ENVIRONMENT CANADA
CONSERVATION AND PROTECTION
ENVIRONMENTAL PROTECTION
PACIFIC AND YUKON REGION

BASELINE MONITORING
WINDY CRAGGY PROJECT
- September 8, 1988 -
- March 21 - 22, 1990 -

By Benoit Godin
and
Michael Hagen

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INTRODUCTION

Windy Craggy is located in the extreme northwest of British Columbia in a triangle bound by Alaska and Yukon, about 205 km southwest of Whitehorse, Yukon, and 840 km northwest of Smithers. The two open pit mines would be sited above 1,500 metres on the east slope of Windy Craggy peak, and be drained east by Tats Creek. Tats Creek flows into the Tatshenshini River about 30 km downstream. The Tatshenshini River flows southwest to the Alsek River. The west slopes of Windy Craggy peak are drained by Noisy and Forbisher Creeks which flow into the Alsek River.

The Alsek and Tatshenshini Rivers support sockeye, chinook, and coho salmon. Anadromous fish have not been found upstream in Tats Creek. Anadromous steelhead trout, resident rainbow trout, Dolly Varden char, whitefish, and Arctic grayling are present in the tributary streams.

Copper will be removed from the ore by a grinding and flotation process. The mill and tailings pond are planned for a site on the northwest branch of Tats Creek near Tats Lake at the 800-metre elevation.

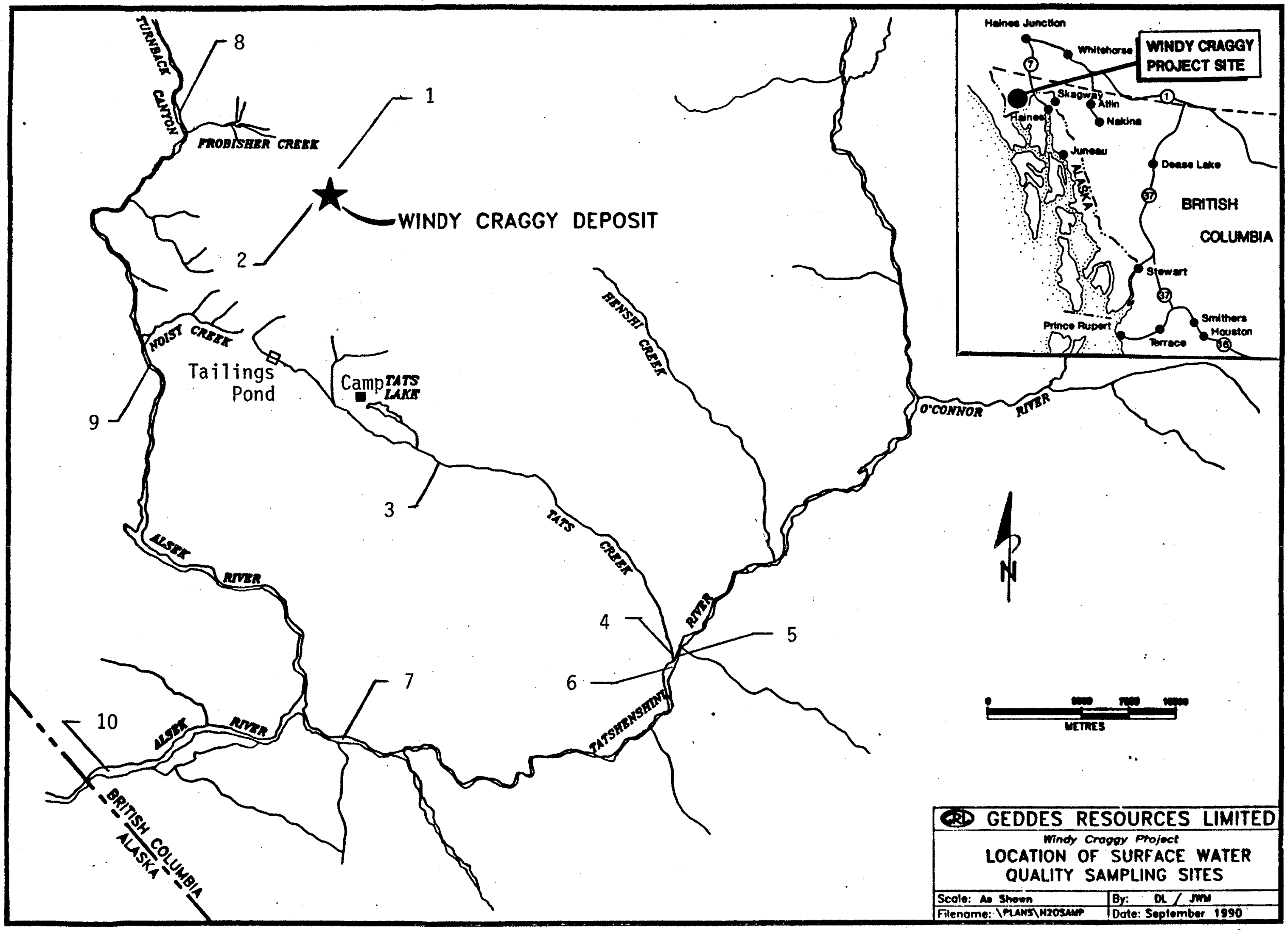
WINDY CRAGGY DEPOSIT
1
2
3
4
5
6
7
8
9
10
TURNBACK CANYON
FROBISHER CREEK
NOIST CREEK
Tailings Pond
Camp
TATS LAKE
TATS CREEK
HENSHI CREEK
O'CONNOR RIVER
RIVER
TATSHENSHINI
ALSEK RIVER
ALSEK RIVER
BRITISH COLUMBIA
ALASKA
N
METRES
WINDY CRAGGY PROJECT SITE
Haines Junction
Whitehorse
Skagway
Atlin
Nakina
Haines
Juneau
ALASKA
Dease Lake
BRITISH COLUMBIA
Stewart
Prince Rupert
Terrace
Smithers
Houston
GEDDES RESOURCES LIMITED
Windy Craggy Project
LOCATION OF SURFACE WATER QUALITY SAMPLING SITES
Scale: As Shown
By: DL / JWM
Filename: \PLANS\H2OSAMP
Date: September 1990

Fig. 1

SAMPLING STATION LOCATION

Station	Location
1	Red Creek, groundwater discharge from mineral body
2	Mine adit
3	Upper Tats Creek below tailings pond site
4	Tats Creek at mouth
5	Tatshenshini River upstream of Tats Creek
6	Tatshenshini River downstream of Tats Creek
7	Tatshenshini River upstream of Alsek River
8	Alsek River upstream of Forbisher Creek
9	Alsek River downstream of Noisy Creek
10	Alsek River downstream of Tatshenshini River

MATERIAL AND METHODS

The site was visited on September 8, 1988 and March 21 - 22, 1990. Four replicate sediment samples were collected at Red Creek and the mine adit in 1988 and at the other eight stations in 1990. Sediment samples were collected from the streambed with a clean acrylic corer. The samples were transferred into kraft bags and kept cool until analysed. The samples were air dried, sieved to <150 um, digested with aqua regia, and analysed for heavy metals using Inductively Coupled Argon Plasma (ICAP). A portion of the sediments were also ignited at 550° C in a muffle furnace. The loss of weight was reported as volatile residue and the remaining residue was reported as fixed residue. 1990 samples were also sieved to <63 um. Analytical method were in accordance with the Environment Canada, Pacific Region, Laboratory Manual (Anon, 1979).

A paired comparison was done with the 1990 <150 um and <63 um sieved sediment metal concentration results. For each screen size, values for the metals were pooled and compared using the student's T-test:

$$t_s = \frac{D}{S_D/\sqrt{n}}$$

The mean, D, was calculated by subtracting the 150 um sample value from the 63 um sample.

Sediment sequential extraction was performed on material collected from lower Tats Creek (Station 4) in order 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 um, 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 degrees C for six hours with 0.04 M $NH_4OH.HCl$ in 25% (v/v) acetic acid.

4) F(d): Metals bound to organic matter and sulphides. The residue from (c) is extracted at 85 degrees C for five hours with 0.02 M HNO_3 and 30% H_2O_2 adjusted to pH 2 with HNO_3 and then at room temperature with 3.2 M NH_4OAc in 20% (v/v) HNO_3 on a wrist action shaker for 30 minutes.

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) 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 Tats Creek material (TATS-1) was used as reference material in subsequent surveys to evaluate changes over time in sequential extraction procedures. The reference material precision was checked by calculating means and standard deviations for each metal, and results were compared to the internal laboratory reference materials EPS-1 and EPS-2.

RESULTS

No metals were at or below their detection limit in <150 um sediments at all stations except antimony, which was not measured at the mine adit or the north face in 1988. Silver (8 ug/g) was detected only at the mine adit. Arsenic, lead, and molybdenum were detected at only a few stations (Table 1 - 3).

Sediment samples from the north face (Station 1) had the highest levels of aluminium (20.7 mg/g), chromium (140 ug/g), copper (390 ug/g), magnesium (25.7 mg/g), manganese (847 ug/g), mercury (0.1 ug/g), nickel (100 ug/g), phosphorus (4148 ug/g), silicon (2155 ug/g), and zinc (352 ug/g). Samples from the mine adit (Station 2) had the highest levels of iron (273.5 mg/g), molybdenum (10 ug/g), and lead (12 ug/g), and the lowest levels of barium (7.9 ug/g), beryllium (0.2 ug/g), calcium (5473 ug/g), sodium (78 ug/g), and strontium (26.5 ug/g). Cadmium and cobalt were below the detection limit at the mine adit. The mine adit had the highest level of volatile sediment at 10%, sediment from all other sites was about 1% volatile.

The mineralization of the area is reflected by the metal content in sediments from Tats Creek, especially in Tats Creek upstream near the site of the camp and tailings pond (Station 3). Sediment samples from this site had generally high metal concentrations, including the highest for arsenic (24 ug/g), cobalt (50 ug/g), and titanium (22.8 ug/g). Conversely, sediment from the Alsek River upstream of Forbisher Creek (Station 8), which is above the drainage from the west slope of Windy Craggy, has relatively low levels of all metals except calcium (61.4 mg/g).

Metal concentrations in sediment sieved to <63 um are generally higher than for sediment sieved to <150 um. This holds for Windy Craggy sediment at the alpha equals 5% level ($p < 0.05$) for all metals except arsenic, cadmium, iron, tin, and vanadium, for which no significant difference exists, and for cobalt which has a significantly greater concentration in the <150 um sediments (Table 4).

Table 1

Sediment Quality - Windy Craggy
September 8, 1988

Station Number		SEDICP 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 MG UG/G	SEDICP MN UG/G
	Repl.1	<2	21700	<8	27.3	0.4	47500	1.7	<20	149	376	87200	0.110	26400	800
	Repl.2	<2	20600	10	23.1	0.4	49500	2.3	<20	138	537	81400	0.091	25700	877
1	Repl.3	<2	21300	<8	24.4	0.4	42400	1.7	<20	144	334	70700	0.100	26700	927
	Repl.4	<2	19200	20	21.8	0.4	42400	1.0	<20	130	312	80900	0.097	23900	783
	Average	---	20700	15	24.2	0.4	45450	1.7	---	140	390	80050	0.100	25675	847
	S.D.	---	1098	7	2.4	0.0	3615	0.5	---	8	102	6858	0.008	1255	67
	Repl.1	9	11100	<8	6.8	0.2	4810	<.8	<20	111	358	296000	0.072	11200	375
	Repl.2	6	15200	<8	8.8	0.3	6880	<.8	<20	147	331	225000	0.050	16000	526
2	Repl.3	9	11200	<8	7.1	<.2	4930	<.8	<20	111	388	305000	0.053	11100	365
	Repl.4	8	14300	<8	8.9	0.2	5270	<.8	<20	139	644	268000	0.030	14200	412
	Average	8	12950	---	7.9	0.2	5473	---	---	127	430	273500	0.051	13125	420
	S.D.	1	2111	---	1.1	0.1	958	---	---	19	144	35968	0.017	2396	74

Table 1 (cont.)

Sediment Quality - Windy Craggy
September 8, 1988

Station Number		SEDICP MO UG/G	SEDICP NA UG/G	SEDICP NI UG/G	SEDICP P UG/G	SEDICP PB 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	8	200	100	4100	10	1980	<8	180	2260	94	392	987000	12500
	Repl.2	8	200	100	3960	10	2120	<8	167	2210	88	328	986000	14300
1	Repl.3	6	200	100	4260	<8	2110	8	153	2130	89	299	986000	13700
	Repl.4	5	200	98	4270	10	2410	<8	161	1940	78	387	985000	14600
	Average	7	200	100	4148	10	2155	---	165	2135	87	352	986000	13775
	S.D.	2	0	1	147	0	182	---	11	141	7	45	816	929
	Repl.1	10	80	80	1920	10	1870	22	22.6	1560	63	122	876000	118000
	Repl.2	9	80	110	2350	18	1920	10	32.0	2220	84	164	909000	91300
2	Repl.3	10	70	76	1920	10	1790	22	24.6	1700	68	116	877000	123000
	Repl.4	10	80	89	2360	10	1920	16	26.9	2270	89	128	917000	82800
	Average	10	78	89	2138	12	1875	18	26.5	1938	76	133	894750	103775
	S.D.	1	5	15	251	4	61	6	4.1	360	12	22	21329	19728

Table 2

Sediment Quality (<150 um) - Windy Craggy
March 21 - 22, 1990

Station Number		SEDICP 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	SEDICP K UG/G	SEDICP MG UG/G	SEDICP MN UG/G
3	Repl.1	<2	16100	21	43.0	0.8	63600	2.0	50	60.4	111	41100	700	14000	655
	Repl.2	<2	14800	17	38.3	0.7	69200	1.8	50	56.4	101	37300	700	13700	662
	Repl.3	<2	16300	<8	48.5	0.8	71600	1.0	50	58.8	90.9	36100	800	13900	677
	Repl.4	<2	14700	34	35.0	0.6	55600	2.0	50	53.8	145	46100	500	13200	594
	Average	---	15475	24	41.2	0.7	65000	1.7	50	57.4	112	40150	675	13700	647
	S.D.	---	842	9	5.9	0.1	7107	0.5	0	2.9	23.5	4503	126	356	37
4	Repl.1	<2	10400	21	50.5	0.7	31400	1.0	40	43.5	58.2	47000	900	7360	354
	Repl.2	<2	9590	<8	47.8	0.7	28500	0.9	40	40.8	115	46800	800	6860	328
	Repl.3	<2	10700	<8	54.4	0.7	30800	1.0	40	44.0	65.5	45900	900	7590	352
	Repl.4	<2	12400	20	55.7	0.7	38100	1.0	40	42.5	86.4	39400	1000	8200	397
	Average	---	10773	21	52.1	0.7	32200	1.0	40	42.7	81.3	44775	900	7503	358
	S.D.	---	1182	1	3.6	0.0	4127	0.0	0	1.4	25.5	3615	82	556	29
5	Repl.1	<2	12900	<8	117	0.8	46300	1.0	30	34.5	58.2	38600	900	9090	355
	Repl.2	<2	11300	10	140	0.8	43800	1.0	30	43.2	74.1	48600	900	8340	343
	Repl.3	<2	11800	32	112	0.8	45800	1.0	40	44.1	85.0	52900	1000	8720	357
	Repl.4	<2	11700	10	131	1.0	45700	1.8	40	56.5	60.5	73500	1000	8420	364
	Average	---	11925	17	125	0.9	45400	1.2	35	44.6	69.5	53400	950	8643	355
	S.D.	---	685	13	12.8	0.1	1098	0.4	6	9.1	12.5	14678	58	340	9
6	Repl.1	<2	14600	<8	96.3	0.6	50800	<0.8	20	30.6	55.9	27900	1000	10400	393
	Repl.2	<2	14500	<8	99.8	0.7	50200	0.9	30	31.3	55.2	28900	1000	10500	394
	Repl.3	<2	13300	<8	101	0.6	47300	<0.8	30	30.0	61.5	31200	1000	9560	361
	Repl.4	<2	12100	<8	144	0.8	43900	1.0	30	41.2	49.9	45400	900	8890	360
	Average	---	13625	---	110	0.7	48050	1.0	28	33.3	55.6	33350	975	9838	377
	S.D.	---	1176	---	22.6	0.1	3161	0.1	5	5.3	4.7	8151	50	759	19
7	Repl.1	<2	14200	9	108	0.9	48400	1.0	30	44.1	49.9	42000	1000	9980	408
	Repl.2	<2	14600	<8	117	0.8	50100	1.0	30	41.8	48.0	39500	1000	10400	416
	Repl.3	<2	16100	<8	126	0.8	54600	1.0	30	42.4	53.9	36900	1000	11500	450
	Repl.4	<2	13400	<8	112	0.8	45500	<0.8	30	41.4	46.7	40200	1000	9510	380
	Average	---	14700	---	116	0.8	49650	1.0	30	42.4	49.6	39650	1000	10348	414
	S.D.	---	1353	---	7.8	0.0	3807	0.0	0	1.2	3.1	2114	0	850	29
8	Repl.1	<2	8260	<8	54.1	0.6	59900	1.0	20	28.9	30.0	32400	900	7370	256
	Repl.2	<2	8530	<8	45.4	0.5	62000	<0.8	20	23.8	26.5	25300	900	7700	256
	Repl.3	<2	7830	<8	46.9	0.5	57900	0.9	20	25.9	26.3	29600	800	7120	247
	Repl.4	<2	9370	<8	46.9	0.5	65600	<0.8	20	22.2	25.8	19900	1000	8220	270
	Average	---	8498	---	48.3	0.5	61350	1.0	20	25.2	27.2	26800	900	7603	257
	S.D.	---	649	---	3.9	0.0	3291	0.1	0	2.9	1.9	5449	82	475	10
9	Repl.1	<2	9100	<8	56.1	0.6	70400	<0.8	20	26.9	28.6	28600	1000	8220	269
	Repl.2	<2	9500	<8	66.4	0.7	71900	2.0	30	35.0	35.1	35000	1000	8200	290
	Repl.3	<2	10500	<8	62.7	0.6	73100	<0.8	20	29.5	36.5	29500	1000	8920	291
	Repl.4	<2	9190	9	64.3	0.7	66300	2.0	30	42.2	39.3	50900	900	8040	283
	Average	---	9573	---	62.4	0.7	70425	2.0	25	33.4	34.9	36000	975	8345	283
	S.D.	---	642	---	4.4	0.1	2964	0.0	6	6.8	4.5	10328	50	392	10
10	Repl.1	<2	11300	<8	56.5	0.5	64800	<0.8	<20	24.8	34.1	23000	1000	8610	300
	Repl.2	<2	11200	<8	58.7	0.6	61200	<0.8	20	29.3	47.8	29200	900	8230	303
	Repl.3	<2	9190	<8	57.4	0.6	55200	<0.8	20	29.0	36.8	31800	800	7210	266
	Repl.4	<2	10900	<8	56.3	0.6	62600	<0.8	20	28.0	32.1	27200	900	8270	298
	Average	---	10648	---	57.2	0.6	60950	---	20	27.8	37.7	27800	900	8080	292
	S.D.	---	986	---	1.1	0.0	4110	---	0	2.1	7.0	3713	82	605	17

Table 2 (cont)

Sediment Quality (<150 um) - Windy Craggy
March 21 - 22, 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
	Repl.1	<2	100	48	1740	10	<8	537	22	231	2410	80	116
	Repl.2	<2	100	45	1780	<8	<8	655	19	245	1840	70	103
3	Repl.3	<2	200	45	1680	<8	<8	461	17	277	2550	80	134
	Repl.4	<2	100	50	1750	49	<8	728	23	187	2070	73	86
	Average	---	125	47	1738	30	---	595	20	235	2218	76	110
	S.D.	---	50	2	42	28	---	119	3	37.3	322	5	20
	Repl.1	<2	200	31	1900	<8	<8	1310	24	107	1750	88	57
	Repl.2	<2	200	30	1770	<8	<8	1260	29	99.4	1580	85	64
4	Repl.3	<2	230	33	1750	<8	<8	1740	25	109	1500	87	103
	Repl.4	<2	200	33	1960	<8	<8	2160	21	134	1720	80	81
	Average	---	208	32	1845	---	---	1618	25	112	1638	85	76
	S.D.	---	15	2	101	---	---	421	3	15.0	118	4	21
	Repl.1	<2	310	26	940	<8	<8	1330	18	150	1380	100	61
	Repl.2	<2	240	26	1100	10	<8	1050	25	132	1380	130	60
5	Repl.3	<2	250	29	990	9	<8	1510	30	135	1250	140	70
	Repl.4	<2	250	30	1100	10	<8	1360	39	132	1470	214	79
	Average	---	263	28	1033	10	---	1313	28	137	1370	146	68
	S.D.	---	32	2	81	1	---	192	9	8.6	91	48	9
	Repl.1	<2	320	25	910	<8	<8	1870	10	164	1310	60	62
	Repl.2	<2	300	26	920	<8	<8	1970	10	162	1230	61	59
6	Repl.3	<2	300	24	970	<8	<8	1500	20	151	1250	67	66
	Repl.4	<2	260	29	1200	<8	<8	1540	22	144	1230	120	69
	Average	---	295	26	1000	---	---	1720	16	155	1255	77	64
	S.D.	---	25	2	136	---	---	235	6	9.4	38	29	5
	Repl.1	<2	390	27	1000	<8	<8	1080	21	163	1510	120	82
	Repl.2	<2	380	27	1100	10	<8	1340	25	161	1410	110	121
7	Repl.3	<2	410	30	1100	<8	<8	1310	17	175	1550	97	97
	Repl.4	<2	340	26	1100	<8	<8	1240	23	153	1380	110	77
	Average	---	380	28	1075	---	---	1243	22	163	1463	109	94
	S.D.	---	29	2	50	---	---	116	3	9.1	81	9	20
	Repl.1	<2	230	20	880	<8	<8	376	20	156	1450	88	41
	Repl.2	2	240	20	760	<8	<8	337	10	166	1360	65	40
8	Repl.3	<2	220	17	810	<8	<8	367	16	150	1320	78	43
	Repl.4	<2	270	17	680	<8	<8	376	9	177	1350	47	41
	Average	---	240	19	783	---	---	364	14	162	1370	70	41
	S.D.	---	22	2	84	---	---	18	5	11.8	56	18	1
	Repl.1	<2	250	18	910	<8	<8	464	10	191	1330	73	44
	Repl.2	<2	260	21	1000	<8	<8	417	21	190	1680	100	54
9	Repl.3	<2	290	20	800	<8	<8	442	10	204	1610	77	53
	Repl.4	<2	240	23	860	<8	<8	482	26	187	1460	150	53
	Average	---	260	21	893	---	---	451	17	193	1520	100	51
	S.D.	---	22	2	85	---	---	28	8	7.5	156	35	5
	Repl.1	<2	280	20	730	<8	<8	732	10	192	1410	57	50
	Repl.2	<2	270	17	960	<8	<8	611	10	183	1710	79	47
10	Repl.3	<2	210	20	1000	<8	<8	620	10	160	1280	87	43
	Repl.4	<2	250	17	890	<8	<8	569	10	181	1450	73	47
	Average	---	253	19	895	---	---	633	10	179	1463	74	47
	S.D.	---	31	2	119	---	---	70	0	13.5	180	13	3

Table 3

Sediment Quality (<63 um) - Windy Craggy
March 21 - 22, 1990

		SEDICP 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	SEDICP K UG/G	SEDICP MG UG/G	SEDICP MN UG/G
	Repl.1	<2	15500	17	61.4	0.8	76900	2.0	50	63.2	128.0	41200	800	13500	767
	Repl.2	<2	15800	10	63.1	0.8	83700	1.0	50	61.6	110.0	38700	700	13900	778
3	Repl.3	<2	15100	<8	54.4	0.7	83000	2.0	40	60.9	98.9	36500	700	13800	774
	Repl.4	<2	15600	22	63.7	0.8	73200	1.7	60	59.1	161.0	45300	800	12600	729
	Average	---	15500	16	60.7	0.8	79200	1.7	50	61.2	124.5	40425	750	13450	762
	S.D.	---	294	6	4.3	0.0	5033	0.5	8	1.7	27.1	3775	58	592	22
	Repl.1	<2	15500	<8	82.5	0.7	47400	1.0	30	55.0	87.8	38800	1000	11300	516
	Repl.2	<2	16200	<8	81.3	0.7	48700	<0.8	30	54.0	85.3	37100	1000	11900	531
4	Repl.3	<2	19200	<9	109	0.7	55400	<0.9	30	69.1	90.1	42900	2000	13600	604
	Repl.4	<2	18200	10	89.2	0.7	54600	<0.8	20	52.4	71.5	36000	1000	12300	578
	Average	---	17275	---	90.5	0.7	51525	---	28	57.6	83.7	38700	1250	12275	557
	S.D.	---	1719	---	12.8	0.0	4061	---	5	7.7	8.3	3028	500	974	41
	Repl.1	<2	14000	31	197	0.8	62400	<0.8	20	45.7	69.7	44700	1000	10900	433
	Repl.2	<2	11000	29	234	1.0	51000	<0.8	30	65.4	77.0	71300	700	8790	384
5	Repl.3	<2	15600	30	216	1.0	67500	<0.8	30	57.8	76.2	57200	1000	12100	471
	Repl.4	<2	15900	21	180	0.8	72600	<0.8	20	46.6	64.9	44800	1000	12300	457
	Average	---	14125	28	207	0.9	63375	---	25	53.9	72.0	54500	925	11023	436
	S.D.	---	2244	5	23.4	0.1	9241	---	6	9.5	5.7	12645	150	1612	38
	Repl.1	<2	16700	<8	127	0.7	60500	<0.8	20	41.7	63.3	32500	1000	12200	497
	Repl.2	<2	16700	20	134	0.8	66300	0.9	20	45.8	72.3	37700	1000	12400	524
6	Repl.3	<2	13900	20	147	0.8	60700	0.8	20	44.1	66.9	39300	1000	10600	450
	Repl.4	<2	14300	23	207	0.9	58700	<0.8	20	63.2	73.7	53800	1000	10900	477
	Average	---	15400	21	154	0.8	61550	0.9	20	48.7	69.1	40825	1000	11525	487
	S.D.	---	1510	2	36.5	0.1	3292	0.1	0	9.8	4.8	9124	0	907	31
	Repl.1	<2	20500	<8	184	1.0	65300	1.7	40	51.7	58.3	35700	2100	13800	524
	Repl.2	<2	18500	<8	165	0.8	62700	1.0	30	45.6	60.4	33800	2000	13600	510
7	Repl.3	<2	19900	<8	165	1.0	72900	1.8	30	52.5	57.4	36600	1800	14500	570
	Repl.4	<2	16800	<8	165	0.9	64500	1.0	30	45.8	60.1	35900	1000	12200	493
	Average	---	18925	---	170	0.9	66350	1.4	33	48.9	59.1	35500	1725	13525	524
	S.D.	---	1646	---	9.5	0.1	4500	0.4	5	3.7	1.4	1197	499	964	33
	Repl.1	<2	8460	10	83.4	0.9	75900	<0.8	20	45.5	40.4	48200	800	7930	310
	Repl.2	<2	9150	<8	62.4	0.6	79400	<0.8	<20	30.7	40.7	32000	1000	8820	308
8	Repl.3	<2	8350	20	64.5	0.8	73100	<0.8	20	39.8	38.5	41600	900	7900	296
	Repl.4	<2	9690	<8	60.6	0.6	80200	<0.8	<20	27.2	36.3	26500	1000	9130	316
	Average	---	8913	15	67.7	0.7	77150	---	20	35.8	39.0	37075	925	8445	308
	S.D.	---	628	7	10.6	0.1	3283	---	0	8.4	2.0	9692	96	625	8
	Repl.1	<2	9770	<8	62.5	0.6	84100	0.9	<20	31.1	40.8	29200	900	8960	317
	Repl.2	<2	10200	<8	63.8	0.7	82900	<0.8	20	32.4	38.7	30700	1000	9130	322
9	Repl.3	<2	9980	<8	59.5	0.6	82300	<0.8	<20	29.3	40.4	27200	1000	9080	313
	Repl.4	<2	11700	10	70.2	0.7	89800	<0.8	20	36.5	46.9	34800	1000	10200	346
	Average	---	10413	---	64.0	0.7	84775	---	20	32.3	41.7	30475	975	9343	325
	S.D.	---	876	---	4.5	0.1	3433	---	0	3.1	3.6	3220	50	576	15
	Repl.1	<2	11200	<8	73.1	0.6	65200	1.0	30	30.1	55.8	30200	900	8460	310
	Repl.2	<2	11000	<8	80.4	0.6	60300	1.0	30	32.1	55.1	34100	900	8240	306
10	Repl.3	<2	9020	<8	98.5	0.8	54800	1.0	30	44.4	69.4	48800	700	7010	283
	Repl.4	<2	9500	<8	102	0.8	57800	1.8	30	44.4	63.4	47300	800	7300	296
	Average	---	10180	---	88.5	0.7	59525	1.2	30	37.8	60.9	40100	825	7753	299
	S.D.	---	1083	---	14.0	0.1	4401	0.4	0	7.7	6.8	9337	96	706	12

Table 3 (cont.)

Sediment Quality (<63 um) - Windy Craggy
March 21 - 22, 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	55	1850	10	<8	842	25	275	2180	75	144	983000	16700
	Repl.2	<2	100	49	1870	8	<8	669	22	307	2300	76	123	983000	16600
3	Repl.3	<2	100	48	1770	<8	<8	680	22	305	1870	71	127	984000	15600
	Repl.4	<2	180	55	1890	10	<8	1100	29	263	2930	83	110	988000	11900
	Average	---	120	52	1845	9	---	823	25	288	2320	76	126	984500	15200
	S.D.	---	40	4	53	1	---	201	3	22	445	5	14	2380	2255
	Repl.1	<2	220	44	2080	<8	<8	2790	25	163	1730	74	94	980000	20500
	Repl.2	<2	420	46	2150	9	<8	2750	24	160	1900	79	134	978000	22000
4	Repl.3	<2	440	67	1980	38	<9	2550	60	189	1950	82	155	---	---
	Repl.4	<2	300	46	2050	<8	<8	1320	17	188	2080	80	127	980000	20100
	Average	---	345	51	2065	24	---	2353	32	175	1915	79	128	979333	20867
	S.D.	---	104	11	70	21	---	696	19	16	145	3	25	1155	1002
	Repl.1	<2	330	36	1400	<8	<8	2250	22	179	1440	120	95	988000	11600
	Repl.2	<2	260	35	1840	9	<8	1490	39	145	1410	208	75	987000	13000
5	Repl.3	<2	340	39	1300	<8	<8	2820	30	198	1530	160	95	984000	16000
	Repl.4	<2	350	37	1200	<8	<8	2180	25	209	1430	110	91	987000	13500
	Average	---	320	37	1435	---	---	2185	29	183	1453	150	89	986500	13525
	S.D.	---	41	2	282	---	---	545	7	28	53	45	9	1732	1836
	Repl.1	<2	370	34	1400	<8	<8	1980	9	188	1840	80	84	986000	13800
	Repl.2	<2	350	39	1600	<8	<8	2340	20	187	1820	89	94	983000	16700
6	Repl.3	<2	300	34	1600	<8	<8	2270	10	167	1520	97	86	986000	14300
	Repl.4	<2	320	41	1720	<8	<8	2200	25	171	1620	150	100	985000	14500
	Average	---	335	37	1580	---	---	2198	16	178	1700	104	91	985000	14825
	S.D.	---	31	4	133	---	---	156	8	11	156	31	7	1414	1284
	Repl.1	<2	670	33	1300	<8	<8	1040	22	223	2160	100	119	983000	16700
	Repl.2	<2	540	32	1300	<8	<8	1730	19	207	1620	85	169	988000	12300
7	Repl.3	<2	550	36	1400	10	<8	1680	21	216	1840	93	148	985000	15300
	Repl.4	<2	450	33	1400	10	<8	1760	21	197	1630	92	114	985000	14900
	Average	---	553	34	1350	10	---	1553	21	211	1813	93	138	985250	14800
	S.D.	---	90	2	58	0	---	343	1	11	253	6	26	2062	1837
	Repl.1	<2	290	22	1600	<8	<8	311	23	179	1990	150	54	994000	5700
	Repl.2	<2	300	22	1100	<8	<8	336	10	188	1590	85	54	993000	7100
8	Repl.3	<2	280	22	1300	<8	<8	351	19	175	1870	130	57	993000	6500
	Repl.4	<2	330	21	1100	<8	<8	332	<8	193	1600	66	52	993000	7300
	Average	---	300	22	1275	---	---	333	17	184	1763	108	54	993250	6650
	S.D.	---	22	1	236	---	---	17	7	8	200	39	2	500	719
	Repl.1	<2	320	24	1300	<8	<8	433	10	201	1660	75	60	995000	5300
	Repl.2	<2	320	25	1300	<8	<8	374	10	203	1850	83	68	993000	7100
9	Repl.3	<2	320	23	1100	<8	<8	420	10	204	1580	69	58	993000	7300
	Repl.4	<2	360	29	1100	<8	<8	472	10	232	1890	90	68	993000	6560
	Average	---	330	25	1200	---	---	425	10	210	1745	79	63	993500	6565
	S.D.	---	20	3	115	---	---	40	0	15	149	9	5	1000	899
	Repl.1	<2	310	22	1200	<8	<8	666	10	191	1710	78	58	993000	7500
	Repl.2	<2	290	20	1400	<8	<8	623	20	180	1780	93	55	993000	7300
10	Repl.3	<2	230	23	1680	<8	<8	545	27	160	1660	150	56	995000	5400
	Repl.4	<2	250	22	1730	<8	<8	501	31	167	1810	150	61	993000	6800
	Average	---	270	22	1503	---	---	584	22	175	1740	118	57	993500	6750
	S.D.	---	37	1	249	---	---	75	9	14	68	38	3	1000	947

Table 4 Paired Comparisons Between Windy Craggy Sediment <150 um and <63 um

Obs	Metal	Mean	Std Error	T_s	T_c
8	Arsenic	-0.50	3.77	-0.13	2.365
32	Barium	36.17	4.66	7.77	2.039
32	Beryllium	0.08	0.02	4.11	2.039
9	Cadmium	0.16	0.19	0.81	2.306
32	Calcium	13,803	1,287	10.73	2.039
32	Cobalt	-3.70	1.70	-2.18	2.039
32	Chromium	8.68	1.40	6.21	2.039
32	Copper	10.27	2.22	4.63	2.039
32	Iron	1959	1828	1.07	2.039
32	Magnesium	1660	316.6	5.29	2.039
32	Manganese	89.4	10.4	8.57	2.039
32	Nickel	7.66	1.08	7.07	2.039
32	Phosphorus	374	37.2	10.04	2.039
32	Potassium	141	61.4	2.29	2.039
32	Silicon	314	90.3	3.48	2.039
32	Sodium	68.8	13.1	5.23	2.039
32	Strontium	31.5	4.48	7.02	2.039
31	Tin	2.45	1.82	1.35	2.042
32	Titanium	275	51.5	5.34	2.039
32	Vanadium	8.66	6.50	1.33	2.039
32	Zinc	24.1	2.96	8.16	2.039

Note: Two-tailed student's T-test used where

$$t_s = \frac{D}{S_D/\sqrt{n}}$$

The mean, D, is calculated by subtracting the 150 um sample value from the 63 um sample.

Sediments from lower Tats Creek (Station 4) were put through a sequential extraction procedure seven times between October 26, 1990 and May 3, 1991 when used as the reference material for Northern Mines, Babine Lake, and Equity Troughs samples. Results can be evaluated for both biological availability of Tats Creek metals and as a check on the precision of the sequential extraction procedure (Tables 5 - 12).

Metals in Tats Creek sediment are not generally biologically available as the exchangeable and carbonate fractions are low. Some cadmium (<0.27 ug/g), copper (4.08 ug/g), nickel (2 ug/g), and zinc (6.3 ug/g) were released in the carbonate fraction, as was a considerable amount of strontium (74.6 ug/g) (Table 12)

An evaluation of the results for the seven TATS-1 sequential extractions shows that there is a general variability in values for all fractions of copper, the carbonate and Fe/Mn oxide fractions of manganese, the carbonate and residual fractions of potassium, the exchangeable fraction of chromium, the carbonate fraction of zinc, the Fe/Mn oxide fraction of aluminium and antimony, and the organic/sulphide fraction of barium and phosphorus. This variability is not present in the results for EPS-1 and EPS-2 (Tables 13 and 14). The TATS-1 sample analysed with the Equity Troughs samples had several anomalous values, including all those for calcium, the exchangeable and Fe/Mn oxide fractions of strontium, the exchangeable fraction of vanadium, the carbonate fraction of aluminium, and the Fe/Mn oxide fractions of cadmium and phosphorus. The first Babine Lakes TATS-1 sample had anomalous values for the exchangeable fraction of cadmium, the Fe/Mn oxide fraction of barium, and the organic/sulphide fraction of calcium. The TATS-1 samples analysed with the Northern Mines samples registered 1900 mg/g for the Fe/Mn oxide fraction of potassium, which is anomalous compared to the other TATS-1 results and to the other fraction results.

TABLE 5: SEDIMENT SEQUENTIAL EXTRACTION

TATS - 1

WITH NORTHERN MINES SAMPLES

(LAB NUMBER 901411-006, Oct. 26, 1990)

Metals (µg/g)	Exchangeable	Carbonates	FE+MN Oxide	Organic & Sulphides	Residual	Total
AG	<0.4	<0.4	<0.4	<0.4	<2	<2
AL	<2	32	713	1620	11600	14000
AS	<2	<2	<2	<2	<8	<8
BA	16.6	23.3	4.59	2.6	29.7	76.8
BE	<0.04	<0.04	0.09	<0.04	<0.31	0.4
CA	1560	33000	907	3030	5100	43600
CD	<0.2	0.3	0.2	<0.2	<0.3	<0.8
CO	<4	<4	<4	<4	<20	<20
CR	<0.2	<0.2	2.2	1.2	40.3	43.7
CU	<0.2	4.19	4.05	47.6	6.26	62.1
FE	<2	115	4740	2790	27000	34600
K	<80	300	1900	<80	<80	800
MN	3.7	197	26	12.3	223	462
MO	<0.4	<0.4	<0.4	<0.4	<1.6	<2
NI	<0.8	2	3	4	22	31
P	<4	7	160	1810	<4	1860
PB	<2	<2	<2	<2	<8	<8
SB	<2	<2	4.6	<2	<3.4	<8
SN	<2	<2	<2	<2	<8	<8
SR	7.5	77.8	8.07	13.8	39.8	147
TI	<0.08	<0.08	<0.08	30.7	1740	1770
V	<0.4	<0.4	4.2	3	64.8	72
ZN	<0.08	8.69	12.5	<0.08	32.6	53.8

TABLE 6: SEDIMENT SEQUENTIAL EXTRACTION

TATS - 1

WITH NORTHERN MINES SAMPLES

(LAB NUMBER 901411-007, Oct. 26, 1990)

Metals (μg/g)	Exchangeable	Carbonates	FE+MN Oxide	Organic & Sulphides	Residual	Total
AG	<0.4	<0.4	<0.4	<0.4	<2	<2
AL	<2	32	637	1730	11700	14100
AS	<2	<2	<2	<2	<8	<8
BA	16.1	21.9	4.18	1.7	34.2	78.1
BE	<0.04	<0.04	0.1	0.04	<0.26	<0.4
CA	1520	32300	816	3150	5710	43500
CD	<0.2	0.4	<0.2	<0.2	<0.5	<0.8
[BCO	<4	<4	<4	<4	<20	<20
CR	<0.2	<0.2	2.2	1.2	39.4	42.8
CU	<0.2	4.01	4.18	41.2	10.8	60.2
FE	<2	164	4590	2780	26200	33700
K	<80	200	1900	<80	<80	900
MN	3.6	192	25.2	12.3	223	456
MO	<0.4	<0.4	<0.4	0.5	<1.5	<2
NI	<0.8	2	3	4	21	30
P	<4	5	120	1860	<4	1840
PB	<2	<2	<2	<2	<8	<8
SB	<2	<2	6.3	<2	<1.7	<8
SN	<2	<2	<2	<2	<8	<8
SR	7.29	76.4	7.34	14.9	41.1	147
TI	<0.08	<0.08	<0.08	32.5	1760	1790
V	<0.4	<0.4	4.1	3	62.9	70
ZN	<0.08	9.37	10.5	<0.08	33.2	53.1

TABLE 7: SEDIMENT SEQUENTIAL EXTRACTION

TATS - 1

WITH NORTHERN MINES SAMPLES

(LAB NUMBER 901411-008, Oct. 26, 1990)

Metals (μg/g)	Exchangeable	Carbonates	FE+MN Oxide	Organic & Sulphides	Residual	Total
AG	<0.4	<0.4	<0.4	<0.4	<2	<2
AL	<2	33	637	1660	11200	13600
AS	<2	<2	<2	<2	<8	<8
BA	15.2	21.7	4.18	2	32.2	75.7
BE	<0.04	<0.04	0.09	<0.04	<0.31	0.4
CA	1520	31900	896	2830	5500	42700
CD	<0.2	0.3	0.2	<0.2	<0.3	<0.8
CO	<4	<4	<4	<4	<20	<20
CR	0.3	0.3	2.2	1.1	38.9	42.8
CU	<0.2	3.7	4.12	43.2	<0.2	48.3
FE	<2	182	4570	2650	25700	33100
K	<80	300	2000	<80	<80	600
MN	3.7	188	25.4	11.8	223	9490
MO	<0.4	<0.4	<0.4	<0.4	<2	2
NI	<0.8	2	3	4	20	29
P	<4	5	150	1730	<4	1830
PB	<2	<2	<2	<2	<8	<8
SB	<2	<2	5.2	<2	<2.8	<8
SN	<2	<2	<2	<2	<8	<8
SR	7.2	74.4	8.03	13.8	40.6	144
TI	<0.08	<0.08	<0.08	31.5	1610	1640
V	<0.4	<0.4	4.1	2	61.9	68
ZN	<0.08	11.9	13.4	4.23	26	55.5

TABLE 8: SEDIMENT SEQUENTIAL EXTRACTION

TATS - 1

WITH BABINE LAKE SAMPLES

(LAB NUMBER 901026-085, January 4, 1991)

Metals (µg/g)	Exchangeable	Carbonates	FE+MN Oxide	Organic & Sulphides	Residual	Total
AG	<0.4	<0.4	<0.4	<0.4	<2	<2
AL	<2	31	683	1700	11600	14000
AS	<2	<2	<2	3	<5	<8
BA	17.7	17.3	6.2	2.6	33	76.8
BE	<0.04	<0.04	0.1	<0.04	<0.3	0.4
CA	1760	34200	1210	3510	2920	43600
CD	.43	0.2	<0.2	<0.2	<0.17	<0.8
CO	<4	<4	<4	<4	<20	<20
CR	<0.2	<0.2	2	1.1	40.6	43.7
CU	<0.2	3.8	4	37.4	16.9	62.1
FE	<2	205	4990	2810	26600	34600
K	<80	200	<80	<80	<600	800
MN	4.28	199	34.4	14.2	210	9700
MO	<0.4	<0.4	<0.4	<0.4	<2	<2
NI	<0.8	2	4	4.1	20.9	31
P	<4	5	150	1660	45	1860
PB	<2	<2	<2	<2	<8	<8
SB	<2	<2	<2	<2	<8	<8
SN	<2	<2	8.9	<2	nil	<8
SR	7.99	75.5	8.58	15.3	39.6	147
TI	<0.08	<0.08	<0.08	38.7	1730	1770
V	<0.4	<0.4	4.2	3	64.8	72
ZN	<0.08	3.1	6.56	7.12	37	53.8

TABLE 9: SEDIMENT SEQUENTIAL EXTRACTION

TATS - 1

WITH BABINE LAKE SAMPLES
(LAB NUMBER 901026-086, January 4, 1991)

Metals (µg/g)	Exchangeable	Carbonates	FE+MN Oxide	Organic & Sulphides	Residual	Total
AG	<0.4	<0.4	<0.4	<0.4	<2	<2
AL	<2	29	577	1580	11900	14100
AS	<2	<2	<2	2	<6	<8
BA	16.2	16	4.86	2.3	38.7	78.1
BE	<0.04	<0.04	0.1	<0.04	<0.3	0.4
CA	1510	31900	1020	3300	5770	43500
CD	<0.2	<0.2	<0.2	<0.2	<0.8	<0.8
CO	<4	<4	<4	<4	<20	<20
CR	0.4	<0.2	1.6	1.1	39.7	42.8
CU	<0.2	3.7	3.3	37	16.2	60.2
FE	<2	189	4210	2590	26700	33700
K	<80	100	<80	<80	<800	900
MN	3.6	188	28.8	12.6	223	9620
MO	<0.4	<0.4	<0.4	<0.4	<2	<2
NI	<0.8	2	3	4.1	20.9	30
P	<4	5	140	1580	115	1840
PB	<2	<2	<2	<2	<8	<8
SB	<2	<2	3	<2	<5	<8
SN	<2	<2	5.7	<2	<2.3	<8
SR	7.25	73.6	7.68	14.4	44.1	147
TI	<0.08	<0.08	<0.08	34	1760	1790
V	<0.4	<0.4	4	3	63	70
ZN	<0.08	2.8	7.33	6.41	36.6	53.1

TABLE 10: SEDIMENT SEQUENTIAL EXTRACTION

TATS - 1

WITH BABINE LAKE SAMPLES
(LAB NUMBER 901026-087, January 4, 1991)

Metals (µg/g)	Exchangeable	Carbonates	FE+MN Oxide	Organic & Sulphides	Residual	Total
AG	<0.4	<0.4	<0.4	<0.4	<2	<2
AL	<2	30	587	1560	11400	13600
AS	<2	<2	<2	3	<5	<8
BA	16.7	15.8	4.46	2	36.7	75.7
BE	<0.04	<0.04	0.1	<0.04	<0.3	0.4
CA	1630	31000	939	3210	5920	42700
CD	<0.2	<0.2	<0.2	<0.2	<0.6	<0.8
CO	<4	<4	<4	<4	<20	<20
CR	<0.2	<0.2	1.7	1	40.1	42.8
CU	<0.2	3.5	3.4	37.1	4.3	48.3
FE	<2	191	4150	2510	26200	33100
K	80	90	<80	<80	<430	600
MN	4.07	183	27.7	11.6	226	9490
MO	<0.4	<0.4	<0.4	<0.4	<2	2
NI	<0.8	2	3	4.1	19.9	29
P	<4	<4	120	1570	140	1830
PB	<2	<2	<2	<2	<8	<8
SB	<2	<2	5	<2	<3	<8
SN	<2	<2	<2	<2	<8	<8
SR	7.59	72.5	7.28	14.4	42.2	144
TI	<0.08	<0.08	<0.08	33.9	1610	1640
V	<0.4	<0.4	4	3	61	68
ZN	<0.08	2.5	5.11	6.36	41.5	53.5

TABLE 11: SEDIMENT SEQUENTIAL EXTRACTION

TATS - 1

WITH EQUITY TROUGHS SAMPLES

(LAB NUMBER 910256-013, May 3, 1991)

Metals (µg/g)	Exchangeable	Carbonates	FE+MN Oxide	Organic & Sulphides	Residual	Total
AG	<0.4	<0.4	<0.4	<0.4	<2	<2
AL	<2	62.9	646	1530	11800	14000
AS	<2	<2	<2	<2	<10	10
BA	15.3	14.3	4.45	1	44.8	79.8
BE	<0.04	<0.04	0.1	<0.04	<0.3	0.4
CA	1140	24200	687	2280	14500	42800
CD	<0.2	0.4	0.51	<0.2	<0.9	1.0
CO	<4	<4	<4	<4	<20	<20
CR	0.68	<0.2	1.6	0.48	39.7	42.5
CU	<0.2	5.64	3.3	32.9	17.7	59.5
FE	<2	484	3950	886	28700	34000
K	<80	200	<80	<80	<800	1000
MN	2.8	166	20.7	8.42	276	474
MO	<0.4	<0.4	<0.4	<0.4	<2	<2
NI	<0.8	2	2	3	24	31
P	<4	6	78	1180	466	1730
PB	<2	<2	<2	<2	<8	<8
SB	<2	<2	<2	<2	<8	<8
SN	<2	<2	<2	<2	<8	<8
SR	6.34	71.8	5.08	13.1	45.7	142
TI	<0.08	<0.08	<0.08	12.9	1760	1770
V	0.5	<0.4	3	1	68.5	73
ZN	<0.08	6	7.04	9.81	34.7	57.6

TABLE 12: REFERENCE MATERIAL PRECISION

TATS - 1

(n = 7)

Metal	Exchangeable	Carbonates	FE+MN Oxide	Organic & Sulphides	Residual	Total
AG	<0.4	<0.4	<0.4	<0.4	<2	<2
AL	<2	35.7 ± 12.1	650 ± 54	1624 ± 77	11600 ± 238	13914 ± 219
AS	<2	<2	<2	<.25 ± >.6	<10	<10
BA	16.3 ± 0.9	18.6 ± 3.4	4.76 ± 0.67	2.0 ± 0.6	35.6 ± 5	77.3 ± 1.5
BE	<0.04	<0.04	0.1	<0.04	<0.3	0.4
CA	1520 ± 190	31214 ± 3252	925 ± 163	3044 ± 398	6496 ± 3678	43200 ± 440
CD	<.23 ± >.09	<.27 ± >.08	<.24 ± >.12	<0.2	<0.5	<1
CO	<4	<4	<4	<4	<20	<20
CR	<.31 ± >.18	<0.21 ± 0.04	1.9 ± 0.3	1.0 ± 0.3	39.8 ± 0.6	43 ± 0.5
CU	<0.2	4.08 ± 0.73	3.8 ± 0.4	39.5 ± 4.9	10.3 ± 6.9	57.2 ± 6.2
FE	<2	219 ± 121	4457 ± 367	2431 ± 691	26729 ± 966	33829 ± 621
K	<80	199 ± 84	874 ± 991	<80	<800	800 ± 153
MN	3.7 ± 0.47	189 ± 12	26.9 ± 4.2	11.9 ± 1.7	229 ± 21	459 ± 8
MO	<0.4	<0.4	<0.4 ± >0.04	<0.4	<2	<2
NI	<0.8	2	3 ± 0.6	3.9 ± 0.4	21.2 ± 1.4	30 ± 1
P	<4	<5.3 ± >1.0	131 ± 28	1627 ± 225	111 ± 166	1827 ± 45
PB	<2	<2	<2	<2	<8	<8
SB	<2	<2	<4 ± >1.7	<2	<8	<8
SN	<2	<2	<2	<2	<8	<8
SR	7.31 ± 0.51	74.6 ± 2.1	7.45 ± 1.13	14.2 ± 0.7	41.9 ± 2.3	145 ± 2
TI	<0.08	<0.08	<0.08	30.6 ± 8.2	1710 ± 69	1743 ± 69
V	<.41 ± >.04	<0.4	3.9 ± 0.4	2.6 ± 0.8	63.8 ± 2.5	70 ± 2
ZN	<0.08	6.3 ± 3.7	8.92 ± 3.20	4.87 ± 3.66	34.5 ± 4.8	54.6 ± 1.7

When some values were below the detection limit for a metal, those values were assumed to be at the detection limit. The resulting arithmetic mean is preceeded with a "<" sign and the resulting standard deviation with a ">" sign.

TABLE 23: REFERENCE MATERIAL PRECISION

EPS - 1
(n = 10)

Metal	Exchangeable	Carbonates	FE+MN Oxide	Organic & Sulphides	Residual	Total
AG	<0.4	<0.4	<0.4	<0.4	<4	<2
AL	<2	11 ± 2	2260 ± 80	5050 ± 100	17300 ± 1310	24600 ± 1300
AS	<2	<2	<2	5.2 ± 1.2	11.8 ± 6.1	17 ± 6
BA	0.76 ± 0.03	6.31 ± 0.22	8.67 ± 0.13	5.27 ± 0.23	25.8 ± 2.2	46.8 ± 2.2
BE	<0.04	<0.04	0.3	0.06 ± 0.01	0.14 ± 0.01	0.5
CA	3130 ± 70	15200 ± 430	3650 ± 80	1560 ± 50	5560 ± 830	29100 ± 700
CD	<0.2	0.58 ± 0.07	0.35 ± 0.11	<0.2	0.67 ± 0.42	1.6 ± 0.4
CO	<4	<4	<4	<4	<36	<20
CR	0.2	0.43 ± 0.07	5.07 ± 0.24	13.2 ± 0.2	23.5 ± 1.2	42.4 ± 1.2
CU	0.45 ± 0.04	<0.2	<0.2	34.9 ± 0.6	nil	32.1 ± 2.9
FE	<2	21.4 ± 1.1	5800 ± 170	5610 ± 150	20400 ± 720	31830 ± 680
K	1030 ± 50	780 ± 50	450 ± 40	150 ± 50	1290 ± 220	3700 ± 200
MN	36.2 ± 0.9	147 ± 4	118 ± 3	67.9 ± 1.3	208 ± 21	577 ± 20
MO	2	<0.4	<0.4	2	nil	2.6 ± 0.5
NI	<0.8	2.7 ± 0.5	10.1 ± 0.5	8.6 ± 0.2	10.0 ± 1.4	31.4 ± 1.2
P	30 ± 4	40	130	874 ± 21	26 ± 45	1100 ± 40
PB	<2	<2	<2	6.6 ± 0.5	6.4 ± 5.0	15 ± 5
SN	<2	<2	<2	<2	<16	<8
SR	34.7 ± 0.6	61.7 ± 1.7	21.0 ± 0.2	6.35 ± 0.20	20.3 ± 4.2	144 ± 4
TI	<0.08	<0.08	<0.08	52.7 ± 2.1	1217 ± 70	1270 ± 70
V	2	0.8 ± 0.2	28.8 ± 0.8	18.8 ± 0.8	49.2 ± 1.4	99.9 ± 0.8
ZN	<0.08	7.20 ± 0.27	25.1 ± 1.3	23.5 ± 0.6	41.9 ± 3.6	97.7 ± 3.3

Source: Anon. August 1989. Sequential Extraction for Metals in Freshwater Sediments. Environment Canada, Environmental Protecion, Laboratory Services.

TABLE 14: REFERENCE MATERIAL PRECISION

EPS - 2
(n = 10)

Metal	Exchangeable	Carbonates	FE+MN Oxide	Organic & Sulphides	Residual	Total
AG	<0.4	<0.4	<0.4	<0.4	<4	<2
AL	<2	25 ± 2	2440 ± 140	4040 ± 60	15100 ± 620	21600 ± 600
AS	<2	<2	<2	3	13.0 ± 7.0	15 ± 7
BA	0.77 ± 0.02	6.63 ± 0.15	8.21 ± 0.20	3.60 ± 0.20	19.4 ± 1.8	38.6 ± 1.2
BE	<0.04	<0.04	0.25 ± 0.05	<0.04	0.15 ± 0.05	0.4
CA	2390 ± 50	11700 ± 200	2710 ± 60	1450 ± 50	7450 ± 640	24900 ± 600
CD	<0.2	0.33 ± 0.12	<0.2	<0.2	0.67 ± 0.16	1.0 ± 0.1
CO	<4	<4	<4	<4	<36	<20
CR	0.25 ± 0.06	0.62 ± 0.08	5.21 ± 0.10	9.57 ± 0.18	23.5 ± 1.2	38.9 ± 1.6
CU	0.35 ± 0.07	0.2	0.25 ± 0.08	35.4 ± 0.8	nil	28.1 ± 1.6
FE	<2	34.1 ± 1.4	6020 ± 160	4350 ± 80	20500 ± 700	30900 ± 700
K	670 ± 20	640 ± 30	300	90	700 ± 170	2400 ± 170
MN	17.7 ± 0.5	67.8 ± 1.9	69.7 ± 1.3	36.0 ± 0.5	215 ± 8	406 ± 8
MO	1	<0.4	<0.4	1.4 ± 0.5	nil	2
NI	<0.8	3	8.2 ± 0.4	5.8 ± 0.3	11.4 ± 0.9	28.4 ± 0.7
P	10	20	140 ± 10	721 ± 17	49 ± 34	940 ± 20
PB	<2	<2	<2	3.5 ± 0.7	6.5 ± 0.7	10
SN	<2	<2	<2	<2	<16	<8
SR	26.6 ± 0.5	43.7 ± 0.9	14.4 ± 0.2	4.99 ± 0.18	17.3 ± 3.2	107 ± 3
TI	<0.08	<0.08	<0.08	82.1 ± 3.8	1540 ± 80	1620 ± 80
V	0.8 ± 0.1	0.5 + 0.1	21.8 ± 0.4	12.7 ± 0.5	57.5 ± 2.6	93.3 ± 2.6
ZN	<0.08	5.33 ± 0.21	17.8 ± 1.0	14.3 ± 0.2	32.0 ± 3.0	69.4 ± 2.8

Source: Anon. August 1989. Sequential Extraction for Metals in Freshwater Sediments. Environment Canada, Environmental Protecion, Laboratory Services.

REFERENCES

Anonymous. 1979. Laboratory Manual. Department of the Environmental Protection Service. Department of Fisheries and Oceans (Pacific Region).

Tessier, A., P.G.C. Campbell, and M. Bisson. 1979. Sequential Extraction Procedure for the Speciation of Particulate Trace Metals. Analytical Chemistry, Vol. 51, No. 7, pp. 844-851.