 74%. The wind speed and direction data for this period of record are not considered reliable because several consecutive days recorded identical wind speeds, indicating a problem in the system which could not be identified from the data recorded. Over this 83-day period, 9.3 mm of precipitation was recorded (Figure 3-4). Due to power interruption, no meteorological data is available for the period November 19, 1993, to April 12, 1994 (low sunlight and camp closure). From April 12, 1994 (camp re-opening) onward, data are being recorded.

For the period April 12, 1994, to August 25, 1994, hourly average wind speed and direction, temperature and total hourly rainfall data were recorded. The average daily temperature recorded was 4.8°C. The maximum recorded temperature was 28.6°C recorded at 4:00 p.m. on July 9, and a minimum temperature of -32.0°C

Plate 3-1: To monitor meteorological conditions at the Boston property, a weather station was intalled in 1993, and upgraded in August 1994.

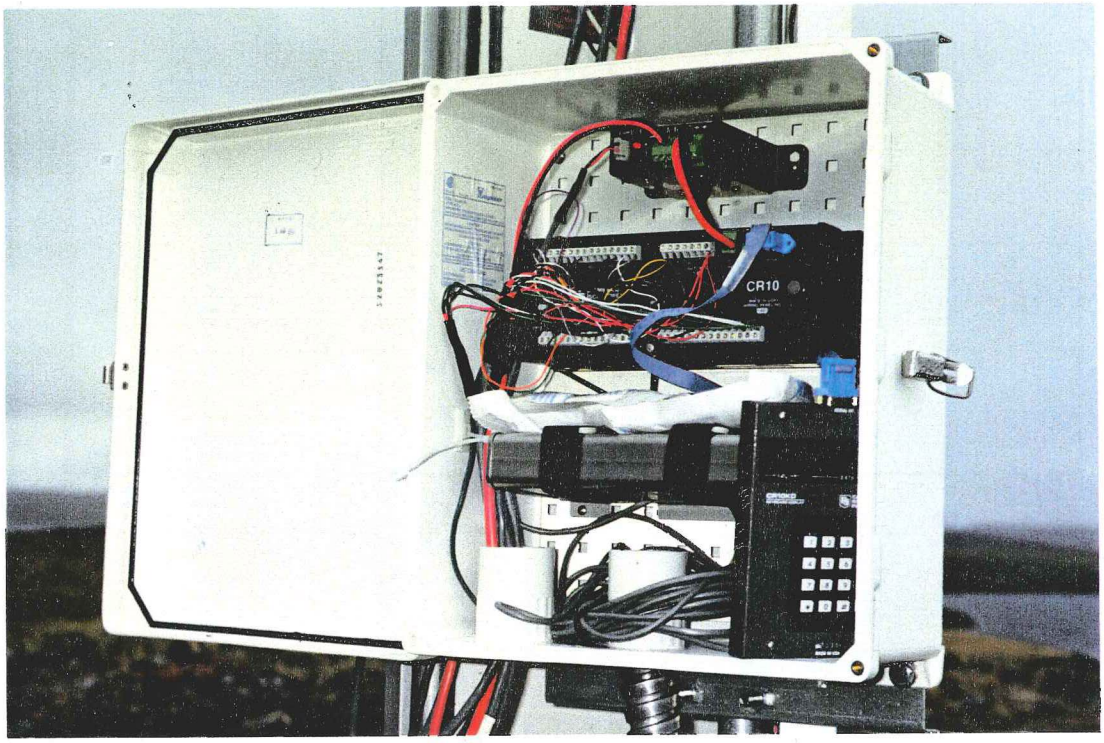


Plate 3-2: Meteorological variables are measured at five second intervals and the hourly averages are stored by the Campbell Scientific CR10 datalogger in a storage module, which can hold several months of data.

Cad No. a571s | Job No. 485-01 | 15/11/1994-02:33pm | RES_BF

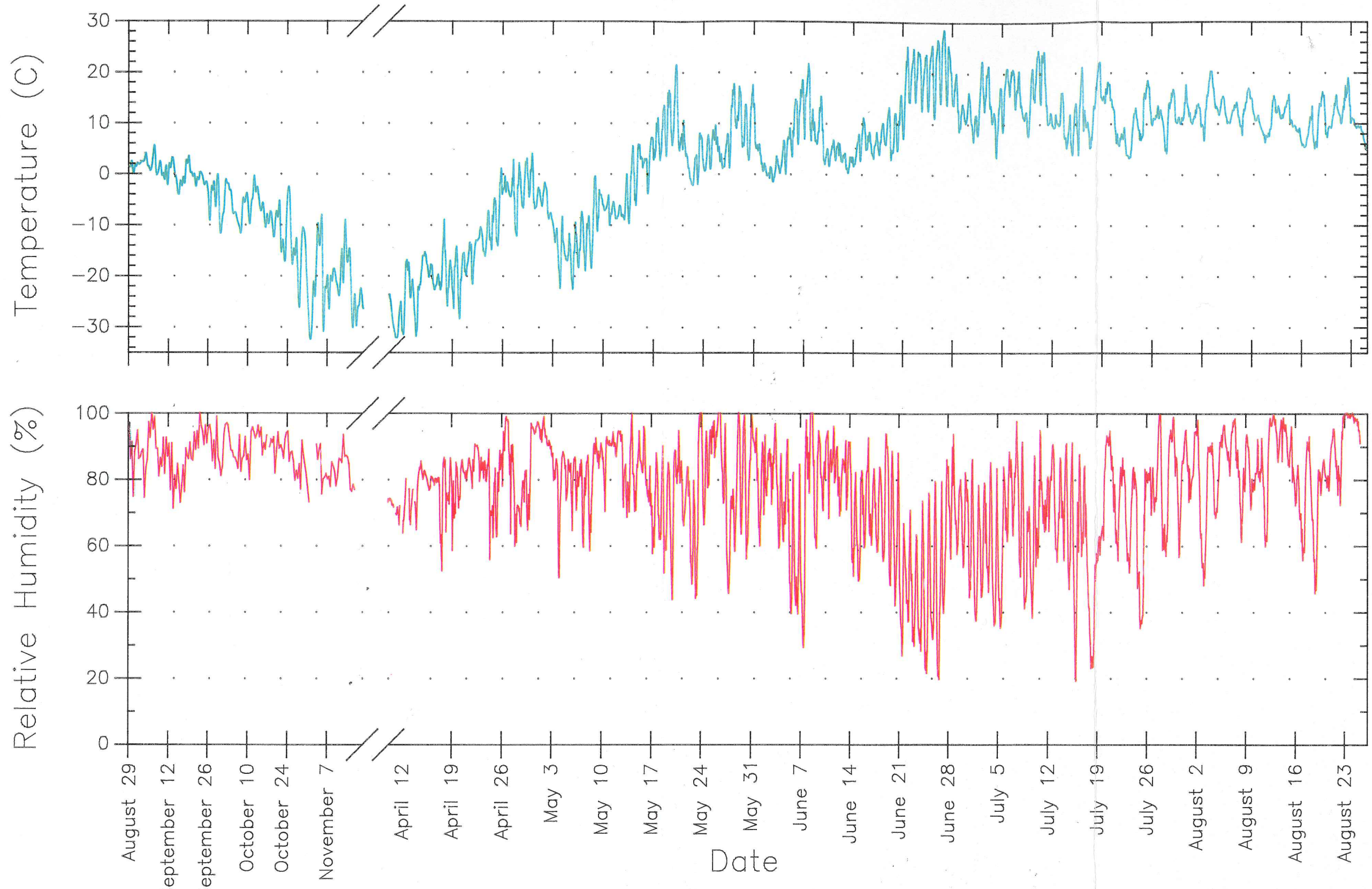


Figure 3-2: Boston Project
Temperature and Relative Humidity
August 29/93 to August 23/94

BHP

Rescan

Fig 3-2

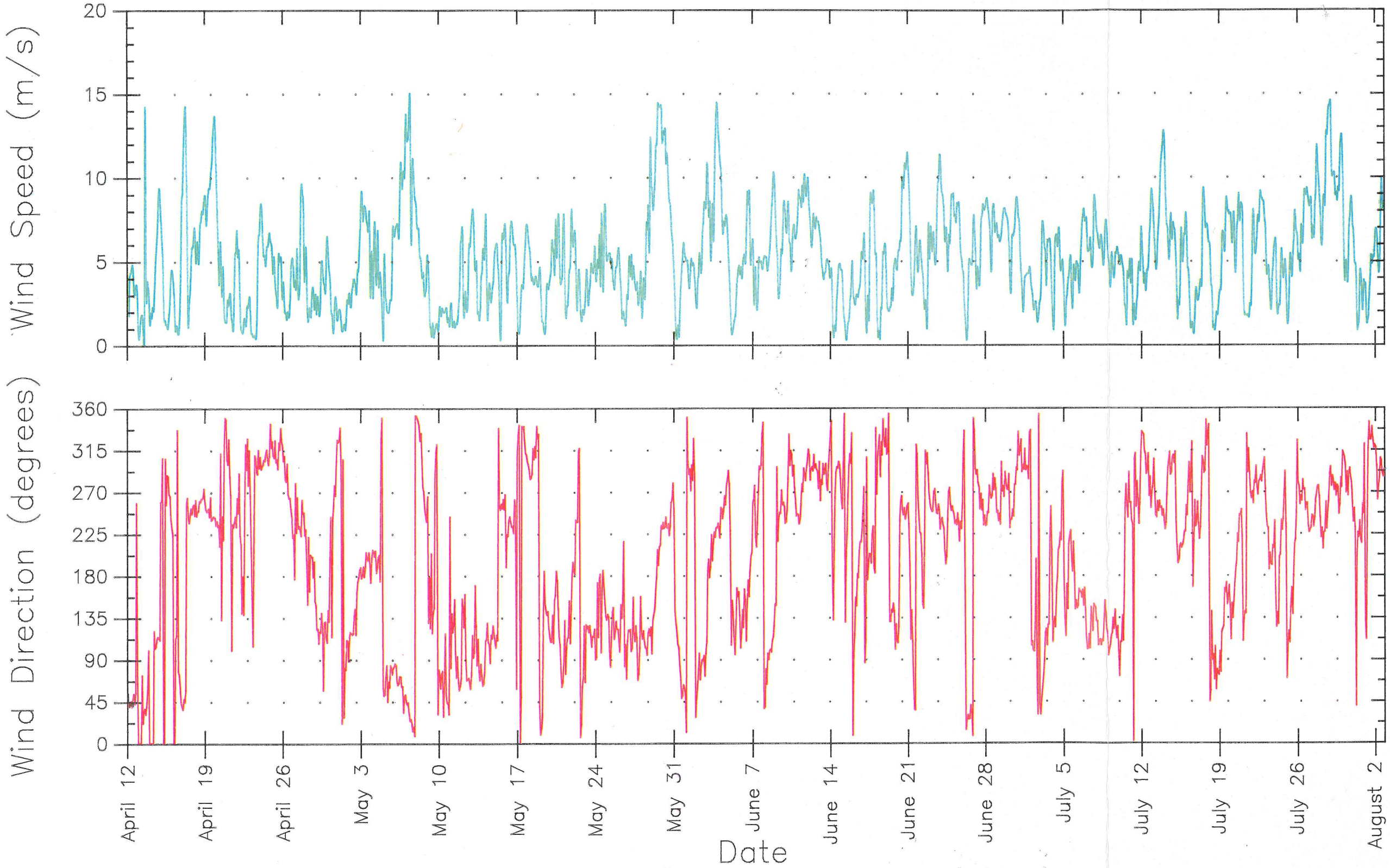


Figure 3-3:

Boston Project - Wind Speed and Direction

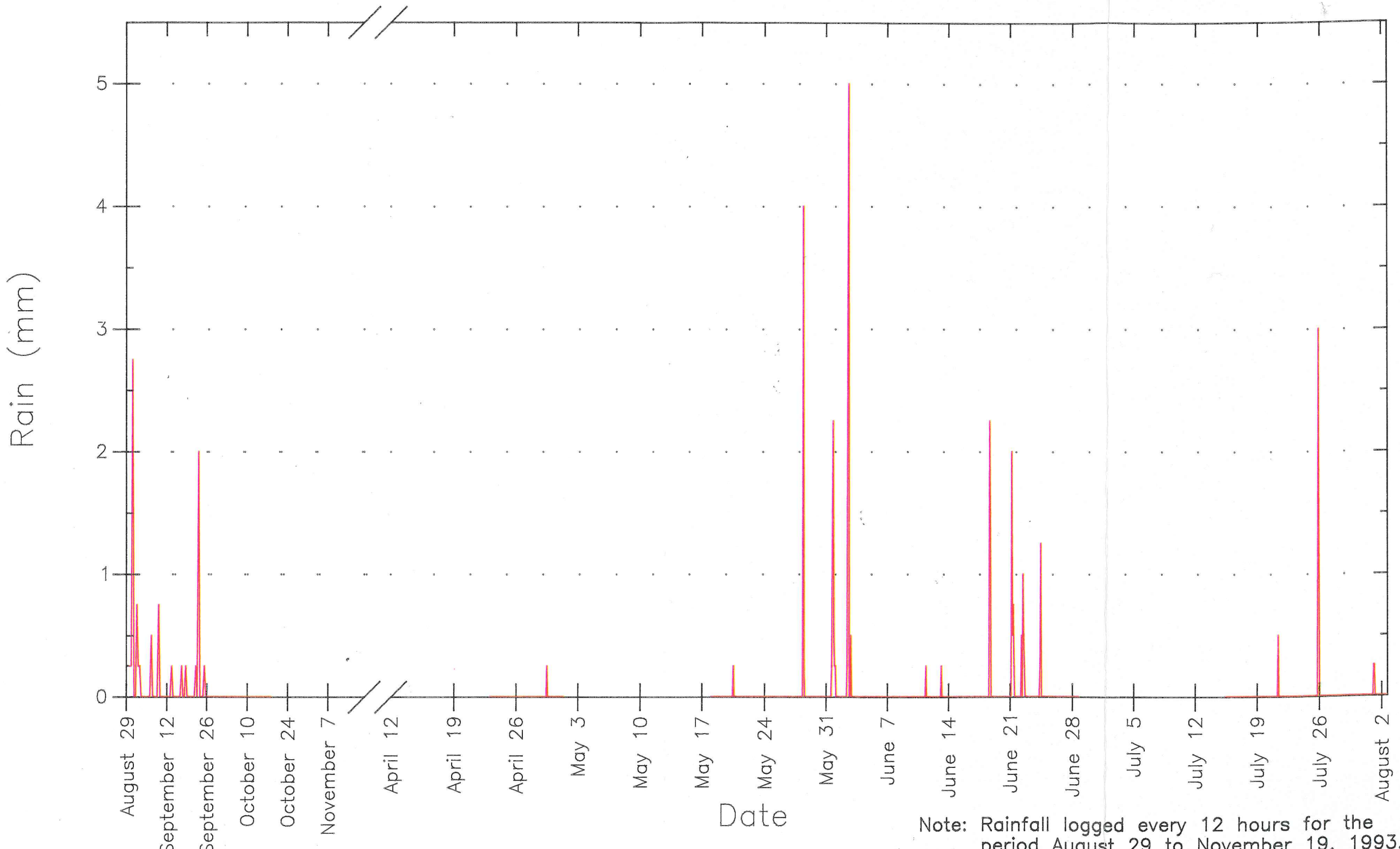
April 12 to August 2/94

BHP

Rescan

Fig 3-3

Cad No. a572s | Job No. 485-01 | 15/11/1994-02:35pm | RES_BF



Note: Rainfall logged every 12 hours for the period August 29 to November 19, 1993. Rainfall logged every 2 hours for the period April 12 to August 2, 1994.

BHP

Figure 3-4: Boston Project - Rainfall

August 29/93 to August 2/94

Rescan

Fig 3-4

was recorded at 5:00 a.m. on April 13. Daily relative humidity averaged 75%. The wind monitor and tipping bucket rain gauge were removed on August 2, 1994, for servicing and re-calibration, and re-installed at the end of August.

Average daily wind speed was 5.3 m/s (19 km/h), with a maximum hourly wind speed of 14.3 m/s (51.5 km/h). A wind rose (Figure 3-5) plotted for the Boston weather station shows that the predominant directions are from the west (21% of the time) and southwest (17% of the time). Calm winds (*i.e.* wind speed <1.0 m/s) only occurred 3.4% of the time. Over the 114-day period of record available for rainfall data, 35.3 mm were recorded. The maximum two-hour rainfall was 5.0 mm, recorded on June 2 at 6:00 p.m.

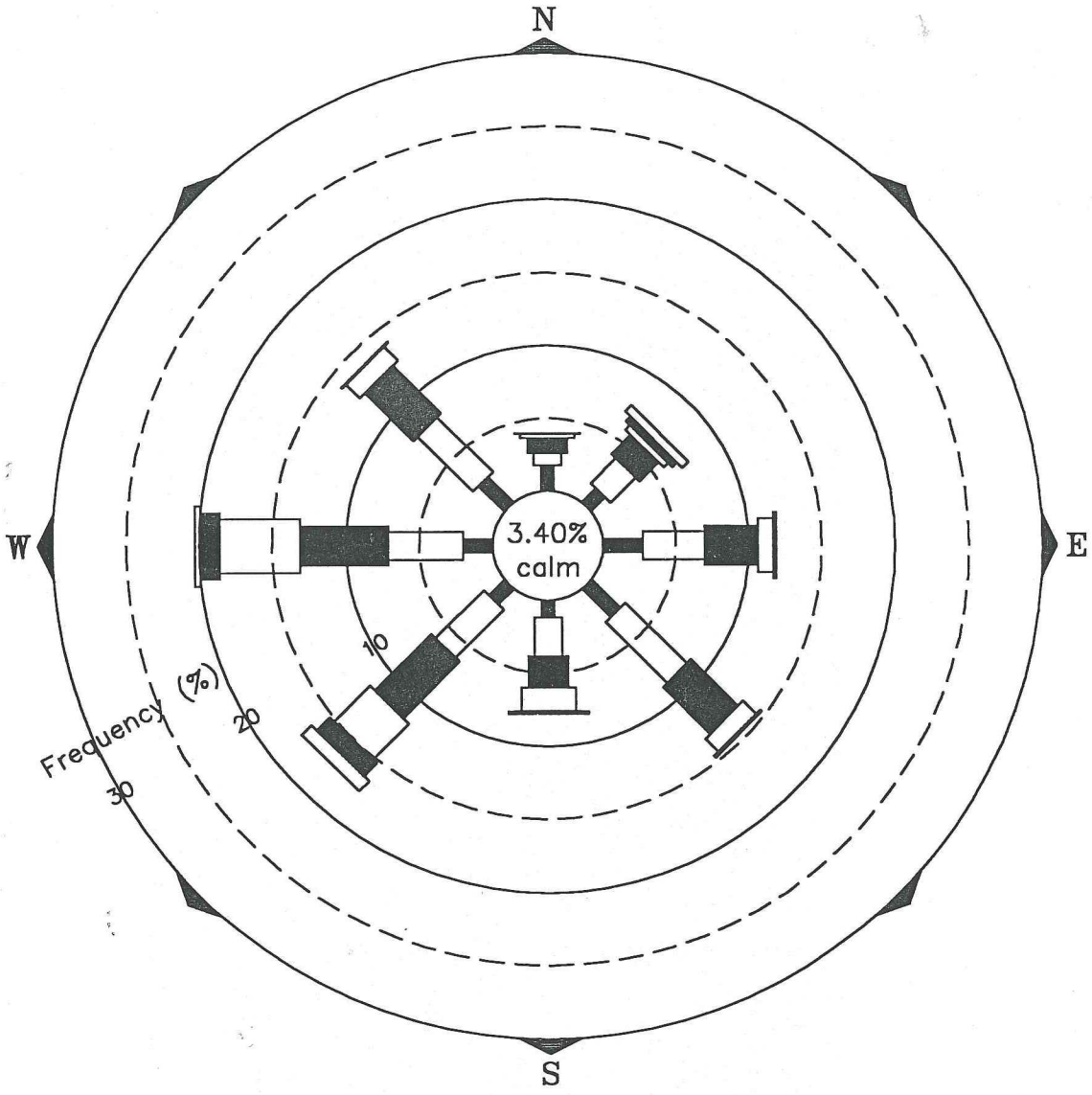
The weather station is unmanned over the winter period and, consequently, has been set up to continue collecting data. A 30 W solar panel will ensure that the marine battery which powers the weather station is recharged when there is sufficient sunlight. The current weather station configuration with a SM192 data storage module allows for storage of approximately seven months of data.

Should the Boston Project advance to the point where an Initial Environmental Evaluation (IEE) may be necessary, evaporation and snowfall will have to be monitored in more detail in order to establish a water balance. A solar radiation sensor will also have to be incorporated, and a second wind anemometer and a snowfall measurement device (such as a Nipher snow gauge) will be required.

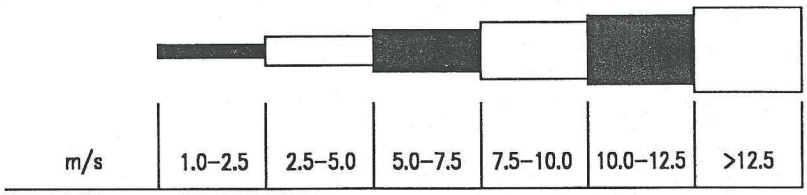
3.3 Surface Hydrology

Surface water discharge was measured in two small creeks: Stickleback Creek (the outlet of Stickleback Lake), and Trout Creek (the outlet of Trout Lake), both of which drain into an arm of Spyder Lake. No flow was recorded in Stickleback Creek during the August campaign. The flow in Trout Creek (Plate 3-3) was 0.0014 m^3/s (23 U.S. gpm). Camp personnel report that all lake levels are much lower than normal this year, a phenomenon being reported from areas throughout the Northwest Territories.

Water level recorders (staff gauges and/or pressure transducers) were not installed during the August programs, owing to concerns that the gauges would not survive



WIND SPEED SCALE



Wind Rose for Boston Project Weather Station

Data Available from April 12/94 to August 2/94

FIGURE 3-5

BHP

Rescan

Plate 3-3: Flow was measured in Trout Creek on the Boston property in August 1994.

the spring melt and subsequent flooding of Spyder Lake (communication with BHP personnel on site).

Again, should the program proceed to the next phase and require a full IEE, a detailed water balance will have to be established for the project area, which would require installation of a number of water level devices, designed to resist damage during freezing and spring breakup, on selected streams and lakes in the immediate area.

3.4 Water Quality

Water quality monitoring of potentially impacted lakes and streams is recognized as a key component of the project development program. Water quality monitoring is limited at present to the ice-free season (June-September). In August 1992, water quality sampling was initiated by BHP on three streams in the project area. In June 1993, three more water quality sites were added, involving the collection of surface samples from Spyder Lake. In August 1993, an additional site was sampled on Stickleback Lake and Trout Lake was added in August 1994. The Federal Water Quality Guidelines (CCME) are presented in Table 3-1 (see Figure 2-1 for sampling locations).

Field water quality parameters measured included pH, dissolved oxygen and temperature. Water quality sampling at lake and stream stations involved the collection of one to three sets of samples at each site (surface, mid and bottom water layers depending upon water depth at the sample site). Dissolved oxygen and temperature profiling was conducted at each lake station. The 1994 water quality results are presented in Tables 3-2, 3-3 and 3-4.

Water quality analyses performed on the samples employed procedures described in "Standard Methods for the Examination of Water and Wastewater" (American Public Health Association 1993). The procedures involve a variety of instrumental analyses, including atomic emission spectrophotometry (ICP) and atomic absorption spectrophotometry (AA), and were carried out at independent, accredited laboratories in Vancouver, B.C.

Table 3-1

CCME Receiving Water Guidelines: Summary

Parameter	Drinking Water Limit (mg/L)	Fresh Water Aquatic Life Limit (mg/L)	Wildlife Drinking Water mg/L
pH	6.5 - 8.5	6-9	-
TSS	-	Increase of 10[a]	Increase of 20[a]
TDS	500	-	-
Sulphate (SO_4^{2-})	500	-	-
Ammonia (NH_3)	-	0.93[d]	-
Nitrate (NO_3^-)	10	-	100
Nitrite (NO_2^-)	1	0.02	10
Aluminum	-	0.1[c]	5.0
Arsenic	0.05	0.05	-
Cadmium	0.005	0.0018[b]	0.02
Copper	1	0.004[b]	0.3
Iron	0.3	0.3	-
Lead	0.05	0.007 X .0001	0.1
Manganese	0.05	-	-
Mercury	0.001	0.001	0.003
Nickel	-	0.15[b] x .025	1.0
Silver	0.05	0.001	-
Zinc	5	0.03	50.0

a For background suspended solids ≤ 100 mg/L.
b For hardness > 180 mg/L as $CaCO_3$.
c For pH > 6.5.
d For pH 8.0 at 20°C.

highest is 110 !

Data generated during the 1992-1994 sampling programs indicate the water to be of neutral pH and low in nutrients (nitrate, phosphorous). Total dissolved solids (TDS) and conductivity for Spyder Lake are fairly consistent, with relatively higher values recorded for Stickleback Lake (WQ7) and the creek areas (WQ1-3). Trout Lake (WQ8) values fall between those of Spyder and Stickleback Lakes.

Total and dissolved metal levels are consistently higher at the creek sites (WQ1-3), in Stickeback Lake (WQ7), and WQ6, located on the shore of Spyder Lake (see Figure 2-1).

Table 3-2

Water Quality Parameters of Samples Taken During August 1994

Analysis	Field Blank	WQ1	WQ2	WQ3	WQ4	WQ5	WQ5	WQ5	WQ6	WQ7	WQ8
Depth (m)	n/a	surface	surface	surface	surface	surface	5 m	11 m	surface	surface	surface
Laboratory Parameters											
Conductivity (µmhos/cm)	1.4	170	200	320	36	36	35	35	34	130	61
Total Dissolved Solids (mg/L)	4	110	160	350	35	40	22	33	29	110	51
Total Suspended Solids (mg/L)	<1	6	27	4	4	1	9	4	13	4	7
Turbidity (NTU)	0.14	6.3	13	2.5	3.0	2.7	2.6	3.0	3.3	1.1	5.2
Hardness-CALC (mg/L)	<1	64	72	110	7	9	10	8	9	36	15
Alkalinity to pH 4.5 (mg $CaCO_3$/L)	<1	53	79	10	7	6	7	7	8	31	13
Acidity to pH 8.3 (mg/$CaCO_3$/L)	1	7.2	5.7	1.8	3.1	2.7	2.2	2.1	2.2	2.2	2.7
Chloride (mg/L)	<0.5	35	23	98	9.5	10	9.5	9.5	9.5	35	17
Fluoride (mg/L)	<0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.10	0.05
Sulphate (mg/L)	<0.5	<0.5	0.5	1.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Free Ammonia (mg NH_3-N/L)	<0.005	0.012	0.099	0.013	0.009	0.012	0.009	0.011	0.013	0.011	0.018
Nitrate (mg NO_3-N/L)	<0.005	0.013	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Nitrite (mg NO_2-N/L)	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total P (mg P/L)	<0.002	0.022	0.010	0.016	0.020	0.018	0.018	0.018	0.020	0.020	0.030
Dissolved P (mg P/L)	<0.002	0.008	0.010	0.004	0.008	0.008	0.006	0.004	0.004	0.004	0.004
Ortho P (mg P/L)	<0.002	0.002	0.010	0.002	<0.002	<0.002	<0.002	0.004	<0.002	0.002	<0.002
Chlorophyll (mg/m)	—	—	—	—	0.72	0.54	—	—	0.48	0.96	—
Field Parameters											
Dissolved Oxygen (mg/L)	—	9.2	8.8	11.0	10.0	8.3	8.2	8.2	10.0	12.0	11.0
Temperature (°C)	—	14.9	12.4	14.2	13.0	13.0	13.0	13.0	12.8	15.7	13.2
pH	—	8.1	6.8	8.2	6.6	6.1	—	—	8.1	8.3	8.4

Table 3-3

Levels of Total Metals Found in Water Quality Samples Taken During August 1994

Element (ppb)	Field Blank	WQ1	WQ2	WQ3	WQ4	WQ5	WQ5	WQ5	WQ6	WQ7	WQ8
Depth (m)	n/a	surface	surface	surface	surface	surface	5 m	11 m	surface	surface	surface
Lithium	21.8	63.0	15.0	8.0	<5	<5	<5	<5	65.0	<5	<5
Beryllium	<0.5	1.72	<0.5	<0.5	0.92	0.95	<0.5	<0.5	2.72	<0.5	<0.5
Boron	11.20	32.20	10.70	34.30	<1.20	4.29	7.48	<1.20	28.20	<1.20	8.57
Sodium	50.0	18500	9430	11400	4710	4760	4730	4120	6710	10200	5690
Magnesium	2.20	10300	9560	8090	1490	1570	1570	1380	2100	4540	1860
Aluminium	4.0	32.6	71.6	70.6	44.2	51.4	61.7	42.1	87.8	5.7	62.4
Phosphorus	<20	60	80	<20	<20	<20	<20	<20	60	<20	<20
Potassium	<50	1800	3030	2930	1080	1160	1160	975	1590	1670	650
Calcium	<10	20300	28300	41900	2110	2540	2170	1980	2980	10000	4640
Titanium	<0.50	0.69	2.72	5.24	5.14	2.41	2.90	1.28	5.08	<0.50	0.94
Vanadium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	0.53	0.83	1.04	0.63	0.69	0.62	0.54	0.55	1.67	<0.30	<0.30
Manganese	<0.10	317	118	5.27	2.97	3.37	2.63	3.29	5.69	6.78	2.61
Iron	<10	1640	2320	80	80	80	80	70	227	40	137
Cobalt	0.08	0.88	0.96	0.31	0.24	0.18	0.09	0.11	0.25	<0.06	<0.06
Nickel	0.30	2.62	3.30	1.27	0.79	1.27	1.57	0.36	0.47	0.53	1.28
Copper	0.980	1.56	3.47	1.65	1.11	2.00	2.00	1.13	10.7	1.21	1.13
Zinc	<1.00	5.82	4.51	1.91	1.27	18.60	<1.00	2.24	5.43	1.23	1.74
Arsenic	1	3	<1	<1	<1	<1	<1	2	<1	2	<1
Selenium	<1	<1	<1	<1	<1	<1	<1	<1	5.00	<1	<1
Strontium	<0.06	34.70	66.50	362.00	7.42	7.16	6.81	6.32	10.10	30.80	15.70
Molybdenum	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	0.27	<0.16	<0.16
Silver	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
Cadmium	0.07	0.12	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	0.12	0.11
Tin	<0.09	<0.09	<0.09	<0.09	0.170	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09
Antimony	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium	<0.03	5.22	6.50	22.10	1.18	1.27	1.16	1.08	1.97	2.23	2.00
Tungsten	<0.07	0.08	0.07	0.11	0.09	<0.07	0.16	0.20	0.15	<0.07	<0.07
Mercury	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Thallium	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Lead	<0.06	0.38	0.31	0.12	0.19	0.32	0.35	0.15	0.39	1.97	0.08
Bismuth	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03

Table 3-4

Levels of Dissolved Metals Found in Water Quality Samples Taken During August 1994

Element (ppm)	Field Blank	WQ1	WQ2	WQ3	WQ4	WQ5	WQ5	WQ5	WQ6	WQ7	WQ8
Depth (m)	n/a	surface	surface	surface	surface	surface	5 m	11 m	surface	surface	surface
Lithium	<5	9.08	<5	7.69	<5	<5	<5	<5	<5	<5	<5
Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron	<1.2	5.19	<1.2	1.28	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
Sodium	<10	11000	5180	7940	2460	3050	3430	2810	3260	7840	4010
Magnesium	<0.37	6410	5710	6030	912	1080	1180	993	1120	3540	1360
Aluminium	<1	1.31	<1	<1	2.50	2.70	3.60	3.11	3.99	1.02	2.25
Phosphorus	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Potassium	<50	1110	1840	2260	636	793	893	714	838	1330	438
Calcium	<10	14900	19600	34500	1490	1760	1940	1630	1820	8630	3930
Titanium	<0.5	0.570	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Vanadium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	<0.3	0.770	1.03	0.350	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Manganese	<0.1	82.9	1.08	0.660	0.200	0.300	0.520	0.280	0.190	<0.1	<0.1
Iron	<10	136	115	<10	<10	10.0	10.0	<10	10.0	<10	<10
Cobalt	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Nickel	<0.3	0.760	1.77	0.320	0.450	0.310	0.950	0.350	<0.3	0.410	0.890
Copper	<0.4	<0.4	0.530	0.640	<0.4	0.630	0.480	<0.4	0.500	<0.4	0.640
Zinc	<1	<1	<1	<1	<1	1.92	<1	1.08	<1	<1	<1
Arsenic	<1	1.00	<1	<1	<1	<1	<1	<1	<1	<1	<1
Selenium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Strontium	<0.06	31.6	56.5	359	6.13	7.09	6.80	6.18	7.77	29.2	15.5
Molybdenum	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
Tin	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09
Antimony	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium	<0.03	4.51	4.81	21.0	0.910	1.05	1.15	0.960	0.930	2.10	1.56
Tungsten	<0.07	0.0800	<0.07	0.0800	<0.07	<0.07	<0.07	<0.07	0.0800	<0.07	<0.07
Mercury	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Thallium	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Lead	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Bismuth	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03

3.5 Aquatic Ecology

In order to provide background baseline information on aquatic flora and fauna, samples were collected for the determination of presence and relative abundance. Stream samples (periphyton and benthic invertebrate) collected in 1993 were sent for analyses as standard sampling procedures were not possible in 1994 due to low water levels and flow rates. Benthic grabs and phytoplankton samples were collected from both Stickleback and Spyder Lakes during the August 1994 field program.

3.5.1 Phytoplankton and Periphyton

Phytoplankton (floating microscopic lake algae) samples were collected from the surface of Stickleback and Spyder Lakes and preserved with Lugol's solution to aid the identification process. Periphyton (benthic stream algae) were scraped from a known area of rock surface in both Trout and Stickleback Creeks, and preserved with Lugol's. Table 3-5 lists the species found and their relative abundances.

Phytoplankton are represented equally well in both Spyder and Stickleback Lakes. A sample collected in 1993 from Spyder Lake indicates no differences in community structure or relative abundances, which may be attributed to environmental conditions. Periphyton were abundant in 1993 in Trout Creek, but would not be expected to be as prolific in 1994 due to low water levels.

3.5.2 Zooplankton

Vertical hauls were accomplished, using a 64 µm net (0.26 m diameter net mouth), in both Spyder and Stickleback Lakes to collect zooplankton samples. Samples were collected in August 1993 and preserved with formalin until analyses in 1994. Table 3-6 lists the zooplankton species and relative abundances found in the lakes.

The Stickleback Lake zooplankton community is dominated by the rotifer group, followed by various crustacean species, whereas Spyder Lake is dominated by crustaceans in general. No other phyla were represented in the samples, which may be due to the lateness of the season (past the reproductive peak of most organisms at that latitude).

Table 3-5

Phytoplankton and Periphyton Relative Abundance in the Boston Area

		Phytoplankton (cells/mL)				Periphyton (cells/cm^2)
Order	Genera	WQ4 (Aug 94)	WQ5 (Aug 93)	WQ5 (Aug 94)	WQ7 (Aug 94)	WQ2 (Aug 93)
Centrales	*Cyclotella*	79.6	91.0	19.9	11.4	Present
	Melosira	45.5	Present[1]	Present	Present	Present
Chaetophorales	*Stigeoclonium*					Present
Chlorococcales	*Ankistrodesmus*	51.2	17.1	56.9	392.5	3018.6
	Botryococcus	91.0	Present	Present	Present	Present
	Crucigenia	91.0	819.2	159.3	455.1	
	Dictyosphaerius	113.8	Present	Present	Present	Present
	Elakatothrix	11.4	Present	Present		
	Lagerheimia				22.8	
	Nephrocytium	Present	22.8	11.4	22.8	
	Oocystis	Present	22.8	Present		
	Pediastrum	Present	Present	Present	Present	Present
	Quadrigula	Present	45.5			
	Scenedesmus	68.3	45.5	5.7	113.8	Present
	Selenastrum			Present		
	Sphaerocystis	91.0	91.0	91.0		
	Tetraedron	Present	Present	11.4	74.0	Present
Chroococcales	*Agmenellum*	Present	Present	22.8	Present	422603.8
	Anacystis	22.8	341.3	Present	2104.9	Present
	Gomphosphaeria	824.9	796.0	298.7	Present	
Cryptomonadales	*Chroomonas*	130.8	256.0	85.3	256.0	
	Cryptomonas	5.7	45.5	11.4	17.1	Present
Dinokontae	*Peridinium*	Present	Present	Present	45.5	Present
Euglenales	*Anabaena*	Present	Present	Present	Present	42260.4
	Euglena					Present
Nostocales	*Rivularia*					Present
Ochromonadales	*Dinobryon*	5.7	11.4	65.4	Present	12074.4
	Mallomonas	5.7	Present	Present		3018.6

1: Genus was identified in fields that fell outside of the specified counting area during laboratory analyses.

(continued)

Table 3-5 (continued)

Phytoplankton and Periphyton Relative Abundance in the Boston Area

		Phytoplankton (cells/mL)				Periphyton (cells/cm^2)
Order	Genera	WQ4 (Aug 94)	WQ5 (Aug 93)	WQ5 (Aug 94)	WQ7 (Aug 94)	WQ2 (Aug 93)
Oedogoniales	*Bulbochaete*					33204.6
	Oedogonium					Present
Oscillatoriales	*Lyngbya*	45.5	216.2	Present	Present	166022.9
	Oscillatoria	Present	Present		159.3	54334.8
Pennales	*Achnanthes*	17.1	22.8	14.2	113.8	36223.2
	Amphora		Present			Present
	Asterionella	119.5	250.3	19.9	153.6	Present
	Ceratoneis	Present	Present	Present	Present	Present
	Cocconeis	Present	Present			
	Cymatopleura			Present		3018.6
	Cymbella	11.4	11.4	2.8	11.4	12074.4
	Diatoma				Present	Present
	Epithemia					
	Eunotia	Present	Present	Present	Present	3018.6
	Fragilaria	28.4	11.4	34.1	17.1	15093.0
	Frustulia	Present		Present		Present
	Gomphonema				Present	
	Navicula	22.8	Present	5.7	11.4	15093.0
	Nitzschia	Present	Present	Present	5.7	Present
	Pleurosigma/ Gyrosigma	Present	Present			Present
	Staureneis	Present	Present		Present	3018.6
	Surirella	Present	Present	Present		3018.6
	Synedra	Present	Present		Present	21130.2
	Tabellaria	Present	Present	Present	Present	196208.9
Rhizochrysidales	*Diceras*	5.7	Present			
Tetrasporales	*Gloeocystis*	Present	85.3	5.7	Present	
Ulothricales	*Geminella*		Present			
	Ulothrix	Present			Present	Present
Ulvales	*Shcizomeris*	Present				
Volvocales	*Chlamydomonas*	Present	5.7		Present	
	Eudorina	Present	Present	Present		Present

(continued)

Table 3-5 (completed)

Phytoplankton and Periphyton Relatives Abundance in the Boston Area

		Phytoplankton (cells/mL)				Periphyton (cells/cm^2)
Order	Genera	WQ4 (Aug 94)	WQ5 (Aug 93)	WQ5 (Aug 94)	WQ7 (Aug 94)	WQ2 (Aug 93)
Zygnematales	*Arthrodesmus*	Present	Present	2.8		3018.6
	Bambusina					
	Closterium					Present
	Cosmarium	Present			Present	Present
	Cylindrocystis					
	Euastrum					Present
	Gonatozygon	Present				Present
	Mougeotia				Present	3018.6
	Spirogyra					Present
	Spondylosium	28.4	11.4	8.5	11.4	Present
	Staurastrum	Present	Present		Present	Present
	Xanthidium					Present
	Zygnema	Present				Present

A 1994 larval drift net (Plate 3-4) sample from Trout Creek yielded various crustaceans and some chironomid larvae, but is probably not representative of true stream conditions, due to low flow rates which allowed sticklebacks to swim in and out of the net and consume various prey items.

3.5.3 Benthic Invertebrates

Benthic invertebrate samples were collected in Stickleback (WQ7) and Spyder (WQ 3-5) Lakes and in Trout Creek (WQ2) (see Figure 2-1 for site locations) to provide baseline information on species present and their relative abundances. An Ekman grab (0.0225 m^3) was used in the lakes to collect three replicate samples of soft-bottom sediments which were then screened through a 250 µm sieve to retain macroinvertebrates (Plate 3-5). A Hess sampler (0.09616 m^2) was used in Trout Creek to collect three replicate samples of benthic invertebrates living amongst the rocks that comprised the substrate. A core sampler (0.00332 m^2) was used to collect three replicate samples of invertebrates living in the soft sediments of the

Table 3-6

Zooplankton Presence and Relative Abundance in Stickleback and Spyder Lakes (1993 Samples)

Species	Stickeback Lake (# individuals/m^3) (Depth 2 m)	Spyder Lake (# individuals/m^3) (Depth 16 m)
Rotifers (four indeterminate species)	893,584.1	12,264.2
Crustacea nauplius larvae	6,037.7	23,207.5
Cyclops sp. copepodite I-II	-	943.4
Cyclops sp. copepodite III-IV	-	1,981.1
Cyclops scutifer	3,018.9	1,132.1
Cyclops sp.	3,018.9	-
Daphnia middendorfiana	3,018.9	188.7
Daphnia sp. immature	3,018.9	-
Diaptomus sp. copepodite IV	-	471.7
Diaptomus sp.	-	94.3
Holopedidium gibberum	-	566.0
Limnocalanus macrurus	-	94.3
TOTAL	911,697.4	40,943.3

shallow arm (WQ3) of Spyder Lake into which Stickleback and Trout Creeks feed. Samples from WQ2 and WQ3 were collected in 1993 as low water levels in 1994 did not permit conventional sampling methods to be employed.

Table 3-7 presents the benthic invertebrate species identified as well as their relative abundances. The bottom of Stickleback Lake is covered with aquatic "moss" which impedes grab sampling but, alternatively, provides more surface area and refuge for surface dwelling organisms such as insect larvae as opposed to soft sediments which harbour more burrowing organisms such (as various oligochaetes and crustaceans). Bryozoan colonies and other invertebrate egg cases/masses were also abundant on the moss as it provides suitable substrate for anchoring and attachment.

Plate 3-4: **A larval drift net sampler was set for 24 hr in Trout Creek, where some flow was recorded, but low flow combined with low water levels hampered sampling efficiency (water depth <15 cm).**

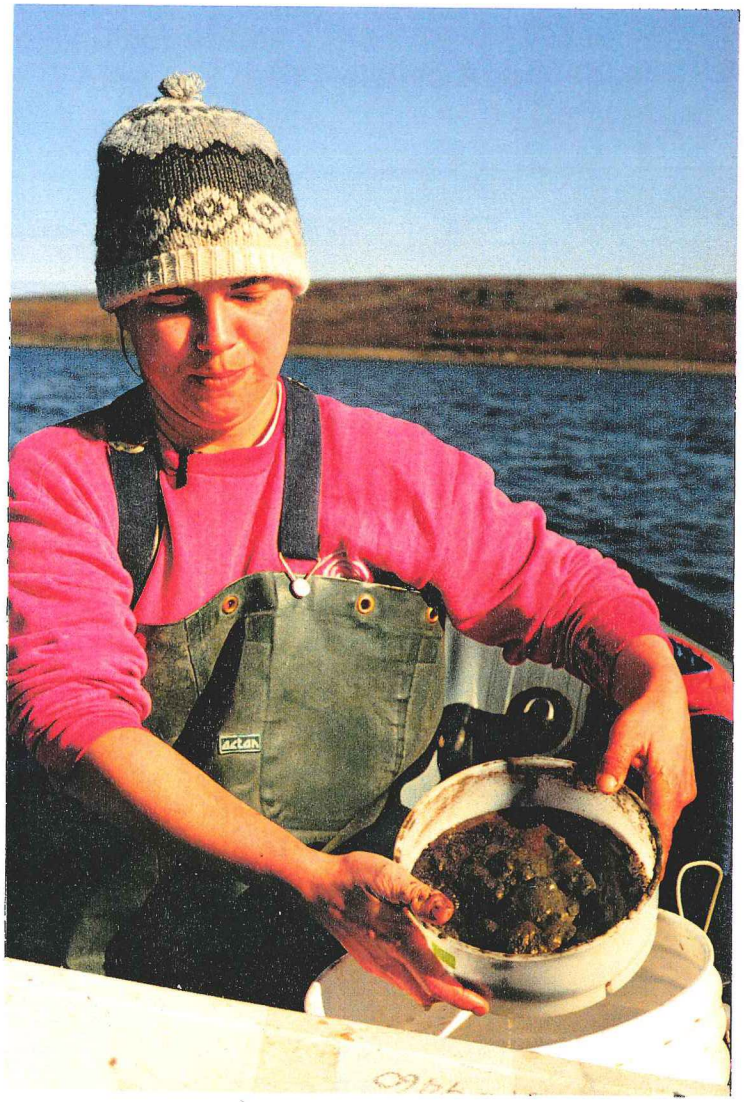


Plate 3-5: An Ekman grab was used to sample lake bottom sediments for benthic invertebrates; the sediments were sieved through a 250 µm screen to retain organisms for identification.

Table 3-7

List of Benthic Invertebrate Taxa Present in the Boston Property Area and their Relative Abundances

Species	WQ2	WQ3	WQ4	WQ5	WQ7
Crustacea					
Gammarus lacustris	27.7				
Gammarus sp.					400.0
Daphnia sp. immat.	27.7	803.2			
Holopedium gibberum				14.8	
Diaptomus sp.		1606.4		414.8	
Cyclopoida copepod	6.9	200.8		785.2	666.7
Harpacticoida copepod	159.5		88.9		4133.3
Ostracoda sp. A	637.8			355.6	2488.9
Ostracoda sp. B	90.1				3977.8
Cypridopsis sp.			1051.9		
Hydroida					
Hydra canadensis	17.3				155.6
Hydroida polyps	3.5				
Arthropoda					
Hydracarina indet.	3.5	803.2			22.2
Typhis sp.			44.4		
Unidentified insecta larvae		100.4			
Chironomidae immat.	1854.5	3413.7		1274.1	3688.9
Tanytarsus sp.	10.4		385.2		
Tanypus sp.			1629.6		
Chironomini indet.	332.8			177.8	400.0
Phaenopsectra sp.	3.5	200.8			
Tanypodinae indet.	52.0			444.4	
Tanytarsini indet.				74.1	2133.3
Euryhapsis sp.					488.9
Plecoptera (nymph)	20.8				
Grensia praeterita	3.5				177.8

(continued)

Table 3-7 (completed)

List of Benthic Invertebrate Taxa Present in the Boston Property Area and their Relative Abundances

Species	WQ2	WQ3	WQ4	WQ5	WQ7
	1993	1993	1994 →		
Mollusca					
Bivalvia indet.				311.1	
Pisidium nitidum				429.6	177.8
Pisidium immature					177.8
Sphaerium nitidum			2474.1		1066.7
Valvata sincera helicoidea					577.7
Nematoda	201.1	9337.3		74.1	3800.0
Oligochaeta					
Lumbricalidae indet.	41.6	803.2		103.7	
Oligochaeta immat.	41.6	3915.7			1422.2
Tubificidae immat.	208.0	803.2			
Tubificidae sp. A	6.9				822.2
Tubificidae sp. B	107.5			192.6	955.6
Enchytraeidae indet.			948.1		
Turbellaria	3.5				

3.5.4 Sediments

Sediment chemistry for selected elements and particle size analyses are presented in Table 3-8 for those sites with soft-bottom substrate. The samples were collected in 1993 and analysed to provide baseline data unaltered by anthropogenic activities. WQ5, the site farthest for the drilling/camp sites, has consistently higher metal concentrations, which is due to the greater clay fraction rather than to any mining related activities. The highest organic carbon content was found at WQ1, and is contributed by the aquatic plants and grasses lining this creek area.

Table 3-8

Sediment Chemistry and Particle Size Analysis of Selected Sites in the Boston Property Area (Dry Weight Basis)

Stickleback lake (# error- this data is not for trout lake-KV) years collected? 1993.

Element (ppm)	WQ2 1	WQ3	WQ4	WQ5
Aluminum	57100	63400	59600	75200
Antimony	<0.05	0.10	<0.05	0.19
Arsenic	1.59	0.86	0.78	11.1
Barium	641	690	619	794
Cadmium	<0.10	<0.10	<0.10	<0.10
Calcium	17600	18700	18900	13400
Chromium	29.3	62.5	21.7	87
Cobalt	5.2	10.1	4.3	72.3
Copper	10.6	19.4	4.3	26.1
Iron	17300	25600	15600	66400
Lead	2.8	6.9	2.9	11.5
Magnesium	5750	10700	5800	14900
Manganese	352	376	333	6710
Mercury	0.013	<0.005	<0.005	0.023
Molybdenum	<1.0	<1.0	<1.0	14.0
Nickel	7.4	19.7	6.1	33.9
Selenium	<0.10	<0.10	<0.10	0.23
Silver	<0.10	<0.10	<0.10	<0.10
Vanadium	37.0	73.9	39.2	118
Zinc	24.2	47.0	25.0	118
Organic Carbon (%)	5.65	0.80	0.50	1.30
Particle Size (%)				
Gravel (>2.00 mm)	4.6	9.5	0.2	-
Sand (0.063 - 2.00 mm)	83.4	25.8	70.7	2.9
Silt (4 µm - 0.063 mm)	5.7	42.0	24.9	29.5
Clay (<4 µm)	6.3	22.8	4.2	67.6

3.6 Fisheries

It is important to obtain adequate baseline information in order to ensure the protection of fisheries and other aquatic resources during any development process. Surveys conducted in 1993 and 1994 at the Boston site, in both Spyder and Stickleback Lakes, involved a presence/absence fish gillnetting effort, using a variety of mesh sizes and nets deployed at the surface and on the bottom (Plate 3-6). In August 1994, baited minnow traps (Plate 3-7) were set in Stickleback and Trout Creeks for 48 hr (checked daily); they yielded large numbers of sticklebacks (40+ /creek), but only one lake trout fry per creek.

The 1993 fisheries study (relative abundance in gillnet catches) indicated the presence of lake trout (*Salvelinus namaycush*) and lake whitefish (*Coregonus clupeaformis*) in Spyder Lake, and the 1994 effort yielded both those species as well as one grayling (reportedly more abundant in the cascades area at the northern end of the lake). Table 3-9 presents the vital statistics of the fish collected in 1994. No fish were caught in Stickleback Lake in either year; however, there are reports of sticklebacks (Gasterosteidae spp.) being trapped in water lines fed from Stickleback Lake (BHP personal communication). As well, 1993 stream electrofishing surveys at WQ1, connecting Stickleback Lake and Spyder Lake, and WQ2 (Trout Creek), connecting Trout Lake and Spyder Lake, both yielded sticklebacks, indicating that this fish occurs in all three water bodies.

Materials for fish age determination, stomach content analyses, and trace metal analyses (muscle and liver tissue), were taken from a representative subsample of fish from Spyder Lake. Age data are included in Table 3-9.

Stomach content analyses are presented in Table 3-10 for selected fish. A cursory examination of the results show that lake trout eat other fish (predominantly whitefish; Plate 3-8) and whitefish eat invertebrates. Most lake trout stomachs were empty when the fish were gutted, although some did contain stones. Whitefish stomachs at first glance appeared full but, when opened, contained large quantities of mucous. The few with obvious contents were sent for analyses, and show a dietary preference for molluscs, although these fish are probably opportunistic feeders.

Plate 3-6: **Gillnets were set in Spyder Lake to sample the fish population (lake trout, *Salvelinus namaycush*, shown).**

Plate 3-7: **Baited minnow traps set in Stickleback and Trout Creeks yielded large numbers of sticklebacks, but only one lake trout fry per creek.**

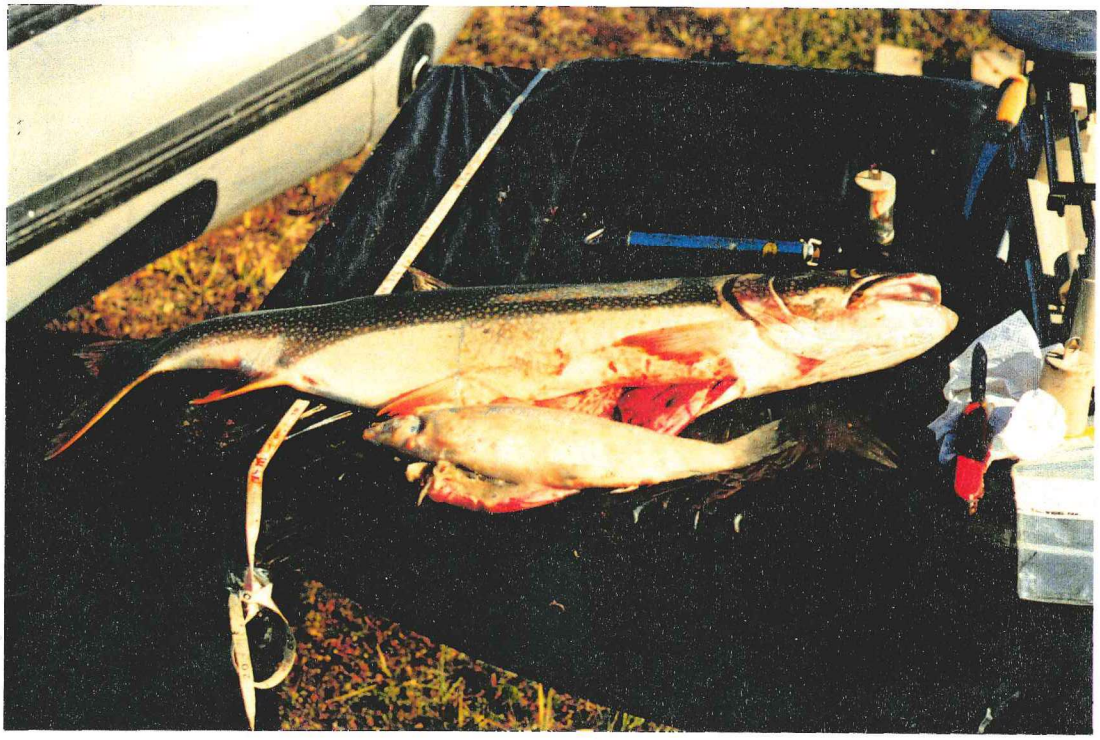


Plate 3-8: **Lake trout show a dietary preference for other fish: this 77 cm long lake trout had a 30 cm whitefish in its stomach.**

Table 3-9

Vital Statistics of Fish Caught in Spyder Lake: August 1994

Species	ID #	Sex	Total Length (cm)	Total Weight (g)	Age	Methods and Notes
Lake Trout (*Salvelinus namaycush*)	LT 1	female	54	1200	10+	Sinking Gillnet
	LT 2	female	51	1000	14+	3.5" mesh; 6'x50' panel
	LT 3	female	62	1900	13+	16 hr set (Aug.27/94)
	LT 4	female	74	3200	14+	(1 live 80cm lake trout
Lake Whitefish (*Coregonus clupeaformis*)	WF 1	male	51	1400	17+	released on site)
	WF 2	male	49	1200	15+	
	WF 3	male	45	1400		immature
	WF 4	male	54	1600	17+	
	WF 5	male	55	1800	23+	
	WF 6	female	50	1500	19+	
	WF 7	female	46	900	14+	
Lake Trout (*Salvelinus namaycush*)	LT 5	female	95	6500	15+	Floating Gillnet (gang) 16 hr set (Aug. 27/94)
	LT 6	female	90	5700	16+	1 - 6'x50' panel (1.5" mesh)
	LT 7	immature	37	400	5+	1 - 6'x50' panel (2.5" mesh)
	LT 8	male	79	3800	15+	1 - 6'x40' panel (3.5" mesh)
	LT 9	female	77	4500	12+	stomach contained 30 cm WF
	LT 10	female	80	3400	12+	
	LT 11	immature	39	450	5+	nematode infestation
	LT 12	male	57	1500	-	
	LT 13	female	75	3300	-	
	LT 14	female	77	3300	-	
	LT 15	male	57	1400	-	

(continued)

Table 3-9 (completed)

Vital Statistics of Fish Caught in Spyder Lake: August 1994

Species	ID #	Sex	Total Length (cm)	Total Weight (g)	Age	Methods and Notes
	LT 16	female	50	1000	6+	
	LT 17	male	85	4700		
	LT 18	male	44	700	6+	
	LT 19	immature	18	35	-	
	LT 20	female	52	1200	-	
Lake Whitefish (*Coregonus clupeaformis*)	WF 8	immature	18	45	-	
	WF 9	female	55	1800	-	
	WF 10	female	41	600	9+	
	WF 11	immature	32	300		
	WF 12	male	52	1400		
	WF 13	female	39	500	7+	
	WF 14	female	51	1300		
	WF 15	immature	19	50		
	WF 16	male	42	700	9+	
	WF 17	male	51	1900		
	WF 18	male	50	1300	17+	
	WF 19	female	53	1600	16+	
	WF 20	immature	37	400		
	WF 21	male	38	350		
	WF 22	female	34	400		
	WF 23	female	39	350		
Arctic Grayling (*Thymallus arcticus*)	GR 1	male	34	400	6+	

Table 3-10

List of Stomach Contents of Lake Whitefish and Lake Trout from Spyder Lake

Fish Species	Stomach Contents*
Lake Whitefish (*Coregonus clupeaformis*)	**Mollusca:** *Valvata sincera helicoidea* (orb snail) *Pisidium casertanum* (peashell clam) *Spaerium nitidum* (finger-nail clam) **Crustacea:** *Mysis relicta* (shrimp) **Insecta:** *Lebertia* sp. (aquatic mite) *Trichoptera* (caddisflies) *Ephemeroptera* (mayflies) **Unidentified Fish Eggs** Stones, Mucous
Lake Trout (*Salvelinus namaycush*)	**Insecta:** *Simulium* sp. (blackflies) Culicidae (mosquitoes) **Crustacea:** *Mysis relicta* (shrimp) *Hyalella azteca* (amphipod) *Lireus* sp. (isopod) (plus unidentifiable remains) **Nematodes** **Mollusca:** *Valvata sincera helicoidea* **Fish:** *Coregonus clupeaformis* (whitefish) Gasteroidae spp. (sticklebacks) Stones, mucous

Trace metals in fish tissues from Spyder Lake are shown in Tables 3-11 and 3-12. Comparison to results from unpolluted waters in Canada for selected metals show levels are well within usual background concentrations and limits for human consumption (Table 3-13), with the exception of mercury in the flesh from lake trout over 60 cm, a common finding with old fish due to bio-accumulation.

Should project development proceed, additional studies will be required for fisheries and other aquatic resources in the project area. For example, a more intensive sampling program during the open water season, using a variety of sampling gear (trap nets, seines, traps, deep-water gillnet sets using a broad range of mesh sizes), might be undertaken to both quantify and qualify fish populations. Quantitative population estimates and age class composition for key species of the community would be obtained through a mark-recapture program.

The requirements for further fisheries and aquatic resources studies will be determined with BHP on the basis of the project development proposal.

3.7 Wildlife

A reconnaissance-level survey of wildlife resources of the Boston property was conducted in 1994. Its objectives were to identify bird and mammal species present, and to identify, if possible, important habitats that will require further study should project development proceed in the future. At this level of the survey, a single interview was conducted with a person knowledgeable of wildlife resources of the study area. A literature search was conducted at the Department of Renewable Resources library in Yellowknife by library staff. Databases searched were Wildlife Worldwide and Arctic and Antarctic Regions. This was supplemented by the camp wildlife log that has been active since 1993.

3.7.1 Caribou

Few caribou were observed within the study area during August 1994. One group of 4 bulls, and 2 lone cows constituted all caribou observations recorded during this period. All were immediately east of Spyder Lake.

The area is, however, of seasonal importance to caribou (Plate 3-9). Most sites with a soft substrate are densely hatched with caribou trails, suggesting fairly

Table 3-11

Muscle Tissue Metal Levels in Fish Caught in Spyder Lake During August 1994 (ppm wet weight)

Species	ID #	Length (cm)	Weight (g)	Mg	Mn	Ni	Cu	Zn	As	Se	Ag	Cd	Te	Hg	Pb
Lake Whitefish	1	51	1400	325	0.7570	0.0473	0.308	4.36	0.0779	0.267	<0.0022	<0.0012	<0.002	0.4770	0.0056
	2	49	1200	285	0.1560	0.0141	0.204	3.37	<0.0100	0.333	<0.0020	<0.0012	<0.002	0.0919	0.0073
	3	45	1400	295	0.3460	0.0333	0.607	4.31	0.0663	0.223	0.0024	<0.0013	<0.002	0.0686	0.0147
	4	54	1600	302	0.3950	0.0414	0.172	3.55	0.0578	0.340	<0.0025	<0.0016	<0.002	0.1700	0.0091
	5	55	1800	309	0.1630	0.0231	0.381	3.46	0.0323	0.221	<0.0023	<0.0015	<0.002	0.2450	0.0091
	8	18	45	212	0.1990	0.1030	0.272	8.86	0.1020	0.200	<0.0026	<0.0014	<0.002	0.0335	0.0390
	10	41	600	317	0.1880	0.0219	0.240	3.18	0.0272	0.220	<0.0023	0.0013	<0.002	0.0674	0.0031
	13	39	500	289	0.1080	0.0188	2.090	3.40	0.0856	0.159	<0.0021	<0.0013	<0.002	0.1190	0.0054
	16	42	700	206	0.1030	0.0106	0.119	2.28	0.0105	0.139	<0.0014	<0.0008	<0.002	0.0337	0.0028
	18	50	1300	264	0.1260	0.1500	0.375	3.02	0.0444	0.151	<0.0020	<0.0013	<0.002	0.1150	0.0031
	19	53	1600	258	0.1470	0.0142	0.217	3.29	0.0474	0.315	<0.0023	<0.0013	<0.002	0.1370	0.0151
Arctic Grayling	1	34	400	277	0.1360	0.0120	0.292	3.28	<0.0100	0.102	<0.0023	<0.0014	<0.002	<0.0076	0.0081
Lake Trout	1	54	1200	246	0.1090	0.0138	0.207	2.73	0.0406	0.188	<0.0023	<0.0015	<0.002	0.3870	0.0029
	2	51	1000	255	0.2100	0.0208	0.356	3.24	0.0530	0.204	<0.0020	<0.0012	<0.002	0.2390	0.0123
	3	62	1900	244	0.1410	0.0236	1.440	3.54	0.0527	0.155	<0.0024	<0.0015	<0.002	0.5380	0.0494
	4	74	3200	242	0.1050	0.0109	0.339	3.31	0.0370	0.124	<0.0021	<0.0011	<0.002	0.8060	0.0311
	5	95	6500	252	0.0895	0.0795	0.254	3.11	0.0739	0.199	<0.0024	<0.0015	<0.002	0.8950	0.0056
	7	37	400	258	0.1390	0.0266	0.250	2.86	<0.0100	0.133	<0.0020	<0.0013	<0.002	0.2070	0.0019
	10	80	3400	260	0.0928	0.0177	0.354	3.96	0.0482	0.186	<0.0023	<0.0015	<0.002	0.6720	0.0154
	11	39	450	303	0.1370	0.0141	0.353	3.39	0.0502	0.171	<0.0021	<0.0012	<0.002	0.2590	0.0029
	16	50	1000	262	0.0992	0.0185	0.314	3.87	0.0104	0.109	<0.0020	<0.0012	<0.002	0.2240	0.3650
	18	44	700	280	0.3000	0.0285	0.292	5.84	0.1270	0.284	<0.0022	<0.0014	<0.002	0.2370	0.1910
	19	18	35	101	0.1460	0.0358	0.321	6.06	<0.0100	0.037	<0.0038	<0.0021	<0.002	<0.0130	0.0115

Table 3-12

Liver Tissue Metal Levels in Fish Caught in Spyder Lake During August 1994 (ppm wet weight)

Species	ID #	Length (cm)	Weight (g)	Mg	Mn	Ni	Cu	Zn	As	Se	Ag	Cd	Te	Hg	Pb
Lake Whitefish	1	51	1400	142	1.560	0.1510	9.74	27.8	0.4270	2.090	0.3020	0.2050	0.0400	2.740	0.0325
	2	49	1200	116	1.170	0.0542	4.83	22.3	0.1390	0.918	0.0285	0.1320	<0.0021	0.309	0.0118
	3	45	1400	183	1.720	0.0764	7.32	30.5	0.2010	0.912	0.0588	0.0569	<0.0025	0.339	0.0126
	4	54	1600	149	1.410	0.1350	7.94	24.5	0.1730	1.360	0.0959	0.2960	<0.0026	0.992	0.0208
	5	55	1800	127	1.100	0.0526	11.80	22.4	0.1270	0.924	0.1590	0.1600	0.0124	0.814	0.0143
	8	18	45	196	0.799	0.0213	1.89	93.2	0.0511	0.410	0.0129	0.0193	0.0144	0.125	0.0172
	10	41	600	178	1.300	0.0291	3.57	27.4	0.1580	0.828	0.0338	0.0900	<0.0024	0.235	0.0162
	13	39	500	160	1.450	0.0421	2.90	45.2	0.1120	0.720	0.0287	0.0157	<0.0038	0.446	0.0254
	16	42	700	198	1.980	0.0636	4.00	24.6	0.1640	0.924	0.0393	0.0583	<0.0030	0.271	0.0073
	18	50	1300	140	1.310	0.0842	6.40	23.1	0.0351	0.828	0.0914	0.1100	0.0118	0.536	0.0081
	19	53	1600	272	2.000	0.0352	4.36	25.3	0.1620	0.924	0.0607	0.1230	0.0049	0.460	0.0062
Arctic Grayling	1	34	400	187	4.030	0.0693	3.30	21.1	<0.0100	0.417	0.0470	0.0350	<0.0026	0.122	0.0105
Lake Trout	1	54	1200	123	1.170	0.0355	13.40	21.9	0.0383	0.562	0.1390	0.0797	<0.0024	0.683	0.0076
	2	51	1000	178	1.300	0.0504	17.50	34.7	0.0264	0.798	0.2020	0.0394	<0.0025	0.599	0.0255
	3	62	1900	125	0.920	0.0205	16.70	25.8	0.0315	0.720	0.3030	0.0421	<0.0020	0.918	0.0093
	4	74	3200	140	1.100	0.0424	21.50	28.4	<0.0100	0.524	0.2350	0.0576	<0.0024	1.820	0.0186
	5	95	6500	134	1.140	0.0421	13.00	26.9	0.1470	1.230	0.0811	0.0618	0.0023	2.310	0.0038
	7	37	400	140	1.270	0.0437	8.49	23.2	0.0809	1.050	0.0859	0.0338	<0.0028	0.329	0.0101
	10	80	3400	146	1.140	0.0371	14.30	26.9	<0.0100	1.060	0.2050	0.0506	<0.0020	1.330	0.0214
	11	39	450	182	1.790	0.1140	10.80	30.5	0.1540	1.150	0.0652	0.0490	<0.0021	0.368	0.0097
	16	50	1000	144	1.050	0.0186	2.67	24.8	0.1160	0.477	0.0204	0.0453	<0.0022	0.337	0.0093
	18	44	700	170	1.570	0.0333	14.60	30.6	0.3090	1.860	0.0851	0.0396	0.0036	0.377	0.0121
	19	18	35	125	0.450	0.0157	1.80	17.6	<0.0100	0.241	0.0128	0.0065	<0.002	0.049	0.0063

Table 3-13

Comparison of Selected Trace Metals in Fish Tissues from Spyder Lake and Unpolluted Waters in Canada

		As		Cd		Cu		Pb		Hg		Zn	
Background concentrations in fish muscle tissue from unpolluted waters		0.2 - 0.5		<0.06		0.5 - 1.53		0.04 - 1.31		<0.005 - 1.5		4.7 - 17.2	
Background concentrations in fish liver tissue from unpolluted waters		-		<0.06		1.5 - 28.0		0.12 - 1.13		-		11.0 - 48.0	
Canadian Standard for Human Consumption		3.5		-		-		10		0.5		100	
Spyder Lake Location	**Sample**	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver
23	mean (± SD)	0.0463 (±0.034)	0.1162 (±0.1013)	<0.002	0.0785 (±0.0663)	0.424 (±0.439)	8.82 (±5.56)	0.0353 (±0.0801)	0.0138 (±0.0072)	0.262 (±0.248)	0.718 (±0.690)	3.84 (±1.37)	29.5 (±14.6)

All values reported as milligrams per kilogram of wet tissue (ppm-wet weight)
< = Less than the detection limit specified.
Mean values were calculated from individual sample results.

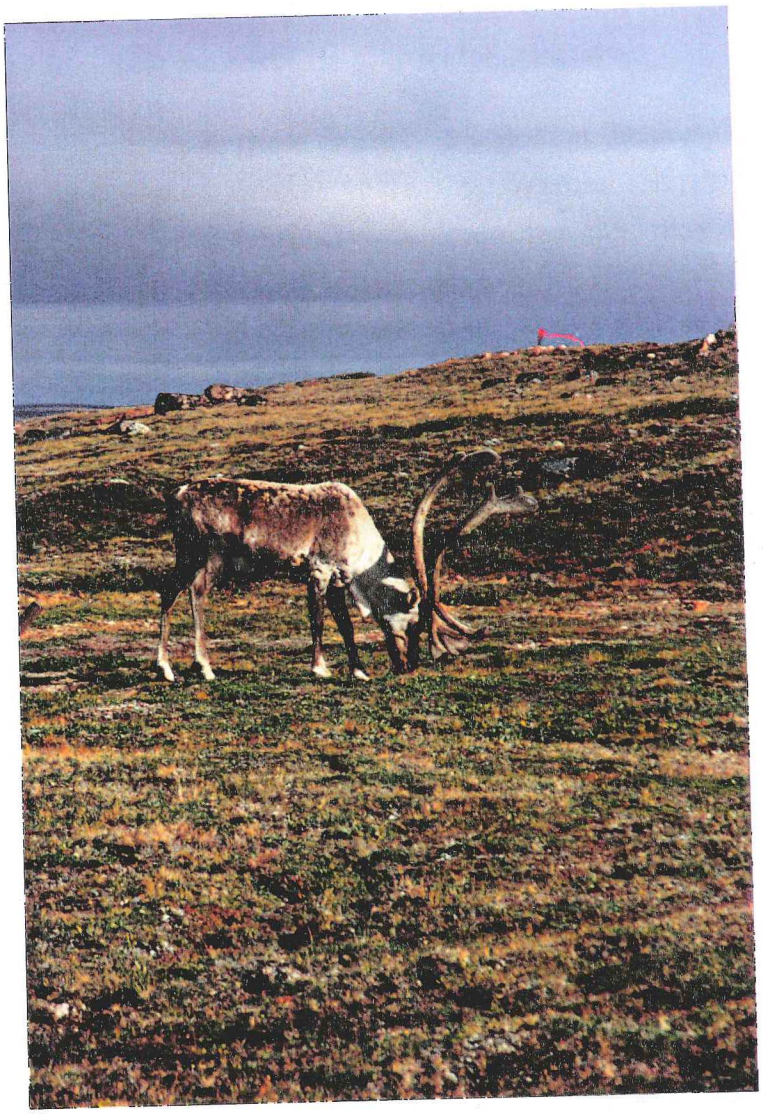


Plate 3-9: **The area appears to be of seasonal importance to caribou, which occasionally wander through the Boston property.**

heavy migration traffic, particularly in a north-south aspect east of Spyder Lake. Caribou pellets are abundant and ubiquitous. Observations recorded in the staff wildlife log (Table 3-14) suggest that the study area is, at times, heavily used by caribou. For example, on 16 July 1994, an estimated 2,200 caribou were observed grazing and moving along the east side of Stickleback Lake.

Traditional calving grounds in the vicinity of the Boston Property do not appear to have been used in the past several years. B. Warner (Burnside Hunters and Trappers Organization, pers. comm.) speculates that this may be due to early spring breakup of major rivers on the migration routes, encouraging more caribou to remain on the west side of Bathurst Inlet. Mr. Warner also reports that "a large number" of caribou remain in this area over winter, resulting in increasing use of the area during winter by wolves and Inuit hunters. However, movement patterns and use of the Boston property area by caribou have not been intensively monitored, and few details are known. Further study on Caribou populations (especially at the calving grounds) will be necessary as the project advances.

3.7.2 Muskox

Muskoxen (Plate 3-10) are apparently not numerous in the study area. Willow (*Salix* sp.) and dwarf birch (*Betula glandulosa*) stands within the study area and, particularly, immediately around the campsite, appear to be desirable forage. Since April 30, 1994, 10 observations of muskoxen, totalling 49 animals, were recorded in the study area (Table 3-14). This is generally consistent with common regional densities.

Muskoxen are hunted by Inuit in the area east of Bathurst Inlet, and the potential for sport hunting is being explored (B. Warner, Burnside Hunters and Trappers Organization, pers. comm.).

3.7.3 Grizzly Bear

Only two grizzly bears were observed within the study area earlier in 1994. A female accompanied by a single cub was observed 400 m east of Boston camp on April 30. A large bear was seen on May 29 near the airstrip.

Table 3-14

Wildlife Log Maintained by BHP Staff at the Boston Camp, NWT, 30 April — 28 August 1994

Date	Species	Number	Class[1]	Location	Direction Headed
30 April	Grizzly Bear	2	1 yoy	400 m east of Boston camp	south
30 April	Caribou	8	?	500 m east of Boston camp	south
30 April	Caribou	12	?	1 km west of Boston camp	south
30 April	Arctic Fox	1	-	in camp garbage	
30 April	Ground Squirrel	1	-	around camp	
30 April	Ptarmigan	20	-	on Wally Ridge	
1 May	Arctic Hare	1	-	supply cache on Spyder Lake	
6 May	Caribou	34+	-	east side of camp, grazing and walking	north
7 May	Caribou	24?	-	west side of Stickleback Lake	some movement to east
8 May	Arctic Fox	1	-	hanging around burning pit in evenings	
8 May	Arctic Hare	1	-	grazing near woodpile in camp	
8 May	Caribou	250	?	north of grid	northeast
12 May	Muskox	6	?	grazing NE of camp 1000 m	east-west
12 May	Wolf	1	-	near airstrip	south
13 May	Arctic Fox	1	-	at tower	northeast
14 May	Wolf	1	-	hanging around drills	
14 May	Arctic Fox	1	-	kitchen	northeast
17 May	Arctic Fox	2	-	garbage pit	southwest
29 May	Muskox	12		grazing 1 km northeast of camp	
29 May	Grizzly Bear	1	ad	near fuel cache at airstrip	west

1 Class: ad = adult; F = female; M = male; yoy = young of the year; u/c = unclassified.

(continued)

Table 3-14 (continued)

Wildlife Log Maintained by BHP Staff at the Boston Camp, NWT, 30 April — 28 August 1994

Date	Species	Number	Class[1]	Location	Direction Headed
30 May	Muskox	12	?	grazing 2 km northeast of camp	north
30 May	Caribou	16	?	grazing 1 km northeast of camp	
3 June	Muskox	3	-	2.5 km south of camp	south
3 June	Caribou	many	some	scattered around south of camp	south
8 June	Muskox	3	-	grazing 1 km southwest of camp	north
14 June	Wolf	3	?	on west shore Spyder L., across from drill cache	south
24 June	Caribou	>100	?	grazing just east of camp	south
26 June	Arctic Fox	1	-	sniffing around camp	
2 July	Tundra Swan	2	-	southwest corner Stickleback Lake	
3 July	Arctic Tern	20+	-	feeding on Stickleback Lake	
5 July	Muskox	9	-	grazing on SW shore Stickleback Lake	north-south-north
12 July	Muskox	1	-	300 m east of Boston camp	?
16 July	Caribou	2200		grazing on east side Stickleback Lake	north
18 July	Caribou	>1000		grazing all along N, E, and S shore Stickleback Lake	
8 Aug.	Caribou	4	2 yoy		
9 Aug.	Muskox	1	-	grazing in creek which drains Fickleduck Lake	
9 Aug.	Arctic Fox	1	-	prowling around north end of camp	
18 Aug.	Ptarmigan	9	juveniles	just east of the drills on Wally grid	

1 Class: ad = adult; F = female; M = male; yoy = young of the year; u/c = unclassified.

(continued)

Table 3-14 (continued)

Wildlife Log Maintained by BHP Staff at the Boston Camp, NWT, 30 April — 28 August 1994

Date	Species	Number	Class[1]	Location	Direction Headed
25 Aug.	Canada Goose	23	u/c	at campsite	
25	Herring Gull	2	u/c	at campsite	
25-28	Arctic Ground Squirrel	4	2 ad 2 yoy	at campsite	
25	Canada Goose	7	u/c	west of Stickleback Lake	south
25	Canada Goose	9	u/c	west of Stickleback Lake	south
25	Caribou	4	ad M	east side Spyder Lake	
25	Tundra Swan	6	2 ad 4 yoy	west of Spyder Lake	
25	Tundra Swan	5	2 ad 3 yoy		
25	Tundra Swan	2	ad		
25	Tundra Swan	2	ad		
25	Canada Goose	29	u/c		
25	Canada Goose	15	u/c		
26	Arctic Loon	4	u/c	Trout Lake	
26	Arctic Loon	1	u/c	overflying Stickleback Lake	
26	White-fronted Goose	33	u/c	grazing at campsite	
26	White-fronted Goose	>100	u/c	Trout Lake	
26	Herring Gull	1	u/c	Stickleback Lake	
26	Lapland Longspur	many	u/c	common throughout study area	
26	Raven	1	u/c	overflying Stickleback Lake	
26	Sandhill Crane	2	u/c	Trout Lake	
26 Aug.	Red-breasted Merganser	5	Ad F 4 yoy	Stickleback Lake	

1 Class: ad = adult; F = female; M = male; yoy = young of the year; u/c = unclassified.

(continued)

Table 3-14 (completed)

Wildlife Log Maintained by BHP Staff at the Boston Camp, NWT, 30 April — 28 August 1994

Date	Species	Number	Class[1]	Location	Direction Headed
26	Muskox	1	Ad M	approached campsite to within 200 m, from east; turned and exited to southeast	
26	Arctic Fox	1	u/c	passed through campsite south-north	
26	Snowy Owl	1	u/c	at drill rig southwest of campsite	
26	Muskox	1	u/c	3 km south of campsite	south
27	Tundra Swan	2	ad		
27	Rough-legged Hawk	1	u/c	west side of Spyder Lake	
27	Sandhill Crane	2	u/c		
27	Rough-legged Hawk	1	u/c	8 km southeast of campsite	
27	Sandhill Crane	2	u/c	5 km southeast of campsite	
27	Sandhill Crane	2	u/c	3 km southeast of campsite	
27	Snow Goose	40	u/c	8 km southeast of campsite	
27	Caribou	2	ad F	east side of Spyder Lake	
27	Arctic Fox	1	u/c	at drill rig southwest of campsite	
27	Tundra Swan	2	ad	Trout Lake	
27	Sandhill Crane	2	ad	Trout Lake	
27	White-fronted Goose	>150	u/c	Trout Lake	
28	Sandhill Crane	2	ad	2 km north of campsite	
28	White-fronted Goose	30	u/c	flying over Trout Lake	south
28	Canada Goose	12	u/c	flying over Trout Lake	south
28	White-fronted Goose	60	u/c	flying over Stickleback Lake	south

1 Class: ad = adult; F = female; M = male; yoy = young of the year; u/c = unclassified.

Plate 3-10: Muskoxen do occur in the area, but are not numerous; this lone male was observed in proximity to the Boston camp (note Canada geese in background).

Densities of grizzly bears in the Bathurst Inlet region are unknown, but are likely low.

3.7.4 Raptors

Few hawks or owls were recorded within the study area in 1994. During August, one rough-legged hawk was observed near Spyder Lake, and a snowy owl was seen near the drill rigs. Good numbers of Arctic ground squirrels (Plate 3-11), Arctic hares, and likely other small mammals, and availability of suitable nesting sites, likely make the area good habitat for breeding populations of rough-legged hawks, snowy owls, and gyrfalcons. Peregrine falcons and golden eagles may also occur in the area, at least occasionally.

Gyrfalcons are believed to nest in the Koignuk River valley downstream (north) of Spyder Lake and the Boston study area (B. Warner, Burnside Hunters and Trappers Organization, pers. comm.).

3.7.5 Waterfowl

The area around the Boston Property appears to be important habitat for staging, and in some cases, breeding waterfowl. White-fronted geese were the most numerous species observed grazing, swimming, or overflying the study area. On several occasions, flocks of up to 40 white-fronted geese grazed immediately adjacent to camp buildings.

Canada geese were also commonly observed, although numbers were smaller than for white-fronted geese. A single flock of about 40 snow geese was recorded on August 2.

Tundra swans also use the study area. Two distinct family units were observed within five kilometres of the camp, indicating breeding on site. Numerous other observations were made of swans, including on Stickleback and Trout Lakes.

Arctic loons were observed on Stickleback, Trout, and Spyder Lakes. An observation of a group of four on Trout Lake was suggestive of breeding there.

Plate 3-11: Arctic ground squirrels are ubiquitous throughout the study site and may be prey for local species of raptors.

3.7.6 Sandhill Cranes

Sandhill cranes were observed on several occasions in the study area. Movement patterns suggested that the birds were migrating through and were not duplicated.

Appendix A - 1993 Fisheries Data

APPENDIX A - 1993 FISHERIES DATA

Table A-1

Vital Statistics of Fish Caught in Spyder Lake During August 1993

	ID#	Length (cm)	Weight (kg)	Age (yr)
Lake Trout	1	68	3.6	8+
(*Salvelinus namaycush*)	2	49	1.3	6+
	3	57	1.9	7+
	7	70	3.6	10+
	8	50	1.1	7+
	9	51	1.2	6+
	10	45	1.0	6+
Lake Whitefish	4	50	1.6	20+
(*Coregonus clupeaformis*)	5	36	0.6	10+
	6	50	1.7	21+
	11	48	1.5	18+
	12	48	1.5	12+
	13	46	—	17+

Table A-2

Muscle and Liver Tissue Metal Levels in Fish Caught in Spyder Lake During August 1993 (ppm Wet Weight)

Species	ID #	Length (cm)	Weight (g)	Age (yr)	Muscle										
					Mg	Mn	Ni	Cu	Zn	As	Se	Ag	Cd	Hg	Pb
Lake Trout	1	68	3.6	8+	311	0.144	<0.2	0.224	4.26	0.025	0.161	<0.01	<0.006	0.332	<0.04
(Salvelinus	2	49	1.3	6+	316	0.123	<0.2	0.356	3.79	0.015	0.153	<0.01	<0.006	0.166	<0.04
namaycush)	3	57	1.9	7+	269	0.109	<0.2	0.269	3.62	0.022	0.154	<0.01	<0.006	0.570	<0.04
Lake Whitefish	4	50	1.6	20+	286	0.235	<0.2	0.235	3.02	0.023	0.185	<0.01	<0.006	0.138	<0.04
(Coregonus	5	36	0.6	10+	321	0.212	<0.2	0.268	3.83	0.013	0.291	<0.01	<0.006	0.046	<0.04
clupeaformis)	6	50	1.7	21+	274	0.215	<0.2	0.223	3.12	0.030	0.195	<0.01	<0.006	0.291	<0.04

Species	ID #	Length (cm)	Weight (g)	Age (yr)	Liver										
					Mg	Mn	Ni	Cu	Zn	As	Se	Ag	Cd	Hg	Pb
Lake Trout	1	68	3.6	8+	135	0.946	<0.2	9.517	27.60	0.012	0.758	0.0618	0.0103	0.900	<0.04
	2	49	1.3	6+	162	0.971	<0.2	26.030	38.19	0.023	1.256	0.1216	0.0627	0.338	<0.04
	3	57	1.9	7+	161	1.139	<0.2	13.483	33.56	0.025	1.055	0.0582	0.1436	1.527	<0.04
Lake Whitefish	4	50	1.6	20+	190	2.091	<0.2	7.616	30.96	0.093	1.539	0.0791	0.1333	0.983	<0.04
	5	36	0.6	10+	198	1.715	<0.2	3.564	28.30	0.091	2.354	0.0432	0.1382	0.211	<0.04
	6	50	1.7	21+	173	1.541	<0.2	5.852	26.41	0.089	2.052	0.0832	0.2964	1.404	<0.04