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PACIFIC AND YUKON REGION

QUINSAM COAL DEVELOPMENT

A MONITORING REPORT ON THE EFFLUENT AND RECEIVING WATER QUALITY

- 1987/1988 -

Regional Data Report
DR 88-07

By

A. Redenbach

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1 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 data from the start of mining, (December 1987) to March 31, 1988. Data comparisons are made to baseline data collected by Quinsam Coal Corporation in the winters of 1982/83 and 1983/84.

2 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 Qunsam-Campbell confluence. The Quinsam drainage, having 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. 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. Two control stations were established on the Quinsam River (station 1) and Flume Creek (station 2) upstream of the Quinsam Coal Development. Receiving water quality was monitored at two stations downstream of the development (Quinsam River - stations 5 and 8).

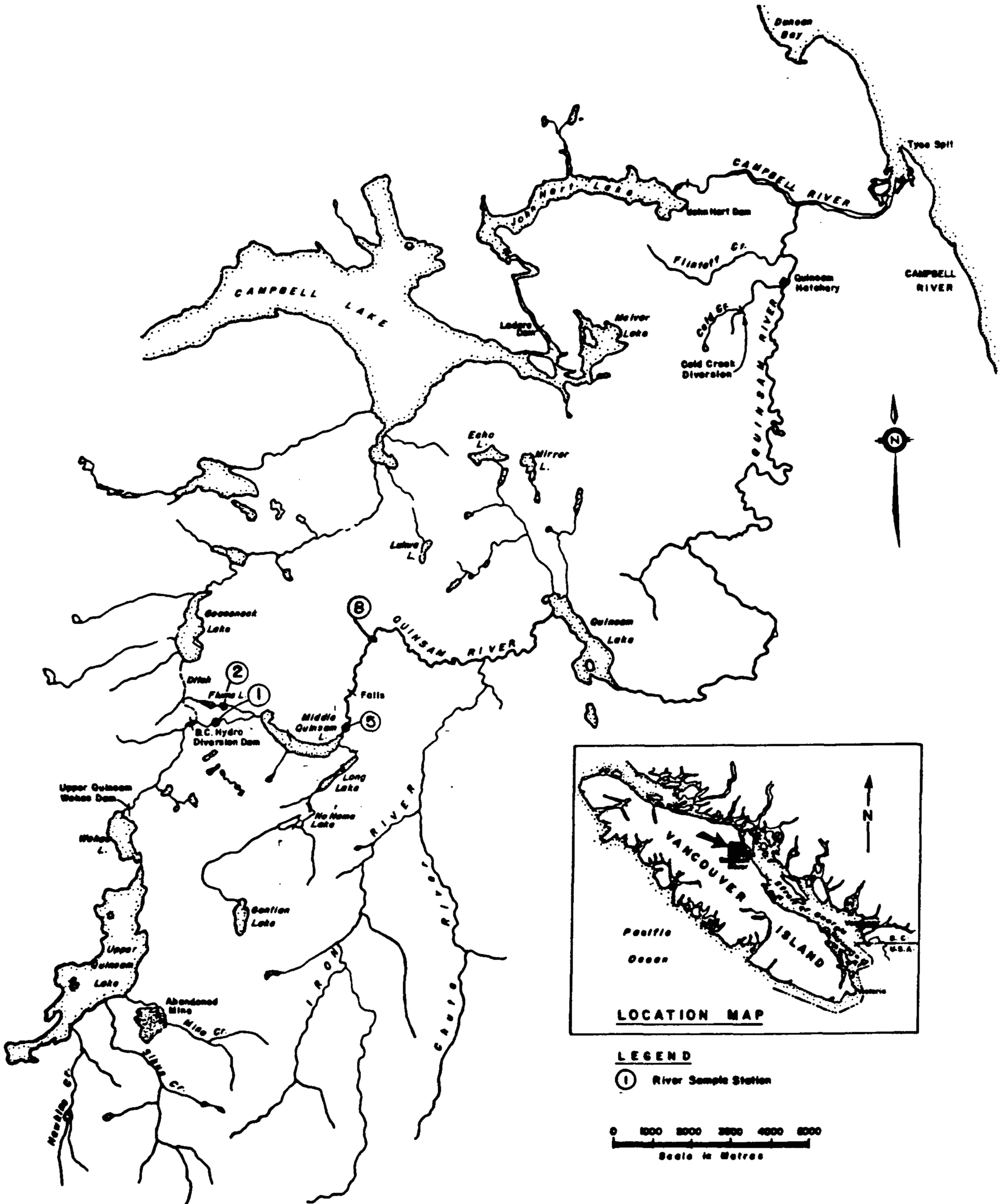

FIGURE 1 QUINSAM DRAINAGE BASIN - STREAM SAMPLING LOCATIONS

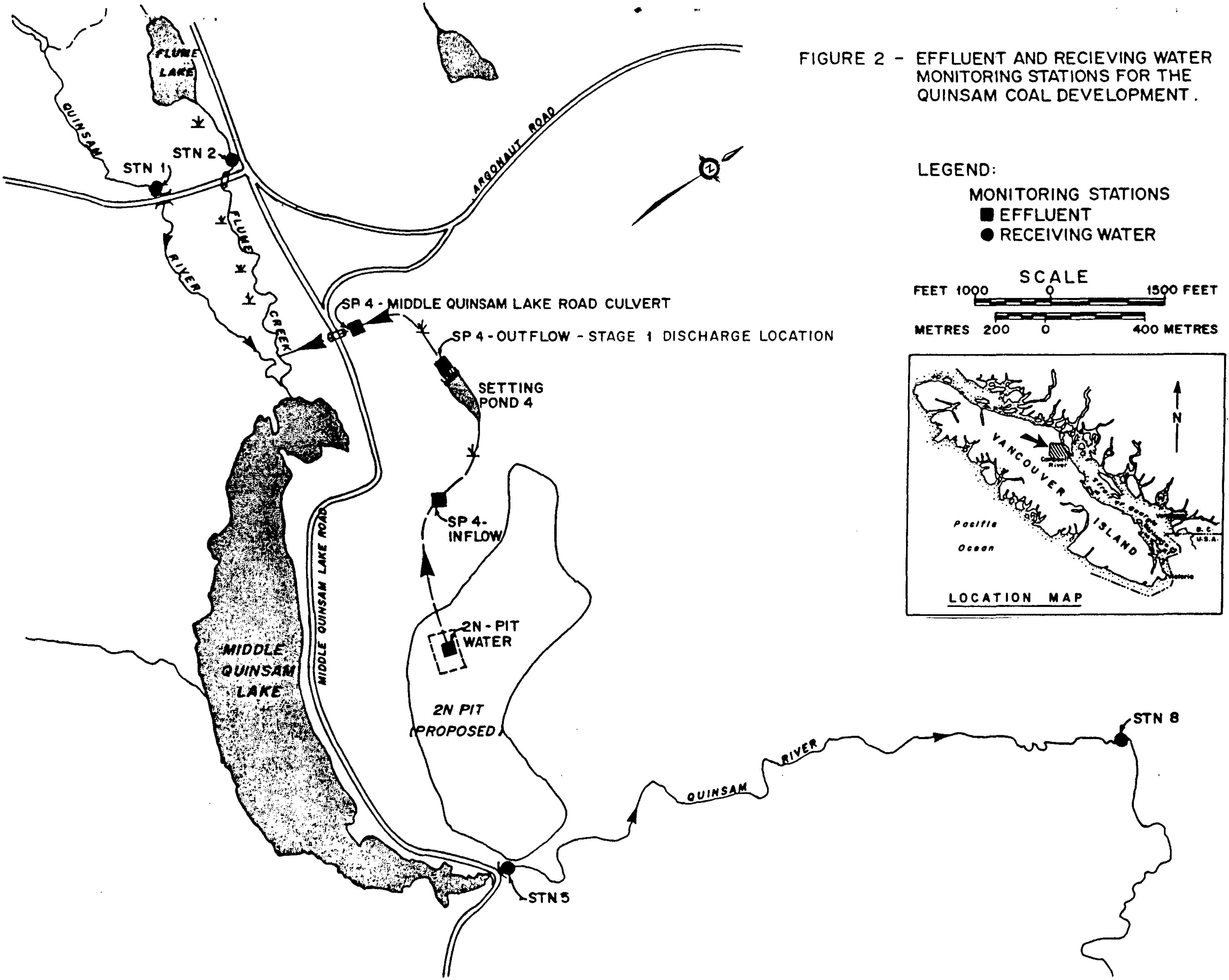

FIGURE 2 - EFFLUENT AND RECIEVING WATER MONITORING STATIONS FOR THE QUINSAM COAL DEVELOPMENT.

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 discharge for the company's permit is the discharge from Settling Pond 4.

3 METHODS AND MATERIALS

Water and effluent samples were collected at approximately three week intervals from December 1987 to March 1988. Triplicate grab samples were collected at all stream and river stations. Initially, effluent was sampled in triplicate, however this effort was reduced to a single grab sample when variability between replicates was determined. Sample means are tabulated in the accompanying tables.

Temperature, pH, conductivity and dissolved oxygen were measured in situ with a Hydrolab Model 4041. 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 until delivered to the laboratory.

River flows were calculated from measurements taken from existing staff guages at stations 1 and 5.

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 Dissolve Phosphorus	EP Lab	- filter through prewashed 0.45 u Sartorius cellulose 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

* Metals are routinely 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:

December 11, 1987
January 12, 1988
February 16, 1988
February 29, 1988
March 8, 1988

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

4. RESULTS

4.1 Detection Limits

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

4.2 Receiving Water Quality

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

Table 3A Physical and Chemical
Table 3B Dissolved Metals
Table 3C Total Metals

b) Station 5 - Quinsam River d/s Middle Quinsam Lake

Table 4A Physical and Chemical
Table 4B Dissolved Metals
Table 4C Total Metals

c) Station 2 - Flume Creek u/s Argonaut Road

Table 5A Physical and Chemical
Table 5B Dissolved Metals
Table 5C Total Metals

d) Station 8 - Quinsam River u/s Iron River

Table 6A Physical and Chemical
Table 6B Dissolved Metals
Table 6C Total Metals

4.3 Effluent Quality

a) 2N Pit Water

Table 7A	Physical and Chemical
Table 7B	Dissolved Metals
Table 7C	Total Metals

b) Settling Pond 4 - Inflow

Table 8A	Physical and Chemical
Table 8B	Dissolved Metals
Table 8C	Total Metals

c) Settling Pond 4 - Outflow

Table 9A	Physical and Chemical
Table 9B	Dissolved Metals
Table 9C	Total Metals

d) Settling Pond 4 - Middle Quinsam Lake Road Culvert

Table 10A	Physcial and Chemical
Table 10B	Dissolved Metals
Table 10C	Total Metals

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

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

TABLE 3 RECEIVING WATER QUALITY STATION 1 (QUINSAM RIVER U/S MIDDLE QUINSAM LAKE)

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO mg/l	pH rel u	COND uS/cm	ACID mg/l	ALK mg/l	SO4 mg/l	FR mg/l	NFR mg/l	TR mg/l	TURB JTU	HARD mg/l	Si mg/l	TDP mg/l	TP mg/l	NO3 mg/l	NO2 mg/l	NH3 mg/l
87/12/11				6.9	34	2.1	13.5	3.0	32	6.7	38.7	.20		2.5	.002	.009	.052	<.005	.021
88/01/12	.46	3.1	12.3	7.6	42	2.1	17.8	2.7	35	<5.0	35	.23	20	1.6	<.002	.005	.047	<.005	.010
88/02/16				6.8	33	5.0	13.5	2.0	35	<5.0	35		13.7	2.2	<.002	.011	.017	<.005	<.005
88/02/29				7.3	42	1.3	18.1	<1.0	29	<5.0	29	.20	19.8	1.7		.011	.040	<.005	<.005
88/03/08	.45	3.9	12.1	7.6	43	1.5	18.0	3.0	33	<5.0	33	.13	19	1.9	.003	.006	.047	<.005	<.005
MEAN	**.46**	**3.5**	**12.2**	**7.2**	**38.8**	**2.4**	**16.2**	**2.3**	**32.8**	**5.3**	**34.1**	**.19**	**18.1**	**2.0**	**.002**	**.008**	**.041**	<.005	**.009**
STD DEV	**.01**	**.6**	**.1**	**.4**	**4.9**	**1.5**	**2.4**	**.9**	**2.5**	**.8**	**3.5**	**.04**	**3.0**	**.4**	**.001**	**.003**	**.014**	**0**	**.007**

B DISSOLVED METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
87/12/11																			
88/01/12	.025	<.05	<.001	<.001	.0001	<.005	<.005	<.0005	<.005	<.001	<.005	<.0005	<.010	.011	<.002	<.002	6.7	.7	.7
88/02/16	<.050	<.05	<.001	.003	.0005	<.005	<.005	<.0005	.017	.002	<.005	<.0005	.013	.011	<.002	<.002	4.4	.6	1
88/02/29	.030	.06	<.001	<.001	.0001	<.005	<.005	.0030	.008	.002	<.005	<.0005	.017	.012	<.002	<.002	6.6	.7	.6
88/03/08	.030	<.05	<.001	<.001	.0001	.006	<.005	<.0005	.009	<.001	<.005	<.0005	.010	.011	<.002	<.002	6.4	.7	.7
MEAN	**.034**	**.05**	**<.001**	**.002**	**.0002**	**.005**	**<.005**	**.0011**	**.010**	**.002**	**<.005**	**<.0005**	**.013**	**.011**	**<.002**	**<.002**	**6.0**	**.7**	**.8**
STD DEV	**.011**	**.01**	**0**	**.001**	**.0002**	**.001**	**0**	**.0013**	**.005**	**.001**	**0**	**0**	**.003**	**.001**	**0**	**0**	**1.1**	**.1**	**.1**

C TOTAL METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
87/12/11	.075	<.05	.022	.004	.0005	.005	.015	.0016	.092	.008	.008	.0006	<.010	.013	.003	<.002	4.6	.8	1.1
88/01/12	.062	<.05	.008	.001	.0001	<.005	.021	.0009	.029	.007	.007	.0006	.037	.012	<.002	<.002	6.4	.8	.8
88/02/16	.067	.09	.018	.004	.0005	<.005	<.005	<.0005	.038	.002	<.005	.0019	<.010	.012	.002	<.002	4.7	.7	1
88/02/29	.125	.06	.002	.002	.0001	.009	<.005	.0022	.084	.003	.011	<.0005	<.010	.012	.003	.002	6.5	.7	.8
88/03/08	.040	<.05	.010	.001	.0001	.006	.005	<.0005	.022	<.001	<.005	<.0005	.028	.011	.004	.002	6.5	.8	.7
MEAN	**.074**	**.06**	**.013**	**.002**	**.0003**	**.006**	**.010**	**.0011**	**.053**	**.004**	**.007**	**.0008**	**.019**	**.012**	**.003**	**.002**	**5.7**	**.8**	**.9**
STD DEV	**.031**	**.02**	**.009**	**.001**	**.0002**	**.002**	**.007**	**.0007**	**.033**	**.003**	**.002**	**.0006**	**.013**	**.001**	**.001**	**0**	**1.0**	**.1**	**.2**

TABLE 5 RECEIVING WATER QUALITY STATION 2 (FLUME CREEK U/S ARGONAUT ROAD)

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO mg/l	pH rel u.	COND uS/cm	ACID mg/l	ALK mg/l	SO4 mg/l	FR mg/l	NFR mg/l	TR mg/l	TURB JTU	HARD mg/l	Si mg/l	TDP mg/l	TP mg/l	NO3 mg/l	NO2 mg/l	NH3 mg/l
88/01/12		2.2	10.3	7.0	44.0	4.3	15.1	2.3	33	<5	33	.27	15.5	2.1	.002	.005	.035	<.005	<.005
88/02/29				6.9	35.7	1.9	15.0	<1.0	28	<5	28	.20	15.3	1.8		.008	.016	<.005	<.005
MEAN		**2.2**	**10.3**	**7.0**	**39.9**	**3.1**	**15.1**	**1.7**	**30.5**	**<5**	**30.5**	**.24**	**15.4**	**2.0**	**.002**	**.007**	**.026**	**<.005**	**<.005**
STD DEV				**.1**	**5.9**	**1.7**	**.1**	**.9**	**3.5**	**0**	**3.5**	**.05**	**.1**	**.2**		**.002**	**.013**	**0**	**0**

B DISSOLVED METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
88/01/12	.034	<.05	.204	.003	<.0001	<.005	<.005	.0007	.028	.002	<.005	<.0005	.023	.012	<.002	<.002	4.9	.7	1.1
88/02/29	.030	.06	.016	.004	<.0001	<.005	<.005	.0019	.038	.003	<.005	<.0005	<.010	.013	<.002	<.002	5.0	.7	1.1
MEAN	**.032**	**.06**	**.110**	**.004**	**<.0001**	**<.005**	**<.005**	**.0013**	**.033**	**.003**	**<.005**	**<.0005**	**.017**	**.013**	**<.002**	**<.002**	**5.0**	**.7**	**1.1**
STD DEV	**.003**	**.01**	**.133**	**.001**	**0**	**0**	**0**	**.0008**	**.007**	**.001**	**0**	**0**	**.009**	**.001**	**0**	**0**	**.1**	**0**	**.0**

C TOTAL METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
88/01/12	.057	<.05	<.001	.004	<.0001	<.005	<.005	.0007	.060	.002	<.005	.0008	.017	.013	<.002	<.002	4.7	.7	1.2
88/02/29	.153	<.05	<.001	.004	.0001	.020	<.005	.0006	.101	.004	.012	<.0005	<.010	.013	.003	.003	4.9	.6	1.0
MEAN	**.105**	**.05**	**<.001**	**.004**	**<.0001**	**.013**	**<.005**	**.0007**	**.081**	**.003**	**.009**	**.0007**	**.014**	**.013**	**.003**	**.003**	**4.8**	**.7**	**1.1**
STD DEV	**.068**	**0**	**0**	**0**	**0**	**.011**	**0**	**.0001**	**.029**	**.001**	**.005**	**.0002**	**.005**	**0**	**.001**	**.001**	**.1**	**.1**	**.1**

TABLE 6 RECEIVING WATER QUALITY STATION 8 (QUINSAM RIVER U/S IRON RIVER)

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO mg/l	pH rel u.	COND uS/cm	ACID mg/l	ALK mg/l	SO4 mg/l	FR mg/l	NFR mg/l	TR mg/l	TURB JTU	HARD mg/l	Si mg/l	TDP mg/l	TP mg/l	NO3 mg/l	NO2 mg/l	NH3 mg/l
88/03/08		4.4	12.1	7.7	41	1.5	13.0	3.0	38	<5	38	.17	14.7	2.5	.005	.006	.074	<.005	.008

B DISSOLVED METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
88/03/08	.043	<.05	.058	<.002	<.0001	<.005	<.005	<.0005	.035	.003	.005	<.0005	.013	.012	<.002	<.002	4.6	.7	1.2

C TOTAL METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
88/03/08	.063	.06	.030	.002	<.0001	<.005	.005	<.0005	.065	.005	<.005	.0007	<.010	.013	<.002	.003	4.6	.8	1.2

TABLE 4 RECEIVING WATER QUALITY STATION 5 (QUINSAM RIVER D/S MIDDLE QUINSAM LAKE)

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO mg/l	pH rel u.	COND uS/cm	ACID mg/l	ALK mg/l	SO4 mg/l	FR mg/l	NFR mg/l	TR mg/l	TURB JTU	HARD mg/l	Si mg/l	TDP mg/l	TP mg/l	NO3 mg/l	NO2 mg/l	NH3 mg/l
87/12/11				7.1	36	2.4	14.0	3	34	5.7	39.7	.37		2.1	.004	.003	.077	<.005	.030
88/01/12	.85	3.2	11.8	7.6	47	2.5	15.3	3	40	<5	40	.33	16.5	2.2	.003	.007	.100	<.005	.013
88/02/16				7.0	33.7	3.4	12.8	2.3	30	<5	30		14.2	2.3	<.002	.009	.078	<.005	<.005
88/02/29				7.0	35	1.5	14.8	<1	28	<5	28	.30	15.2	2.2		.007	.061	<.005	.006
88/03/08	1.56	4.4	11.6	7.3	40	1.5	13	3	36	<5	36	.20	14.2	2.5	.005	.007	.073	<.005	.007
MEAN	**1.21**	**3.8**	**11.7**	**7.2**	**38.3**	**2.3**	**14.0**	**2.5**	**33.6**	**5.1**	**34.7**	**.30**	**15.0**	**2.3**	**.004**	**.007**	**.078**	**<.005**	**.012**
STD DEV	**.50**	**.8**	**.1**	**.3**	**5.4**	**.8**	**1.1**	**.9**	**4.8**	**.3**	**5.5**	**.07**	**1.1**	**.2**	**.001**	**.002**	**.014**	**0**	**.010**

B DISSOLVED METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
87/12/11																			
88/01/12	.045	<.05	<.001	.002	<.0001	<.005	<.005	.0011	.040	.004	<.005	<.0005	<.010	.013	<.002	<.002	5.2	.8	1.2
88/02/16	.050	.05	<.001	.001	<.0005	<.005	<.005	<.0005	.026	.003	<.005	.0005	<.010	.011	<.002	.003	4.5	.7	1.1
88/02/29	.040	.05	<.001	.002	<.0001	<.005	<.005	.0026	.031	.008	.006	.0007	<.010	.012	<.002	<.002	4.8	.7	1.3
88/03/08	.050	.06	<.001	.002	<.0001	<.005	<.005	<.0005	.036	.010	<.005	<.0005	.017	.013	<.002	<.002	4.4	.7	1.1
MEAN	**.046**	**.05**	**<.001**	**.002**	**<.0002**	**<.005**	**<.005**	**.0012**	**.033**	**.006**	**.005**	**.0006**	**.012**	**.012**	**<.002**	**<.002**	**4.7**	**.7**	**1.2**
STD DEV	**.005**	**.01**	**0**	**.001**	**.0002**	**0**	**0**	**.0010**	**.006**	**.003**	**.001**	**.0001**	**.004**	**.001**	**0**	**.001**	**.4**	**.0**	**.1**

C TOTAL METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
87/12/11	.055	.05	.050	.002	<.0005	<.005	.007	.0016	.111	.010	<.005	.0008	<.010	.013	<.002	<.002	4.7	.8	1.2
88/01/12	.087	<.05	.020	.002	<.0001	.006	<.005	.0008	.097	.005	<.005	.0008	<.010	.013	.003	<.002	5.2	.8	1.1
88/02/16	.093	<.05	.019	.002	<.0005	<.005	<.005	.0012	.068	.005	.011	.0006	<.010	.011	.003	<.002	4.5	.7	1.0
88/02/29	.095	<.05	.032	.002	.0004	.012	<.005	.0011	.097	.006	.015	<.0005	<.010	.011	.004	.003	4.8	.7	1.2
88/03/08	.083	<.05	.019	.002	<.0001	<.005	.006	.0006	.067	.011	<.005	.0007	<.010	.012	<.002	<.002	4.5	.8	1.3
MEAN	**.083**	**<.05**	**.028**	**.002**	**.0003**	**.007**	**.006**	**.0011**	**.088**	**.007**	**.008**	**.0007**	**<.010**	**.012**	**.003**	**.002**	**4.7**	**.8**	**1.1**
STD DEV	**.016**	**0**	**.013**	**0**	**.0002**	**.003**	**.001**	**.0004**	**.020**	**.003**	**.005**	**.0001**	**0**	**.001**	**.001**	**.000**	**.3**	**.1**	**.1**

TABLE 7 EFFLUENT QUALITY 2N PIT WATER

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO mg/l	pH rel u	COND uS/cm	ACID mg/l	ALK mg/l	SO4 mg/l	FR mg/l	NFR mg/l	TR mg/l	TURB JTU	HARD mg/l	Si mg/l	TDP mg/l	TP mg/l	NO3 mg/l	NO2 mg/l	NH3 mg/l
87/12/11																			
88/01/12		2.8	8.2	7.8	342	3.4	78.8	69	283	500	783	546	111	2.3	.009	.270	5.54	.84	2.62
88/02/16																			
88/02/29				8.1	530	1.3	163	110	360	390	750	180	72.7	3.5		.280	.92	.14	.41
88/03/08		5.8	9.7	7.6	1080	4.5	121	370	771	23	994	4.30	222	2.9	.006	.022	2.25	.62	.60
MEAN		**4.3**	**9.0**	**7.8**	**651**	**3.1**	**121**	**183**	**471**	**304**	**842**	**243**	**135**	**2.9**	**.008**	**.191**	**2.90**	**.53**	**1.21**
STD DEV		**2.1**	**1.1**	**.3**	**384**	**1.6**	**42**	**163**	**262**	**250**	**132**	**276**	**78**	**.6**	**.002**	**.146**	**2.38**	**.36**	**1.23**

B DISSOLVED METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
87/12/11																			
88/01/12	.201	<.05	.078	.034	<.0001	<.005	<.005	.0010	.056	.063	.098	<.0005	.043	.284	.007	<.002	38.3	3.5	26.2
88/02/16																			
88/02/29	.140	.08	.454	.044	<.0001	.006	<.005	.0038	.106	.034	.014	.0018	.030	.300	<.002	.023	25.8	1.8	90.4
88/03/08	.070	.06	.293	.066	<.0001	<.005	<.005	.0023	<.005	.352	.023	<.0005	.020	.799	<.002	.006	78.1	6.2	116
MEAN	**.137**	**.06**	**.275**	**.048**	**<.0001**	**.005**	**<.005**	**.0024**	**.056**	**.150**	**.045**	**.0009**	**.031**	**.461**	**.004**	**.010**	**47.4**	**3.8**	**77.5**
STD DEV	**.066**	**.02**	**.189**	**.016**	**0**	**.001**	**0**	**.0014**	**.051**	**.176**	**.046**	**.0008**	**.012**	**.293**	**.003**	**.011**	**27.3**	**2.2**	**46.3**

C TOTAL METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
87/12/11																			
88/01/12	25	.21	.155	.135	.0001	.587	.029	.0580	17.5	.317	.109	<.0005	<.010	.349	1.04	.029	46.1	8.3	26.7
88/02/16																			
88/02/29	16	.10	.531	.096	.0016	.485	.040	.0380	15.5	.205	.012	<.0005	<.010	.346	.329	.028	32.8	5.1	92.5
88/03/08	.380	<.05	.288	.064	.0009	<.005	<.005	.0039	.78	.352	.032	<.0005	<.010	.754	.002	.011	73.2	6.3	115
MEAN	**13.8**	**.12**	**.325**	**.098**	**.0009**	**.359**	**.025**	**.0333**	**11.3**	**.291**	**.051**	**<.0005**	**<.010**	**.483**	**.455**	**.023**	**51.4**	**6.6**	**78.1**
STD DEV	**12.5**	**.08**	**.191**	**.036**	**.0008**	**.311**	**.018**	**.0274**	**9.13**	**.077**	**.051**	**0**	**0**	**.235**	**.528**	**.010**	**20.4**	**1.6**	**45.9**

TABLE 8 EFFLUENT QUALITY SETTLING POND 4 - INFLOW

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO mg/l	pH rel u	COND uS/cm	ACID mg/l	ALK mg/l	SO4 mg/l	FR mg/l	NFR mg/l	TR mg/l	TURB JTU	HARD mg/l	Si mg/l	TDP mg/l	TP mg/l	NO3 mg/l	NO2 mg/l	NH3 mg/l
87/12/11				7.4	195	4.1	51.8	19	140	330	470	230				.174	3.99	.108	.611
88/01/12		.2	9.6	6.6	195	18.8	34.4	37	141	41	182	24	30.2	3.0	.006	.036	4.62	.25	.42
88/02/16				7.3	680	10.1	105	190	88	12	100		141	2.7	<.002	.115	6.29	.48	1.14
88/02/29				7.6	375	1	89.5	50	242	25	267	23	89.7	3.9		.030	1.39	.14	3.17
88/03/08		4.7	8.3	7.4	772	10.7	70.5	240	479	<5	479	6.30	169	3.3	.008	.054	1.62	.29	.34
MEAN		**2.5**	**9.0**	**7.3**	**443**	**8.9**	**70.2**	**107**	**218**	**82.6**	**300**	**70.8**	**107**	**3.2**	**.006**	**.082**	**3.58**	**.254**	**1.14**
STD DEV		**3.2**	**.9**	**.4**	**270**	**6.9**	**28.3**	**101**	**156**	**139**	**170**	**106**	**61.1**	**.5**	**.003**	**.062**	**2.08**	**.149**	**1.18**

B DISSOLVED METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
87/12/11																			
88/01/12	.082	<.05	.041	.011	<.0001	.005	<.005	<.0005	.058	.039	.009	<.0005	.023	.066	.003	<.002	8.5	2.0	30.5
88/02/16	<.050	<.05	.339	.054	<.0005	<.005	<.005	.0014	.072	.304	.008	<.0005	<.010	.503	<.002	.003	48.6	4.4	85.3
88/02/29	.140	<.05	.165	.027	<.0001	<.005	<.005	.0030	.074	.212	.015	.0008	.010	.283	<.002	.021	29.4	3.6	57.2
88/03/08	.030	<.05	.174	.053	<.0001	<.005	<.005	.0017	.106	.351	.012	<.0005	.020	.586	<.002	.002	57.6	5.8	76.3
MEAN	**.076**	**<.05**	**.180**	**.036**	**.0002**	**<.005**	**<.005**	**.0017**	**.078**	**.227**	**.011**	**.0006**	**.016**	**.360**	**.002**	**.007**	**36.0**	**4.0**	**62.3**
STD DEV	**.048**	**0**	**.122**	**.021**	**.0002**	**0**	**0**	**.0010**	**.020**	**.138**	**.003**	**.0002**	**.007**	**.234**	**.001**	**.009**	**21.8**	**1.6**	**24.2**

C TOTAL METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
87/12/11																			
88/01/12	2.52	<.05	.094	.020	.0001	.006	.005	.0760	1.94	.058	.008	.0010	<.010	.072	.153	.005	9.5	2.3	25.8
88/02/16	2.08	.09	.294	.063	<.0005	<.005	<.005	.0079	2.68	.331	<.005	.0010	<.010	.526	.009	<.002	50.6	5.50	89.9
88/02/29	2.06	<.05	.227	.034	.0015	.051	.006	.0082	1.83	.227	.012	<.0005	<.010	.286	.099	.017	29.3	3.9	56.3
88/03/08	.350	<.05	.197	.057	.0008	<.005	<.005	.0028	.548	.354	.016	<.0005	<.010	.604	.009	.005	57.2	6.3	85.5
MEAN	**1.75**	**.06**	**.203**	**.044**	**.0007**	**.017**	**.005**	**.0242**	**1.75**	**.243**	**.010**	**.0008**	**<.010**	**.372**	**.068**	**.007**	**36.6**	**4.5**	**64.4**
STD DEV	**.959**	**.02**	**.083**	**.020**	**.0006**	**.023**	**.001**	**.0359**	**.885**	**.135**	**.005**	**.0003**	**0**	**.241**	**.071**	**.007**	**21.7**	**1.8**	**29.7**

TABLE 9 EFFLUENT QUALITY SETTLING POND 4 - OUTFLOW

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO mg/l	pH rel u	COND uS/cm	ACID mg/l	ALK mg/l	SO4 mg/l	FR mg/l	NFR mg/l	TR mg/l	TURB JTU	HARD mg/l	Si mg/l	TDP mg/l	TP mg/l	NO3 mg/l	NO2 mg/l	NH3 mg/l
87/12/11				6.7	69	5.1	14.3	9	65.7	63.3	129	67	27.3	4.0	.007	.069	2.01	.030	.080
88/01/12		2.1	9.3	6.5	76	12.3	18.3	10	73	5.0	78	6.1	23.5	3.6	.010	.019	1.60	.033	.028
88/02/16				6.6	120	10.5	22.0	26	87.7	12.3	100		29.2	2.9	<.002	.023	1.05	.100	.054
88/02/29				6.3	60	3.1	13.8	11	53	<5.0	53	1.8	15.7	2.5		.017	.308	.006	.016
88/03/08		5.2	10.1	6.7	148	8.5	28.5	30	111	9	120	8.8	37.3	3.3	.010	.021	.527	.042	.012
MEAN		**3.7**	**9.7**	**6.6**	**95**	**7.9**	**19.4**	**17**	**78.1**	**18.9**	**96**	**20.9**	**27**	**3.3**	**.007**	**.030**	**1.10**	**.042**	**.038**
STD DEV		**2.2**	**.5**	**.2**	**38**	**3.8**	**6.1**	**10**	**22**	**25**	**31**	**31**	**7.9**	**.6**	**.004**	**.022**	**.713**	**.035**	**.029**

B DISSOLVED METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
87/12/11	1.087	<.05	.023	.006	.0001	.006	<.005	.0028	.703	.035	.007	<.0005	.057	.040	.058	.010	5.6	1.4	4.8
88/01/12	.112	<.05	.007	.004	<.0001	<.005	<.005	.0011	.100	.050	<.005	<.0005	<.010	.036	.003	.028	6.5	1.5	6.4
88/02/16	.060	<.05	.143	.006	<.0001	.007	<.005	.0008	.224	.097	<.005	<.0005	<.010	.055	<.002	.016	8.5	1.7	11.9
88/02/29	.120	<.05	.011	.004	<.0001	<.005	<.005	.0015	.125	.061	.008	.0017	.020	.028	<.002	.016	4.4	1.0	6.1
88/03/08	.080	<.05	<.001	.009	<.0001	<.005	<.005	.0011	.960	.272	<.005	<.0005	<.010	.067	<.002	.015	10.5	2.1	14.0
MEAN	**.292**	**<.05**	**.037**	**.006**	**<.0001**	**.006**	**<.005**	**.0015**	**.422**	**.103**	**.006**	**.0007**	**.021**	**.045**	**.013**	**.017**	**7.1**	**1.5**	**8.6**
STD DEV	**.445**	**0**	**.060**	**.002**	**0**	**.001**	**0**	**.0008**	**.387**	**.097**	**.001**	**.0005**	**.020**	**.016**	**.025**	**.007**	**2.4**	**.4**	**4.0**

C TOTAL METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
87/12/11	6.21	.06	.023	.019	.0008	.017	.014	.0730	5.33	.073	<.005	.0008	<.010	.045	.210	.017	6.2	2.4	5.4
88/01/12	.920	<.05	.016	.006	<.0001	<.005	<.005	.0026	.596	.052	<.005	.0008	.017	.033	.047	.035	6.4	1.7	6.4
88/02/16	.095	<.05	.039	.008	<.0005	<.005	<.005	.0290	1.09	.104	.008	.0015	.013	.056	.041	.017	8.7	2.0	11.7
88/02/29	.240	<.05	<.001	.005	.0013	.020	<.005	.0019	.306	.060	.018	<.0005	<.010	.027	.011	.005	4.3	.9	5.8
88/03/08	.610	<.05	.015	.010	<.0001	<.005	<.005	.0019	1.83	.269	.006	<.0005	<.010	.067	.022	.021	10.2	2.3	14.7
MEAN	**1.62**	**.05**	**.019**	**.010**	**.0006**	**.010**	**.007**	**.0217**	**1.83**	**.112**	**.008**	**.0008**	**.012**	**.047**	**.066**	**.019**	**7.2**	**1.8**	**8.8**
STD DEV	**2.589**	**.00**	**.014**	**.006**	**.0005**	**.007**	**.004**	**.0310**	**2.04**	**.090**	**.006**	**.0004**	**.003**	**.016**	**.082**	**.011**	**2.3**	**.6**	**4.2**

TABLE 10 EFFLUENT QUALITY SETTLING POND 4 - MIDDLE QUINSAM LAKE ROAD CULVERT

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO mg/l	pH rel u	COND uS/cm	ACID mg/l	ALK mg/l	SO4 mg/l	FR mg/l	NFR mg/l	TR mg/l	TURB JTU	HARD mg/l	Si mg/l	TDP mg/l	TP mg/l	NO3 mg/l	NO2 mg/l	NH3 mg/l
87/12/11				6.8	44	3.5	10.3	7	53	5.3	58.3	13	16.7	3.4	.011	.018	1.05	<.005	.018
88/01/12		.1		6.8	44	4.0	11.1	6.3	54	5.3	59.3	1.2	15.7	3.7	.006	.020	.684	<.005	.011
88/02/16				6.9	60	3.4	12.7	11.7	52	<5.0	52		17.0	3.4	<.002	.012	.433	<.005	<.005
88/02/29				6.8	70	1.8	11.5	14	56	<5.0	61	.2	19.7	3.6		.009	.396	<.005	.006
88/03/08		3.9	11.8	7.1	78	3.6	15.0	17	64	<5.0	64	.6	19.2	3.2	.007	.009	.228	<.005	<.005
MEAN		**2**	**11.8**	**6.9**	**59**	**3.3**	**12.1**	**11**	**56**	**5.1**	**59**	**3.8**	**17.7**	**3.5**	**.007**	**.014**	**.56**	**<.005**	**.009**
STD DEV		**2.7**		**.1**	**15**	**.8**	**1.8**	**5**	**5**	**0**	**4**	**6**	**1.7**	**.2**	**.004**	**.005**	**.320**	**0**	**.006**

B DISSOLVED METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
87/12/11	.453	.07	.010	.003	<.0001	.006	<.005	.0025	.301	.003	.007	<.0005	.037	.017	.002	.006	3.53	1.2	2.9
88/01/12	.125	<.05	.014	.002	<.0001	<.005	<.005	.0009	.045	<.001	.005	<.0005	<.01	.017	<.002	<.002	4.0	1.2	3.2
88/02/16	.103	.08	<.001	.002	<.0005	<.005	<.005	<.0005	.052	<.001	<.005	.0005	<.010	.021	<.002	.009	4.5	1.2	5.2
88/02/29	.180	<.05	.007	.003	<.0001	<.005	<.005	<.0005	.019	.003	<.005	.0013	.040	.024	<.002	<.002	5.3	1.5	6.7
88/03/08	.080	<.05	<.001	.003	<.0001	<.005	<.005	.0005	.307	.001	.006	.0005	<.010	.024	<.002	.002	5.1	1.4	7.0
MEAN	**.188**	**.06**	**.007**	**.003**	**<.0002**	**.005**	**<.005**	**.0010**	**.145**	**.002**	**.006**	**.0007**	**.021**	**.021**	**<.002**	**.004**	**4.5**	**1.3**	**5.0**
STD DEV	**.153**	**.01**	**.006**	**.001**	**.0002**	**.000**	**0**	**.0009**	**.146**	**.001**	**.001**	**.0004**	**.016**	**.004**	**0**	**.003**	**.7**	**.1**	**1.9**

C TOTAL METALS

DATE	Al mg/l	As mg/l	B mg/l	Ba mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Mo mg/l	Pb mg/l	Sn mg/l	Sr mg/l	Ti mg/l	Zn mg/l	Ca mg/l	Mg mg/l	Na mg/l
87/12/11	1.17	<.05	<.001	.005	<.0001	.006	<.005	.0270	.979	.009	.005	<.0005	<.010	.018	.046	<.002	3.7	1.3	3.1
88/01/12	.217	<.05	<.001	.002	<.0001	<.005	<.005	.0012	.086	.002	<.005	.0006	.013	.018	.003	.004	4.0	1.2	3.0
88/02/16	.167	.10	<.001	.002	<.0005	<.005	<.005	.0018	.123	.002	.009	.0008	<.010	.020	.007	<.002	4.4	1.3	5.3
88/02/29	.130	<.05	<.001	.003	.0014	.009	<.005	.0007	.042	.002	.012	<.0005	<.010	.022	.002	<.002	4.8	1.5	6.2
88/03/08	.180	<.05	.015	.003	.0001	<.005	<.005	.0006	.341	<.001	.011	<.0005	<.010	.024	.002	<.002	5.1	1.5	7.8
MEAN	**.38**	**.06**	**.004**	**.003**	**.0004**	**.006**	**<.005**	**.0063**	**.31**	**.003**	**.008**	**.0006**	**.011**	**.020**	**.012**	**.002**	**4.4**	**1.4**	**5.1**
STD DEV	**.445**	**.02**	**.006**	**.001**	**.0006**	**.002**	**0**	**.0116**	**.39**	**.003**	**.003**	**.0001**	**.001**	**.003**	**.019**	**.001**	**.6**	**.1**	**2.1**

5. DISCUSSION

5.1 Comparison of EP Effluent and Receiving Water Quality Data (December 1987 to March 1988)

A comparison of seventeen parameters representing QCC permit requirements and Federal concerns were expressed to the provincial Commission of Inquiry in 1983. These were 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.

Because standard deviations are large relative to mean values of many parameters and the number of samples is small, comparisons were made between parameter means (Table 11). A difference of twice the mean control (station 1) value for each parameter was chosen to define a "significant" change in the parameter. Comparisons were made between sample means if the number of samples in each data set were similar.

To compute means and standard deviation, all values less than the detection limits were assumed to equal the detection limit. As a result, the increases in effluent will be under-estimated when control values are lower than the detection limit. Statistical tests were not performed on the data sets for the reasons outlined above.

In the settling pond outflow most parameters, 13 of 17, were elevated, i.e. greater than twice the control value - station 1. The increases varied from 2.4X to 110X. pH was 0.5 rel. u. lower in the effluent. Only alkalinity, hardness, dissolved Cu and Ph were wimilar in the control and effluent (less than a two-fold increase).

In comparison, at the Middle Quinsam Lake Road culvert, only 6 of the 17 parameters (sulphate, turbidity, total dissolved phosphorus, nitrate, dissolved Al and Fe) were greater than twice the control values at station 1. The values are considerably lower than Settling Pond 4 outflow and varied from 3.5X to 20X the control values. pH was only 0.3 rel. u. lower in the effluent stream. Hardness, non filterable residues, nitrite, ammonia and dissolved Cu were the same at both stations. Alkalinity was slightly lower in the effluent stream than in the control (0.8X). The remaining parameters were less than double the control values at station 1.

Receiving water quality at station 5 was very similar to control station 1, only total dissolved phosphorus and dissolved Fe were elevated, 2X and 3.3X respectively. pH, conductivity, non filterable residue, nitrate, dissolved Cu and Zn were identical at both stations. Alkalinity, hardness and total phosphorus were slightly lower in the receiving water while the remainder of the parameters were less than double the control values.

Water quality at station 8 appears similar to the control station and identical to station 5. However, these results should be viewed with caution as it was sampled only once.

5.2 Comparison of EP Monitoring Data (December 87 to March 88) to QCC Baseline Data (82 - 84)

Data collected in the winter (December - March) by EP and QCC was compared in order to verify that there were no other factors influencing the receiving water quality subsequent to QCC's collection of baseline data (Table 12). As in Section 5.1 the same parameters were compared using the same criteria, i.e. less than a two-fold to change between sample dates to determine a significant change between dates sampled.

EP monitoring and QCC baseline data are very similar at control stations 1 and 2 and receiving water stations, station 5 and station 8. Only 2 of the 17 parameters are significantly different at station 1. The parameters are nitrate and dissolved Fe, EP monitoring data for nitrate and dissolved Fe are 3X and 1/3X respectively the QCC baseline data. At control station 2 the comparisons are limited by small data sets (n=2), however, only 3 parameter means are significantly different. The EP results for nitrate are 5X those of QCC, while the QCC values for total dissolved phosphorus and ammonia are 2.5X and 4X those reported by EP.

Receiving water quality at station 5 is the most similar between EP and QCC. The only parameter to vary by more than 2X is nitrate, EP results are 6X those of QCC. Station 8 had the least similar data sets of the river stations, with dissolved Fe, sulphate and turbidity means being significantly different. There are two reasons for this difference; uneven and small data sets and sample stations are 2 to 3 km apart.

EP monitoring data and QCC baseline data were the least similar at Middle Quinsam Lake Road culvert. Eight parameters were significantly different, in all cases the EP results were higher. Nitrate, sulphate, conductivity, turbidity, non filterable residue, and dissolved Fe, Pb and Zn were 33X, 11X, 2.7X, 5.5X, 5X, 4.5X, 7X and 4X, respectively.

There are three possible explanations for the differences at the Middle Quinsam Lake Road culvert:

Uneven and small data sets,
Aerial fertilization of the surrounding forests, and
Mining activities

Differences in the size of data sets will randomly affect the results, therefore one would expect 50% of the parameters in either data set to be significantly different from the other data set. It is unlikely that one data set would have all the significantly larger values.

Aerial fertilization using a nitrogen base fertilizer increases nitrogen concentrations in the forest soils. Water flowing over the surface or through the surficial soils would absorb nitrogen compounds, eg. nitrate. This may explain the higher levels of nitrate at all stations in 87/88.

The most likely explanation for the increase is mining. Several activities associated with mining such as the use of explosives, land clearing and exposure of soils and unweathered minerals and rock will result in increased levels of the above mentioned parameters in the discharge from the settling pond.

TABLE 11 SELECTED EP EFFLUENT AND RECEIVING WATER QUALITY DATA
DECEMBER 87 - MARCH 88 (units in mg/l, except as noted)

AREA OF CONCERN	PARAMETER	STATION 1 (CONTROL) (n=5)	2 (n=2)	5 (n=5)	8 (n=1)	SP4-OUT (n=5)	SP4-MOLR (n=5)
ACID MINE DRAINAGE	pH (Rel.U.)	7.2	7.0	7.2	7.1	6.6	6.9
	Conductivity (uS/cm)	39	40	38	41	95	59
	Sulphate	2.3	1.7	2.5	3	17	11
	Alkalinity	16	15	14	13	19	12
	Hardness	18	15	15	15	27	18
HEAVY METALS	Dissolved Al	.034	.032	.046	.043	.292	.188
	Dissolved Cu	.0011	.0013	.0012	<0.0005	.0015	.0010
	Dissolved Fe	.010	.033	.033	.038	.422	.145
	Dissolved Pb	<0.0005	<0.0005	.0006	<0.0005	.0007	.0007
	Dissolved Zn	<0.002	<0.002	.002	<0.002	.017	.004
NUTRIENTS	Total Dissolved P	.002	.002	.004	.005	.007	.007
	Total P	.008	.007	.007	.006	.030	.014
	Nitrate	.041	.026	.078	.074	1.10	.560
	Nitrite	<0.005	<0.005	<0.005	<0.005	.042	<0.005
	Ammonia	.009	<0.005	.012	.008	.038	.009
SEDIMENTATION	Non Filt. Residue	5.3	<5.0	5.1	<5.0	18.9	5.1
	Turbidity (JTU)	.19	.24	.30	.17	20.9	3.8

TABLE 12 **SELECTED EP MONITORING DATA (DECEMBER 87 - MARCH 88) AND QCC BASELINE DATA (DECEMBER 82 - MARCH 83, DECEMBER 83 - MARCH 84)** (units in mg/l, except as noted)

AREA OF CONCERN	PARAMETER	STATION 1 (CONTROL) QCC	1 (CONTROL) EP	2 QCC	2 EP	5 QCC	5 EP	8 QCC	8 EP	SP4-MQLR QCC	SP4-MQLR EP
		(n=7)	(n=5)	(n=2)	(n=2)	(n=7)	(n=5)	(n=3)	(n=1)	(n=3)	(n=5)
ACID MINE DRAINAGE	pH (Rel.U.)	7.3	7.2	6.8	7.0	7.3	7.2	7.0	7.7	7.3	6.9
	Conductivity (uS/cm)	30	39	31	40	30	38	33	41	22	59
	Sulphate	1.8	2.3	<1.0	1.7	1.8	2.5	1.2	3.0	<1.0	11
	Alkalinity	22	16	24	15	22	14	24	13	19	12
	Hardness	15	18	18	15	15	15	18	15	11	18
HEAVY METALS	Dissolved Al	.034	.034	.047	.032	.034	.046	.044	.043	.103	.188
	Dissolved Cu	<.0008	.0011	<.001	.0013	<.0008	.0012	<.001	<.0005	<.0008	.0010
	Dissolved Fe	.030	.010	.029	.033	.030	.033	.108	.038	.032	.145
	Dissolved Pb	<.001	<.0005	<.001	<.0005	<.001	.0006	<.001	<.0005	<.001	.0007
	Dissolved Zn	.002	<.002	.002	<.002	.002	.002	.002	<.002	.001	.004
NUTRIENTS	Total Dissolved P	.004	.002	.005	.002	.004	.004	.003	.005	.005	.007
	Total P	.008	.008	.007	.007	.008	.007	.004	.006	.008	.014
	Nitrate	.013	.041	.005	.026	.013	.078	.049	.074	.017	.560
	Nitrite	<.001	<.005	<.001	<.005	<.001	<.005	<.001	<.005	<.001	<.005
	Ammonia	.008	.009	.023	<.005	.008	.012	.015	.008	.012	.009
SEDIMENTATION	Non Filt. Residue	<1.0	5.3	<1.0	<5.0	<1.0	5.1	1.1	<5.0	<1.0	5.1
	Turbidity (JTU)	.75	.19	<1.0	.24	.75	.30	1.30	.17	.70	3.80

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A

APPENDIX I

QUINSAM COAL CORPORATION - BASELINE DATA (82-84)

TABLE A1 QCC BASELINE DATA STATION 1 (QUINSAM RIVER U/S MIDDLE QUINSAM LAKE)

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO mg/l	pH rel u	COND uS/cm	ALK mg/l	HARD mg/l	SO4 mg/l	FR mg/l	NFR mg/l	TURB JTU	TDP mg/l	TP mg/l	NO3 mg/l	NO2 mg/l	NH3 mg/l
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 mg/l	Cu mg/l	Fe mg/l	Pb mg/l	Zn mg/l
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 mg/l	Cu mg/l	Fe mg/l	Pb mg/l	Zn mg/l
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**

TABLE A2 QCC BASELINE DATA STATION 5 (QUINSAM RIVER D/S MIDDLE QUINSAM LAKE)

A PHYSICAL & CHEMICAL

DATE	FLOW	TEMP	DO	pH	COND	ALK	HARD	SO4	FR	NFR	TURB	TDP	TP	NO3	NO2	NH3
	cms	deg C	mg/l	rel u	uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	JTU	mg/l	mg/l	mg/l	mg/l	mg/l
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
	mg/l	mg/l	mg/l	mg/l	mg/l
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
	mg/l	mg/l	mg/l	mg/l	mg/l
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

TABLE A3 QCC BASELINE DATA STATION 8 (QUINSAM RIVER U/S IRON RIVER)

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO mg/l	pH rel u	COND uS/cm	ALK mg/l	HARD mg/l	SO4 mg/l	FR mg/l	NFR mg/l	TURB JTU	TDP mg/l	TP mg/l	NO3 mg/l	NO2 mg/l	NH3 mg/l
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 mg/l	Cu mg/l	Fe mg/l	Pb mg/l	Zn mg/l
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 mg/l	Cu mg/l	Fe mg/l	Pb mg/l	Zn mg/l
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

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

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO mg/l	pH rel u	COND uS/cm	ALK mg/l	HARD mg/l	SO4 mg/l	FR mg/l	NFR mg/l	TURB JTU	TDP mg/l	TP mg/l	NO3 mg/l	NO2 mg/l	NH3 mg/l
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 mg/l	Cu mg/l	Fe mg/l	Pb mg/l	Zn mg/l
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 mg/l	Cu mg/l	Fe mg/l	Pb mg/l	Zn mg/l
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

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

A PHYSICAL & CHEMICAL

DATE	FLOW	TEMP	DO	pH	COND	ALK	HARD	SO4	FR	NFR	TURB	TDP	TP	NO3	NO2	NH3
	cms	deg C	mg/l	rel u	uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	JTU	mg/l	mg/l	mg/l	mg/l	mg/l
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
	mg/l	mg/l	mg/l	mg/l	mg/l
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
	mg/l	mg/l	mg/l	mg/l	mg/l
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