ENVIRONMENT CANADA
CONSERVATION AND PROTECTION
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PACIFIC AND YUKON REGION
NORTH VANCOUVER, B.C.

WESTMIN RESOURCES LTD.
PREMIER GOLD MINE
- September 12-15, 1989 -

REGIONAL DATA REPORT: DR 91-06

by

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1.0 INTRODUCTION

The Premier Gold Mine is located on the east side of the Cascade Creek Valley, about 1 km upstream from the B.C./Alaska border, in the Salmon River drainage system. The mine site is drained by Cooper Creek to the north and west, and Fletcher Creek to the south. The creeks join above the Granduc road and flow as Fletcher Creek into Cascade Creek immediately below the falls (Figure 1). The falls are an impassable barrier to salmon migration. Cascade Creek joins the Salmon River about 1.5 km downstream of the falls and supports chum, pink, coho, and sockeye salmon.

The company operates an open pit mine using cyanide leach to extract gold and silver. The tailings pond is located in the Cascade Creek valley bottom and the upper part of the Cascade Creek has been diverted into Lesley Creek. The tailings are discharged using the subaerial technique and the supernatant discharged to Cascade Creek above the falls.

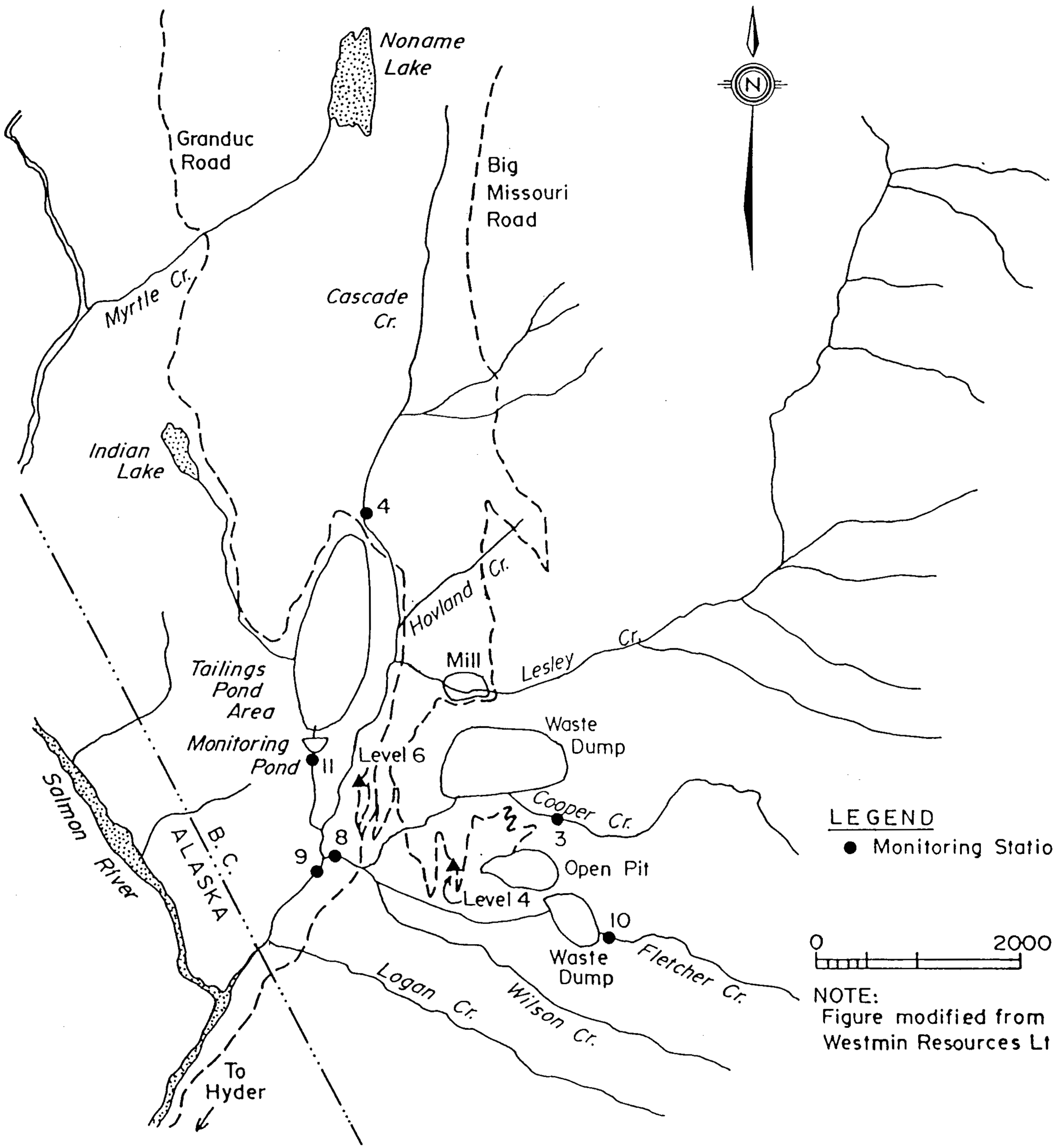


FIGURE 1: RECEIVING WATER SAMPLING STATIONS

2.0 SITE DESCRIPTION

Receiving water sampling stations were established both above and below potential influence of mining operations. Station names and location descriptions are listed below and compared with stations sampled in previous years (refer also to Figure 1).

PREMIER GOLD - STATION LOCATION - SURVEYS 1987 to 1989

Station name	Station number by year 87	88	89
Hovland Ck. u/s Mill	1	-	-
Lesley Ck. u/s Mill	2	2	-
Fletcher Ck. u/s Waste Dump	-	-	10
Cooper Ck. u/s Open Pit	3	3	3[1]
Cascade Ck. u/s Tailings Pond	4	4	4
Lesley Ck. d/s Mill	5	5	-
Hovland Ck.d/s Mill	6	-	-
Cooper Ck. u/s Fletcher Ck.	7	7	-
Fletcher Ck. d/s Granduc Rd.	8[2]	-	8
Monitoring Pond	-	-	11
Cascade Ck. d/s Tailings Pond	9	9	9
Cascade Ck. d/s Logan Ck.	-	-	-
Level 4 - Mine portal	-	-	Level 4
Level 6 - Mine portal	-	Level 6	Level 6

[1] Stations moved upstream due to the development of the waste rock dump
[2] Sample at the mouth in 1987; subsequently sampled below Granduc Road

3.0 MATERIAL AND METHODS

Water chemistry samples were collected at eight stations during a visit to the mine site September 12-15, 1989. The following chemical parameters were included in the analysis: alkalinity, pH, conductivity, ammonia, nitrite, nitrate, total residue, non-filterable residue, and sulphate. Samples were packed with ice until analysed. Dissolved metals were filtered the same day through a 0.45 micron cellulose nitrate membrane filter. Total and dissolved metals were preserved with 0.5 ml nitric acid per 100 ml of sample. All samples were collected with clean polyethylene bottles. Bottles for metal samples were acid washed. Hardness was determined from the dissolved metal sample. The cyanide species were collected in one litre polyethylene bottles and preserved with sodium hydroxide pellets. Total cyanides, weak acid dissociable cyanides, cyanates, and thiocyanates were also analysed.

Inductively Coupled Argon Plasma (ICAP) Emission Spectroscopy was used for the total and dissolved metal analysis and gave a reading of twenty-six metals. Samples were re-analysed for cadmium, copper, and lead with the graphite furnace when the values were below two times the detection limit of the ICAP procedure. Analytical methods were in accordance with the Environment Canada, Pacific Region, Environmental Laboratory Manual (Anon., 1979).

A Sirco model #MK-7 sampler was set to collect one sample every three hours from the monitoring pond effluent from September 12 to September 15, inclusive. Sodium hydroxide pellets were placed in the bottles before water samples were collected. These preserved samples were then analysed for cyanide species as described above.

Sediment samples were collected from the streambed with a clean acrylic corer; four replicates were taken at each site. The samples were transferred into kraft bags and kept cool until analysed. They were air dried, sieved to <150 μm, digested with reverse aqua regia, and analysed for heavy metals using ICAP. A portion of the sediments were ignited at 550°C in a muffle furnace. The loss of weight was noted as volatile residue and the remainder was reported as fixed residue. All results are reported as dry weight.

Sediment sequential extraction was performed at four stations (4, 8, 9, and 11) to evaluate the mobility of metal in the sediment component. The methodology was based on the work of Tessier et al. (1979). Samples were air dried, sieved to <63 μm, and rolled to homogenise. The samples were then weighed into 50 ml centrifuge tubes and subjected to a sequential leaching procedure designed to partition trace metals into the following fractions:

1) F(a): Exchangeable metals. The sediment sample is extracted with 1M $MgCl_2$ initially at pH 7 at room temperature for one hour on a wrist action shaker.
2) F(b): Metals bound to carbonates or specifically adsorbed. The residue from (a) is leached with 1M sodium acetate adjusted to pH 5 with acetic acid at room temperature for five hours on a wrist action shaker.
3) F(c): Metals bound to Fe-Mn oxides. The residue from (b) is extracted at 96°C for six hours with 0.04M $NH_4OH.HCl$ in 25% (vol/vol) acetic acid.
4) F(d): Metals bound to organic matter and sulphides. The residue from (c) is extracted at 85°C for five hours with 0.02M HNO_3 and 30% H_2O_2 adjusted to pH 2 with HNO_3 and then at room temperature with 3.2M NH_4OAc in 20% (vol/vol) HNO_3, on a wrist action shaker.
5) F(e): Residual metals. The original dried samples were weighed in Teflon digestion vessels and digested with HNO_3 and HCl in a microwave oven, resulting in a total fraction (MT). The residual F(e) was calculated as: F(e) = MT - [F(a) + F(b) + F(c) + F(d)].

Analysis was performed via Inductively Coupled Argon Plasma (ICAP) Emission Spectroscopy. The internal laboratory reference material TATS-1 was used for this test to evaluate the performance of the procedure.

Statistical analysis consisted of determining averages and standard deviations for the water quality data. One-way analysis of variance was performed on selected sediment data. Multiple comparison procedures using Tukey's harmonic significant differences were used to produce the various plots (Figures 2-4) and a significant difference was determined when the alpha probability was lower than 5% ($p < 0.05$). Contaminants with values below the detection limit were considered equal to the detection limit. The standard deviation for cadmium at Stations 3 and 10 was equal to zero. A slight variability was arbitrarily introduced so that Tukey's separation procedure would work. This modification does not introduce appreciable changes in the outcome (Atkinson, pers. comm.).

4.0 RESULTS

4.1 Water Quality Analysis

The water metal results can be found in Table 1, while the other water quality results are found in Table 2. Alkalinity in the receiving water was low with a range of 11.9 to 38.9 mg/L. pH was slightly alkaline with the exception of Station 9 where pH was 6.5. Interestingly, the pH readings from laboratory measurements were much more variable than expected (Table 2).

Nitrogen compounds were low for all stations except Stations 9 and 11 where the monitoring pond effluent introduced high levels of nitrogen. The cyanide levels were high with almost similar levels of total and weak acid dissociable cyanides. The thiocyanate in the effluent at Station 11 was not detected downstream at Station 9 perhaps indicating that a transformation from thiocyanates to cyanates had occurred within the distance between the two stations. Ammonia levels in the monitoring pond effluent (34 mg/L) contributed to increased ammonia levels (to 0.327 mg/L) in Cascade Creek.

The residue levels in the receiving environment were usually low. Station 11 had non-filterable residues of 246 mg/L and total residues of 1.5 g/L.

Station 8 was located downstream of Station 3, Station 10, and the mine adit at Level 4. The elevated Station 8 concentrations of calcium, iron, magnesium, manganese, sodium, strontium, and zinc can be attributed to Level 4 discharges. Other constituents at Station 8, such as aluminum, barium, silicon, and titanium, were already present upstream having been detected at either or both Stations 3 and 10 (Table 1).

Total and dissolved metal concentrations were higher at Station 11 for silver, barium, calcium, cobalt, copper, iron, potassium, magnesium, manganese, sodium, antimony, silicon, and strontium than at other stations. Aluminum, lead, and zinc were higher in the total fraction but not in the dissolved fraction. The high non-filterable and filterable residues were responsible for these high metal values.

TABLE 1: WATER QUALITY, METAL ANALYSIS - PREMIER GOLD - SEPTEMBER 12, 1989

Station Number		TOTICP AG MG/L	DISICP AG MG/L	TOTICP AL MG/L	DISICP AL MG/L	TOTICP AS MG/L	DISICP AS MG/L	TOTICP BA MG/L	DISICP BA MG/L	TOTICP CA MG/L	DISICP CA MG/L	TOTICP CD MG/L	DISICP CD MG/L	TOTICP CO MG/L	DISICP CO MG/L	TOTICP CR MG/L	DISICP CR MG/L
	Repl.1	<.01	<.01	0.10	<.05	<.05	<.05	0.103	0.107	10.2	10.7	<.005	<.005	<.005	<.005	<.005	<.005
	Repl.2	<.01	<.01	0.17	<.05	<.05	<.05	0.110	0.101	10.7	10.1	<.005	<.005	<.005	<.005	<.005	<.005
10	Repl.3	<.01	<.01	0.09	<.05	<.05	<.05	0.108	0.111	10.6	10.9	<.005	<.005	<.005	<.005	<.005	<.005
	Average	-.-	-.-	0.12	-.-	-.-	-.-	0.107	0.106	10.5	10.6	-.-	-.-	-.-	-.-	-.-	-.-
	S.D.	-.-	-.-	0.04	-.-	-.-	-.-	0.004	0.005	0.3	0.4	-.-	-.-	-.-	-.-	-.-	-.-
	Repl.1	<.01	<.01	<.05	<.05	<.05	<.05	0.156	0.157	11.1	11.0	<.005	<.005	<.005	<.005	<.005	<.005
	Repl.2	<.01	<.01	<.05	<.05	<.05	<.05	0.161	0.160	11.5	11.3	<.005	<.005	<.005	<.005	<.005	<.005
3	Repl.3	<.01	<.01	<.05	<.05	<.05	<.05	0.156	0.161	11.2	11.5	<.005	<.005	<.005	<.005	<.005	<.005
	Average	-.-	-.-	-.-	-.-	-.-	-.-	0.158	0.159	11.3	11.3	-.-	-.-	-.-	-.-	-.-	-.-
	S.D.	-.-	-.-	-.-	-.-	-.-	-.-	0.003	0.002	0.2	0.3	-.-	-.-	-.-	-.-	-.-	-.-
	Repl.1	<.01	<.01	0.08	<.05	<.05	<.05	0.099	0.104	17.7	19.6	<.005	<.005	<.005	<.005	<.005	<.005
	Repl.2	<.01	<.01	0.12	<.05	<.05	<.05	0.102	0.096	18.3	18.3	<.005	<.005	<.005	<.005	<.005	<.005
8	Repl.3	<.01	<.01	0.10	<.05	<.05	<.05	0.101	0.097	18.2	18.5	<.005	<.005	<.005	<.005	<.005	<.005
	Average	-.-	-.-	0.10	-.-	-.-	-.-	0.101	0.099	18.1	18.8	-.-	-.-	-.-	-.-	-.-	-.-
	S.D.	-.-	-.-	0.02	-.-	-.-	-.-	0.002	0.004	0.3	0.7	-.-	-.-	-.-	-.-	-.-	-.-
	Repl.1	<.01	<.01	<.05	<.05	<.05	<.05	0.015	0.012	4.3	3.9	<.005	<.005	<.005	<.005	<.005	<.005
	Repl.2	<.01	<.01	<.05	<.05	<.05	<.05	0.015	0.012	4.2	3.8	<.005	<.005	<.005	<.005	<.005	<.005
4	Repl.3	<.01	<.01	0.06	<.05	0.05	<.05	0.015	0.014	4.2	4.3	<.005	<.005	<.005	<.005	<.005	<.005
	Average	-.-	-.-	-.-	-.-	-.-	-.-	0.015	0.013	4.2	4.0	-.-	-.-	-.-	-.-	-.-	-.-
	S.D.	-.-	-.-	-.-	-.-	-.-	-.-	0.000	0.001	0.1	0.3	-.-	-.-	-.-	-.-	-.-	-.-
	Repl.1	<.01	<.01	0.18	<.05	<.05	<.05	0.047	0.032	8.7	9.1	<.005	<.005	<.005	<.005	<.005	<.005
	Repl.2	<.01	<.01	0.17	0.06	<.05	<.05	0.046	0.032	8.6	9.2	0.008	<.005	<.005	0.007	<.005	<.005
9	Repl.3	<.01	<.01	0.22	<.05	<.05	<.05	0.047	0.031	8.7	8.7	<.005	<.005	<.005	<.005	<.005	<.005
	Average	-.-	-.-	0.19	-.-	-.-	-.-	0.047	0.032	8.7	9.0	-.-	-.-	-.-	-.-	-.-	-.-
	S.D.	-.-	-.-	0.03	-.-	-.-	-.-	0.001	0.001	0.1	0.3	-.-	-.-	-.-	-.-	-.-	-.-
	Repl.1	0.06	0.03	1.50	0.07	<.05	<.05	0.388	0.203	165.0	174.0	<.005	<.005	0.024	0.039	<.005	<.005
	Repl.2	0.06	0.01	1.51	<.05	<.05	<.05	0.293	0.196	164.0	172.0	<.005	<.005	0.030	0.035	0.006	<.005
11	Repl.3	0.08	0.02	2.37	<.05	0.06	<.05	0.565	0.191	161.0	168.0	<.005	<.005	0.019	0.034	<.005	<.005
	Average	0.07	0.02	1.79	-.-	-.-	-.-	0.415	0.197	163.3	171.3	-.-	-.-	0.024	0.036	-.-	-.-
	S.D.	0.01	0.01	0.50	-.-	-.-	-.-	0.138	0.006	2.1	3.1	-.-	-.-	0.006	0.003	-.-	-.-
Level 4		<.01	<.01	0.13	<.05	<.05	<.05	0.031	0.032	62.7	67.0	0.010	0.013	0.006	<.005	<.005	<.005
Level 6		<.01	<.01	<.05	<.05	0.06	<.05	0.043	0.040	72.4	66.7	0.045	0.037	0.007	<.005	<.005	<.005
Blank		<.01	<.01	<.05	<.05	<.05	<.05	<.001	<.001	<.1	<.1	<.005	<.005	<.005	<.005	<.005	<.005

TABLE 1 (cont'd): WATER QUALITY, METAL ANALYSIS - PREMIER GOLD - SEPTEMBER 12, 1989

Station Number		TOTICP CU MG/L	DISICP CU MG/L	TOTICP FE MG/L	DISICP FE MG/L	TOTICP K MG/L	DISICP K MG/L	TOTICP MG MG/L	DISICP MG MG/L	TOTICP MN MG/L	DISICP MN MG/L	TOTICP MO MG/L	DISICP MO MG/L	TOTICP NA MG/L	DISICP NA MG/L	TOTICP NI MG/L	DISICP NI MG/L
	Repl.1	<.005	<.005	0.079	0.010	<2	<2	0.6	0.7	0.006	0.002	<.01	<.01	0.7	0.6	<.02	<.02
	Repl.2	<.005	<.005	0.142	0.009	<2	<2	0.7	0.6	0.007	<.001	<.01	<.01	0.7	0.6	<.02	<.02
10	Repl.3	<.005	<.005	0.054	0.011	<2	<2	0.6	0.6	0.006	<.001	<.01	<.01	0.7	0.6	<.02	<.02
	Average	-.-	-.-	0.092	0.010	-.-	-.-	0.6	0.6	0.006	-.-	-.-	-.-	0.7	0.6	-.-	-.-
	S.D.	-.-	-.-	0.045	0.001	-.-	-.-	0.1	0.1	0.001	-.-	-.-	-.-	0.0	0.0	-.-	-.-
	Repl.1	<.005	<.005	<.005	<.005	<2	<2	0.8	0.9	<.001	<.001	<.01	<.01	0.6	0.6	<.02	<.02
	Repl.2	<.005	<.005	0.008	<.005	<2	<2	0.9	0.9	<.001	<.001	<.01	<.01	0.7	0.6	<.02	<.02
3	Repl.3	<.005	<.005	<.005	<.005	<2	<2	0.8	1.0	<.001	<.001	<.01	<.01	0.6	0.6	<.02	<.02
	Average	-.-	-.-	-.-	-.-	-.-	-.-	0.8	0.9	-.-	-.-	-.-	-.-	0.6	0.6	-.-	-.-
	S.D.	-.-	-.-	-.-	-.-	-.-	-.-	0.1	0.1	-.-	-.-	-.-	-.-	0.1	0.0	-.-	-.-
	Repl.1	<.005	<.005	0.123	0.017	<2	<2	1.1	1.2	0.033	0.021	<.01	<.01	0.9	0.9	<.02	<.02
	Repl.2	<.005	<.005	0.133	0.016	<2	<2	1.1	1.2	0.031	0.020	<.01	<.01	1.0	0.8	<.02	<.02
8	Repl.3	<.005	<.005	0.141	0.015	<2	<2	1.1	1.2	0.030	0.021	<.01	<.01	0.9	0.8	<.02	<.02
	Average	-.-	-.-	0.132	0.016	-.-	-.-	1.1	1.2	0.031	0.021	-.-	-.-	0.9	0.8	-.-	-.-
	S.D.	-.-	-.-	0.009	0.001	-.-	-.-	0.0	0.0	0.002	0.001	-.-	-.-	0.1	0.1	-.-	-.-
	Repl.1	<.005	<.005	0.113	0.008	<2	<2	0.5	0.5	0.005	0.001	<.01	<.01	0.3	0.3	<.02	<.02
	Repl.2	<.005	<.005	0.061	0.009	<2	<2	0.5	0.5	0.006	0.001	<.01	<.01	0.3	0.3	<.02	<.02
4	Repl.3	0.033	<.005	0.097	0.014	<2	<2	0.5	0.6	0.008	0.002	<.01	<.01	0.4	0.3	<.02	<.02
	Average	-.-	-.-	0.090	0.010	-.-	-.-	0.5	0.5	0.006	0.001	-.-	-.-	0.3	0.3	-.-	-.-
	S.D.	-.-	-.-	0.027	0.003	-.-	-.-	0.0	0.1	0.002	0.001	-.-	-.-	0.1	0.0	-.-	-.-
	Repl.1	<.005	<.005	0.312	0.008	2	<2	0.8	0.9	0.056	0.041	<.01	<.01	2.1	2.1	<.02	<.02
	Repl.2	<.005	0.007	0.497	0.011	<2	2	0.8	0.9	0.054	0.041	<.01	<.01	2.1	2.1	<.02	<.02
9	Repl.3	<.005	0.007	0.320	0.009	2	<2	0.8	0.9	0.055	0.039	<.01	<.01	2.2	2.0	<.02	<.02
	Average	-.-	0.007	0.376	0.009	2	-.-	0.8	0.9	0.055	0.040	-.-	-.-	2.1	2.1	-.-	-.-
	S.D.	-.-	0.000	0.105	0.002	0	-.-	0.0	0.0	0.001	0.001	-.-	-.-	0.1	0.1	-.-	-.-
	Repl.1	0.399	0.438	4.700	0.032	73	77	5.1	5.5	3.880	3.550	0.06	0.06	174.0	174.0	<.02	<.02
	Repl.2	0.389	0.422	3.080	0.026	73	76	5.1	5.3	3.850	3.490	0.06	0.06	173.0	170.0	<.02	<.02
11	Repl.3	0.413	0.425	9.960	0.034	72	72	5.2	5.2	3.780	3.410	0.06	0.06	170.0	165.0	<.02	<.02
	Average	0.400	0.428	5.913	0.031	73	75	5.1	5.3	3.837	3.483	0.06	0.06	172.3	169.7	-.-	-.-
	S.D.	0.012	0.009	3.597	0.004	1	3	0.1	0.2	0.051	0.070	0.00	0.00	2.1	4.5	-.-	-.-
Level 4		0.041	0.010	0.608	<.005	<2	<2	4.6	5.1	0.245	0.249	<.01	<.01	2.8	2.8	<.02	<.02
Level 6		0.009	<.005	0.155	0.006	2	<2	6.5	6.4	0.506	0.450	<.01	<.01	10.7	9.7	<.02	<.02
Blank		<.005	<.005	<.005	<.005	<2	<2	<.1	<.1	<.001	<.001	<.01	<.01	<.1	<.1	<.02	<.02

TABLE 1 (cont'd): WATER QUALITY, METAL ANALYSIS - PREMIER GOLD - SEPTEMBER 12, 1989

Station Number		TOTICP P MG/L	DISICP P MG/L	TOTICP PB MG/L	DISICP PB MG/L	TOTICP SB MG/L	DISICP SB MG/L	TOTICP SI MG/L	DISICP SI MG/L	TOTICP SN MG/L	DISICP SN MG/L	TOTICP SR MG/L	DISICP SR MG/L	TOTICP TI MG/L	DISICP TI MG/L	TOTICP ZN MG/L	DISICP ZN MG/L
	Repl.1	<.1	<.1	<.05	<.05	<.05	<.05	1.30	1.26	<.05	<.05	0.104	0.109	0.003	<.002	0.004	0.006
	Repl.2	<.1	<.1	<.05	<.05	<.05	<.05	1.56	1.27	<.05	<.05	0.110	0.103	0.017	<.002	0.060	<.002
10	Repl.3	<.1	<.1	<.05	<.05	<.05	<.05	1.30	1.28	<.05	<.05	0.109	0.112	<.002	<.002	0.005	<.002
	Average	-.-	-.-	-.-	-.-	-.-	-.-	1.39	1.27	-.-	-.-	0.108	0.108	0.010	-.-	0.023	-.-
	S.D.	-.-	-.-	-.-	-.-	-.-	-.-	0.15	0.01	-.-	-.-	0.003	0.005	0.010	-.-	0.032	-.-
	Repl.1	<.1	<.1	<.05	<.05	<.05	<.05	1.16	1.26	<.05	<.05	0.094	0.094	<.002	<.002	<.002	<.002
	Repl.2	<.1	<.1	<.05	<.05	<.05	<.05	1.26	1.21	<.05	<.05	0.097	0.095	0.003	<.002	<.002	<.002
3	Repl.3	<.1	<.1	<.05	<.05	<.05	<.05	1.18	1.21	<.05	<.05	0.095	0.096	<.002	<.002	<.002	<.002
	Average	-.-	-.-	-.-	-.-	-.-	-.-	1.20	1.23	-.-	-.-	0.095	0.095	-.-	-.-	-.-	-.-
	S.D.	-.-	-.-	-.-	-.-	-.-	-.-	0.05	0.03	-.-	-.-	0.002	0.001	-.-	-.-	-.-	-.-
	Repl.1	<.1	<.1	<.05	<.05	<.05	<.05	1.30	1.38	<.05	<.05	0.170	0.187	0.003	<.002	0.164	0.144
	Repl.2	<.1	<.1	<.05	<.05	<.05	<.05	1.40	1.32	<.05	<.05	0.175	0.171	0.004	<.002	0.155	0.135
8	Repl.3	<.1	<.1	<.05	<.05	<.05	<.05	1.38	1.30	<.05	<.05	0.174	0.174	0.003	<.002	0.145	0.136
	Average	-.-	-.-	-.-	-.-	-.-	-.-	1.36	1.33	-.-	-.-	0.173	0.177	0.003	-.-	0.155	0.138
	S.D.	-.-	-.-	-.-	-.-	-.-	-.-	0.05	0.04	-.-	-.-	0.003	0.009	0.001	-.-	0.010	0.005
	Repl.1	<.1	<.1	<.05	<.05	<.05	<.05	0.51	0.44	<.05	<.05	0.045	0.040	<.002	<.002	0.002	<.002
	Repl.2	<.1	<.1	<.05	<.05	<.05	<.05	0.49	0.44	<.05	<.05	0.044	0.039	<.002	<.002	0.039	<.002
4	Repl.3	<.1	<.1	0.16	<.05	<.05	<.05	0.50	0.46	<.05	<.05	0.044	0.044	<.002	<.002	0.043	<.002
	Average	-.-	-.-	-.-	-.-	-.-	-.-	0.50	0.45	-.-	-.-	0.044	0.041	-.-	-.-	0.028	-.-
	S.D.	-.-	-.-	-.-	-.-	-.-	-.-	0.01	0.01	-.-	-.-	0.001	0.003	-.-	-.-	0.023	-.-
	Repl.1	<.1	<.1	<.05	<.05	<.05	<.05	0.84	0.59	<.05	<.05	0.078	0.082	0.006	<.002	0.064	0.024
	Repl.2	<.1	<.1	<.05	<.05	<.05	<.05	0.78	0.59	<.05	<.05	0.078	0.081	0.005	<.002	0.054	0.024
9	Repl.3	<.1	<.1	<.05	<.05	<.05	<.05	1.02	0.59	<.05	<.05	0.078	0.077	0.006	<.002	0.045	0.023
	Average	-.-	-.-	-.-	-.-	-.-	-.-	0.88	0.59	-.-	-.-	0.078	0.080	0.006	-.-	0.054	0.024
	S.D.	-.-	-.-	-.-	-.-	-.-	-.-	0.12	0.00	-.-	-.-	0.000	0.003	0.001	-.-	0.010	0.001
	Repl.1	0.2	<.1	0.59	<.05	0.16	0.20	4.50	2.57	<.05	<.05	0.789	0.834	0.028	<.002	0.431	0.025
	Repl.2	0.3	<.1	0.57	<.05	0.17	0.18	4.48	2.52	<.05	<.05	0.779	0.812	0.025	<.002	0.227	0.024
11	Repl.3	0.3	<.1	0.57	<.05	0.15	0.19	5.90	2.47	<.05	<.05	0.779	0.787	0.055	<.002	0.862	0.025
	Average	0.3	-.-	0.58	-.-	0.16	0.19	4.96	2.52	-.-	-.-	0.782	0.811	0.036	-.-	0.507	0.025
	S.D.	0.1	-.-	0.01	-.-	0.01	0.01	0.81	0.05	-.-	-.-	0.006	0.024	0.017	-.-	0.324	0.001
Level 4		<.1	<.1	<.05	<.05	<.05	<.05	2.05	2.16	<.05	<.05	0.814	0.866	<.002	<.002	1.490	1.360
Level 6		<.1	<.1	<.05	<.05	<.05	<.05	2.16	2.32	<.05	<.05	1.960	1.830	0.002	<.002	3.890	3.680
Blank		<.1	<.1	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.001	<.001	<.002	<.002	<.002	<.002

TABLE 2: WATER QUALITY, IMMEDIATES ANALYSIS - PREMIER GOLD - SEPTEMBER 12, 1989

Station Number		ALK MG/L	PH REL.U.	COND UMHO/C	DISICP HC MG/L	TOTICP HT MG/L	NH3 MG/L	NO2 MG/L	NO3 MG/L	SO4 MG/L	TR MG/L	NFR MG/L	CN MG/L	CNO MG/L	CNS MG/L	CNWD MG/L
	Repl.1	28.1	7.9	65	29.5	29.8	0.006	<.005	<.005	5	45	<5	-.-	-.-	-.-	-.-
	Repl.2	27.5	7.8	65	27.8	28.1	<.005	<.005	<.005	4	42	<5	-.-	-.-	-.-	-.-
10	Repl.3	27.5	7.8	65	29.9	30.1	<.005	<.005	<.005	5	42	<5	-.-	-.-	-.-	-.-
	Average	27.7	7.8	65	29.1	29.3	-.-	-.-	-.-	5	43	-.-	-.-	-.-	-.-	-.-
	S.D.	0.3	0.1	0	1.1	1.1	-.-	-.-	-.-	1	2	-.-	-.-	-.-	-.-	-.-
	Repl.1	31.6	7.9	68	31.2	31.5	<.005	<.005	<.005	<1	40	<5	-.-	-.-	-.-	-.-
	Repl.2	31.6	7.9	68	32.1	32.3	<.005	<.005	<.005	<1	44	<5	-.-	-.-	-.-	-.-
3	Repl.3	32.6	8.0	68	32.6	32.7	<.005	<.005	<.005	2	43	<5	-.-	-.-	-.-	-.-
	Average	31.9	7.9	68	32.0	32.2	-.-	-.-	-.-	-.-	42	-.-	-.-	-.-	-.-	-.-
	S.D.	0.6	0.1	0	0.7	0.6	-.-	-.-	-.-	-.-	2	-.-	-.-	-.-	-.-	-.-
	Repl.1	37.7	7.9	113	54.2	54.7	<.005	<.005	0.047	10	74	<5	-.-	-.-	-.-	-.-
	Repl.2	37.2	7.9	113	50.6	51.1	<.005	<.005	0.050	14	72	<5	-.-	-.-	-.-	-.-
8	Repl.3	41.8	8.0	113	51.1	51.7	<.005	<.005	0.049	10	75	<5	-.-	-.-	-.-	-.-
	Average	38.9	7.9	113	52.0	52.5	-.-	-.-	0.049	11	74	-.-	-.-	-.-	-.-	-.-
	S.D.	2.5	0.1	0	2.0	1.9	-.-	-.-	0.002	2	2	-.-	-.-	-.-	-.-	-.-
	Repl.1	11.2	7.2	31	11.8	11.9	<.005	<.005	<.005	4	24	<5	0.03	<.005	<.5	<.03
	Repl.2	12.2	7.3	31	11.7	12.0	<.005	<.005	<.005	4	22	<5	<.03	<.005	<.5	<.03
4	Repl.3	12.2	7.4	31	13.2	13.5	<.005	<.005	<.005	3	24	<5	<.03	<.005	<.5	<.03
	Average	11.9	7.3	31	12.2	12.5	-.-	-.-	-.-	4	23	-.-	-.-	-.-	-.-	-.-
	-.-	S.D.	0.6	0.1	0	0.8	0.9	-.-	-.-	-.-	1	1	-.-	-.-	-.-	-.-
	Repl.1	18.4	7.6	73	26.4	26.7	0.327	0.005	0.115	6	52	10	0.03	<.005	<.5	<.03
	Repl.2	<1.0	4.5	70	26.7	27.1	0.327	0.005	0.116	12	47	9	<.03	3.370	<.5	<.03
9	Repl.3	16.3	7.3	70	25.4	25.8	0.327	0.005	0.116	13	55	9	<.03	0.213	<.5	<.03
	Average	17.4	6.5	71	26.2	26.5	0.327	0.005	0.116	10	51	9	-.-	1.792	-.-	-.-
	S.D.	1.5	1.7	2	0.7	0.7	0.000	0.000	0.001	4	4	1	-.-	2.232	-.-	-.-
	Repl.1	163.0	8.3	1750	458.0	466.0	34.800	0.318	9.000	650	1550	254	0.30	<.005	15.5	0.30
	Repl.2	160.0	8.3	1700	452.0	459.0	34.800	0.315	9.200	680	1550	213	0.24	<.005	13.0	0.21
11	Repl.3	159.0	8.3	1700	440.0	447.0	34.900	0.329	8.300	680	1520	270	0.28	<.005	15.4	0.25
	Average	160.7	8.3	1717	450.0	457.3	34.833	0.321	8.833	670	1540	246	0.27	-.-	14.6	0.25
	S.D.	2.1	0.0	29	9.2	9.6	0.058	0.007	0.473	17	17	29	0.03	-.-	1.4	0.05
Level 4		93.8	8.3	345	189.0	192.0	0.029	<.005	0.418	80	248	<5	-.-	-.-	-.-	-.-
Level 6		93.8	8.3	435	193.0	201.0	0.032	<.005	0.093	130	319	<5	-.-	-.-	-.-	-.-

The total copper concentration in samples from Station 9 was less than detection limit (5 µg/L), but the dissolved fraction averaged 7 µg/L. This indicates that the Station 9 samples were contaminated. Iron, manganese, and sodium content reflected levels at Station 11. Zinc concentration averaged 54 µg/L, but the source could be any, or a combination of, Fletcher Creek (Station 8), the monitoring pond, or the Level 6 mine portal.

4.2 Continuous Cyanide Effluent Sampling

Continuous sampling of the monitoring pond was limited due to failure of the power supply. Samples from the first days of the four day collection period had cyanide levels close to 1 mg/L. Concentrations were down to 0.2 mg/L by the end of the sampling period. The weak acid dissociable cyanide concentration was in good agreement with the total cyanide concentration. Replicated samples were collected in the afternoon of September 12, 1989 at about 1630. On September 12 and 13, when the cyanide levels were high, there seems to have been a reduction of cyanide as the day progressed (Table 3). Natural degradation may have an influence on the results when levels are high but treatment may have a greater effect when levels are low.

The cyanide levels were clearly reduced from the initial sampling day on September 12 to a much lower level on September 15. Total cyanide was 0.95 mg/L initially, and stabilised around 0.20 mg/L later in the day.

4.3 Total Sediment Analysis

Sediment data are reported in Table 4 and the evaluation of the total sediments in the receiving environment are presented in Figures 2 to 4.

Sediment sample concentrations of arsenic, calcium, cadmium, copper, mercury, lead, and zinc were low at Stations 3 and 10. Station 3 samples from near the waste rock dump were particularly high in aluminum and manganese, and both stations were high in iron.

TABLE 3: EFFLUENT QUALITY - PREMIER GOLD - SEPTEMBER 12-15, 1989

Sampling Date	Sampling Time	CN mg/L	CNO mg/L	CNS mg/L	CNWD mg/L
09/12	1015	0.95	28.1	24.0	0.94
''	1315	0.97	26.3	31.0	0.93
09/13	1125	0.59	28.1	26.0	0.78
''	1830	0.27	<.005	11.2	0.25
''	2130	0.24	<.005	9.6	0.23
09/14	0030	0.20	<.005	8.4	0.20
''	0330	0.25	<.005	9.2	0.25
''	0630	0.41	<.005	7.6	0.25
''	0930	0.22	<.005	7.4	0.21
''	1000	0.19	<.005	7.4	0.19
''	1300	0.20	<.005	9.4	0.20
''	1600	0.26	<.005	9.8	0.23
''	1900	0.22	<.005	8.2	0.20
''	2200	0.23	<.005	8.8	0.23
09/15	0100	0.19	<.005	8.8	0.19
''	0730	0.18	<.005	9.2	0.18

Samples from Station 8, which is downstream of Stations 3 and 10, had high concentrations of cadmium (20.3 µg/g), copper (127.8 µg/g), lead (330 µg/g), and zinc (2175 µg/g). These metals were significantly different from the controls at Stations 3 and 10.

Samples from Station 4, which was upstream of the tailings pond on Cascade Creek, had low levels of calcium (3.07 mg/g), cadmium (2.9 µg/g), copper (42.0 µg/g), and mercury (0.276 µg/g). This control station showed high concentrations of elements such as arsenic (67 µg/g), lead (188 µg/g), and zinc (412 µg/g). Chromium concentrations were the highest in the survey (20.0 µg/g), but these were low compared to other northwest B.C. regions.

Samples from Station 11, which was downstream of the monitoring pond, had high sediment metal concentrations for arsenic (95 µg/g), calcium (16.0 mg/g), cadmium (17.4 µg/g), mercury (0.47 µg/g), lead (715 µg/g), and zinc (2068 µg/g). Calcium content was a reflection of the high pH requirement in the tailings pond. The copper content averaged 76.5 µg/g, which was lower than the other downstream station (Station 8, 127.8 µg/g).

Station 9, downstream on Cascade Creek, was the last monitoring point before the confluence with the Salmon River. The introduction of metal elements from Fletcher Creek and/or the monitoring pond increased the average concentrations of arsenic, calcium, cadmium, copper, lead, and zinc in samples from Station 9. However, the differences between these samples and those from upstream were not significant ($p > 0.05$).

4.4 Sequential Extraction

Sediment sequential extractions on samples from Stations 4, 8, 9, and 11 were conducted (Tables 5-8). Samples were analysed for cadmium, copper, lead, and zinc due to the toxicity of these elements and their significance in acid rock drainage and mill effluent processes. Biological availability was evaluated by the ease in which the extractive can remobilize metals from the sediments. The metals from the exchangeable and carbonate sequential extraction fractions were viewed as having the highest potential to become bioavailable. Metals from the other fractions may or may not become bioavailable depending on other processes such microbial degradation, bioaccumulation of the organic fraction, oxidation of sulphides, or changes in redox potential and solubilization of the iron and manganese oxides.

Certain differences may occur between the sequential extraction results and the total replicated metal analysis presented in Table 3. These could be explained by the differences in particle size. The sequential extraction uses <63 µm particles while the total metals procedure uses particles <150 µm. Most of the time the sequential extraction leads to slightly higher metal concentrations.

Samples from Station 8 had cadmium levels of 2.7 µg/g in the exchangeable fraction and 4 µg/g more released from the carbonate fraction. This represents 35% of the cadmium in the sediment at that station. Copper bioavailability potential was low. Lead was not found in exchangeable salts but 61.3 µg/g was released at pH 5. Zinc was highly available with 41.9 µg/g in the first fraction and 555 µg/g released in the second fraction.

TABLE 4: SEDIMENT QUALITY, METAL ANALYSIS - PREMIER GOLD - SEPTEMBER 12, 1989

Station Number		AG UG/G	AL UG/G	AS UG/G	BA UG/G	BE UG/G	CA UG/G	CD UG/G	CO UG/G	CR UG/G	CU UG/G	FE UG/G	HG UG/G	K UG/G	MG UG/G
	Repl.1	<2	13100	20	617	0.6	5830	<.8	<20	7.6	35.5	53600	0.043	2000	10500
	Repl.2	<2	13000	23	594	0.6	5420	<.8	<20	6.9	34.1	54100	0.058	1700	10600
10	Repl.3	<2	12200	10	516	0.6	5180	<.8	<20	6.2	25.9	51700	0.035	2000	10000
	Repl.4	<2	13100	17	530	0.6	5330	<.8	<20	6.5	27.8	48600	0.034	1800	10500
	Average	-.-	12850	18	564	0.6	5440	-.-	-.-	6.8	30.8	52000	0.043	1875	10400
	S.D.	-.-	436	6	49	0.0	278	-.-	-.-	0.6	4.7	2491	0.011	150	271
	Repl.1	<2	21200	35	936	0.8	6440	<.8	<20	8.2	30.0	54900	0.100	3300	8080
	Repl.2	<2	21500	37	936	0.8	6230	<.8	<20	8.7	30.8	59400	0.110	3300	8220
3	Repl.3	<2	21900	42	945	0.9	6400	<.8	<20	9.2	33.9	58900	0.092	3300	8450
	Repl.4	<2	23800	43	897	0.9	5850	<.8	<20	8.1	32.9	58400	0.120	3900	8820
	Average	-.-	22100	39	929	0.9	6230	-.-	-.-	8.6	31.9	57900	0.106	3450	8393
	S.D.	-.-	1169	4	21	0.1	269	-.-	-.-	0.5	1.8	2041	0.012	300	323
	Repl.1	21	13800	47	663	0.5	6610	20.4	<20	6.5	131.0	56500	0.150	1800	7150
	Repl.2	20	13600	49	703	0.4	5960	18.6	<20	9.6	105.0	53700	0.140	1000	7080
8	Repl.3	21	13900	57	763	0.4	6150	24.2	<20	9.3	147.0	58900	0.310	1700	7340
	Repl.4	18	13700	52	686	0.4	6230	18.1	<20	3.8	128.0	60300	0.120	1000	7330
	Average	20	13750	51	704	0.4	6238	20.3	-.-	7.3	127.8	57350	0.180	1375	7225
	S.D.	1	129	4	43	0.0	273	2.8	-.-	2.7	17.3	2895	0.088	435	130
	Repl.1	<2	12800	74	695	0.5	3000	2.6	<20	20.2	58.2	45900	0.325	1000	6760
	Repl.2	<2	13200	59	770	0.5	3120	3.0	<20	19.6	39.4	46100	0.281	1000	6930
4	Repl.3	<2	12400	69	663	0.4	2970	3.0	<20	18.5	34.5	44000	0.230	1000	6570
	Repl.4	<2	13900	65	847	0.5	3190	2.8	<20	21.7	35.7	45900	0.267	1700	7030
	Average	-.-	13075	67	744	0.5	3070	2.9	-.-	20.0	42.0	45475	0.276	1175	6823
	S.D.	-.-	640	6	82	0.0	103	0.2	-.-	1.3	11.0	988	0.039	350	202
	Repl.1	9	12300	73	546	0.4	6580	6.7	<20	9.1	51.9	50400	0.258	1000	6950
	Repl.2	20	11300	83	715	0.4	8650	9.5	<20	8.3	60.4	48800	0.273	2000	6260
9	Repl.3	10	11600	85	582	0.4	5710	5.1	<20	8.8	61.7	57600	0.216	1000	6900
	Repl.4	10	12500	62	650	0.4	4660	8.1	<20	9.8	63.0	49700	0.226	1000	6840
	Average	12	11925	76	623	0.4	6400	7.4	-.-	9.0	59.3	51625	0.243	1250	6738
	S.D.	5	568	11	75	0.0	1693	1.9	-.-	0.6	5.0	4037	0.027	500	321
	Repl.1	56	3190	88	613	<.2	15400	16.0	<20	2.5	70.0	32800	0.428	2000	1500
	Repl.2	58	3120	71	799	0.2	15200	12.0	<20	2.9	74.6	26000	0.383	2000	1300
11	Repl.3	78	3000	100	663	<.2	15900	12.0	<20	3.8	81.1	32700	0.438	1000	1300
	Repl.4	60	3960	120	507	0.2	17600	29.5	<20	3.5	80.2	41300	0.659	2000	2000
	Average	63	3318	95	646	0.2	16025	17.4	-.-	3.2	76.5	33200	0.477	1750	1525
	S.D.	10	435	21	121	0.0	1090	8.3	-.-	0.6	5.2	6268	0.124	500	330

TABLE 4 (cont'd): SEDIMENT QUALITY, METAL ANALYSIS - PREMIER GOLD - SEPTEMBER 12, 1989

Station Number		MN UG/G	MO UG/G	NA UG/G	NI UG/G	P UG/G	PB UG/G	SI UG/G	SN UG/G	SR UG/G	TI UG/G	V UG/G	ZN UG/G	SFR MG/KG	SVR MG/KG
	Repl.1	1130	<2	100	10	1100	59	1360	<8	39.1	720	78	135	986000	14100
	Repl.2	1130	<2	200	6	1200	63	1390	<8	37.5	707	78	121	991000	9400
10	Repl.3	1060	<2	100	8	1100	65	1370	<8	34.2	694	76	118	989000	11400
	Repl.4	1240	<2	100	10	1200	70	1510	<8	36.8	647	71	133	986000	13900
	Average	1140	-.-	125	9	1150	64	1408	-.-	36.9	692	76	127	988000	12200
	S.D.	74	-.-	50	2	58	5	69	-.-	2.0	32	3	9	2449	2235
	Repl.1	2580	<2	100	10	1300	90	1350	<8	52.8	178	66	200	912000	87800
	Repl.2	2730	<2	100	10	1300	110	1320	<8	52.4	206	68	191	921000	78600
3	Repl.3	2860	<2	100	10	1400	93	1330	<8	51.4	192	68	231	923000	76800
	Repl.4	3200	<2	100	10	1300	100	1420	<8	48.0	205	73	183	932000	67800
	Average	2843	-.-	100	10	1325	98	1355	-.-	51.2	195	69	201	922000	77750
	S.D.	264	-.-	0	0	50	9	45	-.-	2.2	13	3	21	8206	8198
	Repl.1	1970	<2	90	10	1000	806	984	<8	47.2	639	51	2160	972000	28000
	Repl.2	4170	<2	100	21	980	696	1050	25	46.1	609	48	1970	975000	24600
8	Repl.3	1890	<2	90	10	1100	947	1180	29	45.5	551	47	2620	970000	30100
	Repl.4	2640	<2	90	20	1000	817	1190	<8	46.0	554	47	1950	975000	24800
	Average	2668	-.-	93	15	1020	817	1101	27	46.2	588	48	2175	973000	26875
	S.D.	1057	-.-	5	6	54	103	101	3	0.7	43	2	311	2449	2655
	Repl.1	1570	<2	100	38	1100	191	1040	<8	28.8	48	27	437	981000	18700
	Repl.2	1650	<2	70	27	1100	187	1060	<8	30.3	49	27	415	-.-	-.-
4	Repl.3	1530	<2	60	26	1000	185	991	<8	27.1	48	26	414	-.-	-.-
	Repl.4	1780	<2	100	28	1100	189	1040	<8	33.9	53	29	381	980000	19900
	Average	1633	-.-	83	30	1075	188	1033	-.-	30.0	49	27	412	980500	19300
	S.D.	110	-.-	21	6	50	3	29	-.-	2.9	3	1	23	707	849
	Repl.1	1300	<2	80	10	1100	279	847	<8	39.3	330	36	819	980000	20300
	Repl.2	1440	<2	70	9	1100	448	1050	<8	50.6	270	32	1210	981000	19400
9	Repl.3	1140	<2	80	10	1200	275	1100	<8	37.3	352	37	715	979000	21000
	Repl.4	1340	<2	620	10	1100	316	874	<8	35.6	374	40	886	978000	21800
	Average	1305	-.-	213	10	1125	330	968	-.-	40.7	332	36	908	979500	20625
	S.D.	125	-.-	272	1	50	81	126	-.-	6.8	45	3	214	1291	1021
	Repl.1	1360	<2	30	<3	810	582	540	<8	74.8	20	6	1860	979000	21200
	Repl.2	1360	<2	30	<3	830	363	535	<8	78.4	18	6	1420	984000	15600
11	Repl.3	1390	<2	20	<3	1000	424	527	<8	79.8	20	5	1520	978000	21900
	Repl.4	1480	<2	30	<3	900	1490	513	<8	83.1	47	8	3470	975000	25500
	Average	1398	-.-	28	-.-	885	715	529	-.-	79.0	26	6	2068	979000	21050
	S.D.	57	-.-	5	-.-	86	525	12	-.-	3.4	14	1	954	3742	4093

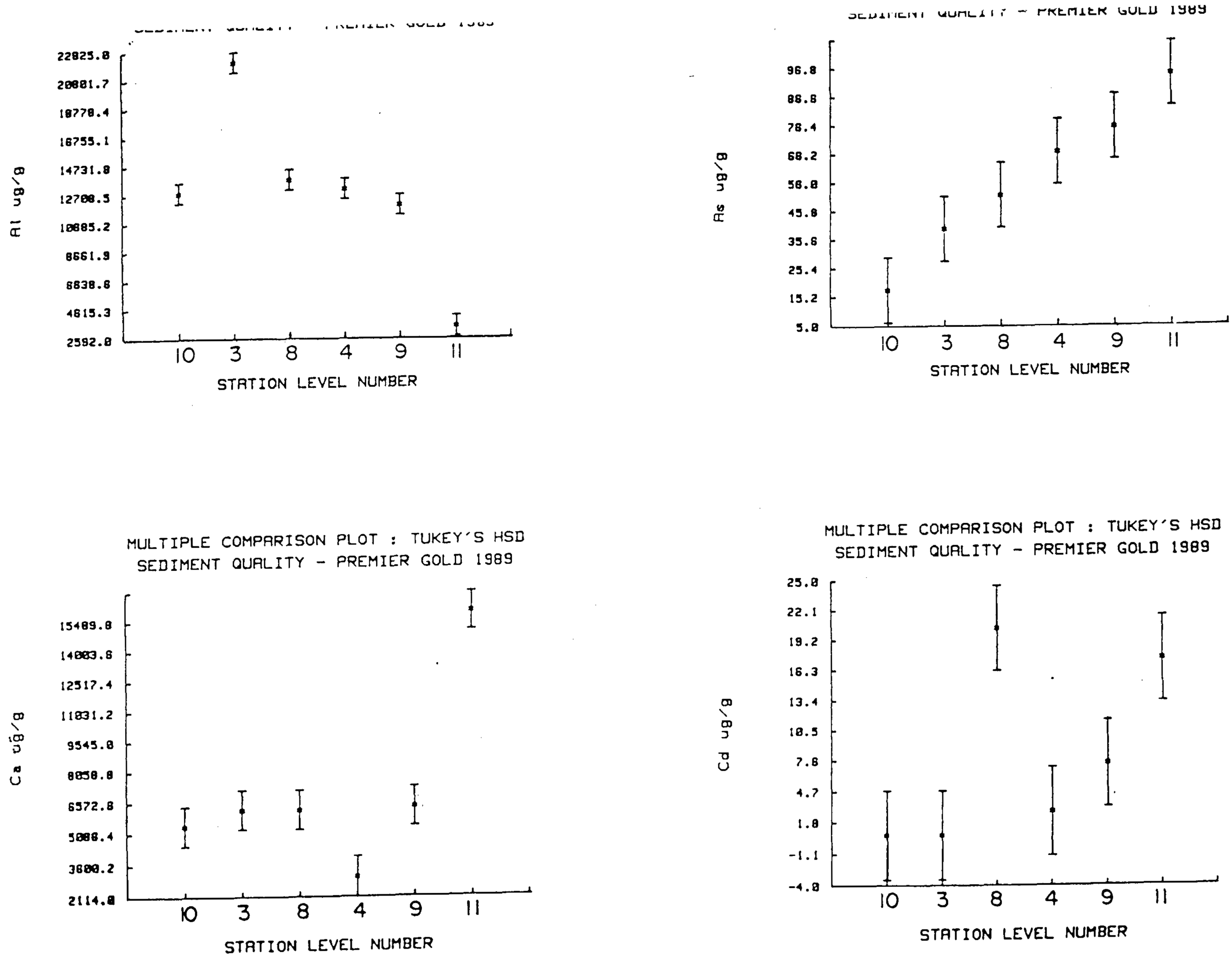
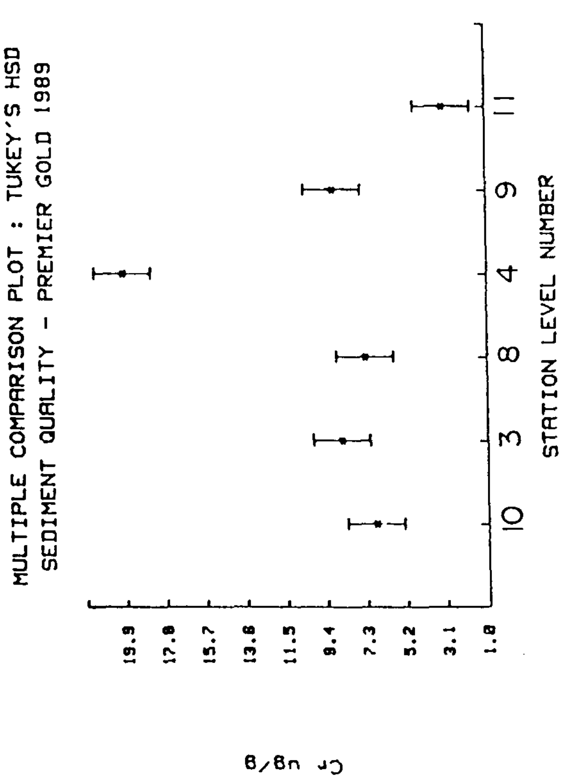
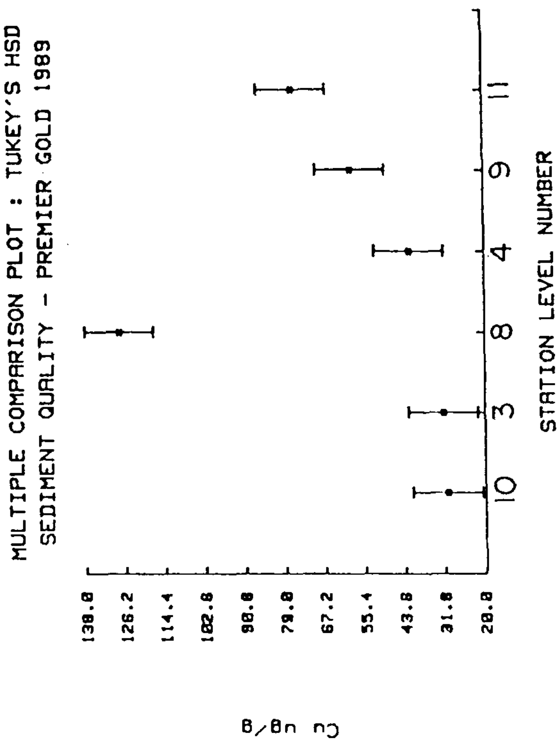
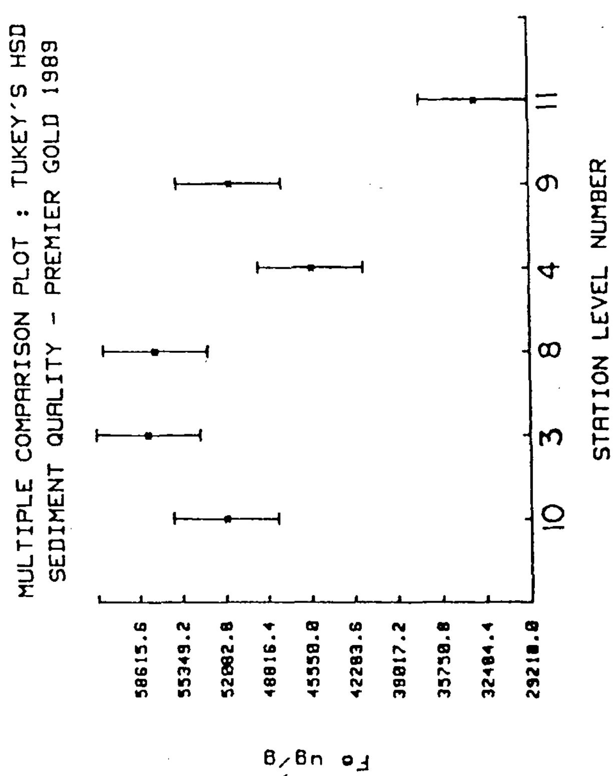
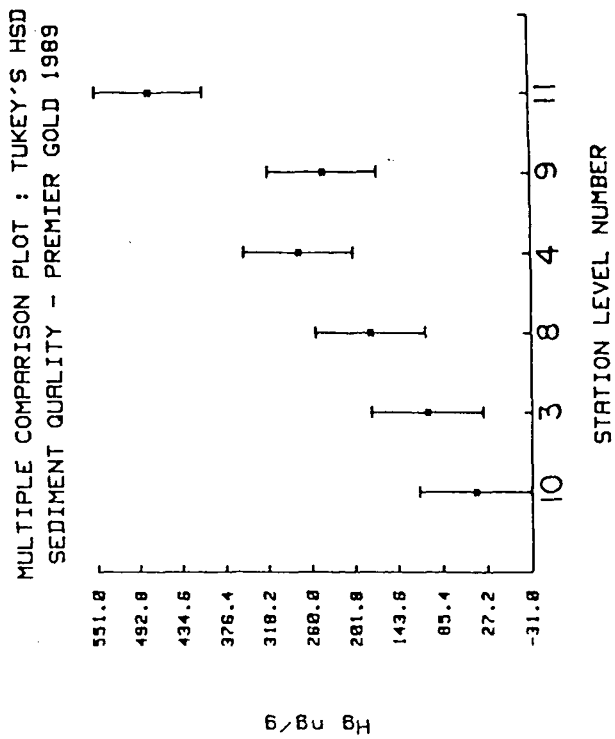


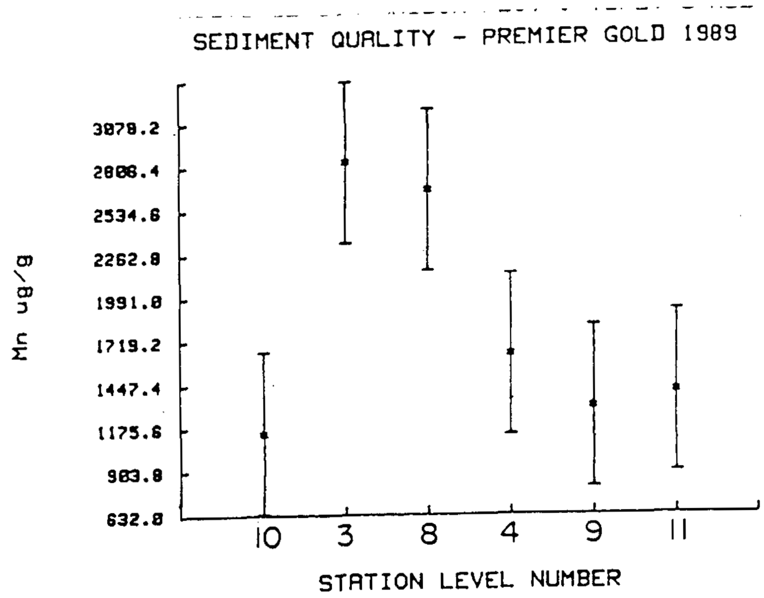
FIGURE 2: SEDIMENT MULTIPLE COMPARISON PLOT - PREMIER GOLD 1989 - Al, As, Ca, Cd

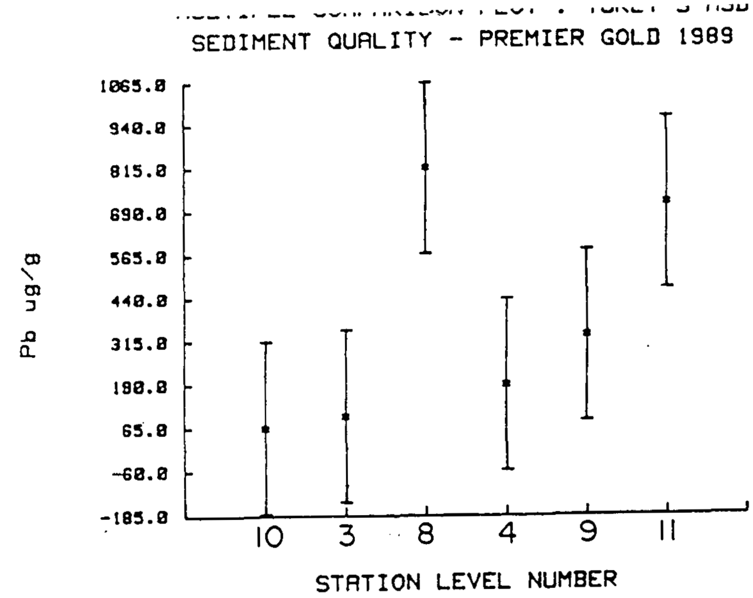

MULTIPLE COMPARISON PLOT : TUKEY'S HSD
SEDIMENT QUALITY - PREMIER GOLD 1989
Cr ug/g
19.9
17.8
15.7
13.6
11.5
9.4
7.3
5.2
3.1
1.0
10
3
8
4
9
11
STATION LEVEL NUMBER


MULTIPLE COMPARISON PLOT : TUKEY'S HSD
SEDIMENT QUALITY - PREMIER GOLD 1989
Cu ug/g
138.0
126.2
114.4
102.6
90.8
79.0
67.2
55.4
43.6
31.8
20.0
10
3
8
4
9
11
STATION LEVEL NUMBER


MULTIPLE COMPARISON PLOT : TUKEY'S HSD
SEDIMENT QUALITY - PREMIER GOLD 1989
Fe ug/g
58615.6
55349.2
52082.8
48816.4
45550.0
42283.6
39017.2
35750.8
32484.4
29218.0
10
3
8
4
9
11
STATION LEVEL NUMBER


MULTIPLE COMPARISON PLOT : TUKEY'S HSD
SEDIMENT QUALITY - PREMIER GOLD 1989
Hg ng/g
551.0
492.8
434.6
376.4
318.2
260.0
201.8
143.6
85.4
27.2
-31.0
10
3
8
4
9
11
STATION LEVEL NUMBER





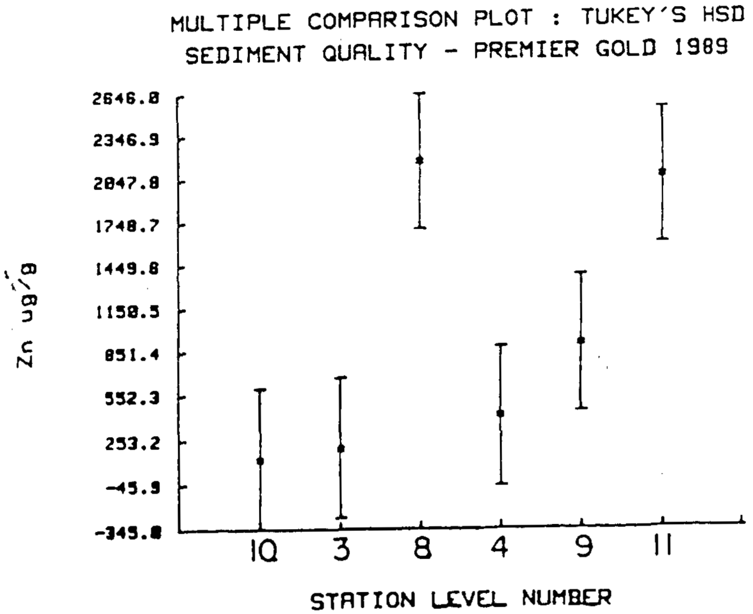


FIGURE 4: SEDIMENT MULTIPLE COMPARISON PLOT - PREMIER GOLD 1989 - Mn, Pb, Zn

Station 4 samples had 0.93 μg/g of cadmium available in the exchangeable and carbonate fractions. Copper and lead availability was negligible while some zinc (66.4 μg/g) was available in the first two fractions.

Samples from Station 9 had 0.7 μg/g of cadmium in the exchangeable and carbonate fractions which was less than that at Station 4 (0.93 μg/g). However, the total amount of cadmium increased from the upstream station (Station 9, 7.4 μg/g; Station 4, 3.1 μg/g). Copper availability potential was negligible. Lead was not detectable in the exchangeable form, but 63.6 μg/g was detected in the carbonate fraction. Zinc was similar, with none detected in the exchangeable form, but 81.7 μg/g detected in the carbonate.

Samples from Station 11 had the lowest available cadmium with non-detectable amounts in the exchangeable form and 0.42 μg/g in the carbonates. The total concentration was 13 μg/g but most of this was in the residual portion (10.9 μg/g). Copper, lead, and zinc were not detected in the exchangeable fraction, but all metals could be detected in the carbonate fraction. Copper levels were 23.1 μg/g, lead 156 μg/g, and zinc 42.2 μg/g. These metals might be in the form of metal cyanide complexes.

TABLE 5: **SEDIMENT SEQUENTIAL EXTRACTION - STATION 4, CASCADE CREEK UPSTREAM OF TAILINGS PONDS - SEPTEMBER 13, 1989**

Metals (µg/g)	Exchange-able	Carbonates	Fe+Mn Oxide	Organic & Sulphides	Residual	Total
Ag	<0.4	<0.4	<0.4	<0.4	<3	<3
Al	<2	54	673	775	12300	13800
As	<2	<2	<2	15	62	77
Ba	44.7	56.4	86.5	11.6	941	1140
Be	<0.04	<0.04	0.04	<0.04	<0.26	<0.3
Ca	423	170	110	2050	407	3160
Cd	0.53	0.4	0.97	0.2	1	3.1
Co	<4	<4	<4	<4	<30	<30
Cr	<0.2	<0.2	2.5	0.5	20	23
Cu	<0.2	1.6	6.71	12.2	15.1	35.6
Fe	<2	16	5780	3860	38200	47900
K	<80	<80	<80	<80	2000	2000
Mn	18.9	102	883	23.8	462	1490
Mo	<0.4	<0.4	<0.4	<0.4	<3	<3
Ni	<0.8	1	4	2	23	30
P	<4	<4	40	918	242	1200
Pb	<2	7.2	48.7	26	78.1	160
Sb	<2	<2	2	<2	<18	<20
Sn	<2	<2	4	<2	<26	30
Sr	5.02	2	1.9	8.96	15.5	33.4
Ti	<0.08	<0.08	<0.08	1.4	119	120
V	<0.4	<0.4	2	1	33	36
Zn	13.2	53.2	62.5	26.8	230	386

TABLE 6: SEDIMENT SEQUENTIAL EXTRACTION - STATION 8, FLETCHER CREEK BELOW GRANDUC ROAD - SEPTEMBER 13, 1989

Metals (µg/g)	Exchange-able	Carbonates	Fe+Mn Oxide	Organic & Sulphides	Residual	Total
Ag	0.4	<0.4	0.6	2	7	10
Al	<2	122	1260	987	13800	16200
As	<2	<2	<2	8	39	47
Ba	45.7	72.7	178	16.8	446	759
Be	<0.04	<0.04	<0.04	<0.04	<0.2	<0.2
Ca	931	1490	230	2020	2270	6940
Cd	2.7	4	2.8	0.69	9.21	19.4
Co	<4	<4	5	<4	<15	20
Cr	<0.2	<0.2	1.1	0.86	13	15
Cu	<0.2	8.43	13.7	45.5	43.4	111
Fe	<2	50.5	6080	4900	48400	59400
K	<80	<80	<80	<80	2100	2100
Mn	7.51	339	3040	40.1	833	4260
Mo	<0.4	<0.4	<0.4	<0.4	<2	<2
Ni	<0.8	4.7	4.6	2	12.7	24
P	<4	<4	30	853	317	1200
Pb	<2	61.3	211	65.2	404	741
Sb	<2	<2	<2	<2	<10	10
Sn	<2	<2	3	<2	55	58
Sr	7.64	8.36	4	6.42	29.3	55.7
Ti	<0.08	<0.08	0.3	24	802	826
V	<0.4	<0.4	3	2	59	64
Zn	41.9	555	273	83.7	1090	2040

TABLE 7: **SEDIMENT SEQUENTIAL EXTRACTION - STATION 9, CASCADE CREEK DOWNSTREAM OF FLETCHER CREEK - SEPTEMBER 13, 1989**

Metals (µg/g)	Exchange-able	Carbonates	Fe+Mn Oxide	Organic & Sulphides	Residual	Total
Ag	<0.4	<0.4	1	2	<2	5
Al	<2	82.8	640	729	11900	13400
As	<2	<2	<2	21	74	95
Ba	54.2	62.6	73.7	10.8	409	610
Be	<0.04	<0.04	<0.04	<0.04	<0.2	<0.2
Ca	628	1390	150	2330	1850	6350
Cd	0.2	0.5	0.76	0.79	5.15	7.4
Co	<4	<4	<4	<4	<20	20
Cr	<0.2	<0.2	1.9	<0.2	11.1	13
Cu	<0.2	5.54	4.88	20.8	36.1	67.3
Fe	<2	107	3820	5770	53600	63300
K	<80	<80	<80	<80	1800	1800
Mn	22.2	310	310	23.8	444	1110
Mo	<0.4	<0.4	<0.4	<0.4	<2	<2
Ni	<0.8	2	2	1	15	20
P	<4	<4	40	1070	190	1300
Pb	<2	63.6	71.7	27	196	358
Sb	<2	<2	3	<2	<6	9
Sn	<2	<2	<2	3	39	42
Sr	5.01	6.61	2.3	6.29	23.4	43.6
Ti	<0.08	<0.08	<0.08	7.88	625	633
V	<0.4	<0.4	2	2	57	61
Zn	1.6	81.7	52.8	83.7	647	867

TABLE 8: SEDIMENT SEQUENTIAL EXTRACTION - STATION 11, MONITORING POND EFFLUENT (SEPTEMBER 13, 1989)

Metals (µg/g)	Exchange-able	Carbonates	Fe+Mn Oxide	Organic & Sulphides	Residual	Total
Ag	<0.4	<0.4	2	11	27	40
Al	<2	53.2	238	257	4420	4970
As	<2	<2	<2	67.8	52.2	120
Ba	65.5	83.3	70.2	9.35	384	612
Be	<0.04	<0.04	<0.04	<0.04	<0.2	<0.2
Ca	465	12000	390	1960	1590	16400
Cd	<0.2	0.42	0.65	1	10.9	13
Co	<4	<4	<4	5	<15	<20
Cr	<0.2	0.57	3.7	<0.2	1.83	6.1
Cu	<0.2	23.1	4.07	29.5	29.7	86.4
Fe	<2	392	2390	10000	22700	35500
K	<80	<80	<80	<80	2200	2200
Mn	32.3	922	211	14.7	210	1390
Mo	<0.4	<0.4	<0.4	0.9	<1.1	<2
Ni	<0.8	1	<0.8	<0.8	<2	<3
P	<4	<4	84	925	191	1200
Pb	<2	156	85.4	25	210	476
Sb	<2	<2	3	2	<22	27
Sn	<2	<2	<2	4	<20	24
Sr	2.7	53.3	3.5	6.58	11.4	77.5
Ti	<0.08	<0.08	<0.08	<0.08	56.6	56.6
V	<0.4	<0.4	0.8	1	8.2	10
Zn	<0.08	42.2	30.9	107	1370	1550

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