NORTHAIR MINES LIMITED
BRANDYWINE FALLS, B. C.

NOTES FROM A REVIEW OF AQUATIC ENVIRONMENTAL INFORMATION, SITE INSPECTION AND WATER QUALITY AUDITS CONDUCTED JUNE 20, 1978 AND MARCH 4, 1981

by

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April, 1981

Notes from a review of aquatic environmental information, site inspection and water quality audits conducted June 20, 1978 and March 4, 1981.

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Notes from a Review of Aquatic Environmental Information, Site Inspection and Water Quality Audits Conducted June 20, 1978 and March 4, 1981.

1 NORTHAIR MINES LTD. (N.P.L.)

The Northair Mines Limited properties (135 claims) are located at elevation 975m (3250 ft) a.m.s.l. within the Coast Mountain Range approximately 56km (35 miles) due north of Squamish, B.C. and 15km (9 miles) due west of the ski resort of Whistler Village (Figure 1). Access to the mine and mill site (123°6'W.Long., 50°8'N.Lat.) can be obtained from Brandywine Falls (N.T.S. 92J/3) via Provincial Highway 99 and thence north on Powder Mountain Road. The area is heavily forested but alternately clear-cut with nature stands of even-aged Douglas Fir, Western Hemlock, Yellow and Western Red Ceder, Balsam and Minor Pine. The climate is that of the West Coast Marine environment where annual rainfall of 142cm (56in) exceeds total evaporation of 71cm (28in). Mean annual temperature is 5.7°C and mean annual snowfall is approximately 7m (20ft.) (Figures quoted are for Alta Lake, Atmospheric Enviroment Service).

The area is underlain by Mesozoic volcanics of andesitic composition, intruded by granitic rocks with recent basalt flows common in the valleys, one of which is located at the junction of Highway 99 and Powder Mountain Road. The volcanics of the mine property also occur as a series of andesitic flows, often porphyrite with agglomeratic boundaries but with no marker horizon or distinguishable flow (MacLeod, 1974). Detailed descriptions of the areas geology and geology of the Brandywine Silver property are described by Miller and Sinclair (1979) and Barr (1980).

The occurrance of mineralization was first discovered in 1969 by a weekend prospector (Dr. M. Warshawski) from stream sediment analyses, followed by exploration drilling in 1973 and partial underground development in 1974 (Vancouver Province, 1974). At that time indicated total reserves were 409,000 tons of ore grading 0.43 oz Au/ton, 3.59 oz Ag/ton, 0.30% Cu, 2.44% Pb and 3.34% Zn occurring in pyrite(4.5%), sphalerite, galena, chalcopyrite, native gold and electrum (in order of abundance) in three tabular ore zones (Discovery, Warman, Manifold) of approximately 1.8, 2.4 and 5.1 meters thick

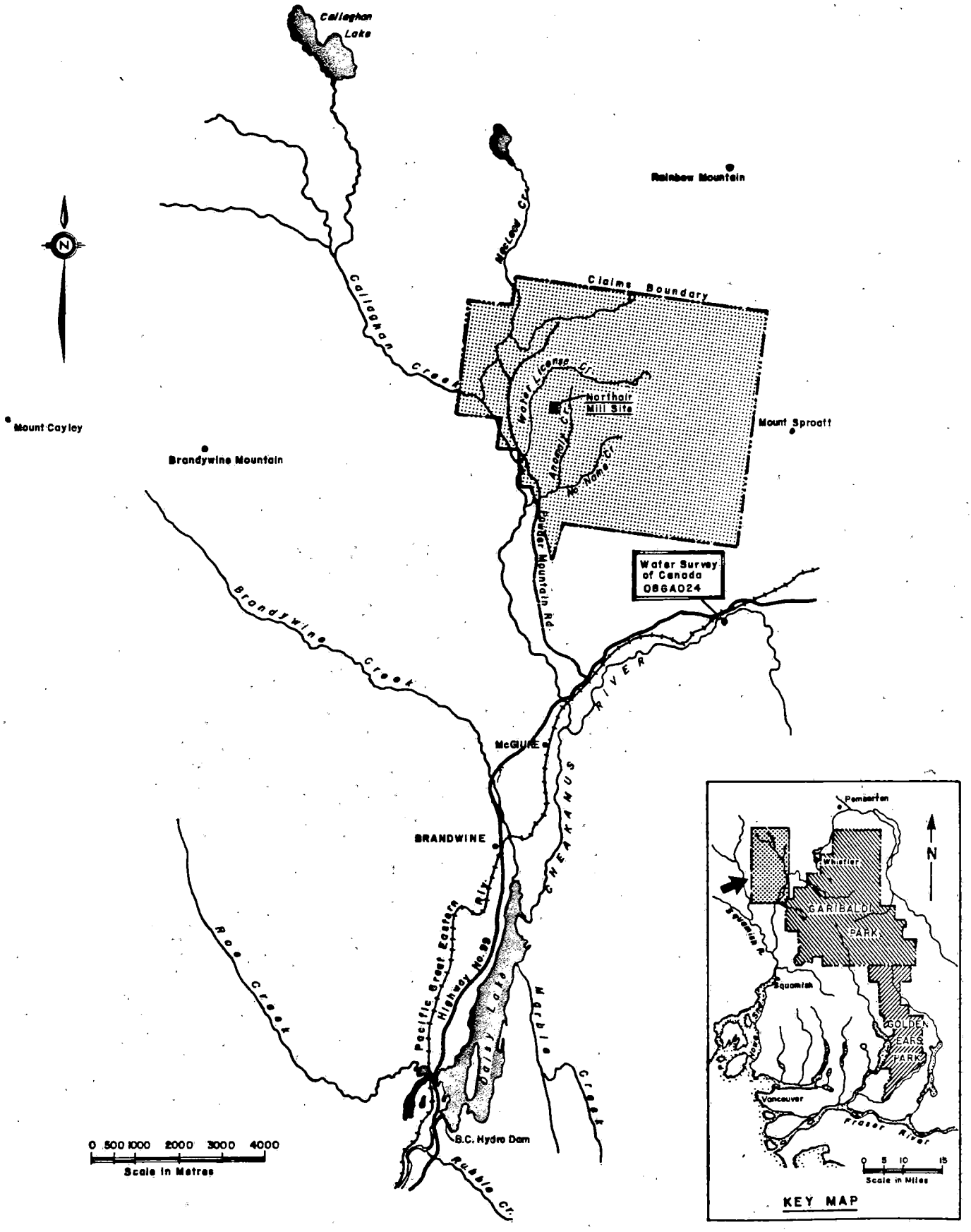

FIGURE I LOCATION MAP OF NORTHAIR MINES LTD. (N.P.L.)

respectively (MacLeod, 1974; Northern Miner, 1975; Miller and Sinclair, 1979). The acid generating potential of waste-rock and ore were examined prior to production and in both cases were found to be overall acid consumers and had no potential for acid generation (B.C. Research, 1974).

Ore grades from zone to zone differed progressively. In general, the southern (Manifold) zone was high in precious metals and low in base metals while the reverse was the case for the most northern(Discovery) zone. A fourth zone, southwest of the Manifold zone, now in production, was opened in 1978. All zones are now interconnected and accessed by six portals (2800', 3250', 3260', 3300', 3500' and 3700'), (Figure 2).

The estimated remaining proven reserves of 50,000 tons at the present head grade of 0.21 oz Au/ton, 1.2oz Ag/ton, 0.05% Cu, 1.6% Pb and 2.25% Zn (Western Miner, 1980; Appendix I) are mined by stope shrinkage and pillar removal and shipped to the adjacent concentrator by rail via the main haulage (3250') or combined rail and truck from the 2800' and 3700' portals. Waste-rock, of which there is relatively little, is used for road bed maintenance or stored underground. At the present mining rate of 350 tons/day and 5 days per week, these reserves will be exhausted by the end of 1981. Ongoing exploration has failed to unearth any additional economically recoverable ore (Appendix I) and while alternate possibilities for extending the life of the operation such as milling ore from other sites are being examined, closure appears imminant at the present price of gold ($460.00/oz U.S.).

A 300 ton/day design capacity mill (plates 1 and 2), located immediately adjacent to the 3250' main haulage, commenced production in July of 1976 employing conventional crushing and grinding (62.5%-200 mesh) and differential flotation to produce separate lead/copper and zinc concentrates. Although gold and silver report in varying amounts to both concentrates, course gold and silver are removed before flotation by a duel duplex jig. Reagent requirements for the two flotation circuits include Aerfloat 208, Dowfroth 250 or 1012, Z6 or 350, zinc sulfate, sodium cyanide (40cc/min at 10% solution as a zinc sulfide depressant), copper sulfate, Reagent MT 2306 and lime, yielding an average 86% copper, 95.5% lead, and 86% zinc recovery. Water requirements, which include make-up water from Water Licence and No-name Creeks and recycled water from the tailings supernatant, is an estimated 120,000 to 150,000 IGPD (6.25 l/sec to 7.8 l/sec).

Concentrates are shipped in 1.5 ton vats to Cominco's Trail smelter (MacLeod, 1974; Northern Miner, 1976; Bacon, Donaldson & Associates Ltd., 1974).

The rough jig concentrate is amalgamated with mercury, cleaned, pressed to a sponge and refined to dore bars on site. recovery averages 96% combined gold and silver and is further refined at the Royal Canadian Mint. Mercury losses in the cleaning and pressing phase are returned to the ball mill and sponge mercury is recovered by retort in the refining phase for re-use. It is reported that approximately 486Kg of mercury was lost from the amalgamation process between 1976 and 1978 (Garrett et al, 1980). This has been reduced to an estimated two - 76lb flasks (68.5 Kg) per year (Appendix I).

The final tails are separated by cyclone and the coarse fractions (approximately 44%) are pumped from the backfill plant and discharged uncemented underground. The fine fraction is chlorinated (200 to 250 lbs Cl_2/day) for cyanide destruction immediately before discharge to a 3.2 hectar (8 acre) tailings impoundment (plate 2) located 30 meters northwest of the mill. The tailings supernatant, of which a portion is returned to the mill for re-use, is pumped to Bellamy Lake polishing pond for additional settling and then released to Water Licence Creek following additional treatment in an activated carbon column. Natural inflow from surrounding drainage that would inundate the tailing area during periods of high run-off are diverted to Anomaly Creek which in turn is culverted past the development.

The camp site consists of trailer type accommodation for up to 160 employees, mill offices, maintenance shops, cookhouse and recreational facilities. Sewage from these facilities is aero-batically batch-treated (plate 3) and chlorinated and discharged to a lagoon before it is released to Anomaly Creek (Figure 2).

2. DESCRIPTION OF EFFLUENT QUALITY AND POLLUTION CONTROL

As a result of a large number of objections from the public (Vancouver Sun, 1975; Northern Miner, 1975; Squamish Times, 1975), British Columbia Fish & Wildlife Branch and the Federal Department of Fisheries & Environment, the British Columbia Pollution Control Branch rejected the original proposal on behalf of Northair Mines Ltd. to decant mine water and tailing supernatant from a small unnamed lake (plate 4) (now the tailings

impoundment), which had a limited capacity of 2.5 years production, to Anomaly Creek. A revised Pollution Control Permit Application was submitted May 28, 1975 which included a plan to construct a second or supplementary supernatant storage area 2 km. north of the mill site (MacLeod Creek holding pond) to be brought into operation when the capacity of the tailings impoundment could no longer accommodate the remaining years of production (Ker, Priestman & Associates Ltd, 1976). The company anticipated that through aging and dilution, the toxic effects of cyanide and heavy metals if any, would have dissipated by the time operations ceased and the contents could then be safely released to Callaghan Creek. A permit (PE-4106) based on the above scenario was granted September 2, 1975.

However it became evident in the first few months of operation that because of the large quantities of mine water encountered underground, this effluent retention scheme would not be adequate (Ker, Priestman & Associates Ltd., 1977). The company subsequently submitted an application (July 15, 1977) to amend the permit to allow discharge of all mine water after settling to Anomaly Creek and tailings supernatant after lime treatment, settling and pH adjustment to Water Licence Creek. Although these modifications, ie;the mine water settling ponds and the Bellamy Lake polishing pond (plates 5 and 6), were instituted in early 1977 the permit amendments were not issued until March 22, 1978 (figure 2).

During this interm the Environmental Protection Service conducted an extensive compliance evaluation (August 15 to 17, 1977) of both the Bellamy Lake discharge to Water Licence Creek and mine water discharges from the 3250', 3500' and 3700' portals for the purposes, in part, of assessing the outstanding application (Villamere et al, 1978).

While their study indicated that the final effluent from Bellamy Lake met all Federal requirements, each of the three mine waters after settling were out of compliance under the Federal Metal Mining Liquid Effluent Guidelines with respect to one or all of total lead, total zinc, suspended solids and toxicity; and led to the incorporation of a permit requirement for a more intensive effluent monitoring program for each final effluent (ie; the weekly monitoring of final supernatant decant from Bellamy Lake, the quarterly monitoring of the tailing impoundment supernatant, and the quarterly monitoring of each of four mine water discharges to Anomaly Creek). The permit was further amended November 21, 1978 to cover the addition of the 2800' mine water discharge. A summary of the monitoring results for the last quarter of 1979 and all four quarters of 1980 (October

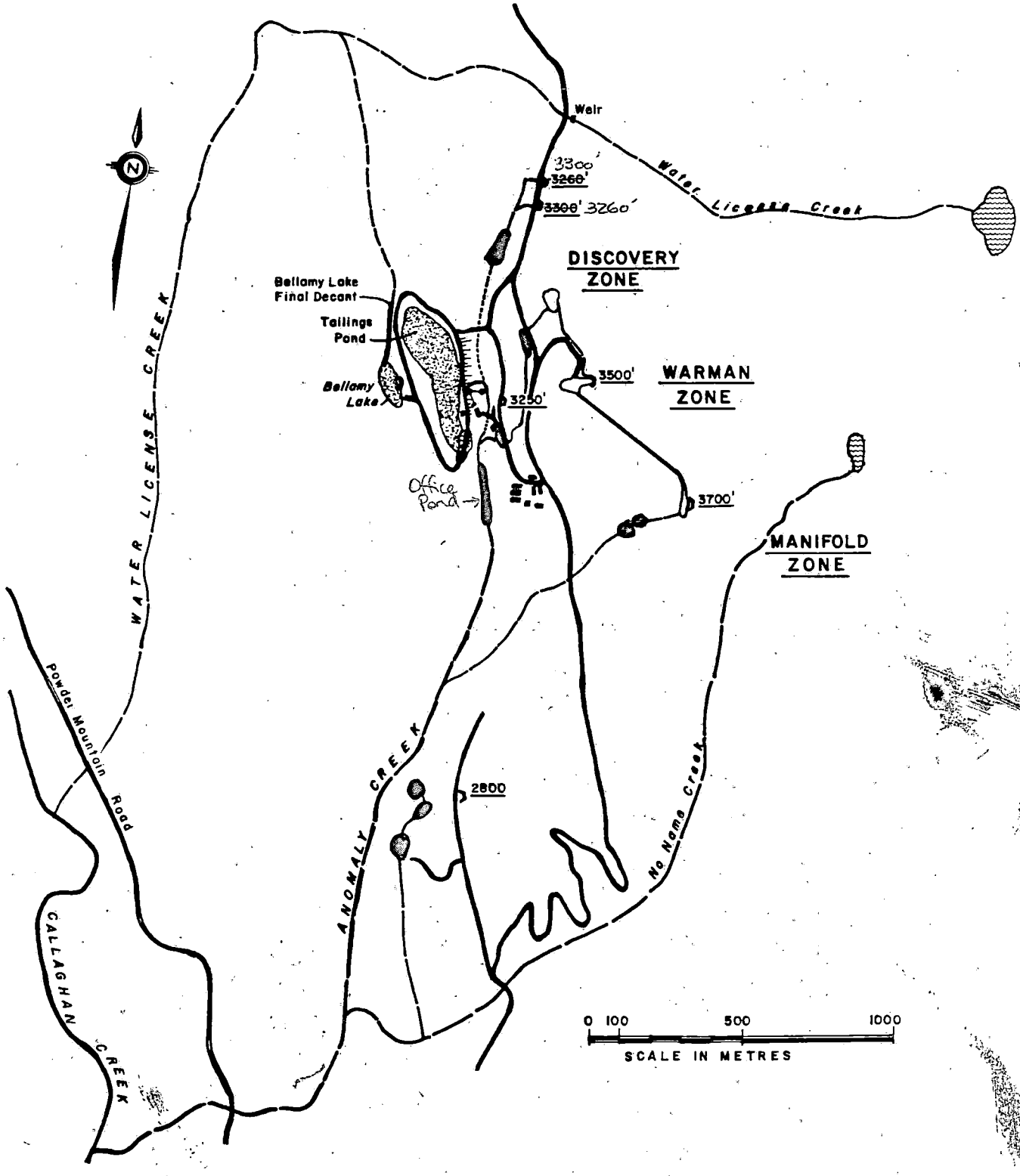

FIGURE 2 NORTHAIR MINES LTD. SITE PLAN

TABLE 1: SUMMARY OF MILL EFFLUENT QUALITY BEFORE AND AFTER TREATMENT FROM QUARTERLY AND WEEKLY MONITORING BETWEEN OCTOBER 1, 1979 TO DECEMBER 31, 1980, PURSUANT TO POLLUTION CONTROL PERMIT PE-4106, NORTHAIR MINES LTD.

Parameter	Pollution Control Permit Requirements	Federal Grab Requirements	Tailings Pond Supernatant			Bellamy Lake Final Discharge			
			Range	Average*	Number of Samples (quarterly)	Range	Average*	Number of Samples (weekly)	% of Samples in Compliance
T.S.S.(mg/l)	L50	L50	0.5-11.50	3.9	5	0.05-237	14.3	37	97
pH(units)	6.5-8.5	G5.0	6.7-11.05	9.85	5	6.2-10.2	8.14	45	52
R.Cl(mg/l)	non-detec.	-	M.N.R.	M.N.R.	M.N.R.	L0.1-0.2	L1.5	27	89
T.Cu(mg/l)	-	L0.6	0.013-0.35	0.090	5	0.009-0.34	0.062	37	100
D.Cu(mg/l)	L0.05	-	0.006-0.13	0.036	5	0.005-0.11	0.027	44	86
T.Fe(mg/l)	-	-	0.046-0.72	0.211	5	0.025-0.74	0.196	37	100
D.Fe(mg/l)	L0.30	-	L0.03-0.057	0.035	5	L0.03-0.11	0.05	37	100
T.Pb(mg/l)	-	0.4	0.005-0.18	0.049	5	0.001-0.024	0.008	37	100
D.Pb(mg/l)	L0.05	-	L0.001-0.001	0.001	5	L0.001-0.007	0.002	37	100
T.Zn(mg/l)	-	1.0	0.006-0.33	0.085	5	004-0.082(8.44)	0.030	37	97
D.Zn(mg/l)	L0.50	-	L0.001-0.27	0.057	5	L0.001-0.075(6.96)	0.001	37	97
D.SO4(mg/l)	L250	-	100-220	179.2	5	L5-195	169.9	37	100
T.CN(mg/l)	L0.10	-	L0.01-0.06	0.022	5	L0.001-0.07	0.016	36	100
T.Hg(mg/l)	L0.001	-	L0.00005-L0.0002	L0.0002	5	L0.00005-0.0004	0.00027	37	100
96hr LC50 (%)	G50%sur. in 100% con	G50%sur. in 100% con	M.N.R.	M.N.R.	M.N.R.	100%sur. in 100% con	100%sur. in 100% con	5	100

( ) One anomalous value of total and dissolved zinc recorded in July, 1980 not used in calculating the average value.
M.N.R. Monitoring is Not Required.
* In calculating average values, analyses of less than the detection limit were assumed to be at the detection limit.

1, 1979 to December 31, 1980) are presented in Tables 1 and 2 together with Provincial permit and Federal guildline requirements (Ker, Priestman & Associates Ltd., 1980a, 1980b, 1980c, 1980d, 1981).

With respect to the mill effluent quality (Table 1), it is noted that with the exception of one anomalous analyses for each of total suspended solids, total zinc and dissolved zinc the Bellamy Lake discharge has met all Federal requirements over the 15 month period examined. Similarly, the final effluent has met all Provincial permit requirements, with the exception of the above noted anomalous analyses, slightly higher than acceptable dissolved copper throughout the last quarter of 1979, and three detectable (G0.2 mg/l) values of residual chlorine during mid 1980.

Although the data is not of sufficient quantity on which to assess efficiencies of treatment facilities it does indicate that the additional settling time provided by Bellamy Lake and the activated carbon filter installed in the fall of 1979 does add substantially to the final effluent quality in particularly with respect to reductions in total and dissolved copper, lead and zinc as seen from comparing average values for the period.

Of further note some 321 daily measurments were taken of the volume of discharge from Bellamy Lake and of Water Licence Creek for the purpose of establishing the required dilution of 20:1 (stream:effluent) prescribed by the Pollution Control Permit. This number of measurements also includes the period of Novemer 9, 1979 to February 11, 1980 when there was a zero discharge from Bellamy Lake. From this data the minimum dilution requirement was only achieved on 49.2% of the time and these occurred almost exclusively in the high run-off months of May, June and July, or when there was zero discharge from Bellamy Lake (mid winter, November 9, 1979 to February 11, 1980). Nevertheless, the data indicates that because most parameters in the final effluent were low or below detection, proportionaly a 20:1 dilution was achieved. While this is not a critical matter at this operation, it does serve to illustrate that establishing allowable effluent discharge rates on dilution requirements, is not a reliable method of pollution control and difficult to enforce.

With respect to the mine water discharges the majority of flow is diverted downward to the 2800' portal (plate 8) where the volume from weekly flow records for the period October 1, 1979 to December 31, 1980 averaged 90 l/sec (1196 IGPM). Flows from the 3250', 3500', 3700' and Discovery (3260'-3300') portals for the same period averaged 1.59 l/sec (21 IGPM),

2.0 l/sec (27 IGPM), 1.7 l/sec (23 IGPM) and 1.4 l/sec (18 IGPM), respectively. Except for total suspended solids analyses, all mine waters achieved both the Provincial and Federal requirements in 100% of each analyses reported over the period.

On the basis of this level of performance, Northair Mines Limited, made application August 18, 1980, for a reduction in their permit monitoring program. For the purposes of responding to this application the Environmental Protection Service undertook a site inspection and detailed audit survey of both the effluent treatment systems and receiving environment March 3 and 4, 1981. On March 3, a series of grab samples were obtained from each of the 2800', 3250', 3500', Discovery, and 3700' mine water before settling and at each point of final treatment, and analysed for pH, total suspended solids, and total and dissolved metals in order to provide and estimate of the efficiency of the settling facilities to remove contaminants. (During this sampling there was a break in the backfill line to the Discovery portal, which distorts the normally expected effluent quality of that particular mine water source and to an unknown degree the estimate of the efficiency of the settling facilities. However, it does, to a degree, represent a worst case situation). All data obtained from samples collected on March 3 are presented in Appendix I-1.

The final point of treatment for the 3250', 3500' and Discovery mine water discharges are best represented by the "Office Pond" overflow to Anomaly Creek. The 3250' and 3500' mine water before treatment were generally of good quality and only marginally above the Provincial permit and Federal guideline requirements. The Discovery mine water, because of the backfill line break, was well above the limits for an allowable discharge. However, the combined settling facilities were sufficient to remove an estimated greater than 99% suspended solids material and all parameters were within compliance. Similarly, in the case of the 3700' mine water settling facilities, an estimated 96% of the suspended solids, generated by activity at this level at the time, were removed together with an extimated 80 to 95% of major total metals (Ba, Mn, Ti, Zn, Fe, Si, Mg) and between 50% and 92% of dissolved metals (Ba, Cu, Pb, Fe, Zn) yielding the final effluent incompliance with Provincial and Federal requirements.

TABLE 2: SUMMARY OF MINE WATER QUALITY AFTER SETTLING FROM QUARTERLY MONITORING BETWEEN OCTOBER 1, 1979 TO DECEMBER 31, 1980, PURSUANT TO POLLUTION CONTROL PERMIT PE-4106, NORTHAIR MINES LTD.

Parameter	Pollution Control Permit Requirements	Federal Grab Requirements	2800' Range	2800' Average *	2800' Number of Samples	2800' % of Samples in Compliance
pH Units	6.5-8.5	G5.0	7.6-8.2	7.93	5	100
T.S.S.(mg/l)	L50	L50	2.0-68.5	30.6	5	80
D.Cu(mg/l)	L0.05	-	L0.001-0.003	L0.0015	4	100
D.Fe(mg/l)	L0.30	-	L0.03	L0.03	4	100
D.Pb(mg/l)	L0.05	-	L0.001-0.002	0.0013	4	100
D.Zn(mg/l)	L0.50	-	0.003-0.011	0.007	4	100
D.So4(mg/l)	-	-	301-350	321	4	100
T.Cu(mg/l)	-	L0.6	0.001-0.017	0.009	3	100
T.Fe(mg/l)	-	-	L0.03-1.79	0.62	4	100
T.Pb(mg/l)	-	L0.4	0.002-0.07	0.029	4	100
T.Zn(mg/l)	-	L1.0	0.007-0.17	0.061	4	100
T.CN(mg/l)	L0.1	-	-	-	0	-
T.Hg(mg/l)	L0.001	-	-	-	0	-

L = less than
G = greater than
* in calculating average values, analyses of less than the detection limit were assumed to be at the detection limit.

NOTE: Weekly flow records from October 1, 1979 to December 31, 1980 indicate that flows from the 3250', 3500', 3700', and Discovery portals were in the same order of magnitude, averaging 21,27,23, and 18 IGPM respectively. However, the largest mine water discharge orginates from the 2800' portal and averaged 1196 IGPM over the same period.

TABLE 2: (Continued) SUMMARY OF MINE WATER QUALITY AFTER SETTLING FROM QUARTERLY MONITORING BETWEEN OCTOBER 1, 1979 TO DECEMBER 31, 1980, PURSUANT TO POLLUTION CONTROL PERMIT PE-4106, NORTHAIR MINES LTD.

Parameter	Pollution Control Permit Requirements	Federal Grab Requirements	DISCOVERY (3260'+ 3300') Range	Average *	Number of Samples	% of Samples in Compliance
pH Units	6.5-8.5	G5.0	7.2-7.3	7.25	2	100
T.S.S.(mg/l)	L50	L50	3.5-8.5	6.0	2	100
D.Cu(mg/l)	L0.05	--	0.003-0.005	0.004	2	100
D.Fe(mg/l)	L0.30	--	0.074-0.26	0.167	2	100
D.Pb(mg/l)	L0.05	--	0.011-0.016	0.014	2	100
D.Zn(mg/l)	L0.50	--	0.018-0.088	0.053	2	100
D.So4(mg/l)	--	--	13-163	88	2	100
T.Cu(mg/l)	--	L0.6	0.01-0.019	0.015	2	100
T.Fe(mg/l)	--	--	0.64-1.09	0.87	2	100
T.Pb(mg/l)	--	L0.4	0.044-0.05	0.047	2	100
T.Zn(mg/l)	--	L1.0	0.05-0.21	0.13	2	100
T.CN(mg/l)	L0.1	--	-	-	0	-
T.Hg(mg/l)	L0.001	--	-	-	0	-

L = less than
G = greater than
* in calculating average values, analyses of less than the detection limit were assumed to be at the detection limit.
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TABLE 2: (Continued) SUMMARY OF MINE WATER QUALITY AFTER SETTLING FROM QUARTERLY MONITORING BETWEEN OCTOBER 1, 1979 TO DECEMBER 31, 1980, PURSUANT TO POLLUTION CONTROL PERMIT PE-4106, NORTHAIR MINES LTD.

Parameter	Pollution Control Permit Requirements	Federal Grab Requirements	3250' Range	3250' Average	3250' Number of Samples	3250' % of Samples in Compliance
pH Units	6.5-8.5	G5.0	7.1-8.05	7.81	5	100
T.S.S.(mg/l)	L50	L50	L1.0-294	92.1	5	60
D.Cu(mg/l)	L0.05	--	L0.001-0.003	0.002	4	100
D.Fe(mg/l)	L0.30	--	L0.03-0.12	0.053	4	100
D.Pb(mg/l)	L0.05	--	L0.001-0.008	0.004	4	100
D.Zn(mg/l)	L0.50	--	0.003-0.082	0.038	4	100
D.So4(mg/l)	--	--	13.5-65.5	38.6	4	100
T.Cu(mg/l)	--	L0.6	0.006-0.045	0.020	4	100
T.Fe(mg/l)	--	--	0.099-3.13	1.355	4	100
T.Pb(mg/l)	--	L0.4	0.020-0.14	0.081	4	100
T.Zn(mg/l)	--	L1.0	0.022-0.48	0.083	4	100
T.CN(mg/l)	L0.1	--	L0.01	L0.01	1	100
T.Hg(mg/l)	L0.001	--	L0.00005	L0.00005	1	100

L = less than
G = greater than
* in calculating average values, analyses of less than the detection limit were assumed to be at the detection limit.
NOTE: Weekly flow records from October 1, 1979 to December 31, 1980 indicate that flows from the 3250', 3500', 3700', and Discovery portals were in the same order of magnitude, averaging 21,27,23, and 18 IGPM respectively. However, the largest mine water discharge originates from the 2800' portal and averaged 1196 IGPM over the same period.

TABLE 2: (Continued) SUMMARY OF MINE WATER QUALITY AFTER SETTLING FROM QUARTERLY MONITORING BETWEEN OCTOBER 1, 1979 TO DECEMBER 31, 1980, PURSUANT TO POLLUTION CONTROL PERMIT PE-4106, NORTHAIR MINES LTD.

Parameter	Pollution Control Permit Requirements	Federal Grab Requirements	3500' Range	3500' Average	3500' Number of Samples	3500' % of Samples in Compliance
pH Units	6.5-8.5	G5.0	7.8-8.3	8.03	4	100
T.S.S.(mg/l)	L50	L50	L1.0-24.5	9.25	4	100
D.Cu(mg/l)	L0.05	-	0.001-0.003	0.002	4	100
D.Fe(mg/l)	L0.30	-	L0.03-L0.03	L0.03	4	100
D.Pb(mg/l)	L0.05	-	L0.001-0.003	0.002	4	100
D.Zn(mg/l)	L0.50	-	0.003-0.034	0.019	4	100
D.So4(mg/l)	-	-	33.5-300	110.8	4	100
T.Cu(mg/l)	-	L0.6	0.002-0.02	0.008	4	100
T.Fe(mg/l)	-	-	0.066-0.93	0.325	4	100
T.Pb(mg/l)	-	L0.4	0.008-0.062	0.024	4	100
T.Zn(mg/l)	-	L1.0	0.014-0.130	0.065	4	100
T.CN(mg/l)	L0.1	-	-	-	0	-
T.Hg(mg/l)	L0.001	-	-	-	0	-

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NOTE: Weekly flow records from October 1, 1979 to December 31, 1980 indicate that flows from the 3250', 3500', 3700', and Discovery portals were in the same order of magnitude, averaging 21,27,23, and 18 IGPM respectively. However, the largest mine water discharge originates from the 2800' portal and averaged 1196 IGPM over the same period.

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Parameter	Pollution Control Permit Requirements	Federal Grab Requirements	3700' Range	3700' Average	3700' Number of Samples	3700' % of Samples in Compliance
pH Units	6.5-8.5	G5.0	7.6-7.9	7.93	5	100
T.S.S.(mg/l)	L50	L50	L0.5-27	11.4	5	100
D.Cu(mg/l)	L0.05	--	L0.001-0.004	0.002	5	100
D.Fe(mg/l)	L0.30	--	L0.03-0.049	0.034	5	100
D.Pb(mg/l)	L0.05	--	L0.001-0.003	0.002	5	100
D.Zn(mg/l)	L0.50	--	L0.001-0.021	0.009	5	100
D.So4(mg/l)	--	--	L5-9.0	6.88	4	100
T.Cu(mg/l)	--	L0.6	L0.001-0.011	0.005	5	100
T.Fe(mg/l)	--	--	L0.03-0.56	0.226	5	100
T.Pb(mg/l)	--	L0.4	L0.001-0.021	0.008	5	100
T.Zn(mg/l)	--	L1.0	L0.001-0.022	0.014	5	100
T.CN(mg/l)	L0.1	--	-	-	0	-
T.Hg(mg/l)	L0.001	--	-	-	0	-

L = less than
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* in calculating average values, analyses of less than the detection limit were assumed to be at the detection limit.

NOTE: Weekly flow records from October 1, 1979 to December 31, 1980 indicate that flows from the 3250', 3500', 3700', and Discovery portals were in the same order of magnitude, averaging 21,27,23, and 18 IGPM respectively. However, the largest mine water discharge originates from the 2800' portal and averaged 1196 IGPM over the same period.

The three small settling ponds (plates 9 and 10) used to treat the 2800' mine water were, however, found to be much less efficient and possibly not of adequate total capacity to produce a final effluent that meets compliance on a consistent basis. For example, on March 3, only 77% of total suspended solids were removed and the final effluent exceeded the Federal grab sample requirements for suspended solids (80 mg/l) and total lead (0.457 mg/l) and the Provincial permit requirements for dissolved lead (0.143 mg/l) and dissolved iron (0.899 mg/l). However, on the following day (March 4) this effluent met all required limits. As previously noted, this source of mine water, by volume, is by far the largest single effluent and because it orginates from the underground area where most activity occurs, additional treatment is deemed necessary.

On March 4, 1981 a more extensive examination was made of the mill effluent treatment system, including the efficiency of the chlorination system to destroy forms of cyanide, and the tailings impoundment and Bellamy Lake settling pond to remove contaminants of concern. Analyses of grab samples included residue components, major anionic constituents, forms of cyanide, residual chlorine, dissolved and total fractions of twenty-five metals. Additional samples were taken of the three mine water final discharges (2800', 3700', "Office Pond"). All data aquired on March 4, 1981 is reported together with bioassay test records in Appendix I-2 and Appendix I-3.

In terms of solids removal from the mill effluent, greater than 99% of total, suspended and volatile residues are retained in the tailings impoundment. Approximately 20% to 30% of what remained was removed by the additional settling provided by Bellamy Lake. Corresponding or even greater reductions were observed with respect to total copper, lead, iron, zinc, silica, calcium, and magnesium while just slightly less dramatic reductions were observed with respect to dissolved metals. For example dissolved copper was reduced by 98%, dissolved lead by 92%, dissolved zinc by 78%, and dissolved iron by 85% overall, producing a final decant from Bellamy Lake well within both the Federal and Provincial limits.

Anionic constituents such as sulfates, phosphates, nitrites, nitrates, and ammonium were reduced overall by approximately 60%, 80%, 41%, 59% and 33% respectively and pH brought from an original milling level of 11.2 down to a near neutral 7.5 at the point of discharge.

Residual chlorine, immediately after chlorination, measured 0.5 mg/l but was found non-detectable in the tailings supernatant with a field HACH Kit and was not tested for at subsequent sample points. Total and dissolved cyanide prior to chlorination measured 6.6 mg/l and 1.8 mg/l, respectively, were reduced to 1.4 mg/l and 1.0 mg/l, respectively, in the tailings supernatant and further reduced to 0.21 mg/l and 0.17 mg/l, respectively in the final decant. An overall reduction of greater than 90% for both, although this level of total cyanide exceeded the Provincial permit level of LO.10 mg/l. Thiocyanates and cyanates were similarly reduced from 8.35 mg/l to 3.35 mg/l and 11.25 mg/l to 7.44 mg/l, respectively on chlorine contact and further reduced to LO.50 mg/l and 1.60 mg/l following settling; an overall reduction of 86% for both.

With the exception of sulfate in the 2800' mine water and total cyanide in the Bellamy Lake discharge all final effluents on March 4, 1981 were within compliance with the respective Federal guidelines and Provincial permit requirements, non-toxic at 100% concentration over 96 hours, and within the range of analyses reported by the company's monitoring program.

Of a minor note, special low-level analyses revealed that the mill tailings pre- and post-chlorination contained minor amounts of extractable mercury and could possibly be sufficient to account for losses from the gold and silver amalgamation process which are returned to the ball mill and escape recovery.

3 DESCRIPTION OF THE RECEIVING ENVIRONMENT AND AQUATIC RESOURCES

The Northair operations are drained by Anomaly Creek of which the headwaters originally began almost at the point of where the Discovery mine water is now discharged. This flow was culverted past the tailings impoundment (a former lake on Anomely Creek) and mill site but is now dammed at two locations to form mine water settling ponds above and below the mill site. Consequently the headwaters of Anomaly Creek is coincidental with the outflow from the most southerly of these settling ponds (Figure 3) and is joined by the sewage lagoon overflow, 2800' mine water, 3700' mine water, and No-Name Creek before discharging to Callaghan Creek 3 km downstream. Water Licence Creek, which drains the northern area of mine activity,

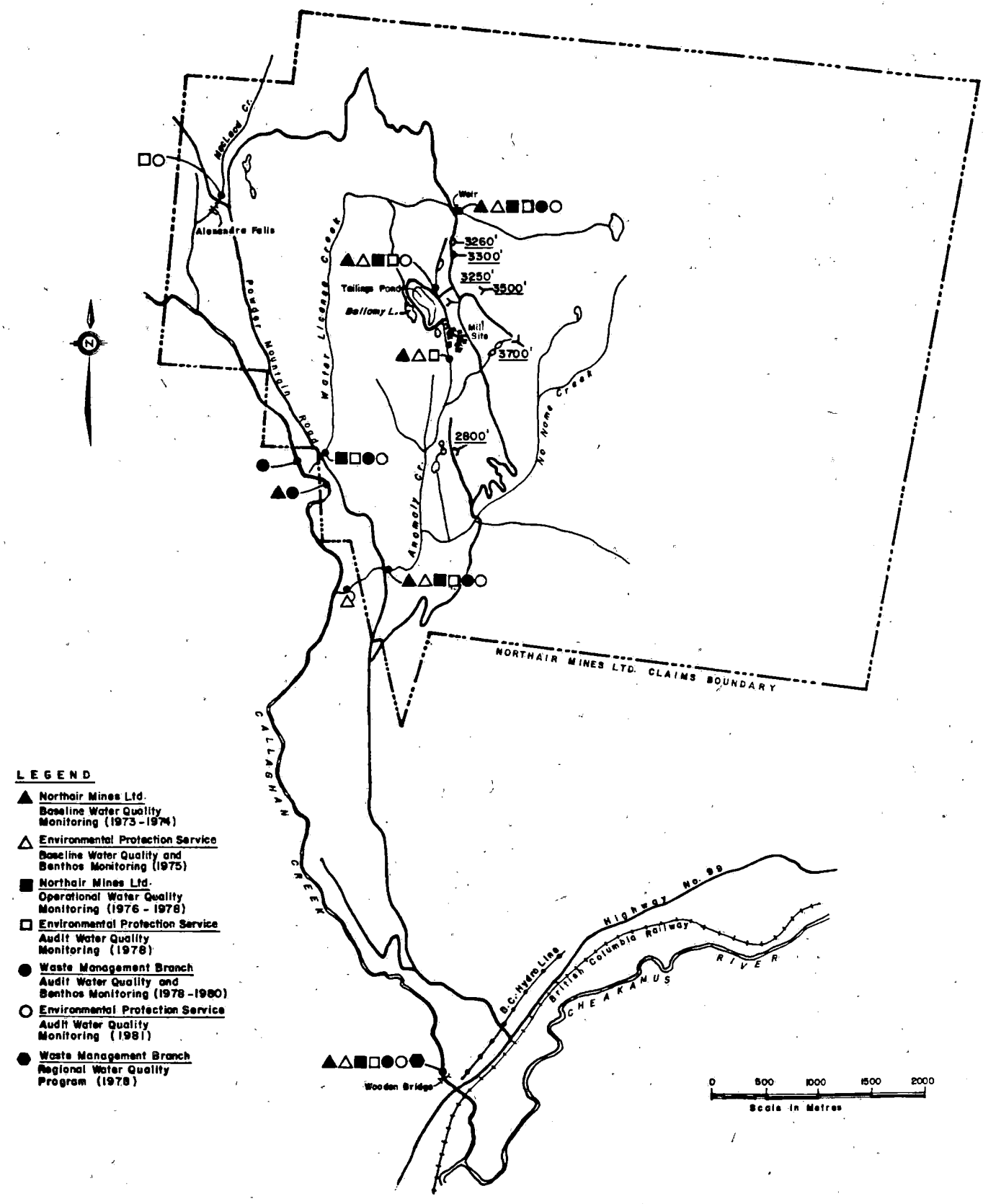

FIGURE 3 RECEIVING WATER QUALITY MONITORING CONDUCTED IN THE VICINITY OF NORTHAIR MINES LTD. FROM 1973 TO 1981

originates in a small lake approximately 1500m (4900ft) a.m.s.l. and flows westerly and then southerly (incorrectly recorded on N.T.S. 92J/3) for approximately 4.5 km were it also joins Callahgan Creek.

Callaghan Creek (drainage area $\simeq$ 210 km^2)is fed in the main by glacial melt from numerous tributaries originating from Mount Callaghan, Mount Cayley, Rainbow Mountain and Brandywine Mountain icefields which border the basin to the north, east and west. The mainstem of Callaghan Creek originates in Callaghan Lake and flows south by southeast, where it is joined by MacLeod Creek, Water Licence Creek and Anomaly Creek approximately 10 km, 7 km and 5 km respectively, upstream from it's confluence with the Cheakamus River.

For the purpose of calculating allowable effluent discharge rates at a 20:1 dilution to Water Licence Creek, flows of this creek are monitored daily during periods of effluent discharge at a wier upstream of the mine development. Low flows of 0.7cfs have been recorded in March of 1980 with highs of 24cfs in June of 1980. Annual means and extreme highs and lows have not been reported. Flows in Anomaly and Callaghan Creeks are not recorded but mine water flows which all ultimately feed this system total an average 3.5cfs year round. Flows for Anomaly Creek, Water Licence Creek at the wier, Water Licence Creek at Powder Mountain Road, MacLeod Creek above Alexandra Falls (plate 11) and Callaghan Creek at Highway 99 (plate 12) during a site inspection conducted March 4, 1980 were estimated to be 30cfs, 2cfs, 6cfs, 400cfs and 550cfs respectively. A full inventory of each of these sample sites is provided in Appendix II.

The Cheakamus River at the confluence with Callaghan Creek, (drainage area 290 km^2) flows southerly for approximately 5 km where it discharges to Daisy Reservoir, a British Columbia Hydro and Power Authority peaking facility brought on-line in 1957 to divert flows to the Squamish River for generating power during overload periods. The natural channels of the Cheakamus and Squamish Rivers merge about 13 km north of the town of Squamish, B.C. prior to discharging to Howe Sound.

The monthly and annual mean discharges for the Cheakamus River near Mons, B.C., (Water Survey of Canada, Station No. 08GA024) upstream of Callaghan Creek (123°02'54"W.Long. 50°05'00"N.Lat-Figure 3), was monitored

continuously between 1925 and 1948. Mean monthly lows of 156cfs occur in March and mean monthly highs of 1740cfs occur in July with an annual mean flow of 694cfs. An extreme low flow of 26cfs and an extreme high of 9080cfs have been recorded (Water Survey of Canada, 1977).

Of the total volume entering Daisy Reservoir, B.C. Hydro and Power Authority, by agreement with the Department of Fisheries (1957), maintain minimum combined flows from Daisy Reservoir and Rubble Creek (a tributary immediately downstream of the reservoir) of 400cfs during periods of salmon spawning.

Both the Squamish and Cheakamus Rivers support large runs of chinook, coho, chum, pink and steelhead trout. For example, in an above average year there may be 250,000 chinook, 18,000 coho, 70,000 pink, 200,000 chum and 18,000 steelhead spawners utilizing the Squamish River (Boyd, 1975) while on an above average year the Cheakamus River supports up to 3,000 chinook, 6,000 coho, 25,000 pink and 60,000 chum Salmon plus 3,000 steelhead trout. These anadramous species spawn in a section of the Cheakamus River between it's confluence with the Squamish River and the impassable falls approximately 14 km upstream (Birtwell, 1977). In addition the Squamish-Cheakamus system supports an important Indian food fishery and an intensive sport fishery. The estimated angler catch of steelhead averages 1,350 fish annually and the estimated combined number of days fished averages 10,000 per season (West, 1875).

Populations of dolly varden char, cutthroat trout and rainbow trout in the Cheakamus system are found upsteam from the falls and in the upper Cheakamus system above the Daisy Reservoir. Daisy Reservoir also contains a number of Kokanee (West, 1975) and this reservoir has been the subject of two preliminary studies (Wightman, 1972, 1973) leading to fishery resource enhancement options that are proposed for 1983-1984 pending further assessment.

Dolly varden char and rainbow trout have been taken in the lower reaches of Callaghan Creek but the upper reaches do not contain a fishery resource (West, 1975). However, the B.C. Fish and Wildlife Branch intend to stock Callaghan Lake with native rainbow trout annually for 3 to 5 years commencing the spirng of 1981. This program is to be followed by a fingerling survival assessment and possible full management program (Swiatkiewicz, 1981)

4 SUMMARY OF RECEIVING WATER QUALITY MONITORING AND ENVIRONMENTAL IMPACT ASSESSMENTS.

During the exploration and development phase, Northair Mines Ltd., personnel obtained pre-production water quality samples from May 23, 1973 to December 22, 1974 on seven occasions from Callaghan Creek near Highway 99 and Anomaly Creek at Powder Mountain Road; on three occasions from Water Licence Creek above the development; and on one occasion each from sites roughly coincidental with Callaghan Creek above Anomaly Creek, Anomaly Creek immediately below the mill and Anomaly Creek above the development. Approximate sample locations are shown in Figure 3 and all untabulated raw data is contained in the Ker, Priestman and Associates Ltd., report (1976). While all samples were analyzed for pH total, dissolved solids, total mercury, total cyanide and dissolved copper, iron, lead and zinc, four samples collected October 25, 1973 were analyzed for a broad spectrum of parameters including total metals and dissolved anions. Examination of the data indicated that all samples were neutral ranging from pH 6.2 to 7.7, moderately soft (60 to 90 mg/l $CaCO_3$), moderately low in suspended solids (L1 mg/l to 12.5 mg/l), absent of cyanide and typical of most coastal waters in low dissolved copper (L0.001 mg/l to 0.024 mg/l), iron (L0.05 mg/l to 0.06 mg/l) lead (L0.001 mg/l to 0.002 mg/l) and zinc (L0.001 mg/l to 0.01 mg/l) but untypical with respect to total mercury levels which were reported to range from 0.04 ug/l to 0.26 ug/l.

The Environmental Protection Service and the British Columbia Fish and Wildlife Branch jointly undertook a spring and fall pre-production assessment of the watershed adjacent to the development during the construction phase in 1975 (Hallam, 1976). Physical (pH, turbidity, conductivity, temperature, hardness), anion (Cl^-, CN^-, TPO_4^-, OPO_4^-, TSO_4^-, NO_2^-, NO_3^-) and total dissolved analyses of nine metals from six locations (Figure 3) as well as replicated (triplicated modified Hess) benthic invertebrate samples from four of these locations downstream of the point of discharge originally proposed were obtained. Benthic samples were analyzed for taxa present, total numbers per taxa, environmental tolerance, population diversity and population evenness. However, development activities (mill construction, culverting of Anomaly Creek, dewatering the tailings impoundment and mine

portal development) conducted between the two survey periods, severely affected the fall (September, 1975) results. In overall terms the data is in close agreement with the Northair Mines Ltd. baseline data. The pH ranged from 6.6 to 7.3, waters were soft (9.6 mg/l to 70 mg/l $CaCO_3$) low in suspended solids (L3 mg/l to 13 mg/l), absent in chlorine, cyanide, phosphates, nitrates, and nitrites, and with the exception of Anomaly Creek immediately below the development, dissolved copper, cadmium, iron, molybdenum, nickel, lead and zinc were below detection. Whereas benthic invertebrate populations during both survey periods were relatively abundant (158 to 441 individual specimens represented by 6 to 15 families at each site), evenly distributed (evenness $\bar{x}$ 0.659) moderately diverse ($\bar{x}$ 2.093) with a high proportion of pollution sensitive taxa and very typical of undisturbed west coast mountainous streams, the effects of silt loads over the summer to Anomaly Creek from site development and to Callaghan Creek from natural glacial deposition are clearly observable from the fall data. It was subsequently concluded in the report from supplementary mine water quality sampling that the major impacts could be expected from untreated mine water discharges.

Because the original Pollution Control Permit PE-4106, issued September 2, 1975 was based on a scenario of tailings supernatant recycle and excess supernatant being decanted to a secondary holding pond (MacLeod Creek holding pond) with no positive discharge, the only receiving environment monitoring required was limited to the quarterly collection of samples from Anomaly Creek above and below the mine and analyzed for pH, total cyanide, dissolved sulfate and dissolved copper, iron, lead and zinc. The subsequent amendments to the premit issued March 22, 1978 to allow the discharge of treated mine water to Anomaly Creek and tailings supernatant to Water Licence Creek included a revised monitoring program which entailed the quarterly collection of samples from Anomaly Creek below the mine, Water Licence Creek above and below the Bellamy Lake final decant and Callaghan Creek below the mouth of Anomaly Creek and analyzed for total suspended solids, pH, total cyanide, total mercury, dissolved sulfate and total and dissolved copper, iron, lead, and zinc. A summary of this data from the last quarter of 1979 and all four quarters of 1980 are presented in Table 3 (Ker, Priestman and Associates Ltd., 1980a, 1980b, 1980c, 1980d, 1981).

This data indicates that the water quality of Water Licence Creek above the tailings supernatant discharge (which is essentially unchanged from baseline conditions) is affected but to a very insignificant degree, by the Bellamy Lake discharge. Small and variable increases are reported (worst case) in dissolved SO_4 (from 8.0 mg/l above to 19.5 mg/l below), total iron (from L0.03 mg/l above to 0.046 mg/l below), and total lead (from 0.001 mg/l above to 0.003 mg/l below); none of which can be considered significant statistically or environmentally in as much as similar or greater increases were reported during periods when there was no discharge of tailings supernatant. In this regard it should be noted that on only two of the five quarterly results reviewed did sampling occur at the time of a discharge. The purpose of receiving water monitoring is to confirm that the treatment facilities and final effluent quality requirements, if met, are adequate to ensure no significant deterioration to the receiving environment. In this case the purpose of monitoring Water Licence Creek is defeated.

Anomaly Creek at Powder Mountain Road can occassionally exceed baseline quality, albeit not to a level of concern based on the reported data (Table 3). For example, the average pH of 7.9 is slightly more alkaline than baseline, and upper levels of dissolved copper (0.012 mg/l), dissolved lead (0.004 mg/l), total copper (0.095 mg/l), total iron (9.19 mg/l), total lead (0.55 mg/l) and total zinc (0.52 mg/l) have been reported. Levels of dissolved sulfate are notably higher and range from 36 mg/l to 137 mg/l.

Callaghan Creek at Highway 99, with the exception of dissolved sulfate shows no change from baseline levels and in all cases did not appear affected by the poorer water quality of Anomaly Creek. The variances noted between sample quarters is attributed to natural seasonal fluctuations.

The British Columbia Waste Management Branch has also conducted a biannual biological and water quality monitoring program of Water Licence, Anomaly and Callaghan Creeks system since the permit (PE-4106) was amended to allow a discharge (Gough and Moore, 1981). The monitoring locations, which to a large degree overlap as well as supplement the permit monitoring locations are shown in Figure 3. It is concluded from those studies (Gough and Moore, 1981) that the final discharge of tailings supernatant from Bellamy Lake has had little, if any impact on Water Licence or Callaghan Creek. However, the combined affects of mine water, particularly the 2800' discharge which has been reported out of compliance on both occasions

TABLE 3: RECEIVING WATER MONITORING RESULTS OBTAINED FROM QUARTERLY REPORTS SUBMITTED BY NORTHAIR MINES LIMITED PURSUANT TO POLLUTION CONTROL PERMIT PE-4106.

LOCATION	DATE	pH	S.S	D.Cu	D.Fe	D.Pb	D.Zn	D.SO4	T.Cu	T.Fe	T.Pb	T.Zn	T.CN	T.Hg
Anomaly	Dec. 22/79	7.80	4.8	0.012	L0.03	0.001	0.007	87	0.014	0.11	0.001	0.016	L0.01	L0.0002
Creek	Feb. 4/80	8.05	7.5	0.008	L0.03	0.004	0.016	137	0.095	9.19	0.37	0.52	L0.01	L0.0002
Below	Jun. 18/80	7.80	6.5	L0.001	L0.03	0.001	0.005	36	0.001	0.20	0.005	0.009	L0.01	L0.0002
Mine	Sep. 23/80	8.00	4.0	L0.015	L0.03	L0.001	L0.001	126	L0.001	0.068	0.005	0.005	L0.01	L0.0002
	Dec. 9/80	7.9	L0.5	L0.001	L0.03	L0.001	L0.015	125	0.003	0.044	0.055	L0.015	L0.01	L0.00005
Water	Dec. 22/79	7.75	1.2	L0.001	L0.03	L0.001	0.003	L5	0.002	L0.03	L0.001	0.005	L0.01	L0.0002
Licence	Feb. 4/80	8.10	3.5	0.002	L0.03	L0.001	0.003	21.1	0.002	0.067	L0.001	0.004	L0.01	L0.0002
Creek	Jun. 18/80	7.55	L1.0	L0.001	L0.03	L0.001	0.004	-	L0.001	0.040	0.001	0.006	L0.01	L0.0002
Above	Sep. 23/80	7.80	L1.0	L0.001	L0.03	L0.001	L0.001	8.0	0.001	L0.03	L0.001	L0.001	L0.01	L0.0002
Mine	**Dec. 5/80	7.75	L0.5	L0.001	L0.03	L0.001	L0.015	L5	0.001	0.036	L0.001	L0.015	L0.01	L0.00005
Water	*Dec. 22/79	7.60	2.8	0.002	0.060	L0.001	0.003	6.5	0.003	0.11	L0.001	0.004	L0.01	L0.0002
Licence	*Feb. 4/80	7.75	0.5	0.002	L0.03	L0.001	0.002	26.5	0.006	0.057	0.004	0.002	L0.01	L0.0002
Creek	Jun. 18/80	7.65	L1.0	L0.001	L0.03	L0.001	L0.001	-	0.001	0.058	0.003	0.008	L0.01	L0.0002
Below	Sep. 23/80	7.70	3.0	L0.001	L0.03	L0.001	L0.001	19.5	L0.001	0.046	L0.001	0.001	L0.01	L0.0002
Mine	*Dec. 9/80	7.60	L0.5	L0.001	L0.03	L0.001	L0.015	31.5	0.002	0.042	L0.001	L0.015	L0.01	L0.00005
Callaghan	Dec. 22/79	7.60	10.0	0.001	L0.03	L0.001	L0.001	10.5	L0.001	0.070	L0.001	0.001	L0.01	L0.0002
Creek	Feb. 4/80	7.50	L0.5	0.008	0.031	L0.001	0.001	15.5	0.001	0.042	0.003	0.001	L0.01	L0.0002
at Hwy 99	Jun. 18/80	7.50	11.5	L0.001	0.032	L0.001	0.006	L5	0.004	0.29	0.002	0.012	L0.01	L0.0002
	Sep. 23/80	7.60	10.0	0.001	L0.03	L0.001	L0.001	10.5	L0.001	0.07	L0.001	0.001	L0.01	L0.0002
	Dec. 9/80	7.45	L0.5	L0.001	L0.03	L0.001	L0.001	22.5	L0.001	0.068	L0.001	L0.015	L0.01	L0.00005

L = Less Than
all values in mg/l unless otherwise stated
* no discharge from Bellamy Lake polishing pond
** not sampled on the same day as other locations

it was examined during this program (July 24 and September 8, 1980) has resulted in a steady decline in the water quality and substrate composition of Anomaly Creek over the three years of study. The deterioration in water quality is most notable in specific conductance, suspended solids, dissolved sulfate, dissolved calcium, total iron, and to a lesser extent in total lead and zinc. Whereas in August of 1978, the bottom of Anomaly Creek was composed of clean rubble, in the following survey (July, 1979) the bottom was "clearly silted [80% stream bottom coverage] and the larger rocks were overgrown with a close-cropped golden brown slime growth" (Gough & Moore, 1981). However, there was only "slight evidence" that the impact of mine water discharges had reached as far downstream as Callaghan Creek at Highway 99.

Based on analyses of replicated benthic macroinvertebrate sample data, the impacts to Anomaly Creek are less discernable. For example, in overall terms, fewer number of specimens represented by fewer families were obtained in Water Licence Creek above and below the Bellamy Lake discharge than from Anomaly Creek. Although there were greater numbers of benthos, there was a lower proportion of pollution intolerant taxa; a possible confirmation of "a decline in water and/or physical quality at this site." Callaghan Creek did not appear affected to any significant degree based on the limitation of the data (Gough and Moore, 1981).

The Environmental Protection Service conducted two audit surveys of the watershed (June 20, 1978 & March 4, 1981) the latter for the purpose of assessing the August 18, 1980 application submitted by Northair Mines Ltd., to reduce their monitoring program. Both surveys engaged a broad spectrum of water analyses from six locations identified in Figure 3. A summary of this data is compared in Table 4 and 5 while the detailed analyses for triplicate sample analyses obtained March 4, 1981 are appended together with an inventory of each sample location (Appendix II). Except for Anomaly Creek below the mine water discharges, the entire watershed on both occasions was observed to be neutral in pH (6.7-7.9) low in total sulfate, total phosphate, nitrite, and nitrate, clear (FTU's 0.13 to 2.1), low in total solids (L35 mg/l), nearly deviod of suspended solids (L10 mg/l), very soft (L50 mg/l $CaCO_3$ equivalents), below the level of detection with respect to total cyanide (L0.03 mg/l) and generally below the level of detection with respect to 17 of the 22 metals examined in both dissolved and total form. Measurable metals include calcium, magnesium, barium, strontium and silica, primarily of the dissolved form (L0.45 u) which comprise the non-settlable silt loads (suspended solids.)

TABLE 4: PHYSICAL MEASUREMENTS AND NON-METAL WATER QUALITY ANALYSES OF SAMPLES COLLECTED FROM THE WATERSHED ADJACENT TO NORTHAIR MINES LTD., JUNE 20, 1978 AND MARCH 4, 1981.

	SAMPLE LOCATION											
	1 Anomaly Creek Above Mine		2 Anomaly Creek Below Mine		3 Water Licence Creek Above Mine		4 Water Licence Creek Below Mine		5 MacLeod Creek Above Alex.Falls		6 Callaghan Creek Near Mouth	
	A	B*	A	B*	A	B*	A	B*	A	B*	A	B*
pH	-	7.6	7.6	8.0	7.4	7.9	7.3	7.6	6.7	7.3	7.1	7.6
Alkalinity($CaCO_3$)	-	-	22.5	-	16.4	-	13.4	-	7.46	-	9.45	-
T.SO_4 (SO_4)	-	13.6	15.9	107	2.96	8.10	2.42	13.5	3.81	9.13	3.32	15.6
T.PO_4 (P)	-	0.0060	L0.0050	0.0061	L0.0050	L0.0050	L0.0050	0.0053	L0.0050	L0.0050	0.0058	0.0055
NO_2 (N)	-	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050
NO_3 (N)	-	0.016	0.055	0.087	L0.010	0.010	L0.010	0.045	0.029	0.049	0.025	0.015
Turbidity (FTU's)	-	2.1	0.58	8.6	0.25	1.3	0.13	1.4	0.34	1.2	1.50	2.1
Conductivity umhos/cm	-	118	850	340	600	95.5	223	82.0	175	47.6	215	77.7
Filterable Res.	-	29	57	90	31	24	24	23	186	15	22	24
Non-Filterable Res.	-	L5	L10	6.5	L10	L5	L10	L5	L10	L5	L10	L5
Total Res.	-	31	59	96	33	25	26	25	187	16	26	24
Hardness ($CaCO_3$)	-	45.7	30.4	43	16.7	39.6	12.5	30.3	8.61	17.5	10.5	28.7
T.CN	-	L0.03	L0.03	L0.03	L0.03	L0.03	L0.03	L0.03	L0.03	L0.03	L0.03	L0.03

A = June 20, 1978
B = March 4, 1981
L = Less than
* =average of triplicate samples.
All values in mg/l unless stated otherwise.

TABLE 5: TOTAL AND DISSOLVED METAL WATER QUALITY ANALYSES OF SAMPLES COLLECTED FROM THE WATERSHED ADJACENT TO NORTHAIR MINES LTD., JUNE 20, 1978 AND MARCH 4, 1981

	SAMPLE LOCATION											
	1		2		3		4		5		6	
	Anomaly Creek Above Mine		Anomaly Creek Below Mine		Water Licence Creek Above Mine		Water Licence Creek Below Mine		MacLeod Creek Above Alex.Falls		Callaghan Creek Near Mouth	
	20/6/78	4/3/81*	20/6/78	4/3/78*	20/6/78	4/3/81*	20/6/78	4/3/81*	20/6/78	4/3/81*	20/6/78	4/3/81*
Total Co	-	L0.015	L0.020	L0.015	L0.020	L0.015	L0.020	L0.015	L0.020	L0.015	L0.020	L0.015
Diss Co	-	L0.015	L0.020	L0.015	L0.020	L0.015	L0.020	L0.015	L0.020	L0.015	L0.020	L0.015
Total Cu	-	L0.01	L0.020	L0.01	L0.020	L0.01	L0.020	L0.01	L0.020	L0.01	L0.020	L0.01
Diss Cu	-	L0.01	L0.020	L0.01	L0.020	L0.01	L0.020	L0.01	L0.020	L0.01	L0.020	L0.01
Total Fe	-	0.091	L0.020	0.283	L0.020	0.055	L0.020	0.053	L0.020	0.091	0.122	0.045
Diss Fe	-	0.027	L0.020	0.120	L0.020	L0.01	L0.020	0.036	L0.020	0.030	L0.020	0.020
Total Pb	-	L0.08	L0.10	L0.08	L0.10	L0.08	L0.10	L0.08	L0.10	L0.08	L0.10	L0.08
Diss Pb	-	L0.08	L0.10	L0.08	L0.10	L0.08	L0.10	L0.08	L0.10	L0.08	L0.10	L0.08
Total Zn	-	0.132	L0.020	0.060	L0.020	L0.02	L0.020	L0.02	L0.020	L0.02	L0.020	L0.02
Diss Zn	-	0.106	L0.020	L0.02	L0.020	L0.02	L0.020	L0.02	L0.020	L0.02	L0.020	L0.02
Total Ca	-	18.5	12.8	52.4	6.74	14.6	4.98	11.0	3.30	6.26	4.07	9.93
Diss Ca	-	17.0	11.5	54.5	6.33	14.6	4.76	11.2	3.31	6.27	3.79	10.40
Total Mg	-	0.833	0.443	1.81	0.244	0.764	0.143	0.571	0.202	0.571	0.283	0.705
Diss Mg	-	0.769	0.418	1.68	0.226	0.669	0.156	0.581	0.193	0.443	0.248	0.653
Total Cd	-	L0.01	L0.010	L0.01	L0.010	L0.01	L0.010	L0.01	L0.010	L0.01	L0.010	L0.01
Diss Cd	-	L0.01	L0.010	L0.01	L0.010	L0.01	L0.010	L0.01	L0.010	L0.01	L0.010	L0.01
Total Ni	-	L0.08	L0.20	L0.08	L0.20	L0.08	L0.20	L0.08	L0.20	L0.08	L0.20	L0.08
Diss Ni	-	L0.08	L0.20	L0.08	L0.20	L0.08	L0.20	L0.08	L0.20	L0.08	L0.20	L0.08
Total Mn	-	0.0969	0.0385	0.056	L0.004	0.0175	L0.004	L0.003	L0.004	0.0073	0.0057	L0.003
Diss Mn	-	0.0772	0.0247	0.019	L0.004	L0.003	L0.004	0.0049	L0.004	0.0053	L0.004	L0.003
Total Al	-	L0.09	L0.20	0.167	L0.20	L0.09	L0.20	L0.09	L0.20	0.102	0.24	L0.09
Diss Al	-	L0.09	L0.20	L0.09	L0.20	L0.09	L0.20	L0.09	L0.20	L0.09	L0.20	L0.09
Total Ba	-	0.0094	0.0075	0.0148	0.0035	0.0071	0.0040	0.0067	0.0041	0.0069	0.0060	0.0061
Diss Ba	-	0.0097	0.0067	0.0147	0.0036	0.0075	0.0043	0.0068	0.0036	0.0075	0.0039	0.0059

TABLE 5: TOTAL AND DISSOLVED METAL WATER QUALITY ANALYSES OF SAMPLES COLLECTED FROM THE WATERSHED ADJACENT TO NORTHAIR MINES LTD., JUNE 20, 1978 AND MARCH 4, 1981
(Continued)

	SAMPLE LOCATION											
	1		2		3		4		5		6	
	Anomaly Creek Above Mine		Anomaly Creek Below Mine		Water Licence Creek Above Mine		Water Licence Creek Below Mine		MacLeod Creek Above Alex. Falls		Callaghan Creek Near Mouth	
	20/6/78	4/3/81*	20/6/78	4/3/81*	20/6/78	4/3/81*	20/6/78	4/3/81*	20/6/78	4/3/81*	20/6/78	4/3/81*
Total Cr	-	L0.015	L0.020	L0.015	L0.020	L0.015	L0.020	L0.015	L0.020	L0.015	L0.020	L0.015
Diss Cr	-	L0.015	L0.020	L0.015	L0.020	L0.015	L0.020	L0.015	L0.020	L0.015	L0.020	L0.015
Total Mo	-	L0.15	L0.20	L0.15	L0.20	L0.15	L0.20	L0.15	L0.20	L0.15	L0.20	L0.15
Diss Mo	-	L0.15	L0.20	L0.15	L0.20	L0.15	L0.20	L0.15	L0.20	L0.15	L0.20	L0.15
Total Sb	-	L0.08	L0.10	L0.08	L0.10	L0.08	L0.10	L0.08	L0.10	L0.08	L0.10	L0.08
Diss Sb	-	L0.08	L0.10	L0.08	L0.10	L0.08	L0.10	L0.08	L0.10	L0.08	L0.10	L0.08
Total Sn	-	L0.02	L0.10	L0.02	L0.10	L0.2	L0.10	L0.2	L0.10	L0.2	L0.10	L0.2
Diss Sn	-	L0.02	L0.10	L0.02	L0.10	L0.2	L0.10	L0.2	L0.10	L0.2	L0.10	L0.2
Total Sr	-	0.0862	0.0982	0.783	0.0326	0.0865	0.0188	0.0654	0.0197	0.0378	0.0233	0.0903
Diss Sr	-	0.0824	0.0951	0.769	0.0374	0.0847	0.0207	0.0653	0.0183	0.0391	0.0214	0.0908
Total Ti	-	L0.0085	L0.010	0.0097	L0.010	L0.0085	L0.010	L0.0085	L0.010	L0.0085	L0.010	L0.0085
Diss Ti	-	L0.0085	L0.010	L0.0085	L0.010	L0.0085	L0.010	L0.0085	L0.010	L0.0085	L0.010	L0.0085
Total V	-	L0.05	L0.030	L0.05	L0.030	L0.05	L0.030	L0.05	L0.030	L0.05	L0.030	L0.05
Diss V	-	L0.05	L0.030	L0.05	L0.030	L0.05	L0.030	L0.05	L0.030	L0.05	L0.030	L0.05
Total As	-	L0.15	L0.20	L0.15	L0.20	L0.15	L0.20	L0.15	L0.20	L0.15	L0.20	L0.15
Diss As	-	L0.15	L0.20	L0.15	L0.20	L0.15	L0.20	L0.15	L0.20	L0.15	L0.20	L0.15
Total Si	-	2.23	1.91	3.75	0.89	2.07	1.26	2.48	0.81	2.16	1.68	2.48
Diss Si	-	1.95	1.59	3.38	1.19	2.03	0.92	2.37	1.09	2.03	1.29	2.43
Total Hg**	-	L0.0002	---	L0.0002	---	L0.0002	---	L0.0002	---	L0.0002	---	L0.0002
Total Hg	-	L0.10	L0.10	L0.10	L0.10	L0.10	L0.10	L0.10	L0.10	L0.10	L0.10	L0.10
Diss Hg	-	L0.10	L0.10	L0.10	L0.10	L0.10	L0.10	L0.10	L0.10	L0.10	L0.10	L0.10

L = less than

All values in mg/l unless otherwise stated.

Analysis by Inductive Coupled Argon Plasma except Total Hg** which was by atomic asorption.

* = represents an average of triplicate samples

Despite the cloudy nature of Anomaly Creek (FTU's 8.6) suspended solids levels were also less than 10 mg/l. The significant differences were noted in particular, higher levels of total sulfate (up to 107 mg/l), total and dissolved iron, calcium, magnesium, barium, strontium and silica. Again, primarily of the silt sized fraction (LO.45 u) not amenable to settling. However, special low-level analyses of copper, lead and zinc and cadmium (Appendix II) revealed that Anomaly Creek downstream of the mine water discharges, contained higher levels of these contaminants, and confirmed the findings of the B.C. Waste Management Branch biannual monitoring program (Gough and Moore, 1981).

5 SUMMARY AND RECOMMENDATIONS

Northair Mines Ltd. a small 300 ton/day copper, gold, silver, lead and zinc mine located approximately 56 km due north of Squamish, B.C. opened in 1976 and is expected to close in late 1981 for the lack of economically recoverable ore. Two flotation concentrates (Cu-Pb & Zn) are produced and silver-gold are recovered by mercury amalgamation and refined to dore bars on site. Cyanide is used to differentially separate the two flotation concentrates.

The mill tailings are separated by cyclone with the coarse fractions used for backfill underground and the slimes chlorinated before being discharged to a tailings impoundment. A portion of the tailings supernatant is returned to the mill and combined with fresh make-up water to supplement process requirements. The tailings supernatant is given additional settling in Bellamy Lake, and passed through in an activated carbon column before it is released to Water Licence Creek. The mine water discharges, of which there are five, are treated in settling ponds with some flocculation, and partially combined, before being discharged to Anomaly Creek.

Anomaly Creek and Water Licence Creek are both tributaries to Callaghan Creek and the Cheakamus River above the B.C. Hydro Daisy Reservoir. Although there are no anadromous fish above the reservoir dam the Cheakamus River and the Squamish River, into which it flows, supports important runs of chinook, coho, chum, and pink salmon as well as steelhead trout. The Daisy Reservoir, Cheakamus River upstream of the reservoir and Callaghan

Creek support populations of dolly varden char, cutthroat trout and rainbow trout and are the subject of several B.C. Fish and Wildlife Branch enhancement or management plans.

Based on the results of regular monitoring conducted by the company pursuant to their Pollution Control Permit (PE-4106) and compliance and audit studies conducted by the B.C. Waste Management Branch (1978-1980) and the Environmental Protection Service (1977, 1978, 1981) it is concluded that:

a) the mill effluent treatment system (tailings impoundment, Bellamy Lake settling pond, activated carbon filter) has been successful in producing a consistant non-toxic final effluent that meets the allowable discharge requirements specified in the Provincial Pollution Control Permit and the Federal Metal Mining Liquid Effluent Guidelines.

b) the company's required monitoring of Water Licence Creek above and below the point of effluent discharge does not coincide with periods of effluent discharge thus defeating the purpose of monitoring the receiving environment. The purpose of monitoring the receiving environment is to confirm that the treatment facilities and final effluent quality requirements, if met, are adequate to ensure the protection of the environment. The permit should specify that receiving water monitoring must coincide with periods of effluent discharge.

c) the minimum dilution requirement, of 20:1 (Water Licence Creek: Bellamy Lake discharge) prescribed by the permit was only achieved on 49.2% of the time between October 1, 1979 and December 31, 1980. These occurred almost exclusively in high run-off months of May, June and July, or when there was zero discharge from Bellamy Lake (mid winter-November 9, 1979 to February 11, 1980).

d) except for the 2800' mine water treatment system, all mine waters discharged to Anomaly Creek have been consistantly in compliance with the requirements of the Provincial Pollution Control Permit and the Federal Metal Mining Liquid Effluent Guidelines.

e) the three small settling ponds used to treat the 2800' mine water are possibly not of adequate total capacity to produce a final effluent that meets compliance with Provincial and Federal requirements on a consistant basis. The efficiency of this system in terms of suspended solids removal has been estimated to be only 77% affective and the final effluent exceeded the Federal grab sample requirements for suspended solids and total lead and the Provincial permit requirements dissolved lead and dissolved iron on March 3, 1981. However, the

following day, March 4, this effluent met all required limits.

f) since the 2800' mine water, by volume, is by far the largest single source of effluent from this operation, and because it originates from the underground area where most activity occurs, additional treatment appears necessary; ie that the hydraulic retention time of these ponds be increased and/or an effective flocculant be used to ensure that effluent quality criteria are met.

g) Whereas the final discharge of tailing supernatant from Bellamy Lake has had little, if any, impact on Water Licence Creek or Callaghan Creek, the combined affects of mine water discharges has resulted in a steady decline in the water quality and substrate composition of Anomaly Creek, most noticably since the 2800' level was opened. This has, however, not yet had a measurable affect on Callaghan Creek.

With respect to the application dated August 18, 1980, submitted by Northair Mines Ltd. to reduce their monitoring program as prescribed in the Pollution Control Permit, the following reduced program is recommended:

Sample Locations

1 Tailings supernatant discharge at final point of treatment (Bellamy Lake discharge)

2 3250, Discovery, 3500' mine water at final point of treatment ("Office Pond" discharge)

3 3700' mine water after settling

4 2800' mine water after settling

5 Water Licence Creek above supernatant discharge point

6 Water Licence Creek below supernatant discharge point (Powder Mountain Road)

7 Anomaly Creek at Powder Mountain Road

8 Callaghan Creek below Anomaly Creek (Highway 99)

Analyses and Frequency

Parameter	Sample Location No. and Frequency							
	1	2	3	4	5*	6*	7	8
total suspended solids	M	Q	Q	Q	Q	Q	Q	Q
pH	M	Q	Q	Q	Q	Q	Q	Q
dissolved copper	M	Q	Q	Q	Q	Q	Q	Q
total copper	Q	Q	Q	Q	Q	Q	Q	Q
dissolved iron	M	Q	Q	Q	Q	Q	Q	Q
dissolved lead	M	Q	Q	Q	Q	Q	Q	Q
total lead	Q	Q	Q	Q	Q	Q	Q	Q
dissolved zinc	M	Q	Q	Q	Q	Q	Q	Q
total zinc	Q	Q	Q	Q	Q	Q	Q	Q
dissolved sulfate	M	Q	Q	Q	Q	Q	Q	Q
total CN	M	-	-	-	-	-	-	-
total mercury	Q	-	-	-	-	-	-	-
residual chlorine	M	-	-	-	-	-	-	-
toxicity bioassay	A	-	-	-	-	-	-	-

* Sampling of Water Licence Creek to coincide with tailings supernatant discharge sampling.

Q = Quarterly

M = Monthly

A = Annually

PLATES

Plate #1

NORTHAIR MINES LTD. MARCH, 1981

MILL - SOUTH VIEW

Plate #2

NORTHAIR MINES LTD. MARCH, 1981

MILL & TAILINGS IMPOUNDMENT-NORTH VIEW

Plate #3

NORTHAIR MINES LTD. SEPTEMBER, 1975

SEWAGE TREATMENT PLANT

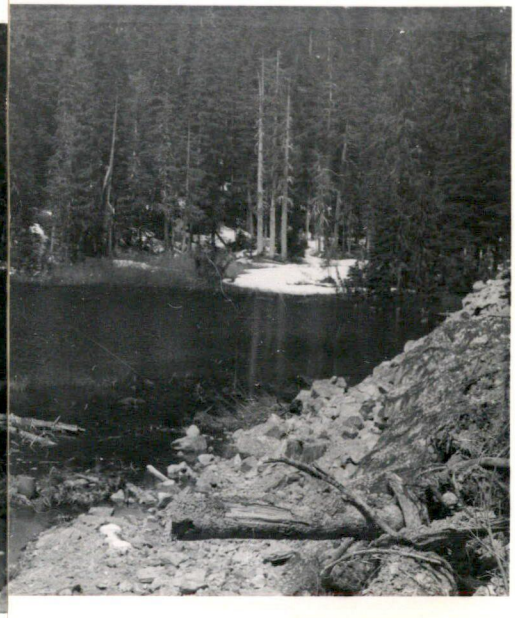

Plate #4

NORTHAIR MINES LTD. JULY, 1975

TAILINGS IMPOUNDMENT BEFORE CONSTRUCTION

Plate #5

NORTHAIR MINES LTD. MARCH, 1981

TAILINGS SUPERNATANT DECANT TO BELLAMY LAKE

Plate #6

NORTHAIR MINES LTD. MARCH, 1981

BELLAMY LAKE SETTLING POND

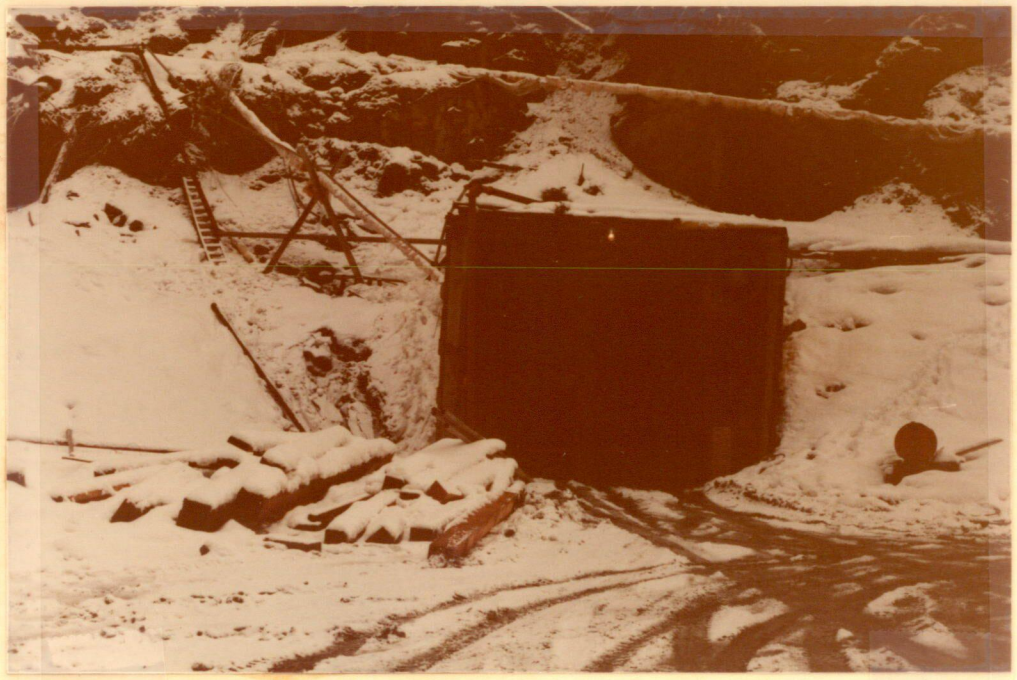

Plate #7

NORTHAIR MINES LTD. MARCH, 1981

DISCOVERY (3300') PORTAL

Plate #8

NORTHAIR MINES LTD. MARCH, 1981

2800' PORTAL

Plate #9

NORTHAIR MINES LTD. MARCH, 1981

2800' MINE WATER NO.1 AND 2 SETTLING POND

Plate #10

NORTHAIR MINES LTD. MARCH, 1981

2800' MINE WATER NO.3 SETTLING POND

PLATE #11

NORTHAIR MINES LTD. MARCH, 1981

MacLEOD CREEK - ALEXANDRA FALLS

Plate #12

NORTHAIR MINES LTD. MARCH, 1981

CALLAGHAN CREEK AT HIGHWAY 99

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APPENDIX I

MINE-MILL SITE INSPECTION REPORT,
EFFLUENT MONITORING DATA AND EFFLUENT BIOASSAY
RECORDS FOR MARCH 3 - 4, 1981

MINE-MILL SITE INSPECTION REPORT

Inspection by Robert Hallam
Date of Inspection March 3, 1981
E.P.S. File No 4780-37/N248

1) GENERAL INFORMATION

Name of Operation Northair Mines Ltd.
Name of Company Same as above (subsidiary of Northair Group)
Name of Contact Mr. John Mitchell (mine manager), Allan Boon (Chief Engineer)
Address Box 2029, Squamish, B.C. V0N 3G0
892-5858 Squamish office (N637935 radio) Phone No. 684-2858
Location 50 Km. (Distance) due N (Direction) Squamish (Nearest Settlement)
Access by Hyw 99 and north on Powder Mt. Rd., 5Km N. of Brandywine.

2) MINE INFORMATION

Name of Mine Brandywine Silver Property (Discovery, Warman, Manifold)
Open Pit ☐ New ☐ Reactivated ☐ Underground ☒ New ☒ Reactivated ☐
Production Rate: Ore 320 Tons/day: Waste Rock — Tons/day: Strip Ratio N/A
Location of Waste Rock Dumps near mine portals, as backfill or road construction
Ore Grade 0.21 oz. Au/ton; 1.2 oz. Ag/ton; 0.05 % Cu; 1.6 % Pb; 2.25 % Zn
% Mo; — % Ni trace % Cd; — Other
Major Sulfides sphalerite, galena

Total Reserves ≅ 50,000 tons* Life Expectancy 8 to 12 months

3) MILL INFORMATION

Type of Process: Crushing ☒ Grinding ☒ Flotation ☒ ** Leaching ☐ Roasting ☐
Magnetic Separation ☐ Pelletizing, Sintering ☐ Gravity Separation ☐
Amalgamation ☒ Alkali-chlorination ☒ Other jig concentrate ***
Production Rate 320 Tons/day; Process Water Requirements ≅ 150,000 ~~gals~~/IGPD
Concentrates produced Pb, Zn and a Au/Ag jig concentrate
Recovery Rate 95.5 Pb, 86% Zn, 96% Au/Ag Mill Grind 62.5 % -200 Mesh
Reagent Requirements Aerofloat 208, Dowfroth 250-1012, Z6 or Z350, $ZnSO_4$, NaCN (10% sol. and 40cc/min), $CuSO_4$, Reagent MT2306, lime, chlorine, and mercury.

4) COMMENTS

* already blocked out - additional reserves from on-going exploration are all below economic recovery at present metal prices (460 $U.S./oz Au).

** separate lead and zinc circuit.

*** jig concentrate is amalgamated, cleaned and sent for refining at the mill. Amalgam losses are sent to the ball mill which discharges to jig before flotation. Cleaned amalgam is pressed to a sponge and retorted. Cyanide is used to differentially separate lead and zinc. The tails are treated with Cl_2 to destroy cyanide.

MINE-MILL SITE INSPECTION REPORT
WASTE DISPOSAL AND CONTROL

Inspection by Robert Hallam
Date of Inspection March 3, 1981
E.P.S. File No. 4780-37/N248

1) TAILINGS DISPOSAL

Volume ≅150,000 ~~cfs~~ / IGPD*; % Solids 40 to 50% by volume
Type of Treatment: Direct Discharge ☐ Impoundment ☒ Polishing Pond ☒
Decant ☒ Exfiltration ☐ Floculation ☐ Recycle ☒ % Recycle 20
Seepage Reclaim ☐ Lime Addition ☐ Piezometer Return ☐
Monitoring: Frequency Weekly Parameters T.S.S., pH, T.Cu, T.Fe, T.Pb, T.Zn, D.Cu, D.Fe, D.Pb, D.Zn, $D.SO_4$, T.CN, T.Hg, R.Cl, Bioassay.
Acid Generating Test performed: Yes ☒ No ☐ Positive ☐ Negative ☒
To where is Discharge directed Water Licence Creek → Callaghan Creek.

2) MINE SEEPAGE WATER

Volume — cfs / IGPD.
Type of Treatment: Direct Discharge ☐ Impoundment ☐
Settling Pond ☒** Decant ☒ Exfiltration ☐ Floculation ☒ (partial)
Lime Addition ☐ Used in Mill Process ☐
Monitoring: Frequency Quarterly Parameters T.S.S., pH, T.Cu, T.Fe, T.Pb, T.Zn, D.Cu, D.Fe, D.Pb, D.Zn, $D.SO_4$.
Acid Generating Test performed: Yes ☒ No ☐ Positive ☐ Negative ☒
To where is Discharge directed Anomaly Creek → Callaghan Creek.

3) WASTE ROCK RUN-OFF

Volume — cfs / IGPD
Type of Treatment: Direct Discharge ☒ Impoundment ☐
Settling Pond ☒ Decant ☐ Exfiltration ☐ Floculation ☐
Lime Addition ☐ Used in Mill Process ☐
Monitoring: Frequency none Parameters In cases where waste-rock run-off enters the mine water settling ponds, monitoring as above applies.

4) SEWAGE DISPOSAL

Volume — cfs / IGPD; Type of Treatment activated sludge and lagoon (aero-batically batch-treated with chlorination → lagoon).
Monitoring: Frequency none required Parameters

To where is Final Discharge directed Anomaly Creek → Callaghan Creek.

COMMENTS

* A portion of the tailings are used for backfill underground. The slimes (≅50%) are impounded with a portion of this supernatant returned for mill process. Backfill tails supernatant is discharged as mine water.
** All mine water from a total of 6 portals receives settling.

APPENDIX I-I DETAILED MINE AND MILL EFFLUENT QUALITY FROM GRAB SAMPLES COLLECTED MARCH 3, 1981, NORTHAIR MINES LTD.

Parameter	Final decant from Bellamy Lake	2800' Before Settling	2800' After Settling	Discovery (3260'-3300') Before Settling (1)	3250' Before Settling	3500' Before Settling	Office Pond Final Decant	3700' Before Settling	3700' After Settling	Detection Limit
pH	7.1	8.0	8.2	5.8	--	--	7.7	8.0	7.9	
T.S.S.	*	350.0	80.0	176,000	17.0	*	11.0	325.0	12.0	L5
T.As	*	*	*	4.92	*	*	*	*	*	L0.15
D.As	*	*	*	*	*	*	*	*	*	L0.15
T.Ba	0.0109	0.0815	0.0366	2.66	0.0135	0.0163	0.0218	0.0592	0.0081	L0.003
D.Ba	0.013	0.0214	0.024	0.0417	0.0084	0.0161	0.0213	0.0134	0.0066	L0.003
T.Cd	*	0.024	*	2.06	*	*	*	*	*	L0.01
D.Cd	*	*	*	*	*	*	*	*	*	L0.01
E.Cd**	*	--	0.0030	--	*	*	0.0015	*	*	L0.0010
D.Cd**	*	*	*	*	*	*	0.0012	*	*	L0.0010
T.Co	*	0.017	*	12.8	*	*	*	0.03	*	L0.015
D.Co	*	*	*	*	*	*	*	*	*	L0.015
T.Cr	*	*	*	0.803	*	*	*	*	*	L0.015
D.Cr	*	*	*	*	*	*	*	*	*	L0.015
T.Cu	0.036	0.338	0.38	27.7	0.014	0.01	0.021	0.084	*	L0.01
D.Cu	0.035	*	*	0.814	*	*	*	*	*	L0.01
E.Cu**	--	--	--	--	--	0.0043	--	--	0.0022	L0.0010
D.Cu**	--	0.0033	0.0063	--	0.0029	0.0026	0.0099	0.0096	0.0019	L0.0010
T.Hg	*	*	*	*	*	*	*	*	*	L0.1
D.Hg	*	0.015	*	*	*	*	*	*	*	L0.1
T.Mn	0.227	4.26	0.433	507.0	0.481	0.0717	0.634	2.0	0.186	L0.003
D.Mn	0.173	0.186	0.221	0.144	0.292	0.821	0.696	0.206	0.128	L0.003
T.Mo	*	*	*	*	*	*	*	*	*	L0.15
D.Mo	*	*	*	*	*	*	*	*	*	L0.15
T.Ni	*	*	*	0.946	*	*	*	*	*	L0.08

APPENDIX I-I (continued) DETAILED MINE AND MILL EFFLUENT QUALITY FROM GRAB SAMPLES COLLECTED MARCH 3, 1981, NORTHAIR MINES LTD.

Parameter	Final decant from Bellamy Lake	2800' Before Settling	2800' After Settling	Discovery (3260'-3300') Before Settling (1)	3250' Before Settling	3500' Before Settling	Office Pond Final Decant	3700' Before Settling	3700' After Settling	Detection Limit
D.Ni	*	*	*	*	*	*	*	*	*	L0.08
T.Pb	*	2.51	0.457	225.0	0.112	*	0.118	0.369	*	L0.08
D.Pb	*	0.098	0.143	*	*	*	*	*	*	L0.08
E.Pb**	0.0019	--	--	--	0.0760	--	--	--	0.0060	L0.0010
D.Pb**	0.0024	--	--	0.0203	0.0091	0.0088	0.0370	0.0340	0.0032	L0.0010
T.Sb	*	*	*	0.244	*	*	*	*	*	L0.08
D.Sb	*	*	*	*	*	*	*	*	*	L0.08
T.Se	*	*	*	*	*	*	*	*	*	L0.15
D.Se	*	*	*	*	*	*	*	*	*	L0.15
T.Sn	*	*	*	*	*	*	*	*	*	L0.2
D.Sn	*	*	*	*	*	*	*	*	*	L0.2
T.Sr	0.144	2.49	2.36	8.47	0.155	0.464	0.202	0.261	0.146	L0.004
D.Sr	0.162	2.52	2.52	0.328	0.16	*	0.211	0.25	0.156	L0.004
T.Ti	*	0.66	0.149	76.3	0.0502	*	0.0164	0.611	0.017	L0.0085
D.Ti	*	0.0183	0.0366	*	*	*	*	0.0358	*	L0.0085
T.V	*	*	*	3.47	*	*	*	*	*	L0.05
D.V	*	*	*	*	*	*	*	*	*	L0.05
T.Zn	0.039	4.04	0.581	295.0	0.156	0.105	0.195	0.456	0.029	L0.02
D.Zn	0.021	0.065	0.112	0.023	0.058	0.046	0.111	0.0334	*	L0.02
E.Zn**	0.0124	--	--	--	--	--	--	--	0.0148	L0.0010
D.Zn**	--	--	--	--	--	--	--	--	0.0107	L0.0010
T.Al	*	7.63	1.91	926.0	0.69	0.119	0.365	7.79	0.33	L0.09
D.Al	0.091	0.314	0.523	0.174	*	*	*	0.472	*	L0.09
T.Fe	0.18	13.9	2.98	3450.0	1.67	0.335	1.1	15.7	0.561	L0.01
D.Fe	0.155	0.48	0.899	0.124	0.06	0.045	0.307	0.885	0.069	L0.01

APPENDIX I-I (continued) DETAILED MINE AND MILL EFFLUENT QUALITY FROM GRAB SAMPLES COLLECTED MARCH 3, 1981, NORTHAIR MINES LTD.

Parameter	Final decant from Bellamy Lake	2800' Before Settling	2800' After Settling	Discovery (3260'-3300') Before Settling (1)	3250' Before Settling	3500' Before Settling	Office Pond Final Decant	3700' Before Settling	3700' After Settling	Detection Limit
T.Si	1.43	19.0	8.66	568.0	3.15	3.52	2.55	15.5	2.46	L0.5
D.Si	1.6	6.86	7.23	1.3	2.38	3.98	2.42	3.45	2.33	L0.5
T.Ca	44.7	172.0	129.0	4250.0	22.4	44.8	31.7	33.8	21.5	L0.025
D.Ca	45.8	164.0	162.0	100.0	24.0	57.8	36.7	29.0	22.3	L0.025
T.Mg	0.501	9.73	4.89	1080.0	1.37	2.98	1.58	6.5	1.19	L0.025
D.Mg	0.487	4.57	4.76	1.51	1.17	3.44	1.67	2.0	1.16	L0.025
T.Na	9.42	4.74	4.42	34.1	1.19	1.57	3.58	1.43	0.919	L0.01
D.Na	10.1	5.86	5.88	17.7	1.55	2.29	4.4	1.33	1.05	L0.01

L = less than
* = less than the detection limit
T = total
D = dissolved
E = Extractable
All analysis by Inductive Coupled Argon Plasma except;
** which were by atomic absorption.
(1) = backfill line break

APPENDIX I-2 NON-METAL ANALYSES OF MINE AND MILL EFFLUENT FROM GRAB SAMPLES COLLECTED MARCH 4, 1981
NORTHAIR MINES LTD.

Parameter (mg/l)	Tailings Before Treatment	Tailings After Alka-Chlor.	Tailings Pond Supernatant	Bellamy Lake Final Discharge	2800' Before Settling	2800' After Settling	3700' After Settling	Office Pond After Settling
pH	11.2	10.5	8.1	7.5	7.9	8.0	8.0	7.8
Non- filter	972,000	277,000	8.0	6.0	190.0	25.0	7.0	18.0
Total Res	1,300,000	311,000	460.0	330.0	770.0	630.0	110.0	180.0
Volatile Res	18,000	2,900	45.0	36.0	57.0	57.0	19.0	27.0
D.SO_4	345.0	307.0	184.0	128.0	315.0	308.0	17.7	44.6
T.PO_4 (P)	0.758	0.631	0.260	0.130	0.113	0.014	0.0074	0.032
NO_2 (N)	0.300	0.220	0.180	0.130	0.0100	0.0069	L0.0050	0.0120
NO_3 (N)	2.59	2.25	1.32	0.930	0.175	0.201	0.135	0.200
NH_3 (N)	0.730	0.720	0.579	0.481	0.0692	0.0339	0.0136	0.0877
DCN	1.8	0.2	1.0	0.17	L0.03	L0.03	L0.03	L0.03
TCN	6.6	5.7	1.4	0.21	L0.03	L0.03	L0.03	L0.03
OCN-	11.25	7.44	3.45	1.60	L0.0050	L0.0050	0.025	0.509
SCN-	8.35	3.35	L0.50	L0.50	L0.50	L0.50	L0.50	L0.50
R.Cl	--	0.5	L0.5	--	--	--	--	--
Hardness ($CaCO_3$)	475.0	404.0	220.0	158.0	417.0	409.0	62.7	99.9
Oil and Grease	L2.0	L2.0	L2.0	L2.0	L2.0	L2.0	L2.0	L2.0
96 hr. LC	--	--	--	non-toxic at 100% con	--	non-toxic at 100% con	--	non-toxic at 100% con

L = less than

APPENDIX I-3 DETAILED MINE AND MILL EFFLUENT QUALITY FROM GRAB SAMPLES COLLECTED MARCH 4, 1981, NORTHAIR MINES LTD.

Parameter	Tailings Before Treatment	Tailings After Alka-Chlor.	Tailings Pond Supernatant	Bellamy Lake Final Discharge	2800' Before Settling	2800' After Settling	3700' After Settling	Office Pond After Settling	Detection Limit
T.As	L3.0	4.54	*	*	*	*	*	*	L0.15
D.As	*	*	*	*	*	*	*	*	L0.15
T.Ba	7.16	0.154	0.0165	0.014	0.0565	0.0213	0.0069	0.0331	L0.003
D.Ba	0.0254	0.027	0.0186	0.0165	0.018	0.0186	0.0068	0.0224	L0.003
T.Cd	0.335	0.982	*	*	*	*	*	*	L0.01
D.Cd	*	*	*	*	*	*	*	*	L0.01
E.Cd**	--	--	*	*	0.0077	0.0015	*	0.0029	L0.0010
D.Cd**	*	*	0.0018	*	*	*	*	0.0025	L0.0010
T.Co	0.453	10.2	*	*	0.016	*	*	*	L0.15
D.Co	*	*	*	*	*	*	*	*	L0.15
T.Cr	1.11	0.733	*	*	*	*	*	*	L0.15
D.Cr	*	*	*	*	*	*	*	*	L0.15
T.Cu	L0.2	37.0	0.245	0.057	0.11	0.026	*	0.054	L0.01
D.Cu	8.73	3.96	0.265	0.059	*	*	*	0.016	L0.01
E.Cu**	--	--	--	--	--	--	0.0022	--	L0.0010
D.Cu**	--	--	--	--	0.0039	0.0022	0.0024	--	L0.0010
T.Hg	*	*	*	*	*	*	*	*	L0.1
D.Hg	*	*	*	*	*	*	*	*	L0.1
T.Mn	183.0	693.0	0.181	0.152	1.88	0.206	0.132	0.791	L0.003
D.Mn	0.0068	0.407	0.0565	0.175	0.0744	0.0693	0.136	0.726	L0.003
T.Mo	L3.0	L3.0	*	*	*	*	*	*	L0.15
D.Mo	*	*	*	*	*	*	*	*	L0.15
T.Ni	L1.6	1.13	*	*	*	*	*	*	L0.08
D.Ni	*	*	*	*	*	*	*	*	L0.08
T.Pb	L1.6	75.9	*	*	1.16	0.218	*	0.341	L0.08
D.Pb	0.095	*	*	*	*	*	*	*	L0.08

APPENDIX I-3 (Continued) DETAILED MINE AND MILL EFFLUENT QUALITY FROM GRAB SAMPLES COLLECTED MARCH 4, 1981, NORTHAIR MINES LTD.

Parameter	Tailings Before Treatment	Tailings After Alka-Chlor.	Tailings Pond Supernatant	Bellamy Lake Final Discharge	2800' Before Settling	2800' After Settling	3700' After Settling	Office Pond After Settling	Detection Limit
E.Pb**	--	--	0.0155	0.0066	--	--	0.0071	--	L0.0010
D.Pb**	--	0.0440	*	0.0035	0.0062	0.0087	0.0036	0.0450	L0.0010
T.Sb	L1.6	L0.16	*	*	*	*	*	*	L0.08
D.Sb	*	*	*	*	*	*	*	*	L0.08
T.Se	L3.0	L3.0	*	*	*	*	*	*	L0.15
D.Se	*	*	*	*	*	*	*	*	L0.15
T.Sn	L4.0	L4.0	*	*	*	*	*	*	L0.2
D.Sn	*	*	*	*	*	*	*	*	L0.2
T.Sr	103.0	34.1	0.28	0.198	2.37	2.27	0.149	0.197	L0.004
D.Sr	0.567	0.545	0.312	0.216	2.45	2.41	0.161	0.21	L0.004
T.Ti	L0.17	0.552	0.0087	*	0.377	0.0433	*	0.0936	L0.0085
D.Ti	*	0.0224	*	*	*	*	*	*	L0.0085
T.V	L1.0	0.245	*	*	*	*	*	*	L0.05
D.V	*	*	*	*	*	*	*	*	L0.05
T.Zn	35.1	157.0	0.09	0.053	1.62	0.305	*	0.448	L0.02
D.Zn	0.213	0.085	*	*	0.033	0.03	*	0.122	L0.02
E.Zn**	--	--	0.0182	0.0180	--	--	0.0163	--	L0.0010
D.Zn**	--	--	0.0141	0.0184	--	--	0.0132	--	L0.0010
T.Al	6.07	935.0	0.288	0.149	4.74	0.639	0.137	2.15	L0.09
D.Al	1.37	1.32	*	*	*	*	*	*	L0.09
T.Fe	1.51	2650.0	0.541	0.319	8.04	1.15	0.289	3.19	L0.01
D.Fe	0.041	0.629	0.027	0.093	0.03	0.011	0.041	0.29	L0.01
T.Si	103.0	985.0	1.74	1.57	13.8	6.73	2.3	5.44	L0.5
D.Si	1.16	2.29	1.49	1.55	6.22	6.08	2.3	2.31	L0.5
T.Ca	64300.0	17500.0	84.6	59.5	161.0	145.0	23.7	37.0	L0.025
D.Ca	190.0	161.0	86.7	62.3	160.0	157.0	23.1	37.4	L0.025

APPENDIX I-3 (Continued) DETAILED MINE AND MILL EFFLUENT QUALITY FROM GRAB SAMPLES COLLECTED MARCH 4, 1981, NORTHAIR MINES LTD.

Parameter	Tailings Before Treatment	Tailings After Alka-Chlor.	Tailings Pond Supernatant	Bellamy Lake Final Discharge	2800' Before Settling	2800' After Settling	3700' After Settling	Office Pond After Settling	Detection Limit
T.Mg	628.0	1080.0	0.936	0.725	7.43	4.24	1.15	2.44	L0.025
D.Mg	0.196	0.572	0.832	0.698	4.23	4.19	1.21	1.59	L0.025
T.Na	44.3	37.9	17.0	12.7	5.1	4.98	0.949	4.31	L0.01
D.Na	29.6	25.0	18.6	13.8	5.75	5.66	1.12	4.65	L0.01
E.Hg**	0.00820	0.00068	*	*	*	*	*	*	L0.00020
D.Hg**	--	*	*	*	*	*	*	*	L0.00020

L = less than
T. = total
D. = dissolved
E. = extractable
* = less than the detection limit
All analyses by Inductive Coupled Argon Plasma except;
** = which was by atomic absorption

Environment Canada
Environmental Protection Service

563-4106

BIOASSAY LABORATORY — BIOASSAY RECORD

SHADED RECTANGLES TO BE FILLED IN BY SAMPLE SUBMITTOR

SAMPLE NO:	COMPANY	ATTENTION
814073	NORTHAIR MINES	KEITH FERGUSON

DESCRIPTION AND AMOUNT OF SAMPLE AND CONTAINER (S)

SAMPLE: MINE EFFLUENT #10

CONTAINER (S): 1 x 5 gal jerry can

COLLECTED BY	DATE	RECEIVED IN LABORATORY BY	DATE
BRUCE CLARK	04 | 03 | 81 (DAY | MONTH | YEAR)	David J. Maul	5 | 03 | 81 (DAY | MONTH | YEAR)
WITNESS	TIME Hrs.	WITNESS	TIME Hrs.

ANALYSIS REQUIRED
☐ 96 Hr LC50 ☑ 96 Hr LT50
☐ Other Specified Concentration (s) .....

RECEIVED FROM

SAMPLE ☐ Legal ☑ Routine

DILUTION WATER ☑ Fresh Water ☐ Salt Water

DILUTIONS MEASURED BY ☑ Weight ☑ Whole Sample Of ☐ Volume ☐ Active Ingredient

FISH SPECIES ☑ Rainbow Trout *(Salmo gairdneri)* ☐ Other

ORIGINAL SAMPLE pH	Salinity ‰	DILUTION WATER pH	Hardness Mg./l. $CaCO_3$	Salinity ‰	BIOASSAY TEMPERATURE	FISH SIZE
8.0		6.4	4.1		15 ± 1 °C	☑ Weekly Average ☐ Actual

LOADING DENSITY	FORK LENGTH (Average)	RANGE	WEIGHT (Average)	RANGE
0.44 gm./l. Or ☐ See Below ☐ See Data Sheet	5.1 cm. ☐ See Data Sheet	4.3 cm. to 6.0 cm. ☐ See Data Sheet	1.3 gm. ☐ See Data Sheet	0.7 gm. to 2.0 gm. ☐ See Data Sheet

CONCENTRATION	TEST AMOUNT	START DATE	START pH	START D.O.	START Time	NO. FISH	CUMULATIVE MORTALITY AT TIME (HRS) 0.25	0.5	1	2	4	8	16	24	48	72	96	FINAL pH	FINAL D.O.	INITIAL LOADING DENSITY gm./l.
CONTROL	30kg	5/3/81	6.4	12.1		10								0	0	0	0	6.9	9.7	
100%	30kg	5/3/81	8.0	12.4		10								0	0	0	0	8.2	9.9	

ANALYSIS RESULTS

96 Hr. LC50 is .....concentration. | 96 Hr. LT50 is ..... at ..... concentration.

Range Conf. Limits Slope

The sample was not toxic at 100% concentration over a period of 96 hours

David J. Maul
Analyst

10 DAY 3 MONTH 81 YEAR
Date

280
Man. Min.

E.P. 3-1101 revised (07/76)

Environment Canada
Environmental Protection Service

563-4106

BIOASSAY LABORATORY — BIOASSAY RECORD

SHADED RECTANGLES TO BE FILLED IN BY SAMPLE SUBMITTOR

SAMPLE NO:	COMPANY	ATTENTION
814074	NORTHAIR MINES	KEITH FERGUSON

DESCRIPTION AND AMOUNT OF SAMPLE AND CONTAINER (S)

SAMPLE MINE EFFLUENT # 11, 12 & 14

CONTAINER (S) 1 X 5 JERRY CAN.

COLLECTED BY	DATE	RECEIVED IN LABORATORY BY	DATE
B.C.	04 DAY 03 MONTH 81 YEAR	E. Lee	05 DAY 03 MONTH 81 YEAR
WITNESS	TIME AM Hrs.	WITNESS	TIME 10:00 Hrs.

ANALYSIS REQUIRED
☐ 96 Hr LC50 ☑ 96 Hr LT50
☐ Other Specified Concentration (s) .....

RECEIVED FROM

SAMPLE ☐ Legal ☑ Routine

DILUTION WATER ☑ Fresh Water ☐ Salt Water

DILUTIONS MEASURED BY ☑ Weight ☑ Whole Sample Of ☐ Volume ☐ Active Ingredient

FISH SPECIES ☑ Rainbow Trout *(Salmo gairdneri)* ☐ Other

ORIGINAL SAMPLE pH	Salinity	DILUTION WATER pH	Hardness	Salinity	BIOASSAY TEMPERATURE	FISH SIZE
7.4	0/00	6.4	4.1 Mg/l. $CaCO_3$	0/00	15 ± 1 °C	☑ Weekly Average ☐ Actual

LOADING DENSITY	FORK LENGTH (Average)	RANGE	WEIGHT (Average)	RANGE
0.44 gm./l. Or ☐ See Below ☐ See Data Sheet	5.1 cm. ☐ See Data Sheet	4.3 cm. to 6.0 cm. ☐ See Data Sheet	1.3 gm. ☐ See Data Sheet	0.7 gm. to 2.0 gm. ☐ See Data Sheet

CONCENTRATION	TEST AMOUNT	START DATE	START pH	START D.O.	START Time	NO. FISH	CUMULATIVE MORTALITY AT TIME (HRS) 24	48	72	96	FINAL pH	FINAL D.O.	INITIAL LOADING DENSITY gm./l.
CONTROL	30kg	5/3/81	6.4	12.1		10	0	0	0	0	6.9	9.7	
100%	30kg	5/3/81	7.4	11.6		10	0	0	0	0	7.8	9.8	

ANALYSIS RESULTS

96 Hr. LC50 is .....concentration. | 96 Hr. LT50 is .....concentration.

Range | Conf. Limits | Slope

The sample was not toxic at 100% concentration over a period of 96 hours.

E.P. 3-1101 revised (01/81)

David J. Mont
Analyst

10 DAY 3 MONTH 81 YEAR
Date

280
Man. Min.

Environment Canada
Environmental Protection Service

BIOASSAY LABORATORY — BIOASSAY RECORD

563-4106

SHADED RECTANGLES TO BE FILLED IN BY SAMPLE SUBMITTOR

SAMPLE NO:	COMPANY	ATTENTION
814075	NORTHAIR MINES	KEITH FERGUSON

DESCRIPTION AND AMOUNT OF SAMPLE AND CONTAINER (S)

SAMPLE MINE EFFLUENT # 4

CONTAINER (S) 8 x 5 GAL. JERRY CANS.

COLLECTED BY	DATE	RECEIVED IN LABORATORY BY	DATE
B.C.	04 (DAY) 03 (MONTH) 81 (YEAR)	E. Lee	05 (DAY) 03 (MONTH) 81 (YEAR)
WITNESS	TIME Am Hrs.	WITNESS	TIME 10:00 Hrs.

ANALYSIS REQUIRED
☑ 96 Hr LC50 ☐ 96 Hr LT50
☐ Other Specified Concentration (s) .....

RECEIVED FROM

SAMPLE ☐ Legal ☑ Routine

DILUTION WATER ☑ Fresh Water ☐ Salt Water

DILUTIONS MEASURED BY ☑ Weight ☑ Whole Sample Of ☐ Volume ☐ Active Ingredient

FISH SPECIES ☑ Rainbow Trout *(Salmo gairdneri)* ☐ Other

ORIGINAL SAMPLE pH	Salinity	DILUTION WATER pH	Hardness	Salinity	BIOASSAY TEMPERATURE	FISH SIZE
7.2	‰	6.4	4.1 Mg./l. $CaCO_3$	‰	15 ± 1 °C	☑ Weekly Average ☐ Actual

LOADING DENSITY	FORK LENGTH (Average)	RANGE	WEIGHT (Average)	RANGE
0.44 gm./l. Or ☐ See Below ☐ See Data Sheet	5.1 cm. ☐ See Data Sheet	4.3 cm. to 6.0 cm. ☐ See Data Sheet	1.3 gm. ☐ See Data Sheet	0.7 gm. to 2.0 gm. ☐ See Data Sheet

CONCENTRATION	TEST AMOUNT	START DATE	START pH	START D.O.	START Time	NO. FISH	CUMULATIVE MORTALITY AT TIME (HRS) 24	48	72	96	FINAL pH	FINAL D.O.	INITIAL LOADING DENSITY gm./l.
CONTROL	30kg	5/3/81	6.4	12.1		10	0	0	0	0	6.9	9.7	
100%	30kg	1	7.1	12.7		10	0	0	0	0	7.4	9.4	
63%	30kg	1	7.0	12.4		10	0	0	0	0	7.3	9.1	
40%	30kg	5/3/81	7.0	12.3		10	0	0	0	0	7.2	9.4	

ANALYSIS RESULTS

96 Hr. LC50 is .....concentration. | 96 Hr. LT50 is .....concentration.

Range Conf. Limits Slope

The sample was not toxic at 100% concentration over a period of 96 hours.

E.P. 3-1101 revised (01/81)

David J. Maul
Analyst

10 (DAY) 3 (MONTH) 81 (YEAR)
Date

360
Man. Min.

APPENDIX II

STREAM INVENTORY RECORDS AND RECEIVING ENVIRONMENT MONITORING DATA FOR MARCH 4, 1981

STREAM INVENTORY SHEET

WATER BODY

Stream Anomaly Creek
Topo Map Sheets 92J/3
Watershed Squamish - Cheakamus

Date of Inventory March 4, 1981
Access Hyw 99 - Powder Mountain Road - Northair Mines Road.
Prepared By Robert Hallam

Sample Site No. 1 Sample Type:

Water	X	Benthos	
Sediment		Drift	
Periphyton		Fish	

Valley Flat Width (m) 10m Gradient (%) 1 to 5% Width (m) 2m
Average Depth (m) Riffle 0.3m Pool 0.1m Max. Width of Channel 1m
Winter Conditions: Snow Cover (m) 0.3m Ice Depth (m) — Free Water (m) 0.6m
Bar Presence none

BED MATERIAL (%)

Fines: Silts/Clays 20% Sand 20%
Gravel: Small 20% Gravel: Large 20%
Rock: Cobble 20% Boulder —
Algal Growth long strands of green diatoms Shoreline Vegetation standing forest canopy and open road on one bank.

HYDRAULICS

Discharge (cfs) 0.25 cfs * Flow Stage pre-freshet - mine water*
Flow Characteristics sluggish Flood Signs —
Pool / Riffle Ratio 1:1

Obstruction to Fish Migration mine-water settling pond dams downstream

Attach Photograph if available

* this flow estimate includes mine water from the 3300' portal Discovery Zone down ramp.

STREAM INVENTORY SHEET

WATER BODY

Stream Anomaly Creek
Topo Map Sheets 92J/3
Watershed Squamish-Cheakamus

Date of Inventory March 4, 1981
Access Hyw-99, Powder Mountain Road.
Prepared By Robert Hallam

Sample Site No. 2 Sample Type:

Water	X	Benthos	
Sediment		Drift	
Periphyton		Fish	

Valley Flat Width (m) 30m Gradient (%) 5 to 10% Width (m) 4m
Average Depth (m) Riffle 0.25m Pool 0.5m Max. Width of Channel 6m
Winter Conditions: Snow Cover (m) — Ice Depth (m) — Free Water (m) 4m
Bar Presence no bars but numerous exposed bolders downstream

BED MATERIAL (%)

Fines: Silts/Clays 10% Sand 10%
Gravel: Small 10% Gravel: Large 10%
Rock: Cobble 20% Boulder 40%
Algal Growth none apparent Shoreline Vegetation standing fir canopy follows the edge of a clear cut.

HYDRAULICS

Discharge (cfs) 30 cfs Flow Stage pre-freshet
Flow Characteristics mountainous Flood Signs exposed bolders in midstream
Pool / Riffle Ratio 1:1

Obstruction to Fish Migration logging debris across stream resulting in several small (1 to 2m) falls.

STREAM INVENTORY SHEET

WATER BODY

Stream: Water Licence Creek
Topo Map Sheets: 92J/3
Watershed: Squamish – Cheakamus

Date of Inventory: March 4, 1981
Access: Hyw-99, Powder Mountain Road, Northair Mines Road.
Prepared By: Robert Hallam

Sample Site No. 3 Sample Type:

Water	X	Benthos	
Sediment		Drift	
Periphyton		Fish	

Valley Flat Width (m) 100m Gradient (%) 5% Width (m) 2m
Average Depth (m) Riffle 0.05m Pool 0.15m Max. Width of Channel 2m
Winter Conditions: Snow Cover (m) 0.3m Ice Depth (m) — Free Water (m) 2m
Bar Presence none

BED MATERIAL (%)

Fines : Silts /Clays 10% Sand 20%
Gravel : Small 20% Gravel: Large 20%
Rock : Cobble 20% Boulder 10%
Algal Growth none apparent Shoreline Vegetation forest canopy

HYDRAULICS

Discharge (cfs) 2 cfs Flow Stage pre-freshet
Flow Characteristics mountainous Flood Signs culvert washed out
Pool / Riffle Ratio 1:2

Obstruction to Fish Migration steep gradient downstream and wier 20m above sample site.

STREAM INVENTORY SHEET

WATER BODY

Stream Water Licence Creek
Topo Map Sheets 92 J/3
Watershed Squamish-Cheakamus

Date of Inventory March 4, 1981
Access Hyw-99, Powder Mountain Road.
Prepared By Robert Hallam

Sample Site No. 4 Sample Type:

Water	X	Benthos	
Sediment		Drift	
Periphyton		Fish	

Valley Flat Width (m) 15m Gradient (%) 15 to 20% Width (m) 4m
Average Depth (m) Riffle 0.1m Pool — Max. Width of Channel 3m
Winter Conditions: Snow Cover (m) 0.3m Ice Depth (m) — Free Water (m) 3m
Bar Presence non

BED MATERIAL (%)

Fines: Silts/Clays 10% Sand 10%
Gravel: Small 10% Gravel: Large 20%
Rock: Cobble 30% Boulder 20%
Algal Growth none apparent Shoreline Vegetation exposed - logged off (ferns and debris)

HYDRAULICS

Discharge (cfs) 6 cfs Flow Stage pre-freshet
Flow Characteristics mountainous Flood Signs culvert washed-out
Pool / Riffle Ratio no pools - steep tumbling.

Obstruction to Fish Migration no obstruction other than overall steepness.

STREAM INVENTORY SHEET

WATER BODY

Stream MacLeod Creek
Topo Map Sheets 92J/3
Watershed Squamish-Cheakamus

Date of Inventory March 4, 1981
Access Hyw 99, Powder Mountain Road. Above Alexandra Falls.
Prepared By Robert Hallam

Sample Site No. 5 Sample Type:

Water	X	Benthos	
Sediment		Drift	
Periphyton		Fish	

Valley Flat Width (m) 1Km Gradient (%) 3% Width (m) 15m
Average Depth (m) Riffle 0.6m Pool 1.5m Max. Width of Channel 15m
Winter Conditions: Snow Cover (m) 0.3m Ice Depth (m) — Free Water (m) 15m
Bar Presence no bars - exposed bolders generally coverd at high water.

BED MATERIAL (%)

Fines: Silts/Clays 5% Sand 5%
Gravel: Small 5% Gravel: Large 5%
Rock: Cobble 20% Boulder 70% (some bedrock)
Algal Growth none apparent Shoreline Vegetation forest canopy

HYDRAULICS

Discharge (cfs) 400 cfs Flow Stage pre-freshel
Flow Characteristics mountainous Flood Signs exposed bolders
Pool / Riffle Ratio 8:1

Obstruction to Fish Migration Alexandra Falls (≅ 40m) immediately downstream

STREAM INVENTORY SHEET

WATER BODY

Stream Callaghan Creek
Topo Map Sheets 92J/3
Watershed Squamish-Cheakamus

Date of Inventory March 4, 1981
Access Hyw-99 - at old wooden bridge.
Prepared By Robert Hallam

Sample Site No. 6 Sample Type:

Water	X	Benthos	
Sediment		Drift	
Periphyton		Fish	

Valley Flat Width (m) 200m Gradient (%) 3 to 5% Width (m) 50m
Average Depth (m) Riffle 0.5m Pool +1m Max. Width of Channel 50 m
Winter Conditions: Snow Cover (m) — Ice Depth (m) — Free Water (m) 20m
Bar Presence bar consisting entirely of bolders.

BED MATERIAL (%)

Fines: Silts/Clays 5% Sand 10%
Gravel: Small 5% Gravel: Large 10%
Rock: Cobble 20 to 30% Boulder 40 to 50%
Algal Growth non apparent Shoreline Vegetation standing fir canopy

HYDRAULICS

Discharge (cfs) ≅ 550 cfs Flow Stage pre-freshet
Flow Characteristics mountainous Flood Signs bar and exposed banks
Pool / Riffle Ratio 1:1

Obstruction to Fish Migration Daisy Lake reservoir to anadromous fish
no obstruction to resident fish.

APPENDIX II-I PHYSICAL MEASUREMENTS AND NON-METAL WATER QUALITY ANALYSES OF TRIPLICATE SAMPLES COLLECTED FROM THE WATERSHED ADJACENT TO NORTHAIR MINES LTD. MARCH 4, 1981

	1 Anomely Creek Above Mine			2 Anomely Creek Below Mine			3 Water Licence Creek Above Mine		
	a	b	c	a	b	c	a	b	c
pH	7.6	7.6	7.6	8.0	8.0	8.0	7.9	7.9	7.9
Alkalinity ($CaCO_3$)	-	-	-	-	-	-	-	-	-
T.SO_4 (SO_4)	13.6	13.6	13.6	106.0	108.0	108.0	8.20	8.10	8.10
T.PO_4 (P)	0.0062	0.0057	0.0060	0.0067	0.0064	0.0053	L0.0050	L0.0050	L0.0050
NO_2	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050
NO_3	0.016	0.016	0.016	0.087	0.088	0.088	0.010	0.010	0.010
Turbidity (FTU's)	2.3	2.0	1.8	9.0	9.5	7.5	1.5	1.3	L1.0
Cond. umhos/cm	119.0	118.0	118.0	340.0	340.0	340.0	95.5	95.5	95.5
Filterable Res.	29.0	28.0	29.0	90.0	90.0	90.0	24.0	24.0	23.0
Non-filterable Res.	L5.0	L5.0	L5.0	6.0	6.0	7.0	L5.0	L5.0	L5.0
Total Res.	31.0	30.0	31.0	96.0	96.0	97.0	26.0	26.0	24.0
Hardness ($CaCO_3$)	45.6	45.7	45.8	144.0	143.0	142.0	39.7	39.7	39.3
T.CN.	L0.03	L0.03	L0.03	L0.03	L0.03	L0.03	L0.03	L0.03	L0.03

APPENDIX II-2 TOTAL AND DISSOLVED METAL ANALYSES OF TRIPLICATE SAMPLES COLLECTED FROM THE WATERSHED ADJACENT TO NORTHAIR MINES LTD. MARCH 4, 1981

(mg/l)	1 Anomely Creek Above Mine			2 Anomely Creek Below Mine			3 Water Licence Creek Above Mine			Detection Limit
	a	b	c	a	b	c	a	b	c	
T.Cu	*	*	*	*	*	*	*	*	*	L0.01
D.Cu	*	*	*	*	*	*	*	*	*	L0.01
E.Cu**	0.0033	0.0036	0.0026	0.0012	0.0017	0.0016	*	*	*	L0.0010
D.Cu**	0.0046	0.0036	0.0026	0.0010	0.0016	0.0012	*	*	*	L0.0010
T.Fe	0.074	0.085	0.114	0.279	0.287	0.284	0.036	0.052	0.077	L0.01
D.Fe	0.029	0.027	0.026	0.011	0.014	0.011	*	*	*	L0.01
T.Pb	*	*	*	*	*	*	*	*	*	L0.08
D.Pb	*	*	*	*	*	*	*	*	*	L0.08
E.Pb**	0.0050	0.0056	0.0058	0.0330	0.0310	0.0300	*	*	*	L0.0010
D.Pb**	0.0038	0.0033	0.0035	0.0027	0.0032	0.0024	*	*	*	L0.0010
T.Zn	0.138	0.124	0.135	0.054	0.064	0.061	*	*	*	L0.02
D.Zn	0.11	0.106	0.103	*	*	*	*	*	*	L0.02
E.Zn**	-	-	-	-	-	-	0.0046	0.0014	0.0014	L0.0010
D.Zn**	-	-	-	0.0122	0.0115	0.0163	0.0031	0.0043	0.0039	L0.0010
T.Ca	19.0	18.7	17.7	53.2	52.5	51.7	14.2	14.8	14.7	L0.025
D.Ca	17.0	17.0	17.1	54.8	54.5	54.1	14.8	14.8	14.7	L0.025
T.Mg	0.846	0.846	0.806	1.81	1.83	1.78	0.747	0.777	0.769	L0.025
D.Mg	0.763	0.789	0.755	1.7	1.67	1.67	0.662	0.673	0.673	L0.025
T.Cd	*	*	*	*	*	*	*	*	*	L0.01
D.Cd	*	*	*	*	*	*	*	*	*	L0.01
E.Cd**	0.0017	0.0017	0.0016	*	*	*	*	*	*	L0.0010
D.Cd**	0.0024	0.0017	0.0016	*	*	*	*	*	*	L0.0010
T.Ni	*	*	*	*	*	*	*	*	*	L0.08
D.Ni	*	*	*	*	*	*	*	*	*	L0.08

APPENDIX II-I (Continued) PHYSICAL MEASUREMENTS AND NON-METAL WATER QUALITY ANALYSES OF TRIPLICATE SAMPLES COLLECTED FROM THE WATERSHED ADJACENT TO NORTHAIR MINES LTD. MARCH 4, 1981

	4 Water Licence Creek Below Mine			5 MacLeod Creek Above Alexandra Falls			6 Callaghan Creek Near Hyw 99		
	a	b	c	a	b	c	a	b	c
pH	7.6	7.6	7.6	7.3	7.3	7.3	7.6	7.6	7.6
Alkalinity ($CaCO_3$)	-	-	-	-	-	-	-	-	-
T.SO_4 (SO_4)	13.5	13.3	12.8	8.90	9.00	9.50	16.0	15.3	15.5
T.PO_4 (P)	0.0055	0.0052	0.0052	L0.0050	L0.0050	L0.0050	0.0056	0.0059	L0.0050
NO_2	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050	L0.0050
NO_3	0.045	0.044	0.045	0.049	0.049	0.049	0.016	0.015	0.015
Turbidity (FTU's)	1.3	1.3	1.5	1.3	1.0	1.4	2.5	2.0	1.8
Cond. umhos/cm	82.0	82.0	82.0	47.7	47.7	47.5	78.0	77.5	77.5
Filterable Res.	23.0	24.0	23.0	15.0	15.0	15.0	24.0	24.0	23.0
Non-filterable Res.	L5.0	L5.0	L5.0	L5.0	L5.0	L5.0	L5.0	L5.0	L5.0
Total Res.	25.0	25.0	24.0	18.0	15.0	15.0	27.0	21.0	23.0
Hardness ($CaCO_3$)	30.4	30.1	30.3	17.4	17.5	17.5	29.2	28.7	28.1
T.CN.	L0.03	L0.03	L0.03	L0.03	L0.03	L0.03	L0.03	L0.03	L0.03

APPENDIX II-2 (Continued) TOTAL AND DISSOLVED METAL ANALYSES OF TRIPLICATE SAMPLES COLLECTED FROM THE WATERSHED ADJACENT TO NORTHAIR MINES LTD. MARCH 4, 1981

(mg/l)	1 Anomely Creek Above Mine			2 Anomely Creek Below Mine			3 Water Licence Creek Above Mine			Detection Limit
	a	b	c	a	b	c	a	b	c	
T.Mn	0.0946	0.0976	0.0986	0.0559	0.056	0.0561	0.0169	0.0147	0.0208	L0.003
D.Mn	0.0761	0.0765	0.0789	0.0186	0.0182	0.0203	*	*	*	L0.003
T.Al	*	*	*	0.17	0.158	0.175	*	*	*	L0.09
D.Al	*	*	*	*	*	*	*	*	*	L0.09
T.Ba	0.0096	0.0093	0.0093	0.0147	0.0149	0.0149	0.0072	0.007	0.0072	L0.003
D.Ba	0.0098	0.0095	0.0099	0.014	0.0136	0.0136	0.0077	0.0074	0.0074	L0.003
T.Co	*	*	*	*	*	*	*	*	*	L0.015
D.Co	*	*	*	*	*	*	*	*	*	L0.015
T.Cr	*	*	*	*	*	*	*	*	*	L0.015
D.Cr	*	*	*	*	*	*	*	*	*	L0.015
T.Mo	*	*	*	*	*	*	*	*	*	L0.15
D.Mo	*	*	*	*	*	*	*	*	*	L0.15
T.Sb	*	*	*	*	*	*	*	*	*	L0.08
D.Sb	*	*	*	*	*	*	*	*	*	L0.08
T.Sn	*	*	*	*	*	*	*	*	*	L0.2
D.Sn	*	*	*	*	*	*	*	*	*	L0.2
T.Sr	0.0878	0.0859	0.085	0.79	0.777	0.782	0.0841	0.0865	0.0834	L0.004
D.Sr	0.0828	0.082	0.0825	0.775	0.77	0.761	0.0849	0.0853	0.0838	L0.004
T.Ti	*	*	*	0.0101	0.0101	0.009	*	*	*	L0.0085
D.Ti	*	*	*	*	*	*	*	*	*	L0.0085
T.V	*	*	*	*	*	*	*	*	*	L0.05
D.V	*	*	*	*	*	*	*	*	*	L0.05
T.As	*	*	*	*	*	*	*	*	*	L0.15
D.As	*	*	*	*	*	*	*	*	*	L0.15

APPENDIX II-2 TOTAL AND DISSOLVED METAL ANALYSES OF TRIPLICATE SAMPLES COLLECTED
(Continued) FROM THE WATERSHED ADJACENT TO NORTHAIR MINES LTD. MARCH 4, 1981

(mg/l)	1 Anomely Creek Above Mine			2 Anomely Creek Below Mine			3 Water Licence Creek Above Mine			Detection Limit
	a	b	c	a	b	c	a	b	c	
T.Si	2.33	2.21	2.15	3.76	3.78	3.72	2.06	2.14	2.0	L0.5
D.Si	1.95	1.94	1.95	3.41	3.37	3.36	2.01	2.1	1.96	L0.5
T.Hg**	*	*	*	*	*	*	*	*	*	L0.00020
T.Hg	*	*	*	*	*	*	*	*	*	L0.1
D.Hg	*	*	*	*	*	*	*	*	*	L0.1

T = total
D = dissolved
E = extractable
* = less than the detection limit
Analyses by Inductive Coupled Argon Plasma except;
** which were by Atomic Absorbtion

APPENDIX II-2 TOTAL AND DISSOLVED METAL ANALYSES OF TRIPLICATE SAMPLES COLLECTED
(Continued) FROM THE WATERSHED ADJACENT TO NORTHAIR MINES LTD. MARCH 4, 1981

(mg/l)	4 Water Licence Creek Below Mine			5 MacLeod Creek Above Alexandra Falls			6 Callaghan Creek Near Hwy 99			Detection Limit
	a	b	c	a	b	c	a	b	c	
T.Cu	*	*	*	*	*	*	*	*	*	L0.01
D.Cu	*	*	*	*	*	*	*	*	*	L0.01
E.Cu**	0.0010	0.0012	*	*	*	*	0.0022	0.0017	*	L0.0010
D.Cu**	0.0010	0.0017	0.0010	0.0010	0.0014	0.0012	*	*	*	L0.0010
T.Fe	0.05	0.054	0.055	0.076	0.11	0.088	0.055	0.042	0.038	L0.01
D.Fe	0.034	0.036	0.037	0.028	0.031	0.028	0.02	0.021	0.02	L0.01
T.Pb	*	*	*	*	*	*	*	*	*	L0.08
D.Pb	*	*	*	*	*	*	*	*	*	L0.08
E.Pb**	*	*	*	*	*	*	*	*	*	L0.0010
D.Pb**	*	*	*	*	*	*	*	*	*	L0.0010
T.Zn	*	*	*	*	*	*	0.021	*	*	L0.02
D.Zn	*	*	*	*	0.07	*	*	*	*	L0.02
E.Zn**	0.0022	*	0.0011	0.0023	0.0011	0.0014	0.0023	0.0023	0.0039	L0.0010
D.Zn**	0.0152	0.0065	0.0063	0.0059	-	0.0061	0.0022	0.0023	0.0031	L0.0010
T.Ca	10.9	10.9	11.2	6.41	6.36	6.01	9.4	10.2	10.2	L0.025
D.Ca	11.2	11.1	11.2	6.27	6.26	6.27	10.6	10.4	10.2	L0.025
T.Mg	0.605	0.589	0.518	0.481	0.584	0.648	0.704	0.676	0.734	L0.025
D.Mg	0.6	0.588	0.556	0.422	0.453	0.453	0.663	0.666	0.629	L0.025
T.Cd	*	*	*	*	*	*	*	*	*	L0.01
D.Cd	*	*	*	*	*	*	*	*	*	L0.01
E.Cd**	*	*	*	*	*	*	*	*	*	L0.0010
D.Cd**	*	*	*	*	*	*	*	*	*	L0.0010
T.Ni	*	*	*	*	*	*	*	*	*	L0.08
D.Ni	*	*	*	*	*	*	*	*	*	L0.08

APPENDIX II-2 TOTAL AND DISSOLVED METAL ANALYSES OF TRIPLICATE SAMPLES COLLECTED
(Continued) FROM THE WATERSHED ADJACENT TO NORTHAIR MINES LTD. MARCH 4, 1981

(mg/l)	4 Water Licence Creek Below Mine			5 MacLeod Creek Above Alexandra Falls			6 Callaghan Creek Near Hwy 99			Detection Limit
	a	b	c	a	b	c	a	b	c	
T.Mn	*	*	*	0.0084	0.0076	0.006	*	*	*	L0.003
D.Mn	0.0048	0.0055	0.0044	0.0045	0.0062	0.0051	*	*	*	L0.003
T.Al	*	*	*	*	0.107	*	*	*	*	L0.09
D.Al	*	*	*	*	*	*	*	*	*	L0.09
T.Ba	0.0065	0.0067	0.0067	0.0067	0.007	0.007	0.0058	0.0065	0.0058	L0.003
D.Ba	0.0065	0.0069	0.0069	0.0072	0.0079	0.0074	0,0061	0.0062	0.0055	L0.003
T.Co	*	*	*	*	*	*	*	*	*	L0.015
D.Co	*	*	*	*	*	*	*	*	*	L0.015
T.Cr	*	*	*	*	*	*	*	*	*	L0.015
D.Cr	*	*	*	*	*	*	*	*	*	L0.015
T.Mo	*	*	*	*	*	*	*	*	*	L0.15
D.Mo	*	*	*	*	*	*	*	*	*	L0.15
T.Sb	*	*	*	*	*	*	*	*	*	L0.08
D.Sb	*	*	*	*	*	*	*	*	*	L0.08
T.Sn	*	*	*	*	*	*	*	*	*	L0.2
D.Sn	*	*	*	*	*	*	*	*	*	L0.2
T.Sr	0.0647	0.0653	0.0662	0.0377	0.0378	0.0378	0.0893	0.0906	0.0911	L0.004
D.Sr	0.0655	0.0648	0.0657	0.0392	0.039	0.039	0.0929	0.0903	0.0893	L0.004
T.Ti	*	*	*	*	*	*	*	*	*	L0.0085
D.Ti	*	*	*	*	*	*	*	*	*	L0.0085
T.V	*	*	*	*	*	*	*	*	*	L0.05
D.V	*	*	*	*	*	*	*	*	*	L0.05
T.As	*	*	*	*	*	*	*	*	*	L0.15
D.As	*	*	*	*	*	*	*	*	*	L0.15

APPENDIX II-2 TOTAL AND DISSOLVED METAL ANALYSES OF TRIPLICATE SAMPLES COLLECTED
(Continued) FROM THE WATERSHED ADJACENT TO NORTHAIR MINES LTD. MARCH 4, 1981

(mg/l)	4 Water Licence Creek Below Mine			5 MacLeod Creek Above Alexandra Falls			6 Callaghan Creek Near Hwy 99			Detection Limit
	a	b	c	a	b	c	a	b	c	
T.Si	2.53	2.54	2.37	2.06	2.18	2.23	2.44	2.46	2.54	LO.5
D.Si	2.38	2.36	2.37	2.02	2.03	2.05	2.47	2.44	2.39	LO.5
T.Hg**	*	*	*	*	*	*	*	*	*	LO.00020
T.Hg	*	*	*	*	*	*	*	*	*	LO.1
D.Hg	*	*	*	*	*	*	*	*	*	LO.1

T = total
D = dissolved
E = extractable
* = less than the detection limit
Analyses by Inductive Coupled Argon Plasma except;
** which were by Atomic Absorbtion