Appendix V5-3B

Boston Property N.W.T. Environmental Data Report (1993)

MAC RESOURCES

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

ENVIRONMENTAL DATA REPORT

Prepared for:
BHP Minerals Canada Ltd.
Vancouver, British Columbia

Prepared by:
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Vancouver, British Columbia

December 1993

Rescan

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1.0 Introduction

1.0 INTRODUCTION

At the request of BHP Minerals Canada Ltd., Rescan Environmental Services Ltd. prepared and submitted a workplan on July 2, 1993 to continue the environmental management program for the Boston property, NWT (Figure 1-1). The objectives of the program were to provide a database for the Project Description Report, and to support environmental assessment and management planning, should the project proceed from exploration to development. After review by the proponent, the workplan was accepted with some modifications, and a limited field program was carried out late in the summer of 1993.

In order to advance the environmental management program as much as possible on the basis of available information, Rescan has prepared the following report on work completed to date and the status of analyses of biological samples collected. Because the focus and scale of further exploration work on the Boston property in 1994 is still undecided, the processing of biological samples has been deferred. All preserved samples which can be held without deterioration have been catalogued and stored for possible future analysis.

Data presented herein include:

- 1992-1993 water quality results;
- bathymetric surveys conducted at Stickleback Lake and Spyder Lake (south arm);
- a summary of meteorological data; and
- presentation of preliminary fisheries and aquatic ecology results.

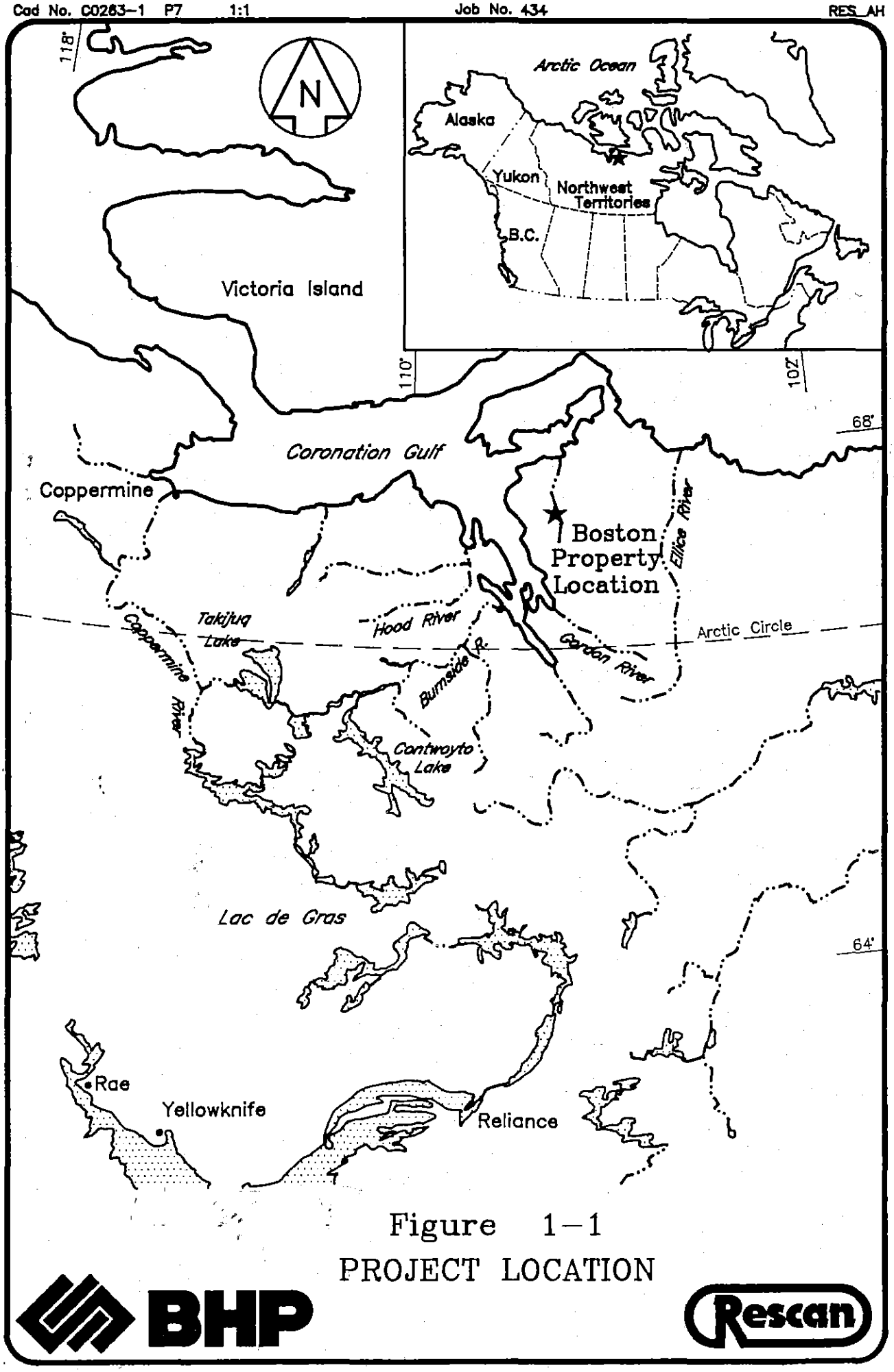

Figure 1-1
PROJECT LOCATION

2.0 Field Program Review 1992-1993

2.0 FIELD PROGRAM REVIEW 1992 - 1993

A limited, reconnaissance-type baseline survey has been initiated for the BHP Boston project, located in the Northwest Territories. Surveys include meteorology and hydrology data collection, water quality sampling, bathymetric surveys of two lakes, as well as fisheries and aquatic ecology surveys.

Meteorology

A datalogger-supported weather station was installed on-site by BHP personnel in August 1993. The 10-metre dedicated tower will collect hourly readings on temperature, humidity, rainfall, wind speed and wind direction.

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 sampled in August 1993, and included dissolved oxygen (D.O.), temperature and field pH measurements (Figure 2-1). The lake stations were sampled from several depths, where possible, and included D.O. and temperature profiles.

In conjunction with water sampling, a reconnaissance-level fisheries and aquatic study was conducted on Spyder and Stickleback Lakes and adjoining streams. These surveys included fish presence/absence surveys using gillnetting or electroshocking methods; and benthos, phytoplankton, zooplankton and periphyton sampling, where available.

Flow measurements were determined at two of the stream sites.

Bathymetry

Bathymetric surveys were completed at the south arm of Spyder Lake and adjoining Stickleback Lake. (Figure 2-1).

The survey used the Rathyeon echosounding chart recorder to record depths, and a topographic map for positioning.

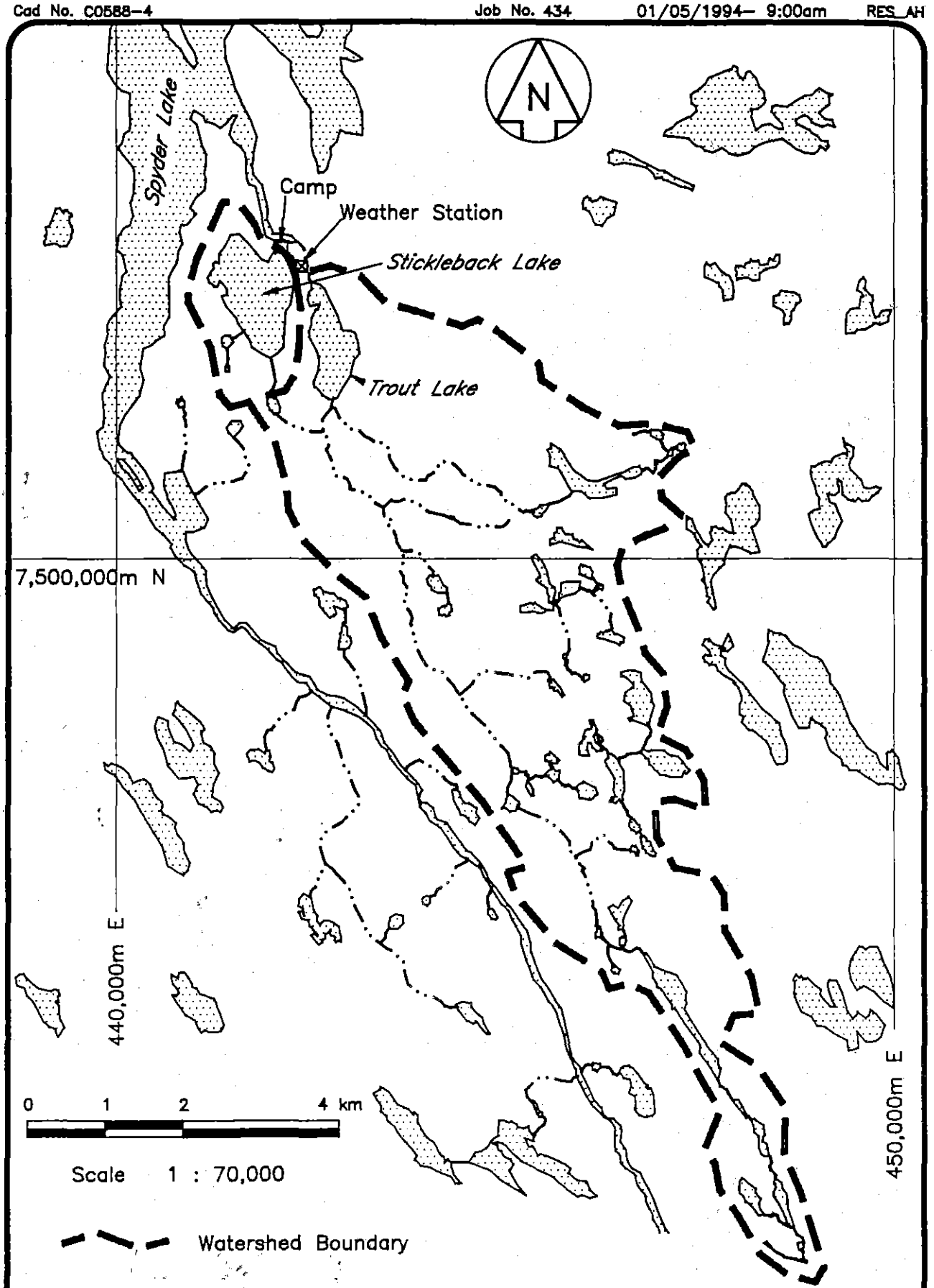

Figure 2-1 : PROJECT LOCATION

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3.0 Results of 1993 Field Program

3.0 RESULTS OF 1993 FIELD PROGRAM

3.1 Meteorology

The Boston property lies in the Canadian Shield within a zone of continuous permafrost. The area experiences very cool summers and extremely cold winters, with January temperatures often below -30°C. Mean annual precipitation is less than 150 mm (Atmospheric Environment Service (AES) 1992).

To monitor site-specific meteorological variables, BHP installed a weather station at the Boston site in July 1993. This site-specific data will be augmented by regional climatic data from AES stations at Byron Bay, Coppermine and Contwoyto Lake (Table 3-1, Figure 3-1). Variables measured include temperature, humidity, rainfall, wind speed and wind direction. Variables are sampled at 1-hour intervals, and the recorded values stored to a Terrascience "Gnome 8" datalogger.

The station has been downloaded once to date. The results are charted in Figures 3-2 and 3-3. From July 30, 1993 to August 29, 1993, the average daily temperature recorded was 9.4°C. The maximum recorded temperature was 20.5°C at 2:00 p.m. on August 16, and a minimum temperature of 1.1°C was recorded at 4:45 a.m. on August 28. Daily humidity averaged 78%. Average daily wind speed was 2.6 m/s (9.3 km/hr), with a maximum hourly speed of 6.53 m/s (23.5 km/hr). Over this 31-day period, 25.5 mm of rainfall was recorded.

The weather station is unmanned over the winter period and, consequently, has been set up to continue collecting data until either the memory storage is filled up or the battery is exhausted. Previous experience suggests that one or both of these conditions will occur in December.

If the proposed project should require an Initial Environmental Evaluation (IEE), evaporation and snowfall will have to be monitored in order to establish a water balance. The weather station will also have to be upgraded to incorporate a solar radiation sensor, possibly a second wind anemometer, and a snowfall measurement device. As well, if the site is to be left unattended, battery capacity

Table 3-1

Atmospheric Environmental Service Regional Climatological Stations

Station Name	Station Number	Latitude North	Longitude West	Elevation (m)	Years of Operation	Number of Years	Observations		
							Temp	Precipitation	Wind
Byron Bay A	-	68°45'	109°04'	112	1955-1990	35	√	√	
Contwoyto Lake	2200850	65°29'	110°22'	451	1956-1981	25	√	√	√
Coppermine	2200900	67°50'	115°07'	9.1	1930 - 1977	47	√	√	
Coppermine A	2200902	67°49'	115°09'	22.2	1977-Present	16	√	√	

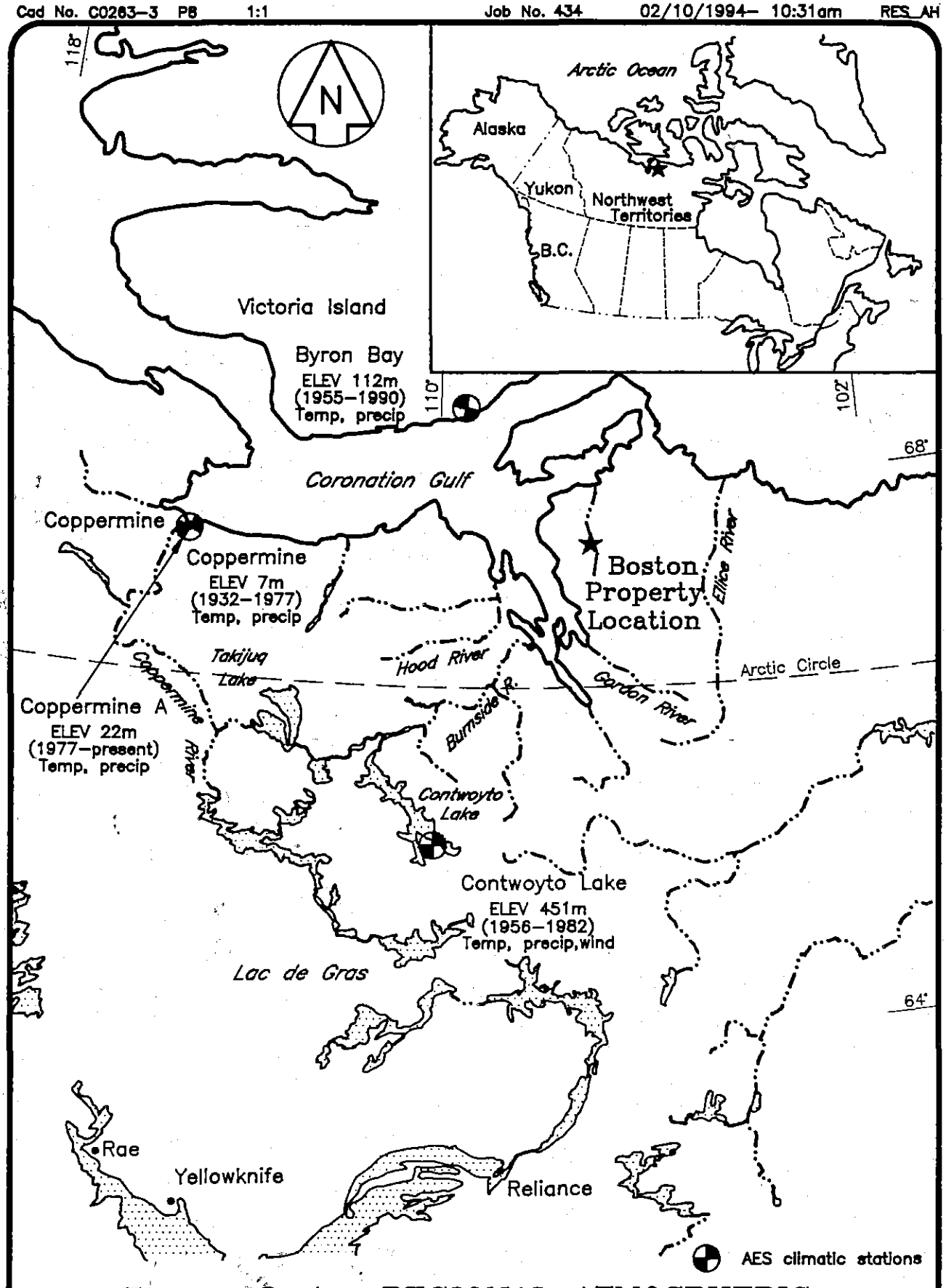

Figure 3–1 : REGIONAL ATMOSPHERIC CLIMATOLOGICAL STATIONS

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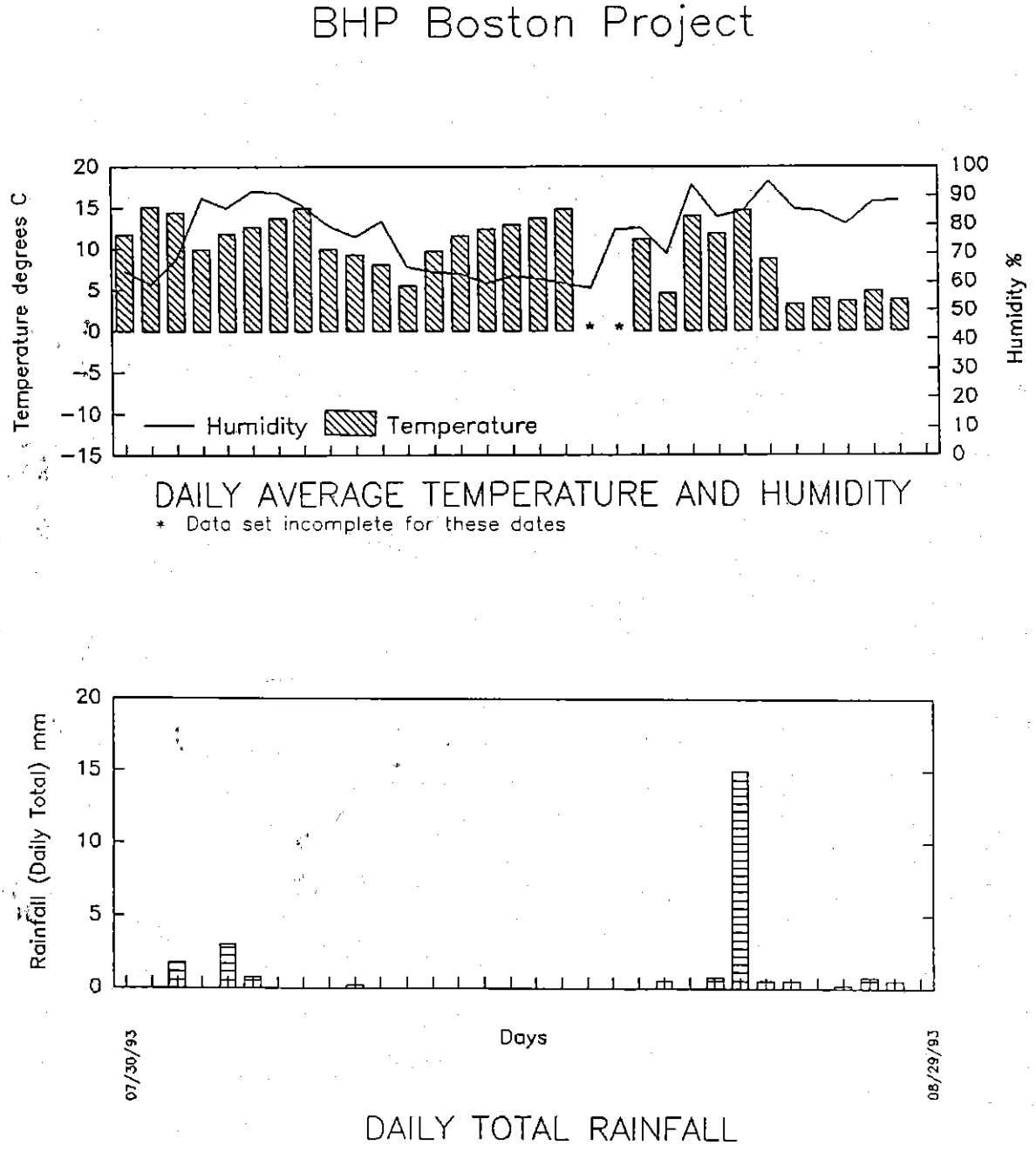

Figure 3-2: Daily Average Temperature and Humidity, Daily Total Rainfall

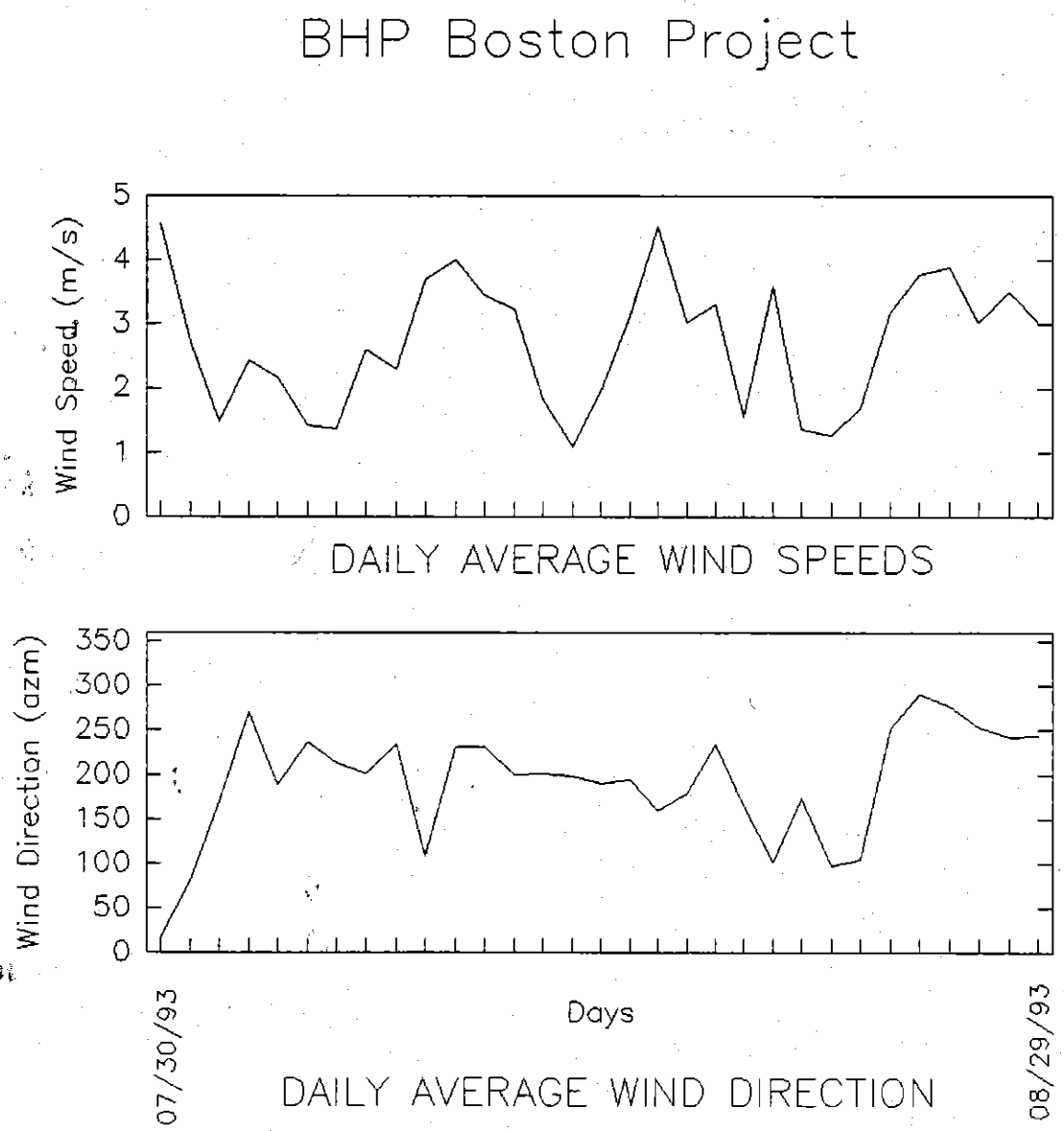

Figure 3–3: Daily Average Wind Speed and Direction

will need to be increased in order to ensure a continuous power source, and an upgrade of the datalogger will be required in order to increase memory storage.

3.2 Surface Hydrology

Surface water discharge was measured from two small creeks: Stickleback Creek, located at the outlet of Stickleback Lake; and Trout Creek, located at the outlet of Trout Lake (Figure 2-1). Flows measured at this time were 0.01 m^3/s from Stickleback Creek and 0.02 m^3/s from Trout Creek.

Water level recorders were not installed during the August program, as there was some concern whether the gauges would survive 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. This may mean installing a number of water level devices, designed to resist damage during freezing and spring breakup, on selected streams and lakes in the immediate area (possibly upstream of Trout lake).

3.3 Water Quality

Water quality monitoring of potentially impacted lakes and streams is recognized as a necessary component of the project development program. Water quality monitoring is limited at present to the ice-free seasons (June-September). In August 1992, stream 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-grab samples from Spyder Lake. In August 1993, one more site was installed at Stickleback Lake. Sample locations and water quality results for 1992-1993 are presented in Figure 3-4 and Appendix A. Federal Water Quality Guidelines (CCME) are presented in Table 3-2.

Measured field stream water quality parameters include pH, dissolved oxygen and temperature. Water quality sampling at lake stations involved the collection of two to three samples from discrete depths, depending upon water depth at the sample site. Dissolved oxygen and temperature profiling was conducted at each lake station. A summary of these results is presented in Tables 3-3 and 3-4.

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WQ4
WQ5
WQ6
WQ3
WQ1
WQ2
WQ

WQ Surface 8m @ 1km

WQ Surface @ 2m

SPYDER LAKE

SPYDER LAKE

Area of Drilling

STICKLEBACK LAKE

TROUT LAKE

Trout Creek

Camp

Weather Station

N

LEGEND :

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

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

0 250 500 750 1000 m

Scale 1 : 16,000

BHP

Figure 3-4 : SAMPLING LOCATIONS

Rescan

Fig 3-4

Table 3-2

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	0.1
Manganese	0.05	-	-
Mercury	0.001	0.001	0.003
Nickel	-	0.15[b]	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.

Water quality analyses performed on the August 1993 samples employ 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).

Data generated during the 1992-1993 sampling program indicate the water to be of neutral pH (6.3-7.6) and low in nutrients (nitrate, phosphorous). Total dissolved solids (TDS) and conductivity for Spyder Lake and Creek are fairly consistent (35 µmhos/cm), with relatively higher values recorded for Stickleback Lake and

Table 3-3

BHP Boston Project
Field Water Quality Measurements - August 17 & 18, 1993

Station	WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	Stickleback Lake
Stream Wetted Width (m)	0.5	2.5	12.5	Lake	Lake		Lake
Sample Depth	Surface	Surface	Surface	Surface	Surface*	Surface	Surface 1 m 2 m
Temperature (°C)	15.0	15.0	14.0	12.4	12.5	14.0	13.6
Dissolved Oxygen (mg/L)	10.0	11.0	11.2	10.9	10.8	11.4	10.8
pH	7.7	7.6	7.9	7.4	7.4	7.6	8.5
Secchi (m)	-	-	-	2.0	3.5	-	2+

* See temperature/dissolved oxygen profile (Table 3-4).

Creek (119 TDS, 149 µmhos). This is most likely due to the salts used in drilling fluids, which are released to the receiving environment during drilling. These salts, which are used to keep the rods from freezing, may be reaching Stickleback Lake through subsurface seepage, as indicated by the lake's relatively high chloride levels. Total metal levels were generally below detection limits, with the exception of Fe, which ranged from 0.71 mg/L to 0.629 mg/L.

3.4 Aquatic Ecology and Fish

It is essential to obtain adequate baseline information in order to ensure the protection of fisheries and other aquatic resources during any development process. Aquatic surveys conducted in 1993 at the Boston site included, for both Spyder and Stickleback Lakes, a presence/absence fish gillnetting effort and benthic, phytoplankton and zooplankton reconnaissance surveys. Also included was a survey of Stickleback and Trout Creeks that involved electrofishing, and benthic and periphyton surveys (Figure 3-1). Pending discussions on the future of the Boston development program, only the fish tissue samples were analyzed, and

Table 3-4

Dissolved Oxygen and Temperature Profile, Spyder Lake Station WQ5 - August 18, 1993

Depth (m)	Temperature (°C)	D.O. (mg/L)
Surface	12.5	10.8
0.70	12.7	10.7
1.80	12.5	10.6
2.30	12.5	10.6
2.80	12.4	10.6
4	12.4	10.6
5	12.4	10.6
6	12.3	10.6
7	12.3	10.6
8	12.3	10.6
9	12.3	10.6
10	12.3	10.6
11	12.3	10.6
11	12.3	10.6
13	12.3	10.6
14	12.3	10.6
15	12.3	10.6
16	12.3	10.6
17	12.3	10.6
18	12.2	9.3

the results presented herein. The benthic, periphyton and zooplankton samples have been preserved, catalogued and stored for possible future analysis (Table 3-5).

Spyder Lake lies within a north-south, elongate (12 km), narrow (0.5 - 3.0 km) irregularly shaped basin, a glacially scoured river valley which, confined by a narrow outlet, forms the present lake. A bathymetric survey, conducted over the

Table 3-5

BHP Boston Project - Stations and Sample Numbers for August, 1993

Samples and Observations Taken	WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	"Stickleback" Lk.	Total No. of Samples	Disposition of Samples
Water Quality	1	1	1	1	3	1	2	10	Analyzed
Phytoplankton					2	1	1	4	Preserved & Held
Chlorophyll *a*						1		1	Analyzed
Periphyton		3						3	Preserved & Held
Zooplankton					4		4	8	Preserved & Held
Benthos	3		3	3	3			12	Preserved & Held
Sediment	1		1	1	1			4	Analyzed
DO, pH, T (*in situ*)	X	X	X	X	X*	X	X		Data Reported Herewith
Gillnetting				X See Map for Location			X		Catch Reported Herewith
Electrofishing	X	X							Catch Reported Herewith
Scale Samples				X					Held for Aging
Stomachs				X					Preserved & Held
Livers				X					Analyzed
Muscle Tissue				X					Analyzed

* T+DO Profile

south arm of the lake, indicated that depths range from 2 to 18 metres, with the deepest portion of the south arm confined to a narrow channel on its east side. Physical measurements indicate the lake is poorly stratified thermally in the summer (August 1993 surface temperatures were near 12.7°C and bottom waters near 12.2°C), with no depletion of dissolved oxygen in near-bottom waters. Secchi disc transparency in the lake was 3.5 metres.

Stickleback Lake, in contrast, is a small, round, two-metre-deep basin, slightly elongated along its north-south axis (1.0 x 1.3 km). Bathymetric soundings show this lake to have a fairly flat bottom.

Surface water temperature was 13.6°C, with dissolved oxygen recorded at 10.8 mg/L. Secchi transparency was clear to the bottom (2 m).

Preliminary sampling (relative abundance in gillnet catches) indicate the presence of lake trout (*Salvelinus namaycush*) and lake whitefish (*Coregonus clupeaformis*) in Spyder Lake (Table 3-6). No fish were caught in Stickleback Lake; however, there are reports of sticklebacks (*Gasterosteidae* spp.) being trapped in water lines fed from Stickleback Lake (BHP personal communication). As well, stream electrofishing surveys at WQ1, connecting Stickleback Lake and Spyder Lake, and WQ2 (Trout Creek), connecting Trout Lake and Spyder Lake, both yielded stickleback (Table 3-7 and Figure 3-4), indicating this species probably occurs in all three water bodies.

Materials for fish age determination, stomach content analysis, and trace metal analysis (muscle and liver tissue), were taken from a representative subsample from Spyder Lake (Appendix B). Electrofishing efforts in adjoining streams netted several stickleback fry, as noted, and one lake trout fry (Table 3-7). Samples were collected and preserved for possible future analysis.

A comparison of trace metals in fish tissues from Spyder Lake with results from unpolluted waters in Canada shows levels are well within usual background concentrations (Table 3-8).

Table 3-6

Gillnetting Results - August 1993

Collection Site	Specimen No.	Species	Sex	Fork Length (cm)	Weight (kg)	Scales	Stomach	Muscle	Liver
Spyder Lake	1	LT	F	68	3.6	√	√	√	√
	2	LT	F	49	1.3	√	√	√	√
	3	LT	F	57	1.9	√	√	√	√
	4	LW	M	50	1.6	√	√	√	√
	5	LW	M	36	0.62	√	√	√	√
	6	LW	M	50	1.7	√	√	√	√
	7	LT	F	70	3.6	√	-	-	-
	8	LT	F	50	1.1	√	-	-	-
	9	LT	-	51	1.2	√	-	-	-
	10	LT	-	45	1.0	√	-	-	-
	11	LW	M	48	1.5	√	-	-	-
	12	LW	F	38	0.64	√	-	-	-
	13	LW	F	46	-	√	-	-	-

LT = Lake trout *(Salvelinus namaycush).*
LW = Lake Whitefish (*Coregonus clupeaformis*).
√ = Sample taken.
Set Duration 7.5 hr., Catch Per Unit Effort (CPUE) 1.73.
Stickleback Lake: Set Duration, 8 hr. Catch = 0.

Table 3-7

Electrofishing Results - August 1993

Station	Wetted Width (m)	Section Length (m)	Duration Seconds	Catch No.	Species	Length (m)	Comments
WQ2*	2.5	20	365	2	ST	34,38	Five seen
WQ1*	0.5	12	150	31	ST	20-54	Hundreds seen
						n = 11 mean = 37.8	

ST = Stickleback (Gasterosteidae) prob. *Pungitius pungitius.*
* = See Figure 3-4.

Table 3-8

Comparison of Trace Metals in Fish Tissues from Spyder Lake and Unpolluted Waters in B.C. and 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		<0.5 - 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 Size (n)**	Muscle (Mean)	Liver (Comp)	Muscle (Mean)	Liver (Comp)	Muscle (Mean)	Liver (Comp)	Muscle (Mean)	Liver (Comp)	Muscle (Mean)	Liver (Comp)	Muscle (Mean)	Liver (Comp)
	(n = 6)	0.02	0.05	<0.03	0.13	0.26	11.0	<0.20	<0.20	0.25	0.89	3.57	30.8

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 (Appendix B)
For location of sample sites see Figure 3-1.

This preliminary study certainly indicates that there could be impact on aquatic resources, simply because fish are present. 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, "minnow" 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 could be obtained, if necessary, through a mark-recapture program.

The details of further fisheries and aquatic resources studies will be determined on the basis of the mining development proposal.

4.0 Environmental Testwork

4.0 ENVIRONMENTAL TESTWORK

Acid Generation Testwork

A set of three samples was taken from each of the three drill holes intersecting the north-south trending mineralized shear zone, and submitted for acid base accounting (ABA) supplemented with sulphide, sulphate and total carbonate analysis. Results of the ABA test are presented in Table 4-1. The auriferous quartz veins are confined within a strongly carbonatized shear zone (mineralized zone) located within metavolcanics and sediments. The predominant mineralogy of this sequence is $FeCO_2$ + sericite + quartz. The ABA tests concur that there is a strong carbonate net neutralization potential (NNP = 136 to 407) favourable throughout the rock sequence. Paste pH values range from 8.7 to 9.4. Should the program proceed, more static ABA tests will be required, and possibly, kinetic humidity cell tests will be performed.

Table 4-1

Acid Generation Testwork

Sample		Paste pH	% Sulfide*	% Sulphate**	kg $CaCO_3$ Equivalent / Tonne				
					S % Total	MPA	NP	NNP	CO_2%
Hanging Wall	93 NOD 59	8.8	2.52	0.03	2.79	87	407	320	22.6
Footwall	93 NOD 59	9.3	1.72	0.03	1.87	58	296	238	15.7
Min. Zone	93 NOD 59	9.1	1.77	0.02	1.78	56	276	220	14.4
Hanging Wall	93 NOD 61	9.3	0.52	0.02	0.471	15	303	288	16.0
Footwall	93 NOD 61	9.4	0.96	0.02	0.942	29	277	248	15.2
Min. Zone	93 NOD 61	8.9	0.26	0.02	0.233	7	307	300	16.4
Hanging Wall	93 NOD 35	9.4	0.18	0.02	0.174	5	252	247	13.4
Footwall	93 NOD 35	8.7	4.40	0.05	4.66	146	282	136	14.7
Min. Zone	93 NOD 35	9.4	0.14	0.02	0.108	3	259	256	14.2

* HNO_3 Solvable Sulfide.
** HCL Solvable Sulphate.

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Appendix A - Water Quality Results

STATION: WQ 1

	Aug-92	Jun-93	Aug-93
Physical Tests			
Conductivity umhos/cm	34.9	149	120
Total Dissolved Solids	28	119	84
Hardness CaCO3	9.24	44.3	36.4
pH	6.36	7.16	7.1
Turbidity NTU	1.79	0.98	1.71
Total Suspended Solids	*	*	4
Dissolved Anions			
Acidity CaCO3	1	11	4
Alkalinity - Total CaCO3	5.5	41.2	32.2
Sulphate SO4	<1.0	2.3	1.8
Chloride	*	*	17
Fluoride	*	*	0.03
Nutrients			
Ammonia Nitrogen N	*	<0.005	0.027
Nitrate Nitrogen N	*	<0.005	0.025
Nitrite Nitrogen N	*	<0.001	<0.001
Ortho-Phosphate	*	*	0.007
Total Dissolved Phosphate	*	*	0.007
Total Phosphorus P	*	0.012	0.013
Total Metals			
Aluminum T-Al	<0.20	<0.20	*
Antimony T-Sb	<0.20	<0.20	*
Arsenic T-As	0.0004	<0.20	*
Barium T-Ba	<0.010	<0.010	*
Beryllium T-Be	<0.005	<0.005	*
Boron T-B	<0.10	*	*
Bismuth T-Bi	<0.10	<0.10	*
Cadmium T-Cd	<0.0002	<0.010	*
Calcium T-Ca	2.08	10	*
Chromium T-Cr	<0.015	<0.015	*
Cobalt T-Co	<0.015	<0.015	*
Copper T-Cu	0.003	<0.010	*
Iron T-Fe	0.101	0.096	*
Lead T-Pb	0.001	<0.050	*
Lithium T-Li	<0.015	<0.015	*
Magnesium T-Mg	0.982	4.7	*
Manganese T-Mn	<0.005	0.207	*
Molybdenum T-Mo	<0.001	<0.030	*
Nickel T-Ni	<0.020	<0.020	*
Phosphorus T-P	<0.30	<0.30	*
Potassium T-K	<2.0	<2.0	*
Silicon T-Si	0.313		*
Selenium T-Se	<0.20	<0.20	*
Silver T-Ag	<0.015	<0.015	*
Sodium T-Na	2.4	13.7	*
Strontium T-Sr	0.006	0.023	*
Thallium T-Tl	<0.10	<0.10	*
Tin T-Sn	<0.30	<0.30	*
Titanium T-Ti	<0.010	<0.010	*
Tungsten T-W	<0.10	<0.10	*
Vanadium T-V	<0.030	<0.030	*
Zinc T-Zn	<0.005	<0.005	*

Note: Results are expressed in mg per liter except where noted.

STATION: WQ 2

	Aug-92	Jun-93	Jun-93 (replicate)	Jun-93 (triplicate)	Aug-93
Physical Tests					
Conductivity umhos/cm	33.4	39.7	38.6	39	57.1
Total Dissolved Solids	27	32	31	31	35
Hardness CaCO3	8.7	13.3	13.3	13	19.6
pH	6.6	6.95	6.8	6.72	7.17
Turbidity NTU	1.85	2.38	2.34	2.35	6.21
Total Suspended Solids	*	*	*	*	<1
Dissolved Anions					
Acidity CaCO3	1	4.3	3.9	3.9	1.9
Alkalinity - Total CaCO3	5.4	9.4	9.7	9	14.4
Sulphate SO4	1.5	3.3	2.2	3.4	1.6
Chloride	*	*	*	*	7.9
Fluoride	*	*	*	*	0.03
Nutrients					
Ammonia Nitrogen N	*	0.015	0.009	0.009	0.015
Nitrate Nitrogen N	*	<0.005	<0.005	<0.005	<0.005
Nitrite Nitrogen N	*	<0.001	<0.001	<0.001	0.005
Ortho-Phosphate	*	*	*	*	0.007
Total Dissolved Phosphate	*	*	*	*	0.007
Total Phosphorus P	*	0.016	0.013	0.016	0.015
Total Metals					
Aluminum T-Al	<0.20	<0.20	<0.20	<0.20	*
Antimony T-Sb	<0.20	<0.20	<0.20	<0.20	*
Arsenic T-As	0.0005	<0.20	<0.20	<0.20	*
Barium T-Ba	<0.010	<0.010	<0.010	<0.010	*
Beryllium T-Be	<0.005	<0.005	<0.005	<0.005	*
Boron T-B	<0.10	*	*	*	*
Bismuth T-Bi	<0.10	<0.10	<0.10	<0.10	*
Cadmium T-Cd	<0.0002	<0.010	<0.010	<0.010	*
Calcium T-Ca	1.84	3.74	3.72	3.63	*
Chromium T-Cr	<0.015	<0.015	<0.015	<0.015	*
Cobalt T-Co	<0.015	<0.015	<0.015	<0.015	*
Copper T-Cu	0.002	<0.010	<0.010	<0.010	*
Iron T-Fe	0.076	0.222	0.205	0.23	*
Lead T-Pb	<0.001	<0.050	<0.050	<0.050	*
Lithium T-Li	<0.015	<0.015	<0.015	<0.015	*
Magnesium T-Mg	0.995	0.967	0.967	0.956	*
Manganese T-Mn	<0.005	<0.005	<0.005	<0.005	*
Molybdenum T-Mo	<0.001	<0.030	<0.030	<0.030	*
Nickel T-Ni	<0.020	<0.020	<0.020	<0.020	*
Phosphorus T-P	<0.30	<0.30	<0.30	<0.30	*
Potassium T-K	<2.0	<2.0	<2.0	<2.0	*
Silicon T-Si	0.277	*	*	*	*
Selenium T-Se	<0.20	<0.20	<0.20	<0.20	*
Silver T-Ag	<0.015	<0.015	<0.015	<0.015	*
Sodium T-Na	2.4	2.5	2.7	2.5	*
Strontium T-Sr	0.006	0.01	0.01	0.01	*
Thallium T-Tl	<0.10	<0.10	<0.10	<0.10	*
Tin T-Sn	<0.30	<0.30	<0.30	<0.30	*
Titanium T-Ti	<0.010	<0.010	<0.010	<0.010	*
Tungsten T-W	<0.10	<0.10	<0.10	<0.10	*
Vanadium T-V	<0.030	<0.030	<0.030	<0.030	*
Zinc T-Zn	<0.005	<0.005	<0.005	<0.005	*

Note: Results are expressed in mg per liter except where noted.

STATION: WQ3

	Aug-92	Jun-93	Aug-93
Physical Tests			
Conductivity umhos/cm	33	38.3	78.8
Total Dissolved Solids	26	31	50
Hardness CaCO3	9.51	12.7	27.7
pH	6.64	6.65	7.14
Turbidity NTU	1.22	2.47	5.44
Total Suspended Solids	*	*	2
Dissolved Anions			
Acidity CaCO3	1	3.3	3.8
Alkalinity - Total CaCO3	5.3	8.6	21.3
Sulphate SO4	<1.0	3.2	<1.0
Chloride	*	*	10.2
Fluoride	*	*	0.03
Nutrients			
Ammonia Nitrogen N	*	0.007	0.026
Nitrate Nitrogen N	*	<0.005	<0.005
Nitrite Nitrogen N	*	<0.001	<0.001
Ortho-Phosphate	*	*	0.007
Total Dissolved Phosphate	*	*	0.009
Total Phosphorus P	*	0.016	0.014
Total Metals			
Aluminum T-Al	<0.20	<0.20	*
Antimony T-Sb	<0.20	<0.20	*
Arsenic T-As	<0.0001	<0.20	*
Barium T-Ba	<0.010	<0.010	*
Beryllium T-Be	<0.005	<0.005	*
Boron T-B	<0.10	*	*
Bismuth T-Bi	<0.10	<0.10	*
Cadmium T-Cd	0.0004	<0.010	*
Calcium T-Ca	2.11	3.46	*
Chromium T-Cr	<0.015	<0.015	*
Cobalt T-Co	<0.015	<0.015	*
Copper T-Cu	0.008	<0.010	*
Iron T-Fe	0.116	0.249	*
Lead T-Pb	0.002	<0.050	*
Lithium T-Li	<0.015	<0.015	*
Magnesium T-Mg	1.03	0.992	*
Manganese T-Mn	0.007	0.007	*
Molybdenum T-Mo	<0.001	<0.030	*
Nickel T-Ni	<0.020	<0.020	*
Phosphorus T-P	<0.30	<0.30	*
Potassium T-K	<2.0	<2.0	*
Silicon T-Si	0.288	*	*
Selenium T-Se	<0.20	<0.20	*
Silver T-Ag	<0.015	<0.015	*
Sodium T-Na	4.8	2.7	*
Strontium T-Sr	0.006	0.01	*
Thallium T-Tl	<0.10	<0.10	*
Tin T-Sn	<0.30	<0.30	*
Titanium T-Ti	<0.010	<0.010	*
Tungsten T-W	<0.10	<0.10	*
Vanadium T-V	<0.030	<0.030	*
Zinc T-Zn	0.018	<0.005	*

Note: Results are expressed in mg per liter except where noted.

STATION: WQ 4

	Jun-93	Aug-93
Physical Tests		
Conductivity umhos/cm	36.8	35.2
Total Dissolved Solids	29	24
Hardness CaCO3	8.48	8.65
pH	6.9	7.27
Turbidity NTU	3.15	1.86
Total Suspended Solids	*	1
Dissolved Anions		
Acidity CaCO3	2.4	2.8
Alkalinity - Total CaCO3	4.7	6.4
Sulphate SO4	1.3	1.3
Chloride	*	5.5
Fluoride	*	0.02
Nutrients		
Ammonia Nitrogen N	0.011	0.012
Nitrate Nitrogen N	0.028	<0.005
Nitrite Nitrogen N	<0.001	<0.001
Ortho-Phosphate	*	0.006
Total Dissolved Phosphate	*	0.006
Total Phosphorus P	0.015	0.007
Cyanides		
Total Cyanide CN	*	<0.005
Cyanate CNO	*	<0.5
Thiocyanate SCN	*	<0.5
WAD Cyanide CN	*	<0.005
Total Metals		
Aluminum T-Al	<0.20	0.038
Antimony T-Sb	<0.20	<0.0001
Arsenic T-As	<0.20	<0.0001
Barium T-Ba	<0.010	<0.010
Beryllium T-Be	<0.005	<0.005
Boron T-B	*	<0.10
Bismuth T-Bi	<0.10	*
Cadmium T-Cd	<0.010	<0.0001
Calcium T-Ca	1.5	1.75
Chromium T-Cr	<0.015	<0.001
Cobalt T-Co	<0.015	<0.001
Copper T-Cu	<0.010	0.02
Iron T-Fe	0.399	0.093
Lead T-Pb	<0.050	<0.001
Lithium T-Li	<0.015	*
Magnesium T-Mg	1.15	1.05
Mercury T-Hg	*	0.00002
Manganese T-Mn	0.028	<0.005
Molybdenum T-Mo	<0.030	<0.001
Nickel T-Ni	<0.020	<0.001
Phosphorus T-P	<0.30	*
Potassium T-K	<2.0	*
Selenium T-Se	<0.20	<0.0005
Silver T-Ag	<0.015	<0.00005
Sodium T-Na	3.5	*
Strontium T-Sr	0.01	*
Thallium T-Tl	<0.10	*
Tin T-Sn	<0.30	*
Titanium T-Ti	<0.010	*
Tungsten T-W	<0.10	*
Vanadium T-V	<0.030	<0.005
Zinc T-Zn	<0.005	<0.005

STATION :WQ 4 (con't)

Dissolved Metals

Aluminum D-Al	*	0.012
Antimony D-Sb	*	<0.0001
Arsenic D-As	*	<0.0001
Barium D-Ba	*	<0.010
Beryllium D-Be	*	<0.005
Boron D-B	*	<0.10
Cadmium D-Cd	*	<0.0001
Calcium D-Ca	*	1.74
Chromium D-Cr	*	<0.001
Cobalt D-Co	*	<0.001
Copper D-Cu	*	<0.0005
Iron D-Fe	*	<0.030
Lead D-Pb	*	<0.001
Magnesium D-Mg	*	1.04
Manganese D-Mn	*	<0.005
Mercury D-Hg	*	<0.00001
Molybdenum D-Mo	*	<0.001
Nickel D-Ni	*	<0.001
Selenium D-Se	*	<0.0005
Silver D-Ag	*	<0.00005
Vanadium D-V	*	<0.005
Zinc D-Zn	*	<0.005

Note: Results are expressed in mg per liter except where noted.

STATION: WQ 5

	Jun-93	Aug-93		
		(surface)	8 m.	16 m.
Physical Tests				
Conductivity umhos/cm	44.3	35.3	35.5	35.8
Total Dissolved Solids	35	25	23	24
Hardness CaCO3	10.6	8.77	8.58	8.57
pH	6.68	7.36	7.31	7.54
Turbidity NTU	3.97	1.08	0.97	1.1
Total Suspended Solids	*	1	<1	<1
Dissolved Anions				
Acidity CaCO3	3.5	2.6	1.9	2.5
Alkalinity - Total CaCO3	6.2	6.2	6.4	6.2
Sulphate SO4	1.3	1.4	2	1.6
Chloride	*	5.6	5.5	5.7
Fluoride	*	0.02	0.02	0.02
Nutrients				
Ammonia Nitrogen N	0.024	0.007	0.009	0.008
Nitrate Nitrogen N	0.028	<0.005	<0.005	<0.005
Nitrite Nitrogen N	<0.001	<0.001	<0.001	0.001
Ortho-Phosphate	*	0.004	0.004	0.006
Total Dissolved Phosphate	*	0.005	0.005	0.006
Total Phosphorus P	0.018	0.007	0.007	0.008
Cyanides				
Total Cyanide CN	*	<0.005	<0.005	0.005
Cyanate CNO	*	<0.5	<0.5	<0.5
Thiocyanate SCN	*	<0.5	<0.5	<0.5
WAD Cyanide CN	*	<0.005	<0.005	<0.005
Total Metals				
Aluminum T-Al	<0.20	0.029	0.033	0.031
Antimony T-Sb	<0.20	<0.0001	<0.0001	<0.0001
Arsenic T-As	<0.20	<0.0001	<0.0001	<0.0001
Barium T-Ba	<0.010	<0.010	<0.010	<0.010
Beryllium T-Be	<0.005	<0.005	<0.005	<0.005
Boron T-B	*	<0.10	<0.10	<0.10
Bismuth T-Bi	<0.10	*	*	*
Cadmium T-Cd	<0.010	<0.0001	<0.0001	<0.0001
Calcium T-Ca	1.99	1.78	1.76	1.75
Chromium T-Cr	<0.015	<0.001	<0.001	<0.001
Cobalt T-Co	<0.015	<0.001	<0.001	<0.001
Copper T-Cu	<0.010	0.001	0.0005	0.0005
Iron T-Fe	0.629	0.071	0.071	0.074
Lead T-Pb	<0.050	<0.001	<0.001	<0.001
Lithium T-Li	<0.015	*	*	*
Magnesium T-Mg	1.37	1.05	1.04	1.05
Mercury T-Hg	*	<0.00001	<0.00001	0.00001
Manganese T-Mn	0.049	<0.005	0.006	<0.005
Molybdenum T-Mo	<0.030	<0.001	<0.001	<0.001
Nickel T-Ni	<0.020	<0.001	<0.001	<0.001
Phosphorus T-P	<0.30	*	*	*
Potassium T-K	<2.0	*	*	*
Selenium T-Se	<0.20	<0.0005	<0.0005	<0.0005
Silver T-Ag	<0.015	<0.00005	<0.00005	<0.00005
Sodium T-Na	4.2	*	*	*
Strontium T-Sr	0.01	*	*	*
Thallium T-Tl	<0.10	*	*	*
Tin T-Sn	<0.30	*	*	*
Titanium T-Ti	<0.010	*	*	*
Tungsten T-W	<0.10	*	*	*
Vanadium T-V	<0.030	<0.005	<0.005	<0.005
Zinc T-Zn	<0.005	<0.005	<0.005	0.008

STATION: WQ 5 (con't)

Dissolved Metals				
Aluminum D-Al	*	0.013	0.013	0.012
Antimony D-Sb	*	<0.0001	<0.0001	<0.0001
Arsenic D-As	*	<0.0001	<0.0001	<0.0001
Barium D-Ba	*	<0.010	<0.010	<0.010
Beryllium D-Be	*	<0.005	<0.005	<0.005
Boron D-B	*	<0.10	<0.10	<0.10
Cadmium D-Cd	*	<0.0001	<0.0001	<0.0001
Calcium D-Ca	*	1.78	1.74	1.73
Chromium D-Cr	*	<0.001	<0.001	<0.001
Cobalt D-Co	*	<0.001	<0.001	<0.001
Copper D-Cu	*	0.001	<0.0005	<0.0005
Iron D-Fe	*	<0.030	<0.030	<0.030
Lead D-Pb	*	<0.001	<0.001	<0.001
Magnesium D-Mg	*	1.05	1.03	1.03
Manganese D-Mn	*	<0.005	<0.005	<0.005
Mercury D-Hg	*	<0.00001	<0.00001	<0.00001
Molybdenum D-Mo	*	<0.001	<0.001	<0.001
Nickel D-Ni	*	<0.001	<0.001	<0.001
Selenium D-Se	*	<0.0005	<0.0005	<0.0005
Silver D-Ag	*	<0.00005	<0.00005	<0.00005
Vanadium D-V	*	<0.005	<0.005	<0.005
Zinc D-Zn	*	<0.005	<0.005	0.006

Note: Results are expressed in mg per liter except where noted.

STATION: WQ6

	Jun-93	Aug-93
Physical Tests		
Conductivity umhos/cm	40.6	35
Total Dissolved Solids	32	23
Hardness CaCO3	9.89	8.89
pH	6.6	7.58
Turbidity NTU	5.19	5.38
Total Suspended Solids	*	7
Dissolved Anions		
Acidity CaCO3	2.6	2.5
Alkalinity - Total CaCO3	5	6.3
Sulphate SO4	1	1.1
Chloride	*	5.4
Fluoride	*	0.02
Nutrients		
Ammonia Nitrogen N	0.016	0.017
Nitrate Nitrogen N	0.03	<0.005
Nitrite Nitrogen N	<0.001	<0.001
Ortho-Phosphate	*	0.011
Total Dissolved Phosphate	*	0.011
Total Phosphorus P	0.023	0.014
Cyanides		
Total Cyanide CN	*	<0.005
Cyanate CNO	*	<0.5
Thiocyanate SCN	*	<0.5
WAD Cyanide CN	*	<0.005
Total Metals		
Aluminum T-Al	<0.20	0.184
Antimony T-Sb	<0.20	<0.0001
Arsenic T-As	<0.20	<0.0001
Barium T-Ba	<0.010	<0.010
Beryllium T-Be	<0.005	<0.005
Boron T-B	*	<0.10
Bismuth T-Bi	<0.10	*
Cadmium T-Cd	<0.010	<0.0001
Calcium T-Ca	1.77	1.85
Chromium T-Cr	<0.015	<0.001
Cobalt T-Co	<0.015	<0.001
Copper T-Cu	<0.010	0.0005
Iron T-Fe	0.601	0.361
Lead T-Pb	<0.050	<0.001
Lithium T-Li	<0.015	*
Magnesium T-Mg	1.33	1.1
Mercury T-Hg	*	0.00003
Manganese T-Mn	0.039	0.018
Molybdenum T-Mo	<0.030	<0.001
Nickel T-Ni	<0.020	<0.001
Phosphorus T-P	<0.30	*
Potassium T-K	<2.0	*
Selenium T-Se	<0.20	<0.0005
Silver T-Ag	<0.015	<0.00005
Sodium T-Na	3.9	*
Strontium T-Sr	0.01	*
Thallium T-Tl	<0.10	*
Tin T-Sn	<0.30	*

Titanium T-Ti	<0.010	*
Tungsten T-W	<0.10	*
Vanadium T-V	<0.030	<0.005
Zinc T-Zn	<0.005	<0.005

STATION: WQ6 (con't)

Dissolved Metals

Aluminum D-Al	*	0.012
Antimony D-Sb	*	<0.0001
Arsenic D-As	*	<0.0001
Barium D-Ba	*	<0.010
Beryllium D-Be	*	<0.005
Boron D-B	*	<0.10
Cadmium D-Cd	*	<0.0001
Calcium D-Ca	*	1.84
Chromium D-Cr	*	<0.001
Cobalt D-Co	*	<0.001
Copper D-Cu	*	<0.0005
Iron D-Fe	*	<0.030
Lead D-Pb	*	<0.001
Magnesium D-Mg	*	1.05
Manganese D-Mn	*	<0.005
Mercury D-Hg	*	<0.00001
Molybdenum D-Mo	*	<0.001
Nickel D-Ni	*	<0.001
Selenium D-Se	*	<0.0005
Silver D-Ag	*	<0.00005
Vanadium D-V	*	<0.005
Zinc D-Zn	*	<0.005

Note: Results are expressed in mg per liter except where noted.

STATION: WQ Stickleback

	Aug-93	
	surface	2 m.
Physical Tests		
Conductivity umhos/cm	119	116
Total Dissolved Solids	80	79
Hardness CaCO3	35	35
Moisture %	*	*
pH	7.55	7.59
Total Suspended Solids	<1	<1
Turbidity NTU	0.69	0.61
Dissolved Anions		
Acidity CaCO3	2.1	2.3
Alkalinity - Total CaCO3	32.1	32
Chloride Cl	16.9	16.9
Fluoride F	0.03	0.03
Sulphate SO4	<1.0	<1.0
Nutrients		
Ammonia Nitrogen N	0.043	0.037
Nitrate Nitrogen N	<0.005	<0.005
Nitrite Nitrogen N	0.001	<0.001
ortho-Phosphate P	0.005	0.005
Total Dissolved Phosphate P	0.007	0.007
Total Phosphorus P	0.009	0.009
Cyanides		
Total Cyanide CN	<0.005	<0.005
Cyanate CNO	<0.5	<0.5
Thiocyanate SCN	<0.5	<0.5
WAD Cyanide CN	<0.005	<0.005
Total Metals		
Aluminum T-Al	0.009	0.011
Antimony T-Sb	<0.0001	<0.0001
Arsenic T-As	<0.0001	<0.0001
Barium T-Ba	<0.010	<0.010
Beryllium T-Be	<0.005	<0.005
Boron T-B	<0.10	<0.10
Cadmium T-Cd	<0.0001	<0.0001
Calcium T-Ca	8.26	8.2
Chromium T-Cr	<0.001	<0.001
Cobalt T-Co	<0.001	<0.001
Copper T-Cu	0.001	<0.0005
Iron T-Fe	0.084	0.081
Lead T-Pb	<0.001	<0.001
Magnesium T-Mg	3.55	3.55
Manganese T-Mn	<0.005	0.009
Mercury T-Hg	0.00002	0.00003
Molybdenum T-Mo	<0.001	<0.001
Nickel T-Ni	<0.001	<0.001
Selenium T-Se	<0.0005	<0.0005
Silver T-Ag	<0.00005	<0.00005

Vanadium T-V	<0.005	<0.005
Zinc T-Zn	<0.005	<0.005

STATION: WQ Stickleback

Dissolved Metals		
Aluminum D-Al	0.005	0.007
Antimony D-Sb	<0.0001	<0.0001
Arsenic D-As	<0.0001	<0.0001
Barium D-Ba	<0.010	<0.010
Beryllium D-Be	<0.005	<0.005
Boron D-B	<0.10	<0.10
Cadmium D-Cd	<0.0001	<0.0001
Calcium D-Ca	8.21	8.2
Chromium D-Cr	<0.001	<0.001
Cobalt D-Co	<0.001	<0.001
Copper D-Cu	<0.0005	<0.0005
Iron D-Fe	<0.030	<0.030
Lead D-Pb	<0.001	<0.001
Magnesium D-Mg	3.51	3.53
Manganese D-Mn	<0.005	<0.005
Mercury D-Hg	<0.00001	0.00001
Molybdenum D-Mo	<0.001	<0.001
Nickel D-Ni	<0.001	<0.001
Selenium D-Se	<0.0005	<0.0005
Silver D-Ag	<0.00005	<0.00005
Vanadium D-V	<0.005	<0.005
Zinc D-Zn	<0.005	<0.005

Note: Results are expressed in mg per liter except where noted.