ENVIRONMENT CANADA
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PACIFIC AND YUKON REGION

QUINSAM COAL DEVELOPMENT

A MONITORING REPORT ON THE EFFLUENT AND RECEIVING ENVIRONMENT

- 1988/1989 -

Regional Program Report 89-05

By

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SEPTEMBER 1989

ABSTRACT

Concerns expressed by the Commission of Inquiry (acid mine drainage, metals, sediment, nutrients and eutrophication) are addressed by monitoring receiving waters in the vicinity of the Quinsam Coal Mine and mine effluent. Receiving water quality is similar to the baseline data. All parameters are less than the Canadian Water Quality (CCME) Guidelines established to protect aquatic life. Periphyton is phosphorus limited throughout but becomes more pronounced with distance downstream of Middle Quinsam Lake. Periphytic biomass is generally low with the exception of Station 5A which exceeds the B.C. Water Quality Criterion for the protection of aesthetics and recreation. Current monitoring data is usually lower than QCC's baseline data.

Effluent monitoring of the Settling Pond 4 discharge indicates that dissolved zinc and total dissolved phosphorus occassionally exceed permitted levels, while iron exceeds the permit levels consistently. Settling Pond 4 discharges have significantly higher levels of dissolved aluminum and iron than the surface flows in the pond. At Middle Quinsam Lake Road, however several parameters (conductivity, sulphate, hardness, nitrate and dissolved zinc) occassionally exceeded the CCME guidelines or were elevated relative to baseline data and/or applicable CCME guidelines. Discharges from Settling Pond 4 which collects all surface drainage from the 2N open pit are less than 5% expected from precipitation data collected concurrently.

RESUME

Les soucis exprimés par la Commission d'Enquête (drainage minier acide, métaux, sédiments, éléments nutritifs, et eutrophication) ont été adressés par l'échantillonnage et la surveillance des eaux réceptrices près de la mine de charbon Quinsam et de son effluent. La qualité des eaux réceptrices est similaire aux données de base. Tout les paramètres sont moins élevées que les lignes directrices de Qualité des Eaux Canadiennes (CCME) établies pour la protection de la vie aquatique. Le périphyton est limité par le phosphore partout mais devient plus prononcé avec la distance en aval du lac Middle Quinsam. La biomasse périphytique est générallement basse, excepté pour la station 5A où le critère de qualité des eaux de la Colombie Britannique pour la protection de l'esthétique et récréation, est dépassé. Les présentes données d'échantillonnage sont habituellement plus basses que les données de base de la mine de charbon Quinsam.

Les échantillons d'effluent de l'étang de sédimentation #4, indiquent que le zinc dissous et le total du phosphore dissous sont occasionnellement au dessous des niveaux permis, tandis que le fer dépasse les limites constamment. L'étang de sédimentation #4 décharge des niveaux significativement plus élevés d'alumimium dissous et de fer que les taux de l'influent. À la route Middle Quinsam Lake, par contre, plusieurs paramètres (conductivité, sulphates, dureté, nitrates, et zinc dissous) occasionnellement dépasse les lignes directrices du CCME ou sont élevés relativement aux données de base et/ou applicables au CCME. Les décharges de l'étang #4, qui collecte toute les eaux de drainage superficielles de la carrière 2N, sont moins de 5% des prédictions de précipitation basées sur les données ramassées simultanément.

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1.0 INTRODUCTION

Quinsam Coal Corporation (QCC) began construction of the 2N Pit and Settling Pond in the fall of 1987. Mining activities followed in December 1987, when the B.C. Ministry of Environment and Parks, Waste Management Branch (MOEP) issued a permit (PE 7008) for the release of coal mine effluent into the surface waters of the Quinsam drainage. The permit limits mining activities to the 2N and 3N pits and requires that the company regulate and monitor the effluent discharge and monitor the water quality of the receiving environment, both surface and groundwater. The permit is staged and requires an increase in monitoring activities as the mine expands in size.

Federal and provincial government agencies in December 1987, decided to monitor the effluent and receiving waters during the initial mining phases, to ensure that acid generation, release of heavy metals, nutrient enrichment and sedimentation did not adversely affect the Quinsam drainage. The information (effluent quality and quantity) would also be used to determine permit levels for discharges into more sensitive areas, i.e. Long Lake, that may be mined at some later date.

The Quinsam Technical Review Committee, established at the recommendation of the Inquiry Commission, requested Environmental Protection (EP), MOEP and QCC to report receiving water and effluent data for the initial phase of mining. This report presents effluent and receiving water quality and biological data collected by EP from April 1, 1988 to March 31, 1989. Data comparisons are made to baseline data collected by Quinsam Coal Corporation in the winters of 1982/83 and 1983/84.

2.0 STUDY AREA

The Quinsam drainage is located in the coastal-Douglas fir biogeoclimatic zone on the eastern slopes of Vancouver Island and covers an area of 210 km^2. The Quinsam River flows northeast, joining the Campbell River three km upstream of its estuary (Figure 1). The study area is located in the upper half of the Quinsam drainage at an elevation of 300m, approximately 20 km southwest of the Quinsam-Campbell confluence. The Quinsam drainage, having been logged in the 1950's, has a well established second growth. Annual precipitation is estimated at 100-150 cm and is concentrated in the fall and winter months (October to March).

Flows in the Quinsam River are regulated by two British Columbia Hydro dams located at the outlet of Upper Quinsam and Wokas lakes and diverted by a third dam 1.9 km upstream of Middle Quinsam Lake. Minimum flows of 0.3 and 1.7 cms are maintained upstream of Middle Quinsam Lake and at the outlet of Lower Quinsam Lake, respectively. The remaining flow is diverted via Gooseneck Lake into the Campbell system where it is used for hydroelectric generation. All other flows in the Quinsam drainage are not regulated.

Stream stations shown in Figures 1 and 2 were established prior to the start of mining. Water quality and biota were monitored at two control stations the Quinsam River (station 1) and Flume Creek (station 2), both upstream of the Quinsam Coal Development. Receiving water quality and biota were also monitored at two stations downstream of the development (Quinsam River - stations 5 and 8). In the summers of 1987, 88 and 89, an additional station, station 5A, was located 0.5 km downstream of Middle Quinsam Lake, primarily to monitor the response of periphytic growth.

Effluent was monitored before (2N Pit - sump and Settling Pond 4 - inflow) and after (Settling Pond 4 outflow and at Middle Quinsam Lake Road culvert) treatment in the settling pond. The point of compliance for the company's permit is the discharge from Settling Pond 4.

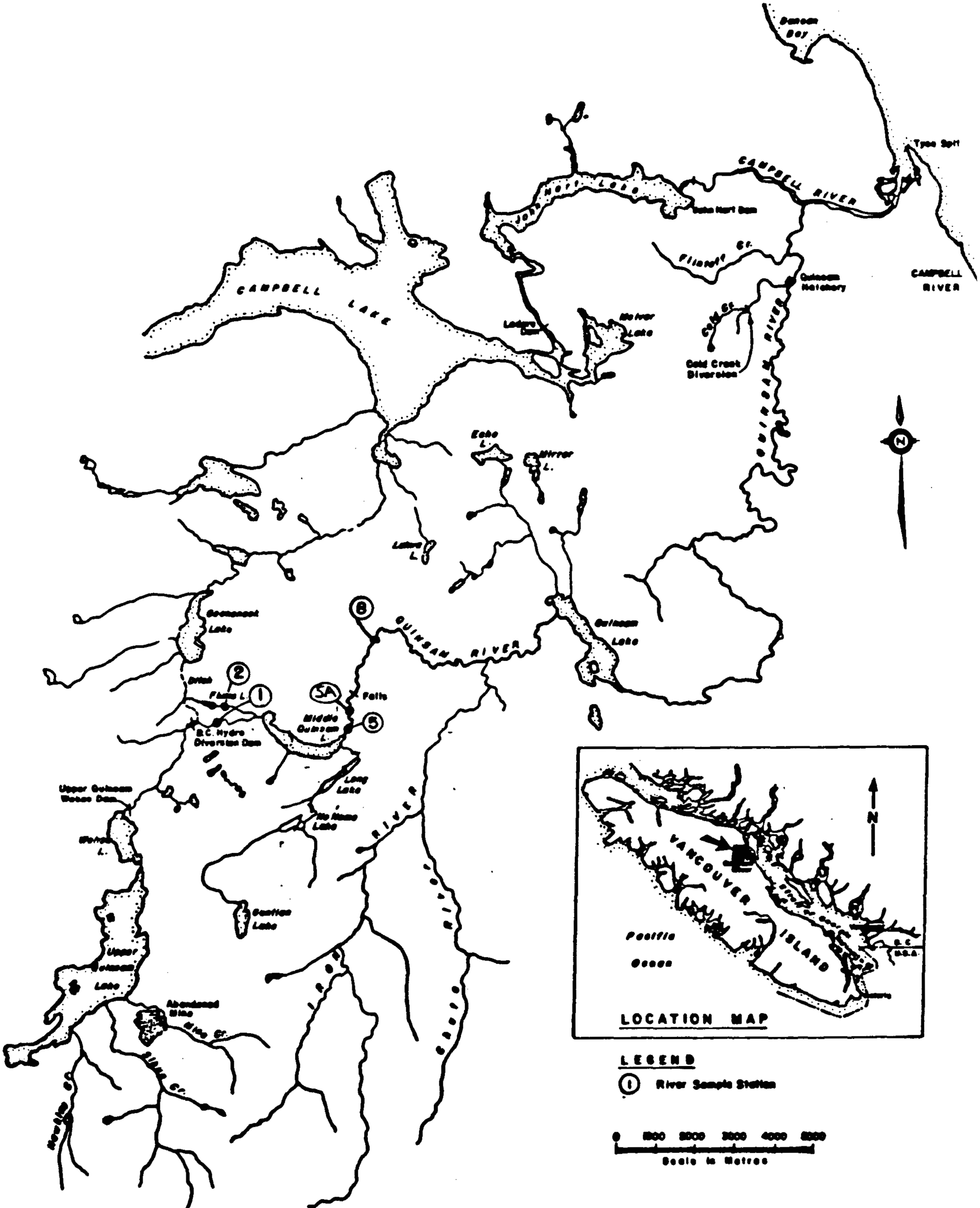
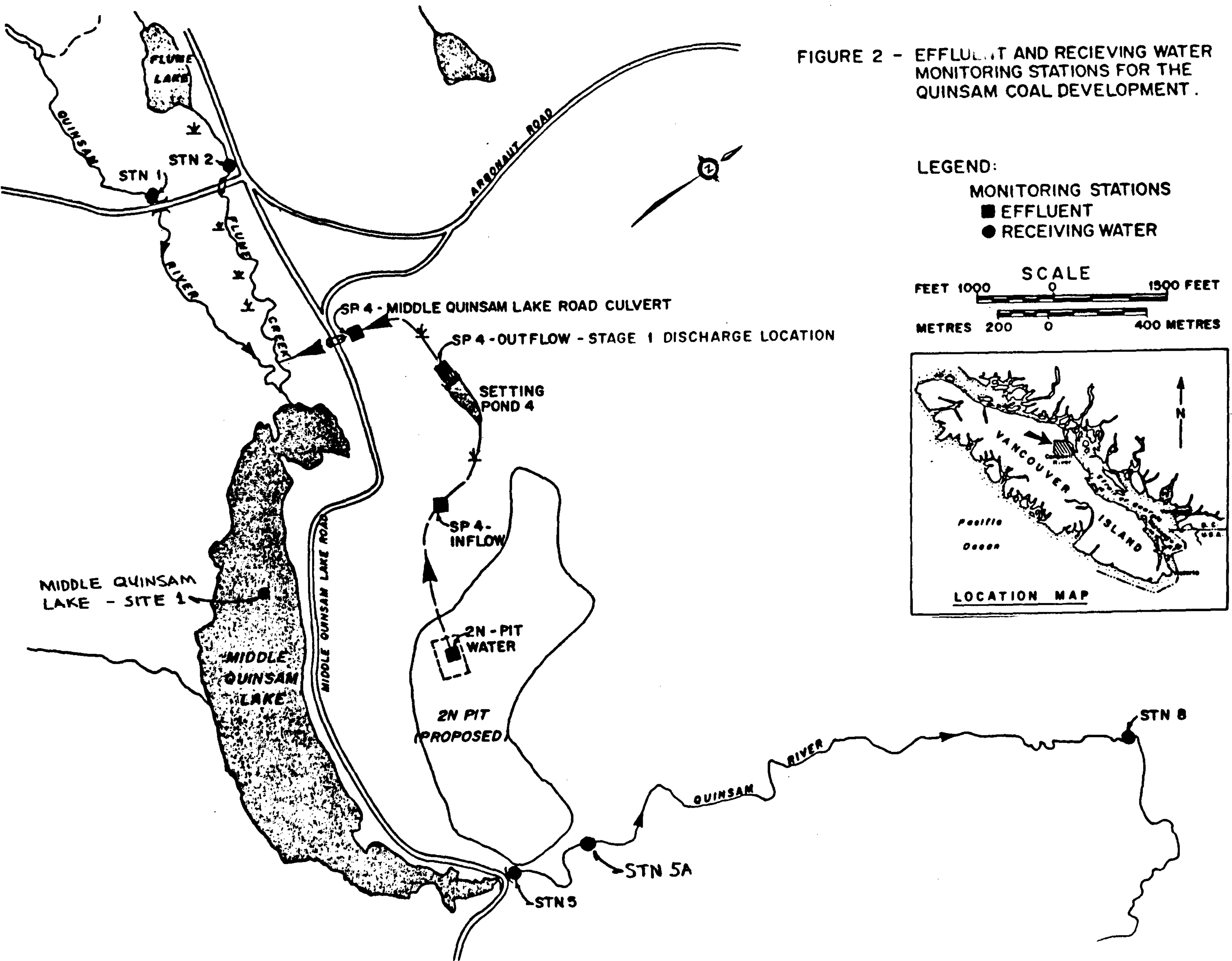


FIGURE 1 QUINSAM DRAINAGE BASIN - STREAM SAMPLING LOCATIONS

FIGURE 2 - EFFLU..T AND RECIEVING WATER MONITORING STATIONS FOR THE QUINSAM COAL DEVELOPMENT.



3.0 METHODS AND MATERIALS

Water and effluent samples were collected at approximately two week intervals from April 1988 to June 1988. Through the remainder of the summer and fall, sampling was at approximately 4 - 6 week intervals. During the winter, the efforts were further reduced to quarterly sampling. Prior to the fall overturn (18 October, 1988) a single survey was conducted on Middle Quinsam Lake at Site 1. Single grab water samples were collected from the surface and the top and bottom of the thermocline. Triplicate grab samples were collected at all stream and river stations. Effluent was sampled as a single grab sample, while triplicate samples of the receiving water were collected. Results are presented in the accompanying tables.

Temperature, pH, conductivity and dissolved oxygen were measured in situ with either a Hydrolab Model 4041 or a Surveyor II model. A summary of field methods, sample preparation and preservation, and parameters is presented in Table 1. Dissolved metal and phosphorus samples were filtered in the field. All samples were kept on ice and in the dark and delivered to the EP Laboratory in West Vancouver within 24 hours.

Periphyton samples were scraped from the leading and upper surfaces of 10 - 25 cm cobbles taken from depths ranging from 0.1 - 0.4 m. The only exception to this was at station 5A where samples were scraped directly from the sandstone bedrock at depths of less than 0.1 m. Each sample was a composite of scrapings from three separate cobbles. Samples were replicated 8 times at each station in order to reduce variability to acceptable levels. The samples were split three ways; species identification and enumeration, nitrogen and phosphorus ratios and total pigments. Total pigment samples were filtered and frozen while samples for N:P ratios were kept on ice and in the dark. Samples for species identification were preserved with Lugol's solution.

River flows were calculated from readings taken from existing staff guages at stations 1 and 5. In addition, flows were measured at Stations 1, 5 and 8 using a Marsh-McBirney Model II velocity meter.

TABLE 1 SUMMARY OF PARAMETERS, LABORATORIES, INSTRUMENTS AND SAMPLE PRESERVATION

	LABORATORY	FIELD PREPARATION
Temperature	Hydrolab 4041	- in situ measurement
Dissolved Oxygen	Hydrolab 4041	- in situ measurement
Conductivity	Hydrolab 4041	- in situ measurement
pH	Hydrolab 4041	- in situ measurement
Turbidity	EPS Lab	
Alkalinity	EP Lab	
Residues	EP Lab	
Sulphate	EP Lab	
Nitrate	EP Lab	
Nitrate	EP Lab	
Ammonia	EP Lab	
Total Phosphorus	EP Lab	
Total Dissolved Phosphorus	EP Lab	- filter through prewashed 0.45 u Sartorius cellulose acetate filters
Total Metals *	EP Lab	- acidify with conc HNO3
Total Metals *	EP Lab	- filter through 0.45 u Sartorius cellulose nitrate filters then acidify with Conc HNO3
Total Pigment	EP Lab	- filter through GFC glass fiber filters and freeze

* Metals are routinly analyzed by Inductively Coupled Argon Plasma techniques. To achieve lower detection limits for Al, Cd, Cu and Pb, these metals are analyzed by Graphite Furnace and Atomic Absorption methods.

Sample dates were: 13 and 26 April 1988
11 and 26 May 1988
6 June 1988
18 July 1988
16 August 1988
18 October 1988
30 November 1988
13 March 1989

Several metals, consistently below the detection limit, are reported separately in Table 2.

TABLE 2 HEAVY METALS IN WATER AT OR BELOW THE DETECTION LIMITS

METAL	ICAP DETECTION LIMIT
Antimony (Sb)	0.05
Beryllium (Be)	0.001
Nickel (Ni)	0.02
Selenium (Se)	0.05
Vanadium (V)	0.005

4.0 RESULTS

4.1 Detection Limits

Table 2 — Heavy Metals in Water, At or Below the Detection Limit

4.2 Receiving Water Quality

a) Table 3 - Station 1 - Quinsam River 1 km u/s Middle Quinsam Lake
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

b) Table 4 - Station 2 - Flume Creek 1 km u/s Middle Quinsam Lake
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

c) Table 5 - Station 5 - Quinsam River 25 m d/s Middle Quinsam Lake
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

d) Table 6 - Station 5A - Quinsam River .5 km d/s Middle Quinsam Lake
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

e) Table 7 - Station 8 - Quinsam River 3 km d/s Middle Quinsam Lake
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

TABLE 3 RECEIVING WATER QUALITY STATION 1 (QUINSAM RIVER - 1 km u/s MIDDLE QUINSAM LAKE)*

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO_4	NFR	FR	TR	TURB JTU	HARD	Si	TDP	TP	NO_3	NO_2	NH_3
88/04/13	.47	7.4	11.2	7.6	43.7	1.3	19.8	2.0	<5.0	32.3	32.3	<.10	19.2	1.7	<.002	.003	.031	<.005	<.005
88/04/26				7.6	45.5	1.3	19.9	2.7	<5.0	30.7	30.7	.17	21.1	1.6		<.002	.029	<.005	.008
88/05/11	.43	11.6	9.9	7.5	47.0	1.3	20.7	2.7	<5.0	31.7	31.7	.17	21.5	1.6	.003	.002	.013	<.005	.014
88/05/26				7.8	46.4	<1.0	21.3	2.7	<5.0	41.0	41.0	.17	20.3	1.5	.004	.003	.008	<.005	<.005
88/06/06	.58	11.7	10.0	7.8	47.5	1.3	20.0	2.7	<5.0	36.0	36.0	.17	21.1	1.4	<.002	<.002	.011	<.005	<.005
88/07/18	.59	18.8	8.8	7.8	46.5	<1.0	21.0	2.0	<5.0	31.7	31.7	.13	20.9	1.4	<.002	<.002	.014	<.005	<.005
88/08/16	.59	17.4	8.8	7.8	45.7	<1.0	21.2	2.3	<5.0	32.3	32.3	<.10	22.8	1.5	<.002	.003	.020	<.005	<.005
88/10/18	1.11	11.6	12.2	7.6	47.0	1.6	21.0	2.0	<5.0	33.7	33.7	<.10	20.8	1.4	<.002	<.002	.008	<.005	<.005
88/11/30	.67	5.3		7.6	41.8	1.2	18.5	2.0	<5.0	30.3	30.3	<.10	19.3	1.8	<.002	<.002	.026	<.005	<.005
89/03/13	.62	3.0	12.8	7.5	42.5	1.9	18.2	2.0	<5.0	42.7	42.7	<.10	19.1	1.8	<.002	<.002	.049	<.005	.006
GRAND MEAN	**.63**	**11.6**	**10.5**	**7.7**	**45.4**	**1.3**	**20.2**	**2.3**	**<5.0**	**34.2**	**34.2**	**.13**	**20.6**	**1.6**	**.002**	**.002**	**.021**	**<.005**	**.006**
STD ERROR	**.21**	**5.4**	**1.6**	**.1**	**2.0**	**.3**	**1.1**	**.3**	**0**	**4.3**	**4.3**	**.03**	**1.2**	**.2**	**.001**	**.001**	**.013**	**0**	**.003**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13	.026	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	.007	<.001	<.01	<.0005	<.05	.012	<.002	<.002	6.5	.7	.9
88/04/26	.013	<.05	<.01	.001	<.0001	<.005	<.005		<.005	<.001	<.01	<.0005	<.05	.012	<.002	.004	7.2	.8	.7
88/05/11	.010	<.05	<.01	<.001	<.0001	<.005	<.005	.0006	<.005	.001	<.01	<.0005	<.05	.012	<.002	.003	7.2	.8	.9
88/05/26	.014	<.05	<.01	<.001	<.0001	<.005	<.005	.0006	<.005	<.001	<.01	<.0005	<.05	.012	.005	<.002	6.9	.7	.7
88/06/06	.035	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	.005	<.001	<.01	<.0005	<.05	.012	<.002	<.002	7.2	.7	.7
88/07/18	.032	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	<.005	<.001	<.01	<.0005	<.05	.011	<.002	<.002	7.3	.7	.7
88/08/16	.020	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	<.005	<.001	<.01	<.0005	<.05	.012	<.002	.003	7.7	.9	.7
88/10/18	.010	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	<.005	<.001	<.01	<.0005	<.05	.012	<.002	.002	7.0	.8	1.0
88/11/30	.022	<.05	<.01	<.001	<.0001	<.005	<.005	.0006	<.005	<.001	<.01	<.0005	<.05	.011	<.002	<.002	7.0	.8	1.0
89/03/13	.025	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	<.005	<.001	<.01	<.0005	<.05	.011	<.002	.002	6.4	.7	.7
GRAND MEAN	**.021**	**<.05**	**<.01**	**<.001**	**<.0001**	**<.005**	**<.005**	**.0005**	**.005**	**<.001**	**<.01**	**<.0005**	**<.05**	**.012**	**.002**	**.002**	**7.0**	**.8**	**.8**
STD ERROR	**.009**	**0**	**0**	**0**	**0**	**0**	**0**	**.0000**	**.001**	**0**	**0**	**0**	**0**	**.001**	**.001**	**.001**	**.4**	**.1**	**.1**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13	.077	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	.013	<.001	<.01	<.0005	<.05	.011	<.002	<.002	6.3	.7	.7
88/04/26	.040	<.05	.01	<.001	<.0001	<.005	<.005		.033	.002	<.01	<.0005	<.05	.012	<.002	.002	6.8	.8	.9
88/05/11	.026	<.05	.01	<.001	<.0001	<.005	<.005	.0007	.012	<.001	<.01	<.0005	.05	.012	.003	<.002	7.0	.6	.7
88/05/26	.080	<.05	<.01	<.001	<.0001	.008	<.005	.0012	.017	.001	<.01	<.0005	<.05	.013	.006	<.002	7.7	.7	.7
88/06/06	.061	<.05	<.01	<.001	<.0001	<.005	<.005	.0013	.014	.002	<.01	<.0005	<.05	.012	<.002	<.002	7.4	.8	.7
88/07/18	.052	<.05	<.01	<.001	<.0001	<.005	<.005	.0006	.012	.001	<.01	<.0005	<.05	.012	<.002	<.002	7.6	.8	.7
88/08/16	.095	<.05	<.01	.001	<.0001	.006	<.005	.0024	.036	.003	<.01	.0008	<.05	.012	.003	<.002	7.8	.9	.8
88/10/18	.017	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	<.005	.001	<.01	<.0005	<.05	.012	<.002	<.002	6.8	.8	.8
88/11/30	.045	<.05	<.01	.001	<.0001	<.005	<.005	.0009	.011	<.001	<.01	<.0005	<.05	.011	<.002	<.002	6.8	.8	.8
89/03/13	.062	<.05	<.01	.001	<.0001	<.005	<.005	<.0005	.011	<.001	<.01	<.0005	<.05	.011	<.002	.002	6.6	.8	.8
GRAND MEAN	**.055**	**<.05**	**<.01**	**<.001**	**<.0001**	**.005**	**<.005**	**.0010**	**.016**	**.001**	**<.01**	**.0005**	**<.05**	**.012**	**.003**	**<.002**	**7.1**	**.8**	**.7**
STD ERROR	**.025**	**0**	**0**	**0**	**0**	**.001**	**0**	**.0006**	**.010**	**.001**	**0**	**.0001**	**0**	**.001**	**.001**	**0**	**.5**	**.1**	**.1**

* (units - mg/l, except as noted; values expressed are means of triplicate samples)

TABLE 4 RECEIVING WATER QUALITY STATION 2 (FLUME CREEK - 1 km u/s MIDDLE QUINSAM LAKE)*

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO_4	NFR	FR	TR	TURB JTU	HARD	Si	TDP	TP	NO_3	NO_2	NH_3
88/04/13	11.1	9.5	7.1	38.8	1.4	14.1	2.0	<5.0	27.7	27.7	.13	16.5	1.7	<.002	<.002	<.005	<.005	<.005
88/04/26			7.2	42.2	1.2	18.5	2.0	<5.0	31.0	31.0	.20	19.0	1.5		<.002	.005	<.005	.005
88/05/11	13.3	6.4	7.1	52.1	not sampled													
88/05/26			7.7	46.5	1.3	25.2	2.0	<5.0	35.7	35.7	.30	20.0	1.3	.002	<.002	.006	<.005	.010
88/06/06	14.1	7.6	6.9	49.9	not sampled													
88/07/18	19.5	5.0	7.8	53.0	<1.0	23.5	2.0	<5.0	39.3	39.3	.20	23.6	1.7	.004	.006	<.005	<.005	<.005
88/08/16	16.4		7.7	47.2	2.0	23.3	1.7	<5.0	39.0	39.0	1.80	23.4	1.7	.003	.004	<.005	<.005	<.005
88/10/18	8.9		7.1	53.0	7.1	22.0	2.0	<5.0	41.3	41.3	.63	22.1	2.6	<.002	.003	.010	<.005	<.005
88/11/30	4.2	12.5	7.5	37.0	1.4	16.5	1.7	<5.0	30.3	30.3	.17	16.2	2.6	<.002	.002	.015	<.005	<.005
89/03/13	3.3	11.4	7.0	32.5	3.7	14.1	1.0	<5.0	27.0	27.0	.10	13.4	2.3	<.002	<.002	.030	<.005	<.005
GRAND MEAN	**11.3**	**8.7**	**7.3**	**45.2**	**2.4**	**19.7**	**1.8**	**<5.0**	**33.9**	**33.9**	**.44**	**19.3**	**1.9**	**.003**	**.003**	**.010**	**<.005**	**.006**
STD ERROR	**5.7**	**2.9**	**.3**	**7.3**	**2.1**	**4.4**	**.4**	**0**	**5.6**	**5.6**	**.57**	**3.7**	**.5**	**.001**	**.002**	**.009**	**0**	**.002**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13	.009	<.05	<.01	.004	<.0001	<.005	<.005	<.0005	.021	.002	<.01	<.0005	<.05	.014	<.002	<.002	5.4	.7	1.2
88/04/26	.005	<.05	<.01	.005	<.0001	<.005	<.005		.021	.007	<.01	<.0005	<.05	.015	<.002	.002	6.2	.8	1.0
88/05/11																			
88/05/26	.009	<.05	<.01	.005	<.0001	<.005	<.005	.0005	.046	.014	<.01	.0007	<.05	.016	.005	<.002	6.6	.8	1.0
88/06/06																			
88/07/18	.006	<.05	<.01	.005	<.0001	<.005	<.005	<.0005	.095	.010	<.01	<.0005	<.05	.019	<.002	<.002	7.7	.9	.9
88/08/16	.009	<.05	<.01	.005	<.0001	<.005	<.005	<.0005	.104	.011	<.01	<.0005	<.05	.018	<.002	<.002	7.7	.9	.9
88/10/18	.009	<.05	<.01	.006	<.0001	<.005	<.005	<.0005	.442	.044	<.01	<.0005	<.05	.018	<.002	<.002	6.9	1.0	1.9
88/11/30	.053	<.05	<.01	.003	<.0001	<.005	<.005	<.0005	.031	.002	<.01	<.0005	<.05	.013	<.002	.002	5.2	.7	1.2
89/03/13	.051	<.05	<.01	.003	<.0001	<.005	<.005	<.0005	.021	.003	<.01	<.0005	<.05	.011	<.002	.002	4.2	.6	1.0
GRAND MEAN	**.019**	**<.05**	**<.01**	**.005**	**<.0001**	**<.005**	**<.005**	**<.0005**	**.098**	**.012**	**<.01**	**.0005**	**<.05**	**.016**	**.002**	**<.002**	**6.2**	**.8**	**1.1**
STD ERROR	**.021**	**0**	**0**	**.001**	**0**	**0**	**0**	**0**	**.143**	**.014**	**0**	**.0001**	**0**	**.003**	**.001**	**0**	**1.2**	**.1**	**.3**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13	.047	<.05	.01	.004	<.0001	<.005	<.005	<.0005	.041	.003	<.01	<.0005	<.05	.014	.002	.010	5.3	.8	1.1
88/04/26	.042	<.05	.01	.005	<.0001	<.005	<.005		.052	.008	<.01	<.0005	<.05	.015	<.002	.002	5.9	.8	1.1
88/05/11																			
88/05/26	.069	<.05	<.01	.005	<.0001	.006	<.005	.0006	.180	.016	<.01	.0006	<.05	.018	.004	<.002	7.2	.9	1.1
88/06/06																			
88/07/18	.019	<.05	<.01	.005	<.0001	<.005	<.005	.0005	.202	.010	<.01	<.0005	<.05	.018	<.002	<.002	8.1	1.0	1.0
88/08/16	.027	<.05	<.01	.007	<.0001	.007	<.005	.0010	.219	.015	<.01	<.0005	<.05	.020	<.002	.005	8.8	1.1	1.2
88/10/18	.019	.05	<.01	.007	<.0001	<.005	<.005	<.0005	1.20	.046	<.01	.0008	<.05	.020	<.002	<.002	7.1	1.0	1.3
88/11/30	.089	.05	.03	.004	<.0001	<.005	<.005	.0008	.049	.002	<.01	<.0005	<.05	.013	<.002	.002	5.2	.8	1.1
89/03/13	.055	<.05	<.01	.003	<.0001	<.005	<.005	<.0005	.033	.003	<.01	<.0005	<.05	.011	<.002	<.002	4.3	.7	1.2
GRAND MEAN	**.046**	**<.05**	**.01**	**.005**	**<.0001**	**.005**	**<.005**	**.0006**	**.247**	**.013**	**<.01**	**.0006**	**<.05**	**.016**	**.002**	**.003**	**6.5**	**.9**	**1.1**
STD ERROR	**.025**	**0**	**.01**	**.001**	**0**	**.001**	**0**	**.0002**	**.393**	**.014**	**0**	**.0001**	**0**	**.003**	**.001**	**.003**	**1.6**	**.1**	**.1**

* (units - mg/l, except as noted; values expressed are means of triplicate samples)

TABLE 5 RECEIVING WATER QUALITY STATION 5 (QUINSAM RIVER - 25 m d/s MIDDLE QUINSAM LAKE)*

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO_4	NFR	FR	TR	TURB JTU	HARD	Si	TDP	TP	NO_3	NO_2	NH_3
88/04/13	1.31	8.2	11.5	7.4	38.0	1.3	14.8	3.3	<5.0	32.7	32.7	.10	15.5	1.9	<.002	.002	.032	<.005	.006
88/04/26				7.5	41.0	1.3	16.2	3.0	<5.0	27.0	27.0	.20	17.1	1.7	.005	.004	.010	<.005	.007
88/05/11	.55	12.9	10.0	7.3	42.5	1.3	18.0	2.7	<5.0	30.7	30.7	.20	18.1	1.6	<.002	.003	<.005	<.005	.018
88/05/26				7.4	43.8	1.1	18.8	2.0	<5.0	28.7	28.7	.20	17.8	1.3	<.002	.004	<.005	<.005	.006
88/06/06	.79	13.3	9.6	7.7	45.0	1.7	18.3	2.0	<5.0	36.7	36.7	.23	18.8	1.3	<.002	<.002	<.005	<.005	<.005
88/07/18	.71	20.6	8.8	7.8	47.5	<1.0	21.0	2.0	<5.0	32.3	32.3	.10	18.7	1.2	<.002	<.002	<.005	<.005	<.005
88/08/16	.91	19.0		7.8	46.8	<1.0	21.7	2.0	<5.0	33.3	33.3	<.10	22.4	1.3	.002	.002	.009	<.005	.006
88/10/18	1.34	12.5	11.2	7.6	48.2	1.5	21.0	2.0	<5.0	34.3	34.3	<.10	22.4	1.5	<.002	<.002	.008	<.005	.005
88/11/30	1.80	4.2		7.5	43.5	1.3	15.8	3.3	<5.0	36.3	36.3	.20	17.8	2.3	<.002	.004	.041	<.005	.011
89/03/13	3.90	2.3	12.7	7.2	40.5	2.6	13.6	4.0	<5.0	38.3	38.3	.10	14.9	2.3	<.002	.002	.067	<.005	.007
GRAND MEAN	**1.41**	**11.6**	**10.6**	**7.6**	**43.7**	**1.4**	**17.9**	**2.6**	**<5.0**	**33.0**	**33.0**	**.15**	**18.3**	**1.6**	**.002**	**.003**	**.019**	**<.005**	**.008**
STD ERROR	**1.08**	**6.5**	**1.4**	**.2**	**3.3**	**.5**	**2.8**	**.7**	**0**	**3.6**	**3.6**	**.06**	**2.5**	**.4**	**.001**	**.001**	**.021**	**0**	**.004**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13	.034	<.05	<.01	.002	<.0001	<.005	<.005	<.0005	.019	.005	<.01	<.0005	<.05	.013	<.002	<.002	4.9	.7	1.5
88/04/26	.015	<.05	<.01	.002	<.0001	<.005	<.005		.019	.005	<.01	<.0005	<.05	.013	<.002	.004	5.6	.8	1.3
88/05/11	.010	<.05	<.01	.002	<.0001	<.005	<.005	<.0005	.020	.003	<.01	<.0005	<.05	.014	<.002	.003	5.8	.9	1.6
88/05/26	.014	<.05	<.01	.001	<.0001	<.005	<.005	<.0005	.015	.002	<.01	.0016	<.05	.013	.005	<.002	5.8	.8	1.2
88/06/06	.022	<.05	.01	.001	<.0001	<.005	<.005	<.0005	.027	.002	<.01	<.0005	<.05	.014	<.002	<.002	6.3	.8	1.2
88/07/18	.025	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	.010	<.001	<.01	<.0005	<.05	.012	<.002	<.002	6.4	.7	.9
88/08/16	.017	<.05	<.01	<.001	.0001	<.005	<.005	<.0005	.011	<.001	<.01	<.0005	<.05	.014	<.002	<.002	7.5	.9	1.0
88/10/18	.006	<.05	<.01	.001	<.0001	<.005	<.005	<.0005	.014	.004	<.01	<.0005	<.05	.013	<.002	<.002	7.0	.8	1.0
88/11/30	.051	<.05	<.01	.002	<.0001	<.005	<.005	.0006	.054	.012	<.01	<.0005	<.05	.014	<.002	<.002	5.6	.8	1.6
89/03/13	.058	<.05	<.01	.002	<.0001	<.005	<.005	<.0005	.033	.004	<.01	<.0005	<.05	.014	<.002	.002	4.6	.8	1.6
GRAND MEAN	**.025**	**<.05**	**<.01**	**.002**	**<.0001**	**<.005**	**<.005**	**.0005**	**.022**	**.004**	**<.01**	**.0006**	**<.05**	**.013**	**.002**	**.002**	**6.0**	**.8**	**1.3**
STD ERROR	**.017**	**0**	**.00**	**.000**	**0**	**0**	**0**	**.0000**	**.013**	**.003**	**0**	**.0004**	**0**	**.001**	**.001**	**.000**	**.9**	**.1**	**.3**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13	.044	<.05	<.01	.002	<.0001	<.005	<.005	.0005	.101	.028	<.01	<.0005	<.05	.012	<.002	.004	5.0	.8	1.3
88/04/26	.080	<.05	.03	.002	<.0001	<.005	<.005		.045	.007	<.01	.0007	<.05	.013	<.002	.016	5.3	.8	1.5
88/05/11	.012	<.05	.02	.002	<.0001	<.005	<.005	.0007	.034	.004	<.01	<.0005	<.05	.012	<.002	<.002	5.4	.6	1.3
88/05/26	.086	<.05	<.01	.001	<.0001	.005	<.005	.0007	.055	.004	<.01	<.0005	<.05	.016	.004	<.002	6.5	.9	1.3
88/06/06	.076	<.05	.01	.001	<.0001	<.005	<.005	.0007	.036	.005	<.01	<.0005	<.05	.014	<.002	<.002	6.3	.9	1.3
88/07/18	.023	<.05	<.01	<.001	<.0001	<.005	<.005	.0006	.038	.005	<.01	<.0005	<.05	.014	<.002	<.002	7.5	.9	1.1
88/08/16	.019	<.05	<.01	.002	.0004	.006	<.005	.0012	.034	.006	<.01	.0017	<.05	.015	<.002	<.002	7.9	1.0	1.1
88/10/18	.008	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	.029	.008	<.01	<.0005	<.05	.013	<.002	<.002	7.1	.7	.8
88/11/30	.077	<.05	<.01	.002	<.0001	<.005	<.005	.0007	.095	.016	<.01	<.0005	<.05	.015	<.002	<.002	5.7	.9	1.5
89/03/13	.074	<.05	<.01	.002	<.0001	<.005	<.005	<.0005	.048	.006	<.01	<.0005	<.05	.015	<.002	<.002	4.8	.8	1.7
GRAND MEAN	**.050**	**<.05**	**.01**	**.002**	**.0001**	**.005**	**<.005**	**.0007**	**.052**	**.009**	**<.01**	**.0006**	**<.05**	**.014**	**.002**	**.004**	**6.1**	**.8**	**1.3**
STD ERROR	**.032**	**0**	**.01**	**.000**	**.0001**	**.000**	**0**	**.0002**	**.026**	**.008**	**0**	**.0004**	**0**	**.001**	**.001**	**.004**	**1.1**	**.1**	**.2**

* (units - mg/l, except as noted; values expressed are means of triplicate samples)

TABLE 6 RECEIVING WATER QUALITY STATION 5A (QUINSAM RIVER - .5 km d/s MIDDLE QUINSAM LAKE)*

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO_4	NFR	FR	TR	TURB JTU	HARD	Si	TDP	TP	NO_3	NO_2	NH_3
88/04/13	not sampled routinely																	
88/04/26	not sampled routinely																	
88/05/11	not sampled routinely																	
88/05/26	not sampled routinely																	
88/06/06	not sampled routinely																	
88/07/18	21.5	8.6	7.8	46.8	<1.0	20.0	2.0	<5.0	34.3	34.3	.10	20.3	1.1	<.002	.002	<.005	<.005	<.005
88/08/16	19		7.8	49.0	<1.0	21.8	2.0	<5.0	36.3	36.3	.13	21.5	1.2	.002	.003	<.005	<.005	.007
88/10/18	not sampled routinely																	
88/11/30	not sampled routinely																	
89/03/13	not sampled routinely																	
GRAND MEAN	**20.3**	**8.6**	**7.8**	**47.9**	**<1.0**	**20.9**	**2.0**	**<5.0**	**35.3**	**35.3**	**.12**	**20.9**	**1.2**	**<.002**	**.003**	**.005**	**<.005**	**.006**
STD ERROR	**1.8**		**0**	**1.6**	**0**	**1.3**	**0**	**0**	**1.4**	**1.4**	**.02**	**.8**	**.0**	**0**	**.001**	**0**	**0**	**.001**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13																			
88/04/26																			
88/05/11																			
88/05/26																			
88/06/06																			
88/07/18	.017	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	.008	<.001	<.01	<.0005	<.05	.013	<.002	<.002	7.0	.7	.9
88/08/16	.015	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	.008	.001	<.01	<.0005	<.05	.014	<.002	<.002	7.2	.9	.9
88/10/18																			
88/11/30																			
89/03/13																			
GRAND MEAN	**.016**	**<.05**	**<.01**	**<.001**	**<.0001**	**<.005**	**<.005**	**<.0005**	**.008**	**<.001**	**<.01**	**<.0005**	**<.05**	**.014**	**<.002**	**<.002**	**7.1**	**.8**	**.9**
STD ERROR	**.001**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**.001**	**0**	**0**	**.1**	**.1**	**0**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13																			
88/04/26																			
88/05/11																			
88/05/26																			
88/06/06																			
88/07/18	.034	<.05	<.01	<.001	.0005	<.005	<.005	.0012	.043	.007	<.01	<.0005	<.05	.014	<.002	.004	7.7	.9	1.1
88/08/16	.024	<.05	<.01	.001	.0005	<.005	<.005	.0012	.029	.004	<.01	<.0005	<.05	.015	<.002	.004	7.9	.9	1.0
88/10/18																			
88/11/30																			
89/03/13																			
GRAND MEAN	**.029**	**<.05**	**<.01**	**<.001**	**.0005**	**<.005**	**<.005**	**.0012**	**.036**	**.006**	**<.01**	**<.0005**	**<.05**	**.015**	**<.002**	**.004**	**7.8**	**.9**	**1.1**
STD ERROR	**.007**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**.010**	**.002**	**0**	**0**	**0**	**.001**	**0**	**0**	**.1**	**0**	**.0**

* (units - mg/l, except as noted; values expressed are means of triplicate samples)

TABLE 7 RECEIVING WATER QUALITY STATION 8 (QUINSAM RIVER - 3 km d/s MIDDLE QUINSAM LAKE)*

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO_4	NFR	FR	TR	TURB JTU	HARD	Si	TDP	TP	NO_3	NO_2	NH_3
88/04/13		not sampled - inaccessible																	
88/04/26		not sampled - inaccessible																	
88/05/11	.52	12.6	9.9	7.3	43.5	1.2	18.2	3.0	<5.0	28.7	28.7	.20	18.3	1.5	.002	.003	.011	<.005	.017
88/05/26		not sampled																	
88/06/06	.82	12.2	10.0	7.7	45.5	1.1	18.3	2.3	<5.0	33.7	33.7	.30	18.3	1.3	<.002	.002	.015	<.005	<.005
88/07/18	.69	23.2	7.9	7.8	47.2	<1.0	20.3	2.3	<5.0	35.3	35.3	.10	19.7	1.1	<.002	.002	.021	<.005	<.005
88/08/16	.79	19.0		7.7	47.2	1.2	21.8	2.0	<5.0	37.3	37.3	<.10	22.2	1.3	.002	.003	.037	<.005	<.005
88/10/18		11.5	12.5	7.5	48.0	1.7	21.0	2.0	<5.0	36.0	36.0	<.10	21.3	1.3	<.002	<.002	.010	<.005	.005
88/11/30		not sampled - inaccessible																	
89/03/13		not sampled - inaccessible																	
GRAND MEAN	**.71**	**15.7**	**10.1**	**7.6**	**46.3**	**1.2**	**19.9**	**2.3**	**<5.0**	**34.2**	**34.2**	**.16**	**20.0**	**1.3**	**<.002**	**.002**	**.019**	**<.005**	**.008**
STD ERROR	**.14**	**5.2**	**1.9**	**.2**	**1.8**	**.3**	**1.6**	**.4**	**0**	**3.3**	**3.3**	**.09**	**1.8**	**.1**	**.000**	**.001**	**.011**	**0**	**.006**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13																			
88/04/26																			
88/05/11	<.002	<.05	<.01	.002	<.0001	<.005	<.005	<.0005	.014	<.001	<.01	<.0005	<.05	.014	<.002	<.002	5.9	.9	1.6
88/05/26																			
88/06/06	.014	<.05	.02	.001	<.0001	<.005	<.005	.0010	.016	<.001	<.01	.0014	<.05	.014	<.002	<.002	6.1	.8	1.2
88/07/18	.009	<.05	<.01	.001	<.0001	<.005	<.005	<.0005	.006	<.001	<.01	<.0005	<.05	.013	<.002	<.002	6.7	.8	1.0
88/08/16	.014	<.05	<.01	.001	<.0001	<.005	<.005	.0009	<.005	<.001	<.01	<.0005	<.05	.014	<.002	<.002	7.4	.9	1.0
88/10/18	.005	<.05	<.01	.001	<.0001	<.005	<.005	<.0005	.015	.001	<.01	<.0005	<.05	.012	<.002	<.002	7.1	.9	1.1
88/11/30																			
89/03/13																			
GRAND MEAN	**.009**	**<.05**	**.01**	**.001**	**<.0001**	**<.005**	**<.005**	**.0007**	**.011**	**<.001**	**<.01**	**.0007**	**<.05**	**.013**	**<.002**	**<.002**	**6.6**	**.8**	**1.2**
STD ERROR	**.005**	**0**	**.00**	**.000**	**0**	**0**	**0**	**.0002**	**.005**	**0**	**0**	**.0004**	**0**	**.001**	**0**	**0**	**.6**	**.1**	**.2**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13																			
88/04/26																			
88/05/11	.004	<.05	.02	.002	.0001	<.005	<.005	<.0005	.038	.003	<.01	<.0005	<.05	.013	<.002	<.002	5.6	.7•	1.2
88/05/26																			
88/06/06	.079	<.05	<.01	.003	.0002	<.005	<.005	.0015	.107	.021	<.01	<.0005	<.05	.014	<.002	.003	6.1	.9	1.2
88/07/18	.034	<.05	<.01	.002	.0003	.005	<.005	.0006	.025	.004	<.01	<.0005	<.05	.014	<.002	<.002	7.1	.9	1.1
88/08/16	.035	<.05	<.01	.001	<.0001	<.005	<.005	.0009	.025	.003	<.01	<.0005	<.05	.016	<.002	.004	8.3	.9	1.0
88/10/18	.012	<.05	<.01	<.001	<.0001	<.005	<.005	.0019	.039	.003	<.01	<.0005	<.05	.013	<.002	<.002	7.1	.9	1.0
88/11/30																			
89/03/13																			
GRAND MEAN	**.033**	**<.05**	**.01**	**.002**	**.0002**	**<.005**	**<.005**	**.0011**	**.047**	**.007**	**<.01**	**<.0005**	**<.05**	**.014**	**<.002**	**.003**	**6.9**	**.9**	**1.1**
STD ERROR	**.029**	**0**	**.00**	**.001**	**.0001**	**.000**	**0**	**.0006**	**.034**	**.008**	**0**	**0**	**0**	**.001**	**0**	**.001**	**1.0**	**.1**	**.1**

* (units - mg/l, except as noted)

4.3 Effluent Quality

a) Table 8 - 2N Pit Water
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

b) Table 9 - Settling Pond 4 - Inflow
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

c) Table 10 - Settling Pond 4 - Outflow
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

d) Table 11 - Settling Pond 4 - Middle Quinsam Lake Road Culvert
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

TABLE 8 EFFLUENT QUALITY 2N PIT WATER *

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO_4	NFR	FR	TR	TURB JTU	HARD	Si	TDP	TP	NO_3	NO_2	NH_3
88/04/13	not sampled																	
88/04/26	not sampled																	
88/05/11	not sampled																	
88/05/26	not sampled																	
88/06/06	not sampled																	
88/07/18	not sampled																	
88/08/16	not sampled																	
88/10/18	10.5		8.2	1750	2.7	103	630	<5.0	1600	1600	3.80	579	1.6	<.002	.004	11.9	.176	.491
88/11/30	5.2	9.0	8.3	1850	<1.0	154	820	<5.0	1510	1510	.20	507	1.9	<.002	<.002	4.46	.061	.597
89/03/13	5.9	9.8	8.3	2550	8.9	140	1300	<5.0	2310	2310	.20	915	1.7	<.002	.003	2.63	.015	.076
MEAN	**7.2**	**9.4**	**8.2**	**2050**	**4.2**	**132.3**	**916.7**	**<5.0**	**1807**	**1807**	**1.40**	**667**	**1.7**	**<.002**	**.003**	**6.328**	**.084**	**.388**
STD DEV	**2.9**	**.6**	**.1**	**436**	**4.2**	**26.4**	**345**	**0**	**438**	**438**	**2.1**	**218**	**.2**	**0**	**.001**	**4.9**	**.083**	**.275**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13																			
88/04/26																			
88/05/11																			
88/05/26																			
88/06/06																			
88/07/18																			
88/08/16																			
88/10/18	.128	<.05	.80	.071	<.0001	.008	<.005	.0058	<.005	.148	.02	<.0005	<.05	2.15	<.002	<.002	202	17.2	316
88/11/30	.003	<.05	.47	.030	<.0001	<.005	<.005	.0066	<.005	.233	<.01	<.0005	<.05	2.18	<.002	<.002	174	16.9	251
89/03/13	.006	<.05	.57	.028	<.0001	<.005	<.005	.0079	.009	.078	<.01	<.0005	<.05	3.61	.004	<.002	309	33.8	323
MEAN	**.046**	**<.05**	**.61**	**.043**	**<.0001**	**.006**	**<.005**	**.0068**	**.006**	**.153**	**.01**	**<.0005**	**<.05**	**2.65**	**.003**	**<.002**	**228**	**22.6**	**297**
STD DEV	**.071**	**0**	**.17**	**.024**	**0**	**.002**	**0**	**.0011**	**.002**	**.078**	**.01**	**0**	**0**	**.834**	**.001**	**0**	**71.2**	**9.7**	**39.7**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13																			
88/04/26																			
88/05/11																			
88/05/26																			
88/06/06																			
88/07/18																			
88/08/16																			
88/10/18	.410	<.05	.68	.067	<.0001	<.005	<.005	.0092	.519	.152	.01	.0043	<.05	1.94	<.002	<.002	188	14.3	198
88/11/30	.073	<.05	.47	.030	<.0001	<.005	<.005	.0078	.017	.240	<.01	<.0005	<.05	2.10	<.002	<.002	179	17.3	261
89/03/13	.159	<.05	.56	.028	<.0001	<.005	<.005	.0102	.085	.077	<.01	<.0005	<.05	3.46	.025	<.002	301	33.5	309
MEAN	**.214**	**<.05**	**.57**	**.042**	**<.0001**	**<.005**	**<.005**	**.0091**	**.207**	**.156**	**<.01**	**.0018**	**<.05**	**2.500**	**.010**	**<.002**	**222.7**	**21.7**	**256**
STD DEV	**.175**	**0**	**.11**	**.022**	**0**	**0**	**0**	**.0012**	**.272**	**.082**	**0**	**.0022**	**0**	**.835**	**.013**	**0**	**68.0**	**10.3**	**55.7**

* (units - mg/l, except as noted)

TABLE 9 EFFLUENT QUALITY SETTLING POND 4 – INFLOW *

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO_4	NFR	FR	TR	TURB JTU	HARD	Si	TDP	TP	NO_3	NO_2	NH_3
88/04/13	9.5	9.2	7.7	600	<1.0	86.8	220	<5.0	447	447	5.70	185	3.8	.006	.010	.294	.038	.074
88/04/26			7.8	600	1.0	102	200	20	448	468	28.0	187	3.8	.017	.031	.169	.020	.085
88/05/11	15.9	7.8	7.5	420	not sampled – no flow													
88/05/26					not sampled – no flow													
88/06/06	15.6	8.6	7.5	660	not sampled – no flow													
88/07/18					not sampled – no flow													
88/08/16					not sampled – no flow													
88/10/18	8.0		8.1	325	1.5	67.5	120	<5.0	1700	1700	.60	133	3.7	.002	.005	.013	<.005	.021
88/11/30	5.9	13.0	8.1	1650	1.9	127	760	<5.0	1400	1400	10.0	534	2.7	<.002	.004	4.28	.042	.216
89/03/13	6.2	10.4	8.3	2150	8.9	130	1100	<5.0	2310	2310	.90	722	1.9	<.002	.004	2.20	.010	.071
MEAN	**10.2**	**9.8**	**7.8**	**915**	**2.9**	**103**	**480**	**8.0**	**1261**	**1265**	**9.04**	**352**	**3.2**	**.006**	**.011**	**1.39**	**.023**	**.093**
STD DEV	**4.5**	**2.0**	**.3**	**698**	**3.4**	**26.6**	**430**	**6.7**	**812**	**807**	**11.28**	**261**	**.9**	**.006**	**.012**	**1.84**	**.016**	**.073**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13	.037	<.05	.20	.044	<.0001	<.005	<.005	.0021	.088	.602	<.01	<.0005	<.05	.608	<.002	.013	62.2	6.6	74.5
88/04/26	.017	<.05	.16	.036	<.0001	<.005	<.005	.0106	.095	.512	.01	<.0005	<.05	.564	<.002	.004	62.0	7.3	61.0
88/05/11																			
88/05/26																			
88/06/06																			
88/07/18																			
88/08/16																			
88/10/18	.021	<.05	<.01	.010	<.0001	<.005	<.005	.0012	<.005	<.001	<.01	<.0005	<.05	.260	<.002	.007	39.4	8.6	26.5
88/11/30	<.002	<.05	.34	.035	<.0001	.006	<.005	.0054	.642	.637	<.01	<.0005	<.05	1.96	.002	.088	179	19.9	200
89/03/13	.010	<.05	.48	.035	<.0001	<.005	<.005	.0065	.205	.214	<.01	<.0005	<.05	2.77	.004	.026	243	27.1	254
MEAN	**.017**	**<.05**	**.24**	**.032**	**<.0001**	**.005**	**<.005**	**.0052**	**.207**	**.393**	**<.01**	**<.0005**	**<.05**	**1.23**	**.002**	**.028**	**117**	**13.9**	**123**
STD DEV	**.013**	**0**	**.18**	**.013**	**0**	**.000**	**0**	**.0038**	**.253**	**.275**	**0**	**0**	**0**	**1.08**	**.001**	**.035**	**89**	**9.2**	**98**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13	.210	<.05	.20	.044	<.0001	<.005	<.005	<.0005	.925	.573	<.01	.0012	<.05	.591	.003	.008	60.1	6.8	72.9
88/04/26	.960	<.05	.19	.041	<.0001	<.005	<.005	.0122	1.82	.524	.01	<.0005	<.05	.568	.040	.007	60.9	7.9	67.9
88/05/11																			
88/05/26																			
88/06/06																			
88/07/18																			
88/08/16																			
88/10/18	.021	<.05	<.01	.012	<.0001	<.005	<.005	.0014	.145	<.001	<.01	<.0005	<.05	.26	<.002	<.002	38.3	8.2	20.8
88/11/30	.143	.05	.31	.035	<.0001	<.005	<.005	.0051	2.02	.655	<.01	<.0005	<.05	1.87	.006	.092	184	20.2	206
89/03/13	.091	<.05	.48	.036	<.0001	<.005	<.005	.0068	.705	.215	<.01	<.0005	<.05	2.81	.009	.023	251	28.2	261
MEAN	**.285**	**<.05**	**.24**	**.034**	**<.0001**	**<.005**	**<.005**	**.0052**	**1.12**	**.394**	**<.01**	**.0006**	**<.05**	**1.22**	**.012**	**.026**	**119**	**14.3**	**126**
STD DEV	**.384**	**0**	**.17**	**.013**	**0**	**0**	**0**	**.0047**	**.78**	**.275**	**0**	**.0003**	**0**	**1.1**	**.016**	**.038**	**94**	**9.5**	**102**

* (units – mg/l, except as noted)

TABLE 10 EFFLUENT QUALITY SETTLING POND 4 - OUTFLOW *

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO_4	NFR	FR	TR	TURB JTU	HARD	Si	TDP	TP	NO_3	NO_2	NH_3
88/04/13	13.1	9.5	7.4	200	1.3	31.0	67	<5.0	146	146	2.50	51.9	2.6	.008	.008	.006	<.005	.012
88/04/26			7.4	225	1.3	40.4	69	<5.0	162	162	1.00	59.9	2.4	.006	.013	<.005	<.005	<.005
88/05/11	18.1	7.9	7.9	235	1.3	38.0	60	<5.0	162	162	.80	62.7	2.4	.007	.012	<.005	<.005	.036
88/05/26			7.8	220	1.3	40.0	58	<5.0	171	171	.70	58.1	2.1	.008	.021	<.005	<.005	.019
88/06/06	16.3	7.9	7.7	240	4.0	47.5	58	5.0	174	174	1.30	64.4	2.3	.010	.020	<.005	<.005	<.005
88/07/18	not sampled - no flow																	
88/08/16	not sampled - no flow																	
88/10/18	11.5		8.0	285	11.6	112	39	<5.0	1670	1670	3.30	84.4	3.3	.011	.028	<.005	<.005	.023
88/11/30	3.8	12.0	7.7	700	1.9	44.0	300	<5.0	340	340	9.30	216	3.1	.003	.014	.877	.017	.016
89/03/13	1.8	8.0	7.8	375	11.8	32.3	100	<5.0	272	272	6.00	106	2.8	<.002	.009	.093	<.005	.027
MEAN	**10.8**	**9.1**	**7.7**	**310**	**4.3**	**48.2**	**93.9**	**<5.0**	**387**	**387**	**3.11**	**88**	**2.6**	**.007**	**.016**	**.125**	**.007**	**.018**
STD DEV	**6.6**	**1.8**	**.2**	**166**	**4.7**	**26.4**	**85.0**	**.0**	**522**	**522.8**	**3.07**	**55**	**.4**	**.003**	**.007**	**.305**	**.004**	**.011**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13	.092	<.05	.05	.011	<.0001	<.005	<.005	.0011	1.22	.234	<.01	<.0005	<.05	.099	<.002	.032	14.8	2.9	22.6
88/04/26	.096	<.05	.04	.012	<.0001	<.005	<.005	.0085	.857	.196	<.01	<.0005	<.05	.113	<.002	.111	17.7	3.2	21.1
88/05/11	.053	<.05	.08	.013	<.0001	<.005	<.005	.0033	.940	.166	.01	<.0005	<.05	.123	<.002	.099	18.1	3.7	20.7
88/05/26	.188	<.05	.05	.013	<.0001	.015	<.005	.0020	1.18	.221	<.01	.0038	<.05	.114	.005	.046	16.7	3.2	21.9
88/06/06	.171	<.05	.05	.015	<.0001	.006	<.005	.0036	1.15	.370	<.01	.0024	<.05	.123	<.002	.042	18.6	3.6	23.1
88/07/18																			
88/08/16																			
88/10/18	.153	<.05	<.01	.025	<.0001	<.005	<.005	<.0005	2.55	.489	<.01	<.0005	<.05	.197	<.002	<.002	23.6	4.8	48.7
88/11/30	.150	<.05	.06	.031	<.0001	.008	<.005	.0072	.780	.255	<.01	<.0005	<.05	.719	.004	.034	70.9	8.7	70.5
89/03/13	.110	<.05	<.01	.015	<.0001	<.005	<.005	<.0005	.363	.186	<.01	<.0005	<.05	.33	.003	.011	34.1	4.8	32.7
MEAN	**.127**	**<.05**	**.04**	**.017**	**<.0001**	**.007**	**<.005**	**.0033**	**1.13**	**.265**	**<.01**	**.0012**	**<.05**	**.227**	**.003**	**.047**	**26.8**	**4.4**	**32.7**
STD DEV	**.046**	**0**	**.02**	**.007**	**0**	**.003**	**0**	**.0030**	**.638**	**.110**	**0**	**.0013**	**0**	**.213**	**.001**	**.039**	**18.8**	**1.9**	**18**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13	.210	<.05	.05	.011	<.0001	.006	<.005	<.0005	1.57	.224	<.01	.0013	<.05	.098	.005	.033	14.2	2.9	23.6
88/04/26	.154	<.05	.06	.012	<.0001	<.005	<.005	.0058	1.20	.196	<.01	<.0005	<.05	.115	<.002	.120	17.0	3.5	26.3
88/05/11	.099	<.05	.05	.012	.0001	<.005	<.005	.0007	1.14	.160	<.01	<.0005	<.05	.111	<.002	.098	16.8	3.0	20.6
88/05/26	.225	<.05	.05	.014	.0002	.024	<.005	.0020	1.57	.247	<.01	<.0005	<.05	.125	.010	.051	18.3	3.6	23.8
88/06/06	.298	<.05	.05	.018	<.0001	.011	.032	.0019	1.57	.400	<.01	<.0005	<.05	.124	.006	.039	18.4	3.6	23.0
88/07/18																			
88/08/16																			
88/10/18	.153	<.05	<.01	.028	<.0001	<.005	<.005	.0005	3.50	.502	<.01	<.0005	<.05	.203	<.002	<.002	23.7	4.7	38.5
88/11/30	.160	<.05	.02	.031	.0001	.006	<.005	.0089	1.95	.260	<.01	<.0005	<.05	.628	.059	.036	71.5	8.7	70.9
89/03/13	.380	<.05	<.01	.016	<.0001	<.005	<.005	<.0005	.836	.187	<.01	<.0005	<.05	.328	.019	.007	34.9	4.9	32.5
MEAN	**.210**	**<.05**	**.04**	**.018**	**.0001**	**.008**	**.010**	**.0026**	**1.67**	**.272**	**<.01**	**.0006**	**<.05**	**.217**	**.013**	**.048**	**26.9**	**4.4**	**32.4**
STD DEV	**.091**	**0**	**.02**	**.008**	**.0000**	**.007**	**.012**	**.0031**	**.815**	**.118**	**0**	**.0003**	**0**	**.183**	**.019**	**.041**	**19.2**	**1.9**	**17**

* (units - mg/l, except as noted)

TABLE 11 EFFLUENT QUALITY SETTLING POND 4 - MIDDLE QUINSAM LAKE ROAD CULVERT *

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO_4	NFR	FR	TR	TURB JTU	HARD	Si	TDP	TP	NO_3	NO_2	NH_3
88/04/13	7.4	10.4	7.1	95	1.3	18.1	25	<5.0	67	67	.10	23.7	3.0	.002	.002	.050	<.005	<.005
88/04/26			7.1	93	1.7	21.2	22	<5.0	66	66	.20	25.1	3.2	.007	.004	.020	<.005	.005
88/05/11	8.6	7.1	8.1	103	1.3	31.0	22	<5.0	75	75	.10	27.9	3.5	.003	.004	.012	<.005	.025
88/05/26			7.4	128	1.3	20.0	40	<5.0	100	100	.10	31.6	3.4	.005	.004	<.005	<.005	<.005
88/06/06	9.0	8.7	7.4	125	4.0	20.0	31	<5.0	92	92	.10	27.1	3.1	.003	.005	.005	<.005	<.005
88/07/18	not sampled - no flow																	
88/08/16	not sampled - no flow																	
88/10/18	8.0		7.6	323	2.3	26.0	23	<5.0	<5.0	<5.0	<.10	34.7	4.6	.002	.005	<.005	<.005	<.005
88/11/30	3.5		7.6	445	1.9	25.0	850	<5.0	333	333	.50	134	3.5	<.002	.003	.416	<.005	.008
89/03/13	.6	13.6	7.7	235	4.1	24.7	61	<5.0	178	178	.60	65.8	2.9	<.002	.004	.065	<.005	<.005
MEAN	**6.2**	**10.0**	**7.5**	**193**	**2.2**	**23.3**	**134**	**<5.0**	**115**	**115**	**.23**	**46**	**3.4**	**.003**	**.004**	**.072**	**<.005**	**.008**
STD DEV	**3.4**	**2.8**	**.3**	**130**	**1.2**	**4.2**	**290**	**.0**	**100**	**100**	**.21**	**38**	**.5**	**.002**	**.001**	**.141**	**0**	**.007**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13	.060	<.05	.03	.004	<.0001	<.005	<.005	<.0005	.035	<.001	<.01	<.0005	<.05	.032	<.002	<.002	6.5	1.7	10.4
88/04/26	.139	<.05	.01	.004	<.0001	<.005	<.005	.0049	.015	.002	<.01	<.0005	<.05	.032	<.002	.004	6.9	1.8	8.1
88/05/11	.062	<.05	.03	.005	<.0001	<.005	<.005	.0031	.016	.001	<.01	<.0005	<.05	.036	<.002	<.002	7.6	2.1	10.4
88/05/26	.130	.08	.03	.007	<.0001	.013	.014	.0015	.018	.004	.01	.0039	<.05	.042	.008	.005	8.6	2.3	12.2
88/06/06	.150	<.05	.02	.005	<.0001	<.005	<.005	.0046	.018	<.001	<.01	.0029	<.05	.036	<.002	<.002	7.5	1.9	13.1
88/07/18																			
88/08/16																			
88/10/18	.080	<.05	<.01	.006	<.0001	<.005	<.005	.0008	.008	<.001	<.01	<.0005	<.05	.045	<.002	.003	9.5	2.6	17.9
88/11/30	.143	<.05	.01	.020	<.0001	<.005	<.005	.0017	.058	<.001	<.01	<.0005	<.05	.361	<.002	.004	43.1	6.2	44.4
89/03/13	.075	<.05	<.01	.007	<.0001	<.005	<.005	<.0005	.072	.003	<.01	<.0005	<.05	.190	<.002	<.002	21.2	3.0	20.2
MEAN	**.105**	**.05**	**.02**	**.007**	**<.0001**	**.006**	**.006**	**.0022**	**.030**	**.002**	**<.01**	**.0012**	**<.05**	**.097**	**.003**	**.003**	**13.9**	**2.7**	**17**
STD DEV	**.039**	**.01**	**.01**	**.005**	**0**	**.003**	**.003**	**.0018**	**.023**	**.001**	**0**	**.0014**	**0**	**.120**	**.002**	**.001**	**12.7**	**1.5**	**12**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
88/04/13	.130	<.05	.03	.004	<.0001	<.005	<.005	<.0005	.040	.001	<.01	.0016	<.05	.031	<.002	<.002	6.3	1.8	10.4
88/04/26	.183	<.05	.04	.004	<.0001	<.005	<.005	.0043	.04	.001	<.01	<.0005	<.05	.032	<.002	.006	6.3	2.0	12.0
88/05/11	.099	<.05	.02	.005	<.0001	<.005	<.005	.0011	.024	<.001	.01	<.0005	<.05	.034	<.002	.004	7.2	1.8	8.3
88/05/26	.196	.33	.03	.006	<.0001	.024	<.005	.0015	.006	.002	<.01	<.0005	<.05	.045	.005	.003	9.1	2.4	13.0
88/06/06	.219	<.05	<.01	.005	<.0001	<.005	<.005	<.0005	.019	.004	<.01	<.0005	<.05	.038	.006	<.002	7.6	2.0	13.4
88/07/18																			
88/08/16																			
88/10/18	.140	.06	<.01	.005	<.0001	<.005	<.005	.0008	<.005	<.001	<.01	<.0005	<.05	.043	<.002	<.002	8.7	2.3	13.2
88/11/30	.150	<.05	<.01	.019	.0002	<.005	<.005	.0019	.111	<.001	<.01	<.0005	<.05	.34	.005	.005	43.0	6.2	44.2
89/03/13	.177	<.05	<.01	.008	<.0001	<.005	<.005	<.0005	.147	.006	<.01	<.0005	<.05	.192	.005	<.002	21.6	3.1	20.3
MEAN	**.162**	**.09**	**.02**	**.007**	**.0001**	**.007**	**<.005**	**.0014**	**.05**	**.002**	**<.01**	**.0006**	**<.05**	**.094**	**.004**	**.003**	**13.7**	**2.7**	**17**
STD DEV	**.039**	**.10**	**.01**	**.005**	**.0000**	**.007**	**0**	**.0013**	**.052**	**.002**	**0**	**.0004**	**0**	**.113**	**.002**	**.002**	**12.9**	**1.5**	**12**

* (units - mg/l, except as noted)

4.4 Periphyton

a) Table 12 - Station 1 - Quinsam River 1 km u/s Middle Quinsam Lake

b) Table 13 - Station 5 - Quinsam River 25 m d/s Middle Quinsam Lake

c) Table 14 - Station 5A - Quinsam River .5 km d/s Middle Quinsam Lake

d) Table 15 - Station 8 - Quinsam River 3 km d/s Middle Quinsam Lake

TABLE 12 PERIPHYTON - STATION 1

(QUINSAM RIVER - 1 km u/s MIDDLE QUINSAM LAKE)

DATE	REPLICATE	TOTAL NITRO (g/m2)	TOTAL PHOS (g/m2)	N/P (at)	CHL a (mg/m2)	PHAEO-PHYTON (mg/m2)	TOTAL PIGMENT (mg/m2)
88/05/11	1	5.14	.333	34.1	7.3	12.0	19.4
	2	6.18	.366	37.3	6.3	11.6	17.8
	3	3.78	.538	15.5	7.9	12.4	20.2
	4	7.79	.313	55.0	10.3	12.0	22.3
	5	16.1	.200	178	7.7	12.3	20.0
	6	17.7	.271	144	3.8	9.2	13.0
	7	16.9	.265	141	5.6	9.5	15.1
	8	9.64	.496	43.0	10.2	16.6	26.8
	mean	**10.4**	**.348**	**80.9**	**7.4**	**12.0**	**19.3**
	std	**5.7**	**.12**	**63**	**2.2**	**2.3**	**4.3**
88/06/06	1	3.45	.217	35.2	5.1	2.2	7.3
	2	3.21	.165	43.1	6.9	.6	7.6
	3	3.13	.172	40.3	5.0	3.0	8.0
	4	4.02	.120	73.7	2.8	1.1	3.9
	5	4.66	.172	59.9	6.4	1.4	7.9
	6	3.69	.167	48.9	2.8	2.4	5.2
	7	3.21	.172	41.3	5.5	3.1	8.6
	8	2.81	.137	45.5	3.1	.6	3.7
	mean	**3.5**	**.165**	**48.5**	**4.7**	**1.8**	**6.5**
	std	**.6**	**.03**	**13**	**1.6**	**1.0**	**1.9**
88/07/18	1	3.78	.964	8.7	5.8	2.5	8.3
	2	10.4	.227	102	4.7	1.9	6.7
	3	8.03	.161	111	5.0	1.5	6.5
	4	4.34	.188	51.0	3.9	.8	4.7
	5	7.39	.212	77.0	6.3	1.1	7.4
	6	7.23	.264	60.5	5.8	2.7	8.4
	7	8.84	.238	82.1	5.6	1.6	7.2
	8	6.59	.259	56.1	4.5	1.0	5.5
	mean	**7.1**	**.314**	**68.4**	**5.2**	**1.6**	**6.8**
	std	**2.2**	**.26**	**32**	**.8**	**.7**	**1.3**
88/08/16	1	4.50	.177	56.3	8.0	2.2	10.1
	2	2.73	.082	73.7	4.3	1.6	5.9
	3	4.34	.153	62.8	12.4	3.2	15.7
	4	4.37	.187	51.6	8.6	2.4	11.0
	5	3.21	.086	82.6	8.4	1.7	10.0
	6	3.78	.109	76.4	9.5	2.0	11.5
	7	4.02	.130	68.2	10.8	1.8	12.5
	8	3.86	.103	82.9	12.0	2.9	14.9
	mean	**3.8**	**.128**	**69.3**	**9.2**	**2.2**	**11.5**
	std	**.6**	**.04**	**12**	**2.6**	**.6**	**3.1**

TABLE 13 PERIPHYTON STATION 5

(QUINSAM RIVER - 25 m d/s MIDDLE QUINSAM LAKE)

DATE	REPLICATE	TOTAL NITRO (g/m2)	TOTAL PHOS (g/m2)	N/P (at)	CHL a (mg/m2)	PHAEO-PHYTON (mg/m2)	TOTAL PIGMENT (mg/m2)
88/05/11	1	9.72	.161	134	6.2	9.2	15.4
	2	4.98	.129	85.6	7.3	10.3	17.6
	3	3.53	.096	81.0	5.0	7.7	12.7
	4	5.30	.104	112	2.8	5.8	8.6
	5	7.47	.271	60.8	5.8	9.2	15.0
	6	2.41	.088	60.3	2.0	3.2	5.2
	7	11.2	.451	55.2	44.3	63.1	107
	8	8.03	.129	138	3.6	5.4	9.0
	mean	**6.59**	**.179**	**90.9**	**9.6**	**14.2**	**23.9**
	std	**3.1**	**.12**	**33**	**14**	**20**	**34**
88/06/06	1	3.37	.153	48.9	4.5	1.6	6.1
	2	2.01	.063	70.8	5.5	1.7	7.1
	3	1.85	.049	83.3	5.4	.4	5.8
	4	2.41	.030	179	5.1	1.8	6.9
	5	5.38	.321	37.0	19.1	5.5	24.6
	6	3.78	.122	68.3	7.6	2.0	9.6
	7	2.17	.043	111	3.0	1.4	4.3
	8	7.15	.386	41.0	30.6	5.3	35.9
	mean	**3.51**	**.146**	**79.9**	**10.1**	**2.4**	**12.5**
	std	**1.9**	**.14**	**47**	**10**	**2**	**11**
88/07/18	1	4.26	.177	53.2	4.5	1.4	5.9
	2	4.98	.137	80.6	5.0	1.2	6.2
	3	3.29	.078	93.4	2.8	.4	3.2
	4	5.14	.129	88.4	4.3	1.1	5.5
	5	6.91	.175	87.2	5.0	1.2	6.2
	6	5.46	.233	51.8	3.2	1.0	4.2
	7	4.98	.184	59.8	3.5	.8	4.3
	8	9.64	.221	96.4	6.4	2.0	8.4
	mean	**5.58**	**.167**	**76.4**	**4.3**	**1.1**	**5.5**
	std	**1.9**	**.05**	**18**	**1**	**0**	**2**
88/08/16	1	2.41	.072	73.7	4.7	1.9	6.7
	2	2.73	.078	77.5	8.4	2.3	10.7
	3	2.49	.070	78.7	7.6	2.1	9.6
	4	3.69	.102	80.0	9.5	2.6	12.0
	5	2.41	.104	51.0	2.6	1.2	3.8
	6	2.09	.078	59.2	3.9	1.0	4.8
	7	4.42	.321	30.4	4.3	3.1	7.4
	8	2.49	.118	46.6	2.8	1.1	3.9
	mean	**2.84**	**.118**	**62.1**	**5.5**	**1.9**	**7.4**
	std	**.8**	**.08**	**18**	**3**	**1**	**3**

TABLE 14 PERIPHYTON STATION 5A

(QUINSAM RIVER - .5 km d/s MIDDLE QUINSAM LAKE)

DATE	REPLICATE	TOTAL NITRO (g/m2)	TOTAL PHOS (g/m2)	N/P (at)	CHL a (mg/m2)	PHAEO-PHYTON (mg/m2)	TOTAL PIGMENT (mg/m2)
88/07/18	1	20.9	.610	75.6	77.1	20.1	97.2
	2	14.5	.298	107	90.0	32.9	123
	3	9.64	.362	58.8	49.8	18.5	68.3
	4	5.86	.187	69.2	2.57	3.13	5.70
	5	8.84	.312	62.7	51.4	7.23	58.6
	6	8.84	.307	63.6	32.2	17.5	49.7
	7	4.02	.112	78.9	10.8	7.15	17.9
	8	6.02	.191	69.6	22.1	14.7	36.8
	mean	**9.82**	**.297**	**73.2**	**42.0**	**15.2**	**57.1**
	std	**5.5**	**.15**	**15**	**31**	**9.5**	**39**
88/08/18	1	10.44	.437	52.8	66.7	22.5	89.2
	2	12.85	.405	70.2	23.4	7.71	31.1
	3	16.06	.297	119	88.4	28.9	117
	4	8.84	.217	90.0	28.0	5.14	33.1
	5	7.07	.217	72.0	18.7	4.74	23.5
	6	5.62	.182	68.1	25.5	5.30	30.8
	7	.803	.456	3.89	138	78.7	217
	8	8.84	.337	57.9	189	51.4	240
	mean	**8.82**	**.319**	**66.8**	**72.2**	**25.6**	**97.7**
	std	**4.6**	**.11**	**33**	**63**	**27**	**87**

TABLE 15 PERIPHYTON STATION 8

(QUINSAM RIVER - 3 km d/s MIDDLE QUINSAM LAKE)

DATE	REPL-ICATE	TOTAL NITRO (g/m2)	TOTAL PHOS (g/m2)	N/P (at)	CHL a (mg/m2)	PHAEO-PHYTON (mg/m2)	TOTAL PIGMENT (mg/m2)
88/05/11	1	7.63	.137	124	.9	1.5	2.4
	2	7.07	.120	130	1.7	2.4	4.1
	3	6.59	.071	206	1.1	1.9	3.1
	4	7.15	.073	216	1.1	1.8	2.9
	5	8.03	.073	243	1.3	2.9	4.2
	6	5.94	.039	341	1.9	2.3	4.3
	7	7.71	.088	193	1.8	3.5	5.4
	8	1.77	.067	58.6	3.3	5.3	8.6
	mean	**6.49**	**.083**	**189**	**1.6**	**2.7**	**4.4**
	std	**2.0**	**.03**	**86**	**.8**	**1.2**	**2.0**
88/06/06	1	2.17	.038	127	1.0	.7	1.8
	2	2.73	.044	137	1.4	2.2	3.5
	3	3.21	.071	99.3	1.9	.9	2.8
	4	1.45	.034	94.7	1.3	1.3	2.6
	5	1.29	.033	86.2	2.0	.2	2.2
	6	1.04	.035	66.8	2.0	1.8	3.9
	7	.80	.019	92.1	1.8	1.1	2.9
	mean	**1.81**	**.039**	**100**	**1.6**	**1.2**	**2.8**
	std	**.9**	**.02**	**24**	**.4**	**.7**	**.7**
88/07/18	1	7.63	.162	103.9	1.7	.8	2.5
	2	7.07	.088	177	1.0	.6	1.6
	3	6.59	.137	106.6	1.5	.6	2.2
	4	7.15	.129	123	1.3	.1	1.4
	5	8.03	.120	147	2.3	1.1	3.5
	6	5.94	.153	86.1	1.7	.8	2.5
	7	7.71	.129	132.6	.9	.2	1.0
	8	1.77	.129	30.4	1.0	1.4	2.5
	mean	**6.49**	**.131**	**113**	**1.4**	**.7**	**2.1**
	std	**2.0**	**.02**	**44**	**.5**	**.5**	**.8**
88/08/16	1	1.45	.060	53.0	2.3	.6	3.0
	2	1.45	.051	62.2	1.3	.5	1.8
	3	1.37	.057	52.9	2.3	1.4	3.7
	4	1.20	.053	50.2	1.3	.2	1.5
	5	.96	.064	33.2	1.0	.3	1.4
	6	1.77	.048	81.0	1.9	1.4	3.3
	7	1.45	.042	76.5	.4	.8	1.2
	8	1.93	.061	69.8	2.8	1.3	4.1
	mean	**1.45**	**.055**	**59.9**	**1.7**	**.8**	**2.5**
	std	**.3**	**.01**	**16**	**.8**	**.5**	**1.2**

4.5 **Fall Lake Survey**

a) Table 16 - Hydrolab (Surveyor II) Profile - Middle Quinsam Lake - Site 1 - 19 October, 1988

b) Table 17 - Receiving Water Quality and Phytoplankton - Middle Quinsam Lake - Site 1 - Water Quality Profile 19 October, 1988

TABLE 16 HYDROLAB (SURVEYOR II) PROFILE +

MIDDLE QUINSAM LAKE - SITE 1 (19 OCT 1988)

DEPTH (m)	TEMP (Deg C	pH (rel u)	DO (mg/l)	COND (uS/cm)	ORP	LIGHT TRANSMISSION (uE/m2/s)	(%)
0	12.4	6.6	8.8	57	228	281	100
1	12.4	6.6	8.8	57	225	116	41
2	12.4	6.7	8.7	57	221	73	26
3	12.4	6.7	8.6	57	224	39	14
4	12.4	6.7	8.2	57	228	30	11
5	12.4	6.7	8.1	57	226	20	5.0
6	12.4	6.7	8.1	57	225	14	3.6
7	12.2	6.7	7.7	57	225	10	3.2
8	12.0	6.7	8.0	57	224	8.9	1.4
9	12.0	6.7	7.9	57	224	3.9	.9
10 *	11.8	6.7	8.0	57	224	2.5	
11	11.7	6.7	7.8	57	225		
12	11.4	6.6	6.9	60	228		
13	10.3	6.3	2.5	69	239		
14	9.9	6.1	2.1	72	242		
15	9.8	6.1	2.1	72	242		
15.1	BOTTOM						

+ MOE WASTE MANAGEMENT BRANCH

* SECCHI DEPTH (9.5 - 10 m)

WATER QUALITY SAMPLE DEPTHS: 1, 12 and 14 m

PHYTOPLANKTON SAMPLE DEPTHS: 1, 4 and 9 m

TABLE 17 RECEIVING WATER QUALITY AND PHYTOPLANKTON - MIDDLE QUINSAM LAKE (SITE 1) WATER QUALITY PROFILE 19 OCT '88 *

A PHYSICAL & CHEMICAL

DEPTH (m)	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO_4	NFR	FR	TR	TURB JTU	HARD	Si	TDP	TP	NO_3	NO_2	NH_3
1	12.4	8.8	7.8	48.0	1.5	22.5	2.0	<5.0	39	39	.10	21.2	1.4	<.002	.004	.010	<.005	.021
12	11.4	6.9	7.4	49.5	1.9	21.0	2.0	<5.0	34	34	.20	21.0	1.5	<.002	.004	.009	<.005	.017
14	9.9	2.1	6.7	63.0	7.7	19.5	3.0	<5.0	45	45	1.00	20.1	1.8	.003	.005	.038	<.005	.111

B DISSOLVED METALS

DEPTH (m)	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
1	.006	<.05	<.01	<.001	<.0001	<.005	<.005	.0020	.012	.007	<.01	<.0005	<.05	.012	<.002	.003	7.1	.8	1.1
12	.006	<.05	<.01	<.001	<.0001	<.005	<.005	.0006	.024	.020	<.01	<.0005	<.05	.013	<.002	<.002	7.1	.8	1.6
14	.002	<.05	<.01	.003	<.0001	<.005	<.005	.0005	.038	.250	<.01	<.0005	<.05	.017	<.002	<.002	6.6	.8	4.8

C TOTAL METALS

DEPTH (m)	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
1	.013	<.05	<.01	<.001	<.0001	<.005	<.005	.0045	.037	.010	<.01	<.0005	<.05	.013	<.002	.004	7.2	.8	.8
12	.010	.06	<.01	.001	<.0001	<.005	<.005	.0022	.059	.023	<.01	<.0005	<.05	.013	<.002	<.002	7.1	.8	1.1
14	.016	.08	<.01	.004	<.0001	<.005	.012	.0036	.441	.274	<.01	<.0005	<.05	.018	<.002	<.002	6.8	.8	3.6

D PHYTOPLANKTON PIGMENTS

REPLICATE	DEPTH (m) 1		4		9	
	Chl a (ug/l)	Phaeo (ug/l)	Chl a (ug/l)	Phaeo (ug/l)	Chl a (ug/l)	Phaeo (ug/l)
1	.3	.9	.5	.4	.3	.3
2	2.1	<.2	.5	.4	.3	.3
3	<.2	1.1	.8	<.2	.5	<.2
MEAN	.9	.7	.6	.3	.4	.3
STD	1.1	.5	.2	.1	.1	.1

* (units - mg/l, except as noted)

5.0 DISCUSSION

5.1 Comparison of Selected EP Data on Effluent, Receiving Water Quality and Biological Parameters (April 1988 - March 1989)

A comparison of seventeen parameters representing QCC permit requirements and Federal concerns that were expressed to the provincial Commission of Inquiry in 1983 are as follows:

Acid Mine Drainage - pH, conductivity and sulphate
Heavy Metals - dissolved Al, Cu, Fe, Pb and Zn
Nutrients - phosphorus (total and dissolved), nitrate, nitrite and ammonia
Sedimentation - non filterable residue and turbidity

In addition, alkalinity and hardness are compared in order to detect changes in the effluent and receiving water buffering capacities.

Comparisons are made between receiving water quality parameter means and Canadian Water Quality Guidelines, (CCREM) (Table 18) for freshwater aquatic life as well as between effluent parameter means and permitted levels. Student's t test is used to determine the level of significance of the respective changes in the selected parameters. The level of significance in this case is 0.05 (5%), a conventionally used biological statistic. To compute means, grand means, standard deviations and standard errors, all values that are less than the detection limit are assumed to equal the detection limit. As a result, increases are underestimated when compared to values consistently below the detection limit. Additionally, as standard deviations and errors reported are large relative to the mean and grand mean values and the number of samples collected is small, care must be used to interpret the data presented in this report.

Dissolved iron and zinc and total dissolved phosphorus in the SP4 discharge exceed PE7008 permit levels (Appendix B). Phosphorus and zinc marginally exceed the permitted levels by 10%, 1 of 8 times sampled, however,

TABLE 18 COMPARISON OF SELECTED RECEIVING WATER AND EFFLUENT DATA MEANS *
(APRIL 1988 - MARCH 1989)

AREA OF CONCERN	PARAMETER	CONTROLS 1 (n=10)	CONTROLS 2 (n=8)	STATION RECIEVING MQL 1 (n=3)	STATION RECIEVING 5 (n=10)	STATION RECIEVING 5A (n=2)	STATION RECIEVING 8 (n=5)	EFFLUENT SP4-OUT (n=8)	EFFLUENT SP4-MQLR (n=8)	CCREM GUIDELINE
ACID MINE DRAINAGE	pH (Rel.U.)	7.7	7.3	7.3	7.6	7.8	7.6	7.7	7.5	6.5 - 9.0
	Conduct(uS/cm)	45.4	45.2	53.3	43.7	47.9	46.3	310	193	-
	Sulphate	2.3	1.8	2.3	2.6	2.0	2.0	94	134	-
	Alkalinity	20.2	19.7	21.0	17.9	20.9	19.9	48.2	23.3	-
	Hardness	20.6	19.3	20.7	18.3	20.9	20.0	88.0	46.0	-
HEAVY METALS	Dissolved Al	.021	.019	.005	.025	.016	.009	.127	.101	0.1
	" Cu	.0005	<.0005	.0010	.0005	<.0005	.0007	.0033	.0022	0.002 [1]
	" Fe	.005	.098	.025	.022	.008	.011	1.130	.030	0.3
	" Pb	<.0005	.0005	<.0005	.0006	<.0005	.0007	.0012	.0012	0.001 [1]
	" Zn	<.002	<.002	.002	.002	<.002	<.002	.047	.003	0.03
NUTRIENTS	Total Diss P	.002	.003	.002	.002	<.002	<.002	.007	.003	-
	Total P	.002	.003	.004	.003	.003	.002	.016	.004	-
	Nitrate	.013	.010	.019	.019	<.005	.019	.125	.072	-
	Nitrite	<.005	<.005	<.005	<.005	<.005	<.005	.007	<.005	0.06
	Ammonia	.006	.006	.050	.008	.006	.008	.018	.008	1.37 - 2.2 [2]
SEDIMENTATION	Non Filt. Res.	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	-
	Turbid (JTU)	.13	.44	.43	.15	.12	.16	3.11	.23	-
EUTROPHICATION (periphyton & phytoplankton)	TN/TP (atomic)	67	-	-	77	70	115	-	-	-
	Total Pigments (mg/m^2)	11	-	1.2 (mg/m^3)	13	78	3.0	-	-	-

* (units in mg/l, except as noted)
1 @ hardness < 60 mg/l
2 2.2 @ pH 6.5 & Temp 10°C; 1.37 @ pH 8.0 & Temp 10°C

mean values are less than permitted. Iron exceeds the permit 8 of 8 times by an average of 3.8 times and is the only significantly elevated parameter in the effluent (0.5% probability). The remaining permitted parameters are consistently within the levels. Several non-permitted parameters used as indicators for acid mine drainage (conductivity, alkalinity, hardness and sulphate) increased significantly from the previous year.

In comparison, at the Middle Quinsam Lake Road culvert (MQLR), 3 of 12 parameters (dissolved aluminum, copper and lead) exceed the CCREM guidelines for freshwater aquatic life. These values vary from 1% to 20% higher than the guidelines and are considerably lower than the effluent discharged from SP4. Student's t tests indicate that the means are not significantly different from the guideline values.

Water quality at Middle Quinsam Lake (MQL), site 1 is similar to baseline studies conducted by QCC and EP. Single grab samples were collected at three depths (surface, bottom of epilimnion and hypolimnion). Dissolved iron and ammonia showed increases in the hypolimnion, but are not significant. These levels historically have occurred in the hypolimnion prior to the fall overturn (Redenbach et al, 1985; Redenbach et al, 1987). This is discussed in Section 5.2.

Receiving water quality at station 5 was very similar to control station 1 and 2. Although water quality was only monitored twice (July & August) at station 5A, .5 km downstream of MQL, all results are similar to the control stations and the monitoring station at the outlet of MQL. Water quality at station 8 is similar to the control stations. There are no significant differences between parameter means of the control stations when compared to the downstream receiving water quality monitoring stations (5, 5A and 8). All parameters in the receiving waters are within the guidelines set out in CCREM 87.

Atomic nitrogen:phosphorus ratios at the four stations monitored (Tables 12-15, 18) demonstrate that periphytic algal productivity is phosphorus limited (mean 82, range 50 - 190) during the growing season.

Phosphorus deficiency is least pronounced at the control station and increases with distance downstream. This suggests that phosphorus is possibly limiting periphytic algal growth in the receiving environment.

Periphyton and phytoplankton biomass (chlorophyll a and phaeopigtments) is low at all stations (mean 9.0 mg/m^2, range 2.1 - 24 mg/m^2), with the exception of Station 5A, during the spring, summer and fall. At Station 5A, located immediately adjacent to and down slope from the eastern extremity of the 2N-Pit, the average pigment level is 78 mg/m^2. Periphyton pigment levels at Station 5A exceed the B.C. MOE Water Quality criterion for the protection of aesthetics and recreational values (50 mg/m^2) and approach the criterion for the protection of aquatic life (100 mg/m^2) during the summer months.

5.2 Comparison of Selected EP Monitoring Data (April 1988 - March 1989) to QCC Baseline Data (1983 - 1984)

Data collected from April 1988 to March 1989 by EP was compared to the QCC baseline data (1983 and 1984) to verify that there are no other factors influencing the receiving water quality subsequent to QCC's collection of baseline data (Table 19). As in Section 5.1 the same parameter means are compared using the same criteria, i.e. student's t test to determine if significant changes between baseline and operation monitoring have occurred.

EP operational monitoring and QCC baseline water quality data are very similar at both control stations. Two parameters differ significantly at station 1. Total phosphorus and dissolved iron, are 40% of the QCC baseline data. At station 2, one parameter mean differs, QCC baseline data for ammonia is significantly higher than the EP data. At both control stations the differences in the parameter means are likely due to analytical uncertainties, as the values are near the limit of detection. Small uneven data sets also reduce the ability to detect differences in the means with a similar degree of confidence in the significance of the change.

TABLE 19 COMPARISON OF SELECTED EP MONITORING DATA MEANS (APRIL 1988 - MARCH 1989) AND QCC BASELINE DATA MEANS * (JANUARY 1983 - OCTOBER 1984) BIOLOGICAL MONITORING DATA ARE FROM COMPARABLE SEASONS

AREA OF CONCERN	PARAMETER	CONTROLS 1 QCC (n=22)	1 EP (n=10)	2 QCC (n=4)	2 EP (n=8)	MQL 1 QCC (n=6)	MQL 1 EP (n=3)	RECIEVIEIVING 5 QCC (n=22)	5 EP (n=10)	8 QCC (n=13)	8 EP (n=5)	EFFLUENT SP4-MQLR QCC (n=5)	SP4-MQLR EP (n=8)
ACID MINE DRAINAGE	pH (Rel.U.)	7.4	7.7	6.9	7.3	7.3	7.3	7.3	7.6	7.2	7.6	7.2	7.5
	Cond (uS/cm)	37.0	45.4	36.5	45.2	44.5	53.3	32.9	43.7	36.6	46.3	22.0	193
	Sulphate	1.8	2.3	<1.0	1.8	1.6	2.3	1.4	2.6	1.3	2.0	<1.0	134
	Alkalinity	24.9	20.2	25.9	19.7	24.7	21.0	22.9	17.9	24.9	19.9	19.4	23.3
	Hardness	20.0	20.6	19.8	19.3	19.0	20.7	16.4	18.3	19.0	20.0	12.0	46.0
HEAVY METALS	Dissolved Al	.023	.021	.033	.019	.007	.005	.025	.025	.022	.009	.071	.101
	Dissolved Cu	<.0010	.0005	<.0010	<.0005	<.001	.001	.0023	.0005	<.0010	.0007	<.0010	.0022
	Dissolved Fe	.012	.005	.048	.098	.027	.025	.028	.022	.094	.011	.032	.030
	Dissolved Pb	<.0010	<.0005	<.0010	.0005	<.001	<.0005	<.0010	.0006	<.0010	.0007	<.0010	.0012
	Dissolved Zn	.002	<.002	.003	<.002	.001	.002	.002	.002	.002	<0.002	.001	.003
NUTRIENTS	Total Diss P	.003	.002	.004	.003	.002	.002	.003	.002	.002	<.002	.004	.003
	Total P	.005	.002	.006	.003	.004	.004	.005	.003	.004	.002	.006	.004
	Nitrate	.012	.013	.004	.010	<.005	.019	.007	.019	.020	.019	.013	.072
	Nitrite	<.001	<.005	<.001	<.005	<.001	<.005	<.001	<.005	<.001	<.005	<.001	<.005
	Ammonia	.009	.006	.017	.006	<.010	.050	.009	.008	.011	.008	.012	.008
SEDIMENTATION	Non Filt. Res	1.3	<5.0	<1.0	<5.0	2.6	<5.0	1.3	<5.0	1.5	<5.0	1.5	<5.0
	Turbidity (QCC=NTU; EP=JTU)	<1.0	.13	1.18	.44	<1.0	.43	<1.0	.15	1.1	.16	<1.0	.23
EUTROPHICATION (periphyton & phytoplankton)	TN/TP (atomic)	55	67	-	-	-	-	50	77	33	115	-	-
	Total Pigments (mg/m²)	20	11	-	-	2.0 (mg/m³)	1.2 (mg/m³)	11	13	17	3.0	-	-

* (units in mg/l, except as noted)

EP receiving water quality monitoring data at stations 5 and 8 are similar to the QCC baseline data. At station 5, the only parameter to differ is nitrate, EP data are significantly higher than the QCC baseline data. Water quality at Middle Quinsam Lake, site 1, is similar to the QCC baseline data collected just prior to the fall overturn. Two parameters, nitrate and ammonia increased significantly, when compared to the QCC baseline data. These apparent increases, evident only in the hypolimnion, are the result of natural processes in stratified lakes or sampling at different depths. EP routinely samples from two zones (oxic and hypoxic) of the hypolimnion, when possible, while QCC sampled at one depth, usually in the oxic zone. The differences in the monitoring results for MQL site 1 reflect natural conditions in the hypoxic zone of the hypolimnion (Redenbach et al, 1985; Redenbach et al, 1987).

Station 8 had the least similar parameter means, dissolved aluminum and iron and turbidity differ significantly. EP values vary from 10 - 40% of the QCC baseline data. When comparing mean values, the trend is to a lower value in the EP data for receiving waters. There are several possible reasons; uneven and small data sets, different sampling locations and techniques and different laboratory analytical methods, are but a few.

Historically, QCC baseline monitoring data for periphytic nitrogen and phosphorus demonstrated that algal productivity is phosphorus limited at all stations during the spring and summer months. This has changed little at stations 1 and 5, however, phosphorus has become significantly more limited at Station 8. Periphyton and phytoplankton biomass (chlorophyll a and phaeopigments) data from 1988 are very similar to the QCC baseline data at stations 1, 5 and Middle Quinsam Lake - site 1. Similar to nutrient status, EP periphyton biomass data at Station 8 in 1988, is significantly less than the QCC baseline data when compared to data from the same season. As mentioned above there are several possible reasons for the differences.

EP water quality monitoring data and QCC baseline data are the least similar at the Middle Quinsam Lake Road culvert. Three parameters are significantly different, in all cases the EP monitoring results are higher. Conductivity, hardness and dissolved zinc are from 3 to 9 times higher. Although several other parameters increased well above historical levels, these changes are not significant because standard deviations exceeded mean values.

Several activities associated with mining such as the use of explosives, land clearing, exposure of soils, unweathered minerals and rock result in increased levels of the above mentioned parameters in mine effluent discharges. EP monitoring of the effluent stream from the sump in the 2N pit to the outlet of the settling pond shows elevated levels and three trends in the effluent concentration. Table 20 lists several parameters showing the three trends. Several dissolved metals (barium, calcium, copper, magnesium, sodium and strontium), alkalinity, conductivity, hardness, filterable residue and nitrogen consistently decrease in concentration with distance from the pit. However, the dissolved metals (aluminum, iron and manganese) phosphorus, turbidity and non filterable residue increase and peak at the settling pond. The concentration of sulphate is lowest at the outlet of the settling pond and then increases by 35% at the MQLR culvert. The reason(s) for this is not clear at present but it is suspected that groundwater discharges affect the effluent stream prior to the compliance point and downstream in the receiving environment.

5.3 Comparison of QCC Effluent Discharge Volumes and Predicted Discharges from Settling Pond 4 (April 1988 - March 1989)

QCC monitoring data indicates that the mean discharge from Settling Pond 4 is less than 1% of the allowable discharge stated in PE 7008 for the stage 1 operations. The maximum daily flow from the pond is 3% of the permitted discharge. Similarly, QCC precipitation monitoring data and calculated area of disturbance indicates that the discharge from the pond is approximately 5% of the expected flow. The majority of the precipitation, received from late fall to early spring when evaporation and transpiration is minimal, does not account for a significant portion of the annual water budget at the mine site. It appears that approximately 95% of the

TABLE 20 COMPARISON OF SELECTED PARAMETERS SHOWING TRENDS IN THE EFFLUENT STREAM (APRIL 1988 - MARCH 1989) *

	STATION			
PARAMETER	2N PIT	SP4-IN	SP4-OUT	MQLR-CULVERT
Al (dis)	.05	.02	.13	.11
Ba "	.04	.03	.02	.01
Ca "	230	120	26.8	13.9
Cu "	.0068	.0052	.0033	.0018
Fe "	.06	.21	1.13	.03
Mg "	22.6	13.9	4.4	2.7
Mn "	.15	.39	.27	.002
Na "	300	120	32.7	17.0
Sr "	2.65	1.23	.23	.10
Alkalinity	130	100	48	23
Ammonia	.39	.09	.02	.007
Condutivity (uS/cm)	2100	920	310	190
Hardness	667	350	88	46
Nitrate	6.3	1.4	.13	.07
Nitrite	.08	.02	.01	<.005
Phosphorus (dis)	<.002	.006	.007	.003
" (tot)	.003	.011	.016	.004
Residue, Filt.	1810	1260	390	115
Residue, Non Filt.	<5	8	<5	<5
Sulphate	920	480	95	130
Turbidity (JTU)	1.4	9.0	3.1	.2

* (units in mg/l, except as noted)

precipitation received on the minesite is not discharged from the treatment pond.

Questions regarding this issue should be addressed to determine:

- the reasons for such a large difference between the actual and predicted discharges from the treatment pond,
- where the discharge occurs, and
- if there are any potential impacts on the receiving environment beyond the monitoring that is required for PE 7008.

5.4 Conclusion

At the outlet of Settling Pond 4, three parameters exceeded permit levels as set out in PE7008. Two parameters exceeded permit levels 12% of the time while dissolved iron exceeded the permit level 100% of the time. The quality of the discharge into Settling Pond 4 however, does not show the same degree of contamination. Therefore the contaminants in the discharge from Settling Pond 4 must originate from at least two sources. The most likely source of the contamination is groundwater. To answer this and other questions related to this, groundwater quality, quantity and flow direction should be re-examined.

A comparison of the current receiving water quality to the historical baseline data indicates there is no impact at receiving water stations with the exception of Middle Quinsam Lake Road culvert. At MQLR approximately 30% of the parameters are significantly elevated relative to historical baseline data. Small data sets of unequal size, large standard deviations and intermittent flows make it difficult to determine differences with any degree of confidence.

Periphytic algae in the Quinsam River both up and down stream of the existing mine range from 2.1 to 24 mg/m^2. These values are similar to the baseline data, however at Station 5A, immediately to the east and down gradient of the 2N pit, algal pigment concentrations exceed B.C. MOE water quality criteria for periphyton. Mid-summer pigment levels range from 57 to 98 mg/m^2, exceeding the criteria for aesthetics (50 mg/m^2) and approaching levels set to protect aquatic life (100 mg/m^2). The reason(s) for this anomally should be determined. As discussed in Section 5.3, a potential source for nutrients is groundwater.

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ACKNOWLEDGEMENTS

The author wishes to acknowledge the assistance of staff from Environmental Protection, Pacific and Yukon Region; Paul Kluckner and laboratory staff for chemical analyses, Keith Ferguson and Greg Linton for field assistance, Bryan Kelson and Keith Ferguson for report editing and Heather Hindle and Bev Defehr for word processing and editing. Additionally, I would like to thank Barry Lawley (Department of Fisheries and Oceans, Habitat Management), John Deniseger (B.C. MOE, Waste Management) and Jack Cann (Quinsam Coal Corp.) for their assistance in the field.

APPENDIX A

QUINSAM COAL CORPORATION - BASELINE DATA (1983-1984)

Table A1	QCC Baseline Data - Station 1 (Quinsam River u/s Middle Quinsam Lake)
Table A2	QCC Baseline Data - Station 5 (Quinsam River d/s Middle Quinsam Lake)
Table A3	QCC Baseline Data - Station 8 (Quinsam River u/s Iron River)
Table A4	QCC Baseline Data - Station 2 (Flume Creet at Argonaut Road)
Table A5	QCC Baseline Data - Settling Pond 4 (Middle Quinsam Lake Road Culvert)

TABLE A1 QCC BASELINE DATA STATION 1 (QUINSAM RIVER 1 km u/s MIDDLE QUINSAM LAKE) *

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO	pH rel u	COND uS/cm	ALK	HARD	SO_4	FR	NFR	TURB JTU	TDP	TP	NO_3	NO_2	NH_3
83/01/23		2.0		7.4	34		19.0	<5.0		<1.0	<.10		<.005	.011	<.002	.009
83/02/25		3.5	12.8	8.2	35		18.4	<1.0		<1.0	.56	.008	.009	<.005	<.001	<.010
83/03/22	.67	4.0	13.2	7.2	45		19.4	<1.0		1.6	.90	.004	.005	<.005	<.001	<.010
83/12/13	.52	4.0	12.2		35	26.4	19.7	2.0		<1.0	<1.00	.002	.003	.024	<.001	<.010
84/01/17	.56	1.5	13.6	7.4	26	26.4	22.9	2.0		<1.0	<1.00	.004	.005	.014	<.001	<.005
84/02/11	.41	4.0	12.4	7.2	24	24.2	23.3	2.0		<1.0	<1.00	.007	.008	.023	<.001	.007
84/03/12	.57	5.0	12.2	7.2	23	22.8	22.1	1.7		<1.0	<1.00	.002	.003	.015	<.001	.007
MEAN	**.54**	**3.4**	**12.7**	**7.4**	**31.7**	**25.0**	**20.7**	**2.1**		**1.1**	**.79**	**.005**	**.005**	**.014**	**<.001**	**.008**
STD DEV	**.09**	**1.2**	**.6**	**.4**	**7.9**	**1.8**	**2.0**	**1.4**		**.2**	**.35**	**.003**	**.002**	**.008**	**.000**	**.002**

B DISSOLVED METALS

DATE	Al	Cu	Fe	Pb	Zn
83/01/23	.015	.0007	.009	<.001	.001
83/02/25	.039	<.0005	.007	<.001	.001
83/03/22	.024	<.0005	.009	<.001	.001
83/12/13	.020	<.0010	.009	<.001	.004
84/01/17	.046	.0010	.013	<.001	.004
84/02/11	.027	<.0010	.008	<.001	.003
84/03/12	.020	<.0010	.024	<.001	.001
MEAN	**.027**	**.0008**	**.011**	**<.001**	**.002**
STD DEV	**.011**	**.0002**	**.006**	**0**	**.002**

C TOTAL METALS

DATE	Al	Cu	Fe	Pb	Zn
83/01/23	.016	.0017	.010	<.001	<.0005
83/02/25	.068	<.0005	.031	<.001	.0010
83/03/22	.055	.0006	.041	<.001	.0030
83/12/13	.025	.0020	.017	<.001	.0100
84/01/17	.150	.0100	.023	<.001	.0050
84/02/11	.030	<.0010	.042	<.001	.0050
84/03/12	.020	<.0010	.042	<.001	.0020
MEAN	**.052**	**.0024**	**.029**	**<.001**	**.0038**
STD DEV	**.047**	**.0034**	**.013**	**0**	**.0033**

* (units - mg/l, except as noted)

TABLE A2 QCC BASELINE DATA STATION 5 (QUINSAM RIVER 25 m d/s MIDDLE QUINSAM LAKE) *

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO	pH rel u	COND uS/cm	ALK	HARD	SO_4	FR	NFR	TURB JTU	TDP	TP	NO_3	NO_2	NH_3
83/01/23		2.0		7.2	25		13.0	<5.0		<1.0	<.10		<.005	<.005	<.002	.008
83/02/25		4.0	12.8	8.2	28		11.8	<1.0		1.2	.58	.006	.014	<.005	<.001	<.010
83/03/22		5.0	14.2	7.2	28		15.0	<1.0		<1.0	.60	.005	.018	.010	<.001	<.010
83/12/13	.832	3.5	13.0	6.7	35	23.1	17.8	<1.0	28	<1.0	<1.00	.003	.005	.016	<.001	.013
84/01/17	1.557	2.5	12.7	7.3	32	22.0	16.3	1.8	22	<1.0	<1.00	.003	.004	.022	<.001	<.005
84/02/11	3.110	4.0	12.1	7.2	28	20.2	16.5	<1.0	22	<1.0	<1.00	.005	.006	.022	<.001	<.005
84/03/12	1.390	5.0	12.2	7.3	32	20.9	17.2	1.5	24	<1.0	<1.00	.001	.002	.012	<.001	<.005
MEAN	**1.722**	**3.7**	**12.8**	**7.3**	**29.7**	**21.6**	**15.4**	**1.8**	**24**	**1.0**	**<.75**	**.004**	**.008**	**.013**	**<.001**	**.008**
STD DEV	**.976**	**1.1**	**.8**	**.4**	**3.4**	**1.3**	**2.2**	**1.5**	**2.8**	**.1**	**.35**	**.002**	**.006**	**.007**	**.000**	**.003**

B DISSOLVED METALS

DATE	Al	Cu	Fe	Pb	Zn
83/01/23	.021	.0005	.028	<.001	<.0005
83/02/25	.043	<.0005	.026	<.001	.001
83/03/22	.029	<.0005	.016	<.001	<.001
83/12/13	.029	<.0010	.032	<.001	.002
84/01/17	.051	<.0010	.024	<.001	.003
84/02/11	.040	<.0010	.033	<.001	.004
84/03/12	.023	<.0010	.054	<.001	.002
MEAN	**.034**	**<.0008**	**.030**	**<.001**	**.002**
STD DEV	**.011**	**.0003**	**.012**	**0**	**.001**

B TOTAL METALS

DATE	Al	Cu	Fe	Pb	Zn
83/01/23	.030	.0008	.043	<.001	<.0005
83/02/25	.070	<.0005	.045	<.001	.0020
83/03/22	.045	<.0005	.043	<.001	.0020
83/12/13	.044	<.0010	.050	<.001	.0030
84/01/17	.080	.0010	.050	<.001	.0030
84/02/11	.050	<.0010	.051	<.001	.0040
84/03/12	.031	<.0010	.092	<.001	.0040
MEAN	**.050**	**<.0008**	**.053**	**<.001**	**.0026**
STD DEV	**.019**	**.0002**	**.017**	**0**	**.0012**

* (units - mg/l, except as noted)

TABLE A3 QCC BASELINE DATA STATION 8 (QUINSAM RIVER u/s IRON RIVER) *

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ALK	HARD	SO_4	FR	NFR	TURB JTU	TDP	TP	NO_3	NO_2	NH_3
83/12/13	4.0	11.5	7.0	35	22.0	16.8	1.5		1.2	1.00	.003	.004	.073	.001	.017
84/02/09	4.0	12.1	7.1	31	27.5	18.3	<1.0		<1.0	1.80	.004	.005	.047	.001	.024
84/03/15	5.0	10.8	7.0	33	20.9	18.1	<1.0		<1.0	<1.00	.002	.003	.026	<.001	<.005
MEAN	**4.3**	**11.5**	**7.0**	**33**	**23.5**	**17.7**	**1.2**		**1.1**	**1.27**	**.003**	**.004**	**.049**	**<.001**	**.015**
STD DEV	**.6**	**.7**	**.1**	**2**	**3.5**	**.8**	**.3**		**.1**	**.46**	**.001**	**.001**	**.024**	**0**	**.010**

B DISSOLVED METALS

DATE	Al	Cu	Fe	Pb	Zn
83/12/13	.048	<.001	.100	<.001	.001
84/02/09	.063	<.001	.083	<.001	.003
84/03/15	.022	<.001	.140	<.001	.001
MEAN	**.044**	**<.001**	**.108**	**<.001**	**.002**
STD DEV	**.021**	**0**	**.029**	**0**	**.001**

B TOTAL METALS

DATE	Al	Cu	Fe	Pb	Zn
83/12/13	.076	<.001	.160	<.001	.003
84/02/09	.190	<.001	.160	<.001	.003
84/03/15	.030	<.001	.150	<.001	.003
MEAN	**.099**	**<.001**	**.157**	**<.001**	**.003**
STD DEV	**.082**	**0**	**.006**	**0**	**0**

* (units - mg/l, except as note)

TABLE A4 QCC BASELINE DATA STATION 2 (FLUME CREEK AT ARGONAUT ROAD) *

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ALK	HARD	SO_4	FR	NFR	TURB JTU	TDP	TP	NO_3	NO_2	NH_3
83/11/15	8.0	10.0	6.8	28	20.0	15.5	<1.0		<1.0	< 1.00	.006	.010	.004	<.001	.023
84/02/11	5.0	11.6	6.9	33	28.6	19.4	<1.0		<1.0	< 1.00	.004	.004	.005	<.001	.023
MEAN	**6.5**	**10.8**	**6.8**	**30.5**	**24.3**	**17.5**	**<1.0**		**<1.0**	**< 1.00**	**.005**	**.007**	**.005**	**<.001**	**.023**
STD DEV	**2.1**	**1.1**	**.1**	**3.5**	**6.1**	**2.8**	**0**		**0**	**0**	**.001**	**.004**	**.001**	**0**	**0**

B DISSOLVED METALS

DATE	Al	Cu	Fe	Pb	Zn
83/11/15	.070	<.001	.029	<.001	.002
84/02/11	.024	<.001	.028	<.001	.002
MEAN	**.047**	**<.001**	**.029**	**<.001**	**.002**
STD DEV	**.033**	**0**	**.001**	**0**	**0**

C TOTAL METALS

DATE	Al	Cu	Fe	Pb	Zn
83/11/15	.110	<.001	.061	<.001	.003
84/02/11	.052	<.001	.042	<.001	.005
MEAN	**.081**	**<.001**	**.052**	**<.001**	**.004**
STD DEV	**.041**	**0**	**.013**	**0**	**.001**

* (units - mg/l, except as noted)

TABLE A5 QCC BASELINE DATA SETTLING POND 4 - MIDDLE QUINSAM LAKE ROAD CULVERT *

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ALK	HARD	SO_4	FR	NFR	TURB JTU	TDP	TP	NO_3	NO_2	NH_3
83/02/25	4.0	12.6	8.2	21		8.8	<1.0		<1.0	.15	.004	.008	.006	<.001	<.010
83/11/15	7.8	12.6	6.8	23	16.0	11.5	<1.0		<1.0	< 1.00	.007	.009	<.005	<.001	<.020
84/02/07	1.0	13.4	6.8	22	20.9	13.2	<1.0		<1.0	< 1.00	.004	.006	.040	.001	.006
MEAN	**4.3**	**12.9**	**7.3**	**22**	**18.5**	**11.2**	**<1.0**		**<1.0**	**< .72**	**.005**	**.008**	**.017**	**<.001**	**<.012**
STD DEV	**3.4**	**.5**	**.8**	**1**	**3.5**	**2.2**	**0**		**0**	**.49**	**.002**	**.002**	**.020**	**0**	**.007**

B DISSOLVED METALS

DATE	Al	Cu	Fe	Pb	Zn
83/02/25	.081	<.0005	.021	<.001	.001
83/11/15	.130	<.0010	.026	<.001	.002
84/02/07	.099	<.0010	.050	<.001	.001
MEAN	**.103**	**<.0008**	**.032**	**<.001**	**.001**
STD DEV	**.025**	**.0003**	**.016**	**0**	**.001**

C TOTAL METALS

DATE	Al	Cu	Fe	Pb	Zn
83/02/25	.085	<.0005	.023	<.001	.001
83/11/15	.170	<.0010	.033	<.001	.004
84/02/07	.100	<.0010	.051	<.001	.001
MEAN	**.118**	**<.0008**	**.036**	**<.001**	**.002**
STD DEV	**.045**	**.0003**	**.014**	**0**	**.002**

APPENDIX B

QUINSAM COAL CORPORATION - PE 7008 (STAGE 1 OPERATION)

TABLE B1 QCC Permitted Parameter Limits for PE 7008 - Stage 1 Operation

TABLE B1 QCC PERMITTED PARAMETER LIMITS FOR PE 7008 - STAGE 1 OPERATION

PARAMETER	ALLOWABLE LEVELS AT SP 4 OUTLET
A) Physical/Chemical (mg/l)	
Flow (CMS)	0.54
Non Filterable Residue	25 daily composite 35 hourly composite
pH (rel. units)	6.0 - 8.0
Ammonia	1.0
Total Dissolved Phosphorus	0.01
B) Dissolved Metals (mg/l)	
Aluminum	0.5
Copper	0.02
Iron	0.3
Lead	0.05
Zinc	0.1
C) Biota Monitoring (Quinsam River)*	
Periphyton (mg/m^2)	50 aesthetics 100 aquatic life

* B.C. MOE W/Q Criteria for Nutrients & Algae