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

WESTMIN RESOURCES LTD.
PREMIER GOLD MINE
- February 25, 1991 -

REGIONAL DATA REPORT: DR 91-08A

by

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MARCH 1992

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1.0 INTRODUCTION

The Premier Gold Mine is located on the east side of the Cascade Creek Valley in the Salmon River drainage system, about 1 km upstream from the B.C./Alaska border. 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, which supports chum, pink, coho, and sockeye salmon, joins the Salmon River about 1.5 km downstream from the Fletcher Creek confluence.

Westmin Resources operates an open pit mine using a cyanide leach to extract gold and silver. The tailings pond is located in the Cascade Creek Valley and the upper part of 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.

The objective of this study was to examine sediment characteristics (metal content, metal "species", toxicity) and surface water quality at sampling stations above and below potential mine influence.

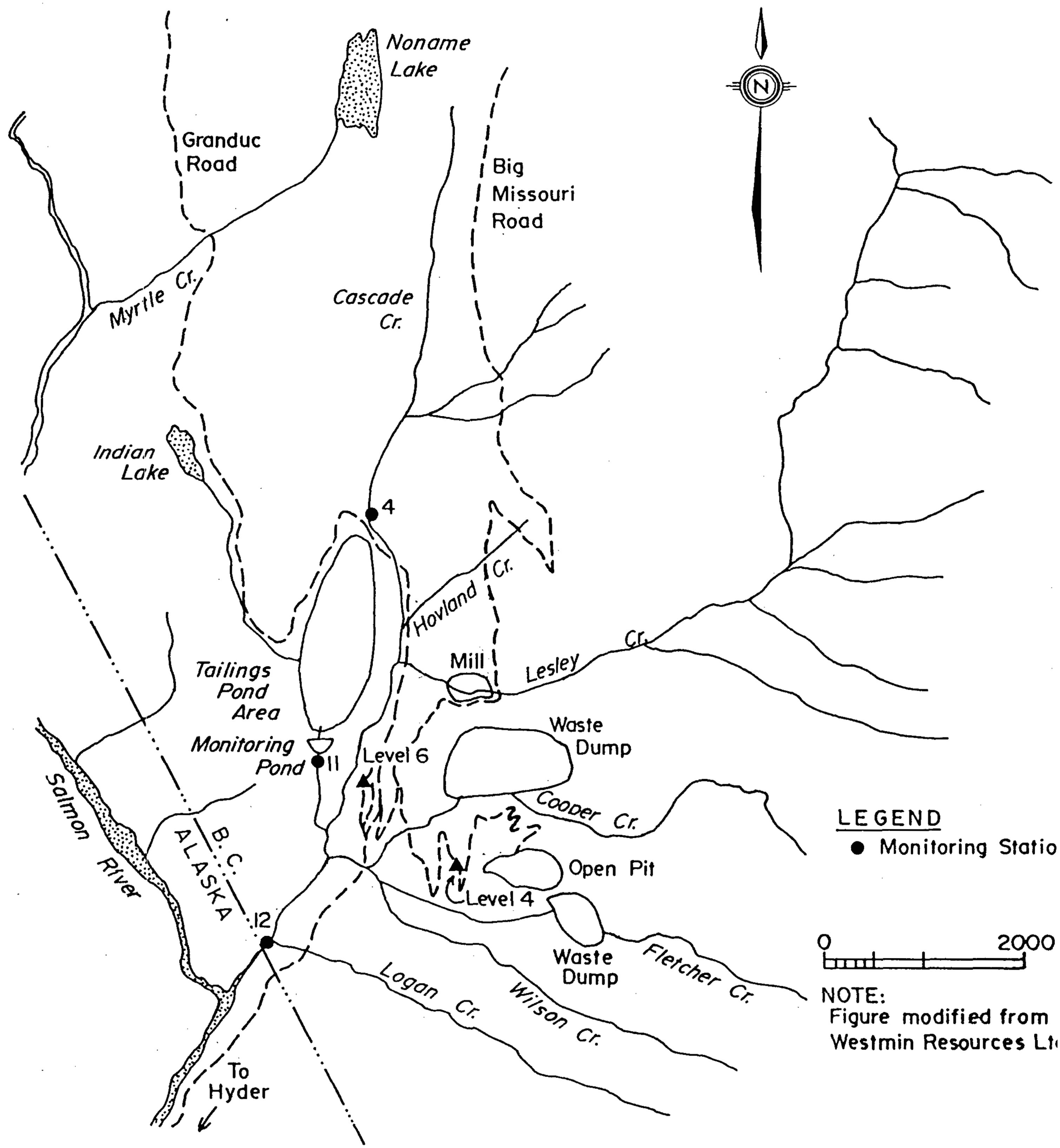


FIGURE 1: RECEIVING WATER SAMPLING STATIONS

2.0 SITE DESCRIPTION

Receiving water monitoring stations were established both above and below potential mining operation influences. Stations names and locations sampled in 1991 are listed below and shown on Figure 1. For comparison, Table 8 lists stations sampled each year from 1987 to 1991. Some stations required relocation due to mining development.

STATION	LOCATION
4	Cascade Creek upstream of the tailings pond
11	Monitoring Pond discharge
12	Cascade Creek downstream of Logan Creek
Level 6	Treated mine water effluent

3.0 MATERIALS AND METHODS

3.1 Sediment Analysis

Sediment samples were collected at four stations during a visit to the mine site on February 25, 1991. A clean acrylic corer was used to collect four replicates from the streambed at each site. The samples were transferred into kraft bags and kept cool until analysed. All samples were sieved to <63 μm except for Station 4 where the sample for sequential analysis was sieved to <150 μm due to shortage of material. Sequential extractions were air dried while the routine total metal analysis samples were oven dried. Total metal samples were digested with reverse aqua regia and analysed for heavy metals using ICAP (Inductively Coupled Argon Plasma) Emission Spectroscopy. A portion of the sediment was ignited at 550°C in a muffle furnace to determine the volatile organic component. 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 methodology was based on the work of Tessier et al. (1979). The samples were rolled to homogenise, 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 for thirty minutes on a wrist action shaker.

5) F(e): <u>Residual metals</u>. The original dried samples were weighed in Teflon digestion vessels and digested with HNO3 and HCl in a microwave oven, resulting in a total fraction (MT). The residual F(e) is 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 reference material NBS 1646 was used as a check on the precision of the procedure.

3.2 Sediment Bioassays

Sediment bioassays using the freshwater cladoceran, Daphnia magna, were conducted on samples from the Premier Gold property and Cascade Creek using a test procedure adapted from Nebeker et al. (1984). The tests were performed by EVS Consultants of North Vancouver, B.C. The test sediments were received on February 27, 1991 and stored in the dark at 4°C until the bioassays were initiated on March 5, 1991. The water used for culture, testing, and controls was reconstituted "hard" water (APHA, 1989). Reagent-grade chemicals were added to Milli-Q deionized water in specific amounts to achieve a final hardness of 160-180 mg/L as $CaCO_3$. The bioassays were conducted in a constant environment chamber at the required test temperature and photoperiod.

Juvenile daphnids were obtained from an in-house laboratory culture. Cultures of daphnids were maintained in two-litre glass beakers (approximately 20 adults/L). Culture medium was replaced every Monday, Wednesday, and Friday; offspring were removed at that time and new cultures initiated if required. The daphnids were fed a diet, consisting of YCTF (yeast, cereal leaves, trout food) and three species of algae, at a rate of 10 ml/L whenever the culture medium was renewed. The daphnids used for the ten-day sediment bioassays were six days old at the start of the bioassay. Neonates (<24 hours old) were collected from one of the culture beakers and held separately until the bioassays were initiated. Feeding and renewal of culture medium was the same as for the main cultures. Six-day-old animals were used because they had not yet begun to produce off-spring but were expected to fully mature during the ten-day exposure period.

Acute lethality testing of whole fresh (unfrozen) sediments involved a ten-day exposure of juvenile daphnids to the test sediments. Sediments were prepared the day before the test was initiated and allowed to settle overnight. The daphnids were added the following day (Day 0). A one cm layer of test sediment was placed in one-litre glass jars, covered with 400 ml of culture water, and mixed thoroughly. The negative (clean) control consisted of culture water only. Five replicates were prepared for each treatment. The jars were covered with plastic lids, fitted with aeration lines, and allowed to equilibrate overnight. The following day, each jar was seeded (randomly and blindly) with ten six-day-old daphnids. Water chemistry parameters (pH, dissolved oxygen, temperature) were measured in one replicate for each treatment on Day 0 and every Monday, Wednesday, and Friday throughout the bioassay period. These parameters were measured in every replicate on Day 10. The containers were checked every Monday, Wednesday, and Friday to establish trends in mortality and to count and remove any offspring produced. The animals were also fed at that time. Any daphnids which had become trapped by surface tension at the air/water interface were gently submerged. The bioassay was allowed to proceed for ten days at a temperature of 23 ± 1°C under a 16:8 hour light:darkness photoperiod.

Final counts of surviving adults and offspring were made after ten days. Daphnids were considered dead when there was no response to physical stimulation and microscopic examination revealed no evidence of movement.

3.3 Statistical Analysis

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, with an alpha value equal to 0.05. Barlett's test was used to evaluate the homogeneity of the variance between sample sites.

An arcsine square-root transformation was used on the sediment bioassay survival data, as recommended for percentage data (Steel and Torrie, 1960). All data were tested for normality and homogeneity of variance prior to detailed statistical analyses. Any significant decreases in survival or total reproduction between the test sediments and negative control were determined by analysis of variance and Dunnett's t-test using the TOXSTAT software program (Gulley et al., 1990).

Power analyses were performed on the sediment bioassays using the computer model "POWER" from Borenstein and Cohen (1988) in order to determine the appropriate sample size for future reproductive sediment bioassays.

4.0 RESULTS

4.1 Total Sediment Analysis

Background aluminum and arsenic concentrations in samples from Cascade Creek upstream (Station 4) were higher than those from the other stations. Calcium, copper, mercury, lead, and zinc concentrations were lowest in sediment samples from Station 4 (Table 1).

Sediment samples collected from Cascade Creek downstream of the tailings pond and the treated mine water discharge point (Station 12), had no significant differences with the upstream station results for any of the metals plotted (Figure 2). The paired comparison between Stations 4 and 12 for cadmium and zinc showed significant differences; however, Tukey's multiple comparison test is not too sensitive to normality departures of the data but it is sensitive to pronounced departure from homogeneity of variance. Bartlett's test, which evaluates the homogeneity of the variance, showed an X^2 equal to 32.47 for cadmium and 35.06 for zinc at alpha equals 0.05 and 3 degrees of freedom. The criteria for significance of $X^2_{(0.05,3)}$ is 7.815 (Zar, 1984). The effect of discharges from Level 6 are quite evident for these two elements using this procedure.

Monitoring pond sediments (Station 11) were high in calcium showing the influence of the milling process where lime is added to increase the pH for cyanidation. Cadmium, copper, mercury, lead, and zinc content were slightly elevated but not significantly different than the upstream station.

Sediments samples from the treated mine water discharge (Level 6) had significant levels of calcium, cadmium, copper, mercury, manganese, lead and zinc. Calcium content was high due to the treatment of mine water with lime to precipitate metal complexes out of the water.

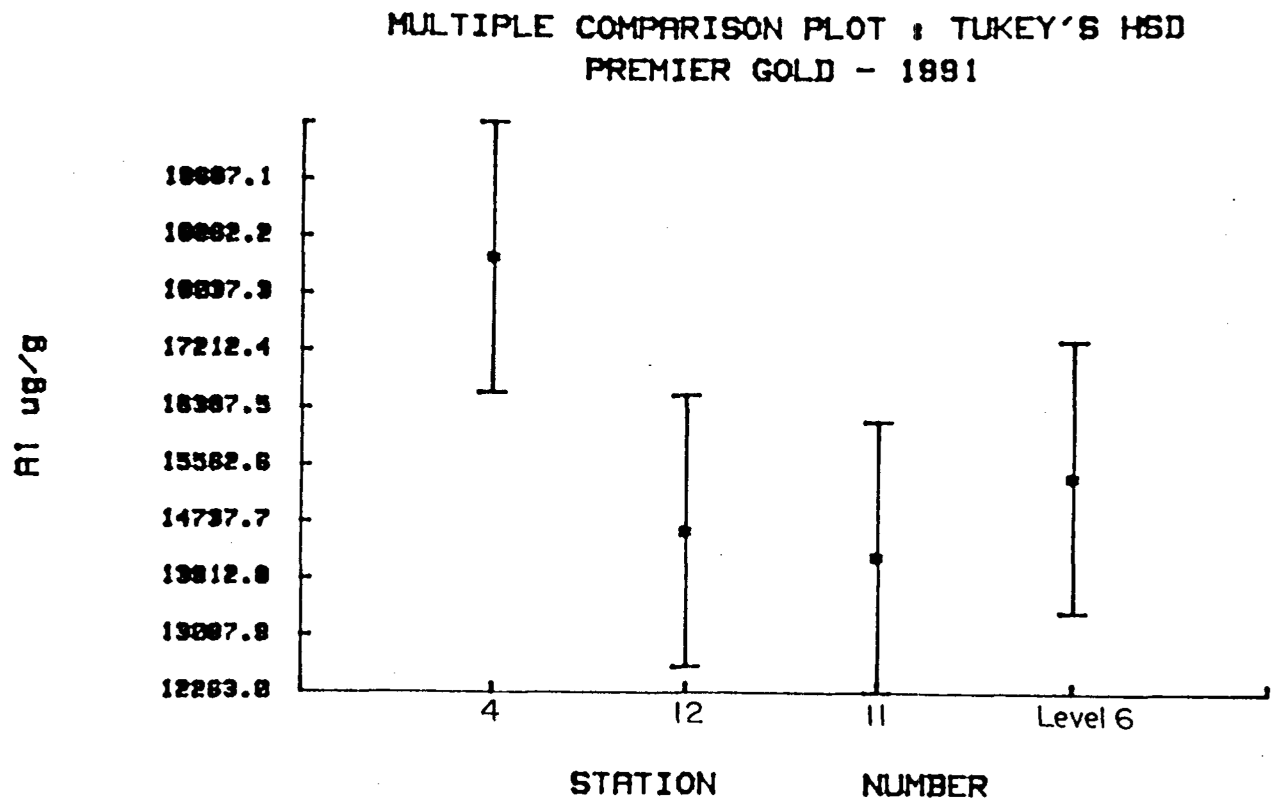
TABLE 1:

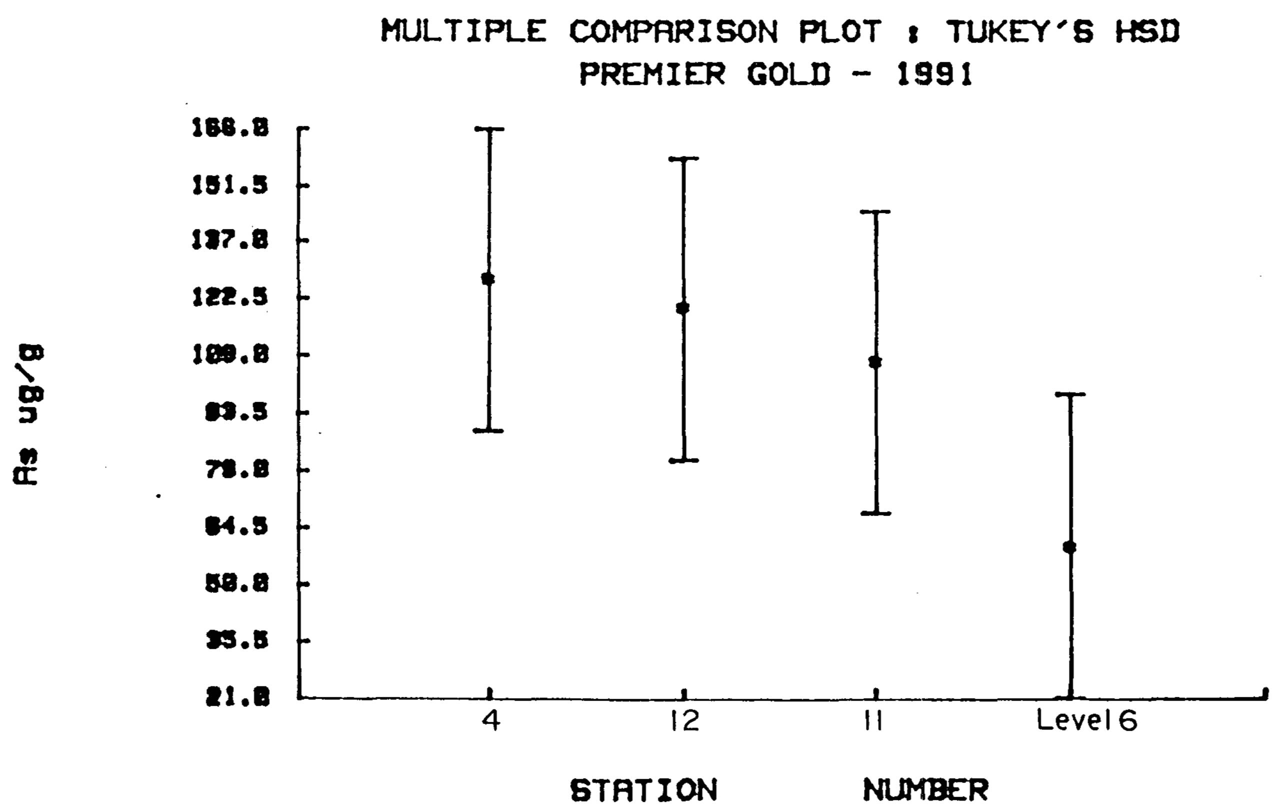
SEDIMENT QUALITY - PREMIER GOLD -
FEBRUARY 25, 1991

Station Number		SEDICP AG UG/G	SEDICP AL UG/G	TOTICP AS UG/G	SEDICP BA UG/G	SEDICP BE UG/G	SEDICP CA UG/G	SEDICP CD UG/G	SEDICP CO UG/G	SEDICP CR UG/G	SEDICP CU UG/G	SEDICP FE UG/G	SEDICP HG UG/G	SEDICP K UG/G	SEDICP MG UG/G	SEDICP MN UG/G
	Repl.1	<2	16500	226	907	0.7	3950	5.4	<20	151.0	59.1	54700	0.350	2400	6800	2320
	Repl.2	<2	18900	82	1360	0.8	4580	5.1	<20	101.0	53.9	53900	0.363	3000	7740	2710
4	Repl.3	<2	18500	110	1220	0.8	5850	8.1	<20	41.5	92.1	63200	0.645	2100	7450	4640
	Repl.4	<2	20300	92	2310	0.9	5130	7.1	<20	58.0	71.6	56400	0.280	3500	7880	3340
	Average	-.-	18550	128	1449	0.8	4878	6.4	-.-	87.9	69.2	57050	0.410	2750	7468	3253
	S.D.	-.-	1570	67	604	0.1	808	1.4	-.-	49.0	17.0	4230	0.161	624	480	1016
	Repl.1	6	17300	160	582	0.6	12100	31.1	<20	33.2	263.0	71000	0.540	2600	6360	3590
	Repl.2	39	13300	110	722	0.5	11700	27.3	<20	24.1	188.0	50500	0.572	2600	4640	2810
12	Repl.3	37	15800	100	792	0.6	9250	23.2	<20	19.3	202.0	54400	0.490	2900	5160	3070
	Repl.4	50	12000	110	687	0.5	11600	27.2	<20	14.0	178.0	51400	0.550	2500	4370	2200
	Average	33	14600	120	696	0.6	11163	27.2	-.-	22.7	207.8	56825	0.538	2650	5133	2918
	S.D.	19	2393	27	87	0.1	1293	3.2	-.-	8.2	38.1	9596	0.035	173	882	578
	Repl.1	42	12400	110	858	0.5	25700	20.5	<20	10.0	174.0	47700	0.511	3300	5000	2290
	Repl.2	<2	15400	110	1120	0.4	30400	27.5	<20	12.0	290.0	53500	0.609	4700	5010	2590
11	Repl.3	53	13100	110	762	0.4	53900	23.2	<20	10.0	174.0	49200	0.460	3100	4990	2420
	Repl.4	41	16000	96	1110	0.5	56900	25.7	<20	11.0	275.0	48300	0.540	4400	5260	2770
	Average	45	14225	107	963	0.5	41725	24.2	-.-	10.8	228.3	49675	0.530	3875	5065	2518
	S.D.	7	1744	7	180	0.1	15954	3.0	-.-	1.0	62.9	2623	0.062	793	130	208
	Repl.1	21	15300	54	537	1.0	136000	369.0	<20	5.5	1370.0	48700	1.700	2900	4050	4310
	Repl.2	26	15100	61	604	1.0	163000	394.0	<20	5.3	1440.0	48600	1.900	2600	4400	4780
Level 6	Repl.3	27	17600	76	642	1.0	137000	318.0	<20	13.0	1290.0	51700	2.100	2900	5860	4420
	Repl.4	21	13600	48	467	1.0	171000	430.0	<20	2.3	1550.0	47300	1.800	2200	4330	4770
	Average	24	15400	60	563	1.0	151750	377.8	-.-	6.5	1412.5	49075	1.875	2650	4660	4570
	S.D.	3	1651	12	77	0.0	17914	47.0	-.-	4.6	110.3	1863	0.171	332	814	241
nbs 1646		<2	23800	<8	56	1.0	4260	<.8	<20	50.3	16.0	32000	0.062	5300	8790	264
nbs 1646		<2	23000	<8	54	1.0	4200	<.8	<20	49.6	16.0	31900	0.064	5100	8650	259
nbs 1646		<2	26700	16	64	1.0	4460	<.8	<20	53.4	16.7	33600	0.068	6100	9230	273

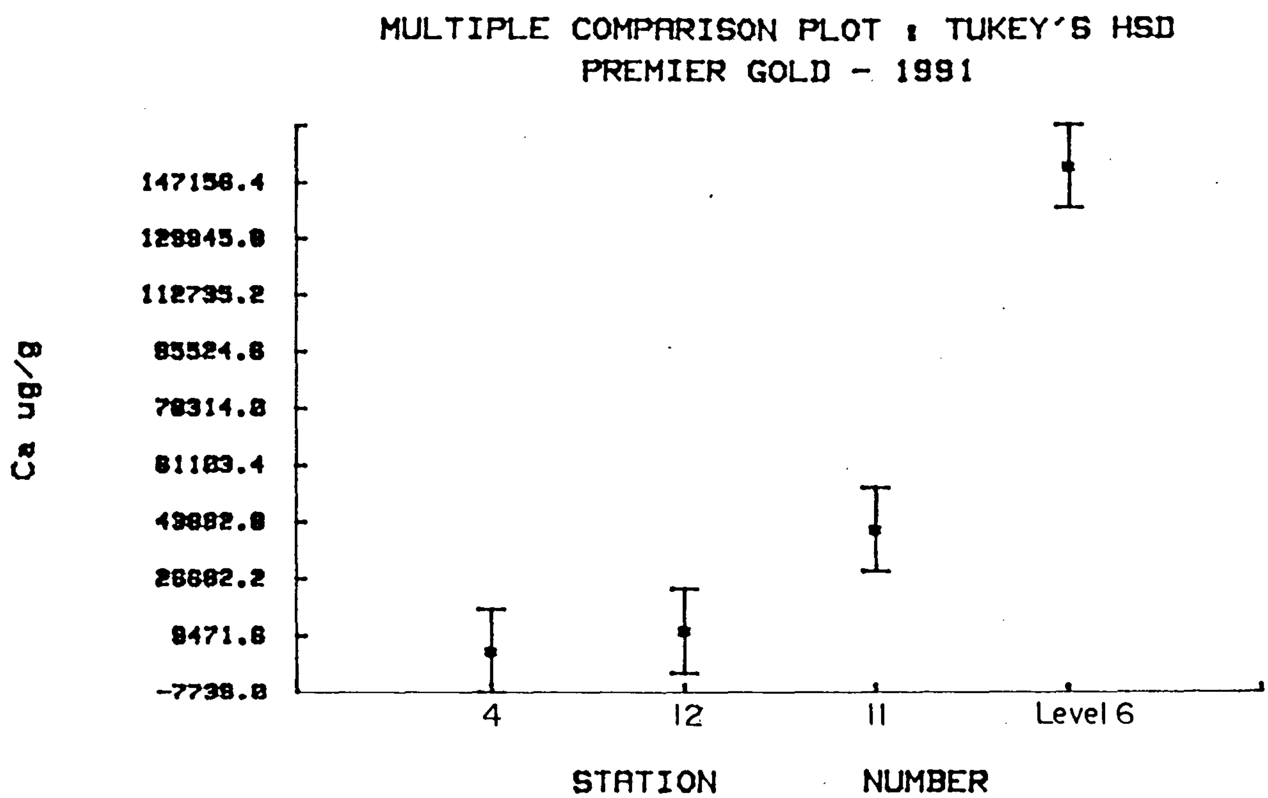
TABLE 1 (cont'd): SEDIMENT QUALITY - PREMIER GOLD - FEBRUARY 25, 1991

Station Number		SEDICP MO UG/G	SEDICP NA UG/G	TOTICP NI UG/G	SEDICP P UG/G	SEDICP PB UG/G	SEDICP SB UG/G	SEDICP SI UG/G	SEDICP SN UG/G	SEDICP SR UG/G	SEDICP TI UG/G	SEDICP V UG/G	SEDICP ZN UG/G	SFR MG/KG	SVR MG/KG
	Repl.1	20	100	120	1300	416	<10	1000	140	36.4	97.8	38	561	-.-	-.-
	Repl.2	10	100	76	1600	722	<8	980	166	45.5	68.9	40	550	-.-	-.-
4	Repl.3	8	90	43	1680	434	<8	1170	43	56.4	126.0	40	689	964000	35500
	Repl.4	9	100	56	1700	426	<9	950	57	70.6	72.5	44	749	-.-	-.-
	Average	12	98	74	1570	500	-.-	1025	102	52.2	91.3	41	637	-.-	-.-
	S.D.	6	5	34	185	149	-.-	99	61	14.7	26.5	3	98	-.-	-.-
	Repl.1	7	100	24	1600	737	<8	608	<8	69.4	398.0	47	3530	-.-	-.-
	Repl.2	7	100	17	1300	633	20	814	10	70.7	325.0	34	3190	959000	41200
12	Repl.3	7	100	18	1300	579	20	935	10	63.4	405.0	42	2750	953000	47400
	Repl.4	6	100	20	1400	582	18	792	<8	66.4	326.0	34	3200	959000	41200
	Average	7	100	20	1400	633	19	787	10	67.5	363.5	39	3168	957000	43267
	S.D.	1	0	3	141	74	1	135	0	3.3	44.0	6	320	3464	3580
	Repl.1	4	100	10	1300	691	20	895	<8	109.0	244.0	34	2370	972000	28200
	Repl.2	6	100	9	1300	894	<8	685	<8	115.0	204.0	34	3270	967000	33100
11	Repl.3	4	200	9	1300	632	23	1760	<8	144.0	373.0	28	2780	973000	26700
	Repl.4	6	220	10	1100	920	24	1860	<8	148.0	337.0	32	3130	976000	24200
	Average	5	155	10	1250	784	22	1300	-.-	129.0	289.5	32	2888	972000	28050
	S.D.	1	64	1	100	144	2	597	-.-	19.8	78.8	3	402	3742	3749
	Repl.1	4	100	9	910	1830	<8	969	<8	623.0	222.0	29	38100	808000	192000
	Repl.2	5	100	9	940	2090	<8	1440	<8	782.0	261.0	28	41700	893000	107000
Level 6	Repl.3	6	200	10	1000	2090	<8	1360	<8	641.0	412.0	41	33400	899000	101000
	Repl.4	4	200	10	840	1740	<8	1150	<8	881.0	145.0	21	46000	893000	107000
	Average	5	150	10	923	1938	-.-	1230	-.-	731.8	260.0	30	39800	873250	126750
	S.D.	1	58	1	67	180	-.-	213	-.-	122.3	112.2	8	5351	43592	43592
nbs 1646		3	10800	25	540	25	<8	1100	<8	31.2	789.0	57	124	-.-	-.-
nbs 1646		3	10700	26	530	26	<8	1100	<8	30.5	754.0	57	121	-.-	-.-
nbs 1646		4	11200	28	560	29	<8	931	<8	32.9	823.0	63	131	-.-	-.-





<u>FIGURE 2</u>: SEDIMENT MULTIPLE COMPARISON PLOT - PREMIER GOLD 1991 - **Al, As**



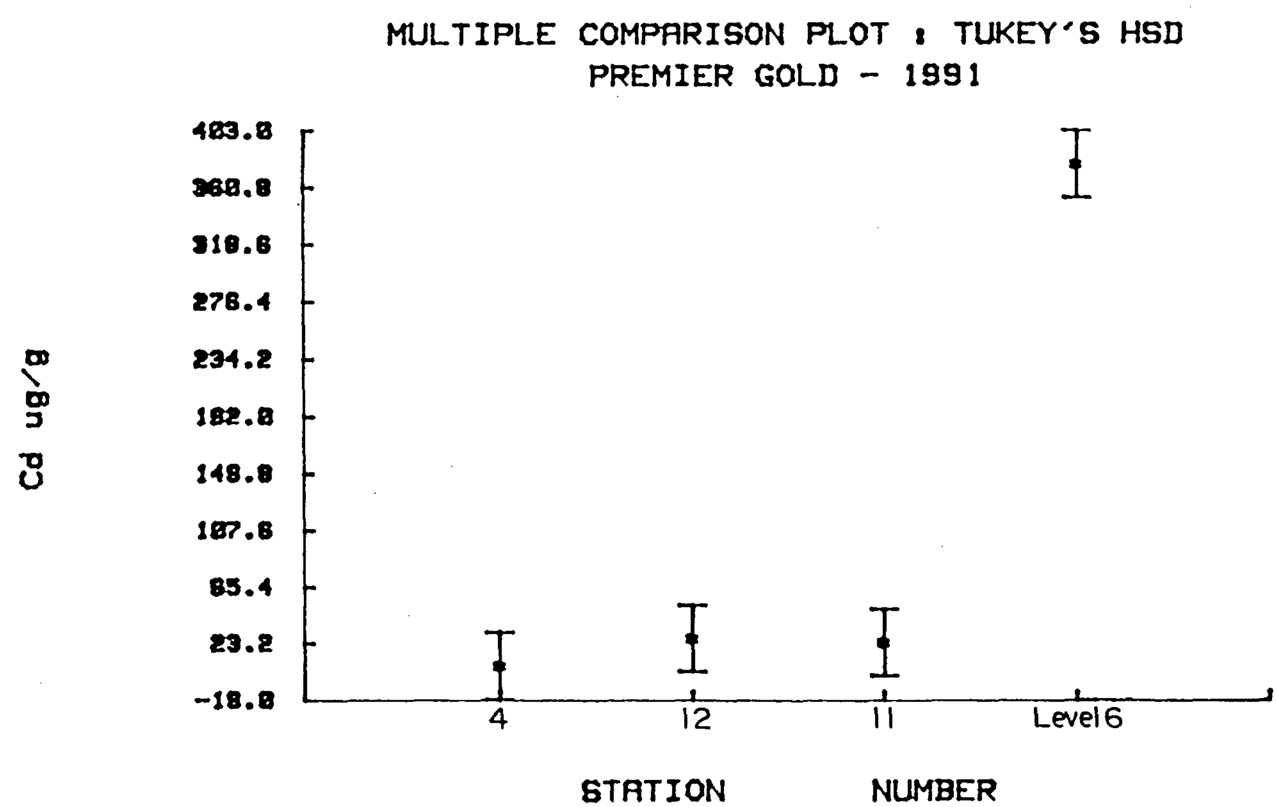
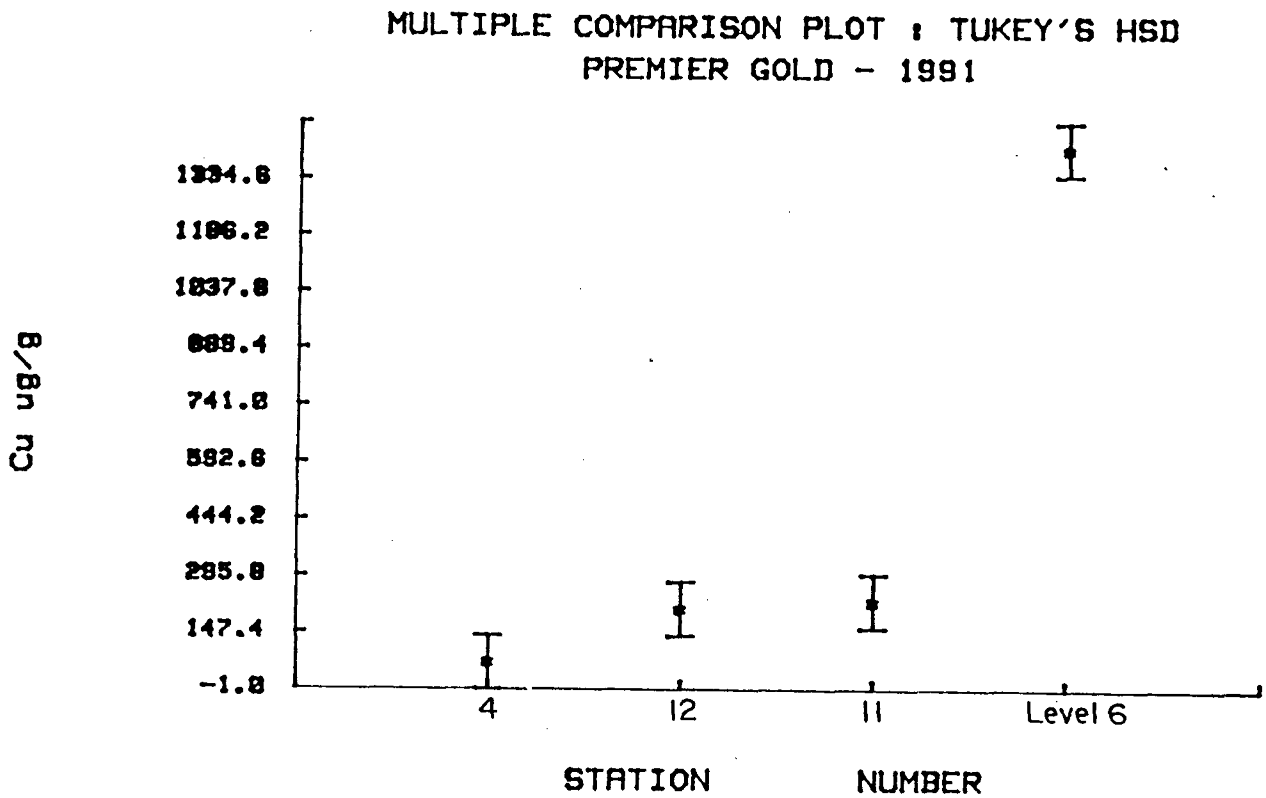
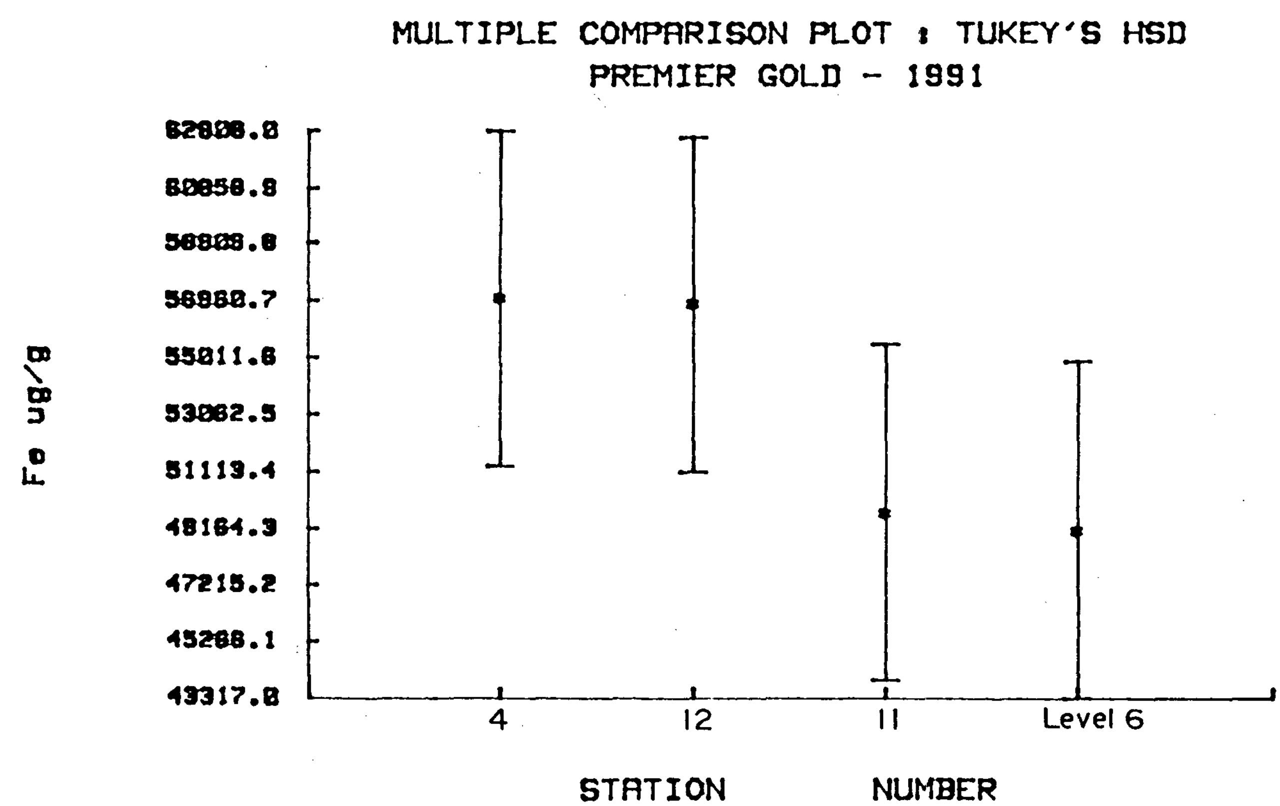
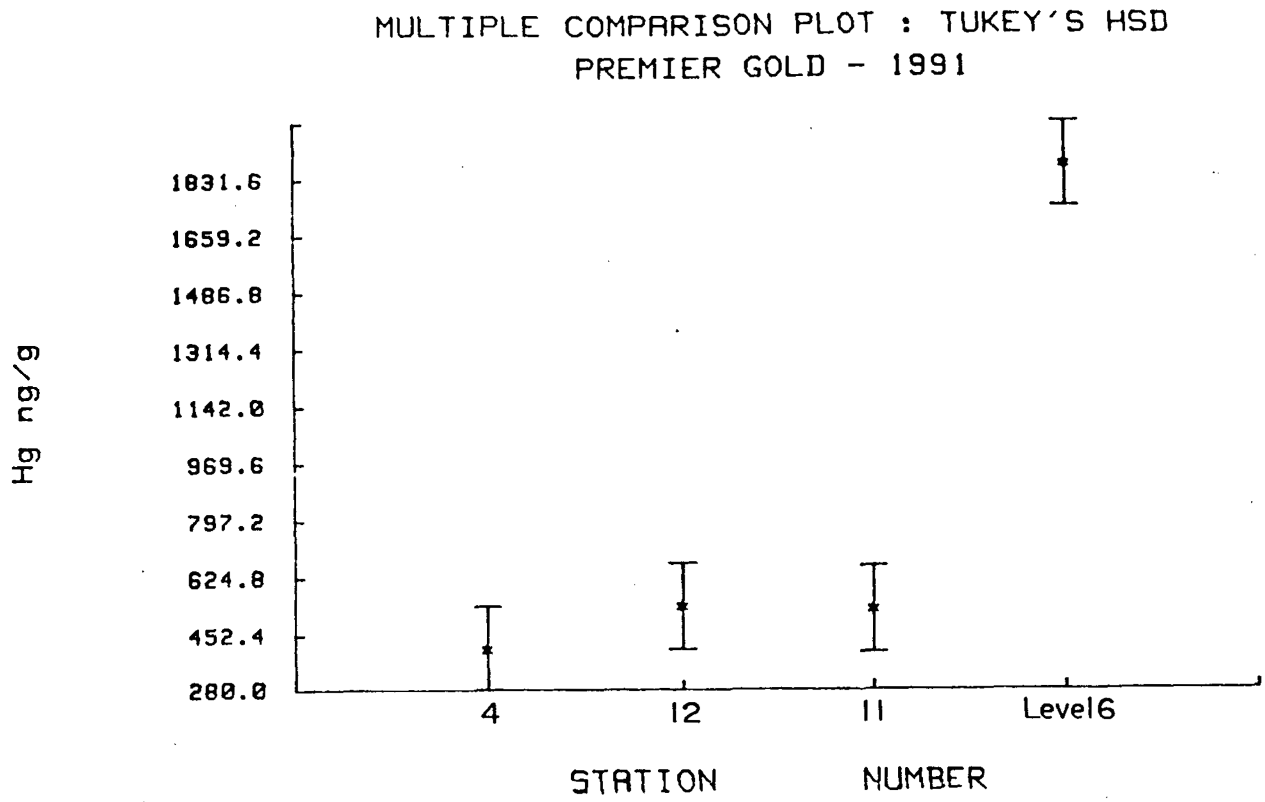


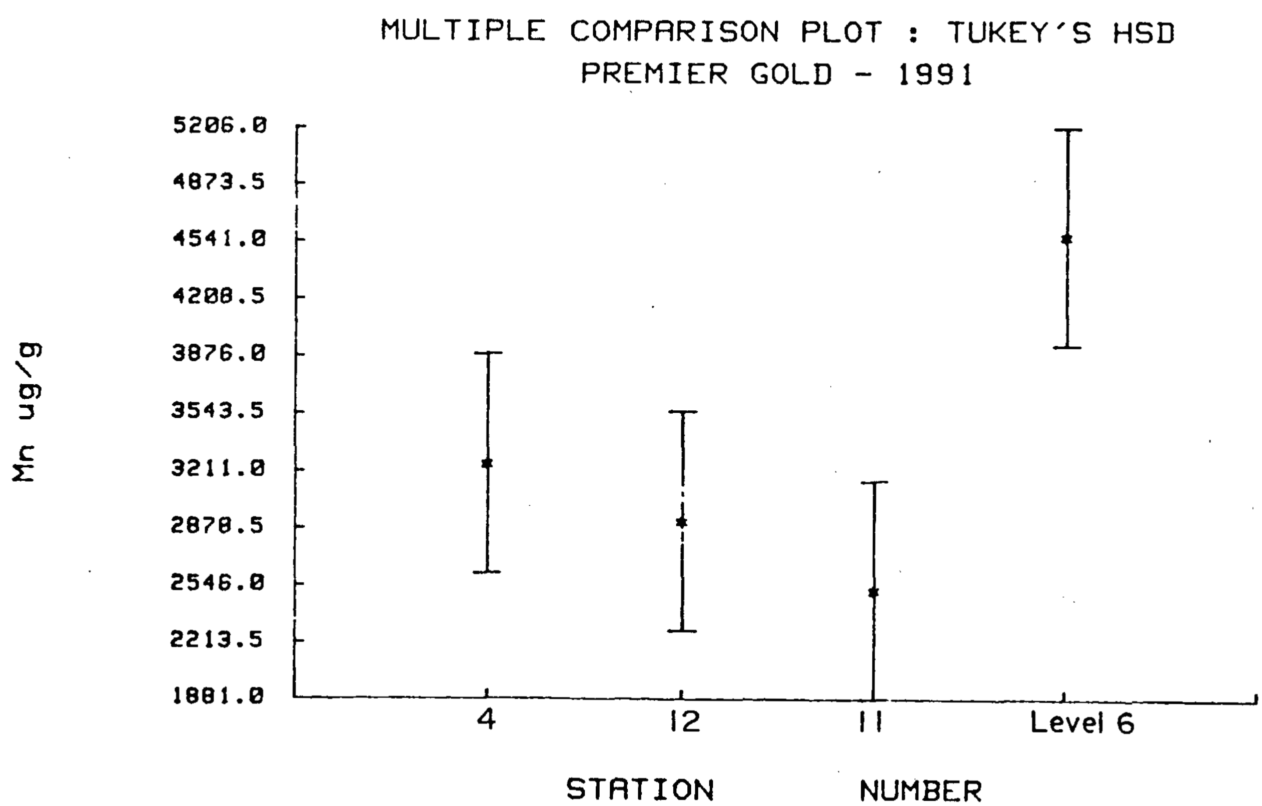
FIGURE 2: SEDIMENT MULTIPLE COMPARISON PLOT - PREMIER GOLD 1991 - Ca, Cd



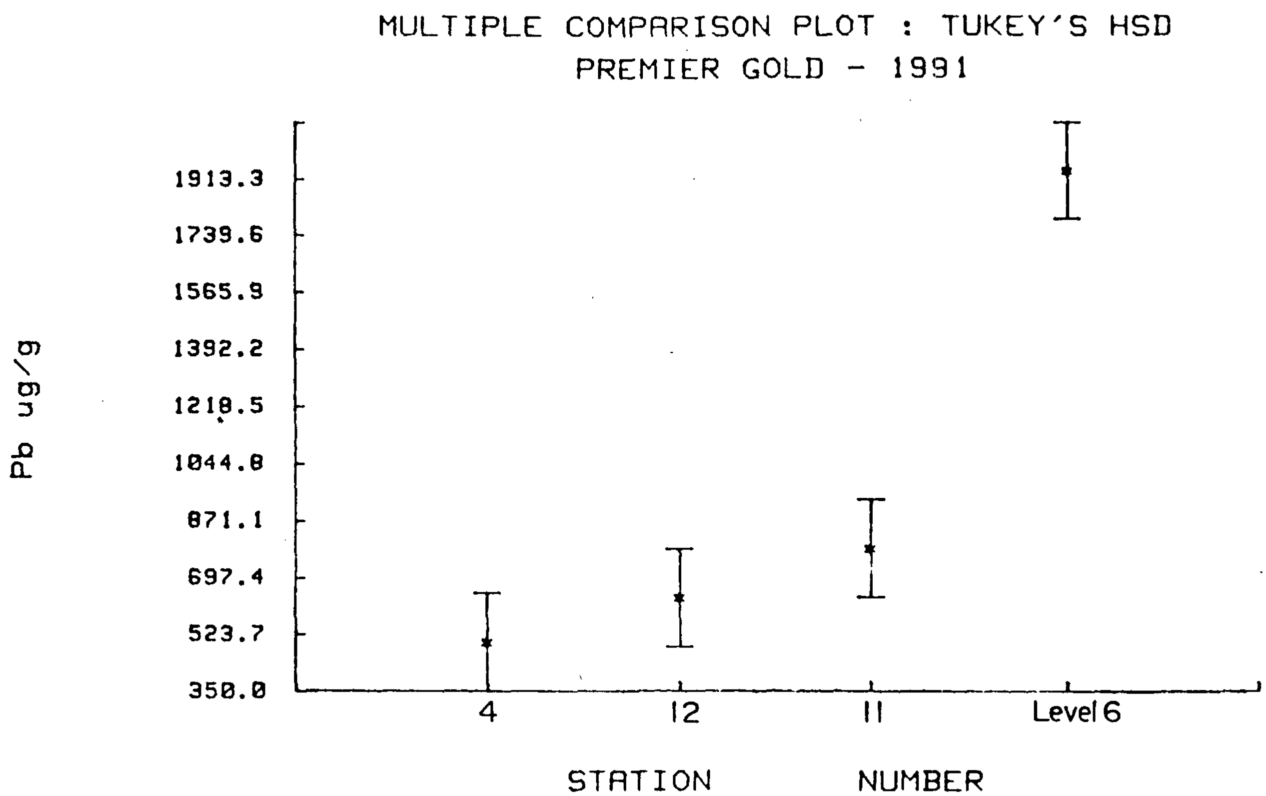


<u>FIGURE 2</u>: SEDIMENT MULTIPLE COMPARISON PLOT - PREMIER GOLD 1991 - Cu, Fe





<u>FIGURE 2</u>: SEDIMENT MULTIPLE COMPARISON PLOT - PREMIER GOLD 1991 - Hg, Mn



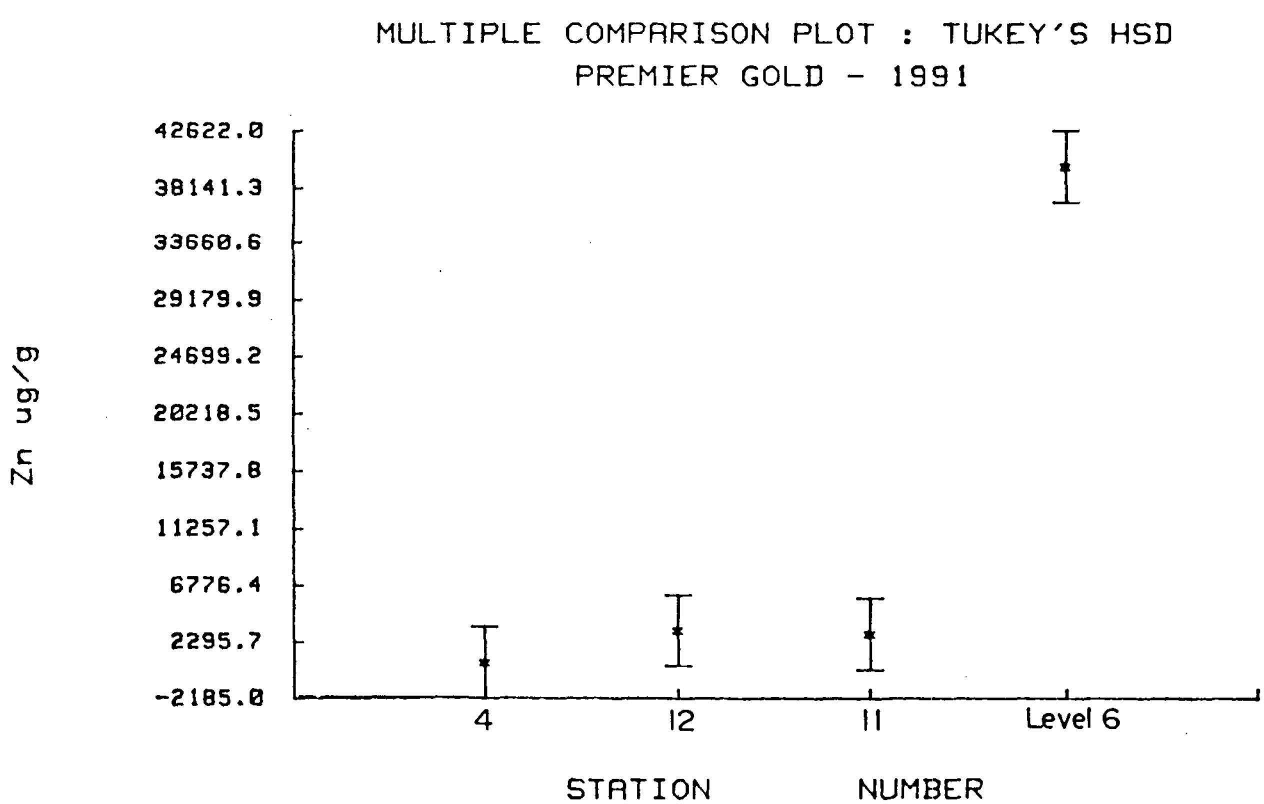


__FIGURE 2__: **SEDIMENT MULTIPLE COMPARISON PLOT - PREMIER GOLD 1991 - Pb, Zn**

4.2 Sequential Extraction

Sediment sequential extractions were performed for all stations (Tables 2 - 5). Evaluation focuses on cadmium, copper, lead, and zinc due to their significance in the acid rock drainage and mill effluent process (Figures 3 - 6). The biological availability of an element was evaluated by the ease at which it can be remobilized from the sediments. The exchangeable and carbonate fractions were viewed as having the highest potential to become bioavailable. The other fractions may or may not become bioavailable depending on other processes such asa microbial degradation, bioaccumulation of the organic fraction, oxidation of sulphides, or changes in redox potential and solubilization of the iron and manganese oxides.

Sediments from Cascade Creek upstream of the tailings pond (Station 4) had some cadmium available with a combined exchangeable and carbonate fraction of 1.8 μg/g. Copper (8.16 μg/g) and lead (121 μg/g) were available in the carbonate fraction while zinc (139.9 μg/g) was available in the first two fractions.

Sediments from Cascade Creek downstream of the tailings and monitoring ponds (Station 12) had a pattern similar to that at Station 4. Cadmium (4.5 μg/g) and zinc (483.8 μg/g) were present in the exchangeable and carbonate fractions. Copper (21.2 μg/g) and lead (190 μg/g) were available in the carbonate fraction. Levels were considerably higher than at Station 4.

Sediments from the monitoring pond discharge (Station 3) had undetectable amounts of cadmium, copper, lead, and zinc in the exchangeable fraction. All metals could be detected in the carbonate fraction. Cadmium levels were 1.3 μg/g, the lowest of the four sites. Copper concentration was 35.8 μg/g, lead 249 μg/g, and zinc was 123 μg/g. These metals might be in the form of metal cyanide complexes.

Concentrations in sediments from the mine water treatment pond (Station 4) were the highest measured. Cadmium was 201.4 μg/g, copper 309.4 μg/g, lead 337 μg/g, and zinc 18,633 μg/g in the exchangeable plus carbonate fractions. In each case the carbonate fraction was much greater.

TABLE 2: SEDIMENT SEQUENTIAL EXTRACTION - STATION 4 - CASCADE CREEK UPSTREAM OF TAILINGS POND - FEBRUARY 26, 1991

Metals (μg/g)	Exchange-able	Carbonates	Fe+Mn Oxide	Organic & Sulphides	Residual	Total
Ag	<0.5	<0.5	<0.5	<0.5	<2	<2
Al	<3	223	1020	594	14700	16500
As	<3	<3	<3	16	210	226
Ba	41.5	80	97.7	3.5	684	907
Be	<0.05	0.1	0.2	<0.05	<0.4	0.7
Ca	555	240	170	1040	1950	3950
Cd	0.5	1.3	0.89	<0.3	<2.71	5.4
Co	<5	<5	8	<5	<12	<20
Cr	0.56	0.55	2.9	1.4	146	151
Cu	<0.3	8.16	7.91	13.9	29.1	59.1
Fe	<3	455	6520	1970	45800	54700
K	<100	<100	<100	<100	2400	2400
Mn	14.1	284	591	14.7	1420	2320
Mo	<0.5	<0.5	<0.5	<0.5	20	20
Ni	<1	2	3	1	114	120
P	<5	7	50	685	558	1300
Pb	<3	121	47	<3	248	416
Sb	<3	<3	<3	<3	<10	<10
Sn	<3	<3	<3	<3	140	140
Sr	7.45	2.5	2.4	6.76	17.3	36.4
Ti	<0.1	<0.1	<0.1	<0.1	97.8	97.8
V	0.6	<0.5	1	0.7	35.7	38
Zn	10.9	129	84.1	23.8	313	561

TABLE 3: SEDIMENT SEQUENTIAL EXTRACTION - STATION 12, CASCADE CREEK DOWNSTREAM OF LOGAN CREEK - FEBRUARY 26, 1991

Metals (µg/g)	Exchange-able	Carbonates	Fe+Mn Oxide	Organic & Sulphides	Residual	Total
Ag	<0.5	<0.5	<0.5	0.7	<5.3	6
Al	3	550	1330	850	14600	17300
As	<2	<2	<2	14	146	160
Ba	35.4	65	72	3.3	406	582
Be	<0.05	0.08	0.2	<0.05	<0.32	0.6
Ca	1800	2740	460	1420	5680	12100
Cd	2.6	1.9	1.1	1.7	23.8	31.1
Co	<5	<5	<5	<5	<20	<20
Cr	<0.2	0.5	1.5	1.1	30.1	33.2
Cu	<0.2	21.2	8.23	78.7	155	263
Fe	<2	748	8460	4190	57600	71000
K	<90	<90	<90	<90	2600	2600
Mn	53.3	665	771	22.5	2080	3590
Mo	<0.5	<0.5	0.5	<0.5	<6.5	7
Ni	<0.9	1	1	<0.9	22	24
P	<5	10	30	890	670	1600
Pb	<2	190	84.4	<2	463	737
Sb	<2	<2	<2	<2	<8	<8
Sn	<2	<2	<2	<2	<8	<8
Sr	12.9	14.2	4.1	6.63	31.6	69.4
Ti	<0.09	<0.09	<0.09	9	389	398
V	<0.5	<0.5	2	1	44	47
Zn	36.8	447	156	231	2660	3530

TABLE 4: **SEDIMENT SEQUENTIAL EXTRACTION - STATION 11, MONITORING POND EFFLUENT - FEBRUARY 26, 1991**

Metals (μg/g)	Exchange-able	Carbonates	Fe+Mn Oxide	Organic & Sulphides	Residual	Total
Ag	<0.4	<0.4	<0.4	<0.4	42	42
Al	3	526	803	684	10400	12400
As	<2	<2	<2	9	101	110
Ba	32.3	62.6	48	3.5	712	858
Be	<0.04	0.08	0.1	<0.04	<0.32	0.5
Ca	1470	14300	670	1270	7990	25700
Cd	<0.2	1.3	0.85	2.7	15.7	20.5
Co	<4	<4	<4	<4	<20	<20
Cr	0.5	1.2	0.98	0.62	6.7	10
Cu	<0.2	35.8	5.46	71.5	61.2	174
Fe	<2	2660	5330	4070	35600	47700
K	80	100	<80	<80	3120	3300
Mn	132	1240	143	19.3	756	2290
Mo	<0.4	<0.4	<0.4	<0.4	<4	4
Ni	<0.8	3	<0.8	<0.8	<7	10
P	<4	20	30	837	413	1300
Pb	<2	249	72.7	<2	369	691
Sb	<2	4	2	<2	<14	20
Sn	<2	<2	<2	<2	<8	<8
Sr	6	58.6	5.97	7.1	31.3	109
Ti	<0.08	<0.08	<0.08	3.9	240	244
V	<0.4	<0.4	2	1	31	34
Zn	<0.08	123	62.5	405	1780	2370

TABLE 5: **SEDIMENT SEQUENTIAL EXTRACTION - LEVEL 6, TREATED MINE WATER EFFLUENT - FEBRUARY 26, 1991**

Metals (µg/g)	Exchange-able	Carbonates	Fe+Mn Oxide	Organic & Sulphides	Residual	Total
Ag	<0.4	<0.4	<0.4	<0.4	21	21
Al	2	2640	1660	1110	9890	15300
As	<2	<2	<2	8	46	54
Ba	16.5	49.8	20.4	7.11	443	537
Be	<0.04	0.4	0.48	0.06	0.06	1
Ca	4200	57600	3960	260	70000	136000
Cd	24.4	177	12.1	3.6	152	369
Co	<4	<4	<4	<4	<20	<20
Cr	0.3	<0.2	<0.2	0.62	4.58	5.5
Cu	2.4	307	4.1	666	391	1370
Fe	<2	2420	17700	4920	23700	48700
K	<80	<80	<80	<80	2900	2900
Mn	249	1620	403	29.9	2010	4310
Mo	<0.4	<0.4	<0.4	0.7	<3.3	4
Ni	<0.8	3	<0.8	<0.8	<6	9
P	<4	50	53	310	497	910
Pb	<2	337	218	105	1170	1830
Sb	<2	<2	<2	<2	<8	<8
Sn	<2	<2	<2	<2	<8	<8
Sr	57.6	330	26.4	1.8	207	623
Ti	<0.08	<0.08	<0.08	12.8	209	222
V	<0.4	<0.4	1	2	26	29
Zn	233	18400	4240	546	14700	38100

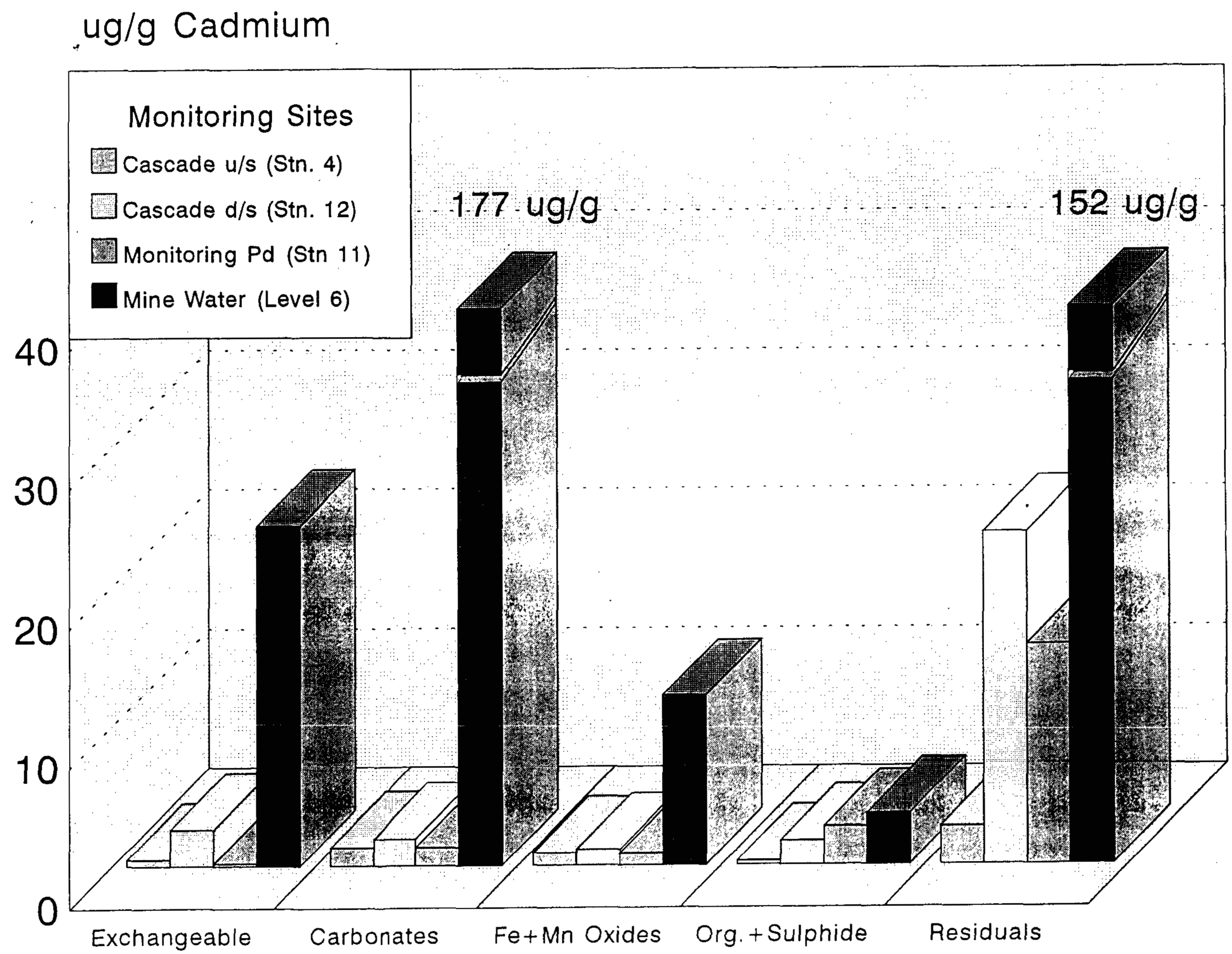


FIGURE 3: SEDIMENT SEQUENTIAL EXTRACTION - PREMIER GOLD 1991 - CADMIUM

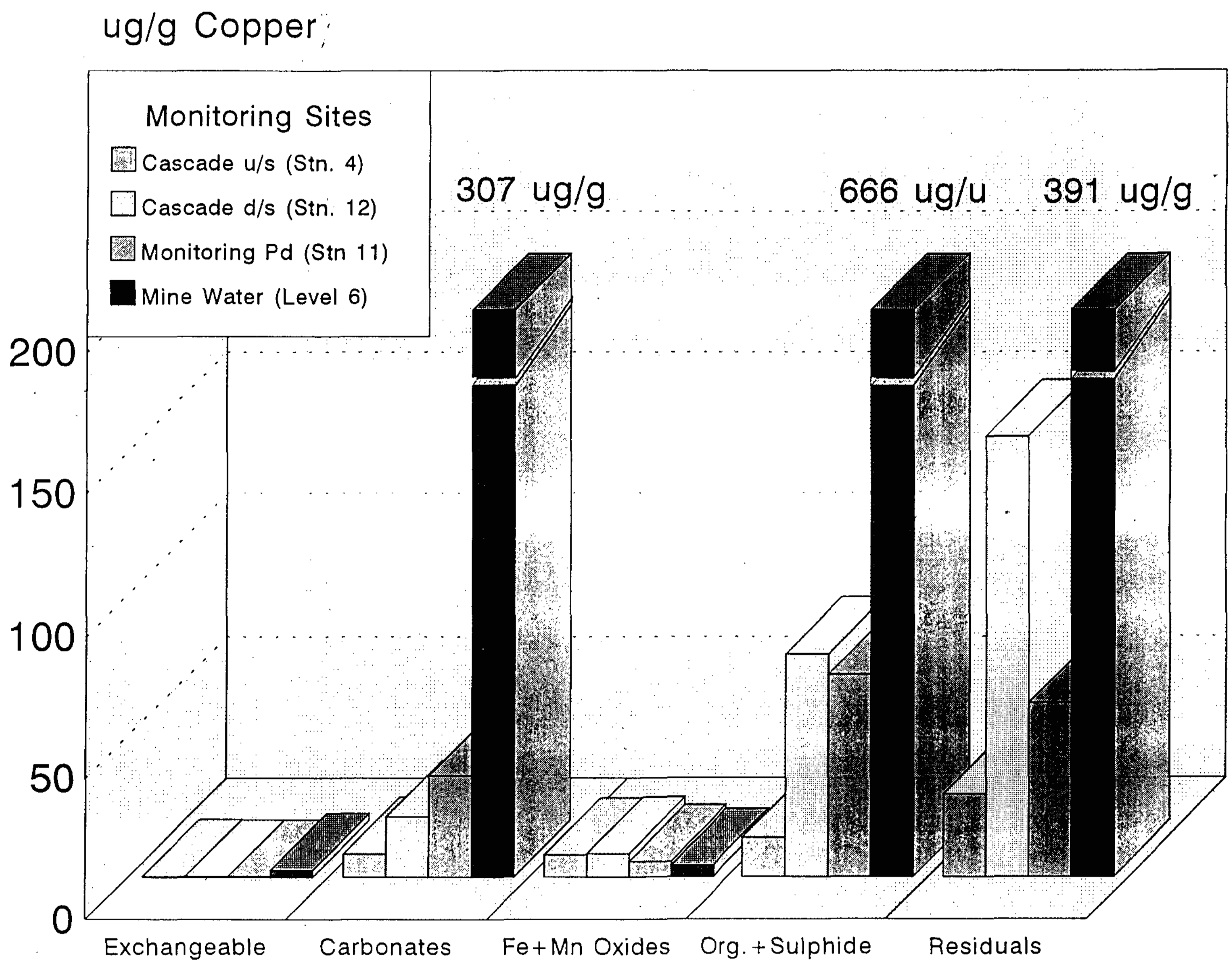


FIGURE 4: SEDIMENT SEQUENTIAL EXTRACTION - PREMIER GOLD 1991 - COPPER

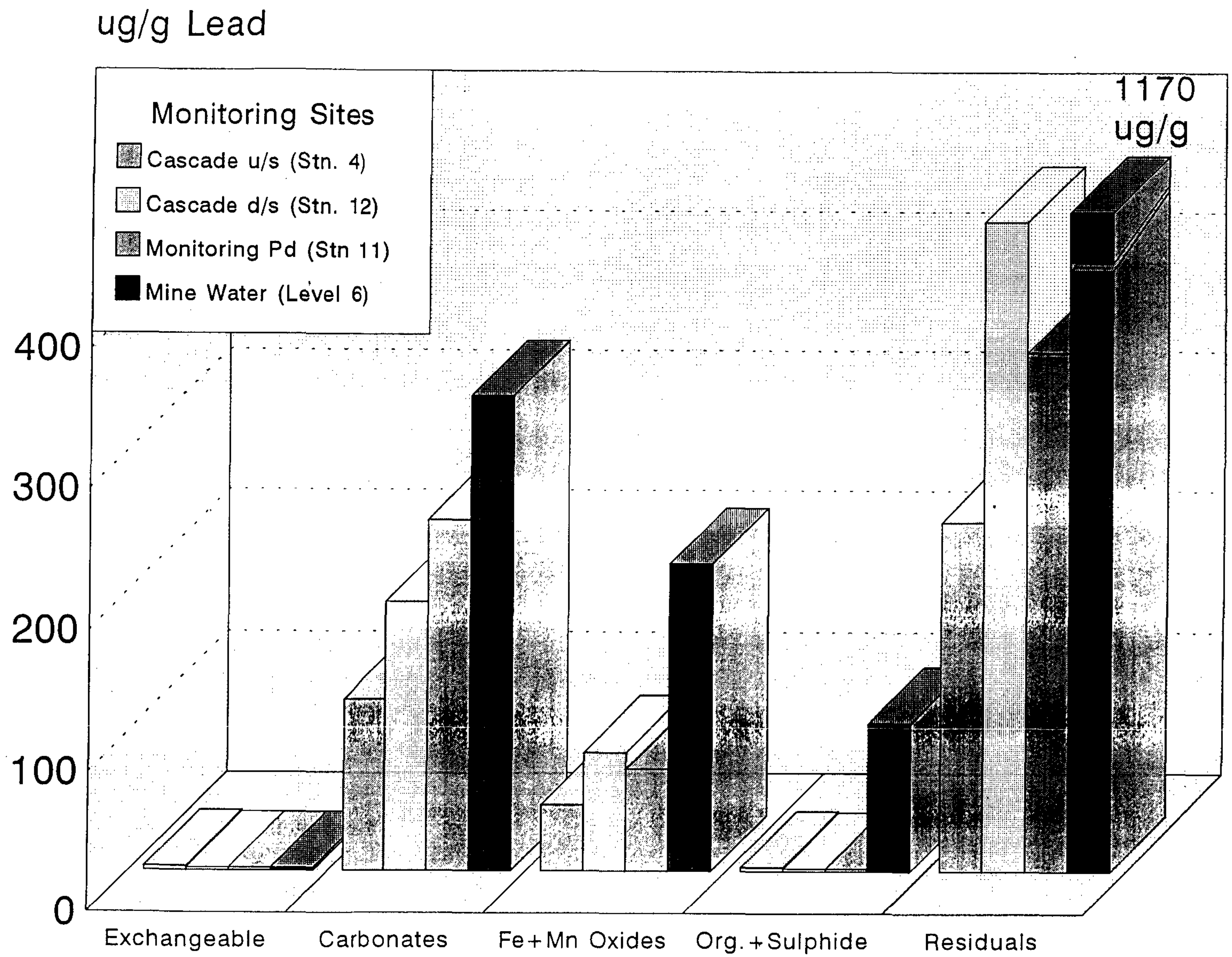


FIGURE 5: SEDIMENT SEQUENTIAL EXTRACTION - PREMIER GOLD 1991 - LEAD

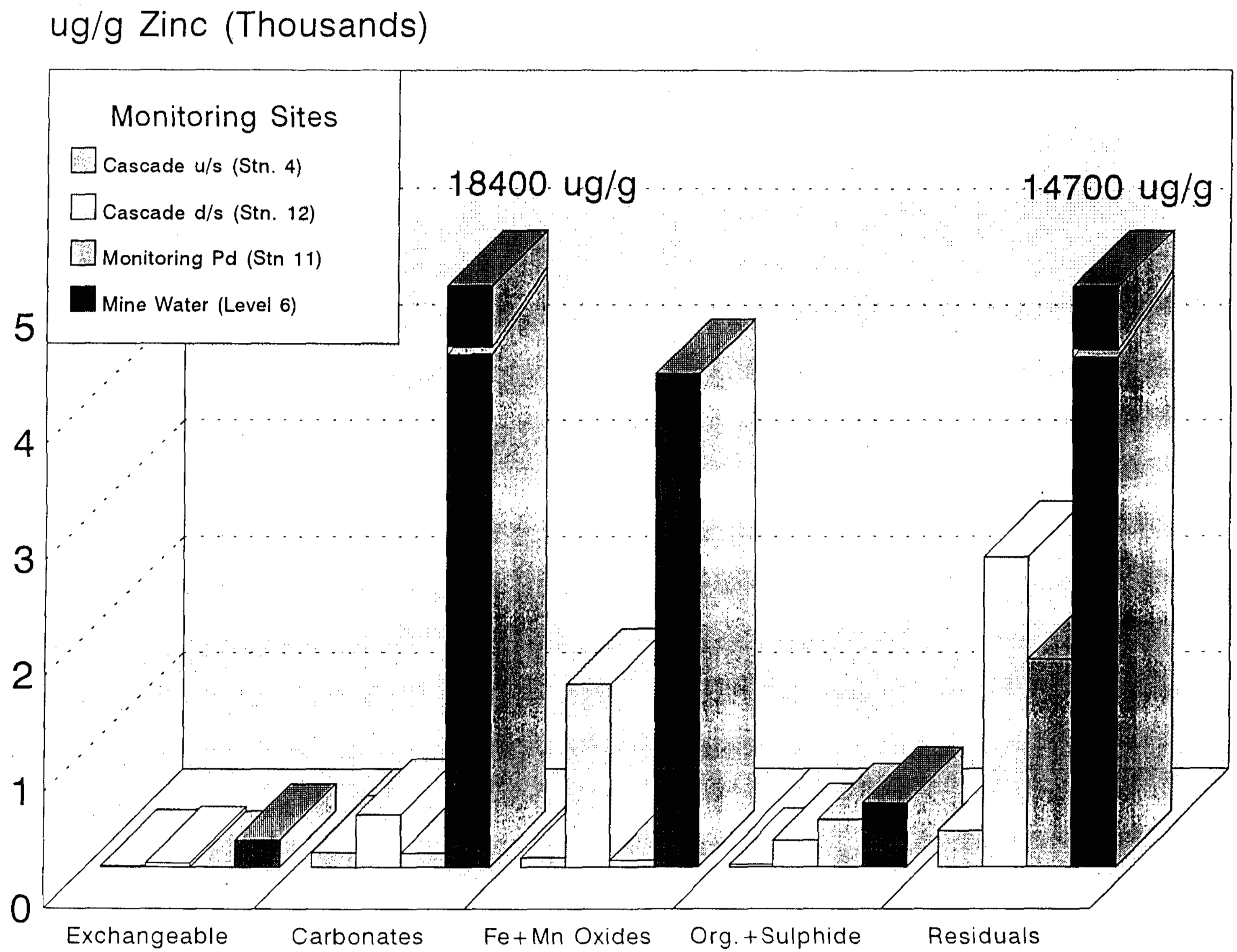


FIGURE 6: SEDIMENT SEQUENTIAL EXTRACTION - PREMIER GOLD 1991 - ZINC

4.3 Sediment Bioassays

The sediment bioassay data are reproduced in Table 6 while the results of the sediment bioassays are summarized in Table 7. Mean survival in the test sediments ranged from a low of 0.2 out of 10 (2%) for Level 6 to a high of 9.6 out of 10 (96%) for Station 4. Three of the test sediments had mean survival values of at least 84%. Mean survival in the negative control was 9.8 out of 10 (98%), which was above the minimum criterion of 90%. The results of the analysis of variance (performed on arcsine square-root transformed data) indicated that there were significant differences (p=0.05) in survival between the treatments. Using Dunnett's t-test, Level 6 was identified as having a significantly lower mean survival relative to the control.

Statistical analysis was also performed on the reproduction data. Offspring were observed in large numbers on Day 6 for Stations 4, 11 and 12. Reproduction for Level 6 was very low throughout the test. The mean number of offspring produced (per test container) ranged from a low of 5.0 for Level 6 to a high of 250.6 for Station 11, and was 122.8 in the control. Only Station 11 had higher reproduction than the control. The results of the statistical analyses indicated that there were significant decreases in reproduction for Stations 4, 12, and Level 6 relative to the control.

Power analysis

A power analysis of the survival data was done to compare Station 12 and the control. The test showed that with a sample size of 8 for each site, a significant difference can be obtained 80% of the time for difference in population means of 8.5% or greater for a one-tail analysis with a probability $\alpha = 0.10$.

In order to produce a significant difference 80% of the time for a 7.3% or greater difference between downstream and upstream sediment bioassay, population means would require a sample size of 11 at these two sampling sites.

TABLE 6: *Daphnia magna* **10-DAY SEDIMENT BIOASSAY TEST DATA**

Lab Control

Totals at Day 10			Water Chemistry at Day 10			
Replicate	Adults Alive at Day 10	Total Offspring Produced	Temp (°C)	D.O. (mg/L)	pH	Cond. (μmho/cm)
A	10	140	23	8.3	7.9	380
B	10	110	23	8.3	8.0	-
C	9	127	23	8.3	8.0	-
D	10	108	23	8.3	8.1	-
E	10	129	23	8.3	8.1	-

Station 4

Totals at Day 10			Water Chemistry at Day 10			
Replicate	Adults Alive at Day 10	Total Offspring Produced	Temp (°C)	D.O. (mg/L)	pH	Cond. (μmho/cm)
A	10	83	23	8.3	7.9	335
B	9	52	23	8.3	7.9	-
C	10	68	23	8.3	7.9	-
D	9	72	23	8.1	7.9	-
E	10	64	23	8.1	7.9	-

Station 11

Totals at Day 10			Water Chemistry at Day 10			
Replicate	Adults Alive at Day 10	Total Offspring Produced	Temp (°C)	D.O. (mg/L)	pH	Cond. (μmho/cm)
A	10	218	23	7.5	8.0	425
B	8	216	23	7.5	7.9	-
C	10	261	23	7.5	8.0	-
D	10	295	23	7.5	8.0	-
E	9	263	23	7.5	8.0	-

TABLE 6 (cont): ***Daphnia magna*** **10-DAY SEDIMENT BIOASSAY TEST DATA**

Station 12

Totals at Day 10			Water Chemistry at Day 10			
Replicate	Adults Alive at Day 10	Total Offspring Produced	Temp (°C)	D.O. (mg/L)	pH	Cond. (µmho/cm)
A	10	63	23	8.1	7.9	345
B	9	36	23	8.1	7.9	-
C	7	24	23	8.1	8.0	-
D	10	61	23	8.1	7.9	-
E	6	23	23	8.1	8.0	-

Level 6

Totals at Day 10			Water Chemistry at Day 10			
Replicate	Adults Alive at Day 10	Total Offspring Produced	Temp (°C)	D.O. (mg/L)	pH	Cond. (µmho/cm)
A	1	12	23	8.9	8.5	360
B	0	1		-	-	-
C	0	3		-	-	-
D	0	3		-	-	-
E	0	6		-	-	-

TABLE 7: SUMMARY OF 10-DAY *Daphnia magna* SEDIMENT BIOASSAY RESULTS

Sample I.D.	Mean Values ± S.D.[1]	
	Survival[2]	Reproduction
Station 4	9.6 ± 0.5	67.8 ± 11.3*
Station 11	8.4 ± 1.8	41.4 ± 19.5*
Station 12	9.4 ± 0.9	250.6 ± 33.5
Level 6	0.2 ± 0.4*	5.0 ± 4.3*
Control	9.8 ± 0.4	122.8 ± 13.6

[1] n=5 ; * denote values significantly different (p<0.05) from the control.
[2] A value of 10.0 = 100% survival.

Evaluation of significant difference between Station 4 and Station 12

Reproduction test

Two samples one sided t-test

Hypothesis

Ho: U1 = U2

Ha: U1 > U2

U1 = 67.8 (mean reproduction at site 1)
U2 = 41.4 (mean reproduction at site 2)
S = 15.936 (combined standard deviation)
n = 5 (sampling size at each site)

T-Test: $$t = \frac{U1 - U2}{S\sqrt{2/n}} = \frac{67.8 - 41.4}{15.936\sqrt{2/5}} = 2.619$$

t0.05, 2(n-1) = 1.860

Since t > t0.05, 2(n-1), Reject Ho

Conclusion

Reproduction from Station 4 is significantly higher than Station 12.

4.4 Temporal Perspective from Sediment Results

Sediment samples have been collected from the site since 1987. These data were reported as data reports (Godin, 1988; Godin and Chamberlain, 1990; Godin, 1991a; Godin, 1991b). Sampling locations have changed between 1987 to 1991 (Table 8). The sediment data from the above reports are reproduced in Appendix I.

TABLE 8: PREMIER GOLD - STATION CORRELATION - SURVEYS 1987 to 1991

Station name	Station number by year				
	87	88	89	90	91
Hovland Ck. u/s Mill	1	-	-	-	-
Lesley Ck. u/s Mill	2	2	-	-	-
Fletcher Ck. u/s Waste Dump	-	-	10	10	-
Cooper Ck. u/s Open Pit	3	3	3[1]	3[1]	-
Cascade Ck. u/s Tailings Pond	4	4	4	4	4
Lesley Ck. d/s Mill	5	5	-	5	-
Hovland Ck.d/s Mill	6	-	-	-	-
Cooper Ck. u/s Fletcher Ck.	7	7	-	7	-
Fletcher Ck. d/s Granduc Rd.	8[2]	-	8	8	-
Monitoring Pond	-	-	11	-	11
Cascade Ck. d/s Tailings Pond	9	9	9	9	-
Cascade Ck. d/s Logan Ck.	-	-	-	12	12
Level 4	-	-	Level 4	-	-
Level 6	-	Level 6	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

Temporal sediment profile showed that cadmium concentration at the Cascade Creek upstream station was significantly higher in 1991 compared to 1987, 1988, and 1989. Lead and zinc were significantly higher in 1991 only when compared to 1987 levels (Figures 7 - 10).

The concentration of cadmium, copper, and zinc at the Cascade Creek downstream station were significantly higher in 1991 than any previous surveys. No significant difference could be detected for lead concentrations. This element did not seemed to change temporally at that station.

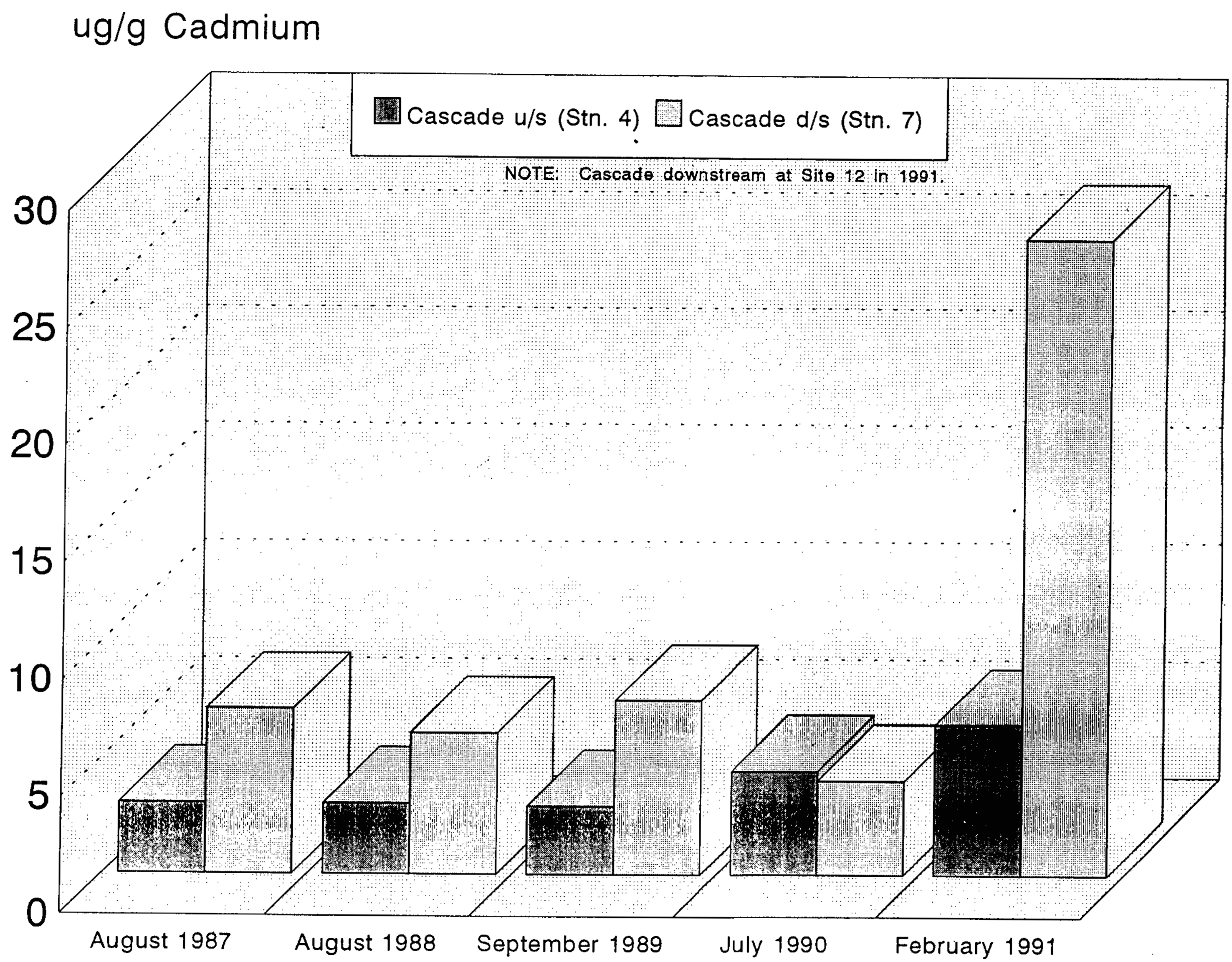


FIGURE 7: CASCADE CREEK SEDIMENT PROFILE - CADMIUM

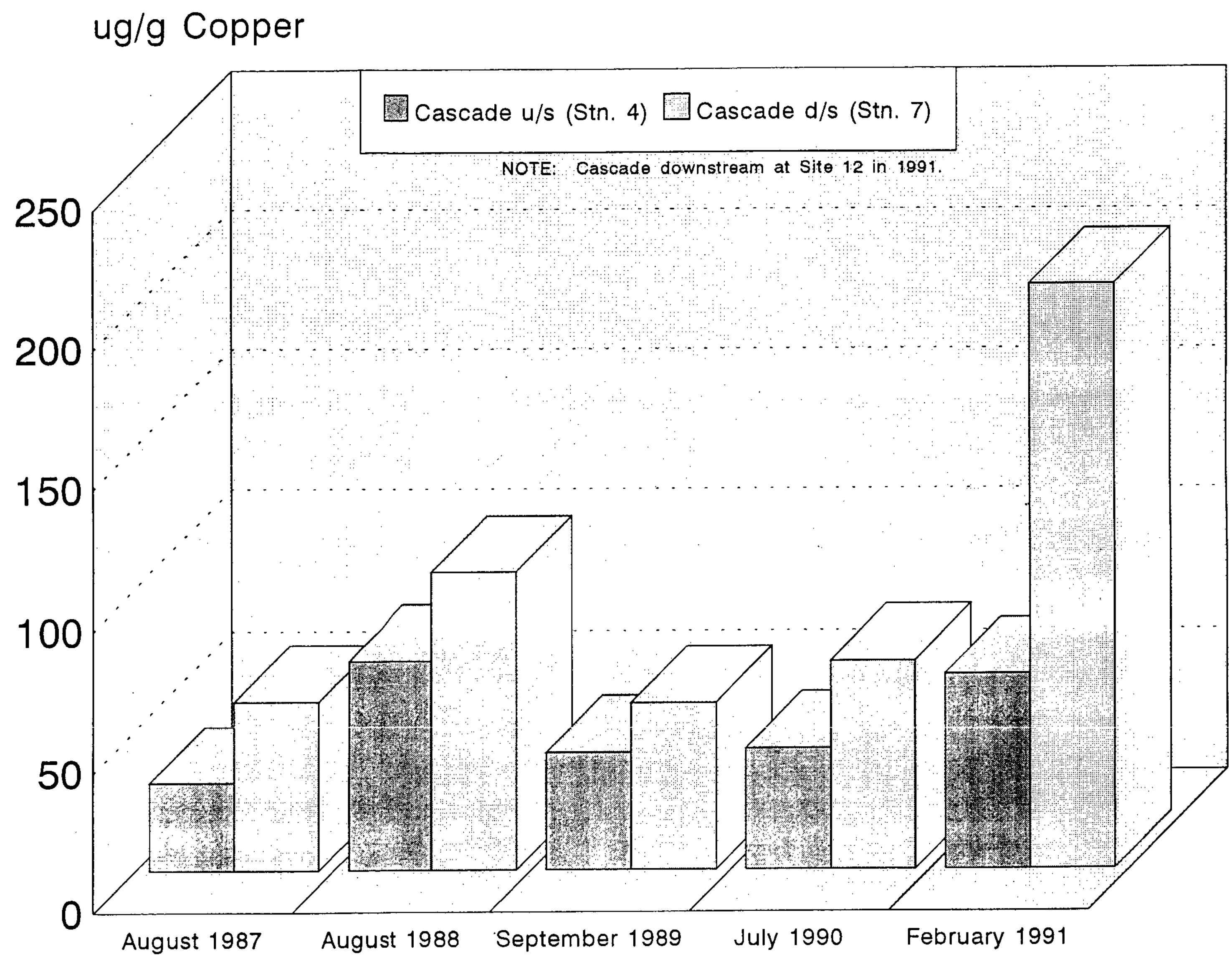
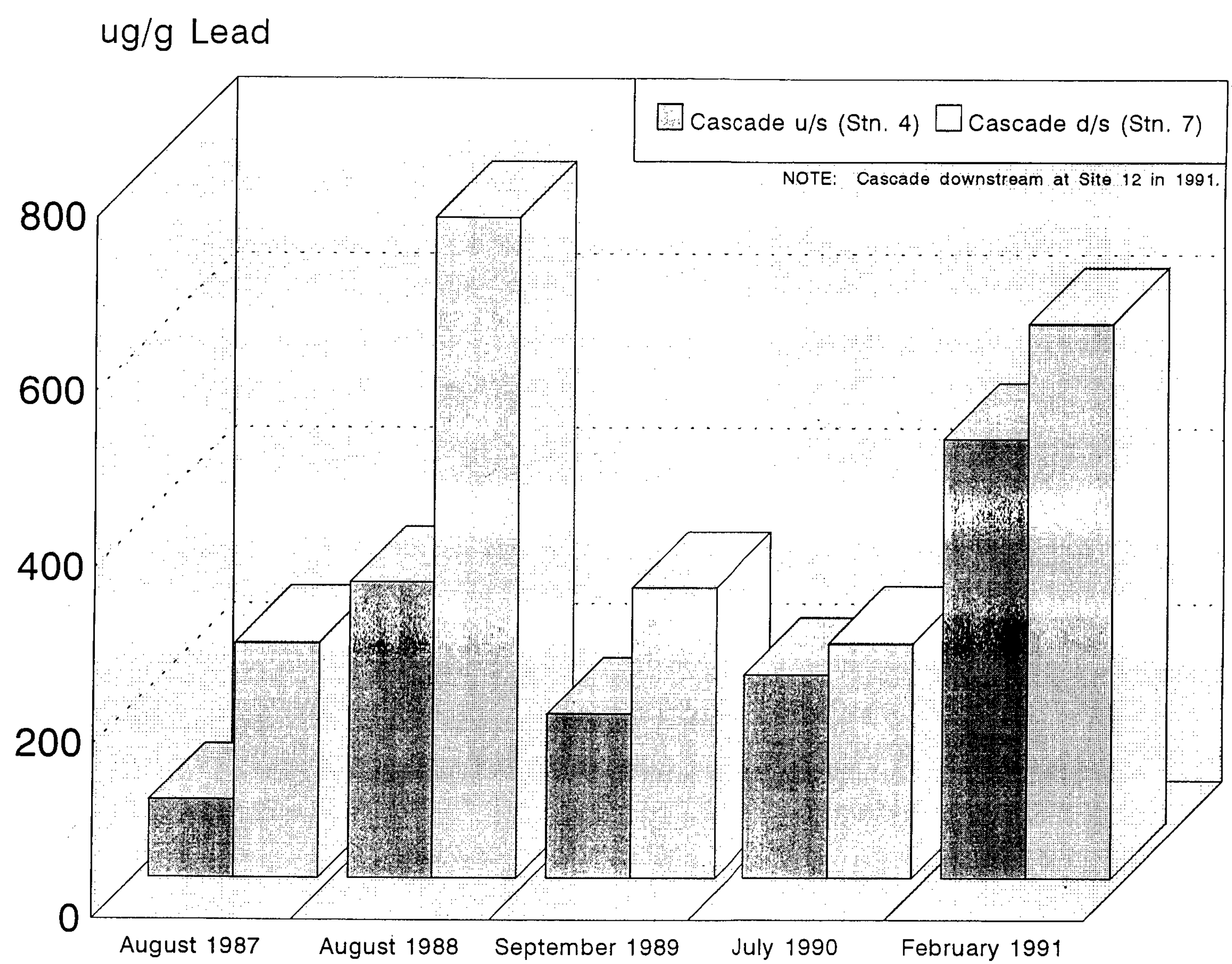


FIGURE 8: CASCADE CREEK SEDIMENT PROFILE - COPPER



<u>FIGURE 9</u>: CASCADE CREEK SEDIMENT PROFILE - LEAD

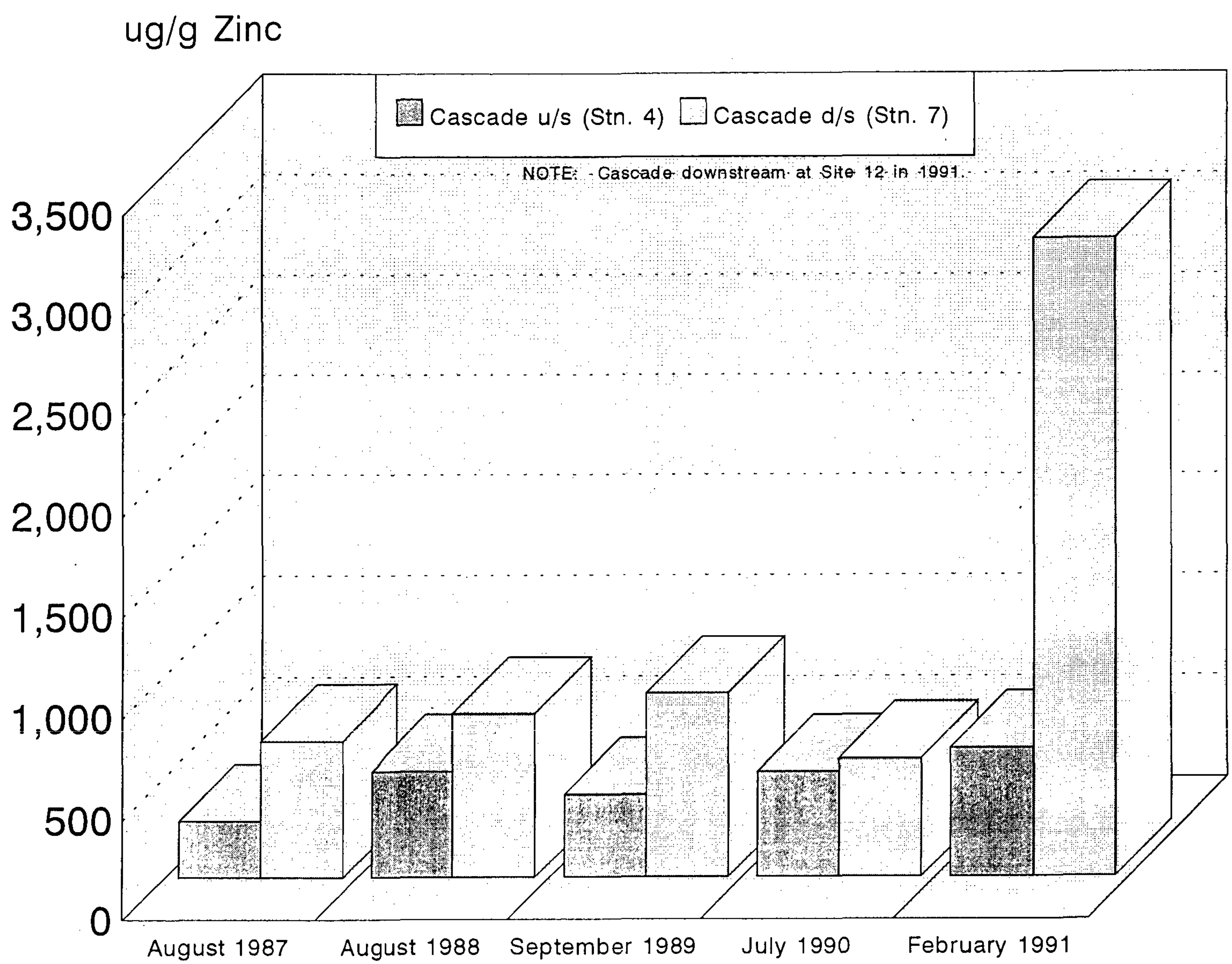


FIGURE 10: CASCADE CREEK SEDIMENT PROFILE - ZINC

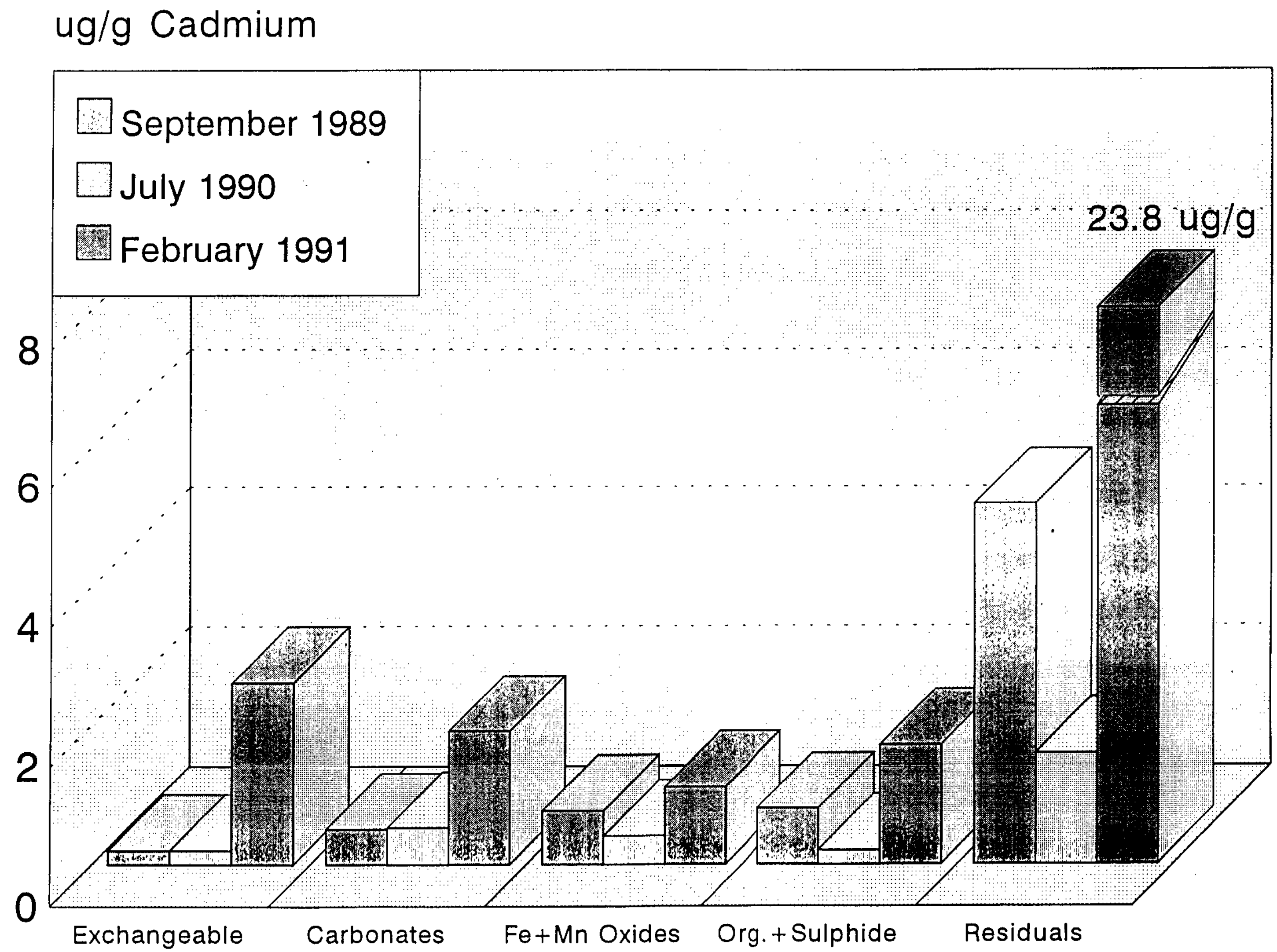


FIGURE 11: CASCADE CREEK DOWNSTREAM OF TAILINGS POND - SEDIMENT PROFILE - SEQUENTIAL EXTRACTION - CADMIUM

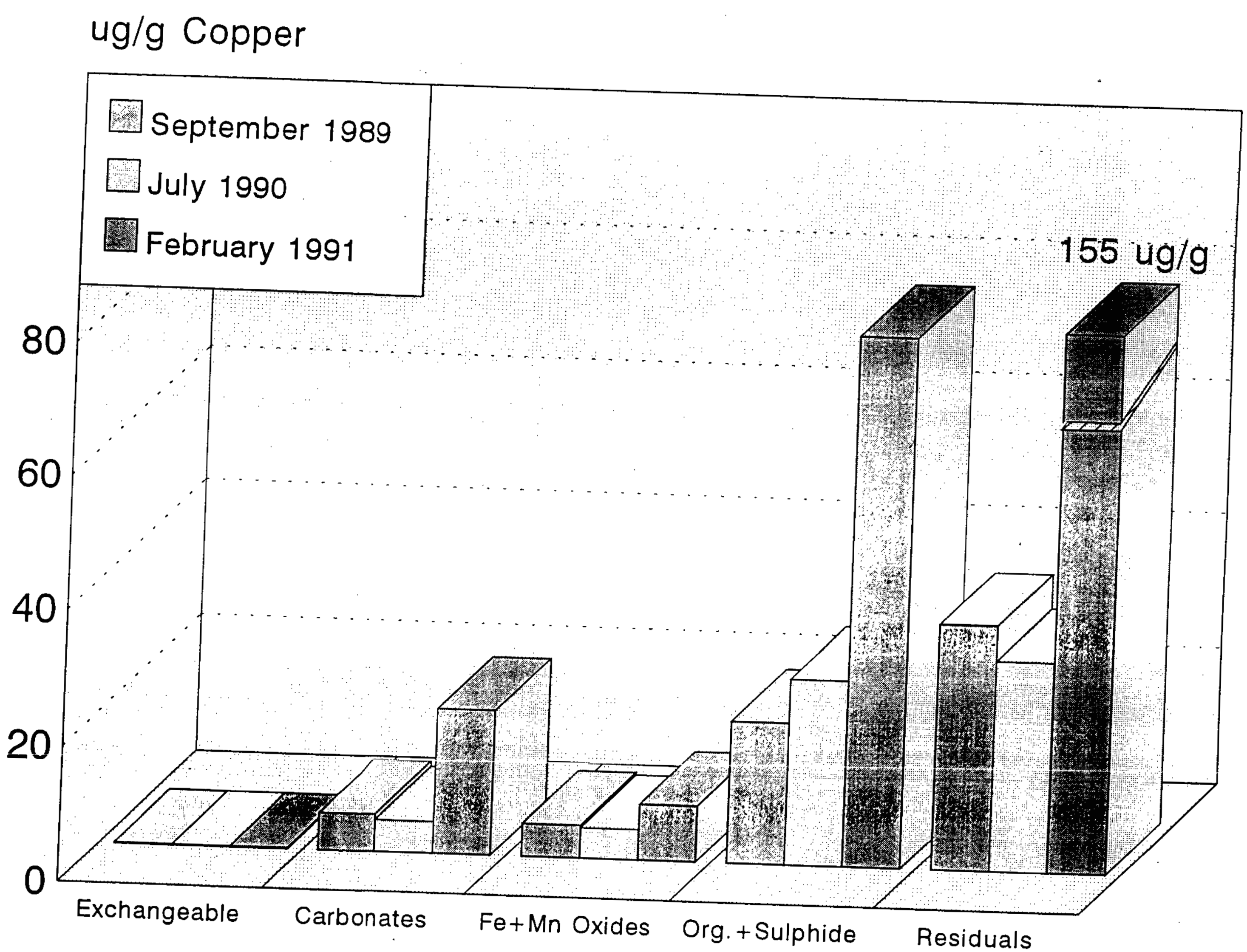


FIGURE 12: CASCADE CREEK DOWNSTREAM OF TAILINGS POND - SEDIMENT PROFILE - SEQUENTIAL EXTRACTION - COPPER

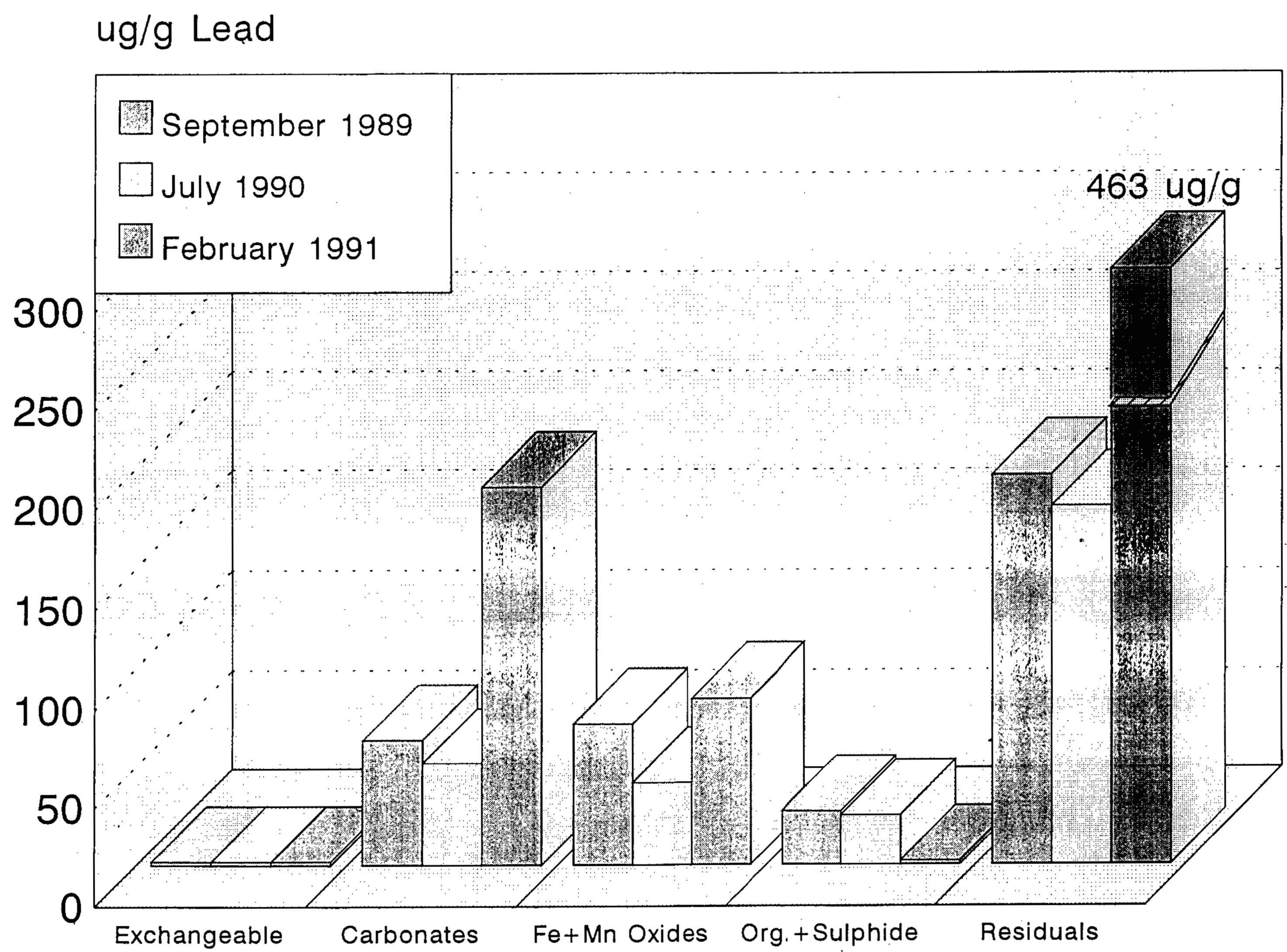


FIGURE 13: CASCADE CREEK DOWNSTREAM OF TAILINGS POND - SEDIMENT PROFILE - SEQUENTIAL EXTRACTION - LEAD

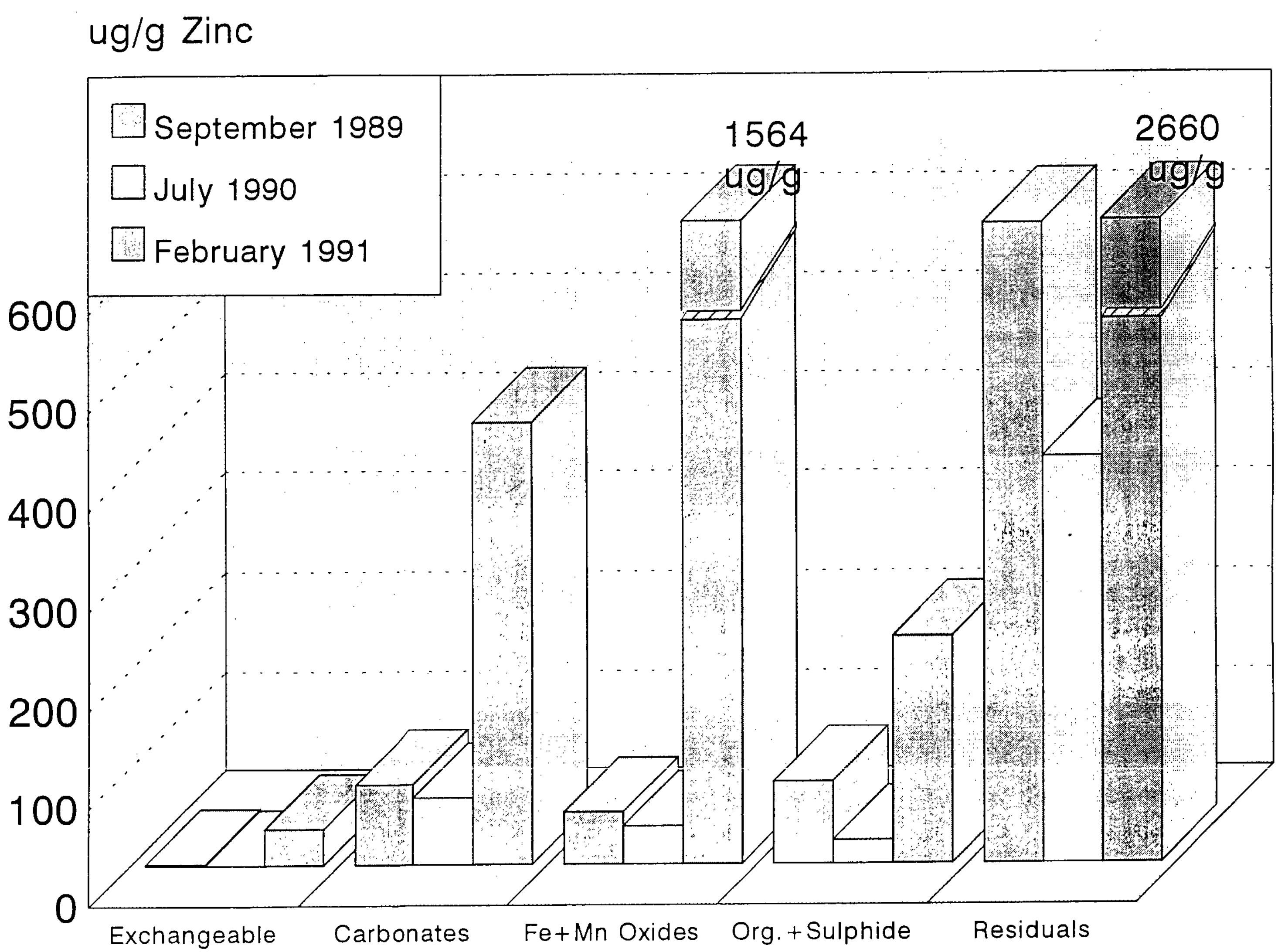


FIGURE 14: CASCADE CREEK DOWNSTREAM OF TAILINGS POND - SEDIMENT PROFILE - SEQUENTIAL EXTRACTION - ZINC

The sequential extraction analysis showed that, in addition to the increase of cadmium concentration downstream of the tailings pond, the pattern of metal availability changed. The exchangeable fraction was proportionally more available in 1991 than in 1989 or 1990 (Figure 11).

A comparison of sequential extractions from September 1989, July 1990, and February 1991 shows that the pattern of distribution among the fractions did not change for copper, lead, or zinc, but more metal was available as concentrations were higher in 1991 (Figures 12 - 14).

4.5 Metal Loadings in Cascade Creek

Monthly zinc loading to Cascade Creek downstream was calculated based on Premier Gold water quality data collected pursuant to their monitoring program under Waste Management permit PE-8044 (Table 9).

Table 10 shows the percent contribution of the three major zinc sources to Cascade Creek. It is evident from this table that during winter months (November to April) level 6 contributes more than 80% of the total. Unfortunately no data were collected for zinc levels from Fletcher Creek to complete the source survey. From more recent information collected during winter 1991-1992, metal contribution from waste rock pile above Fletcher Creek is not negligible.

Sphalerite is the main zinc mineral present in the Premier Gold property. Cadmium is often present as a substitute for zinc in the sphalerite crystal (Berry and Mason, 1959). Cadmium also has a higher pH requirement for precipitation than zinc. Although cadmium concentration in the acid mine drainage is not extremely high, cadmium will be reduced less proportionally in the treatment system than zinc.

TABLE 9: CASCADE CREEK ZINC LOADING CONTRIBUTORS

	CASCADE U/S (Diss. Zn)	COMBINED DISCHARGE (Tot. Zn)	TREATED MINE WATER (Tot. Zn)
Av. Monthly Discharge (m^3/s)			
Nov 90	1.44	0.036	0.093
Dec 90	1.23	0.045	0.0719
Jan 91	-	0.032	-
Feb 91	1.32	0.044	0.084
Mar 91	0.87	0.029	0.08
Apr 91	1.27	0.048	0.093
May 91	7.16	0.090	0.160
Av. Monthly Zinc Conc. (mg/L)			
Nov 90	0.003[1]	0.080[2]	0.376
Dec 90		0.096	0.673
Jan 91		0.078[2]	-
Feb 91		0.102	0.682
Mar 91		0.112	0.237
Apr 91		0.082	0.408
May 91		0.169	0.226
Daily Av. Loading to Cascade Creek (kg/day)			
Nov 90	0.373	0.249[2]	3.02
Dec 90	0.318	0.373	4.18
Jan 91	-	0.216[2]	-
Feb 91	0.342	0.388	4.95
Mar 91	0.226	0.280	1.64
Apr 91	0.329	0.340	3.28
May 91	1.856	1.314	3.12
Monthly Loading to Cascade Creek (kg)			
Nov 90	11.19	7.47[2]	90.6
Dec 90	9.86	11.56	129.6
Jan 91	-	6.70[2]	-
Feb 91	9.58	10.86	138.6
Mar 91	7.00	8.68	50.8
Apr 91	9.87	10.2	98.4
May 91	57.54	40.73	96.7

1 Zinc concentration for this period was arbitrarily determined as 0.003 mg/L Dissolved Zn

2 These measurements are Dissolved Zn

TABLE 10: CASCADE CREEK ZINC LOADINGS

Monthly Loading to Cascade Creek -
Zinc - % Contribution from Various Sources

	Total (kg)	Cascade u/s Diss. Zn	Treated Level 6 Tot. Zn	Tailings Pond Tot. Zn
Nov 90	109.3	10.2	82.9	6.9
Dec 90	151.0	6.5	81.5	7.7
Feb 91	159.0	6.0	87.2	6.8
Mar 91	66.5	10.5	76.4	13.1
Apr 91	118.5	8.3	83.1	8.6
May 91	195.0	29.5	49.6	20.9

Figure 15 shows the total zinc concentration in the treated mine water while Figure 16 shows the pH of the effluent. The correlation of these two variables using six months of data showed $r = -0.642$, for 181 data points. This correlation is very significant, $r(0.01, 150) = 0.208$. The correlation could be better if the pH unit was changed to hydrogen ion concentration. The linear relationship between these two variables can be described by:

$$pH = -1.02066\ [Tot.\ Zn] + 9.49798$$

According to this formula a concentration of 0.2 mg/L of Total Zinc in the effluent should be achieved with a pH of 9.29 in the effluent.

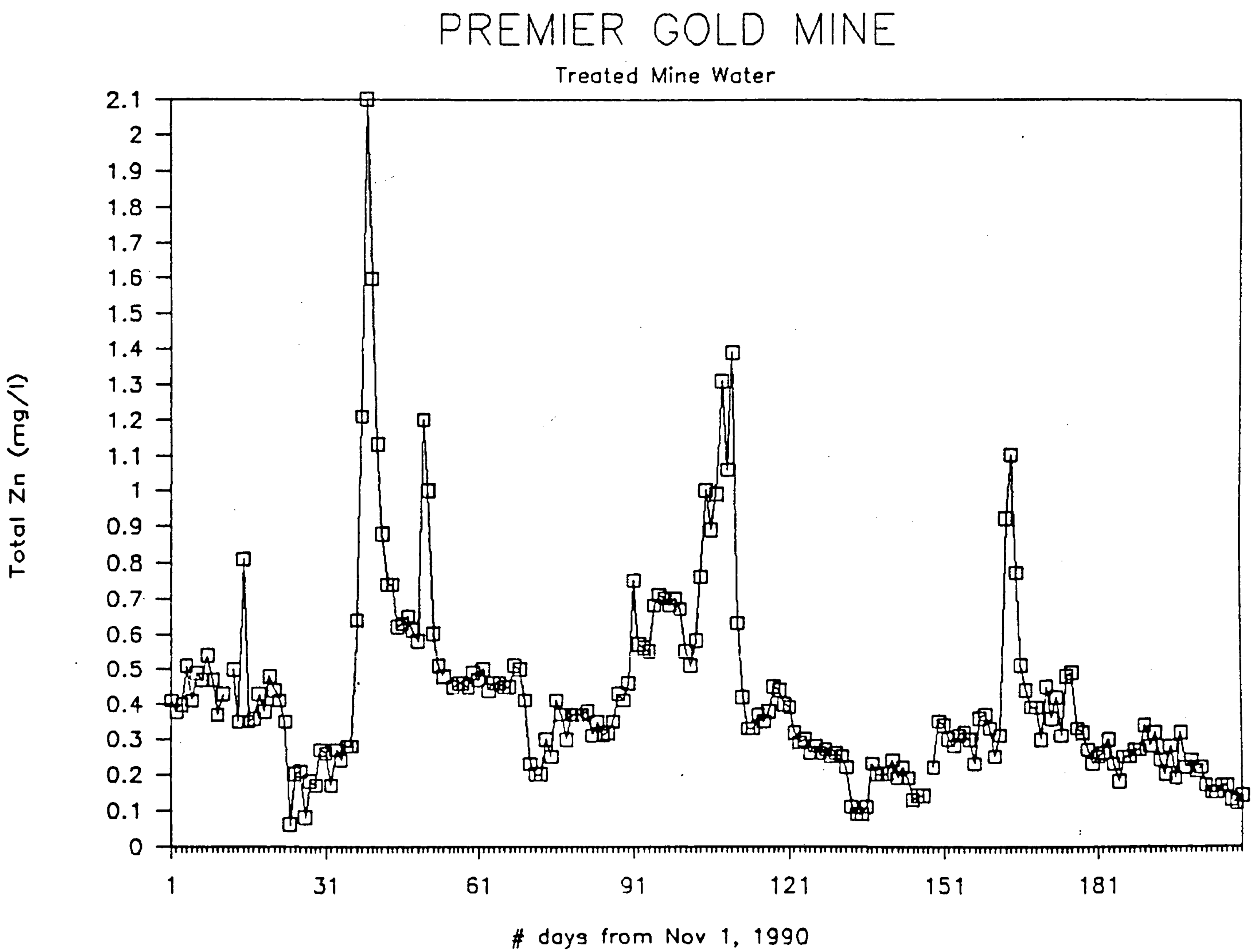


FIGURE 15: TREATED MINE WATER - TOTAL ZINC - FROM NOVEMBER 1, 1990

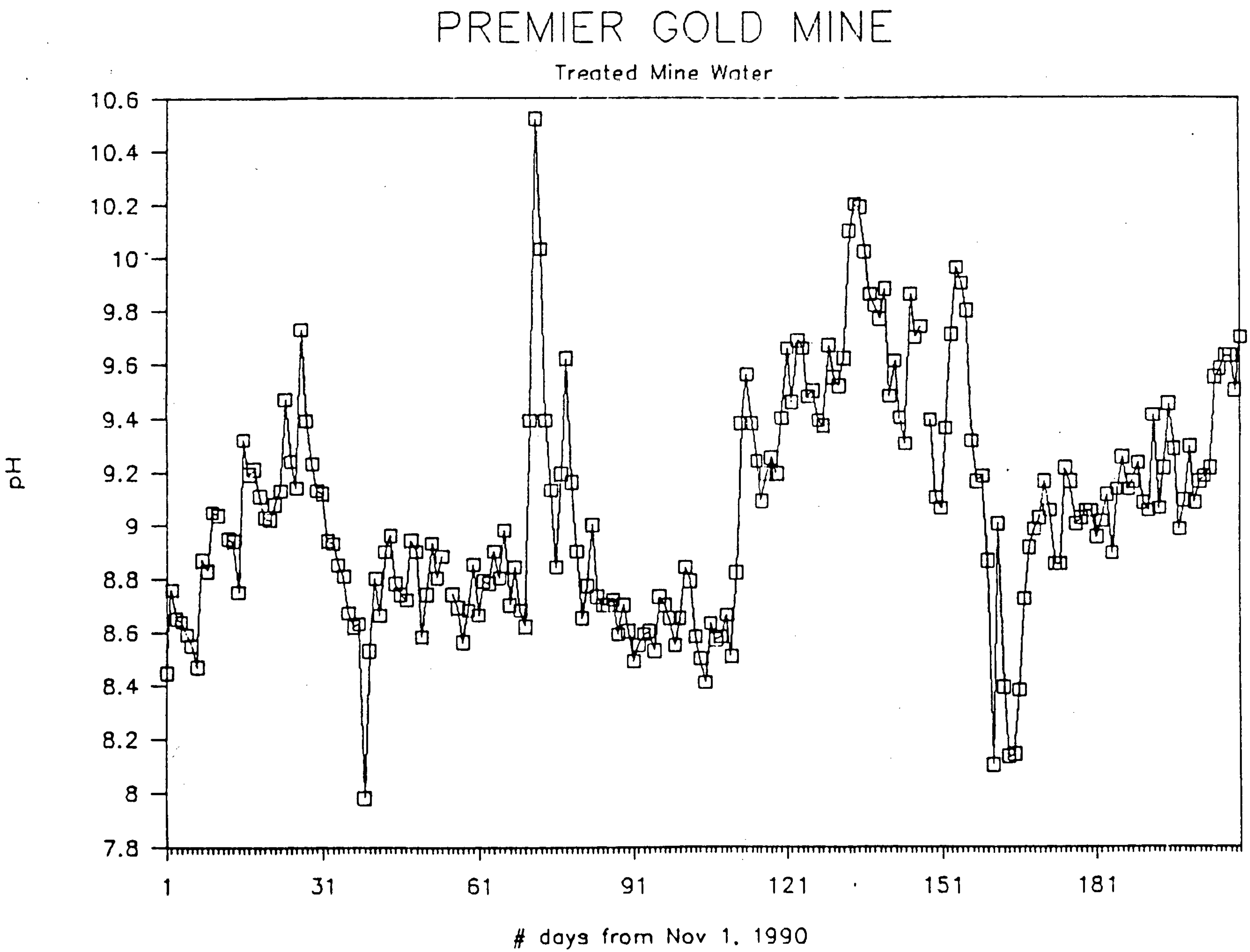


FIGURE 16: TREATED MINE WATER - pH - FROM NOVEMBER 1, 1990

5.0 CONCLUSION

During February 1991, bioassays on Daphnia magna using sediments from Cascade Creek downstream of the tailings pond had reduced reproduction and survival. This corresponded to elevated heavy metal concentrations. The bioassays and sequential extractions showed that the tailings from the tailings pond are not responsible for the reduction in Daphnia reproduction but rather the effluent from the treated mine water is to blame. The sediment extraction showed that cadmium was proportionally more mobile in the sediment downstream than other metals. This effect was due to the higher pH requirement of the element. Winter sediment concentrations were higher than during summer surveys reflecting the low dilution and stable hydrological conditions which favour high concentrations and quiescent conditions for precipitation.

This survey showed the value of using sediment techniques to assess mine impact. The use of sediment bioassay can demonstrate toxicity of the sediment and identify possible sources. The sediment sequential extractions can identify the suspect element while regular total metal concentration can be used for monitoring environmental changes.

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APPENDIX I

SEDIMENT QUALITY - PREMIER GOLD -
1987, 1988, 1989, 1990

Table 1 :

Silbak sediments (< 150 um) dry weight - August 9, 1987

Station Number	Sample Number	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	MG UG/G	MN UG/G	MO UG/G
	1	21000	45	583	0.5	11500	1.9	19.2	45.6	22.4	41900	0.197	7310	2840	8.1
1	2	23200	55	517	0.5	10100	2.1	21.3	58.1	25.6	45500	0.160	8510	2630	6.1
	3	24400	58	764	0.6	14600	2.0	16.0	19.3	25.4	46600	0.225	7160	2940	6.5
	4	25700	61	733	0.6	15700	1.0	19.4	15.0	26.0	46100	0.237	6720	3450	3.4
	Average	23575	55	649	0.6	12975	1.8	19.0	34.5	24.9	45025	0.205	7425	2965	6.0
	S.D.	1997	7	118	0.1	2615	0.5	2.2	20.7	1.7	2131	0.034	765	348	2.0
	5	14600	29	305	0.6	3850	0.7	14.0	17.2	23.1	45200	0.093	8850	1120	5.7
2	6	20200	48	468	0.8	4960	3.3	18.2	65.2	46.9	51900	0.140	10400	1610	6.5
	7	16400	29	446	0.6	4290	2.2	14.0	17.0	27.0	46900	0.097	9140	1310	<.8
	8	15800	19	302	0.6	3800	2.2	13.0	17.5	31.5	44700	0.130	9340	1150	1.8
	Average	16750	31	380	0.7	4225	2.1	14.8	29.2	32.1	47175	0.115	9433	1298	4.7
	S.D.	2419	12	89	0.1	537	1.1	2.3	24.0	10.4	3288	0.024	676	224	2.5
	9	21600	24	866	0.6	7040	1.0	8.3	14.0	24.8	50900	0.308	7350	1980	1.9
3	10	19800	36	698	0.5	6130	2.3	6.6	16.0	23.3	46600	0.307	7300	1550	5.0
	11	21000	55	907	0.5	7050	0.6	13.0	15.0	25.0	46700	0.390	7510	1810	1.0
	12	20300	39	814	0.5	6000	1.0	15.0	15.0	22.2	54800	0.198	7520	2030	2.0
	Average	20675	39	821	0.5	6555	1.2	10.7	15.0	23.8	49750	0.301	7420	1843	2.5
	S.D.	789	13	91	0.0	568	0.7	3.9	0.8	1.3	3918	0.079	112	217	1.7
	13	13100	49	455	0.4	3100	2.0	9.5	22.6	32.6	40900	0.259	7140	949	3.6
4	14	13600	48	548	0.4	3070	3.9	7.1	25.9	30.0	42200	0.223	7320	941	4.0
	15	13500	69	597	0.4	3240	3.0	16.0	27.2	35.9	43500	0.281	7250	947	3.3
	16	12500	65	480	0.4	2890	2.9	13.0	25.9	27.5	39300	0.207	6630	819	<.8
	Average	13175	58	520	0.4	3075	3.0	11.4	25.4	31.5	41475	0.243	7085	914	3.6
	S.D.	499	11	65	0.0	144	0.8	3.9	2.0	3.6	1797	0.034	312	63	0.4
	17	15300	19	316	0.6	4630	0.8	16.0	14.0	28.2	45200	0.095	9950	1240	<.8
5	18	16000	34	312	0.6	4730	1.9	12.0	13.0	25.1	45100	0.099	10000	1280	<.8
	19	16700	31	368	0.7	4900	2.0	21.0	16.0	27.3	47900	0.177	10200	1320	<.8
	20	15200	51	304	0.7	4550	2.0	15.0	13.0	25.5	46900	0.140	9850	1210	2.1
	Average	15800	34	325	0.7	4703	1.7	16.0	14.0	26.5	46275	0.128	10000	1263	--
	S.D.	698	13	29	0.1	151	0.6	3.7	1.4	1.5	1362	0.039	147	48	--
	21	24600	81	683	0.6	10400	1.0	20.0	11.0	33.2	55300	0.421	7760	3120	4.0
6	22	24700	98	758	0.6	11600	3.5	23.8	11.0	59.5	60100	0.425	7380	4400	2.0
	23	24100	130	876	0.7	13200	2.9	24.2	11.0	84.2	58400	0.422	6920	4900	3.1
	24	26000	140	814	0.7	12400	3.3	25.8	12.0	113.0	61300	0.473	7590	3900	3.3
	Average	24850	112	783	0.7	11900	2.7	23.5	11.3	72.5	58775	0.435	7413	4080	3.1
	S.D.	810	27	82	0.1	1194	1.1	2.5	0.5	34.1	2604	0.025	363	759	0.8
	25	19500	52	530	0.5	5170	40.0	23.8	14.0	394.0	52100	1.140	6730	2760	4.0
7	26	16800	33	411	0.4	4530	12.0	16.0	14.0	96.5	40200	1.450	7630	1330	<.8
	27	17200	81	1070	0.5	5580	44.9	21.6	11.0	361.0	61800	1.890	6520	2590	2.8
	28	16900	45	442	0.3	4440	15.0	12.0	14.0	117.0	40600	0.878	7340	1370	<.8
	Average	17600	53	613	0.4	4930	28.0	18.4	13.3	242.1	48675	1.340	7055	2013	3.4
	S.D.	1278	20	309	0.1	542	16.9	5.4	1.5	157.1	10345	0.435	518	768	0.8
	29	12400	46	429	0.4	6910	7.2	22.7	6.8	45.5	54600	0.215	9530	951	<.8
8	30	12800	30	536	0.4	8240	5.4	18.8	5.5	38.9	45600	0.288	9530	1080	1.7
	31	13700	83	595	0.5	6870	12.0	25.9	7.0	102.0	64100	0.964	9440	1380	<.8
	32	14800	41	801	0.5	6840	9.2	21.9	7.6	81.1	60700	0.380	9900	1130	2.0
	Average	13425	50	590	0.5	7215	8.5	22.3	6.7	66.9	56250	0.462	9600	1135	1.9
	S.D.	1066	20	156	0.1	684	2.8	2.9	0.9	29.9	8115	0.342	204	180	0.2
	33	15600	88	625	0.5	4320	6.9	17.6	21.7	53.8	55100	0.382	8480	1320	2.9
9	34	15000	77	617	0.5	4070	6.6	16.2	20.0	53.5	54000	0.302	8070	1310	2.6
	35	15700	95	553	0.5	4590	7.2	18.4	20.6	75.5	59400	0.417	8590	1310	3.6
	36	14200	85	490	0.4	4140	7.1	16.3	18.2	57.0	55300	0.309	8210	1270	1.9
	[illegible]	[illegible]	[illegible]	571	0.5	4280	7.0	17.1	20.1	60.0	55950	0.353	8338	1303	2.8
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	22	0.7

Station Number	Sample Number	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	[illegible] UG/G
	1	5520	20	1110	32	720	<2	139	516	49.1	256	776000	224000	4100
1	2	4490	35	1160	38	840	<2	124	609	54.3	169	838000	162000	3200
	3	1700	10	1290	58	680	<2	178	548	52.7	249	753000	247000	5000
	4	100	4	1360	46	750	<2	188	505	52.4	228	726000	274000	7200
	Average	2953	17	1230	44	748	--	157	545	52.1	226	773250	226750	4875
	S.D.	2494	14	115	11	68	--	31	47	2.2	40	47759	47759	1715
	5	100	21	1140	35	510	<2	30	393	61.5	189	984000	16500	230
2	6	1810	63	1340	50	540	<2	50	480	66.7	221	972000	27700	690
	7	170	16	1250	49	460	<2	38	436	66.1	192	978000	22500	580
	8	620	22	1170	32	460	<2	32	367	57.4	195	985000	14900	210
	Average	675	31	1225	42	493	--	38	419	62.9	199	979750	20400	428
	S.D.	791	22	90	9	39	--	9	50	4.4	15	6021	5864	244
	9	280	10	1310	39	530	<2	69	429	66.5	197	899000	101000	2800
3	10	100	10	1250	41	500	<2	58	550	57.4	178	915000	85500	3000
	11	1200	10	1360	40	540	<2	68	495	59.5	201	897000	103000	1800
	12	360	9	1320	49	520	6	58	444	67.6	215	929000	71100	1800
	Average	485	10	1310	42	523	--	63	480	62.8	198	910000	90150	2350
	S.D.	489	1	45	5	17	--	6	55	5.1	15	15011	14915	640
	13	60	29	1180	77	470	<2	40	41	26.0	270	981000	18700	200
4	14	90	36	1280	87	450	<2	33	51	27.1	287	982000	17600	240
	15	80	34	1340	100	430	<2	34	52	28.7	300	983000	16900	210
	16	70	35	1130	93	460	<2	30	38	27.6	283	525000	475000	200
	Average	75	34	1233	89	453	--	34	46	27.4	285	867750	132050	213
	S.D.	13	3	95	10	17	--	4	7	1.1	12	228501	228635	19
	17	100	24	1220	40	560	<2	38	499	63.1	193	984000	16200	220
5	18	100	20	1240	49	510	<2	41	512	65.7	205	982000	18100	280
	19	100	31	1330	50	490	<2	43	541	68.3	229	981000	18600	300
	20	100	26	1280	43	520	<2	37	505	66.6	191	986000	14100	200
	Average	100	25	1268	46	520	--	40	514	65.9	205	983250	16750	250
	S.D.	0	5	49	5	29	--	3	19	2.2	17	2217	2047	48
	21	100	7	1370	86	950	<2	131	486	50.7	285	868000	132000	3000
6	22	190	8	1490	110	890	<2	146	445	50.0	351	835000	165000	3200
	23	390	7	1490	120	910	<2	166	399	46.9	386	797000	203000	4300
	24	220	10	1550	110	990	<2	157	480	53.3	356	840000	160000	3400
	Average	225	8	1475	107	935	--	150	453	50.2	345	835000	165000	3475
	S.D.	121	1	75	14	44	--	15	40	2.6	43	29200	29200	574
	25	210	20	1160	1320	1000	<2	51	739	47.9	4600	958000	41500	900
7	26	200	10	1040	365	540	<2	43	765	48.6	1490	978000	21800	570
	27	100	20	1350	1280	710	<2	62	664	47.5	4010	957000	43300	1100
	28	90	22	1040	484	490	<2	43	793	44.9	1710	980000	20100	390
	Average	150	18	1148	862	685	--	50	740	47.2	2953	968250	31675	740
	S.D.	64	5	146	508	230	--	9	55	1.6	1583	12447	12425	320
	29	100	6	1290	265	560	10	45	771	75.5	554	991000	9000	90
8	30	220	9	1310	150	490	<2	53	784	70.5	532	994000	5900	200
	31	260	7	1400	463	480	<2	51	785	77.9	1230	984000	16400	250
	32	340	7	1520	341	500	<2	58	1090	101.0	883	984000	16300	350
	Average	230	7	1380	305	508	--	52	858	81.2	800	988250	11900	223
	S.D.	100	1	105	132	36	--	6	155	13.5	329	5058	5292	108
	33	1100	30	1290	254	430	<2	46	316	52.3	715	981000	19200	320
9	34	270	30	1280	226	410	<2	44	299	48.6	625	981000	19200	290
	35	340	23	1340	383	460	<2	45	339	52.7	652	979000	21100	320
	36	170	23	1290	207	460	<2	37	285	47.6	710	982000	18400	200
	Average	470	27	1300	268	440	--	43	310	50.3	676	980750	19475	283
	S.D.	426	4	27	79	24	--	4	23	2.6	44	1258	1147	57

Table 2 :

Sediment Quality, Metal Analysis
Silbak Premier - August 9, 1988

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	MG UG/G	MN UG/G
	Repl.1	<2	22500	87	383	0.6	5500	1	<20	18.3	32.6	46900	0.07	7610	1530
	Repl.2	<2	18000	57	388	0.5	6160	<.8	<20	29.6	36.0	46100	0.06	7900	1490
2	Repl.3	<2	19100	88	586	0.5	18900	2	<20	19.6	54.2	40300	0.10	6640	1900
	Repl.4	<2	17700	96	417	0.5	19300	1	<20	14.0	53.5	41900	0.07	6880	1510
	Average	--	19325	82	444	0.5	12465	1	---	20.4	44.1	43800	0.08	7258	1608
	S.D.	--	2201	17	96	0.0	7668	1	---	6.6	11.4	3202	0.02	595	196
	Repl.1	3	25700	65	1020	0.7	8530	<.8	<20	11.0	34.1	57400	0.09	7480	2450
	Repl.2	3	24700	52	826	0.6	8590	1	<20	19.9	30.8	57600	0.06	7550	2260
3	Repl.3	<2	29400	60	1020	0.7	8060	<.8	<20	13.0	35.6	61000	0.09	7240	2300
	Repl.4	3	25000	60	867	0.7	7390	<.8	<20	14.0	32.4	57200	0.10	7500	2170
	Average	3	26200	59	933	0.7	8143	--	---	14.5	33.2	58300	0.09	7443	2295
	S.D.	0	2174	5	102	0.0	555	--	---	3.8	2.1	1807	0.02	138	117
	Repl.1	2	16200	90	584	0.5	3680	2	<20	31.3	53.5	50200	0.19	7510	1890
	Repl.2	2	21500	100	873	0.7	3790	2	20	44.9	57.4	56700	0.29	8590	2000
4	Repl.3	2	17300	110	697	0.5	3590	2	<20	36.1	55.1	52800	0.29	7710	1700
	Repl.4	2	19800	110	793	0.6	3930	6	<20	43.7	131.0	55500	0.41	8360	2280
	Average	2	18700	103	737	0.6	3748	3	---	39.0	74.3	53800	0.30	8043	1968
	S.D.	0	2399	10	125	0.1	147	2	---	6.4	37.9	2902	0.09	515	242
	Repl.1	3	15900	39	163	0.4	3560	<.8	<20	13.0	27.7	36900	0.04	7590	908
	Repl.2	2	16400	34	179	0.4	3720	<.8	<20	12.0	27.5	37200	0.04	7560	1080
5	Repl.3	2	16200	47	180	0.4	3480	<.8	<20	14.0	19.7	35900	0.04	7630	3020
	Repl.4	<2	16100	48	151	0.4	3450	<.8	<20	13.0	19.2	34800	0.03	7610	898
	Average	2	16150	42	168	0.4	3553	--	---	13.0	23.5	36200	0.04	7598	1477
	S.D.	1	208	7	14	0.0	121	--	---	0.8	4.7	1086	0.00	30	1032
	Repl.1	<2	15500	85	1110	0.3	10300	13	<20	10.0	182.0	51300	0.59	5980	1770
	Repl.2	<2	13200	91	828	0.3	11900	6	<20	8.3	96.4	52700	0.44	5680	1430
7	Repl.3	<2	12500	85	729	0.2	12800	5	<20	7.8	90.6	48900	0.39	5530	1330
	Repl.4	<2	12400	73	813	0.3	12500	5	<20	8.0	63.4	45500	0.41	5550	1350
	Average	--	13400	84	870	0.3	11875	7	---	8.5	108.1	49600	0.46	5685	1470
	S.D.	--	1445	8	166	0.0	1115	4	---	1.0	51.3	3152	0.09	208	205
	Repl.1	<2	15000	150	378	0.4	4630	8	<20	15.0	142.0	89100	0.20	7390	1870
	Repl.2	<2	13500	110	365	0.4	5350	5	<20	14.0	92.9	79300	0.42	7220	1190
9	Repl.3	<2	13600	150	384	0.4	4320	4	<20	16.0	119.0	91500	0.22	7280	1250
	Repl.4	3	16400	92	455	0.5	6070	6	<20	15.0	68.0	61100	0.29	7410	1510
	Average	--	14625	126	396	0.4	5093	6	---	15.0	105.5	80250	0.28	7325	1455
	S.D.	--	1367	29	40	0.0	782	2	---	0.8	32.0	13814	0.10	90	310
	Repl.1	<2	15100	62	152	0.3	13300	<.8	<20	24.7	72.7	38100	0.05	8480	803
	Repl.2	<2	12300	49	114	0.3	11600	<.8	<20	19.5	53.1	31000	0.03	7420	700
10	Repl.3	<2	12600	39	117	0.3	13800	<.8	<20	20.4	65.1	31600	0.03	7680	718
	Repl.4	<2	12900	79	113	0.2	11700	<.8	<20	28.0	71.7	44500	0.02	7530	655
	Average	--	13225	57	124	0.3	12600	--	---	23.2	65.7	36300	0.03	7778	719
	S.D.	--	1274	17	19	0.0	1117	--	---	4.0	9.0	6342	0.01	480	62

Table 2 (cont.):

Sediment Quality, Metal Analysis
Silbak Premier - August 9, 1988

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	MG UG/G	MN UG/G
	Repl.1	2	21400	130	1680	0.9	16600	194	60	17.0	1850.0	83900	4.50	4860	15600
	Repl.2	2	18900	120	1220	0.7	25600	230	40	28.8	4300.0	102000	4.20	3720	7640
Level	Repl.3	2	21000	120	1290	0.8	11900	148	40	16.6	1650.0	81600	6.20	5370	8910
#4	Repl.4	2	20600	130	1460	0.8	15000	197	60	16.0	2390.0	81200	4.20	4760	13800
	Average	2	20475	125	1413	0.8	17275	192	50	19.6	2547.5	87175	4.78	4678	11488
	S.D.	0	1100	6	205	0.1	5883	34	12	6.1	1209.4	9955	0.96	692	3817
	Repl.1	<2	18000	110	701	0.4	8530	75	<20	16.7	732.0	61200	1.10	7630	3690
	Repl.2	<2	16200	96	571	0.3	8210	70	<20	15.0	757.0	61500	1.20	7640	2850
Level	Repl.3	<2	15600	87	574	0.2	7240	75	<20	14.0	805.0	68300	1.30	7540	3130
#6	Repl.4	<2	15800	77	562	0.3	7500	52	<20	16.4	518.0	53800	0.66	7980	2020
	Average	--	16400	93	602	0.3	7870	68	---	15.5	703.0	61200	1.07	7698	2923
	S.D.	--	1095	14	66	0.1	601	11	---	1.3	127.0	5923	0.28	194	696

Table 2 (cont.):

Sediment Quality, Metal Analysis
Silbak Premier - August 9, 1988

		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	10	100	22	1000	69	830	10	43.0	380	64	202	965000	34900
	Repl.2	10	100	36	1100	130	608	44	43.4	358	65	227	978000	22000
2	Repl.3	9	100	21	1200	110	638	10	97.2	348	47	251	958000	42200
	Repl.4	10	100	10	1100	85	631	<8	99.3	358	51	227	974000	26400
	Average	10	100	22	1100	99	677	21	70.7	361	57	227	968750	31375
	S.D.	1	0	11	82	27	103	20	31.8	14	9	20	8995	8986
	Repl.1	10	190	10	1400	21	770	<8	77.5	188	78	153	863000	137000
	Repl.2	10	230	20	1300	50	735	10	65.7	227	69	277	877000	123000
3	Repl.3	10	190	10	1400	25	840	<8	79.8	366	88	218	865000	135000
	Repl.4	10	160	10	1300	30	769	<8	68.6	256	79	198	889000	111000
	Average	10	193	13	1350	32	779	--	72.9	259	79	212	873500	126500
	S.D.	0	29	5	58	13	44	--	6.8	76	8	51	12042	12042
	Repl.1	10	70	43	1200	174	670	23	36.4	66	33	362	978000	21700
	Repl.2	10	100	62	1300	198	693	21	48.5	91	45	413	974000	26400
4	Repl.3	10	70	48	1300	150	634	20	39.0	64	35	403	979000	21500
	Repl.4	10	100	51	1300	823	700	26	45.1	73	41	927	980000	20500
	Average	10	85	51	1275	336	674	23	42.3	74	39	526	977750	22525
	S.D.	0	17	8	50	325	30	3	5.5	12	6	268	2630	2636
	Repl.1	7	70	17	930	33	516	<8	29.0	457	56	112	985000	14500
	Repl.2	7	70	23	870	35	536	<8	29.6	405	52	123	981000	18800
5	Repl.3	9	70	17	880	59	577	<8	29.7	441	53	105	983000	16600
	Repl.4	9	80	20	890	30	591	<8	29.5	441	53	102	982000	18400
	Average	8	73	19	893	39	555	--	29.5	436	54	111	982750	17075
	S.D.	1	5	3	26	13	35	--	0.3	22	2	9	1708	1965
	Repl.1	10	80	10	1200	1120	719	<8	76.3	705	52	3050	972000	27500
	Repl.2	10	60	10	1300	642	642	<8	73.8	630	50	2110	981000	18900
7	Repl.3	10	60	9	1200	586	590	<8	71.1	562	45	1650	983000	16900
	Repl.4	10	60	9	1200	538	547	<8	72.0	528	42	1540	985000	15400
	Average	10	65	10	1225	722	625	--	73.3	606	47	2088	980250	19675
	S.D.	0	10	1	50	269	74	--	2.3	78	5	688	5737	5410
	Repl.1	20	100	20	1200	1260	941	<8	36.3	462	75	987	979000	21000
	Repl.2	20	80	10	1300	403	749	15	36.8	570	84	696	980000	20000
9	Repl.3	17	90	19	1200	1110	943	20	34.8	533	81	724	981000	19200
	Repl.4	10	100	16	1200	239	618	8	46.6	565	70	825	971000	28700
	Average	17	93	16	1225	753	813	14	38.6	533	78	808	977750	22225
	S.D.	5	10	5	50	507	159	6	5.4	50	6	132	4573	4379
	Repl.1	10	370	17	1200	45	669	<8	69.0	1440	98	243	987000	13100
	Repl.2	9	180	10	1100	36	633	<8	55.5	1070	76	194	989000	10700
10	Repl.3	9	200	20	1100	34	662	<8	64.8	1230	81	223	990000	10100
	Repl.4	10	190	20	1100	50	632	<8	57.5	1250	110	168	989000	11400
	Average	10	235	17	1125	41	649	--	61.7	1248	91	207	988750	11325
	S.D.	1	90	5	50	8	19	--	6.3	152	16	33	1258	1297

Table 2 (cont.):

Sediment Quality, Metal Analysis
Silbak Premier - August 9, 1988

		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	34	100	40	1300	6620	1060	10	114.0	144	35	16900	963000	36800
	Repl.2	27	100	60	1100	8160	1090	140	133.0	202	38	26600	867000	133000
Level	Repl.3	29	100	37	1200	6230	1470	36	89.2	171	39	16100	962000	37700
#4	Repl.4	40	100	23	1200	6780	1220	37	105.0	150	34	17500	957000	42800
	Average	33	100	40	1200	6948	1210	56	110.3	167	37	19275	937250	62575
	S.D.	6	0	15	82	841	187	58	18.3	26	2	4917	46907	47024
	Repl.1	19	100	10	1200	2250	927	17	95.0	730	65	9540	960000	40000
	Repl.2	20	100	10	1100	2600	1020	10	73.5	672	60	9780	982000	18300
Level	Repl.3	20	90	10	1200	3040	1270	<8	66.0	652	68	10100	982000	18400
#6	Repl.4	16	100	10	1100	1530	855	<8	65.4	731	67	7460	982000	18400
	Average	19	98	10	1150	2355	1018	14	75.0	696	65	9220	976500	23775
	S.D.	2	5	0	58	638	181	5	13.8	40	4	1196	11000	10817

TABLE 3: SEDIMENT QUALITY, IMMEDIATES 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 3 (cont'd): SEDIMENT QUALITY, IMMEDIATES 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

TABLE 4:

SEDIMENT QUALITY - PREMIER GOLD -
JULY 23, 1990

Station Number		SEDIC AG UG/G	SEDICP AL UG/G	SEDICP AS UG/G	SEDICP BA UG/G	SEDICP BE UG/G	SEDICP CA UG/G	SEDICP CD UG/G	SEDICP CO UG/G	SEDICP CR UG/G	SEDICP CU UG/G	SEDICP FE UG/G	SEDHG HG UG/G	SEDICP K UG/G	SEDICP MG UG/G	SEDICP MN UG/G
	Repl.1	2	13800	73	644	0.6	5340	3.7	<20	13.0	46.4	43900	0.370	2300	6190	2690
	Repl.2	<2	12700	62	520	0.6	4750	3.9	<20	13.0	44.9	42600	0.300	1700	5960	2390
4	Repl.3	<2	11700	41	562	0.4	4120	3.8	<20	13.0	39.5	40600	0.240	900	5790	1840
	Repl.4	<2	12900	77	645	0.5	5690	6.2	<20	13.0	42.2	43200	0.330	2400	5880	2580
	Average	---	12775	63	593	0.5	4975	4.4	---	13.0	43.3	42575	0.310	1825	5955	2375
	S.D.	---	862	16	62	0.1	689	1.2	---	0.0	3.0	1419.8	0.055	690	171	378
	Repl.1	10	12600	93	403	0.5	5860	4.2	<20	10.0	63.3	57200	0.260	600	7070	1050
	Repl.2	9	12000	110	311	0.4	6840	4.2	<20	7.7	51.4	57400	0.250	<300	7010	962
5	Repl.3	4	12300	45	265	0.5	8700	3.4	<20	7.4	33.4	52500	0.180	700	7130	955
	Repl.4	2	12100	10	296	0.5	5380	2.0	<20	8.5	31.9	36900	0.110	400	7020	1020
	Average	6	12250	65	319	0.5	6695	3.5	---	8.4	45.0	51000	0.200	567	7058	997
	S.D.	4	265	46	59	0.0	1468	1.0	---	1.2	15.1	9668.85	0.070	153	55	46
	Repl.1	10	11800	30	437	0.4	6890	6.9	<20	7.1	62.1	43000	0.140	800	6530	1220
	Repl.2	19	11900	64	540	0.4	6780	12.0	<20	7.0	104.0	51700	0.210	<300	6160	1390
8	Repl.3	23	10700	49	516	0.4	7630	12.0	<20	7.1	114.0	50900	0.230	500	5570	1280
	Repl.4	27	12100	56	436	0.4	8020	12.0	<20	7.3	113.0	60800	0.067	2000	6280	1350
	Average	20	11625	50	482	0.4	7330	10.7	---	7.1	98.3	51600	0.162	1100	6135	1310
	S.D.	7	629	15	54	0.0	595	2.5	---	0.1	24.5	7282.4	0.074	794	407	75
	Repl.1	2	11500	66	250	0.3	10500	2.0	<20	3.7	40.6	50500	0.049	<300	6870	1160
	Repl.2	5	14000	86	347	0.6	5770	3.9	<20	7.4	66.9	60500	4.170	2000	6490	1370
9	Repl.3	10	11600	130	275	0.4	8250	5.6	<20	5.3	98.0	78600	0.140	1900	6370	1150
	Repl.4	10	12600	100	338	0.4	8010	4.6	<20	5.6	90.5	70600	0.130	1000	6550	1280
	Average	7	12425	96	303	0.4	8133	4.0	---	5.5	74.0	65050	1.122	1633	6570	1240
	S.D.	4	1162	27	47	0.1	1934	1.5	---	1.5	25.9	12204	2.032	551	214	105
	Repl.1	8	12500	74	415	0.4	7060	4.5	<20	5.6	62.7	58200	0.130	1900	6730	1130
	Repl.2	18	11300	206	245	0.5	6420	3.4	20	3.1	104.0	100000	<.02	900	5940	1070
12	Repl.3	7	12600	96	304	0.4	6730	2.8	<20	5.0	50.9	59700	5.570	800	6430	1120
	Repl.4	9	11500	179	215	0.4	7220	2.9	20	3.0	82.7	92100	0.130	<300	6170	1130
	Average	11	11975	139	295	0.4	6858	3.4	20	4.2	75.1	77500	1.943	1200	6318	1113
	S.D.	5	670	64	88	0.0	356	0.8	0	1.3	23.3	21669.8	3.141	608	340	29

TABLE 4 (cont.):

SEDIMENT QUALITY - PREMIER GOLD -
JULY 23, 1990

Station Number		SEDICP MO UG/G	SEDICP NA UG/G	SEDICP NI UG/G	SEDICP P UG/G	SEDICP PB UG/G	SEDICP SB UG/G	SEDICP SI UG/G	SEDICP SN UG/G	SEDICP SR UG/G	SEDICP TI UG/G	SEDICP V UG/G	SEDICP ZN UG/G	SFR MG/KG	SVR MG/KG
	Repl.1	2	100	19	1400	244	10	767	<8	38.4	104	30	542	970000	29800
	Repl.2	4	100	24	1300	232	18	764	<8	34.5	82	28	534	974000	25600
4	Repl.3	3	80	21	1300	216	<8	713	<8	30.2	81	26	481	981000	19000
	Repl.4	4	100	23	1300	240	9	743	<8	40.0	93	29	525	974000	25900
	Average	3	95	22	1325	233	12	747	---	35.8	90	28	521	974750	25075
	S.D.	1	10	2	50	12	5	25	---	4.4	11	2	27	4573	4479
	Repl.1	4	200	24	1200	276	<8	833	<8	34.0	518	53	680	973000	27400
	Repl.2	4	100	20	1200	363	20	846	<8	36.1	487	50	681	973000	26700
5	Repl.3	3	90	10	1200	190	<8	818	<8	41.4	538	51	495	980000	20200
	Repl.4	3	80	17	1000	90	10	885	<8	28.3	326	39	306	981000	19300
	Average	4	118	18	1150	230	15	846	---	35.0	467	48	541	976750	23400
	S.D.	1	56	6	100	117	7	29	---	5.4	96	6	179	4349	4240
	Repl.1	5	100	10	1100	305	<8	797	<8	37.8	519	43	951	981000	19300
	Repl.2	3	100	20	1300	611	20	900	<8	39.3	501	43	1450	976000	23700
8	Repl.3	3	60	20	1200	686	10	940	<8	41.1	387	36	1630	977000	23000
	Repl.4	2	90	10	1200	627	10	891	<8	43.8	614	52	1470	971000	28800
	Average	3	88	15	1200	557	13	882	---	40.5	505	44	1375	976250	23700
	S.D.	1	19	6	82	171	6	61	---	2.6	93	7	294	4113	3910
	Repl.1	2	60	9	1400	120	<8	1020	<8	40.7	200	30	351	979000	21100
	Repl.2	4	100	20	1300	223	9	968	<8	32.7	390	47	609	971000	28800
9	Repl.3	4	80	10	1300	427	10	968	<8	35.9	451	49	753	966000	33800
	Repl.4	4	100	10	1500	302	10	980	<8	37.2	442	48	630	971000	29300
	Average	4	85	12	1375	268	10	984	---	36.6	371	44	586	971750	28250
	S.D.	1	19	5	96	130	1	25	---	3.3	117	9	169	5377	5270
	Repl.1	2	100	10	1400	247	<8	848	<8	36.9	453	43	654	979000	21100
	Repl.2	7	100	18	1300	463	19	1130	<8	32.2	485	58	659	961000	38800
12	Repl.3	3	80	10	1400	209	<8	865	<8	33.6	392	42	562	978000	22400
	Repl.4	6	100	20	1300	498	10	1020	<8	32.9	400	48	619	955000	44900
	Average	5	95	15	1350	354	15	966	---	33.9	433	48	624	968250	31800
	S.D.	2	10	5	58	147	6	134	---	2.1	44	7	45	12093	11881